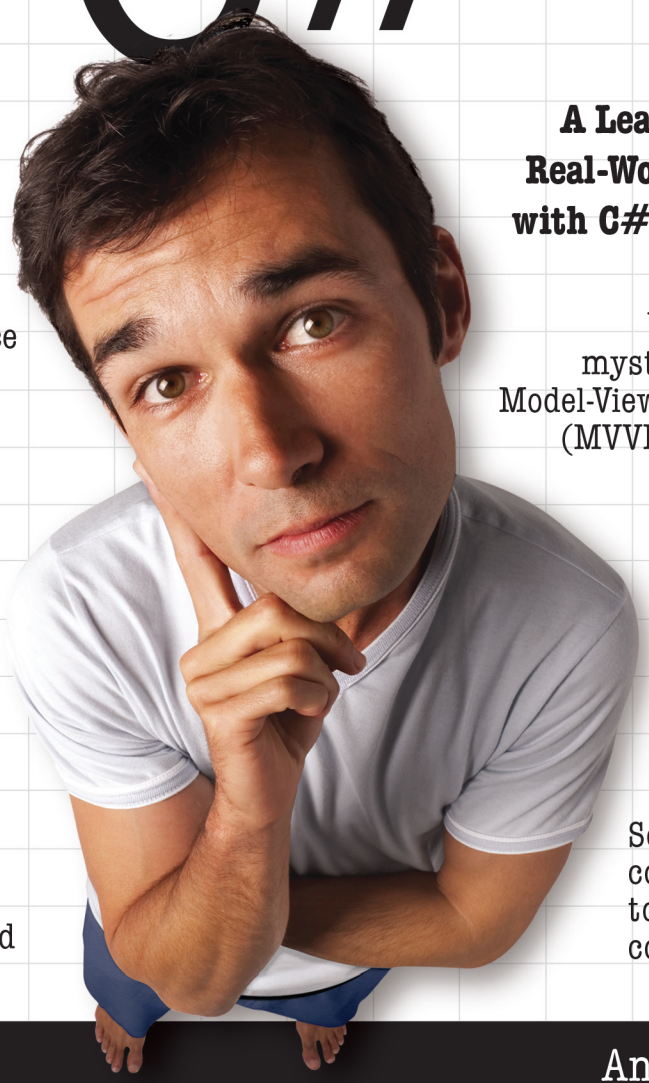
A Brain-Friendly Guide

3rd Edition
Includes a Bonus Windows Phone Project

Head First C#

Boss your objects around with abstraction and inheritance



A Learner's Guide to Real-World Programming with C#, XAML, and .NET

Unravel the mysteries of the Model-View-ViewModel (MVVM) pattern

Build a fully functional retro classic arcade game

See how Jimmy used collections and LINQ to wrangle an unruly comic book collection

Learn how asynchronous programming helped Sue keep her users thrilled

O'REILLY®

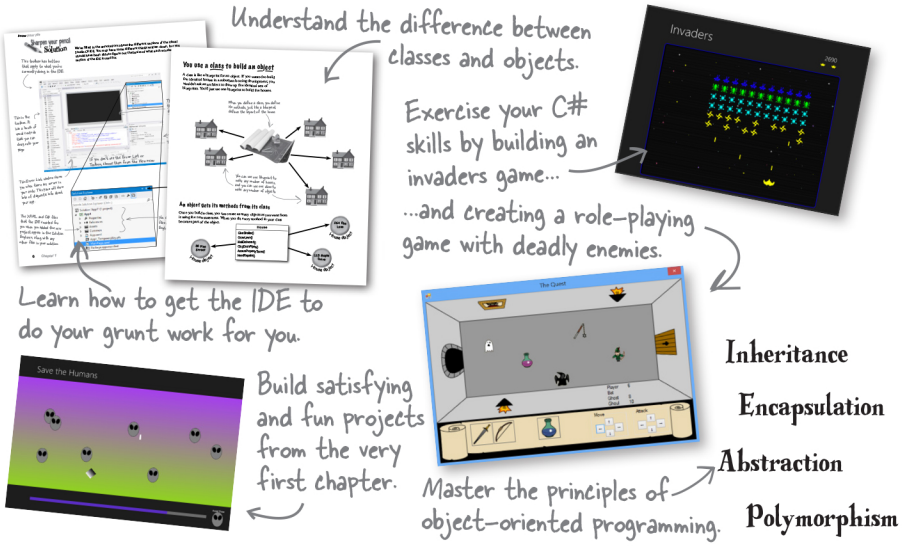
Andrew Stellman
& Jennifer Greene

Head First C#

Programming/C#/.NET

What will you learn from this book?

Head First C# is a complete learning experience for programming with C#, XAML, the .NET Framework, and Visual Studio. Built for your brain, this book keeps you engaged from the first chapter, where you'll build a fully functional video game. After that, you'll learn about classes and object-oriented programming, draw graphics and animation, query your data with LINQ, and serialize it to files. And you'll do it all by building games, solving puzzles, and doing hands-on projects. By the time you're done you'll be a solid C# programmer, and you'll have a great time along the way!



Why does this book look so different?

We think your time is too valuable to spend struggling with new concepts. Using the latest research in cognitive science and learning theory to craft a multi-sensory learning experience, *Head First C#* uses a visually rich format designed for the way your brain works, not a text-heavy approach that puts you to sleep.

"If you want to learn C# in depth and have fun doing it, this is THE book for you."

—Andy Parker, fledgling C# programmer

"*Head First C#* will guide beginners of all sorts to a long and productive relationship with C# and the .NET Framework."

—Chris Burrows, Developer on Microsoft's C# Compiler team

"*Head First C#* got me up to speed in no time for my first large scale C# development project at work—I highly recommend it."

—Shalewa Odusanya, Technical Account Manager, Google

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ISBN: 978-1-449-34350-7

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Advance Praise for *Head First C#*

"*Head First C#* is a great book, both for brand new developers and developers like myself coming from a Java background. No assumptions are made as to the reader's proficiency yet the material builds up quickly enough for those who are not complete newbies—a hard balance to strike. This book got me up to speed in no time for my first large scale C# development project at work—I highly recommend it."

— Shalewa Odusanya, Technical Account Manager, Google

"*Head First C#* is an excellent, simple, and fun way of learning C#. It's the best piece for C# beginners I've ever seen—the samples are clear, the topics are concise and well written. The mini-games that guide you through the different programming challenges will definitely stick the knowledge to your brain. A great learn-by-doing book!"

— Johnny Halife, Chief Architect, *Mural.ly*

"*Head First C#* is a comprehensive guide to learning C# that reads like a conversation with a friend. The many coding challenges keep it fun, even when the concepts are tough."

— Rebeca Duhn-Krahn, founding partner at Semphore Solutions

"I've never read a computer book cover to cover, but this one held my interest from the first page to the last. If you want to learn C# in depth and have fun doing it, this is THE book for you."

— Andy Parker, fledgling C# programmer

"It's hard to really learn a programming language without good engaging examples, and this book is full of them! *Head First C#* will guide beginners of all sorts to a long and productive relationship with C# and the .NET Framework."

—Chris Burrows, developer for Microsoft's C# Compiler team

"With *Head First C#*, Andrew and Jenny have presented an excellent tutorial on learning C#. It is very approachable while covering a great amount of detail in a unique style. If you've been turned off by more conventional books on C#, you'll love this one."

—Jay Hilyard, software developer, co-author of *C# 3.0 Cookbook*

"I'd reccomend this book to anyone looking for a great introduction into the world of programming and C#. From the first page onwards, the authors walks the reader through some of the more challenging concepts of C# in a simple, easy-to-follow way. At the end of some of the larger projects/labs, the reader can look back at their programs and stand in awe of what they've accomplished."

—David Sterling, developer for Microsoft's Visual C# Compiler team

"*Head First C#* is a highly enjoyable tutorial, full of memorable examples and entertaining exercises. Its lively style is sure to captivate readers—from the humorously annotated examples, to the Fireside Chats, where the abstract class and interface butt heads in a heated argument! For anyone new to programming, there's no better way to dive in."

—Joseph Albahari, C# Design Architect at Egton Medical Information Systems, the UK's largest primary healthcare software supplier, co-author of *C# 3.0 in a Nutshell*

"[*Head First C#*] was an easy book to read and understand. I will recommend this book to any developer wanting to jump into the C# waters. I will recommend it to the advanced developer that wants to understand better what is happening with their code. [I will recommend it to developers who] want to find a better way to explain how C# works to their less-seasoned developer friends."

—Giuseppe Turitto, C# and ASP.NET developer for Cornwall Consulting Group

"Andrew and Jenny have crafted another stimulating Head First learning experience. Grab a pencil, a computer, and enjoy the ride as you engage your left brain, right brain, and funny bone."

—Bill Mietelski, software engineer

"Going through this *Head First C#* book was a great experience. I have not come across a book series which actually teaches you so well.…This is a book I would definitely recommend to people wanting to learn C#"

—Krishna Pala, MCP

Praise for other *Head First books*

"I feel like a thousand pounds of books have just been lifted off of my head."

—Ward Cunningham, inventor of the Wiki and founder of the Hillside Group

"Just the right tone for the geeked-out, casual-cool guru coder in all of us. The right reference for practical development strategies—gets my brain going without having to slog through a bunch of tired stale professor-speak."

—Travis Kalanick, Founder of Scour and Red Swoosh
Member of the MIT TR100

"There are books you buy, books you keep, books you keep on your desk, and thanks to O'Reilly and the Head First crew, there is the penultimate category, Head First books. They're the ones that are dog-eared, mangled, and carried everywhere. *Head First SQL* is at the top of my stack. Heck, even the PDF I have for review is tattered and torn."

— Bill Sawyer, ATG Curriculum Manager, Oracle

"This book's admirable clarity, humor and substantial doses of clever make it the sort of book that helps even non-programmers think well about problem-solving."

— Cory Doctorow, co-editor of Boing Boing
Author, *Down and Out in the Magic Kingdom*
and *Someone Comes to Town, Someone Leaves Town*

Praise for other *Head First books*

"I received the book yesterday and started to read it…and I couldn't stop. This is definitely très 'cool.' It is fun, but they cover a lot of ground and they are right to the point. I'm really impressed."

— Erich Gamma, IBM Distinguished Engineer, and co-author of *Design Patterns*

"One of the funniest and smartest books on software design I've ever read."

— Aaron LaBerge, VP Technology, ESPN.com

"What used to be a long trial and error learning process has now been reduced neatly into an engaging paperback."

— Mike Davidson, CEO, Newsvine, Inc.

"Elegant design is at the core of every chapter here, each concept conveyed with equal doses of pragmatism and wit."

— Ken Goldstein, Executive Vice President, Disney Online

"Usually when reading through a book or article on design patterns, I'd have to occasionally stick myself in the eye with something just to make sure I was paying attention. Not with this book. Odd as it may sound, this book makes learning about design patterns fun.

"While other books on design patterns are saying 'Bueller… Bueller… Bueller…' this book is on the float belting out 'Shake it up, baby!'"

— Eric Wuehler

"I literally love this book. In fact, I kissed this book in front of my wife."

— Satish Kumar

Other related books from O'Reilly

Programming C# 4.0

C# 4.0 in a Nutshell

C# Essentials

C# Language Pocket Reference

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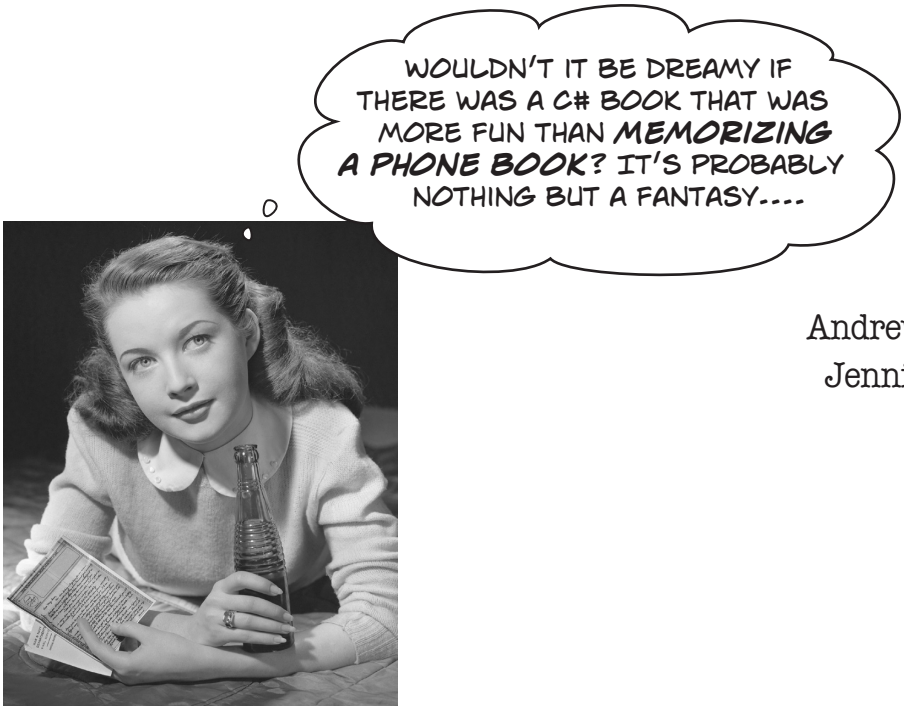
Third Edition



Andrew Stellman
Jennifer Greene

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Head First C#

Third Edition

by Andrew Stellman and Jennifer Greene

Printed in the United States of America.

Published by O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472.

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Proofreader: Rachel Monaghan

Indexer: Ellen Troutman-Zaig

Page Viewers: Quentin the whippet and Tequila the pomeranian

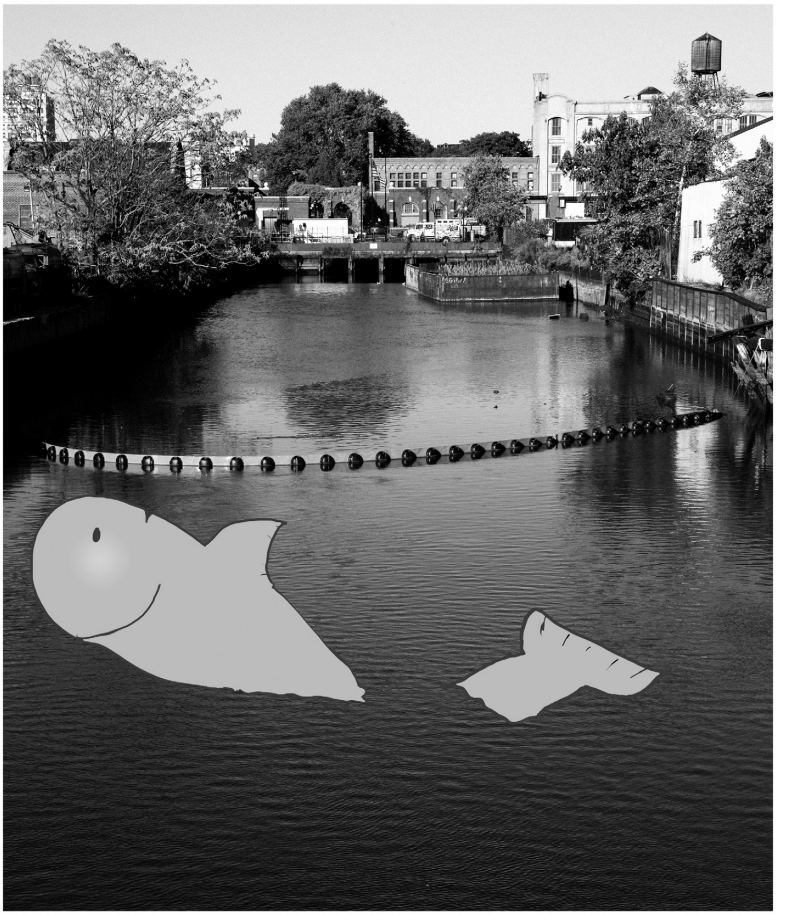
Printing History:

November 2007: First Edition.
May 2010: Second Edition.
August 2013: Third Edition.

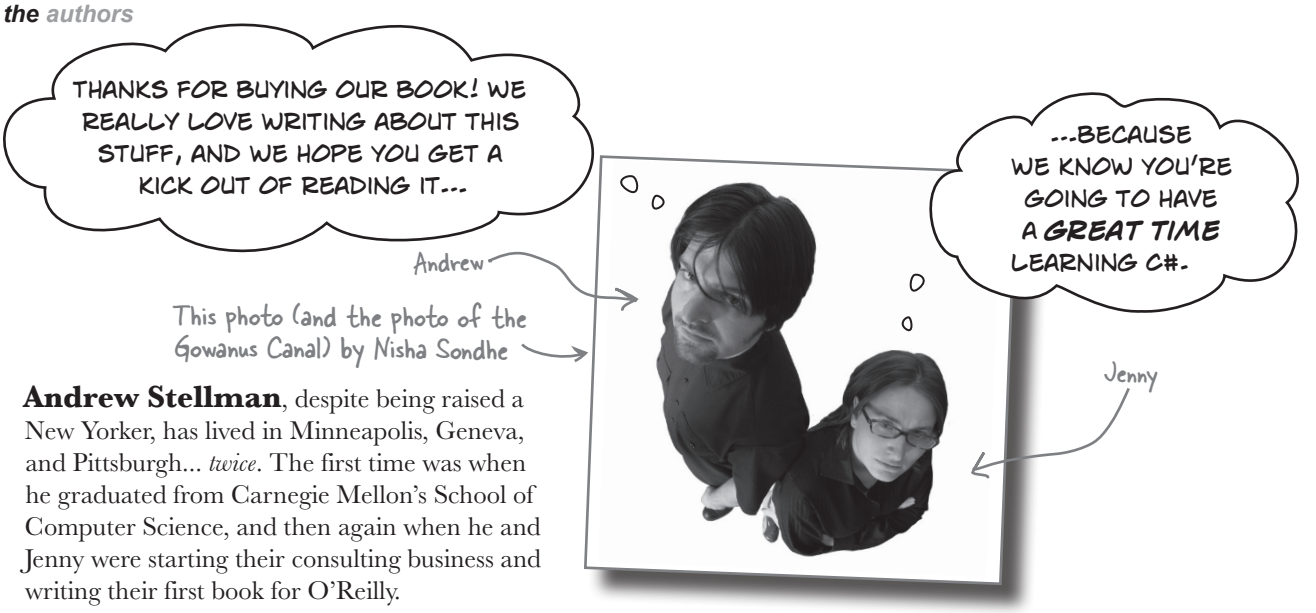
ISBN: 978-1-449-34350-7

[M]

This book is dedicated to the loving memory of Sludgie the Whale,
who swam to Brooklyn on April 17, 2007.



You were only in our canal for a day,
but you'll be in our hearts forever.



Andrew Stellman, despite being raised a New Yorker, has lived in Minneapolis, Geneva, and Pittsburgh... *twice*. The first time was when he graduated from Carnegie Mellon's School of Computer Science, and then again when he and Jenny were starting their consulting business and writing their first book for O'Reilly.

Andrew's first job after college was building software at a record company, EMI-Capitol Records—which actually made sense, as he went to LaGuardia High School of Music & Art and the Performing Arts to study cello and jazz bass guitar. He and Jenny first worked together at a company on Wall Street that built financial software, where he was managing a team of programmers. Over the years he's been a Vice President at a major investment bank, architected large-scale real-time back end systems, managed large international software teams, and consulted for companies, schools, and organizations, including Microsoft, the National Bureau of Economic Research, and MIT. He's had the privilege of working with some pretty amazing programmers during that time, and likes to think that he's learned a few things from them.

When he's not writing books, Andrew keeps himself busy writing useless (but fun) software, playing both music and video games, practicing taiji and aikido, and owning a Pomeranian.

Jennifer Greene studied philosophy in college but, like everyone else in the field, couldn't find a job doing it. Luckily, she's a great software engineer, so she started out working at an online service, and that's the first time she really got a good sense of what good software development looked like.

She moved to New York in 1998 to work on software quality at a financial software company. She's managed a teams of developers, testers and PMs on software projects in media and finance since then.

She's traveled all over the world to work with different software teams and build all kinds of cool projects.

She loves traveling, watching Bollywood movies, reading the occasional comic book, playing PS3 games, and hanging out with her huge siberian cat, Sascha.

Jenny and Andrew have been building software and writing about software engineering together since they first met in 1998. Their first book, **Applied Software Project Management**, was published by O'Reilly in 2005. Other Stellman and Greene books for O'Reilly include **Beautiful Teams** (2009), and their first book in the Head First series, **Head First PMP** (2007).

They founded Stellman & Greene Consulting in 2003 to build a really neat software project for scientists studying herbicide exposure in Vietnam vets. In addition to building software and writing books, they've consulted for companies and spoken at conferences and meetings of software engineers, architects and project managers.

Check out their blog, **Building Better Software**: **http://www.stellman-greene.com**

Follow **@AndrewStellman** and **@JennyGreene** on Twitter

Table of Contents (Summary)

Table of Contents (the real thing)

Intro

Your brain on C#. You're sitting around trying to *learn* something, but your *brain* keeps telling you all that learning *isn't important*. Your brain's saying, "Better leave room for more important things, like which wild animals to avoid and whether nude archery is a bad idea." So how *do* you trick your brain into thinking that your life really depends on learning C#?

1 start building with C#
Build something cool, fast!

Want to build great apps really fast?

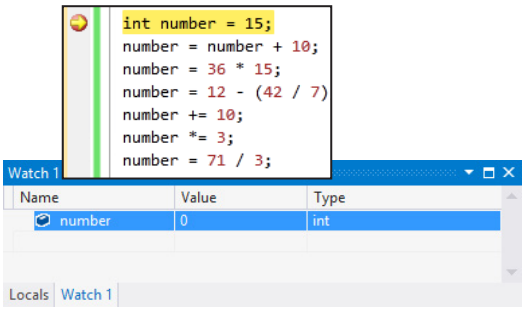
With C#, you've got a **great programming language** and a **valuable tool** at your fingertips. With the **Visual Studio IDE**, you'll never have to spend hours writing obscure code to get a button working again. Even better, you'll be able to **build really cool software**, rather than remembering which bit of code was for the *name* of a button, and which one was for its *label*. Sound appealing? Turn the page, and let's get programming.

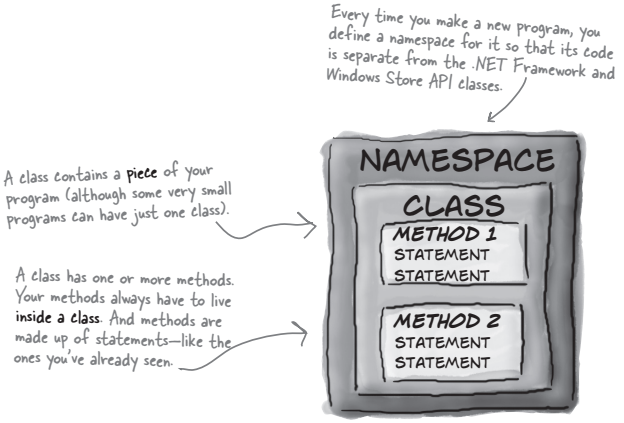
it's all just code

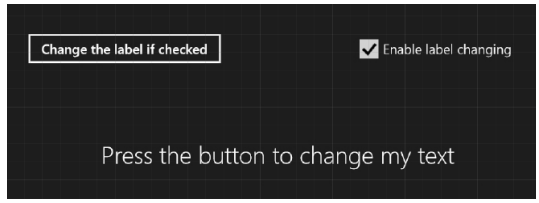
2 Under the hood

You're a programmer, not just an IDE user.

You can get a lot of work done using the IDE. But there's only so far it can take you. Sure, there are a lot of **repetitive tasks** that you do when you build an application. And the IDE is great at doing those things for you. But working with the IDE is *only the beginning*. You can get your programs to do so much more—and **writing C# code** is how you do it. Once you get the hang of coding, there's *nothing* your programs can't do.





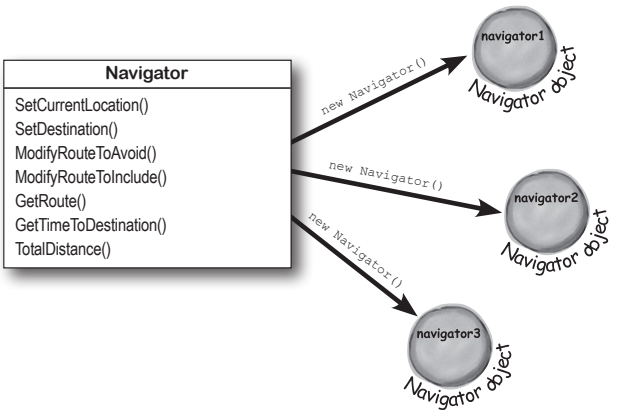


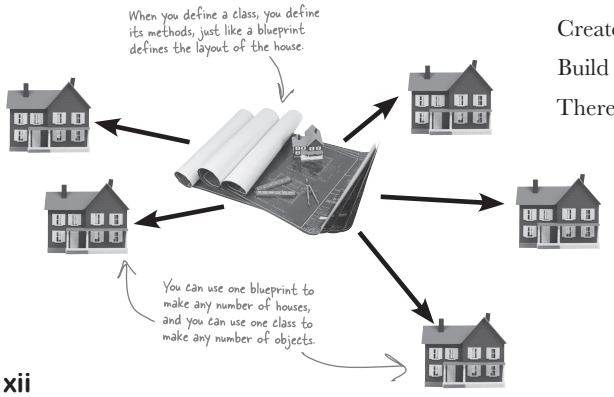
objects: get oriented!

3 Making Code Make Sense

Every program you write solves a problem.

When you're building a program, it's always a good idea to start by thinking about what *problem* your program's supposed to solve. That's why **objects** are really useful. They let you structure your code based on the problem it's solving, so that you can spend your time *thinking about the problem* you need to work on rather than getting bogged down in the mechanics of writing code. When you use objects right, you end up with code that's *intuitive* to write, and easy to read and change.



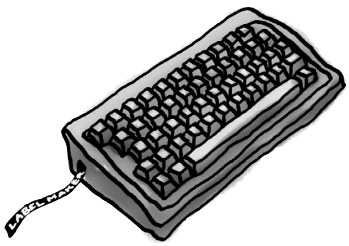


4

types and references

It's 10:00. Do you know where your data is?

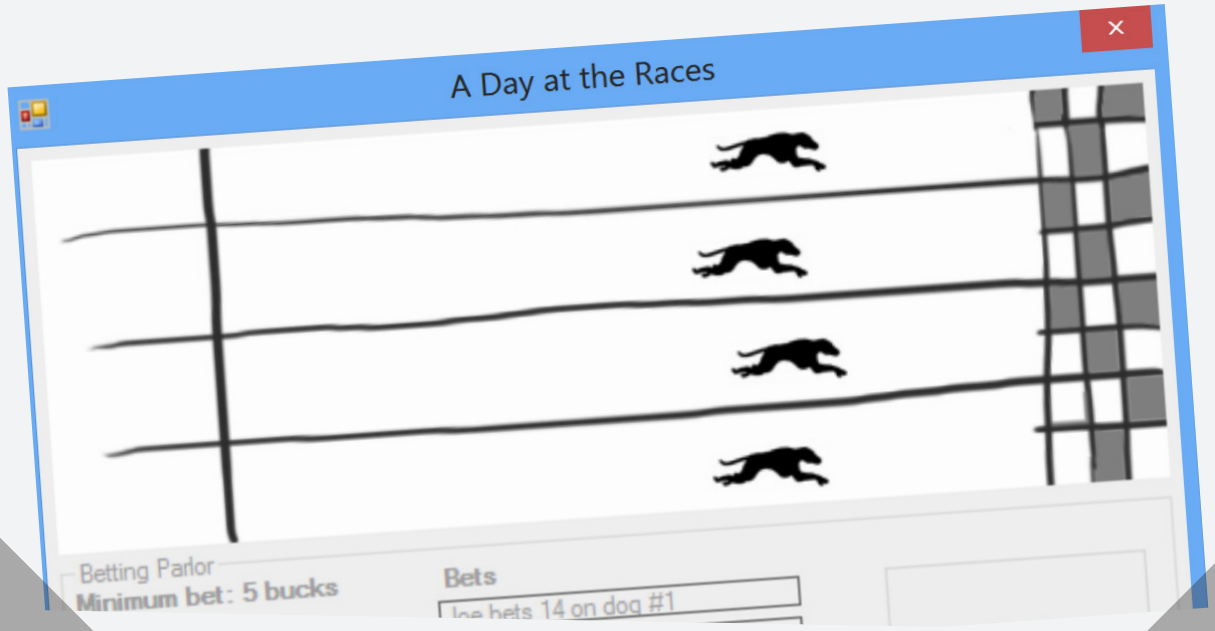
Data type, database, Lieutenant Commander Data… it's all important stuff. Without data, your programs are useless. You need **information** from your users, and you use that to look up or produce new information to give back to them. In fact, almost everything you do in programming involves **working with data** in one way or another. In this chapter, you'll learn the ins and outs of C#'s **data types**, see how to work with data in your program, and even figure out a few dirty secrets about **objects** (*pssst…objects are data, too*).



C# Lab 1

A Day at the Races

Joe, Bob, and Al love going to the track, but they're tired of losing all their money. They need you to build a simulator for them so they can figure out winners before they lay their money down. And, if you do a good job, they'll cut you in on their profits.

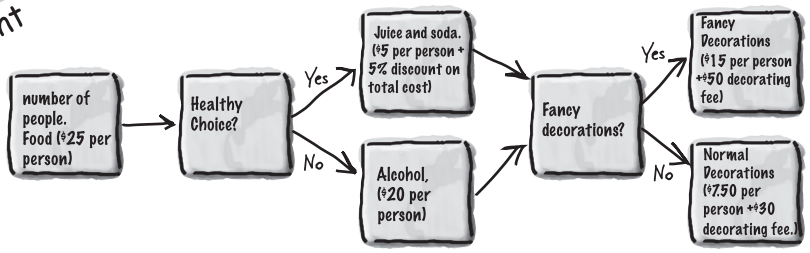


encapsulation

5 Keep your privates... private

Ever wished for a little more privacy?

Sometimes your objects feel the same way. Just like you don't want anybody you don't trust reading your journal or paging through your bank statements, good objects don't let ***other*** objects go poking around their fields. In this chapter, you're going to learn about the power of **encapsulation**. You'll **make your object's data private**, and add methods to **protect how that data is accessed**.

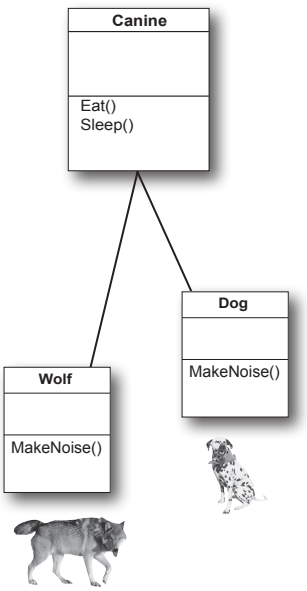


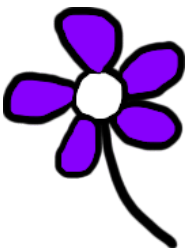
inheritance

6 Your object's family tree

Sometimes you *DO* want to be just like your parents.

Ever run across an object that ***almost*** does exactly what you want ***your*** object to do? Found yourself wishing that if you could just ***change a few things***, that object would be perfect? Well, that's just one reason that **inheritance** is one of the most powerful concepts and techniques in the C# language. Before you're through with this chapter, you'll learn how to **subclass** an object to get its behavior, but keep the **flexibility** to make changes to that behavior. You'll **avoid duplicate code**, **model the real world** more closely, and end up with code that's **easier to maintain**.



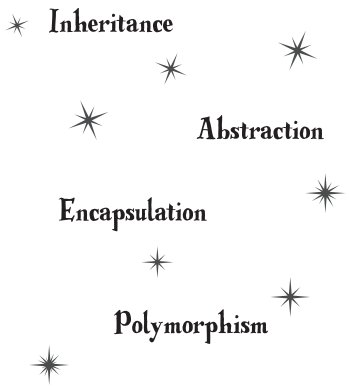


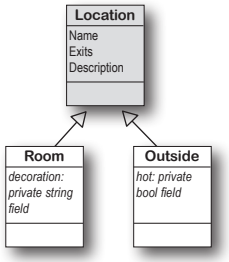
interfaces and abstract classes

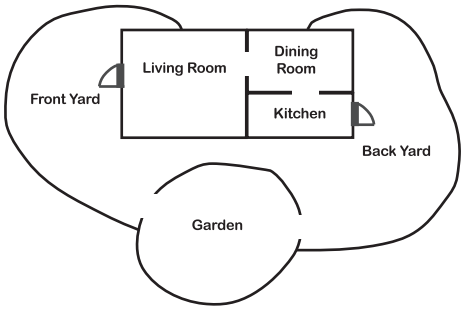
7 Making classes keep their promises

Actions speak louder than words.

Sometimes you need to group your objects together based on the **things they can do** rather than the classes they inherit from. That's where **interfaces** come in—they let you work with any class that can do the job. But with **great power comes great responsibility**, and any class that implements an interface must promise to **fulfill all of its obligations**…or the compiler will break their kneecaps, see?





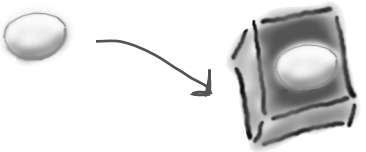


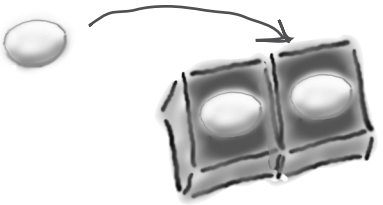
enums and collections

8 Storing lots of data

When it rains, it pours.

In the real world, you don't get to handle your data in tiny little bits and pieces. No, your data's going to come at you in **loads, piles, and bunches**. You'll need some pretty powerful tools to organize all of it, and that's where **collections** come in. They let you **store, sort, and manage** all the data that your programs need to pore through. That way, you can think about writing programs to work with your data, and let the collections worry about keeping track of it for you.



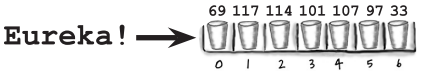


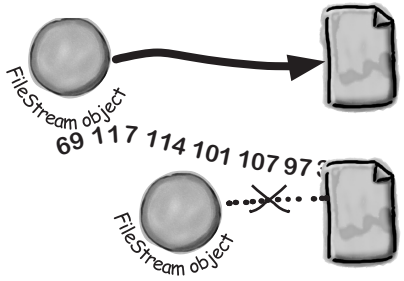
reading and writing files

9 Save the last byte for me!

Sometimes it pays to be a little persistent.

So far, all of your programs have been pretty short-lived. They fire up, run for a while, and shut down. But that's not always enough, especially when you're dealing with important information. You need to be able to **save your work**. In this chapter, we'll look at how to **write data to a file**, and then how to **read that information back in** from a file. You'll learn about the .NET **stream classes**, and also take a look at the mysteries of **hexadecimal** and **binary**.

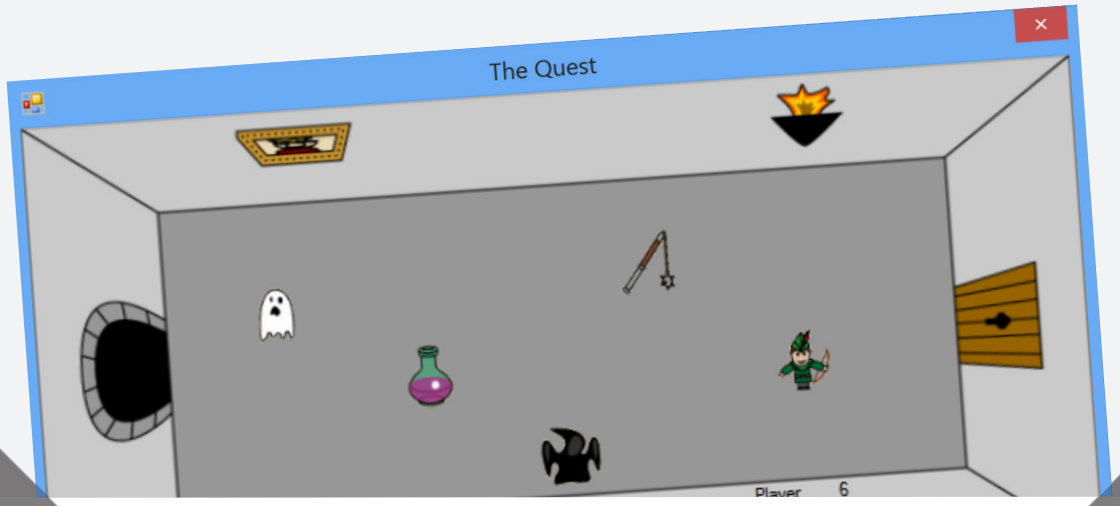




C# Lab 2

The Quest

Your job is to build an adventure game where a mighty adventurer is on a quest to defeat level after level of deadly enemies. You'll build a turn-based system, which means the player makes one move and then the enemies make one move. The player can move or attack, and then each enemy gets a chance to move and attack. The game keeps going until the player either defeats all the enemies on all seven levels or dies.

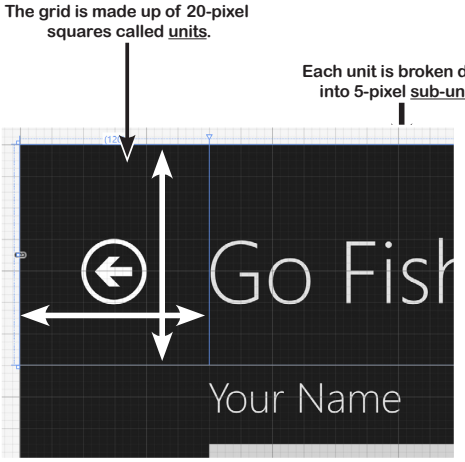


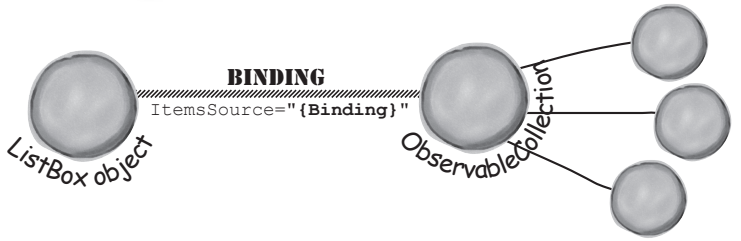
designing windows store apps with xaml

10 Taking your apps to the next level

You're ready for a whole new world of app development.

Using WinForms to build Windows Desktop apps is a great way to learn important C# concepts, but there's *so much more* you can do with your programs. In this chapter, you'll use **XAML** to design your Windows Store apps, you'll learn how to **build pages to fit any device**, **integrate** your data into your pages with **data binding**, and use Visual Studio to cut through the mystery of XAML pages by exploring the objects created by your XAML code.





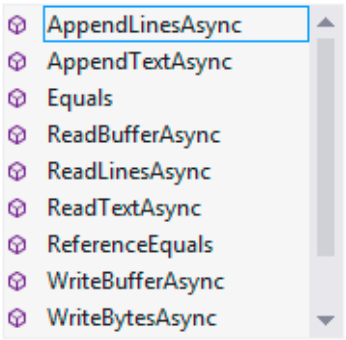
xaml, file i/o, and data contract serialization

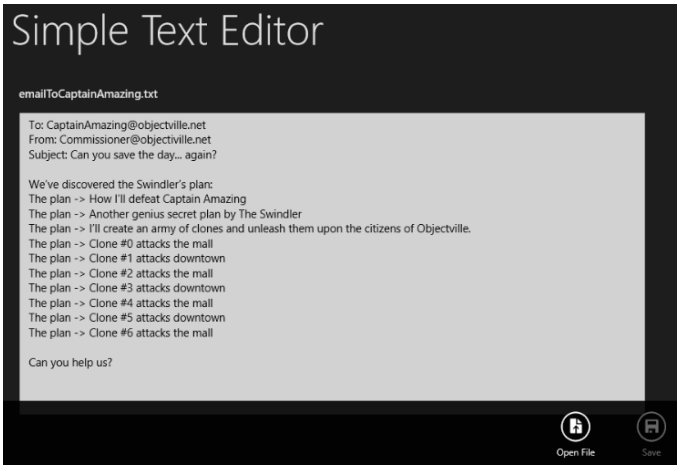
11 Writing files right

Nobody likes to be kept waiting...especially not users.

Computers are good at doing lots of things at once, so there's no reason your apps shouldn't be able to as well. In this chapter, you'll learn how to keep your apps responsive by **building asynchronous methods**. You'll also learn how to use the **built-in file pickers and message dialogs** and **asynchronous file input and output** without freezing up your apps. Combine this with **data contract serialization**, and you've got the makings of a thoroughly modern app.


```
FileIO.
```



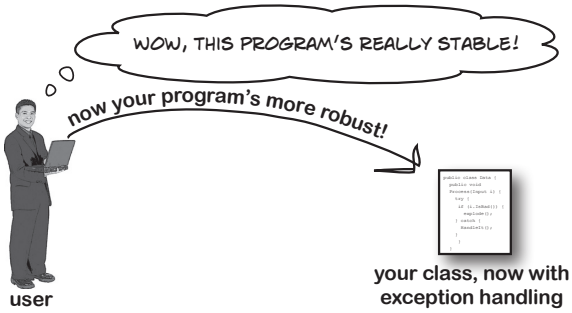


exception handling

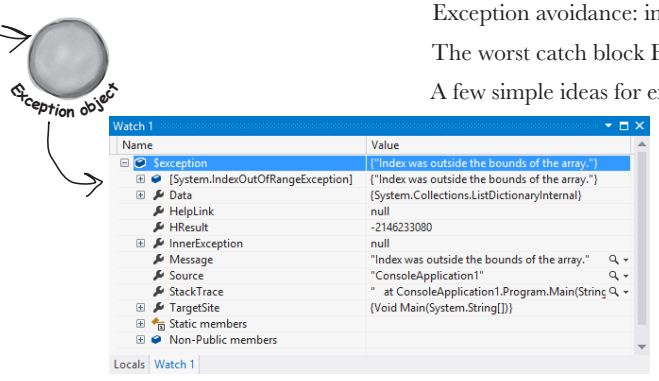
12 Putting out fires gets old

Programmers aren't meant to be firefighters.

You've worked your tail off, waded through technical manuals and a few engaging *Head First* books, and you've reached the pinnacle of your profession. But you're still getting panicked phone calls in the middle of the night from work because **your program crashes**, or **doesn't behave like it's supposed to**. Nothing pulls you out of the programming groove like having to fix a strange bug...but with **exception handling**, you can write code to **deal with problems** that come up. Better yet, you can even react to those problems, and **keep things running**.

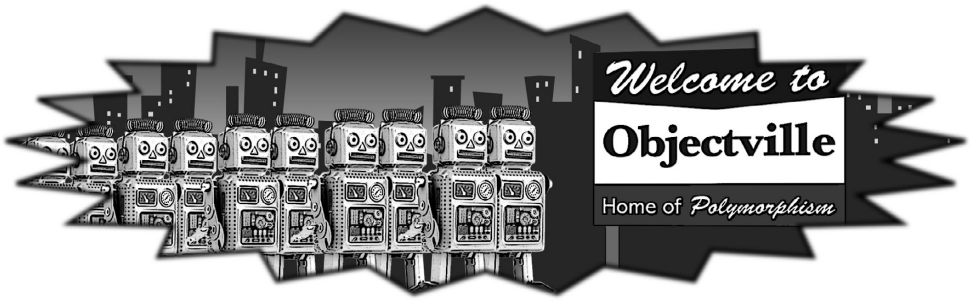



```
int[] anArray = {3, 4, 1, 11};
int aValue = anArray[15];
```



CAPTAIN AMAZING
THE DEATH OF THE OBJECT

13



querying data and building apps with LINQ

14 Get control of your data

It's a data-driven world…it's good to know how to live in it.

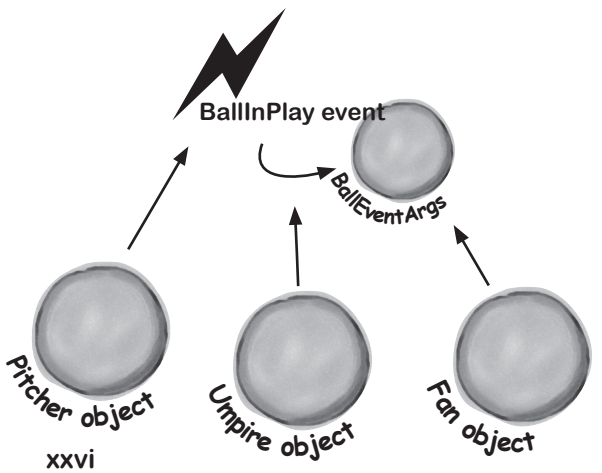
Gone are the days when you could program for days, even weeks, without dealing with **loads of data**. Today, ***everything is about data***. And that's where **LINQ** comes in. LINQ not only lets you **query data** in a simple, intuitive way, but it lets you **group data** and **merge data from different data sources**. And once you've wrangled your data into manageable chunks, your Windows Store apps **have controls for navigating data** that let your users navigate, explore, and even zoom into the details.

events and delegates

15 What your code does when you're not looking

Your objects are starting to think for themselves.

You can't always control what your objects are doing. Sometimes things…happen. And when they do, you want your objects to be smart enough to **respond to anything** that pops up. And that's what events are all about. One object *publishes* an event, other objects *subscribe*, and everyone works together to keep things moving. Which is great, until you want your object to take control over who can listen. That's when **callbacks** will come in handy.

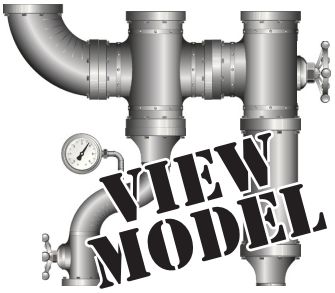


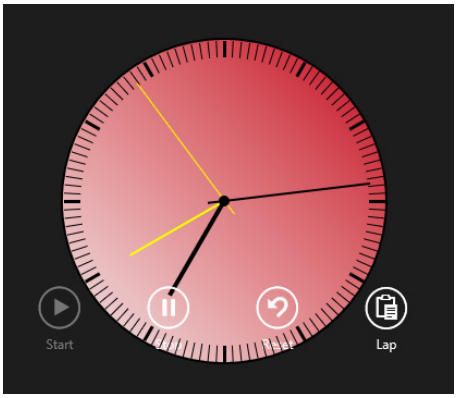
architecting apps with the mvvm pattern

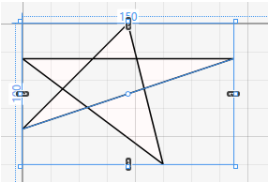
16 Great apps on the inside and outside

Your apps need to be more than just visually stunning.

When you think of *design*, what comes to mind? An example of great building architecture? A beautifully-laid-out page? A product that's as aesthetically pleasing as it is well engineered? Those same principles apply to your apps. In this chapter you'll learn about **the Model-View-ViewModel pattern** and how you can use it to build well-architected, loosely coupled apps. Along the way you'll learn about **animation** and **control templates** for your apps' visual design, how to use **converters** to make data binding easier, and how to pull it all together to ***lay a solid C# foundation*** to build any app you want.



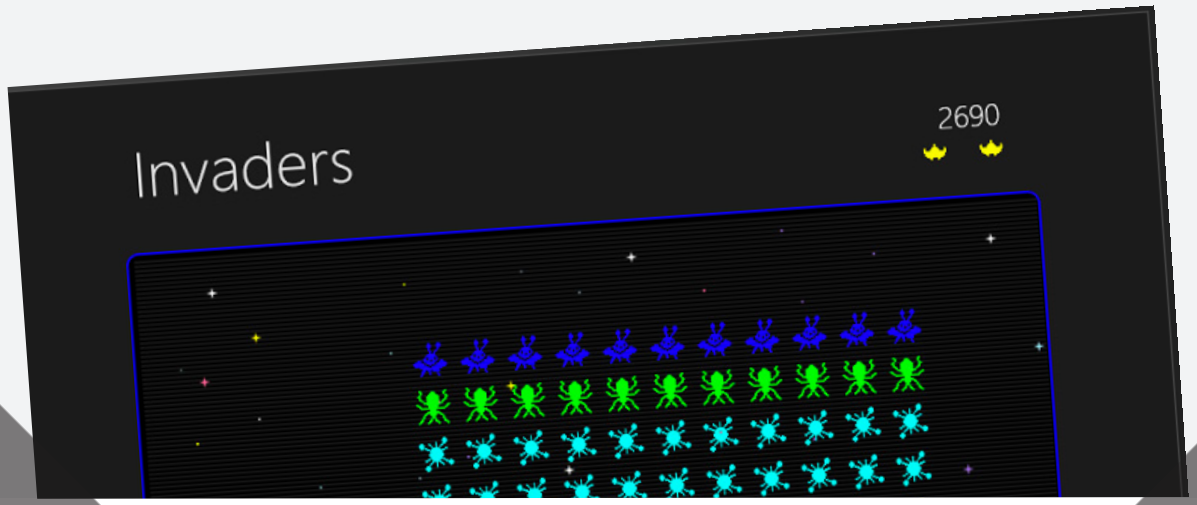




C# Lab 3

Invaders

In this lab you'll pay homage to one of the most popular, revered and replicated icons in video game history, a game that needs no further introduction. It's time to build Invaders.

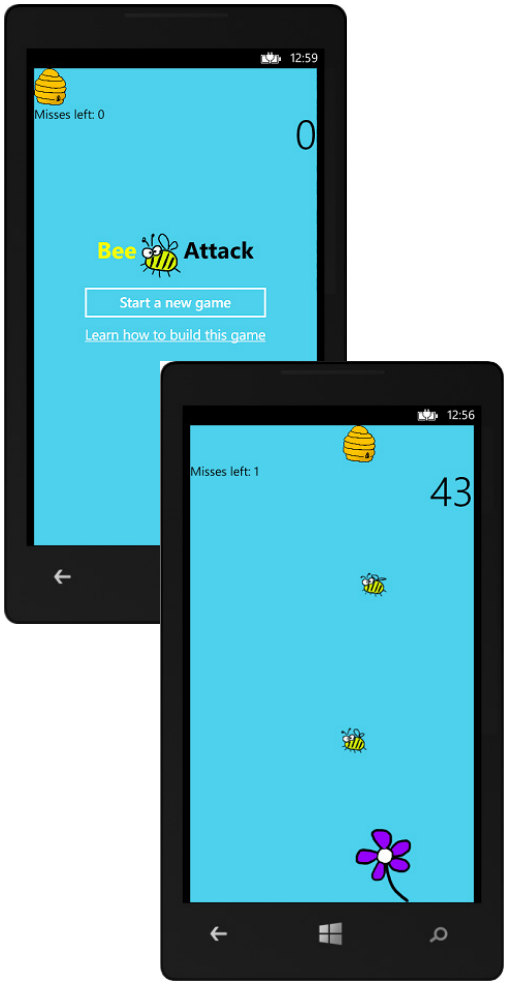


bonus project!

17 Build a Windows Phone app

You're already able to write Windows Phone apps.

Classes, objects, XAML, encapsulation, inheritance, polymorphism, LINQ, MVVM… you've got all of the tools you need to build great Windows Store apps and desktop apps. But did you know that you can **use these same tools to build apps for *Windows Phone***? It's true! In this bonus project, we'll walk you through creating a game for Windows Phone. And if you don't have a Windows Phone, don't worry—you'll still be able to use the **Windows Phone emulator** to play it. Let's get started!

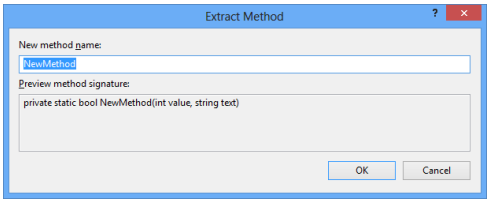


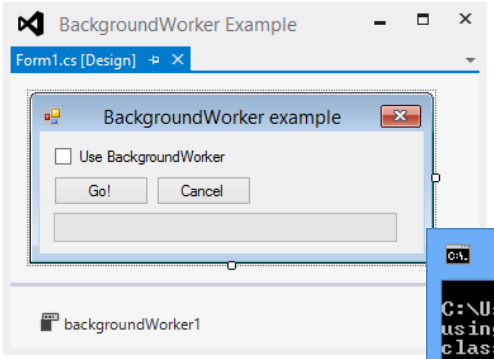
appendix: leftovers

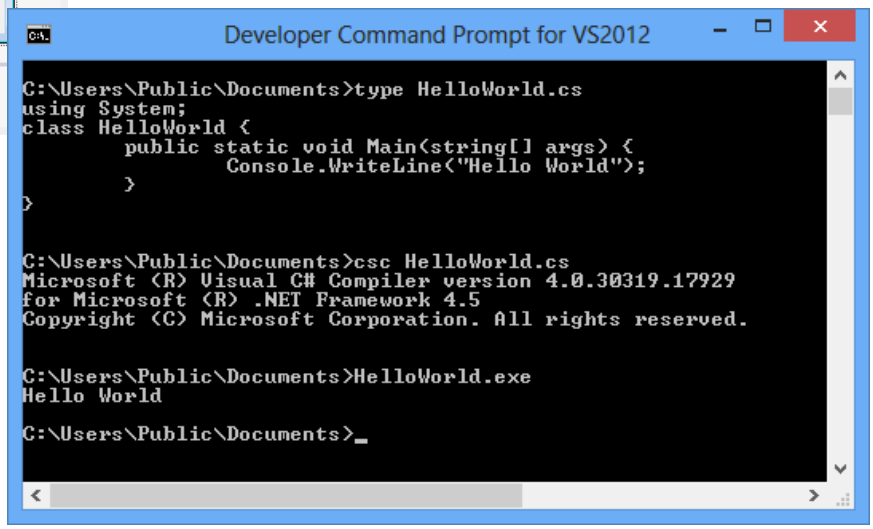
The top 11 things we wanted to include in this book

The fun's just beginning!

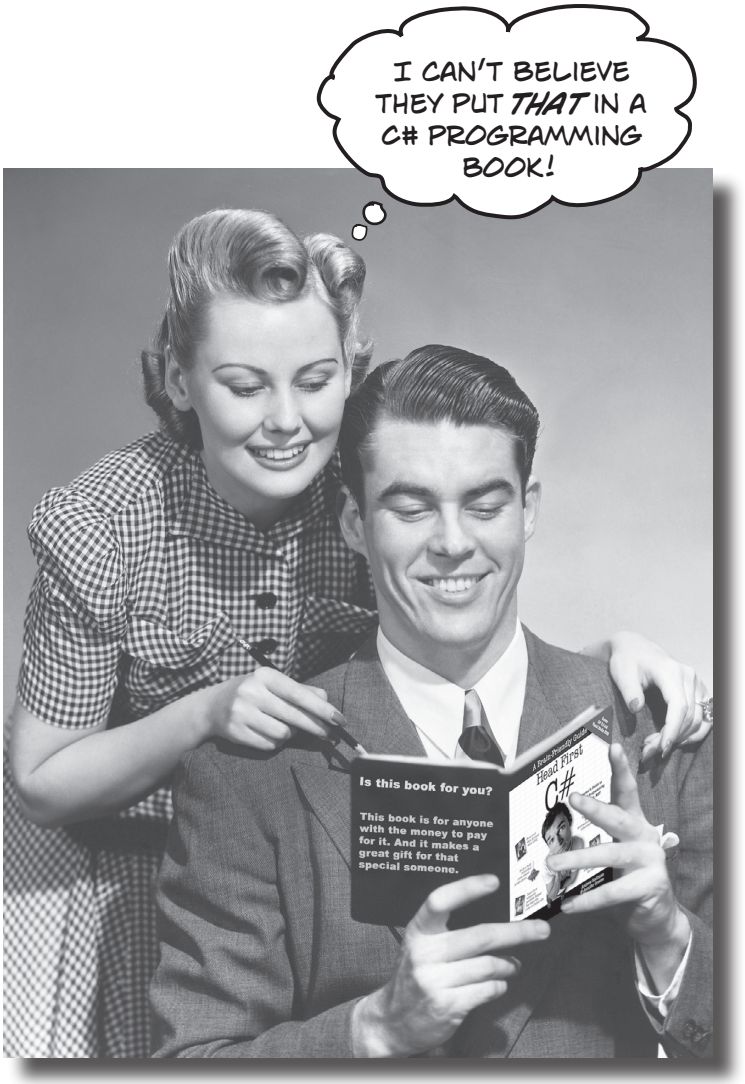
We've shown you a lot of great tools to build some really **powerful software** with C#. But there's no way that we could include **every single tool, technology, or technique** in this book—there just aren't enough pages. We had to make some *really tough choices* about what to include and what to leave out. Here are some of the topics that didn't make the cut. But even though we couldn't get to them, we still think that they're **important and useful**, and we wanted to give you a small head start with them.







Intro



In this section, we answer the burning question:
"So why DID they put that in a C# programming book?"

Who is this book for?

If you can answer "yes" to all of these:

1. Do you want to **learn** C#?
2. Do you like to tinker—do you learn by doing, rather than just reading?
3. Do you prefer **stimulating dinner party conversation** to **dry**, **dull**, **academic lectures**?

this book is for you.

Do you know another programming language, and now you need to ramp up on C#?

Are you already a good C# developer, but you want to learn more about XAML, Model-View-ViewModel (MVVM), or Windows Store app development?

Do you want to get practice writing lots of code?

If so, then lots of people just like you have used this book to do exactly those things!

No programming experience is required to use this book... just curiosity and interest! Thousands of beginners with no programming experience have already used Head First C# to learn to code. That could be you!

Who should probably back away from this book?

If you can answer "yes" to any of these:

1. Does the idea of writing a lot of code make you bored and a little twitchy?
2. Are you a kick-butt C++ or Java programmer looking for a reference book?
3. Are you **afraid to try something different**? Would you rather have a root canal than mix stripes with plaid? Do you believe that a technical book can't be serious if C# concepts are anthropomorphized?

this book is not for you.

[Note from marketing: this book is for anyone with a credit card.]

We know what you're thinking.

"How can *this* be a serious C# programming book?"

"What's with all the graphics?"

"Can I actually *learn* it this way?"

And we know what your *brain* is thinking.

Your brain craves novelty. It's always searching, scanning, *waiting* for something unusual. It was built that way, and it helps you stay alive.

So what does your brain do with all the routine, ordinary, normal things you encounter? Everything it *can* to stop them from interfering with the brain's *real* job—recording things that *matter*. It doesn't bother saving the boring things; they never make it past the "this is obviously not important" filter.

How does your brain *know* what's important? Suppose you're out for a day hike and a tiger jumps in front of you, what happens inside your head and body?

Neurons fire. Emotions crank up. *Chemicals surge*.

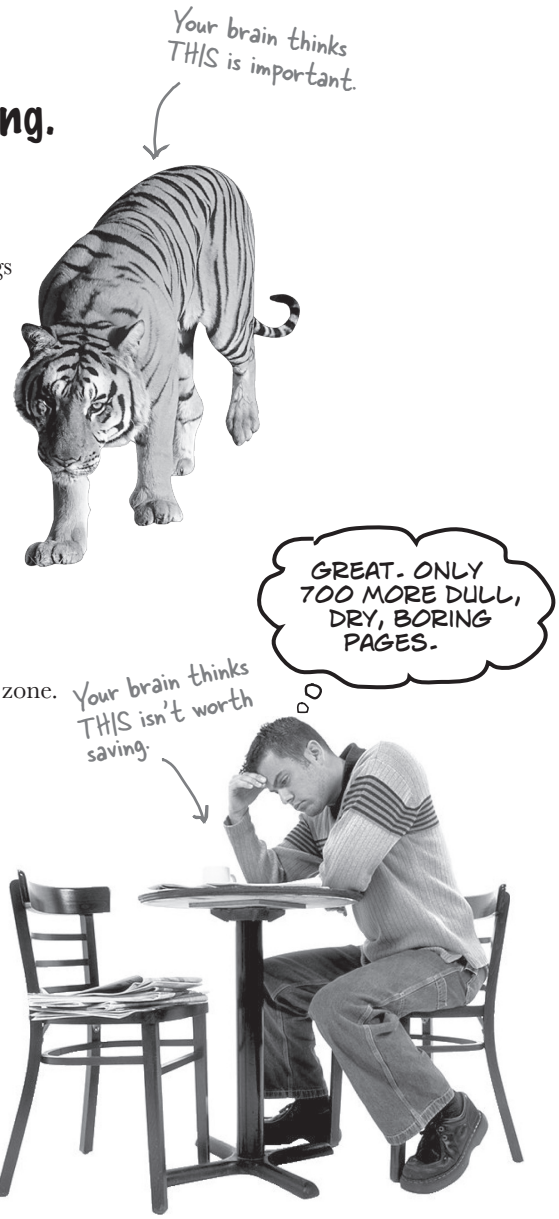
And that's how your brain knows…

This must be important! Don't forget it!

But imagine you're at home, or in a library. It's a safe, warm, tiger-free zone. You're studying. Getting ready for an exam. Or trying to learn some tough technical topic your boss thinks will take a week, ten days at the most.

Just one problem. Your brain's trying to do you a big favor. It's trying to make sure that this *obviously* non-important content doesn't clutter up scarce resources. Resources that are better spent storing the really *big* things. Like tigers. Like the danger of fire. Like how you should never have posted those "party" photos on your Facebook page.

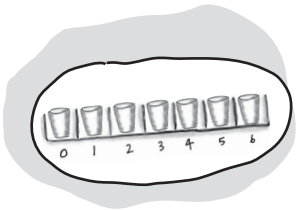
And there's no simple way to tell your brain, "Hey brain, thank you very much, but no matter how dull this book is, and how little I'm registering on the emotional Richter scale right now, I really *do* want you to keep this stuff around."



We think of a "Head First" reader as a learner.

So what does it take to *learn* something? First, you have to *get* it, then make sure you don't *forget* it. It's not about pushing facts into your head. Based on the latest research in cognitive science, neurobiology, and educational psychology, *learning* takes a lot more than text on a page. We know what turns your brain on.

Some of the Head First learning principles:

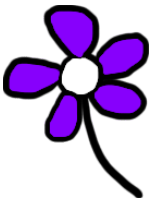


Make it visual. Images are far more memorable than words alone, and make learning much more effective (up to 89% improvement in recall and transfer studies). It also makes things more understandable. **Put the words within or near the graphics** they relate to, rather than on the bottom or on another page, and learners will be up to *twice* as likely to solve problems related to the content.

Use a conversational and personalized style. In recent studies, students performed up to 40% better on post-learning tests if the content spoke directly to the reader, using a first-person, conversational style rather than taking a formal tone. Tell stories instead of lecturing. Use casual language. Don't take yourself too seriously. Which would *you* pay more attention to: a stimulating dinner party companion, or a lecture?

Get the learner to think more deeply. In other words, unless you actively flex your neurons, nothing much happens in your head. A reader has to be motivated, engaged, curious, and inspired to solve problems, draw conclusions, and generate new knowledge. And for that, you need challenges, exercises, and thought-provoking questions, and activities that involve both sides of the brain and multiple senses.

Get—and keep—the reader's attention. We've all had the "I really want to learn this but I can't stay awake past page one" experience. Your brain pays attention to things that are out of the ordinary, interesting, strange, eye-catching, unexpected. Learning a new, tough, technical topic doesn't have to be boring. Your brain will learn much more quickly if it's not.



Touch their emotions. We now know that your ability to remember something is largely dependent on its emotional content. You remember what you care about. You remember when you *feel* something. No, we're not talking heart-wrenching stories about a boy and his dog. We're talking emotions like surprise, curiosity, fun, "what the…?", and the feeling of "I Rule!" that comes when you solve a puzzle, learn something everybody else thinks is hard, or realize you know something that "I'm more technical than thou" Bob from engineering *doesn't*.

Metacognition: thinking about thinking

If you really want to learn, and you want to learn more quickly and more deeply, pay attention to how you pay attention. Think about how you think. Learn how you learn.

Most of us did not take courses on metacognition or learning theory when we were growing up. We were *expected* to learn, but rarely *taught* to learn.

But we assume that if you're holding this book, you really want to learn how to build programs in C#. And you probably don't want to spend a lot of time. If you want to use what you read in this book, you need to *remember* what you read. And for that, you've got to *understand* it. To get the most from this book, or *any* book or learning experience, take responsibility for your brain. Your brain on *this* content.

The trick is to get your brain to see the new material you're learning as Really Important. Crucial to your well-being. As important as a tiger. Otherwise, you're in for a constant battle, with your brain doing its best to keep the new content from sticking.

So just how *DO* you get your brain to treat C# like it was a hungry tiger?

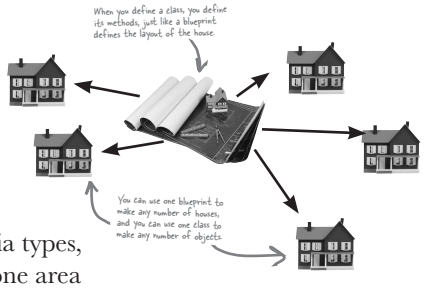
There's the slow, tedious way, or the faster, more effective way. The slow way is about sheer repetition. You obviously know that you *are* able to learn and remember even the dullest of topics if you keep pounding the same thing into your brain. With enough repetition, your brain says, "This doesn't *feel* important to him, but he keeps looking at the same thing *over* and *over* and *over*, so I suppose it must be."

The faster way is to do ***anything that increases brain activity,*** especially different *types* of brain activity. The things on the previous page are a big part of the solution, and they're all things that have been proven to help your brain work in your favor. For example, studies show that putting words *within* the pictures they describe (as opposed to somewhere else in the page, like a caption or in the body text) causes your brain to try to makes sense of how the words and picture relate, and this causes more neurons to fire. More neurons firing = more chances for your brain to *get* that this is something worth paying attention to, and possibly recording.

A conversational style helps because people tend to pay more attention when they perceive that they're in a conversation, since they're expected to follow along and hold up their end. The amazing thing is, your brain doesn't necessarily *care* that the "conversation" is between you and a book! On the other hand, if the writing style is formal and dry, your brain perceives it the same way you experience being lectured to while sitting in a roomful of passive attendees. No need to stay awake.

But pictures and conversational style are just the beginning.

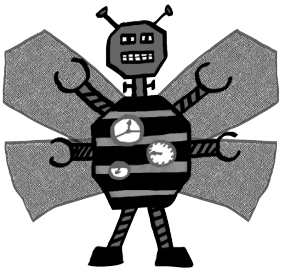
Here's what WE did:



We used ***pictures***, because your brain is tuned for visuals, not text. As far as your brain's concerned, a picture really *is* worth a thousand words. And when text and pictures work together, we embedded the text *in* the pictures because your brain works more effectively when the text is *within* the thing the text refers to, as opposed to in a caption or buried in the text somewhere.

We used ***redundancy***, saying the same thing in *different* ways and with different media types, and *multiple senses*, to increase the chance that the content gets coded into more than one area of your brain.

We used concepts and pictures in ***unexpected*** ways because your brain is tuned for novelty, and we used pictures and ideas with at least *some* ***emotional*** *content*, because your brain is tuned to pay attention to the biochemistry of emotions. That which causes you to *feel* something is more likely to be remembered, even if that feeling is nothing more than a little ***humor***, ***surprise***, or ***interest.***

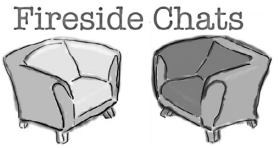


We used a personalized, ***conversational style***, because your brain is tuned to pay more attention when it believes you're in a conversation than if it thinks you're passively listening to a presentation. Your brain does this even when you're *reading*.

We included dozens of ***activities***, because your brain is tuned to learn and remember more when you ***do*** things than when you *read* about things. And we made the paper puzzles and code exercises challenging-yet-do-able, because that's what most people prefer.

We used ***multiple learning styles***, because *you* might prefer step-by-step procedures, while someone else wants to understand the big picture first, and someone else just wants to see an example. But regardless of your own learning preference, *everyone* benefits from seeing the same content represented in multiple ways.

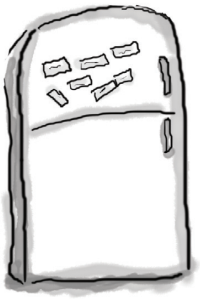
We include content for ***both sides of your brain***, because the more of your brain you engage, the more likely you are to learn and remember, and the longer you can stay focused. Since working one side of the brain often means giving the other side a chance to rest, you can be more productive at learning for a longer period of time.



And we included ***stories*** and exercises that present ***more than one point of view,*** because your brain is tuned to learn more deeply when it's forced to make evaluations and judgments.

We included ***challenges***, with exercises, and by asking ***questions*** that don't always have a straight answer, because your brain is tuned to learn and remember when it has to *work* at something. Think about it—you can't get your *body* in shape just by *watching* people at the gym. But we did our best to make sure that when you're working hard, it's on the *right* things. That ***you're not spending one extra dendrite*** processing a hard-to-understand example, or parsing difficult, jargon-laden, or overly terse text.

We used ***people***. In stories, examples, pictures, etc., because, well, because *you're* a person. And your brain pays more attention to *people* than it does to *things*.



Cut this out and stick it on your refrigerator.

Here's what YOU can do to bend your brain into submission

So, we did our part. The rest is up to you. These tips are a starting point; listen to your brain and figure out what works for you and what doesn't. Try new things.

1. **Slow down. The more you understand, the less you have to memorize.**

   Don't just *read*. Stop and think. When the book asks you a question, don't just skip to the answer. Imagine that someone really *is* asking the question. The more deeply you force your brain to think, the better chance you have of learning and remembering.

2. **Do the exercises. Write your own notes.**

   We put them in, but if we did them for you, that would be like having someone else do your workouts for you. And don't just *look* at the exercises. **Use a pencil.** There's plenty of evidence that physical activity *while* learning can increase the learning.

3. **Read the "There are No Dumb Questions"**

   That means all of them. They're not optional sidebars—***they're part of the core content!*** Don't skip them.

4. **Make this the last thing you read before bed. Or at least the last challenging thing.**

   Part of the learning (especially the transfer to long-term memory) happens *after* you put the book down. Your brain needs time on its own, to do more processing. If you put in something new during that processing time, some of what you just learned will be lost.

5. **Drink water. Lots of it.**

   Your brain works best in a nice bath of fluid. Dehydration (which can happen before you ever feel thirsty) decreases cognitive function.

6. **Talk about it. Out loud.**

   Speaking activates a different part of the brain. If you're trying to understand something, or increase your chance of remembering it later, say it out loud. Better still, try to explain it out loud to someone else. You'll learn more quickly, and you might uncover ideas you hadn't known were there when you were reading about it.

7. **Listen to your brain.**

   Pay attention to whether your brain is getting overloaded. If you find yourself starting to skim the surface or forget what you just read, it's time for a break. Once you go past a certain point, you won't learn faster by trying to shove more in, and you might even hurt the process.

8. **Feel something.**

   Your brain needs to know that this *matters*. Get involved with the stories. Make up your own captions for the photos. Groaning over a bad joke is *still* better than feeling nothing at all.

9. **Write a lot of software!**

   There's only one way to learn to program: **writing a lot of code**. And that's what you're going to do throughout this book. Coding is a skill, and the only way to get good at it is to practice. We're going to give you a lot of practice: every chapter has exercises that pose a problem for you to solve. Don't just skip over them—a lot of the learning happens when you solve the exercises. We included a solution to each exercise—don't be afraid to **peek at the solution** if you get stuck! (It's easy to get snagged on something small.) But try to solve the problem before you look at the solution. And definitely get it working before you move on to the next part of the book.

The screenshots in this book match Visual Studio 2012 Express Edition, the latest free version available at the time of this printing. We'll keep future printings up to date, but Microsoft typically makes older versions available for download.

What you need for this book:

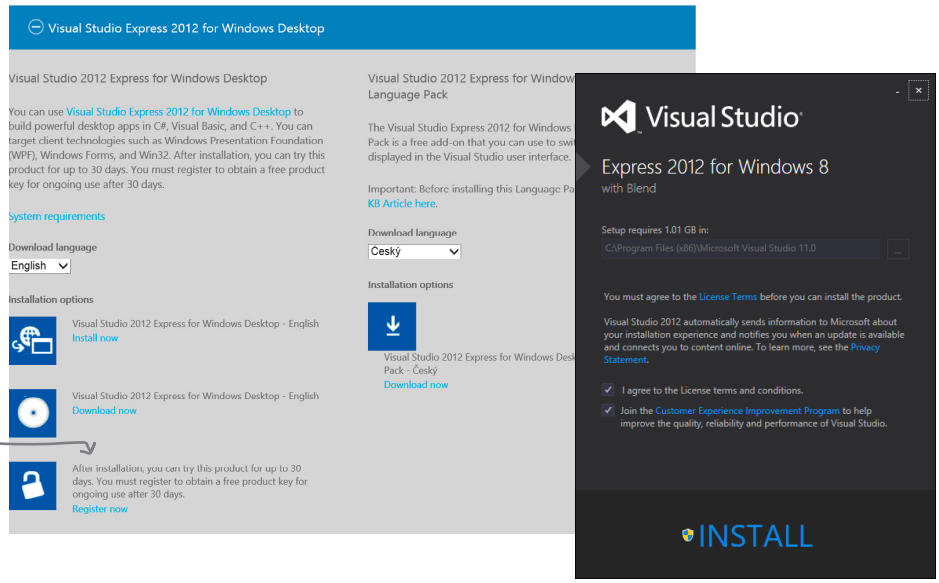
We wrote this book using **Visual Studio Express 2012 for Windows 8** and **Visual Studio Express 2012 for Windows Desktop**. All of the screenshots that you see throughout the book were taken from those two editions of Visual Studio, so we recommend that you use them. You can also use Visual Studio 2012 Professional, Premium, Ultimate or Test Professional editions, but you'll see some small differences (but nothing that will cause problems with the coding exercises throughout the book).

SETTING UP VISUAL STUDIO 2012 EXPRESS EDITIONS

- You can download **Visual Studio Express 2012 for Windows 8** *for free* from Microsoft's website. It installs cleanly alongside other editions, as well as previous versions: **http://www.microsoft.com/visualstudio/eng/downloads**

Click the "Install Now" link to launch the web installer, which automatically downloads and installs Visual Studio.

You'll also need to generate a product key, which is free for the Express editions (but requires you to create a Microsoft.com account).



- Once you've got it installed, you'll need to do the same thing for **Visual Studio Express 2012 for Windows Desktop**.

What to do if you don't have Windows 8 or can't run Visual Studio 2012

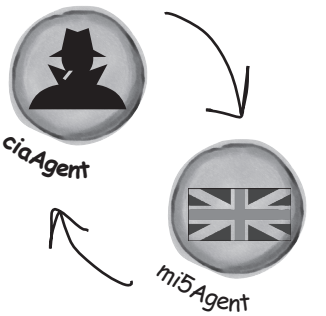
Many of the coding exercises in this book require Windows 8. But we definitely understand that some of our readers may not be running it—for example, a lot of professional programmers have office computers that are running operating systems as old as Windows 2003, or only have Visual Studio 2010 installed and cannot upgrade it. **If you're one of these readers, don't worry**—you can still do *almost* every exercise in this book. Here's how:

- The exercises in chapters 3 through 9 the first two labs do not require Windows 8 at all. You'll even be able to do them using Visual Studio 2010 (and even 2008), although the screenshots may differ a bit from what you see.
- For the rest of the book, **you'll need to build Windows Presentation Foundation (WPF) desktop apps** instead of Windows 8 apps. We've put together a PDF that you can download from the Head First Labs website (*http://headfirstlabs.com/hfcsharp*) to help you out with this. *Flip to leftover #11 in the appendix to learn more.*

Read me

This is a learning experience, not a reference book. We deliberately stripped out everything that might get in the way of learning whatever it is we're working on at that point in the book. And the first time through, you need to begin at the beginning, because the book makes assumptions about what you've already seen and learned.

We use a lot of diagrams to make tough concepts easier to understand.



The activities are NOT optional.

The puzzles and activities are not add-ons; they're part of the core content of the book. Some of them are to help with memory, some for understanding, and some to help you apply what you've learned. ***Don't skip the written problems.*** The pool puzzles are the only things you don't *have* to do, but they're good for giving your brain a chance to think about twisty little logic puzzles.

You should do ALL of the "Sharpen your pencil" activities

The redundancy is intentional and important.

One distinct difference in a Head First book is that we want you to *really* get it. And we want you to finish the book remembering what you've learned. Most reference books don't have retention and recall as a goal, but this book is about *learning*, so you'll see some of the same concepts come up more than once.

Activities marked with the Exercise (running shoe) logo are really important! Don't skip them if you're serious about learning C#.

Do all the exercises!

The one big assumption that we made when we wrote this book is that you want to learn how to program in C#. So we know you want to get your hands dirty right away, and dig right into the code. We gave you a lot of opportunities to sharpen your skills by putting exercises in every chapter. We've labeled some of them "Do *this*!"—when you see that, it means that we'll walk you through all of the steps to solve a particular problem. But when you see the Exercise logo with the running shoes, then we've left a big portion of the problem up to you to solve, and we gave you the solution that we came up with. Don't be afraid to peek at the solution—**it's not cheating**! But you'll learn the most if you try to solve the problem first.

We've also placed all the exercise solutions' source code on the web so you can download it. You'll find it at `http://www.headfirstlabs.com/books/hfcsharp/`

If you see the Pool Puzzle logo, the activity is optional, and if you don't like twisty logic, you won't like these either.

The "Brain Power" questions don't have answers.

For some of them, there is no right answer, and for others, part of the learning experience of the Brain Power activities is for you to decide if and when your answers are right. In some of the Brain Power questions you will find hints to point you in the right direction.

The technical review team

Lisa Kellner

Rebeca Dunn-Krahn

Chris Burrows

Johnny Halife

David Sterling

Not pictured (but just as awesome are the reviewers from previous editions): Joe Albahari, Jay Hilyard, Aayam Singh, Theodore, Peter Ritchie, Bill Meitelski Andy Parker, Wayne Bradney, Dave Murdoch, Bridgette Julie Landers, Nick Paldino, David Sterling. Special thanks to reader Alan Ouellette and our other readers who let us know about issues that slipped through QC for the first and second editions.

Technical Reviewers:

The book you're reading has very few errors in it, and give a lot of credit for its high quality to some great technical reviewers. We're really grateful for the work that they did for this book—we would have gone to press with errors (including one or two big ones) had it not been for the most kick-ass review team EVER.…

First of all, we really want to thank **Lisa Kellner**—this is our ninth (!) book that she's reviewed for us, and she made a huge difference in the readability of the final product. Thanks, Lisa! And special thanks to **Chris Burrows, Rebeca Dunn-Krahn,** and **David Sterling** for their enormous amount of technical guidance, and to **Joe Albahari** and **Jon Skeet** for their really careful and thoughtful review of the first edition, and **Nick Paladino** who did the same for the second edition.

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David Sterling has worked on the Visual C# Compiler team for nearly three years.

Johnny Halife is a Chief Architect & Co-Founder of Mural.ly (*http://murally.com*), a web start-up that allows people to create murals: collecting any content inside them and organizing it in a flexible and organic way in one big space. Johnny's a specialist on cloud and high-scalability solutions. He's also a passionate runner and sports fan.

Acknowledgments

Our editor:

We want to thank our editor, **Courtney Nash**, for editing this book. Thanks!

Courtney Nash

The O'Reilly team:

There are so many people at O'Reilly we want to thank that we hope we don't forget anyone. Special Thanks to production editor **Melanie Yarbrough**, indexer **Ellen Troutman-Zaig**, **Rachel Monaghan** for her sharp proofread, **Ron Bilodeau** for volunteering his time and preflighting expertise, and for offering one last sanity check—all of whom helped get this book from production to press in record time. And as always, we love **Mary Treseler**, and can't wait to work with her again! And a big shout out to our other friends and editors, **Andy Oram**, **Mike Hendrickson**, **Laurie Petryki**, **Tim O'Reilly**, and **Sanders Kleinfeld**. And if you're reading this book right now, then you can thank the greatest publicity team in the industry: **Marsee Henon**, **Sara Peyton**, and the rest of the folks at Sebastopol.

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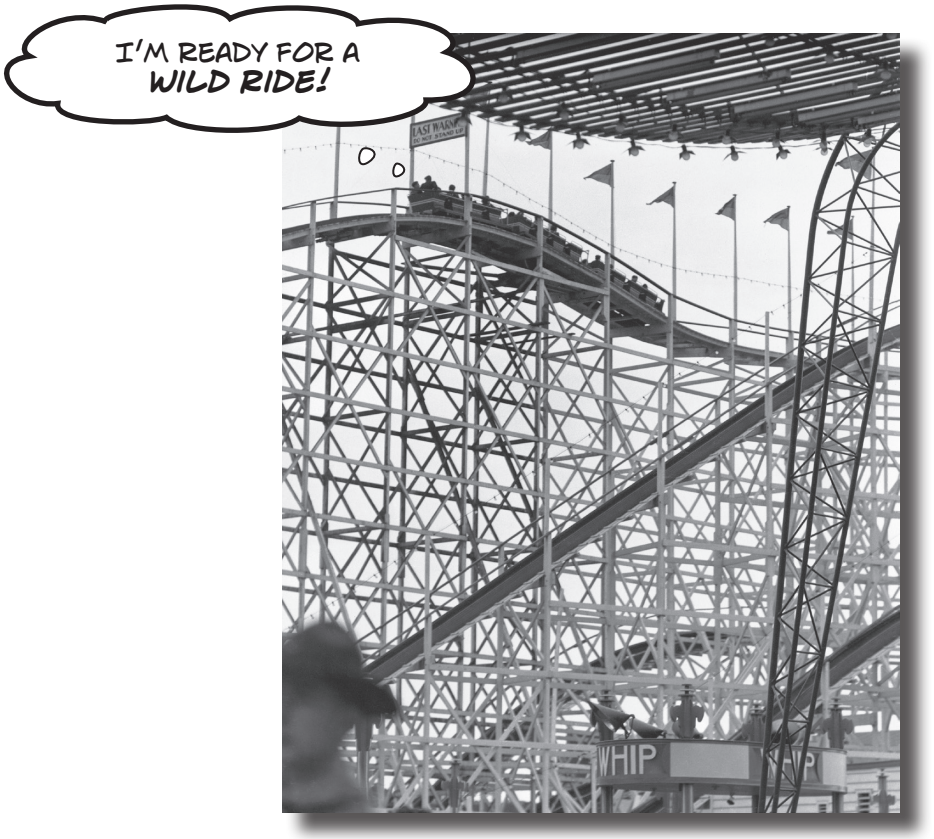
1 start building with c#

Build something cool, fast!



Want to build great apps really fast?

With C#, you've got a **great programming language** and a **valuable tool** at your fingertips. With the **Visual Studio IDE**, you'll never have to spend hours writing obscure code to get a button working again. Even better, you'll be able to **build really cool software**, rather than remembering which bit of code was for the *name* of a button, and which one was for its *label*. Sound appealing? Turn the page, and let's get programming.

Why you should learn C#

C# and the Visual Studio IDE make it easy for you to get to the business of writing code, and writing it fast. When you're working with C#, the IDE is your best friend and constant companion.

The IDE—or Visual Studio **Integrated Development Environment**—is an important part of working in C#. It's a program that helps you edit your code, manage your files, and submit your apps to the Windows Store.

Here's what the IDE automates for you...

Every time you want to get started writing a program, or just putting a button on a page, your program needs a whole bunch of repetitive code.

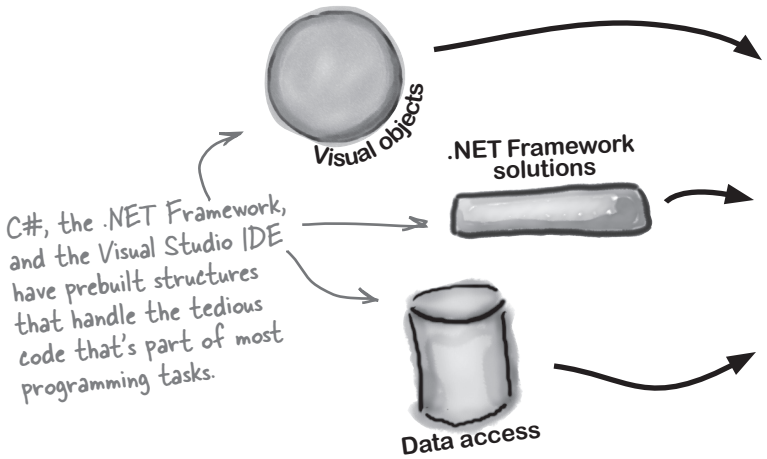
```
using System;
using System.Collections.Generic;
using System.Windows.Forms;
namespace A_New_Program
{
    static class Program
    {
        /// <summary>
        /// The main entry point for the application.
        /// </summary>
        [STAThread]
        static void Main()
        {
            Application.EnableVisualStyles();
            Application.SetCompatibleTextRenderingDefault(false);
            Application.Run(new Form1());
        }
    }
}
```

```
private void InitializeComponent()
{
  this.button1 = new System.Windows.Forms.Button();
  this.SuspendLayout();
  //
  // button1
  //
  this.button1.Location = new System.Drawing.Point(105, 56);
  this.button1.Name = "button1";
  this.button1.Size = new System.Drawing.Size(75, 23);
  this.button1.TabIndex = 0;
  this.button1.Text = "button1";
  this.button1.UseVisualStyleBackColor = true;
  this.button1.Click += new System.EventHandler(this.button1_Click);
  //
  // Form1
  //
  this.AutoScaleDimensions = new System.Drawing.SizeF(8F, 16F);
  this.AutoScaleMode = System.Windows.Forms.AutoScaleMode.Font;
  this.ClientSize = new System.Drawing.Size(292, 267);
  this.Controls.Add(this.button1);
  this.Name = "Form1";
  this.Text = "Form1";
  this.ResumeLayout(false);
}
```

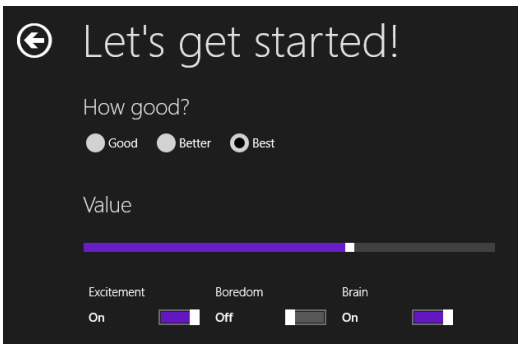
It takes all this code just to draw a button in a window. Adding a bunch of visual elements to a page could take 10 times as much code.

What you get with Visual Studio and C#...

With a language like C#, tuned for Windows programming, and the Visual Studio IDE, you can focus on what your program is supposed to **do** immediately:



The result is a better-looking app that takes less time to write.



C# and the Visual Studio IDE make lots of things easy

When you use C# and Visual Studio, you get all of these great features, without having to do any extra work. Together, they let you:

1. **Build an application, FAST.** Creating programs in C# is a snap. The language is flexible and easy to learn, and the Visual Studio IDE does a lot of work for you automatically. You can leave mundane coding tasks to the IDE and focus on what your code should accomplish.

2. **Design a great-looking user interface.** The Visual Designer in the Visual Studio IDE is one of the easiest-to-use design tools out there. It does so much for you that you'll find that creating user interfaces for your programs is one of the most satisfying parts of developing a C# application. You can build full-featured professional programs without having to spend hours writing a graphical user interface entirely from scratch.

3. **Build visually stunning programs.** When you combine C# with XAML, the visual markup language for designing user interfaces, you're using one of the most effective tools around for creating visual programs... and you'll use it to build software that looks as great as it acts.

4. **Focus on solving your REAL problems.** The IDE does a lot for you, but ***you*** are still in control of what you build with C#. The IDE lets you just focus on your program, your work (or fun!), and your users. It handles all the grunt work for you:

   - Keeping track of all your projects
   - Making it easy to edit your project's code
   - Keeping track of your project's graphics, audio, icons, and other resources
   - Helping you manage and interact with your data

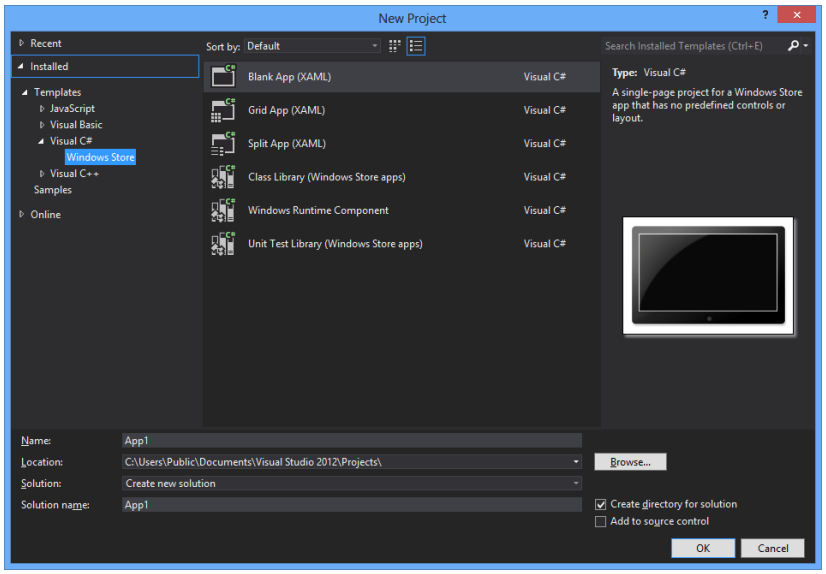
   All this means you'll have all the time you would've spent doing this routine programming to put into **building and sharing killer apps**.

You're going to see exactly what we mean next.

What you do in Visual Studio...

If you don't see this option, you might be running Visual Studio 2012 for Windows Desktop. You'll need to exit that IDE and launch Visual Studio Express 2012 for Windows 8.

Go ahead and start up Visual Studio for Windows 8, if you haven't already. Skip over the start page and select New Project from the **File** menu. There are several project types to choose from. Expand **Visual C#** and **Windows Store**, and select **Blank App (XAML)**. The IDE will create a folder called *Visual Studio 2012* in your *Documents* folder, and put your applications in a *Projects* folder under it (you can use the Location box to change this).



Watch it!

Things may look a bit different in your IDE.

*This is what the New Project window looks like in **Visual Studio for Windows 8 Express Edition**. If you're using the Professional or Team Foundation edition, it might be a bit different. But don't worry, everything still works exactly the same.*

What Visual Studio does for you...

As soon as you save the project, the IDE creates a bunch of files, including *MainPage.xaml*, *MainPage.Xaml.cs*, and *App.xaml.cs*, when you create a new project. It adds these to the Solution Explorer window, and by default, puts those files in the *Projects\App1\App1* folder.

Make sure that you save your project as soon as you create it by selecting Save All from the File menu—that'll save all of the project files out to the folder. If you select Save, it just saves the one you're working on.

This file contains the XAML code that defines the user interface of the main page.

The C# code that controls the main page's behavior lives here.

This file contains the C# code that's run when the app is launched or resumed.

MainPage.xaml

MainPage.Xaml.cs

App.xaml.cs

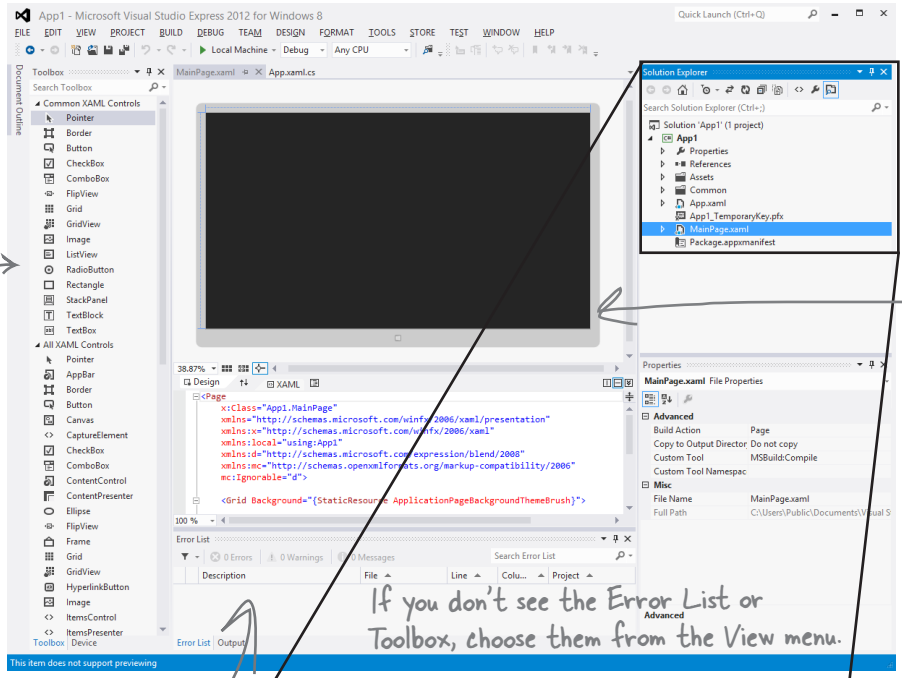
Visual Studio creates all three of these files automatically. It creates several other files as well! You can see them in the Solution Explorer window.

Sharpen your pencil

Just a couple more steps and your screen will match the picture below. First, make sure you open the Toolbox and Error List windows by **choosing them from the View menu**. Next, select the **Light color theme from the Options menu**. You should be able to figure out the purpose of many of these windows and files based on what you already know. Then, in each of the blanks, try to fill in an annotation saying what that part of the IDE does. We've done one to get you started. See if you can guess what all of these things are for.

This toolbar has buttons that apply to what you're currently doing in the IDE.

We've blown up this window below so you have more room.

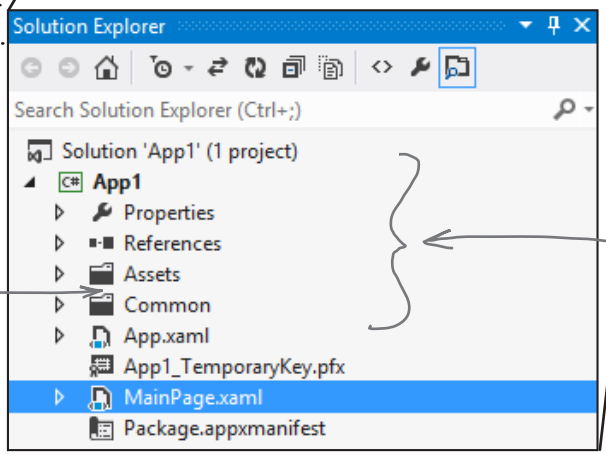


The designer lets you edit the user interface by dragging controls onto it.

If you don't see the Error List or Toolbox, choose them from the View menu.

The screenshot on page 4 is in the Dark color theme.

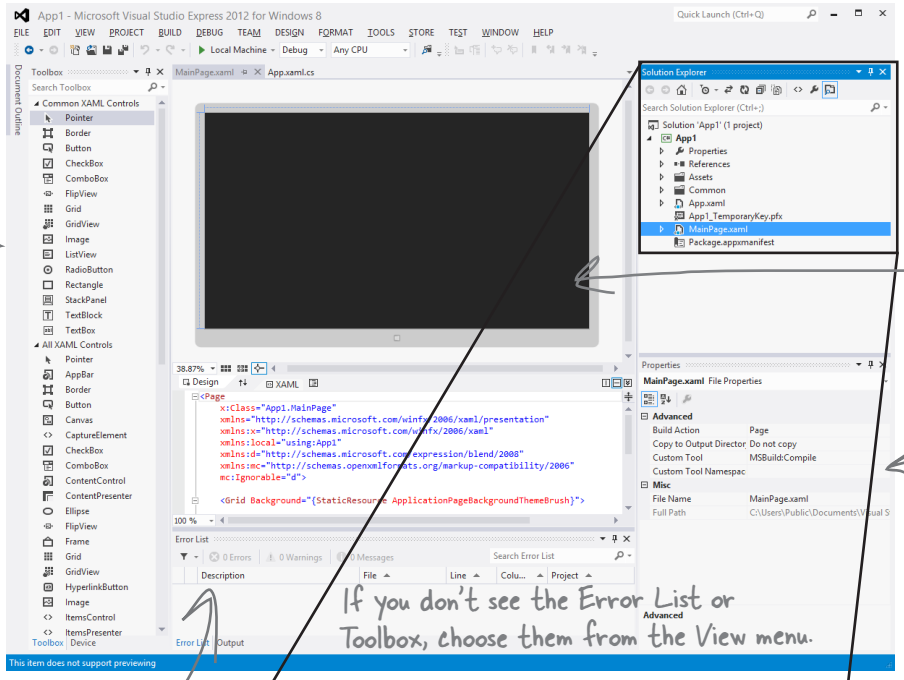
We switched to the Light color theme because it's easier to see light screenshots in a book. If you like it, pick "Options..." from the Tools menu, expand Environment, and click on General to change it (feel free to change back).



Sharpen your pencil Solution

We've filled in the annotations about the different sections of the Visual Studio C# IDE. You may have some different things written down, but you should have been able to figure out the basics of what each window and section of the IDE is used for.

This toolbar has buttons that apply to what you're currently doing in the IDE.



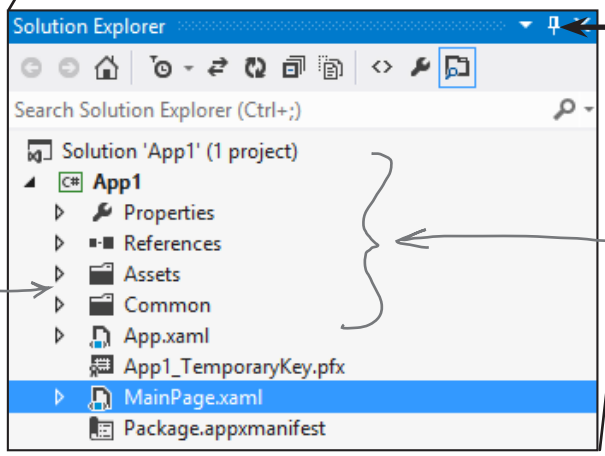
This is the toolbox. It has a bunch of visual controls that you can drag onto your page.

The designer lets you edit the user interface by dragging controls onto it.

This window shows properties of whatever is currently selected in your designer.

If you don't see the Error List or Toolbox, choose them from the View menu.

This Error List window shows you when there are errors in your code. This pane will show lots of diagnostic info about your app.



See this little pushpin icon? If you click it, you can turn auto-hide on or off. The Toolbox window has auto-hide turned on by default.

The XAML and C# files that the IDE created for you when you added the new project appear in the Solution Explorer, along with any other files in your solution.

You can switch between files using the Solution Explorer in the IDE.

there are no Dumb Questions

Q: So if the IDE writes all this code for me, is learning C# just a matter of learning how to use the IDE?

A: No. The IDE is great at automatically generating some code for you, but it can only do so much. There are some things it's really good at, like setting up good starting points for you, and automatically changing properties of controls on your forms. But the hard part of programming—figuring out what your program needs to do and making it do it—is something that no IDE can do for you. Even though the Visual Studio IDE is one of the most advanced development environments out there, it can only go so far. It's ***you***—not the IDE—who writes the code that actually does the work.

Q: What if the IDE creates code I don't want in my project?

A: You can change it. The IDE is set up to create code based on the way the element you dragged or added is most commonly used. But sometimes that's not exactly what you wanted. Everything the IDE does for you—every line of code it creates, every file it adds—can be changed, either manually by editing the files directly or through an easy-to-use interface in the IDE.

Q: Is it OK that I downloaded and installed Visual Studio Express? Or do I need to use one of the versions of Visual Studio that isn't free in order to do everything in this book?

A: There's nothing in this book that you can't do with the free version of Visual Studio (which you can download from Microsoft's website). The main differences between Express and the other editions aren't going to get in the way of writing C# and creating fully functional, complete applications.

Q: You said something about combining C# and XAML. What is XAML, and how does it combine with C#?

A: XAML (the X is pronounced like Z, and it rhymes with "camel") is a **markup language** that you'll use to build your user interfaces for your full-page Windows Store apps. XAML is based on XML (which you'll also learn about later in the book), so if you've ever worked with HTML you have a head start. Here's an example of a XAML **tag** to draw a gray ellipse:

```
<Ellipse Fill="Gray"
Height="100" Width="75"
/>
```

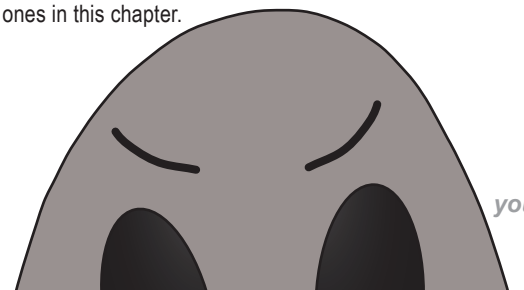
You can tell that that's a tag because it starts with a < followed by a word ("`Ellipse`"), which makes it a **start tag**. This particular `Ellipse` tag has three **properties**: one to set its fill color to gray, and two to set its height and width. This tag ends with `/>`, but some XAML tags can contain other tags. We can turn this tag into a **container tag** by replacing `/>` with a `>`, adding other tags (which can also contain additional tags), and closing it with an **end tag** that looks like this: `</Ellipse>`. You'll learn a lot more about how XAML works and the different XAML tags throughout the book.

Q: I'm looking at the IDE right now, but my screen doesn't look like yours! It's missing some of the windows, and others are in the wrong place. What gives?

A: If you click on the Reset Window Layout command under the Window menu, the IDE will restore the default window layout for you. Then you can use the View→Other Windows menu to make your screen look just like the ones in this chapter.

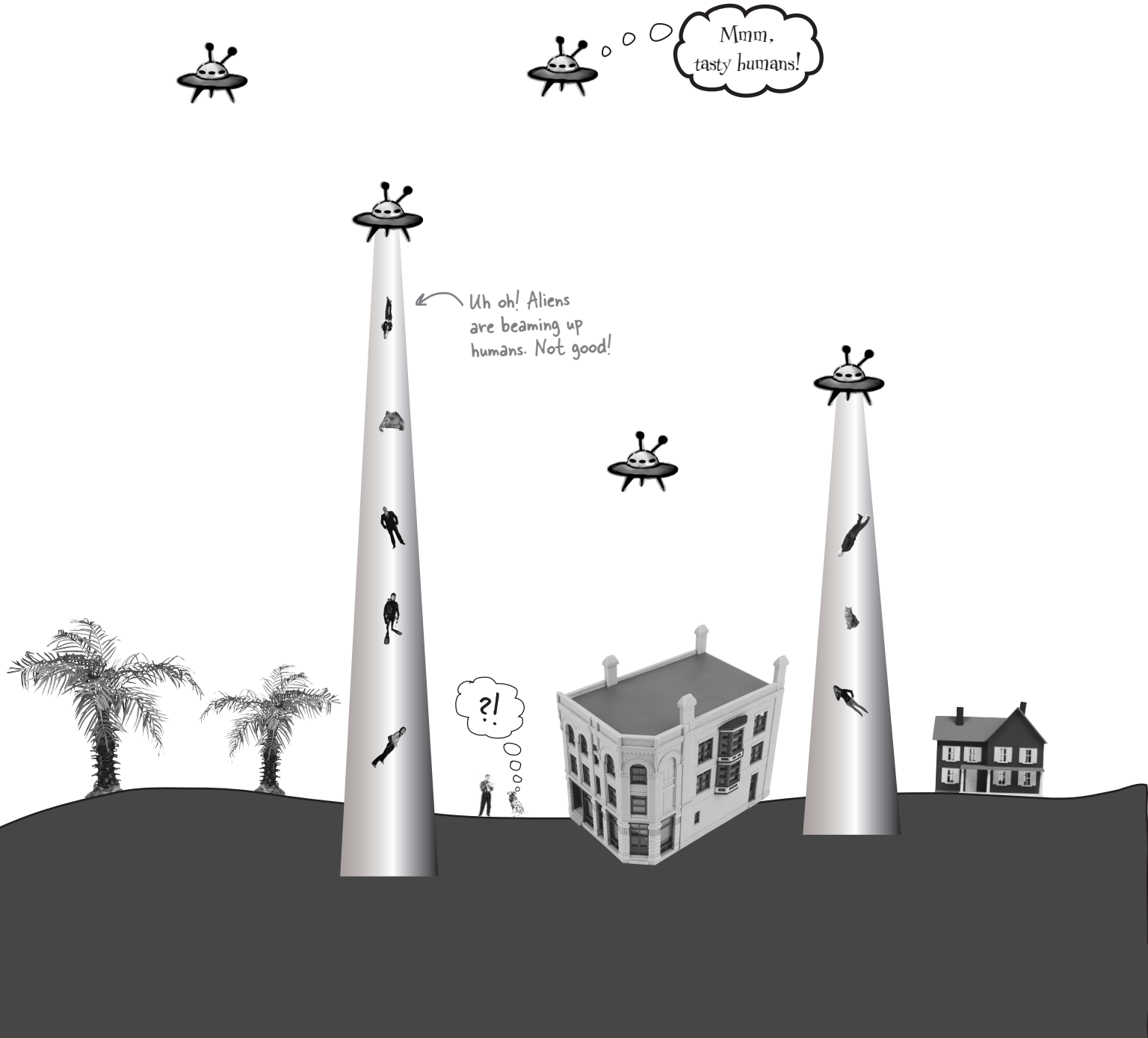
Visual Studio will generate code you can use as a starting point for your applications.

Making sure the app does what it's supposed to do is entirely up to you.



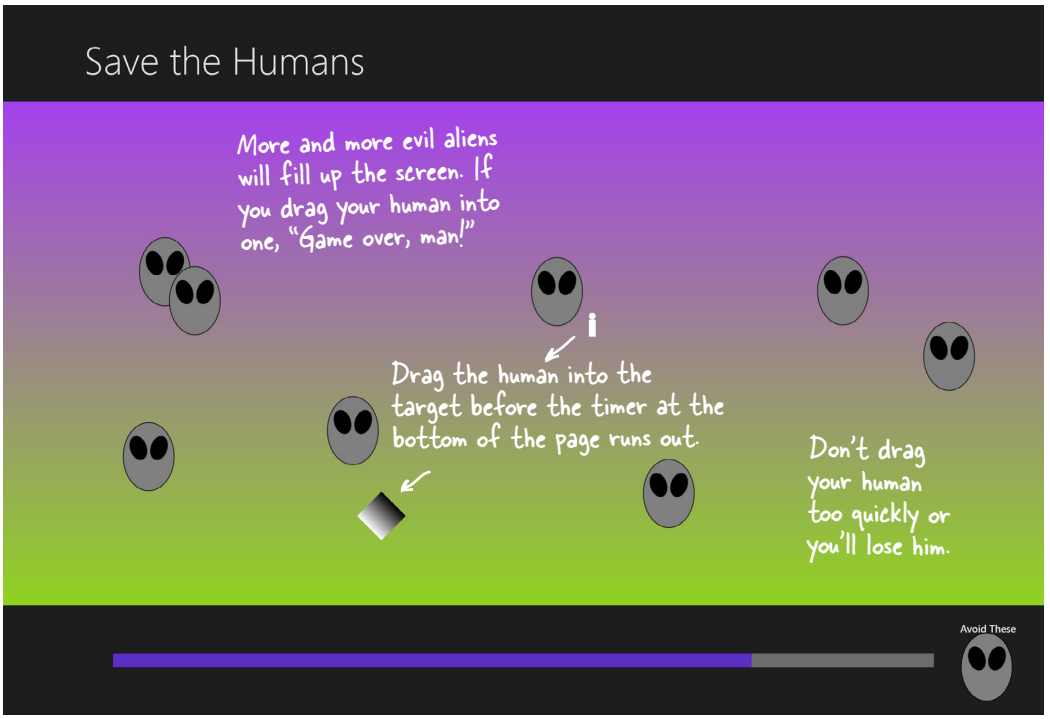
Aliens attack!

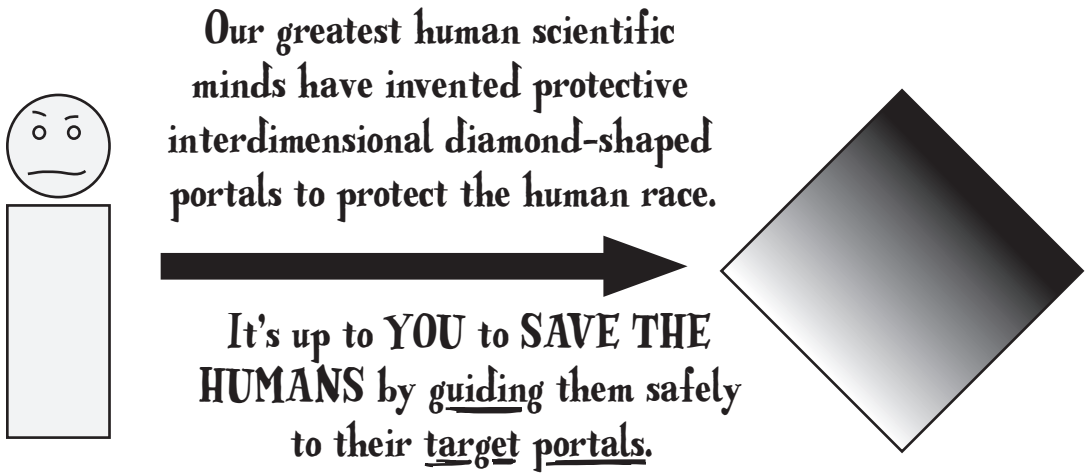
Well, there's a surprise: vicious aliens have launched a full-scale attack on planet Earth, abducting humans for their nefarious and unspeakable gastronomical experiments. Didn't see that coming!



Only you can help save the Earth

The last hopes of humanity rest on your shoulders! The people of planet Earth need you to **build an awesome C# app** to coordinate their escape from the alien menace. Are you up to the challenge?





Here's what you're going to build

GRAB A CUP OF COFFEE AND SETTLE IN! YOU'RE ABOUT TO REALLY PUT THE IDE THROUGH ITS PACES, AND BUILD A PRETTY COOL PROJECT.

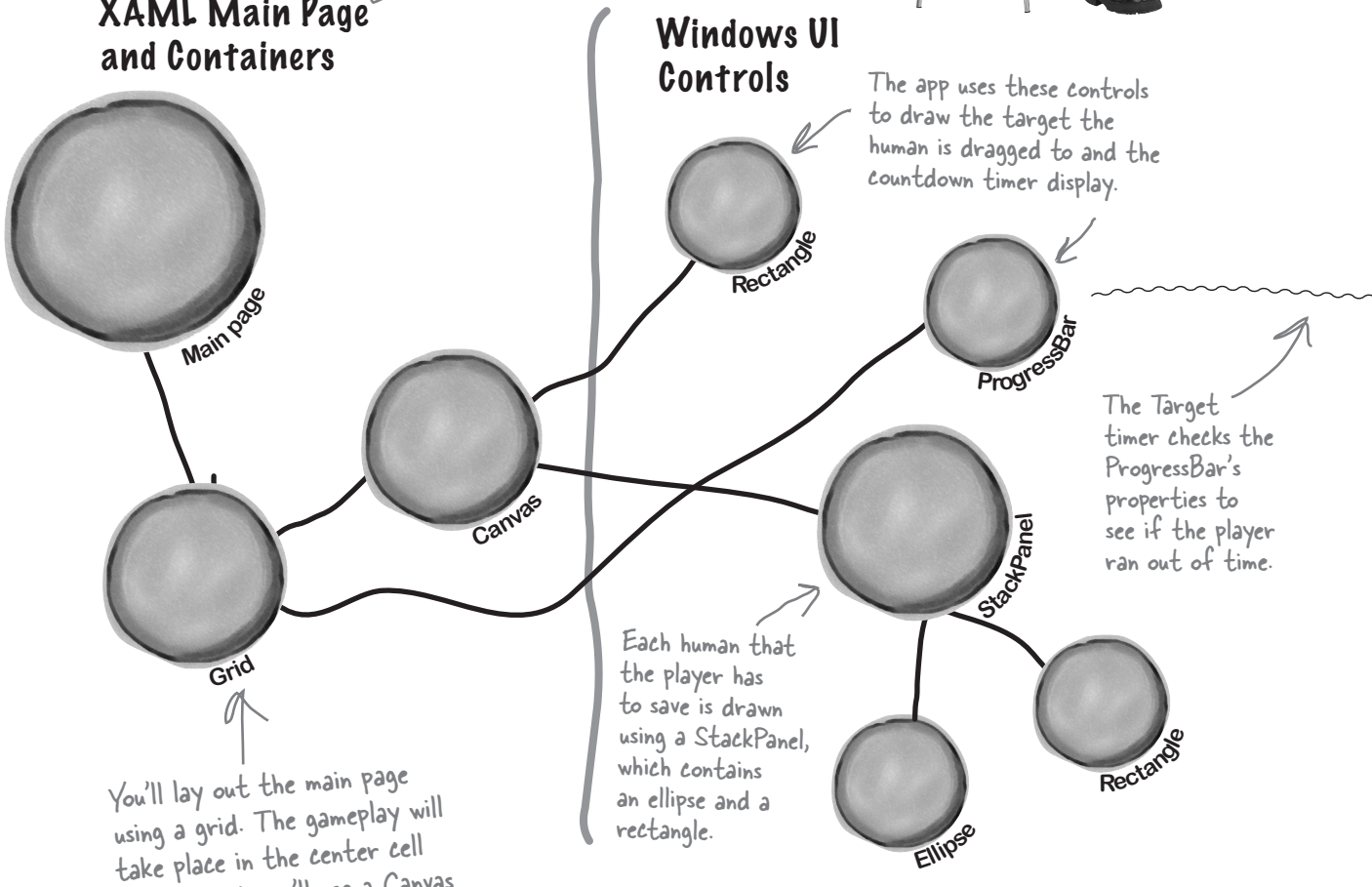
By the end of this chapter, you'll know your way around the IDE, and have a good head start on writing code.

You're going to need an application with a graphical user interface, objects to make the game work, and an executable to run. It sounds like a lot of work, but you'll build all of this over the rest of the chapter, and by the end you'll have a pretty good handle on how to use the IDE to design a page and add C# code.

Here's the structure of the app we're going to create:

You'll be building an app that has a main page with a bunch of visual controls on it.

The app uses controls to provide gameplay for the player.



The app uses these controls to draw the target the human is dragged to and the countdown timer display.

The Target timer checks the ProgressBar's properties to see if the player ran out of time.

Each human that the player has to save is drawn using a StackPanel, which contains an ellipse and a rectangle.

You'll lay out the main page using a grid. The gameplay will take place in the center cell of the grid—we'll use a Canvas for that.

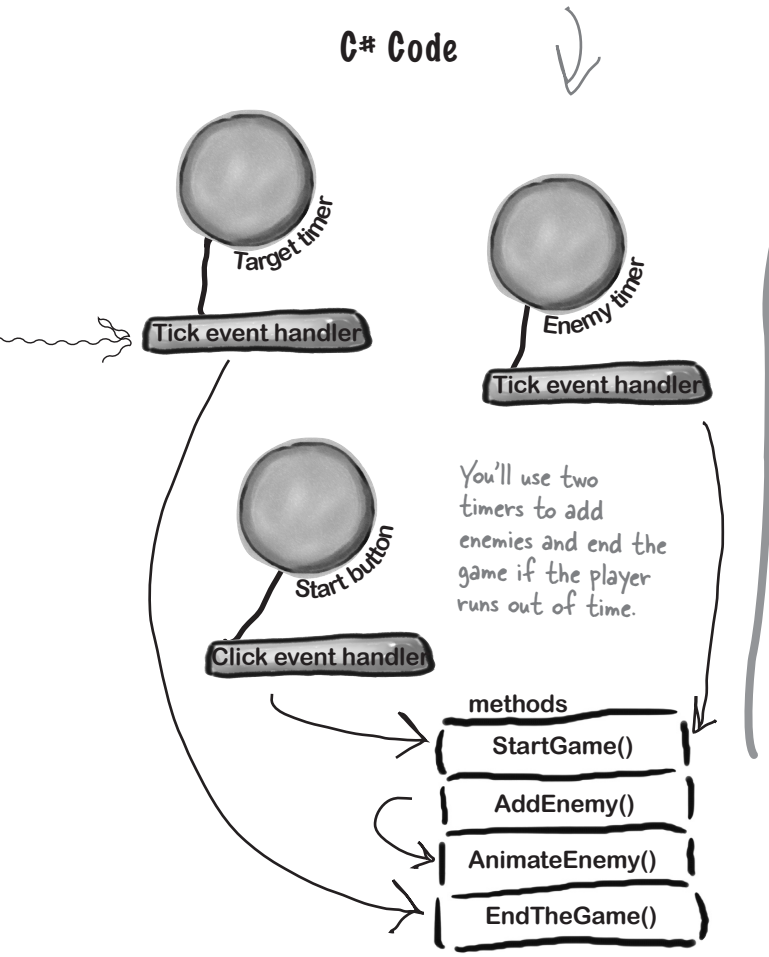
You'll be building an app with two different kinds of code. First you'll design the user interface using XAML (Extensible Application Markup Language), a really flexible design language. Then you'll add C# code to make the game actually work. You'll learn a lot more about XAML throughout the second half of the book.

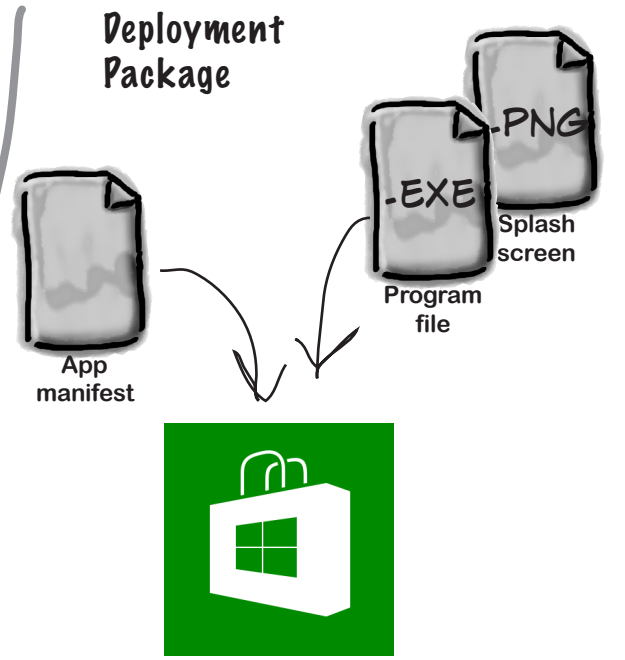
It's not unusual for computers in an office to be running an operating system as old as Windows 2003. With this PDF, you can still do the projects in the book.

No Windows 8? No problem.

The first two chapters and the last half of this book have many projects that are built with *Visual Studio 2012 for Windows 8*, but many readers aren't running Windows 8 yet. Luckily, most of the Windows Store apps in this book can also be built using Windows Presentation Foundation (WPF), which is compatible with earlier operating systems. You can download a free PDF with details and instructions from *http://www.headfirstlabs.com/hfcsharp*...flip to **leftover #11 in the appendix** for more information.

You'll write C# code that manipulates the controls and makes the game work.





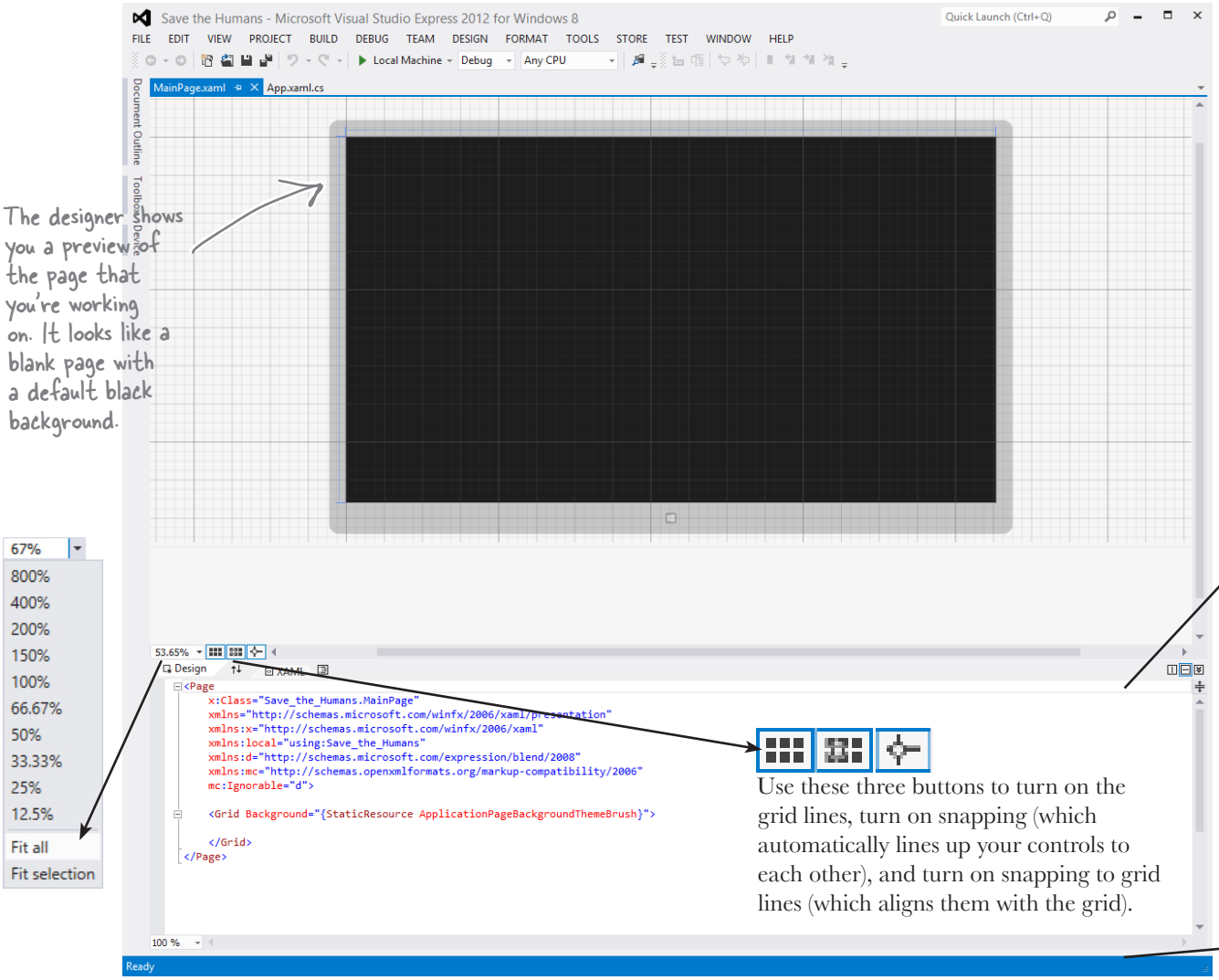
After your app is working, you can package it up so it can be uploaded to the Windows Store, Microsoft's online marketplace for selling and distributing apps.

Start with a blank application

If your code filenames don't end in ".cs" you may have accidentally created a JavaScript, Visual Basic, or Visual C++ program. You can fix this by closing the solution and starting over. If you want to keep the project name "Save the Humans," then you'll need to delete the previous project folder.

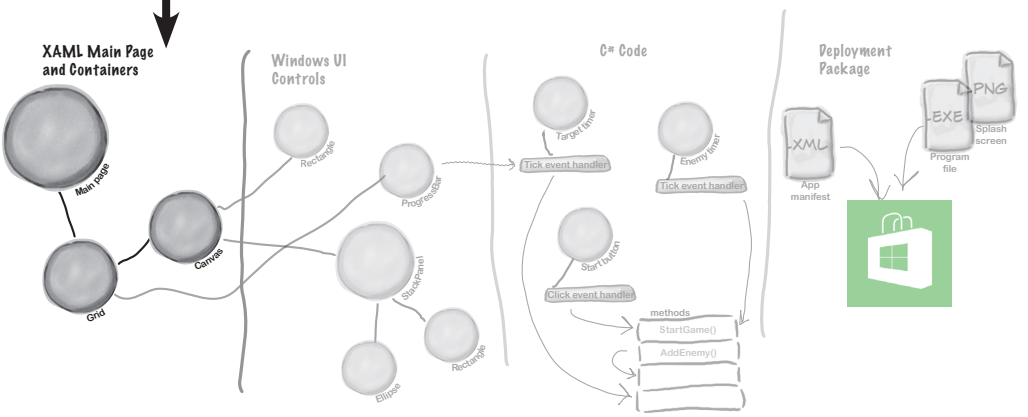
Every great app starts with a new project. Choose New Project from the File menu. Make sure you have Visual C#→Window Store selected and choose **Blank App (XAML)** as the project type. Type **`Save the Humans`** as the project name.

① Your starting point is the **Designer window**. Double-click on *MainPage.xaml* in the Solution Explorer to bring it up. Find the zoom drop-down in the lower-left corner of the designer and choose "Fit all" to zoom it out.



Use these three buttons to turn on the grid lines, turn on snapping (which automatically lines up your controls to each other), and turn on snapping to grid lines (which aligns them with the grid).

You are here!



The bottom half of the Designer window shows you the XAML code. It turns out your "blank" page isn't blank at all—it contains a **XAML grid**. The grid works a lot like a table in an HTML page or Word document. We'll use it to lay out our pages in a way that lets them grow or shrink to different screen sizes and shapes.

You can see the XAML code for the blank grid that the IDE generated for you. Keep your eyes on it—we'll add some columns and rows in a minute.

53.65% Design XAML

```
<Page
    x:Class="Save_the_Humans.MainPage"
    xmlns="http://schemas.microsoft.com/winfx/2006/xaml/presentation"
    xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml"
    xmlns:local="using:Save_the_Humans"
    xmlns:d="http://schemas.microsoft.com/expression/blend/2008"
    xmlns:mc="http://schemas.openxmlformats.org/markup-compatibility/2006"
    mc:Ignorable="d">

    <Grid Background="{StaticResource ApplicationPageBackgroundThemeBrush}">

    </Grid>
</Page>
```

100 %

These are the opening and closing tags for a grid that contains controls. When you add rows, columns, and controls to the grid, the code for them will go between these opening and closing tags.

This part of the project has steps numbered ① to ⑤.

Flip the page to keep going!

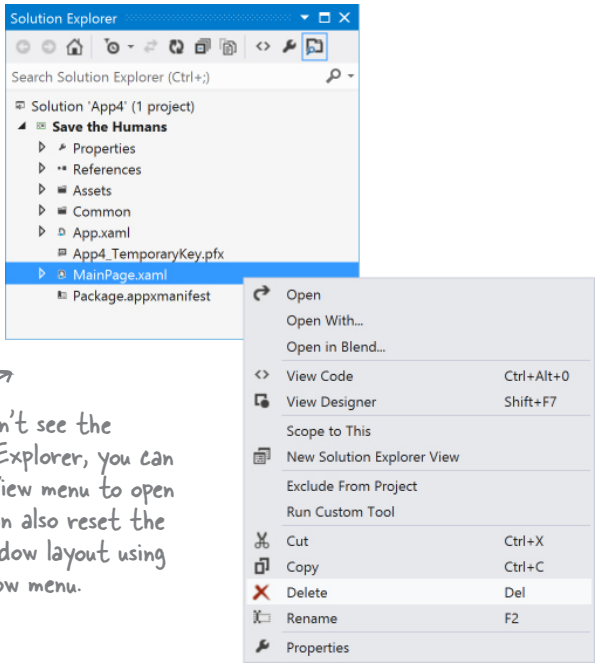
LOOKING TO LEARN WPF? LOOK NO FURTHER!

Most of the Windows Store apps in this book **can be built with WPF** (Windows Presentation Foundation), which is compatible with Windows 7 and earlier operating systems. Download the free WPF guide to *Head First C#* PDF from our website: *http://headfirstlabs.com/hfcsharp* (see leftover #11 in the appendix for more details)

Over the next few pages you'll explore a lot of different features in the Visual Studio IDE, because we'll be using the IDE as a powerful tool for learning and teaching. You'll use the IDE throughout the book to explore C#. That's a really effective way to get it into your brain!

② Your page is going to need a title, right? And it'll need margins, too. You can do this all by hand with XAML, but there's an easier way to get your app to look like a normal Windows Store app.

Go to the Solution Explorer window and find MainPage.xaml. Right-click on it and choose Delete to **delete the *MainPage.xaml* page**:

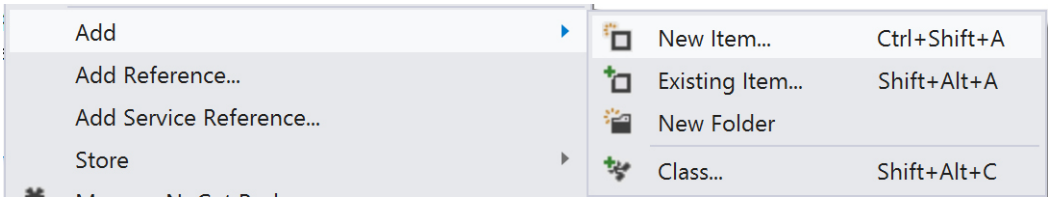


If you don't see the Solution Explorer, you can use the View menu to open it. You can also reset the IDE's window layout using the Window menu.

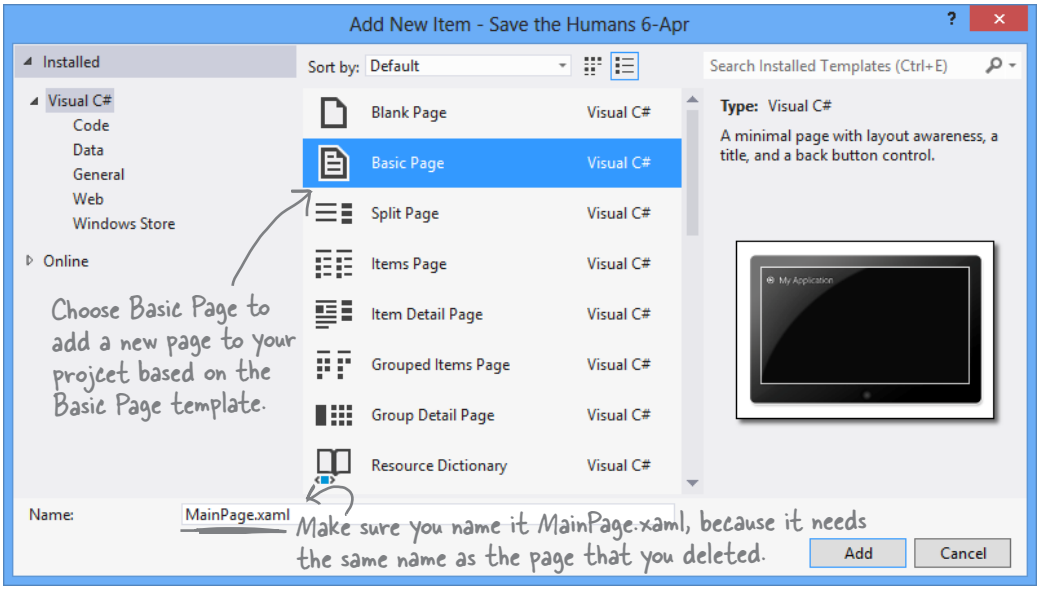
When you start a Windows Store app, you'll often replace the main page with one of the templates that Visual Studio provides.

If you chose a different name when you created your project, you'll see that name instead of "Save the Humans" in the Solution Explorer.

③ Now you'll need to replace the main page. Go back to the Solution Explorer and right-click on **Save the Humans** (it should be the second item in the Solution Explorer) to select the project. Then choose **Add→New Item...** from the menu:



The IDE will pop up the Add New Item window for your project. Choose **Basic Page** and give it the name **MainPage.xaml**. Then click the **Add** button to add the replacement page to your project.



When you replace MainPage.xaml with the new Basic Page item, the IDE needs to add additional files. Rebuilding the solution brings everything up to date so it can display the page in the designer.

The IDE will prompt you to add missing files—**choose *Yes* to add them**. Wait for the designer to finish loading. It might display either Invalid Markup or Build the Project to update Design view.. Choose **Rebuild Solution** from the Build menu to bring the IDE's Designer window up to date. Now you're ready to roll!

Let's explore your newly added *MainPage.xaml file*. Scroll through the XAML pane in the designer window until you find this XAML code. This is the grid you'll use as the basis for your program:

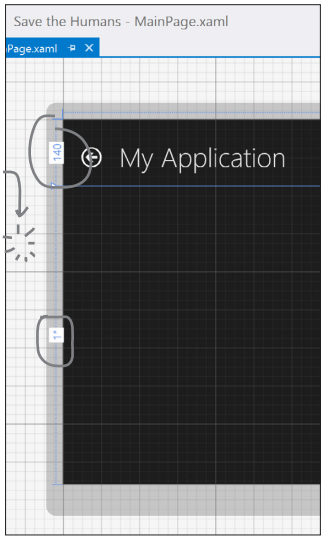
```
68.22%
Design  XAML
    <!--
        This grid acts as a root panel for the page that defines two rows:
        * Row 0 contains the back button and page title
        * Row 1 contains the rest of the page layout
    -->
    <Grid Style="{StaticResource LayoutRootStyle}">
        <Grid.RowDefinitions>
            <RowDefinition Height="140"/>
            <RowDefinition Height="*"/>
        </Grid.RowDefinitions>

        <!-- Back button and page title -->
        <Grid>
            <Grid.ColumnDefinitions>
                <ColumnDefinition Width="Auto"/>
                <ColumnDefinition Width="*"/>
            </Grid.ColumnDefinitions>
            <Button x:Name="backButton" Click="GoBack" IsEnabled="{Binding Frame.CanGoBack,
            <TextBlock x:Name="pageTitle" Grid.Column="1" Text="{StaticResource AppName}" St
        </Grid>
100 %
```

You'll use the IDE to lay out your app by modifying this grid.

Notice how there's a whole separate grid, with its own starting <Grid> and ending </Grid> tags? That's the page header that displays the app name. This grid is also contained inside the root grid that you'll be adding controls to.

Your page should be displayed in the designer. If it isn't, double-click on MainPage.xaml in the Solution Explorer.

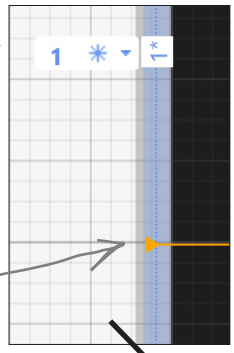
④ Your app will be a grid with two rows and three columns (plus the header row that came with the blank page template), with one big cell in the middle that will contain the play area. Start defining rows by hovering over the border until a line and triangle appear:



If you don't see the numbers 140 and 1* along the border of your page, click outside the page.

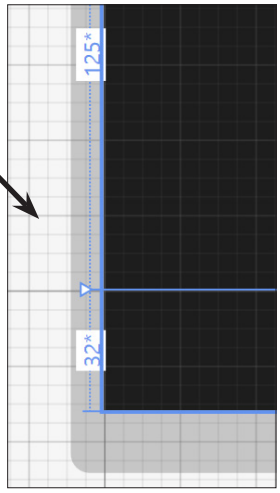
Hover over the border of the grid until an orange triangle and line appear...

...then click to create a bottom row in the grid.



Windows Store apps need to look right on any screen, from tablets to laptops to giant monitors, in portrait or landscape.

After the row is added, the line will change to blue and you'll see the row height in the border. The height of the center row will change from 1* to a larger number followed by a star.



Laying out the page using a grid's columns and rows allows your app to automatically adjust to the display.

there are no Dumb Questions

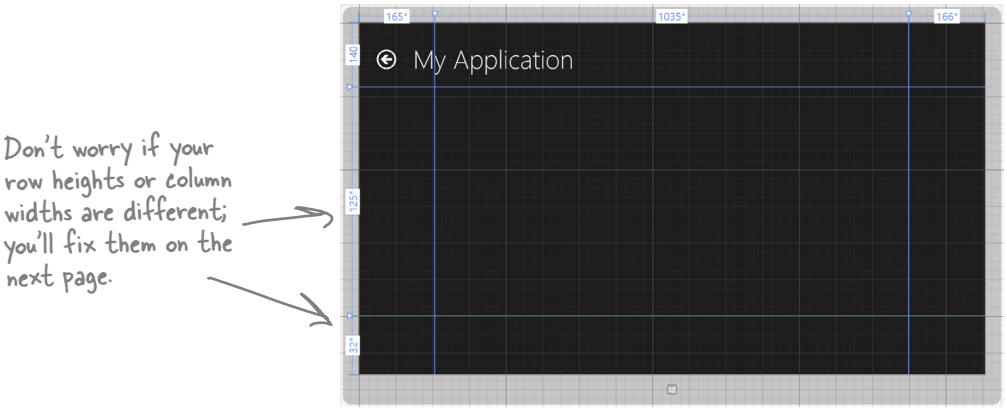
Q: But it looks like I already have many rows and and columns in the grid. What are those gray lines?

A: The gray lines were just Visual Studio giving you a grid of guidelines to help you lay your controls out evenly on the page. You can turn them on and off with the button. None of the lines you see in the designer show up when you run the app outside of Visual Studio. But when you clicked and created a new row, you actually altered the XAML, which will change the way the app behaves when it's compiled and executed.

Q: Wait a minute. I wanted to learn about C#. Why am I spending all this time learning about XAML?

A: Because Windows Store apps built in C# almost always start with a user interface that's designed in XAML. That's also why Visual Studio has such a good XAML editor—to give you the tools you need to build stunning user interfaces. Throughout this book, you'll learn how to build two other types of programs with C#, desktop applications and console applications, neither of which use XAML. Seeing all three of these will give you a deeper understanding of programming with C#.

⑤ Do the same thing along the top border of the page—except this time create two columns, a small one on the lefthand side and another small one on the righthand side. Don't worry about the row heights or column widths—they'll vary depending on where you click. We'll fix them in a minute.



When you're done, look in the XAML window and go back to the same grid from the previous page. Now the column widths and row heights match the numbers on the top and side of your page.

Design XAML

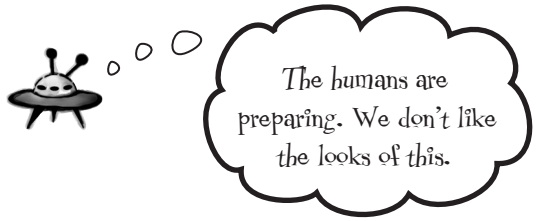
```
<!--
    This grid acts as a root panel for the page that defines two rows:
    * Row 0 contains the back button and page title
    * Row 1 contains the rest of the page layout
-->
<Grid Style="{StaticResource LayoutRootStyle}">
    <Grid.ColumnDefinitions>
        <ColumnDefinition Width="165*"/>
        <ColumnDefinition Width="1035*"/>
        <ColumnDefinition Width="166*"/>
    </Grid.ColumnDefinitions>
    <Grid.RowDefinitions>
        <RowDefinition Height="140"/>
        <RowDefinition Height="125*"/>
        <RowDefinition Height="32*"/>
    </Grid.RowDefinitions>
```

100 %

Here's the width of the left column you created in step 5—the width matches the width that you saw in the designer. That's because the IDE generated this XAML code for you.

Your grid rows and columns are now added!

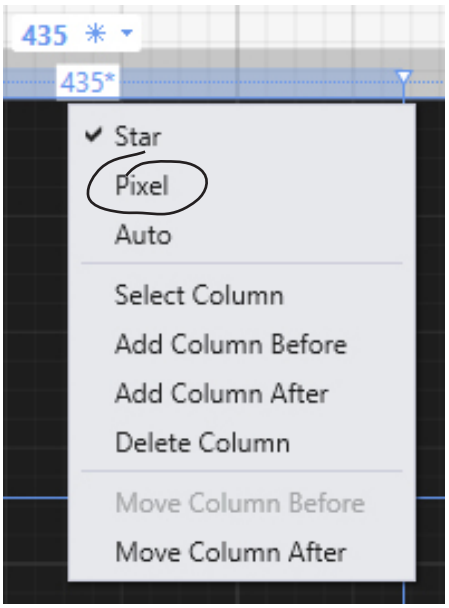
XAML grids are **container controls**, which means they hold other controls. Grids consist of rows and columns that define cells, and each cell can hold other XAML controls that show buttons, text, and shapes. A grid is a great way to lay out a page, because you can set its rows and columns to resize themselves based on the size of the screen.



Set up the grid for your page

Your app needs to be able to work on a wide range of devices, and using a grid is a great way to do that. You can set the rows and columns of a grid to a specific pixel height. But you can also use the **Star** setting, which keeps them the same size proportionally—to each other and also to the page—no matter how big the display or what its orientation is.

When you change this number, you modify the grid—and its XAML code.



1. **SET THE WIDTH OF THE LEFT COLUMN.**
Hover over the number above the first column until a drop-down menu appears. Choose Pixel to change the star to a lock, then click on the number to change it to `160`. Your column's number should now look like this:

2. **REPEAT FOR THE RIGHT COLUMN AND THE BOTTOM ROW.**
Make the right column and the bottom row 160 by choosing Pixel and typing `160` into the box.

Set your columns or rows to Pixel to give them a fixed width or height. The Star setting lets a row or column grow or shrink proportionally to the rest of the grid. Use this setting in the designer to alter the Width or Height property in the XAML. If you remove the Width or Height property, it's the same as setting the property to 1*.

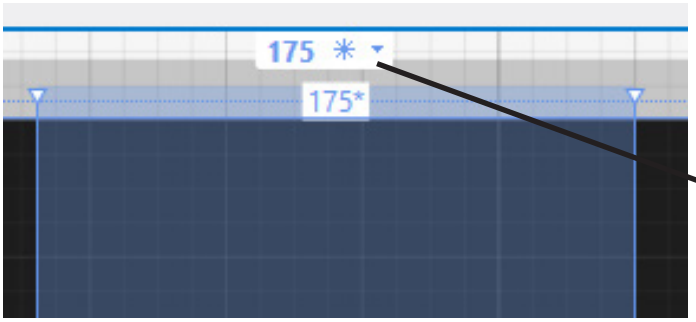
It's OK if you're not a pro at app design...*yet*.

We'll talk a lot more about what goes into designing a good app later on. For now, we'll walk you through building this game. By the end of the book, you'll understand exactly what all of these things do!

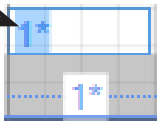
3 MAKE THE CENTER COLUMN AND CENTER ROW THE DEFAULT SIZE 1* (IF THEY AREN'T ALREADY).

Click on the number above the center column and enter 1. Don't use the drop-down (leave it Star) so it looks like the picture below. Then make sure to look back at the other columns to make sure the IDE didn't resize them. If it did, just change them back to `160`.

XAML and C# are case sensitive! Make sure your uppercase and lowercase letters match example code.



When you enter 1* into the box, the IDE sets the column to its default width. It might adjust the other columns. If it does, just reset them back to 160 pixels.



4 LOOK AT YOUR XAML CODE!

Click on the grid to make sure it's selected, then look in the XAML window to see the code that you built.

```
<!--
    This grid acts as a root panel for the page that defines two rows:
    * Row 0 contains the back button and page title
    * Row 1 contains the rest of the page layout
-->
<Grid Style="{StaticResource LayoutRootStyle}">
    <Grid.ColumnDefinitions>
        <ColumnDefinition Width="160"/>
        <ColumnDefinition/>
        <ColumnDefinition Width="160"/>
    </Grid.ColumnDefinitions>
    <Grid.RowDefinitions>
        <RowDefinition Height="140"/>
        <RowDefinition/>
        <RowDefinition Height="160"/>
    </Grid.RowDefinitions>
```

The <Grid .. > line at the top means everything that comes after it is part of the grid.

This is how a column is defined for a XAML grid. You added three columns and three rows, so there are three ColumnDefinition tags and three RowDefinition tags.

This top row with a height of 140 pixels is part of the Basic Page template you added.

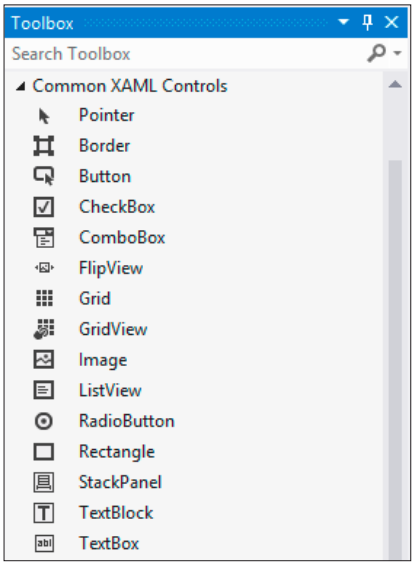
You used the column and row drop-downs to set the Width and Height properties.

In a minute, you'll be adding controls to your grid, which will show up here, after the row and column definitions.

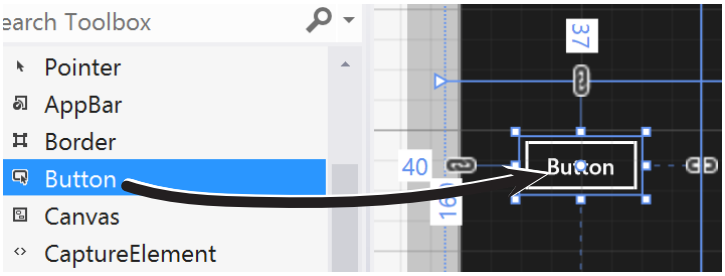
Add controls to your grid

Ever notice how apps are full of buttons, text, pictures, progress bars, sliders, drop-downs, and menus? Those are called **controls**, and it's time to add some of them to your app—*inside* the cells defined by your grid's rows and columns.

If you don't see the toolbox in the IDE, you can open it using the View menu. Use the pushpin to keep it from collapsing.



1 Expand the Common XAML Controls section of the toolbox and drag a Button into the **bottom-left cell** of the grid.



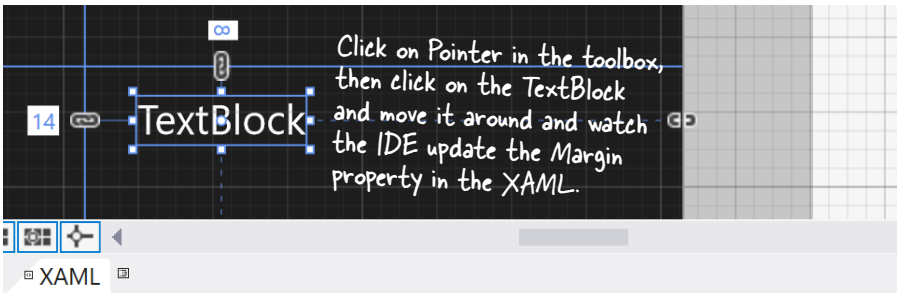
Then look at the bottom of the Designer window and have a look at the **XAML tag** that the IDE generated for you. You'll see something like this—your margin numbers will be different depending on where in the cell you dragged it, and the properties might be in a different order.

These are properties. Each property has a name, followed by an equals sign, followed by its value.

The XAML for the button starts here, with the opening tag.

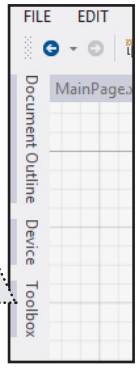
```
<Button Content="Button" HorizontalAlignment="Left"
        Margin="60,72,0,0" Grid.Row="2" VerticalAlignment="Top"/>
```

2 Drag a TextBlock into the **lower-right cell** of the grid. Your XAML will look something like this. See if you can figure out how it determines which row and column the controls are placed in.



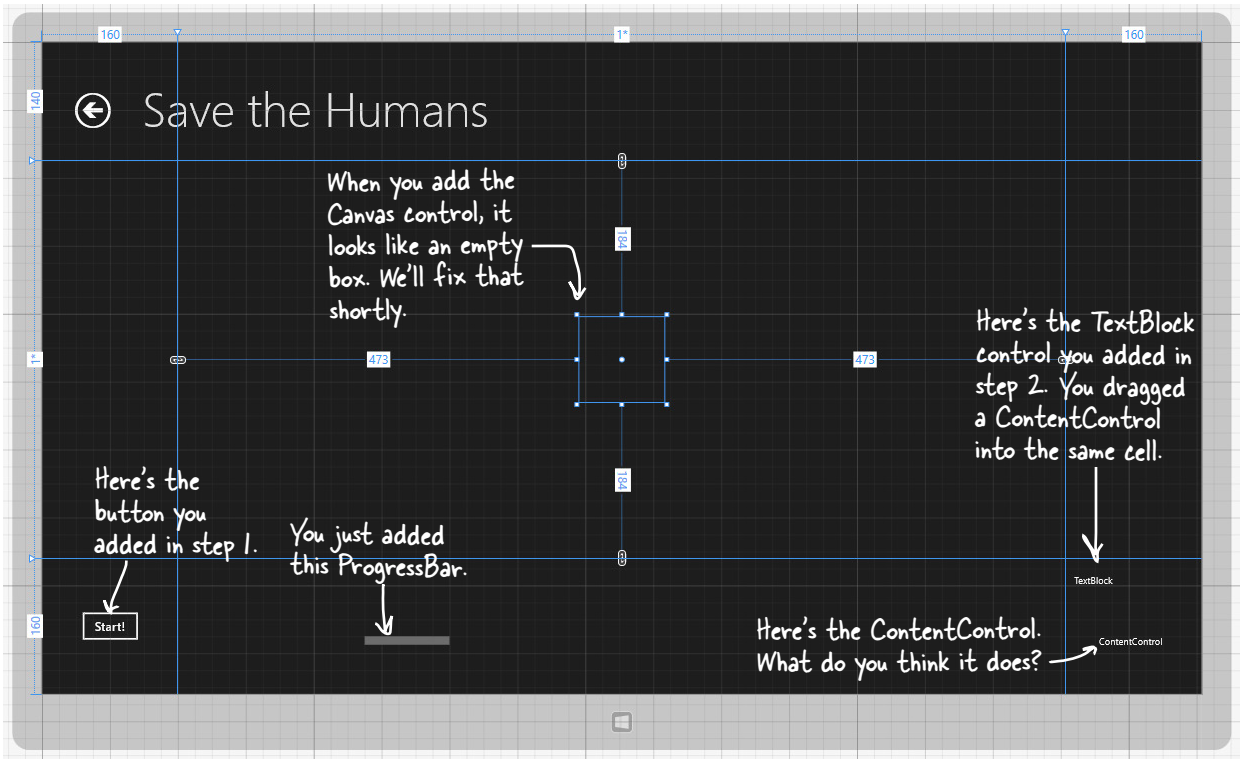

```
<TextBlock Grid.Column="2" HorizontalAlignment="Left"
           Margin="14,8,0,0" Grid.Row="2" TextWrapping="Wrap"
           Text="TextBlock" VerticalAlignment="Top"/>
```

If you don't see the toolbox, try clicking on the word "Toolbox" that shows up in the upper-left corner of the IDE. If it's not there, select Toolbox from the View menu to make it appear.



We added line breaks to make the XAML easier to read. You can add line breaks too. Give it a try!

3 Next, expand the All XAML Controls section of the toolbox. Drag a ProgressBar into the bottom-center cell, a ContentControl into the bottom-right cell (make sure it's **below** the TextBlock you already put in that cell), and a Canvas into the center cell. Your page should now have controls on it (don't worry if they're placed differently than the picture below; we'll fix that in a minute):



4 You've got the Canvas control currently selected, since you just added it. (If not, use the pointer to select it again.) Look in the XAML window:

```
<Canvas Grid.Column="1" Grid.Row="1" HorizontalAlignment="Left" Height="100"...
```

It's showing you the XAML tag for the Canvas control. It starts with `<Canvas` and ends with `/>`, and between them it has properties like `Grid.Column="1"` (to put the Canvas in the center column) and `Grid.Row="1"` (to put it in the center row). Try clicking *in both the grid and the XAML window* to select different controls.

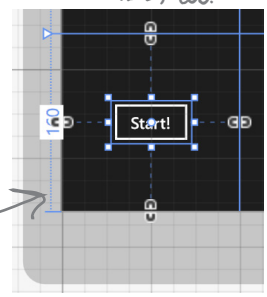
Try clicking this button. It brings up the Document Outline window. Can you figure out how to use it? You'll learn more about it in a few pages.

When you drag a control out of the toolbox and onto your page, the IDE automatically generates XAML to put it where you dragged it.

Use properties to change how the controls look

The Visual Studio IDE gives you fine control over your controls. The **Properties window** in the IDE lets you change the look and even the behavior of the controls on your page.

When you're editing text, use the Escape key to finish. This works for other things in the IDE, too.



1 Change the text of the button.

Right-click on the button control that you dragged onto the grid and choose **Edit Text** from the menu. Change the text to: `Start!` and see what you did to the button's XAML:

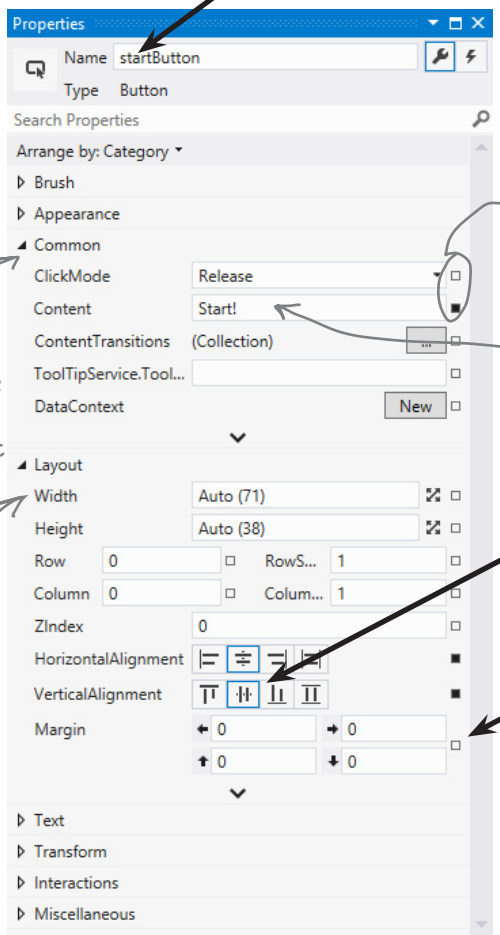
```
<Button Content="Start!" HorizontalAlignment="Left" VerticalAlignment="Top" . . .
```

When you edit the text in the button, the IDE updates the Content property in the XAML.

2 Use the Properties window to modify the button.

Make sure the button is selected in the IDE, then look at the Properties window in the lower-right corner of the IDE. Use it to change the name of the control to `startButton` and center the control in the cell. Once you've got the button looking right, **right-click on it and choose View Source** to jump straight to the `<Button>` tag in the XAML window.

Use the Name box to change the name of the control to startButton.



You might need to expand the Common and Layout sections.

These little squares tell you if the property has been set. A filled square means it's been set; an empty square means it's been left with a default value.

When you used "Edit Text" on the right-click menu to change the button's text, the IDE updated the Content property.

Use the [=] and [||] buttons to set the HorizontalAlignment and VerticalAlignment properties to "Center" and center the button in the cell.

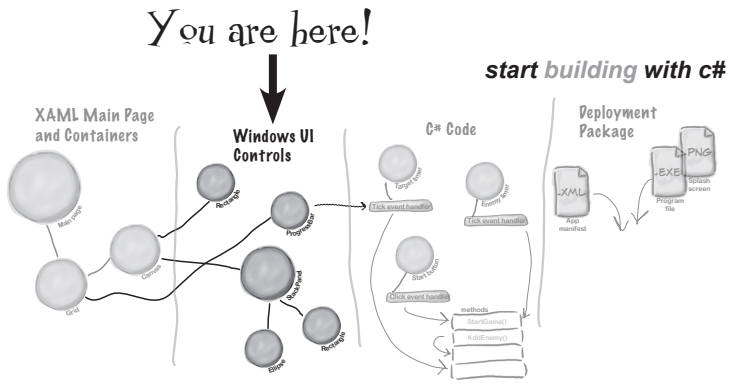
When you dragged the button onto the page, the IDE used the Margin property to place it in an exact position in the cell. Click on the square ■ and choose Reset from the menu to reset the margins to 0.

```
<Button x:Name="startButton"
        Content="Start!"
        Grid.Row="2"
        HorizontalAlignment="Center"
        VerticalAlignment="Center"/>
```

Go back to the XAML window in the IDE and have a look at the XAML that you updated!

The properties may be in a different order. That's OK!

You can use Edit→Undo (or Ctrl-Z) to undo the last change. Do it several times to undo the last few changes. If you selected the wrong thing, you can choose Select None from the Edit menu to deselect. You can also hit Escape to deselect the control. If it's living inside a container like a StackPanel or Grid, hitting Escape will select the container, so you may need to hit it a few times.



3 Change the page header text.

Right-click on the page header ("My Application") and choose View Source to jump to the XAML for the text block. Scroll in the XAML window until you find the `Text` property:

```
Text="{StaticResource AppName}"
```

Wait a minute! That's not text that says "My Application"—what's going on here?

The Blank Page template uses a **static resource** called `AppName` for the name that it displays at the top of the page. Scroll to the top of the XAML code until you find a `<Page.Resources>` section that has this XAML code in it:

```
<x:String x:Key="AppName">My Application</x:String>
```

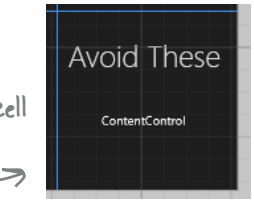
Replace "My Application" with the name of your application:

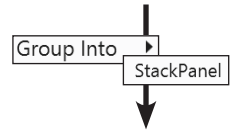
```
<x:String x:Key="AppName">Save the Humans</x:String>
```

Now you should see the correct text at the top of the page:

Don't worry about that back button. You'll learn all about how to use it in Chapter 14. You'll also learn about static resources.

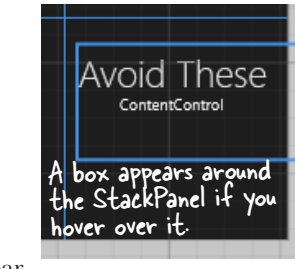
Your TextBlock and ContentControl are in the lower-right cell of the grid.





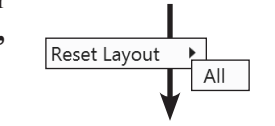
4 Update the TextBlock to change its text and its style.

Use the Edit Text right-mouse menu option to change the TextBlock so it says `Avoid These` (hit Escape to finish editing the text). Then right-click on it, choose the Edit Style menu item, and then choose the Apply Resource submenu and select **`SubheaderTextStyle`** to make its text bigger.



5 Use a StackPanel to group the TextBlock and ContentControl.

Make sure that the TextBlock is near the top of the cell, and the ContentControl is near the bottom. **Click and drag to select both the TextBlock and ContentControl, and then right-click**. Choose Group Into from the pop-up menu, then choose StackPanel. This adds a new control to your form: a **StackPanel control**. You can select the StackPanel by clicking between the two controls.



The StackPanel is a lot like the Grid and Canvas: its job is to hold other controls (it's called a "container"), so it's not visible on the form. But since you dragged the TextBlock to the top of the cell and the ContentControl to the bottom, the IDE created the StackPanel so it fills up most of the cell. Click in the middle of the StackPanel to select it, then right-click and choose Reset Layout and All to quickly reset its properties, which will set its vertical and horizontal alignment to Stretch. Finally, right-click on the TextBox and ContentControl to reset their layouts as well. While you have the ContentControl selected, set its vertical and horizontal alignments to Center.

Controls make the game work

Controls aren't just for decorative touches like titles and captions. They're central to the way your game works. Let's add the controls that players will interact with when they play your game. Here's what you'll build next:

You'll create a play area with a gradient background...

...and you'll work on the bottom row.

You'll make the ProgressBar as wide as its column...

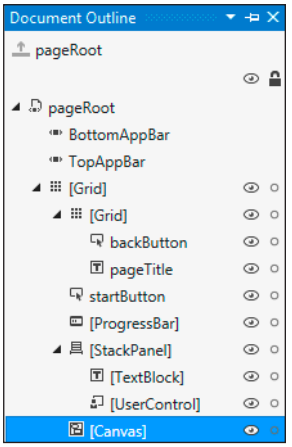
...and you'll use a template to make your enemy look like this.

1 **Update the ProgressBar.**

Right-click on the ProgressBar in the bottom-center cell of the grid, choose the **Reset Layout** menu option, and then choose **All** to reset all of the properties to their default values. Use the Height box in the Layout section of the Properties window to set the `Height` to **20**. The IDE stripped all of the layout-related properties from the XAML, and then added the new `Height`:

```
<ProgressBar Grid.Column="1" Grid.Row="2" Height="20"/>
```

You can also get to the Document Outline by choosing the View→Other Windows menu.



2 **Turn the Canvas control into the gameplay area.**

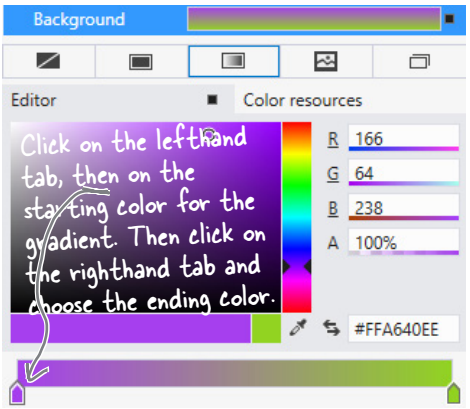
Remember that Canvas control that you dragged into the center square? It's hard to see it right now because a Canvas control is invisible when you first drag it out of the toolbox, but there's an easy way to find it. Click the very small button above the XAML window to bring up the **Document Outline**. Click on [Canvas] to select the Canvas control.

Make sure the Canvas control is selected, then **use the Name box** in the Properties window to set the name to `playArea`.

Once you change the name, it'll show up as playArea instead of [Canvas] in the Document Outline window.

Document Outline

You can also open the Document Outline by clicking the tab on the side of the IDE.



After you've named the Canvas control, you can close the Document Outline window. Then use the and buttons in the Properties window to set its vertical and horizontal alignments to Stretch, reset the margins, and click both buttons to set the `Width` and `Height` to Auto. Then set its Column to 0, and its ColumnSpan (next to Column) to 3.

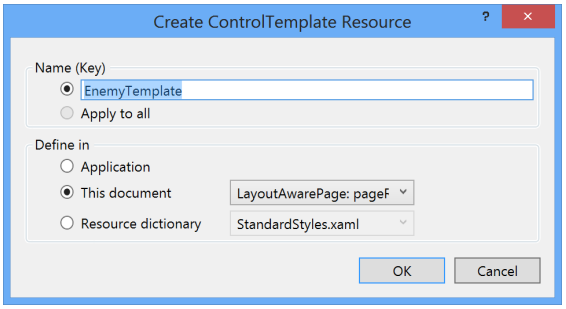
Finally, open the **Brush** section of the Properties window and use the button to give it a **gradient**. Choose the starting and ending colors for the gradient by clicking each of the tabs at the bottom of the color editor and then clicking on a color.

3 Create the enemy template.

Your game will have a lot of enemies bouncing around the screen, and you're going to want them to all look the same. Luckily, XAML gives us **templates**, which are an easy way to make a bunch of controls look alike.

Next, right-click on the ContentControl in the Document Outline window. Choose **Edit Template**, then choose **Create Empty...** from the menu. Name it `EnemyTemplate`. The IDE will add the template to the XAML.

You're "flying blind" for this next bit—the designer won't display anything for the template until you add a control and set its height and width so it shows up. Don't worry; you can always undo and try again if something goes wrong.



You can also use the Document Outline window to select the grid if it gets deselected.

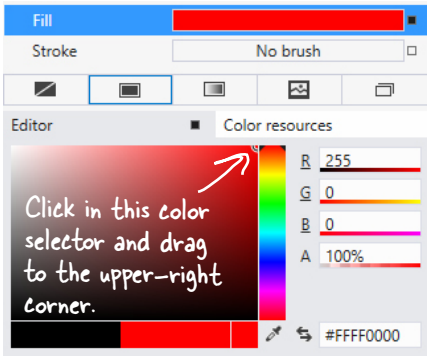
Your newly created template is currently selected in the IDE. Collapse the Document Outline window so it doesn't overlap the Toolbox. *Your template is* ***still invisible****, but you'll change that in the next step. If you accidentally click out of the control template,* ***you can always get back to it*** *by opening the Document Outline, right-clicking on the Content Control, and choosing Edit Template→Edit Current.*

4 Edit the enemy template.

Make sure you don't click anywhere else in the designer until you see the ellipse. That will keep the template selected.

Add a red circle to the template:

- Double-click on Ellipse in the toolbox to add an ellipse.
- Set the ellipse's `Height` and `Width` properties to **`100`**, which will cause the ellipse to be displayed in the cell.
- Reset the `HorizontalAlignment`, `VerticalAlignment`, and `Margin` properties by clicking on their squares and choosing Reset.
- Go to the Brush section of the Properties window and click on ■ to select a solid-color brush.
- Color your ellipse red by clicking in the color bar and dragging to the top, then clicking in the color sector and dragging to the upper-right corner.



The XAML for your ContentControl now looks like this:

```
<ContentControl Content="ContentControl"  HorizontalAlignment="Center"
                VerticalAlignment="Center" Template="{StaticResource EnemyTemplate}"/>
```

Scroll around your page's XAML window and see if you can find where the EnemyTemplate is defined. It should be right below the AppName resource.

5 Use the Document Outline to modify the StackPanel and TextBlock controls.

Go back to the Document Outline (if you see EnemyTemplate (ContentControl Template) at the top of the Document Outline window, just click ↑ to get back to the Page outline). Select the StackPanel control, make sure its vertical and horizontal alignments are set to center, and clear the margins. Then do the same for the TextBlock.

You're almost done laying out the form! Flip the page for the last steps... →

6 Add the human to the Canvas.

You've got two options for adding the human. The first option is to follow the next three paragraphs. The second, quicker option is to just type the four lines of XAML into the IDE. It's your choice!

Select the Canvas control, then open the **All XAML Controls** section of the toolbox and double-click on Ellipse to add an Ellipse control to the Canvas. Select the Canvas control again and double-click on Rectangle. The Rectangle will be added right on top of the Ellipse, so drag the Rectangle below it.

Hold down the Shift key and click on the Ellipse so both controls are selected. Right-click on the Ellipse, choose **Group Into**, and then **StackPanel**. Select the Ellipse, use the solid brush property to change its color to white, and set its `Width` and `Height` properties to 10. Then select the Rectangle, make it white as well, and change its `Width` to 10 and its `Height` to 25.

Use the Document Outline window to select the Stack Panel (make sure you see Type StackPanel at the top of the Properties window). Click both ⛶ buttons to set the `Width` and `Height` to Auto. Then use the Name box at the top of the window to set its name to `human`. Here's the XAML you generated:

```
<StackPanel x:Name="human" Orientation="Vertical">
    <Ellipse Fill="White" Height="10" Width="10"/>
    <Rectangle Fill="White" Height="25" Width="10"/>
</StackPanel>
```

If you choose to type this into the XAML window of the IDE, make sure you do it directly above the </Canvas> tag. That's how you indicate that the human is contained in the Canvas.

Go back to the Document Outline window to see how your new controls appear:

Your XAML may also set a Stroke property for the shapes that add an outline. Can you figure out how to add or remove it?

7 Add the Game Over text.

When your player's game is over, the game will need to display a Game Over message. You'll do it by adding a TextBlock, setting its font, and giving it a name:

- Select the Canvas, then drag a TextBlock out of the toolbox and onto it.
- Use the Name box in the Properties window to change the TextBlock's name to `gameOverText`.
- Use the Text section of the Properties window to change the font to Arial Black, change the size to 100 px, and make it Bold and Italic.
- Click on the TextBlock and drag it to the middle of the Canvas.
- Edit the text so it says `Game Over`.

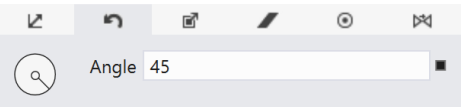
When you drag a control around a Canvas, its Left and Top properties are changed to set its position. If you change the Left and Top properties, you move the control.

8 **Add the target portal that the player will drag the human onto.**

There's one last control to add to the Canvas: the target portal that your player will drag the human into. (It doesn't matter where in the Canvas you drag it.)

Select the Canvas control, then drag a Rectangle control onto it. Use the button in the Brushes section of the Properties window to give it a gradient. Set its `Height` and `Width` properties to **50**.

Turn your rectangle into a diamond by rotating it 45 degrees. Open the Transform section of the Properties window to rotate the Rectangle 45 degrees by clicking on and setting the angle to **45**.



Finally, use the Name box in the Properties window to give it the name `target`.

Congratulations—you've finished building the main page for your app!

WHO DOES WHAT?

Now that you've built a user interface, you should have a sense of what some of the controls do, and you've used a lot of different properties to customize them. See if you can work out which property does what, and where in the Properties window in the IDE you find it.

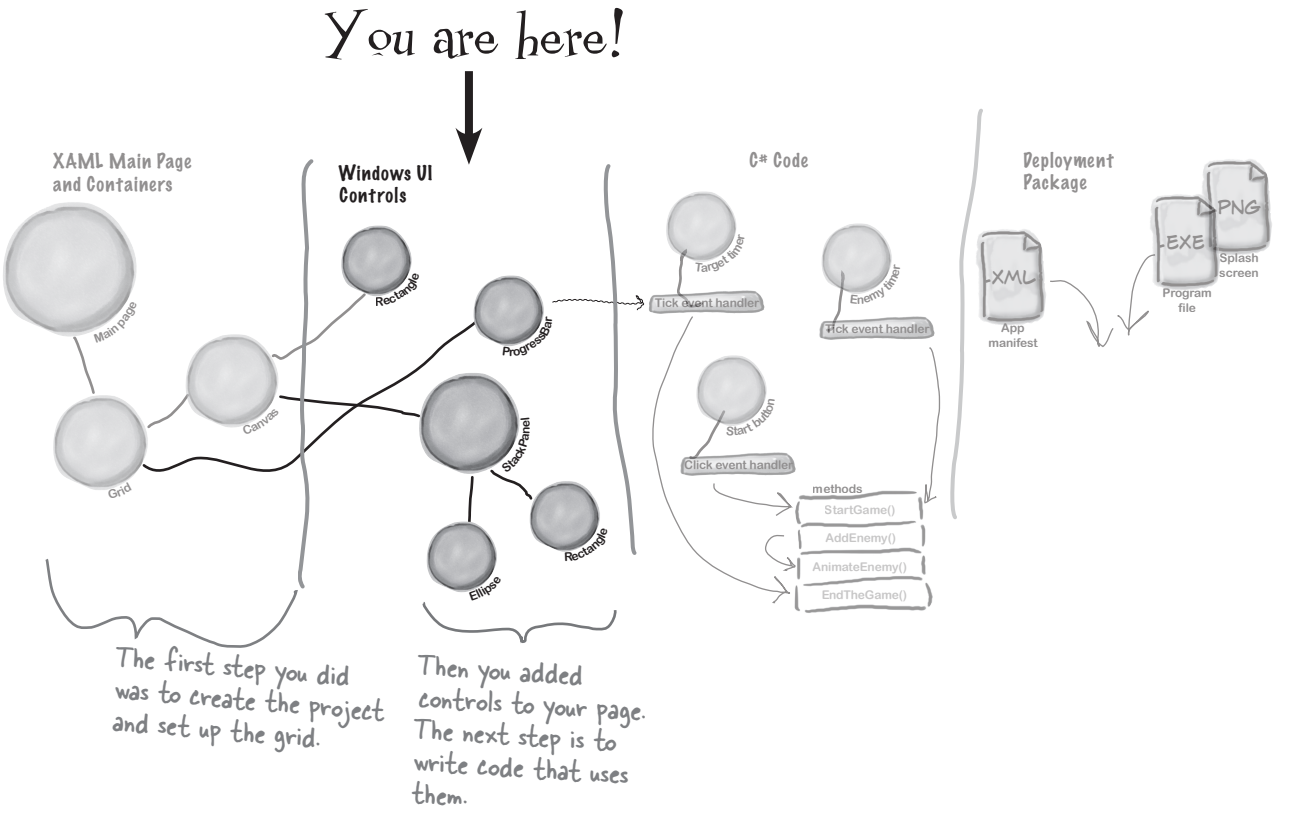
XAML property	Where to find it in the Properties window in the IDE	What it does
`Content`	At the top	Determines how tall the control should be
`Height`	Brush	Sets the angle that the control is turned
`Rotation`	Appearance	You use this in your C# code to manipulate a specific control
`Fill`	Common	The color of the control
`x:Name`	Layout	Use this when you want to change text displayed inside your control
	Transform	

Solution on page 37

Here's a hint: you can use the Search box in the Properties window to find properties—but some of these properties aren't on every type of control.

You've set the stage for the game

Your page is now all set for coding. You set up the grid that will serve as the basis of your page, and you added controls that will make up the elements of the game.



Visual Studio gave you useful tools for laying out your page, but all it really did was help you create XAML code. You're the one in charge!

What you'll do next

Now comes the fun part: adding the code that makes your game work. You'll do it in three stages: first you'll animate your enemies, then you'll let your player interact with the game, and finally you'll add polish to make the game look better.

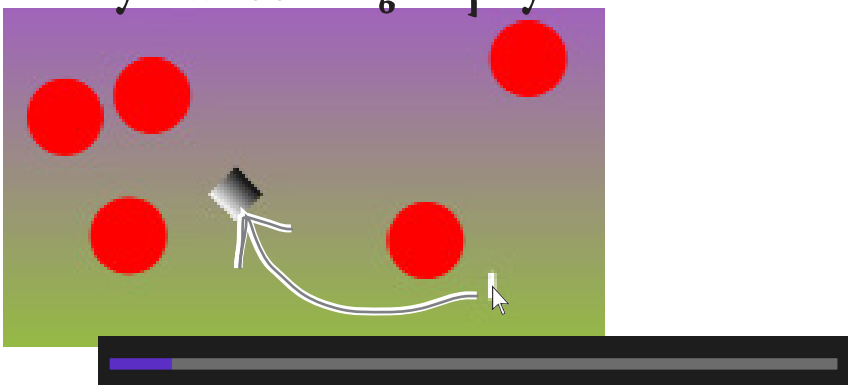
First you'll animate the enemies...

The first thing you'll do is add C# code that causes enemies to shoot out across the play area every time you click the Start button.

A lot of programmers build their code in small increments, making sure one piece works before moving on to the next one. That's how you'll build the rest of this program. You'll start by creating a method called `AddEnemy()` that adds an animated enemy to the Canvas control. First you'll hook it up to the Start button so you can fill your page up with bouncing enemies. That will lay the groundwork to build out the rest of the game.

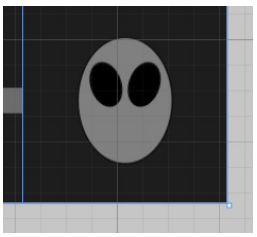
...then you'll add the gameplay...

To make the game work, you'll need the progress bar to count down, the human to move, and the game to end when the enemy gets him or time runs out.



You used a template to make the enemies look like red circles. Now you'll update the template to make them look like evil alien heads.

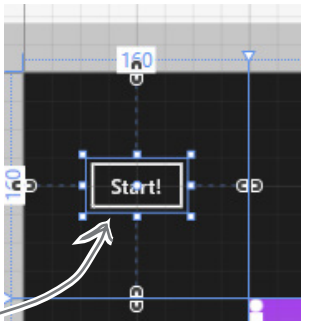
...and finally, you'll make it look good.



Add a method that does something

It's time to start writing some C# code, and the first thing you'll do is add a **method**—and the IDE can give you a great starting point by generating code.

When you're editing a page in the IDE, double-clicking on any of the controls on the page causes the IDE to automatically add code to your project. Make sure you've got the page designer showing in the IDE, and then double-click on the Start button. The IDE will add code to your project that gets run any time a user clicks on the button. You should see some code pop up that looks like this:



When you double-clicked on the Button control, the IDE created this method. It will run when a user clicks the "Start!" button in the running application.

```
private void startButton_Click(object sender, RoutedEventArgs e)
{

}
```

```
Click="startButton_Click"
```

The IDE also added this to the XAML. See if you can find it. You'll learn more about what this is in Chapter 2.

Use the IDE to create your own method

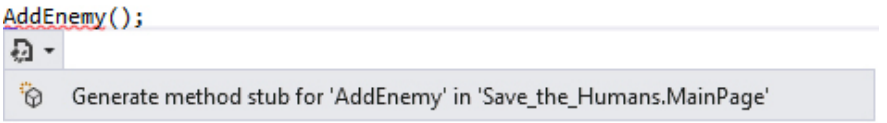
Click between the { } brackets and type this, including the parentheses and semicolon:

```
private void startButton_Click(object sender, RoutedEventArgs e)
{
    AddEnemy();
}
```

The red squiggly line is the IDE telling you there's a problem, and the blue box is the IDE telling you that it might have a solution.

Notice the red squiggly line underneath the text you just typed? That's the IDE telling you that something's wrong. If you click on the squiggly line, a blue box appears, which is the IDE's way of telling you that it might be able to help you fix the error.

Hover over the blue box and click the  icon that pops up. You'll see a box asking you to generate a method stub. What do you think will happen if you click it? Go ahead and click it to find out!



there are no Dumb Questions

Q: What's a method?

A: A **method** is just a *named block of code*. We'll talk a lot more about methods in Chapter 2.

Q: And the IDE generated it for me?

A: Yes...for now. A method is one of the basic building blocks of programs—you'll write a lot of them, and you'll get used to writing them by hand.

Fill in the code for your method

It's time to make your program ***do something***, and you've got a good starting point. The IDE generated a **method stub** for you: the starting point for a method that you can fill in with code.

C# code must be added exactly as you see it here.

It's really easy to throw off your code. When you're adding C# code to your program, the capitalization has to be exactly right, and make sure you get all of the parentheses, commas, and semicolons. If you miss one, your program won't work!

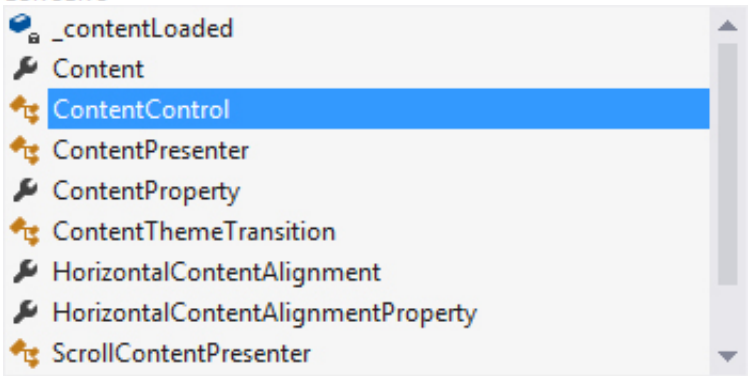
1. Delete the contents of the method stub that the IDE generated for you.

```
private void AddEnemy()
{
    throw new NotImplementedException();
}
```

Select this and delete it. You'll learn about exceptions in Chapter 12.

2. Start adding code. Type the word Content into the method body. The IDE will pop up a window called an **IntelliSense Window** with suggestions. Choose `ContentControl` from the list.

```
private void AddEnemy()
{
    Content
}
```



3. Finish adding the first line of code. You'll get another IntelliSense window after you type `new`.

```
private void AddEnemy()
{
    ContentControl enemy = new ContentControl();
}
```

This line creates a new ContentControl object. You'll learn about objects and the new keyword in Chapter 3, and reference variables like enemy in Chapter 4.

4 Before you fill in the `AddEnemy()` method, you'll need to add a line of code near the top of the file. Find the line that starts with **`public sealed partial class MainPage`** and add this line after the bracket (**{**):

```
/// <summary>
/// A basic page that provides characteristics common to most applications.
/// </summary>
public sealed partial class MainPage : Save_the_Humans.Common.LayoutAwarePage
{
    Random random = new Random();
```

This is called a field. You'll learn more about how it works in Chapter 4.

5 Finish adding the method. You'll see some squiggly red underlines. The ones under `AnimateEnemy()` will go away when you generate its method stub.

Do you see a squiggly underline under playArea? Go back to the XAML editor and sure you set the name of the Canvas control to playArea.

```
private void AddEnemy()
{
    ContentControl enemy = new ContentControl();
    enemy.Template = Resources["EnemyTemplate"] as ControlTemplate;
    AnimateEnemy(enemy, 0, playArea.ActualWidth - 100, "(Canvas.Left)");
    AnimateEnemy(enemy, random.Next((int)playArea.ActualHeight - 100),
        random.Next((int)playArea.ActualHeight - 100), "(Canvas.Top)");
    playArea.Children.Add(enemy);
}
```

This line adds your new enemy control to a collection called Children. You'll learn about collections in Chapter 8.

If you need to switch between the XAML and C# code, use the tabs at the top of the window.

6 Use the blue box and the  button to generate a method stub for `AnimateEnemy()`, just like you did for `AddEnemy()`. This time it added four **parameters** called `enemy`, `p1`, `p2`, and `p3`. Edit the top line of the method to change the last three parameters. Change the parameter `p1` to **`from`**, the parameter `p2` to **`to`**, and the parameter `p3` to **`propertyToAnimate`**. Then change any `int` types to **`double`**.

```
private void AnimateEnemy(ContentControl enemy, int p1, double p2, string p3)
{
    throw new NotImplementedException();
}
```

You'll learn about methods and parameters in Chapter 2.

```
private void AnimateEnemy(ContentControl enemy, double from, double to, string propertyToAnimate)
```

The IDE may generate the method stub with "int" types. Change them to "double". You'll learn about types in Chapter 4.

Flip the page to see your program run!

Finish the method and run your program

Your program is almost ready to run! All you need to do is finish your `AnimateEnemy()` method. Don't panic if things don't quite work yet. You may have missed a comma or some parentheses—when you're programming, you need to be really careful about those things!

Still seeing red? The IDE helps you track down problems.

If you still have some of those red squiggly lines, don't worry! You probably just need to track down a typo or two. If you're still seeing squiggly red underlines, it just means you didn't type in some of the code correctly. We've tested this chapter with a lot of different people, and we didn't leave anything out. All of the code you need to get your program working is in these pages.

1 Add a using statement to the top of the file.

Scroll all the way to the top of the file. The IDE generated several lines that start with `using`. Add one more to the bottom of the list:

Statements like these let you use code from .NET libraries that come with C#. You'll learn more about them in Chapter 2.

```
using System;
using System.Collections.Generic;
using System.IO;
using System.Linq;
using Windows.Foundation;
using Windows.Foundation.Collections;
using Windows.UI.Xaml;
using Windows.UI.Xaml.Controls;
using Windows.UI.Xaml.Controls.Primitives;
using Windows.UI.Xaml.Data;
using Windows.UI.Xaml.Input;
using Windows.UI.Xaml.Media;
using Windows.UI.Xaml.Navigation;

using Windows.UI.Xaml.Media.Animation;
```

You'll need this line to make the next bit of code work. You can use the IntelliSense window to get it right—and don't forget the semicolon at the end.

This using statement lets you use animation code from the .NET Framework in your program to move the enemies on your screen.

2 Add code that creates an enemy bouncing animation.

You generated the method stub for the `AnimateEnemy()` method on the previous page. Now you'll add its code. It makes an enemy start bouncing across the screen.

You'll learn about object initializers like this in Chapter 4.

And you'll learn about animation in Chapter 16.

```
private void AnimateEnemy(ContentControl enemy, double from, double to, string propertyToAnimate)
{
    Storyboard storyboard = new Storyboard() { AutoReverse = true, RepeatBehavior = RepeatBehavior.Forever };
    DoubleAnimation animation = new DoubleAnimation()
    {
        From = from,
        To = to,
        Duration = new Duration(TimeSpan.FromSeconds(random.Next(4, 6)))
    };
    Storyboard.SetTarget(animation, enemy);
    Storyboard.SetTargetProperty(animation, propertyToAnimate);
    storyboard.Children.Add(animation);
    storyboard.Begin();
}
```

This code makes the enemy you created move across playArea. If you change 4 and 6, you can make the enemies move slower or faster.

3 Look over your code.

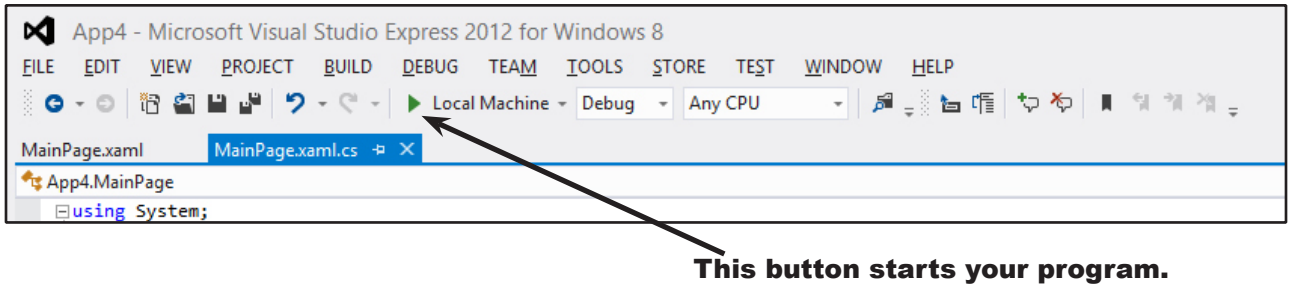
You shouldn't see any errors, and your Error List window should be empty. If not, double-click on the error in the Error List. The IDE will jump your cursor to the right place to help you track down the problem.

If you can't see the Error List window, choose Error List from the View menu to show it. You'll learn more about using the error window and debugging your code in Chapter 2.

Here's a hint: if you move too many windows around your IDE, you can always reset by choosing Reset Window Layout from the Window menu.

4 Start your program.

Find the ▶ button at the top of the IDE. This starts your program running.



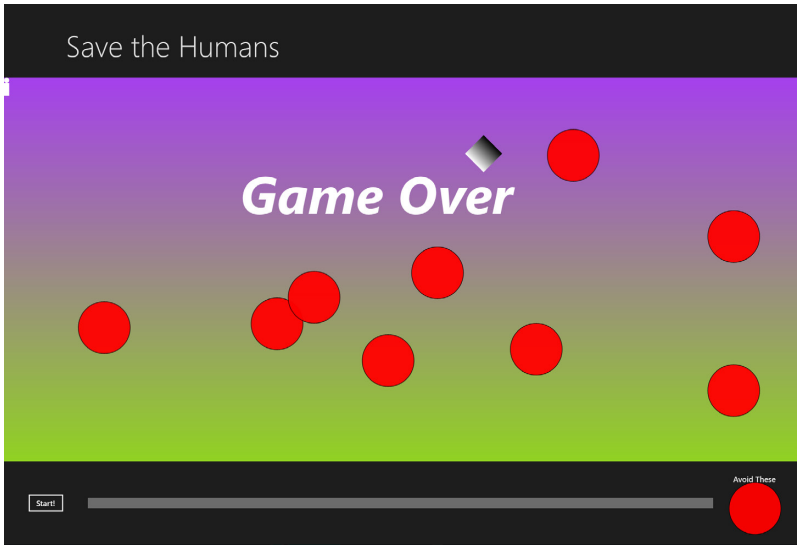
This button starts your program.

5 Now your program is running!

First, a big X will be displayed for a few seconds, and then your main page will be displayed. Click the "Start!" button a few times. Each time you click it, a circle is launched across your canvas.

This big X is the splash screen. You'll make your own splash screen at the end of the chapter.

You built something cool! And it didn't take long, just like we promised. But there's more to do to get it right.



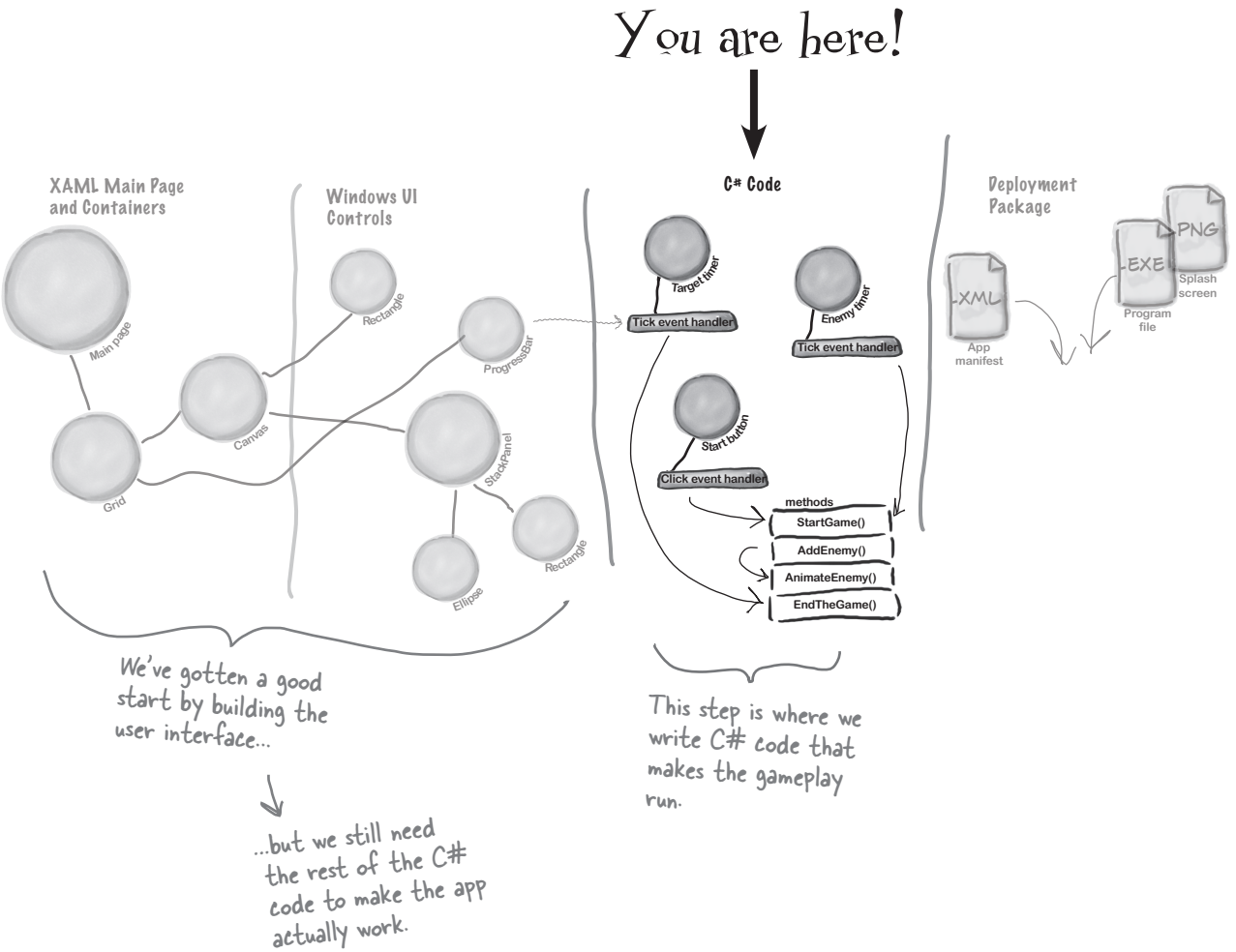
If the enemies aren't bouncing, or if they leave the play area, double-check the code. You may be missing parentheses or keywords.

6 Stop your program.

Press Alt-Tab to switch back to the IDE. The ▶ button in the toolbar has been replaced with ⏸ ■ ↻ to break, stop, and restart your program. Click the square to stop the program running.

Here's what you've done so far

Congratulations! You've built a program that actually does something. It's not quite a playable game, but it's definitely a start. Let's look back and see what you built.



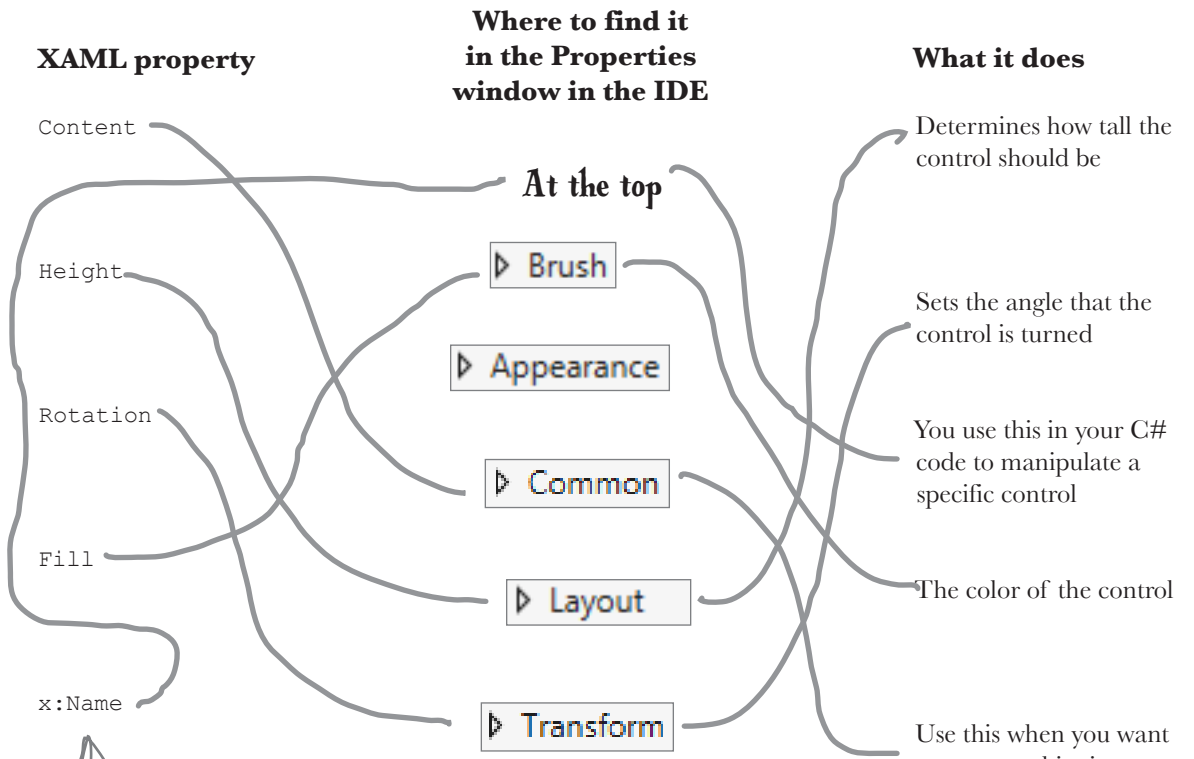
Visual Studio can generate code for you, but you need to know what you want to build BEFORE you start building it. It won't do that for you!

Here's the solution for the "Who Does What" exercise on page 28. We'll give you the anwers to the pencil-and-paper puzzles and exercises, but they won't always be on the next page.

WHO DOES WHAT?

solution

Now that you've built a user interface, you should have a sense of what some of the controls do, and you've used a lot of different properties to customize them. See if you can work out which property does what, and where in the Properties window in the IDE you find it.



Remember how you set the Name of the Canvas control to "playArea"? That set its "x:Name" property in the XAML, which will come in handy in a minute when you write C# code to work with the Canvas.

Add timers to manage the gameplay

Let's build on that great start by adding working gameplay elements. This game adds more and more enemies, and the progress bar slowly fills up while the player drags the human to the target. You'll use **timers** to manage both of those things.

The MainPage.Xaml.cs file you've been editing contains the code for a class called MainPage. You'll learn about classes in Chapter 3.

1 **ADD MORE LINES TO THE TOP OF YOUR C# CODE.** Go up to the top of the file where you added that `Random` line. Add three more lines:

```
/// <summary>
/// A basic page that provides characteristics common to most applications.
/// </summary>
public sealed partial class MainPage : Save_the_Humans.Common.LayoutAwarePage
{
    Random random = new Random();
    DispatcherTimer enemyTimer = new DispatcherTimer();
    DispatcherTimer targetTimer = new DispatcherTimer();
    bool humanCaptured = false;
```

Add these three lines below the one you added before. These are fields, and you'll learn about them in Chapter 4.

2 **ADD A METHOD FOR ONE OF YOUR TIMERS.** Find this code that the IDE generated:

```
public MainPage()
{
    this.InitializeComponent();
}
```

Put your cursor right after the semicolon, hit Enter two times, and type `enemyTimer.` (including the period). As soon as you type the dot, an IntelliSense window will pop up. Choose `Tick` from the IntelliSense window and type the following text. As soon as you enter `+=` the IDE pops up a box:

```
enemyTimer.Tick +=
```

enemyTimer_Tick; (Press TAB to insert)

Press the Tab key. The IDE will pop up another box:

```
enemyTimer.Tick +=enemyTimer_Tick;
```

Press TAB to generate handler 'enemyTimer_Tick' in this class

Press Tab one more time. Here's the code the IDE generated for you:

```
public MainPage()
{
    this.InitializeComponent();

    enemyTimer.Tick += enemyTimer_Tick;
}

void enemyTimer_Tick(object sender, object e)
{
    throw new NotImplementedException();
}
```

The IDE generated a method for you called an event handler. You'll learn about event handlers in Chapter 15.

Timers "tick" every time interval by calling methods over and over again. You'll use one timer to add enemies every few seconds, and the other to end the game when time expires.

It's normal to add parentheses () when writing about a method.

3 FINISH THE MainPage() METHOD.

You'll add another `Tick` event handler for the other timer, and you'll add two more lines of code. Here's what your finished `MainPage()` method and the two methods the IDE generated for you should look like:

```
public MainPage()
{
    this.InitializeComponent();

    enemyTimer.Tick += enemyTimer_Tick;
    enemyTimer.Interval = TimeSpan.FromSeconds(2);

    targetTimer.Tick += targetTimer_Tick;
    targetTimer.Interval = TimeSpan.FromSeconds(.1);
}

void targetTimer_Tick(object sender, object e)
{
    throw new NotImplementedException();
}

void enemyTimer_Tick(object sender, object e)
{
    throw new NotImplementedException();
}
```

Try changing these numbers once your game is finished. How does that change the gameplay?

The IDE generated these lines as placeholders when you pressed Tab to add the Tick event handlers. You'll replace them with code that gets run every time the timers tick.

BRAIN POWER

Right now your Start button adds bouncing enemies to the play area. What do you think you'll need to do to make it start the game instead?

4 ADD THE EndTheGame() METHOD.

Go to the new `targetTimer_Tick()` method, delete the line that the IDE generated, and add the following code. The IntelliSense window might not seem quite right:

```
void targetTimer_Tick(object sender, object e)
{
    progressBar.Value += 1;
    if (progressBar.Value >= progressBar.Maximum)
        EndTheGame();
}
```

Did the IDE keep trying to capitalize the P in progressBar? That's because there was no lowercase-P progressBar, and the closest match it could find was the type of the control.

If you closed the Designer tab that had the XAML code, double-click on MainPage.xaml in the Solution Explorer window to bring it up.

Notice how `progressBar` has an error? That's OK. We did this on purpose (and we're not even sorry about it!) to show you what it looks like when you try to use a control that doesn't have a name, or has a typo in the name. Go back to the XAML code (it's in the other tab in the IDE), find the ProgressBar control that you added to the bottom row, and change its name to `progressBar`.

Next, go back to the code window and generate a method stub for `EndTheGame()`, just like you did a few pages ago for `AddEnemy()`. Here's the code for the new method:

```
private void EndTheGame()
{
    if (!playArea.Children.Contains(gameOverText))
    {
        enemyTimer.Stop();
        targetTimer.Stop();
        humanCaptured = false;
        startButton.Visibility = Visibility.Visible;
        playArea.Children.Add(gameOverText);
    }
}
```

If gameOverText comes up as an error, it means you didn't set the name of the "Game Over" TextBlock. Go back and do it now.

This method ends the game by stopping the timers, making the Start button visible again, and adding the GAME OVER text to the play area.

Make the Start button work

Remember how you made the Start button fire circles into the Canvas? Now you'll fix it so it actually starts the game.

Ready Bake Code

We're giving you a lot of code to type in.

By the end of the book, you'll know what all of this code does—in fact, you'll be able to write code just like it on your own.

For now, your job is to make sure you enter each line accurately, and to follow the instructions exactly. This will get you used to entering code, and will help give you a feel for the ins and outs of the IDE.

If you get stuck, you can download working versions of *MainPage.xaml* and *MainPage.Xaml.cs* or copy and paste XAML or C# code for each individual method: *http://www.headfirstlabs.com/hfcsharp.*

1 **Make the Start button start the game.**

Find the code you added earlier to make the Start button add an enemy. Change it so it looks like this:

```
private void startButton_Click(object sender, RoutedEventArgs e)
{
    StartGame();
}
```

When you change this line, you make the Start button start the game instead of just adding an enemy to the playArea Canvas.

2 **Add the StartGame() method.**

Generate a method stub for the `StartGame()` method. Here's the code to fill into the stub method that the IDE added:

```
private void StartGame()
{
    human.IsHitTestVisible = true;
    humanCaptured = false;
    progressBar.Value = 0;
    startButton.Visibility = Visibility.Collapsed;
    playArea.Children.Clear();
    playArea.Children.Add(target);
    playArea.Children.Add(human);
    enemyTimer.Start();
    targetTimer.Start();
}
```

You'll learn about IsHitTestVisible in Chapter 15.

Did you forget to set the names of the target Rectangle or the human StackPanel? You can look a few pages back to make sure you set the right names for all of the controls.

3 **Make the enemy timer add the enemies.**

Find the `enemyTimer_Tick()` method that the IDE added for you and replace its contents with this:

```
void enemyTimer_Tick(object sender, object e)
{
    AddEnemy();
}
```

Once you're used to working with code, you'll be good at spotting those missing parentheses, semicolons, etc.

Are you seeing errors in the Error List window that don't make sense? One misplaced comma or semicolon can cause two, three, four, or more errors to show up. Don't waste your time trying to track down every typo! Just go to the Head First Labs web page—we made it really easy for you to copy and paste all of the code in this program.

http://www.headfirstlabs.com/hfcsharp/

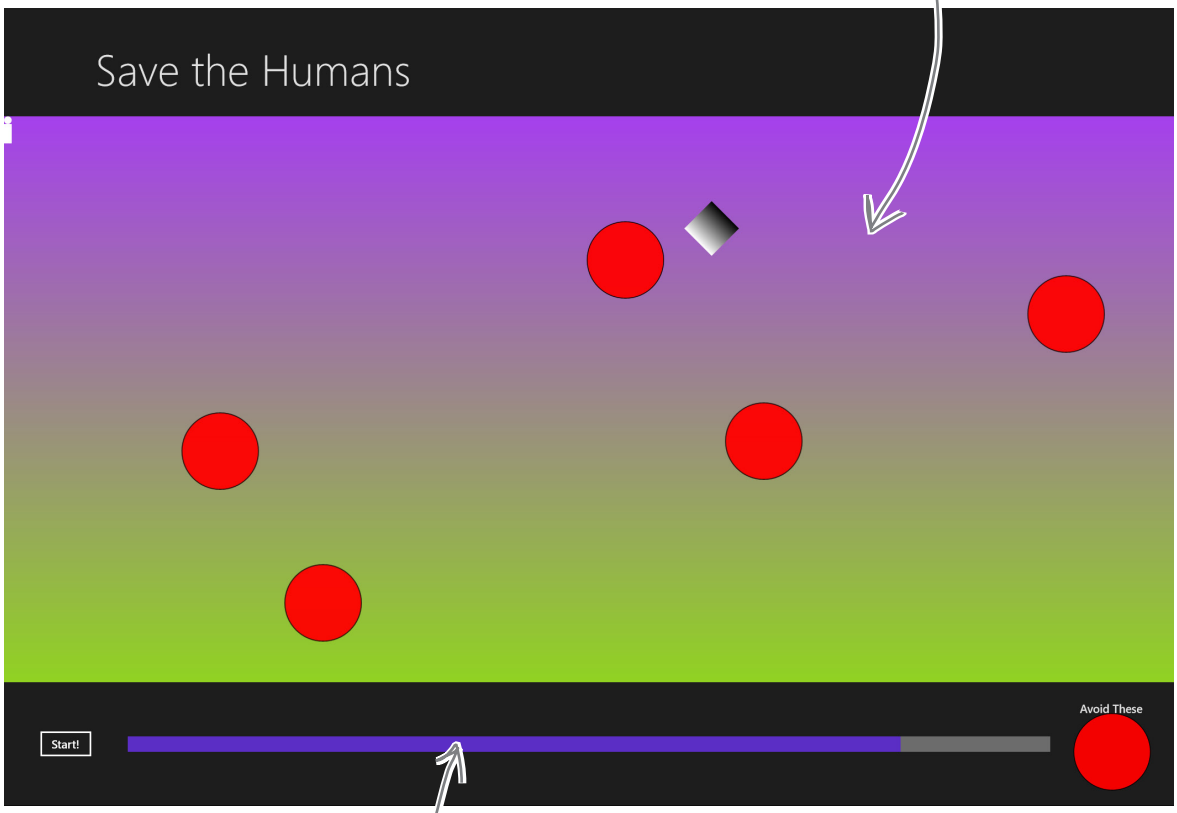
Run the program to see your progress

Your game is coming along. Run it again to see how it's shaping up.

Alert! Our spies have reported that the humans are building up their defenses!

When you press the "Start!" button, it disappears, clears the enemies, and starts the progress bar filling up.

The play area slowly starts to fill up with bouncing enemies.



When the progress bar at the bottom fills up, the game ends and the Game Over text is displayed.

The target timer should fill up slowly, and the enemies should appear every two seconds. If the timing is off, make sure you added all of the lines to the MainPage() method.

BRAIN POWER

What do you think you'll need to do to get the rest of your game working?

Flip the page to find out!

Add code to make your controls interact with the player

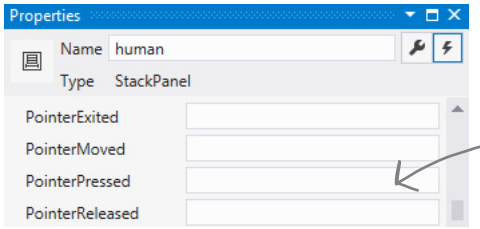
You've got a human that the player needs to drag to the target, and a target that has to sense when the human's been dragged to it. It's time to add code to make those things work.

Make sure you switch back to the IDE and stop the app before you make more changes to the code.

You'll learn more about the event handlers in the Properties window in Chapter 4.

1. Go to the XAML designer and use the Document Outline window to select `human` (remember, it's the StackPanel that contains a Circle and a Rectangle). Then go to the Properties window and press the button to switch it to show event handlers. Find the PointerPressed row and double-click in the empty box.

The Document Outline may have collapsed [Grid], playArea, and other lines. If it did, just expand them to find the human control.



Now go back and check out what the IDE added to your XAML for the StackPanel:

```
<StackPanel x:Name="human" Orientation="Vertical" PointerPressed="human_PointerPressed">
```

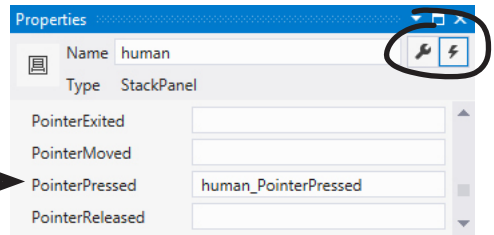
It also generated a method stub for you. Right-click on `human_PointerPressed` in the XAML and choose "Navigate to Event Handler" to jump straight to the C# code:

```
private void human_PointerPressed(object sender, PointerRoutedEventArgs e)
{

}
```

2. Fill in the C# code:

```
private void human_PointerPressed(object sender, PointerRoutedEventArgs e)
{
    if (enemyTimer.IsEnabled)
    {
        humanCaptured = true;
        human.IsHitTestVisible = false;
    }
}
```

You can use these buttons to switch between showing properties and event handlers in the Properites window.



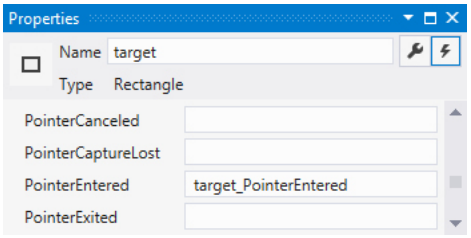
If you go back to the designer and click on the StackPanel again, you'll see that the IDE filled in the name of the new event handler method. You'll be adding more event handler methods the same way.

Make sure you add the right event handler! You added a PointerPressed event handler to the human, but now you're adding a PointerEntered event handler to the target.

3 Use the Document Outline window to select the Rectangle named `target`, then use the event handlers view of the Properties window to add a `PointerEntered` event handler. Here's the code for the method:

When the Properties window is in the mode where it displays event handlers, double-clicking on an empty event handler box causes the IDE to add a method stub for it.

```
private void target_PointerEntered(object sender, PointerRoutedEventArgs e)
{
    if (targetTimer.IsEnabled && humanCaptured)
    {
        progressBar.Value = 0;
        Canvas.SetLeft(target, random.Next(100, (int)playArea.ActualWidth - 100));
        Canvas.SetTop(target, random.Next(100, (int)playArea.ActualHeight - 100));
        Canvas.SetLeft(human, random.Next(100, (int)playArea.ActualWidth - 100));
        Canvas.SetTop(human, random.Next(100, (int)playArea.ActualHeight - 100));
        humanCaptured = false;
        human.IsHitTestVisible = true;
    }
}
```



You'll need to switch your Properties window back to show properties instead of event handlers.

4 Now you'll add two more event handlers, this time to the `playArea` Canvas control. You'll need to find the right `[Grid]` in the Document Outline (there are two of them—use the child grid that's indented under the main grid for the page) and set its name to `grid`. Then you can add these event handlers to playArea:

```
private void playArea_PointerMoved(object sender, PointerRoutedEventArgs e)
{
    if (humanCaptured)
    {
        Point pointerPosition = e.GetCurrentPoint(null).Position;
        Point relativePosition = grid.TransformToVisual(playArea).TransformPoint(pointerPosition);
        if ((Math.Abs(relativePosition.X - Canvas.GetLeft(human)) > human.ActualWidth * 3)
            || (Math.Abs(relativePosition.Y - Canvas.GetTop(human)) > human.ActualHeight * 3))
        {
            humanCaptured = false;
            human.IsHitTestVisible = true;
        }
        else
        {
            Canvas.SetLeft(human, relativePosition.X - human.ActualWidth / 2);
            Canvas.SetTop(human, relativePosition.Y - human.ActualHeight / 2);
        }
    }
}
```

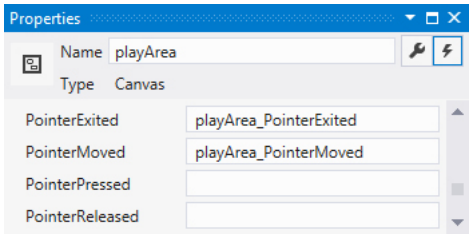
That's a lot of parentheses! Be really careful and get them right.

These two vertical bars are a logical operator. You'll learn about them in Chapter 2.

You can make the game more or less sensitive by changing these 3s to a lower or higher number.

```
private void playArea_PointerExited(object sender, PointerRoutedEventArgs e)
{
    if (humanCaptured)
        EndTheGame();
}
```

Make sure you put the right code in the correct event handler! Don't accidentally swap them.



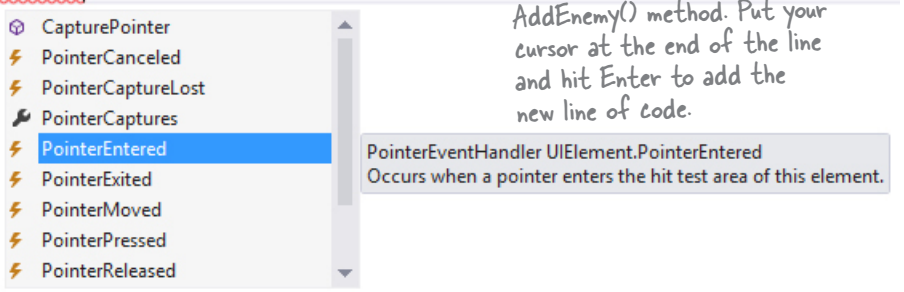
Dragging humans onto enemies ends the game

When the player drags the human into an enemy, the game should end. Let's add the code to do that. Go to your `AddEnemy()` method and add one more line of code to the end. Use the IntelliSense window to fill in `enemyPointer.PointerEntered` from the list:

```
private void AddEnemy()
{
    ContentControl enemy = new ContentControl();
    enemy.Template = Resources["EnemyTemplate"] as ControlTemplate;
    AnimateEnemy(enemy, 0, playArea.ActualWidth - 100, "(Canvas.Left)");
    AnimateEnemy(enemy, random.Next((int)playArea.ActualHeight - 100),
        random.Next((int)(playArea.ActualHeight - 100)), "(Canvas.Top)");
    playArea.Children.Add(enemy);

    enemy.Pointer
}
```

Here's the last line of your AddEnemy() method. Put your cursor at the end of the line and hit Enter to add the new line of code.

Start typing this line of code. As soon as you enter the dot, an IntelliSense window will pop up. Keep typing "Pointer" to jump down to the entries in the list that start with "Pointer..."



Choose `PointerEntered` from the list. (If you choose the wrong one, don't worry—just backspace over it to delete everything past the dot. Then enter the dot again to bring up the IntelliSense window.)

Next, add an event handler, just like you did before. Type += and then press Tab:

```
enemy.PointerEntered +=
```

enemy_PointerEntered; (Press TAB to insert)

You'll learn all about how event handlers like this work in Chapter 15.

Then press Tab again to generate the stub for your event handler:

```
enemy.PointerEntered += enemy_PointerEntered;
```

Press TAB to generate handler 'enemy_PointerEntered' in this class

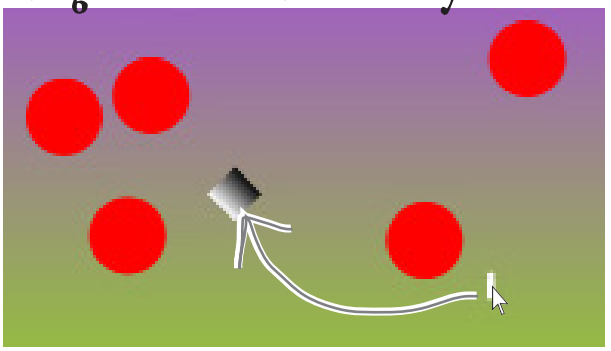
Now you can go to the new method that the IDE generated for you and fill in the code:

```
void enemy_PointerEntered(object sender, PointerRoutedEventArgs e)
{
    if (humanCaptured)
        EndTheGame();
}
```

Your game is now playable

Run your game—it's almost done! When you click the Start button, your play area is cleared of any enemies, and only the human and target remain. You have to get the human to the target before the progress bar fills up. Simple at first, but it gets harder as the screen fills with dangerous alien enemies!

Drag the human to safety!

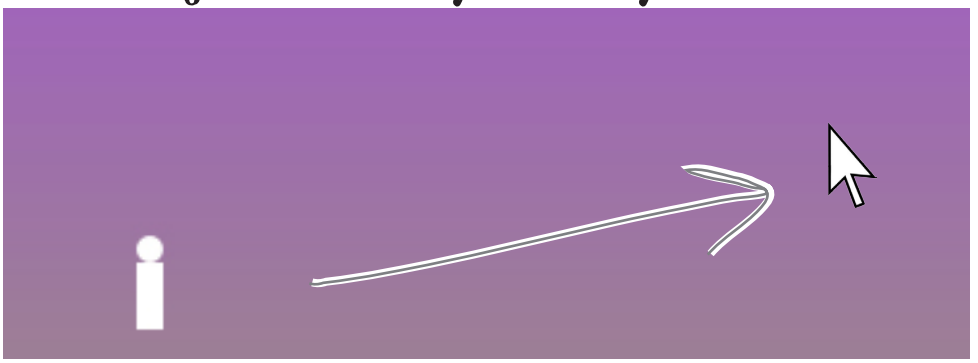


The aliens only spend their time patrolling for moving humans, so the game only ends if you drag a human onto an enemy. Once you release the human, he's temporarily safe from aliens.

Look through the code and find where you set the IsHitTestVisible property on the human. When it's on, the human intercepts the PointerEntered event because the human's StackPanel control is sitting between the enemy and the pointer.

Get him to the target before time's up...

...but drag too fast, and you'll lose your human!



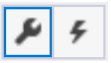
Make your enemies look like aliens

Red circles aren't exactly menacing. Luckily, you used a template. All you need to do is update it.

Watch it!

Seeing events instead of properties?

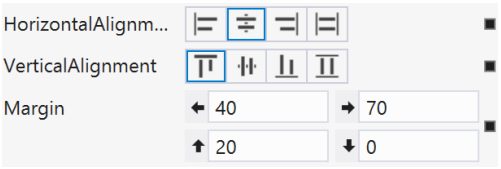
You can toggle the Properties window between displaying properties or events for the selected control by clicking the wrench or lightning bolt icons.



1. Go to the Document Outline, right-click on the ContentControl, choose Edit Template, and then Edit Current to edit the template. You'll see the template in the XAML window. Edit the XAML code for the ellipse to set the width to `75` and the fill to `Gray`. Then add `Stroke="Black"` to add a black outline, and reset its vertical and horizontal alignments. Here's what it should look like (you can delete any additional properties that may have inadvertently been added while you worked on it):

```
<Ellipse Fill="Gray" Height="100" Width="75" Stroke="Black" />
```

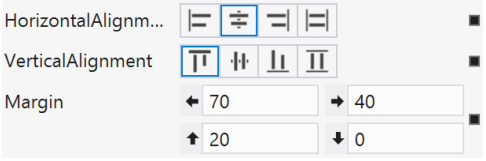
2. Drag another Ellipse control out of the toolbox on top of the existing ellipse. Change its **Fill** to black, set its width to `25`, and its height to `35`. Set the alignment and margins like this:



You can also "eyeball" it (excuse the pun) by using the mouse or arrow keys to drag the ellipse into place. Try using Copy and Paste in the Edit menu to copy the ellipse and paste another one on top of it.

3. Use the ◢ button in the Transforms section of the Properties window to add a Skew transform:

4. Drag one more Ellipse control out of the toolbox on top of the existing ellipse. Change its fill to `Black`, set its width to `25`, and set its height to `35`. Set the alignment and margins like this:



and add a skew like this:

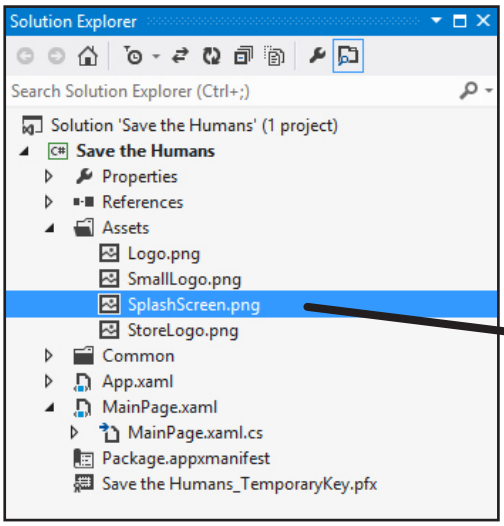
Now your enemies look a lot more like human-eating aliens.

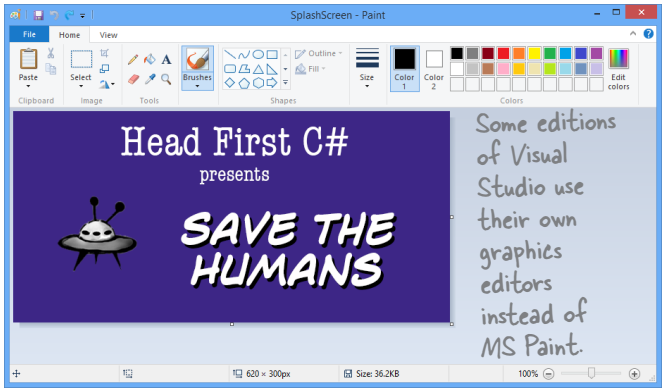
Add a splash screen and a tile

That big X that appears when you start your program is a splash screen. And when you go back to the Windows Start page, there it is again in the tile. Let's change these things.

Don't feel like making your own splash screen or logos? You can download ours: http://www.headfirstlabs.com/hfcsharp

Expand the Assets folder in the Solution Explorer window and you'll see four files. Double-click each of them to edit them in Paint. Edit *SplashScreen.png* to create a splash screen that's displayed when the game starts. *Logo.png* and *SmallLogo.png* are displayed in the Start screen. And when your app is displayed in the search results (or in the Windows Store!), it displays *StoreLogo.png*.






```
<ControlTemplate x:Key="EnemyTemplate" TargetType="ContentControl">
    <Grid>
        <Ellipse Fill="Gray" Stroke="Black" Height="100" Width="75"/>
        <Ellipse Fill="Black" Stroke="Black" Height="35" Width="25"
                 HorizontalAlignment="Center" VerticalAlignment="Top"
                 Margin="40,20,70,0" RenderTransformOrigin="0.5,0.5">
            <Ellipse.RenderTransform>
                <CompositeTransform SkewX="10"/>
            </Ellipse.RenderTransform>
        </Ellipse>
        <Ellipse Fill="Black" Stroke="Black" Height="35"  Width="25"
                 HorizontalAlignment="Center" VerticalAlignment="Top"
                 Margin="70,20,40,0" RenderTransformOrigin="0.5,0.5">
            <Ellipse.RenderTransform>
                <CompositeTransform SkewX="-10"/>
            </Ellipse.RenderTransform>
        </Ellipse>
    </Grid>
</ControlTemplate>
```

Here's the updated XAML for the new enemy template that you created.

See if you can get creative and change the way the human, target, play area, and enemies look.

THERE'S JUST ONE MORE THING YOU NEED TO DO...

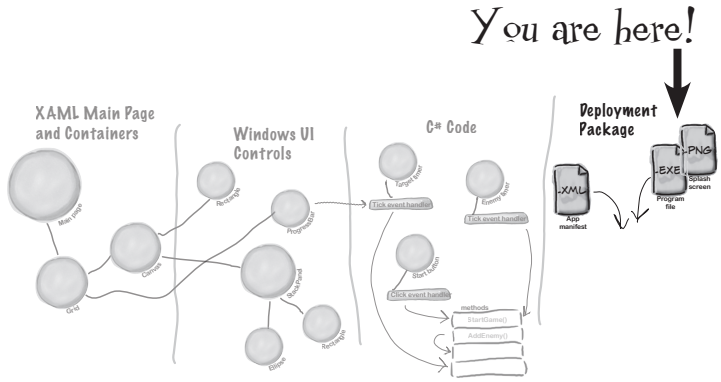
PLAY YOUR GAME!

And don't forget to step back and really appreciate what you built. Good job!

Publish your app

You should be pretty pleased with your app! Now it's time to deploy it. When you publish your app to the Windows Store, you make it available to millions of potential users. The IDE can help guide you through the steps to publish your app to the Windows Store.

Here's what it takes to get your app out there:

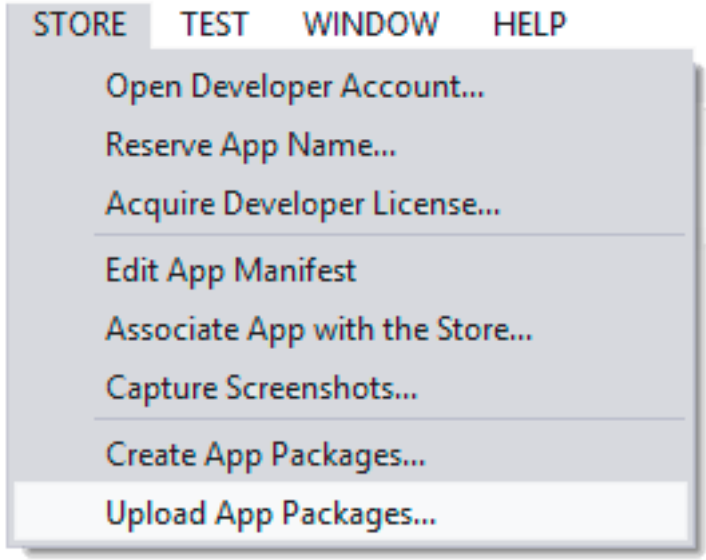


1. Open a Windows Store developer account.

2. Choose your app's name, set an age rating, write a description, and choose a business model to determine if your app is free, ad-supported, or has a price.

3. Test your app using the Windows App Certification Kit to identify and fix any problems.

4. **Submit your app to the Store!** Once it's accepted, millions of people around the world can find and download it.



The Store menu in the IDE has all of the tools you need to publish your app.

In some editions of Visual Studio, the Windows Store options appear under the Project menu instead of having their own top-level Store menu.

Throughout the book we'll show you where to find more information from MSDN, the Microsoft Developer Network. This is a really valuable resource that helps you keep expanding your knowledge.

You can learn more about how to publish apps to the Windows Store here:
http://msdn.microsoft.com/en-us/library/windows/apps/jj657972.aspx

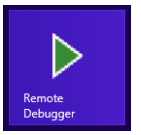
Use the Remote Debugger to sideload your app

Sometimes you want to run your app on a remote machine without publishing it to the Windows Store. When you install your app on a machine without going through the Windows Store it's called **sideloading**, and one of the easiest ways to do it is to install the **Visual Studio Remote Debugger** on another computer.

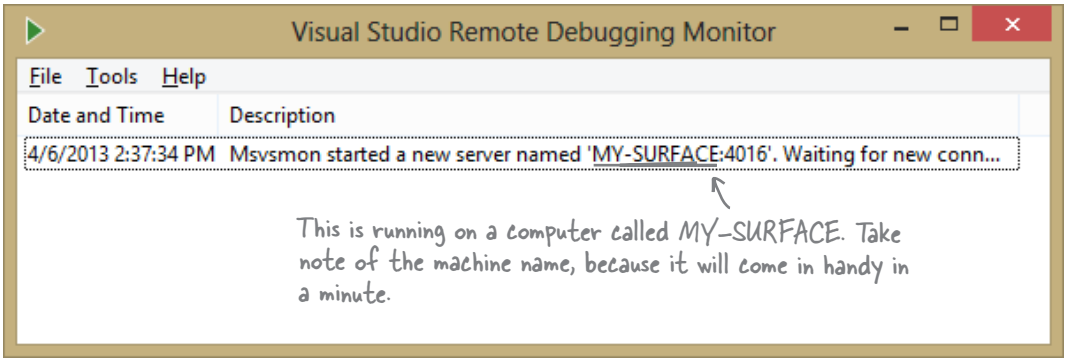
Here's how to get your app loaded using the Remote Debugger:

At the time this is being written, you'll find "Remote Tools for Visual Studio 2012 Update 2," but you may find future updates.

- Make sure the remote machine is running Windows 8.
- Go to the Microsoft Download Center (*http://www.microsoft.com/en-hk/download/default.aspx*) on the remote machine and search for "Remote Tools for Visual Studio 2012."
- Download the installer for your machine's architecture (x86, x64, ARM) and run it to install the remote tools.
- Go to the Start page and launch the Remote Debugger.



- If your computer's network configuration needs to change, it may pop up a wizard to help with that. Once it's running, you'll see the Visual Studio Remote Debugging Monitor window:



- Your remote computer is now running the Visual Studio Remote Debugging Monitor and waiting for incoming connections from Visual Studio on your development machine.

If you have an odd network setup, you may have trouble running the remote debugger. This MDSN page can help you get it set up: http://msdn.microsoft.com/en-us/library/vstudio/bt727f1t.aspx

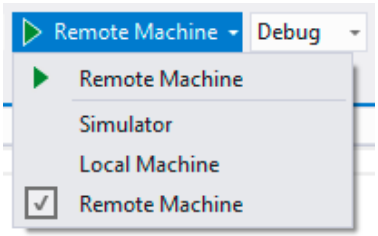
Flip to get your app up and running on the remote computer!

Start remote debugging

Once you've got a remote computer running the remote debugging monitor, you can launch the app from Visual Studio to install and run it. This will automatically sideload your app on the computer, and you'll be able to run it again from the Start page any time you want.

1 CHOOSE "REMOTE MACHINE" FROM THE DEBUG DROP-DOWN.

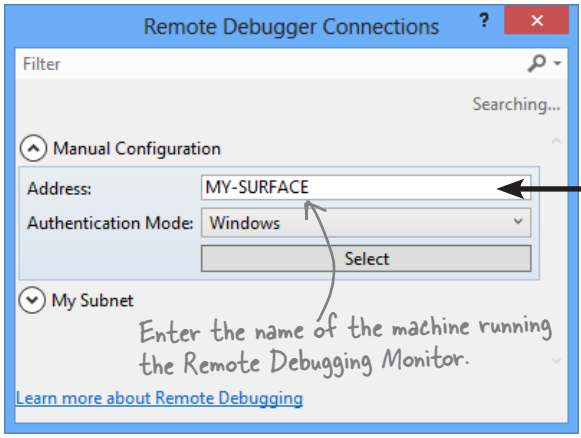
You can use the Debug drop-down to tell the IDE to run your program on a remote machine. Take a close look at the Local Machine button you've been using to run your program—you'll see a drop-down ( ). Click it to show the drop-down and choose Remote Machine:



Don't forget to change this back to Simulator when you're ready to move on to the next chapter! You'll be writing a bunch of programs, and you'll need this button to run them.

2 RUN YOUR PROGRAM ON THE REMOTE MACHINE.

Now run your program by clicking the button. The IDE will pop up a window asking for the machine to run on. If it doesn't detect it in your subnet, you can enter the machine name manually:



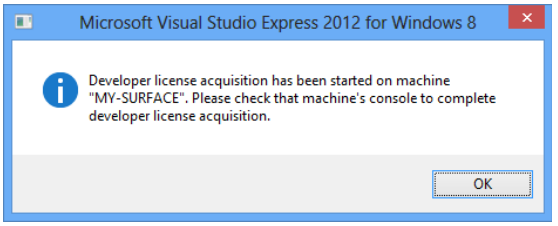
If you need to change the machine in the future, you can do it in the project settings. Right-click on the project name in the Solution Explorer and choose Properties, then choose the Debug tab. If you clear the Remote machine: field and restart the remote debugger, the Remote Debugger Connections window will pop up again.

3 ENTER YOUR CREDENTIALS.

You'll be prompted to enter the username and password of the user on the remote machine. You can turn off authentication in the Remote Debugging Monitor if you want to avoid this (but that's not a great idea, because then anyone can run programs on your machine remotely!).

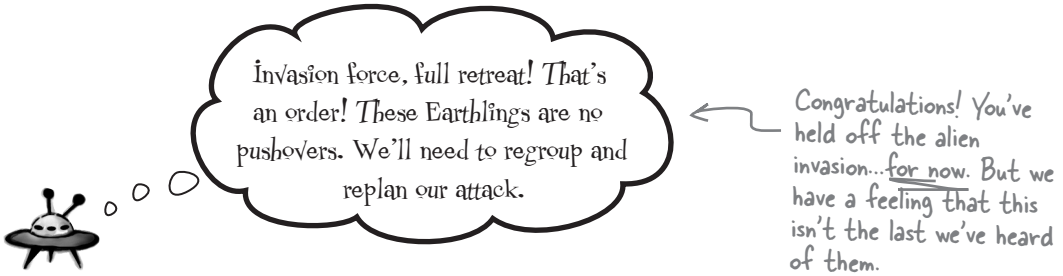
4 GET YOUR DEVELOPER LICENSE.

You already obtained a free developer license from Microsoft when you installed Visual Studio. You need that license in order to sideload apps onto a machine. Luckily, the Remote Debugging Monitor will pop up a wizard to get it automatically.

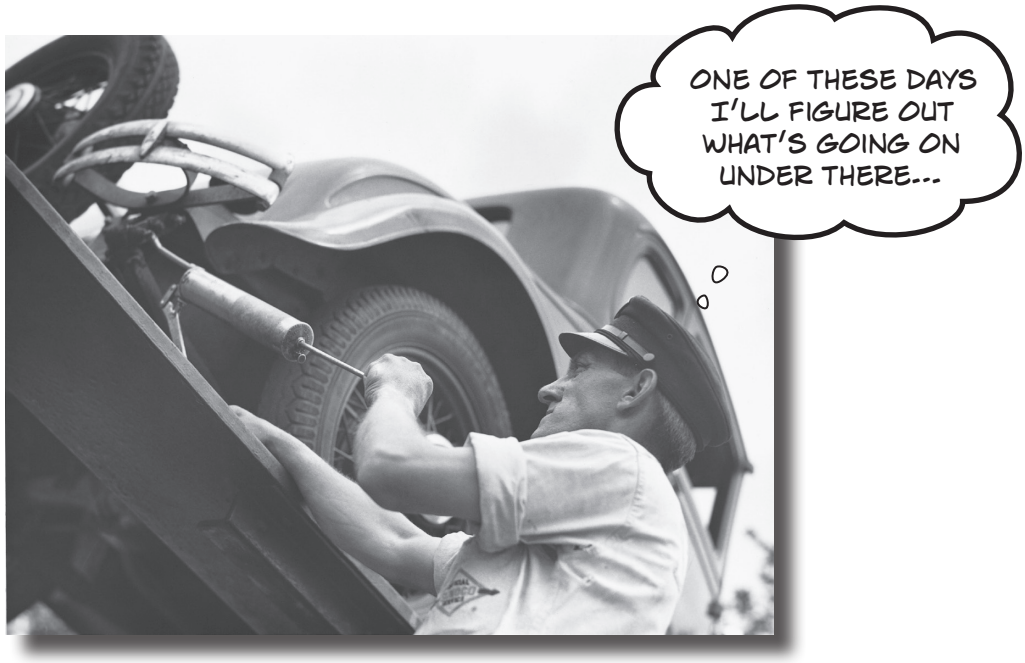


5 NOW...SAVE SOME HUMANS!

Once you get through that setup, your program will start running on the remote machine. Since it's sideloaded, if you want to run it again you can just run it from the Windows Start page. Congratulations, you've built your first Windows Store app and loaded it onto another computer!



Under the hood



You're a programmer, not just an IDE user.

You can get a lot of work done using the IDE. But there's only so far it can take you. Sure, there are a lot of **repetitive tasks** that you do when you build an application. And the IDE is great at doing those things for you. But working with the IDE is *only the beginning*. You can get your programs to do so much more—and **writing C# code** is how you do it. Once you get the hang of coding, there's *nothing* your programs can't do.

When you're doing this...

The IDE is a powerful tool—but that's all it is, a *tool* for you to use. Every time you change your project or drag and drop something in the IDE, it creates code automatically. It's really good at writing **boilerplate** code, or code that can be reused easily without requiring much customization.

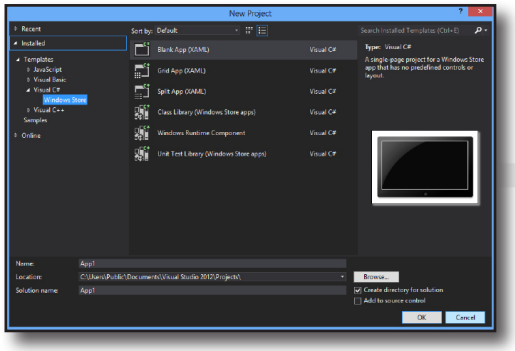
Let's look at what the IDE does in a typical application development, when you're…

All of these tasks have to do with standard actions and boilerplate code. Those are the things the IDE is great for helping with.

1 CREATING A WINDOWS STORE PROJECT

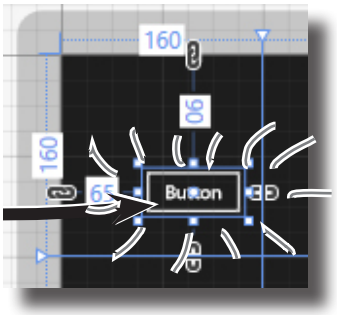
There are several kinds of applications the IDE lets you build. We'll be concentrating on Windows Store applications for now—you'll learn about other kinds of applications in the next chapter.

In Chapter 1, you created a blank **Windows Store** project—that told the IDE to create an empty page and add it to your new project.



2 DRAGGING A CONTROL OUT OF THE TOOLBOX AND ONTO YOUR PAGE, AND THEN DOUBLE-CLICKING IT

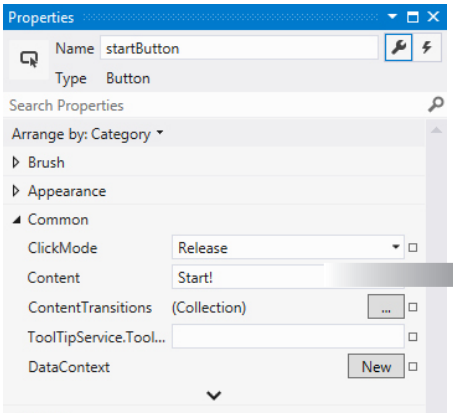
Controls are how you make things happen in your page. In this chapter, we'll use Button controls to explore various parts of the C# language.



3 SETTING A PROPERTY ON YOUR PAGE

The **Properties window** in the IDE is a really powerful tool that you can use to change attributes of just about everything in your program: all visual and functional properties for the controls on your page, and even options on your project itself.

The **Properties window** in the IDE is a really easy way to edit a specific chunk of XAML code in MainPage.xaml automatically, and it can save you time. Use the **Alt-Enter** shortcut to open the Properties window if it's closed.



...the IDE does this

Every time you make a change in the IDE, it makes a change to the code, which means it changes the files that contain that code. Sometimes it just modifies a few lines, but other times it adds entire files to your project.

These files are created from a predefined template that contains the basic code to create and display a page.

1 ...THE IDE CREATES THE FILES AND FOLDERS FOR THE PROJECT.

Save The Humans .csproj | MainPage.xaml | MainPage.xaml.cs | SplashScreen.png | Properties

2 ...THE IDE ADDS CODE TO MAINPAGE.XAML THAT ADDS A BUTTON, AND THEN ADDS A METHOD TO MAINPAGE.XAML.CS THAT GETS RUN ANY TIME THE BUTTON IS CLICKED.

```
private void startButton_Click(object sender, RoutedEventArgs e)
{

}
```

The IDE knows how to add an empty method to handle a button click. But it doesn't know what to put inside it—that's your job.

MainPage.xaml

MainPage.xaml.cs

3 ...THE IDE OPENS THE MAINPAGE.XAML FILE AND UPDATES A LINE OF XAML CODE.

The IDE went into this file...

```
<Button x:Name="startButton"
                Content="Start!"
                HorizontalAlignment="Center"
                VerticalAlignment="Center" Click="startButton_Click"/>
```

MainPage.xaml

...and updated this XAML code.

Where programs come from

A C# program may start out as statements in a bunch of files, but it ends up as a program running in your computer. Here's how it gets there.

Every program starts out as source code files

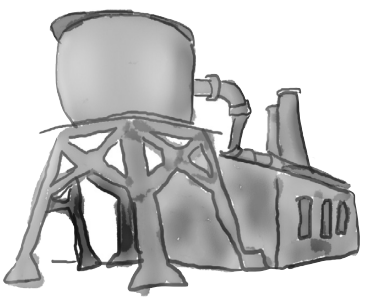
You've already seen how to edit a program, and how the IDE saves your program to files in a folder. Those files **are** your program—you can copy them to a new folder and open them up, and everything will be there: pages, resources, code, and anything else you added to your project.

You can think of the IDE as a kind of fancy file editor. It automatically does the indenting for you, changes the colors of the keywords, matches up brackets for you, and even suggests what words might come next. But in the end, all the IDE does is edit the files that contain your program.

There's no reason you couldn't build your programs in Notepad, but it'd be a lot more time-consuming.

The IDE bundles all of the files for your program into a **solution** by creating a solution (*.sln*) file and a folder that contains all of the other files for the program. The solution file has a list of the project files (which end in *.csproj*) in the solution, and the project files contain lists of all the other files associated with the program. In this book, you'll be building solutions that only have one project in them, but you can easily add other projects to your solution using the IDE's Solution Explorer.

Build the program to create an executable



When you select Build Solution from the Build menu, the IDE **compiles** your program. It does this by running the **compiler**, which is a tool that reads your program's source code and turns it into an **executable**. The executable is a file on your disk that ends in *.exe*—that's the actual program that Windows runs. When you build the program, it creates the executable inside the *bin* folder, which is inside the project folder. When you publish your solution, it copies the executable (and any other files necessary) into into a package that can be uploaded to the Windows Store or sideloaded.

When you select Start Debugging from the Debug menu, the IDE compiles your program and runs the executable. It's got some more advanced tools for **debugging** your program, which just means running it and being able to pause (or "break") it so you can figure out what's going on.

The .NET Framework gives you the right tools for the job

C# is just a language—by itself, it can't actually ***do*** anything. And that's where the **.NET Framework** comes in. Those controls you dragged out of the toolbox? Those are all part of a library of tools, classes, methods, and other useful things. It's got visual tools like the XAML toolbox controls you used, and other useful things like the DispatcherTimer that made your *Save the Humans* game work.

All of the controls you used are part of **.NET for Windows Store apps**, which contains an API with grids, buttons, pages, and other tools for building Windows Store apps. But for a few chapters starting with Chapter 3, you'll learn all about writing desktop applications, which are built using tools from the **.NET for Windows Desktop** (which some people call "WinForms"). It's got tools to build desktop applications from windows that hold forms with checkboxes, buttons, and lists. It can draw graphics, read and write files, manage collections of things…all sorts of tools for a lot of jobs that programmers have to do every day. The funny thing is that Windows Store apps need to do those things, too! One of the things you'll learn by the end of this book is how Windows Store and Windows Desktop apps do some of those things differently. That's the kind of insight and understanding that helps *good* programmers become *great* programmers.

An API, or Application Programming Interface, is a collection of code tools that you use to access or control a system. Many systems have APIs, but they're especially important for operating systems like Windows.

The tools in both the Windows Runtime and the .NET Framework are divided up into **namespaces**. You've seen these namespaces before, at the top of your code in the "using" lines. One namespace is called `Windows.UI.Xaml.Conrols`—it's where your buttons, checkboxes, and other controls come from. Whenever you create a new Windows Store project, the IDE will add the necessary files so that your project contains a page, and those files have the line "`using Windows.UI.Xaml.Controls;`" at the top.

You can see an overview of .NET for Windows Store apps here:
http://msdn.microsoft.com/en-us/library/windows/apps/br230302.aspx

Your program runs inside the Common Language Runtime

Every program in Windows 8 runs on an architecture called the Windows Runtime. But there's an extra "layer" between the Windows Runtime and your program called the **Common Language Runtime**, or CLR. Once upon a time, not so long ago (but before C# was around), writing programs was harder, because you had to deal with hardware and low-level machine stuff. You never knew exactly how someone was going to configure his computer. The CLR—often referred to as a **virtual machine**—takes care of all that for you by doing a sort of "translation" between your program and the computer running it.

You don't really have to worry about the CLR much right now. It's enough to know it's there, and takes care of running your program for you automatically. You'll learn more about it as you go.

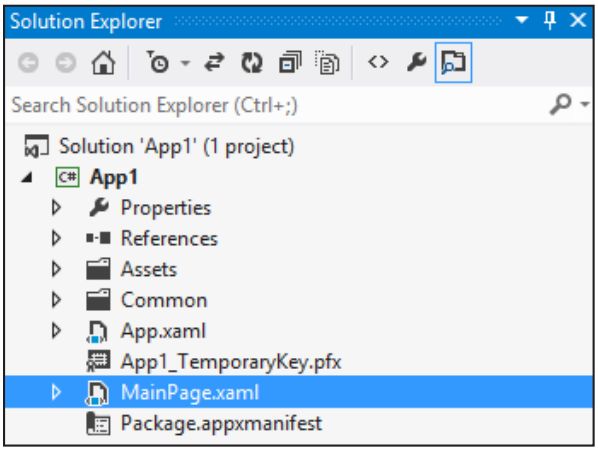
You'll learn about all sorts of things the CLR does for you. For example, it tightly manages your computer's memory by figuring out when your program is finished with certain pieces of data and getting rid of them for you. That's something programmers used to have to do themselves, and it's something that you don't have to be bothered with. You won't know it at the time, but the CLR will make your job of learning C# a whole lot easier.

The IDE helps you code

You've already seen many of the things that the IDE can do. Let's take a closer look at some of the tools it gives you, to make sure you're starting off with all the tools you need.

THE SOLUTION EXPLORER SHOWS YOU EVERYTHING IN YOUR PROJECT

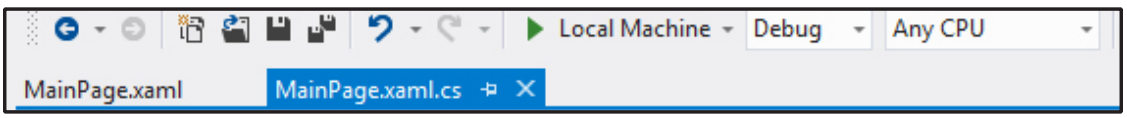
You'll spend a lot of time going back and forth between classes, and the easiest way to do that is to use the Solution Explorer. Here's what the Solution Explorer looked like after creating a blank app called App1:



The Solution Explorer shows you the different files in the solution folder.

USE THE TABS TO SWITCH BETWEEN OPEN FILES

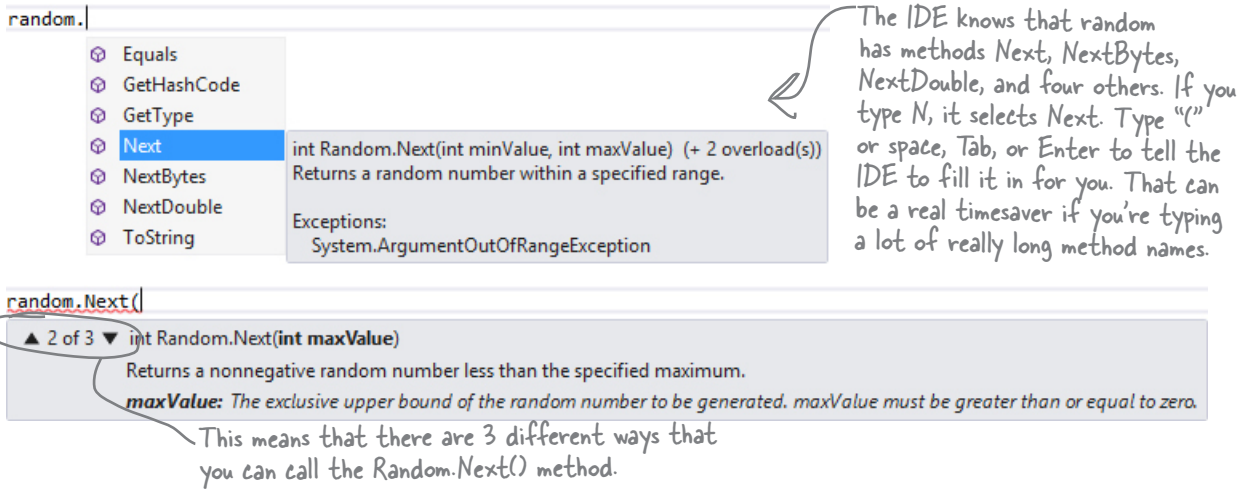
Since your program is split up into more than one file, you'll usually have several code files open at once. When you do, each one will be in its own tab in the code editor. The IDE displays an asterisk (*) next to a filename if it hasn't been saved yet.



When you're working on a program, you'll often have two tabs for it at the same time—one for the designer, and one to view the code. Use **Control–Tab** to switch between open windows quickly.

THE IDE HELPS YOU WRITE CODE

Did you notice little windows popping up as you typed code into the IDE? That's a feature called IntelliSense, and it's really useful. One thing it does is show you possible ways to complete your current line of code. If you type `random` and then a period, it knows that there are three valid ways to complete that line:



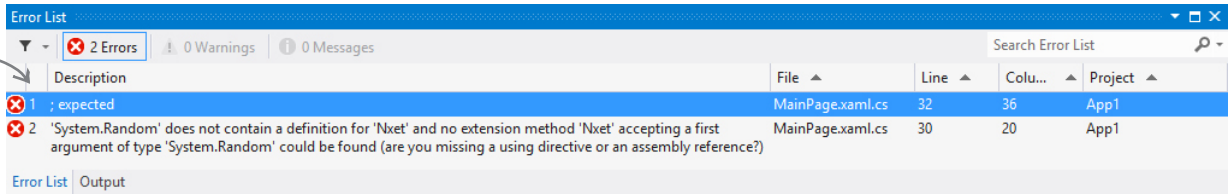
If you select Next and type `(`, the IDE's IntelliSense will show you information about how you can complete the line.

When you use the debugger to run your program inside the IDE, the first thing it does is build your program. If it compiles, then your program runs. If not, it won't run, and will show you errors in the Error List.

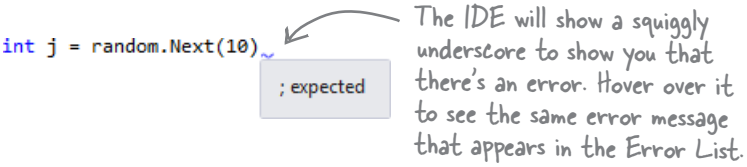
THE ERROR LIST HELPS YOU TROUBLESHOOT COMPILER ERRORS

If you haven't already discovered how easy it is to make typos in a C# program, you'll find out very soon! Luckily, the IDE gives you a great tool for troubleshooting them. When you build your solution, any problems that keep it from compiling will show up in the Error List window at the bottom of the IDE:

A missing semicolon at the end of a statement is one of the most common errors that keeps your program from building.



Double-click on an error, and the IDE will jump to the problem in the code:



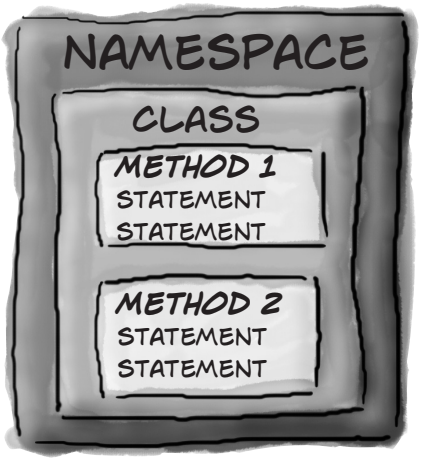
Anatomy of a program

Every C# program's code is structured in exactly the same way. All programs use **namespaces**, **classes**, and **methods** to make your code easier to manage.

Every time you make a new program, you define a namespace for it so that its code is separate from the .NET Framework and Windows Store API classes.

A class contains a **piece** of your program (although some very small programs can have just one class).

A class has one or more methods. Your methods always have to live **inside a class**. And methods are made up of statements—like the ones you've already seen.



The order of the methods in the class file doesn't matter—method 2 can just as easily come before method 1.

Let's take a closer look at your code

Open up the code from your Save the Humans project's *MainPage.xaml.cs* so we can have a closer look at it.

1 THE CODE FILE STARTS BY USING THE .NET FRAMEWORK TOOLS

You'll find a set of `using` lines at the top of every program file. They tell C# which parts of the .NET Framework or Windows Store API to use. If you use other classes that are in other namespaces, then you'll add `using` lines for them, too. Since apps often use a lot of different tools from the .NET Framework and Windows Store API, the IDE automatically adds a bunch of `using` lines when it creates a page (which isn't quite as "blank" as it appeared) and adds it to your project.

```
using System;
using System.Collections.Generic;
using System.IO;
using System.Linq;
using Windows.Foundation;
using Windows.Foundation.Collections;
using Windows.UI.Xaml;
```

These **using** lines are at the top of every code file. They tell C# to use all of those .NET Framework classes. Each one tells your program that the classes in this particular .cs file will use all of the classes in one specific .NET Framework (System) or Windows Store API namespace.

One thing to keep in mind: you don't actually *have* to use a `using` statement. You can always use the fully qualified name. Back in your Save the Humans app, you added this line:

```
using Windows.UI.Xaml.Media.Animation;
```

Try commenting out that line by adding `//` in front of it, then have a look at the errors that show up in the error list. You can make one of them go away. Find a `Storyboard` that the IDE now tells you has an error, and change it to `Windows.UI.Xaml.Media.Animation.Storyboard` (but you should undo the comment you added to make your program work again).

2 C# PROGRAMS ARE ORGANIZED INTO CLASSES

Every C# program is organized into **classes**. A class can do anything, but most classes do one specific thing. When you created the new program, the IDE added a class called `MainPage` that displays the page.

When you called your program Save the Humans, the IDE created a namespace for it called Save_the_Humans (it converted the spaces to underscores because namespaces can't have spaces) by adding the namespace keyword at the top of your code file. Everything inside its pair of curly brackets is part of the Save_the_Humans namespace.

```
namespace Save_the_Humans
{
    public sealed partial class MainPage : Page
    {
```

This is a class called MainPage. It contains all of the code to make the page work. The IDE created it when you told it to create a new blank C# Windows Store project.

Look for the matching pairs of brackets. Every { is eventually paired up with a }. Some pairs can be inside others.

3 CLASSES CONTAIN METHODS THAT PERFORM ACTIONS

When a class needs to do something, it uses a **method**. A method takes input, performs some action, and sometimes produces an output. The way you pass input into a method is by using **parameters**. Methods can behave differently depending on what input they're given. Some methods produce output. When they do, it's called a **return value**. If you see the keyword `void` in front of a method, that means it doesn't return anything.

```
        void startButton_Click(object sender, object e)
        {
            StartGame();
        }
```

This line **calls a method** named StartGame(), which the IDE helped you create when you asked it to add a method stub.

This method has two **parameters** called sender and e.

4 A STATEMENT PERFORMS ONE SINGLE ACTION

When you filled in the `StartGame()` method, you added a bunch of **statements**. Every method is made up of statements. When your program calls a method, it executes the first statement in the method, then the next, then the next, etc. When the method runs out of statements or hits a `return` statement, it ends, and the program resumes after the statement that originally called the method.

This is the **method** called StartGame() that gets called when the user clicks the Start button.

```
        private void StartGame()
        {
            human.IsHitTestVisible = true;
            humanCaptured = false;
            progressBar.Value = 0;
            startButton.Visibility =
                        Visibility.Collapsed;
            playArea.Children.Clear();
            playArea.Children.Add(target);
            playArea.Children.Add(human);
            enemyTimer.Start();
            targetTimer.Start();
        }
    }
}
```

The StartGame() method contains nine **statements**. Each statement ends with a semicolon.

It's OK to add extra line breaks to make your statements more readable. They're ignored when your program builds.

Here's the closing bracket at the very bottom of your MainPage.xaml.cs file.

there are no Dumb Questions

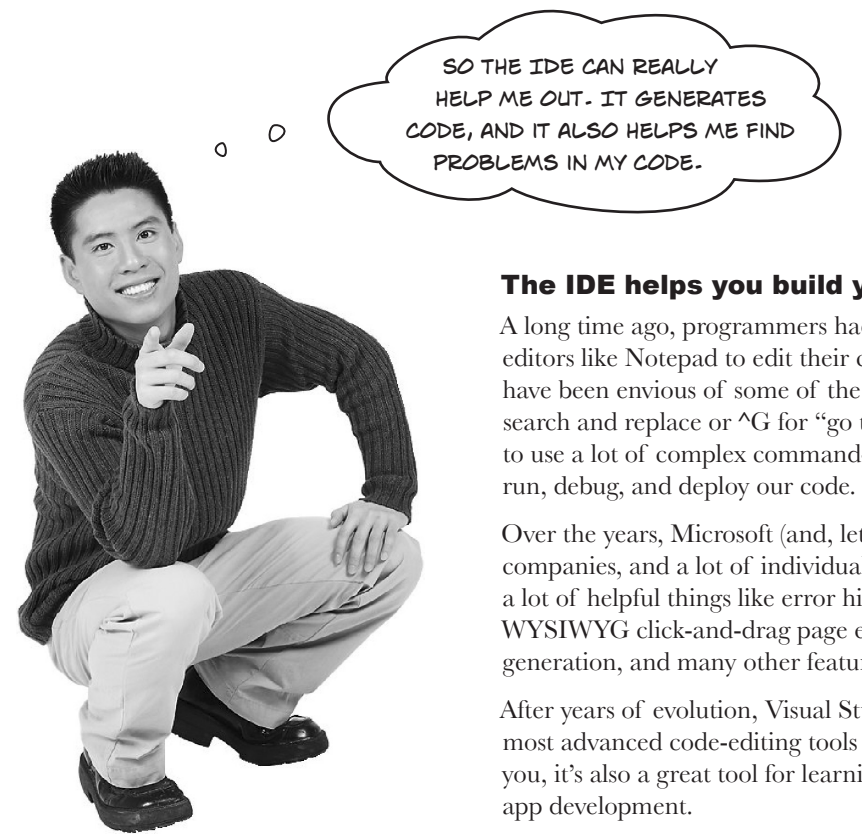
Q: What's with all the curly brackets?

A: C# uses curly brackets (or "braces") to group statements together into **blocks**. Curly brackets always come in pairs. You'll only see a closing curly bracket after you see an opening one. The IDE helps you match up curly brackets—just click on one, and you'll see it and its match get shaded darker.

Q: How come I get errors in the Error List window when I try to run my program? I thought that only happened when I did "Build Solution."

A: Because the first thing that happens when you choose Start Debugging from the menu or press the toolbar button to start your program running is that it saves all the files in your solution and then tries to compile them. And when you compile your code—whether it's when you run it, or when you build the solution—if there are errors, the IDE will display them in the Error List instead of running your program.

A lot of the errors that show up when you try to run your program also show up in the Error List window and as red squiggles under your code.



The IDE helps you build your code right.

A long time ago, programmers had to use simple text editors like Notepad to edit their code. (In fact, they would have been envious of some of the features of Notepad, like search and replace or ^G for "go to line number.") We had to use a lot of complex command-line applications to build, run, debug, and deploy our code.

Over the years, Microsoft (and, let's be fair, a lot of other companies, and a lot of individual developers) figured out a lot of helpful things like error highlighting, IntelliSense, WYSIWYG click-and-drag page editing, automatic code generation, and many other features.

After years of evolution, Visual Studio is now one of the most advanced code-editing tools ever built. And lucky for you, it's also a great tool for learning and exploring C# and app development.

WHAT'S MY PURPOSE?

Match each of these fragments of code generated by the IDE to what it does. (Some of these are new—take a guess and see if you got it right!)

```
myGrid.Background =
    new SolidColorBrush(Colors.Violet);
```

Set properties for a TextBlock control

```
// This loop gets executed three times
```

Nothing—it's a comment that the programmer added to explain the code to anyone who's reading it

```
public sealed partial class MainPage : Page
{
  private void InitializeComponent()
  {
  ⋮
  }
}
```

Disable the maximize icon () in the title bar of the `Form1` window

```
helloLabel.Text = "hi there";
helloLabel.FontSize = 24;
```

A special kind of comment that the IDE uses to explain what an entire block of code does

```
/// <summary>
/// Bring up the picture of Rover when
/// the button is clicked
/// </summary>
```

Change the background color of a Grid control named `myGrid`

```
partial class Form1
{
  ⋮
  this.MaximizeBox = false;
  ⋮
}
```

A method that executes whenever a program displays its main page

WHAT'S MY PURPOSE?

Match each of these fragments of code generated by the IDE to what it does. (Some of these are new—take a guess and see if you got it right!)

```
myGrid.Background =
    new SolidColorBrush(Colors.Violet);
```

```
// This loop gets executed three times
```

```
public sealed partial class MainPage : Page
{
  private void InitializeComponent()
  {
  ⋮
  }
}
```

```
helloLabel.Text = "hi there";
helloLabel.FontSize = 24;
```

```
/// <summary>
/// Bring up the picture of Rover when
/// the button is clicked
/// </summary>
```

```
partial class Form1
{
  ⋮
  this.MaximizeBox = false;
  ⋮
}
```

Set properties for a TextBlock control

Nothing—it's a comment that the programmer added to explain the code to anyone who's reading it

Disable the maximize icon () in the title bar of the `Form1` window

Wait, a window? Not a page? You'll start learning about desktop apps with windows and forms later in this chapter.

A special kind of comment that the IDE uses to explain what an entire block of code does

Change the background color of a Grid control named `myGrid`

A method that executes whenever a program displays its main page

Two classes can be in the same namespace

Take a look at these two class files from a program called `PetFiler2`. They've got three classes: a `Dog` class, a `Cat` class, and a `Fish` class. Since they're all in the same `PetFiler2` namespace, statements in the `Dog.Bark()` method can call `Cat.Meow()` and `Fish.Swim()`. It doesn't matter how the various namespaces and classes are divided up between files. They still act the same when they're run.

SomeClasses.cs

```
namespace PetFiler2 {

   class Dog {

      public void Bark() {
         // statements go here
      }

   }

   partial class Cat {

      public void Meow() {
         // more statements
      }

   }
}
```

When a method is "public" it means every other class in the namespace can access its methods.

MoreClasses.cs

```
namespace PetFiler2 {

  class Fish {

      public void Swim() {
        // statements
      }

  }

  partial class Cat {

      public void Purr() {
         // statements
      }

  }
}
```

Since these classes are in the same namespace, they can all "see" each other—even though they're in different files. A class can span multiple files too, but you need to use the "partial" keyword when you declare it.

You can only split a class up into different files if you use the "partial" keyword. You probably won't do that in any of the code you write in this book, but the IDE used it to split your page up into two files so it could put the XAML code into MainPage.xaml and the C# code into MainPage.xaml.cs.

There's more to namespaces and class declarations, but you won't need them for the work you're doing right now. Flip to #3 in the "Leftovers" appendix to read more.

Your programs use variables to work with data

When you get right down to it, every program is basically a data cruncher. Sometimes the data is in the form of a document, or an image in a video game, or an instant message. But it's all just data. And that's where **variables** come in. A variable is what your program uses to store data.

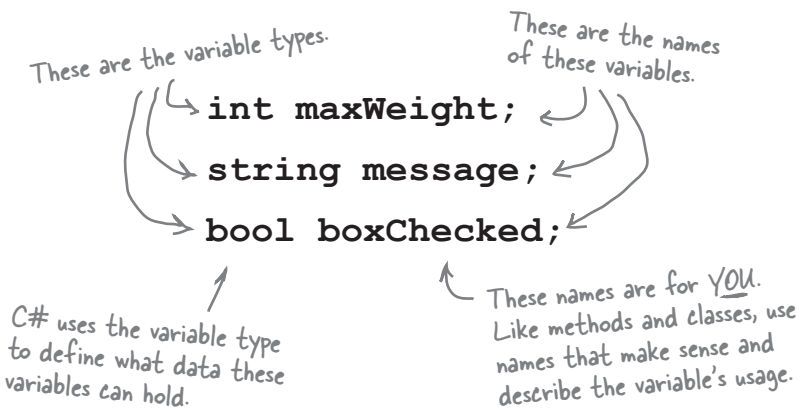
Watch it!

Are you already familiar with another language?

If so, you might find that a few things in this chapter seem really familiar. Still, it's worth taking the time to run through the exercises anyway, because there may be a few ways that C# is different from what you're used to.

Declare your variables

Whenever you **declare** a variable, you tell your program its *type* and its *name*. Once C# knows your variable's type, it'll keep your program from compiling if you make a mistake and try to do something that doesn't make sense, like subtract "Fido" from 48353.



Variables vary

A variable is equal to different values at different times while your program runs. In other words, a variable's value ***varies***. (Which is why "variable" is such a good name.) This is really important, because that idea is at the core of every program that you've written or will ever write. So if your program sets the variable `myHeight` equal to 63:

```
int myHeight = 63;
```

any time `myHeight` appears in the code, C# will replace it with its value, 63. Then, later on, if you change its value to 12:

```
myHeight = 12;
```

C# will replace `myHeight` with 12—but the variable is still called `myHeight`.

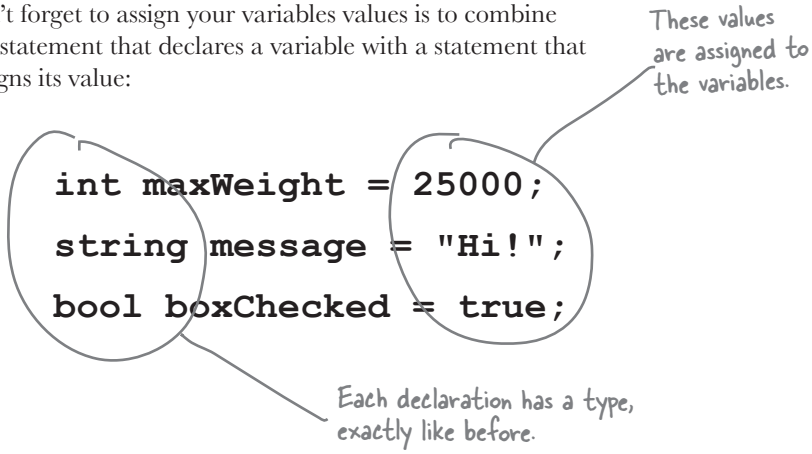
Whenever your program needs to work with numbers, text, true/false values, or any other kind of data, you'll use variables to keep track of them.

You have to assign values to variables before you use them

Try putting these statements into a C# program:

```
string z;
string message = "The answer is " + z;
```

Go ahead, give it a shot. You'll get an error, and the IDE will refuse to compile your code. That's because the compiler checks each variable to make sure that you've assigned it a value before you use it. The easiest way to make sure you don't forget to assign your variables values is to combine the statement that declares a variable with a statement that assigns its value:



If you write code that uses a variable that hasn't been assigned a value, your code won't compile. It's easy to avoid that error by combining your variable declaration and assignment into a single statement.

Once you've assigned a value to your variable, that value can change. So there's no disadvantage to assigning a variable an initial value when you declare it.

A few useful types

Every variable has a type that tells C# what kind of data it can hold. We'll go into a lot of detail about the many different types in C# in Chapter 4. In the meantime, we'll concentrate on the three most popular types. `int` holds integers (or whole numbers), `string` holds text, and `bool` holds Boolean true/false values.

var-i-a-ble, noun.
an element or feature likely to change.
Predicting the weather would be a whole lot easier if meterologists didn't have to take so many ***variables*** *into account.*

C# uses familiar math symbols

To programmers, the word "string" almost always means a string of text, and "int" is almost always short for integer.

Once you've got some data stored in a variable, what can you do with it? Well, if it's a number, you'll probably want to add, subtract, multiply, or divide it. And that's where **operators** come in. You already know the basic ones. Let's talk about a few more. Here's a block of code that uses operators to do some simple math:

```
int number = 15;
number = number + 10;
number = 36 * 15;
number = 12 - (42 / 7);
number += 10;
number *= 3;
number = 71 / 3;

int count = 0;
count ++;
count --;

string result = "hello";
result += " again " + result;
output.Text = result;
result = "the value is: " + count;
result = "";

bool yesNo = false;
bool anotherBool = true;
yesNo = !anotherBool;
```

We declared a new int variable called number and set it to 15. Then we added 10 to it. After the second statement, number is equal to 25.

The third statement changes the value of number, setting it equal to 36 times 15, which is 540. Then it resets it again, setting it equal to 12 – (42 / 7), which is 6.

This operator is a little different. += means take the value of number and add 10 to it. Since number is currently equal to 6, adding 10 to it sets its value to 16.

The *= operator is similar to +=, except it multiplies the current value of number by 3, so it ends up set to 48.

Normally, 71 divided by 3 is 23.666666.... But when you're dividing two ints, you'll always get an int result, so 23.666... gets truncated to 23.

You'll use int a lot for counting, and when you do, the ++ and -- operators come in handy. ++ increments count by adding one to the value, and -- decrements count by subtracting one from it, so it ends up equal to zero.

This sets the contents of a TextBlock control named output to "hello again hello".

When you use the + operator with a string, it just puts two strings together. It'll automatically convert numbers to strings for you.

The "" is an empty string. It has no characters. (It's kind of like a zero for adding strings.)

A bool stores true or false. The ! operator means NOT. It flips true to false, and vice versa.

Don't worry about memorizing these operators now.

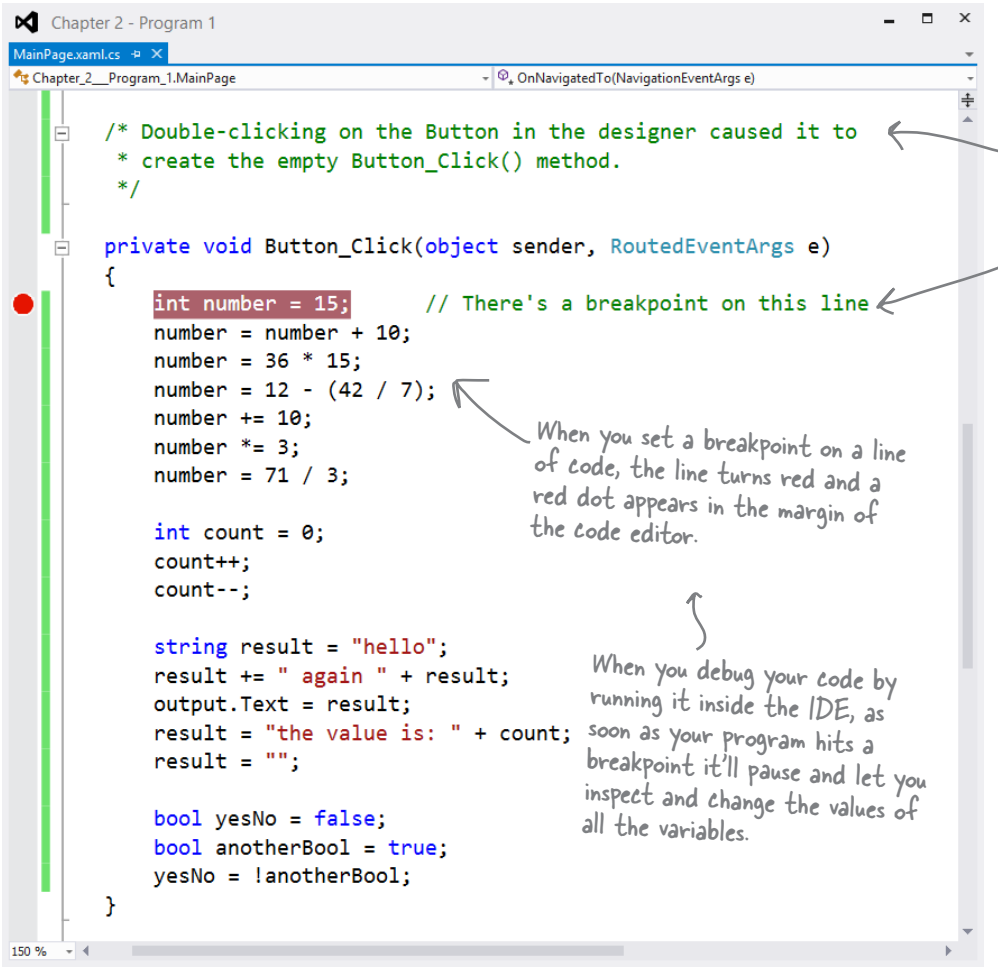
You'll get to know them because you'll see 'em over and over again.

Use the debugger to see your variables change

The debugger is a great tool for understanding how your programs work. You can use it to see the code on the previous page in action.

1. **CREATE A NEW VISUAL C# WINDOWS STORE BLANK APP (XAML) PROJECT.**
Drag a TextBlock onto your page and give it the name `output`. Then add a Button and double-click it to add a method called `Button_Click()`. The IDE will automatically open that method in the code editor. Enter all of the code on the previous page into the method.

2. **INSERT A BREAKPOINT ON THE FIRST LINE OF CODE.**
Right-click on the first line of code (`int number = 15;`) and choose Insert Breakpoint from the Breakpoint menu. (You can also click on it and choose Debug→Toggle Breakpoint or press F9.)



Comments (which either start with two or more slashes or are surrounded by /* and */ marks) show up in the IDE as green text. You don't have to worry about what you type in between those marks, because comments are always ignored by the compiler.

When you set a breakpoint on a line of code, the line turns red and a red dot appears in the margin of the code editor.

When you debug your code by running it inside the IDE, as soon as your program hits a breakpoint it'll pause and let you inspect and change the values of all the variables.

Creating a new Blank App project will tell the IDE to create a new project with a blank page. You might want to name it something like UseTheDebugger (to match the header of this page). You'll be building a whole lot of programs throughout the book, and you may want to go back to them later.

Flip the page and keep going!

3 START DEBUGGING YOUR PROGRAM.

Run your program in the debugger by clicking the Start Debugging button (or by pressing F5, or by choosing Debug→Start Debugging from the menu). Your program should start up as usual and display the page.

4 CLICK ON THE BUTTON TO TRIGGER THE BREAKPOINT.

As soon as your program gets to the line of code that has the breakpoint, the IDE automatically brings up the code editor and highlights the current line of code in yellow.

```
int number = 15;
number = number + 10;
number = 36 * 15;
number = 12 - (42 / 7);
number += 10;
number *= 3;
number = 71 / 3;
```

IDE Tip: ⊞+D

When you're debugging a Windows Store app, you can return to the debugger by pressing the Windows logo key+D. If you're using a touch screen, swipe from the left edge of the screen to the right. Then you can pause or stop the debugger using the Debug toolbar or menu items.

5 ADD A WATCH FOR THE `number` VARIABLE.

Right-click on the `number` variable (any occurrence of it will do!) and choose Add Watch from the menu. The Watch window should appear in the panel at the bottom of the IDE:

Watch 1

Name	Value	Type
number	0	int

Locals | Watch 1

Adding a watch can help you keep track of the values of the variables in your program. This will really come in handy when your programs get more complex.

6 STEP THROUGH THE CODE.

Press F10 to step through the code. (You can also choose Debug→Step Over from the menu, or click the Step Over button in the Debug toolbar.) The current line of code will be executed, setting the value of `number` to 15. The next line of code will then be highlighted in yellow, and the Watch window will be updated:

Watch 1

Name	Value	Type
number	15	int

Locals | Watch 1

As soon as the number variable gets a new value (15), its watch is updated.

You can also **hover** over a variable while you're debugging to see its value displayed in a tooltip...and you can pin it so it stays open!

7 CONTINUE RUNNING THE PROGRAM.

When you want to resume, just press F5 (or Debug→Continue), and the program will resume running as usual.

Loops perform an action over and over

Here's a peculiar thing about most large programs: they almost always involve doing certain things over and over again. And that's what **loops** are for—they tell your program to keep executing a certain set of statements as long as some condition is `true` (or `false`!).

```
while (x > 5)
{
    x = x - 3;
}
```

That's a big part of why Booleans are so important. A loop uses a test to figure out if it should keep looping.

In a while loop, all of the statements inside the curly brackets get executed as long as the condition in the parentheses is true.

Every for loop has three statements. The first sets up the loop. It will keep looping as long as the second statement is true. And the third statement gets executed after each time through the loop.

```
for (int i = 0; i < 8; i = i + 2)
{
    // Everything between these brackets
    // is executed 4 times
}
```

IDE Tip: Brackets

If your brackets (or braces—either name will do) don't match up, your program won't build, which leads to frustrating bugs. Luckily, the IDE can help with this! Put your cursor on a bracket, and the IDE highlights its match:

```
bool test = true;
while (test == true)
{
    // Contents of the loop
}
```

Use a code snippet to write simple for loops

You'll be typing for loops in just a minute, and the IDE can help speed up your coding a little. Type `for` followed by two tabs, and the IDE will automatically insert code for you. If you type a new variable, it'll automatically update the rest of the snippet. Press Tab again, and the cursor will jump to the length.

Press Tab to get the cursor to jump to the length. The number of times this loop runs is determined by whatever you set length to. You can change length to a number or a variable.

```
for (int i = 0; i < length; i++)
{

}
```

If you change the variable to something else, the snippet automatically changes the other two occurrences of it.

if/else statements make decisions

Use **if/else statements** to tell your program to do certain things only when the **conditions** you set up are (or aren't) true. A lot of if/else statements check if two things are equal. That's when you use the == operator. That's different from the single equals sign (=) operator, which you use to set a value.

```
string message = "";

if (someValue == 24)
{
    message = "The value was 24.";
}
```

Every if statement starts with a conditional test.

The statement inside the curly brackets is executed only if the test is true.

Always use two equals signs to check if two things are equal to each other.

```
if (someValue == 24)
{
    // You can have as many statements
    // as you want inside the brackets
    message = "The value was 24.";
} else {
    message = "The value wasn't 24.";
}
```

if/else statements are pretty straightforward. If the conditional test is true, the program executes the statements between the first set of brackets. Otherwise, it executes the statements between the second set.

Watch it!

Don't confuse the two equals sign operators!

You use one equals sign (=) to set a variable's value, but two equals signs (==) to compare two variables. You won't believe how many bugs in programs—even ones made by experienced programmers!—are caused by using = instead of ==. If you see the IDE complain that you "cannot implicitly convert type 'int' to 'bool', that's probably what happened.

Make sure you choose a sensible name for this project, because you'll refer back to it later in the book.

When you see these sneakers, it means that it's time for you to come up with code on your own.

Exercise

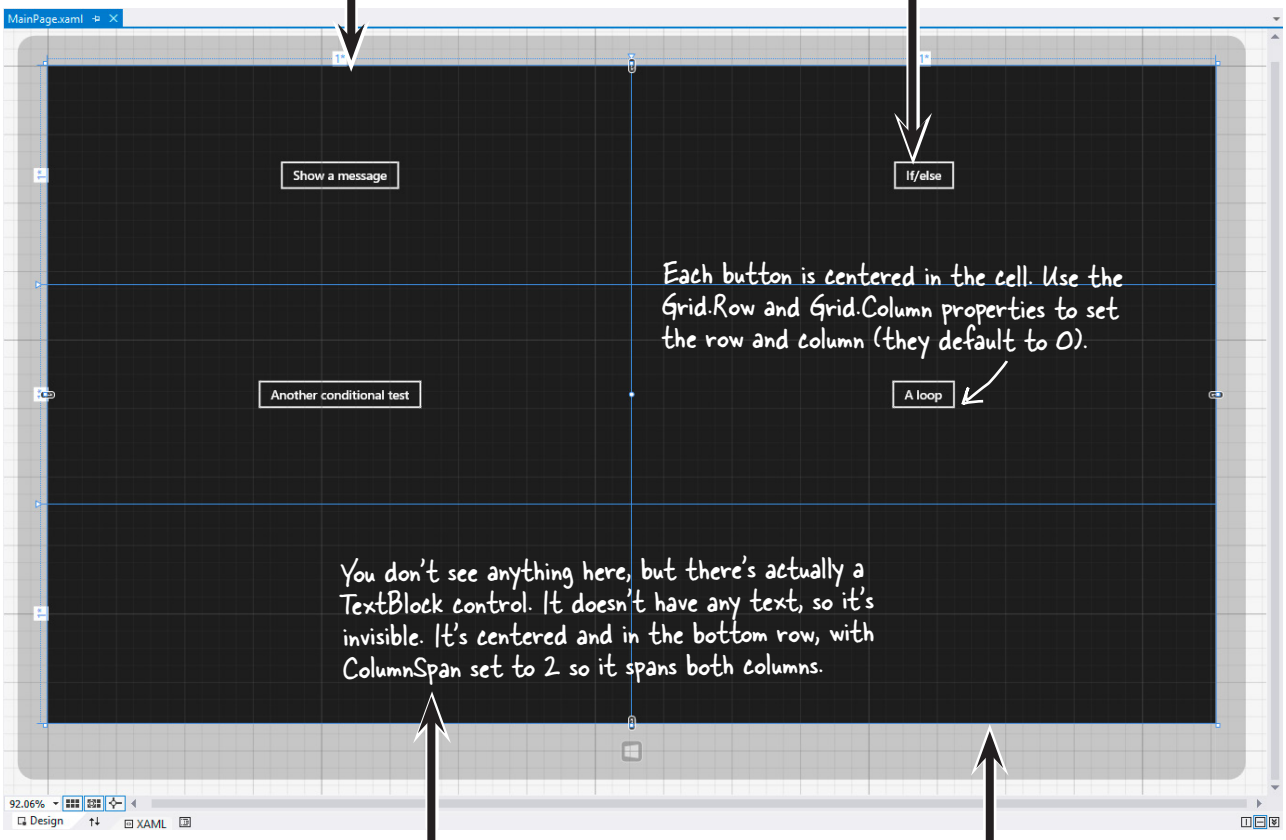
Build an app from the ground up

The real work of any program is in its statements. You've already seen how statements fit into a page. Now let's really dig into a program so you can understand every line of code. Start by **creating a new Visual C# Windows Store Blank App project**. This time, instead of deleting the *MainPage.xaml* file created by the Blank App template, use the IDE to modify it by adding three rows and two columns to the grid, then adding four Button controls and a TextBlock to the cells.

Build this page

The page has a grid with three rows and two columns. Each row definition has its height set to `1*`, which gives it a `<RowDefinition/>` without any properties. The column heights work the same way.

The page has four Button controls, one in each row. Use the `Content` property to set their text to Show a message, If/else, Another conditional test, and A loop.



Each button is centered in the cell. Use the Grid.Row and Grid.Column properties to set the row and column (they default to 0).

You don't see anything here, but there's actually a TextBlock control. It doesn't have any text, so it's invisible. It's centered and in the bottom row, with ColumnSpan set to 2 so it spans both columns.

The bottom cell has a TextBlock control named `myLabel`. Use its `Style` property to set the style to `BodyTextStyle`.

Use the `x:Name` property to name the buttons `button1`, `button2`, `button3`, and `button4`. Once they're named, double-click on each of them to add an event handler method.

If you need to use the Edit Style right-mouse menu to set this but you're having trouble selecting the control, you can right-click on the TextBlock control in the Document Outline and choose Edit Style from there.

Exercise Solution

Here's our solution to the exercise. Does your solution look similar? Are the line breaks different, or the properties in a different order? If so, that's OK!

A lot of programmers don't use the IDE to create their XAML—they build it by hand. If we asked you to type in the XAML by hand instead of using the IDE, would you be able to do it?

MainPage.xaml

```
<Page
    x:Class="Chapter_2___Program_2.MainPage"
    xmlns="http://schemas.microsoft.com/winfx/2006/xaml/presentation"
    xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml"
    xmlns:local="using:Chapter_2___Program_2"
    xmlns:d="http://schemas.microsoft.com/expression/blend/2008"
    xmlns:mc="http://schemas.openxmlformats.org/markup-compatibility/2006"
    mc:Ignorable="d">

    <Grid Background="{StaticResource ApplicationPageBackgroundThemeBrush}">
        <Grid.RowDefinitions>
            <RowDefinition/>
            <RowDefinition/>
            <RowDefinition/>
        </Grid.RowDefinitions>
        <Grid.ColumnDefinitions>
            <ColumnDefinition/>
            <ColumnDefinition/>
        </Grid.ColumnDefinitions>

        <Button x:Name="button1" Content="Show a message"
                HorizontalAlignment="Center" Click="button1_Click"/>

        <Button x:Name="button2" Content="If/else" HorizontalAlignment="Center"
                Grid.Column="1" Click="button2_Click"/>

        <Button x:Name="button3" Content="Another conditional test" HorizontalAlignment="Center"
                Grid.Row="1" Click="button3_Click"/>

        <Button x:Name="button4" Content="A loop" HorizontalAlignment="Center"
                Grid.Column="1" Grid.Row="1" Click="button4_Click"/>

        <TextBlock x:Name="myLabel" HorizontalAlignment="Center" VerticalAlignment="Center"
                   Grid.Row="2" Grid.ColumnSpan="2" Style="{StaticResource BodyTextStyle}"/>
    </Grid>
</Page>
```

Here's the <Page> and <Grid> tags that the IDE generated for you when you created the blank app.

Here are the row and column definitions: three rows and two columns.

When you double-clicked on each button, the IDE generated a method with the name of the button followed by _Click.

This button is in the second column and second row, so these properties are set to 1.

BRAIN POWER

Why do you think the left column and top row are given the number 0, not 1? Why is it OK to leave out the `Grid.Row` and `Grid.Column` properties for the top-left cell?

Make each button do something

Here's how your program is going to work. Each time you press one of the buttons, it will update the TextBlock at the bottom (which you named `myLabel`) with a different message. The way you'll do it is by adding code to each of the four event handler methods that you had the IDE generate for you. Let's get started!

When you see a "Do this!", pop open the IDE and follow along. We'll tell you exactly what to do, and point out what to look for to get the most out of the example we show you.

1 **MAKE BUTTON1 UPDATE THE LABEL.**

Go to the code for the `button1_Click()` method and fill in the code below. This is your chance to really understand what every statement does, and why the program will show this output:

```
name is Quentin
x is 51
d is 1.5707963267949
```

Here's the code for the button:

```
private void button1_Click(object sender, RoutedEventArgs e)
{
    // this is a comment
    string name = "Quentin";
    int x = 3;
    x = x * 17;
    double d = Math.PI / 2;
    myLabel.Text = "name is " + name
        + "\nx is " + x
        + "\nd is " + d;
}
```

x is a variable. The "int" part tells C# that it's an integer, and the rest of the statement sets its value to 3.

This line creates the output of the program: the updated text in the TextBlock named myLabel.

There's a built-in class called Math, and it's got a member called PI. Math lives in the System namespace, so the file this code came from needs to have a `using System;` line at the top.

Luckily, the IDE generated the using line for you.

The \n is an **escape sequence** to add a line break to the TextBlock text.

Run your program and make sure the output matches the screenshot on this page.

A few helpful tips

- Don't forget that all your statements need to end in a semicolon:

```
name = "Joe";
```

- You can add comments to your code by starting them with two slashes:

```
// this text is ignored
```

- Variables are declared with a **name** and a **type** (there are plenty of types that you'll learn about in Chapter 4):

```
int weight;
// weight is an integer
```

- The code for a class or a method goes between curly braces:

```
public void Go() {
    // your code here
}
```

- Most of the time, extra whitespace is fine:

```
int j     =      1234  ;
```

is the same as:

```
int j = 1234;
```

Flip the page to finish your program!

Set up conditions and see if they're true

Use **if/else statements** to tell your program to do certain things only when the **conditions** you set up are (or aren't) true.

Use logical operators to check conditions

You've just looked at the == operator, which you use to test whether two variables are equal. There are a few other operators, too. Don't worry about memorizing them right now—you'll get to know them over the next few chapters.

- The `!=` operator works a lot like ==, except it's true if the two things you're comparing are **not equal**.
- You can use > and < to compare numbers and see if one is bigger or smaller than the other.
- The ==, `!=`, >, and < operators are called **conditional operators**. When you use them to test two variables or values, it's called performing a **conditional test.**
- You can combine individual conditional tests into one long test using the `&&` operator for AND and the `||` operator for OR. So to check if `i` equals 3 or `j` is less than 5, do `(i == 3) || (j < 5)`.

When you use a conditional operator to compare two numbers, it's called a conditional test.

Make sure you stop your program before you do this—the IDE won't let you edit the code while the program's running. You can stop it by closing the window, using the stop button on the toolbar, or selecting Stop Debugging from the Debug menu.

2 **SET A VARIABLE AND THEN CHECK ITS VALUE.** Here's the code for the second button. It's an if/else statement that checks an integer **variable** called `x` to see if it's equal to 10.

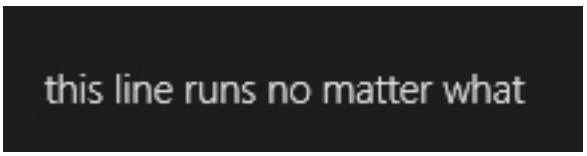
```
private void button2_Click(object sender, RoutedEventArgs e)
{
    int x = 5;
    if (x == 10)
    {
        myLabel.Text = "x must be 10";
    }
    else
    {
        myLabel.Text = "x isn't 10";
    }
}
```

First we set up a variable called x and make it equal to 5. Then we check if it's equal to 10.

Here's the output. See if you can tweak one line of code and get it to say "x must be 10" instead.

3 ADD ANOTHER CONDITIONAL TEST.

The third button makes this output. Then change it so `someValue` is set to 3 instead of 4. The TextBlock gets updated twice, but it happens so fast that you can't see it. Put a breakpoint on the first statement and step through the method, using Alt-Tab to switch to the app and back to make sure the TextBlock gets updated.



This line checks someValue to see if it's equal to 3, and then it checks to make sure name is "Joe".

```
private void button3_Click(object sender, RoutedEventArgs e)
{
    int someValue = 4;
    string name = "Bobbo Jr.";
    if ((someValue == 3) && (name == "Joe"))
    {
        myLabel.Text = "x is 3 and the name is Joe";
    }
    myLabel.Text = "this line runs no matter what";
}
```

4 ADD LOOPS TO YOUR PROGRAM.

Here's the code for the last button. It's got two loops. The first is a **`while`** loop, which repeats the statements inside the brackets as long as the condition is true—do something *while* this is true. The second one is a **`for`** loop. Take a look and see how it works.

```
private void button4_Click(object sender, RoutedEventArgs e)
{
    int count = 0;

    while (count < 10)
    {
        count = count + 1;
    }

    for (int i = 0; i < 5; i++)
    {
        count = count - 1;
    }

    myLabel.Text = "The answer is " + count;
}
```

This loop keeps repeating as long as the count variable is less than 10.

The second part of the for statement is the test. It says "for as long as i is less than five, the loop should keep on going." The test is run before the code block, and the block is executed only if the test is true.

This sets up the loop. It just assigns a value to the integer that'll be used in it.

This statement gets executed at the end of each loop. In this case, it adds one to i every time the loop executes. This is called the iterator, and it's run **immediately after** all the statements in the code block.

Before you click on the button, read through the code and try to figure out what the TextBlock will show. Then click the button and see if you were right!

Sharpen your pencil

Let's get a little more practice with conditional tests and loops. Take a look at the code below. Circle the conditional tests, and fill in the blanks so that the comments correctly describe the code that's being run.

```
int result = 0; // this variable will hold the final result
int x = 6; // declare a variable x and set it to 6
while (x > 3) {
  // execute these statements as long as .....
  result = result + x; // add x .....
  x = x - 1; // subtract .....
}
for (int z = 1; z < 3; z = z + 1) {
  // start the loop by .....
  // keep looping as long as .....
  // after each loop, .....
  result = result + z; // .....
}
// The next statement will update a TextBlock with text that says
// .....
myLabel.Text = "The result is " + result;
```

We filled in the first one for you.

More about conditional tests

You can do simple conditional tests by checking the value of a variable using a comparison operator. Here's how you compare two ints, x and y:

```
x < y (less than)
x > y (greater than)
x == y (equals - and yes, with two equals signs)
```

These are the ones you'll use most often.

WAIT UP! THERE'S A FLAW IN YOUR LOGIC. WHAT HAPPENS TO MY LOOP IF I WRITE A CONDITIONAL TEST THAT NEVER BECOMES FALSE?

Then your loop runs forever!

Every time your program runs a conditional test, the result is either **`true`** or **`false`**. If it's **`true`**, then your program goes through the loop one more time. Every loop should have code that, if it's run enough times, should cause the conditional test to eventually return **`false`**. But if it doesn't, then the loop will keep running until you kill the program or turn the computer off!

This is sometimes called an infinite loop, and there are actually times when you'll want to use one in your program.

Sharpen your pencil

Here are a few loops. Write down if each loop will repeat forever or eventually end. If it's going to end, how many times will it loop?

LOOP #1

```
int count = 5;
while (count > 0) {
    count = count * 3;
    count = count * -1;
}
```

For Loop #3, how many times will this statement be executed?

LOOP #2

```
int i = 0;
int count = 2;
while (i == 0) {
    count = count * 3;
    count = count * -1;
}
```

LOOP #3

```
int j = 2;
for (int i = 1; i < 100;
     i = i * 2)
{
    j = j - 1;
    while (j < 25)
    {
        j = j + 5;
    }
}
```

For Loop #5, how many times will this statement be executed?

LOOP #4

```
while (true) { int i = 1;}
```

LOOP #5

```
int p = 2;
for (int q = 2; q < 32;
     q = q * 2)
{
    while (p < q)
    {
        p = p * 2;
    }
    q = p - q;
}
```

Hint: p starts out equal to 2. Think about when the iterator "p = p * 2" is executed.

Remember, a for loop always runs the conditional test at the beginning of the block, and the iterator at the end of the block.

BRAIN POWER

Can you think of a reason that you'd want to write a loop that never stops running?

Sharpen your pencil Solution

Let's get a little more practice with conditional tests and loops. Take a look at the code below. Circle the conditional tests, and fill in the blanks so that the comments correctly describe the code that's being run.

```
int result = 0; // this variable will hold the final result
int x = 6; // declare a variable x and set it to 6
while (x > 3) {
// execute these statements as long as x is greater than 3

result = result + x; // add x to the result variable


x = x - 1; // subtract 1 from the value of x
}
for (int z = 1; z < 3; z = z + 1) {
// start the loop by declaring a variable z and setting it to 1
// keep looping as long as z is less than 3
// after each loop, add 1 to z
result = result + z; // add the value of z to result
}
// The next statement will update a TextBlock with text that says
// The result is 18
myLabel.Text = "The result is " + result;
```

This loop runs twice—first with z set to 1, and then a second time with z set to 2. Once it hits 3, it's no longer less than 3, so the loop stops.

Sharpen your pencil Solution

Here are a few loops. Write down if each loop will repeat forever or eventually end. If it's going to end, how many times will it loop?

LOOP #1
This loop executes once

LOOP #2
This loop runs forever

LOOP #3
This loop executes 7 times

LOOP #4
Another infinite loop

LOOP #5
This loop executes 8 times

Take the time to really figure this one out. Here's a perfect opportunity to try out the debugger on your own! Set a breakpoint on the statement `q = p - q;`. Add watches for the variables p and q and step through the loop.

there are no Dumb Questions

Q: Is every statement always in a class?

A: Yes. Any time a C# program does something, it's because statements were executed. Those statements are a part of classes, and those classes are a part of namespaces. Even when it looks like something is not a statement in a class—like when you use the designer to set a property on a control on your page—if you search through your code you'll find that the IDE added or changed statements inside a class somewhere.

Q: Are there any namespaces I'm not allowed to use? Are there any I *have* to use?

A: Yes, there are a few namespaces that will technically work, but which you should avoid. Notice how all of the `using` lines at the top of your C# class files always said `System`? That's because there's a `System` namespace that's used by the Windows Store API and the .NET Framework. It's where you find all of your important tools to add power to your programs, like `System.Linq`, which lets you manipulate sequences of data, and `System.IO`, which lets you work with files and data streams. But for the most part, you can choose any name you want for a namespace (as long as it only has letters, numbers, and underscores). When you create a new program, the IDE will automatically choose a namespace for you based on the program's name.

Q: I still don't get why I need this partial class stuff.

A: Partial classes are how you can spread the code for one class between more than one file. The IDE does that when it creates a page—it keeps the code you edit in one file (like *MainPage.xaml*), and the code it modifies automatically for you in another file (*MainPage.xaml.cs*). You don't need to do that with a namespace, though. One namespace can span two, three, or a dozen or more files. Just put the namespace declaration at the top of the file, and everything within the curly brackets after the declaration is inside the same namespace. One more thing: you can have more than one class in a file. And you can have more than one namespace in a file. You'll learn a lot more about classes in the next few chapters.

Q: Let's say I drag something onto my page, so the IDE generates a bunch of code automatically. What happens to that code if I click Undo?

A: The best way to answer this question is to try it! Give it a shot—do something where the IDE generates some code for you. Drag a button on a page, change properties. Then try to undo it. What happens? For most simple things, you'll see that the IDE is smart enough to undo it itself. (For some more complex things, like working with databases, you might be given a warning message that you're about to make a change that the IDE can't undo. You won't see any of those in this book.)

Q: So exactly how careful do I have to be with the code that's automatically generated by the IDE?

A: You should generally be pretty careful. It's really useful to know what the IDE is doing to your code, and once in a while you'll need to know what's in there in order to solve a serious problem. But in almost all cases, you'll be able to do everything you need to do through the IDE.

BULLET POINTS

- You tell your program to perform actions using statements. Statements are always part of classes, and every class is in a namespace.
- Every statement ends with a semicolon (`;`).
- When you use the visual tools in the Visual Studio IDE, it automatically adds or changes code in your program.
- Code blocks are surrounded by curly braces `{ }`. Classes, `while` loops, if/else statements, and lots of other kinds of statements use those blocks.
- A conditional test is either `true` or `false`. You use conditional tests to determine when a loop ends, and which block of code to execute in an if/else statement.
- Any time your program needs to store some data, you use a variable. Use = to assign a variable, and == to test if two variables are equal.
- A `while` loop runs everything within its block (defined by curly braces) as long as the *conditional test* is `true`.
- If the conditional test is `false`, the `while` loop code block won't run, and execution will move down to the code immediately after the loop block.

Code Magnets

Part of a C# program is all scrambled up on the fridge. Can you rearrange the code snippets to make a working C# program that produces the output? Some of the curly braces fell on the floor and they were too small to pick up, so feel free to add as many of those as you need! (Hint: you'll definitely need to add a couple. Just write them in!)

The "" is an empty string—it means the variable result has no characters in it yet.

This magnet didn't fall off the fridge...

```
string result = "";
```

```
output.Text = result;
```

```
if (x == 1) {
 result = result + "d";
 x = x - 1;
}
```

```
if (x == 2) {
 result = result + "b c";
}
```

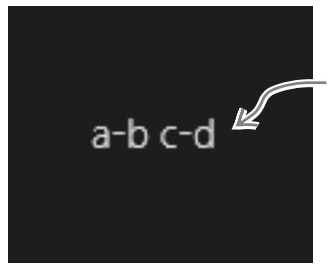
```
if (x > 2) {
 result = result + "a";
}
```

```
int x = 3;
```

```
x = x - 1;
result = result + "-";
```

```
while (x > 0)
```

Output:



This is a TextBlock named "output" that the program updates by setting its Text property.

→ Answers on page 86.

We'll give you a lot of exercises like this throughout the book. We'll give you the answer in a couple of pages. If you get stuck, don't be afraid to peek at the answer—it's not cheating!

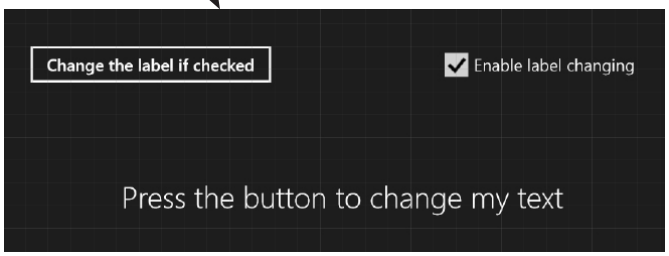
You'll be creating a lot of applications throughout this book, and you'll need to give each one a different name. We recommend naming this one "PracticeUsingIfElse". It helps to put programs from a chapter in the same folder.

Exercise

Time to get some practice using if/else statements. Can you build this program?

If you create two rows and set one row's height to 1* in the IDE, it seems to disappear because it's collapsed to a tiny size. Just set the other row to 1* and it'll show up again.

Build this page.
It's got a grid with two rows and two columns.



Add a Button and a CheckBox.
You can find the CheckBox control in the toolbox, just below the Button control. Set the Button's name to `changeText` and the CheckBox's name to `enableCheckbox`. Use the Edit Text right-click menu option to set the text for both controls (hit Escape to finish editing the text). Right-click on each control and chose Reset Layout→All, then make sure both of them have their VerticalAlignment and HorizontalAlignment set to `Center`.

Add a TextBlock.
It's almost identical to the one you added to the bottom of the page in the last project. This time, name it `labelToChange` and set its `Grid.Row` property to `"1"`.

Set the TextBlock to this message if the user clicks the button but the box IS NOT checked.

Here's the conditional test to see if the checkbox is checked:

Text changing is disabled

```
enableCheckbox.IsChecked == true
```

If that test is **NOT** true, then your program should execute two statements:

Hint: you'll put this code in the else block.

```
labelToChange.Text = "Text changing is disabled";
labelToChange.HorizontalAlignment = HorizontalAlignment.Center;
```

If the user clicks the button and the box IS checked, change the TextBlock so it either shows Left on the lefthand side or Right on the righthand side.

If the label's `Text` property is currently equal to `"Right"` then the program should change the text to `"Left"` and set its `HorizontalAlignment` property to `HorizontalAlignment.Left`. Otherwise, set its text to `"Right"`and its `HorizontalAlignment` property to `HorizontalAlignment.Right`. This should cause the program to flip the label back and forth when the user presses the button—but only if the checkbox is checked.

Pool Puzzle

Your ***job*** is to take code snippets from the pool and place them into the blank lines in the code. You may **not** use the same snippet more than once, and you won't need to use all the snippets. Your ***goal*** is to make a class that will compile and run. Don't be fooled—this one's harder than it looks.

Output

```
a noise annoys an oyster
```

Here's another TextBlock, and we also gave it the name "output".

We included these Pool Puzzle exercises throughout the book to give your brain an extra-tough workout. If you're the kind of person who loves twisty little logic puzzles, then you'll love this one. If you're not, give it a shot anyway—but don't be afraid to look at the answer to figure out what's going on. And if you're stumped by a pool puzzle, definitely move on.

```
int x = 0;
string poem = "";

while ( ___________ ) {

  ___________________________________
  if ( x < 1 ) {
    ___________________________________
  }
  ___________________________________

  if ( ___________ ) {

    ___________________________________

    ___________
  }
  if ( x == 1 ) {

    ___________________________________
  }
  if ( ___________ ) {

    ___________________________________
  }

  ___________
}
___________________
```

Note: each snippet from the pool can only be used once!

```
x > 0
x < 1
x > 1
x > 3
x < 4

x = x + 1;
x = x + 2;
x = x - 2;
x = x - 1;

poem = poem + " ";
poem = poem + "a";
poem = poem + "n";
poem = poem + "an";

output.Text = poem;

poem = poem + "noys ";
poem = poem + "oise ";
poem = poem + " oyster ";
poem = poem + "annoys";
poem = poem + "noise";
```

Time to get some practice using if/else statements. Can you build this program?

We added line breaks as usual to make it easier to read on the page.

Here's the XAML code for the grid:

```
<Grid Background="{StaticResource ApplicationPageBackgroundThemeBrush}">
    <Grid.RowDefinitions>
        <RowDefinition/>
        <RowDefinition/>
    </Grid.RowDefinitions>
    <Grid.ColumnDefinitions>
        <ColumnDefinition/>
        <ColumnDefinition/>
    </Grid.ColumnDefinitions>

    <Button x:Name="changeText" Content="Change the label if checked"
            HorizontalAlignment="Center" Click="changeText_Click"/>

    <CheckBox x:Name="enableCheckbox" Content="Enable label changing"
              HorizontalAlignment="Center" IsChecked="true" Grid.Column="1"/>

    <TextBlock x:Name="labelToChange" Grid.Row="1" TextWrapping="Wrap"
               Text="Press the button to set my text"
               HorizontalAlignment="Center" VerticalAlignment="Center"
               Grid.ColumnSpan="2"/>
</Grid>
```

If you double-clicked the button in the designer before you set its name, it may have created a Click event handler method called Button_Click_1() instead of changeText_Click().

And here's the C# code for the button's event handler method:

```
private void changeText_Click(object sender, RoutedEventArgs e)
{
    if (enableCheckbox.IsChecked == true)
    {
        if (labelToChange.Text == "Right")
        {
            labelToChange.Text = "Left";
            labelToChange.HorizontalAlignment = HorizontalAlignment.Left;
        }
        else
        {
            labelToChange.Text = "Right";
            labelToChange.HorizontalAlignment = HorizontalAlignment.Right;
        }
    }
    else
    {
    labelToChange.Text = "Text changing is disabled";
    labelToChange.HorizontalAlignment = HorizontalAlignment.Center;
    }
}
```

Code Magnets Solution

```
string result = "";

int x = 3;

while (x > 0)
{
    if (x > 2) {
      result = result + "a";
    }
    x = x - 1;
    result = result + "-";
    if (x == 2) {
      result = result + "b c";
    }
    if (x == 1) {
      result = result + "d";
      x = x - 1;
    }
}
output.Text = result;
```

This magnet didn't fall off the fridge...

The first time through the loop, x is equal to 3, so this conditional test will be true.

This statement makes x equal to 2 the first time through the loop, and 1 the second time through.

Pool Puzzle Solution

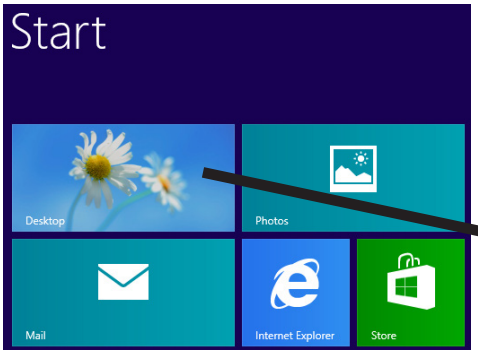
```
int x = 0;
string poem = "";

while ( x < 4 ) {

  poem = poem + "a";
  if ( x < 1 ) {
    poem = poem + " ";
  }
  poem = poem + "n";

  if ( x > 1 ) {

    poem = poem + " oyster";

    x = x + 2;
  }
  if ( x == 1 ) {

    poem = poem + "noys ";
  }
  if ( x < 1 ) {

    poem = poem + "oise ";
  }

  x = x + 1;
}
output.Text = poem;
```

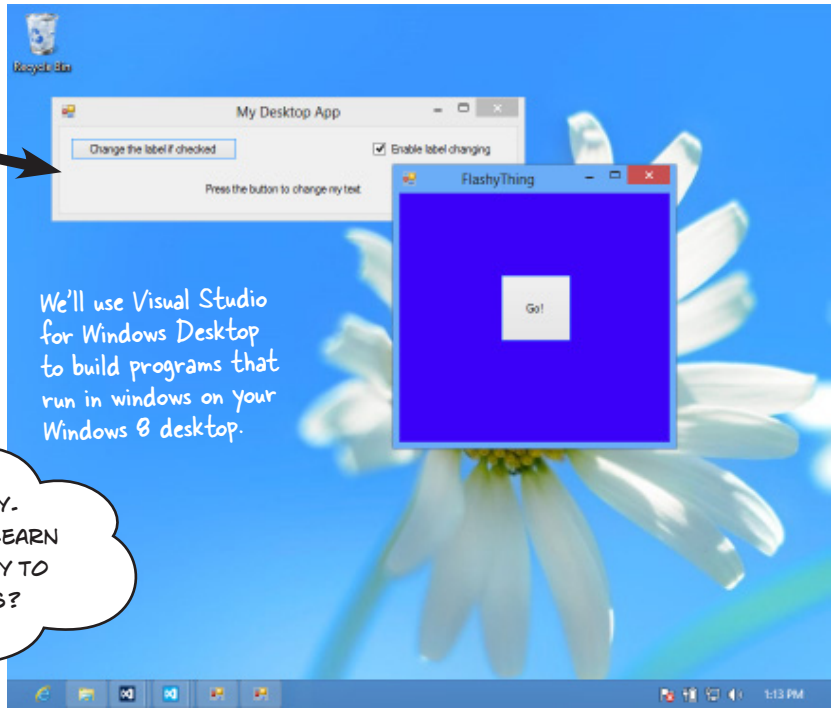
Did you get a different solution? Type it into the IDE and see if it works! There's more than one correct solution to the pool puzzle.

If you want a real challenge, see if you can figure out what that other solution is! Here's a hint: there's another solution that keeps the word fragments in order. If you came up with that solution instead of the one on this page, see if you can figure out why this one works too.

Windows Desktop apps are easy to build

Windows 8 brought Windows Store apps, and that gave everyone a totally new way to use software on Windows. But that's not the only kind of program that you can create with Visual Studio. You can use Visual Studio for Windows Desktop to build **Windows Desktop applications** that run in windows on your Windows 8 desktop.





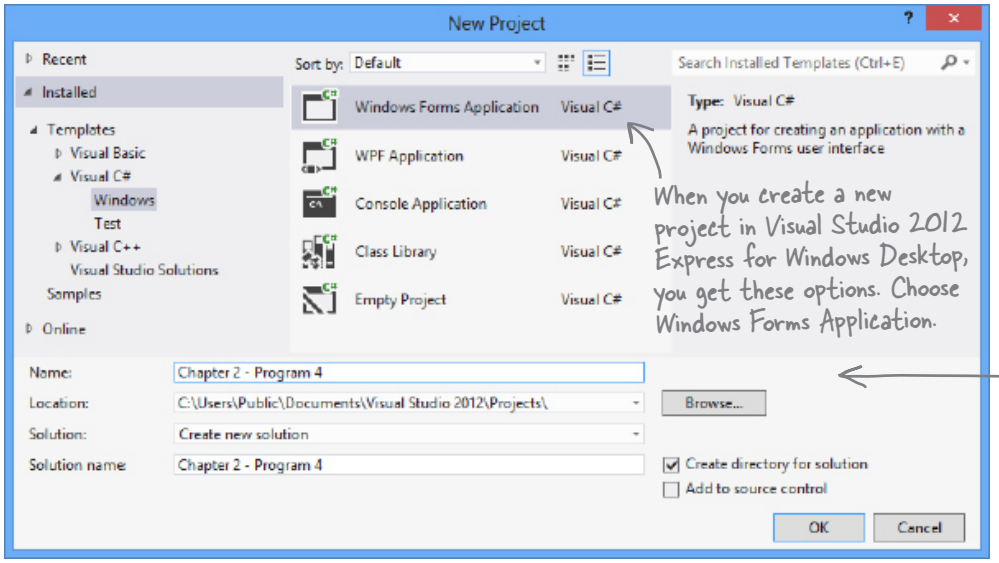
Windows Desktop apps are an effective learning tool

We'll spend the next several chapters building programs using Visual Studio for Windows Desktop before coming back to Windows Store apps. The reason is that in many ways, Windows Desktop apps are simpler. They may not look as slick, and more importantly, they don't integrate with Windows 8 or provide the great, consistent user interface that you get with Windows Store apps. But there are a lot of important, fundamental concepts that you need to understand in order to build Windows Store apps effectively. Windows Desktop programming is a **great tool for exploring those fundamental concepts**. We'll return to programming Windows Store apps once we've laid down that foundation.

Another great reason to learn Windows Desktop programming is that you get to see the same thing done more than one way. That's a really quick way to get concepts into your brain. Flip the page to see what we mean...

Rebuild your app for Windows Desktop

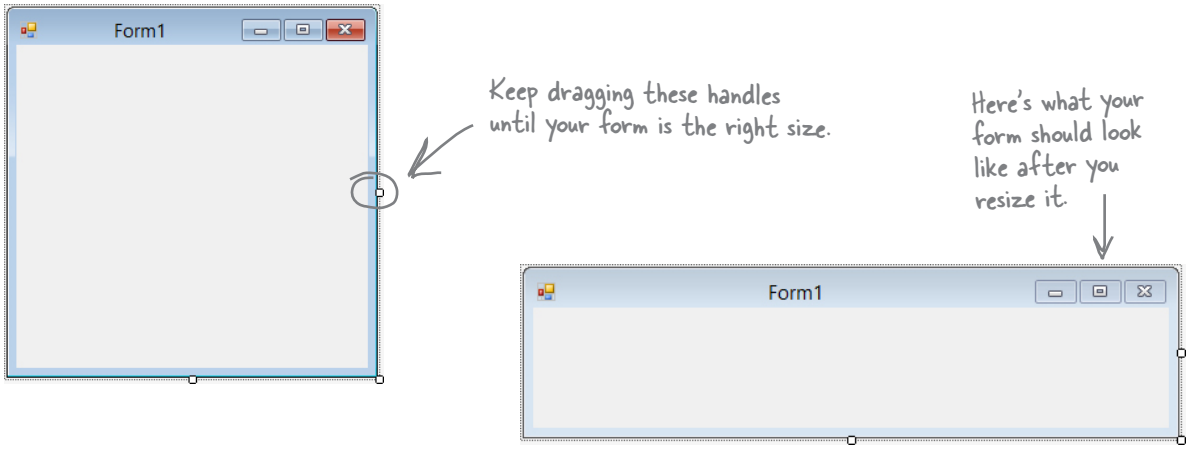
Start up Visual Studio 2012 for Windows Desktop and create a new project. This time, you'll see different options than before. Click on Visual C# and Windows, and **create a new Windows Forms Application project**.



Normally you should choose a better name than "Chapter 2 – Program 4," but we're specifically using a name with spaces and a hyphen for this project so you can see what it does to the namespace.

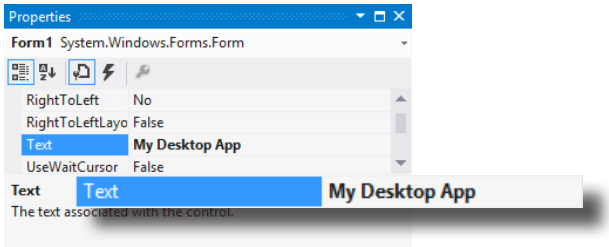
1 **WINDOWS FORMS APPS START WITH A FORM THAT YOU CAN RESIZE.**

Your Windows Forms Application has a main window that you design using the designer in the IDE. Start by resizing it to 500×130. Find the handle on the form in the Designer window and drag to resize it. As you drag it, keep an eye on the changing numbers in the status bar in the IDE that show you the new size. Keep dragging until you see 500 x 130 in the status bar.



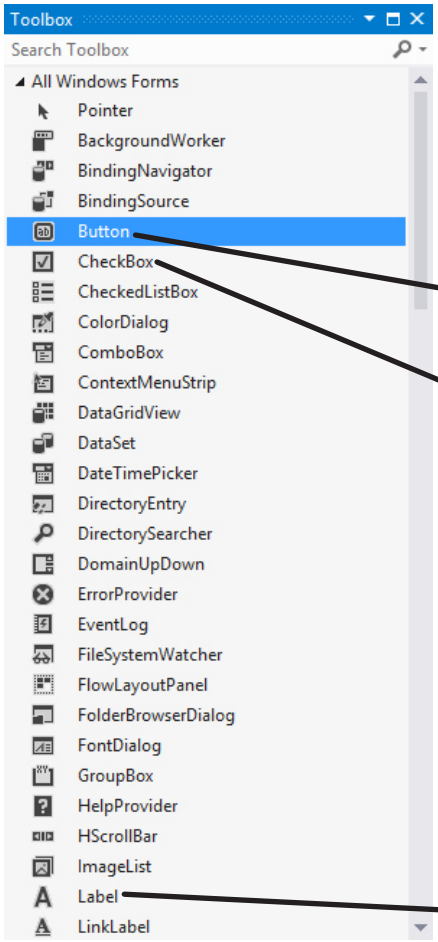
2 CHANGE THE TITLE OF YOUR FORM.

Right now the form has the default title ("Form1"). You can change that by clicking on the form to select it, and then changing the `Text` property in the Properties window.



3 ADD A BUTTON, CHECKBOX, AND LABEL.

Open up the toolbox and drag a Button, CheckBox, and Label control onto your form.



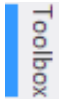
Hint: you'll need to use the AutoSize property to get the Label control to look right.

Watch it!

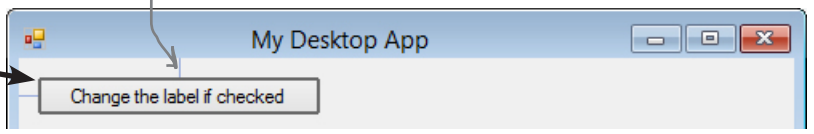
Make sure you're using the right Visual Studio

*If you're using the Express edition of Visual Studio 2012, you'll need to install two versions. You've been using Visual Studio 2012 for Windows 8 to build Windows Store apps. Now you'll need to use **Visual Studio 2012 for Windows Desktop**. Luckily, both Express editions are available for free from Microsoft.*

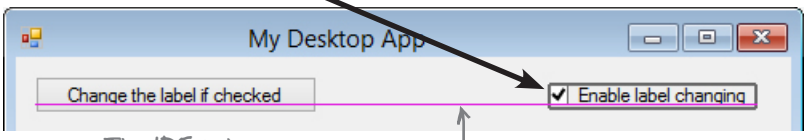
You can expand the toolbox by choosing "Toolbox" from the View menu, or by clicking on the Toolbox tab on the side of the IDE. You can keep it from disappearing by clicking the pushpin icon () on the Toolbox window. You can also drag the window title so that it floats over the IDE.



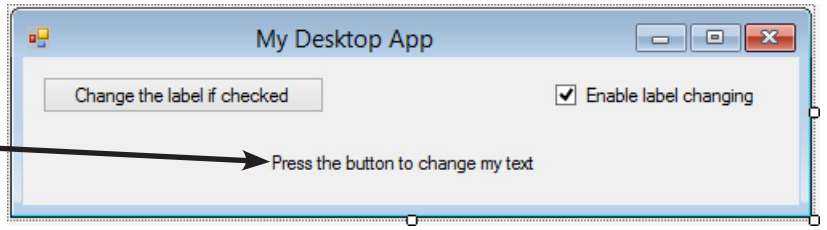
These spacer lines help you position your controls as you drag them around.



On the next page you'll use the Properties window to change the text on each control, and to set the CheckBox control's state to checked. See if you can figure out how to do that before you flip the page!



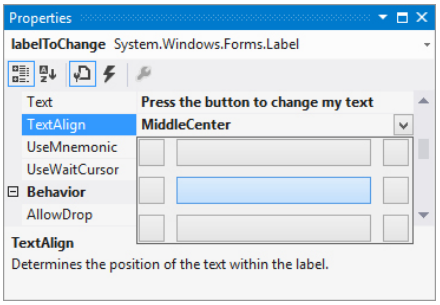
The IDE helps you align your controls by displaying alignment lines as you drag them around the form.



4 USE THE PROPERTIES WINDOW TO SET UP THE CONTROLS.

Click on the Button control to select it. Then go to the Properties window and set its `Text` property:

Change the `Text` property for the CheckBox control and the Label control so they match the screenshot on the next page, and set the CheckBox's `Checked` property to `True`. Then select the Label control and set the TextAlign control to `MiddleCenter`. Use the Properties window to **set the names of your controls**. Name the Button `changeText`, set the CheckBox control's name to `enableCheckbox`, and name the Label control `labelToChange`. Look at the code below carefully and see if you can see how those names are used in the code.



Change the `AutoSize` property on the Label control to `False`. Labels normally resize themselves based on their contents. Disabling `AutoSize` to `true` causes the drag handles to show up. Drag it so it's the **entire width of the window**.

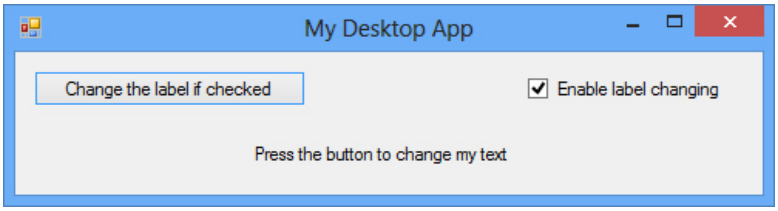
5 ADD THE EVENT HANDLER METHOD FOR YOUR BUTTON.

Double-click on the button to make the IDE add an event handler method. Here's the code:

```
namespace Chapter_2___Program_4
{
    public partial class Form1 : Form
    {
        public Form1()
        {
            InitializeComponent();
        }

        private void changeText_Click(object sender, EventArgs e)
        {
            if (enableCheckbox.Checked == true)
            {
                if (labelToChange.Text == "Right")
                {
                    labelToChange.Text = "Left";
                    labelToChange.TextAlign = ContentAlignment.MiddleLeft;
                }
                else
                {
                    labelToChange.Text = "Right";
                    labelToChange.TextAlign = ContentAlignment.MiddleRight;
                }
            }
            else
            {
                labelToChange.Text = "Text changing is disabled";
                labelToChange.TextAlign = ContentAlignment.MiddleCenter;
            }
        }
    }
}
```

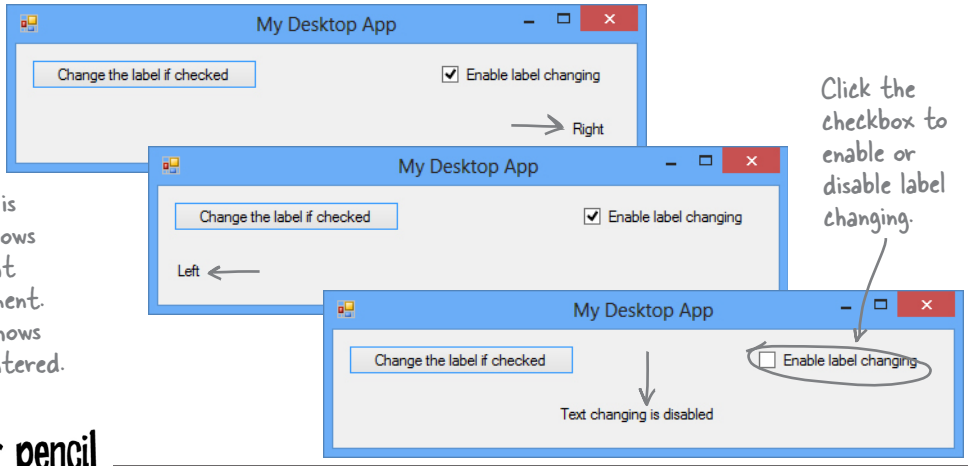
When you double-clicked on the button, the IDE generated this event handler and named it changeText_Click() to match your button's name, changeText.

Here's the code for the event handler method. Take a careful look—can you see what's different from the similar code you added for the exercise?



Debug your program in the IDE.

When you do, the IDE will build your program and run it, which pops up the main window that you built. Try clicking the button and checkbox.



When label changing is enabled, the label shows either Left or Right with matching alignment. If it's disabled, it shows a message that's centered.

Click the checkbox to enable or disable label changing.

Sharpen your pencil

Fill in the annotations so they describe the lines in this C# file that they're pointing to. We've filled in the first one for you. Can you **guess** what the last annotation should say?

```
using System;
using System.Linq;
using System.Text;
using System.Windows.Forms;


namespace SomeNamespace
{
      class MyClass {
            public static void DoSomething() {
                  MessageBox.Show("This is a message");
            }
      }
}
```

C# classes have these "using" lines to add methods from other namespaces

Here's a hint. You haven't seen MessageBox yet, but it's something that a lot of desktop apps use. Like most classes and methods, it has a sensible name.

Solution on page 95

Your desktop app knows where to start

When you created the new Windows Forms Application project, one of the files the IDE added was called *Program.cs*. Go to the Solution Explorer and double-click on it. It's got a class called `Program`, and inside that class is a method called `Main()`. That method is the **entry point**, which means that it's the very first thing that's run in your program.

Desktop apps are different, and that's good for learning.

Windows Desktop applications are a lot less slick than Windows Store apps because it's much harder (but not impossible) to build the kinds of advanced user interfaces that Windows Store apps give you. And that's a good thing for now! Beacuse they're simple and straightforward, desktop apps are a great tool for learning the core C# concepts, and that will make it much easier for you to understand Windows Store apps when we return to them later.

Here's some code the IDE built for you automatically in the last chapter. You'll find it in Program.cs.

Your Code Up Close

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;
using System.Windows.Forms;

namespace Chapter_2___Program_4
{
    static class Program
    {
        /// <summary>
        /// The main entry point for the application.
        /// </summary>
        [STAThread]
        static void Main()
        {
            Application.EnableVisualStyles();
            Application.SetCompatibleTextRenderingDefault(false);
            Application.Run(new Form1());
        }
    }
}
```

The IDE generated this namespace based on the project name. We named ours "Chapter 2 – Program 4," so this is the namespace the IDE generated for us. We chose a name with spaces and a hyphen to show you how the IDE converts them to underscores in the namespace.

Lines that begin with two or more slashes are comments, which you can add anywhere you want. The slashes tell C# to ignore them.

Every time you run your program, it starts here, at the entry point.

This statement creates and displays the form, and ends the program when the form's closed.

I do declare!

The first part of every class or method is called a declaration.

Remember, this is just a starting point for you to dig into the code. But before you do, you'll need to know what you're looking at.

These are some of the "nuts and bolts" of desktop apps. You'll play with them on the next few pages so you can see what's going on behind the scenes. But most of the work you do on desktop apps will be done by dragging controls out of the toolbox and onto a form—and, obviously, editing C# code.

1 **C# AND .NET HAVE LOTS OF BUILT-IN FEATURES.**

You'll find lines like this at the top of almost every C# class file. `System.Windows.Forms` is a **namespace**. The `using System.Windows.Forms` line makes everything in that namespace available to your program. In this case, that namespace has lots of visual elements in it, like buttons and forms.

Your programs will use more and more namespaces like this one as you learn about C# and .NET's other built-in features throughout the book.

If you didn't specify the "using" line, you'd have to explicitly type out System.Windows.Forms every time you use anything in that namespace.

2 **THE IDE CHOSE A NAMESPACE FOR YOUR CODE.**

Here's the namespace the IDE created for you—it chose a namespace based on your project's name. All of the code in your program lives in this namespace.

Namespaces let you use the same name in different programs, as long as those programs aren't also in the same namespace.

3 **YOUR CODE IS STORED IN A CLASS.**

This particular class is called `Program`. The IDE created it and added the code that starts the program and brings up the form called Form1.

You can have multiple classes in a single namespace.

4 **THIS CODE HAS ONE METHOD, AND IT CONTAINS SEVERAL STATEMENTS.**

A namespace has classes in it, and classes have methods. Inside each method is a set of statements. In this program, the statements handle starting up the form. You already know that methods are where the action happens—every method **does** something.

Technically, a program can have more than one Main() method, and you can tell C# which one is the entry point... but you won't need to do that now.

5 **EACH DESKTOP APP HAS A SPECIAL KIND OF METHOD CALLED THE ENTRY POINT.**

Every desktop app **must** have exactly one method called `Main`. Even though your program has a lot of methods, only one can be the first one that gets executed, and that's your `Main` method. C# checks every class in your code for a method that reads `static void Main()`. Then, when the program is run, the first statement in this method gets executed, and everything else follows from that first statement.

Every desktop app must have exactly one method called Main. That method is the entry point for your code.

When you run your code, the code in your Main() method is executed FIRST.

You can change your program's entry point

As long as your program has an entry point, it doesn't matter which class your entry point method is in, or what that method does. There's nothing magical or mysterious about how it works, or how your desktop app runs. You can prove it to yourself by changing your program's entry point.

1. Go back to the program you just wrote. Edit *Program.cs* and change the name of the `Main()` method to `NotMain()`. Now **try to build and run your program**. What happens? Can you guess why it happened?

2. Now let's create a new entry point. **Add a new class** called *AnotherClass.cs*. You add a class to your program by right-clicking on the project name in the Solution Explorer and selecting "Add→Class…". Name your class file *AnotherClass.cs*. The IDE will add a class to your program called `AnotherClass`. Here's the file the IDE added:

Right–click on the project in Properties and select "Add" and "Class..."

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Threading.Tasks;

namespace Chapter_2___Program_4
{
    class AnotherClass
    {
    }
}
```

These four standard using lines were added to the file.

This class is in the same namespace that the IDE added when you first created the project.

The IDE automatically named the class based on the filename.

3. Add a new `using` line to the top of the file: **`using System.Windows.Forms;`** Don't forget to end the line with a semicolon!

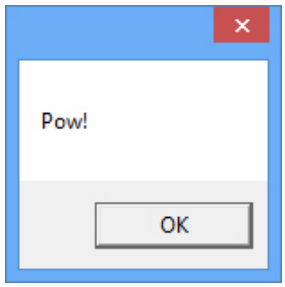
4. Add this method to the **`AnotherClass`** class by typing it in between the curly brackets:

MessageBox is a class that lives in the System.Windows.Forms namespace, which is why you had to add the using line in step #3. Show() is a method that's part of the MessageBox class.

```
class AnotherClass
{
    public static void Main()
    {
        MessageBox.Show("Pow!");
    }
}
```

C# is case-sensitive! Make sure your upper- and lowercase letters match the example code.

Now run it!



Desktop apps use MessageBox.Show() to pop up windows with messages and alerts.

So what happened?

Instead of popping up the app you wrote, your program now shows this message box. When you made the new `Main()` method, you gave your program a new entry point. Now the first thing the program does is run the statements in that method—which means running that `MessageBox.Show()` statement. There's nothing else in that method, so once you click the OK button, the program runs out of statements to execute and then it ends.

5 Figure out how to fix your program so it pops up the app again.

Hint: you only have to change two lines in two files to do it.

Sharpen your pencil Solution

Fill in the annotations so they describe the lines in this C# file that they're pointing to. We've filled in the first one for you.

```
using System;
using System.Linq;
using System.Text;
using System.Windows.Forms;


namespace SomeNamespace
{
      class MyClass {
            public static void DoSomething() {
                  MessageBox.Show("This is a message");
            }
      }
}
```

C# classes have these "using" lines to add methods from other namespaces.

All of the code lives in classes, so the program needs a class here.

This class has one method. Its name is "DoSomething," and when it's called it pops up a MessageBox.

This is a statement. When it's executed, it pops up a little window with a message inside of it.

When you change things in the IDE, you're also changing your code

The IDE is great at writing visual code for you. But don't take our word for it. Open up Visual Studio, **create a new Windows Forms Application project**, and see for yourself.

Do this!

1 OPEN UP THE DESIGNER CODE.

Open the *Form1.Designer.cs* file in the IDE. But this time, instead of opening it in the Form Designer, open up its code by right-clicking on it in the Solution Explorer and selecting View Code. Look for the `Form1` class declaration:

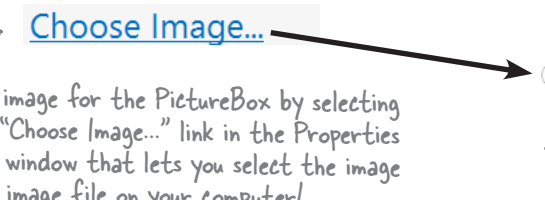
```
partial class Form1
```

Notice how it's a partial class? We'll talk about that in a minute.

2 OPEN UP THE FORM DESIGNER AND ADD A PICTUREBOX TO YOUR FORM.

Get used to working with more than one tab. Go to the Solution Explorer and open up the Form designer by double-clicking on *Form1.cs*. **Drag a new PictureBox control** out of the toolbox and onto the form. A PictureBox control displays a picture, which you can import from an image file.

You can choose the image for the PictureBox by selecting it and clicking the "Choose Image..." link in the Properties window to pop up a window that lets you select the image to load. Choose any image file on your computer!



Select "Local resource" and click the Import... button to pop up a dialog to find the image file to import.

3 FIND AND EXPAND THE DESIGNER-GENERATED CODE FOR THE PICTUREBOX.

Then go back to the Form1.Designer.cs tab in the IDE. Scroll down and look for this line in the code:

Click on the plus sign.

Click on the + on the lefthand side of the line to expand the code. Scroll down and find these lines:

If you double-click on Form1.resx in the Solution Explorer, you'll see the image that you imported. The IDE imported our image and named it "pictureBox1.Image"—and here's the code that it generated to load that image into the PictureBox control so it's displayed.

```
//
// pictureBox1
//
this.pictureBox1.Image = ((System.Drawing.Image)(resources.GetObject("pictureBox1.Image")));
this.pictureBox1.Location = new System.Drawing.Point(416, 160);
this.pictureBox1.Name = "pictureBox1";
this.pictureBox1.Size = new System.Drawing.Size(141, 147);
this.pictureBox1.TabIndex = 0;
this.pictureBox1.TabStop = false;
```

Don't worry if the numbers in your code for the Location and Size lines are a little different than these. They'll vary depending on where you dragged your PictureBox control.

Wait, wait! What did that say?

Scroll back up for a minute. There it is, at the top of the Windows Form Designer–generated code section:

```
/// <summary>
/// Required method for Designer support - do not modify
/// the contents of this method with the code editor.
/// </summary>
```

Most comments only start with two slashes (//). But the IDE sometimes adds these three-slash comments.

These are XML comments, and you can use them to document your code. Flip to "Leftovers" section #2 in the Appendix of this book to learn more about them.

There's nothing more attractive to a kid than a big sign that says, "Don't touch this!" Come on, you know you're tempted…let's go modify the contents of that method with the code editor! **Add a button to your form** called `button1` (you'll need to switch back to the designer)**, and then go ahead and do this:**

1. **CHANGE THE CODE THAT SETS THE BUTTON1.TEXT PROPERTY. WHAT DO YOU THINK IT WILL DO TO THE PROPERTIES WINDOW IN THE IDE?**
   Give it a shot—see what happens! Now go back to the form designer and check the `Text` property. Did it change?

2. **STAY IN THE DESIGNER, AND USE THE PROPERTIES WINDOW TO CHANGE THE NAME PROPERTY TO SOMETHING ELSE.**
   See if you can find a way to get the IDE to change the `Name` property. It's in the Properties window at the very top, under "(Name)". What happened to the code? What about the comment in the code?

3. **CHANGE THE CODE THAT SETS THE LOCATION PROPERTY TO (0,0) AND THE SIZE PROPERTY TO MAKE THE BUTTON REALLY BIG.**
   Did it work?

4. **GO BACK TO THE DESIGNER, AND CHANGE THE BUTTON'S BACKCOLOR PROPERTY TO SOMETHING ELSE.**
   Look closely at the *Form1.Designer.cs* code. Were any lines added?

You don't have to save the form or run the program to see the changes. Just make the change in the code editor, and then click on the tab labeled "Form1.cs [Design]" to flip over to the form designer—the changes should show up immediately.

It's always easier to use the IDE to change your form's designer-generated code. But when you do, any change you make in the IDE ends up as a change to your project's code.

there are no Dumb Questions

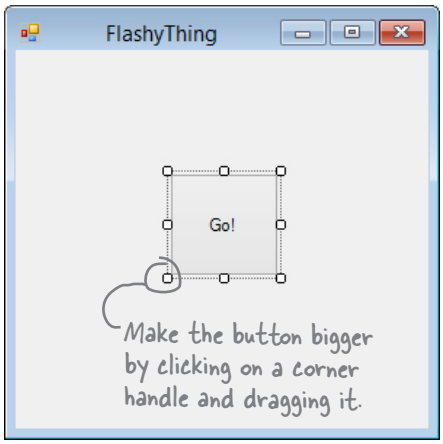
Q: I don't quite get what the entry point is. Can you explain it one more time?

A: Your program has a whole lot of statements in it, but they're not all run at once. The program starts with the first statement in the program, executes it, and then goes on to the next one, and the next one, etc. Those statements are usually organized into a bunch of classes. So when you run your program, how does it know which statement to start with?

That's where the entry point comes in. The compiler will not build your code unless there is **exactly one method called** `Main()`, which we call the entry point. The program starts running with the first statement in `Main()`.

Desktop apps aren't nearly as easy to animate as Windows Store apps, but it's definitely possible! Let's build something **flashy** to prove it. Start by creating a new **Windows Forms Application**.

1 HERE'S THE FORM TO BUILD.



Here's a hint for this exercise: if you declare a variable inside a for loop—for (int c = 0; ...)—then that variable's only valid inside the loop's curly brackets. So if you have two for loops that both use the variable, you'll either declare it in each loop or have one declaration outside the loop. And if the variable c is already declared outside of the loops, you can't use it in either one.

2 MAKE THE FORM BACKGROUND GO ALL PSYCHEDELIC!

When the button's clicked, make the form's background color cycle through a whole lot of colors! Create a loop that has a variable **c** go from 0 to 253. Here's the block of code that goes inside the curly brackets:

```
this.BackColor = Color.FromArgb(c, 255 - c, c);

Application.DoEvents();
```

This line tells the program to stop your loop momentarily and do the other things it needs to do, like refresh the form, check for mouse clicks, etc. Try taking out this line and see what happens. The form doesn't redraw itself, because it's waiting until the loop is done before it deals with those events.

For now, you'll use Application.DoEvents() to make sure your form stays responsive while it's in a loop, but it's kind of a hack. You shouldn't use this code outside of a toy program like this. Later on in the book, you'll learn about a much better way to let your programs do more than one thing at a time!

I'm tickled pink!

The .NET Framework has a bunch of predefined colors like Blue and Red, but it also lets you make your own colors using the Color.FromArgb() method, by specifying three numbers: a red value, a green value, and a blue value.

3 MAKE IT SLOWER.

Slow down the flashing by adding this line after the `Application.DoEvents()` line:

```
System.Threading.Thread.Sleep(3);
```

This statement inserts a 3 millisecond delay in the loop. It's a part of the .NET Framework, and it's in the System.Threading namespace.

Remember, to create a Windows Forms Application you need to be using Visual Studio for Windows Desktop.

4 MAKE IT SMOOTHER.

Let's make the colors cycle back to where they started. Add another loop that has `c` go from 254 down to 0. Use the same block of code inside the curly brackets.

5 KEEP IT GOING.

Surround your two loops with another loop that continuously executes and doesn't stop, so that when the button is pressed, the background starts changing colors and then keeps doing it. (Hint: the `while (true)` loop will run forever!)

When one loop is inside another one, we call it a "nested" loop.

Uh oh! The program doesn't stop!

Run your program in the IDE. Start it looping. Now close the window. Wait a minute—the IDE didn't go back into edit mode! It's acting like the program is still running. You need to actually stop the program using the square stop button in the IDE (or select Stop Debugging from the Debug menu).

6 MAKE IT STOP.

Make the loop you added in step #5 stop when the program is closed. Change your outer loop to this:

```
while (Visible)
```

Now run the program and click the X box in the corner. The window closes, and then the program stops! Except…there's a delay of a few seconds before the IDE goes back to edit mode.

When you're checking a Boolean value like Visible in an if statement or a loop, sometimes it's tempting to test for (Visible == true). You can leave off the "== true"—it's enough to include the Boolean.

When you're working with a form or control, Visible is true as long as the form or control is being displayed. If you set it to false, it makes the form or control disappear.

Hint: the && operator means "AND." It's how you string a bunch of conditional tests together into one big test that's true only if the first test is true AND the second is true AND the third, etc. And it'll come in handy to solve this problem.

Can you figure out what's causing that delay? Can you fix it so the program ends immediately when you close the window?

Exercise Solution

Sometimes we won't show you the entire code in the solution, just the bits that changed. All of the logic in the FlashyThing project is in this button1_Click() method that the IDE added when you double-clicked the button in the form designer.

When the IDE added this method, it added an extra return before the curly bracket. Sometimes we'll put the bracket on the same line like this to save space—but C# doesn't care about extra space, so this is perfectly valid.

Consistency is generally really important to make it easy for people to read code. But we're purposefully showing you different ways, because you'll need to get used to reading code from different people using different styles.

```
private void button1_Click(object sender, EventArgs e) {
    while (Visible) {
        for (int c = 0; c < 254 && Visible; c++) {
            this.BackColor = Color.FromArgb(c, 255 - c, c);
            Application.DoEvents();
            System.Threading.Thread.Sleep(3);
        }
        for (int c = 254; c >= 0 && Visible; c--) {
            this.BackColor = Color.FromArgb(c, 255 - c, c);
            Application.DoEvents();
            System.Threading.Thread.Sleep(3);
        }
    }
}
```

The outer loop keeps running as long as the form is visible. As soon as it's closed, Visible is false, and the while will stop looping.

The first for loop makes the colors cycle one way, and the second for loop reverses them so they look smooth.

We used && Visible instead of && Visible == true. It's just like saying "if it's visible" instead of "if it's true that it's visible"—they mean the same thing.

We fixed the extra delay by using the && operator to make each of the for loops also check Visible. That way the loop ends as soon as Visible turns false.

Can you figure out what's causing that delay? Can you fix it so the program ends immediately when you close the window?

The delay happens because the `for` loops need to finish before the `while` loop can check if `Visible` is still `true`. You can fix it by adding **`&& Visible`** to the conditional test in each for loop.

Was your code a little different than ours? There's more than one way to solve any programming problem (e.g., you could have used while loops instead of for loops). If your program works, then you got the exercise right!

3 objects: get oriented!

Making code make sense

Every program you write solves a problem.

When you're building a program, it's always a good idea to start by thinking about what *problem* your program's supposed to solve. That's why **objects** are really useful. They let you structure your code based on the problem it's solving, so that you can spend your time *thinking about the problem* you need to work on rather than getting bogged down in the mechanics of writing code. When you use objects right, you end up with code that's *intuitive* to write, and easy to read and change.

How Mike thinks about his problems

Mike's a programmer about to head out to a job interview. He can't wait to show off his C# skills, but first he has to get there—and he's running late!

1 **Mike figures out the route he'll take to get to the interview.**

I'LL TAKE THE 31ST STREET BRIDGE, HEAD UP LIBERTY AVENUE, AND GO THROUGH BLOOMFIELD.

Mike sets his destination, then comes up with a route.

2 **Good thing he had his radio on. There's a huge traffic jam that'll make him late!**

Mike gets new information about a street he needs to avoid.

THIS IS FRANK LOUDLY WITH YOUR EYE-IN-THE-SKY SHADOW TRAFFIC REPORT. IT LOOKS LIKE A THREE-CAR PILEUP ON LIBERTY HAS TRAFFIC BACKED UP ALL THE WAY TO 32ND STREET.

3 **Mike comes up with a new route to get to his interview on time.**

Now he can come up with a new route to the interview.

NO PROBLEM. IF I TAKE ROUTE 28 INSTEAD, I'LL STILL BE ON TIME!

How Mike's car navigation system thinks about his problems

Mike built his own GPS navigation system, which he uses to help him get around town.

Here's a diagram of a class in Mike's program. It shows the name on top, and the methods on the bottom.

Navigator

- SetCurrentLocation()
- SetDestination()
- ModifyRouteToAvoid()
- ModifyRouteToInclude()
- GetRoute()
- GetTimeToDestination()
- TotalDistance()

```
SetDestination("Fifth Ave & Penn Ave");
string route;
route = GetRoute();
```

Here's the output from the GetRoute() method—it's a string that contains the directions Mike should follow.

The navigation system sets a destination and comes up with a route.

```
"Take 31st Street Bridge to Liberty Avenue to Bloomfield"
```

The navigation system gets new information about a street it needs to avoid.

```
ModifyRouteToAvoid("Liberty Ave");
```

Now it can come up with a new route to the destination.

```
string route;
route = GetRoute();
```

```
"Take Route 28 to the Highland Park Bridge to Washington Blvd"
```

GetRoute() gives a new route that doesn't include the street Mike wants to avoid.

Mike's navigation system solves the street navigation problem the same way he does.

Mike's Navigator class has methods to set and modify routes

Mike's `Navigator` class has methods, which are where the action happens. But unlike the `button_Click()` methods in the forms you've built, they're all focused around a single problem: navigating a route through a city. That's why Mike stuck them together into one class, and called that class `Navigator`.

Mike designed his `Navigator` class so that it's easy to create and modify routes. To get a route, Mike's program calls the `SetDestination()` method to set the destination, and then uses the `GetRoute()` method to put the route into a string. If he needs to change the route, his program calls the `ModifyRouteToAvoid()` method to change the route so that it avoids a certain street, and then calls the `GetRoute()` method to get the new directions.

Mike chose method names that would make sense to someone who was thinking about how to navigate a route through a city.

```
class Navigator {

   public void SetCurrentLocation(string locationName) { ... }

   public void SetDestination(string destinationName) { ... }

   public void ModifyRouteToAvoid(string streetName) { ... }

   public string GetRoute() { ... }

}
```

This is the **return type** of the method. It means that the statement calling the GetRoute() method can use it to set a string variable that will contain the directions. When it's **void**, that means the method doesn't return anything.

```
string route =
       GetRoute();
```

Some methods have a return value

Every method is made up of statements that do things. Some methods just execute their statements and then exit. But other methods have a **return value**, or a value that's calculated or generated inside the method, and sent back to the statement that called that method. The type of the return value (like `string` or `int`) is called the **return type**.

The **`return`** statement tells the method to immediately exit. If your method doesn't have a return value—which means it's declared with a return type of `void`—then the `return` statement doesn't need any values or variables ("`return;`"), and you don't always have to have one in your method. But if the method has a return type, then it *must* use the `return` statement.

Here's an example of a method that has a return type—it returns an int. The method uses the two **parameters** to calculate the result.

```
public int MultiplyTwoNumbers(int firstNumber, int secondNumber) {
    int result = firstNumber * secondNumber;
    return result;
}
```

This **return** statement passes the value back to the statement that called the method.

Here's a statement that calls a method to multiply two numbers. It returns an `int`:

```
int myResult = MultiplyTwoNumbers(3, 5);
```

Methods can take values like 3 and 5. But you can also use variables to pass values to a method.

BULLET POINTS

- Classes have methods that contain statements that perform actions. You can design a class that is easy to use by choosing methods that make sense.
- Some methods have a **return type**. You set a method's return type in its declaration. A method with a declaration that starts "`public int`" returns an `int` value. Here's an example of a statement that returns an `int` value: `return 37;`
- When a method has a return type, it **must** have a `return` statement that returns a value that matches a return type. So if you've got a method that's declared "`public string`" then you need a `return` statement that returns a string.
- As soon as a `return` statement in a method executes, your program jumps back to the statement that called the method.
- Not all methods have a return type. A method with a declaration that starts "`public void`" doesn't return anything at all. You can still use a `return` statement to exit a `void` method: `if (finishedEarly) { return; }`

Use what you've learned to build a program that uses a class

Let's hook up a form to a class, and make its button call a method inside that class.

Do this!

1. Create a **new Windows Forms Application project** in the IDE. Then add a class file to it called *Talker.cs* by right-clicking on the project in the Solution Explorer and selecting "Class…" from the Add menu. When you name your new class file "Talker.cs," the IDE will automatically name the class in the new file `Talker`. Then it'll pop up the new class in a new tab inside the IDE.

2. Add `using System.Windows.Forms;` to the top of the class file. Then add code to the class:

```
class Talker {
    public static int BlahBlahBlah(string thingToSay, int numberOfTimes)
    {
        string finalString = "";
        for (int count = 0; count < numberOfTimes; count++)
        {
            finalString = finalString + thingToSay + "\n";
        }
        MessageBox.Show(finalString);
        return finalString.Length;
    }
}
```

This statement declares a finalString variable and sets it equal to an empty string.

This line of code adds the contents of thingToSay and a line break ("\n") onto the end of it to the finalString variable.

The BlahBlahBlah() method's return value is an integer that has the total length of the message it displayed. You can add ".Length" to any string to figure out how long it is.

This is called a **property**. Every string has a property called Length. When it calculates the length of a string, a line break ("\n") counts as one character.

Flip the page to keep going!

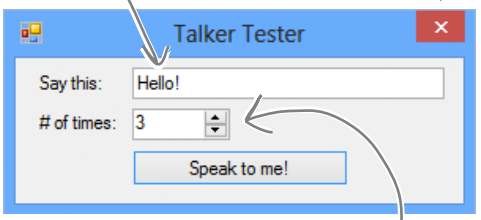
So what did you just build?

The new class has one method called `BlahBlahBlah()` that takes two parameters. The first parameter is a string that tells it something to say, and the second is the number of times to say it. When it's called, it pops up a message box with the message repeated a number of times. Its return value is the length of the string. The method needs a string for its `thingToSay` parameter and a number for its `numberOfTimes` parameter. It'll get those parameters from a form that lets the user enter text using a **`TextBox`** control and a number using a **`NumericUpDown`** control.

Now add a form that uses your new class!

To turn off the minimize and maximize buttons, set the form's MaximizeBox and MinimizeBox properties to False.

Set the default text of this TextBox control to "Hello!" using its Text property.



3 Make your project's form look like this.

Then double-click on the button and have it run this code that calls `BlahBlahBlah()` and assigns its return value to an integer called `len`:

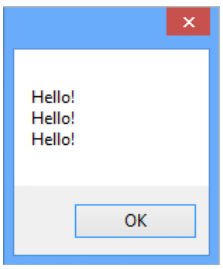
This is a NumericUpDown control. Set its Minimum property to 1, its Maximum property to 10, and its Value property to 3.

```
private void button1_Click(object sender, EventArgs e)
{
    int len = Talker.BlahBlahBlah(textBox1.Text, (int)numericUpDown1.Value);
    MessageBox.Show("The message length is " + len);
}
```

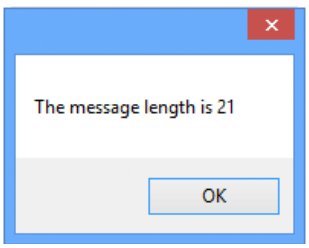
The length is 21 because "Hello!" is six characters, plus the \n counts as another character, which gives 7 x 3 = 21.

4 Now run your program! Click the button and watch it pop up two message boxes. The class pops up the first message box, and the form pops up the second one.

The BlahBlahBlah() method pops up this message box based on what's in its parameters.



When the method returns a value, the form pops it up in this message box.



You can add a class to your project and share its methods with the other classes in the project.

Mike gets an idea

The interview went great! But the traffic jam this morning got Mike thinking about how he could improve his navigator.

IT'D BE GREAT IF I COULD COMPARE A FEW ROUTES AND FIGURE OUT WHICH IS FASTEST....

He could create three different Navigator classes...

Mike *could* copy the `Navigator` class code and paste it into two more classes. Then his program could store three routes at once.

This box is a **class diagram**. It lists all of the methods in a class, and it's an easy way to see everything that it does at a glance.

Navigator
SetCurrentLocation()
SetDestination()
ModifyRouteToAvoid()
ModifyRouteToInclude()
GetRoute()
GetTimeToDestination()
TotalDistance()

Navigator2
SetCurrentLocation()
SetDestination()
ModifyRouteToAvoid()
ModifyRouteToInclude()
GetRoute()
GetTimeToDestination()
TotalDistance()

Navigator3
SetCurrentLocation()
SetDestination()
ModifyRouteToAvoid()
ModifyRouteToInclude()
GetRoute()
GetTimeToDestination()
TotalDistance()

WHOA, THAT CAN'T BE RIGHT! WHAT IF I WANT TO CHANGE A METHOD? THEN I NEED TO GO BACK AND FIX IT IN THREE PLACES.

Right! Maintaining three copies of the same code is really messy. A lot of problems you have to solve need a way to represent one ***thing*** a bunch of different times. In this case, it's a bunch of routes. But it could be a bunch of people, or aliens, or music files, or anything. All of those programs have one thing in common: they always need to treat the same kind of thing in the same way, no matter how many of the thing they're dealing with.

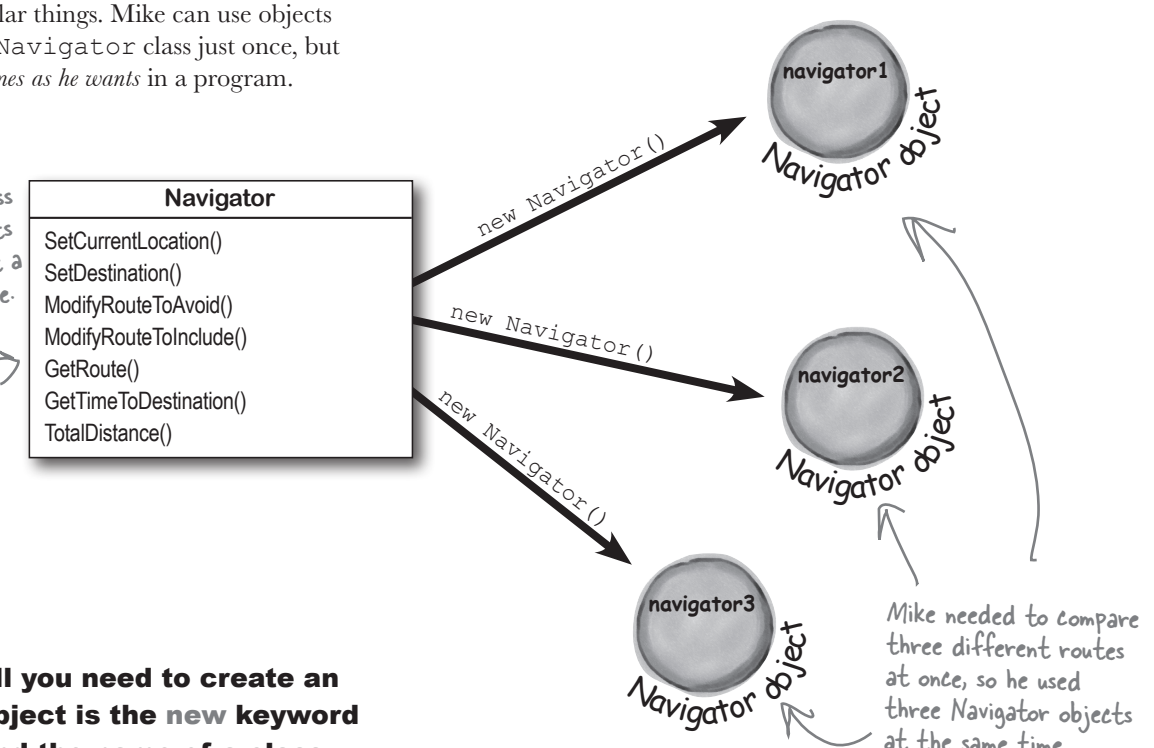
Mike can use objects to solve his problem

Objects are C#'s tool that you use to work with a bunch of similar things. Mike can use objects to program his `Navigator` class just once, but use it *as many times as he wants* in a program.

This is the Navigator class in Mike's program. It lists all of the methods that a Navigator object can use.

Navigator

SetCurrentLocation()
SetDestination()
ModifyRouteToAvoid()
ModifyRouteToInclude()
GetRoute()
GetTimeToDestination()
TotalDistance()



Mike needed to compare three different routes at once, so he used three Navigator objects at the same time.

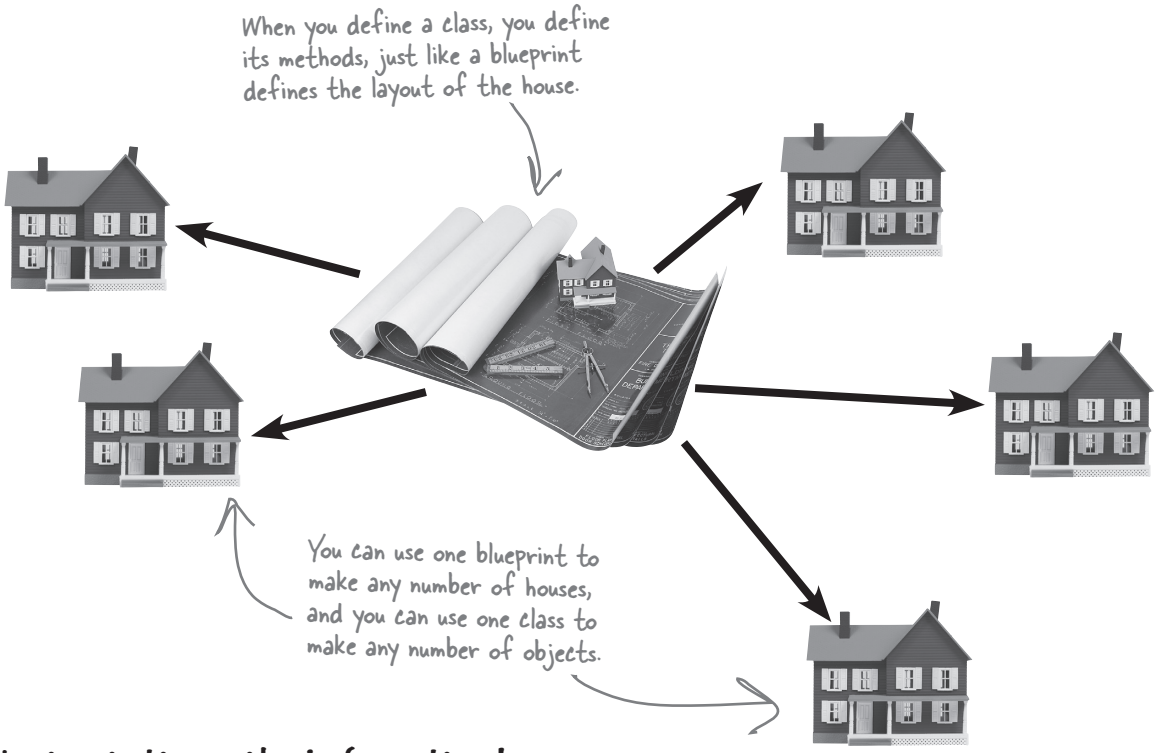
All you need to create an object is the new keyword and the name of a class.

```
Navigator navigator1 = new Navigator();
navigator1.SetDestination("Fifth Ave & Penn Ave");
string route;
route = navigator1.GetRoute();
```

Now you can use the object! When you create an object from a class, that object has all of the methods from that class.

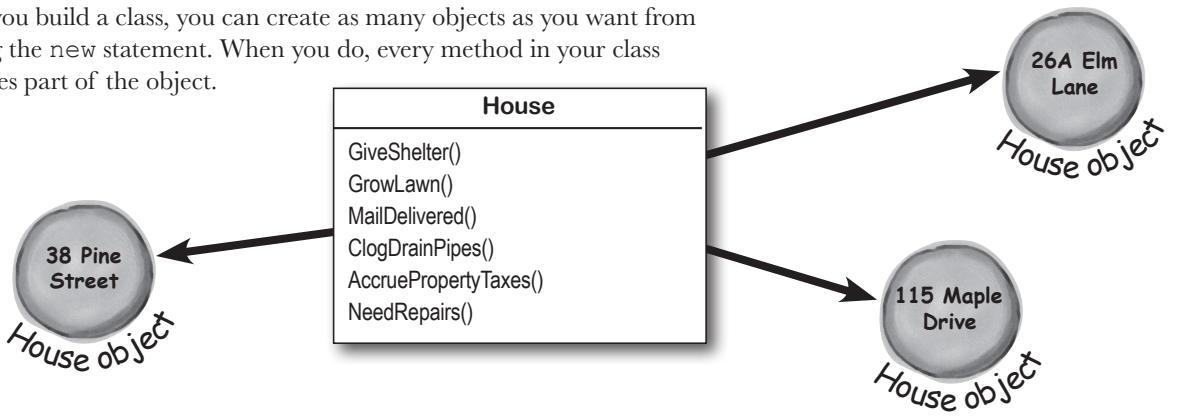
You use a class to build an object

A class is like a blueprint for an object. If you wanted to build five identical houses in a suburban housing development, you wouldn't ask an architect to draw up five identical sets of blueprints. You'd just use one blueprint to build five houses.



An object gets its methods from its class

Once you build a class, you can create as many objects as you want from it using the `new` statement. When you do, every method in your class becomes part of the object.



When you create a new object from a class, it's called an instance of that class

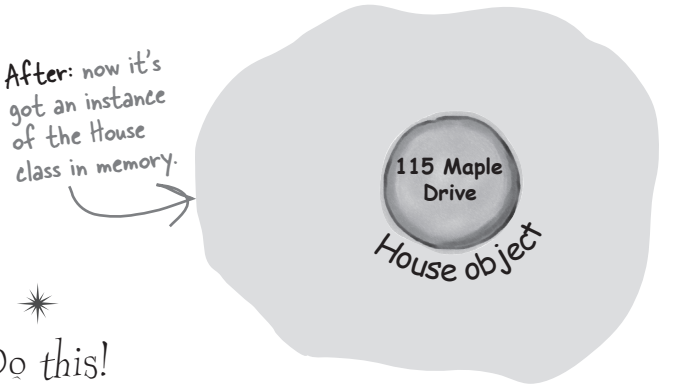
Guess what…you already know this stuff! Everything in the toolbox is a class: there's a `Button` class, a `TextBox` class, a `Label` class, etc. When you drag a button out of the toolbox, the IDE automatically creates an instance of the `Button` class and calls it `button1`. When you drag another button out of the toolbox, it creates another instance called `button2`. Each instance of `Button` has its own properties and methods. But every button acts exactly the same way, because they're all instances of the same class.

Before: here's a picture of your computer's memory when your program starts.

Your program executes a new statement.

```
House mapleDrive115 = new House();
```

After: now it's got an instance of the House class in memory.



Do this!

Check it out for yourself!

Open any project that uses a button called `button1`, and use the IDE to search the entire project for the text "**`button1 = new`**". You'll find the code that the IDE added to the form designer to create the instance of the `Button` class.

in-stance, noun.
an example or one occurrence of something. *The IDE search-and-replace feature finds every* ***instance*** *of a word and changes it to another.*

A better solution...brought to you by objects!

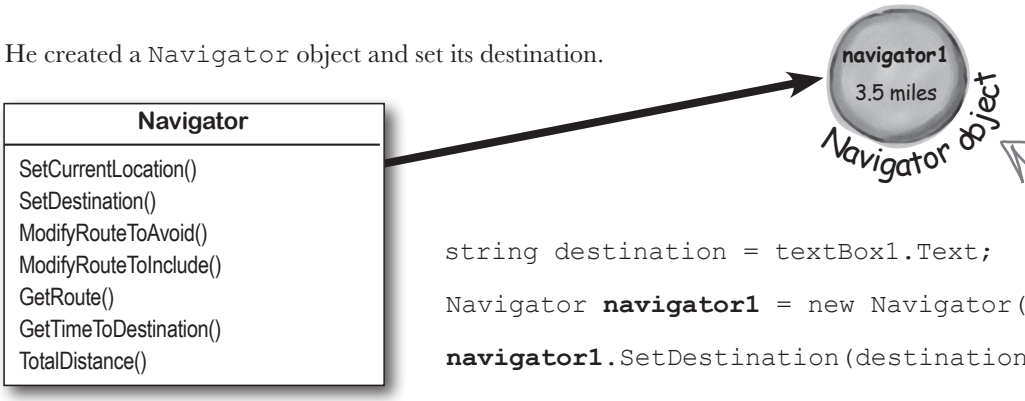
GUI stands for Graphical User Interface, which is what you're building when you make a form in the form designer.

Mike came up with a new route comparison program that uses objects to find the shortest of three different routes to the same destination. Here's how he built his program.

1. Mike set up a GUI with a textbox—`textBox1` contains the **destination** for the three routes. Then he added `textBox2`, which has a street that one of the routes should **avoid**; and `textBox3`, which contains a different street that the third route has to **include**.

2. He created a `Navigator` object and set its destination.

The navigator1 object is an instance of the Navigator class.




```
string destination = textBox1.Text;
Navigator navigator1 = new Navigator();
navigator1.SetDestination(destination);
route = navigator1.GetRoute();
```

3. Then he added a second `Navigator` object called `navigator2`. He called its `SetDestination()` method to set the destination, and then he called its `ModifyRouteToAvoid()` method.

The SetDestination(), ModifyRouteToAvoid(), and ModifyRouteToInclude() methods all take a string as a parameter.

4. The third `Navigator` object is called `navigator3`. Mike set its destination, and then called its `ModifyRouteToInclude()` method.

5. Now Mike can call each object's `TotalDistance()` method to figure out which route is the shortest. And he only had to write the code once, not three times!

Any time you create a new object from a class, it's called creating an instance of that class.

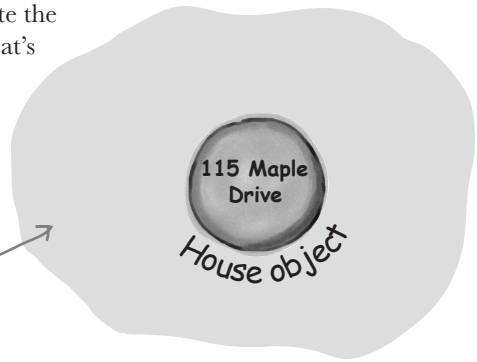
That's right, we didn't. A geographic navigation program is a really complicated thing to build. But complicated programs follow the same patterns as simple ones. Mike's navigation program is an example of how someone would use objects in real life.

Theory and practice

Speaking of patterns, here's a pattern that you'll see over and over again throughout the book. We'll introduce a concept or idea (like objects) over the course of a few pages, using pictures and short code excerpts to demonstrate the idea. This is your opportunity to take a step back and try to understand what's going on without having to worry about getting a program to work.

```
House mapleDrive115 = new House();
```

When we're introducing a new concept (like objects), keep your eyes open for pictures and code excerpts like this.



After we've introduced a concept, we'll give you a chance to get it into your brain. Sometimes we'll follow up the theory with a writing exercise—like the *Sharpen your pencil* exercise on the next page. Other times, we'll jump straight into code. This combination of theory and practice is an effective way to get these concepts off of the page and stuck in your brain.

A little advice for the code exercises

If you keep a few simple things in mind, it'll make the code exercises go smoothly:

- It's easy to get caught up in syntax problems, like missing parentheses or quotes. One missing bracket can cause many build errors.
- It's ***much better*** to look at the solution than to get frustrated with a problem. When you're frustrated, your brain doesn't like to learn.
- All of the code in this book is tested and definitely works in Visual Studio 2012! But it's easy to accidentally type things wrong (like typing a one instead of a lowercase L).
- If your solution just won't build, try downloading it from the Head First Labs website: ***http://www.headfirstlabs.com/hfcsharp***

When you run into a problem with a coding exercise, don't be afraid to peek at the solution. You can also download the solution from the Head First Labs website.

Sharpen your pencil

Follow the same steps that Mike followed earlier in the chapter to write the code to create `Navigator` objects and call their methods.

```
string destination = textBox1.Text;
string route2StreetToAvoid = textBox2.Text;
string route3StreetToInclude = textBox3.Text;
```

We gave you a head start. Here's the code Mike wrote to get the destination and street names from the text boxes.

```
Navigator navigator1 = new Navigator();
navigator1.SetDestination(destination);
int distance1 = navigator1.TotalDistance();
```

And here's the code to create the navigator object, set its destination, and get the distance.

1. Create the `navigator2` object, set its destination, call its `ModifyRouteToAvoid()` method, and use its `TotalDistance()` method to set an integer variable called `distance2`.

```
Navigator navigator2 = .....
navigator2.....
navigator2.....
int distance2 = .....
```

2. Create the `navigator3` object, set its destination, call its `ModifyRouteToInclude()` method, and use its `TotalDistance()` method to set an integer variable called `distance3`.

```
.....
.....
.....
.....
```

The Math.Min() method built into the .NET Framework compares two numbers and returns the smallest one. Mike used it to find the shortest distance to the destination.

```
int shortestDistance = Math.Min(distance1, Math.Min(distance2, distance3));
```

Sharpen your pencil Solution

Follow the same steps that Mike followed earlier in the chapter to write the code to create `Navigator` objects and call their methods.

```
string destination = textBox1.Text;
string route2StreetToAvoid = textBox2.Text;
string route3StreetToInclude = textBox3.Text;
```

We gave you a head start. Here's the code Mike wrote to get the destination and street names from the text boxes.

```
Navigator navigator1 = new Navigator();
navigator1.SetDestination(destination);
int distance1 = navigator1.TotalDistance();
```

And here's the code to create the navigator object, set its destination, and get the distance.

1. Create the `navigator2` object, set its destination, call its `ModifyRouteToAvoid()` method, and use its `TotalDistance()` method to set an integer variable called `distance2`.

```
Navigator navigator2 = new Navigator()
navigator2.SetDestination(destination);
navigator2.ModifyRouteToAvoid(route2StreetToAvoid);
int distance2 = navigator2.TotalDistance();
```

2. Create the `navigator3` object, set its destination, call its `ModifyRouteToInclude()` method, and use its `TotalDistance()` method to set an integer variable called `distance3`.

```
Navigator navigator3 = new Navigator()
navigator3.SetDestination(destination);
navigator3.ModifyRouteToInclude(route3StreetToInclude);
int distance3 = navigator3.TotalDistance();
```

The Math.Min() method built into the .NET Framework compares two numbers and returns the smallest one. Mike used it to find the shortest distance to the destination.

```
int shortestDistance = Math.Min(distance1, Math.Min(distance2, distance3));
```

I'VE WRITTEN A FEW CLASSES NOW, BUT I HAVEN'T USED "NEW" TO CREATE AN INSTANCE YET! SO DOES THAT MEAN I CAN CALL METHODS WITHOUT CREATING OBJECTS?

Yes! That's why you used the `static` keyword in your methods.

Take another look at the declaration for the `Talker` class you built a few pages ago:

```
class Talker
{
  public static int BlahBlahBlah(string thingToSay, int numberOfTimes)
  {
    string finalString = "";
```

When you called the method, you didn't create a `new` instance of `Talker`. You just did this:

```
Talker.BlahBlahBlah("Hello hello hello", 5);
```

That's how you call `static` methods, and you've been doing that all along. If you take away the `static` keyword from the `BlahBlahBlah()` method declaration, then you'll have to create an instance of `Talker` in order to call the method. Other than that distinction, static methods are just like object methods. You can pass parameters, they can return values, and they live in classes.

There's one more thing you can do with the `static` keyword. You can mark your **whole class** as static, and then all of its methods **must** be `static` too. If you try to add a nonstatic method to a static class, it won't compile.

there are no Dumb Questions

Q: When I think of something that's "static," I think of something that doesn't change. Does that mean nonstatic methods can change, but static methods don't? Do they behave differently?

A: No, both static and nonstatic methods act exactly the same. The only difference is that static methods don't require an instance, while nonstatic methods do. A lot of people have trouble remembering that, because the word "static" isn't really all that intuitive.

Q: So I can't use my class until I create an instance of an object?

A: You can use its static methods. But if you have methods that aren't static, then you need an instance before you can use them.

Q: Then why would I want a method that needs an instance? Why wouldn't I make all my methods static?

A: Because if you have an object that's keeping track of certain data—like Mike's instances of his `Navigator` class that each kept track of a different route—then you can use each instance's methods to work with that data. So when Mike called his `ModifyRouteToAvoid()` method in the `navigator2` instance, it only affected the route that was stored in that particular instance. It didn't affect the `navigator1` or `navigator3` objects. That's how he was able to work with three different routes at the same time—and his program could keep track of all of it.

Q: So how does an instance keep track of data?

A: Turn the page and find out!

An instance uses fields to keep track of things

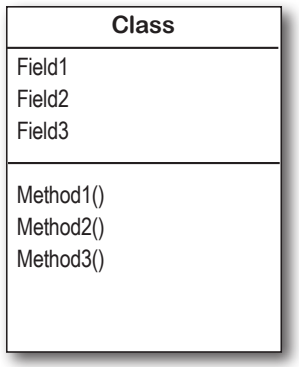
You change the text on a button by setting its `Text` property in the IDE. When you do, the IDE adds code like this to the designer:

```
button1.Text = "Text for the button";
```

Technically, it's setting a **property**. A property is very similar to a field—but we'll get into all that a little later on.

Now you know that `button1` is an instance of the `Button` class. What that code does is modify a **field** for the `button1` instance. You can add fields to a class diagram—just draw a horizontal line in the middle of it. Fields go above the line, methods go underneath it.

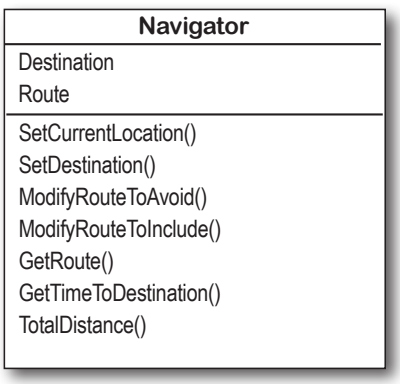
This is where a class diagram shows the fields. Every instance of the class uses them to keep track of its state.



Add this line to separate the fields from the methods.

Methods are what an object does. Fields are what the object knows.

When Mike created three instances of `Navigator` classes, his program created three objects. Each of those objects was used to keep track of a different route. When the program created the `navigator2` instance and called its `SetDestination()` method, it set the destination for that one instance. But it didn't affect the `navigator1` instance or the `navigator3` instance.



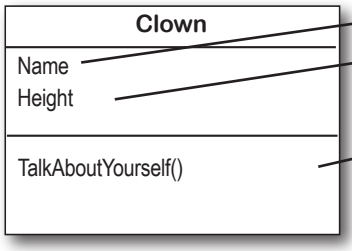
Every instance of Navigator knows its destination and its route.

What a Navigator object does is let you set a destination, modify its route, and get information about that route.

An object's behavior is defined by its methods, and it uses fields to keep track of its state.

Let's create some instances!

It's easy to add fields to your class. Just declare variables outside of any methods. Now every instance gets its own copy of those variables.




```
class Clown {
   public string Name;
   public int Height;

   public void TalkAboutYourself() {
      MessageBox.Show("My name is "
         + Name + " and I'm "
         + Height + " inches tall.");
   }
}
```

Remember, when you see "void" in front of a method, it means that it doesn't return any value.

When you want to create instances of your class, **don't use** the static keyword in either the class declaration or the method declaration.

Remember, the *= operator tells C# to take whatever's on the left of the operator and multiply it by whatever's on the right.

Sharpen your pencil

Write down the contents of each message box that will be displayed after the statement next to it is executed.

```
Clown oneClown = new Clown();
oneClown.Name = "Boffo";
oneClown.Height = 14;
```

```
oneClown.TalkAboutYourself();
```

"My name is _____ and I'm _____ inches tall."

```
Clown anotherClown = new Clown();
anotherClown.Name = "Biff";
anotherClown.Height = 16;
```

```
anotherClown.TalkAboutYourself();
```

"My name is _____ and I'm _____ inches tall."

```
Clown clown3 = new Clown();
clown3.Name = anotherClown.Name;
clown3.Height = oneClown.Height - 3;
```

```
clown3.TalkAboutYourself();
```

"My name is _____ and I'm _____ inches tall."

```
anotherClown.Height *= 2;
```

```
anotherClown.TalkAboutYourself();
```

"My name is _____ and I'm _____ inches tall."

Thanks for the memory

When your program creates an object, it lives in a part of the computer's memory called the **heap**. When your code creates an object with a `new` statement, C# immediately reserves space in the heap so it can store the data for that object.

Here's a picture of the heap before the project starts. Notice that it's empty.

Let's take a closer look at what happened here

Sharpen your pencil Solution

Write down the contents of each message box that will be displayed after the statement next to it is executed.

Each of these **new** statements creates an instance of the Clown class by reserving a chunk of memory on the heap for that object and filling it up with the object's data.

```
Clown oneClown = new Clown();
oneClown.Name = "Boffo";
oneClown.Height = 14;
oneClown.TalkAboutYourself();
```

"My name is Boffo and I'm 14 inches tall."

```
Clown anotherClown = new Clown();
anotherClown.Name = "Biff";
anotherClown.Height = 16;
anotherClown.TalkAboutYourself();
```

"My name is Biff and I'm 16 inches tall."

```
Clown clown3 = new Clown();
clown3.Name = anotherClown.Name;
clown3.Height = oneClown.Height - 3;
clown3.TalkAboutYourself();
```

"My name is Biff and I'm 11 inches tall."

```
anotherClown.Height *= 2;
anotherClown.TalkAboutYourself();
```

"My name is Biff and I'm 32 inches tall."

When your program creates a new object, it gets added to the heap.

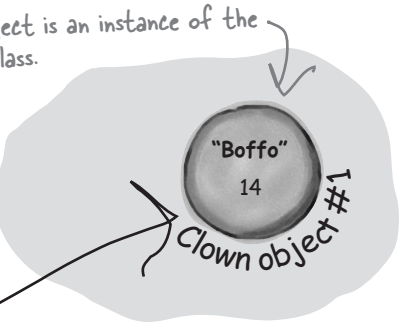
What's on your program's mind

Here's how your program creates a new instance of the `Clown` class:

```
Clown myInstance = new Clown();
```

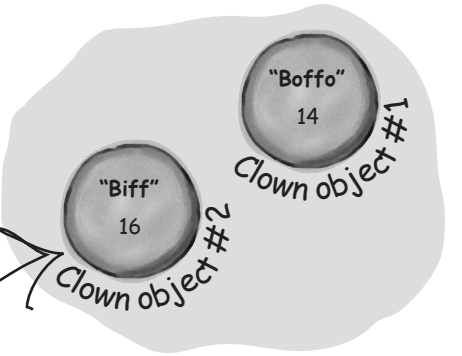
That's actually two statements combined into one. The first statement declares a variable of type `Clown` (`Clown myInstance;`). The second statement creates a new object and assigns it to the variable that was just created (`myInstance = new Clown();`). Here's what the heap looks like after each of these statements:

This object is an instance of the Clown class.



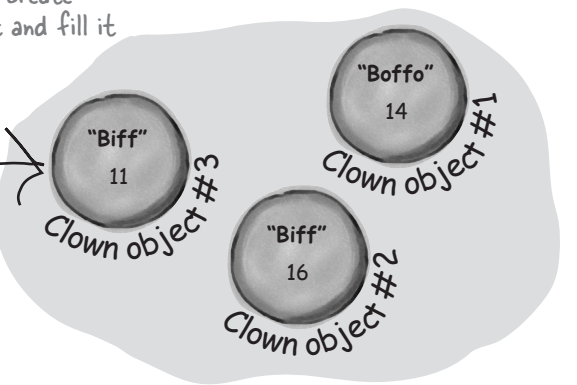
1
```
Clown oneClown = new Clown();
oneClown.Name = "Boffo";
oneClown.Height = 14;
oneClown.TalkAboutYourself();
```

The first object is created, and its fields are set.



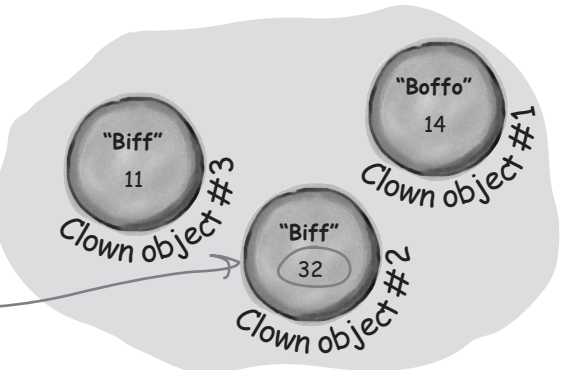
2
```
Clown anotherClown = new Clown();
anotherClown.Name = "Biff";
anotherClown.Height = 16;
anotherClown.TalkAboutYourself();
```

These statements create the second object and fill it with data.



3
```
Clown clown3 = new Clown();
clown3.Name = anotherClown.Name;
clown3.Height = oneClown.Height - 3;
clown3.TalkAboutYourself();
```

Then the third Clown object is created and populated.



4
```
anotherClown.Height *= 2;
anotherClown.TalkAboutYourself();
```

There's no "new" statement, which means these statements don't create a new object. They're just modifying one that's already in memory.

You can use class and method names to make your code intuitive

When you put code in a method, you're making a choice about how to structure your program. Do you use one method? Do you split it into more than one? Or do you even need a method at all? The choices you make about methods can make your code much more intuitive—or, if you're not careful, much more convoluted.

Great developers write code that's easy to understand. Comments can help, but nothing beats choosing intuitive names for your methods, classes, variables, and fields.

1 Here's a nice, compact chunk of code. It's from a control program that runs a machine that makes candy bars.

```
int t = m.chkTemp();
if (t > 160) {
  T tb = new T();
  tb.clsTrpV(2);
  ics.Fill();
  ics.Vent();
  m.airsyschk();
}
```

The chkTemp() method returns an integer...but what does it do?

"tb", "ics", and "m" are terrible names! We have no idea what they do. And what's that T class for?

The clsTrpV() method has one parameter, but we don't know what it's supposed to be.

Take a second and look at that code. Can you figure out what it does?

2 Those statements don't give you any hints about why the code's doing what it's doing. In this case, the programmer was happy with the results because she was able to get it all into one method. But making your code as compact as possible isn't really useful! Let's break it up into methods to make it easier to read, and make sure the classes are given names that make sense. But we'll start by figuring out what the code is supposed to do.

How do you figure out what your code is supposed to do? Well, all code is written for a reason. So it's up to you to figure out that reason! In this case, we can look up the page in the specification manual that the programmer followed.

General Electronics Type 5 Candy Bar Maker Specification Manual

The nougat temperature must be checked every 3 minutes by an automated system. If the temperature **exceeds 160°C**, the candy is too hot, and the system must **perform the candy isolation cooling system (CICS) vent procedure**.

- Close the trip throttle valve on turbine #2.
- Fill the isolation cooling system with a solid stream of water.
- Vent the water.
- Verify that there is no evidence of air in the system.

3 That page from the manual made it a lot easier to understand the code. It also gave us some great hints about how to make our code easier to understand. Now we know why the conditional test checks the variable **t** against 160—the manual says that any temperature above 160°C means the nougat is too hot. And it turns out that **m** was a class that controlled the candy maker, with static methods to check the nougat temperature and check the air system. So let's put the temperature check into a method, and choose names for the class and the methods that make the purpose obvious.

```
public boolean IsNougatTooHot() {
    int temp = Maker.CheckNougatTemperature();
    if (temp > 160) {
      return true;
    } else {
      return false;
    }
}
```

The IsNougatTooHot() method's return type

By naming the class "Maker" and the method "CheckNougatTemperature", we make the code a lot easier to understand.

This method's return type is Boolean, which means it returns a true or false value.

4 What does the specification say to do if the nougat is too hot? It tells us to perform the candy isolation cooling system (or CICS) vent procedure. So let's make another method, and choose an obvious name for the `T` class (which turns out to control the turbine) and the `ics` class (which controls the isolation cooling system, and has two static methods to fill and vent the system):

```
public void DoCICSVentProcedure() {
    Turbine turbineController = new Turbine();
    turbineController.CloseTripValve(2);
    IsolationCoolingSystem.Fill();
    IsolationCoolingSystem.Vent();
    Maker.CheckAirSystem();
}
```

A void return type means the method doesn't return any value at all.

5 Now the code's a lot more intuitive! Even if you don't know that the CICS vent procedure needs to be run if the nougat is too hot, **it's a lot more obvious what this code is doing**:

```
if (IsNougatTooHot() == true) {
    DoCICSVentProcedure();
}
```

You can make your code easier to read and write by thinking about the problem your code was built to solve. If you choose names for your methods that make sense to someone who understands that problem, then your code will be a lot easier to decipher...and develop!

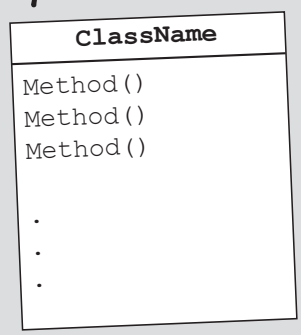
Give your classes a natural structure

Take a second and remind yourself why you want to make your methods intuitive: **because every program solves a problem or has a purpose.** It might not be a business problem—sometimes a program's purpose (like FlashyThing) is just to be cool or fun! But no matter what your program does, the more you can make your code resemble the problem you're trying to solve, the easier your program will be to write (and read, and repair, and maintain…).

Use class diagrams to plan out your classes

A class diagram is a simple way to draw your classes out on paper. It's a really valuable tool for designing your code BEFORE you start writing it.

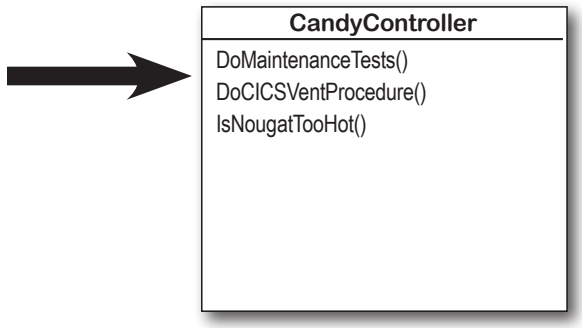
Write the name of the class at the top of the diagram. Then write each method in the box at the bottom. Now you can see all of the parts of the class at a glance!



Let's build a class diagram

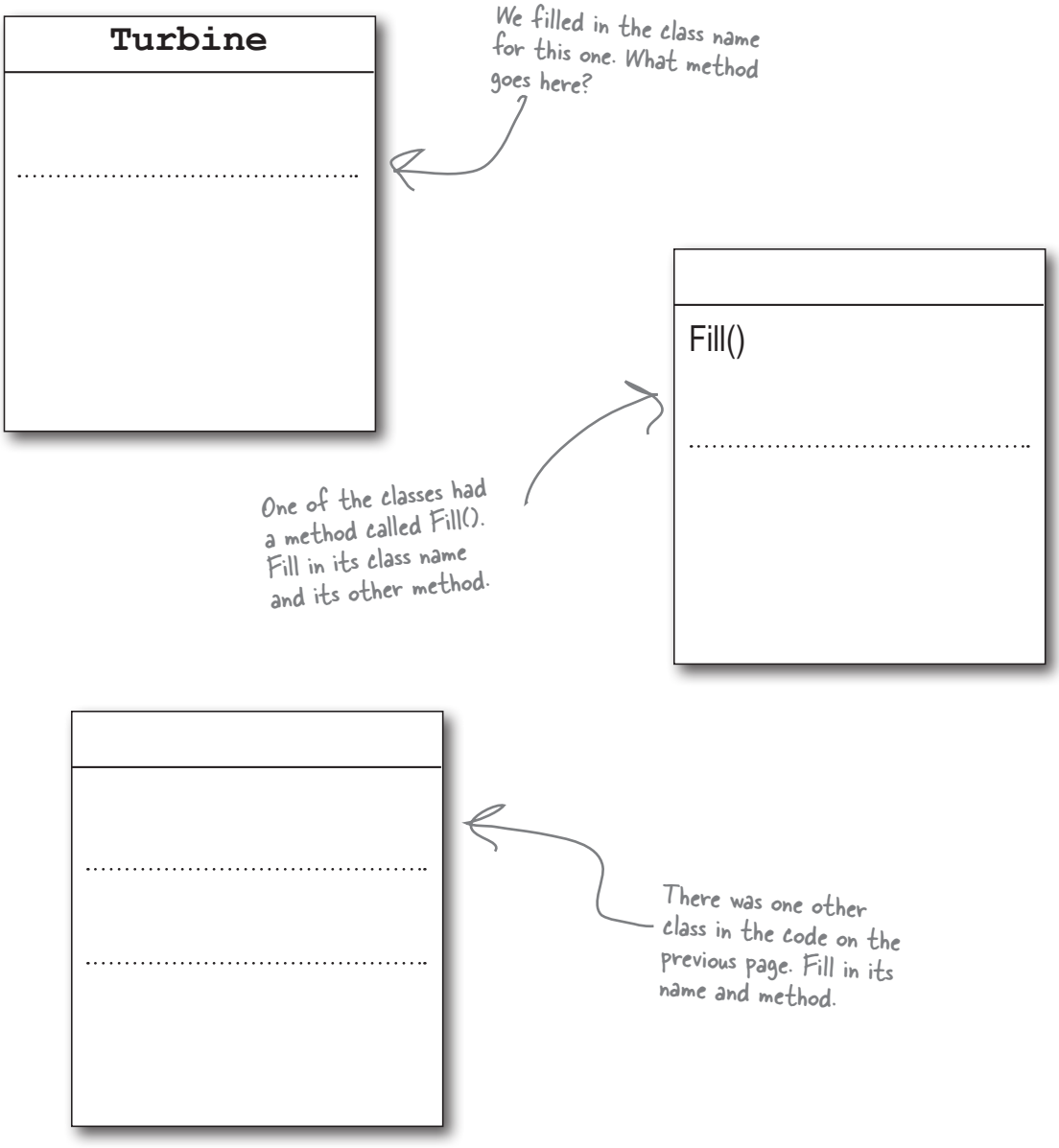
Take another look at the `if` statement in #5 on the previous page. You already know that statements always live inside methods, which always live inside classes, right? In this case, that `if` statement was in a method called `DoMaintenanceTests()`, which is part of the `CandyController` class. Now take a look at the code and the class diagram. See how they relate to each other?

```
class CandyController {

  public void DoMaintenanceTests() {
    ...
    if (IsNougatTooHot() == true) {
       DoCICSVentProcedure();
    }
    ...
  }

  public void DoCICSVentProcedure() ...

  public boolean IsNougatTooHot() ...

}
```



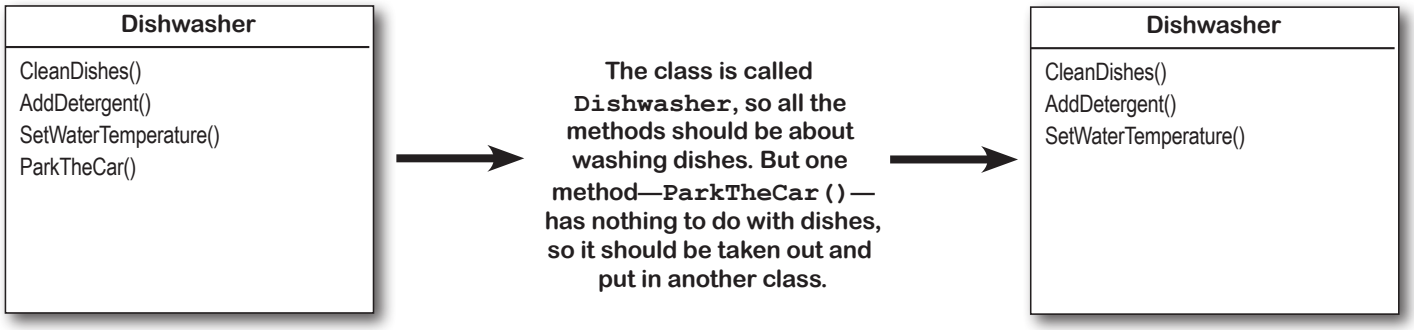
Sharpen your pencil

The code for the candy control system we built on the previous page called three other classes. Flip back and look through the code, and fill in their class diagrams.



Class diagrams help you organize your classes so they make sense

Writing out class diagrams makes it a lot easier to spot potential problems in your classes **before** you write code. Thinking about your classes from a high level before you get into the details can help you come up with a class structure that will make sure your code addresses the problems it solves. It lets you step back and make sure that you're not planning on writing unnecessary or poorly structured classes or methods, and that the ones you do write will be intuitive and easy to use.



Sharpen your pencil Solution

The code for the candy control system we built on the previous page called three other classes. Flip back and look through the code, and fill in their class diagrams.

You could figure out that Maker is a class because it appears in front of a dot in Maker.CheckAirSystem().

Turbine	IsolationCoolingSystem	Maker
CloseTripValve()	Fill()	CheckNougatTemperature()
	Vent()	CheckAirSystem()

Sharpen your pencil

Each of these classes has a serious design flaw. Write down what you think is wrong with each class, and how you'd fix it.

Class23

CandyBarWeight()
PrintWrapper()
GenerateReport()
Go()

This class is part of the candy manufacturing system from earlier.

DeliveryGuy

AddAPizza()
PizzaDelivered()
TotalCash()
ReturnTime()

DeliveryGirl

AddAPizza()
PizzaDelivered()
TotalCash()
ReturnTime()

These two classes are part of a system that a pizza parlor uses to track the pizzas that are out for delivery.

CashRegister

MakeSale()
NoSale()
PumpGas()
Refund()
TotalCashInRegister()
GetTransactionList()
AddCash()
RemoveCash()

The `CashRegister` class is part of a program that's used by an automated convenience store checkout system.

Sharpen your pencil Solution

Here's how we corrected the classes. We show just one possible way to fix the problems—but there are plenty of other ways you could design these classes depending on how they'll be used.

This class is part of the candy manufacturing system from earlier.

The class name doesn't describe what the class does. A programmer who sees a line of code that calls Class23.Go() will have no idea what that line does. We'd also rename the method to something that's more descriptive—we chose MakeTheCandy(), but it could be anything.

CandyMaker

CandyBarWeight()
PrintWrapper()
GenerateReport()
MakeTheCandy()

These two classes are part of a system that a pizza parlor uses to track the pizzas that are out for delivery.

It looks like the DeliveryGuy class and the DeliveryGirl class both do the same thing—they track a delivery person who's out delivering pizzas to customers. A better design would replace them with a single class that adds a field for gender.

DeliveryPerson

Gender

AddAPizza()
PizzaDelivered()
TotalCash()
ReturnTime()

We added the Gender field because we assumed there was a reason to track delivery guys and girls separately, and that's why there were two classes for them.

The `CashRegister` class is part of a program that's used by an automated convenience store checkout system.

All of the methods in the class do stuff that has to do with a cash register—making a sale, getting a list of transactions, adding cash...except for one: pumping gas. It's a good idea to pull that method out and stick it in another class.

CashRegister

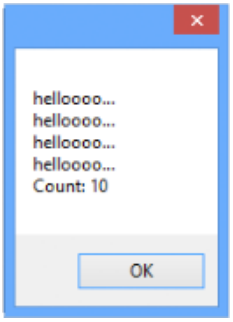
MakeSale()
NoSale()
Refund()
TotalCashInRegister()
GetTransactionList()
AddCash()
RemoveCash()

```
public partial class Form1 : Form {
  public Form1() {
    InitializeComponent();
  }
  private void button1_Click(object sender, EventArgs e) {
    string result = "";
    Echo e1 = new Echo();
    ____________________________
    int x = 0;
    while ( ____________ ) {
      result = result + e1.Hello() + "\n";
      ____________________________
      if ( ____________ ) {
        e2.count = e2.count + 1;
      }
      if ( ____________ ) {
        e2.count = e2.count + e1.count;
      }
      x = x + 1;
    }
    MessageBox.Show(result + "Count: " + e2.count);
  }
}
class ____________ {
  public int _________ = 0;
    public string ___________ {
      return "helloooo...";
  }
}
```

Pool Puzzle

Your ***job*** is to take code snippets from the pool and place them into the blank lines in the code. You **may** use the same snippet more than once, and you won't need to use all the snippets. Your ***goal*** is to make classes that will compile and run and produce the output listed.

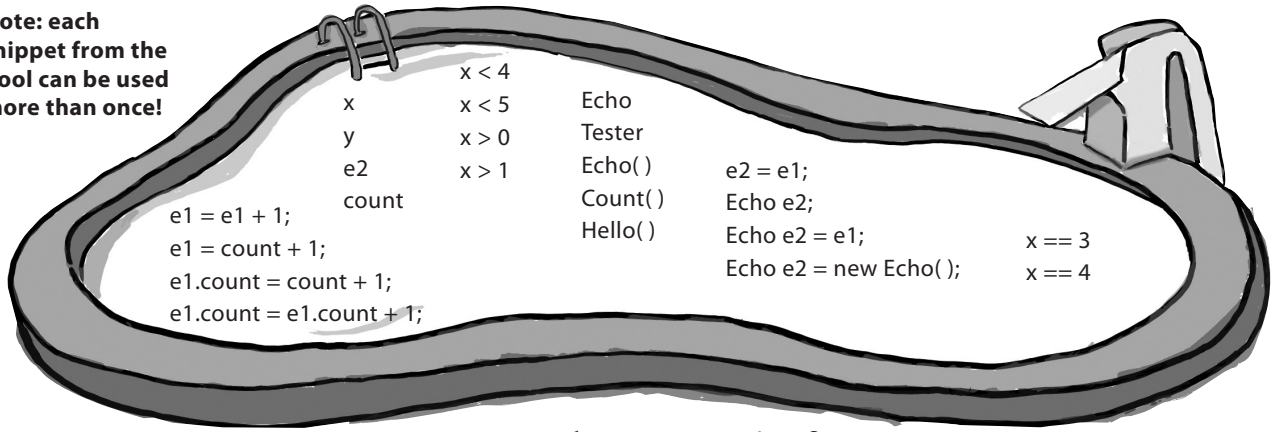
Output



Bonus Question!

If the last line of output was **24** instead of **10,** how would you complete the puzzle? You can do it by changing just one statement.

Note: each snippet from the pool can be used more than once!

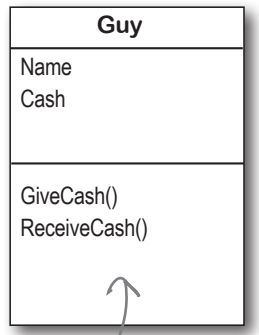


Answers on page 138.

There are two possible solutions to this puzzle. Can you find them both?

Build a class to work with some guys

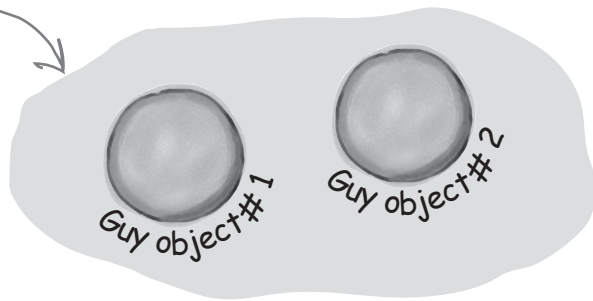
Joe and Bob lend each other money all the time. Let's create a class to keep track of them. We'll start with an overview of what we'll build.



We chose names for the methods that make sense. You call a Guy object's GiveCash() method to tell him to give up some of his cash, and his ReceiveCash() method when you want him to take some cash back. We could have called them GiveCashToSomeone() and ReceiveCashFromSomeone(), but that would have been very long!

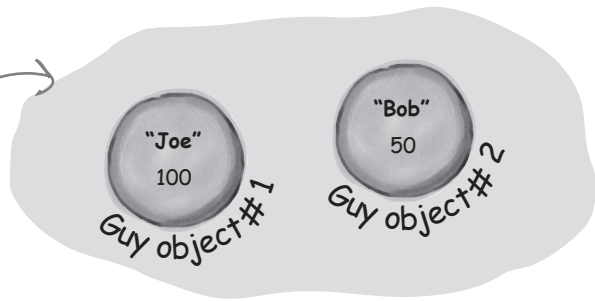
1 We'll create a Guy class and add two instances of it to a form.
The form will have two fields, one called `joe` (to keep track of the first object), and the other called `bob` (to keep track of the second object).

The new statements that create the two instances live in the code that gets run as soon as the form is created. Here's what the heap looks like after the form is loaded.



2 We'll set each Guy object's cash and name fields.
The two objects represent different guys, each with his own name and a different amount of cash in his pocket.

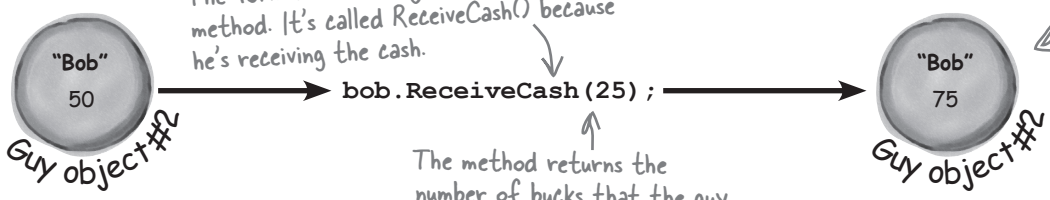
Each guy has a Name field that keeps track of his name, and a Cash field that has the number of bucks in his pocket.



3 We'll give cash to the guys and take cash from them.
We'll use each guy's `ReceiveCash()` method to increase a guy's cash, and we'll use his `GiveCash()` method to reduce it.

When you take an instance of Guy and call its ReceiveCash() method, you pass the amount of cash the guy will take as a parameter. So calling bob.ReceiveCash(25) tells Bob to receive 25 bucks and add them to his wallet.

The form calls the object's ReceiveCash() method. It's called ReceiveCash() because he's receiving the cash.



The method returns the number of bucks that the guy added to his Cash field.

Create a project for your guys

Create a new Windows Forms Application project (because we'll be using a form). Then use the Solution Explorer to add a new class to it called `Guy`. Make sure to add "`using System.Windows.Forms;`" to the top of the `Guy` class file. Then fill in the `Guy` class. Here's the code for it:

The Guy class has two fields. The Name field is a string, and it'll contain the guy's name ("Joe"). And the Cash field is an int, which will keep track of how many bucks are in his pocket.

```
class Guy {
    public string Name;
    public int Cash;

    public int GiveCash(int amount) {
        if (amount <= Cash && amount > 0) {
            Cash -= amount;
            return amount;
        } else {
            MessageBox.Show(
             "I don't have enough cash to give you " + amount,
             Name + " says...");
            return 0;
        }
    }
```

The GiveCash() method has one parameter called amount that you'll use to tell the guy how much cash to give you.

He uses an if statement to check whether he has enough cash—if he does, he takes it out of his pocket and returns it as the return value.

The guy makes sure that you're asking him for a positive amount of cash—otherwise, he'd add to his cash instead of taking away from it.

If the guy doesn't have enough cash, he'll tell you so with a message box, and then he'll make GiveCash() return 0.

```
    public int ReceiveCash(int amount) {
        if (amount > 0) {
            Cash += amount;
            return amount;
        } else {
            MessageBox.Show(amount + " isn't an amount I'll take",
                   Name + " says...");
            return 0;
        }
    }
```

The ReceiveCash() method works just like the GiveCash() method. It's passed an amount as a parameter, checks to make sure that amount is greater than zero, and then adds it to his cash.

If the amount was positive, then the ReceiveCash() method returns the amount added. If it was zero or negative, the guy shows a message box and then returns 0.

Be careful with your curly brackets. It's easy to have the wrong number—make sure that every opening bracket has a matching closing bracket. When they're all balanced, the IDE will **automatically indent** them for you when you type the last closing bracket.

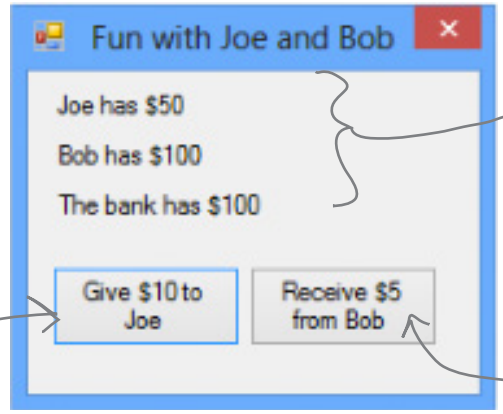
What happens if you pass a negative amount to a Guy object's ReceiveCash() or GiveCash() method?

Build a form to interact with the guys

The `Guy` class is great, but it's just a start. Now put together a form that uses two instances of the `Guy` class. It's got labels that show you their names and how much cash they have, and buttons to give and take cash from them. They have to get their money from *somewhere* before they can lend it to each other, so we'll also need to add a bank.

1 **Add two buttons and three labels to your form.**

The top two labels show how much cash each guy has. We'll also add a field called `bank` to the form—the third label shows how much cash is in it. We're going to have you name some of the labels that you drag onto the forms. You can do that by **clicking on each label** that you want to name and **changing its "(Name)" row** in the Properties window. That'll make your code a lot easier to read, because you'll be able to use "joesCashLabel" and "bobsCashLabel" instead of "label1" and "label2".



This button will call the Joe object's ReceiveCash() method, passing it 10 as the amount, and subtracting from the form's bank field the cash that Joe receives.

Name the top label joesCashLabel, the label underneath it bobsCashLabel, and the bottom label bankCashLabel. You can leave their Text properties alone; we'll add a method to the form to set them.

This button will call the Bob object's GiveCash() method, passing it 5 as the amount, and adding the cash that Bob gives to the form's bank field.

2 **Add fields to your form.**

Your form will need to keep track of the two guys, so you'll need a field for each of them. Call them `joe` and `bob`. Then add a field to the form called `bank` to keep track of how much money the form has to give to and receive from the guys.

```
namespace Your_Project_Name {
    public partial class Form1 : Form {
        Guy joe;
        Guy bob;
        int bank = 100;

        public Form1() {
            InitializeComponent();
        }
```

Since we're using Guy objects to keep track of Joe and Bob, you declare their fields in the form using the Guy class.

The amount of cash in the form's bank field goes up and down depending on how much money the form gave to and received from the Guy objects.

3 Add a method to the form to update the labels.

The labels on the righthand side of the form show how much cash each guy has and how much is in the `bank` field. So add the `UpdateForm()` method to keep them up to date—**make sure the return type is `void`** to tell C# that the method doesn't return a value. Type this method into the form right underneath where you added the `bank` field:

```
public void UpdateForm() {
    joesCashLabel.Text = joe.Name + " has $" + joe.Cash;
    bobsCashLabel.Text = bob.Name + " has $" + bob.Cash;
    bankCashLabel.Text = "The bank has $" + bank;
}
```

Notice how the labels are updated using the Guy objects' Name and Cash fields.

This new method is simple. It just updates the three labels by setting their Text properties. You'll have each button call it to keep the labels up to date.

4 Double-click on each button and add the code to interact with the objects.

Make sure the lefthand button is called `button1`, and the righthand button is called `button2`. Then double-click each of the buttons—when you do, the IDE will add two methods called `button1_Click()` and `button2_Click()` to the form. Add this code to each of them:

You already know that you can choose names for controls. Are **`button1`** and **`button2`** really the best names we can find? What names would *you* choose for these buttons?

```
private void button1_Click(object sender, EventArgs e) {
    if (bank >= 10) {
        bank -= joe.ReceiveCash(10);
        UpdateForm();
    } else {
        MessageBox.Show("The bank is out of money.");
    }
}

private void button2_Click(object sender, EventArgs e) {
    bank += bob.GiveCash(5);
    UpdateForm();
}
```

When the user clicks the "Give $10 to Joe" button, the form calls the Joe object's ReceiveCash() method—but only if the bank has enough money.

The bank needs at least $10 to give to Joe. If there's not enough, it'll pop up this message box.

The "Receive $5 from Bob" button doesn't need to check how much is in the bank, because it'll just add whatever Bob gives back.

If Bob's out of money, GiveCash() will return zero.

5 Start Joe out with $50 and start Bob out with $100.

It's up to you to **figure out how to get Joe and Bob to start out with their `Cash` and `Name` fields set properly.** Put it right underneath `InitializeComponent()` in the form. That's part of that designer-generated method that gets run once, when the form is first initialized. Once you've done that, click both buttons a number of times—make sure that one button takes $10 from the bank and adds it to Joe, and the other takes $5 from Bob and adds it to the bank.


```
public Form1() {
    InitializeComponent();
    // Initialize joe and bob here!
}
```

Add the lines of code here to create the two objects and set their Name and Cash fields.

It's up to you to **figure out how to get Joe and Bob to start out with their `Cash` and `Name` fields set properly.** Put it right underneath `InitializeComponent()` in the form.

```
public Form1() {
    InitializeComponent();

    bob = new Guy();
    bob.Name = "Bob";
    bob.Cash = 100;

    joe = new Guy();
    joe.Name = "Joe";
    joe.Cash = 50;

    UpdateForm();
}
```

Here's where we set up the first instance of Guy. The first line creates the object, and the next two set its fields.

Then we do the same for the second instance of the Guy class.

Make sure you call UpdateForm() so the labels look right when the form first pops up.

there are no Dumb Questions

Make sure you save the project now—we'll come back to it in a few pages.

Q: Why doesn't the solution start with "`Guy bob = new Guy()`"? Why did you leave off the first "`Guy`"?

A: Because you already declared the `bob` field at the top of the form. Remember how the statement "`int i = 5;`" is the same as the two statements "`int i`" and "`i = 5;`"? This is the same thing. You could try to declare the `bob` field in one line like this: "`Guy bob = new Guy();`". But you already have the first part of that statement ("`Guy bob;`") at the top of your form. So you only need the second half of the line, the part that sets the `bob` field to create a new instance of `Guy()`.

Q: OK, so then why not get rid of the "`Guy bob;`" line at the top of the form?

A: Then a variable called `bob` will only exist inside that special "`public Form1()`" method. When you declare a variable inside a method, it's only valid inside the method—you can't access it from any other method. But when you declare it outside of your method but inside the form or a class that you added, then you've added a field accessible from ***any other method*** inside the form.

Q: What happens if I don't leave off that first "`Guy`"? What if it's `Guy bob = new Guy()` instead of `bob = new Guy()`?

A: You'll run into problems—your form won't work, because it won't ever set the form's `bob` variable. If you have this code at the top of your form:

```
public partial class Form1 : Form {
    Guy bob;
```

and then you have this code later on, inside a method:

```
Guy bob = new Guy();
```

then you've declared ***two*** variables. It's a little confusing, because they both have the same name. But one of them is valid throughout the entire form, and the other one—the new one you added—is only valid inside the method. The next line (`bob.Name = "Bob";`) only updates that ***local*** variable, and doesn't touch the one in the form. So when you try to run your code, it'll give you a nasty error message ("NullReferenceException not handled"), which just means you tried to use an object before you created it with `new`.

There's an easier way to initialize objects

Almost every object that you create needs to be initialized in some way. And the `Guy` object is no exception—it's useless until you set its `Name` and `Cash` fields. It's so common to have to initialize fields that C# gives you a shortcut for doing it called an **object initializer**. And the IDE's IntelliSense will help you do it.

Object initializers save you time and make your code more compact and easier to read...and the IDE helps you write them.

1. Here's the original code that you wrote to initialize Joe's `Guy` object.

```
joe = new Guy();
joe.Name = "Joe";
joe.Cash = 50;
```

2. Delete the second two lines and the semicolon after "`Guy()`," and add a right curly bracket.

```
joe = new Guy() {
```

3. Press space. As soon as you do, the IDE pops up an IntelliSense window that shows you all of the fields that you're able to initialize.

```
joe = new Guy() {
```

4. Press Tab to tell it to add the `Cash` field. Then set it equal to 50.

```
joe = new Guy() { Cash = 50
```

5. Type in a comma. As soon as you do, the other field shows up.

```
joe = new Guy() { Cash = 50,
```

6. Finish the object initializer. Now you've saved yourself two lines of code!

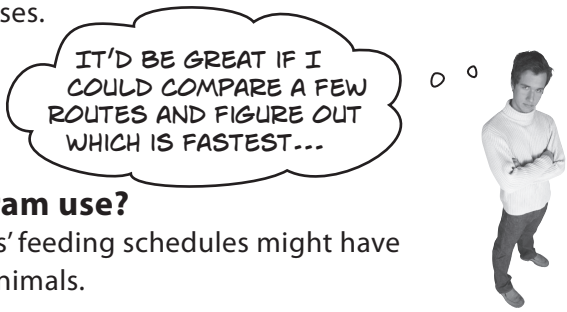
```
joe = new Guy() { Cash = 50, Name = "Joe" };
```

This new declaration does exactly the same thing as the three lines of code you wrote originally. It's just shorter and easier to read.

You used an object initializer in your "Save the Humans" game. Flip back and see if you can spot it!

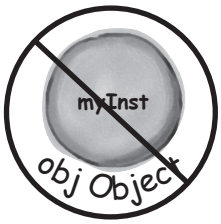
A few ideas for designing intuitive classes

- **You're building your program to solve a problem.**
  Spend some time thinking about that problem. Does it break down into pieces easily? How would you explain that problem to someone else? These are good things to think about when designing your classes.

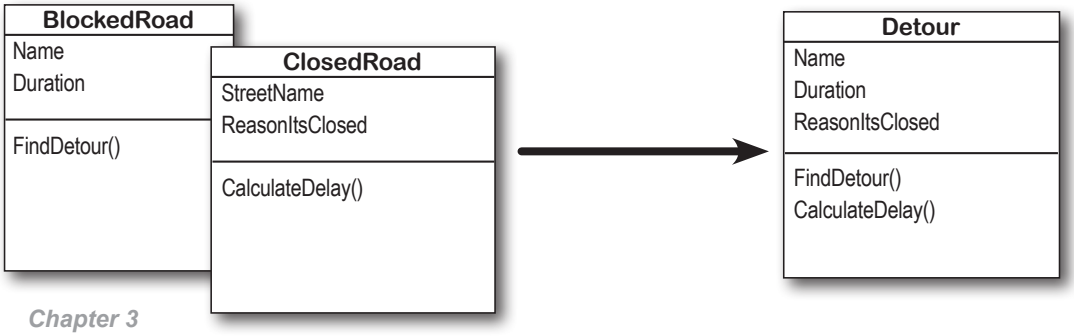


- **What real-world things will your program use?**
  A program to help a zookeeper track her animals' feeding schedules might have classes for different kinds of food and types of animals.

- **Use descriptive names for classes and methods.**
  Someone should be able to figure out what your classes and methods do just by looking at their names.



- **Look for similarities between classes.**
  Sometimes two classes can be combined into one if they're really similar. The candy manufacturing system might have three or four turbines, but there's only one method for closing the trip valve that takes the turbine number as a parameter.



Add buttons to the "Fun with Joe and Bob" program to make the guys give each other cash.

1 USE AN OBJECT INITIALIZER TO INITIALIZE BOB'S INSTANCE OF GUY.

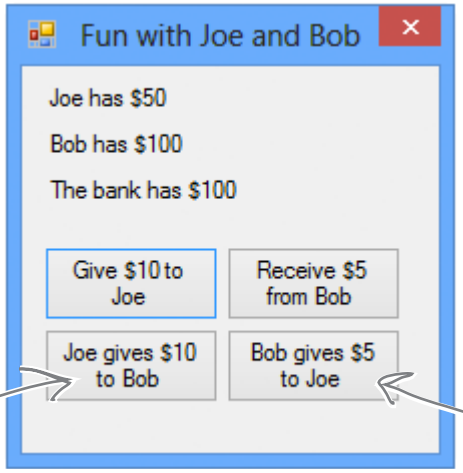
You've already done it with Joe. Now make Bob's instance work with an object initializer too.

If you already clicked the button, just delete it, add it back to your form, and rename it. Then delete the old button3_Click() method that the IDE added before, and use the new method it adds now.

2 ADD TWO MORE BUTTONS TO YOUR FORM.

The first button tells Joe to give 10 bucks to Bob, and the second tells Bob to give 5 bucks back to Joe. **Before you double-click on the button,** go to the Properties window and change each button's name using the "(Name)" row—it's **at the top** of the list of properties. Name the first button **`joeGivesToBob`**, and the second one **`bobGivesToJoe`**.

This button tells Joe to give 10 bucks to Bob, so you should use the "(Name)" row in the Properties window to name it joeGivesToBob.

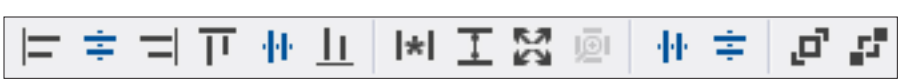


This button tells Bob to give 5 bucks to Joe. Name it bobGivesToJoe.

3 MAKE THE BUTTONS WORK.

Double-click on the `joeGivesToBob` button in the designer. The IDE will add a method to the form called `joeGivesToBob_Click()` that gets run any time the button's clicked. Fill in that method to make Joe give 10 bucks to Bob. Then double-click on the other button and fill in the new `bobGivesToJoe_Click()` method that the IDE creates so that Bob gives 5 bucks to Joe. Make sure the form updates itself after the cash changes hands.

Here's a tip for designing your forms. You can use these buttons on the IDE's toolbar in the form designer to align controls, make them equal sizes, space them evenly, and bring them to the front or back.



Add buttons to the "Fun with Joe and Bob" program to make the guys give each other cash.

```
public partial class Form1 : Form {
    Guy joe;
    Guy bob;
    int bank = 100;

    public Form1() {
        InitializeComponent();
        bob = new Guy() { Cash = 100, Name = "Bob" };
        joe = new Guy() { Cash = 50, Name = "Joe" };
        UpdateForm();
    }

    public void UpdateForm() {
        joesCashLabel.Text = joe.Name + " has $" + joe.Cash;
        bobsCashLabel.Text = bob.Name + " has $" + bob.Cash;
        bankCashLabel.Text = "The bank has $" + bank;
    }

    private void button1_Click(object sender, EventArgs e) {
        if (bank >= 10) {
            bank -= joe.ReceiveCash(10);
            UpdateForm();
        } else {
            MessageBox.Show("The bank is out of money.");
        }
    }

    private void button2_Click(object sender, EventArgs e) {
        bank += bob.GiveCash(5);
        UpdateForm();
    }

    private void joeGivesToBob_Click(object sender, EventArgs e) {
        bob.ReceiveCash(joe.GiveCash(10));
        UpdateForm();
    }

    private void bobGivesToJoe_Click(object sender, EventArgs e) {
        joe.ReceiveCash(bob.GiveCash(5));
        UpdateForm();
    }

}
```

Here are the object initializers for the two instances of the Guy class. Bob gets initialized with 100 bucks and his name.

To make Joe give cash to Bob, we call Joe's GiveCash() method and send its results into Bob's ReceiveCash() method.

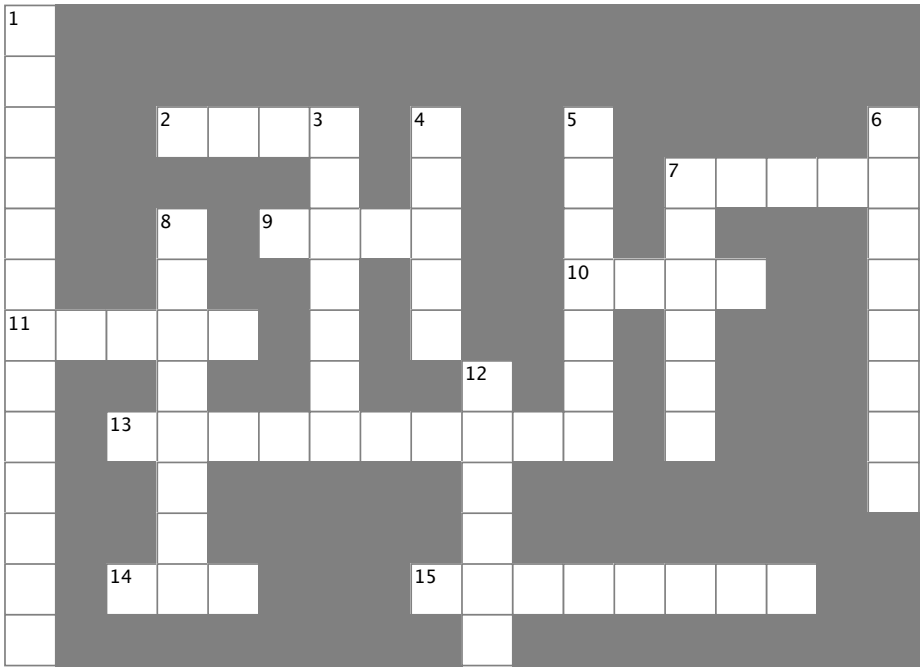
Take a close look at how the Guy methods are being called. The results returned by GiveCash() are pumped right into ReceiveCash() as its parameter.

The trick here is thinking through who's giving the cash and who's receiving it.

Before you go on, take a minute and flip to #2 in the "Leftovers" appendix, because there's some basic syntax that we haven't covered yet. You won't *need* it to move forward, but it's a good idea to see what's there.

Objectcross

It's time to give your left brain a break, and put that right brain to work: all the words are object-related and from this chapter.



Across

2. If a method's return type is _____, it doesn't return anything

7. An object's fields define its _____

9. A good method _____ makes it clear what the method does

10. Where objects live

11. What you use to build an object

13. What you use to pass information into a method

14. The statement you use to create an object

15. Used to set an attribute on controls and other classes

Down

1. This form control lets the user choose a number from a range you set

3. It's a great idea to create a class _____ on paper before you start writing code

4. An object uses this to keep track of what it knows

5. These define what an object does

6. An object's methods define its _____

7. Don't use this keyword in your class declaration if you want to be able to create instances of it

8. An object is an _____ of a class

12. This statement tells a method to immediately exit, and can specify the value that should be passed back to the statement that called the method

Pool Puzzle Solution

Your ***job*** was to take code snippets from the pool and place them into the blank lines in the code. Your ***goal*** was to make classes that will compile and run and produce the output listed.

```
public partial class Form1 : Form {
  public Form1() {
    InitializeComponent();
  }
  private void button1_Click(object sender, EventArgs e)
    string result = "";
    Echo e1 = new Echo();
    Echo e2 = new Echo();
    int x = 0;
    while ( x < 4 ) {
      result = result + e1.Hello() + "\n";
      e1.count = e1.count + 1;
      if ( x ==3 ) {
        e2.count = e2.count + 1;
      }
      if ( x > 0 ) {
        e2.count = e2.count + e1.count;
      }
      x = x + 1;
    }
    MessageBox.Show(result + "Count: " + e2.count);
  }
}
class Echo {
  public int count = 0;
    public string Hello() {
      return "helloooo...";
  }
}
```

That's the correct answer.

And here's the bonus answer!

Echo e2 = e1;

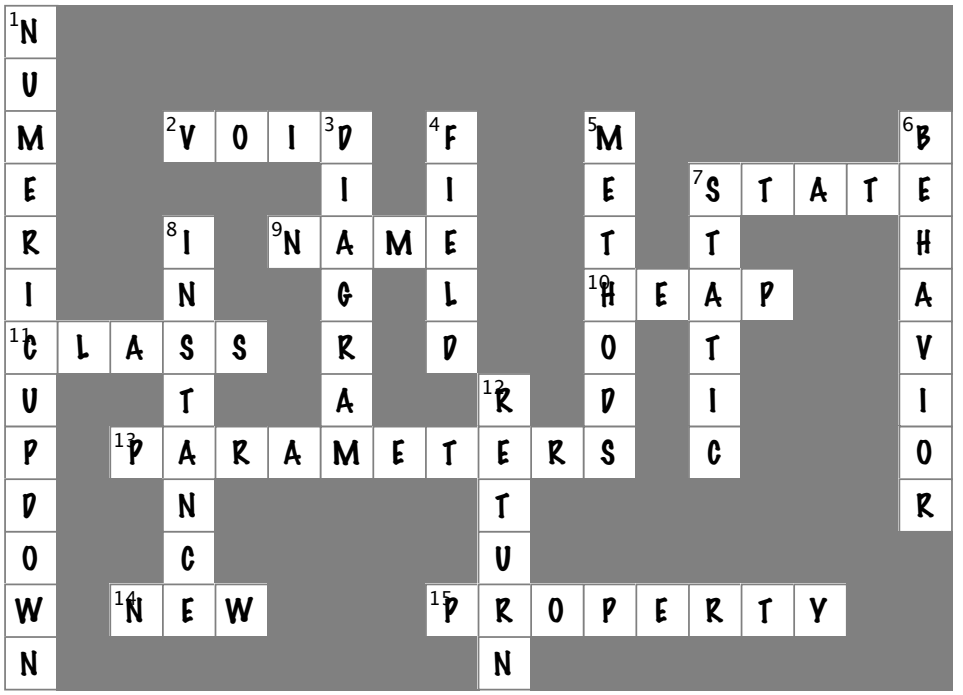
The alternate solution has this in the fourth blank:

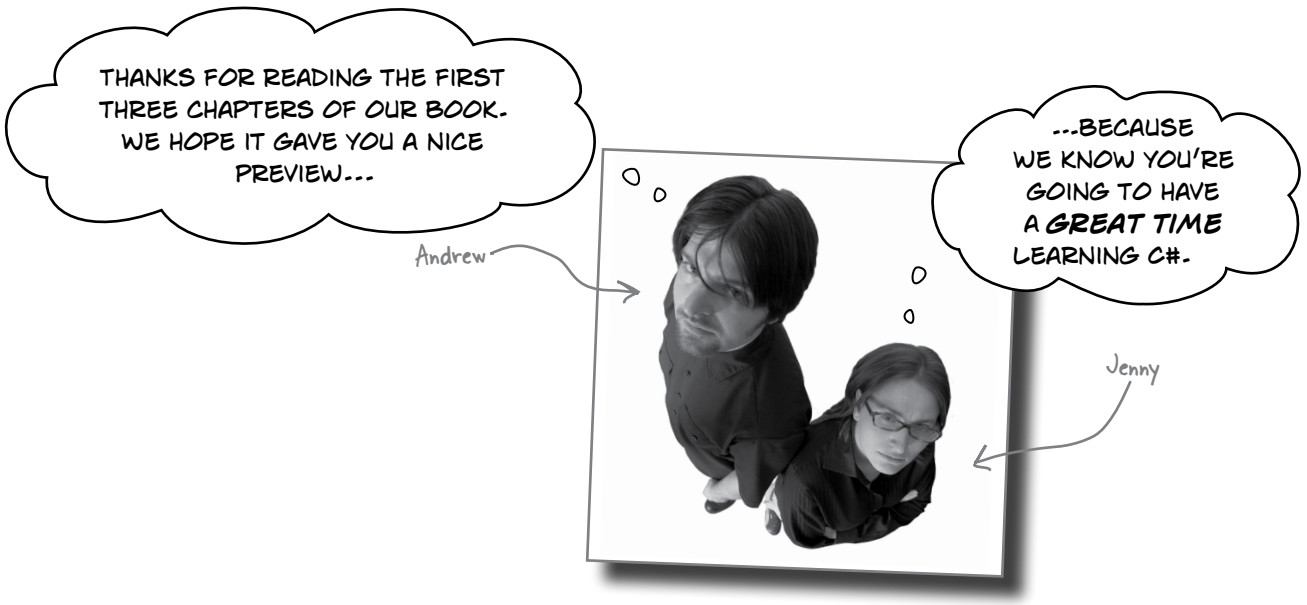
x == 4

and this in the fifth:

x < 4

Objectcross Solution





Flip the page to see what else you'll learn in Head First C#...

The fun's just beginning!

Get C# programming into your brain… fast!

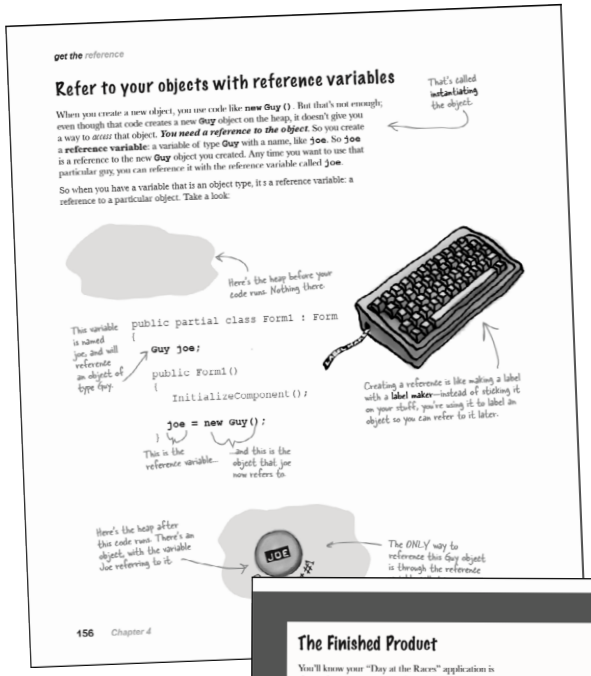
Head First C# is a complete learning experience for programming with C#, XAML, the .NET Framework, and Visual Studio. **Built for your brain**, this book keeps you engaged from the first chapter. You'll learn about classes and object-oriented programming, draw graphics and animation, query your data with LINQ, and serialize it to files. And you'll do it all by building **games**, solving **puzzles**, and doing **hands-on projects**. By the time you're done you'll be a solid C# programmer, and you'll have a great time along the way!

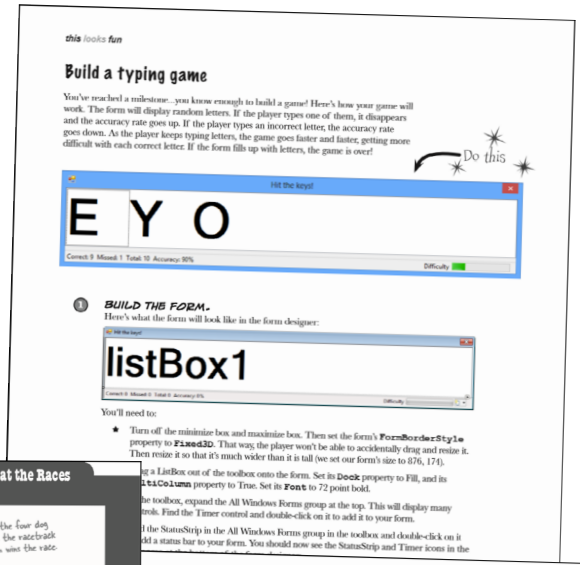
Do you want to be a great C# developer? Are you looking for a fun and engaging way to get C# concepts into your brain? Head First C# is the fastest and most effective way to learn C#, XAML, and the .NET Framework. Have a look through the next few pages for a sample of what you'll find in the book...

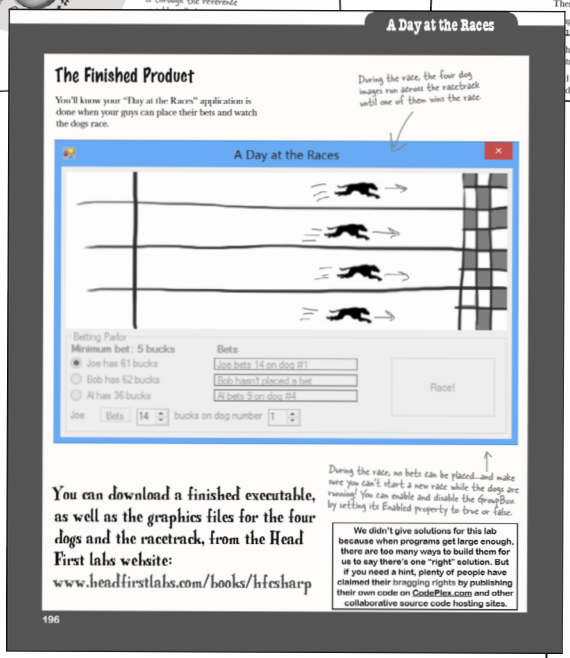
You'll learn all about objects and references, and how they help make your data make sense in the real world.

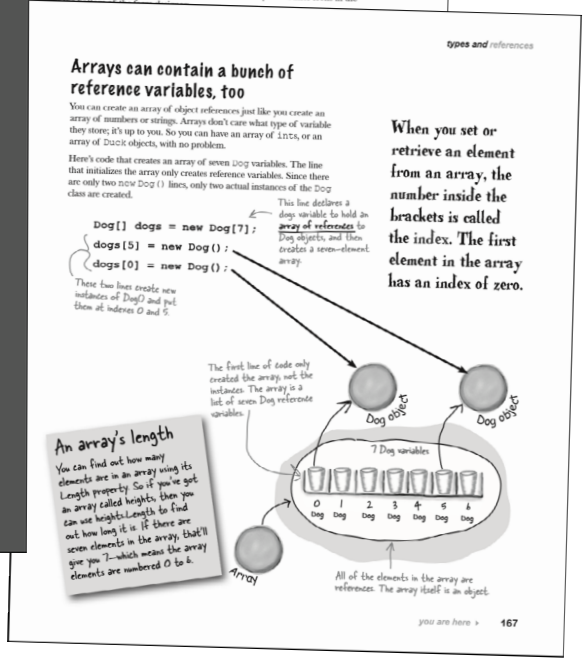
"If you want to learn C# in depth and have fun doing it, this is THE book for you."

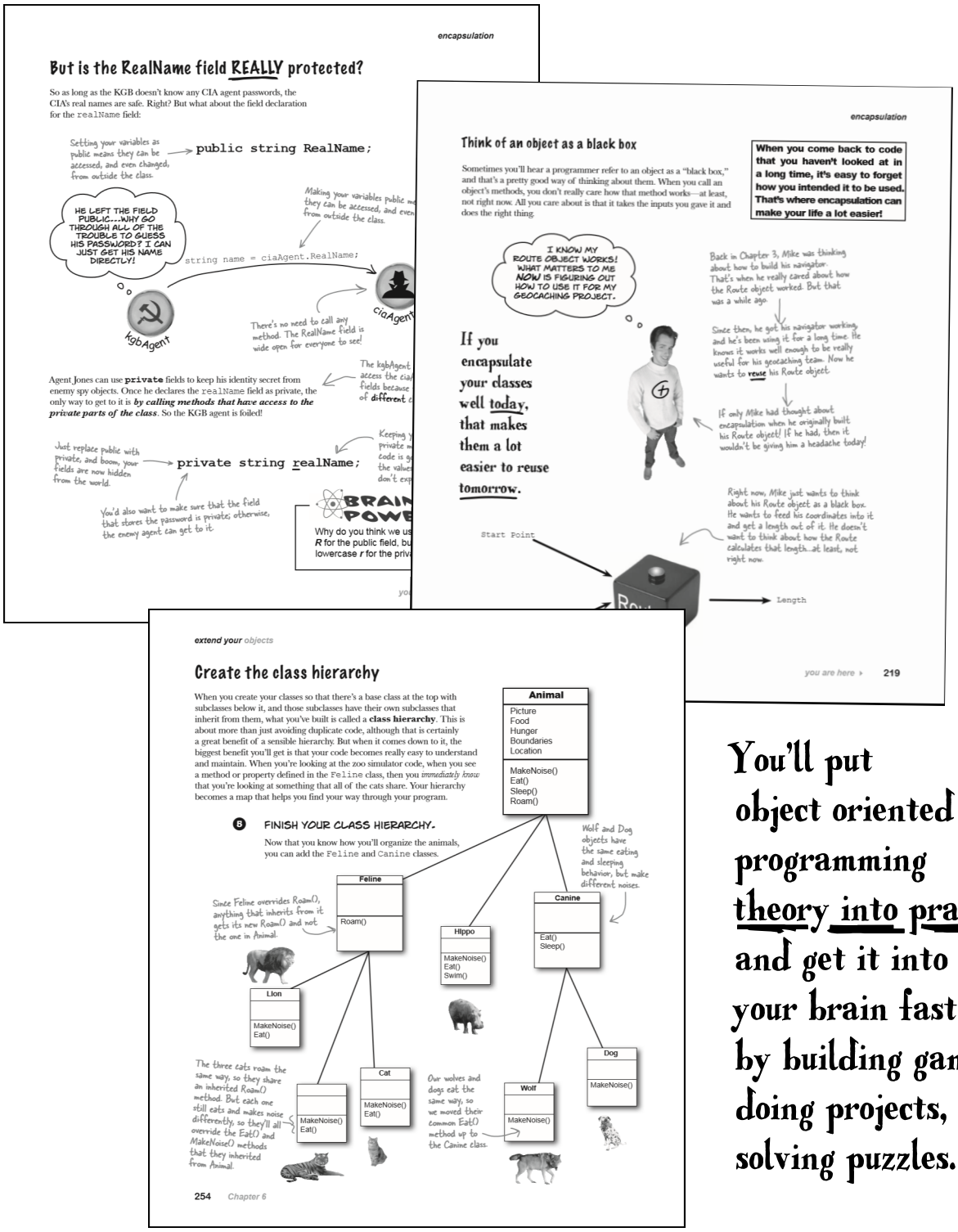
—Andy Parker, fledgling C# programmer











encapsulation

But is the RealName field REALLY protected?

So as long as the KGB doesn't know any CIA agent passwords, the CIA's real names are safe. Right? But what about the field declaration for the `realName` field:

Setting your variables as public means they can be accessed, and even changed, from outside the class.

```
public string RealName;
```

Making your variables public means they can be accessed, and even from outside the class.

HE LEFT THE FIELD PUBLIC...WHY GO THROUGH ALL OF THE TROUBLE TO GUESS HIS PASSWORD? I CAN JUST GET HIS NAME DIRECTLY!

```
string name = ciaAgent.RealName;
```

KgbAgent

CiaAgent

There's no need to call any method. The RealName field is wide open for everyone to see!

Agent Jones can use **private** fields to keep his identity secret from enemy spy objects. Once he declares the `realName` field as private, the only way to get to it is ***by calling methods that have access to the private parts of the class***. So the KGB agent is foiled!

The kgbAgent access the cia fields because of different

Just replace public with private, and boom, your fields are now hidden from the world.

```
private string realName;
```

You'd also want to make sure that the field that stores the password is private; otherwise, the enemy agent can get to it.

Keeping private code is the values don't exp

BRAIN POWE

Why do you think we us R for the public field, bu lowercase r for the priva

encapsulation

Think of an object as a black box

Sometimes you'll hear a programmer refer to an object as a "black box," and that's a pretty good way of thinking about them. When you call an object's methods, you don't really care how that method works—at least, not right now. All you care about is that it takes the inputs you gave it and does the right thing.

When you come back to code that you haven't looked at in a long time, it's easy to forget how you intended it to be used. That's where encapsulation can make your life a lot easier!

I KNOW MY ROUTE OBJECT WORKS! WHAT MATTERS TO ME NOW IS FIGURING OUT HOW TO USE IT FOR MY GEOCACHING PROJECT.

Back in Chapter 3, Mike was thinking about how to build his navigator. That's when he really cared about how the Route object worked. But that was a while ago.

Since then, he got his navigator working, and he's been using it for a long time. He knows it works well enough to be really useful for his geocaching team. Now he wants to reuse his Route object.

If only Mike had thought about encapsulation when he originally built his Route object! If he had, then it wouldn't be giving him a headache today!

If you encapsulate your classes well today, that makes them a lot easier to reuse tomorrow.

Right now, Mike just wants to think about his Route object as a black box. He wants to feed his coordinates into it and get a length out of it. He doesn't want to think about how the Route calculates that length...at least, not right now.

Start Point

Length

you are here ▸ 219

extend your objects

Create the class hierarchy

When you create your classes so that there's a base class at the top with subclasses below it, and those subclasses have their own subclasses that inherit from them, what you've built is called a **class hierarchy**. This is about more than just avoiding duplicate code, although that is certainly a great benefit of a sensible hierarchy. But when it comes down to it, the biggest benefit you'll get is that your code becomes really easy to understand and maintain. When you're looking at the zoo simulator code, when you see a method or property defined in the `Feline` class, then you *immediately know* that you're looking at something that all of the cats share. Your hierarchy becomes a map that helps you find your way through your program.

Animal
Picture
Food
Hunger
Boundaries
Location
MakeNoise()
Eat()
Sleep()
Roam()

6 FINISH YOUR CLASS HIERARCHY.

Now that you know how you'll organize the animals, you can add the `Feline` and `Canine` classes.

Wolf and Dog objects have the same eating and sleeping behavior, but make different noises.

Feline
Roam()

Since Feline overrides Roam(), anything that inherits from it gets its new Roam() and not the one in Animal.

Canine
Eat()
Sleep()

Hippo
MakeNoise()
Eat()
Swim()

Lion
MakeNoise()
Eat()

Cat
MakeNoise()
Eat()

Dog
MakeNoise()

Wolf
MakeNoise()

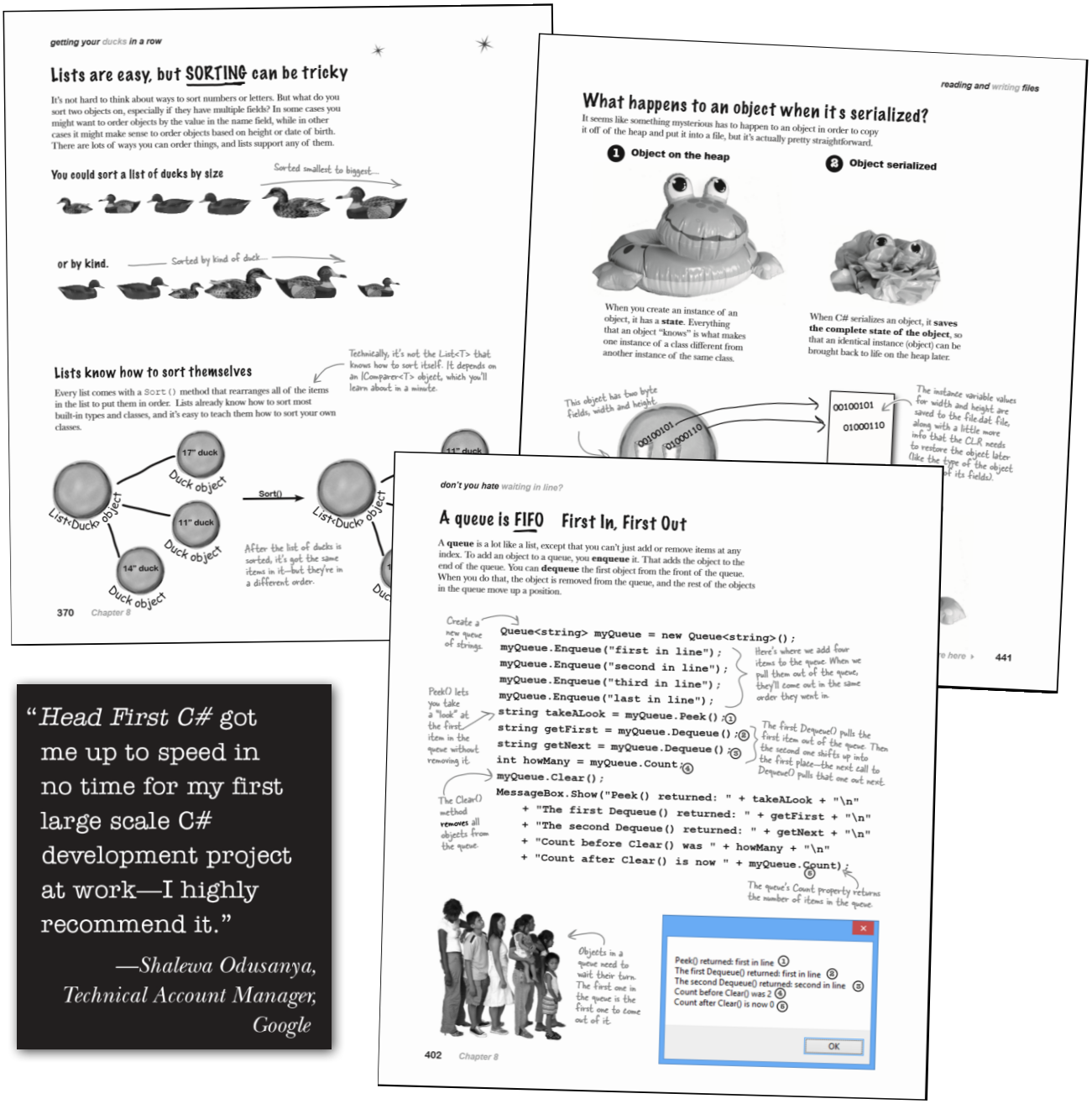
The three cats roam the same way, so they share an inherited Roam() method. But each one still eats and makes noise differently, so they'll all override the Eat() and MakeNoise() methods that they inherited from Animal.

Our wolves and dogs eat the same way, so we moved their common Eat() method up to the Canine class.

254 Chapter 6

You'll put object oriented programming theory into practice and get it into your brain fast by building games, doing projects, and solving puzzles.

Effective programming means getting a handle on your data. You'll learn to model your data, manage it in memory, write it to files, and get into the bits and bytes.



getting your ducks in a row

Lists are easy, but SORTING can be tricky

It's not hard to think about ways to sort numbers or letters. But what do you sort two objects on, especially if they have multiple fields? In some cases you might want to order objects by the value in the name field, while in other cases it might make sense to order objects based on height or date of birth. There are lots of ways you can order things, and lists support any of them.

You could sort a list of ducks by size

Sorted smallest to biggest...

or by kind.

Sorted by kind of duck...

Lists know how to sort themselves

Technically, it's not the List<T> that knows how to sort itself. It depends on an IComparer<T> object, which you'll learn about in a minute.

Every list comes with a `Sort()` method that rearranges all of the items in the list to put them in order. Lists already know how to sort most built-in types and classes, and it's easy to teach them how to sort your own classes.

List<Duck> object

17" duck

Duck object

11" duck

Duck object

14" duck

Duck object

Sort()

After the list of ducks is sorted, it's got the same items in it—but they're in a different order.

370 Chapter 8

reading and writing files

What happens to an object when it's serialized?

It seems like something mysterious has to happen to an object in order to copy it off of the heap and put it into a file, but it's actually pretty straightforward.

1 Object on the heap

2 Object serialized

When you create an instance of an object, it has a **state**. Everything that an object "knows" is what makes one instance of a class different from another instance of the same class.

When C# serializes an object, it **saves the complete state of the object**, so that an identical instance (object) can be brought back to life on the heap later.

This object has two byte fields, width and height.

00100101

01000110

The instance variable values for width and height are saved to the file.dat file, along with a little more info that the CLR needs to restore the object later (like the type of the object and its fields).

441

don't you hate waiting in line?

A queue is FIFO First In, First Out

A **queue** is a lot like a list, except that you can't just add or remove items at any index. To add an object to a queue, you **enqueue** it. That adds the object to the end of the queue. You can **dequeue** the first object from the front of the queue. When you do that, the object is removed from the queue, and the rest of the objects in the queue move up a position.

Create a new queue of strings.

```
Queue<string> myQueue = new Queue<string>();
myQueue.Enqueue("first in line");
myQueue.Enqueue("second in line");
myQueue.Enqueue("third in line");
myQueue.Enqueue("last in line");
string takeALook = myQueue.Peek();①
string getFirst = myQueue.Dequeue();②
string getNext = myQueue.Dequeue();③
int howMany = myQueue.Count;④
myQueue.Clear();
MessageBox.Show("Peek() returned: " + takeALook + "\n"
    + "The first Dequeue() returned: " + getFirst + "\n"
    + "The second Dequeue() returned: " + getNext + "\n"
    + "Count before Clear() was " + howMany + "\n"
    + "Count after Clear() is now " + myQueue.Count);⑤
```

Here's where we add four items to the queue. When we pull them out of the queue, they'll come out in the same order they went in.

Peek() lets you take a "look" at the first item in the queue without removing it.

The first Dequeue() pulls the first item out of the queue. Then the second one shifts up into the first place—the next call to Dequeue() pulls that one out next.

The Clear() method removes all objects from the queue.

The queue's Count property returns the number of items in the queue.

Objects in a queue need to wait their turn. The first one in the queue is the first one to come out of it.

Peek() returned: first in line ①
The first Dequeue() returned: first in line ②
The second Dequeue() returned: second in line ③
Count before Clear() was 2 ④
Count after Clear() is now 0 ⑤

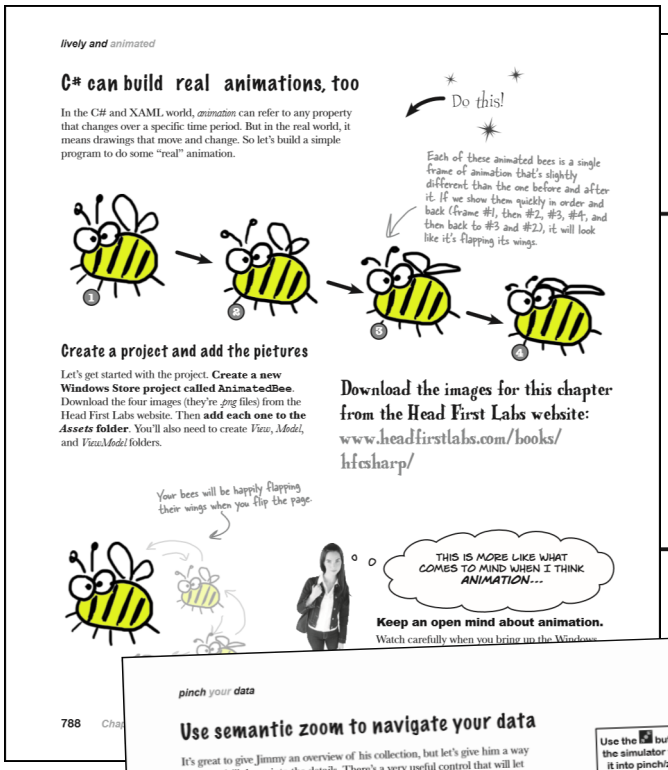
OK

402 Chapter 8

"*Head First C#* got me up to speed in no time for my first large scale C# development project at work—I highly recommend it."

—*Shalewa Odusanya, Technical Account Manager, Google*

Harness the power of XAML to build sleek, modern apps. You'll learn how to create a modern user interface with graphics, animation, pinch-to-zoom, and more.



lively and animated

C# can build real animations, too

In the C# and XAML world, *animation* can refer to any property that changes over a specific time period. But in the real world, it means drawings that move and change. So let's build a simple program to do some "real" animation.

Do this!

Each of these animated bees is a single frame of animation that's slightly different than the one before and after it. If we show them quickly in order and back (frame #1, then #2, #3, #4, and then back to #3 and #2), it will look like it's flapping its wings.

Create a project and add the pictures

Let's get started with the project. **Create a new Windows Store project called `AnimatedBee`.** Download the four images (they're *.png* files) from the Head First Labs website. Then **add each one to the *Assets* folder**. You'll also need to create *View*, *Model*, and *ViewModel* folders.

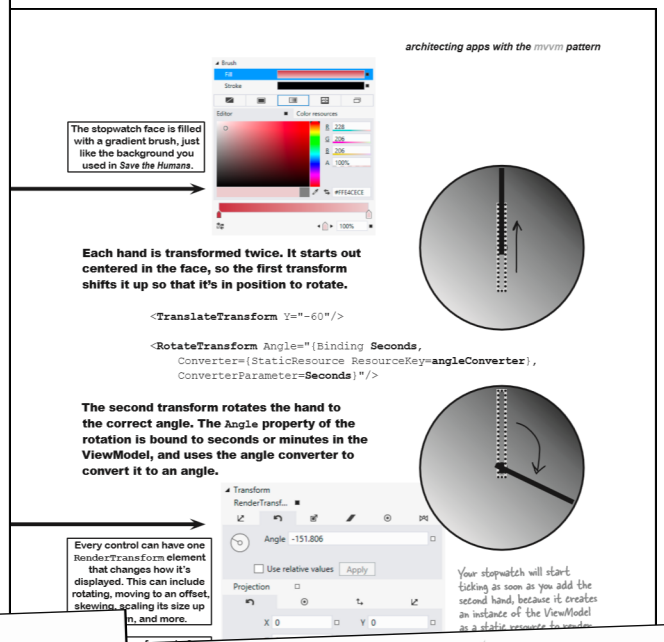
Download the images for this chapter from the Head First Labs website:
www.headfirstlabs.com/books/hfcsharp/

Your bees will be happily flapping their wings when you flip the page.

THIS IS MORE LIKE WHAT COMES TO MIND WHEN I THINK *ANIMATION*...

Keep an open mind about animation.
Watch carefully when you bring up the Windows

788 Cha



architecting apps with the mvvm pattern

The stopwatch face is filled with a gradient brush, just like the background you used in *Save the Humans*.

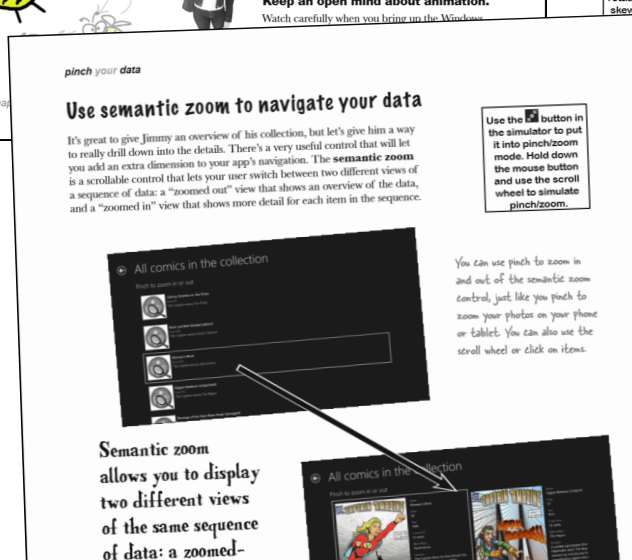
Each hand is transformed twice. It starts out centered in the face, so the first transform shifts it up so that it's in position to rotate.

```
<TranslateTransform Y="-60"/>

<RotateTransform Angle="{Binding Seconds,
    Converter={StaticResource ResourceKey=angleConverter},
    ConverterParameter=Seconds}"/>
```

The second transform rotates the hand to the correct angle. The `Angle` property of the rotation is bound to seconds or minutes in the ViewModel, and uses the angle converter to convert it to an angle.

Every control can have one `RenderTransform` element that changes how it's displayed. This can include rotating, moving to an offset, skewing, scaling its size up

Your stopwatch will start ticking as soon as you add the second hand, because it creates an instance of the ViewModel as a static resource to render



pinch your data

Use semantic zoom to navigate your data

It's great to give Jimmy an overview of his collection, but let's give him a way to really drill down into the details. There's a very useful control that will let you add an extra dimension to your app's navigation. The **semantic zoom** is a scrollable control that lets your user switch between two different views of a sequence of data: a "zoomed out" view that shows an overview of the data, and a "zoomed in" view that shows more detail for each item in the sequence.

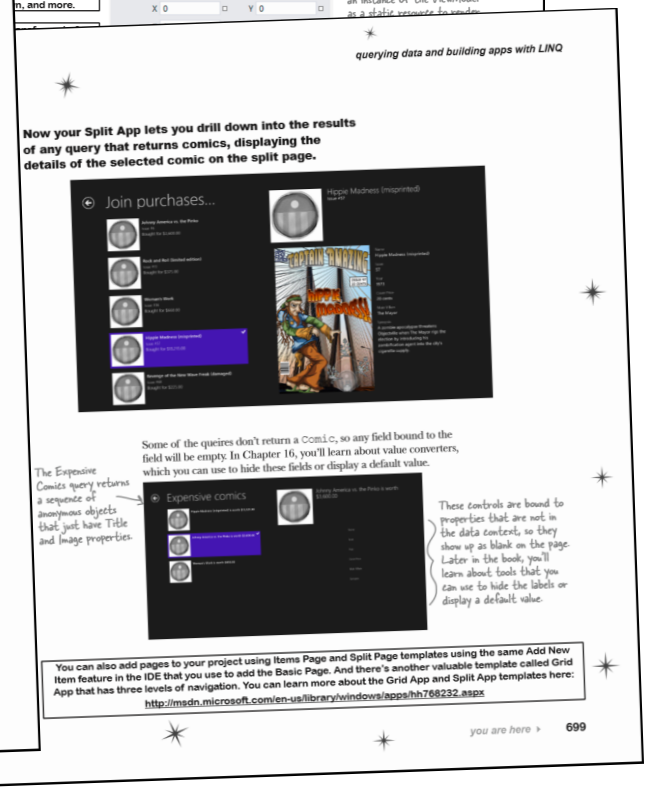
Use the button in the simulator to put it into pinch/zoom mode. Hold down the mouse button and use the scroll wheel to simulate pinch/zoom.

You can use pinch to zoom in and out of the semantic zoom control, just like you pinch to zoom your photos on your phone or tablet. You can also use the scroll wheel or click on items.

Semantic zoom allows you to display two different views of the same sequence of data: a zoomed-out view that shows many items, and a zoomed-in view that shows more detail.

You can learn more about how semantic zoom fits into your apps here:
http://msdn.microsoft.com/en-us/library/windows/apps/hh465319.aspx

684 Chapter 14



querying data and building apps with LINQ

Now your Split App lets you drill down into the results of any query that returns comics, displaying the details of the selected comic on the split page.

Some of the queires don't return a `Comic`, so any field bound to the field will be empty. In Chapter 16, you'll learn about value converters, which you can use to hide these fields or display a default value.

The Expensive Comics query returns a sequence of anonymous objects that just have Title and Image properties.

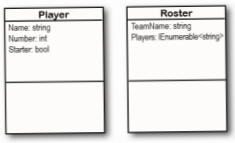
These controls are bound to properties that are not in the data context, so they show up as blank on the page. Later in the book, you'll learn about tools that you can use to hide the labels or display a default value.

You can also add pages to your project using Items Page and Split Page templates using the same Add New Item feature in the IDE that you use to add the Basic Page. And there's another valuable template called Grid App that has three levels of navigation. You can learn more about the Grid App and Split App templates here:
http://msdn.microsoft.com/en-us/library/windows/apps/hh768232.aspx

you are here › 699

Do you design for binding or for working with data?

You already know how important it is to build an object model that makes your data easy to work with. But what if you need to do **two different things** with those objects? That's one of the most common problems that you face as an app designer. Your objects need to have public properties and `ObservableCollections` to bind to your XAML controls. But sometimes that makes your data harder to work with, because it forces you to build an uninteruitive object model that's difficult to work with.



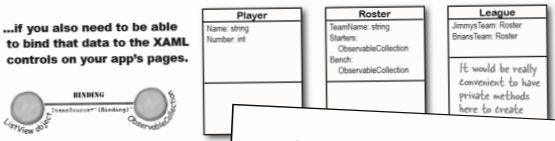
It's hard to optimize your classes to make it easy to slice and dice your data with LINQ queries...

```
var benchPlayers =
    from player in _roster.Players
    where player.Starter == false
    select player;
```

If you model your data like this, it limits your ability to build the pages that you want.

If you model your data like this, it's easier to build your pages but harder to write code to query and manage the data.

...if you also need to be able to bind that data to the XAML controls on your app's pages.



MVVM lets you design for binding and data

Almost all apps that have a large or complex enough object model face the problem of having to either compromise the class design or compromise the objects available for binding. Luckily, there's a design pattern that app developers use to solve this problem. It's called **Model-View-ViewModel** (or **MVVM**), and it works by splitting your app into three layers: the ***Model*** to hold the data and state of the app, the ***View*** that contains the pages and controls that the user interacts with, and the ***ViewModel*** that converts the data in the Model into objects that can be bound and listens for events in the View that the model needs to know about.

MVVM is a pattern that uses the existing tools you already have, just like the callback and Observer patterns in the last chapter.

Any object that the user directly interacts with goes in the View.

That includes pages, buttons, text, grids, StackPanels, ListViews, and any other controls that can be laid out using XAML. The controls are bound to objects in the ViewModel, and the controls' event handlers call methods in the ViewModel objects.

The ViewModel has the properties that can bind to the controls in the View.

The properties in the view get their data from the objects in the Model, convert that data into a form that the View's controls can understand, and notify the View when the data changes.

All of the objects that hold the state of the app live in the Model.

This is where your app keeps its data. The ViewModel calls the properties and methods in the Model. If there are objects that change over the course of the app's lifetime, or if data needs to be saved or loaded from files, those things go here.

The ViewModel is like the plumbing that connects the objects in the View to the objects in the Model, using tools you already know how to work with.

MVVM means thinking about the state of the app

MVVM apps use the Model and View to separate the state from the user interface. So when you start building an MVVM app, the first thing you usually do is think about exactly what it means to manage the state of the app. Once you've got the state under control in your brain, you can start building the Model, which will use fields and properties to keep track of the state—or everything the app needs to keep track of to do its job. Most apps need to modify the state as well, so the Model exposes public methods that change the state. The rest of the app needs to be able to see the current state, so the Model provides public properties.

So what does it mean to manage the state of a stopwatch?

The stopwatch knows whether or not it's running.

You can see at a glance whether or not the hands are moving, so the stopwatch Model needs to have a way to tell whether or not it's running.

The elapsed time is always available.

Whether it's the hands on an analog stopwatch or numbers on a digital one, you can always see the elapsed time.

The lap time can be set and viewed.

Most stopwatches have a lap time function that lets you save the current time without stopping the clock. Analog stopwatches use an extra set of hands to show the lap time, while digital stopwatches usually have a separate lap time readout.

stopwatch can stop, start, and reset.

app will need to provide a way to start the stopwatch, it, and reset the time, which means the Model will to give the rest of the app a way to do this.

The Model keeps track of the state of the app: what the app knows right now. It provides actions that modify the app's state and properties to let the rest of the app see the current state.

"*Head First C#* will guide beginners of all sorts to a long and productive relationship with C# and the .NET Framework."

—Chris Burrows, Developer on Microsoft's C# Compiler team

Advanced concepts like MVVM and design patterns are made simple with examples, projects, and straightforward explanations.

You'll build full-featured, exciting video games! We'll keep your brain engaged, and give you the practice that you need to become a solid C# programmer.

The spec: build an adventure game

Your job is to build an adventure game where a mighty adventurer is on a quest to defeat level after level of deadly enemies. You'll build a **turn-based system**, which means the player makes one move and then the enemies make one move. The player can move ***or*** attack, and then each enemy gets a chance to move ***and*** attack. The game keeps going until the player either defeats all the enemies on all seven levels or dies.

It's possible to build Windows Desktop programs that automatically scale to any size display, but that's beyond the scope of what we're teaching. (You'll learn all about how to do that with XAML in the next chapter, but that obviously won't help with WinForms.) However, this means that the inventory PictureBoxes, GroupBoxes, and TableLayoutPanel on the form may look right in the designer, but end up in strange places when you run the program. Just drag them so they look right for your screen when you run the program.

The game window gives an overhead view of the dungeon where the player fights his enemies.

The player can pick up weapons and potions along the way.

The enemies get a bit of an advantage—they move every turn, and after they move they'll attack the player if he's in range.

The player and enemies move around in the dungeon.

Here's the player's inventory. It shows what items the player's picked up, and draws a box around the item that they're currently using. The player clicks on an item to equip it, and uses the Attack button to use the item.

The game shows you the number of **hit points** for the player and enemies. When the player attacks an enemy, the enemy's hit points go down. Once the hit points get down to zero, the enemy or player dies.

The player moves using the four Move buttons.

These four butt... used to attack ... and drink potion... player can use ... these buttons ... an equipped pot...

The grandfather of video games

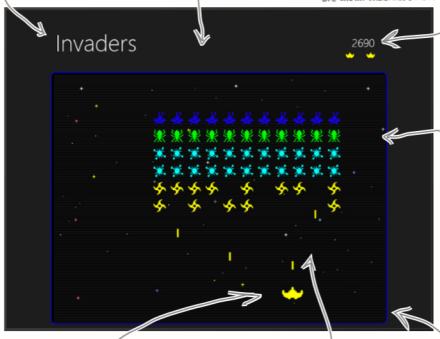
In this lab you'll pay homage to one of the most popular, revered, and replicated icons in video game history, a game that needs no further introduction: **it s time to build *Invaders*!**

As the player destroys the invaders, the score goes up. It's displayed in the upper-righthand corner.

Invaders is a Windows Store app using a single Basic Page.

The invaders attack in waves of 11 columns with six invaders. The first wave moves slowly and fires a few shots at a time. The next wave moves faster, and fires more shots more frequently. If all invaders in a wave are destroyed, the next wave attacks.

The player starts out with three ships. The first ship is in play, and the other two are kept in reserve. The spare ships are shown underneath the score.



The invaders' ships are animated with blocky, pixelated, retro 80s-style graphics. The whole playing area has a 4:3 aspect ratio just like an old arcade cabinet, complete with simulated scan lines to make it look authentic.

The player moves the ship left and right, and fires shots at the invaders. If a shot hits an invader, the invader is destroyed and the player's score goes up.

The invaders return fire. If one of the shots hits the ship, the player loses a life. Once all lives are gone, or if the invaders reach the bottom of the screen, the game ends and a big "GAME OVER" is displayed in the middle of the screen.

The multicolored stars in the background twinkle on and off, but don't affect gameplay at all.

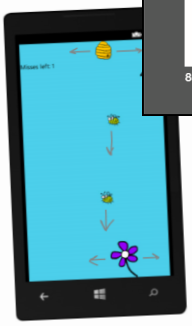
bonus project

Bee Attack!

You'll be building a Windows Phone 8 game called **Bee Attack**. There's a hive of seriously ticked-off bees, and the only way you'll pacify them is with a tasty, tasty flower. The more bees you catch with the flower, the higher your score.

Catch the bees as they fly down the scr...

The hive moves back and forth across the top of the s... launching bees down at your flower. As you catch mo... and more bees, the hive shoots them out more frequen... and moves farther to the left or right between bees.

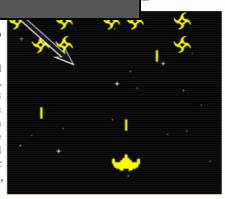


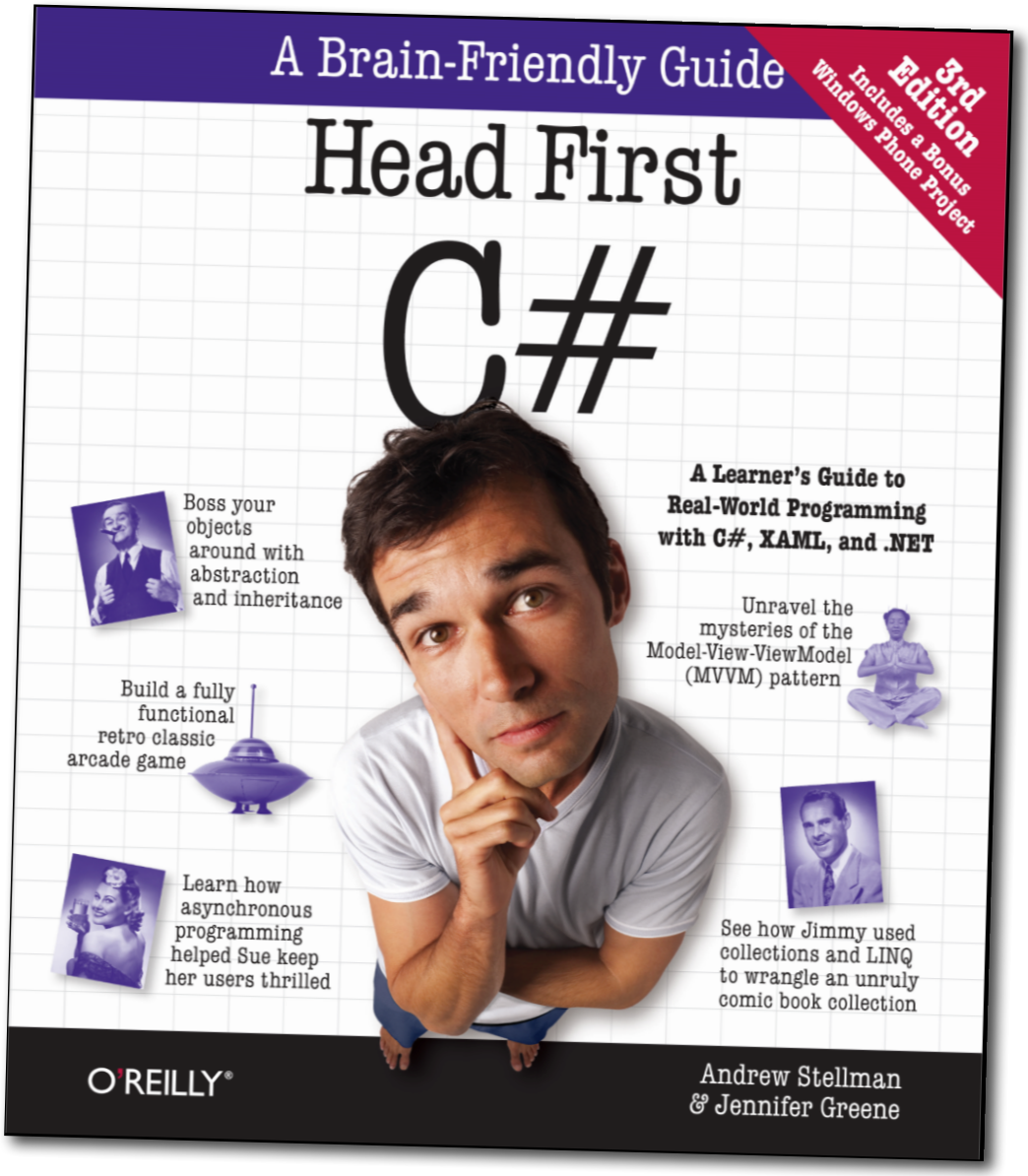
Control the flower with touch gestures.

You control the flower by dragging left and right across the screen. It will follow your finger as you drag, letting you catch the bees as they fly down toward the bottom. You've only got five misses before the game ends, and it gets harder as the game goes on.

The play area is always resized to keep a 4:3 aspect ratio.

The main play area is a `Border` with rounded corners that contains an `ItemsControl` with the `ItemsPath` bound to the `Sprites` property, and whose `ItemsPanel` is a `Canvas` with a black background. We'll give you code on the next page that updates its margins to make sure it always keeps a **4:3 aspect ratio**—it will modify the `Margin` property of the `Border` to keep the `Height` 4/3 the size of the `Width`, even if the screen is rotated or resized.





Head First C#

by Andrew Stellman and Jennifer Greene

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