AP CS A
Unit 2. Using Objects. Notes

class {idea/template}
↙ ↘
objects - digital objects/things

Classes and Objects. A class is generally used to serve as a blueprint to create objects. An object typically contains variables and has methods that allow it to do something.

↳ characteristics behavior

Creates an object variable, *x*, of type Scanner.

Calls a constructor of the Scanner class and creates a Scanner object. The keyword new must be used when calling a constructor. you instantiate a new Scanner!

```
Scanner x = new Scanner( System.in );
```

System.in tells the Scanner to read information from the keyboard.

```
System.out.println( "Enter a number " );

int num = x.nextInt();
```

nextInt is a method of the Scanner class. It returns the integer that the user entered.

Once the object is created (aka constructed), you can use its methods. To call a method you need to know:

- Its name.
- What parameters, if any, it has. These are the inputs to a method.
- What the method returns (aka its return type)

Let's look at some methods of the Scanner class.

Return Type	Scanner method name	Parameters
int	nextInt ( )	none
double	nextDouble ( )	none
String	nextLine ( )	none

Consider the following code:

classes start w/ capitals

```
Dog fido = new Dog( "Timmy" );      // calls a Dog constructor, instantiates dog object
int a = fido.fetch( 14.8 );         // calls a method that returns a value
double b = fido.good( true, 100 );  // calls a different method
```

Return Type	Dog method name	Parameters
int	fetch	double
double	good	boolean, int

Do exercises 1 to 10.

```
public class Dog
{
    private String name;                  // instance variables
    private double fetchDistance;         // instance variables
```

To help illustrate the concepts of classes, objects, and methods. We will work with a simple rectangle class that has only a few methods. use this reference below only.

A **Rectangle** object represents a rectangle on a coordinate plane. The sides are parallel to the x and y axes. The vertices are restricted to integer values. This *NOT* the same Rectangle class as the one defined in the Java library of classes. to see Oracle's Rectangle class. search "java rectangle class"

Here are the constructors of our Rectangle class

Name(parameters)	Comments
Rectangle(int x1, int y1, int x2, int y2)	(x1, y1) is the lower left-hand corner. (x2, y2) is the upper right-hand corner.
Rectangle(int width, int height)	The lower left-hand corner is at the origin. width and height are the dimensions of the rectangle

Methods of our Rectangle class – represent behaviors of class Rectangle

Return Type	Name(parameters)	Comments
int	getX()	Returns the x coordinate of the lower left-hand corner
int	getY()	Returns the y coordinate of the lower left-hand corner
boolean	contains(int x, int y)	Returns true if (x,y) is a point within the rectangle. Returns false if it is on the edge or outside the rectangle.
int	area()	Returns the rectangle's area
void	translate(int dx, int dy)	Adds dx to the x coordinate and dy to the y coordinate. Does not change the rectangle's size.
double	diagonal()	Returns the length of the rectangle's diagonal

alters objects state → no value returned

void means that a method returns nothing.

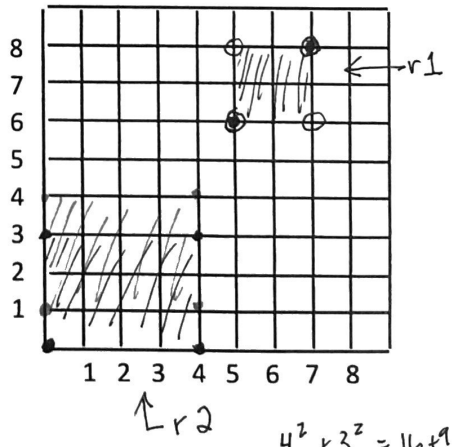
if we have Rectangle r0; we have a reference pointer for Rectangle object.

r0 → NULL

r1 is an instance of the Rectangle class

```
Rectangle r1 = new Rectangle( 5, 6, 7, 8 );   r1 → [5 6 7 8]
Rectangle r2 = new Rectangle( 4, 3 );
boolean b = r2.contains( 1, 2 );              b [true]
System.out.println( b );          // true
int n = r1.getY();                n [6]
System.out.println( n );          // 6
r2.translate( 0, 1 );             // note void methods don't return!
int a = r2.area();                a [12]
System.out.println( a );          // 12
double len = r2.diagonal();
System.out.println( len );        // 5.0
```

mutator method call →



$4^2 + 3^2 = 16 + 9 = 5$

len [5.0]

How many Rectangle objects are instantiated in the above code? 2

look for new key word

Do exercises 11 to 14.

do after binary info.

The String Class. A String object represents a sequence of one or more characters where a character could be a letter, digit, or punctuation mark. Each character in a string has a unique index starting at 0. Anything in quotes is a string literal and is an object of the String class.

"jump now"; // the *u* is at index 1, the *n* is at index 5

Classes have constructors that are used to create objects.

String a = new String("easy 123"); ← new keyword calls the constructor. "easy123" is the parameter.

However, the String constructor does not have to be explicitly called, you can do this:

☆ String a = "easy123"; ← java compiler fills in the rest String a = new String("easy123");

The **concatenation** operator is +. It is used to join a string to another string or a primitive type such a double or an int. "class" + num1 ⇒ "class 2"

num1 2

"2" + 3 + 4 = "234"

2 + 3 + "4" = 54

The addition and concatenation operators have the same level of precedence and are evaluated left to right

For example:

```
String a = "MY";
a = a + a;
System.out.println(a);          // "MYMY"

String b = "40";
b = b + 3;
System.out.println(b);          // "403"

String c = "a" + 3 + 4;
System.out.println(c);          // "a34"

String d = 3 + 4 + "a";
System.out.println(d);          // "7a"
```

a → ~~"MY"~~ "MYMY"

Note. While you can concatenate a string with an int or double or boolean, you cannot assign these values to a string.

int a = 23;
int b = 1;
String c = a + b;
	int a = 23;
	int b = 1;
	String c = a + b + ""; ← empty ~~character~~ string but turns number into a String.

The last line is try to store an int into a string variable. Won't compile!	The last line stores "24" in c.

String c = "" + a + b;

Escape sequences start with a \ and have a special meaning in Java. You are responsible for knowing three of these sequences: \", \n, and \\. " \ → newline \ backslash

Since quotes (") mark the beginning and end of a string, we must use an escape sequence if we want the include quotes as part of a string.

```
String s = "He said \"GOAT\"?";
System.out.println( s );          // He said "GOAT"?
```
s.length() returns 15

If we want a line break to be part of a string, then we must use a different escape sequence.

```
String s = "One\nTwo";
System.out.println( s );          // One
                                  // Two
```

Since \ is used to start an escape sequence, if we want to print a \ then we use an escape sequence.

```
String s = "\\";
System.out.println(s);            // \
```

Do exercises 15 to 24.

String Methods.

While the String class has many methods, we only cover a few of them.

The **length** method returns the number of characters in a string.

```
String s = "A cat";               // there is one space between the two words
int n = s.length();               // 5
```
method — counting starts at 1

The **substring** method returns a portion of the string. This method is overloaded which means that there are multiple methods with the same name but different number of parameters or different types of parameters.

```
String a = "ABCDEF";
String b = a.substring( 1, 3 );   // Returns the string in the range [ 1, 3 )
System.out.println( b );          // BC
String c = a.substring( 4 );      // Returns the string in the range [4, to the end]
System.out.println( c );          // EF
```

a → ABCDEF make a copy of part of a

[1, 3)

Position starts at 0

to end

IMPORTANT. The substring method does NOT alter a string. It returns a new string.

BIGGER NOTE; in java strings are immutable. you only make a new copy!

Do exercises 25 to 34.

ie:
```
String a = "whole string";
a.substring(6)
```
a → whole string

string

made a copy, never assigned!

}

}

The **indexOf** method searches a string for another string. This method is also overloaded. Here is one version.

```
String a = "there were others";
int n = a.indexOf( "er" );               // return the index of the first occurrence of er
System.out.println( n );                 // 2
n = "haystack".indexOf("needle");        // string literals are string objects
System.out.println( n );                 // returns -1 if not found
```

Another version of indexOf has two parameters: the string that is looked for and the index where the search should start. The search always goes to the right.

```
String a = "there were others";
int n = a.indexOf( "er", 2 );
System.out.println( n );                 // 2
n = a.indexOf( "er", 3 );
System.out.println( n );                 // 7
n = "bobble".indexOf( "bob", 2);
System.out.println( n );                 // -1
```

NOTE. indexOf is case-sensitive.

```
String a = "Every one";
int k = a.indexOf("e");
System.out.println( k );                 // 2
```

The **equals** method returns true if two strings are equal; otherwise it returns false. This is case-sensitive.

```
String a = "cat";
String b = "CAT";
boolean c = a.equals( b );
System.out.println( c );
```

The **toLowerCase** method returns a copy of the string where all the letters are lower-case.

```
String a = "The 4 STARS!";
String b = a.toLowerCase();
System.out.println( b );          // the 4 star!
```

The toLowerCase method is often used in combination with other methods that are case-sensitive. For example, we might first convert two strings to lower-case letters before checking if they are equal or before calling the indexOf method.

Win
win
winner

ABC plumbing
AAA plumbing

String s1 = "Baby";
String s2 = "baby";

int x = s1.compareTo(s2);
value ↑ calling string — ↑ parameter string

The **compareTo** method has one parameter, a string, and returns an integer. The integer is positive if the string is greater than the parameter, negative if the string is less than the parameter, or zero the string equals the parameter.

What does it mean for one string to be greater than or less than another string? In the simple case (which is the only situation we will consider), if two strings are both all lower-case or all upper-case, then here are the rules:

B < b
ie: 1 < 2.
a < b

- Letters that come earlier in alphabet are smaller than letters that come later.
- If the first two letters in a string are the same, then compare the next two letters, and so on.
- If both strings are identical except one string has additional letters at the end (e.g. "ax" and "axes" then the shorter string is smaller than the longer string.

capitals
number
lowercase

Another way to say this is, words that come earlier in the dictionary are smaller than words that come later in the dictionary.

Remember, this assumes that both strings consist of only upper-case letters or only lower-case letters. We will not use the compareTo method with any kinds of other strings.

1. This prints (a) a negative number then a positive number. b) a positive number then a negative number. c) two positive numbers. d) two negative numbers.	String a = "ADAM"; smaller String b = "BETTY"; larger int n1 = a.compareTo(b); value a - b. so negative System.out.println(n1); n1 = b.compareTo(a); value b - a so positive System.out.println(n1);
2. This prints a) a negative number then a positive number. (b) a positive number then a negative number. c) two positive numbers. d) two negative numbers.	String a = "milk"; larger String b = "and cookies"; smaller int n1 = a.compareTo(b); larger - smaller positive System.out.println(n1); n1 = b.compareTo(a); smaller - larger negative System.out.println(n1);
3. This prints a) a negative number then a positive number. (b) a positive number then a negative number. c) two positive numbers. d) two negative numbers.	String a = "window"; larger String b = "win"; smaller int n1 = a.compareTo(b); positive System.out.println(n1); n1 = b.compareTo(a); negative System.out.println(n1);

Do exercises 35 to 47.

if (num < num2)

static class → we do not create objects of the Math class

The **Math Class**. In general, methods are associated with objects because they return information about the object or do something to the object. For instance, consider the String class's length method. It returns the number of characters in a specific String object. You must have a specific String to use its length method.

However, there are methods that are associated with a class, and not the objects of that class. These methods are called static methods. To call them, you refer to their class, not an object.

Scanner df = new Sc~
int n = df.nextInt();

The Math class has many static methods; here are five that you need to know.

```
double n = Math.sqrt( 16 );          // returns the 4.0
n = Math.sqrt( n );
System.out.println( n );             // 2.0
```

Notice how the *sqrt* method is called. We do NOT create a Math object; we simply use the name of the class.

The return type of the *sqrt* method is double. If need be, we can cast the returned value to an int.

```
int n = (int) Math.sqrt( 81 );
System.out.println( n );             // 9
n = (int) Math.sqrt( 80 );
System.out.println( n );             // 8
```

Note: calling a method has higher precedence than the casting operator. The method is called first and then the returned value is cast to an int before the value is assigned to n.

****

The *abs* method returns the absolute value of the parameter.

```
int d = Math.abs( -7 );
System.out.println( d );             // 7
double e = Math.abs( -12.7 );
System.out.println( e );             // 12.7
```

overloading

In the above example, the first time we called the *abs* method, it returned an int and the second time it returned a double. It can do that because this method is overloaded.

If the parameter is an int, then it returns an int.

If the parameter is a double, then it returns a double.

****

The *pow* method has two parameters, both doubles, and returns a double. It returns the value of the first parameter raised to the second parameter.

```
double num = Math.pow( 3, 4 );      // 3^4  81.0
System.out.println( num );          // 81.0
```

The *random* method returns a random number in the range [0, 1).

```
double a = Math.random();
System.out.println( a );            // 0.5673112178583647
a = Math.random();
System.out.println( a );            // 0.06784309086038653
```

If you ran this code again, you would get two different numbers. Without getting into details, Math.random returns pseudorandom decimals: numbers that appear to be random but are actually based on an algorithm and the time when the code was executed.

While these random decimals can be useful, in many of the programs that you will write, you need to generate a random integer within some range. Here is a formula to generate a random integer in the range [min, max] with an equal likelihood of any of the numbers being returned.

```
int n = (int) ( range * Math.random() ) + min;   // where range = max – min + 1
```

For example, to generate a random integer in the range [-1, 3]

```
int n = (int) ( 5 * Math.random() ) + -1;   // num will be: -1, 0, 1, 2, or 3
```

1. *a* is a random integer in the range: [3, 7]	int a = (int)(5 * Math.random()) + 3;
2. *b* is a random integer in the range: [0, 11]	int b = (int)(12 * Math.random());
3. *c* is a random integer in the range: [-7, -5]	int c = (int)(3 * Math.random()) - 7;

You need to memorize the formula for generating a range of random integers.

Do exercises 48 to the end.