Core Java

A general-purpose programming language that is class-based, object-oriented, and designed to have as few implementation dependencies as possible.

Cognixia™

Outline

1. Introduction
2. Basic Programming
3. Flow Control
4. Classes & Objects
5. Inheritance & Composition
6. Arrays
7. Strings
8. Regular Expressions
9. Enums
10. Dates
11. Interfaces
12. Packages & Imports
13. Collections and Generics
14. Exceptions & Assertions
15. JUnit

Prerequisites

1. JDK Version 11
    - If on Windows, make sure **java is on your path**: How to set up Path
    - At least Java 11
2. Eclipse Download **(Windows Users)**
    - Select option for **"Eclipse IDE for Enterprise Java Developers"**
    - Create a folder in root directory called **"Java_Workspace"** and set your workspace to this folder when asked
    - Once opened, click **Help** -> **Eclipse Marketplace** -> **Search for "Spring Tools 4"** -> **Install**
3. STS Download **(Mac/Linux Users)**
    - Click on download for STS on Eclipse

Introduction to Java

What is Java?

- Java is a **programming language** and a platform
- **Platform** – any hardware or software environment in which a program runs
- Used in 9 billion devices around the world
- Used in 4 types of Applications:
  - Standalone Application
  - Web Application
  - Enterprise Application
  - Mobile Application

Why Java?

According to Sun, the **Java** language is simple because:

- **Simple syntax**, based in C++ (easier to learn it after C++)
- Removed confusing and/or rarely-used features (explicit pointer, operator overloading etc.)
- No need to remove unreferenced objects, there is **Automatic Garbage Collection**
- **Object-oriented**
- **Architecture neutral**

Java Virtual Machine (JVM)

➔ What is a Virtual Machine?

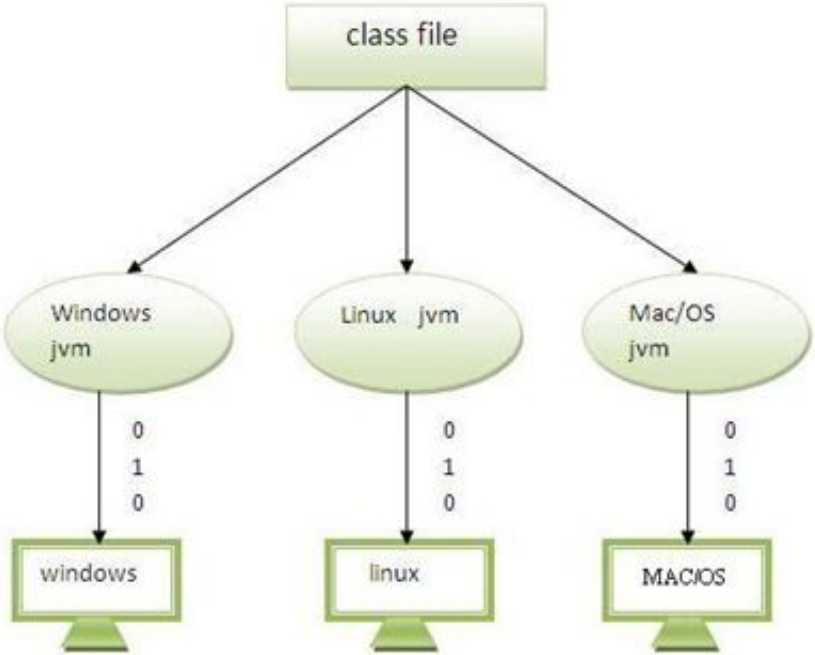
Java Virtual Machine (JVM)

- Abstract machine
- **Provides runtime environment** for java bytecode to be executed
- Main tasks:
  - *Loads code*
  - *Verifies code*
  - *Executes code*
  - *Provides runtime environment*

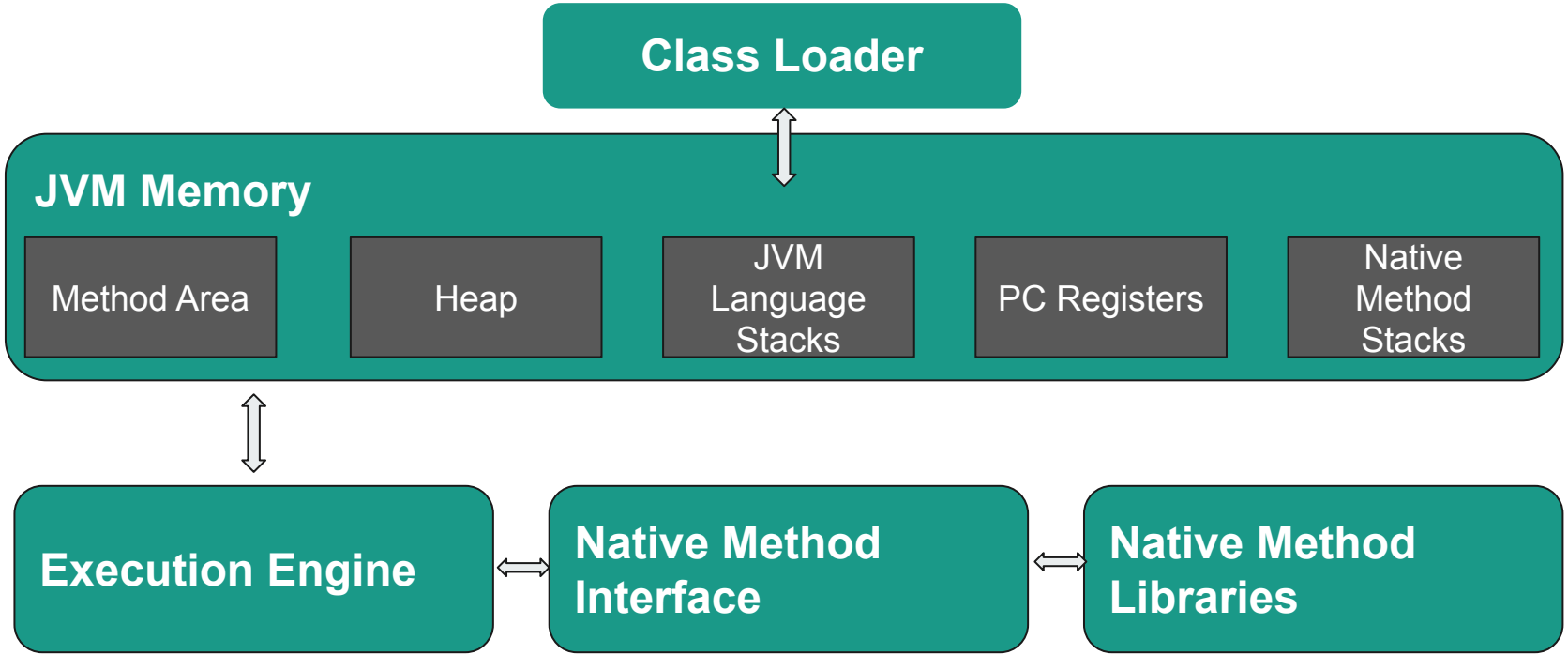
JVM - Platform Independence

- Java code can be run on **multiple platforms**
  - Windows, Linux, Sun Solaris, Mac/OS
- Java code is compiled by the compiler and converted into **bytecode**
- This **bytecode is a platform independent** code because it can be run on multiple platforms
  - Write Once and Run Anywhere (WORA)

JVM - Platform Independence

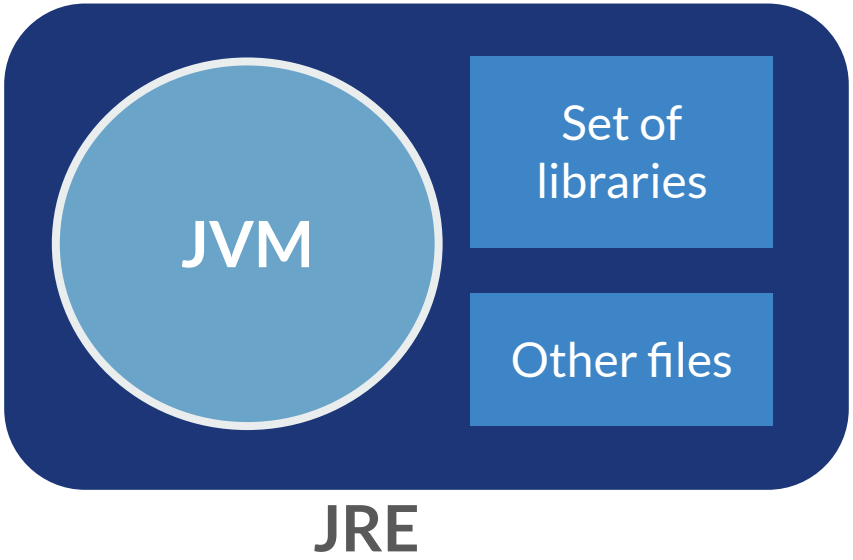


JVM - Architecture



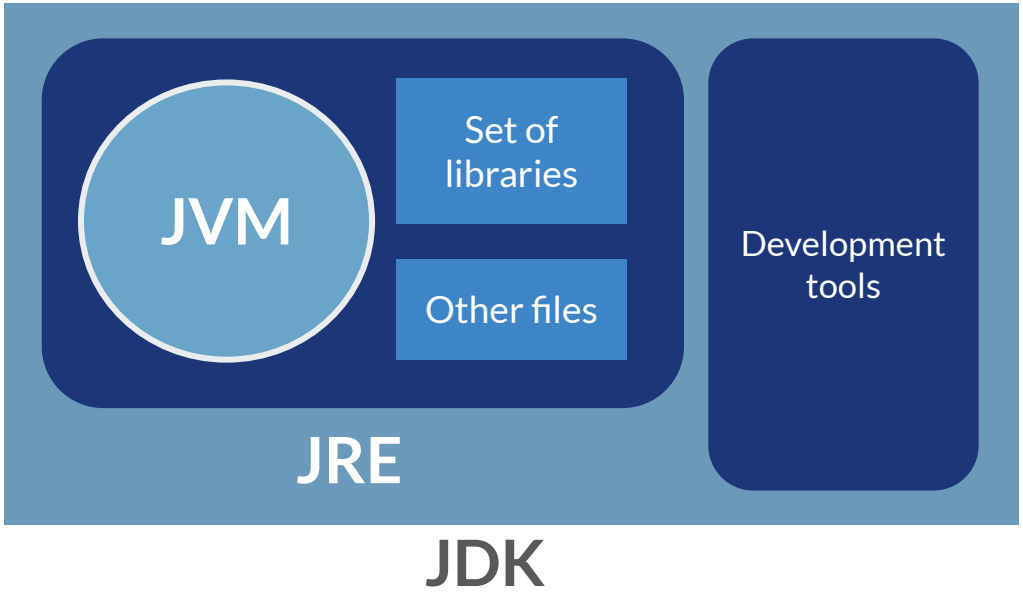
Java Runtime Environment (JRE)

- ➔ Provides runtime environment
- ➔ **Implementation of JVM**
- ➔ Physically exists
- ➔ **Contains libraries + other files that JVM uses at runtime**



Java Development Kit (JDK)

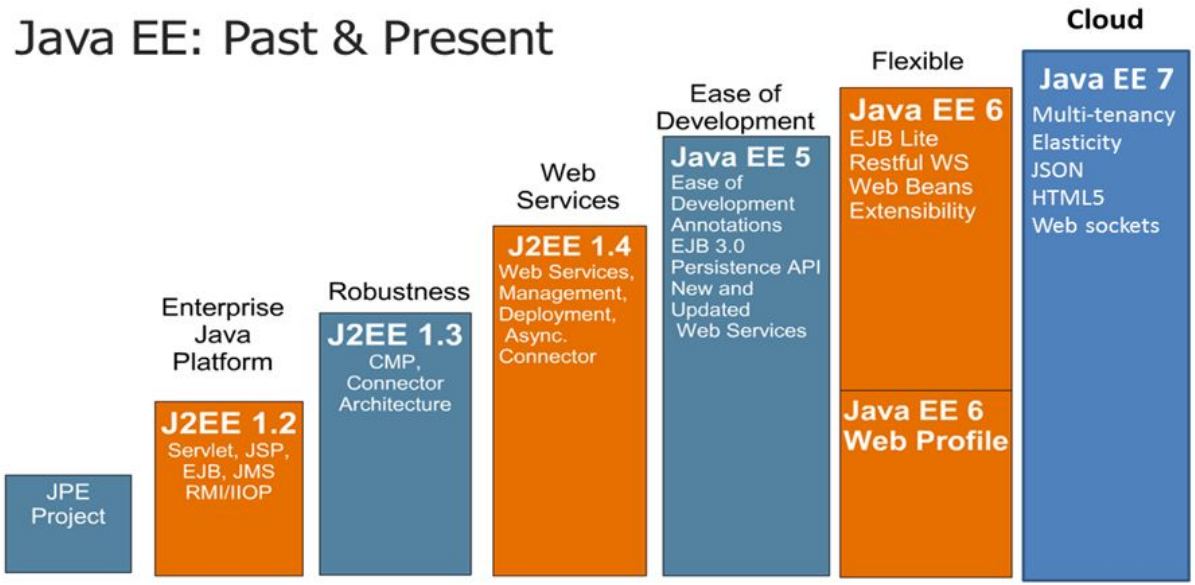
- ➔ Physically exists
- ➔ **Contains JRE + development tools**



Java Editions

- Java Standard Edition (J2SE)
  - Core Java Platform targeting applications running on workstations
- Java Enterprise Edition (J2EE / JEE)
  - Component-based approach to developing distributed, multi-tier enterprise applications
- Java Micro Edition (J2ME)
  - Targeted at small, stand-alone or connectable consumer and embedded devices

Java - Continued Evolution



Java - JAR , WAR, and EAR

JAR:

EJB modules which contains enterprise java beans class files and EJB deployment descriptor are packed as JAR files with .jar extension

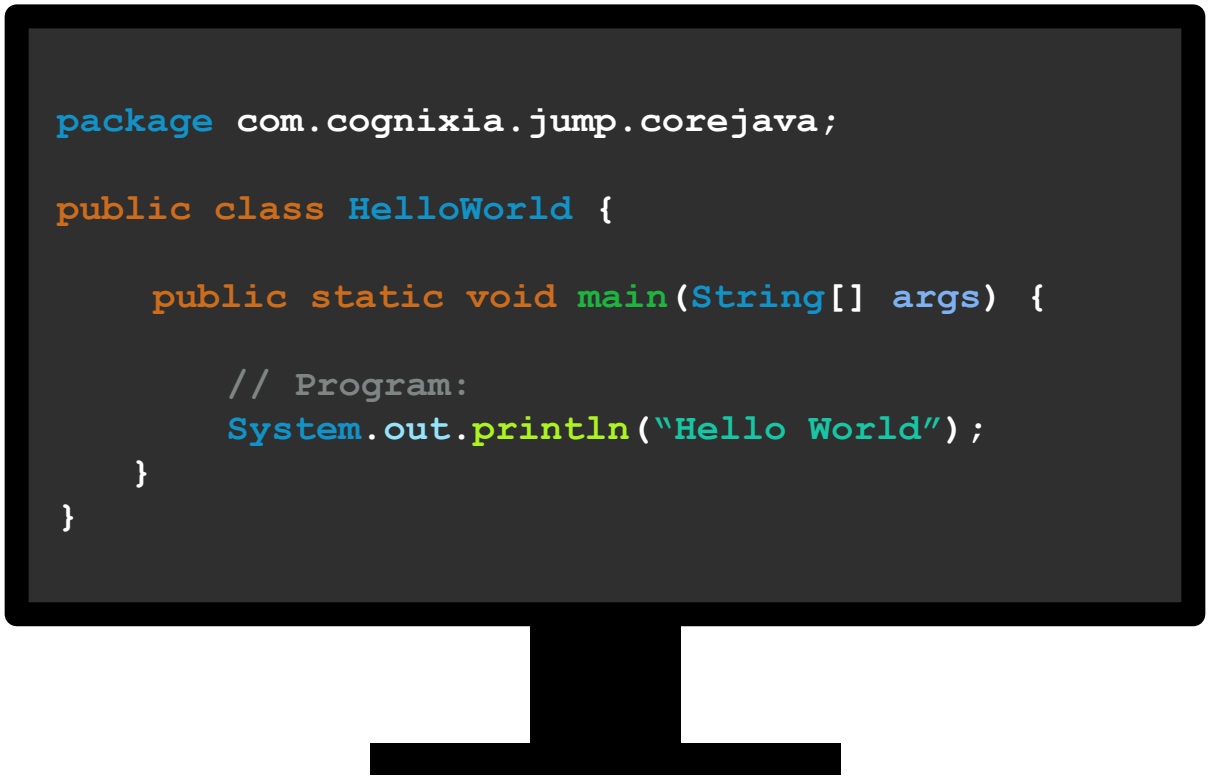
WAR:

Web modules which contains Servlet class files, JSP Files, supporting files, GIF and HTML files are packaged as JAR file with .war(web archive) extension

EAR:

All above files(.jar and .war) are packaged as JAR file with . ear (enterprise archive) extension and deployed into Application Server

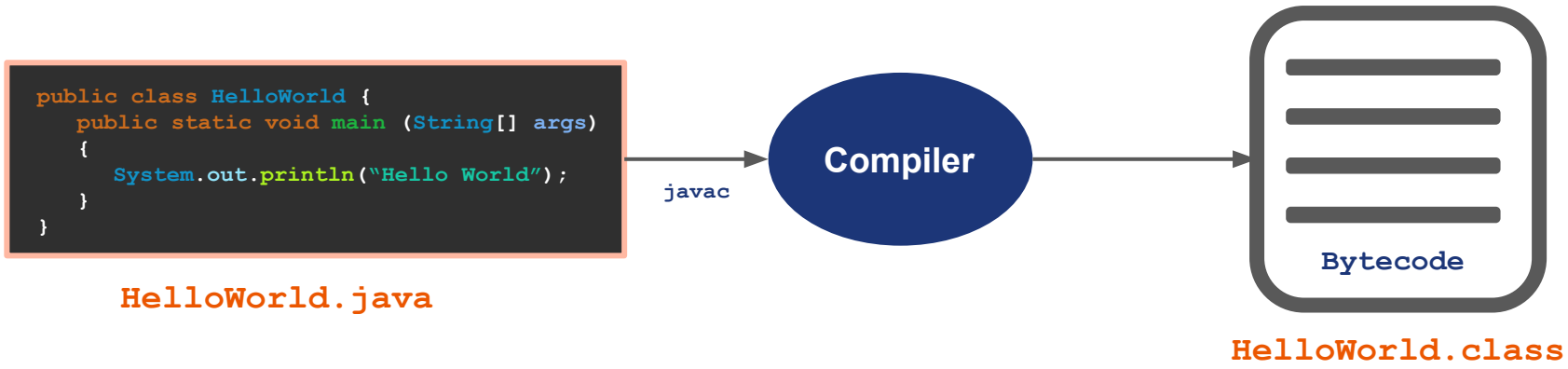
Hello World: First Program



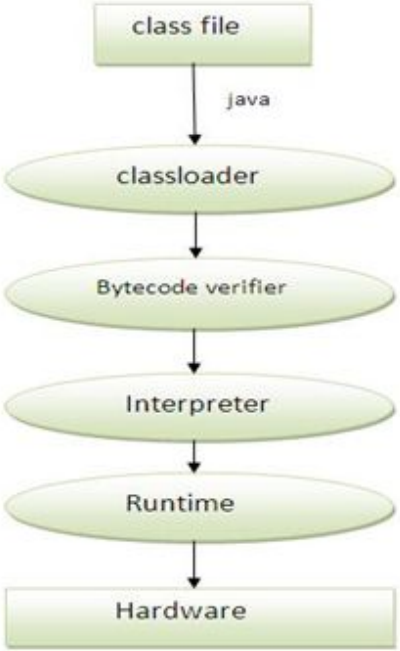
```
package com.cognixia.jump.corejava;

public class HelloWorld {

    public static void main(String[] args) {

        // Program:
        System.out.println("Hello World");
    }
}
```

What Happens at Compile Time?

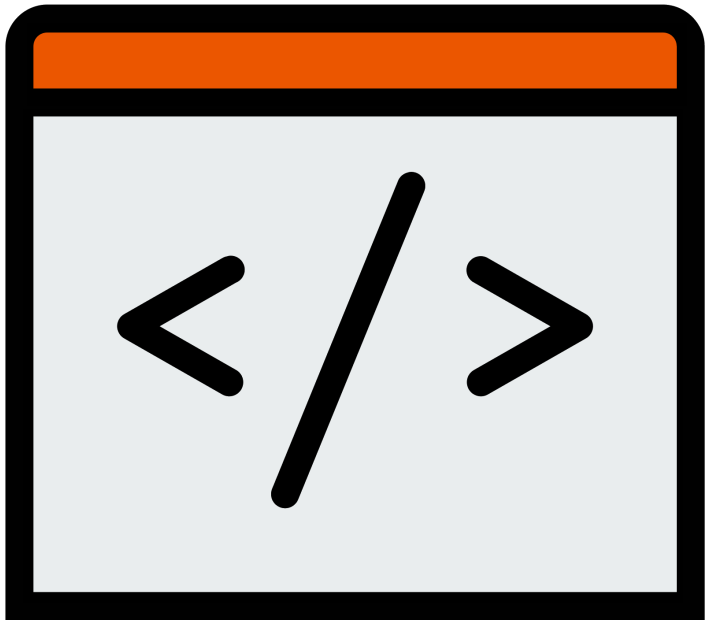
At **compile time**, the java file is compiled by the Java Compiler (does not interact with the OS) and converts the java code into bytecode.



What Happens at Runtime?



Basic Programming



Variable Types

Primitives - most basic data type in Java, hold pure, simple values of a kind

Name	byte	short	int	long	float	double	char	boolean
Value	number	number	number	number	float number	float number	character	true or false
Size	1 byte	2 byte	4 byte	8 byte	4 byte	8 byte	2 byte	1 byte

The main method

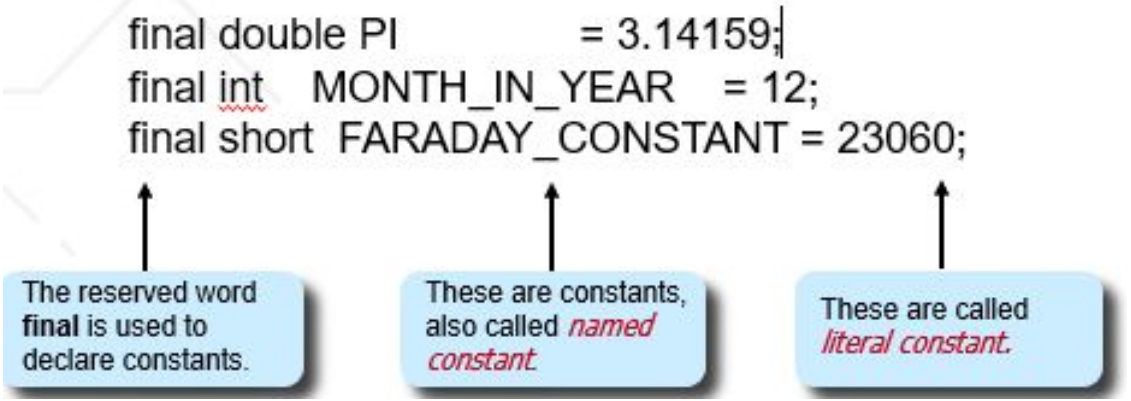
```
public class UserInput {

    public static void main(String[] args) {

        ...
    }
}
```

Final Keyword

Final - a constant in Java

Final can apply to:

- ➔ **Variables**
- ➔ Methods and Classes (covered later)
- ➔ Are Immutable - *constant*

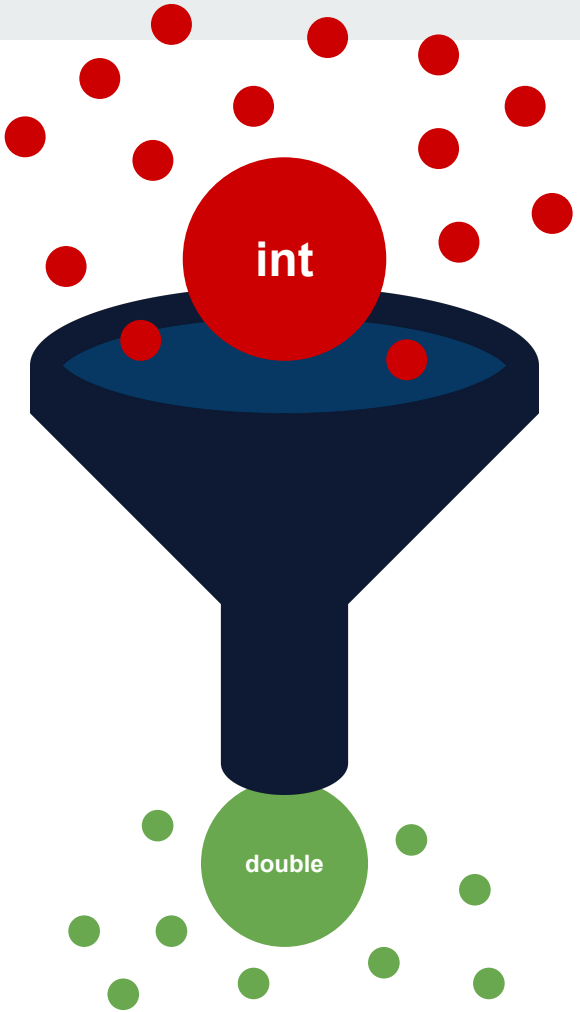


Casting Variables

Casting variables is explicitly convert one type to another.

Primitives and **Objects** can be converted between one another using casting.

```
// converts from double to int
double dubs = 5.0;
int num = (int) dubs;
```



Order of Precedence (High to Low)

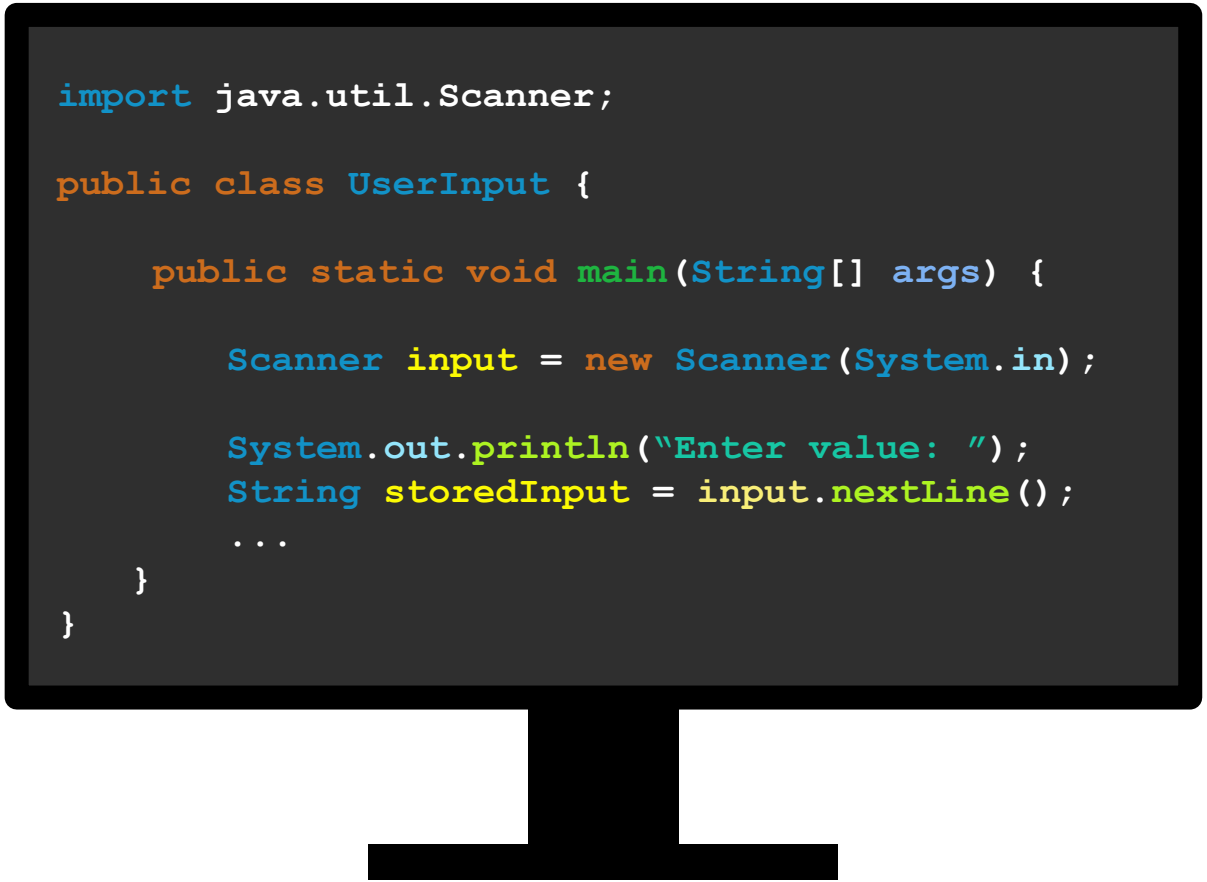
Order of Precedence - order in which operators in an expression are evaluated

Oracle Documentation:

https://docs.oracle.com/cd/E19253-01/817-6223/chp-typeopexpr-12/index.html

	Important to note
1	`!, +, - (unary)`
2	`*, /, %`
3	`+, -`
4	`<, <=, >=, >`
5	`==, !=`
6	`&&`
7	`||`
8	`= (assignment)`

Read From the Console



Flow Control

Conditionals: If/Else

- ➔ Conditionals are a core part of nearly every programming language.
- ➔ Java uses **if / else if/ else** syntax to control the flow of a program

```
if (condition1){
    // this code will execute if condition1 a strict true boolean
}
else if (condition2){
    // this code will execute if condition2 a strict true boolean
    // and condition1 is a strict false boolean
}
else {
    // this code will execute if neither condition1 or condition2
    // are strict true booleans
}
```

Conditionals: Nested If Statements

➔ Nesting if statements can test conditions that are reliant on the state of other conditions

```
if (condition1) {
    if (condition2) {
        // this code will execute if condition1 and condition2 are
        // strict true booleans
    } else {
        // this code will execute if condition1 is a strict true
        // boolean, and condition2 is a strict false boolean
    }
} else {
    // this code will execute if condition1 is a strict false boolean,
    // but has no relationship to condition2
}
```

Conditionals: Logical Operators

Logical operators can be used to check the conditions on primitive data types

```
<  → Less than
>  → Greater than
<= → Less than or equal to
>= → Greater than or equal to
== → Equal to (NOTE: This compares memory locations)
!= → Not equal to
!  → Not (reverses a boolean)
&& → And (True if Both booleans are true)
|| → Or (True if at least one boolean is true)
^  → XOR (True if one boolean is true and the other false)
```

Important note: Strings are objects, not primitives, these operators with not work as properly on Strings.

Conditionals: Switch

- ➔ Switch statements are a more compact syntax for conditionals.
- ➔ Switch statements can be used to direct the flow of a program based on the value of an int, char or (as of Java 7) an enum value

```
switch (condition){
     case condition1:
          // code
          break;
     case condition2:
          // code
          break;
}
```

- ➔ Note the break statements. Without them, the switch will execute all code following the matching condition

Conditionals: Switch

➔ A default case can be added to a switch expression which will be executed when no case is matched

```
switch (condition){
     case condition1:
          // code
          break;
     case condition2:
          // code
          break;
    default:
        // This code will run if neither
        // condition1 or condition2 is met
        break;
}
```

Loops: While Loop

- **Loops** executes block of code a number of times until condition is met
- **While loop** repeat a code block until condition is a strict boolean false

```
int counter = 1;
while (counter < 10){
      System.out.println(counter);
      counter++;
}
```

- Above, the loop will print numbers from 1 to 9
- While loops have no internal means of keeping track of the number of loops
- Developer must be careful to ensure that infinite loops don't occur

Loops: While Loop

- The conditional in a while loop does not have to be a counter

```
boolean condition1 = true;
while (condition1){
      // code
      if (condition2) {
          condition1 = false;
      }
}
```

- Above, loop executes code block indefinitely because it is looping on a true boolean
- Once **condition2** is met, will swap the loop boolean **condition1** to false
- Last loop is executed

Loops: Do While

➔ The **do/while loop** similar to while loop, except it executes its code block at least once before checking the condition

```
boolean condition = false;
do {
      // code
} while (condition);
```

➔ Above, even though condition is immediately set to false, the loop will execute once

Loops: For Loop

- **For loops** are more complex loop that have terminating and increment conditions built in
- Consist of an ***initialization block***, a ***condition block,*** and an ***increment block***

```
for (int i = 0; i < 10; i++){
     System.out.println(i);
}
```

- Above, an int i is set to zero, it is incremented by one for each iteration of the loop, and once i is greater than ten, the loop terminates.
- Initialized variable is block-scoped to the for loop, i cannot be accessed outside the loop

Loops: For Loop

- Standard form of for loop is the most common, but there are a few variations possible

```
boolean condition = true;
for (int i = 1; condition; i *= 5){
     if (i % 3 == 0){
          condition = false;
     }
     System.out.println(i);
}
```

- Above, an int i is set to one, it is incremented by multiplying it by five each time through the loop, and the loop is broken through some outside condition
- Some specific use cases for unusual for loops like this, but most standard cases require a loop initialized to 1 that increments by one, and ends when a number is reached

Loops: Nested Loops

- Nesting loops can be used to generate two dimensional arrays or tables

```
for (int length = 1; length < 4; length++){
    for (int width = 1; width < 4; width++){
        area = length * width;
        System.out.println("area: " + area);
    }
    System.out.println("");
}
```

- Code above will print a grid that labels the area of rectangles of the given length and width
- Nesting loops is significantly more memory and processor intensive than a single for loop, so be careful with implementations that require them

Loops: Break and Continue

- **Loop-and-a-half** conditions implemented for more precise control of code execution within a loop
- **Break**
  - Will immediately end all repetitions of a loop and return to normal flow of a program
- **Continue**
  - Will end the current iteration of a loop, and move on to the next iteration
  - In ***for loop***, will still trigger the increment block
- **Return**
  - Within a method, return statement can be used to end a loop and return a value; similar to a break statement.
  - Will end any resources associated with a method, including any further iterations of loop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EXERCISE

```java
public class FizzBuzz {

    public static void main(String[] args) {
        System.out.println("1");
        System.out.println("2");
        System.out.println("Fizz");
        System.out.println("4");
        System.out.println("Buzz");
        System.out.println("Fizz");
        System.out.println("7");
        System.out.println("8");
        System.out.println("Fizz");
        System.out.println("Buzz");
        System.out.println("11");
        System.out.println("Fizz");
        System.out.println("13");
        System.out.println("14");
        System.out.println("FizzBuzz");
        System.out.println("16");
        System.out.println("17");
        System.out.println("Fizz");
        System.out.println("19");
        System.out.println("Buzz");
        System.out.println("Fizz");
        System.out.println("22");
        System.out.println("23");
        System.out.println("Fizz");
        System.out.println("Buzz");
        System.out.println("26");
        System.out.println("Fizz");
        System.out.println("28");
        System.out.println("29");
        System.out.println("FizzBuzz");
        System.out.println("31");
        System.out.println("32");
        System.out.println("Fizz");
```

Create a method that follows the following rules that :

The method should print out a list of length n, with each index i following these rules

If a number n is divisible by 3, print “Fizz”

If a number n is divisible by 5, print “Buzz”

If a number n is divisible by 3 and 5, print “Fizzbuzz”

Bonus :

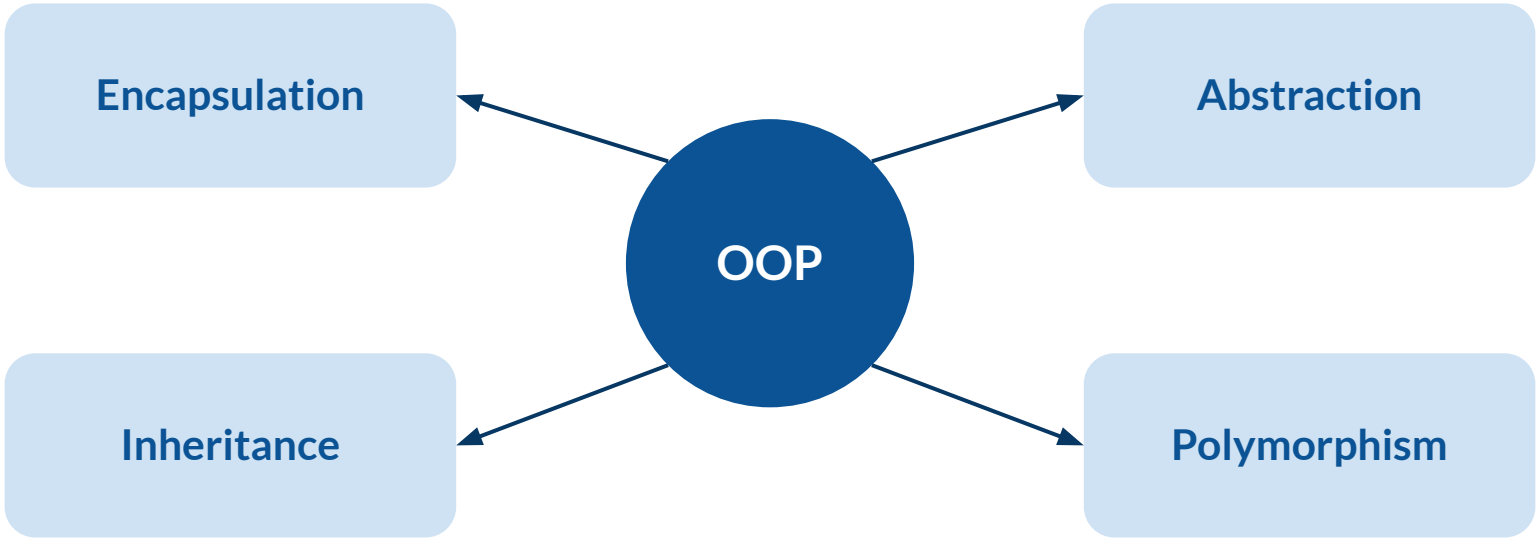
If a number is prime, do not print it.

Classes & Objects

Blueprint

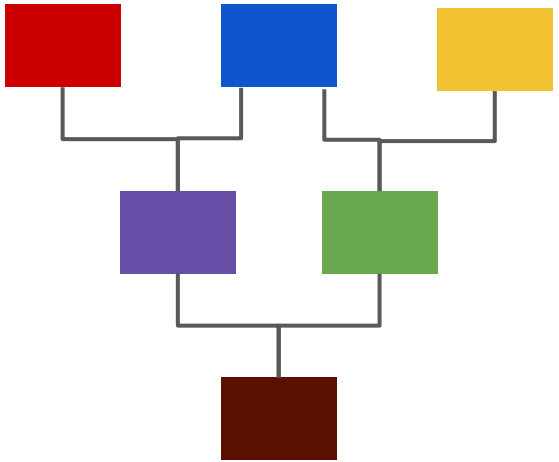
Houses built according to the blueprint

Object Oriented Programming (OOP)

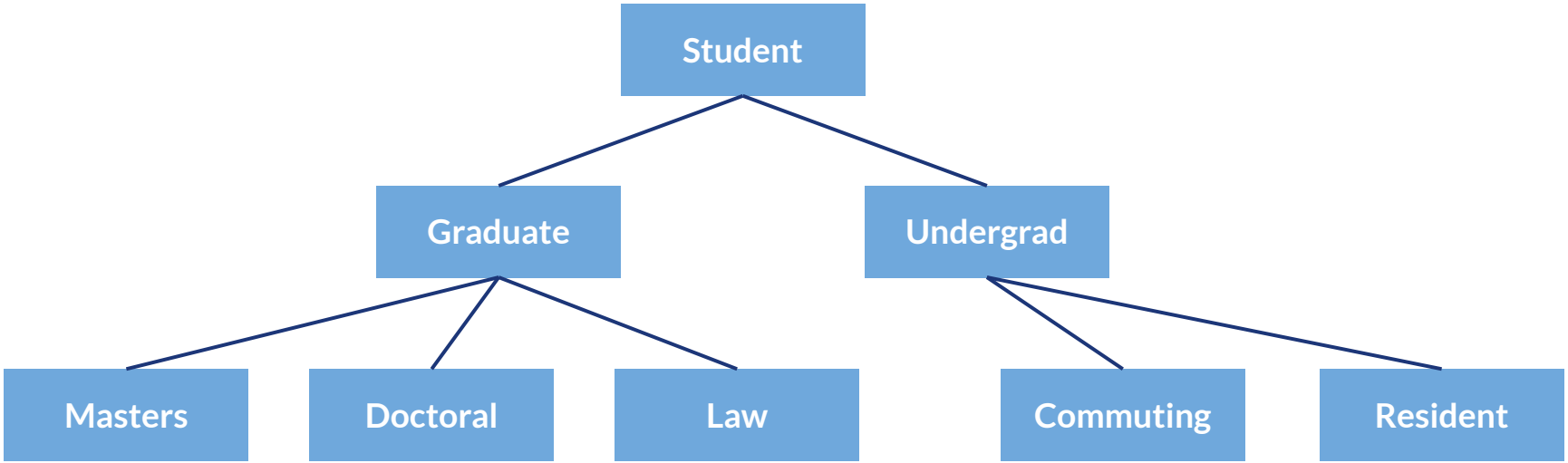


OOP - Inheritance

- ➔ ***Inheritance*** is a mechanism in OOP to design two or more entities that are different but share many common features
- ➔ Features common to all classes are defined in the ***superclass***
- ➔ The classes that inherit common features from the superclass are called ***subclasses***
- ➔ We also call the superclass an ***ancestor*** and the subclass a ***descendant***

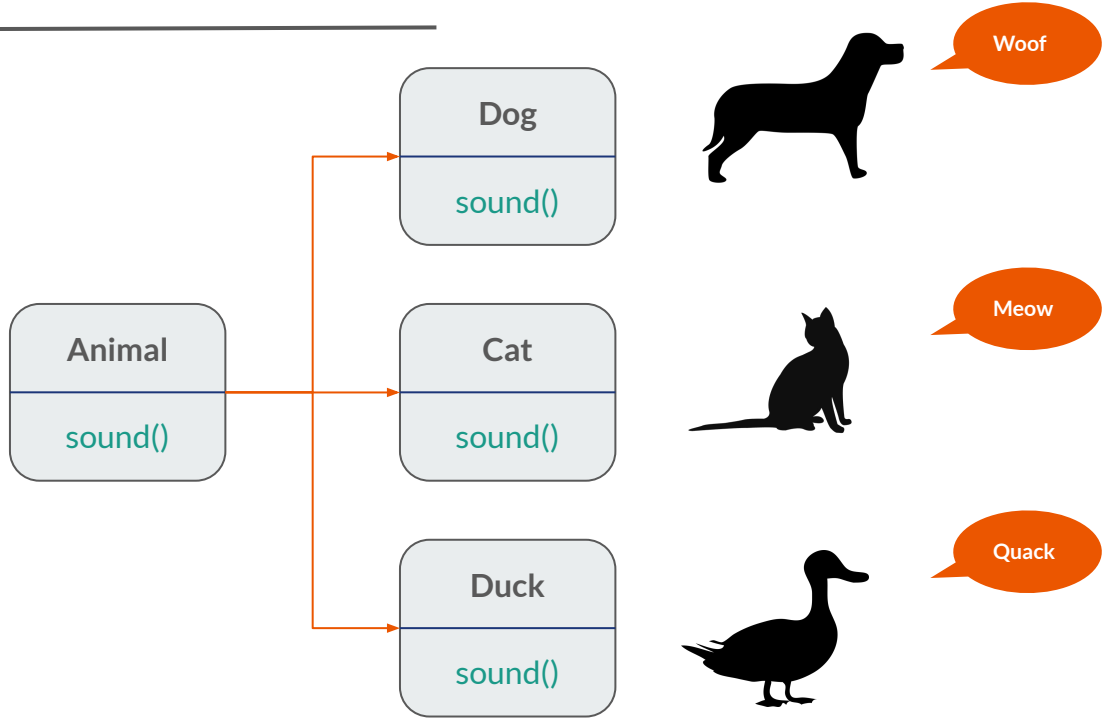


OOP - Inheritance



OOP - Polymorphism

- ***Polymorphism*** is a mechanism in OOP where one element of code can have many forms
  - Polymorphism can be implemented in such as **objects** and **classes**, and **class methods**

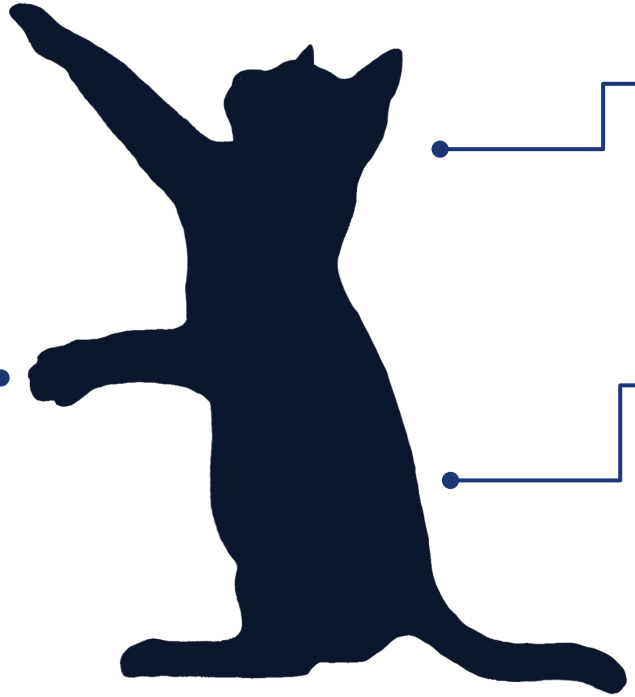


OOP - Abstraction and Encapsulation

Abstraction as a concept of OOP enforces "***data hiding***". That is, only relevant code is displayed, so that code is layered.

Encapsulation is a "***data grouping***". Think of this as a protective shield around code. An example would be grouping functions together in class.

Classes



Methods
Meow
Play
Sleep

Class
Cat

Attributes
Name
Favorite Toy

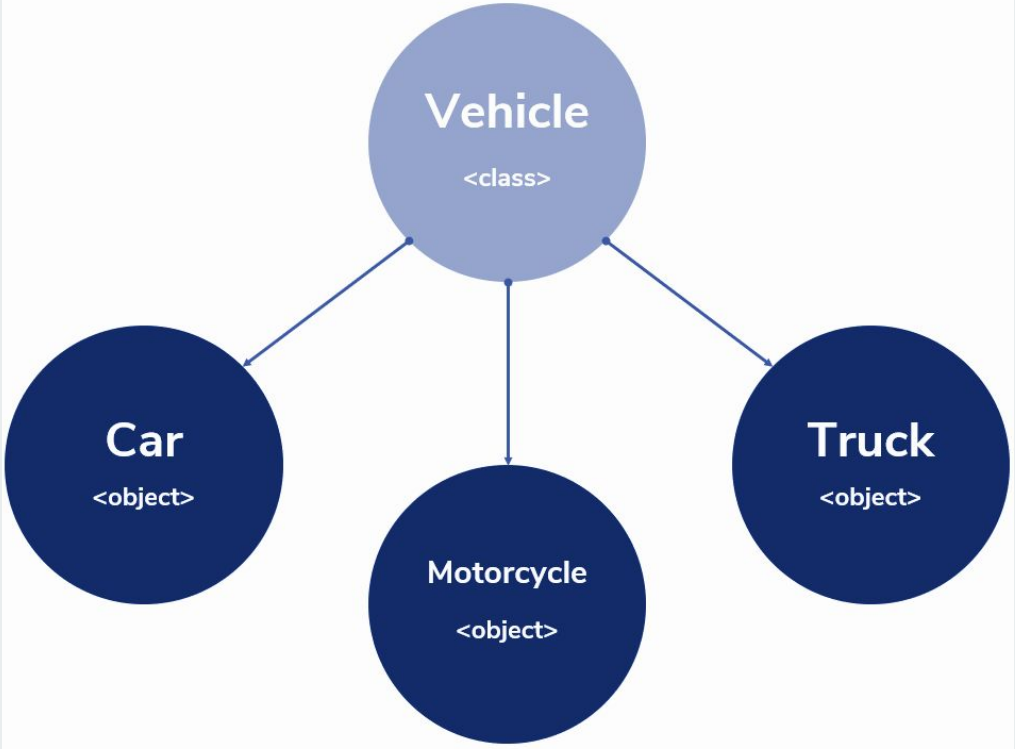
Classes and Objects

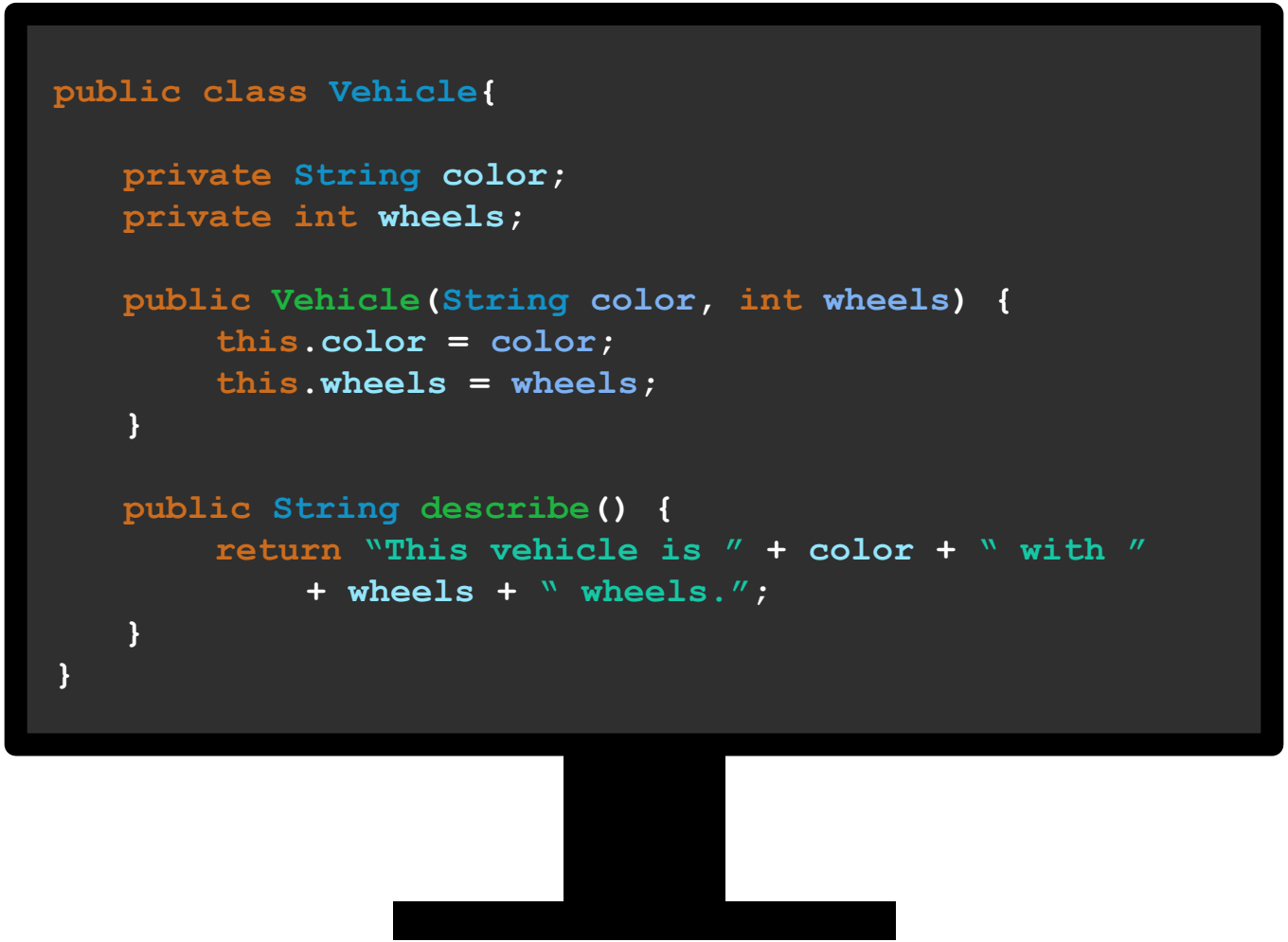
Object-oriented programs use **objects**.

An ***object*** is a thing, both tangible and intangible.

To create an object inside the computer program, we must provide a definition for objects—how they behave and what kinds of information they maintain —called a ***class***.

An object is called an ***instance*** of a class.


Vehicle
<class>
Car
<object>
Motorcycle
<object>
Truck
<object>


public class Vehicle{
private String color;
private int wheels;
public Vehicle(String color, int wheels) {
this.color = color;
this.wheels = wheels;
}
public String describe() {
return "This vehicle is " + color + " with "
+ wheels + " wheels.";
}
}

Messages and Methods

To instruct a class or an object to perform a task, we send a ***message*** to it.

You can send a message only to the classes and objects that understand the message you sent to them.

A class or an object must possess a matching ***method*** to be able to handle the received message.

Messages and Methods

A method defined for a class is called a ***class method***, and a method defined for an object is called an ***instance method***.

A value we pass to an object when sending a message is called an ***argument*** of the message.

Access Modifiers

Modifier	Class	Package	Subclass	Global
Public	Allowed	Allowed	Allowed	Allowed
Protected	Allowed	Allowed	Allowed	Denied
Default	Allowed	Allowed	Denied	Denied
Private	Allowed	Denied	Denied	Denied

Static Keyword

- Means the method or attribute is bound to the entire Class
  - No object needs creation to call static methods
  - Static attributes are reflected for all objects of a class
    - E.g. - a count int, that counts all objects of a class is static
- To call a static method
  - Use: *ClassName.methodName();*

Static Keyword

- Static Block
  - Block of code that executes once, when a class is loaded into the program heap.
  - Will execute *BEFORE* a constructor, but only once.

```
// Static Block - executed once, first time the class is loaded
static {
    System.out.println("This is our static block");
}
```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Class Example

```
public class Animal {

    // attributes here

    // create constructor

    // define methods

}
```


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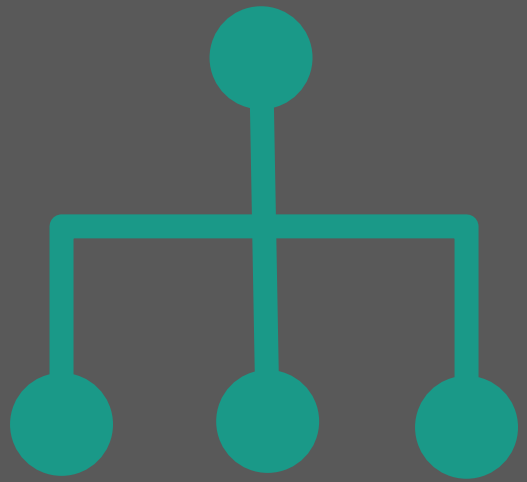
Creating a Class Diagram

Create Class	Class Properties	Child Class	Polymorphism	Explain
Choose a topic and create a class for this, draw it up on the board	Create attributes and methods for this class.	Create a child class that can inherit from this original class. Come up with attributes and methods for this child class.	Create a method that will override one of the methods from the parent.	What is happening in this diagram? Is there encapsulation?

Naming Conventions

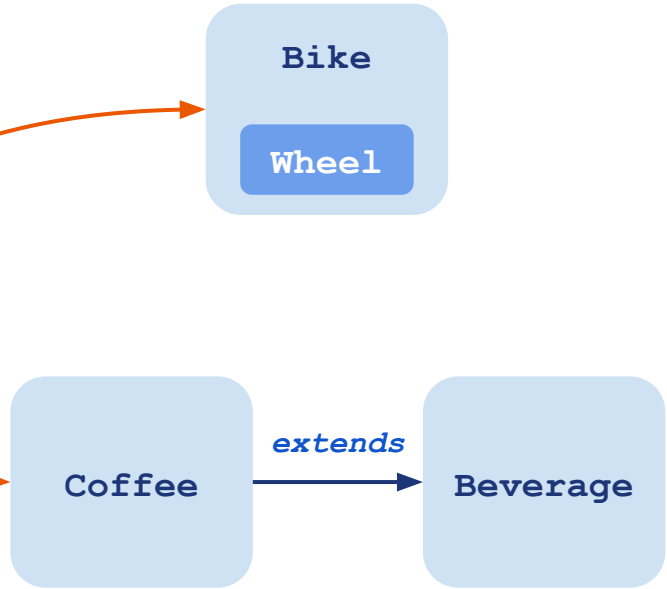
- ***Classes*** - should be nouns, in mixed case with the first letter of each internal word capitalized
- ***Interfaces*** - should be adjectives, in mixed case with the first letter of each internal word capitalized
- ***Methods*** - should be verbs, in mixed case with the first letter of each internal word capitalized
- ***Variables*** - should be short yet meaningful. The choice of a variable name should be mnemonic- that is, designed to indicate to the casual observer the intent of its use. Lowercase first letter and camelcased
- ***Final Variables and Enums*** - should be all uppercase with words separated by underscores ("_")

Composition & Inheritance



Has-A vs Is-A Relationship

- **Composition** - a class can contain an instance of another class
  - *Has-A* relationship
    - Ex: a bike ***has a*** wheel
- **Inheritance** - a child class can obtain the properties of its parent class
  - *Is-A* relationship
    - Ex: a coffee ***is a*** beverage
  - Access modifiers determine what attributes/methods are accessible to the child class

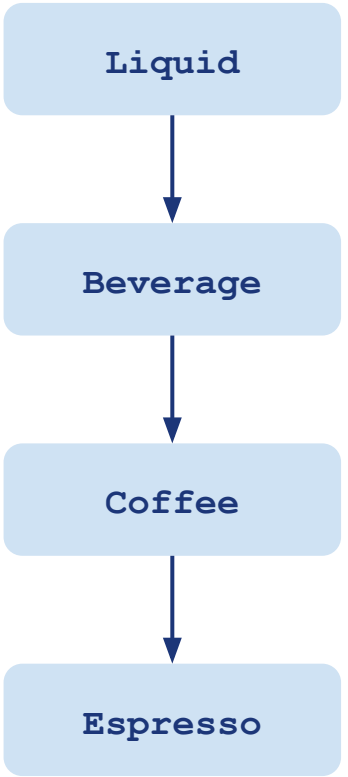


Inheritance Hierarchy

A child class will inherit from its parent class and all the classes its parent inherits from. Because an Espresso is a Liquid, a variable of type Liquid can be assigned an Espresso object. However, a Liquid cannot be an Espresso because a Liquid does not inherit from Espresso.

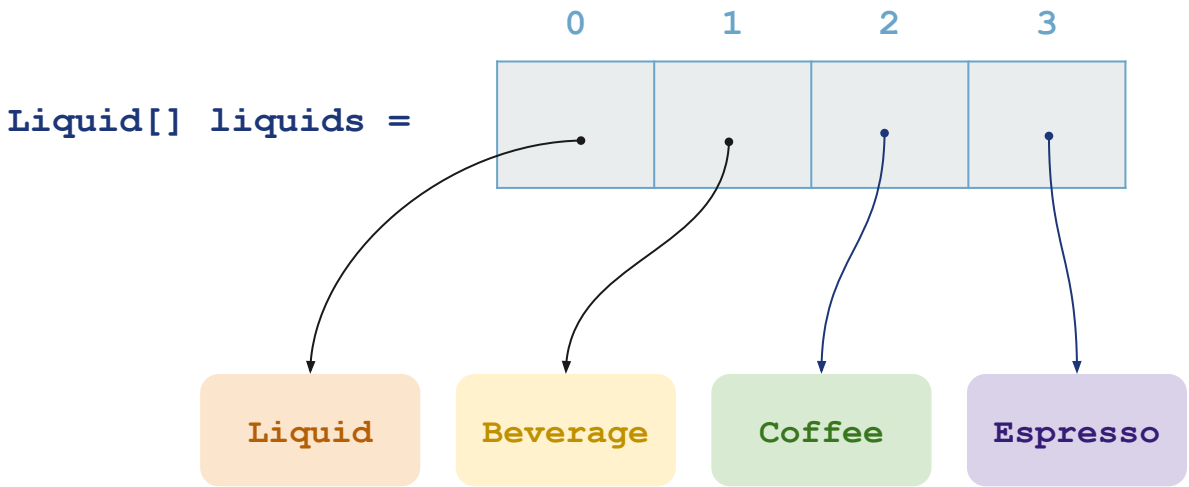
```
Liquid liquid = new Espresso();
```

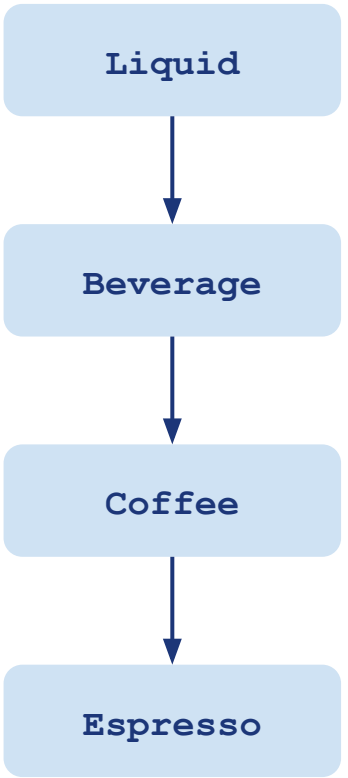
```
Espresso espresso = new Liquid();
```



Inheritance Hierarchy

An array of Liquids can take in any objects that inherit from it. So Beverage, Coffee, and Espresso objects can be placed in this array.





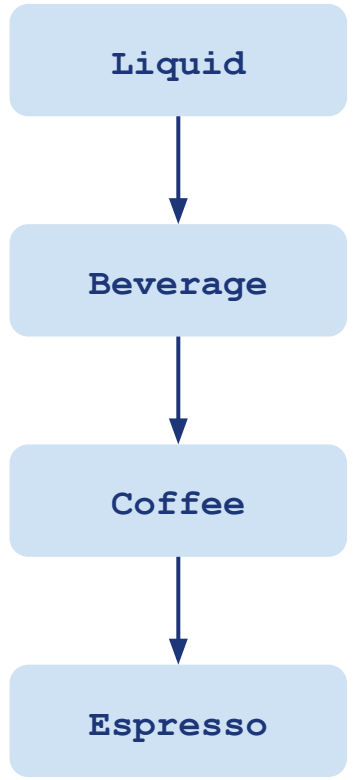
Final Classes and Inheritance

A class declared **final** cannot be extended by another class. Classes like String are final and use this implementation so no other classes can inherit and use their functionality.

```
public final class Espresso {
    ...
}
```

```
public class Latte extends Espresso {
    ...
}
```

Will cause error

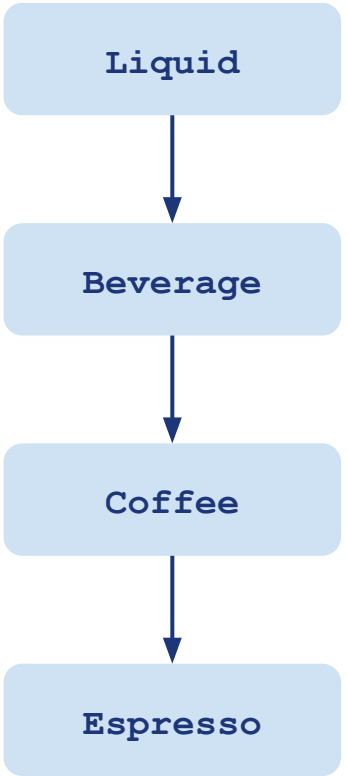


Polymorphism

Polymorphism is the ability for an object to take on different forms. Like how an Espresso is an Espresso, but also a Coffee.

```
Espresso espresso = new Espresso();
```

```
Coffee espresso = new Espresso();
```



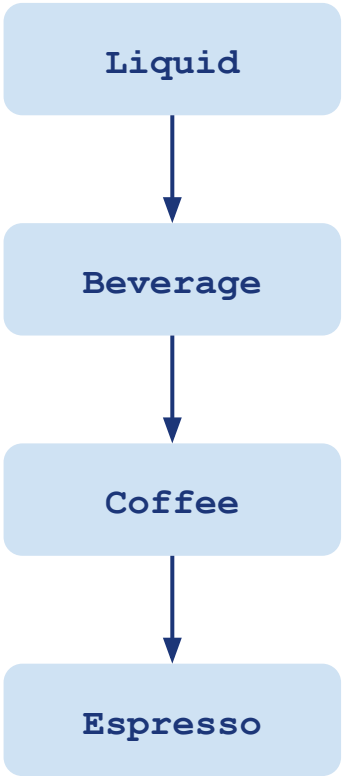
Polymorphism: Methods

RunTime Polymorphism is when **method overriding** is used to redefine a method with the same method signature from a parent class in your child class. Also known as ***dynamic polymorphism***.

```
Espresso espresso = new Espresso();
espresso.whatAmI(); // prints: I am an
                    // espresso
```

```
Coffee espresso = new Espresso();
espresso.whatAmI(); // prints: I am an
                    // espresso
```

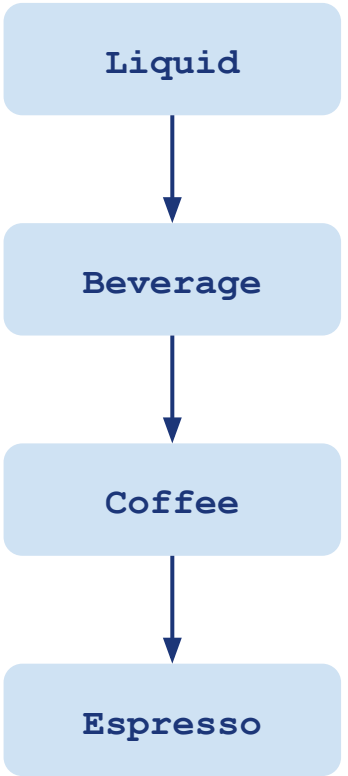
Note: Can't override static methods.



Polymorphism: Methods

Only time you won't be able to override a method is if it is **final** or you try to override a **static** method.

```
public class Espresso {
    // methods cannot be overridden
    public final void whatAmI() {
        ...
    }
    public static void hello() {
        ...
    }
}
```



Polymorphism: Methods

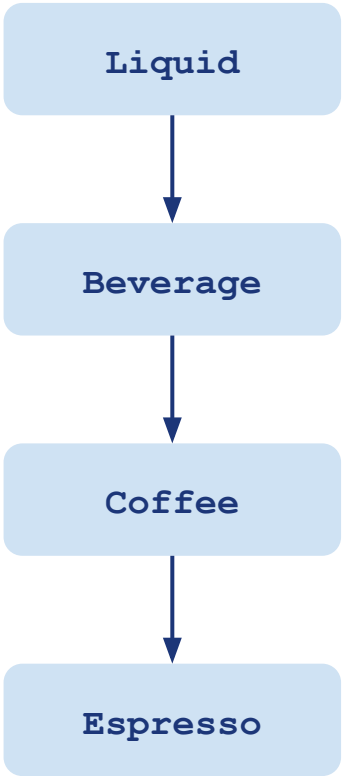
Compile Time Polymorphism is when **method overloading** is used to define multiple methods with the same name, but different parameters. Also known as ***static polymorphism***.

```
Espresso espresso = new Espresso();

espresso.whatAmI();          // prints: I am an
                             // espresso

espresso.whatAmI("Sam"); // prints: I am an
                         // espresso prepared
                         // by Sam

espresso.whatAmI(3);     // prints: I am 3
                         // espressos
```



Super Keyword

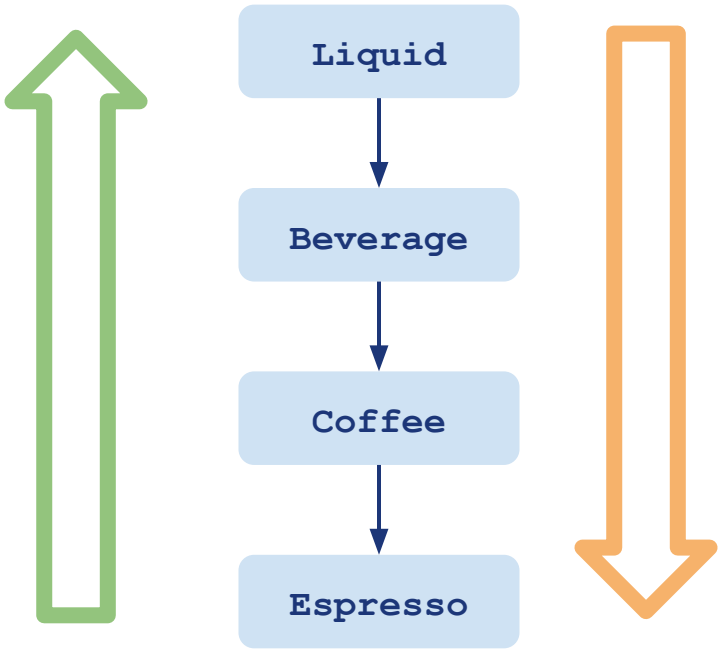
- The **super** keyword references the superclass of a class
- Super can be used to
  - call constructor of the parent
  - access data members of parent class

```
class ParentClass {
    private int num;
    public ParentClass(int num) {
        this.num = num;
    }
    ...
}

public class ChildClass extends ParentClass {
    private String str;
    public ChildClass(int num, String str) {
        super(num);
        this.str = str;
    }
    ...
}
```

Casting Between Types

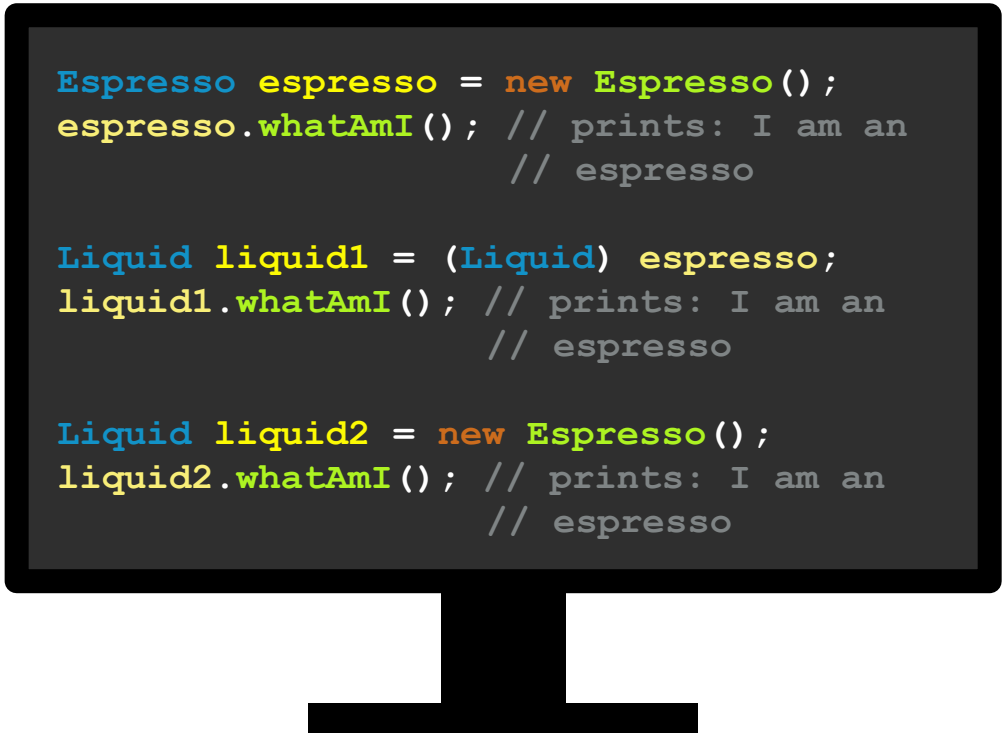
We **Upcast** to convert the type from that of a child class to the type of its parent or any of the classes it inherits from along the chain of inheritance.



We **Downcast** by converting the type from a parent class to a child class or any class that inherits from the original parent.

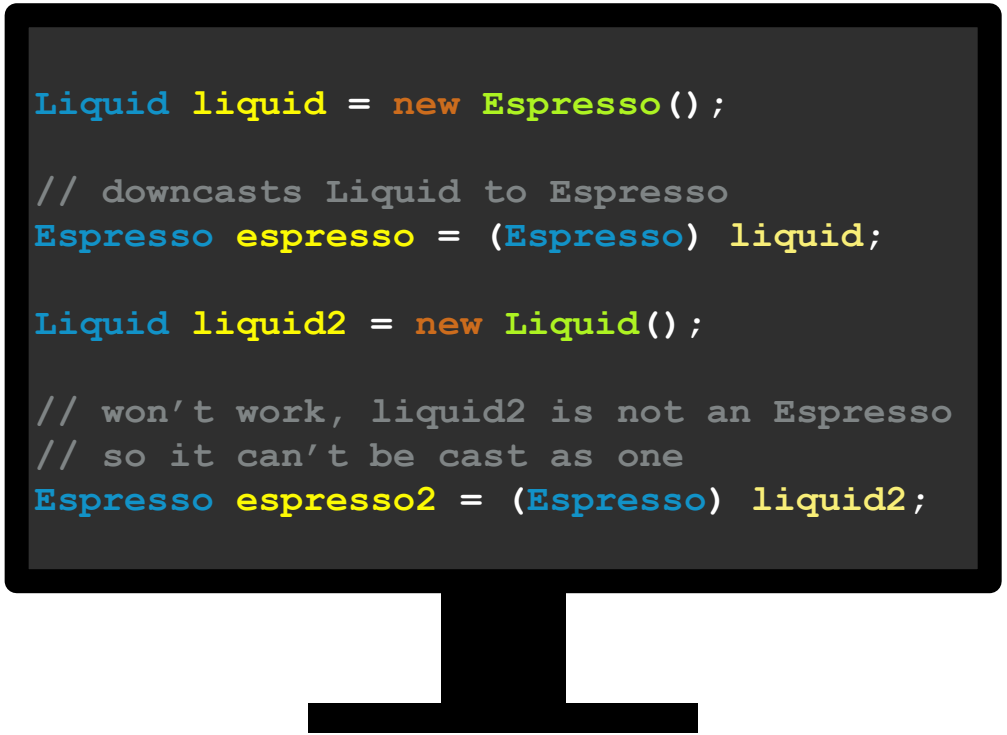
UpCasting

- Can cast by...
  - Explicitly casting with parenthesis and type specified
  - Initializing the object with new keyword
- Why upcast?
  - Want to write code that deals with only supertype



DownCasting

- Can cast by...
  - Explicitly casting with parenthesis and type specified
- Why downcast?
  - Want to access specific behaviors of a subtype

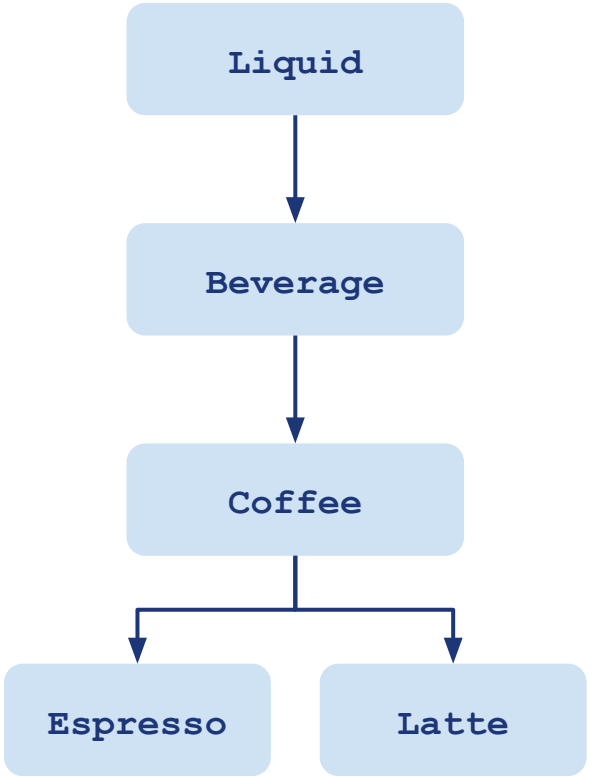


Instance of an Object

The **instanceof** keyword checks if an object is of a given type and returns back true or false. Checks ***is-a relationship***.

```
Espresso expr = new Espresso();

if ( expr instanceof Espresso ){ // will print
     System.out.println("expr is an Espresso");
}
if ( expr instanceof Liquid ){ // will print
     System.out.println("expr is a Liquid");
}
if ( expr instanceof Latte ){ // compile error
     System.out.println("expr is a Latte");
}
```



Instance of an Object

The **instanceof** keyword will return false if object not of the type or if the object is null.

```
Coffee cof1 = new Coffee();
Coffee cof2 = null;

if ( cof1 instanceof Espresso ){ // won't print
     System.out.println("expr is an Espresso");
}
if ( cof2 instanceof Coffee ){ // won't print
     System.out.println("expr is a Liquid");
}
```