Chapter 2:
Understanding Structure

Programming Logic and Design, 4th Edition Introductory

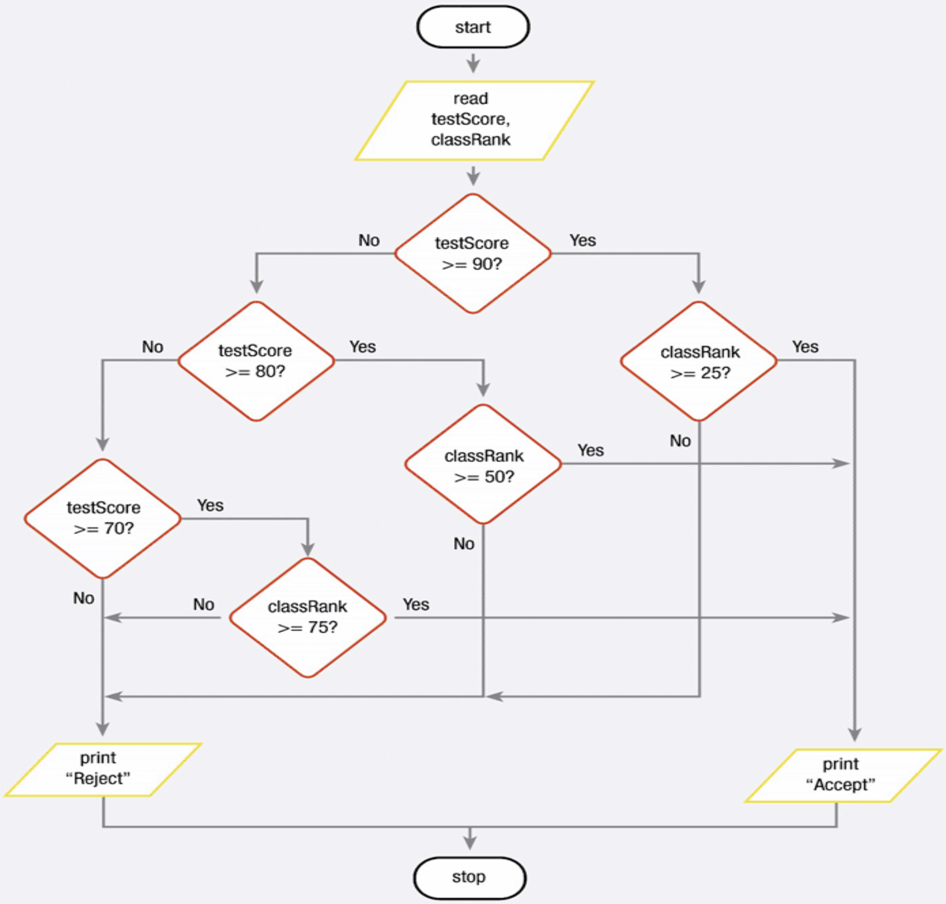
Objectives

- After studying Chapter 2, you should be able to:
- Describe the features of unstructured spaghetti code
- Describe the three basic structures of sequence, selection, and loop
- Use a priming read
- Appreciate the need for structure
- Recognize structure
- Describe two special structures—case and do until

Understanding Unstructured Spaghetti Code

- **The popular name for snarled program statements is spaghetti code**
- **The reason for the name should be obvious—the code is as confusing to read as following one noodle through a plate of spaghetti**

FIGURE 2-2: SPAGHETTI CODE EXAMPLE



Understanding the Three Basic Structures

- A **structure** is a basic unit of programming logic; each structure is a sequence, selection, or loop
- The first of these structures is a sequence, as shown in Figure 2-3
- With a **sequence structure**, you perform an action or event, and then you perform the next action, in order

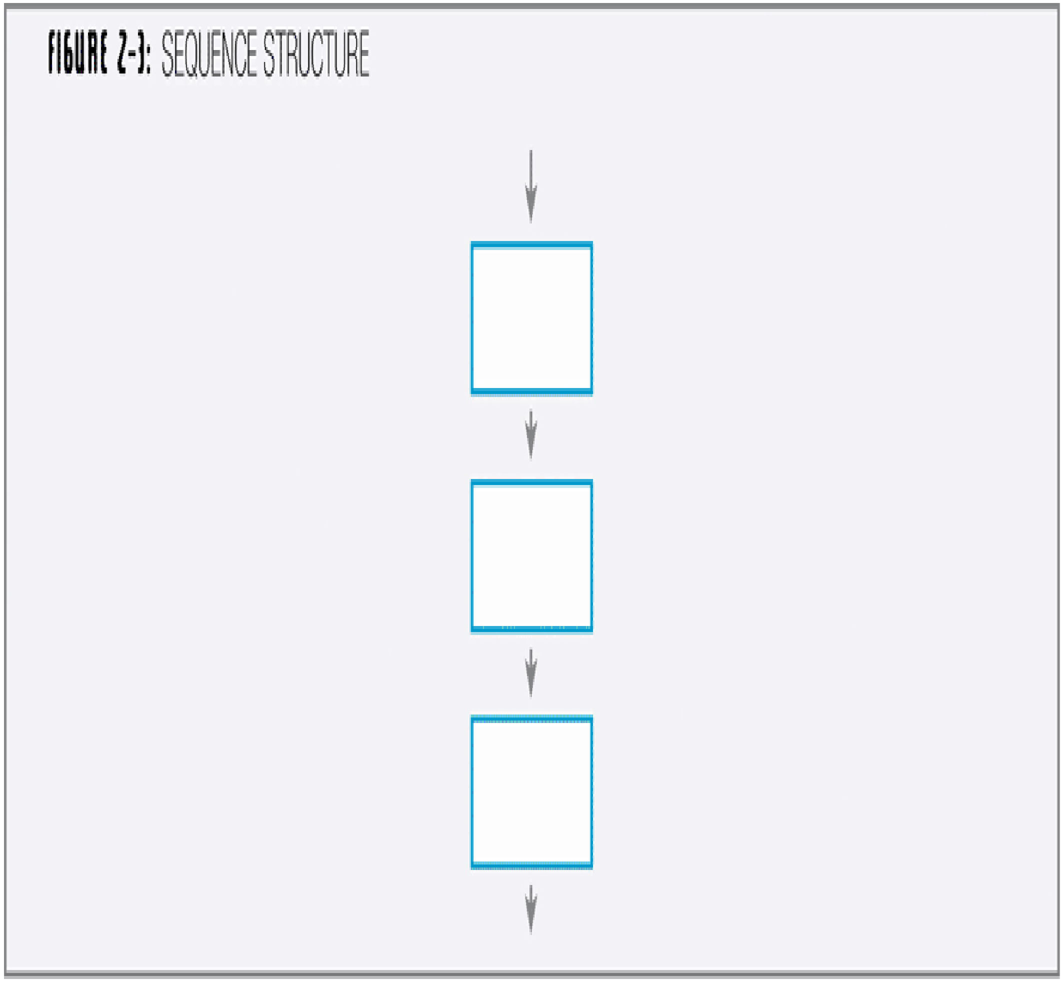


FIGURE 2-3: SEQUENCE STRUCTURE

Understanding the Three Basic Structures (continued)

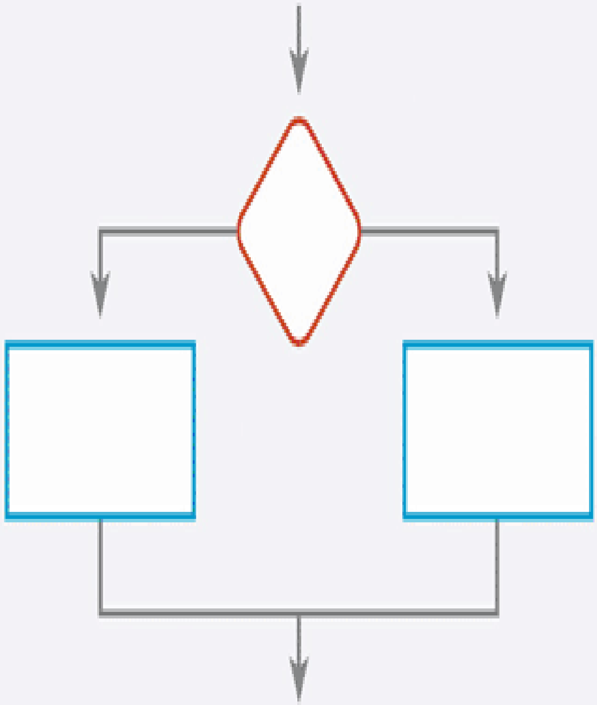
- The second structure is called a selection structure or decision structure (if-then-else)
  - You ask a question
  - depending on the answer,
    - you take one of two courses of action
- no matter which path you follow, you continue with the next event

Understanding the Three Basic Structures (continued)

- selection structure or decision structure (else-if)
  - You ask a series of questions
  - Each question has a separate answer
- If none of the conditions are met, the last answer is chosen.

Understanding the Three Basic Structures (continued)

FIGURE 2-4: SELECTION STRUCTURE



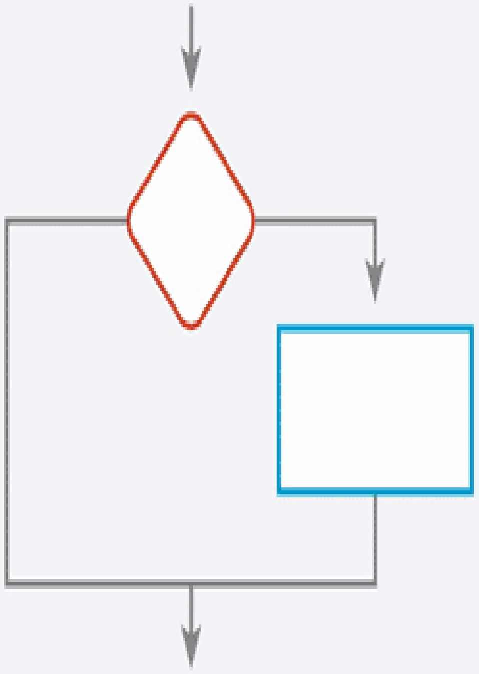
Understanding the Three Basic Structures (continued)

- **The selection structure is sometimes called an if-then-else because it fits the following statement:**

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

Understanding the Three Basic Structures (continued)

FIGURE 2-5: SINGLE-ALTERNATIVE DECISION STRUCTURE



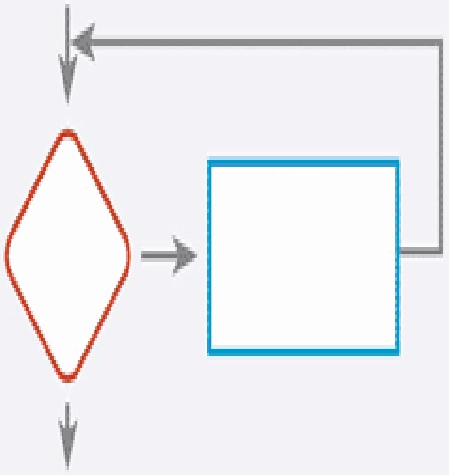
Understanding the Three Basic Structures (continued)

- In a loop structure, you ask a question; if the answer requires an action, you perform the action and ask the original question again
- If the answer requires that the action be taken again, you take the action and then ask the original question again
- Continues until the answer to the question is such that the action is no longer required; then you exit the structure

Understanding the Three Basic Structures (continued)

- You may hear programmers refer to looping as **repetition** or **iteration**

FIGURE 2-6: LOOP STRUCTURE

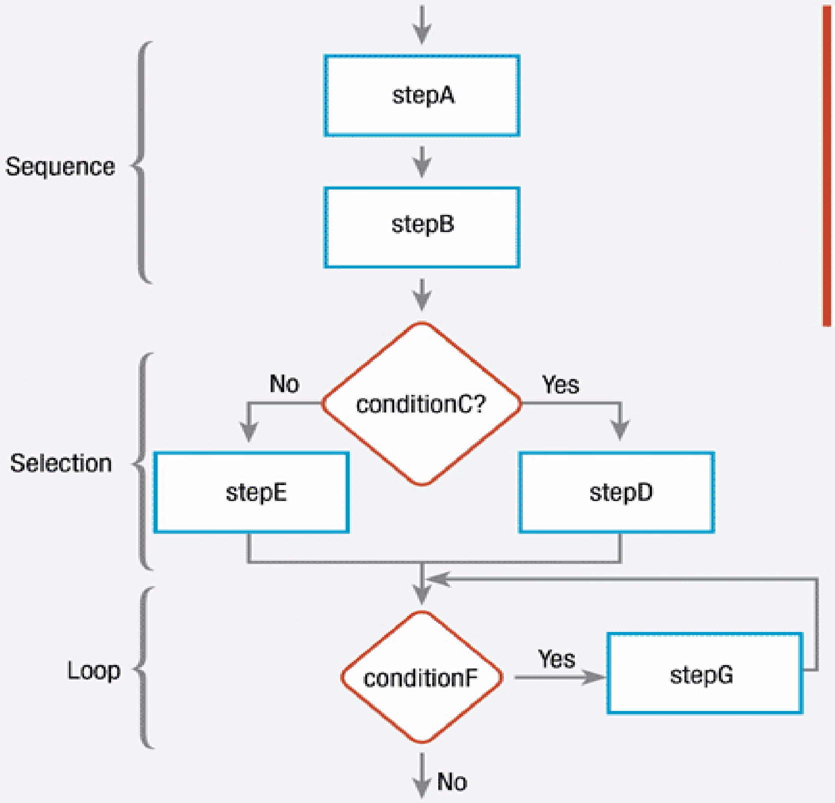


Understanding the Three Basic Structures (continued)

- **All logic problems can be solved using only these three structures—sequence, selection, and looping**
- **The three structures can be combined in an infinite number of ways**
- **Attaching structures end-to-end is called stacking structures**

Understanding the Three Basic Structures (continued)

FIGURE 2-1: STRUCTURED FLOWCHART AND PSEUDOCODE

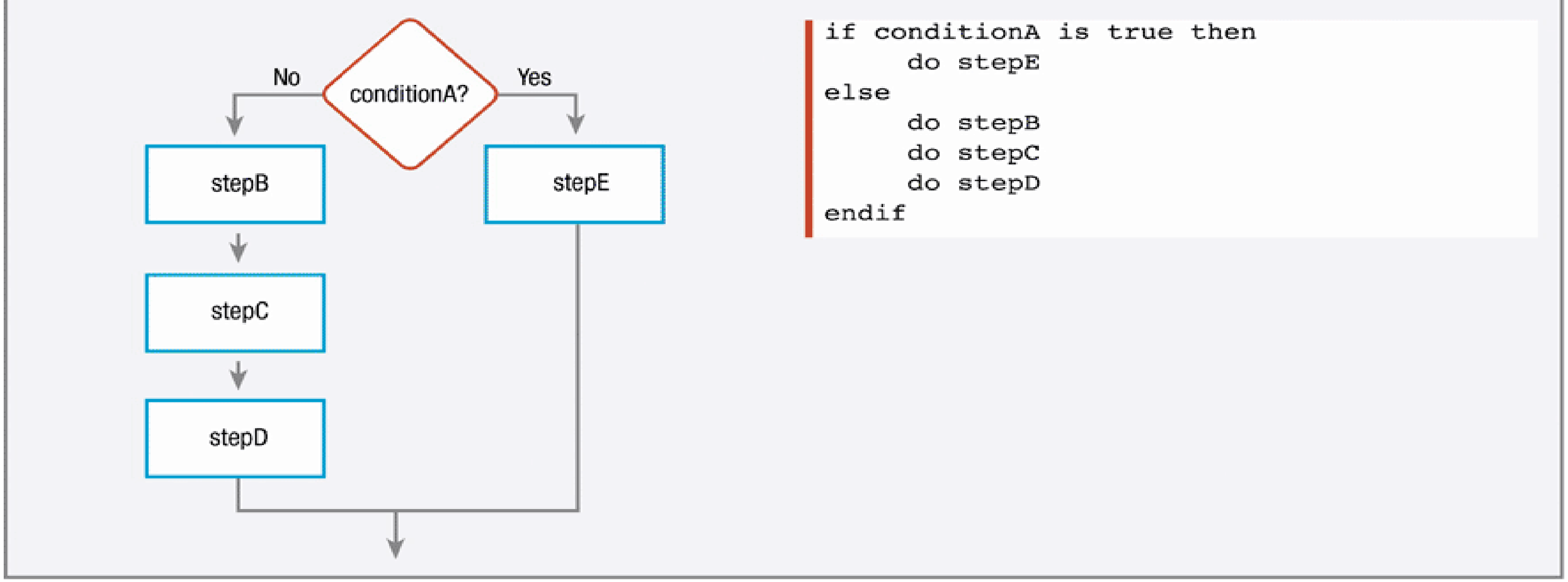


```
do stepA
do stepB
if conditionC is true then
        do stepD
else
        do stepE
endif
while conditionF is true
        do stepG
endwhile
```

Understanding the Three Basic Structures (continued)

- Placing a structure within another structure is called nesting the structures

FIGURE 2-8: FLOWCHART AND PSEUDOCODE SHOWING A SEQUENCE NESTED WITHIN A SELECTION



```
if conditionA is true then
      do stepE
else
      do stepB
      do stepC
      do stepD
endif
```

Using the Priming Read

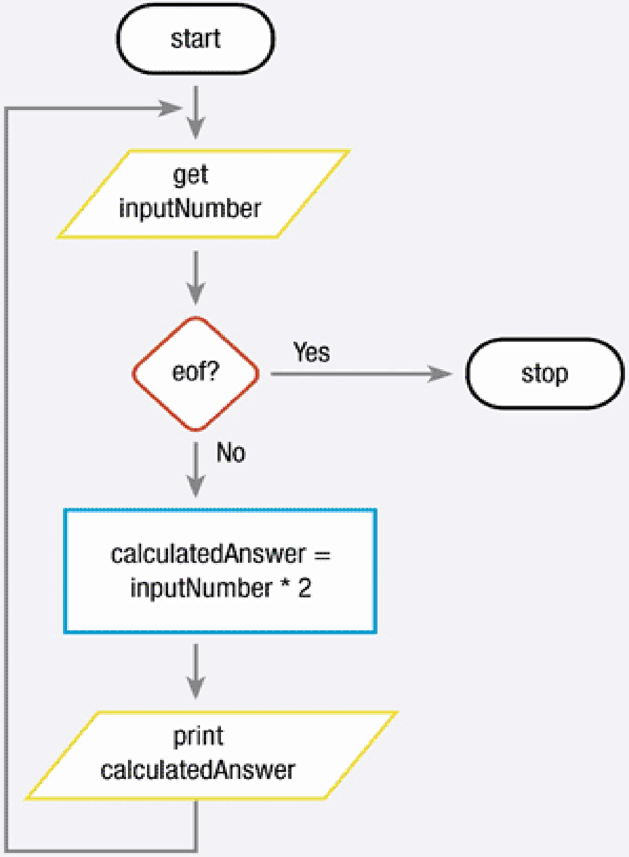
- A priming read or priming input is the first read or data input statement in a program
- If a program will read 100 data records, you read the first data record in a statement that is separate from the other 99
- You must do this to keep the program structured
- With a selection structure, the logic goes in one of two directions after the question, and then the flow comes back together; the question is not asked a second time

Using the Priming Read (continued)

- In a loop, if an answer results in the loop being entered and loop statements executing, then
  - the logic returns to the question that started the loop
- when the body of a loop executes, the question that controls the loop is always asked again

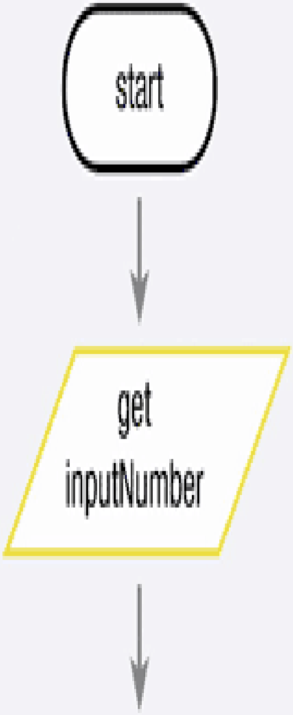
Using the Priming Read (continued)

FIGURE 2-12: UNSTRUCTURED FLOWCHART OF A NUMBER-DOUBLING PROGRAM



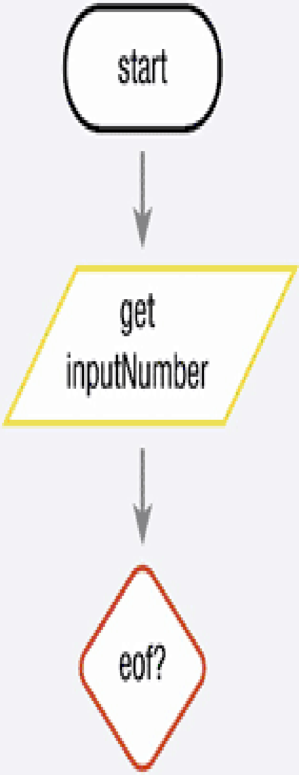
Using the Priming Read (continued)

FIGURE 2-13: BEGINNING OF A NUMBER-DOUBLING FLOWCHART



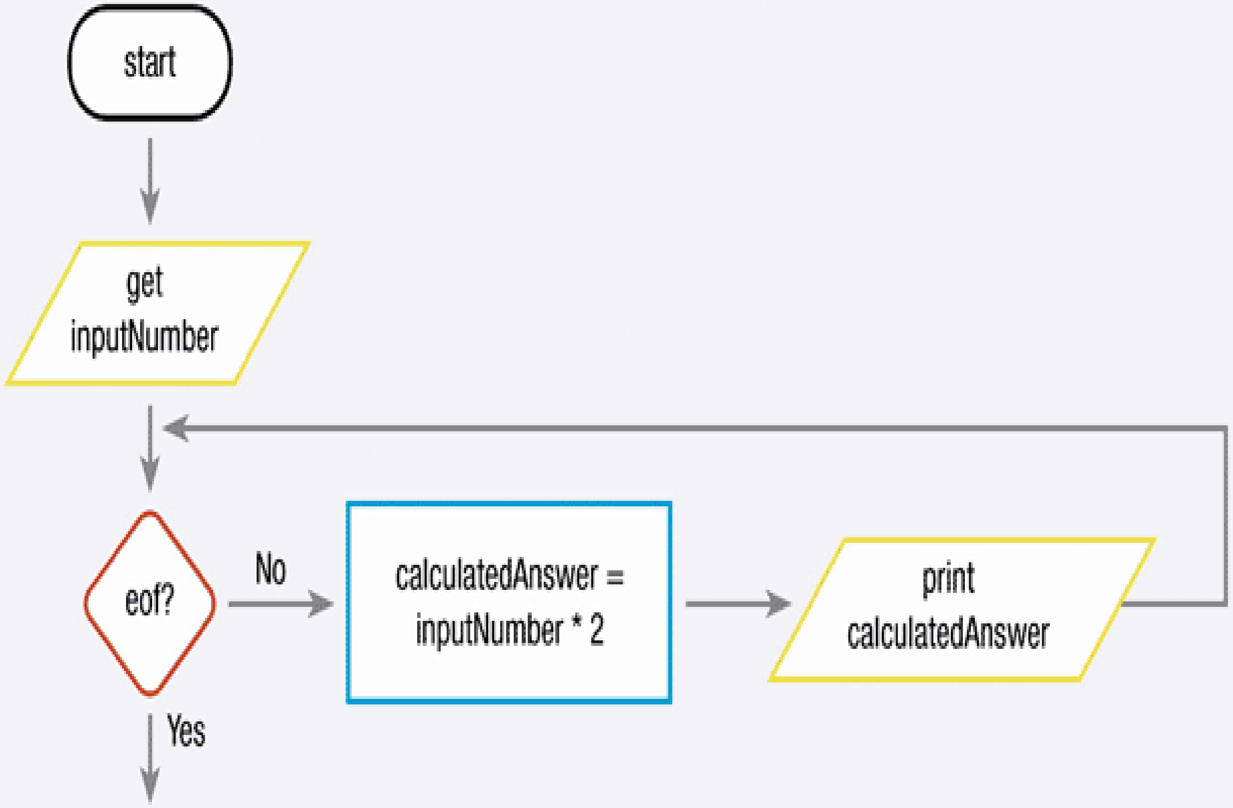
Using the Priming Read (continued)

FIGURE 2-14: NUMBER-DOUBLING FLOWCHART CONTINUED



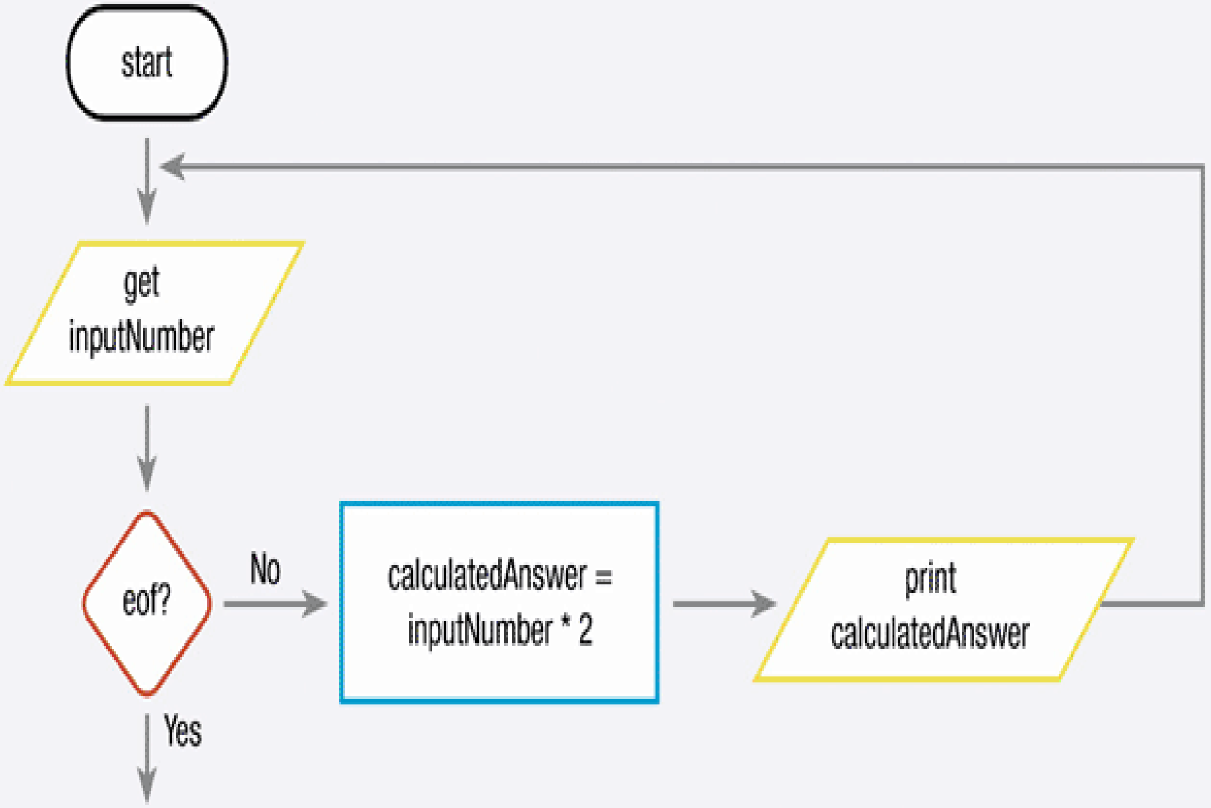
Using the Priming Read (continued)

FIGURE 2-15: STRUCTURED, BUT NONFUNCTIONAL, FLOWCHART OF NUMBER-DOUBLING PROBLEM



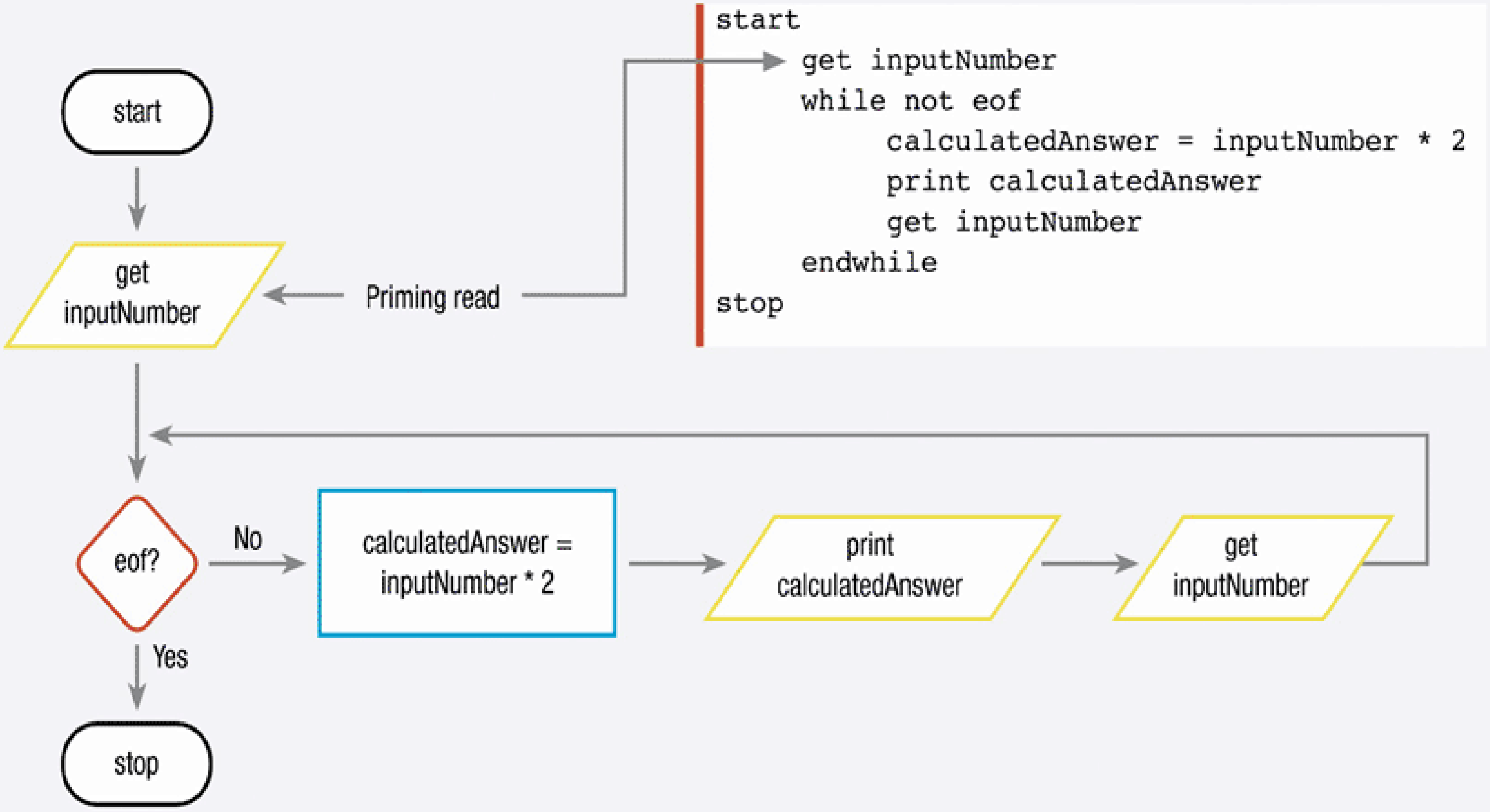
Using the Priming Read (continued)

FIGURE 2-16: FUNCTIONAL BUT NONSTRUCTURED FLOWCHART



Using the Priming Read (continued)

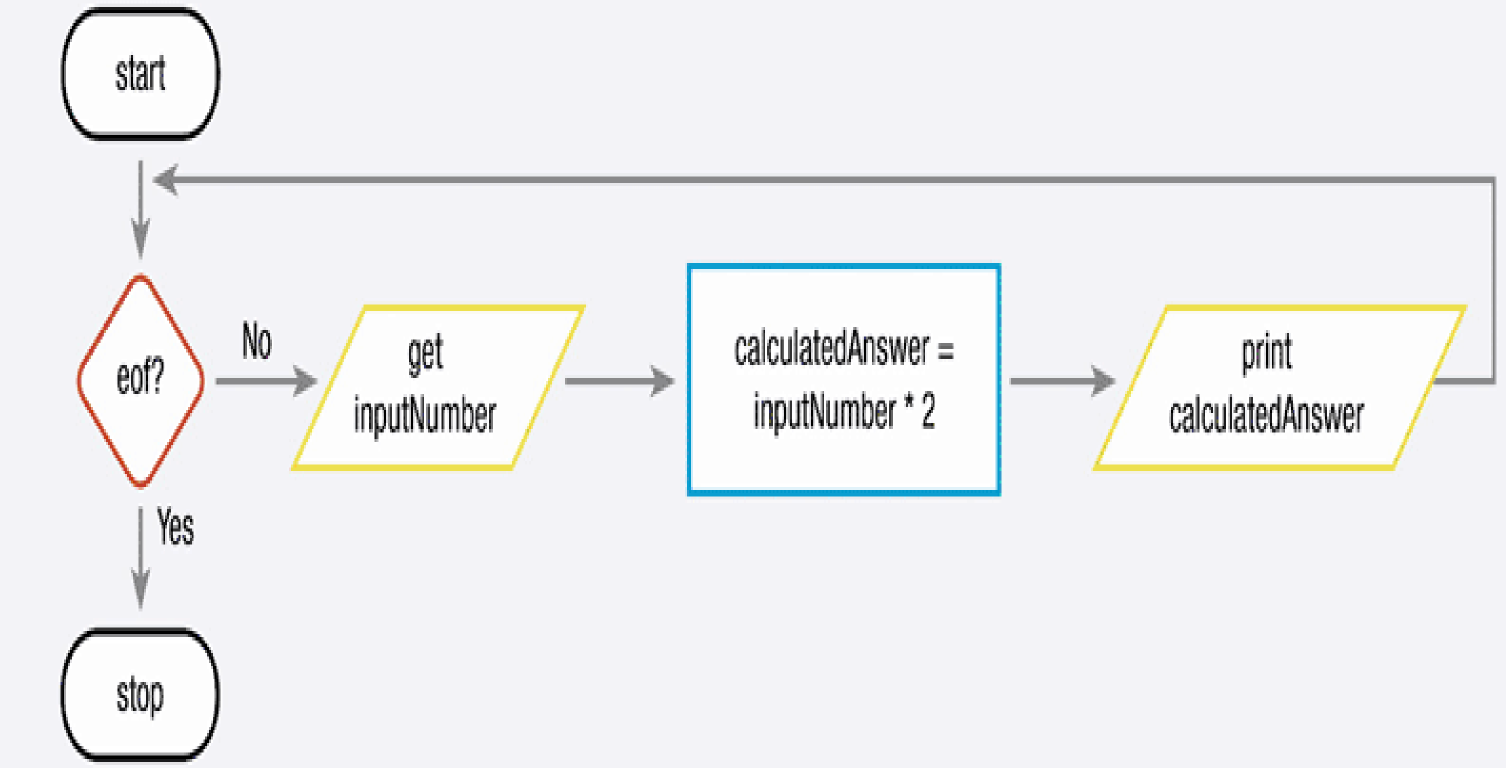
FIGURE 2-11: FUNCTIONAL, STRUCTURED FLOWCHART AND PSEUDOCODE FOR THE NUMBER-DOUBLING PROBLEM



```
start
    get inputNumber
    while not eof
        calculatedAnswer = inputNumber * 2
        print calculatedAnswer
        get inputNumber
    endwhile
stop
```

Using the Priming Read (continued)

FIGURE 2-18: STRUCTURED BUT INCORRECT SOLUTION TO THE NUMBER-DOUBLING PROBLEM

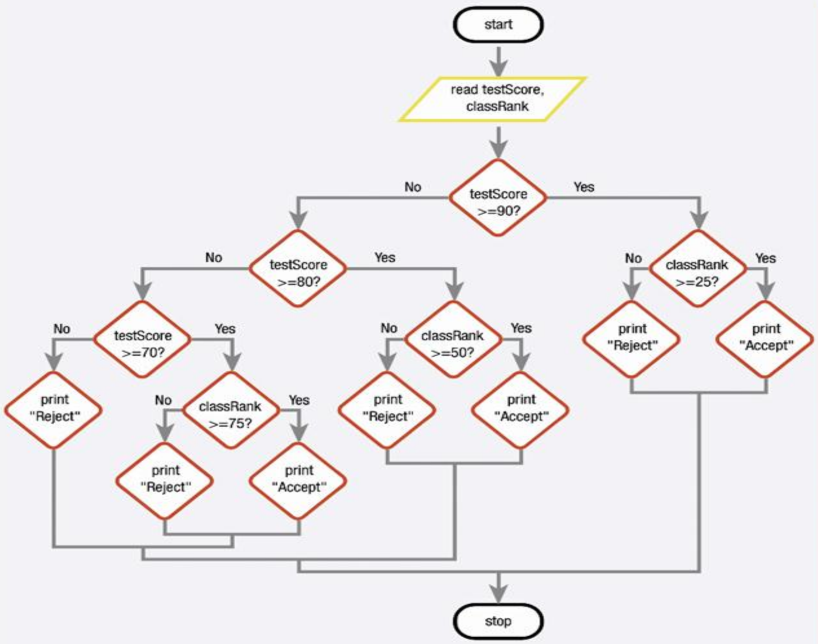


Understanding the Reasons for Structure

- Until you have some programming experience, it might be difficult to appreciate the reasons for using only the three structures—sequence, selection, and loop
- However, staying with these three structures is better for the following reasons:
  - Clarity
  - Efficiency
  - Modularity
  - Professionalism
  - Maintenance

Flowchart and Pseudocode of Structured College Admission Program

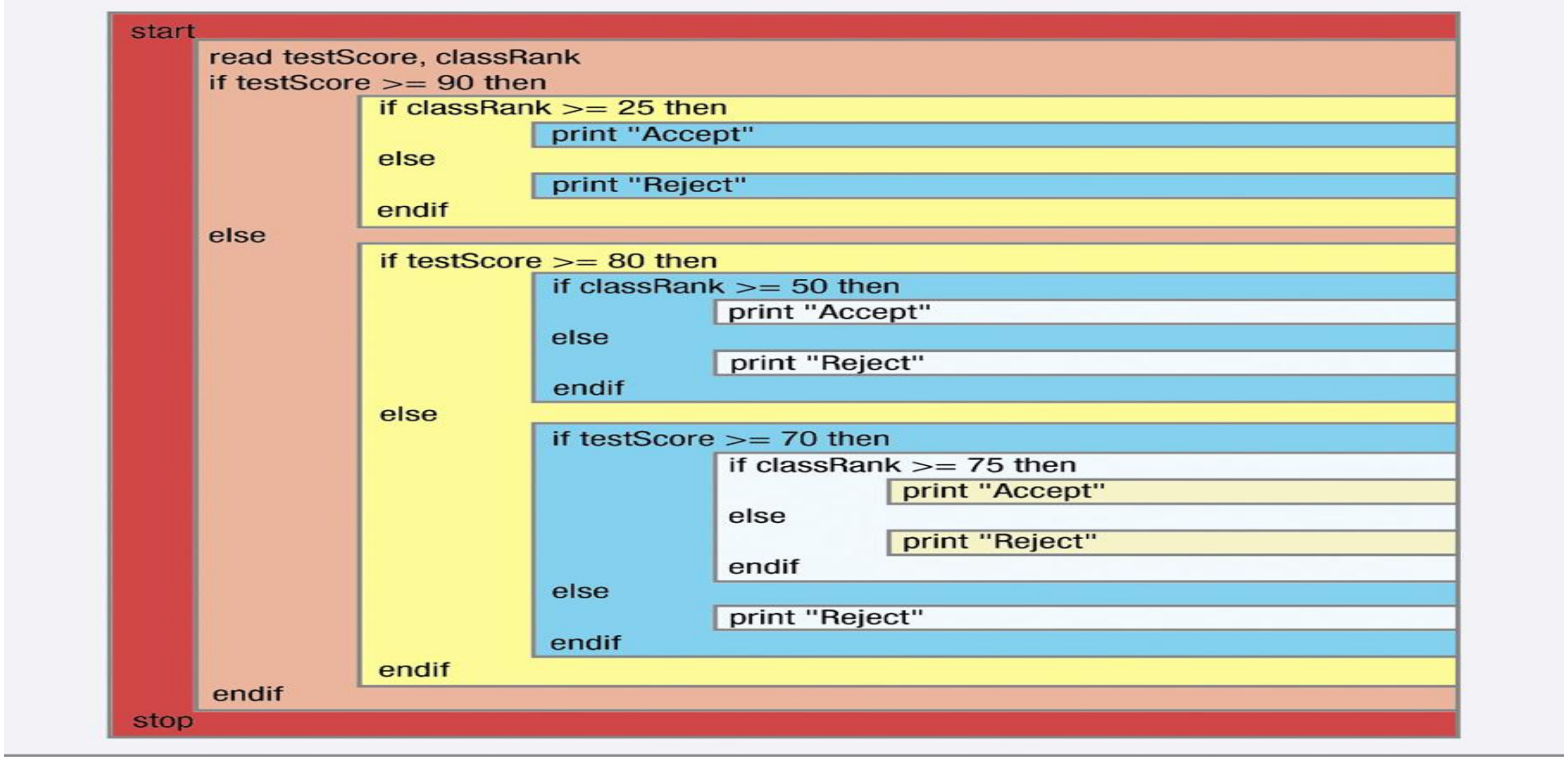
FIGURE 2-19: FLOWCHART AND PSEUDOCODE OF STRUCTURED COLLEGE ADMISSION PROGRAM



```
start
    read testScore, classRank
    if testScore >= 90 then
        if classRank >= 25 then
            print "Accept"
        else
            print "Reject"
        endif
    else
        if testScore >= 80 then
            if classRank >= 50 then
                print "Accept"
            else
                print "Reject"
            endif
        else
            if testScore >= 70 then
                if classRank >= 75 then
                    print "Accept"
                else
                    print "Reject"
                endif
            else
                print "Reject"
            endif
        endif
    endif
stop
```

Flowchart and Pseudocode of Structured College Admission Program (continued)

Figure 2-19 (continued)



```
start
    read testScore, classRank
    if testScore >= 90 then
        if classRank >= 25 then
            print "Accept"
        else
            print "Reject"
        endif
    else
        if testScore >= 80 then
            if classRank >= 50 then
                print "Accept"
            else
                print "Reject"
            endif
        else
            if testScore >= 70 then
                if classRank >= 75 then
                    print "Accept"
                else
                    print "Reject"
                endif
            else
                print "Reject"
            endif
        endif
    endif
stop
```

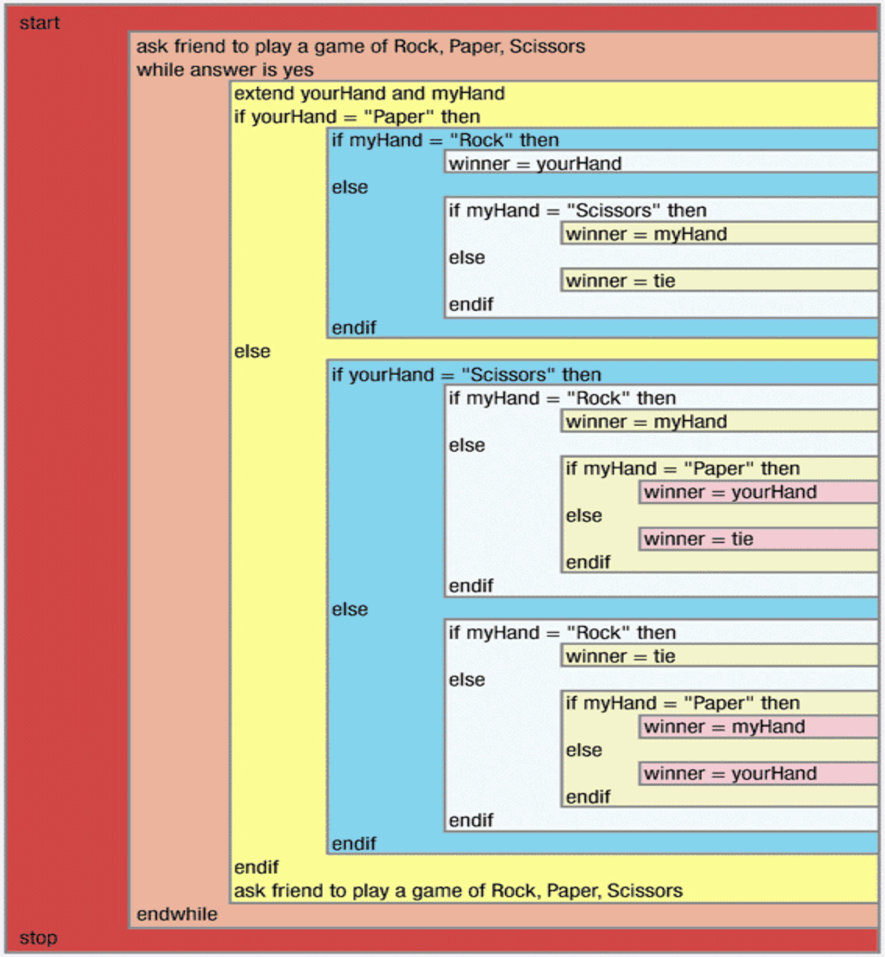
Recognizing Structure

- **Any set of instructions can be expressed in a structured format**
- **If you can teach someone how to perform any ordinary activity, then you can express it in a structured way**

Pseudocode for the Rock, Paper, Scissors Game

- **Any task with applied rules can be expressed logically using only combinations of sequence, selection, and looping**

FIGURE 2-20: PSEUDOCODE FOR THE ROCK, PAPER, SCISSORS GAME



```
start
    ask friend to play a game of Rock, Paper, Scissors
    while answer is yes
        extend yourHand and myHand
        if yourHand = "Paper" then
            if myHand = "Rock" then
                winner = yourHand
            else
                if myHand = "Scissors" then
                    winner = myHand
                else
                    winner = tie
                endif
            endif
        else
            if yourHand = "Scissors" then
                if myHand = "Rock" then
                    winner = myHand
                else
                    if myHand = "Paper" then
                        winner = yourHand
                    else
                        winner = tie
                    endif
                endif
            else
                if myHand = "Rock" then
                    winner = tie
                else
                    if myHand = "Paper" then
                        winner = myHand
                    else
                        winner = yourHand
                    endif
                endif
            endif
        endif
        ask friend to play a game of Rock, Paper, Scissors
    endwhile
stop
```

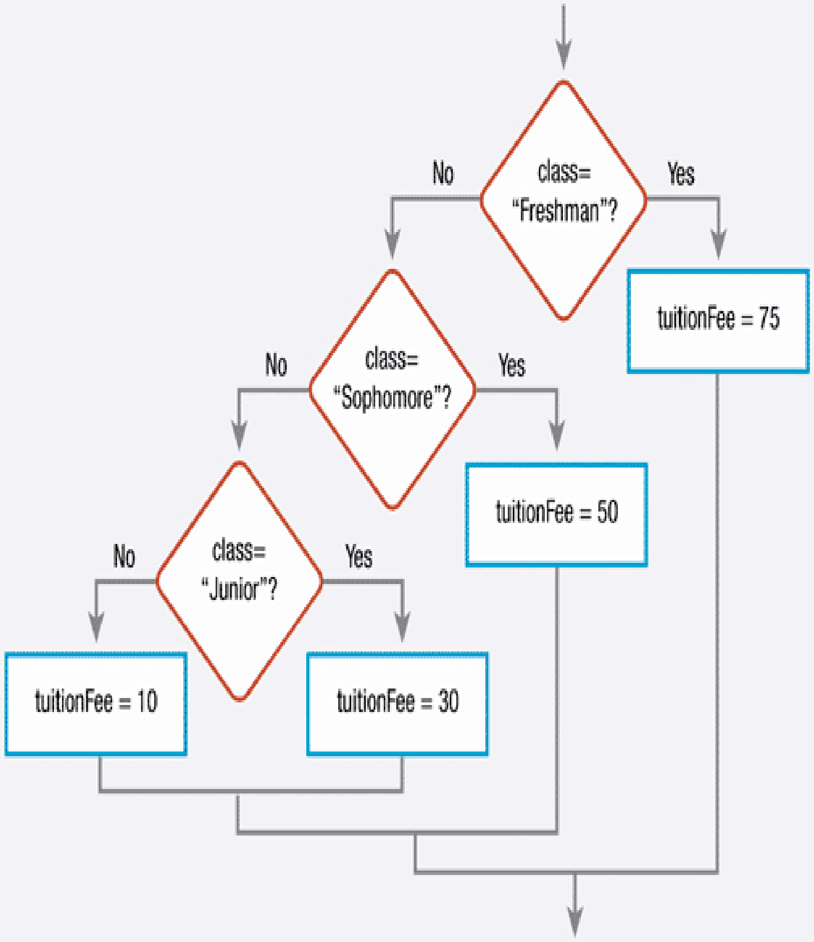
Two Special Structures—Case and Do Until

- **Many programming languages allow two more structures: the case structure and the do until loop**
- **Never *needed* to solve any problem though sometimes are convenient**
- **Programmers consider them both to be acceptable, legal structures**

The Case Structure

- **Use the case structure when there are several distinct possible values for a single variable being tested and each value requires different actions**

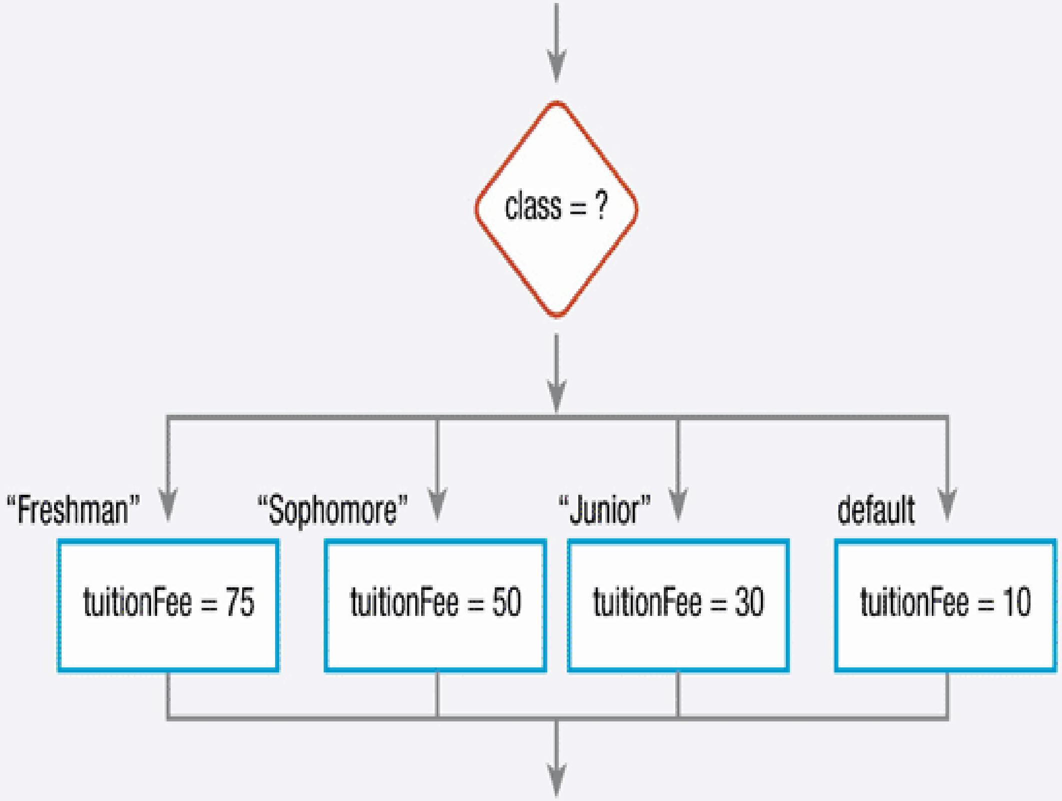
FIGURE 2-31: FLOWCHART AND PSEUDOCODE OF TUITION DECISIONS



```
if class = "Freshman" then
     tuitionFee = 75
else
     if class = "Sophomore" then
          tuitionFee = 50
     else
          if class = "Junior" then
               tuitionFee = 30
          else
               tuitionFee = 10
        endif
     endif
endif
```

The Case Structure (continued)

FIGURE 2-32: FLOWCHART AND PSEUDOCODE OF CASE STRUCTURE



```
case based on class
     case "Freshman"
          tuitionFee = 75
     case "Sophomore"
          tuitionFee = 50
     case "Junior"
          tuitionFee = 30
     default
          tuitionFee = 10
endcase
```

The Do Until Loop

- In a do while loop, you ask a question and, depending on the answer, you might or might not enter the loop to execute the loop's procedure
- Conversely, in a do until loop, you ensure that the procedure executes at least once; then, depending on the answer to the controlling question, the loop may or may not execute additional times

The Do Until Loop (continued)

- Because programmers understand that a do until can be expressed with a sequence followed by a do while, most languages allow the do until
- Again, you are never required to use a do until; you can always accomplish the same events with a sequence followed by a do while

The Do Until Loop (continued)

FIGURE 2-33: DO WHILE LOOP

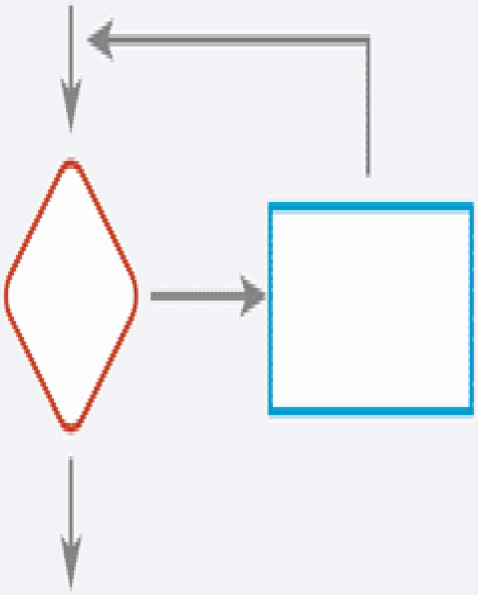
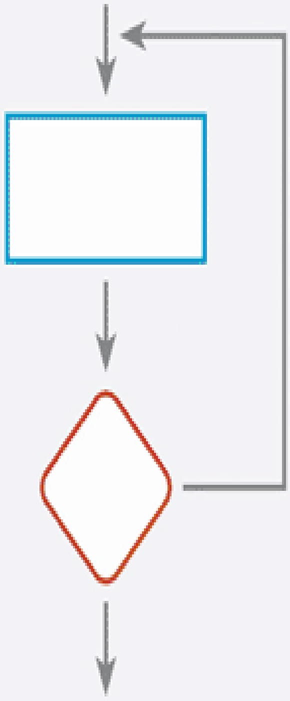


FIGURE 2-34: DO UNTIL LOOP



The Do Until Loop (continued)

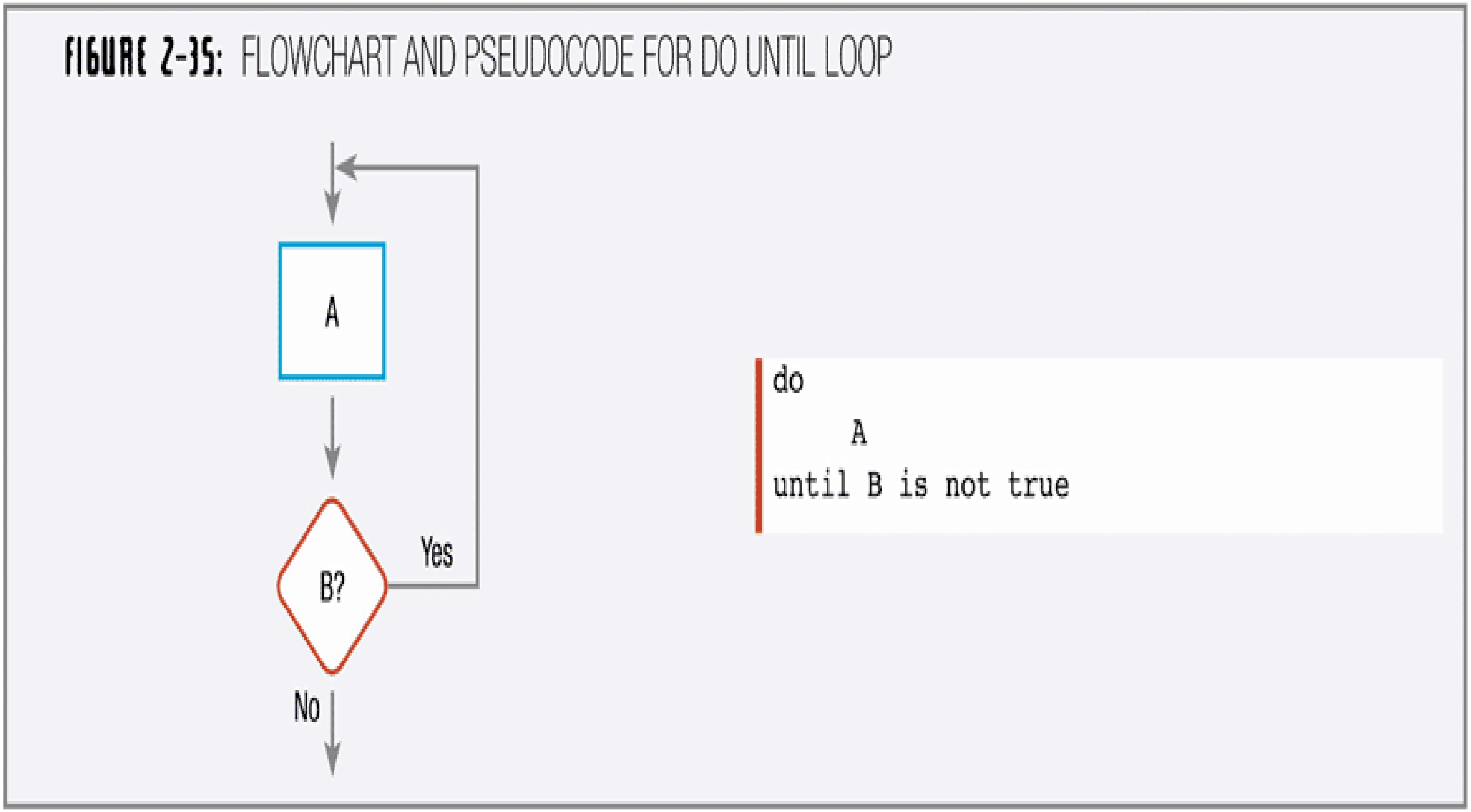
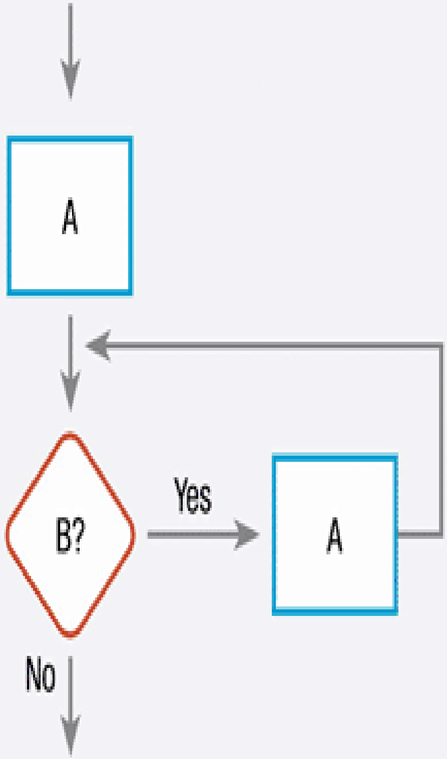


FIGURE 2-35: FLOWCHART AND PSEUDOCODE FOR DO UNTIL LOOP

```
do
     A
until B is not true
```

The Do While Loop (continued)

FIGURE 2-36: FLOWCHART AND PSEUDOCODE FOR SEQUENCE FOLLOWED BY DO WHILE LOOP



```
do A
while B is true
     do A
endwhile
```

Summary

- The popular name for snarled program statements is spaghetti code
- A priming read or priming input is the first read or data input statement prior to beginning a structured loop
- The last step within the loop gets the next, and all subsequent, input values

Summary (continued)

- You can use a case structure when there are several distinct possible values for a variable you are testing
- In a do while loop, you ask a question and, depending on the answer, you might never enter the loop to execute the loop’s procedure
- In a do until loop, you ensure that the procedure executes at least once