Programming Logic and Design

Seventh Edition

Chapter 1

An Overview of Computers and Programming

Objectives

In this chapter, you will learn about:

- Computer systems
- Simple program logic
- The steps involved in the program development cycle
- Pseudocode statements and flowchart symbols
- Using a sentinel value to end a program
- Programming and user environments
- The evolution of programming models

Understanding Computer Systems

- **Computer system**
  - Combination of all the components required to process and store data using a computer
- **Hardware**
  - Equipment associated with a computer
- **Software**
  - Computer instructions
  - Tells the hardware what to do
  - **Programs**
    - Instructions written by programmers

Understanding Computer Systems (continued)

  - **Application software** such as word processing, spreadsheets, payroll and inventory, even games
  - **System software** such as operating systems like Windows, Linux, or UNIX
- Computer hardware and software accomplish three major operations
  - **Input**
    - **Data items** such as text, numbers, images, and sound
  - **Processing**
    - Calculations and comparisons performed by the **central processing unit** (**CPU**)

Understanding Computer Systems (continued)

- **Output**
  - Resulting information that is sent to a printer, a monitor, or **storage devices** after processing

- **Programming language**
  - Used to write computer instructions
  - Examples
    - Visual Basic, C#, C++, or Java

- **Syntax**
  - Rules governing word usage and punctuation

Understanding Computer Systems (continued)

- **Computer memory**
  - Computer's temporary, internal storage – **random access memory** (**RAM**)
  - **Volatile** memory – lost when the power is off
- Permanent storage devices
  - **Nonvolatile** memory
- **Compiler** or **interpreter**
  - Translates source code into **machine language** (**binary language**) statements called **object code**
  - Checks for syntax errors

Understanding Simple Program Logic

- Program **executes** or **runs**
  - Input will be accepted, some processing will occur, and results will be output
- Programs with syntax errors cannot execute
- **Logical errors**
  - Errors in program logic produce incorrect output
- **Logic** of the computer program
  - Sequence of specific instructions in specific order
- **Variable**
  - Named memory location whose value can vary

Understanding the Program Development Cycle

- **Program development cycle**
  - Understand the problem
  - Plan the logic
  - Code the program
  - Use software (a compiler or interpreter) to translate the program into machine language
  - Test the program
  - Put the program into production
  - Maintain the program

Understanding the Program Development Cycle (continued)

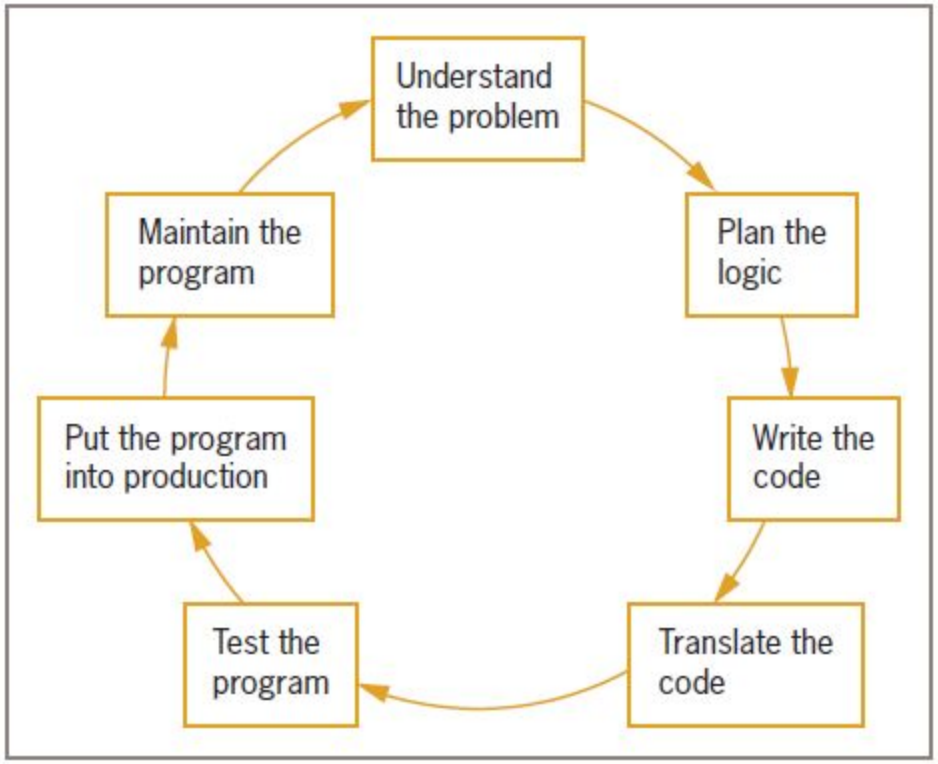


Figure 1-1 The program development cycle

Understanding the Problem

- One of the most difficult aspects of programming
- **Users** or **end users**
  - People for whom a program is written
- **Documentation**
  - Supporting paperwork for a program

Planning the Logic

- Heart of the programming process
- Most common planning tools
  - Flowcharts
  - Pseudocode
  - **IPO charts** (input, processing, and output)
  - **TOE charts** (tasks, objects, and events)
- **Desk-checking**
  - Walking through a program's logic on paper before you actually write the program

Coding the Program

- Hundreds of programming languages available
  - Choose based on features
  - Similar in their basic capabilities
- Easier than the planning step

Using Software to Translate the Program into Machine Language

- Translator program
  - Compiler or interpreter
  - Changes the programmer's English-like **high-level programming language** into the **low-level machine language**
- **Syntax error**
  - Misuse of a language's grammar rules
  - Programmer corrects listed syntax errors
  - Might need to recompile the code several times

Using Software to Translate the Program into Machine Language (continued)

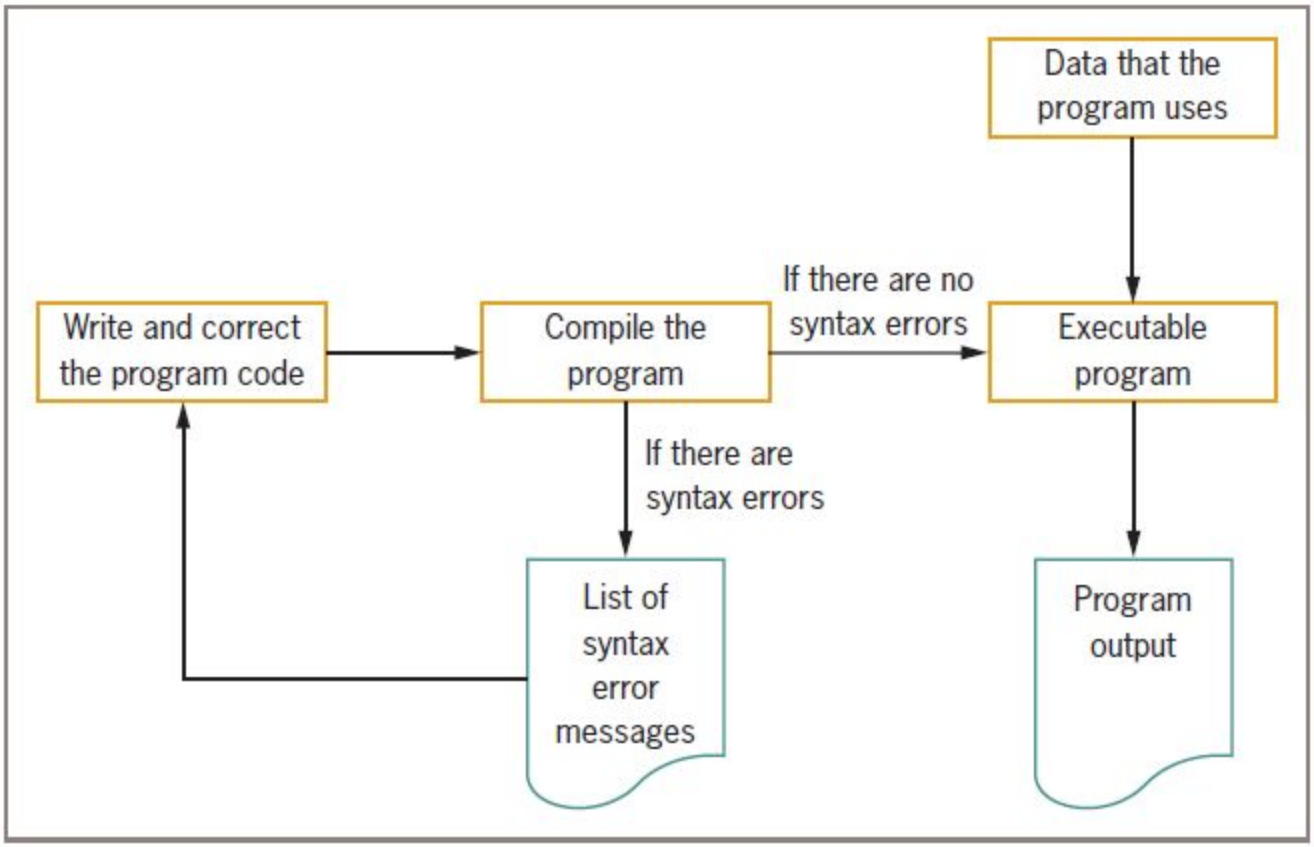


Figure 1-2 Creating an executable program

Testing the Program

- Logical error
  - Results when a syntactically correct statement, but the wrong one for the current context, is used
- Test
  - Execute the program with some sample data to see whether the results are logically correct
- **Debugging** is the process of finding and correcting program errors
- Programs should be tested with many sets of data

Putting the Program into Production

- Process depends on program's purpose
  - May take several months
- **Conversion**
  - The entire set of actions an organization must take to switch over to using a new program or set of programs

Maintaining the Program

- **Maintenance**
  - Making changes after the program is put into production
- Common first programming job
  - Maintaining previously written programs
- Make changes to existing programs
  - Repeat the development cycle

Using Pseudocode Statements and Flowchart Symbols

- **Pseudocode**
  - English-like representation of the logical steps it takes to solve a problem
- **Flowchart**
  - Pictorial representation of the logical steps it takes to solve a problem

Writing Pseudocode

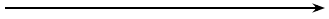
- Pseudocode representation of a number-doubling problem

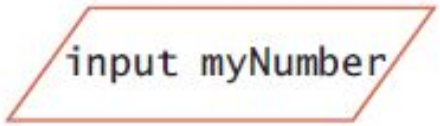
```
start
    input myNumber
    set myAnswer = myNumber * 2
    output myAnswer
stop
```

Writing Pseudocode (continued)

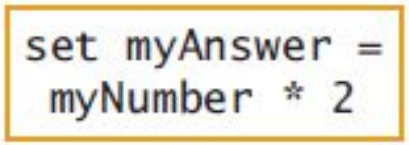
- Programmers preface their pseudocode with a beginning statement like `start` and end it with a terminating statement like `stop`
- Flexible planning tool

Drawing Flowcharts

- Create a flowchart
  - Draw geometric shapes that contain the individual statements
  - Connect shapes with arrows 
- **Input symbol**
  - Indicates input operation
  - Parallelogram

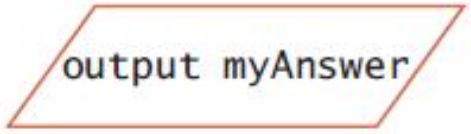


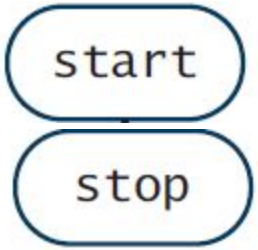
- **Processing symbol**
  - Contains processing statements such as arithmetic
  - Rectangle



Drawing Flowcharts (continued)

- **Output symbol**
  - Represents output statements
  - Parallelogram
- **Flowlines**
  - Arrows that connect steps
- **Terminal symbols**
  - Start/stop symbols
  - Shaped like a racetrack
  - Also called lozenges





Drawing Flowcharts (continued)

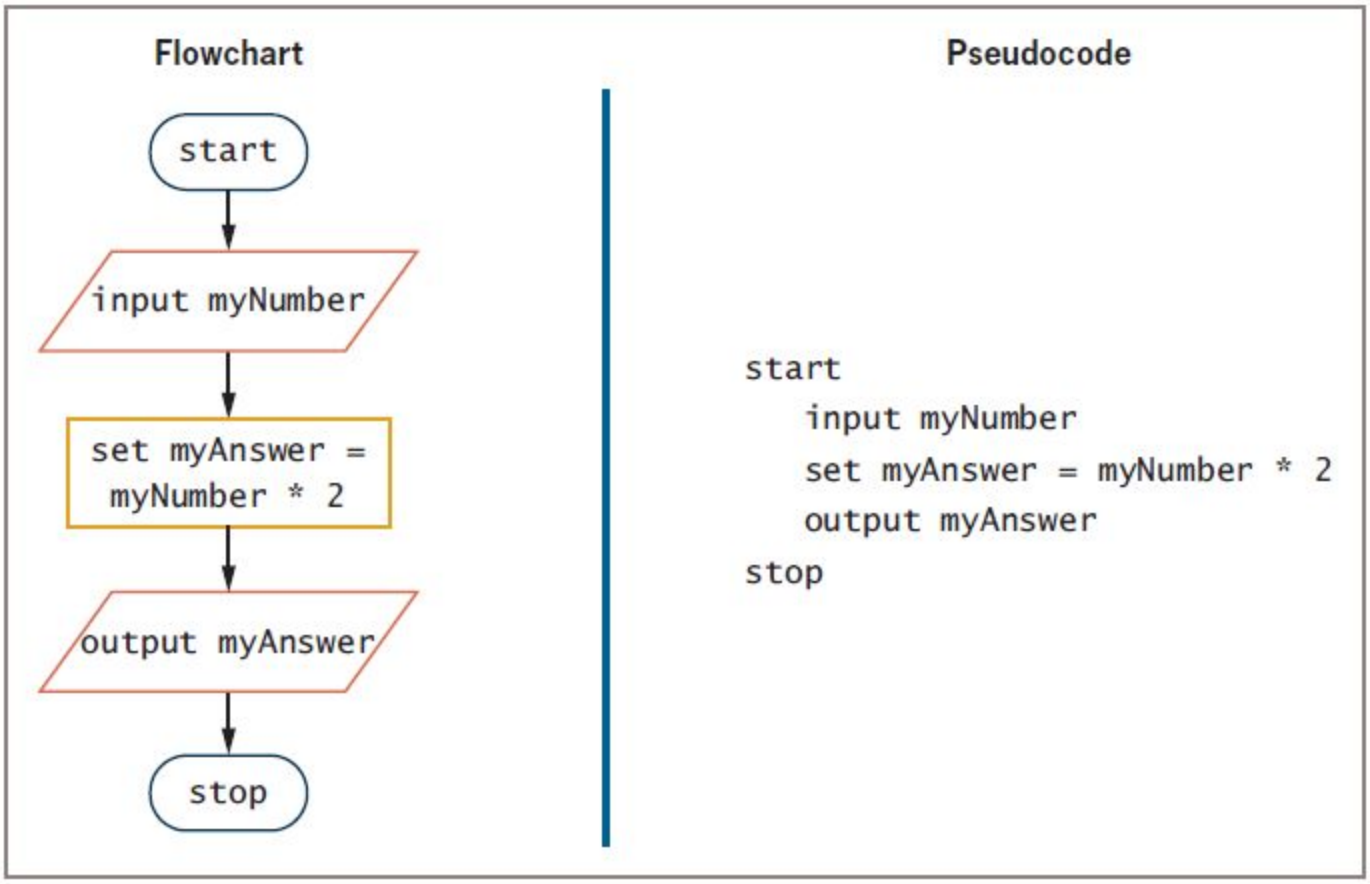


Figure 1-6 Flowchart and pseudocode of program that doubles a number

Repeating Instructions

- Program in Figure 1-6 only works for one number
- Not feasible to run the program over and over 10,000 times
- Not feasible to add 10,000 lines of code to a program
- Create a **loop** (repetition of a series of steps) instead
- Avoid an **infinite loop** (repeating flow of logic that never ends)

Repeating Instructions (continued)

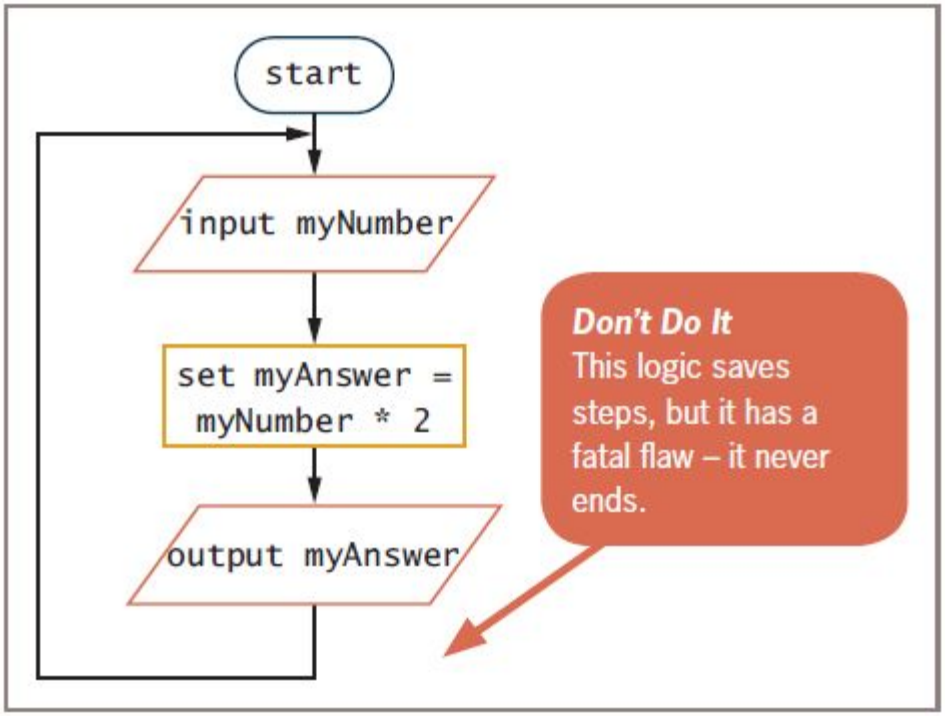
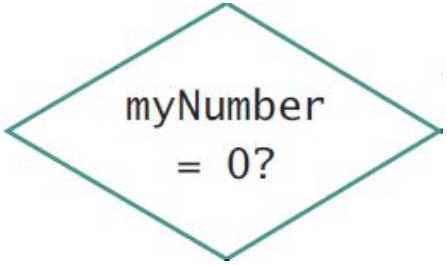


Figure 1-8 Flowchart of infinite number-doubling program

Using a Sentinel Value to End a Program

- **Making a decision**
  - Testing a value
  - **Decision symbol**
    - Diamond shape



- **Dummy value**
  - Data-entry value that the user will never need
  - **Sentinel value**
- `eof` ("end of file")
  - Marker at the end of a file that automatically acts as a sentinel

Using a Sentinel Value to End a Program (continued)

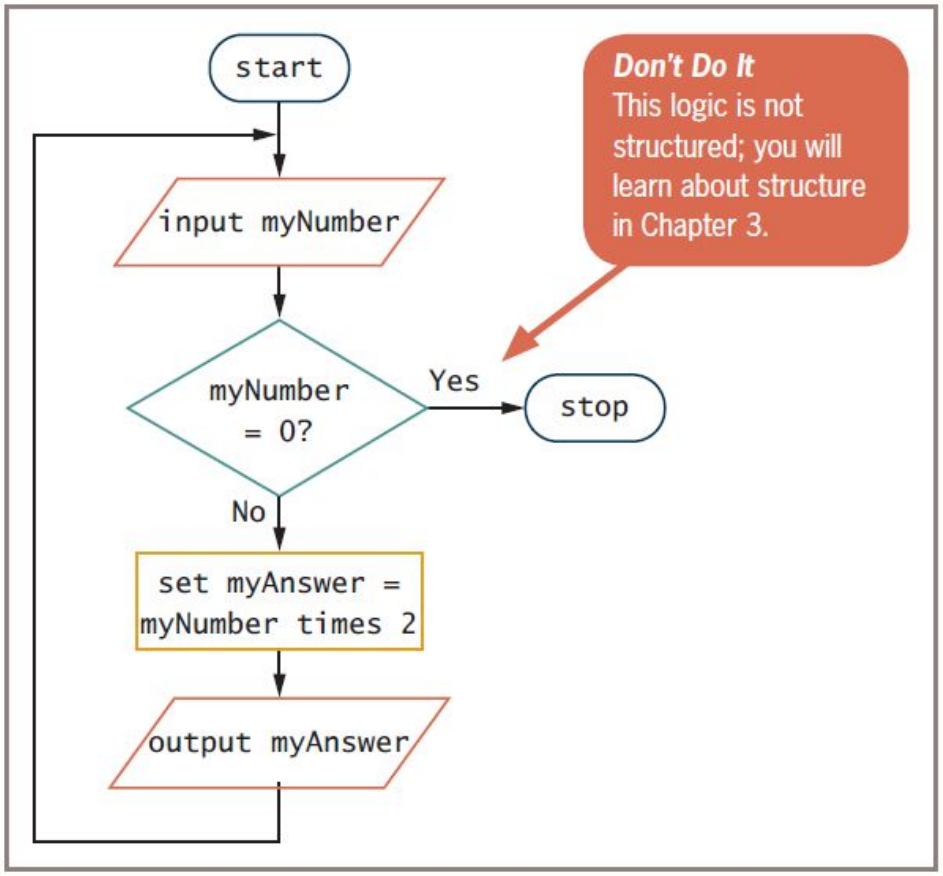


Figure 1-9 Flowchart of number-doubling program with sentinel value of 0

Using a Sentinel Value to End a Program (continued)

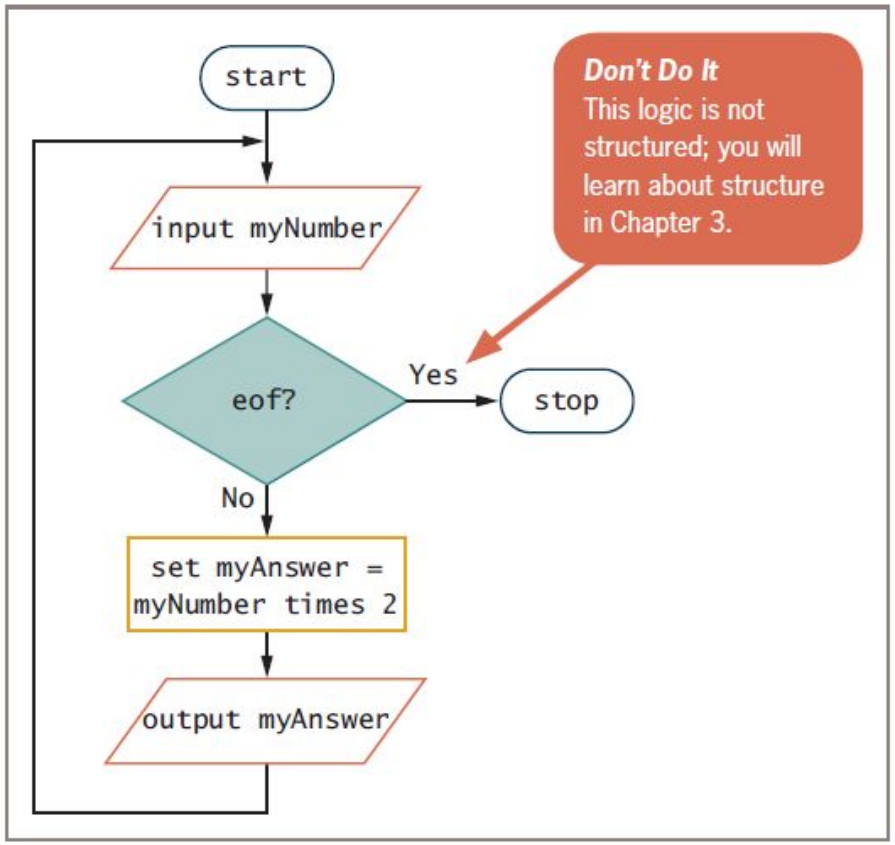


Figure 1-10 Flowchart using `eof`

Understanding Programming and User Environments

- Many options for programming and user environments
  - Planning
    - Flowchart
    - Pseudocode
  - Coding
    - Text editors
  - Executing
    - Input from keyboard, mouse, microphone
  - Outputting
    - Text, images, sound

Understanding Programming Environments

- Use a keyboard to type program statements into an editor
  - Plain **text editor**
    - Similar to a word processor but without as many features
  - Text editor that is part of an **integrated development environment** (**IDE**)
    - Software package that provides an editor, a compiler, and other programming tools

Understanding Programming Environments (continued)

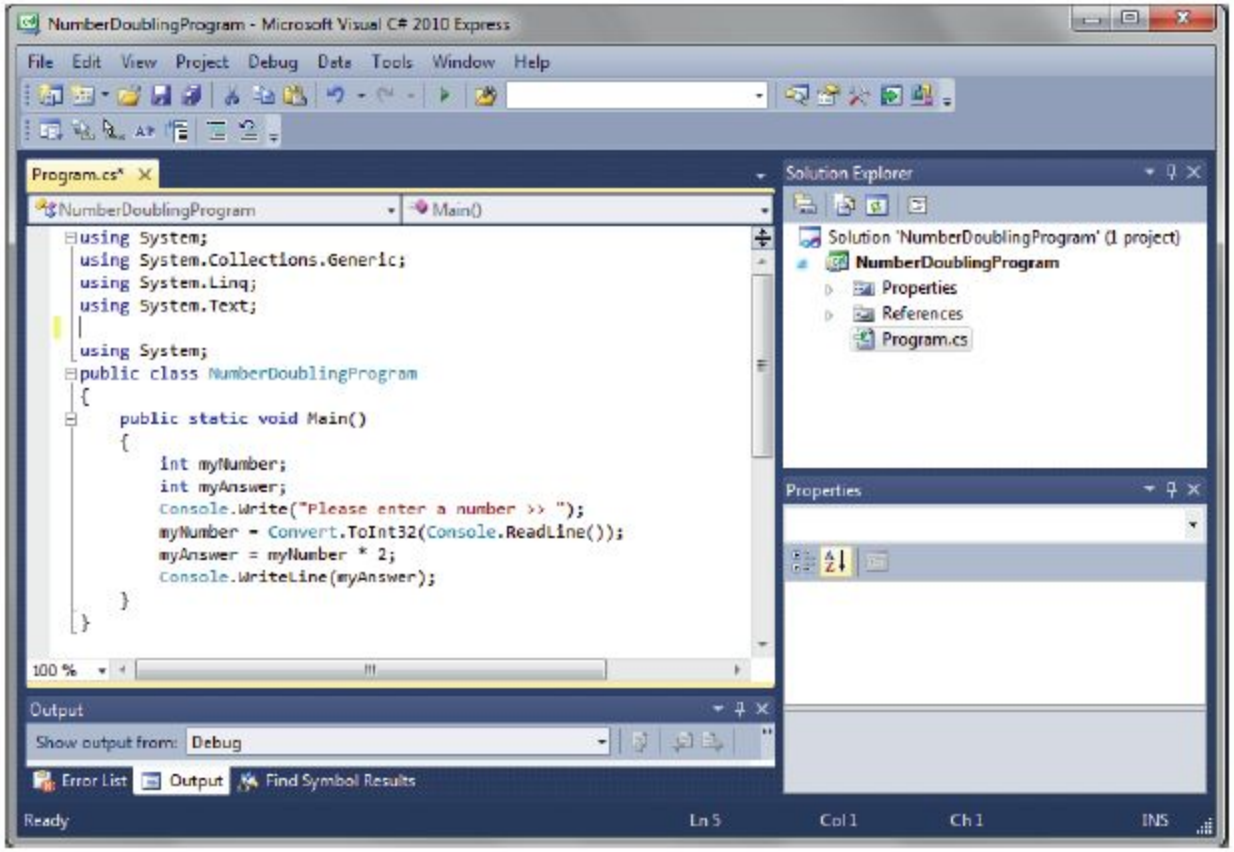


Figure 1-12 A C# number-doubling program in Visual Studio

Understanding User Environments

- **Command line**
  - Location on your computer screen where you type text entries to communicate with the computer's operating system
- **Graphical user interface** (**GUI**)
  - Allows users to interact with a program in a graphical environment

Understanding User Environments (continued)

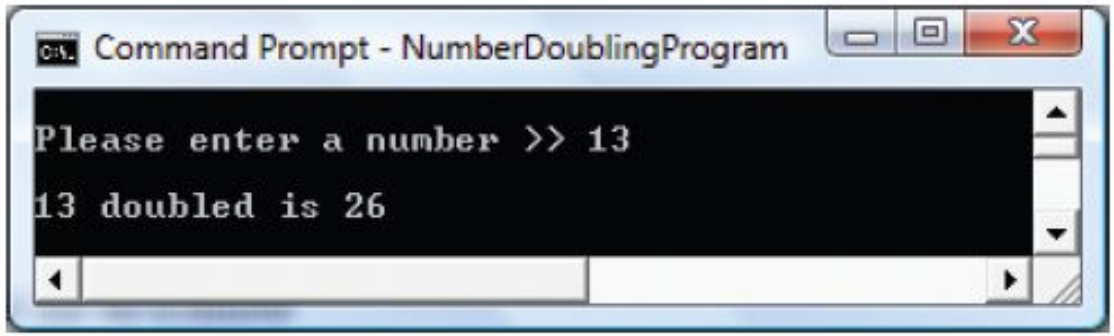


Figure 1-13 Executing a number-doubling program in a command-line environment

Understanding User Environments (continued)

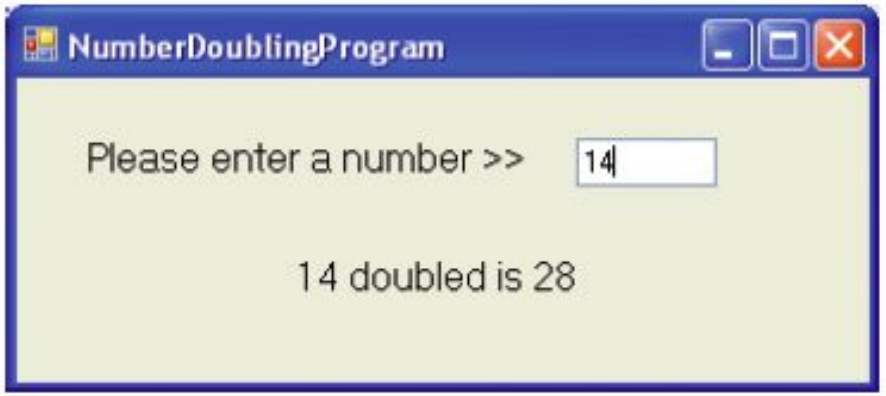


Figure 1-14 Executing a number-doubling program in a GUI environment

Understanding the Evolution of Programming Models

- People have been writing modern computer programs since the 1940s
- Newer programming languages
  - Look much more like natural language
  - Are easier to use
  - Create self-contained modules or program segments that can be pieced together in a variety of ways

Understanding the Evolution of Programming Models (continued)

- Major models or paradigms used by programmers
  - **Procedural programming**
    - Focuses on the procedures that programmers create
  - **Object-oriented programming**
    - Focuses on objects, or "things," and describes their features (or attributes) and their behaviors
  - This text
    - Focuses on procedural programming techniques

Summary

- Hardware and software accomplish input, processing, and output
- Logic must be developed correctly
- Logical errors are much more difficult to locate than syntax errors
- Use flowcharts, pseudocode, IPO charts, and TOE charts to plan the logic
- Avoid infinite loops by testing for a sentinel value
- Use a text editor or an IDE to enter your program statements