CS160

Flow of Control: Branching (Savitch, Chapter 3)

TOPICS

- Conditional Execution
- if and else Statement
- Boolean Data
- switch Statement

`if` Statement

- Ensures that a statement is executed only when some condition is **`true`**
- Conditions typically involve comparison of variables or quantities for equality or inequality
- Example:

Expression in parenthesis must evaluate to either true or false

```
if (age >= 18)
   System.out.println("You are eligible to vote.");
```


The `if` Statement

- The *if statement* has the following syntax

`if` **is a Java reserved word**

The *`condition`* must be a boolean expression. It must evaluate to either true or false.

```
if ( condition )
   statement;
```

If the *`condition`* is true, the *`statement`* is executed. If it is false, the *`statement`* is skipped.

Numeric Relational Operators

Math	Java	description
<	<	Less than
>	>	Greater than
≤	<=	Less than or equal to
≥	>=	Greater than or equal to
=	==	Equal to
≠	!=	Not equal to

`if` Statement with `else`

- An **`if`** statement may have an optional **`else`** clause that will only be executed when the condition is false
- Example:

```
if ( wages <= 57600.0 )
     tax = 0.124 * wages;
else
     tax = 0.124 * 57600.0;
```

Give an example of when BOTH statements will execute?

NONE! One or the other must execute

Give an example of when NEITHER statement will execute?

Defining Blocks

- To execute more than one statement conditionally, use **{ }** to define a block (aka "compound statement") for the sequence of statements
- Example:

```
if (firstNumber <= secondNumber)
{
  quotient = secondNumber / firstNumber;
  remainder = secondNumber % firstNumber;
}
else
{
  quotient = firstNumber / secondNumber;
  remainder = firstNumber % secondNumber;
}
```


Cascading if-else Statements

- Example:

```
if (condition1)
       statement1;
 else
    if (condition2)
       statement2;
    else
       statement3;
```


Dangling else

- Code written:

```
if (condition1)
 if (condition2)
statement1;
 else
 statement2;
```

Be sure to use indentation properly Otherwise too difficult to read!

- Which `if` does the `else` finish?

`else` will match to the nearest unmatched `if` within the same block

Fix dangling else using blocks

- Code written:

```
if (condition1)
{
     if (condition2)
       statement1;
}
else
     statement2;
```


`boolean` Data Type

- boolean
- A primitive data type that can be set to:
  - `true`
  - `false`
- Example:

```
boolean correct = true;
```

Notice there are no quotation marks around `true` and `false`!

Boolean Expressions

- Conditions are expressions that have a truth value.
- Arithmetic relational operators produce a truth value, e.g.,
  - `10 < 3`
  - `x > y`
  - `a >= (b + 12)`

`boolean` Operators

- Logical "and" (conjunction)
  - Java symbol **&&**
  - Math symbol **∧**
  - true only when both expressions are true

```
(MINIMUM_WAGE <= wages) && (wages <= MAXIMUM_WAGE)
```

- Logical inclusive "or" (disjunction)
  - Java symbol **||**
  - Math symbol **∨**
  - true when either or both expressions are true

```
(wages < MINIMUM_WAGE ) || (wages > MAXIMUM_WAGE )
```

`boolean` Operators (cont.)

- Logical "exclusive or"
  - Java symbol ^
  - Math symbol ⊕
  - true when exactly one of the expressions is true

```
(MINIMUM_WAGE < wages) ^ (MINIMUM_WAGE == wages)
```

- Logical "not" (negation)
  - Java symbol !
  - Math symbol ¬

```
!(MINIMUM_WAGE == wages)
```


Java Logical and Arithmetic Operator Precedence Rules

1.	!	- (unary)		
2.	*	/	%	
3.	+	-		
4.	<	<=	>	>=
5.	==	!=		
6.	^	&	|	
7.	&&			
8.	||			

Complicated Boolean Expressions

```
boolean isLeapYear = ((year % 4) == 0)
                     && ((year % 100) != 0)
                        || ((year % 400) == 0);
```

Interpretation:

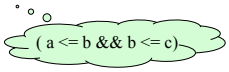
- Leap years are every four years (divisible by 4) except for centuries that are not divisible by 400.

Combining Relational Operators

- Unlike some other operators, relationals cannot be combined in Java.
- Example:

```
(a <= b <= c)
```

  - Does not mean a <= b and b <= c.
  - It produces a compile-time error -- cannot compare a boolean (return value of <= operator) with a number.
  - How should this be done?



switch Statement

- Used to accomplish multi-way branching based on the value of an integer selector variable
- Example:

```
switch (numberOfPassengers)
{
   case 0: System.out.println("The Harley");
      break;
   case 1: System.out.println("The Dune Buggy");
      break;
   default:
      System.out.println("The Humvee");
}
```

Expression in ( ) must evaluate to an int or char ONLY!

break moves flow of control to end of switch statement

Don't need a break after **default** – already at end

default case is executed if no other case values match expression

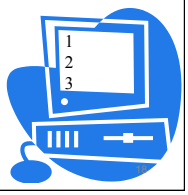
Using break in switch statements

- Consider the code fragment below

```
int i = 1;
switch (i)
{
   case 0: System.out.println("0");
   case 1: System.out.println("1");
   case 2: System.out.println("2");
   case 3: System.out.println("3");
}
System.out.println( );
```

- Without breaks what is the output?

(note: it is legal to leave out the breaks and sometimes desired)



Why execute multiple cases?

- Consider if you want a base level with add-ons for increasing numbers as in…

```
switch (zoomember_level)
{
   case 500: System.out.print(" Meet a tiger");
   case 100: System.out.print(" Free t-shirt");
   case 50: System.out.print("Free admission!");
   default: System.out.println();
}
```

- Example of when we want to leave off the break statements to allow execution to follow through

Symbolic Constants in switch Statements

```
final int
   SUNDAY = 1, MONDAY = 2, TUESDAY = 3,
   WEDNESDAY = 4, THURSDAY = 5, FRIDAY = 6,
   SATURDAY = 7;
int d;
...
switch (d) {
   case SUNDAY: System.out.print("Sunday"); break;
   case MONDAY: System.out.print("Monday"); break;
   case TUESDAY: System.out.print("Tuesday"); break;
   case WEDNESDAY: System.out.print("Wednesday"); break;
   case THURSDAY: System.out.print("Thursday"); break;
   case FRIDAY: System.out.print("Friday"); break;
   case SATURDAY: System.out.print("Ski day"); break;
}
```

Multiple `case` Labels

```
switch (d) {
  case MONDAY:
  case WEDNESDAY:
  case FRIDAY:
    System.out.println("C.S. meets at 9:00 today");
    System.out.println("Math meets at 10:00 today");
    break;
  case TUESDAY:
  case THURSDAY:
    System.out.println("English meets at 9:00 today");
    System.out.println("Chemistry meets at 10:00 today");
    break;
  case SUNDAY:
  case SATURDAY:
    System.out.println("Enjoy the weekend");
}
```


switch example

- Display the students' grade based on entering their grade as an int between 0 and 100 (90+ = A, 80-89 = B, 70-79 = C)

```
switch( grade / 10 )
{
        case 10:
        case 9:
                System.out.println( "A" );
                break;
        case 8:
                System.out.println( "B" );
                break;
        case 7:
                System.out.println( "C" );
                break;
        default:
                System.out.println( "F" );
}
```

Integer division is our friend!

Comparing `switch` and `if` statements

- `switch` statement

```
switch (expression)
{
    case value1: statement1;
   break;
    case value2: statement2;
   break;
    …
    case valueX: statementX;
   break;
    default: statementY;
}
```

- `if` equivalent

```
value = expression;
if (value == value1)
    statement1;
else if (value == value2)
    statement2;
…
else if (value == valueX)
    statementX;
else
    statementY;
```


Comparing `switch` and `if` statements
Print out whether the char **ch** is a vowel or not

- `switch` statement

```
switch (letter)
{
    case 'A' : case 'a' :
    case 'E' : case 'e' :
    case 'I' : case 'i' :
    case 'O' : case 'o' :
    case 'U' : case 'u' :
          System.out.println( "vowel" );
          break;
    default:
       System.out.println( "consonant" );
}
```

- `if` equivalent

```
if    ( letter == 'A' || letter == 'a'
     || letter == 'E' || letter == 'e'
     || letter == 'I'  || letter == 'i'
     || letter == 'O' || letter == 'o'
     || letter == 'U' || letter == 'u'     )
          System.out.println( "vowel" );
else
          System.out.println( "consonant" );
```

Summary

- Flow of control
- **if** statements
- **boolean** expressions
- **if-else** statements
- Order of operations
- Relational operators
- **switch** statement