Programming Logic and Design

Chapter 3

Understanding Structure

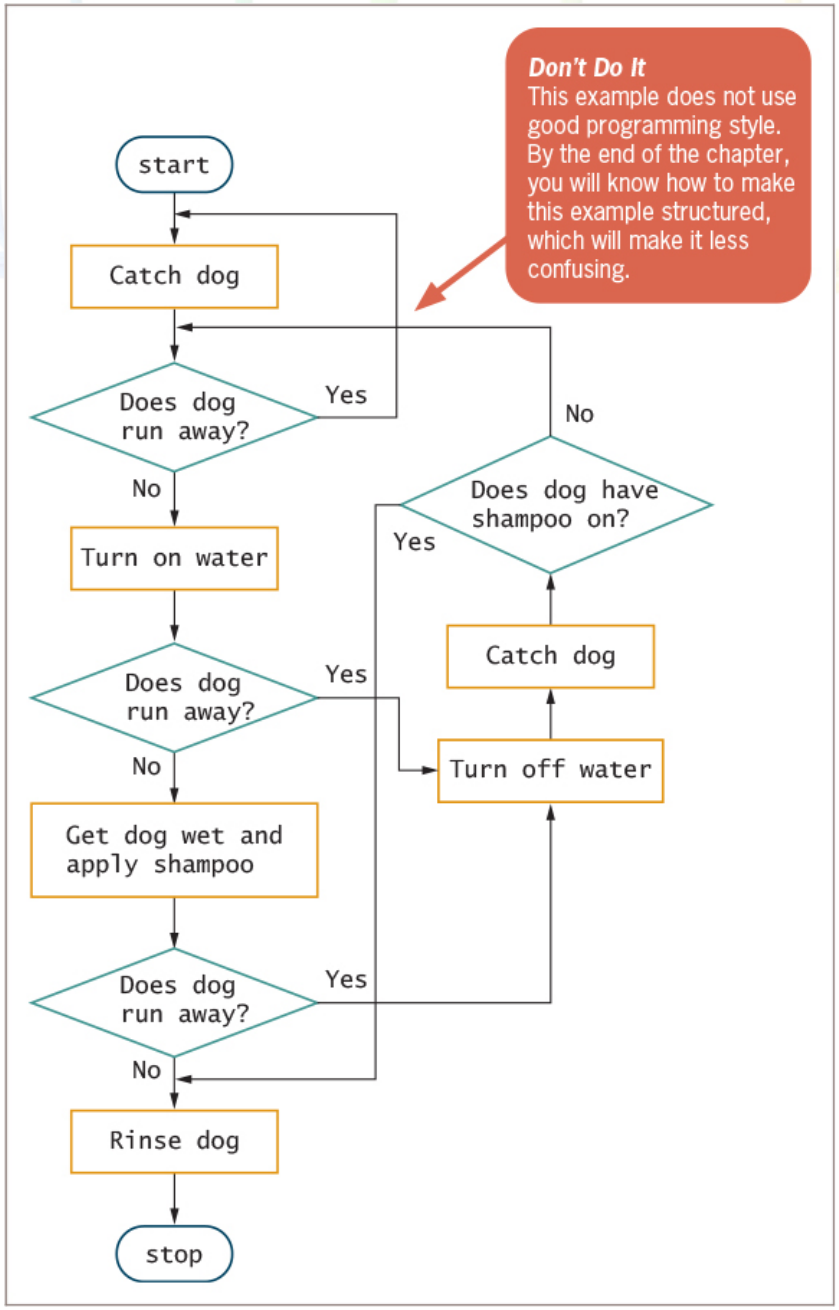
Objectives

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

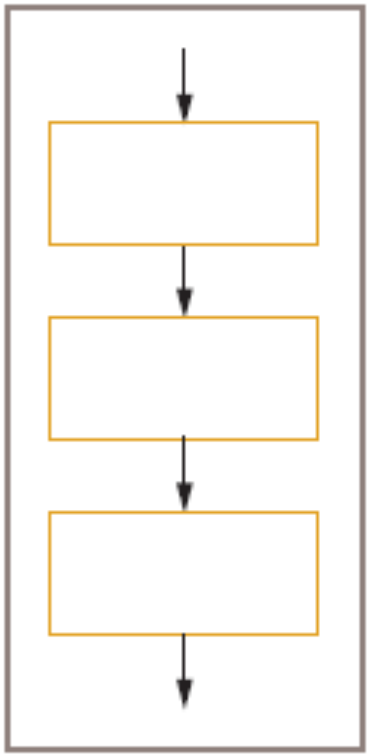


Spaghetti code logic for washing a dog

Understanding the Three Basic Structures

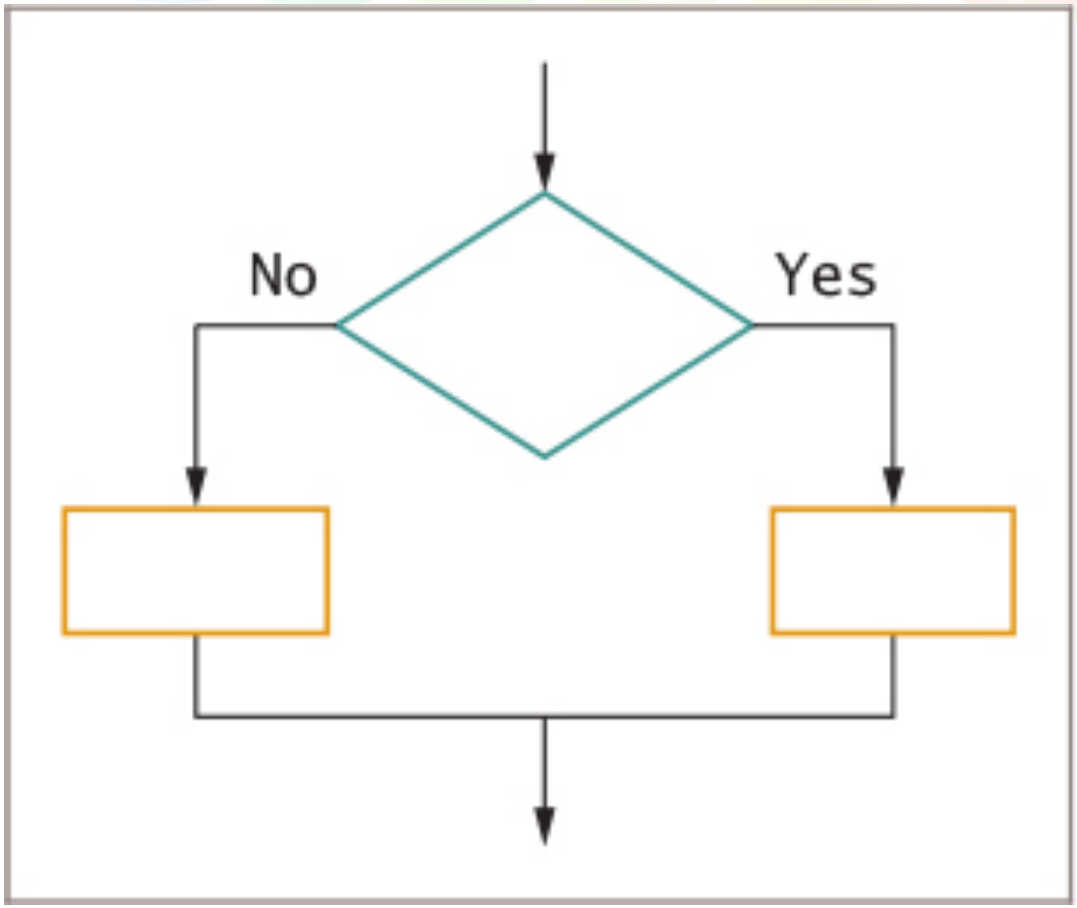
- **Structure**
  - Basic unit of programming logic
  - **Sequence structure**
    - Perform actions or tasks in order
    - No branching or skipping any task
  - **Selection structure** (**decision structure**)
    - Ask a question, take one of two actions
    - Often called **if-then-else**
    - **Dual-alternative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

Understanding the Three Basic Structures (continued)



Sequence structure

Understanding the Three Basic Structures (continued)



Selection structure

Understanding the Three Basic Structures (continued)

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

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

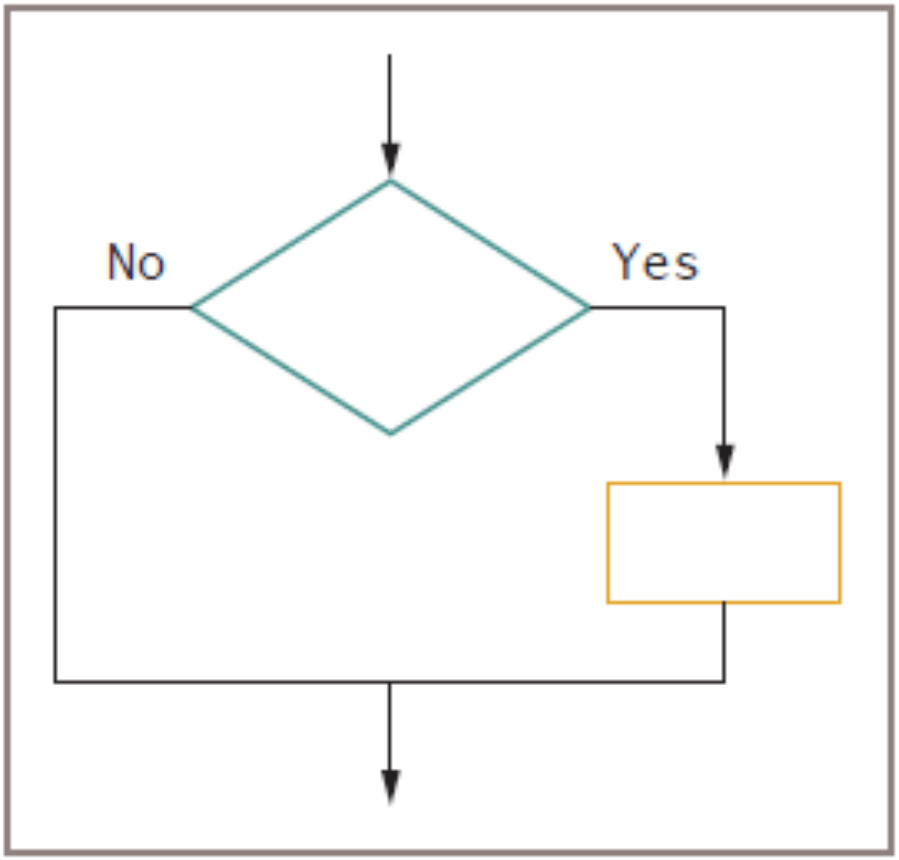
Understanding the Three Basic Structures (continued)

- **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)

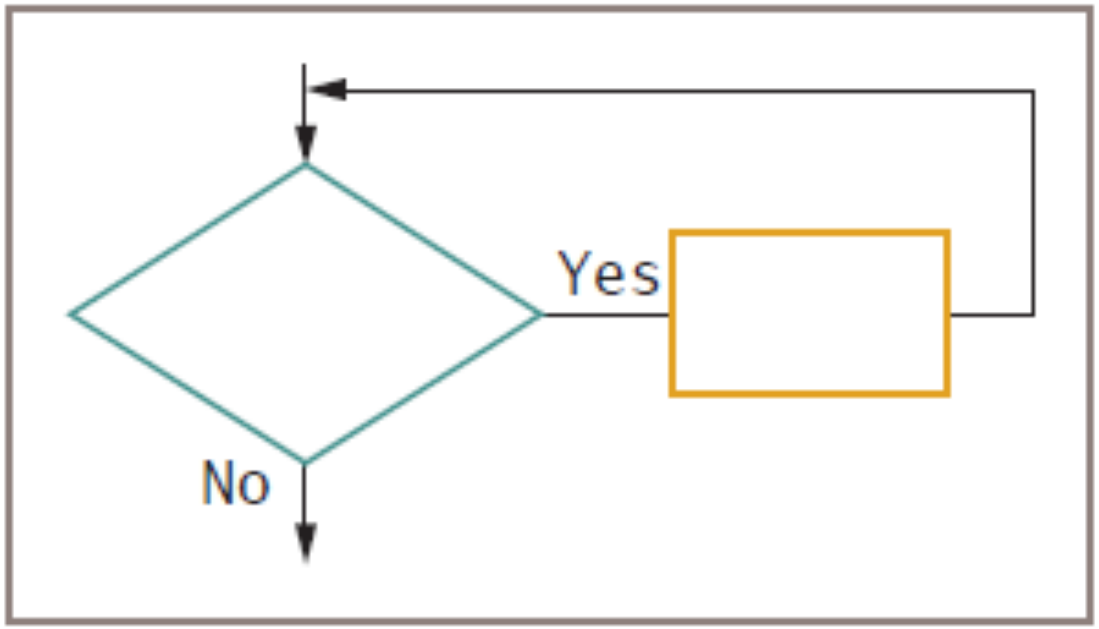


Single-alternative selection structure

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)



Loop structure

Understanding the Three Basic Structures (continued)

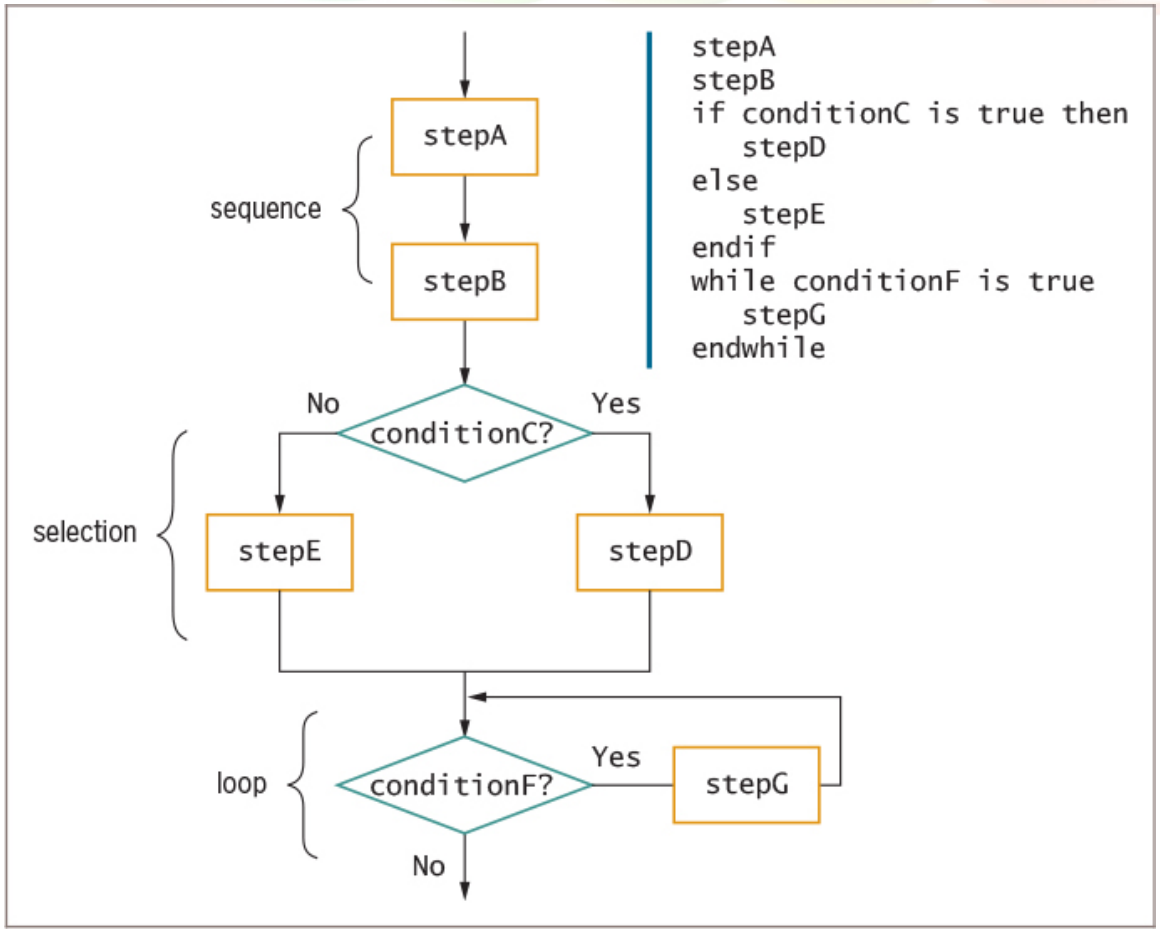
- **Loop structure**

```
while testCondition continues to be true
      do someProcess
endwhile
while you continue to be hungry
      take another bite of food
      determine if you still feel hungry
endwhile
```

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)

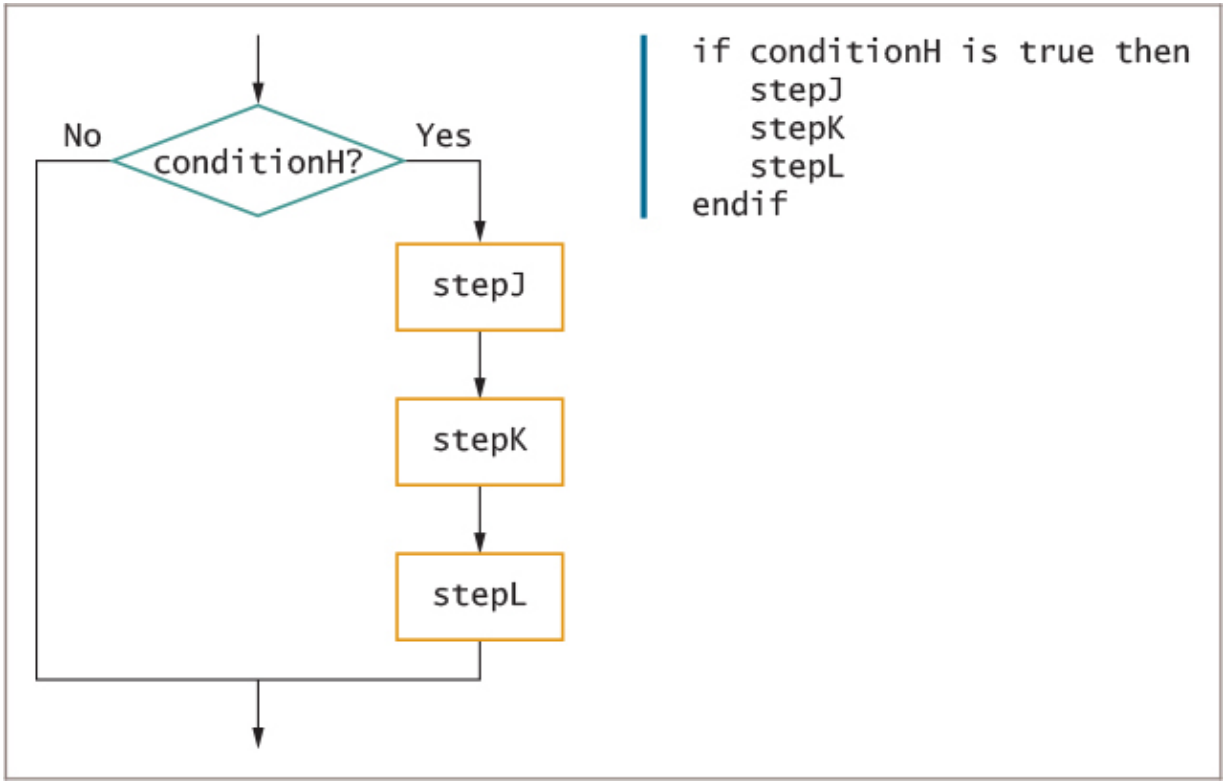


Structured flowchart and pseudocode with three stacked structures

Understanding the Three Basic Structures (continued)

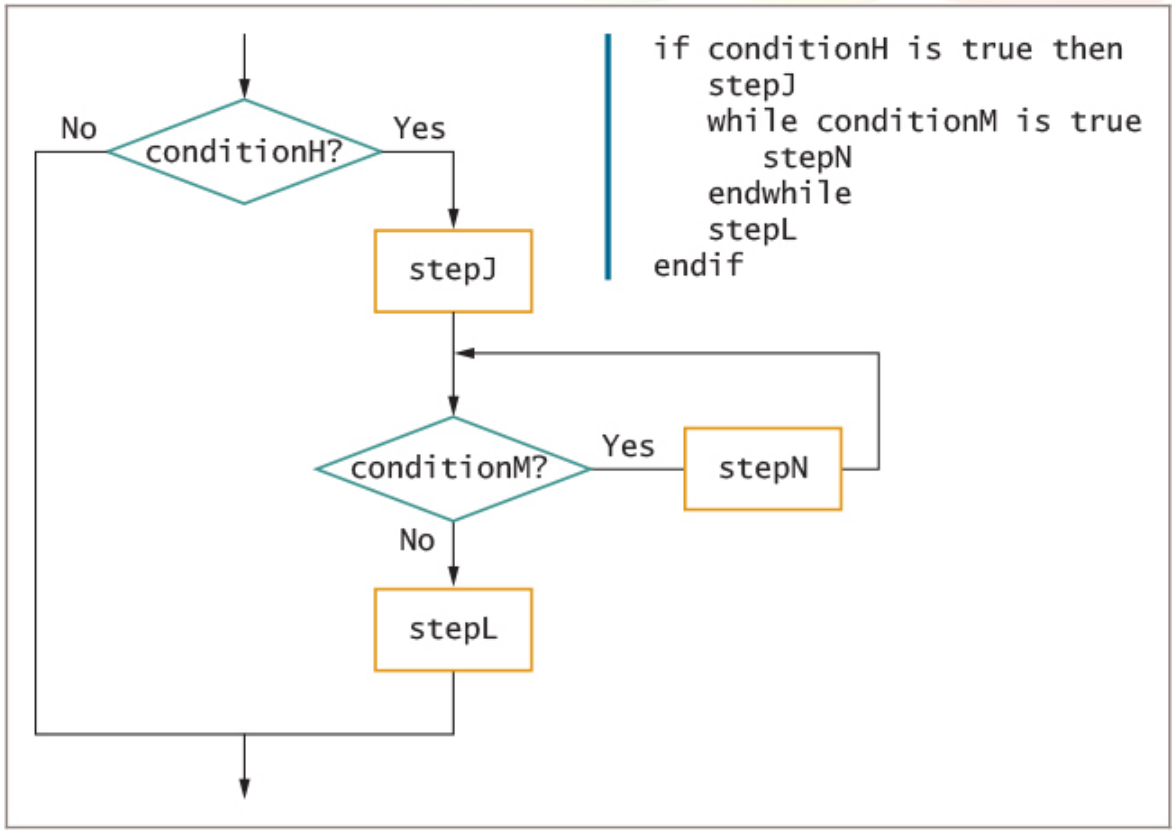
- Any individual task or step in a structure can be replaced by a structure
- **Nesting structures**
  - Placing one structure within another
  - Indent the nested structure's statements
- **Block**
  - A group of statements that execute as a single unit

Understanding the Three Basic Structures (continued)



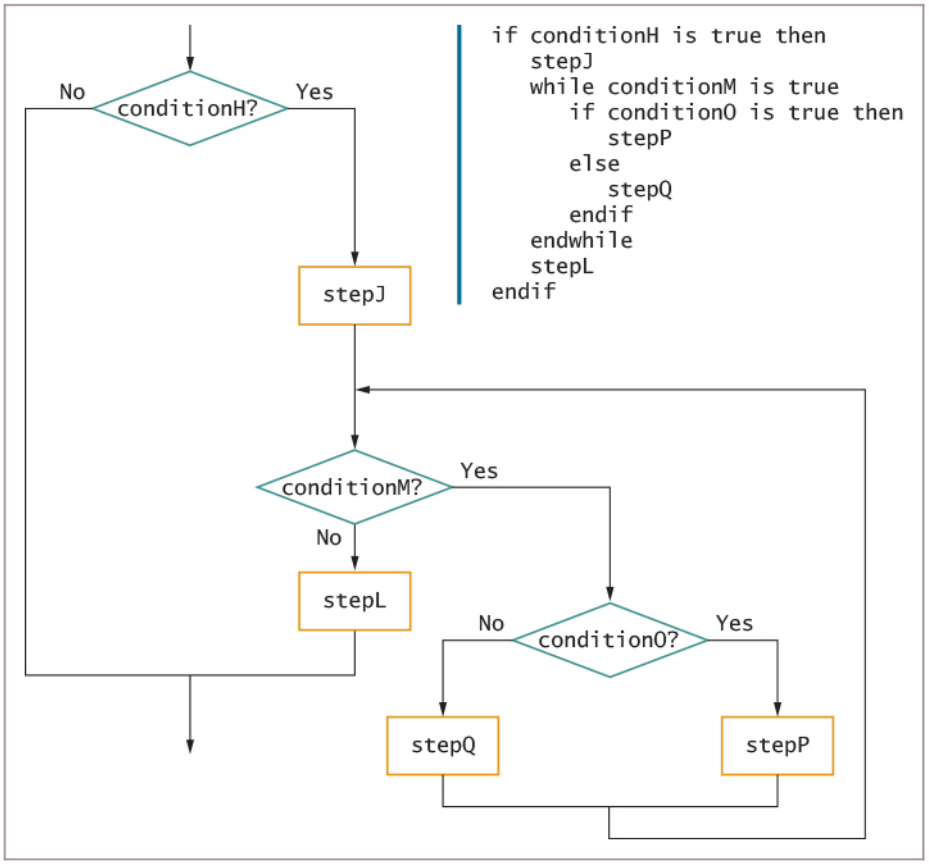
Flowchart and pseudocode showing nested structures—a sequence nested within a selection

Understanding the Three Basic Structures (continued)



Flowchart and pseudocode showing nested structures—a loop nested within a sequence, nested within a selection

Understanding the Three Basic Structures (continued)



Flowchart and pseudocode for a selection within a loop within a sequence within a selection

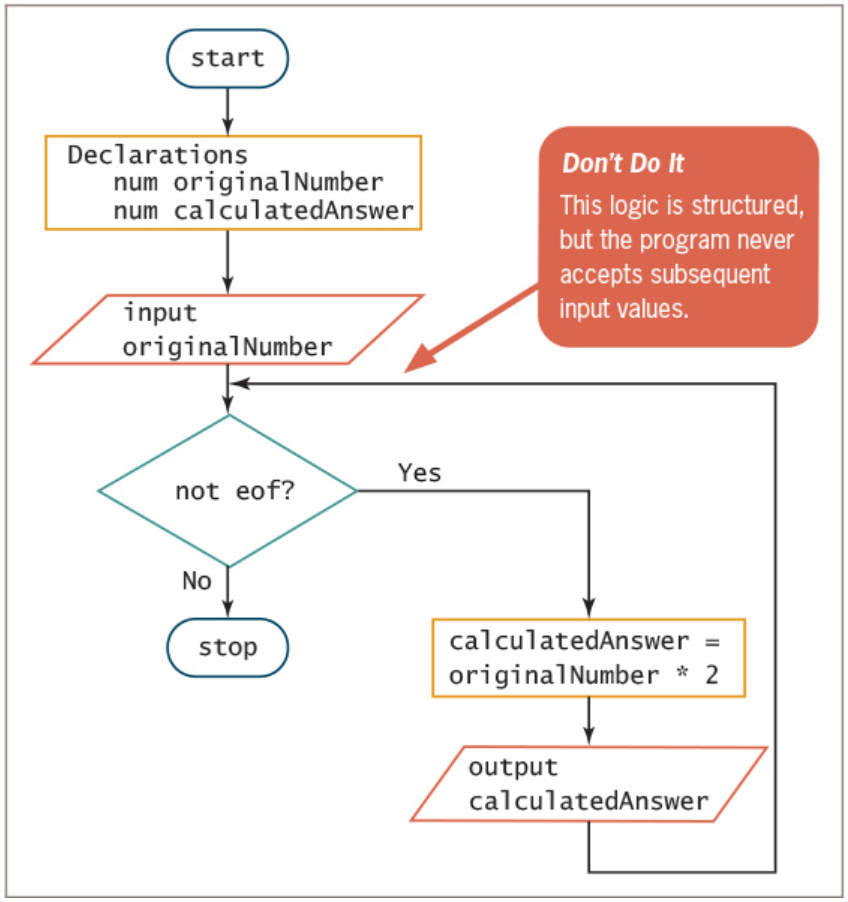
Understanding the Three Basic Structures (continued)

- 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

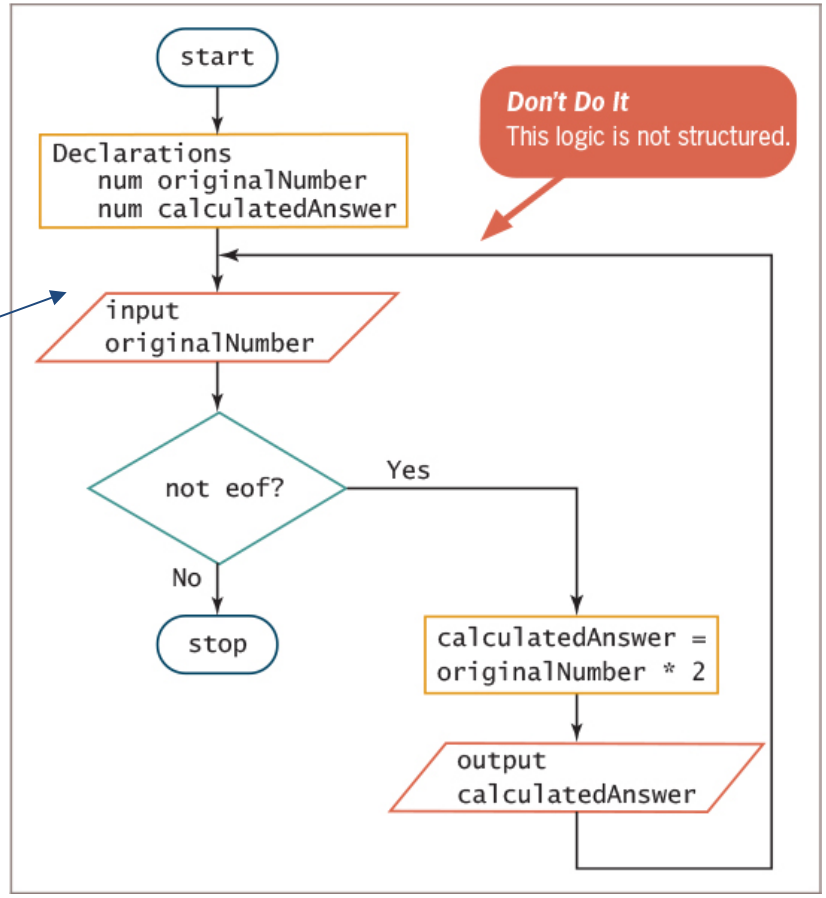
- **Priming input** (or **priming read**)
  - Reads the first input data record
  - Is outside the loop that reads the rest of the records
  - Helps keep the program structured
- Analyze a flowchart for structure one step at a time
- Watch for unstructured loops that do not follow this order
  - First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

Using a Priming Input to Structure a Program (continued)



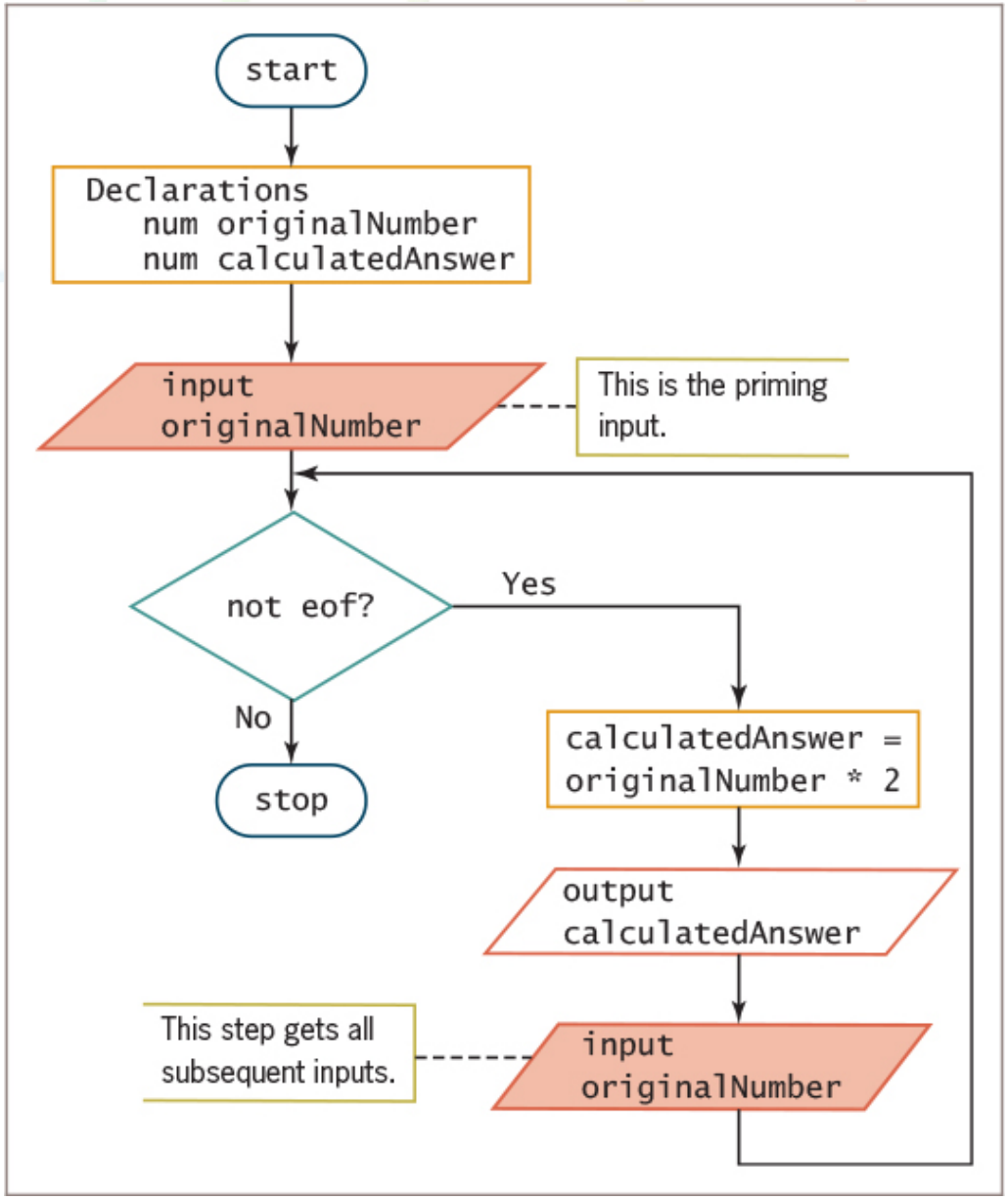
Structured, but nonfunctional, flowchart of number-doubling problem

Using a Priming Input to Structure a Program (continued)

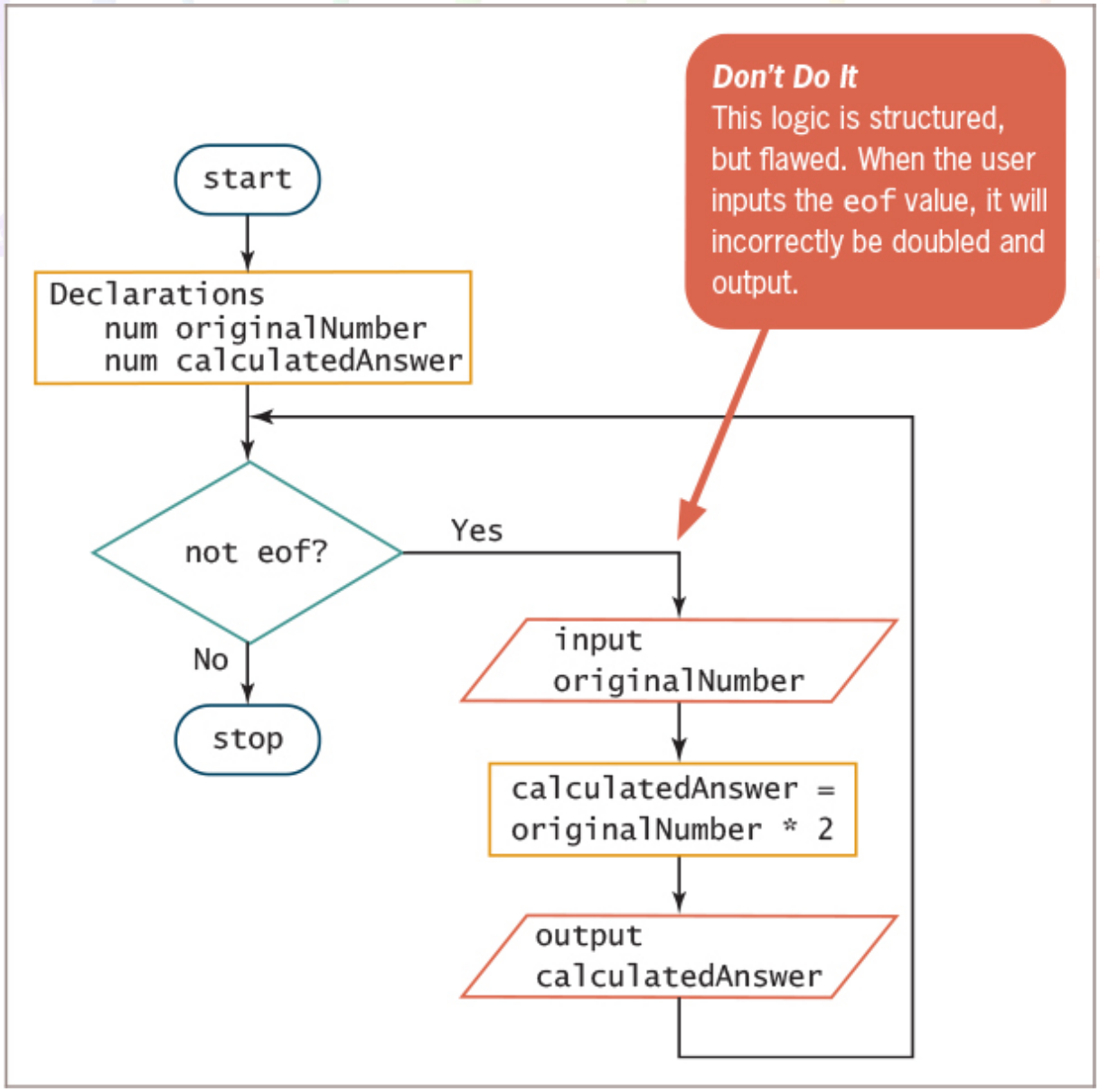


Your loop cannot include the sequence item of inputting the original number. It must return to the loop question, the start of the loop.

Functional but unstructured flowchart



Functional, structured flowchart for the number-doubling problem



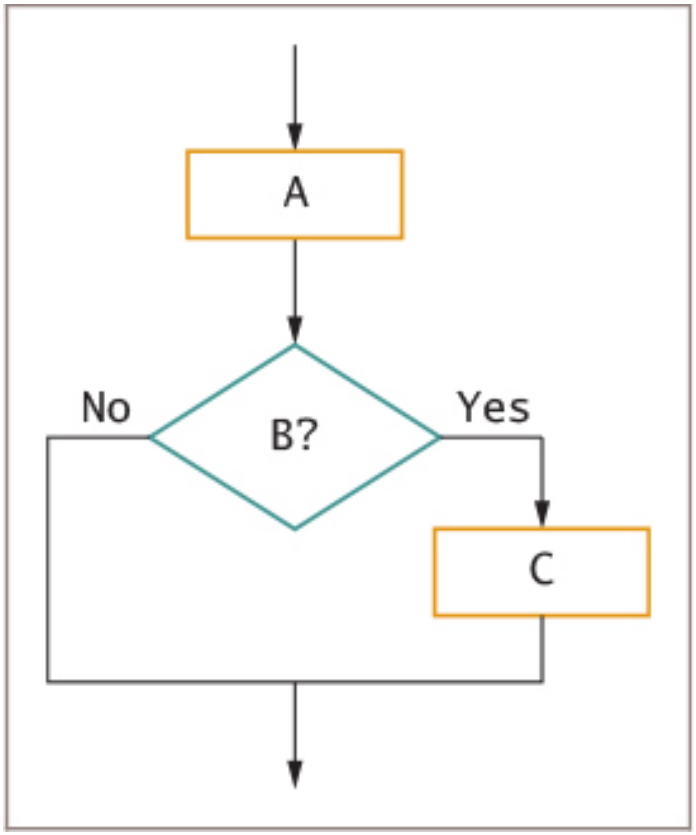
Structured but incorrect solution to the number-doubling problem

Understanding the Reasons for Structure

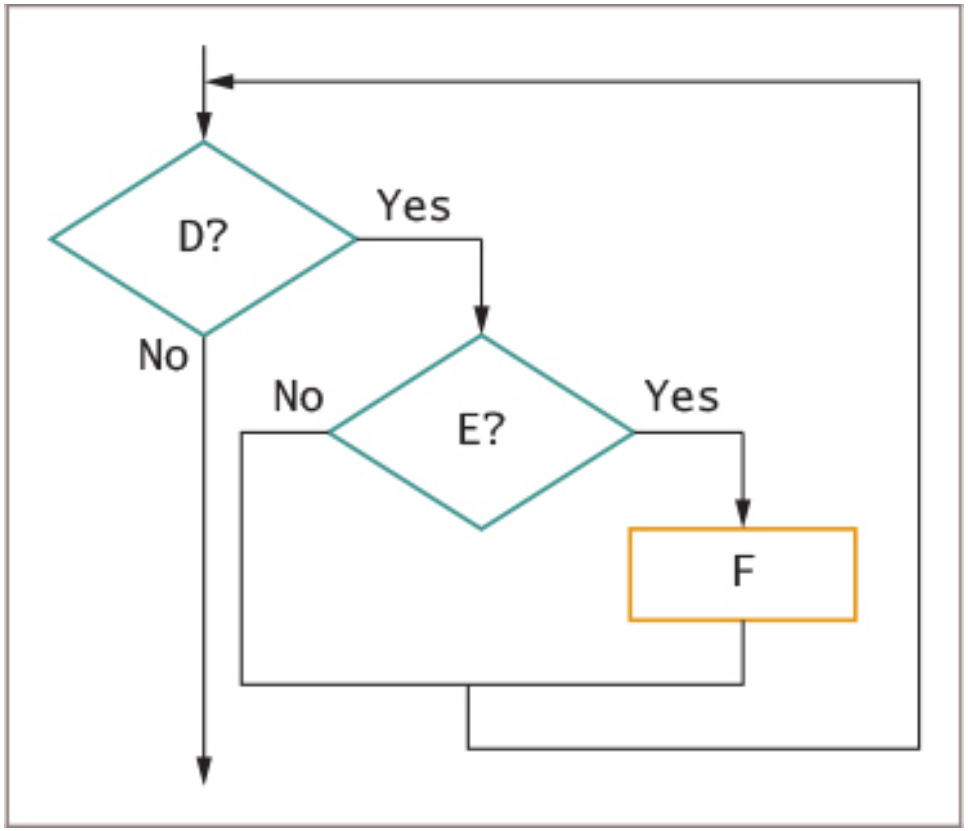
- ***Clarity***—unstructured programs are confusing
- ***Professionalism***—other programmers expect it
- ***Efficiency***—most languages support it
- ***Maintenance*** —other programmers find it easier to read
- ***Modularity*** —easily broken down into modules

Recognizing Structure

Structured Flowcharts?



Example 1



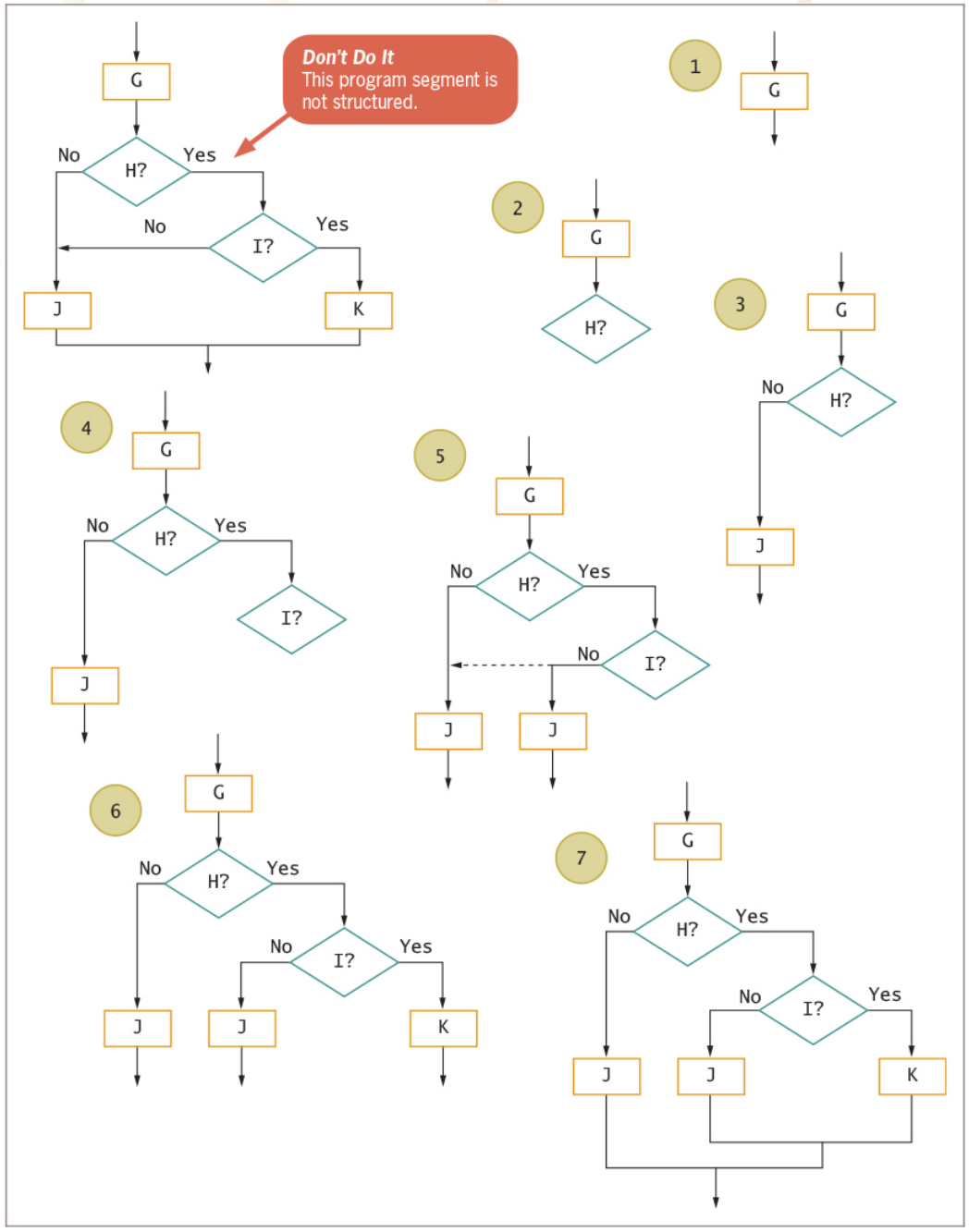
Example 2

Yes, they are both structured.

Recognizing Structure (continued)

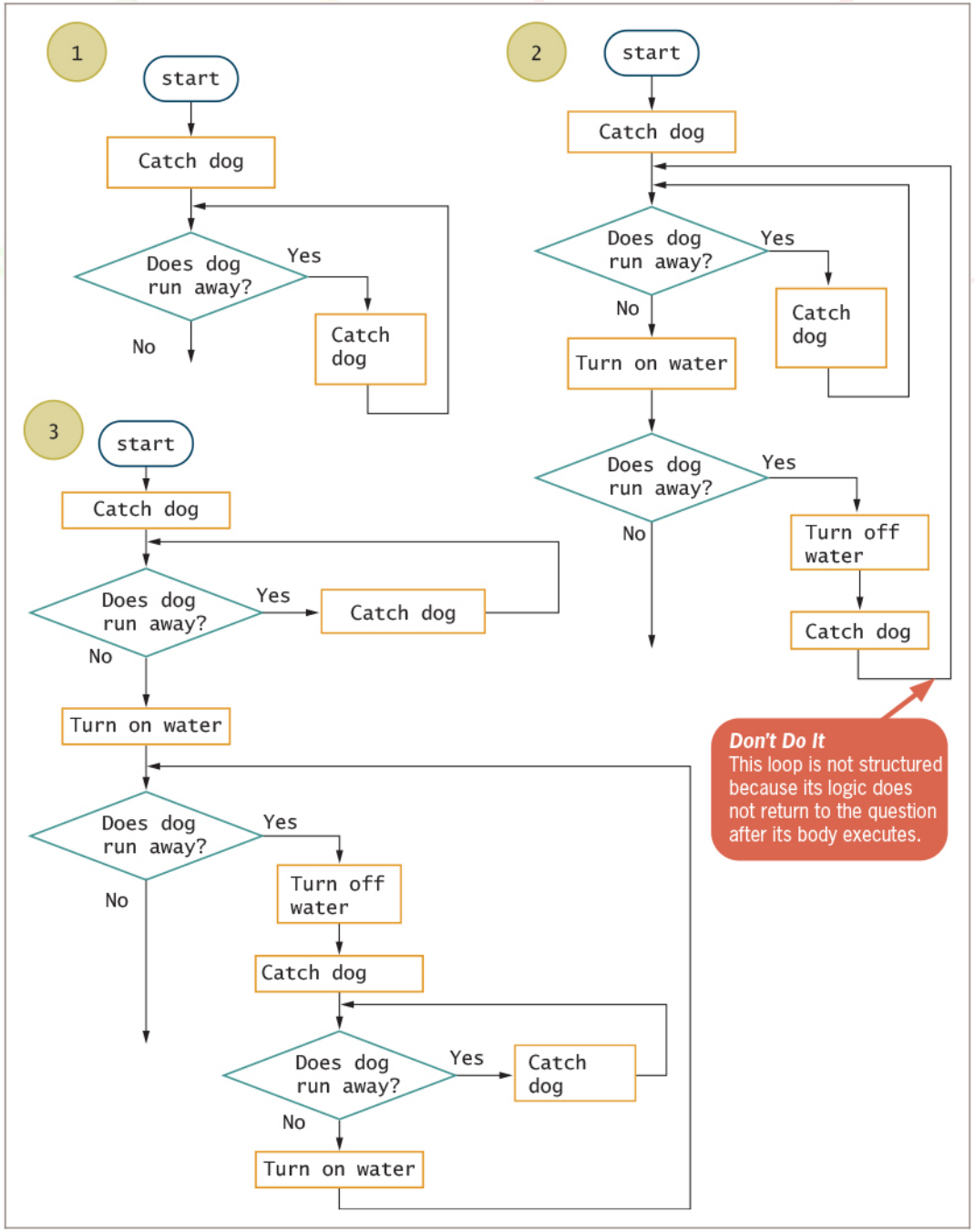
An Unstructured Flowchart

The flowchart is formed in a structured manner by following the numbered steps 1 – 7.



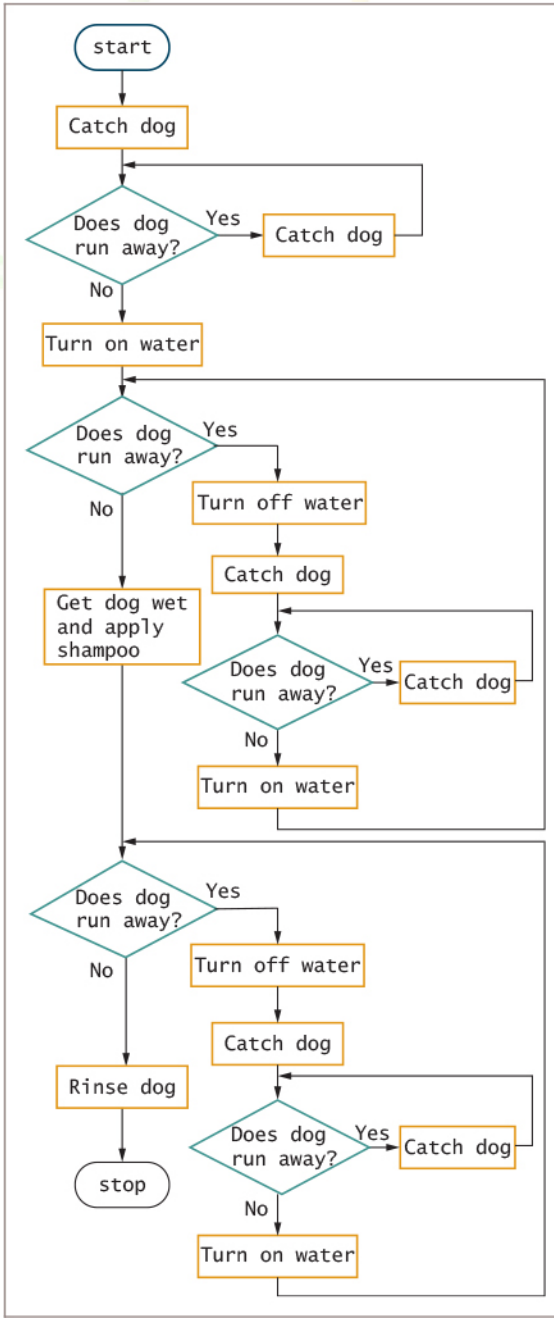
Example 3

Recognizing Structure (continued)



Steps to structure the dog-washing process

Recognizing Structure (continued)




```
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
```

Structured dog-washing flowchart and pseudocode

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