

Java Programming, 9e

Chapter 5

Making Decisions





Objectives (1 of 2)

- Plan decision-making logic
- Make decisions with the `if` and `if...else` statements
- Use multiple statements in `if` and `if...else` clauses
- Nest `if` and `if...else` statements
- Use AND and OR operators



Objectives (2 of 2)

- Make accurate and efficient decisions
- Use the `switch` statement
- Use the conditional and NOT operators
- Assess operator precedence
- Add decisions and constructors to instance methods



Planning Decision-Making Logic (1 of 5)

- **Pseudocode**

- Use paper and a pencil
- Plan a program's logic by writing plain English statements
- Accomplish important steps in a given task
- Use everyday language

- **Flowchart**

- Steps in diagram form
- A series of shapes connected by arrows



Planning Decision-Making Logic (2 of 5)

- **Flowchart (cont'd.)**

- Programmers use a variety of shapes for different tasks
 - Rectangle to represent any unconditional step
 - Diamond to represent any decision

- **Sequence structure**

- One step follows another unconditionally
- Cannot branch away or skip a step



Planning Decision-Making Logic (3 of 5)

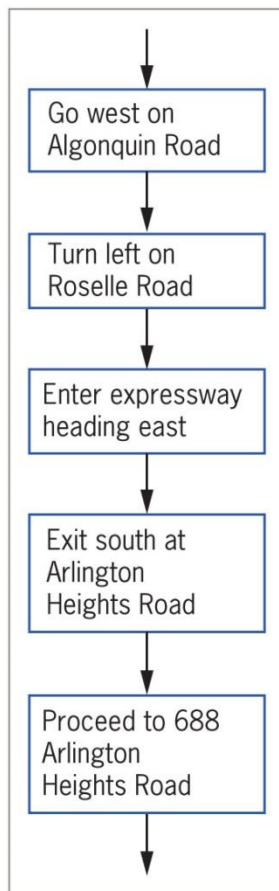


Figure 5-1 Flowchart of a series of sequential steps



Planning Decision-Making Logic (4 of 5)

- **Decision structure**

- Involves choosing among alternative courses of action
- Based on some value within a program

- All computer decisions are yes-or-no decisions

- **Boolean values**

- `true` and `false` values
- Used in every computer decision



Planning Decision-Making Logic (5 of 5)

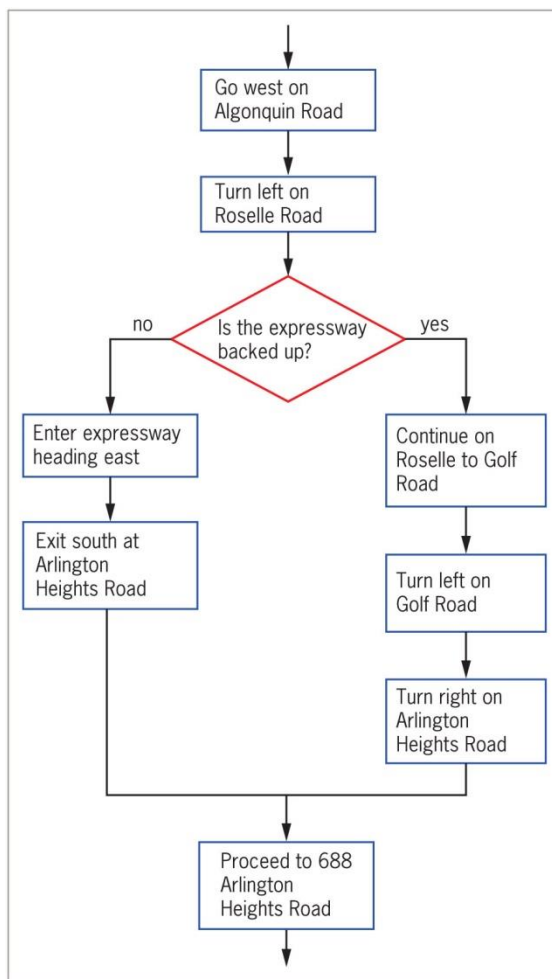


Figure 5-2 Flowchart including a decision



The `if` and `if...else` Statements (1 of 2)

- **`if` statement**

- The simplest statement to make a decision
- A Boolean expression appears within parentheses
- No space between the keyword `if` and the opening parenthesis
- Execution always continues to the next independent statement
- Use a double equal sign (`==`) to determine equivalency



The if and if...else Statements (2 of 2)

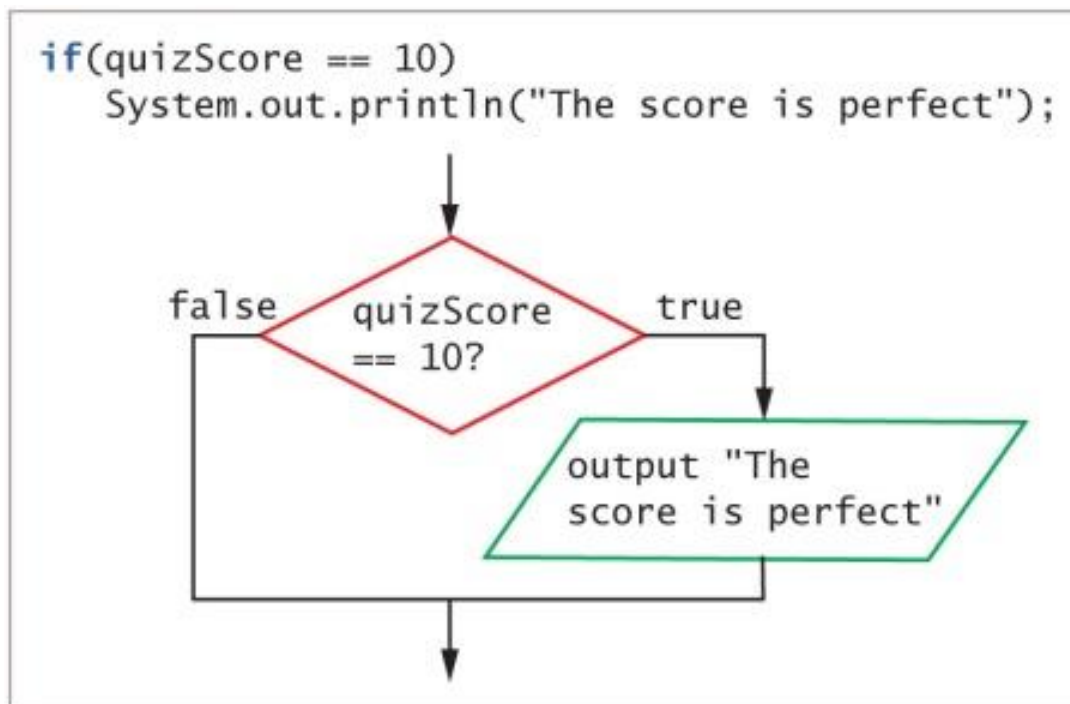


Figure 5-3 A Java if statement and its logic



Pitfall: Misplacing a Semicolon in an `if` Statement (1 of 2)

- There should be no semicolon at the end of the first line of the `if` statement
 - `if(someVariable == 10)`
 - The statement does not end there
- When a semicolon follows `if` directly:
 - An **empty statement** contains only a semicolon
 - Execution continues with the next independent statement



Pitfall: Misplacing a Semicolon in an if Statement (2 of 2)

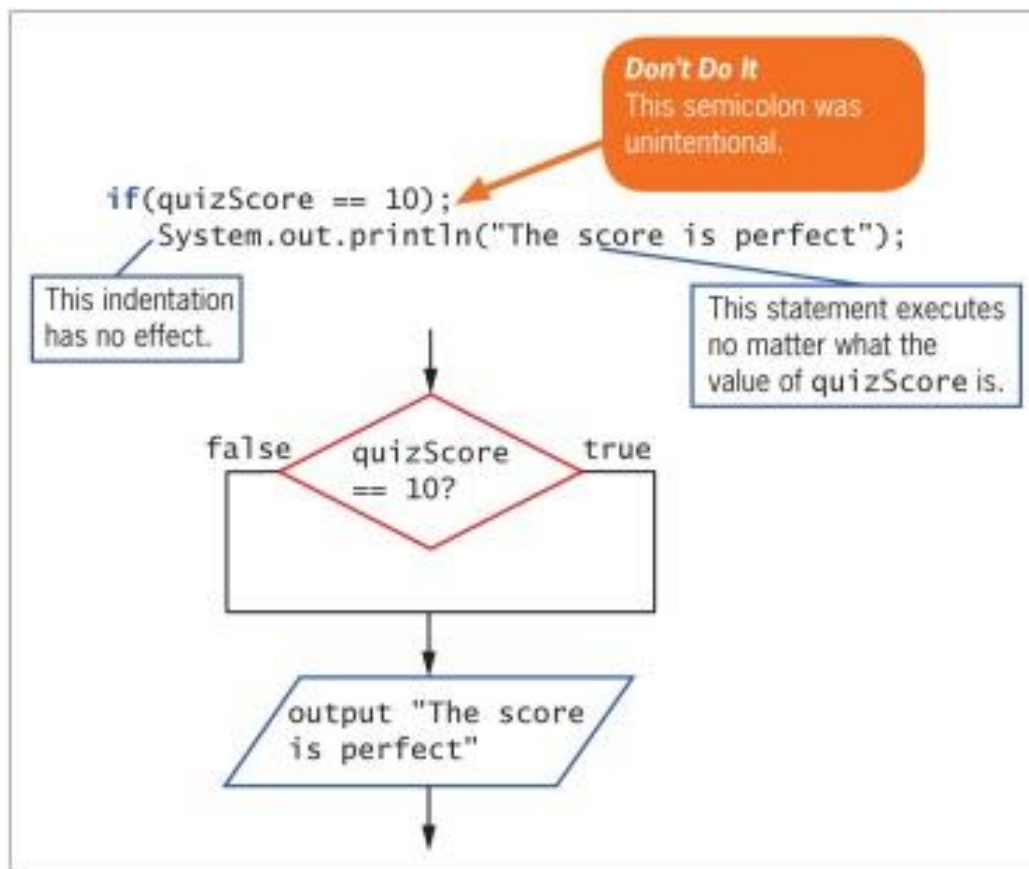


Figure 5-4 Logic that executes when an extra semicolon is inserted in an if statement



Pitfall: Using the Assignment Operator Instead of the Equivalency Operator

- Attempt to determine equivalency
 - Using a single equal sign rather than a double equal sign is illegal
- You can store a Boolean expression's value in a Boolean variable before using it in an `if` statement



Pitfall: Attempting to Compare Objects Using the Relational Operators

- Use standard relational operators to compare values of primitive data types
 - Not objects
- You can use the equals and not equals comparisons (`==` and `!=`) with objects
 - Compare objects' memory addresses instead of values



The `if...else` Statement (1 of 3)

- **Single-alternative `if`**

- Perform an action, or not
 - Based on one alternative

- **Dual-alternative `if`**

- Two possible courses of action

- **`if...else` statement**

- Performs one action when a Boolean expression evaluates as `true`
- Performs a different action when a Boolean expression evaluates as `false`



The `if...else` Statement (2 of 3)

- **`if...else` statement** (cont'd.)

- A statement that executes when `if` is `true` or `false` and ends with a semicolon
- Vertically align the keyword `if` with the keyword `else`
- Illegal to code `else` without `if`
- Depending on the evaluation of the Boolean expression following `if`, only one resulting action takes place



The if...else Statement (3 of 3)

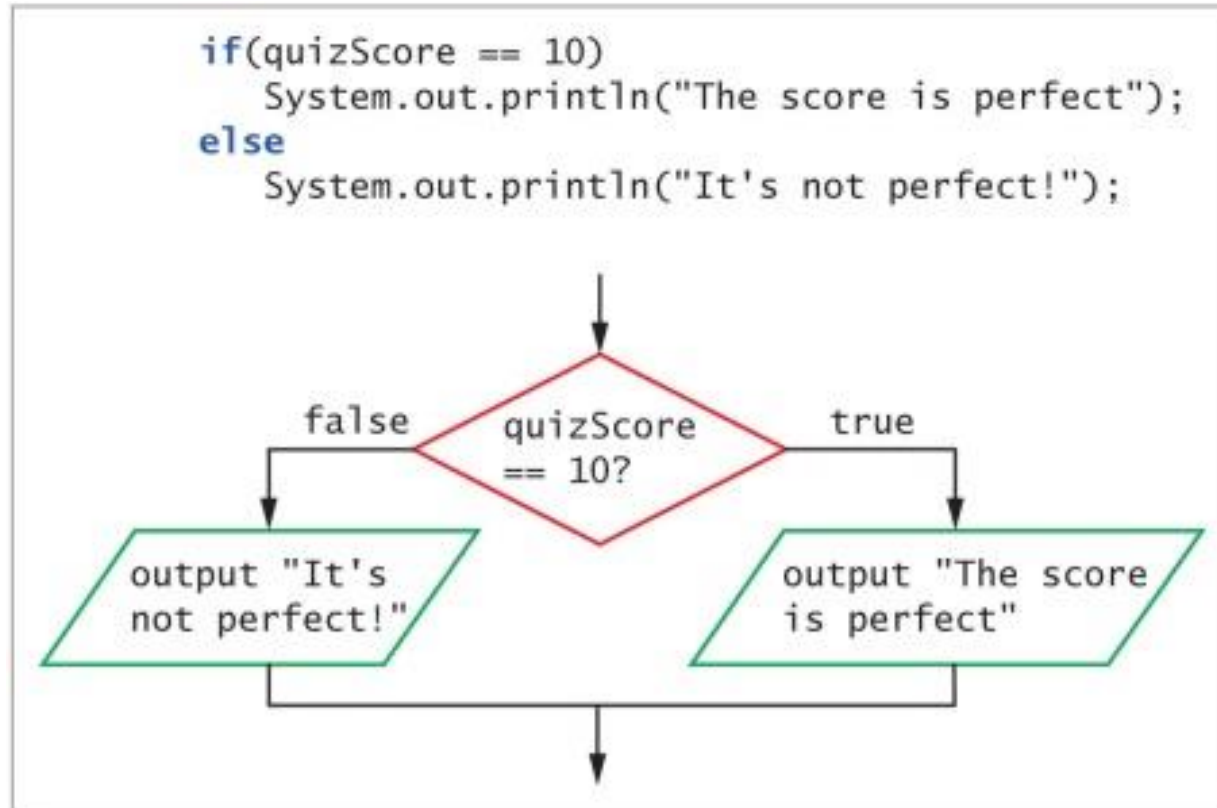


Figure 5-5 An if...else statement and its logic



Using Multiple Statements in `if` and `if...else` Clauses (1 of 2)

- To execute more than one statement, use a pair of curly braces
 - Place dependent statements within a block
 - Crucial to place the curly braces correctly
- Any variable declared within a block is local to that block



Using Multiple Statements in `if` and `if...else` Clauses (2 of 2)

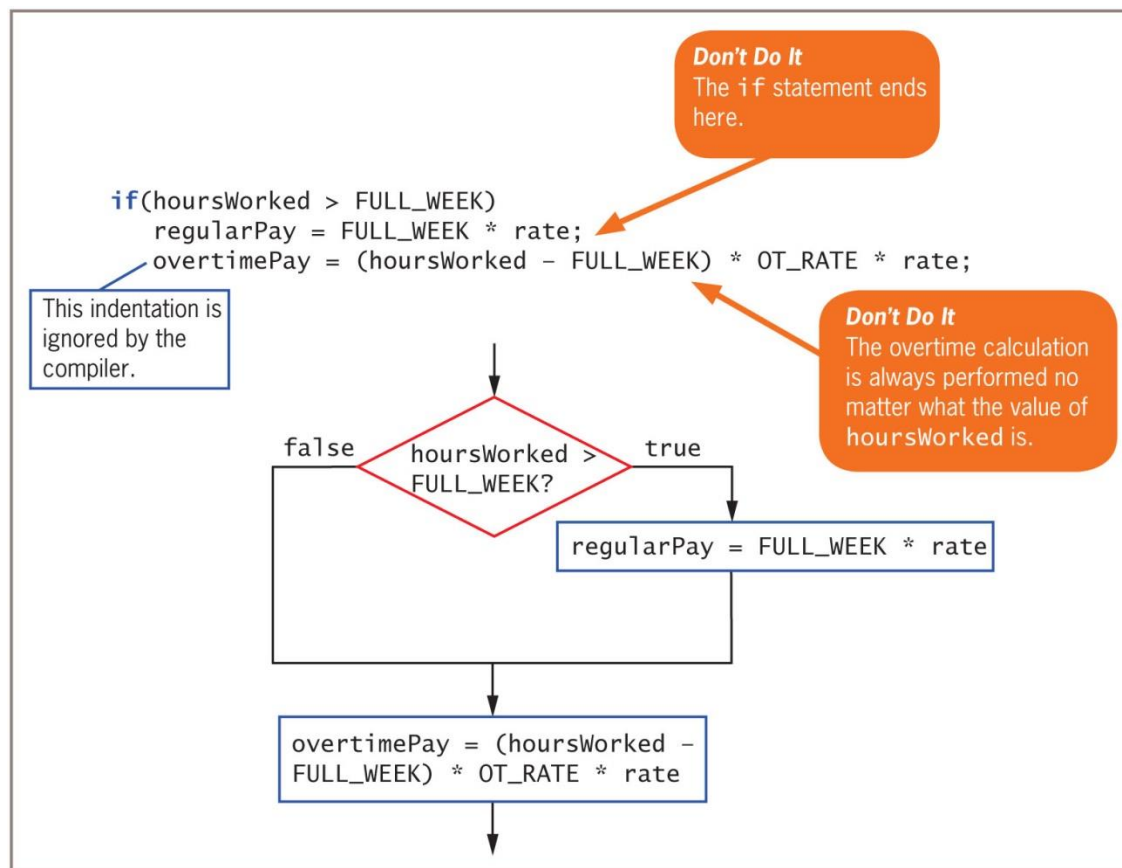


Figure 5-8 Erroneous overtime pay calculation with missing curly braces



Nesting `if` and `if...else` Statements (1 of 2)

- **Nested `if` statements**

- Statements in which an `if` structure is contained inside another `if` structure
- Two conditions must be met before some action is taken
- Pay careful attention to the placement of `else` clauses
- `else` statements are always associated with `if` on a “first in-last out” basis



Nesting if and if...else Statements (2 of 2)

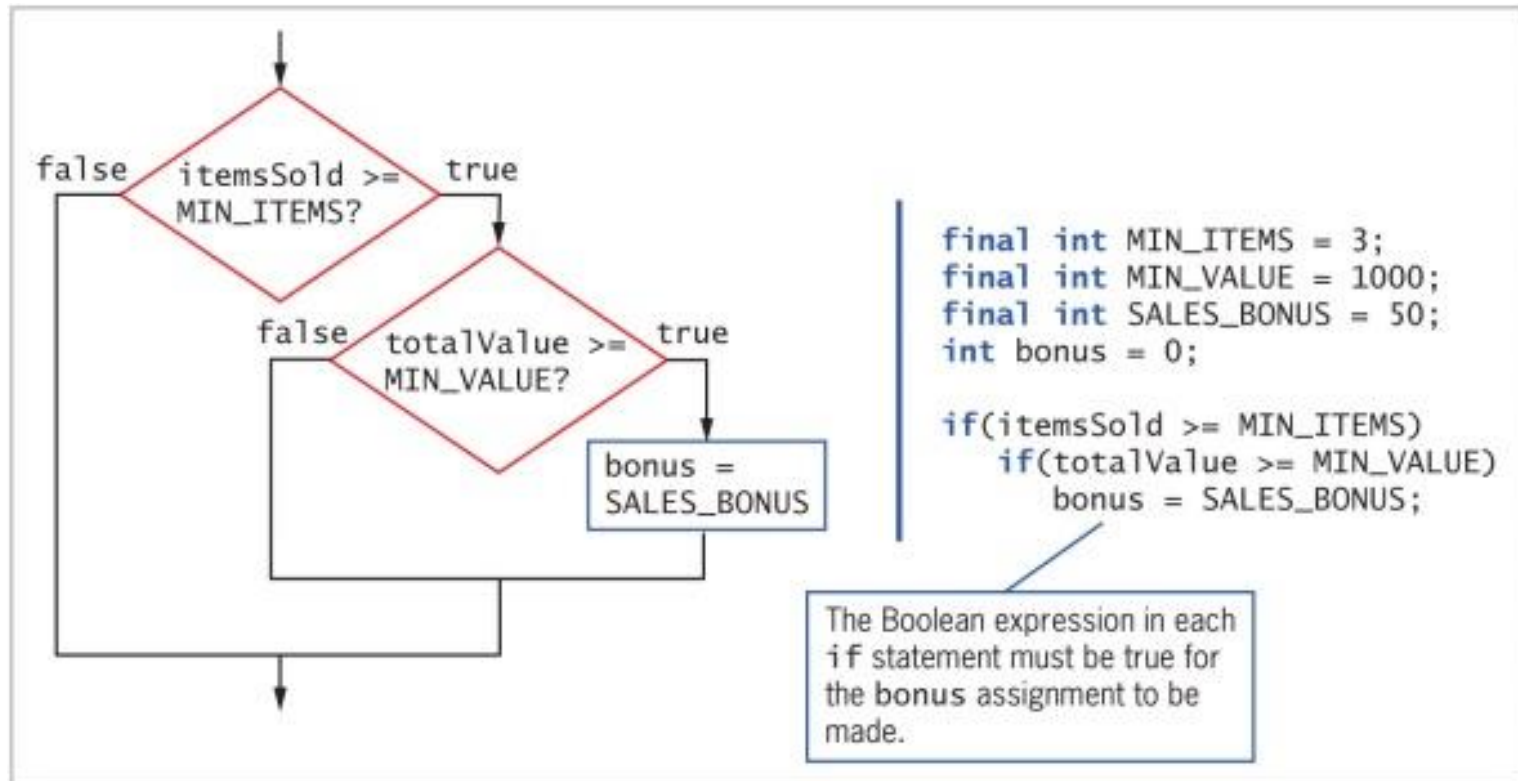


Figure 5-12 Determining whether to assign a bonus using nested if statements



Using Logical AND and OR Operators (1 of 5)

- The **logical AND operator**

- An alternative to some nested `if` statements
- Used between two Boolean expressions to determine whether both are `true`
- Written as two ampersands (`&&`)
 - Include a complete Boolean expression on each side
- Both Boolean expressions that surround the operator must be true before the action in the statement can occur



Using Logical AND and OR Operators (2 of 5)

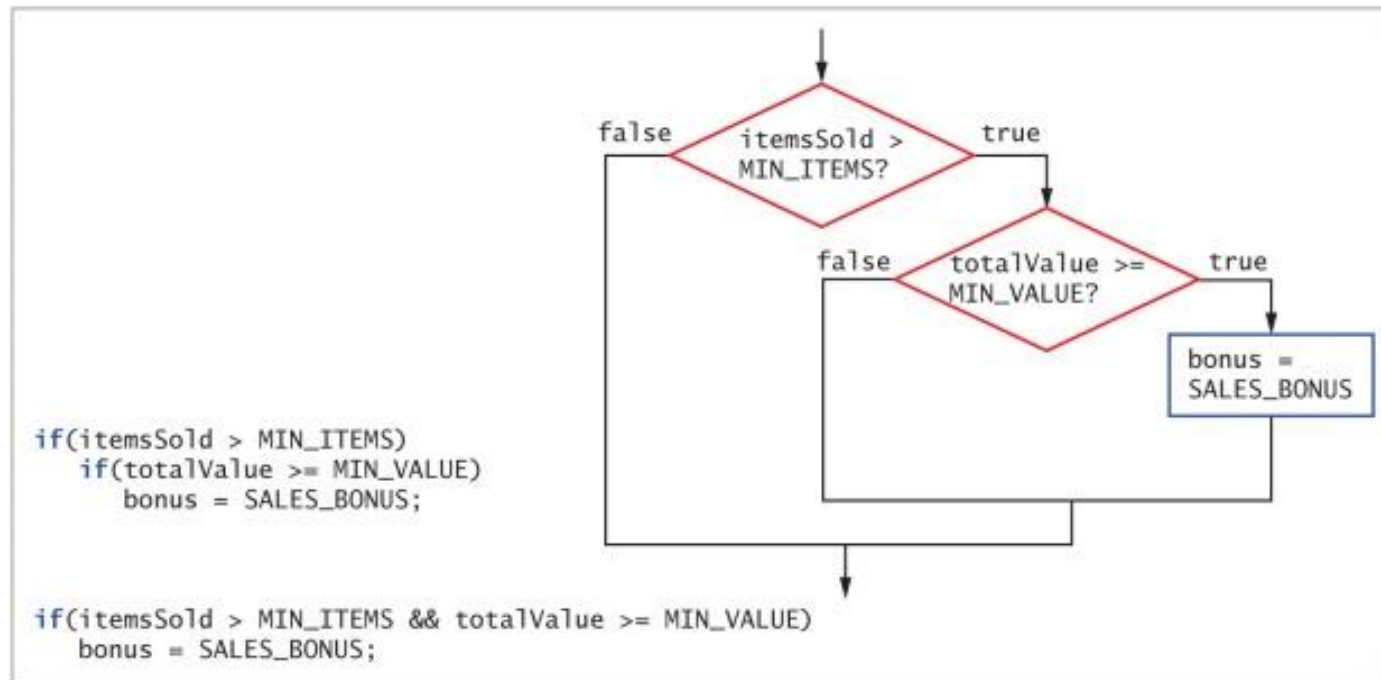


Figure 5-15 Code and logic for bonus-determining decision using nested `if`s and the `&&` operator



Using Logical AND and OR Operators (3 of 5)

- The **OR** operator

- An action to occur when at least one of two conditions is true
- Written as `| |`
 - Sometimes called pipes



Using Logical AND and OR Operators (4 of 5)

```
if(itemsBought >= MIN_ITEMS)
    discountRate = DISCOUNT;
else
    if(itemsValue >= MIN_VALUE)
        discountRate = DISCOUNT;

if(itemsBought >= MIN_ITEMS || itemsValue >= MIN_VALUE)
    discountRate = DISCOUNT;
```

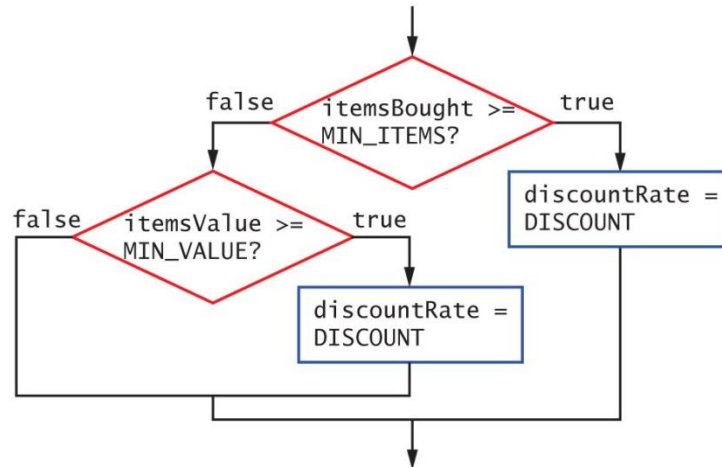


Figure 5-16 Determining customer discount when customer needs to meet only one of two criteria



Using Logical AND and OR Operators (5 of 5)

- **Short-circuit evaluation**

- Expressions on each side of the logical operator are evaluated only as far as necessary
- Determine whether an expression is `true` or `false`



Making Accurate and Efficient Decisions (1 of 4)

- Making accurate range checks
 - **Range check:** a series of `if` statements that determine whether a value falls within a specified range
 - Java programmers commonly place each `else` of a subsequent `if` on the same line
 - Within a nested `if...else` statement:
 - It is most efficient to ask the most likely question first
 - Avoid asking multiple questions

Making Accurate and Efficient Decisions (2 of 4)

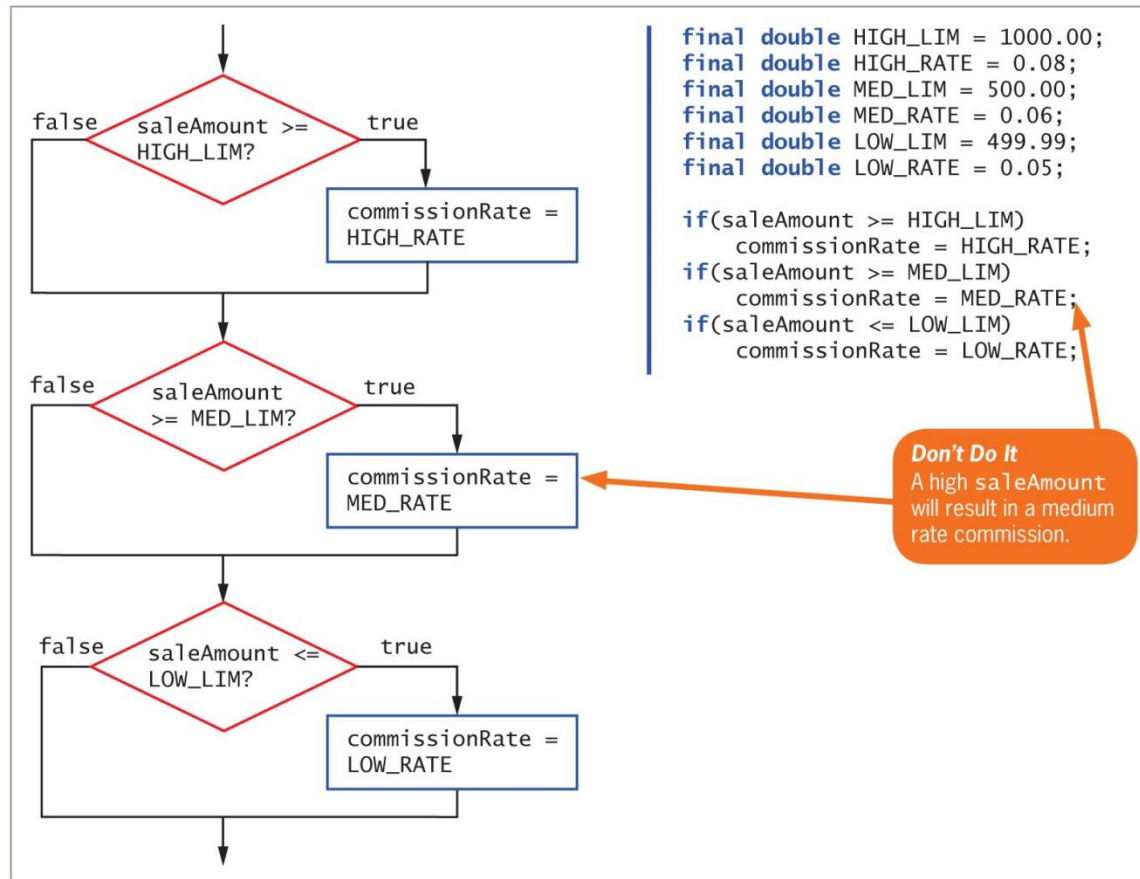


Figure 5-19 Incorrect commission-determining code and its logic



Making Accurate and Efficient Decisions (3 of 4)

- It is most efficient to ask a question most likely to be `true` first
 - Avoids asking multiple questions
 - Makes a sequence of decisions more efficient



Making Accurate and Efficient Decisions (4 of 4)

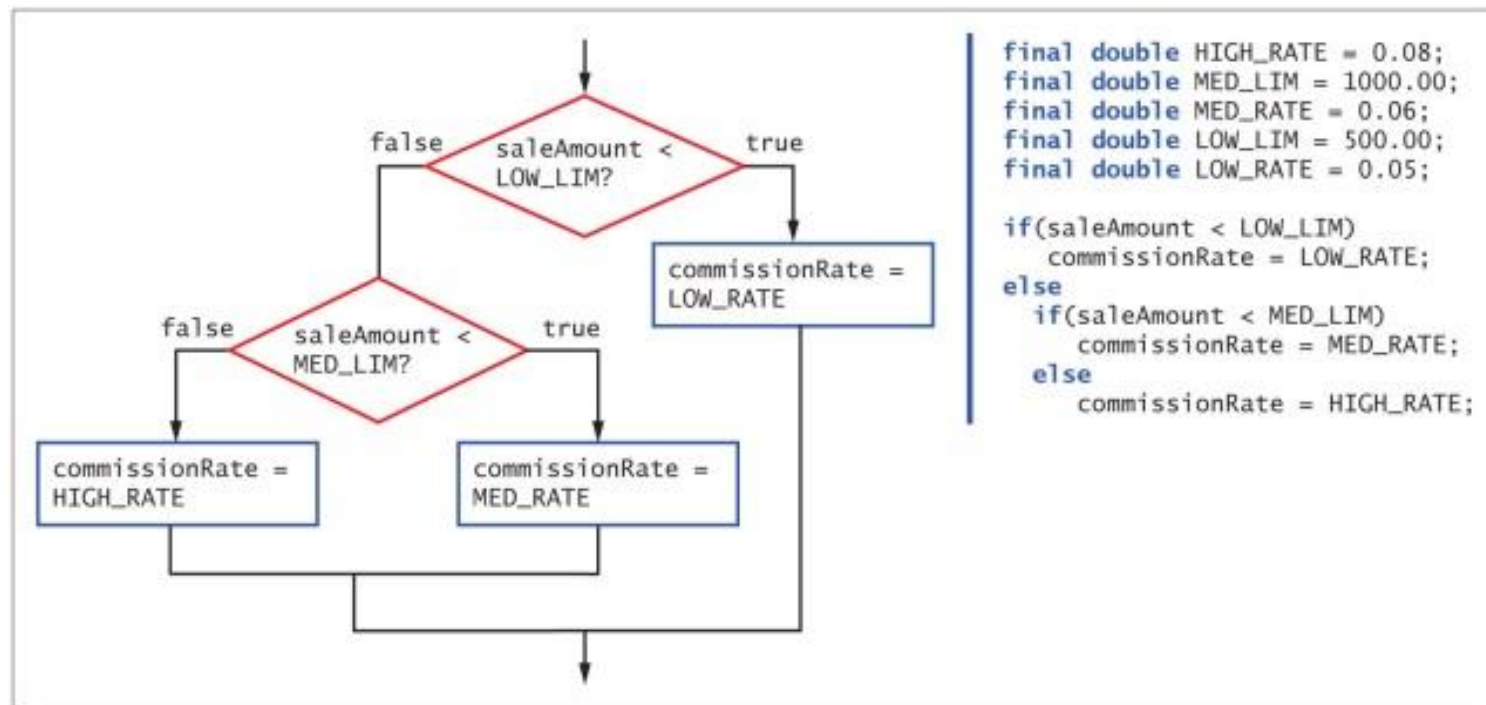


Figure 5-22 Commission-determining code and logic that evaluates smallest first



Using && and || Appropriately

- Errors of beginning programmers:
 - Using the AND operator when they mean to use OR
 - Example: No `payRate` value can ever be both less than 5.65 and more than 60 at the same time

```
if (payRate < LOW && payRate > HIGH)
    System.out.println("Error in pay rate");
```
 - Use pipes "`||`" operator instead
 - Using a single ampersand or pipe to indicate a logical AND or OR



Using the `switch` Statement (1 of 3)

- `switch` statement
 - An alternative to a series of nested `if` statements
 - Test a single variable against a series of exact integer, character, or string values
- Keywords
 - `switch`
 - Starts the structure
 - Followed by a test expression enclosed in parentheses
 - `case`
 - Followed by one of the possible values for the test expression and a colon
 - `break`
 - Optionally terminates a `switch` statement at the end of each case
 - `default`
 - Optionally is used prior to any action that should occur if the test variable does not match any case



Using the switch Statement (2 of 3)

```
switch(year)
{
    case 1:
        System.out.println("Freshman");
        break;
    case 2:
        System.out.println("Sophomore");
        break;
    case 3:
        System.out.println("Junior");
        break;
    case 4:
        System.out.println("Senior");
        break;
    default:
        System.out.println("Invalid year");
}
```

Figure 5-24 Determining class status using a switch statement



Using the `switch` Statement (3 of 3)

- `break` statements in the `switch` structure
 - If a `break` statement is omitted:
 - The program finds a match for the test variable
 - All statements within the `switch` statement execute from that point forward
- `case` statement
 - No need to write code for each case
 - Evaluate `char` variables
 - Ignore whether it is uppercase or lowercase
- Why use `switch` statements?
 - They are convenient when several alternative courses of action depend on a single integer, character, or string value
 - Use only when there is a reasonable number of specific matching values to be tested



Using the Conditional and NOT Operators (1 of 2)

- **Conditional operator**

- Requires three expressions separated with a question mark and a colon
- Used as an abbreviated version of the `if...else` structure
- You are never required to use it

- Syntax of a conditional operator:

```
testExpression ? trueResult : falseResult;
```



Using the Conditional and NOT Operators (2 of 2)

- A Boolean expression is evaluated as `true` or `false`
 - If the value of `testExpression` is `true`:
 - The entire conditional expression takes on the value of the expression following the question mark
 - If the value is `false`:
 - The entire expression takes on the value of `falseResult`
- An advantage of using the conditional operator is the conciseness of the statement



Using the NOT Operator

- **NOT operator**

- Written as an exclamation point (!)
- Negates the result of any Boolean expression
- When preceded by the NOT operator, any expression evaluated as:
 - `true` becomes `false`
 - `false` becomes `true`

- Statements with the NOT operator:

- Are harder to read
- Require a double set of parentheses



Understanding Operator Precedence (1 of 4)

- Combine as many AND or OR operators as needed
- An operator's precedence
 - How an expression is evaluated
 - The order agrees with common algebraic usage
 - Arithmetic is done first
 - Assignment is done last
 - The AND operator is evaluated before the OR operator
 - Statements in parentheses are evaluated first



Understanding Operator Precedence (2 of 4)

Table 5-1 Operator precedence for operators used so far		
Precedence	Operator(s)	Symbol(s)
Highest	Logical NOT	!
Intermediate	Multiplication, division, modulus	*/%
	Addition, subtraction	+ -
	Relational	> < >= <=
	Equality	== !=
	Logical AND	&&
	Logical OR	
	Conditional	?:
Lowest	Assignment	=



Understanding Operator Precedence (3 of 4)

- Two important conventions
 - The order in which operators are used makes a difference
 - Always use parentheses to change precedence or make your intentions clearer



Understanding Operator Precedence (4 of 4)

```
// Assigns extra premiums incorrectly  
if(trafficTickets > 2 || age < 25 && gender == 'M')  
    extraPremium = 200;
```

The expression that uses the && operator is evaluated first.

```
// Assigns extra premiums correctly  
if((trafficTickets > 2 || age < 25) && gender == 'M')  
    extraPremium = 200;
```

The expression within the inner parentheses is evaluated first.

Figure 5-31 Two comparisons using && and ||



Adding Decisions and Constructors to Instance Methods (1 of 2)

- Helps ensure that fields have acceptable values
- Determines whether values are within the allowed limits for the fields



Adding Decisions and Constructors to Instance Methods (2 of 2)

```
public class Employee
{
    private int empNum;
    private double payRate;
    public int MAX_EMP_NUM = 9999;
    public double MAX_RATE = 60.00;
    Employee(int num, double rate)
    {
        if(num <= MAX_EMP_NUM)
            empNum = num;
        else
            empNum = MAX_EMP_NUM;
        if(payRate <= MAX_RATE)
            payRate = rate;
        else
            payRate = 0;
    }
    public int getEmpNum()
    {
        return empNum;
    }
    public double getPayRate()
    {
        return payRate;
    }
}
```

Figure 5-32 The Employee class that contains a constructor that makes decisions



Don't Do It (1 of 2)

- Don't ignore subtleties in boundaries used in decision making
- Don't use the assignment operator instead of the comparison operator
- Don't insert a semicolon after the Boolean expression in an `if` statement
- Don't forget to block a set of statements with curly braces when several statements depend on the `if` or the `else` statement



Don't Do It (2 of 2)

- Don't forget to include a complete Boolean expression on each side of an `&&` or `||` operator
- Don't try to use a `switch` structure to test anything other than an integer, a character, or a string value
- Don't forget a `break` statement if one is required
- Don't use the standard relational operators to compare objects



Summary (1 of 3)

- `if` statement
 - Makes a decision based on a Boolean expression
- Single-alternative `if`
 - Performs an action based on one alternative
- Dual-alternative `if`
 - `if...else`
 - Performs one action when a Boolean expression evaluates as `true`
 - Performs a different action when an expression evaluates as `false`



Summary (2 of 3)

- AND operator
 - `& &`
 - Determines whether two expressions are both `true`
- OR operator
 - `||`
 - Carries out some action even if only one of two conditions is `true`
- `switch` statement
 - Tests a single variable against a series of exact integer or character values



Summary (3 of 3)

- Conditional operator
 - An abbreviated version of an `if...else` statement
- NOT operator
 - `!`
 - Negates the result of any Boolean expression
- Operator precedence