CISC 1115 (MY11) EXAM 2 REVIEW SHEET

NOTE*: This review sheet covers most (but not all) topics for your upcoming exam. It is here to clear up any confusion you may have about a particular concept, however, please keep in mind that we cannot and will not provide you with all the answers. Programming is a hands-on skill, please take it upon yourself to understand these concepts AND put them to use practically. Please work on the sample exercises provided; the only way to get better at writing code is by actually writing code.*

Chapter 2: Variables and Operators

Identifiers and Keywords

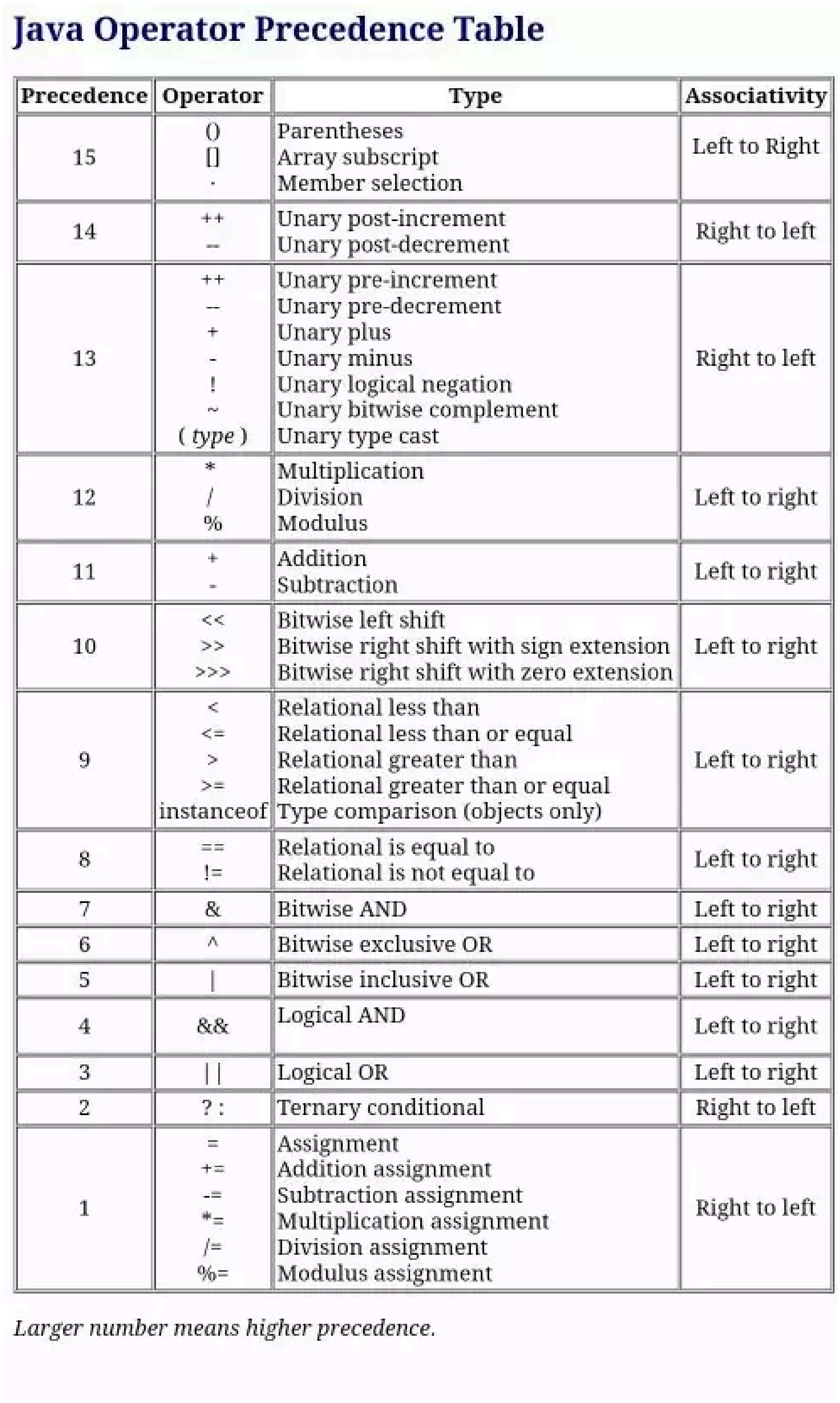
- Keywords are predefined, reserved words used in Java programming with special meanings to the compiler.
  - **For example: int, char, double, new, return, static, etc.**
- You cannot use keywords like int, for, class, etc. as variable names (or identifiers) as they are part of the Java programming language syntax.
- Identifiers are the names given to variables, classes, methods, etc.
  - **For example: n, num, number, score, etc.**

Arithmetic Expressions

Operator	Name	Description	Example
+	Addition	Adds together two values	x + y
-	Subtraction	Subtracts one value from another	x - y
*	Multiplication	Multiplies two values	x * y
/	Division	Divides one value by another	x / y
%	Modulus	Returns the division remainder	x % y
++	Increment	Increases the value of a variable by 1	++x
--	Decrement	Decreases the value of a variable by 1	--x

- Pre-increment (++x), i.e. System.out.println(++x); ➡➡➡ result: new value of x
- Post-increment (x++), i.e. System.out.println(x++); ➡➡➡ result: original value of x, store new value for next action
- (=): assignment vs (==): equivalence

Arithmetic Precedence



Java Operator Precedence Table

Precedence	Operator	Type	Associativity
15	() [] ·	Parentheses Array subscript Member selection	Left to Right
14	++ --	Unary post-increment Unary post-decrement	Right to left
13	++ -- + - ! ~ (*type*)	Unary pre-increment Unary pre-decrement Unary plus Unary minus Unary logical negation Unary bitwise complement Unary type cast	Right to left
12	* / %	Multiplication Division Modulus	Left to right
11	+ -	Addition Subtraction	Left to right
10	<< >> >>>	Bitwise left shift Bitwise right shift with sign extension Bitwise right shift with zero extension	Left to right
9	< <= > >= instanceof	Relational less than Relational less than or equal Relational greater than Relational greater than or equal Type comparison (objects only)	Left to right
8	== !=	Relational is equal to Relational is not equal to	Left to right
7	&	Bitwise AND	Left to right
6	^	Bitwise exclusive OR	Left to right
5	|	Bitwise inclusive OR	Left to right
4	&&	Logical AND	Left to right
3	||	Logical OR	Left to right
2	? :	Ternary conditional	Right to left
1	= += -= *= /= %=	Assignment Addition assignment Subtraction assignment Multiplication assignment Division assignment Modulus assignment	Right to left

Larger number means higher precedence.

Java.lang.Math class methods

- Math Class methods are built-in methods that make performing numeric operations like square, square root, cube, cube root, exponential and trigonometric operations, etc. easier.

- Math class methods include (but are not limited to):

  - **abs()**: java.lang.Math.abs(datatype arg) method returns the absolute value of any type of argument passed. This method can handle all the data types
    - **Parameters:**
      arg: the argument whose absolute value we need
    - **Returns:**
      the absolute value of the passed argument

  - **pow()**: java.lang.Math.pow(double b, double e) method returns the value as b^e
    - **Parameters:**
      b: base
      e: exponent
    - **Returns:**
      value as base^exponent

  - **round()**: java.lang.Math.round(double arg) method rounds off the passed argument up to closest decimal places
    - **Parameters**:
      arg - argument needs to round off
    - **Returns:**
      round off the value of the argument

  - **See the Java API for the full list of Math class methods: https://docs.oracle.com/en/java/javase/12/docs/api/java.base/java/lang/Math.html**

- **Sample exercises:**

  1. **Write a Java program that prompts the user to enter a base number (double) and an exponent number (double) and use Math.pow() to compute the result of the base to the power of the exponent.**

     Sample Data (Input/Output):

     ```
     Enter base: 5
     Enter exponent: 4

     The result of 5 to the power of 4 is: 625
     ```

Chapter 3: Input and Output

Writing to the Screen (System.out)

- System.out represents the Standard Output Stream. That means that if we want to print any statement on the console, we should use the following statement:

  System.out.print();

- There are three methods we use to print statements:
  - **print(String s)**: used to print on the console. It accepts a string as a parameter (we can concatenate parts to the string if necessary, i.e. “Hello” + “ World”, etc. however, it is typical convention to include all string literals in the same pair of quotations if they are consecutive) After printing the statement, the cursor remains on the same line.
  - **println(String s)**: upgraded version of the print() method. It is also used to display text on the console. After printing the statement, it throws the cursor at the start of the next line. It is the main() difference between the println() and the print() method.
  - **printf(String format, datatype args)**: It accepts two parameters:
    - format: It is a formatted String, uses placeholders with specific conversion characters to refer to the arguments that will be replaced when printing
    - args: It is an argument referenced by the format specifiers. If the number of arguments is more than the format specifiers, the other arguments are ignored. The number of arguments may be zero.
    - Conversion characters are only valid for certain data types. Here are some common ones:
      - **%s formats strings (String)**
      - **%d formats decimal integers (int)**
      - **%f formats floating-point numbers (double)**
    - Optional Modifiers:
      - **The [flags] define standard ways to modify the output and are most common for formatting integers and floating-point numbers.**
      - **The [width] specifies the field width for outputting the argument. It represents the minimum number of characters written to the output.**
      - **The [.precision] specifies the number of digits of precision when outputting floating-point values. Additionally, we can use it to define the length of a substring to extract from a String.**
    - %[flags][width][.precision]conversion-character (i.e. %2.2f would print a double value with two decimal places with left padding of two spaces)

        - printf() throws **NullPointerException** if the format is null, also throws the **IllegalFormatException** if a format string contains illegal syntax, and throws an **IllegalFormatConversionException** if the placeholder and corresponding argument are not of the same type.

Read Interactively from the Keyboard (System.in)

- All reading done in Java uses the Scanner class. Using this class, we can create an object to read input from the standard input channel System.in (the keyboard)

- To use the Scanner class, it is necessary to import the class Scanner from the library java.util by including the following line at the top of program:

  import java.util.Scanner;

- We can declare a Scanner object by saying:

  Scanner sc = new Scanner (System.in);

    - where:

        - sc is the name of the Scanner object (this can be changed and is entirely up to the person who writes the code)
        - and System.in connects our object to standard input (the keyboard)

- The Scanner class has multiple built-in methods that we can access to help us read data, for example: **we can use sc.nextLine() to read in a line of String(s) (spaces included)**

- Other methods include:

    - **nextBoolean(): reads a boolean value from the user**
    - **nextByte(): reads a byte value from the user**
    - **nextDouble(): reads a double value from the user**
    - **nextFloat(): reads a float value from the user**
    - **nextInt(): reads a int value from the user**
    - **next(): reads a complete token (String) from the user. A complete token is preceded and followed by input that matches the delimiter pattern, in most instances this is a space**

- **Sample exercises:**

    1. **Write a Java program that prompts the user for their first and last name and then prints out a message: “Hello, [FIRST NAME, LAST NAME]!”**

       <u>Sample Data (Input/Output)</u>:

       ```
       Enter your name: Jane Doe
       Hello, Jane Doe!
       ```

Reading and Writing Using Files

- As previously mentioned, we use a Scanner to read data whether or not the data is from the keyboard or a file. **To read from a file we only need to make one or two modifications from what we learned from reading from the keyboard.**

- First, since we are using files we need to allow our program(s) to use them by including:

import java.io.File; //import the File class

- Now we can add a **throws Exception** declaration to main and create the File object that we will be reading from:

File file= new File("[filename].txt");

- And create a Scanner like we have previously done, only changing our reference from the keyboard to the corresponding file object:

Scanner sc = new Scanner(file);

- It is important that you remember to **create the .txt file that you are trying to reading from and make sure that it is in the correct directory or to specify the path where the file is located when creating the File object** else you will receive a FileNotFoundException when you attempt to run your code.

- Writing to a file is slightly less work since we do not have to manually create the .txt file ourselves prior to running the program, the program will do the creation for us.

- Like before, we need to import the PrintWriter class in order to use it:

import java.io.PrintWriter;

- We will use the PrintWriter class to create our file:

PrintWriter pw = new PrintWriter("[filename].txt");

- It is important to **make sure that the filename that you are trying to create does not already exist in the directory that you are trying to create it in otherwise, you will overwrite the file and lose your original file data**

- Now we can use the PrintWriter object to write, the same way that we wrote to the screen only replacing System.out with our PrintWriter object, **i.e. pw.print(), pw.println(), pw.printf()**

- **Try modifying the programs that you may have previously done so that they write to both the screen AND to a file**

Chapter 5: Conditionals and Logic

If and if-else statements

- An if statement specifies a statement(s) to be executed only if a particular boolean expression is true.

- An if statement can be followed by an optional else statement, which executes when the boolean expression is false.

- An if statement can be followed by an else if statement to specify a new condition if the first condition is false. If you choose to include an else if statement it **MUST COME BEFORE** the else statement

- Syntax:

  -
    ```
    if(condition1) {
            //statement(s) to be executed if condition1 is true
    }
    else if(condition2) {
            //statement(s) to be executed if the condition1 is false and condition2 is
            true
    }
    else {
            //statement(s) to be executed if the condition1 is false and condition2 is
            false
    }
    ```

- **Sample exercises:**

  1. **Write a Java program that prompts the user for a number and prints whether it is even or odd.**

     <u>Sample Data (Input/Output)</u>:

     Enter number: 104

     104 is an even number.

  2. **Write a Java program that prompts the user for three numbers and prints out the largest of the three.**

     <u>Sample Data (Input/Output)</u>:

     Enter three numbers: 78 25 87

     The largest number is: 87

Nested if-else statements

- Nested if statements means an if statement inside an if statement
- Syntax:

    -
      ```
      if (condition1) {
                //statement(s) to be executed if condition1 is true
                if (condition2) {
                          //statement(s) to be executed if condition2 is true
                }
      }
      ```
- **Sample exercises:**
    1. **Write a Java program that prompts the user for a year and prints whether that year is a leap year or not. (*Note: Leap Years are any year that can be evenly divided by 4. A year that is evenly divisible by 100 is a leap year only if it is also evenly divisible by 400. For example, the years 1700, 1800, and 1900 are not leap years, but the years 1600 and 2000 are.)***

       Sample Data (Input/Output):

       Enter year: 2016

       2016 is a leap year.

Logical and Relational Operators

- Boolean expressions (evaluates to true/false):
    - Less than: **a < b**
    - Less than or equal to: **a <= b**
    - Greater than: **a > b**
    - Greater than or equal to: **a >= b**
    - Equal to: **a == b**
    - Not Equal to: **a != b**

Integer and Logical Values

- We can include integers in our boolean expressions and determine whether or not they are true or false. For instance, if we were to print out:
    - System.out.print(6 > 5) we would see a result value of ‘true’
    - while System.out.print(6 < 5) or System.out.print(6 == 5) would result in a value of ‘false’ for obvious reasons

Chapter 7: Loops

While Loops

- allows code to be executed repeatedly based on a given Boolean condition (T/F). Needs two parts: **condition/test expression and increment/decrement/update expression**

- Syntax:

    -
      ```
      int i = 1;
      while(i <= 10) {
              //statement(s) to be executed while the condition is true
              i++;
      }
      ```

    - where:

        - i <= 10 is a boolean expression. **If the condition evaluates to true, we will execute the body of the loop and go to the update expression.** Otherwise, we will exit from the while loop without reaching the statements inside the body.
        - and i++ increments the variable i

- How many times does this loop run? What would happen if you forgot to include i++;? Try writing code that uses a while loop like this.

- **Sample exercises:**

    1. **Write a Java program that prompts the user for age and prints out "Sorry, you are ineligible to vote." and increments the age until the user is eligible to vote, and prints out "Congratulations, you are eligible to vote!" once they are 18+.**

       Sample Data (Input/Output):

       ```
       Enter your age: 16

       Sorry, you are ineligible to vote.
       Sorry, you are ineligible to vote.
       Congratulations, you are eligible to vote!
       ```

    2. **Write a Java program that prompts the user to input an integer and then outputs the number with the digits reversed. For example, if the input is 12345, the output should be 54321.**

       Sample Data (Input/Output):

       ```
       Enter a number: 12345
       Reverse of 12345 is: 54321
       ```

For Loops

- Unlike a while loop, a for statement has the **initialization, condition, and increment/decrement** in one line

- Syntax:

    - **for (int i = 1; i <= 10; i++) {**
      //statement(s) to be executed while the condition is true
      }

    - where:
        - int i = 1; is the initialization
        - i <= 10; is a boolean condition
        - and i++ increments the variable i

- How many times does this loop run? Try writing code that uses a for loop like this.

- **Sample exercises:**

    1. **Write a program to print numbers from 10 to 100 in increments of 10.**

       Sample Data (Output only):

       ```
       10 20 30 40 50 60 70 80 90 100
       ```

    2. **Write a program that prompts the user to input a positive integer. It should then print the multiplication table of that number. (0 - 12)**

       Sample Data (Input/Output):

       ```
       Enter a number: 5
       Multiplication Table of 5
       5 x 0 = 0
       5 x 1 = 5
       .... .. ....
       5 x 12 = 60
       ```

More Complex Loops

- **Nested loops**: if a loop exists inside the body of another loop, it's called a nested loop.

- **Loops with more than one condition**: a condition is a boolean expression and can have more than one part to be considered. For example, to vote you need to be 18+ AND an American citizen. In this case, only when both requirements are true can a person be eligible to vote. It works the same with loop conditions.

    - when using AND (&&), both parts of the condition must be true to evaluate to true
    - when using OR (||), only one part needs to be true to evaluate to true

- **Sample exercises:**

1. **Write a Java program that prints out each day of the week for a month (approximately 4 weeks).**

   <u>Sample Data (Output)</u>:

   ```
   Week: 1
           Day: 1
           Day: 2
           Day: 3
           .....  ..  ....
   Week: 2
           Day: 1
           Day: 2
           Day: 3
           ....  ..  ....
   ....  .. ....
   ```

2. **Write a Java program that prompts the user for a number of rows and then prints out a half pyramid of asterisks (‘*’) with the same number of rows.**

   <u>Sample Data (Input/Output)</u>:

   ```
   Enter the number of rows: 5

   *
   * *
   * * *
   * * * *
   * * * * *
   ```

3. **Write a Java program that prompts the user for a number less than 100 and prints out all the even numbers starting from the number that they entered up to and including 100.**

   <u>Sample Data(Input/Output)</u>:

   ```
   Enter a number: 85

   86 88 90 92 94 96 98 100
   ```

Chapter 9: Strings and Things

String Representation

- Strings are used for storing text.
- A String variable contains a collection of characters surrounded by double quotes, it can be declared using a string literal, such as:

  String greeting = “Hello”;

- Like arrays, **Strings are immutable** as well. Whenever a change to a String is made, an entirely new String is created.
- Methods used to obtain information about a String are known as **accessor methods**. One accessor method that you can use with Strings is the **length()** method, which returns the number of characters contained in the String.

  System.out.println(“The length of String greeting is: “ + greeting.length());

  What should this print out? How long is our String greeting?

- **Sample exercises:**

  1. **Write a Java program that prompts the user for their first and last name, prints out the length of both and then greets them with a message.**

     Sample Data (Input/Output):

     ```
     Enter first name: John
     Enter last name: Doe

     The length of first name: John is 4
     The length of last name: Doe is 3

     Hello, John Doe!
     ```

String Methods

- As previously mentioned, when we create a String, we have access to methods that can perform certain operations on Strings. These methods include (but are not limited to):
  - **char charAt(int index)**
    - **Parameters:**
      index - the index of the char value
    - **Returns:**
      the char value at the specified index of this string. The first char value is at index 0
    - **Throws:**
      IndexOutOfBoundsException - if the index argument is negative or not less than the length of this string

        - Example: what does **greeting.charAt(2)** return?
          ***note:remember that Strings are char arrays and array indexes start from 0**
    - **int compareTo(String anotherString)**
        - **Parameters:**
          anotherString - the String to be compared
        - **Returns:**
          the value 0 if the argument string is equal to this string;
          a value less than 0 if this string is lexicographically less than the string argument;
          and a value greater than 0 if this string is lexicographically greater than the string argument
    - **int compareToIgnoreCase(String str)**
        - **Parameters:**
          str - the String to be compared
        - **Returns:**
          a negative integer, zero, or a positive integer as the specified String is greater than, equal to, or less than this String, ignoring case considerations
    - **String concat(String str)**
        - **Parameters:**
          str - the String that is concatenated to the end of this String
        - **Returns:**
          a string that represents the concatenation of this object's characters followed by the string argument's characters
          ***note: we can also use the + operator between strings to concatenate them.**
    - **boolean equals(Object anObject)**
        - **Parameters:**
          anObject - The object to compare this String against
        - **Returns:**
          true if the given object represents a String equivalent to this string, false otherwise
    - **boolean equalsIgnoreCase(String anotherString)**
        - **Parameters:**
          anotherString - The String to compare this String against
        - **Returns:**
          true if the argument is not null and it represents an equivalent String ignoring case; false otherwise
    - **int indexOf(int ch)**
        - **Parameters:**
          ch - a character (Unicode code point)
        - **Returns:**
          the index of the first occurrence of the character in the character sequence represented by this object, or -1 if the character does not occur
    - **int indexOf(int ch, int fromIndex)**
        - **Parameters:**
          ch - a character (Unicode code point)
          fromIndex - the index to start the search from
        - **Returns:**

    the index of the first occurrence of the character in the character sequence represented by this object that is greater than or equal to fromIndex, or -1 if the character does not occur

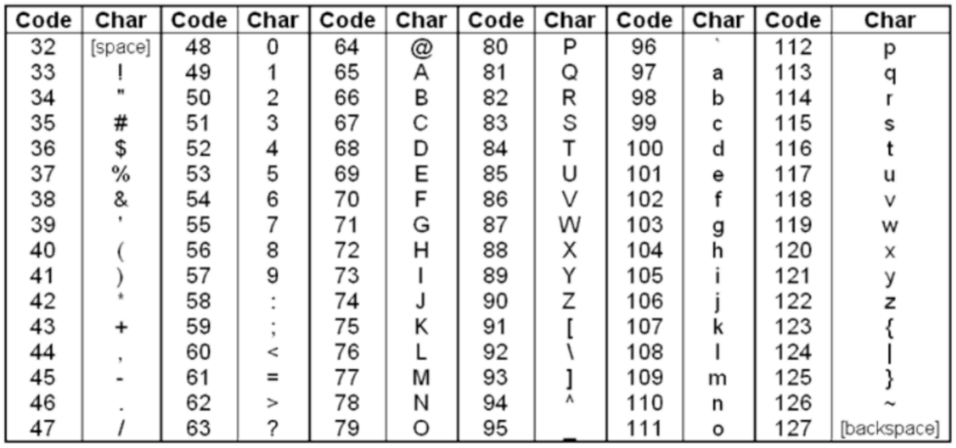
- **String substring(int beginIndex)**
    - **Parameters:**
      beginIndex - the beginning index, inclusive
    - **Returns:**
      the specified substring
    - **Throws:**
      IndexOutOfBoundsException - if beginIndex is negative or larger than the length of this String object
- **String substring(int beginIndex, int endIndex)**
    - **Parameters:**
      beginIndex - the beginning index, inclusive
      endIndex - the ending index, exclusive
    - **Returns:**
      the specified substring
    - **Throws:**
      IndexOutOfBoundsException - if the beginIndex is negative, or endIndex is larger than the length of this String object, or beginIndex is larger than endIndex
- **See the Java API for full list of String class methods:**
  https://docs.oracle.com/en/java/javase/12/docs/api/java.base/java/lang/String.html

Integer and Character Variables

- A char is a single character, that is a letter, a digit, a punctuation mark, a tab, a space or something similar. A char literal is a single one character enclosed in single quote marks like this:
  char c = 'a';

- A variable whose type is char is stored as a Unicode character in 16 bits or two bytes.

- We can perform computations and compare equivalence between char and int variables due to the char ASCII values. Consult the table:



Code	Char	Code	Char	Code	Char	Code	Char	Code	Char	Code	Char
32	[space]	48	0	64	@	80	P	96	`	112	p
33	!	49	1	65	A	81	Q	97	a	113	q
34	"	50	2	66	B	82	R	98	b	114	r
35	#	51	3	67	C	83	S	99	c	115	s
36	$	52	4	68	D	84	T	100	d	116	t
37	%	53	5	69	E	85	U	101	e	117	u
38	&	54	6	70	F	86	V	102	f	118	v
39	'	55	7	71	G	87	W	103	g	119	w
40	(	56	8	72	H	88	X	104	h	120	x
41	)	57	9	73	I	89	Y	105	i	121	y
42	*	58	:	74	J	90	Z	106	j	122	z
43	+	59	;	75	K	91	[	107	k	123	{
44	,	60	<	76	L	92	\	108	l	124	|
45	-	61	=	77	M	93	]	109	m	125	}
46	.	62	>	78	N	94	^	110	n	126	~
47	/	63	?	79	O	95	_	111	o	127	[backspace]

- The ASCII chart shown lists all of the printable characters.

- There are additional characters (whitespace, movement, computer codes) that are represented by codes 0-31.

- Note that there are different codes for “A” (decimal 65) and “a” (decimal 97).

- The computer has no idea what an “A” or an “a” is, or that they represent the same letter.

- This is important to remember – a computer only understands electronic signals, and has no knowledge of our alphabet.

- Some characters are hard to type. For these Java provides escape sequences. This is a backslash followed by an alphanumeric code. For instance '\n' is the newline character. '\t' is the tab character. '\\' is the backslash itself.

- The following escape sequences are defined:

    - \b - backspace
    - \t - tab
    - \n - new line
    - \r - carriage return
    - \" - double quote, "
    - \' - single quote, '
    - \\ - backslash, \

- **Sample exercises:**

    1. **Write a Java program that prompts the user to enter a String, counts the number of vowels (a, e, i, o, u) in the String and prints out the result.**

       <u>Sample Data (Input/Output)</u>:

       Enter a String: good morning starshine, the earth says hello!

       The number of vowels in this String is: 13

    2. **Write a Java program to check whether the first two characters present at the end of a given string.**

       <u>Sample Data (Output only)</u>:

       The given strings is: educated
       The first two characters appear in the last is: true

Chapter 8: Methods (Call By Value)

A method in Java is a block of code that, when called, performs specific actions mentioned in it.

For instance, if you have written instructions to draw a circle in the method, it will do that task. You can insert values or parameters into methods, and they will only be executed when called. They are also referred to as functions.

The primary uses of methods in Java are:

- It allows code reusability (define once and use multiple times)
- It breaks a complex program into smaller chunks of code
- It increases code readability

Call by Value means calling a method with a parameter as value. Through this, the argument value is passed to the parameter.

In call by value, the modification done to the parameter passed does not reflect in the caller's scope (originally where the method was called), unless returned.

Void Methods

- Void methods mean that the method does not return a value (e.g. main())

Value Methods

- Value methods have a return type (int, double, String, boolean, etc.) and must return a value of that type

- **Sample exercises:**

    1. **Trace the following program:**

```
public static void main(String[] args){
        int a = 30;
        int b = 45;
        System.out.println("Before swap (in main), a = " + a + " and b = " + b);
        // Invoke the swap method
        swap(a, b);
        System.out.println("After swap (in main), a = " + a + " and b is " + b);
        //Invoke the modify method
        b = modify(a, b);
        System.out.println("After modify (in main), a = " + a + " and b is " + b);
}

public static void swap(int a, int b) {
        System.out.println("Before swap (in method), a = " + a + " b = " + b);
        // Swap n1 with n2
        int c = a;
        a = b;
        b = c;
        System.out.println("After swap (in method), a = " + a + " b = " + b);
    }

    public static int modify(int a, int b) {
        System.out.println("Before modify (in method), a = " + a + " b = " + b);
        // modify values
        a = b * 2;
        b = a * 3;
        System.out.println("After modify (in method), a = " + a + " b = " + b);
        return a;
    }
```

Chapter 9: Arrays

One Dimensional Arrays

- Arrays are used to store multiple values in a single variable, instead of declaring separate variables for each individual value.

- To declare a one-dimensional array, we define the variable type with square brackets:

  int [] numbers

- We have now declared a variable that holds an array of integers. To insert values to it, we can use an array literal - place the values in a comma-separated list, inside curly braces:

  int [] numbers = {10, 20, 30, 40};

- If we know the intended size of our array beforehand (or at least the maximum threshold that we are confident that the array should not exceed) we can also initialize its size first and add values later. We can do this by using the new keyword and specifying the size in square brackets:

  int [] numbers2 = new int [SIZE GOES HERE];

  - In this case, we want to create an array of the same size as the previous example so we would declare it as such:

    int [] numbers2 = new int [4];

- We can access a specific array element by referring to the index number. **IMPORTANT TO REMEMBER: ARRAY INDEXES START AT 0**

- The elements in the array allocated by new will automatically be initialized to zero (for numeric types), false (for boolean), or null (for reference types).

- Let's populate the numbers2 array with the same values as the numbers array.

- We want to put the same values in the same position:

    - where the value 10 is in the first position
    - the value 20 is in the second position
    - the value 30 is in the third position
    - and the value 40 is in the fourth position

```
numbers2[0] = 10;
numbers2[1] = 20;
numbers2[2] = 30;
numbers2[3] = 40;
```

    What would happen if we changed 3 to 4, or tried to set numbers2[4] = 50? Why would that not work?

- To find out how many elements an array has, we can use the length property

    - **numbers 2.length**
    - What should System.out.println(numbers.length); print out?

- Each element in the array is accessed via its index. The index begins with 0 and ends at (total array size)-1. All the elements of the array can be accessed using a for Loop.

```
// accessing the elements of the specified array
for (int i = 0; i < numbers2.length; i++) {
        System.out.println("Element at index " + i + " : "+ numbers2[i]);
}
```

Using Arrays in Methods

- You can pass arrays to a method just like normal variables
.
- When we pass an array to a method as an argument, actually the address of the array in the memory is passed (reference). Therefore, **any changes to this array in the method will affect the array.**

- **Sample exercises:**

    1. **Write a Java program that reads data (integers) from an external data file (input file) that has no more than 100 integers, with one on each line, into an integer array: numbers and save the amount of numbers read in into an integer: size. Print out the array (up to n) in main.**

        Write a method: average(), that accepts an integer array: nums and an integer: n, which will calculate and return the average (hint: the average SHOULD be a double, how can we ensure that we get the accurate number and avoid integer division?) of the n numbers in the array and print out this value in main.

Write another method: stats(), that accepts an integer array: nums and an integer: n, which will determine and print out how many of the numbers are even, how many are odd, how many are equal to or greater than the average, and how many are below the average.

Sample Data (Input/Output):

(Input file)

```
5
11
2
4
32
```

(Output)

```
Array: 5 11 2 4 32
Average of array: 10.8

Number of even numbers: 3
Number of odd numbers: 2
Number of numbers equal to or greater than average: 2
Number of numbers below average: 3
```

2. **Write a Java program that has an integer array declared and initialized in the main method. Write a method printArray(), that prints out the array, and two separate methods: arrayMax() and arrayMin(), which accepts an integer array as a parameter and calculates and returns the maximum and minimum values of the given array respectively. Call each of these methods in main and print all output to the screen.**

   Sample Data(Output only):

```
Array values: 45 12 48 53 55
Maximum value in the array is: 55
Minimum value in the array is: 12
```

3. **Write a Java program that has an integer array declared and initialized in the main method. Write a method that prints out the array, and another method called powerOfTwo(), which accepts an integer array as a parameter and updates each index of the array with the former value to the power of two. Call both methods in main so that your program prints out the original array, modifies the array, and then prints out the modified array.**

   Sample Data (Output only):

```
Array values (original): 2 4 6 8 10
Array values (modified): 4 16 36 64 100
```

Parallel Arrays

- Parallel Arrays: multiple arrays of the same size such that the i-th element of each array is closely related and all i-th elements together represent an object or entity. An example parallel array is two arrays that represent x and y coordinates of n points.
- Below is an example (***note: the arrays do not have to be of the same datatype to be parallel, we could have a set of parallel arrays that are of Strings and corresponding integers**):

String [] name = {“Usagi Tsukino”, ”Ami Mizuno”, “Rei Hino”, “Makoto Kino”, “Minako Aino”};

String [] identity = {“Moon”, “Mercury”, “Mars”, “Jupiter”, “Venus”};

String [] guardianOf = {“Love and Justice”, “Water and Wisdom”, “Fire and Passion”, “Thunder and Courage”, “Love and Beauty”};

name:

0	1	2	3	4
Usagi Tsukino	Ami Mizuno	Rei Hino	Makoto Kino	Minako Aino

identity:

0	1	2	3	4
Moon	Mercury	Mars	Jupiter	Venus

guardianOf:

0	1	2	3	4
Love and Justice	Water and Wisdom	Fire and Passion	Thunder and Courage	Love and Beauty

- This way we could easily store the information and for accessing, the first index of each array corresponds to the data belonging to the same person.

- **Sample exercises:**

    1. **Write a Java program that prompts the user for a size (number of students/number of grades) and then declares an integer array of that size. Then prompt the user to enter integer grades (0 - 100) to populate the array (hint: use a for loop). Create a separate method called letterGrade() that accepts an integer array and returns a new parallel array of type String that is populated by the equivalent letter grade. (hint(s): parallel arrays have the same size, once again use a for loop, this time you also need if/else if/else blocks) Print out the entire array of both integer grades and letter grades (you can create a separate method for this).**

Letter Grade	Percent Grade	4.0 Scale
A+	97-100	4.0
A	93-96	4.0
A-	90-92	3.7
B+	87-89	3.3
B	83-86	3.0
B-	80-82	2.7
C+	77-79	2.3
C	73-76	2.0
C-	70-72	1.7
D+	67-69	1.3
D	65-66	1.0

(Use the above table to help you determine the necessary condition(s), use F as the letter grade for any integer lower than 65)

Sample Data (Input/Output):

```
Enter number of students: 4
Enter student 1 grade: 79
Enter student 2 grade: 95
Enter student 3 grade: 96
Enter student 4 grade:  83

Student grades:
Student 1: 79   Final Grade: C+
Student 2: 95   Final Grade: A
Student 3: 96   Final Grade: A
Student 4: 82   Final Grade: B-
```

Searching

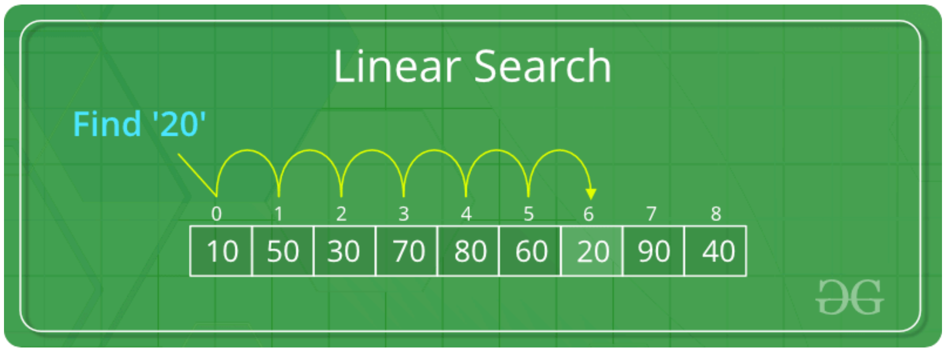
- A key is a value that you are looking for in an array.
- The simplest type of search is the **sequential (or linear) search**.
- In the sequential search, each element of the array is compared to the key, in the order it appears in the array, until the desired element is found.
- If you are looking for an element that is near the front of the array, the sequential search will find it quickly.
- The more data that must be searched, the longer it will take to find the data that matches the key.
- Consider this method which will search for a key integer value:
    - If found, the index (subscript) of the first location of the key will be returned.
    - If not found, a value of -1 will be returned.

```
public static int search(int [ ] numbers, int key) {
        for (int i = 0; i < numbers.length; i++) {
                if ( numbers[i] = = key )
                        return index;  //We found the key and this index !!!
        }
        // If we get to the end of the loop, a value has not yet
        // been returned.  We did not find the key in this array.
        return -1;
}
```

- If the key value is found, the index (subscript) of the location is returned. This tells us that the return value x, will be the first integer found such that:

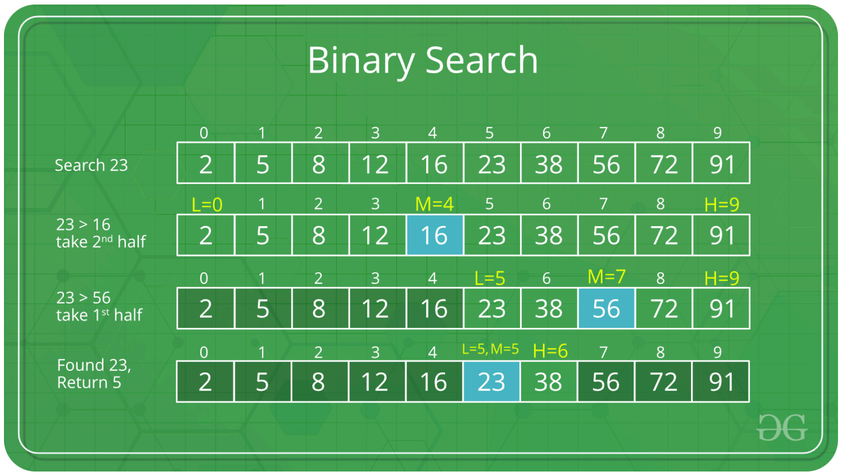
numbers [x] = key

- There may be additional key locations in this array beyond this location.
- Types of searches:
    - **Linear search: the list or array is traversed sequentially and every element is checked (sequential search!!)**



        - Start from the leftmost element of arr[] and one by one compare x with each element of arr[]
        - If x matches with an element, return the index.
        - If x doesn't match with any of elements, return -1.

- **Binary search:**



  - Search a sorted array by repeatedly dividing the search interval in half.
  - Begin with an interval covering the whole array.
  - If the value of the search key is less than the item in the middle of the interval, narrow the interval to the lower half.
  - Otherwise, narrow it to the upper half.
  - Repeatedly check until the value is found or the interval is empty.

```
public static int binarySearch(int arr[], int l, int r, int x) {
        if (r >= l) {
                int mid = l + (r - l) / 2;

        // if the element is present at the middle itself
        if (arr[mid] == x)
                        return mid;

        // if element is smaller than mid, then
        // it can only be present in left subarray
        if (arr[mid] > x)
                        return binarySearch(arr, l, mid - 1, x);

        // else the element can only be present
        // in right subarray
        return binarySearch(arr, mid + 1, r, x);
        }

        // We reach here when element is not present in array
        return -1;
}
```

- Sample exercises:

    1. **Modify the previous exercise to use three parallel arrays, an array of Strings called firstName, an array of Strings called lastName, and an array of integers called grades, and populate them. Add a search method that allows the user to input a last name and a first name and prints out the student's corresponding integer and letter grade if they are found in the database and prints out: "Invalid -- Student not found" if they are not.**

        Sample Data (Input/Output):

        ```
        Enter student's last name: Wilkins
        Enter student's first name: Samantha-Eve

        Student's grade: 96 - A

        Enter student's last name: Sloane
        Enter student's first name: Rex

        Invalid -- Student not found

        Enter student's last name: Grayson
        Enter student's first name: Mark

        Student's grade: 79 - C+
        ```