## Day 1: Data Types

Terms you'll find helpful in completing today's challenge are outlined below, along with sample Java code (where appropriate).

### Data Types

Data types define and restrict what type values can be stored in a variable, as well as set the rules for what types of operations can be performed on it.

### [Primitive Data Types](https://docs.oracle.com/javase/tutorial/java/nutsandbolts/datatypes.html)

Java has 8 [primitive data types](https://docs.oracle.com/javase/tutorial/java/nutsandbolts/datatypes.html): byte, short, int, long, float, double, boolean, and char. For most challenges, you'll only need to concern yourselves with ints (e.g.: , , , etc.) and doubles (e.g.: , , , etc.). Another important data type we mentioned yesterday is the String class, whose objects are immutable strings of characters.

### [Scanner](https://docs.oracle.com/javase/7/docs/api/java/util/Scanner.html)

Yesterday, we discussed Scanner's next, nextLine, hasNext, and hasNextLine methods. Scanner also has readNextand hasNext methods for different data types, which is very helpful when you know exactly what type of input you'll be reading. The next methods scan for tokens (you can think of this as a word), and the nextLine methods reads from the Scanner's current location until the beginning of the next line. For example, nextInt() will scan the next token of input as an int, and nextDouble() will scan the next token of input as a double. You should only ever usescanner object for your entire program.

Each line of multi-line input contains an invisible separator indicating that the end of a line of input has been reached. When you use Scanner functions that read tokens (e.g.: next(), nextInt(), etc.), the Scanner reads and returns the next token. When you read an entire line (i.e.: readLine()), it reads from the current position until the beginning of the next line. Because of this, a call to nextLine() may return an empty string if there are no characters between the end of the last read and the beginning of the next line. For example, given the following input:

a b cd efg

The breakdown below shows how a certain sequence of calls to a Scanner object, , will read the above input:

1. A call to scan.next(); returns the next token, a.
2. A call to scan.next(); returns the next token, b.
3. A call to scan.nextLine(); returns the next token, c. It's important to note that the scanner returns a space and a letter, because it's reading from the end of the last token until the beginning of the next line.
4. A call to scan.nextLine(); returns the contents of the next line, d e.
5. A call to scan.next(); returns the next token, f.
6. A call to scan.nextLine(); returns everything after f until the beginning of the next line; because there are no characters there, it returns an empty String.
7. A call to scan.nextLine(); returns g.

**Note:** You will struggle with this challenge if you did not review this section. You must understand what happens when you switch between reading a token (single word) of input and reading an entire line of input to successfully complete this challenge.

### [Additive Operator](https://docs.oracle.com/javase/tutorial/java/nutsandbolts/op1.html)

The + operator is used for mathematical addition and String concatenation (i.e.: combining two Strings into one new String). If you add the contents of two variables together (e.g.: a + b), you can assign their result to another variable using the assignment operator (=). You can also pass the result to a function instead of assigning it to a variable; for example, if  and , System.out.println(a + b); will print 3 on a new line.

### C++

You may find this information helpful when completing this challenge in C++.

To consume the whitespace or newline between the end of a token and the beginning of the next line:

if (getline(cin >> ws, s2)) { // eat whitespace

getline(cin, s2);}

where s2 is a string. In addition, you can specify the scale of floating-point output with the following code:

#include <iostream>#include <iomanip>

using namespace std;int main(int argc, char \*argv[]) {

double pi = 3.14159;

// Let's say we wanted to scale this to 2 decimal places:

cout << fixed << setprecision(2) << pi << endl;

printf("%.2f", pi);}

which produces this output:

3.14

3.14

## Day 2: Operators

Terms you'll find helpful in completing today's challenge are outlined below, along with sample Java code (where appropriate).

[**Operators**](https://docs.oracle.com/javase/tutorial/java/nutsandbolts/operators.html)   
These allow you to perform certain operations on your data. There are 3 basic types:

1. Unary: operates on 1 operand
2. Binary: operates on 2 operands
3. Ternary: operates on 3 operands

**Arithmetic Operators**   
The binary operators used for arithmetic are as follows:

* +: Additive
* -: Subtraction
* \*: Multiplication
* /: Division
* %: Remainder ([modulo](https://en.wikipedia.org/wiki/Modulo_operation))

**Additional Operators**

* +: A binary operator used for String concatenation
* ++: This unary operator is used to preincrement (increment by 1 before use) when prepended to a variable name or postincrement (increment by 1 after use) when appended to a variable.
* --: This unary operator is used to predecrement (decrement by 1 before use) when prepended to a variable name or postdecrement (decrement by 1 after use) when appended to a variable.
* !: This unary operator means not (negation). It's used before a variable or logical expression that evaluates to true or false.
* ==: This binary operator is used to check the equality of 2 primitives.
* !=: This binary operator is used to check the inequality of 2 primitives.
* <, >, <=, >=: These are the respective binary operators for less than, greater than, less than or equal to, and greater than or equal to, and are used to compare two operands.
* &&, ||: These are the respective binary operators used to perform logical AND and logical OR operations on two boolean (i.e.: true or false) statements.
* ? : This ternary operator is used for simple conditional statements (i.e.: if ? then : else).

## Day 3: Intro to Conditional Statements

Terms you'll find helpful in completing today's challenge are outlined below, along with sample Java code (where appropriate).

### [Boolean](https://en.wikipedia.org/wiki/Boolean_data_type)

A logical statement that evaluates to true or false. In some languages, true is interchangeable with the number and false is interchangeable with the number .

### [Conditional Statements](https://en.wikipedia.org/wiki/Conditional_(computer_programming))

These are a way of programming different workflows depending on some boolean condition. The if-elsestatement is probably the most widely used conditional in programming, and its workflow is demonstrated below:

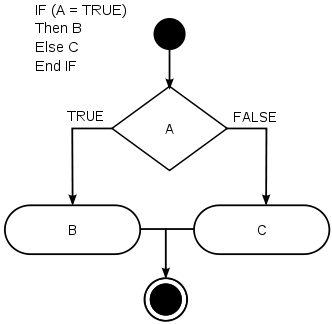


Image Source: [Wikipedia(Conditional Statements)](https://en.wikipedia.org/wiki/Conditional_(computer_programming)#/media/File:If-Then-Else-diagram.svg)

The basic syntax used by Java (and many other languages) is:

if(condition) {

// do this if 'condition' is true}else {

// do this if 'condition' is false}

where  is a boolean statement that evaluates to true or false. You can also use an if without an else, or follow an if(condition) with else if(secondCondition) if you have a second condition that only need be checked when  is false. If the if (or else if) condition evaluates to true, any other sequential statements connected to it (i.e.: else or an additional else if) will not execute.

### Logical Operators

Customize your condition checks by using logical operators. Here are the three to know:

* || is the OR operator, also known as logical disjunction.
* && is the AND operator, also known as logical conjunction.
* ! is the NOT operator, also known as negation.

Here are some usage examples:

// if A is true and B is true, then Cif(A && B){

C; }

// if A is true or B is true, then Cif(A || B){

C;}

// if A is false (i.e.: not true), then Bif(!A){

B;}

Another great operator is the ternary operator for conditional statements (? :). Let's say we have a variable, , and a condition, . If the condition is true, we want  to be assigned the value of ; if condition  is false, we want  to be assigned the value of . We can write this with the following simple statement:

v = c ? a : b;

In other words, you can read c ? a : b as "if  is true, then ; otherwise, ". Whichever value is chosen by the statement is then assigned to .

### [Switch Statement](http://docs.oracle.com/javase/tutorial/java/nutsandbolts/switch.html)

This is a great control structure for when your control flow depends on a number of known values. Let's say we have a variable, , whose possible values are , , , and each value has an action to perform (which we will call some variant of ). We can switch between actions with the following code:

switch (condition) {

case val0: behavior0;

break;

case val1: behavior1;

break;

case val2: behavior2;

break;

default: behavior;

break;}

**Note:** Unless you include break; at the end of each case statement, the statements will execute sequentially. Also, while it's good practice to include a default: case (even if it's just to print an error message), it's not strictly necessary.

## Day 4: Class vs. Instance

Terms you'll find helpful in completing today's challenge are outlined below, along with sample Java code (where appropriate).

### [Class](https://en.wikipedia.org/wiki/Class-based_programming)

A blueprint defining the charactaristics and behaviors of an object of that class type. Class names should be written in CamelCase, starting with a capital letter.

class MyClass{

...}

Each class has two types of variables: [class variables](https://en.wikipedia.org/wiki/Class_variable) and [instance variables](https://docs.oracle.com/javase/tutorial/java/javaOO/classvars.html); class variables point to the same (static) variable across all instances of a class, and instance variables have distinct values that vary from instance to instance.

### [Class Constructor](https://en.wikipedia.org/wiki/Constructor_(object-oriented_programming))

Creates an instance of a class (i.e.: calling the Dog constructor creates an instance of Dog). A class can have one or more constructors that build different versions of the same type of object. A constructor with no parameters is called a [default constructor](https://en.wikipedia.org/wiki/Default_constructor); it creates an object with default initial values specified by the programmer. A constructor that takes one or more parameters (i.e.: values in parentheses) is called a parameterized constructor. Many languages allow you to have multiple constructors, provided that each constructor takes different types of parameters; these are called [overloaded constructors](https://en.wikipedia.org/wiki/Function_overloading).

class Dog{ // class name

static String unnamed = "I need a name!"; // class variable

int weight; // instance variable

String name; // instance variable

String coatColor; // instance variable

Dog(){ // default constructor

this.weight = 0;

this.name = unnamed;

this.coatColor = "none";

}

Dog(int weight, String color){ // parameterized constructor

// initialize instance variables

this.weight = weight; // assign parameter's value to instance variable

this.name = unnamed;

this.coatColor = color;

}

Dog(String dogName, String color){ // overloaded parameterized constructor

// initialize instance variables

this.weight = 0;

this.name = dogName;

this.coatColor = color;

}}

### [Method](https://en.wikipedia.org/wiki/Method_(computer_programming))

A sort of named procedure associated with a class that performs a predefined action. In the sample code below, returnType will either be a data type or  if no value need be returned. Like a constructor, a method can have or more parameters.

returnType methodName(parameterOne, ..., parameterN){

...

return variableOfReturnType; // no return statement if void}

Most classes will have methods called getters and setters that get (return) or set the values of its instance variables. Standard getter/setter syntax:

class MyClass{

dataType instanceVariable;

...

void setInstanceVariable(int value){

this.instanceVariable = value;

}

dataType getInstanceVariable(){

return instanceVariable;

}}

Structuring code this way is a means of managing how the instance variable is accessed and/or modified.

### [Parameter](https://en.wikipedia.org/wiki/Parameter_(computer_programming))

A parenthetical variable in a function or constructor declaration (e.g.: in int methodOne(int x), the parameter is int x).

### Argument

The actual value of a parameter (e.g.: in methodOne(5), the argument passed as variable x is 5).

## Day 5: Loops

Terms you'll find helpful in completing today's challenge are outlined below, along with sample Java code (where appropriate). As you code more, you may see these loops implemented in different ways than are shown here.

### [For Loop](https://docs.oracle.com/javase/tutorial/java/nutsandbolts/for.html)

This is an iterative loop that is widely used. The basic syntax is as follows:

for (initialization; termination; increment) {

// ...}

The initialization component is the starting point in your iteration, and your code for this section will typically be int i = 0. When we declare and initialize int i in the loop like this, we are creating a [*temporary variable*](https://en.wikipedia.org/wiki/Temporary_variable) that exists only inside this loop for the purposes of iterating through the loop; once we finish iterating and exit (or break) the loop,  is deleted and can be declared elsewhere in our program.

The termination component is the condition which, once met, you would like to exit (or break) the loop and proceed to the next line in your code. This is the ending point for your loop, and is typically written as i < endValue, where  is the variable from the initialization section and  is some variable holding the stopping point for your iteration.

The increment component is executed each time the end of the code inside the loop's brackets is reached, and should generally be some modification on the initialization variable that brings it closer to the termination variable. This will typically be i++. The ++ operator is also called the [post-increment](https://en.wikipedia.org/wiki/Increment_and_decrement_operators) operator, and it will increment a variable by  after a line executes (for more detail and an example, see the While section).

To recap, this sample code:

int endOfRange = 4;for(int i = 0; i < endOfRange; i++){

System.out.println(i);}

produces this output:

0

1

2

3

### [While Loop](https://docs.oracle.com/javase/tutorial/java/nutsandbolts/while.html)

This type of loop requires a single boolean condition and continues looping as long as that condition continues to be true. Each time the the end of the loop is reached, it loops back to the top and checks if the condition is still true. If it's true, the loop will run again; if it's false, then the program will skip over the loop and continue executing the rest of the code.

Much like in the For section, the code below prints the numbers  through . Notice that we are using the post-increment operator on :

int min = 0;int max = 4;while(min < max){

System.out.println(min++);}

Once , the boolean condition () evaluates to false and the loop is broken. The line System.out.println(min++); is a compact way of writing:

System.out.println(min);min = min + 1;

### [Do-While Loop](https://docs.oracle.com/javase/tutorial/java/nutsandbolts/while.html)

This is a variation on the While loop where the condition is checked at the end of the brackets. Because of this, the content between the brackets is guaranteed to always be executed at least once:

do{

// this will execute once

// it will execute again each time while(condition) is true} while(condition);

### [Unlabeled Break](https://docs.oracle.com/javase/tutorial/java/nutsandbolts/branch.html)

You may recall break; from our previous discussion of Switch Statements. It will break you out of a loop even if the loop's termination condition still holds true.

## Day 6: Let's Review

Terms you'll find helpful in completing today's challenge are outlined below, along with sample Java code (where appropriate).

### [Strings](https://docs.oracle.com/javase/tutorial/java/data/strings.html) and [Characters](https://docs.oracle.com/javase/tutorial/java/data/characters.html)

As we've mentioned previously, a String is a sequence of characters. In the same way that words inside double quotes signify a String, a single letter inside single quotes signifies a character. Each character has an [ASCII](http://www.asciitable.com/) value associated with it, which is essentially a numeric identifier. The code below creates a char variable with the value , and then prints its ASCII value.

char myChar = 'c'; // create char cSystem.out.println("The ASCII value of " + myChar + " is: " + (int) myChar);

Output:

The ASCII value of c is: 99

Observe the (int) before the variable name in the code above. This is called explicit casting, which is a method of representing one thing as another. Putting a data type inside parentheses right before a variable is essentially saying: "The next thing after this should be represented as this data type". [Casting](http://docs.oracle.com/javase/specs/jls/se8/html/jls-5.html#jls-5.1) only works for certain types of relationships, such as between primitives or [objects that inherit from another class](https://docs.oracle.com/javase/tutorial/java/IandI/subclasses.html).

To break a String down into its component characters, you can use the [String.toCharArray](https://docs.oracle.com/javase/7/docs/api/java/lang/String.html" \l "toCharArray()) method. For example, this code:

String myString = "This is String example.";char[] myCharArray = myString.toCharArray();for(int i = 0; i < myString.length(); i++){

// Print each sequential character on the same line

System.out.print(myCharArray[i]); }// Print a newlineSystem.out.println();

produces this output:

This is String example.

Notice that we were able to simulate printing myString by instead printing each individual character in the character array, myCharArray, created from myString.

## Day 7: Arrays

Terms you'll find helpful in completing today's challenge are outlined below, along with sample Java code (where appropriate).

## [Data Structures](https://en.wikipedia.org/wiki/Data_structure)

A way of organizing data that enables efficient storage, retrieval, and use.

## [Arrays](https://docs.oracle.com/javase/tutorial/java/nutsandbolts/arrays.html)

A type of data structure that stores elements of the same type (generally). It's important to note that you'll often see arrays referred to as  in documentation, but the variable names you use when coding should be descriptive and begin with lowercase letters.

You can think of an array, , of size  as a contiguous block of cells sequentially indexed from  to  which serve as containers for elements of the array's declared data type. To store an element, , in some index  of array , use the syntax A[i] and treat it as you would any other variable (i.e., A[i] = value;). For example, the following code:

// the number of elements we want to holdfinal int \_arraySize = 4;

// our array declarationString[] stringArray = new String[\_arraySize];

for(int i = 0; i < \_arraySize; i++) {

// assign value to index i

stringArray[i] = "This is stored in index " + i;

// print value saved in index i

System.out.println(stringArray[i]); }

saves and then prints the values listed below in their respective indices of :

This is stored in index 0

This is stored in index 1

This is stored in index 2

This is stored in index 3

Most languages also have a method, attribute, or member that allows you to retrieve the size of an array. In Java, arrays have a  attribute; in other words, you can get the length of some array, arrayName, by using the arrayName.length syntax.

**Note:** The final keyword used in the code above is a means of protecting the variable's value by locking it to its initialized value. Any attempt to reassign (overwrite) the value of a final variable will generate an error.

## Note on Arrays in C++

If you want to create an array whose size is unknown at compile time (i.e., being read as input), you need to create a [pointer](http://www.cplusplus.com/doc/tutorial/pointers/#declaration) to whatever data type you'll be declaring your array as (e.g., char, int, double, etc.). Then you must use the [new operator](http://www.cplusplus.com/reference/new/operator%20new%5b%5d/) to set aside the space you need for your array. The example below shows how to create an array of type DataType and unknown size n that is read from stdin.

// array sizeint n; cin >> n;

// create array of unknown size nDataType\* arrayName = new DataType[n];

## Day 8: Dictionaries and Maps

Terms you'll find helpful in completing today's challenge are outlined below, along with sample Java code (where appropriate).

## Java Maps

[Map](https://docs.oracle.com/javase/7/docs/api/java/util/Map.html) is an [interface](https://docs.oracle.com/javase/tutorial/java/concepts/interface.html) that provides a blueprint for data structures that take  pairs and map keys to their associated values (it's important to note that both the  and the  must be Objects and not primitives). The implementation is done by implementing classes such as [HashMap](https://docs.oracle.com/javase/8/docs/api/java/util/HashMap.html) or [LinkedHashMap](https://docs.oracle.com/javase/8/docs/api/java/util/LinkedHashMap.html). Consider the following code:

// Declare a String to String mapMap<String, String> myMap;

// Initialize it as a new String to String HashMapmyMap = new HashMap<String, String>();

// Change myMap to be a new (completely different) String to String LinkedHashMap insteadmyMap = new LinkedHashMap<String, String>();

Here are a few Map methods you will find helpful for this challenge:

* containsKey(Object key): Returns true if the map contains a mapping for ; returns false if there is no such mapping.
* get(Object key): Returns the value to which the  is mapped; returns null if there is no such mapping.
* put(K key, V value): Adds the (Key, Value) mapping to the Map; if the  is already in the map, the  is overwritten.

### Example (Java)

The code below:

// Create a Map of String Keys to String Values, implemented by the HashMap classMap<String,String> myMap = new HashMap<String,String>();

// Adds ("Hi","Bye") mapping to myMapmyMap.put("Hi", "Bye");

// Print the Value mapped to from "Hi"System.out.println(myMap.get("Hi"));

// Replaces "Bye" mapping from "Hi" with "Bye!" myMap.put("Hi", "Bye!");

// Print the Value mapped to from "Hi"System.out.println(myMap.get("Hi"));

produces the following output:

Bye

Bye!

It is not necessary to declare myMap as type Map; you can certainly declare it as a HashMap (the instantiated type).

## Day 9: Recursion

Terms you'll find helpful in completing today's challenge are outlined below, along with sample Java code (where appropriate).

## [Recursion](https://en.wikipedia.org/wiki/Recursion_(computer_science))

This is an algorithmic concept that involves splitting a problem into two parts: a聽base case聽and a聽recursive case. The problem is divided into smaller subproblems which are then solved recursively until such time as they are small enough and meet some base case; once the base case is met, the solutions for each subproblem are combined and their result is the answer to the entire problem.

If the base case is not met, the function's recursive case calls the function again with modified values. The code must be structured in such a way that the base case is reachable after some number of iterations, meaning that each subsequent modified value should bring you closer and closer to the base case; otherwise, you'll be stuck in the dreaded聽[infinite loop](https://en.wikipedia.org/wiki/Infinite_loop)!

## Example

The code below produces the multiple of two numbers by combining addition and recursion:

// Multiply 'n' by 'k' using addition:private static int nTimesK(int n, int k) {

System.out.println("n: " + n);

// Recursive Case

if(n > 1) {

return k + nTimesK(n - 1, k);

}

// Base Case n = 1

else {

return k;

}}public static void main(String[] args) {

int result = nTimesK(4, 4);

System.out.println("Result: " + result);}

When executed, this code prints:

n: 4

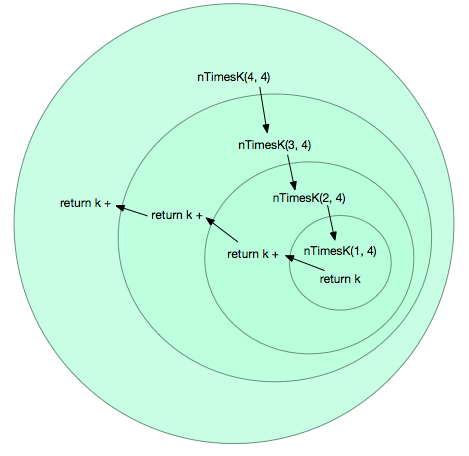
n: 3

n: 2

n: 1

Result: 16

The diagram below depicts the execution of the code above. Each call to聽聽is represented by a bubble, and each new recursive call bubble is stacked inside and on top of the bubble that was responsible for calling it. The function recursively calls itself using reduced values until it reaches the base case (). Once it reaches the base case, it passes back the base case's return value () to the bubble that called it and continues passing back聽k +聽the previously returned value until the final result (i.e.: the multiplication by addition result of聽) is returned.



Once the code hits the base case in the聽聽bubble, it returns聽聽(which is聽) to the聽聽bubble.聽  
Then the聽聽bubble returns聽, which is聽, to the聽聽bubble.聽  
Then the聽聽bubble returns聽, which is聽, to the聽聽bubble.聽  
Then the聽聽bubble returns聽, which is聽, to the first line in聽main聽as the result for聽, which assigns聽聽to the聽聽variable.

## Day 10: Binary Numbers

Terms you'll find helpful in completing today's challenge are outlined below, along with sample Java code (where appropriate).

## [Radix (Base)](https://en.wikipedia.org/wiki/Radix)

The number of digits that can be used to represent a number in a positional number system. The [decimal number system](http://www.britannica.com/topic/decimal-number-system) (base-) has  digits (); the [binary](https://en.wikipedia.org/wiki/Binary_number) (base-) number system has  digits ().

We think in terms of base-, because the decimal number system is the only one many people need in everyday life. For situations where there is a need to specify a number's radix, number  having radix  should be written as.

## Binary to Decimal Conversion

In the same way that , a binary number having  digits in the form of  can be converted to decimal by summing the result for each  where ,  is the [most significant bit](https://en.wikipedia.org/wiki/Most_significant_bit), and  is the [least significant bit](https://en.wikipedia.org/wiki/Least_significant_bit).

For example:  is evaluated as

## Decimal to Binary Conversion

To convert an integer from decimal to binary, repeatedly divide your base- number, , by . The dividend at each step  should be the result of the integer division at each step . The remainder at each step of division is a single digit of the binary equivalent of ; if you then read each remainder in order from the last remainder to the first (demonstrated below), you have the entire binary number.

For example: . After performing the steps outlined in the above paragraph, the remainders form  (the binary equivalent of ) when read from the bottom up:

This can be expressed in [pseudocode](https://en.wikipedia.org/wiki/Pseudocode) as:

while(n > 0):

remainder = n%2;

n = n/2;

Insert remainder to front of a list or push onto a stack

Print list or stack

Many languages have built-in functions for converting numbers from decimal to binary. To convert an integer, , from decimal to a String of binary numbers in Java, you can use the Integer.toBinaryString(n) function.

**Note:** The algorithm discussed here is for converting integers; converting fractional numbers is a similar (but different) process.

## Day 11: 2D Arrays

Terms you'll find helpful in completing today's challenge are outlined below, along with sample Java code (where appropriate).

## [2D Arrays](https://en.wikipedia.org/wiki/Matrix_representation)

Also known as multidimensional arrays, they are very similar to the regular [*1D Array*](https://docs.oracle.com/javase/tutorial/java/nutsandbolts/arrays.html) data structure we've already discussed.

Consider the following code:

int rowSize = 2;int colSize = 4;int[][] myArray = new int[rowSize][colSize];

This creates a  matrix where each element, , can be graphically represented as follows:

(0, 0) (0, 1) (0, 2) (0, 3) (1, 0) (1, 1) (1, 2) (1, 3)

You may find it helpful to think of these  elements in terms of real-world structures such as the cells in a spreadsheet table.

To fill the array's cells with values, you can use a nested loop. The outer loop represents the matrix's rows and uses  as its variable, and the inner loop represents the matrix's columns and uses  as its variable. The code below assigns the value of  to each element in the 2D array we declared previously:

int count = 0;

for(int i = 0; i < rowSize; i++) {

for(int j = 0; j < colSize; j++, count++) {

myArray[i][j] = count;

}}

If we print the contents of each row:

for(int i = 0; i < rowSize; i++) {

// print the row of space-separated values

for(int j = 0; j < colSize; j++) {

System.out.print(myArray[i][j] + " ");

}

// end of row is reached, print newline

System.out.println();}

we'll see the following output:

0 1 2 3 4 5 6 7

## Day 12: Inheritance

Terms you'll find helpful in completing today's challenge are outlined below, along with sample Java code (where appropriate).

[**Inheritance**](https://docs.oracle.com/javase/tutorial/java/IandI/subclasses.html)   
This allows you to establish a hierarchy for your classes. A class that inherits from some other class (referred to as a superclass) is called a subclass. While a subclass inherits methods and behaviors from a superclass, it can also declare new fields and methods (as well as override superclass methods).

**Subclass**   
A subclass is defined with the extends keyword. For example, the syntax ClassB extends ClassA establishes ClassB as a subclass of of ClassA. Java only supports single inheritance, meaning a subclass cannot extend more than one superclass.   
Synonymous terms: derived class, extended class, child class.

**Subclass Constructors**   
Because a constructor initializes an instance of a class, they are never inherited; however, the subclass must call a superclass constructor as it is an extension of a superclass object. This can be done in either of the two ways shown below.

Consider the following class:

class MySuperclass{

// superclass instance variable:

String myString;

// superclass default (empty) constructor:

MySuperclass(){}

// superclass parameterized constructor:

MySuperclass(String myString){

// initialize instance variable

this.myString = myString;

}}

1) The subclass makes an explicit call to the superclass' parameterized constructor (i.e.: it calls super(...);):

class MySubclass extends MySuperclass{

// subclass constructor:

MySubclass(String myString){

// explicit call to superclass constructor:

super(myString);

}}

2) The subclass makes an implicit call to the superclass' default constructor (i.e.: a behind-the-scenes call to super(); happens automatically):

class MySubclass extends MySuperclass{

MySubclass(String myString){

// behind-the-scenes implicit call to superclass' default constructor happens

// subclass can now initialize superclass instance variable:

this.myString = myString;

}}

In the second example above, observe that we are initializing a field (myString) that isn't even declared in that class; the reason why this works is because it's inherited from MySuperclass and therefore can be accessed with the [this](https://en.wikipedia.org/wiki/This_(computer_programming)) keyword.

**Note:** If a superclass does not have a default constructor, any subclasses extending it must make an explicit call to one of the superclass' parameterized constructors.

[**Overriding Methods**](https://docs.oracle.com/javase/tutorial/java/IandI/override.html)   
When overriding a method, it is best practice to precede the method with the @Override annotation. This signifies to both the reader and the compiler that this method is overriding an inherited method, and will also help you check your work by generating a compiler error if no such method exists in the superclass. Method overriding is demonstrated in the example below.

**Example**   
Let's say a not-for-profit organization has an Employee class, and each instance of the Employee class contains the name and salary for an employee. Then they decide that they need a similar-yet-different way to store information about volunteers, so they decide to write a Volunteer class that inherits from Employee. This is beneficial because any fields and methods added to Employee will also be accessible to Volunteer.   
  
Take some time to review the code below. Observe that the Volunteer class calls the superclass' getName method, but overrides its print method.

import java.util.Locale;import java.text.NumberFormat;

class Employee {

// instance variables:

protected String name;

private int salary;

/\*\* Parameterized Constructor \* @param name The volunteer's name. \*\*/

Employee(String name){

// use name param to initialize instance variable:

this.name = name;

}

/\*\* @return The name instance variable. \*\*/

String getName(){

return name;

}

/\*\* @param salary The integer to set as the salary instance variable. \*\*/

void setSalary(int salary){

this.salary = salary;

}

/\*\* @return The salary instance variable. \*\*/

int getSalary(){

return salary;

}

/\*\* Print information about an instance of Employee. \*\*/

void print(){

if(this.salary == 0){

System.err.println("Error: No salary set for " + this.name

+ "; please set salary and try again.\n");

}

else{ // Print employee information

// Formatter for salary that will add commas between zeroes:

NumberFormat salaryFormat = NumberFormat.getNumberInstance(Locale.US);

System.out.println("Employee Name: " + this.name

+ "\nSalary: " + salaryFormat.format(this.salary) + "\n");

}

}}

class Volunteer extends Employee{

// instance variable:

int hours;

/\*\* Parameterized Constructor \* @param name The volunteer's name. \*\*/

Volunteer(String name){

// explicit call to superclass' parameterized constructor

super(name);

}

/\*\* @param Set the hours instance variable. \*\*/

void setHours(int hours){

this.hours = hours;

}

/\*\* @return The hours instance variable \*\*/

int getHours(){

return hours;

}

@Override

/\*\* Overrides the superclass' print method and prints information about an instance of Volunteer. \*\*/

void print(){

System.out.println("Volunteer Name: " + this.getName()

+ "\nHours: " + this.getHours());

}}

The following code:

Employee employee = new Employee("Erica");employee.print();employee.setSalary(60000);employee.print();

Volunteer volunteer = new Volunteer("Anna");volunteer.setHours(20);volunteer.print();

produces this output:

Error: No salary set for Erica; please set salary and try again.

Employee Name: Erica

Salary: 60,000

Volunteer Name: Anna

Hours: 20

## Day 13: Абстрактни класове

Terms you'll find helpful in completing today's challenge are outlined below, along with sample Java code (where appropriate). 

**Abstraction**   
This is is an essential feature of object-oriented programming. In essence, it's the separation between what a class does and how it's accomplished.

One real world example of this concept is a snack machine, where you give the machine money, make a selection, and the machine dispenses the snack. The only thing that matters is what the machine does (i.e.: dispenses the selected snack); you can easily buy a snack from any number of snack machines without knowing howthe machine's internals are designed (i.e.: the implementation details).

[**Abstract Class**](https://docs.oracle.com/javase/tutorial/java/IandI/abstract.html)   
This type of class can have abstract methods as well as defined methods, but it cannot be instantiated (meaning you cannot create a new instance of it). To use an abstract class, you must create and instantiate a subclass that extends the abstract class. Any abstract methods declared in an abstract class must be implemented by its subclasses (unless the subclass is also abstract).   
  
The Java code below demonstrates an abstract Canine class and 2 of its canine breed subclasses, KleeKai and SiberianHusky:

/\*\* Superclass \*\*/

abstract class Canine{

// instance variables

String name;

String color;

String gender;

int age;

/\*\* Parameterized Constructor

\* @param name Dog's name

\* @param color Dog's color

\* @param age Dog's age

\* @param mF Dog's gender ('M' for male, 'F' for female)

\*\*/

Canine(String name, String color, int age, char mF){

this.name = name;

this.color = color;

this.age = age;

this.gender = (mF == 'M') ? "Male " : "Female ";

}

/\*\* Abstract method declaration

\* @return Implementations should return a string describing the breed \*\*/

abstract String getBreed();

/\*\* Defined method \*\*/

void printInfo(){

// print information about the dog:

System.out.println(name + " is " + ((age%10 == 8)? "an " : "a ") + age + " year old "

+ gender + getBreed() + " with a " + color + " coat.");

// note: the '(age%10 == 8)' conditional ensures grammatical correctness if dog is 8 or 18; dogs do not live longer than this.

}

}

//\*\* Subclass of Canine \*\*/

class KleeKai extends Canine{

/\*\* Parameterized Constuctor \*\*/

KleeKai(String name, String color, int age, char mF){

super(name, color, age, mF);

}

/\*\* Abstract method implementation

\* @return "Klee Kai" \*\*/

String getBreed(){ // abstract method implementation

return "Klee Kai";

}

}

/\*\* Subclass of Canine \*\*/

class SiberianHusky extends Canine{

/\*\* Parameterized Constuctor \*\*/

SiberianHusky(String name, String color, int age, char mF){ // Constructor

super(name, color, age, mF);

}

/\*\* Abstract method implementation

\* @return "Siberian Husky" \*\*/

String getBreed(){ // abstract method implementation

return "Siberian Husky";

}

}

The Canine class has 1 abstract method, abstract void getBreed(), and 1 defined method, void printInfo(). Because an abstract class is not fully defined, attempting to instantiate it like so:

Canine myPuppy = new Canine("Lilah", "Grey/White", 5, 'F');

results in error: Canine is abstract; cannot be instantiated. This type of class is only meant to serve as a base or blueprint for connecting the subclasses that inherit (extend) it. While we can't instantiate Canine, we can instantiate its subclasses, KleeKai and SiberianHusky. This code:

Canine c = new KleeKai("Lilah", "Grey/White", 5, 'F');

Canine d = new SiberianHusky("Alaska", "Grey/Black/White", 16, 'F');

c.printInfo();

d.printInfo();

executes and produces this output:

Lilah is a 5 year old Female Klee Kai with a Grey/White coat.

Alaska is a 16 year old Female Siberian Husky with a Grey/Black/White coat.

because c and d are [polymorphic references](https://en.wikipedia.org/wiki/Polymorphism_%28computer_science%29) objects of Canine's subclasses.

## Day 14: Scope

Terms you'll find helpful in completing today's challenge are outlined below, along with sample Java code (where appropriate).

**Scope**   
This term refers to the region of the program to which an identifier applies. While it is not good practice, you can declare multiple variables within a program that use the same identifier as long as the identifiers have differing scopes; some exceptions to this are:

1. A constructor or method parameter will often have the same name as a class field it's intended to initialize or modify.
2. It is customary to use i as the condition variable in a for-loop (and, in cases of nested for-loops, to use j as the condition variable for the inner loop).

**Note:** When dealing with a class variable (field), it's always best to explicitly refer to it using the [this](https://docs.oracle.com/javase/tutorial/java/javaOO/thiskey.html) keyword. For example:

class MyClass{

private int myInt;

public MyClass(int myInt){

this.myInt = myInt;

}

}

Even though there is a myInt field in the class, the constructor has a completely different myInt parameter. The field (this.myInt) is then assigned the value of the parameter, so any argument passed as that parameter will initialize the myInt field in the class.

Still confused? Take some time to review the Scope class below and understand why variables with the same name will be of different types (and produce different outputs) at various points in the program:

public class Scope{

boolean b = true; // b1 has scope of entire class

int x = 88; // x1 has scope of entire class

Scope(){

double d = 9.0;

example(d);

classVariable();

}

void example(double x){ // parameter x2 has scope of this method

System.out.println("----- example(double x):\n"

+ "Initial value of Local Variable `x`: " + x + "\n");

x = 4.4; // reassign value of local variable x2

System.out.println("New value of Local Variable `x`: " + x + "\n");

for(int b = 0; b < 4; b++){ // b2 has scope of this loop

int i = b + 4; // begin scope of int i

System.out.println( "For Loop 1 in example(double x):\n"

+ "Local Variable `b` (local to loop): " + b + "\n"

+ "Local Variable `i` (local to loop): " + i + "\n"

+ "Local Variable `x` (method parameter): " + x + "\n");

} // end the scope of int b2; end scope of int i

for(int b = 0; b < 4; b++){

x = b;

System.out.println( "For Loop 2 in example(double x):\n"

+ "Local Variable `b` (local to loop): " + b + "\n"

+ "Local Variable `x` (method parameter): " + x + "\n");

} // end of the scope of this version of int b

System.out.println("Local Variable `x` after Loop 2: " + x + "\n");

} // end scope of double x2

void classVariable(){

System.out.println( "----- classVariable():\n"

+ "Instance Variable `b`: " + b + "\n"

+ "Instance Variable `x`: " + x);

}

public static void main(String[] args){

Scope s = new Scope();

}

} // end of boolean b's scope; end of int x's scope

which produces this output:

----- example(double x):

Initial value of Local Variable `x`: 9.0

New value of Local Variable `x`: 4.4

For Loop 1 in example(double x):

Local Variable `b` (local to loop): 0

Local Variable `i` (local to loop): 4

Local Variable `x` (method parameter): 4.4

For Loop 1 in example(double x):

Local Variable `b` (local to loop): 1

Local Variable `i` (local to loop): 5

Local Variable `x` (method parameter): 4.4

For Loop 1 in example(double x):

Local Variable `b` (local to loop): 2

Local Variable `i` (local to loop): 6

Local Variable `x` (method parameter): 4.4

For Loop 1 in example(double x):

Local Variable `b` (local to loop): 3

Local Variable `i` (local to loop): 7

Local Variable `x` (method parameter): 4.4

For Loop 2 in example(double x):

Local Variable `b` (local to loop): 0

Local Variable `x` (method parameter): 0.0

For Loop 2 in example(double x):

Local Variable `b` (local to loop): 1

Local Variable `x` (method parameter): 1.0

For Loop 2 in example(double x):

Local Variable `b` (local to loop): 2

Local Variable `x` (method parameter): 2.0

For Loop 2 in example(double x):

Local Variable `b` (local to loop): 3

Local Variable `x` (method parameter): 3.0

Local Variable `x` after Loop 2: 3.0

----- classVariable():

Instance Variable `b`: true

Instance Variable `x`: 88