Programming Logic and Design

Seventh Edition

Chapter 3

Understanding Structure

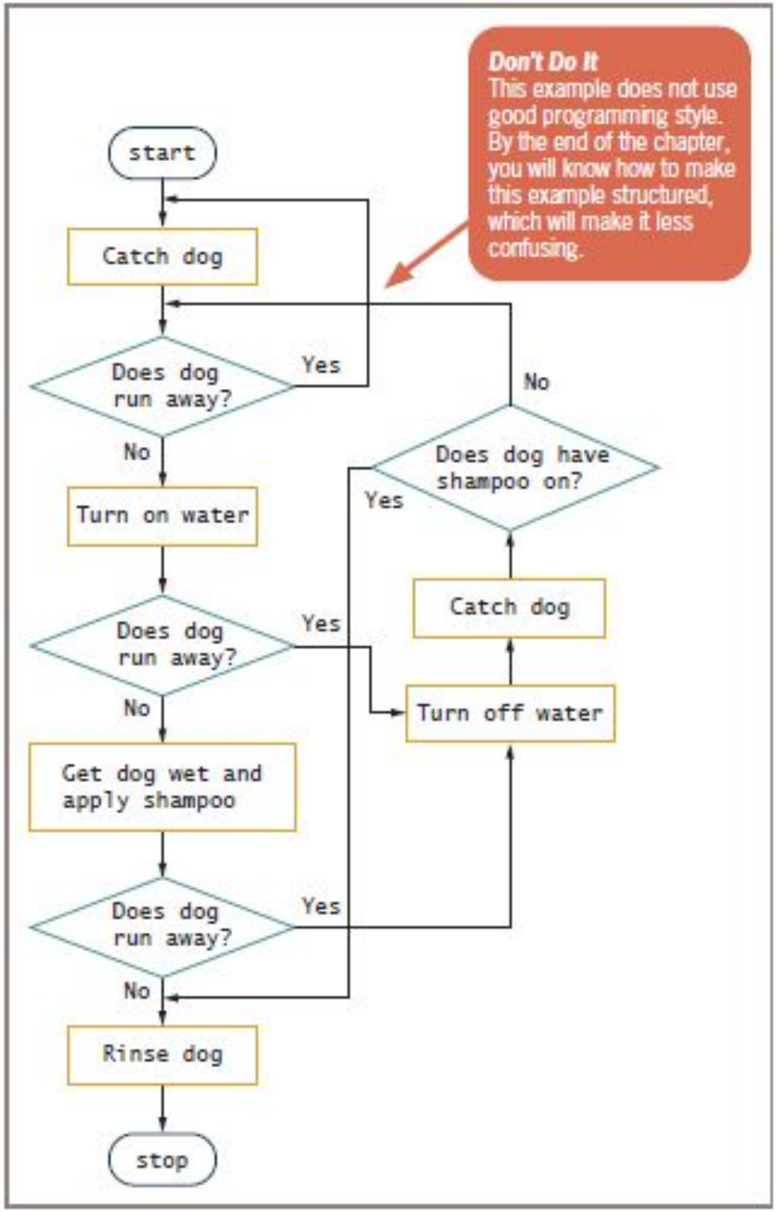
Objectives

In this chapter, you will learn about:

- The disadvantages of unstructured spaghetti code
- The three basic structures—sequence, selection, and loop
- Using a priming input to structure a program
- The need for structure
- Recognizing structure
- Structuring and modularizing unstructured logic

The Disadvantages of Unstructured Spaghetti Code

- **Spaghetti code**
  - Logically snarled program statements
  - Often a complicated mess
  - Programs often work but are difficult to read and maintain
  - Confusing and prone to error
- **Unstructured programs**
  - Do not follow the rules of structured logic
- **Structured programs**
  - Follow the rules of structured logic



Don't Do It
This example does not use good programming style. By the end of the chapter, you will know how to make this example structured, which will make it less confusing.

Figure 3-1 Spaghetti code logic for washing a dog

Understanding the Three Basic Structures

- **Structure**
  - Basic unit of programming logic
  - **Sequence structure**
    - Perform actions in order
    - No branching or skipping any task
  - **Selection structure (decision structure)**
    - Ask a question, take one of two actions
    - **Dual-alternative `ifs`** or **single-alternative `ifs`**
  - **Loop structure**
    - Repeat actions while a condition remains true

Understanding the Three Basic Structures (continued)

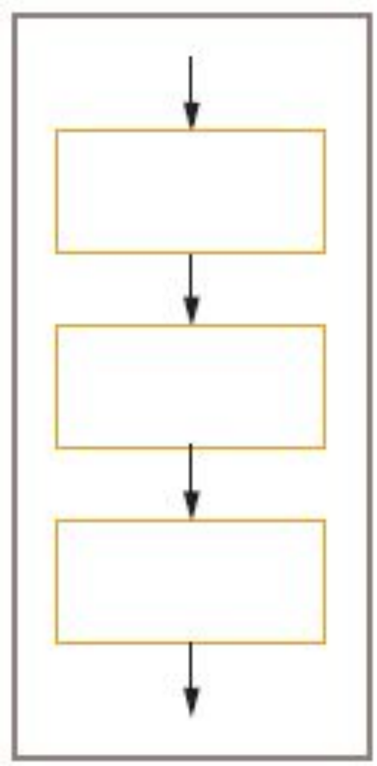


Figure 3-2 Sequence structure

Understanding the Three Basic Structures (continued)

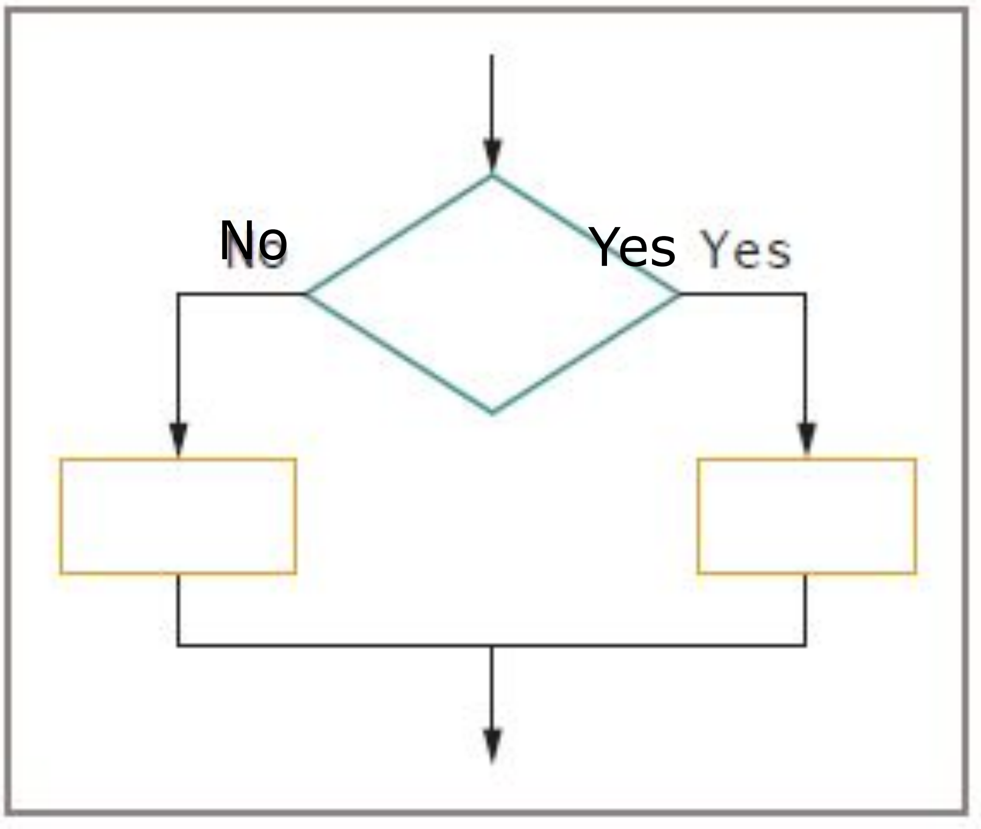


Figure 3-3 Selection structure

Understanding the Three Basic Structures (continued)

- **Dual-alternative `ifs`**
  - Contain two alternatives
  - The **`if-then-else`** structure

```
if someCondition is true then
   do oneProcess
else
   do theOtherProcess
endif
```

Understanding the Three Basic Structures (continued)

- **Single-alternative `ifs`**

```
if employee belongs to dentalPlan then
   deduct $40 from employeeGrossPay
```

  - An `else` clause is not required
- **null case**
  - Situation where nothing is done

Understanding the Three Basic Structures (continued)

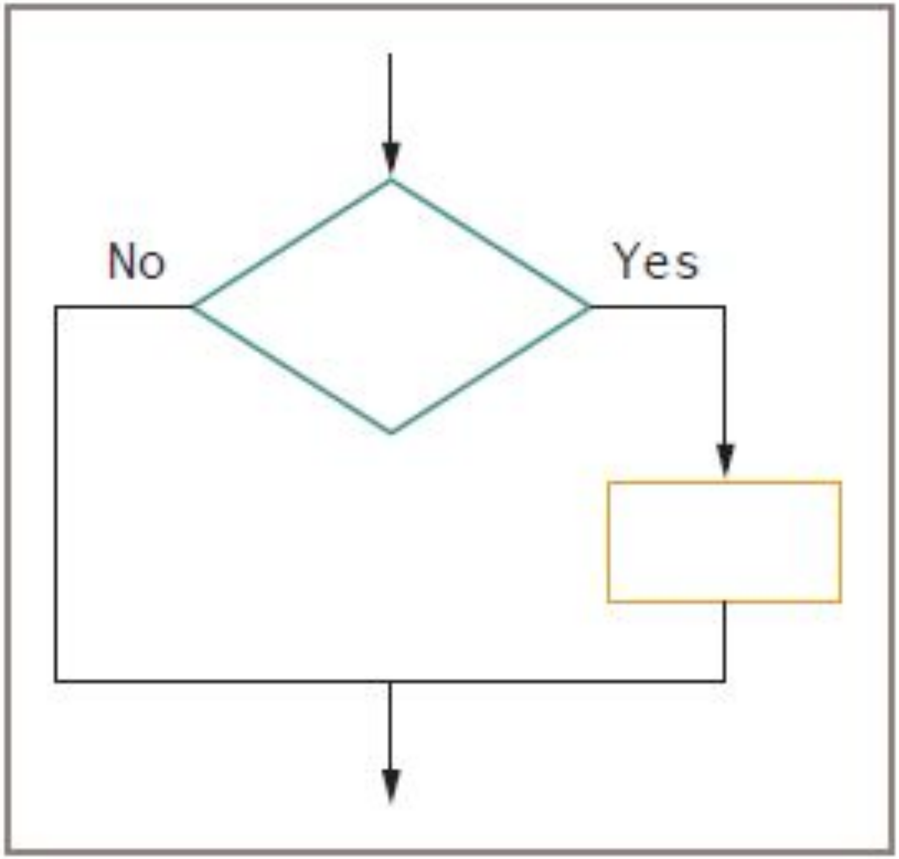


Figure 3-4 Single-alternative selection structure

Understanding the Three Basic Structures (continued)

- **Loop structure**
  - Repeats a set of actions while a condition remains true
    - **Loop body**
  - Also called **repetition** or **iteration**
  - Condition is tested first in the most common form of loop
  - The **`while`…`do`** or **`while` loop**

Understanding the Three Basic Structures (continued)

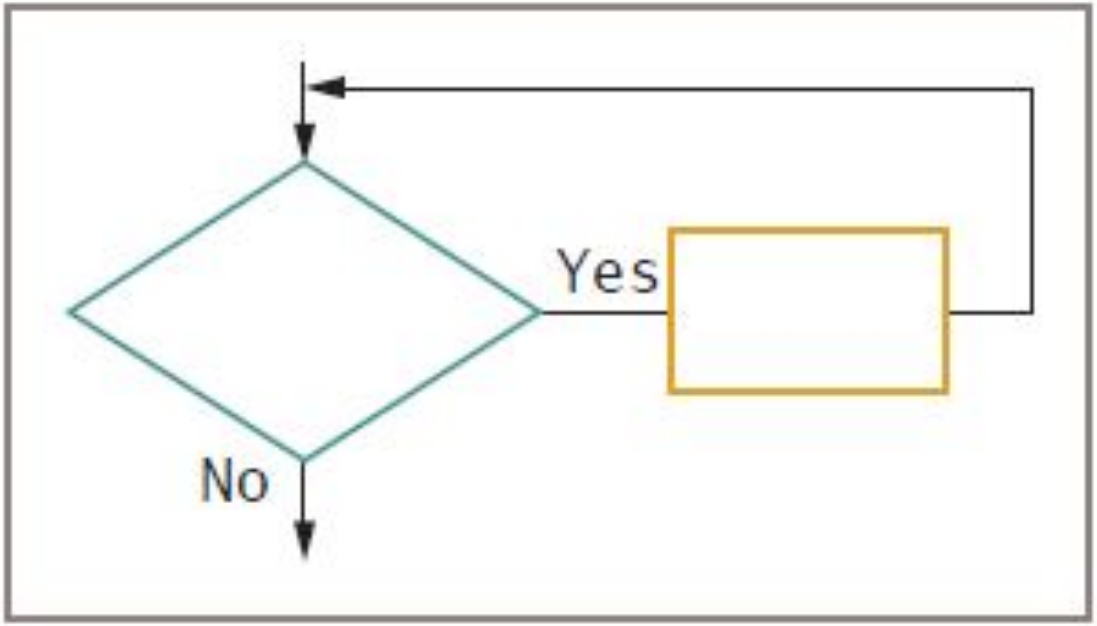


Figure 3-5 Loop structure

Understanding the Three Basic Structures (continued)

- **Loop structure**

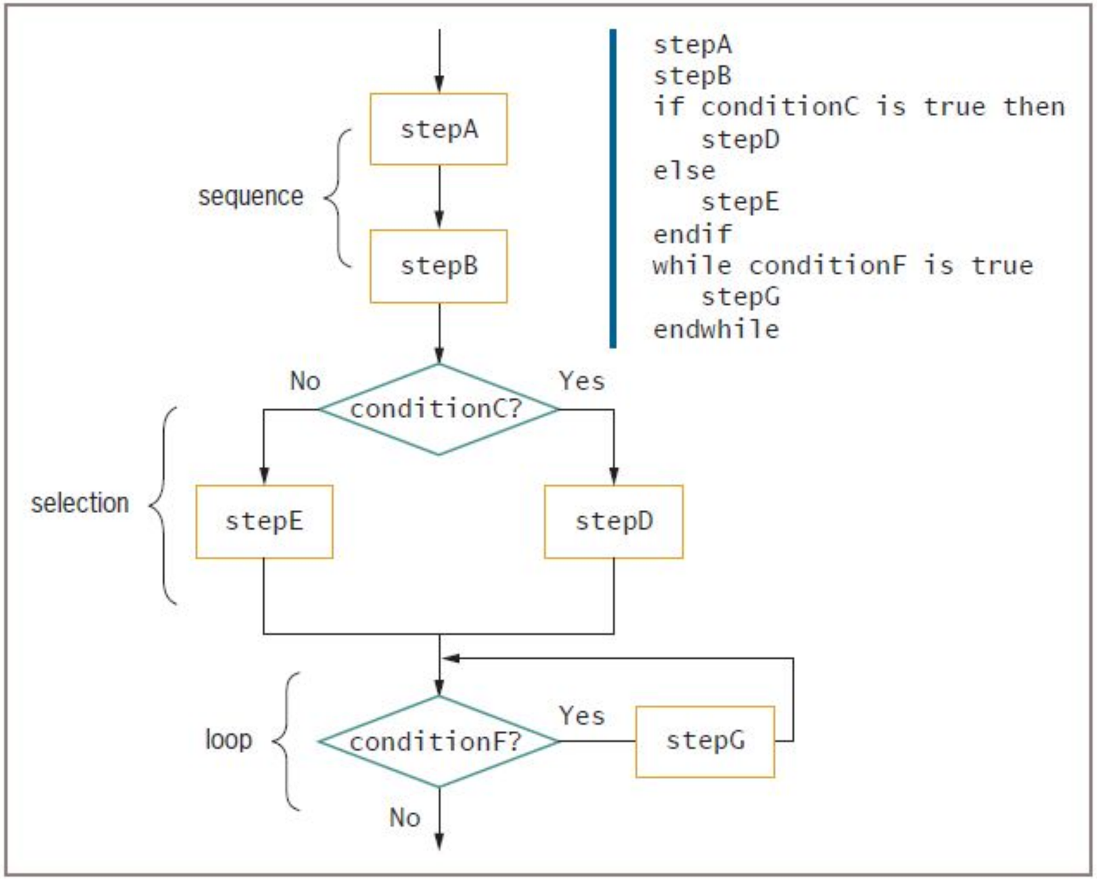
```
while testCondition continues to be true
   do someProcess


while you continue to be hungry
   take another bite of food
      determine if you still feel hungry
```

Understanding the Three Basic Structures (continued)

- All logic problems can be solved using only sequence, selection, and loop
- Structures can be combined in an infinite number of ways
- **Stacking structures**
  - Attaching structures end-to-end
- **End-structure statement**
  - Indicates the end of a structure
  - The `endif` statement ends an `if-then-else` structure
  - The `endwhile` statement ends a loop structure

Understanding the Three Basic Structures (continued)



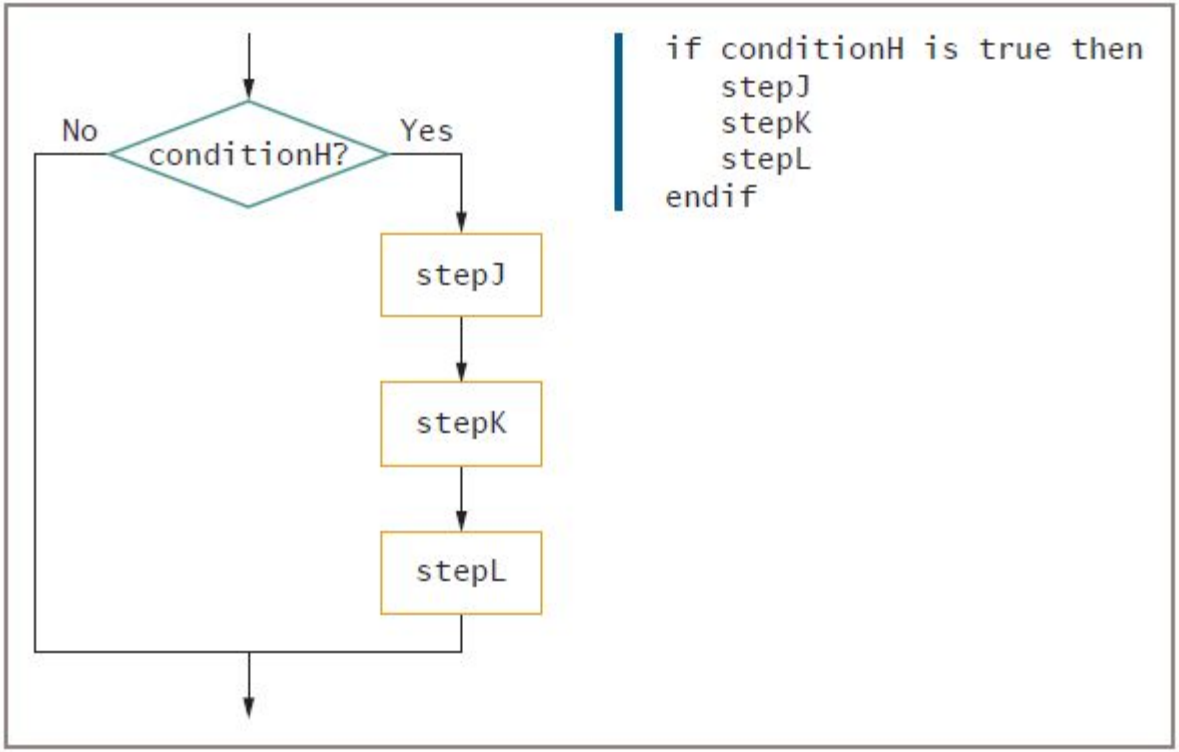
```
stepA
stepB
if conditionC is true then
   stepD
else
   stepE
endif
while conditionF is true
   stepG
endwhile
```

Figure 3-6 Structured flowchart and pseudocode with three stacked structures

Understanding the Three Basic Structures (continued)

- Any individual task or step in a structure can be replaced by a structure
- **Nesting structures**
  - Placing one structure within another
  - Indent the nested structure’s statements
- **Block**
  - A group of statements that execute as a single unit

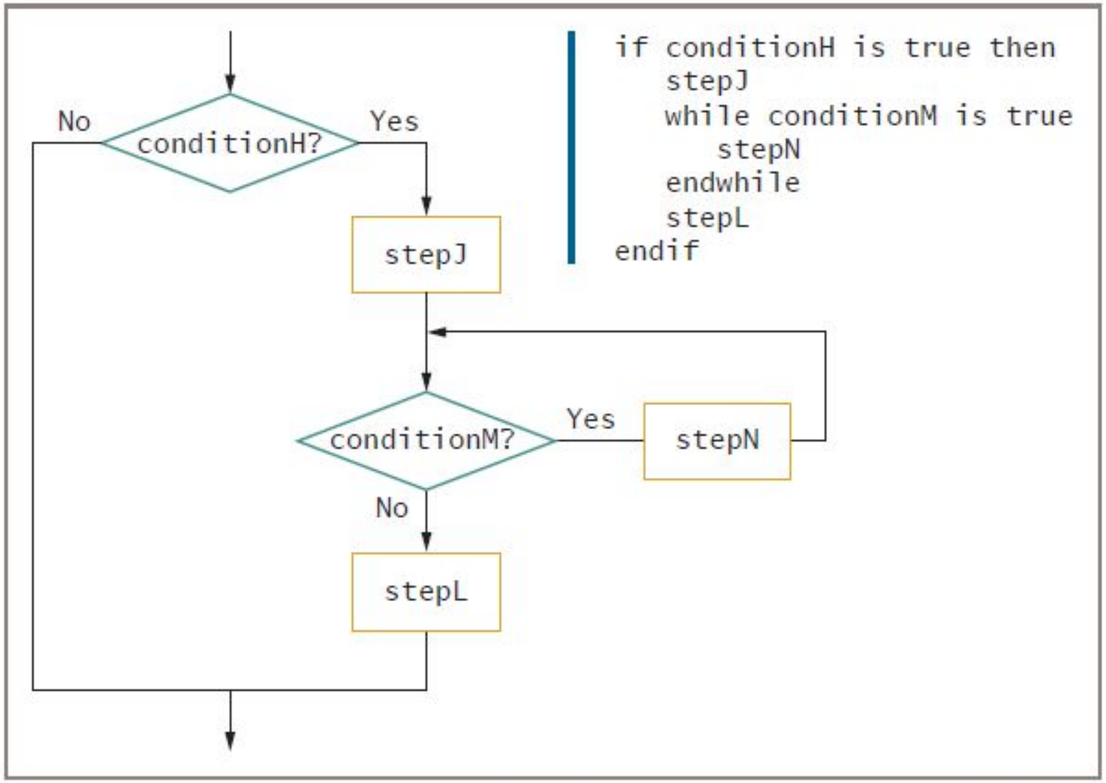
Understanding the Three Basic Structures (continued)



```
if conditionH is true then
   stepJ
   stepK
   stepL
endif
```

Figure 3-7 Flowchart and pseudocode showing nested structures—a sequence nested within a selection

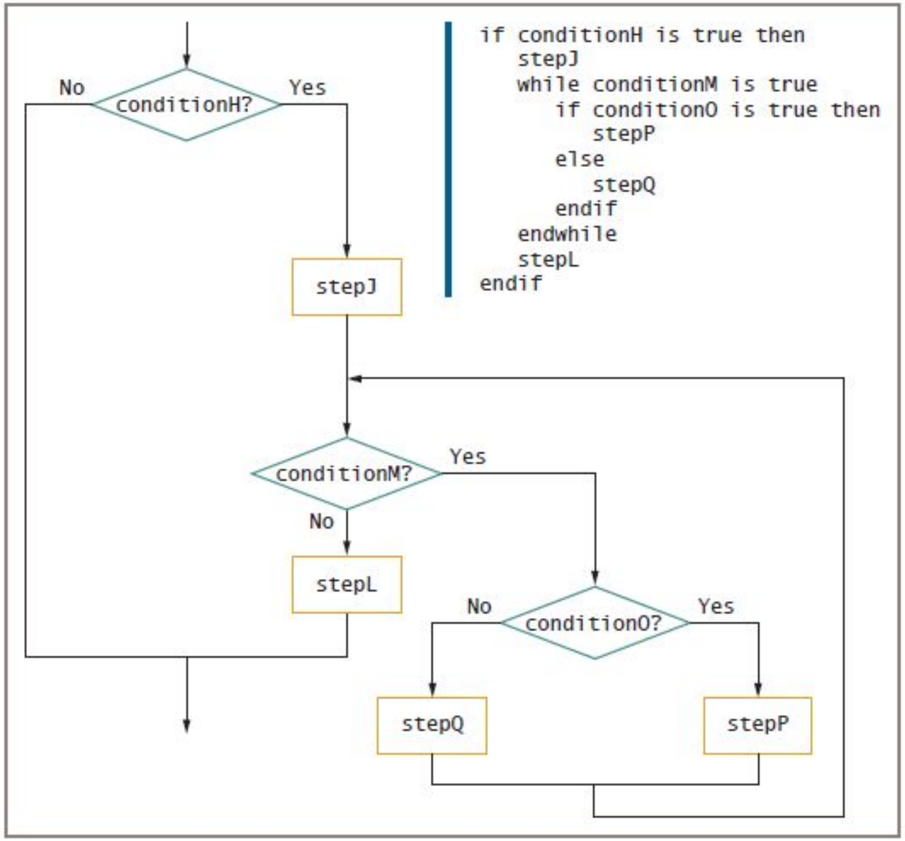
Understanding the Three Basic Structures (continued)



```
if conditionH is true then
   stepJ
   while conditionM is true
      stepN
   endwhile
   stepL
endif
```

Figure 3-8 Flowchart and pseudocode showing nested structures—a loop nested within a sequence, nested within a selection

Understanding the Three Basic Structures (continued)



```
if conditionH is true then
   stepJ
   while conditionM is true
      if conditionO is true then
         stepP
      else
         stepQ
      endif
   endwhile
   stepL
endif
```

Figure 3-9 Flowchart and pseudocode for a selection within a loop within a sequence within a selection

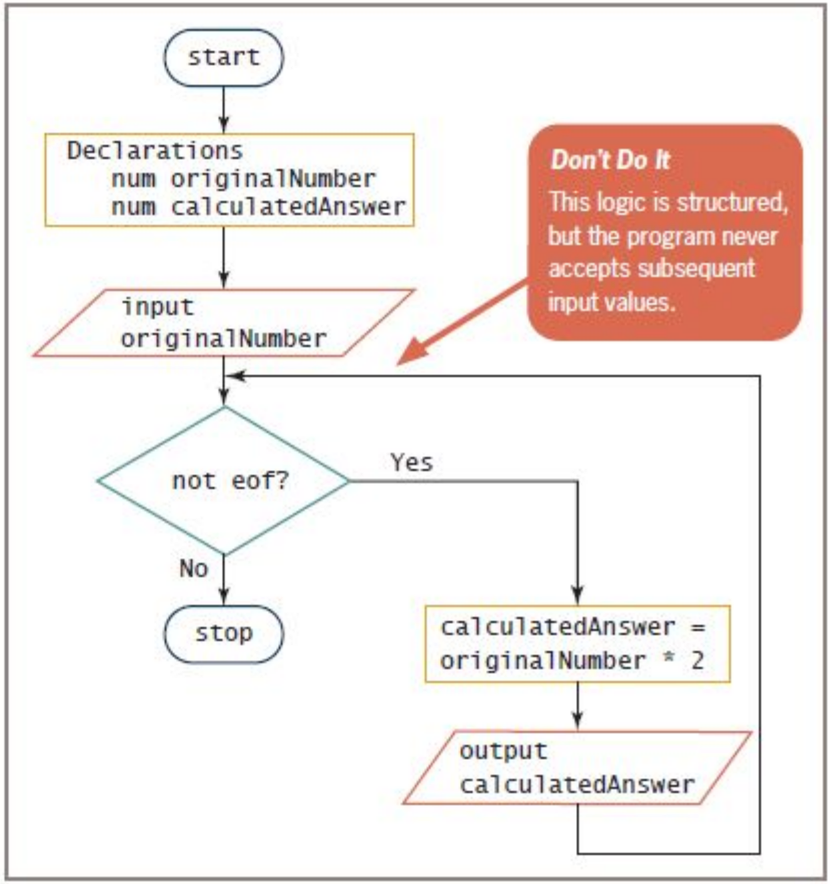
Understanding the Three Basic Structures (continued)

- Structured programs have the following characteristics:
  - Include only combinations of the three basic structures
  - Each structure has a single entry point and a single exit point
  - Structures can be stacked or connected to one another only at their entry or exit points
  - Any structure can be nested within another structure

Using a Priming Input to Structure a Program

- **Priming input** (or **priming read**)
  - Reads the first input data record
  - Is outside the loop that reads the rest of the records
  - Helps keep the program structured
- Analyze a flowchart for structure one step at a time
- Watch for unstructured loops that do not follow this order
  - First ask a question
  - Take action based on the answer
  - Return to ask the question again

Using a Priming Input to Structure a Program (continued)



Don't Do It
This logic is structured, but the program never accepts subsequent input values.

Figure 3-15 Structured, but nonfunctional, flowchart of number-doubling problem

Using a Priming Input to Structure a Program (continued)

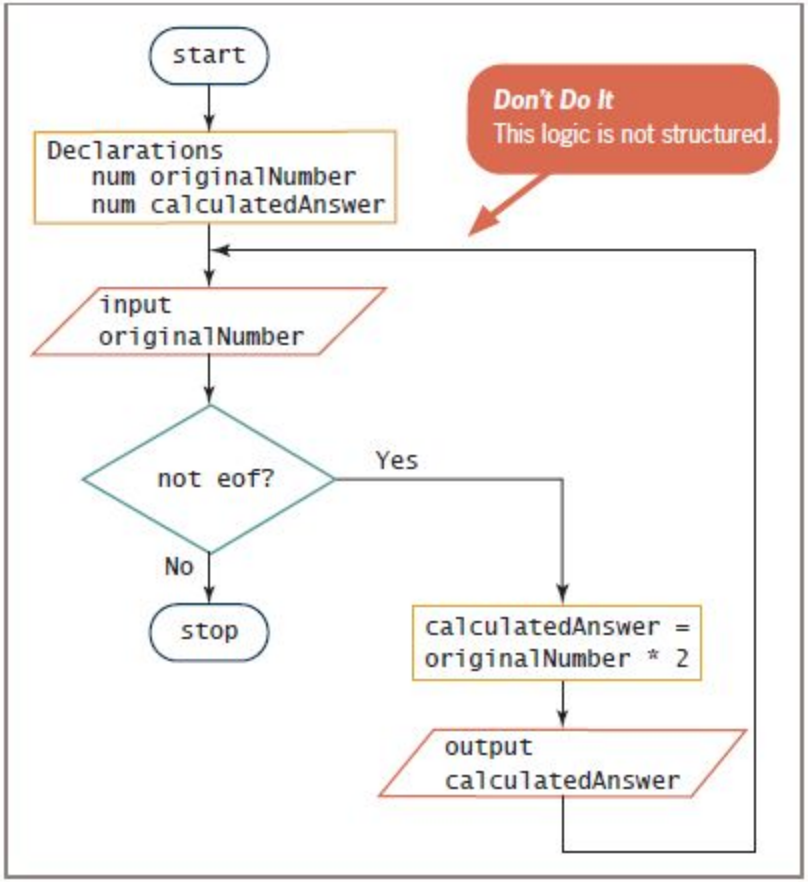


Figure 3-16 Functional but unstructured flowchart

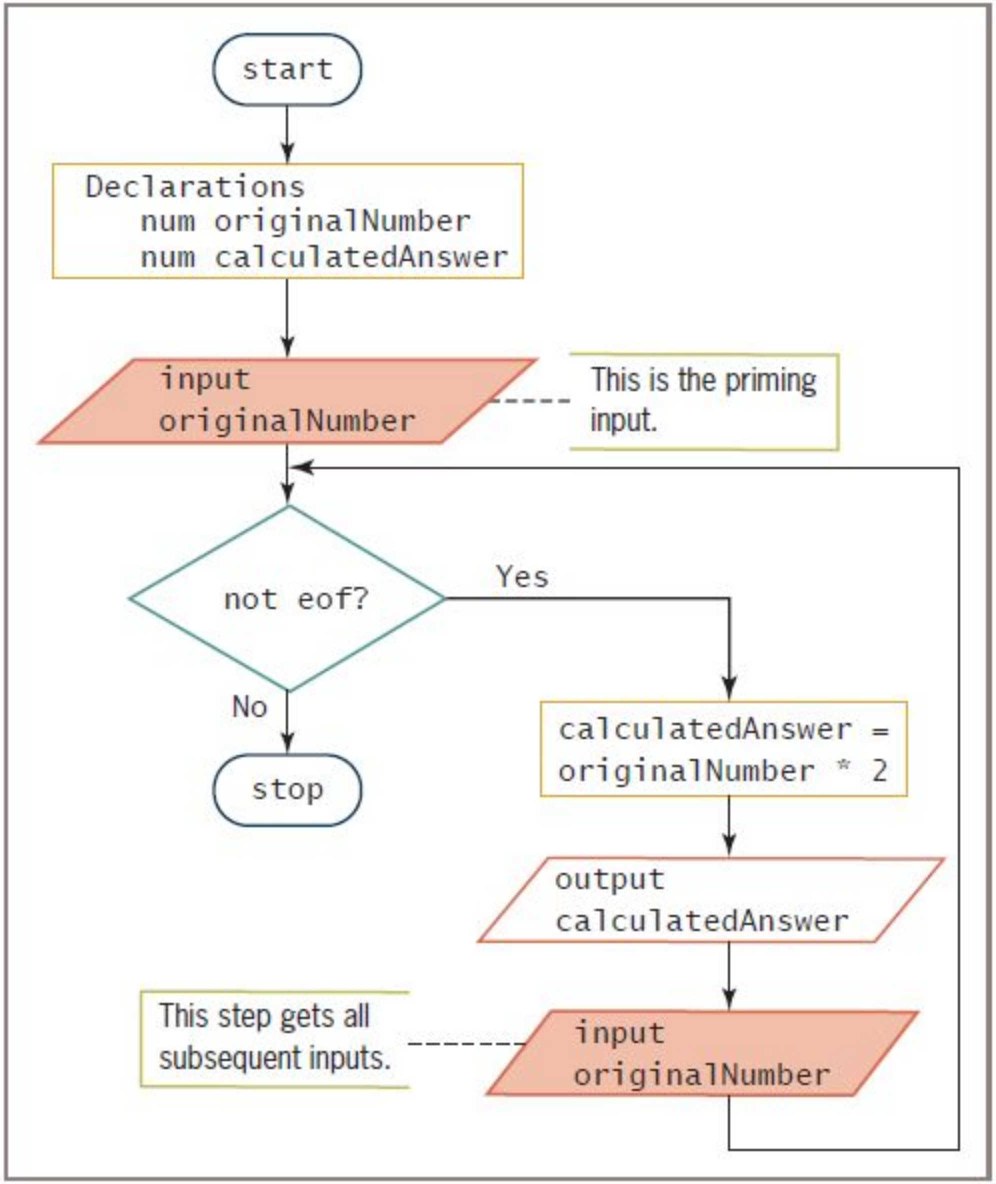
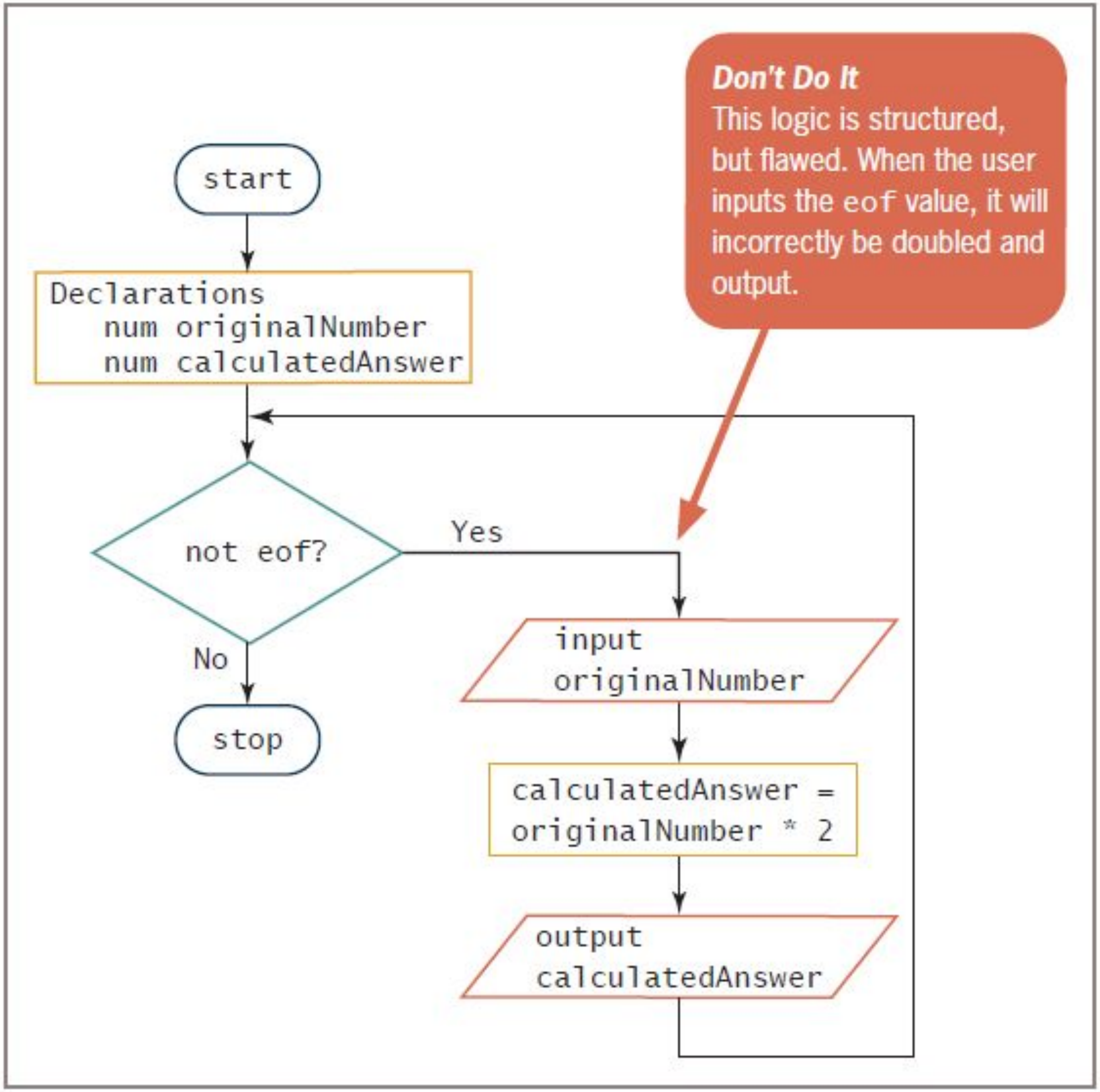


Figure 3-17 Functional, structured flowchart for the number-doubling problem



Don't Do It
This logic is structured, but flawed. When the user inputs the eof value, it will incorrectly be doubled and output.

Figure 3-18 Structured but incorrect solution to the number-doubling problem

Understanding the Reasons for Structure

- *Clarity*—unstructured programs are confusing
- *Professionalism*—other programmers expect it
- *Efficiency*—most languages support it
- *Ease of maintenance*—other programmers find it easier to read
- *Supports modularity*—easily broken down into modules
- It can be difficult to detect whether a flowchart is structured

Recognizing Structure

A Structured Flowchart

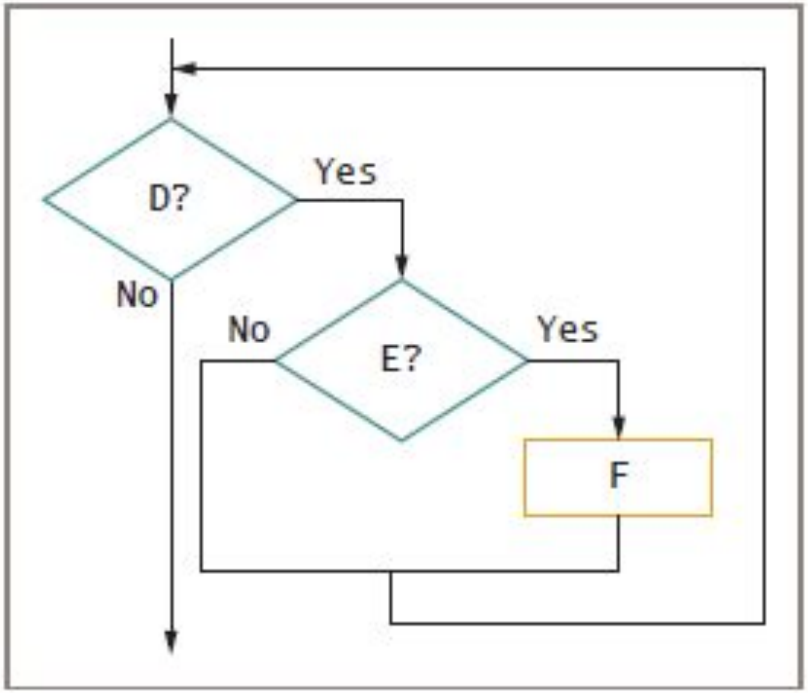


Figure 3-20 Example 2

Recognizing Structure (continued)

An Unstructured Flowchart

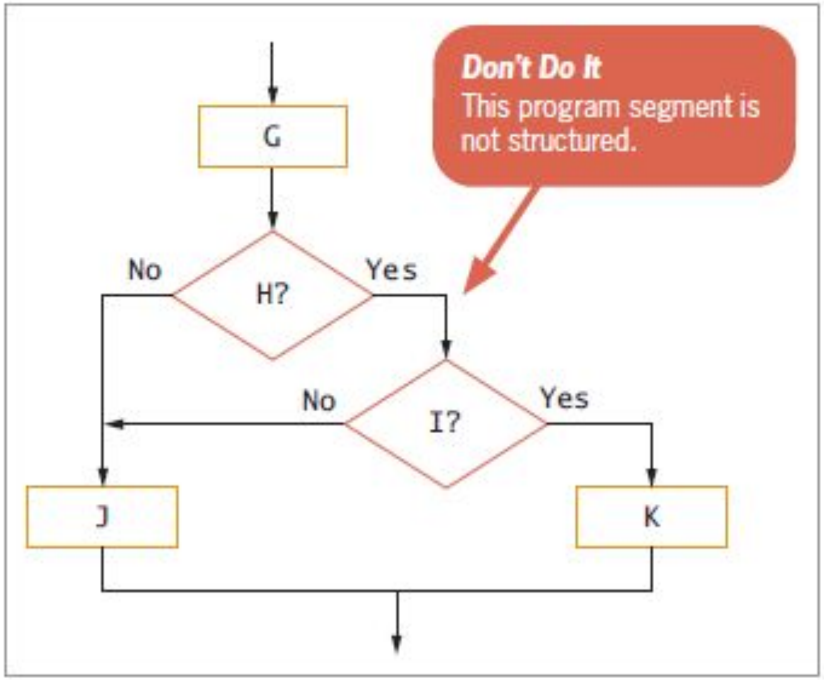
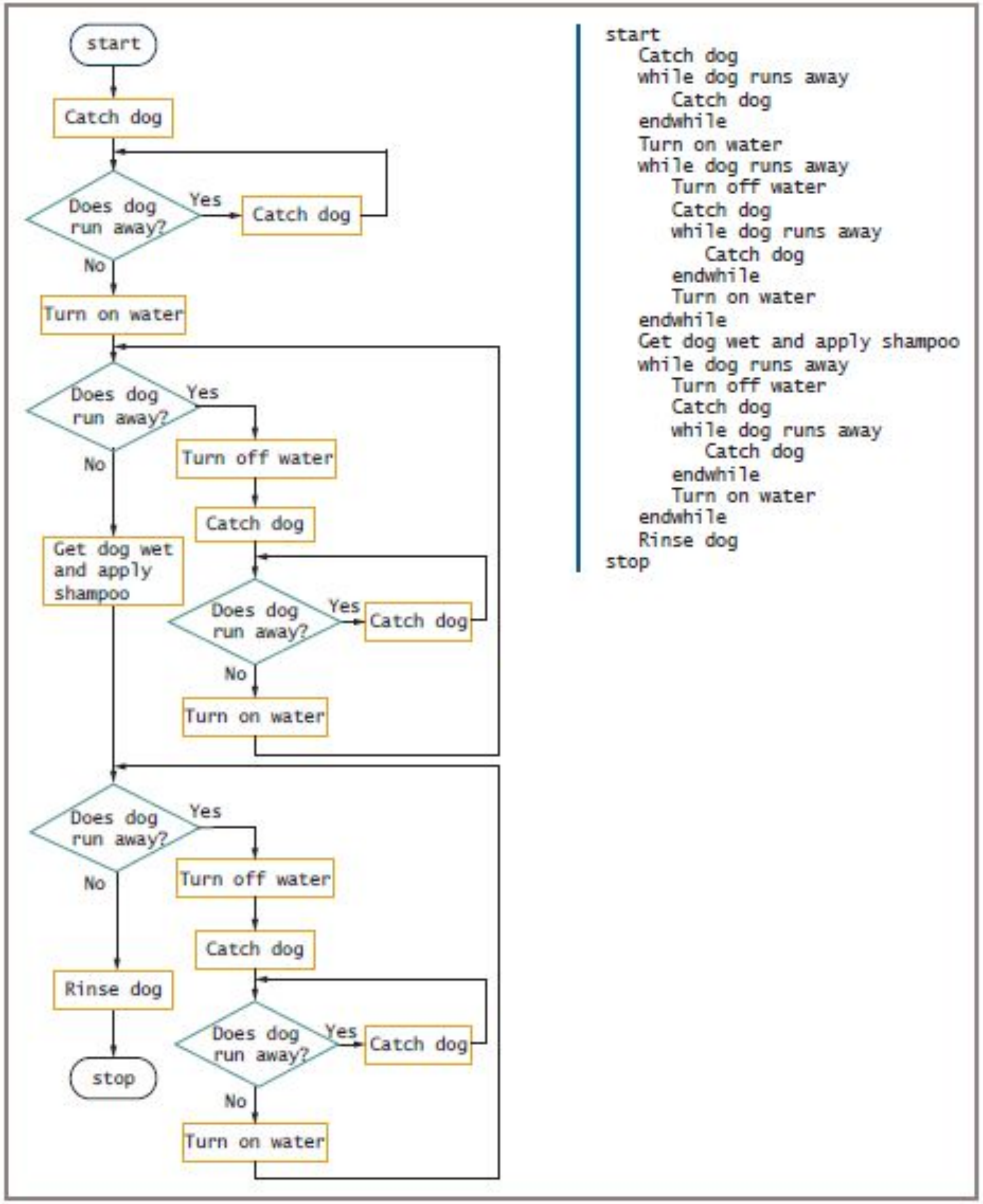
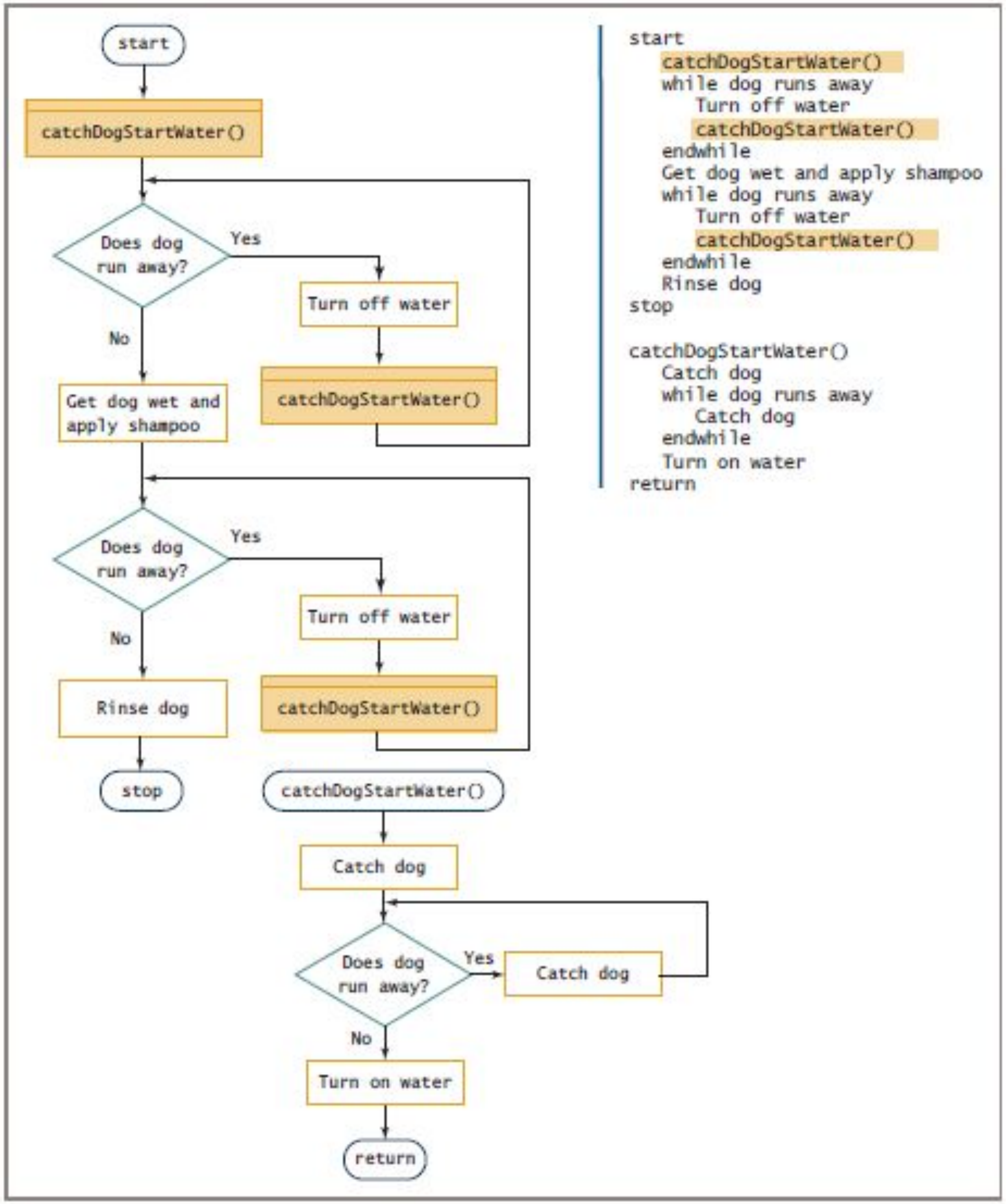


Figure 3-21 Example 3



```
start
    Catch dog
    while dog runs away
        Catch dog
    endwhile
    Turn on water
    while dog runs away
        Turn off water
        Catch dog
        while dog runs away
            Catch dog
        endwhile
        Turn on water
    endwhile
    Get dog wet and apply shampoo
    while dog runs away
        Turn off water
        Catch dog
        while dog runs away
            Catch dog
        endwhile
        Turn on water
    endwhile
    Rinse dog
stop
```

Figure 3-23 Structured dog-washing flowchart and pseudocode



```
start
    catchDogStartWater()
    while dog runs away
        Turn off water
        catchDogStartWater()
    endwhile
    Get dog wet and apply shampoo
    while dog runs away
        Turn off water
        catchDogStartWater()
    endwhile
    Rinse dog
stop

catchDogStartWater()
    Catch dog
    while dog runs away
        Catch dog
    endwhile
    Turn on water
return
```

Figure 3-24 Modularized version of the dog-washing program

Summary

- Spaghetti code
  - Statements that do not follow rules of structured logic
- Three basic structures
  - Sequence, selection, and loop
  - Combined by stacking and nesting
- Priming input
  - Statement that reads the first input value prior to starting a structured loop

Summary (continued)

- Structured techniques promote:
  - Clarity
  - Professionalism
  - Efficiency
  - Modularity
- Flowcharts can be made structured by untangling
- Logical steps can be rewritten to conform to the three structures