CSC110AB Module 3

General Notes

- A **core generic top-level domain (core gTLD)** name, which can be found at ICANN: gTLDSs, is one of the following

  Internet domains:

  - .com
  - .net
  - .org
  - .info
- Chapter 3 Q&A

Optional Material

Conditional Statements / Decision Statements

- if-else Statements and More
- Decisions Part 1: if statements
- Decisions Part 3: if-else statements
- Decisions Part 5: if-else-if

String Class

- String Part1: Introduction to the String Class
- String Part2: charAt
- String part 3: substring
- String Part 4: length
- String Part 5: indexOf
- String Part 6: compareTo
- String Part 7: equals

Google Slides - Conditionals and Loops - `if`, `if-else`, `switch`

Boolean Expressions

- **Boolean expressions:** Java expressions that evaluate to `true` or `false`.

- You can use **relational operators** to perform comparisons

```
int num = 42;
int value = 23;
int count = 4;

count < 8      // evaluates to true
value <= num    // evaluates to true
num <= num     // evaluates to true
1516 >= value   // evaluates to true
count == 8     // evaluates to false
value == value  // evaluates to true
count != 8     // evaluates to true
value != value  // evaluates to false
```

Flow Control

- Your program is made up of statements organized into **code blocks**
  - Code blocks are made up of one or more statements
- **Flow control** statements allow us to skip or repeat statements based on evaluating certain boolean expressions that evaluate to true or false

Conditional Statements

Conditional statements (sometimes called **selection statements**) let us specify a condition that must be `true` before a statement or block of code will be executed.

Java's Conditional Statements

- The `if` statement
- The `if-else` statement
- The `switch` statement

`if` Statement

```
if (hoursWorked == 40)
   System.out.println("Have a good weekend!");

if (bountyHunters > 6) {
   System.out.println("We will find Solo");
}

if (spot != 'x') {
   System.out.println("No treasure here");
}
```

- "**if**" is a Java reserved word
- The condition must be a boolean expression
  - It must evaluate to true or false
- If the condition is `true`, then the code block is executed
- If the condition is `false`, then the code block is skipped
- Always put braces around the statements you want to include in the code block
  - For one line of code it isn't required, but do it anyway to avoid bugs later

Logical Operators

Operator	Description	Example	Evaluation
`!`	Logical NOT	`! finished`	`true` if finished is `false` and `false` if finished is `true`
`&&`	Logical AND	`good && ready`	`true` if both `good` and `ready` are `true`, `false` otherwise
`&vert;&vert;`	Logical OR	`fix &vert;&vert; replace`	`true` if `fix` is `true`, `replace` is `true`, or both `fix` and `replace` are `true`. `false` if neither is `true`

- The logical AND (`&&`) and logical OR (`||`) operators are `binary operators` (they operate on two operands)
- The logical NOT operator (`!`) is a `unary operator` - it operates on just one operand
- We can show the result of logical expressions using a `truth table` that shows all possible `true-false` combinations of the terms

Logical NOT

a	!a
`false`	`true`
`true`	`false`

- The logical NOT operation is also called **logical negation** or **logical complement**
- If a boolean condition a is true, then `!a` is `false`
- If a boolean condition a is false, then `!a` is `true`

Logical AND and Logical OR

The logical AND expression: `a && b`

- `true` if both `a` and `b` are `true`
- `false` otherwise

The logical OR expression: `a || b`

- `true` if `a` or `b` or both are `true`
- `false` otherwise

there are four possible combinations of values - here is the true table for both `&&` and `||` :

a	b	a && b	a || b
false	false	false	false
false	true	false	true
true	false	false	true
true	true	true	true

Short-Circuited Operators

If the left operand is sufficient to determine the result, the right operand is not evaluated:

```
if (count != 0 && total/count > MAX)
    System.out.println("Testing");
```

- If `count` is not zero, then the 2nd boolean operation is not evaluated
- **This type of processing must be used carefully**

The `if-else` Statement

```
if (condition) {
// code block 1 - executed if condition is true
}
else {
// code block 2 - executed if condition is not true
}
```

- One or the other will be executed, *but not both*

The Ternary Conditional Operator

Java has a ternary (3 operands) conditional operator that uses a boolean condition to determine which of two expressions is evaluated:

```
condition ? expression1 : expression2
```

- If `condition` is `true`, `expression1` is evaluated
- if `condition` is `false`, `expression2` is evaluated
- In general, `if-else` statement should be used instead

```
// Ternary Operator
System.out.println ("Your change is "
   + count + ((count == 1) ? "Dime" : "Dimes"));

// if-else - Preferred method
System.out.print ("Your change is ");
if (count == 1) {
System.out.println ("Dime");
}
else {
System.out.println ("Dimes");
}
```

- If `count` equals `1`, then `Dime` is printed
- If `count` is anything other than `1`, then `Dimes` is printed

Nested `if` Statements

A nested `if` statement is when you have an `if` or `if-else` statement inside the code block of another `if` (or `if-else`) statement

```
if (num1 < num2) {
  if (num1 < num3) {
    min = num1;
  }
  else {
    min = num3;
  }
}
else {
  if (num2 < num3) {
    min = num2;
  }
  else {
    min = num3;
  }
}
```

Comparing Data

Floating Point Values

- You should rarely use the equality operator (`==`) when comparing two floating point values (`float` or `double`)
- Two floating point values are equal only if their underlying binary representations match exactly
- Computations often result in slight differences that may be irrelevant
- In many situations, you might consider two floating point numbers to be “close enough” even if they aren't exactly equal

To determine the equality of two floats, you may want to use the following technique:

```
if (Math.abs(f1 - f2) < TOLERANCE)
 System.out.println("Essentially equal");
```

- If the difference between the two floating point values is less than the tolerance, they are considered to be equal
- The tolerance could be set to any appropriate level, such as 0.000001

Comparing Characters

- Java character data is based on the Unicode character set
  - Unicode establishes a particular numeric value for each character, and therefore an ordering
- Appendix C provides an overview of Unicode

Comparing Strings - Lexicographic Ordering

Because comparing characters and strings is based on a character set, it is called a **lexicographic ordering**

- Lexicographic ordering is not strictly alphabetical when uppercase and lowercase characters are mixed
  - For example, the string "Great" comes before the string "fantastic" because all of the uppercase letters come before all of the lowercase letters in Unicode
- Also, short strings come before longer strings with the same prefix (lexicographically)
  - Therefore "book" comes before "bookcase"

The equals method can be called with strings to determine if two strings contain exactly the same characters in the same order:

```
if (name1.equals(name2))
  System.out.println("Same name");
```

The `String compareTo` method determines if one string comes before another.

Calling `name1.compareTo(name2)`

- returns zero if `name1` and `name2` are equal (contain the same characters)
- returns a negative value if `name1` is less than `name2`
- returns a positive value if `name1` is greater than `name2`

```
if (name1.compareTo(name2) < 0)
    System.out.println(name1 + "comes first");
  else
    if (name1.compareTo(name2) == 0)
      System.out.println("Same name");
    else
      System.out.println(name2 + "comes first");
```

Comparing with `==` vs `equals`

The == operator can be applied to objects

- it returns `true` if the two references are aliases of each other
- The `equals` method is defined for all objects, and unless we redefine it when we write a class, it has the same semantics as the `==` operator
- It has been redefined in the `String` class to compare the characters in the two strings
- You can/should redefine the `equals` method to return `true` under whatever conditions are appropriate

The switch Statement

The switch statement evaluates an expression, then attempts to match the result to one of several possible **cases**:

```
// Integer Example
int code = 12;

switch (code)
{
 case 10:
   System.out.println("Hello.");
   break;

 case 12 :
   System.out.println("Good-bye.");
   break;

 default :
   System.out.println("Until next time.");
}

// Char Example
switch (option)
{
  case 'A':
       aCount++;
        break;
  case 'B':
       bCount++;
       break;
  case 'C':
       cCount++;
       break;
}

// String Example
String drinkSize = " ";

System.out.print("Enter drink size:");
drinkSize = scan.next();

switch (drinkSize) //switching on a String
{
  case "Small": cost = 5.95;
    break;
```

```
    case "Medium": cost = 7.95;
      break;
    case "Large": cost = 9.95;
      break;
    default: cost = 0.00;
      break;
}
System.out.println("Your cost is: " + cost)
```

- The flow of control transfers to the code block associated with the first case value that matches
- The expression of a switch statement must result in an integral type, meaning an integer (`byte` , `short` , `int` , `long`) or a `char`
- It cannot be a boolean value or a floating point value (`float` or `double`)
- The implicit boolean condition in a switch statement is equality
- You cannot perform relational checks with a switch statement
- Often a **break** statement is used as the last statement in each case's statement list
    - If a break statement is not used, the flow of control will continue into the next case
- A switch statement can have an optional **default** case
- If the **default** case is present, control will transfer to it if no other case value matches
    - If there is no **default** case, and no other value matches, control falls through to the statement after the switch

Microsoft Word Notes

Java Foundations Chapter 4 Notes

Zybooks

If-else Branches

A **branch** is a sequence of statements only executed under a certain condition.

An `if-else` branch has two branches: The first branch is executed `IF` an expression is `true`, `ELSE` the other branch is executed.

```
int x = 5;
int y = 10;

if (expression1) {
  // Statements that execute when expression1 is true
  // (first branch)
} else if (expression2) {
  // Statements that execute when expression1 is false and expression2 is true
  // (second branch)
} else {
  // Statements that execute when expression1 is false and expression2 is false
  // (third branch)
}
```

- It's possible to repeat the `else if` branch as many times as necessary.

Detecting Equal Values With Branches

An `if` statement executes a group of statements if an expression is true.

- An `if` statement is surrounded by **Braces {}**, also known as *curly braces*.

```
public static void main(String[] args) {
    int numOne = 5;
    int numTwo = 5;

    if (numOne == numTwo) {
        System.out.print("True");
    } else {
        System.out.print("False");
    }
}
```

- Each branch's expression is checked in sequence. As soon as one branch's expression is found to be true, that branch's statements execute (and no

subsequent branch is considered). If no expression is true, the else branch executes.

Equality and Inequality Operators

The **inequality operator (!=)** evaluates to `true` if the left and right sides are **not** equal, or different.

- The expression evaluates to a **Boolean**, which is a type that has just two values: `true` and `false`.

Operator	Description	Example (assume `x` is `3`)
`==`	`a == b` means `a` is equal to `b`	`x == 3` is `true` `x == 4` is `false`
!=	a != b means a is not equal to b	x != 3 is false x != 4 is true

Comparing Characters, Strings, and Floating-point Types

The **relational** and **equality** operators can be used with the following built-in types:

- Integer
- Character
- Floating-point

Floating-point types should not be compared using the equality operators due to the imprecise representation of floating-point numbers.

For strings, use `equals()` and `compareTo()`.

Detecting Ranges With Branches (General)

```
public static void main(String[] args) {
   int x = 15;

   if (x < 10) {
      // Do this code if x is anywhere from -infinity to 09
   } else if (x < 15) {
      // Do this code if x is anywhere from 10 - 14
   } else if (x < 30) {
      // Do this code if x is anywhere from 14 to 29
   } else {
      // Do this code if x is anywhere from 30 to infinity
   }
}
```

Detecting Ranges Using Logical Operators

Logical `AND`, `OR`, and `NOT` (General)

A **logical operator** treats operands as being true or false, and evaluates to true or false. Logical operators include:

- `AND`
  - Returns `true` if both expressions evaluate to `true`
  - Returns `false` if either expression doesn't evaluate to `true`
- `OR`
  - Returns `true` if either expressions evaluate to `true`
  - Returns `false` if both expressions evaluate to `false`
- `NOT`
  - Returns `true` is the expressions **does not** evaluate to `true`
  - Returns `false` is the expressions **does** evaluate to `true`

Logical operator Description

a AND b Logical AND: true when both of its operands are true.

a OR b Logical OR: true when at least one of its two operands are true.

NOT a Logical NOT: true when its one operand is false, and vice-versa.

Logical Operator	Description
a AND b	**Logical AND:** true when both of its operands are true.
a OR b	**Logical OR:** true when at least one of its two operands are true.
NOT a	**Logical NOT:** true when its one operand is false, and vice-versa.

```
public static void main(String[] args) {
   int x = 5;
   int y = 10;

   if ((x > 5) && (y < 10)) {
      // Do this code
      System.out.println();
   } else {
      // Do this code
      System.out.println();
   }

   if ((x > 5) || (y < 10)) {
      // Do this code
      System.out.println();
   } else {
      // Do this code
      System.out.println();
   }

   if (!(x > 5)) {
      // Do this code if x is NOT greater than 5
      System.out.println();
   } else {
      // Do this code if x IS greater than 5
      System.out.println();
   }
}
```

Logical Operators

Logical Operator	Description
`a && b`	**Logical AND (`&&`):** true when both of its operands are true
||	**Logical OR (** || **):** true when at least one of its two operands are true
`!a`	**Logical NOT (`!`):** true when its one operand is false, and vice-versa.

- A common error is to use `&` instead of `&&` and `|` instead `||`. `&` and `|` are not logical operators and may produce unexpected output.

Detecting ranges implicitly vs. explicitly

```
// =============Implicit=============

if (x < 0) {
   // Negative
} else if ((x >= 0) && (x <= 10)) {
   // 0..10
} else if ((x >= 11) && (x <= 20)) {
   // 11..20
} else {
   // 21+
}

// =============Explicit=============

if (x < 0) {
   // Negative
} else if (x <= 10) {  // x >= 0 is implicit
   // 0..10
} else if (x <= 20) {  // x > 10 is implicit
   // 11..20
} else {               // x > 20 is implicit
   // 21+
}
```

Detecting Ranges With Gaps

Basic Ranges With Gaps

```
import java.util.Scanner;

public class MovieTicketPrices {
  public static void main(String[] args) {
    int userAge;
    int movieTicketPrice;
    Scanner scnr = new Scanner(System.in);

    System.out.println("Enter your age: ");
    userAge = scnr.nextInt();

    if (userAge <= 12) {        // Age 12 and under
      System.out.println("Child ticket discount.");
      movieTicketPrice = 11;
    }
    else if (userAge >= 65) {    // Age 65 and older
      System.out.println("Senior ticket discount.");
      movieTicketPrice = 12;
    }
    else {                    // All other ages
      movieTicketPrice = 14;
    }

    System.out.println("Movie ticket price: $" +
      movieTicketPrice);
  }
}
```

Ranges With Gaps Using Logical Operators

```
if (officeNum >= 100 && officeNum <= 150) {
  // valid office number
}
else if (officeNum >= 200 && officeNum <= 250) {
  // valid office number
}
else {
  // invalid office number
}
```

Detecting Multiple Features With Branches

```
import java.util.Scanner;

public class AgeStats {
  public static void main(String[] args) {
    Scanner scnr = new Scanner(System.in);
    int userAge;

    System.out.print("Enter age: ");
    userAge = scnr.nextInt();

    // Note that more than one "if" statement can execute
    if (userAge < 16) {
      System.out.println("Enjoy your early years.");
    }

    if (userAge > 15) {
      System.out.println("You are old enough to drive.");
    }

    if (userAge > 17) {
      System.out.println("You are old enough to vote.");
    }

    if (userAge > 24) {
      System.out.println("Most car rental companies will rent to you.");
    }

    if (userAge > 34) {
      System.out.println("You can run for president.");
    }
  }
}
```

Output

```
Enter age: 12
Enjoy your early years.

...

Enter age: 27
You are old enough to drive.
You are old enough to vote.
Most car rental companies will rent to you.

...

Enter age: 99
You are old enough to drive.
You are old enough to vote.
Most car rental companies will rent to you.
You can run for president.
```

Nested `if-else` Statements

```
if (numItems > 3) {
  if (totalCost > 100) {      // numItems > 3 and totalCost > 100
    saleDiscount = 20;
  }
  else if (totalCost > 50) {  // numItems > 3 and totalCost > 50
    saleDiscount = 10;
  }
}
else if (numItems > 0) {
  ...
}
```

Common Branching Errors

Missing Braces

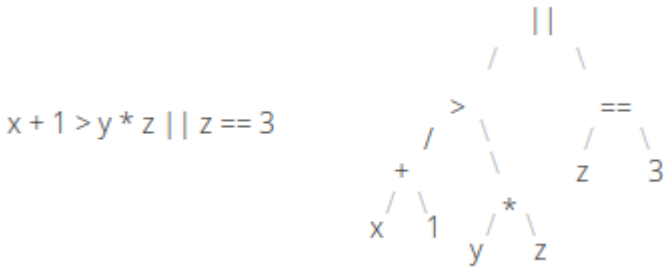
When a branch has a single statement, the braces are optional, but good practice always uses the braces. Always using braces even when a branch only has one statement prevents the common error of mistakenly thinking a statement is part of a branch.

```
// ============WITHOUT BRACES============ (Not Recommended)
if (numSales < 20)
  salesBonus = 0;
else
  totBonus = totBonus + 1;
  salesBonus = 20;  // This is not considered part of the else statement

// ============WITH BRACES============ (Recommended)
if (numSales < 20) {
  salesBonus = 0;
} else {
  totBonus = totBonus + 1;
  salesBonus = 20;
}
```

Order of Evaluation

Precedence rules

Operator / Convention	Description	Explanation
`( )`	Items within parentheses are evaluated first	In `(a * (b + c)) - d`, the `+` is evaluated first, then `*`, then `-`.
!	! (logical **NOT**) is next	! x || y is evaluated as (!x) || y
`* / % + -`	Arithmetic operators (using their precedence rules; see earlier section)	`z - 45 * y < 53` evaluates `*` first, then `-`, then `<`.
< <= > >=	Relational operators	x < 2 || x >= 10 is evaluated as (x < 2) || (x >= 10) because < and >= have precedence over || .
`== !=`	Equality and inequality operators	`x == 0 && x >= 10` is evaluated as `(x == 0) && (x >= 10)` because `<` and `>=` have precedence over `&&`. `==` and `!=` have the same precedence and are evaluated left to right.
&&	Logical **AND**	x == 5 || y == 10 && z != 10 is evaluated as (x == 5) || ((y == 10) && (z != 10)) because && has precedence over || .
`&#124;&#124;`	Logical **OR**	`&#124;&#124;` has the lowest precedence of the listed arithmetic, logical, and relational operators.



- The expression is actually treated like a "tree", evaluated from the bottom upwards.
- Good style would use parentheses to make order of evaluation explicit.

Common Errors

- Missing Parenthesis
- Math expression for range
  - `16 < age < 25`

Switch Statements

Switch Statement

A **switch** statement can more clearly represent multi-branch behavior involving a variable being compared to constant values.

The program executes the first **case** whose constant expression matches the value of the switch expression, executes that case's statements, and then jumps to the end. If no case matches, then the **default case** statements are executed.

```
switch (a) {
  case 0:
    // Print "zero"
    break;

  case 1:
    // Print "one"
    break;

  case 2:
    // Print "two"
    break;

   default:
    // Print "unknown"
    break;
}
// Input: a = 1 | Output: "one"
// Input: a = 5 | Output: "unknown"
```

- Switch statements can be rewritten as multi-branch `if-else` statements, but a switch statement may make the programmer's intent clearer.

Switch Statement General Form

- The switch statement's expression should be an integer, char, or string.
- The expression should not be a Boolean or a floating-point type.
- Each case must have a constant expression like 2 or 'q'
    - A case expression cannot be a variable.
- The order of cases doesn't matter assuming break statements exist at the end of each case.
- *Good practice is to always have a default case for a switch statement. A programmer may be sure all cases are covered only to be surprised that some case was missing.*

```java
import java.util.Scanner;

/* Estimates dog's age in equivalent human years.
   Source: www.dogyears.com
*/

public class DogYears {
   public static void main(String[] args) {
      Scanner scnr = new Scanner(System.in);
      int dogAgeYears;

      System.out.print("Enter dog's age (in years): ");
      dogAgeYears = scnr.nextInt();

      switch (dogAgeYears) {
         case 0:
            System.out.println("That's 0..14 human years.");
            break;

         case 1:
            System.out.println("That's 15 human years.");
            break;

         case 2:
            System.out.println("That's 24 human years.");
            break;

         case 3:
            System.out.println("That's 28 human years.");
            break;

         case 4:
            System.out.println("That's 32 human years.");
            break;

         case 5:
            System.out.println("That's 37 human years.");
            break;

         default:
            System.out.println("Human years unknown.");
```

```
            break;
        }
    }
}
```

Omitting The Break Statement

Omitting the **break** statement for a case will cause the statements within the next case to be executed. Such "falling through" to the next case can be useful when multiple cases, such as cases 0, 1, and 2, should execute the same statements.

```
import java.util.Scanner;

public class DogYearsMonths {
  public static void main(String[] args) {
    Scanner scnr = new Scanner(System.in);
    int dogAgeYears;
    int dogAgeMonths;

    System.out.print("Enter dog's age (in years): ");
    dogAgeYears = scnr.nextInt();

    if (dogAgeYears == 0) {
      System.out.print("Enter dog's age in months: ");
      dogAgeMonths = scnr.nextInt();

      switch (dogAgeMonths) {
        case 0:
        case 1:
        case 2:
          System.out.println("That's 0..14 human months.");
          break;

        case 3:
        case 4:
        case 5:
        case 6:
          System.out.println("That's 14 months to 5 human years.");
          break;

        case 7:
        case 8:
          System.out.println("That's 5..9 human years.");
          break;

        case 9:
        case 10:
        case 11:
        case 12:
          System.out.println("That's 9..15 human years.");
          break;

        default:
```

```
            System.out.println("Invalid input.");
            break;
        }
      }
      else {
        System.out.println("FIXME: Do earlier dog years cases");
        switch (dogAgeYears) {
        }
      }
    }
  }
```

Boolean Data Type

Boolean refers to a quantity that has only two possible values, `true` or `false`. Java has the built-in data type **boolean** for representing Boolean quantities.

A Boolean variable may be set using true or false keywords:

- `boolean isMale = true;` - Assigns `isMale` with the boolean value `true`
- `boolean isFemale = false;` - Assigns `isFemale` with the boolean value `false`

Uses of Boolean Data Types

An expression that combines logical and relational operators can be simplified by assigning boolean variables with the result of the expression using relational operators:

```
isHot = (currentTemp > desiredTemp);
isReallyHot = (currentTemp > (desiredTemp + 5.0));
isHumid = (currentHumidity > 0.50);

if (isReallyHot) {
  // Use A/C and evaporative cooler
  acOn = true;
  evapCoolerOn = true;
}
else if (isHot && isHumid) {
  // Use A/C
  acOn = true;
  evapCoolerOn = false;
}
else if (isHot && !isHumid) {
  // Use evaporative cooler
  acOn = false;
  evapCoolerOn = true;
}
else {
  acOn = false;
  evapCoolerOn = false;
}
```

String Comparisons

Equal strings have the same number of characters, and each corresponding character is identical.

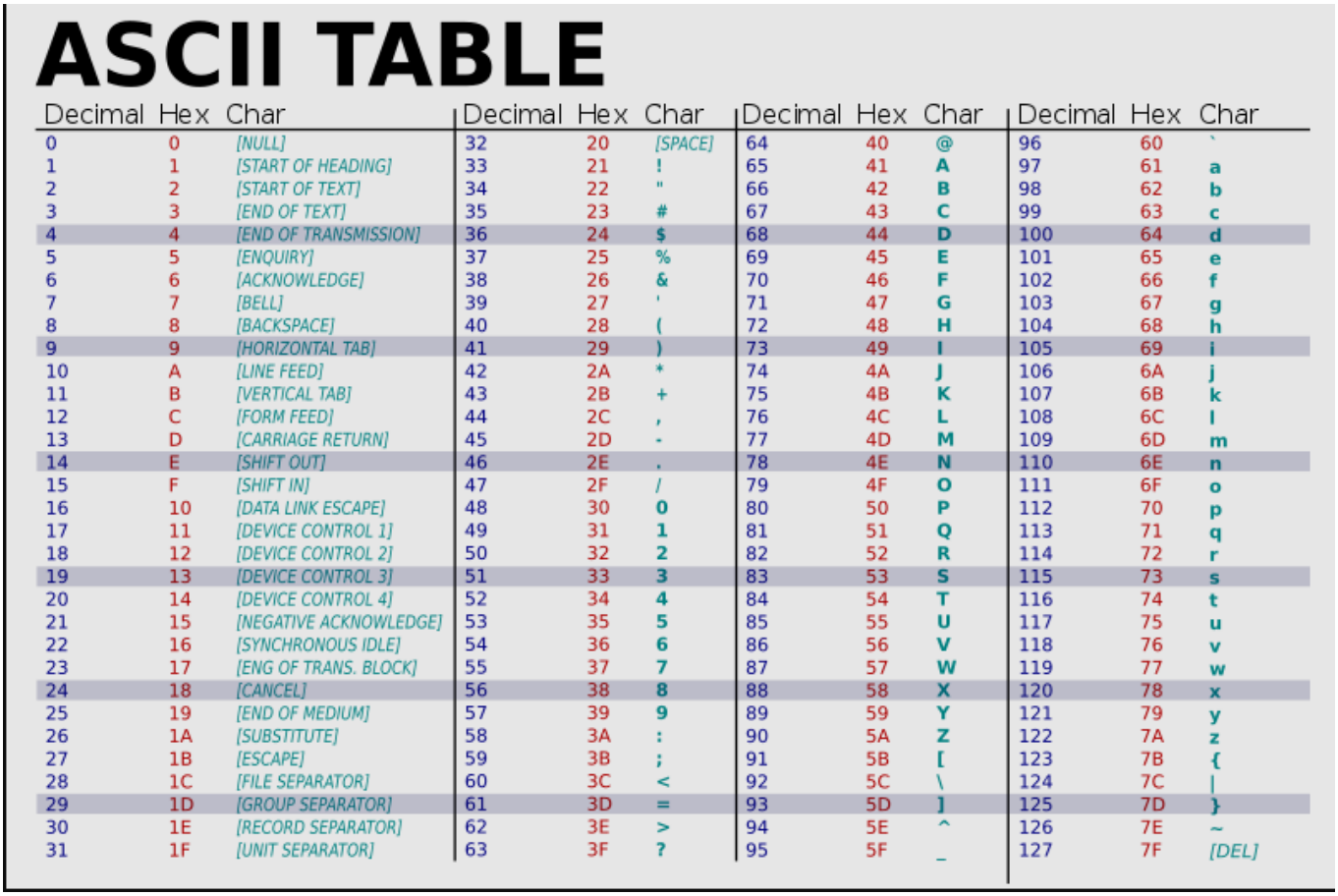
- Use the **equals** method to return `true` if two strings are equal, or `false` if two they are not.
  - Do **not** use `==` to compare two strings.
  - `str1.equals(str2)`

```java
import java.util.Scanner;

public class StringEquality {
  public static void main(String[] args) {
    Scanner scnr = new Scanner(System.in);
    String userWord;

    System.out.print("Enter a word: ");
    userWord = scnr.next();

    if (userWord.equals("USA")) {
      System.out.println("United States of America");
    }
    else {
      System.out.println(userWord);
    }
  }
}
```

String Comparison: Relational

Strings are sometimes compared relationally (less than, greater than), as when sorting words alphabetically. A comparison begins at index 0 and compares each character until the evaluation results in false, or the end of a string is reached.

- `'A'` is `65`, `'B'` is `66`, etc., while `'a'` is `97`, `'b'` is `98`, etc.
  - So `"Apples"` is less than `"apples"` because `65` is less than `97`.



ASCII TABLE

Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char
0	0	[NULL]	32	20	[SPACE]	64	40	@	96	60	`
1	1	[START OF HEADING]	33	21	!	65	41	A	97	61	a
2	2	[START OF TEXT]	34	22	"	66	42	B	98	62	b
3	3	[END OF TEXT]	35	23	#	67	43	C	99	63	c
4	4	[END OF TRANSMISSION]	36	24	$	68	44	D	100	64	d
5	5	[ENQUIRY]	37	25	%	69	45	E	101	65	e
6	6	[ACKNOWLEDGE]	38	26	&	70	46	F	102	66	f
7	7	[BELL]	39	27	'	71	47	G	103	67	g
8	8	[BACKSPACE]	40	28	(	72	48	H	104	68	h
9	9	[HORIZONTAL TAB]	41	29	)	73	49	I	105	69	i
10	A	[LINE FEED]	42	2A	*	74	4A	J	106	6A	j
11	B	[VERTICAL TAB]	43	2B	+	75	4B	K	107	6B	k
12	C	[FORM FEED]	44	2C	,	76	4C	L	108	6C	l
13	D	[CARRIAGE RETURN]	45	2D	-	77	4D	M	109	6D	m
14	E	[SHIFT OUT]	46	2E	.	78	4E	N	110	6E	n
15	F	[SHIFT IN]	47	2F	/	79	4F	O	111	6F	o
16	10	[DATA LINK ESCAPE]	48	30	0	80	50	P	112	70	p
17	11	[DEVICE CONTROL 1]	49	31	1	81	51	Q	113	71	q
18	12	[DEVICE CONTROL 2]	50	32	2	82	52	R	114	72	r
19	13	[DEVICE CONTROL 3]	51	33	3	83	53	S	115	73	s
20	14	[DEVICE CONTROL 4]	52	34	4	84	54	T	116	74	t
21	15	[NEGATIVE ACKNOWLEDGE]	53	35	5	85	55	U	117	75	u
22	16	[SYNCHRONOUS IDLE]	54	36	6	86	56	V	118	76	v
23	17	[ENG OF TRANS. BLOCK]	55	37	7	87	57	W	119	77	w
24	18	[CANCEL]	56	38	8	88	58	X	120	78	x
25	19	[END OF MEDIUM]	57	39	9	89	59	Y	121	79	y
26	1A	[SUBSTITUTE]	58	3A	:	90	5A	Z	122	7A	z
27	1B	[ESCAPE]	59	3B	;	91	5B	[	123	7B	{
28	1C	[FILE SEPARATOR]	60	3C	<	92	5C	\	124	7C	|
29	1D	[GROUP SEPARATOR]	61	3D	=	93	5D	]	125	7D	}
30	1E	[RECORD SEPARATOR]	62	3E	>	94	5E	^	126	7E	~
31	1F	[UNIT SEPARATOR]	63	3F	?	95	5F	_	127	7F	[DEL]

- If existing characters are equal, the shorter string is less than.

Other Methods for Comparing

- `compareTo()`
  - `str1.compareTo(str2)`
- `compareToIgnoreCase()`
- `equalsIgnoreCase()`

How `compareTo()` Returns Values:

Relation	Returns	Expression to detect
str1 less than str2	Negative number	`str1.compareTo(str2) < 0`
str1 equal to str2	0	`str1.compareTo(str2) == 0`
str1 greater than str2	Positive number	`str1.compareTo(str2) > 0`

- *A common error is to forget that case matters in a string comparison. A programmer can compare strings while ignoring case using*

`str1.equalsIgnoreCase(str2)` and `str1.compareToIgnoreCase(str2)`.

String Access Operations

String Character Indices

A string is a sequence of characters in memory. Each string character has a position number called an **index**, starting with 0 (not 1).

- For string `"Hello, World!"`, `e` is at index **1**, and `,` is at index **5**.

Working With The End of a String

- If a string's length is known, the last character is at **index length - 1**.
- The method `str1.length()` returns the length of a string as well.
  - "Hello there".length
- A string's length is 1 greater than the string's last index.
- Does not work with appending character literals
  - Single characters in a single quote `h`.

To append to a string:

- Use `+`
  - `"Hey" + "!!!"` returns `"Hey!!!"`
- Use `str1.concat(str2)`

A common error is to access an invalid string index, especially exactly one larger than the largest index.

Character Operations

All `Character` operations below must prepend `Character.` as in `Character.isLetter`.

Method	Description	Example

`isLetter(c)`	true if alphabetic:
	a-z or **A-Z**
		`isLetter('x') // true`
		`isLetter('6') // false`
		`isLetter('!') // false`

`isDigit(c)`	true if digit: **0-9**.	`isDigit('x') // false` `isDigit('6') // true`

`isWhitespace(c)`	true if
	whitespace.
		`isWhitespace(' ') // true`
		`isWhitespace('\n') // true`
		`isWhitespace('x') // false`

`toUpperCase(c)`	Uppercase version	`toUpperCase('a') // A`
		`toUpperCase('A') // A`
		`toUpperCase('3') // 3`

`toLowerCase(c)`	Lowercase version	`toLowerCase('A') // a`
		`toLowerCase('a') // a`
		`toLowerCase('3') // 3`

Example

```
import java.util.Scanner;

public class CheckingPasscodes {
  public static void main (String [] args) {
    Scanner scnr = new Scanner(System.in);
    boolean hasDigit;
    String passCode;

    hasDigit = false;
    passCode = scnr.next();

    /* Your solution goes here  */
    for(int i = 0; i < passCode.length(); i++) {
      if (Character.isDigit(passCode.charAt(i))) {
        hasDigit = true;
      }
    }

    if (hasDigit) {
      System.out.println("Has a digit.");
    }
    else {
      System.out.println("Has no digit.");
    }
  }
}
```

More String Operations

The following are all methods of the `String` class.

- Java String Class Documentation

Finding in a string / Getting a substring

Method	Constructors	Examples

`indexOf()`	`indexOf(item)` gets index of first item occurrence in a string, else `-1`. Item may be **char**, **String variable**, or **string literal**.
	
	`indexOf(item, indx)` starts at index `indx`.
	
	`lastIndexOf(item)` finds the last occurrence of the item in a string, else `-1`.
		`// userText is "Help me!"`
		`userText.indexOf('p') // Returns 3`
		`userText.indexOf('e') // Returns 1 (first occurrence)`
		`userText.indexOf('z') // Returns -1`
		`userText.indexOf("me") // Returns 5`
		`userText.indexOf('e', 2) // Returns 6 (starts at index 2)`
		`userText.lastIndexOf('e') // Returns 6 (last occurrence)`

`substring()`	`substring(startIndex)` returns substring starting at `startIndex`.
	
	`substring(startIndex, endIndex)` returns substring starting at `startIndex` and ending at `endIndex - 1`. The length of the substring is given by `endIndex - startIndex`.
		`// userText is "http://google.com"`
		`userText.substring(7) // Returns "google.com"`
		`userText.substring(13) // Returns ".com"`
		`userText.substring(0, 7) // Returns "http://"`
		`userText.substring(13, 17) // Returns ".com"`
		
		`// Returns last 4: ".com"`
		`userText.substring(userText.length() - 4, userText.length())`

Combining / Replacing

The String class has more methods for modifying strings.

Method	Constructors	Examples

`concat`	`concat(moreString)` creates a new String that appends the String `moreString` at the end.	`// userText is "Hi"`
		`userText = userText.concat(" friend"); // Now "Hi friend"`
		`newText = userText.concat(" there");`
		`// newText is "Hi friend there"`

replace()	replace(findStr, replaceStr) returns a new String in which all occurrences of findStr have been replaced with replaceStr.
	
	replace(findChar, replaceChar) returns a new String in which all occurrences of findChar have been replaced with replaceChar .
		// userText is "Hello"
		userText = userText.replace('H', 'j'); // Now "jello"
		// userText is "You have many gifts"
		userText = userText.replace("many", "a plethora of"); // Now "You have a plethora of gifts"
		// userText is "Goodbye"
		newText = userText.replace("bye"," evening");
		// newText is "Good evening"

`str1 + str2`	Returns a new String that is a copy of `str1` with `str2` appended.
	
	`str1` may be a String variable or string literal.Likewise for `str2` .
	One of `str1` or `str2` (not both) may be a character.
		`// userText is "A B"`
		`myString = userText + " C D";`
		`// myString is "A B C D"`
		`myString = myString + '!';`
		`// myString now "A B C D!"`
		`myString = myString + userText;`
		`// myString now "A B C D!A B"`

str1 += str2	Shorthand for str1 = str1 + str2 . str1 must be a String variable, and str2 may be a String variable, a string literal, or a character.	// userText is "My name is " userText += "Tom"; // Now "My name is Tom"

- Strings are considered **immutable**, meaning they cannot be changed.
  - The String's characters aren't changed, instead the variable is being assigned
    with the new String.

Conditional Expressions

A **Conditional expression** has the form `condition ? exprWhenTrue : exprWhenFalse`.

- All three operands are expressions.
- If `condition` is `true`, then `expreWhenTrue` is evaluated.
- If `condition` is `false`, then `expreWhenFalse` is evaluated.
- The `?` and `:` together are referred to as a **ternary operator**.
- Good practice is to restrict conditional expressions to an assignment statement as in: `y = (x == 2) ? 5 : 9 * x;`
  - Common practice is put parenthesis around the first expression of the conditional expression to enhance readability.

Floating-point Comparison

Do not compare floating-point numbers with `==`.

- Some floating-point numbers cannot be exactly represented in the limited available memory bits like 64 bits.

Floating-point numbers expected to be equal may be close but not exactly equal.

- Floating-point numbers should be compared for "close enough" rather than exact equality.
  - Ex. `If (x - y) < .0001` then `x` and `y` are deemed equal.
- The difference may be negative, so use `Math.abs` with floats:
  - `If Math.abs(x - y) < .0001`
- Rounding occurs when variables are printed due to the limited number of printed digits.

```
// examples of what is NOT okay for floating-point numbers (like doubles)
x == y;
x == 25.0;
x == 25;

// Figuring out the value of a floating point
float x = 25.0;
String numIsTwentyFive;
numIsTwentyFive = (x - 25.0) < 0.0001 ? "Yes it is 25." : "No, it's not 25.";
```

The difference threshold indicating that floating-point numbers are equal is called the **epsilon**.

- Epsilon's value depends on the program's expected values, but `0.0001` is common.

To observe the inexact value stored in a floating point value, use the `BigDecimal` class:

```
import java.math.BigDecimal;

public class DoublePrecisionEx {
  public static void main(String[] args) {
    double sampleValue1 = 0.2;
    double sampleValue2 = 0.3;
    double sampleValue3 = 0.7;
    double sampleValue4 = 0.0;
    double sampleValue5 = 0.25;

    System.out.println("sampleValue1 with System.out.println " + sampleValue1);

    // Uses BigDecimal to print floating-point values without rounding
    System.out.println("sampleValue1 is " + new BigDecimal(sampleValue1));
    System.out.println("sampleValue2 is " + new BigDecimal(sampleValue2));
    System.out.println("sampleValue3 is " + new BigDecimal(sampleValue3));
    System.out.println("sampleValue4 is " + new BigDecimal(sampleValue4));
    System.out.println("sampleValue5 is " + new BigDecimal(sampleValue5));

    return;
  }
}
```

32-bit representation of floating-point values:

Output

```
sampleValue1 with System.out.println 0.2
sampleValue1 is 0.200000000000000011102230246251565404236316680908203125
sampleValue2 is 0.299999999999999988897769753748434595763683319091796875
sampleValue3 is 0.699999999999999955591079014993738383054733276367 1875
sampleValue4 is 0
sampleValue5 is 0.25
```

Short Circuit Evaluation

Short circuit evaluation skips evaluating later operands if the result of the logical operator can already be determined.

- The logical `AND` operator short circuits to false if the first operand evaluates to false, and skips evaluating the second operand.
- The logical `OR` operator short circuits to true if the first operand is true, and skips evaluating the second operand.

Operator	Example	Short Circuit Evaluation
operand1 && operand2	true && operand2 false && operand2	If the first operand evaluates to `true`, `operand2` is evaluated. If the first operand evaluates to `false`, the result of the `AND` operation is always `false`, so `operand2` is not evaluated.
operand1 || operand2	true || operand2 false || operand2	If the first operand evaluates to `true`, the result of the `OR` operation is always `true`, so `operand2` is not evaluated. If the first operand evaluates to `false`, `operand2` is evaluated.