Selection Statements

CS 180
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Problem

- *Write a program that tells a patient if their total cholesterol measure is too high or not.*
  - *The measure is an integer and is too high if it exceeds 239.*
- *Your program should read in the measure and output an appropriate evaluation.*

Choices

- Clearly, in order to solve this problem, we need to be able to choose which of the alternative messages to print.
- All programming languages provide this ability to choose: selection statements
- Java provides **if-else** and **switch** statements.

Flow of control

- Once a statement is executed, the next statement of the program is executed.
- Calling a method transfers the control to the statements in the method.
- Once the method returns, control returns to statement that made the call.
- Changing this flow of control is achieved using **if** and **switch** (and other) statements.
- These are called control flow statements.

Solution

```
import javax.swing.*;

public class CholesterolCheck {
  public static void main (String[] args){
    int chLevel;

    chLevel = Integer.parseInt(JOptionPane.showInputDialog(null,
                                                            "Please
enter your cholesterol level"));

    if(chLevel>239)
      JOptionPane.showMessageDialog(null,
                    "Your cholesterol level is too high");
    else
      JOptionPane.showMessageDialog(null,
                     "Your cholesterol level is not too high");
  }
}
```

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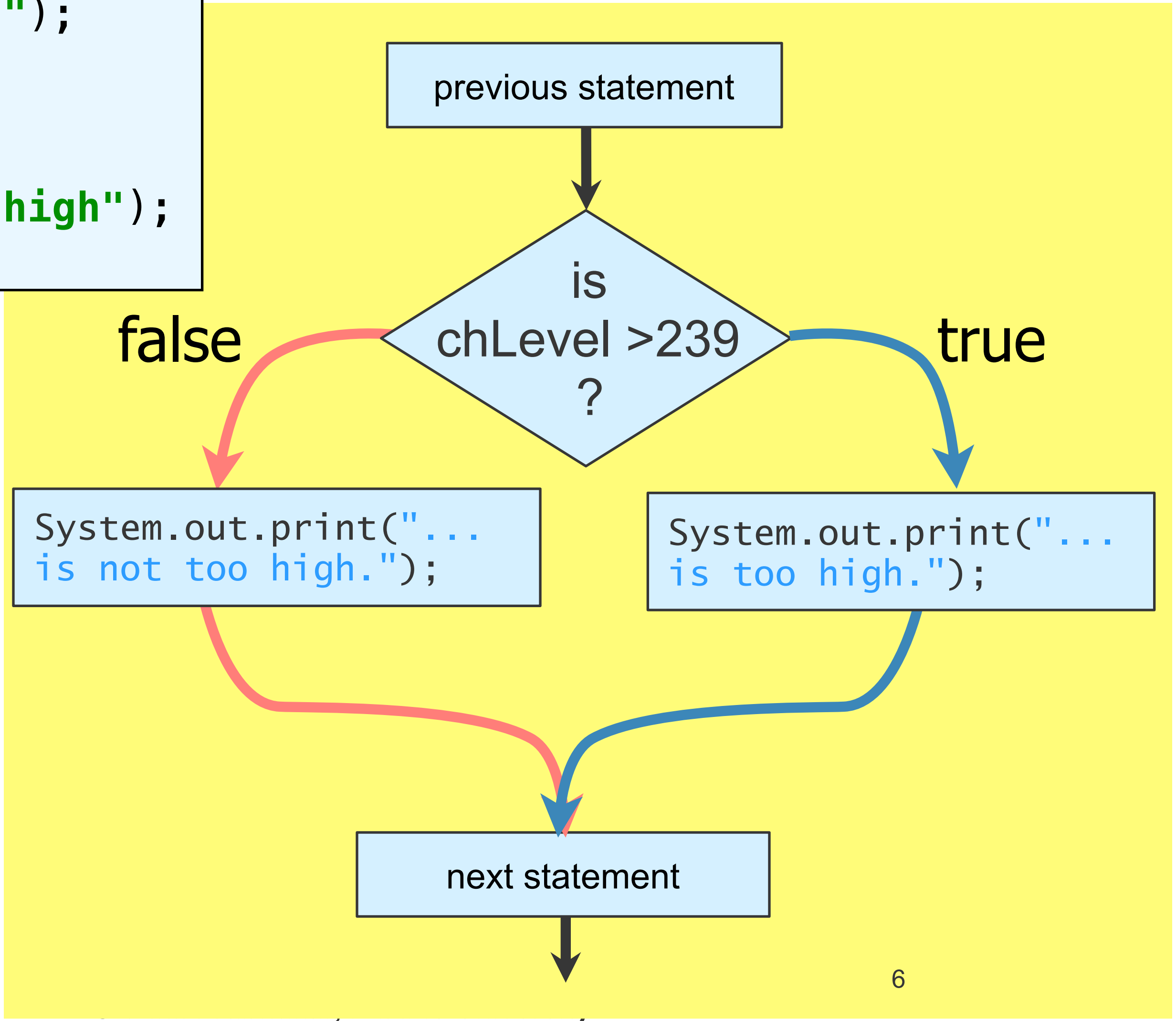
if-else Control Flow

```
if(chLevel>239)
     System.out.println(
        ". . .is too high");
else
     System.out.println(

        ". . .is not too high");
```


previous statement
is chLevel >239 ?
false
true
System.out.print("... is not too high.");
System.out.print("... is too high.");
next statement

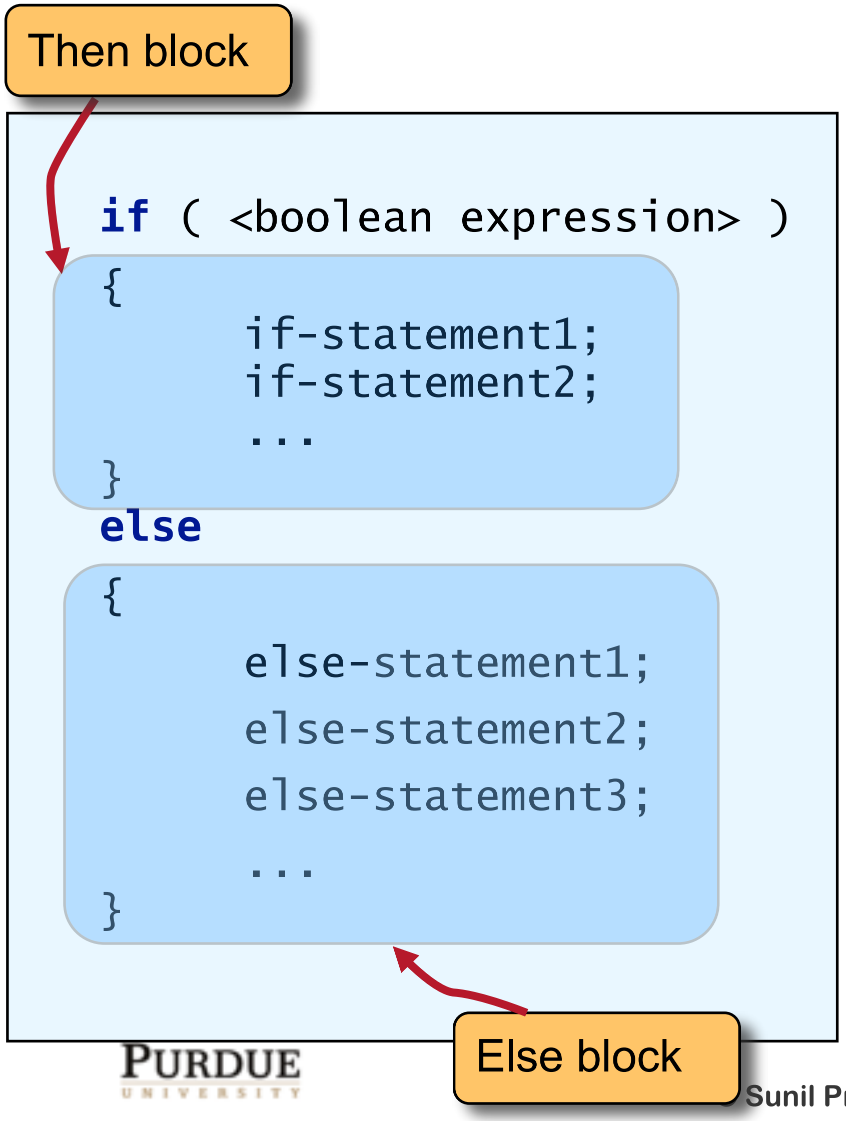
Depending upon the value of chLevel, one or the other branch is executed, not both.

if-else syntax

```
if ( <boolean expression> )
        if-statement;
else
        else-statement;
```

- The boolean expression is a special type of expression which can have one of two values: **true** or **false** values
- If the expression evaluates to **true**, the if-statement is executed; otherwise
- the else-statement is executed.

Multiple conditional statements

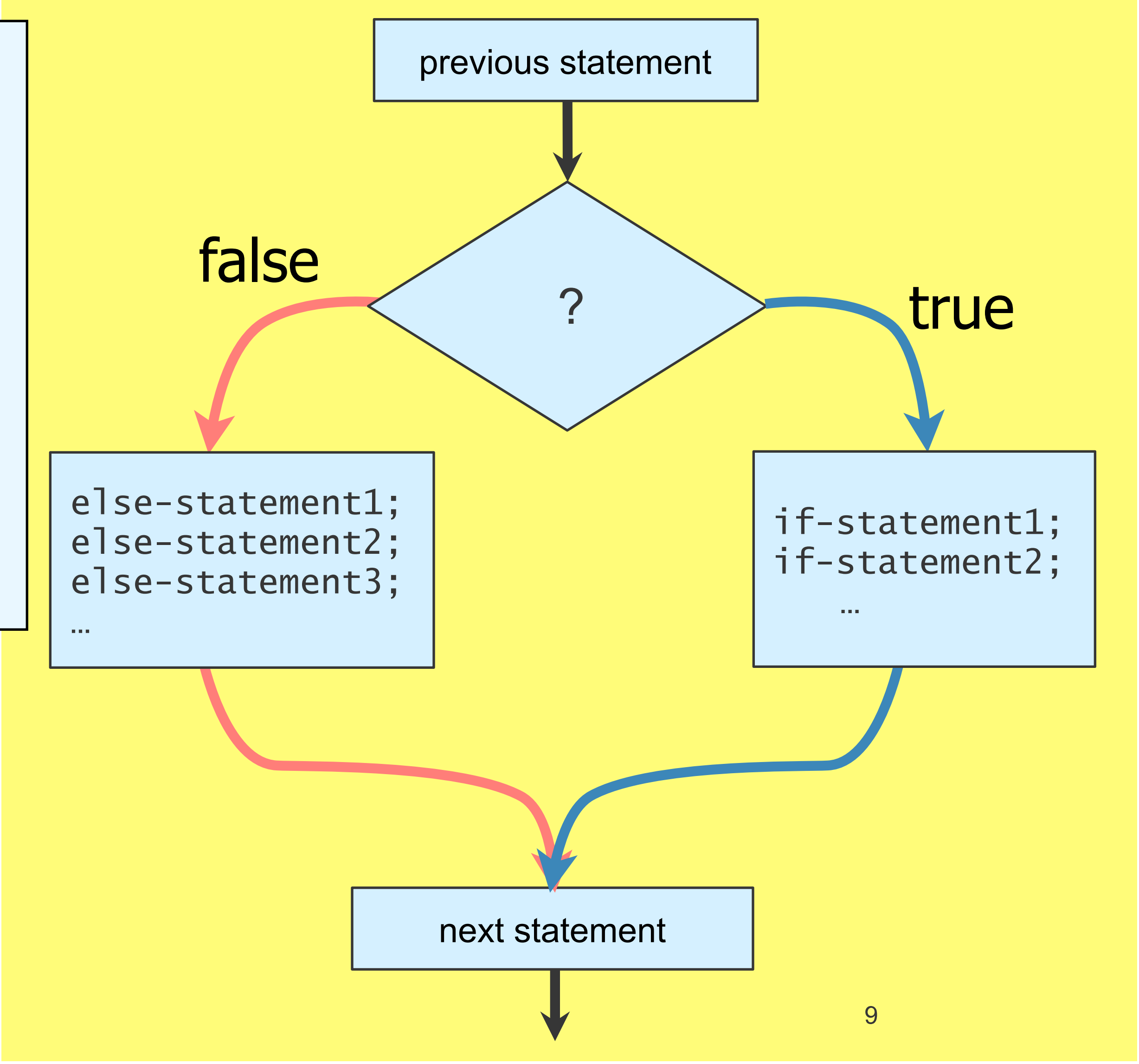


```
if ( <boolean expression> )
{
        if-statement1;
        if-statement2;
        ...
}
else
{
        else-statement1;
        else-statement2;
        else-statement3;
        ...
}
```

- We can have multiple statements for the if and/or else branches.
- Braces are used to combine multiple statements into a single block.

if-else Blocks Control Flow

```
if (<boolean expression>)
{
   if-statement1;
   if-statement2;
      …
}
else
{
   else-statement1;
   else-statement2;
   else-statement3;
      …
}
```



Solution

```
public class CholesterolCheck2 {
    public static void main(String[] args){
        int chLevel;
        chLevel = Integer.parseInt(JOptionPane.showInputDialog(
                null, "Enter your cholesterol measure"));

        if(chLevel > 239) {

            System.out.println("Your cholesterol level is too high.");
            System.out.println ("You should probably see a doctor.");

        } else {

            System.out.println("Your cholesterol level is not too high.");
            System.out.println("Don't forget to exercise.");

        }

    }
}
```

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Boolean Expressions

- `boolean` is a primitive data type.
- A boolean value can only be either `true` or `false`
- A simple boolean expression compares two values using a relational operator, e.g.,
  - chLevel > 239
  - height < weight
  - gpa == 3.0
- The operands can be either variables or literal values.

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Relational Operators

- The following operators can be used to compare numeric data types:

Relational Operator	Meaning
>	Greater than
<	Less than
==	Equal to
>=	Greater than or equal to
<=	Less than or equal to
!=	Not equal to

Do not confuse with assignment (=).

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Complex boolean expressions

- Boolean expressions can be combined using boolean operators to form more complex expressions.
  - Analogous to normal conditional statements.
- For example,
  - given three **`int`** variables i,j, and k:

```
(i > j) && (k == 5)
```

  - evaluates to **`true`** only if the value stored in i is greater than the value stored in j AND the value stored in k is equal to 5; **`false`** otherwise.

Boolean Operators

- Boolean operators take boolean expressions as operands.

Boolean Operator	Meaning
&&	AND
||	OR
!	Not (negation). Takes only one operand
^	Exclusive-OR

These are two "pipe" characters

Boolean Operators (contd)

- bool1 && bool2
  - is **true** if both bool1 and bool2 are **true**;
  - otherwise it is **false**
    - (x > 2) && (x<10) is **true** for x=3; **false** for x=11;
- bool1 || bool2
  - is **true** if either bool1 or bool2 (or both) are **true**;
  - otherwise it is **false**
    - (x>2) || (x<10) is always true.

Boolean Operators (contd)

- !bool1
  - is **true** if bool1 is **false**,
  - and **false** if bool1 is **true**
    - !(x>2) is **true** for x=1; and **false** for x=3;

- bool1 ^ bool2
  - is **true** if bool1 and bool2 are **different**;
  - otherwise it is **false**
    - (x>2) ^ (x<10) is false for x=3; and true for x = 11;

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Definition of Boolean Operators

- Truth table for boolean operators

p	q	p && q	p || q	!p	p^q
`false`	`false`	`false`	`false`	`true`	`false`
`false`	`true`	`false`	`true`	`true`	`true`
`true`	`false`	`false`	`true`	`false`	`true`
`true`	`true`	`true`	`true`	`false`	`false`

- Sometimes true and false are represented by 1 and 0 (NOT in Java).
- In C and C++, 0 is **`false`**, everything else is **`true`**.

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Examples of boolean expressions.

```
int i, j;
byte b, c;
float f, g;
double d, e;
```

```
i < j
```

```
f >= i
```

```
d > 9.3
```

```
2 == c
```

```
j != i
```

```
g <= (b*c + d)
```

```
(i > j)  &&  (f >= i)
```

```
(d > 9.3) || (2 != d)
```

```
!(c <= j) ^ (j != i)
```

```
((i > j)  &&  (f >= i)) || ((d > 9.3) || (2 != d)) ^ (!(c <= j) ^ (j != i))
```

Problem

- *Write a program that tells a patient how to interpret their total cholesterol measure. The measure is an integer. A cholesterol measure*
  - *Less than 200 is "Desirable"*
  - *200-239 is "Mildly High"*
  - *240 and above is "High"*
- *Your program should read in the measure and output an appropriate evaluation.*

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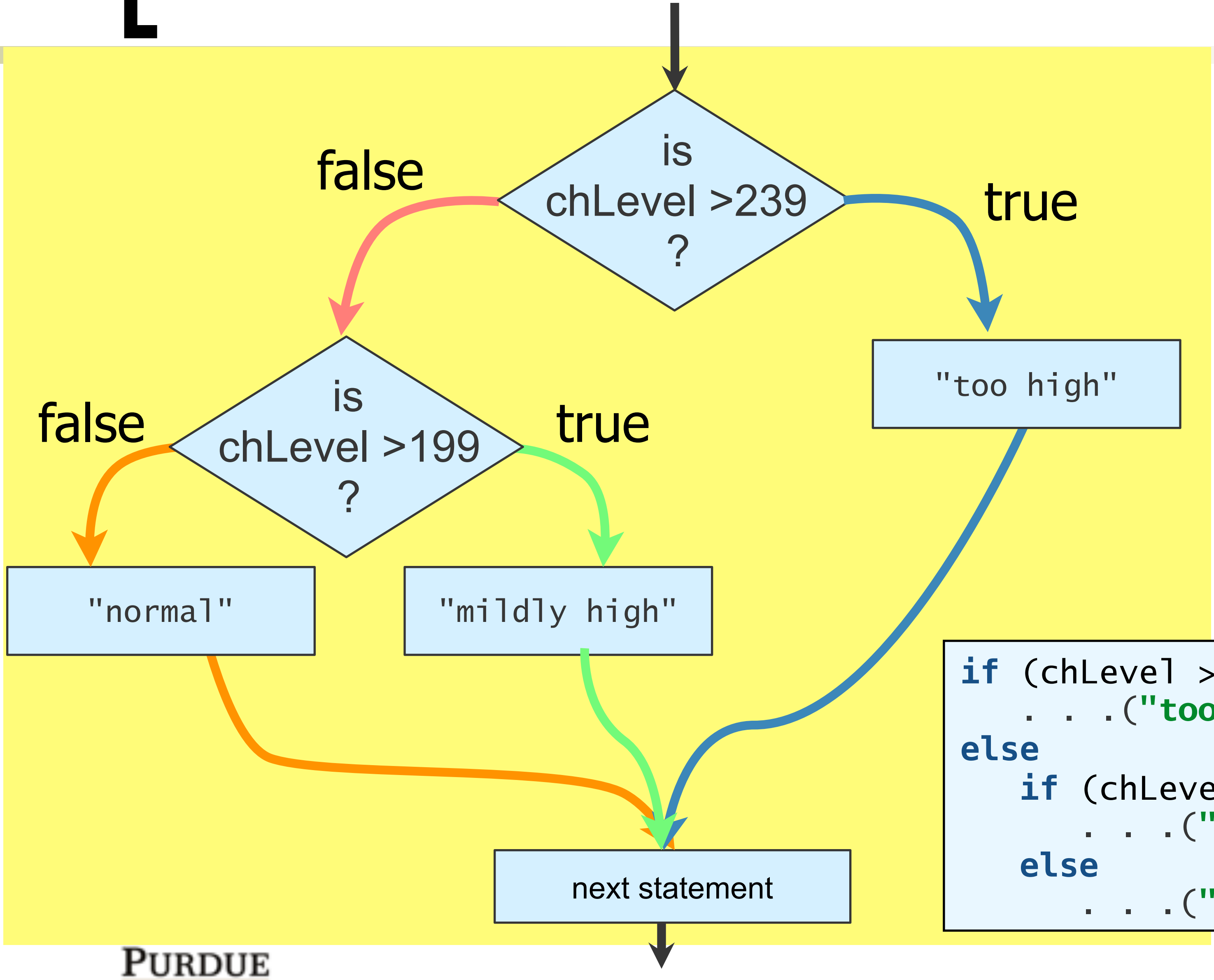
The Nested-`if` Statement

- The `then` and `else` block of an **`if`** statement can contain any valid statements, including other if statements. An if statement containing another if statement is called a nested-if statement.

```
if(chLevel>239)
  JOptionPane.showMessageDialog(null, ". . .is too high");
else
   if (chLevel > 199)
      JOptionPane.showMessageDialog(null, ". . . mildly high");
   else
      JOptionPane.showMessageDialog(null, " . . is normal");
```

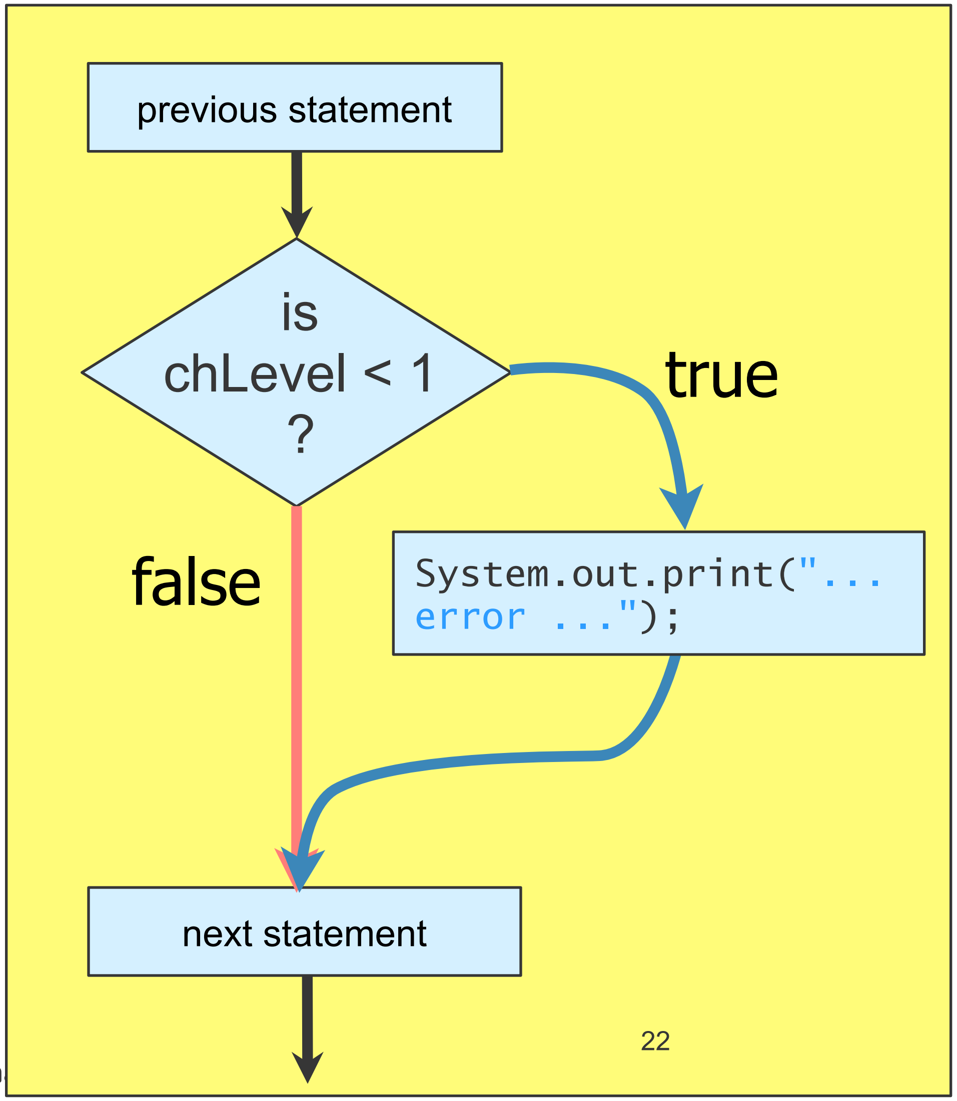
Sample control flow



```
if (chLevel > 239)
   . . .("too high.");
else
   if (chLevel > 199)
      . . .("mildly high.");
   else
      . . .("normal.");
```

else is Not Required

```
if (chLevel < 1){
    System.out.print("There is an
    error in your input");
}
...
```



Caution: Dangling else

```
if (chLevel > 199)
   if (chLevel > 239)
      System.out.print("Too High");
   else
      System.out.print("Mildly High");
```

Same as

```
if (chLevel > 199){
   if (chLevel > 239)
      System.out.print("Too High");
   else
      System.out.print("Mildly High");
}
```

```
if (chLevel > 199)
   if (chLevel > 239)
      System.out.print("Too High");
else
   System.out.print("Normal");
```

⚠

Same as

```
if (chLevel > 199) {
   if (chLevel > 239)
      System.out.print("Too High");
   else
      System.out.print("Normal");
}
```

⚠

```
if (chLevel > 199) {
   if (chLevel > 239)
      System.out.print("Too High");
} else
      System.out.print("Normal");
```

Each else paired with nearest unmatched if -- use braces to change this as needed.

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Boolean Variables

- Boolean values can be stored in **boolean** variables -- a primitive datatype.
  - Hint: pick meaningful names
- Can be used in boolean expressions.

```
boolean hasWon,isFinalLevel;

    isFinalLevel = false;
    …
    isFinalLevel = (gameLevel == 10);
    hasWon = (numberOfZombies == 0);

    if (hasWon)
        if (isFinalLevel)
            System.out.println("WOW -- you beat the game!");
        else
            startNextLevel();
    else
        restartSameLevel();
}
```

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Boolean Methods

- A method that returns a boolean value is a Boolean method.
- A call to this method can be used as a boolean value.

```java
public boolean isGameOver(){
    if((numberOfHumans < 1) || (numberOfZombies<1))
        return true;
    else
        return false;
}
```

```java
if( isGameOver() )
    if(numberOfZombies < 1)
        System.out.println("You WON!!");
    else
        System.out.println("Sorry, you lost!!");
else
    System.out.println("Battle on…");
```

Operator Precedence Rules

Group	Operator	Order
Subexpresion	( )	Innermost first
Postfix increment and decrement	++, --	**Right to Left**
Unary operators Prefix increment and decrement	++, --, - , !	**Right to Left**
Multiplicative	*, /, %	Left to Right
Additive	+ , -	Left to Right
Relational	<, <=, >, <,	Left to Right
Equality	!=, ==	Left to Right
Boolean AND	&&	Left to Right
Boolean OR	||	Left to Right
Assignment	=	**Right to Left**

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Increment and Decrement

- The increment (++) and decrement (--) operators can precede the operand
  - x++;   ++x; y--; --y;
- Their effect on the operand is the same, however, they vary only in terms of the timing of the increment or decrement.
- The postfix operators are applied AFTER the variable's value is used.
- The prefix operator are applied BEFORE

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Example

```
int x=2, y=10;

x = y++;
System.out.println("X is:" + x);
System.out.println("Y is:" + y);
```

```
X is: 10
Y is: 11
```

```
int x=2, y=10;

x = y--;
System.out.println("X is:" + x);
System.out.println("Y is:" + y);
```

```
X is: 10
Y is: 9
```

```
int x=2, y=10;

x = ++y;
System.out.println("X is:" + x);
System.out.println("Y is:" + y);
```

```
X is: 11
Y is: 11
```

```
int x=2, y=10;

x = --y;
System.out.println("X is:" + x);
System.out.println("Y is:" + y);
```

```
X is: 9
Y is: 9
```

```
int x=2, y=10, z;

z = x++ * --y;
System.out.println("X is:" + x);
System.out.println("Y is:" + y);
System.out.println("Z is:" + z);
```

```
X is: 3
Y is: 9
Z is: 18
```

```
int x=2, y=10;

x = --x * ++y;
System.out.println("X is:" + x);
System.out.println("Y is:" + y);
```

```
X is: 11
Y is: 11
```

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Examples

- Write a program that classifies triangles
  - by their sides
  - by their angles
- Write a program that classifies quadrilaterals by their sides and one angle
  - consider only parallelograms, rectangles, squares and rhombi.

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TriangleClassifier

```
public class TriangleClassifier {
  public static void main(String args[]) {
      int side1, side2, side3;
      String type;

      //get the three lengths from the user
      if (side1 == side2)
          if (side1 == side3)
              type = "Equilateral";
          else
              type = "Isosceles";
      else
              type = "Scalene";

    System.out.println("This is a " + type + " triangle.");
}
```

Not quite!!

TriangleClassifier

```
public class TriangleClassifier {
  public static void main(String args[]) {
      int side1, side2, side3;
      String type;

      //get the three lengths from the user
      if (side1 == side2)
          if (side1 == side3)
              type = "Equilateral";
          else
              type = "Isosceles";
      else
           if(side2==side3)
              type = "Isosceles";
           else
              type = "Scalene";

    System.out.println("This is a " + type + " triangle.");
}
```

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TriangleClassifier2

```
public class TriangleClassifier2 {
    public static void main(String args[]) {
        //variables for the three angles input by the user, and the maximum
Angle.
        double angle1, angle2, angle3, maxAngle;
       //read  angles from the user
       . . .
        //determine the maximum angle
        maxAngle = Math.max(angle1, Math.max(angle2, angle3));

        //determine the type of triangle.
        if (((maxAngle - 90.0) < 0.0000001) || ((90.0 - maxAngle) < 0.0000001))
            type = " right-angled";
        else if (maxAngle > 90.0)
            type = "n obtuse";
        else
            type = "n acute";

        System.out.println("This is a " + type + " triangle.");
    }
    . . .
}
```

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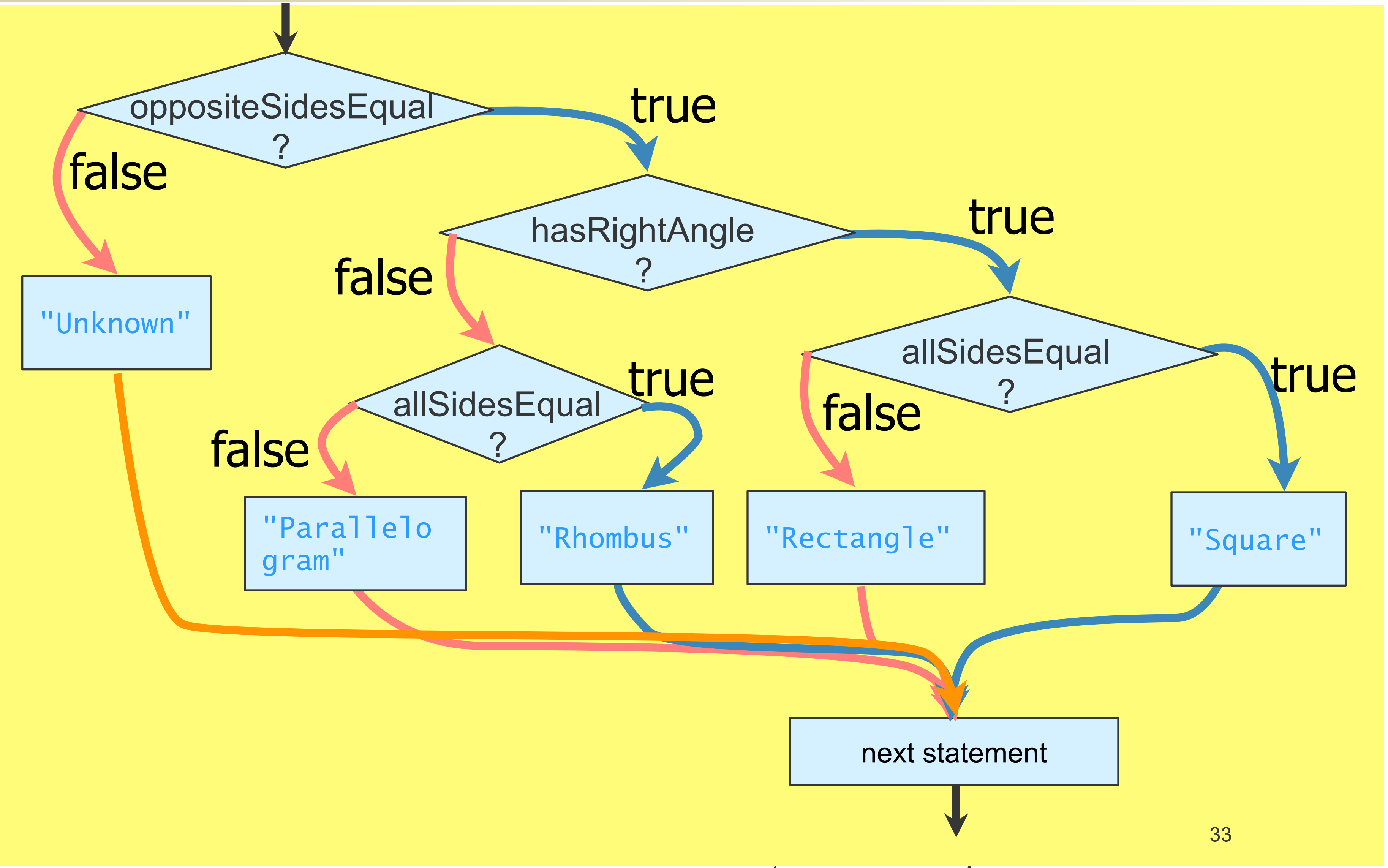
Quadrilateral Logic



QuadClassifier

```java
public class QuadClassifier {
    public static void main(String args[]) {
        int side1, side2, side3, side4;
        int anyAngle;

        if ((side1 == side3) && (side2 == side4))
            if (anyAngle == 90)
                if (side1 == side2)
                    type = "Square";
                else
                    type = "Rectangle";
            else
                if (side1 == side2)
                    type = "Rhombus";
                else
                    type = "Parallelogram";
        else
            type = " type that is unfamiliar to this program";

        System.out.println("The quadilateral is a " + type);
    }
```

```
public class QuadClassifier2 {
   . . .
   boolean oppositeSidesEqual, allSidesEqual, hasRightAngle;
    . . .
   oppositeSidesEqual = (side1==side3) && (side2==side4);
   allSidesEqual = oppositeSidesEqual && (side1 == side2);
   hasRightAngle = anyAngle==90;
    if (oppositeSidesEqual) {
        if (hasRightAngle) {
            if (allSidesEqual) {
                type = "Square";
            } else {
                type = "Rectangle";
            }
        } else {
            if (allSidesEqual) {
                type = "Rhombus";
            } else {
                type = "Parallelogram";
            }
        }
    } else {
        type = " type that is unfamiliar to this program";
    }

   System.out.println("The quadilateral is a " + type);
```

Easier to understand.

QuadClassifier2

Comparing Objects

- As with numeric types, we can compare two objects for equality and inequality
  - Relational operators (<, < , <=, <=) are **not allowed** for objects.
- Recall that these are reference types.
  - Thus, we are really testing for equality of the references, i.e., are the two variable referencing the same object or not?
- If we want to compare their contents, we need special methods.

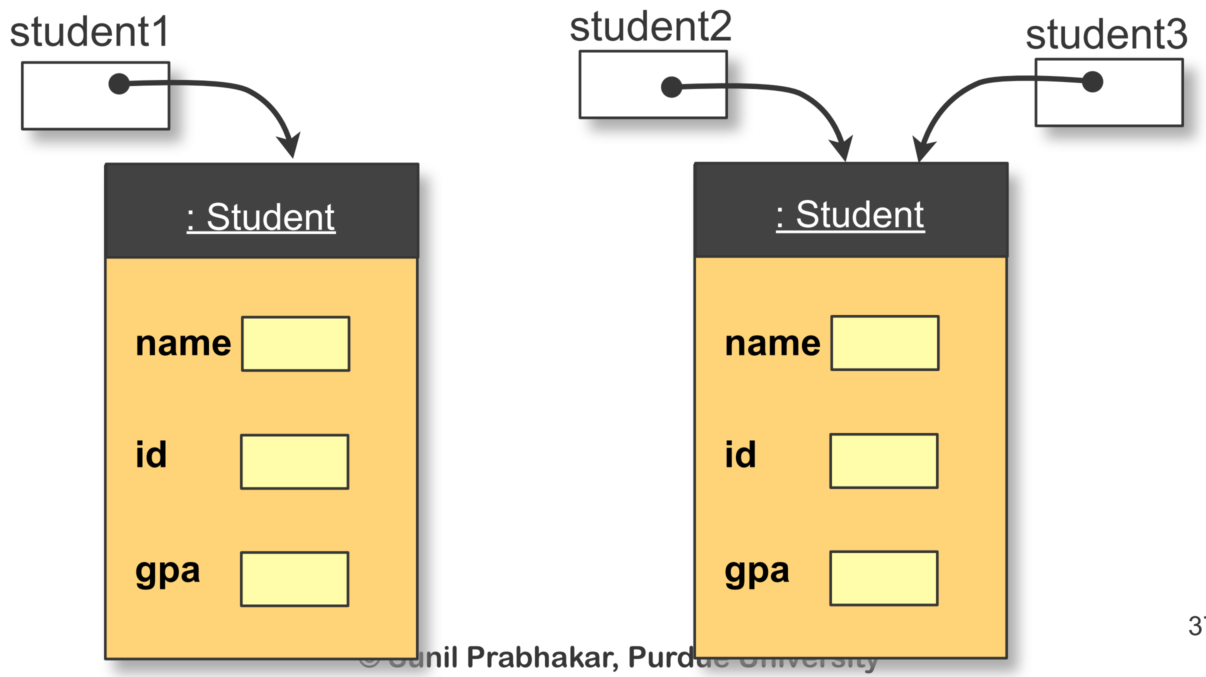
Comparing Objects

```
Student student1, student2, student3;

student1 = new Student();
student2 = new Student();
student3 = student2;

if(student1 == student2)
   System.out.println("Equal");
else
   System.out.println("Not Equal");
```

"Not Equal"



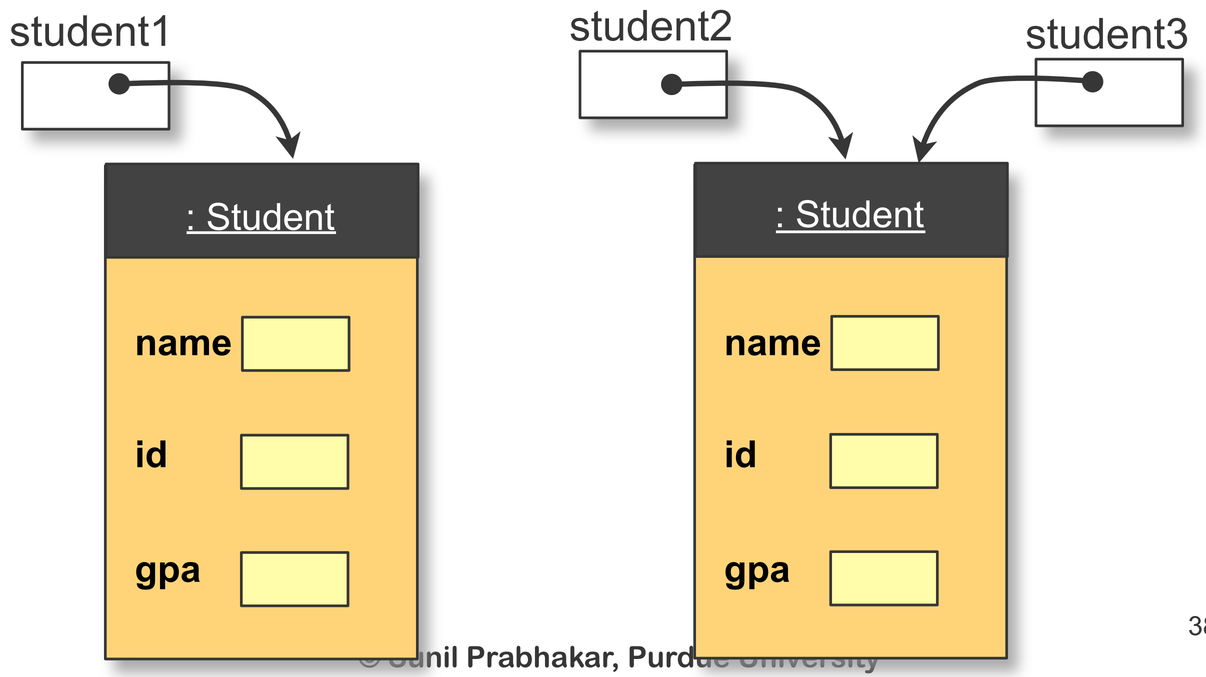
Comparing Objects

```
Student student1, student2, student3;

student1 = new Student();
student2 = new Student();
student3 = student2;

if(student3 == student2)
   System.out.println("Equal");
else
   System.out.println("Not Equal");
```

"Equal"



Comparing Object Contents

- If we want to compare the internal contents of objects, we have to use methods
- For example, with String objects, we can use
  - equals() to test equality of two strings' contents
  - equalsIgnoreCase() to test equality while treating upper and lower case of the same letter as equal
  - compareTo() to determine the relative position of two strings in lexicographic order.
  - each is called on one string with the other as an argument

Comparing Strings

```
String str1 = "Elephant", str2 = "eLePhant";

if(str1.equals(str2)){
     System.out.println("They are equal");
} else {
     System.out.println("They are not equal");
}

if(str1.equalsIgnoreCase(str2)){
     System.out.println("Equal, but for case");
} else {
     System.out.println("They are not equal");
}
```

$\rightarrow$ "They are not equal"

$\rightarrow$ "Equal but for case"

compareTo method

- Strings are compared character by character. The return value is an integer that tells us their relative order.

```
String str1, str2;
int i;

i = str1.compareTo(str2);

if(i==0)
     System.out.println(str1 + " equals " + str2);
else
   if(i>0)
     System.out.println(str2 + " precedes " + str1);
   else
     System.out.println(str1 + " precedes " + str2);
```

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equals() for Other Classes

- All classes get an equals() method for free.
- However, it may not work as expected.
- If you wish to compare objects of your classes for equality of content you should write an appropriate method.
- We will see some examples later.

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The **char** Data Type

Each character of a string is an instance of a primitive type called **char**.

- In Java, a **char** variable is stored using two bytes
  - each character is encoded using an international standard called UNICODE
  - character literal are written with single quotes, e.g., 'c' 'x' 'δ' 'स' 'س' 'ש' '大' '๛' '☜'
  - some languages may use ASCII -- an older subset of UNICODE (1 byte per char).

Unicode Encoding

- Extended version of ASCII to accommodate world languages and common symbols.
  - Each character mapped to a code (2 bytes)
  - Often written in hexadecimal e.g., '\u1234'
  - Can convert between **int** and **char** types

```java
char ch = 'A';
int code = '\u2620';

System.out.println(ch);
System.out.println( (int) ch);
ch = (char)code;
System.out.println(ch);
```

```
A
61

☠
```

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Characters and Relational Operators

- We can compare characters with each other or with numeric

```
char ch1='x', ch2=64, ch3='\u00a9';
int i,j;

if( ch1 == ‘X’ || ch2 == 99){
   …
}

if(ch2 < i && ch3 < ch2){
   …
}
System.out.println(ch1 +  ch2 + ch3);
System.out.println("" + ch1 +  ch2 + ch3);
```

```
353
x@©
```

Strings and Characters

- We can get the character at a given index of a string using charAt()

```
char ch;
String s = "Go Purdue!!!";

ch = s.charAt(4);
System.out.println("The Character at index 4 is:" + ch);
```

- We can combine characters into a string

```
char ch1 = 'C', ch2 = 111, ch3 = '\u006c', ch4='\u0089';
String s;
s = "" + ch1 + ch2 + ch2 + ch3 + ch4;
System.out.println(s);
```

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`if` and `switch`

- The `if` statement is essential for writing useful programs.
- Other control flow statements (e.g., switch and loops) can be implemented using if statements.
  - However, programs are more readable and less error-prone by using these other control flow statements.
- Next: `switch`

Converting Grades to Points

```
class StudentV5 {
 . . .

 public void recordGrade(){
   char letterGrade;
    . . .
   letterGrade = JOptionPane.showInputDialog(null, "Enter Grade").charAt(0);
   if (letterGrade == 'A')
       grade = 4;
   else if (letterGrade == 'B')
       grade = 3;
   else if (letterGrade == 'C')
       grade = 2;
   else if (letterGrade == 'D')
       grade = 1;
  else
       grade = 0;
    . . .
```

Using a **switch** statement

```
if (letterGrade == 'A')
    grade = 4;
else if (letterGrade == 'B')
    grade = 3;
else if (letterGrade == 'C')
    grade = 2;
else if (letterGrade == 'D')
    grade = 1;
else
    grade = 0;
```

Equivalent code

```
switch(letterGrade) {
    case 'A':
        grade = 4;
        break;
    case 'B':
        grade = 3;
        break;
    case 'C':
        grade = 2;
        break;
    case 'D':
        grade = 1;
        break;
    default:
        grade = 0;
}
```

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Using a switch statement

Equivalent code

```
if (letterGrade == 'A')
    grade = 4;
else if (letterGrade == 'B')
    grade = 3;
else if (letterGrade == 'C')
    grade = 2;
else if (letterGrade == 'D')
    grade = 1;
else
    grade = 0;
```

Executed only if letterGrade == 'A'

Executed only if letterGrade == 'B'

Executed only if letterGrade == 'C'

Executed only if letterGrade == 'D'

Executed only if none of the above cases match

```
switch(letterGrade) {
    case 'A':
        grade = 4;
        break;
    case 'B':
        grade = 3;
        break;
    case 'C':
        grade = 2;
        break;
    case 'D':
        grade = 1;
        break;
    default:
        grade = 0;
}
```

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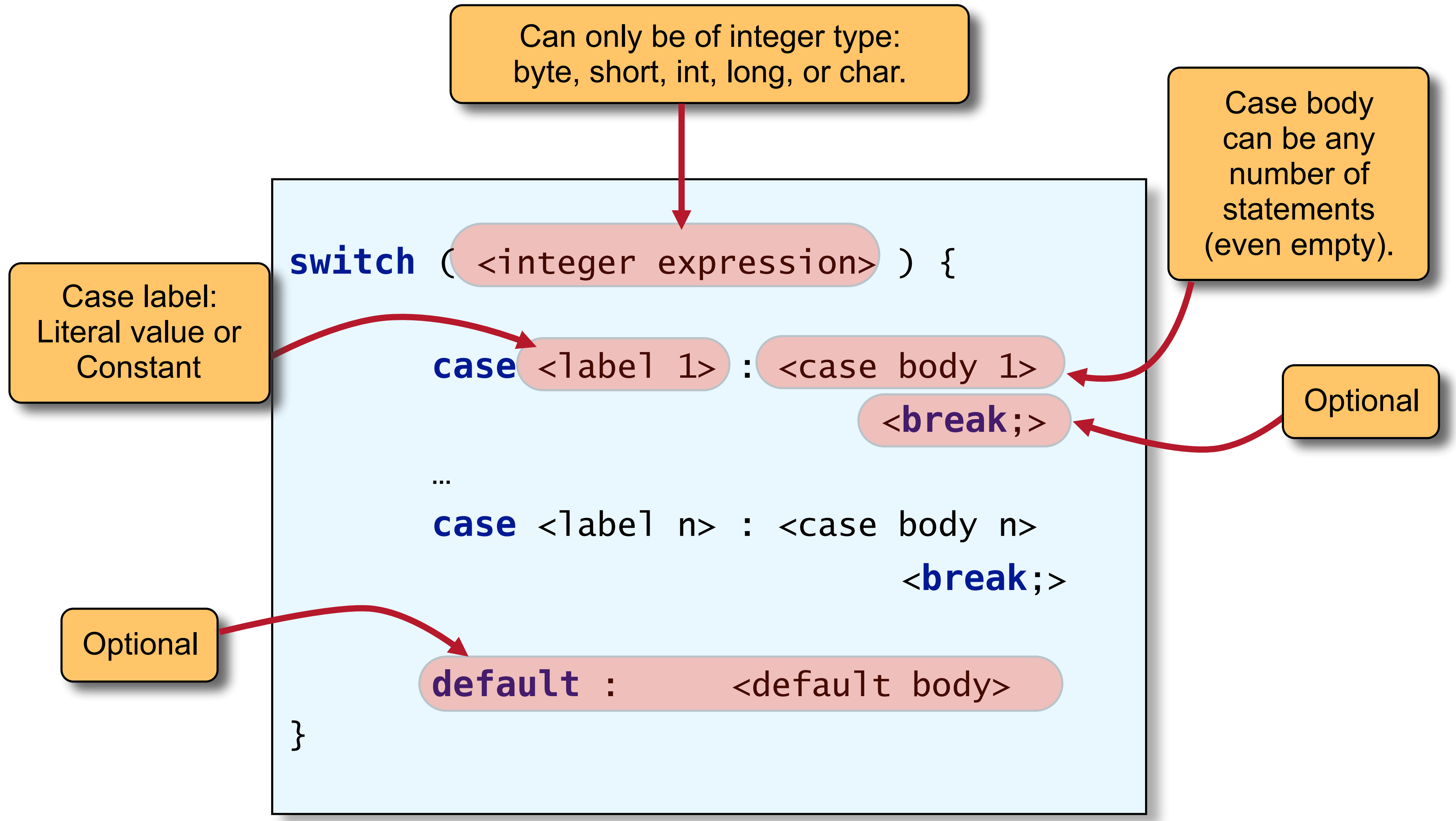
Syntax for the `switch` Statement


Can only be of integer type: byte, short, int, long, or char.
Case body can be any number of statements (even empty).
Case label: Literal value or Constant
Optional
Optional

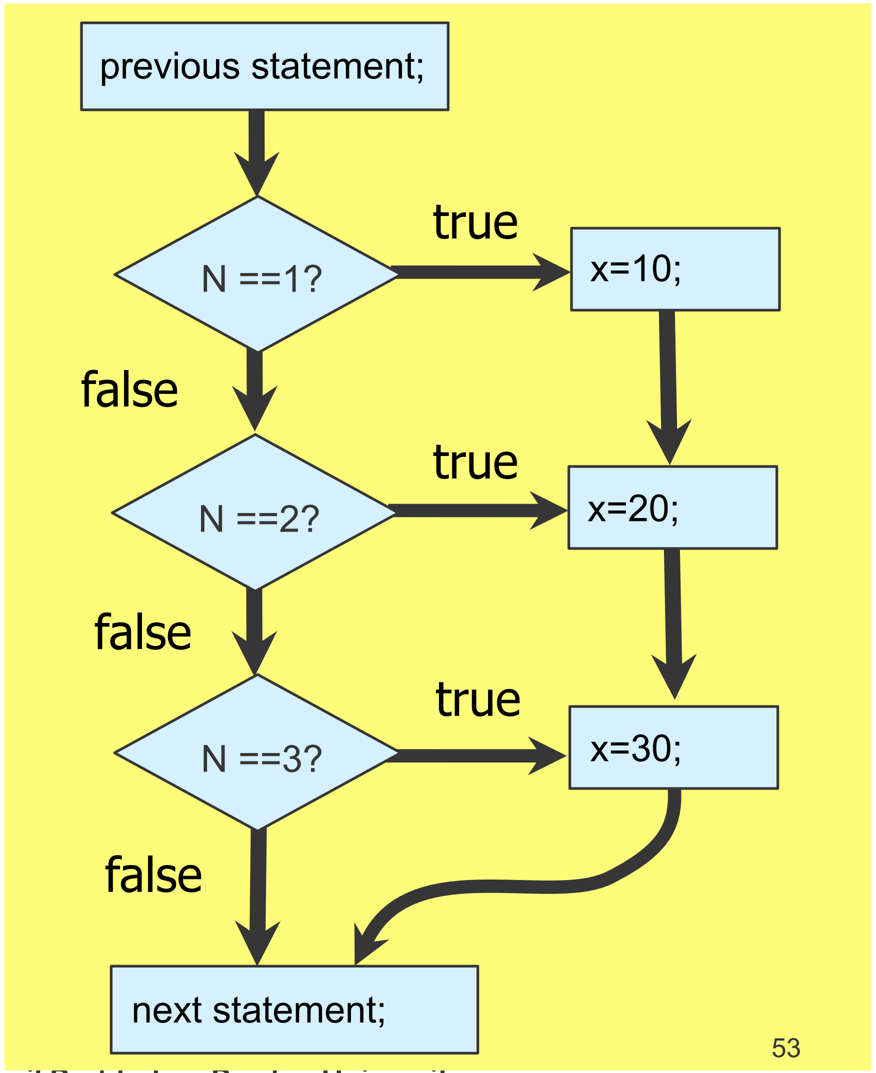
```
switch ( <integer expression> ) {

        case <label 1> : <case body 1>
                             <break;>
        …
        case <label n> : <case body n>
                             <break;>

        default :      <default body>
}
```

`switch` statement (cont.)

- The integer expression can have only one of the following types:
  - `char`, `byte`, `short`, or `int` (and enum types)
  - Java 7 allows Strings too.
- The label must be a literal or named constant of the same type as the integer expression
  - Each label must be unique.
  - Labels may be listed in any order.
  - The `default` case applies when no label matches.
- A `break` causes execution to break out of the switch statement to the next statement.
  - each `break` is optional

Simple switch statement

```
switch ( N ) {
    case 1: x = 10;
    case 2: x = 20;
    case 3: x = 30;
}
```



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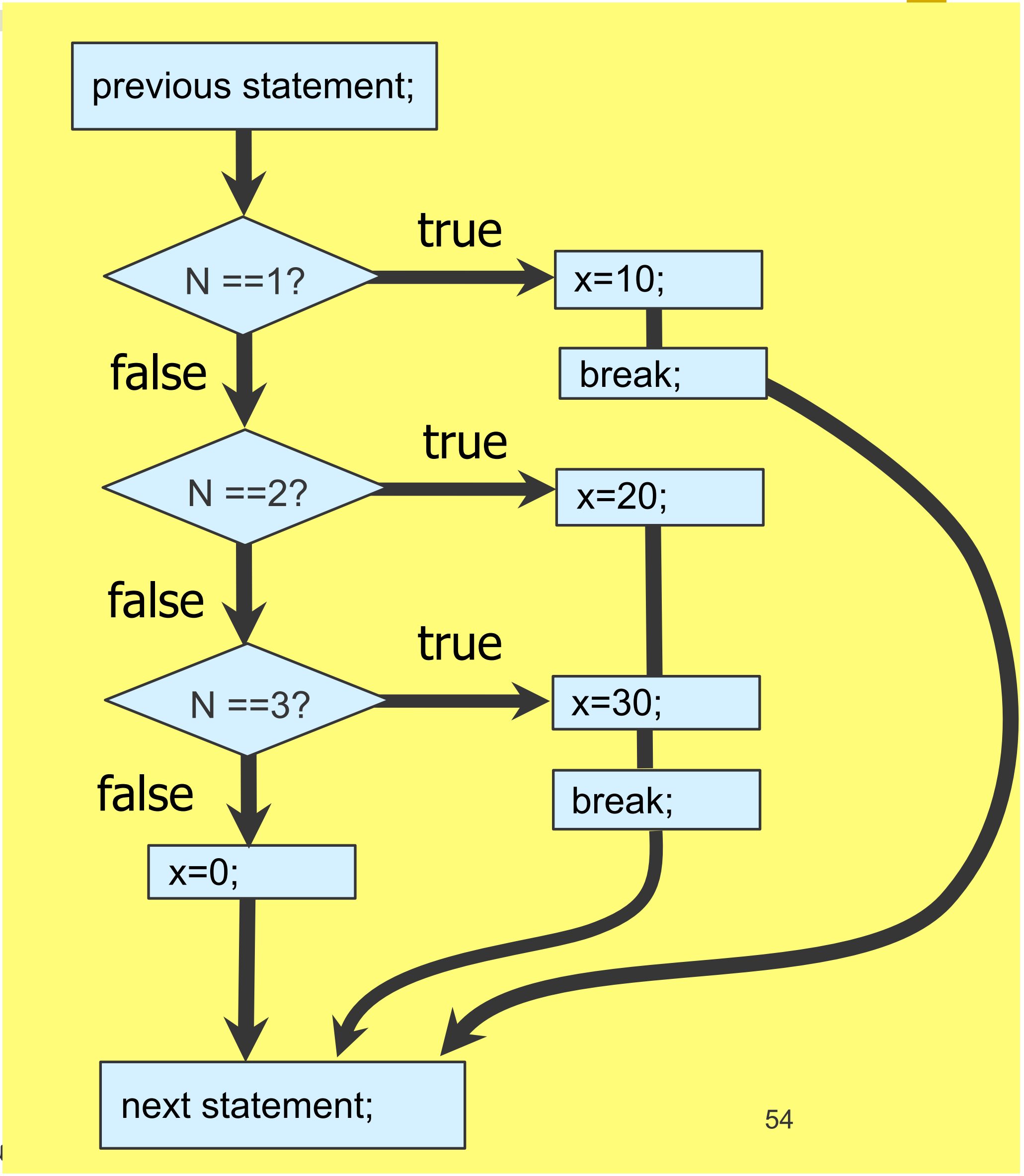
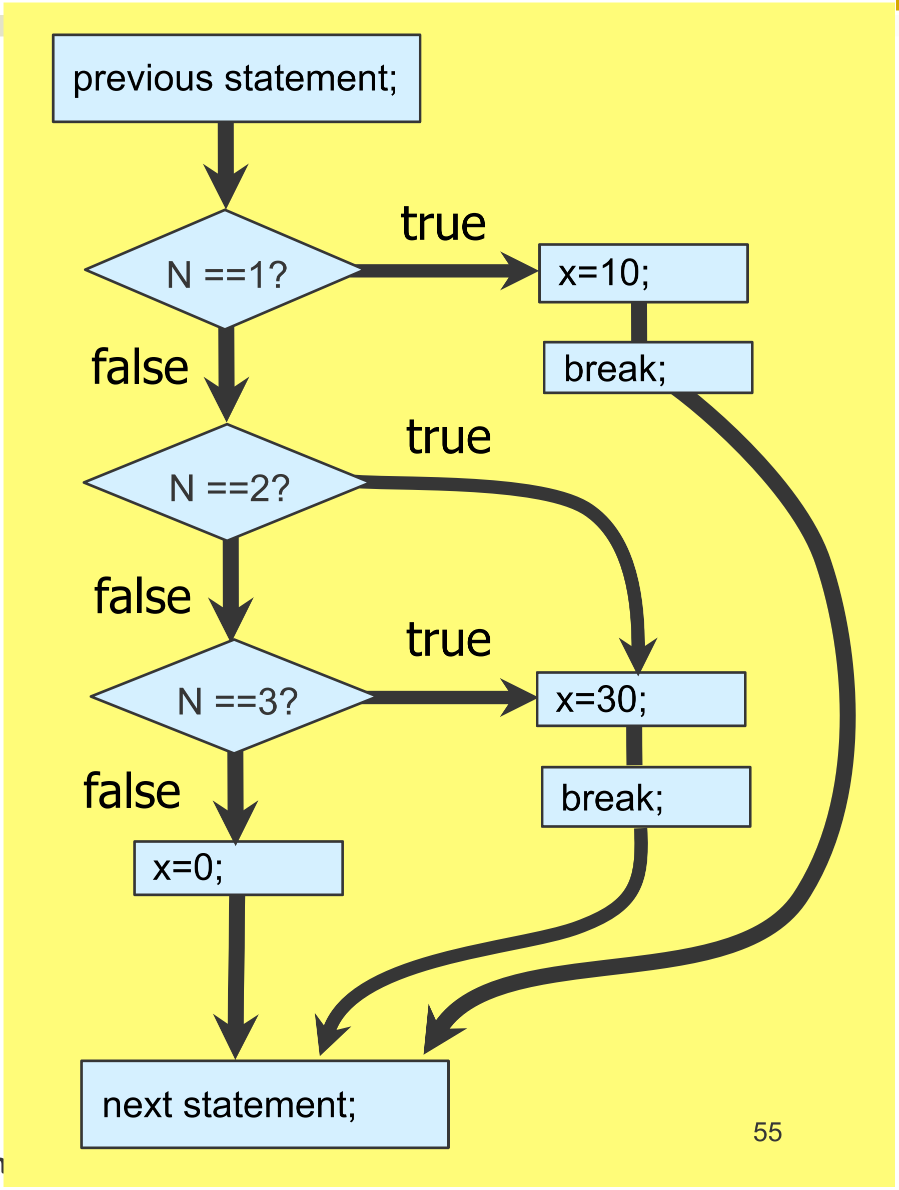
switch with break, and default

```
switch ( N ) {
    case 1: x = 10;
                break;
    case 2: x = 20;
    case 3: x = 30;
                break;
    default: x = 0;
}
```



Missing case body

```
switch ( N ) {
    case 1: x = 10;
                break;
    case 2:
    case 3: x = 30;
                break;
    default: x = 0;
}
```



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DaysInMonth

```
int month, daysInMonth;
boolean leapYear;
 . . . // set month (1 - 12) and leapYear appropriately
 switch (month) {
   case 2:
            if (side1 == side2)
                daysInMonth = 29
             else
                daysInMonth = 28;
             break;
   case 3:
   case 5:
   case 7:
   case 8:
   case 10:
   case 12:
            daysInMonth = 31;
            break;
   default :
            daysInMonth = 30;
}
```

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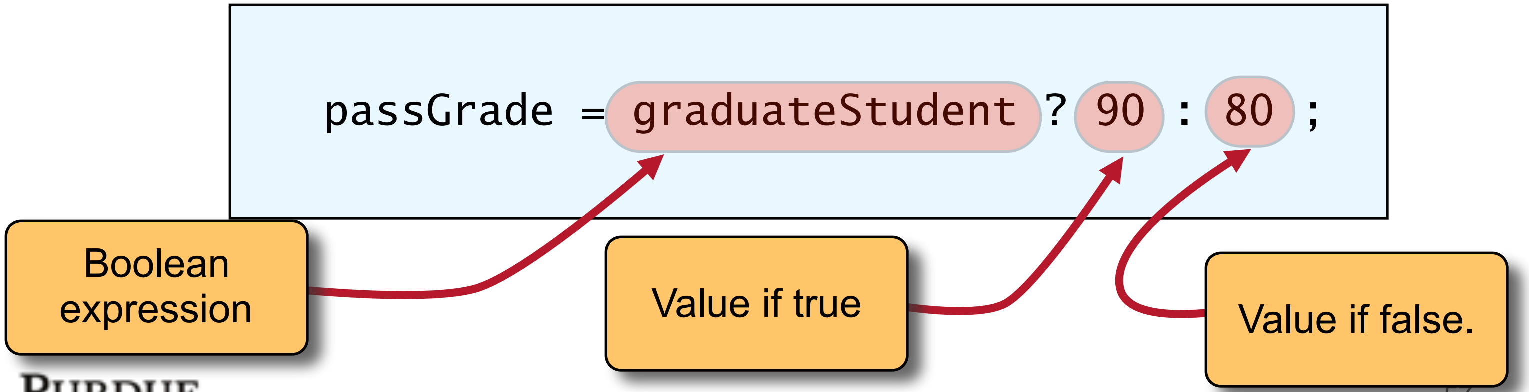
Ternary Assignment Operator

- A common situation is to assign one of two alternative values depending on a condition

```
if (graduateStudent)
   passGrade = 90;
else
   passGrade = 80;
```

- We can use the following ternary shortcut:



```
passGrade = graduateStudent ? 90 : 80 ;
```

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Short-Circuit Evaluation

- Sometimes it is unnecessary to compute all subparts of a boolean expression in order to know the overall value. E.g.,
  - i == j || k <5
    - if i is equal to j, the expression is **`true`** no matter what the value of k is
  - i == j && k < 5
    - if i is not equal to j, the expression is **`false`** no matter what the value of k is
- Most compilers will stop evaluating a expression if its overall value is clear earlier.
  - Called Short-Circuit (Lazy) Evaluation

Short-Circuit Evaluation

- Why should we care?
- Can impact side effects of expressions:
  - done = (i == j) || (k++ < 5)
    - k is incremented only if i was not equal to j
- Can be useful
  - okay = (j == 0) || (i/j > 5)
    - prevents divide by 0 error
- We can force Full (Eager) Evaluation by using & instead of && and | instead of ||
- Caution:&, |, ^ also denote bitwise operations if the operands are integer values not boolean.

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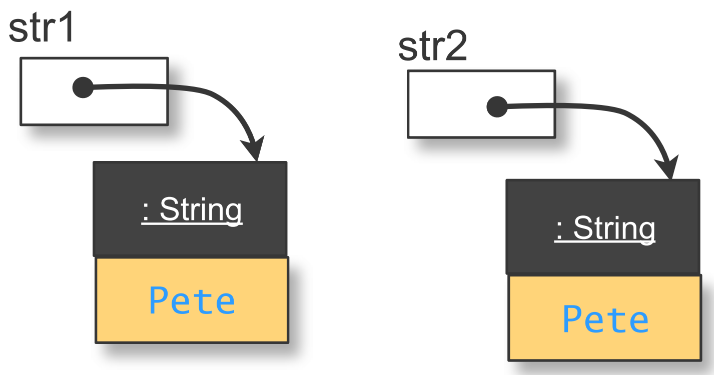
Caution: Strings

```
String str1, str2;

str1 = new String("Pete");
str2 = new String("Pete");

if(str1==str2)
    System.out.println("Equal");
else
    System.out.println("Not equal");
```

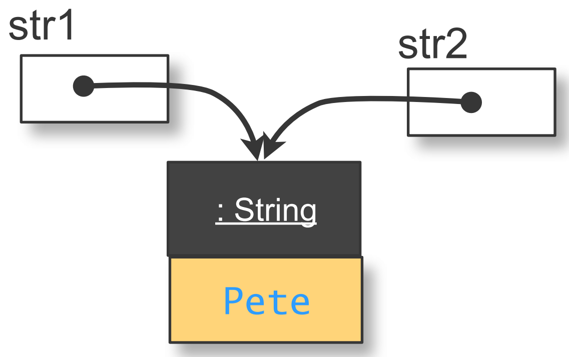
"Not equal"



```
String str1, str2;

str1 = "Pete";
str2 = "Pete";

if(str1==str2)
    System.out.println("Equal");
else
    System.out.println("Not equal");
```



"Equal"

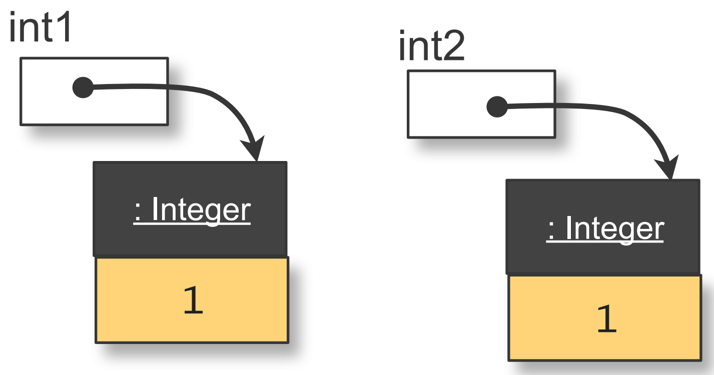
Caution: Wrapper Classes

```
Integer int1, int2;

int1 = new Integer(1);
int2 = new Integer(1);

if( int1 == int2 )
   System.out.println("Equal");
else
   System.out.println("Not equal");
```

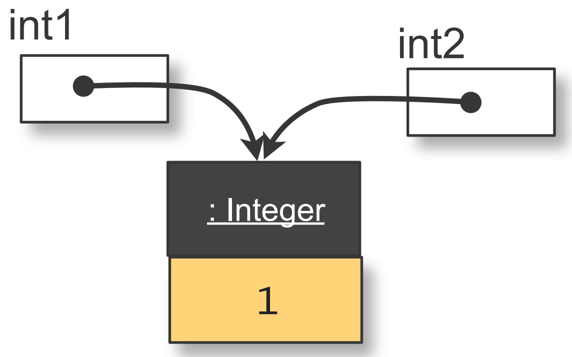
"Not equal"



```
Integer int1, int2;

int1 = 1;
int2 = 1;

if( int1 == int2 )
   System.out.println("Equal");
else
   System.out.println("Not equal");
```



"Equal"

Caution: Wrapper Classes

```
Integer int1, int2;

int1 = 1;
int2 = 1;

if(int1==int2)
   System.out.println("Equal");
else
   System.out.println("Not equal");

int1 += 1;
if(int1==int2)
   System.out.println("Equal");
else
   System.out.println("Not equal");

int2 += 1;
if(int1==int2)
   System.out.println("Equal");
else
   System.out.println("Not equal");
```

→ "Equal"

→ "Not equal"

→ "Equal"

Caution: Wrapper Classes

```
Integer int1, int2;

int1 = new Integer(1);
int2 = new Integer(1);

if (int1 == int2)
   System.out.println("Equal");
else
   System.out.println("Not equal");

int1 += 1;
if (int1==int2)
   System.out.println("Equal");
else
   System.out.println("Not equal");

int2 += 1;
if ( int1==int2)
   System.out.println("Equal");
else
   System.out.println("Not equal");
```

$\longrightarrow$ "Not equal"

$\longrightarrow$ "Not equal"

$\longrightarrow$ "Equal"

Caution: Object Equality

- Be very careful about using == and != with both Wrapper classes and Strings.
- They can have some surprising behaviors.
- In general, when using numeric values for boolean conditions, do not use

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Precedence Examples

```
int x = 1, y = 10, z = 100;
boolean bool, test = false;
```

x = -y + y * z;	x = (-y) + (y * z);
x == 1 && y > 5	(x == 1) && (y > 5)
4 < x && !test	(4 < x) && (!test)
bool = x != y && y == z	bool = (x! = y) && (y == z)
x == y || y > 4 && z < 2	(x == y) || ((y > 4) && (z < 2))

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Side effects -- 1

```
int x= 1, y=10;
```

x = y++;	x: 10	y: 11
x = ++y;	x: 11	y: 11
x = -++y;	x: -11	y: 11
x = -y++;	x: -10	y: 11
x = -y--;	x: -10	y: 9
x = -(--y);	x: -9	y: 9
x = ++y++;	ERROR!	

Prefix vs. postfix.

- A prefix (postfix) operator is equivalent to executing the operator before (after) using the value of the variable:

```
z = x++ * --y;
```

- Is equivalent to:

```
y = y-1;
z = x * y;
x = x + 1;
```

What about:

```
z = x++ * x++;
```

More Examples

```
z = x++ * x++;
```

- Is equivalent to:

```
z = x * (x+1);
     x = x+2;
```

```
z = x++ * --x;
```

- Is equivalent to:

```
     z = x * x;
```

Can be tricky -- use with care.

Side effects -- 2

```
int x = 1, y = 10, z = 100;
boolean bool, test = false;
```

`x = y = z;`	x: 100 y: 100 z: 100
`x = y = ++z;`	x: 101 y: 101 z: 101
`bool = (x = 11) > y`	x: 11 y: 10 bool: **true**
`bool = (x = 11) > y++`	x: 11 y: 11 bool: **true**
`bool = (x = 11) > ++y`	x: 11 y: 11 bool: **false**
`bool = (x = 3) > y && (z = 5) < 10`	x: 3 y: 10 z: 10 bool: **false**
`bool = (x = 3) > y & (z = 5) < 10`	x: 3 y: 10 z: 5 bool: **false**

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Alternative styles

```
if ( <boolean expression> ) {
    …
}
else {
    …
}
```

```
if ( <boolean expression> )
{
    …
}
else
{
    …
}
```

```
if ( <boolean expression> ){
    …
} else {
    …
}
```

All are equivalent -- the compiler doesn't care.