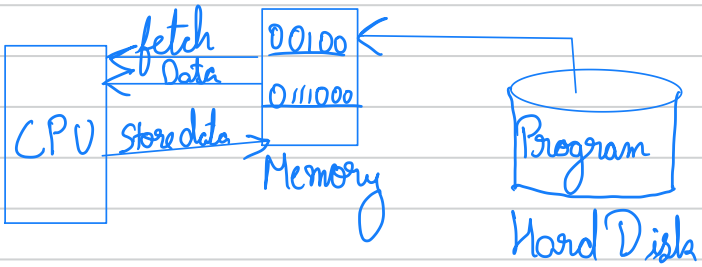
Java

CPU's fetch and execute cycle (Not Imp but should know)



How Java code is executed

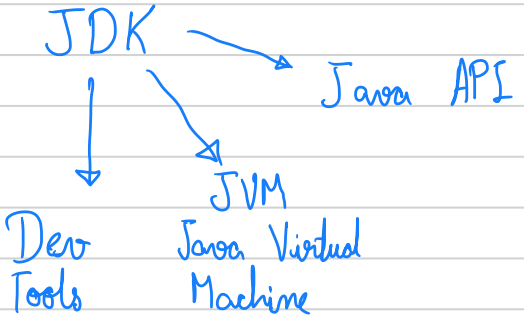
Source Code
↓
Java Compiler
↓
Java Byte Code
↓
Java Interpreter (JVM → Java Virtual Machine)
↓
Results

Eg:-

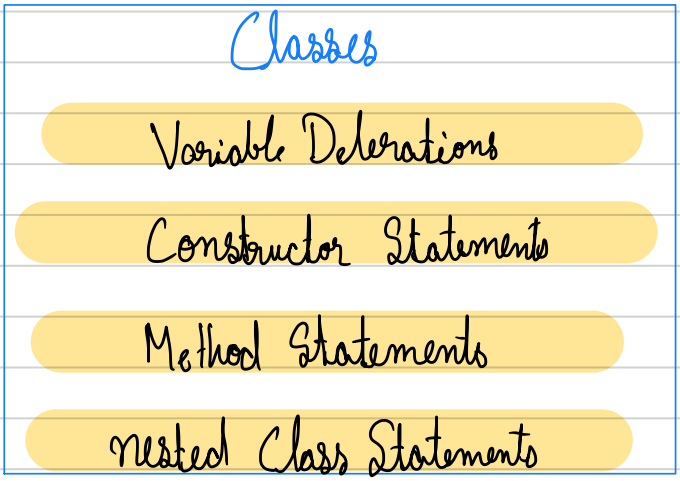
Hello.java
javac Hello.java
↓
compilation
↓
Java Bytecode Hello.class

java Hello
JVM windows
JVM linux
JVM macOS

What Does JDK include

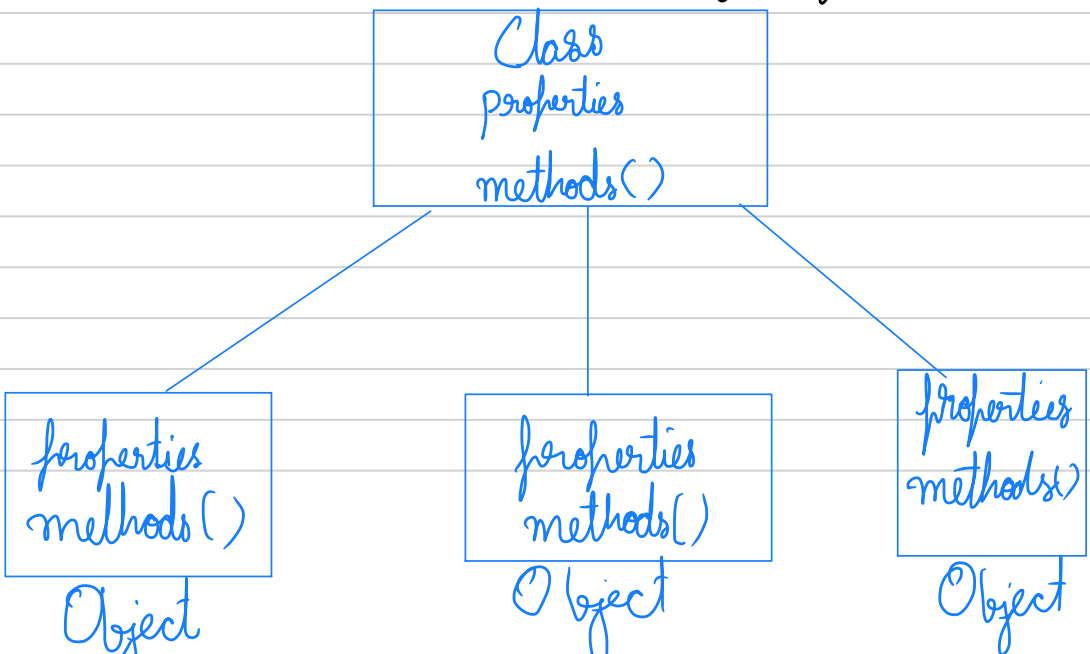


Java Program Structure



Classes and Objects

→ A Class is a blueprint for creating objects



→ An Objects can get methods and properties from a class while at the same time having their own properties and methods.

→
```
class Student {
    int id;
    String name;
    String gender;

    boolean updateProfile (String newName){
        name = newName;
        return true;
    }
}
```

Variable declaration

method defenation

Creating object using class

→
```
class StudentTest {

    public static void main (String [ ] args)
        Student s = new Student ( );

        s.id = 1000;
        s.name = "Aryan";
        s.gender = "male";

        s.updateProfile ("John");
    }
}
```

Data type is class name for creating object from class

keyword

Class name

Creating new student object

Assigning Values

Calling methods

→ Naming methods / variables / classes

→ Names given to different parts of program are known as Identifier
→ Identifiers can include letters, underscore, digits and $.
→ Identifiers cannot begin with a number.
→ It cannot be a reserved keyword of java.
→ Identifiers are case sensitive

→ Printing in Java

→ System.out.println(value) → advances the cursor to next line
→ System.out.print(value) → Cursor stays at the end

System.out.println() → Prints blank line
System.out.print("") → Prints blank

→ Java is a Statically Typed Language language

→ Declaring Variable

<type> <name> [= literal or expression];

Types can be both

Primitive
int etc
boolean

Non-Primitive
Class name etc
String

Passing value or expression is known as initialization and it is optional in a class

→ Reinitializing Variable

<name> = literal or expression;

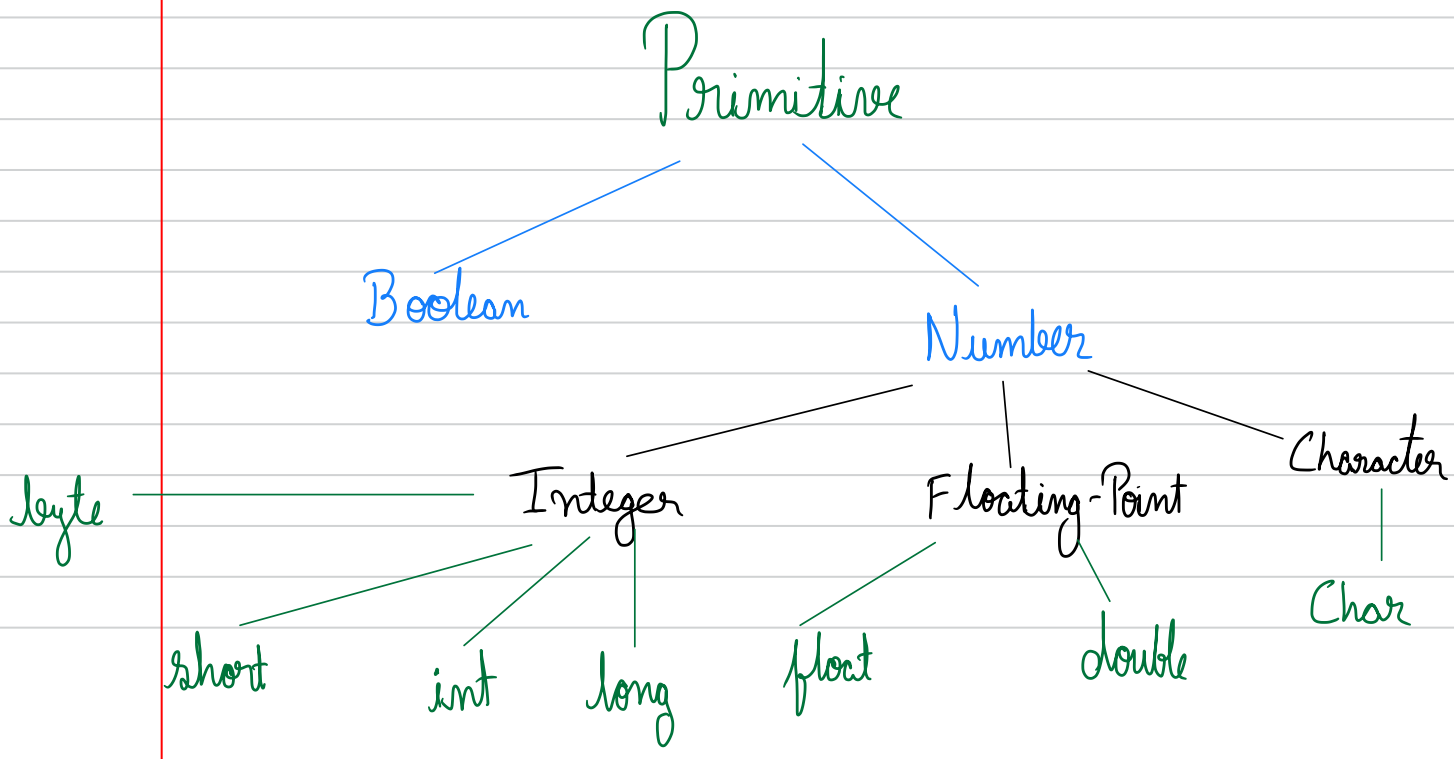
Reinitialization cannot take place at class-level.

It can only take place within methods in a class

Local Variables that are initialized within a method do not get Default Values.

Only Global Variables that are initialized within a class get Default Values

→ Primitive Data types



→ Integers

→ Whole or fixed-point numbers, eg :- 65, -100

→ byte, short, int, long → prefer int

Type	Bit depth	Value range	Default
byte	8 bits (8-1=7)	-2^7 to $2^7 - 1$	0
short	16 bits (16-1=15)	-2^{15} to $2^{15} - 1$	0
int	32 bits (32-1=31)	-2^{31} to $2^{31} - 1$	0
long	64 bits (64-1=63)	-2^{63} to $2^{63} - 1$	0

1 bit in (left most bit) each is known as sign bit and it tells weather a number is -ve or +ve it is also known as Most Significant Bit (MSB)

→ if sign bit is 0 → +ve number
if sign bit is 1 → -ve number

→ Floating Point Numbers

→ float, double → prefer double

Type	Bit depth	Value range	Default	Precision
float	32 bits	-3.4E38 to 3.4E38	0.0f	6-7 decimal digits
double	64 bits	-1.7E308 to 1.7E308	0.0d	15-16 decimal digits

→ Character

→ Single letter characters, eg :- 'A', '0', '$' } Single Quotes only

→ Internally character is stored as an Integer ~ 16-bit unsigned Integer

↓

UTF-16 ⇒ hexadecimal

→ Boolean

→ default value is false

→ Local, Static & Instance Variables

→ Instance & Static Variables

- Declared within Class
- Scope : Entire Class
- Gets Default Value
- Cannot be redefined directly within block (can be redefined through methods)

→ Local Variables

- Declared within a method
- Scope : Local
- Doesnot get default value
- Can be redefined directly within the method

→ Instance : Represents object state → Belongs to each object

→ Values are unique to object

→ From outside class can be accessed via object reference

→ Unique to each object

→ Static :

→ Values are unique to class ~ shared across objects → Belongs to Class

→ From outside class can be accessed via Class name and also within method

→ Some copy shared among all objects

→ Type Casting

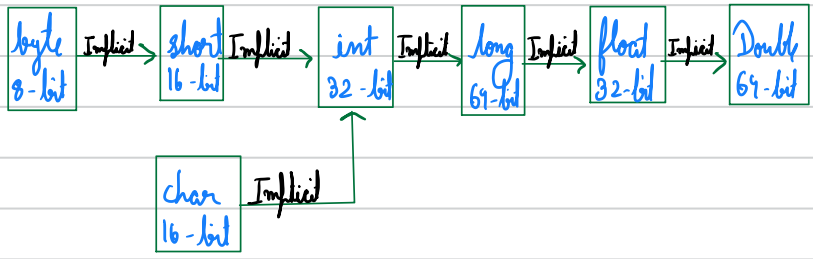
→ Assigning a variable of one type to variable of another type

→ Only numeric-to-numeric casting is possible

→ Implicit Casting ⇒ Done by Compiler

→ Possible is smaller datatype is assigned to larger

Eg:- `int x = 65;`
`float y = x;` Implicit casting by compiler



→ Explicit Casting

→ Larger datatype to smaller datatype

→ Order is opposite of Implicit

→ Conversion to and from char to short and char to byte is Explicit.

Eg:- `long y = 42L;`
`int x = (int)y;`

→ Object References ⇒ Un-Primitive data-type

Assigns student object's address

`Student s = new Student();`

Allocates space for reference

Allocates space for new Student object

→ All objects are stored on heap

↑

area of memory

→ default value is null

→ Statement types

→ Declaration Statements

Eg :- int count = 25;

→ Expression statements

Eg :- → count = 35; // asignment

→ getCount(); // method invocation

→ count++; // increment

→ Control flow statements

Eg :- if (x<50) {

}

these statements cannot be executed at class level

→ Arrays

→ It is an object

→ In Java the number of elements an array can store is fixed

→ It stores values of a single type

→ There are 3 ways to initialize an Array

1. `int[] scores = new int[4];`

   - `int[]` → Data type of value that will be stored
   - `new int[4]` → number of elements in array

   now to add values (cannot be added at class level)

```
scores[0] = 90;
scores[1] = 100;
scores[2] = 80;
scores[3] = 70;
```

   can be used for long arrays

2. `int[] scores = new int[] {90, 100, 80, 70}`

   - `int[]` → data type of elements
   - `{90, 100, 80, 70}` → elements

3. `int[] scores = {90, 100, 80, 70}`

   - `int[]` → data type of elements
   - `{90, 100, 80, 70}` → elements

   used for short arrays

→ How to reinitialize an array created within a class from a method.

1.
```
public class Main {

    static int[] scores;

    public static void main(String[] args) {

        scores = new int[4];
        now to add values

        scores[0] = 90;
        scores[1] = 100;
        scores[2] = 80;
        scores[3] = 70;
}
```

2.
```
public class Main {
    static int[] scores;
    public static void main(String[] args) {
        scores = new int[4]{90,100,80,70};
    }
```

→ To get length of array

array.length

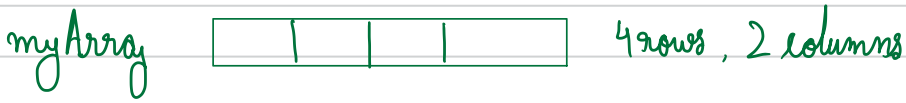
→ You can also create an array of a class and assign object references to it

```
class Student {
    int id;
    String name;
    String gender;
    boolean updateProfile(String newName){
        name = newName;
        return true;
    }
}

class array {
    public static void main(String[] args){
        Student[] students = new student[3];

        students[0] = new Student();
        students[1] = new Student();
        students[2] = new Student();
}
```

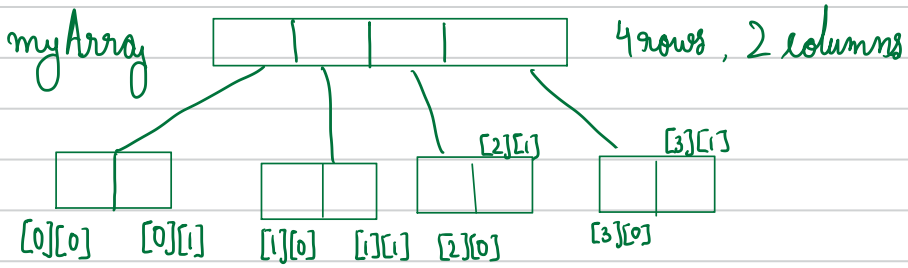
A Class in different file but same directory can be accessed from another file within the directory

→ 2D Arrays

→ JVM creates an array for each row



→ Each element then references to an array with 2 values of the columns.



→ Creating 2D arrays

1. `int[][] myArray = new int [4][2];`

row column

```
myArray[0][0] = 9;
myArray[0][1] = 11;
```

2. `int [][] myArray = new int[][] {`

```
{9,11},
{2,5},
{4,4},
{6,13}
};
```

Rows

3. `int[][] myArray = {`

```
{9,11},
{2,5},
{4,4},
{6,13}
};
```

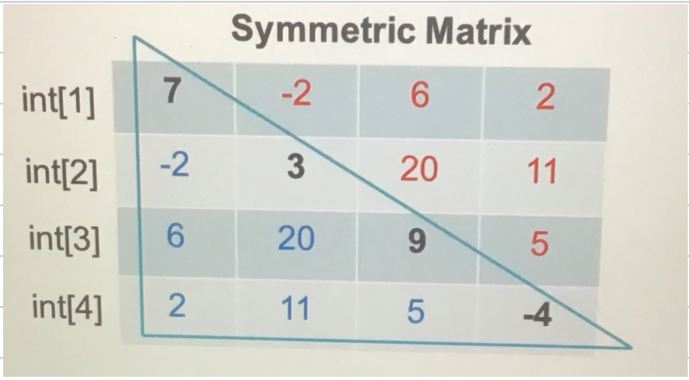
→ 2D Array with Irregular Rows ⇒ column not fixed

Eg:-

```
int[][] myArray = new int[2][];
myArray[0] = new int[5];
myArray[1] = new int[2];
```

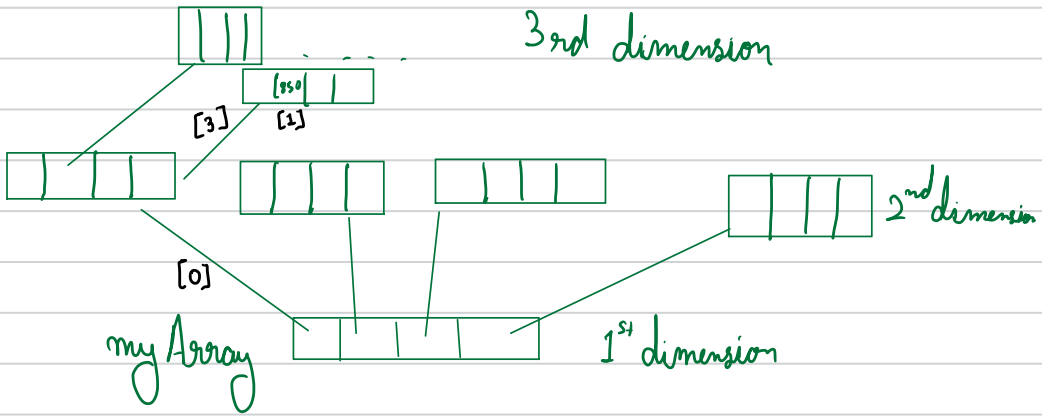
→ columns not fixed

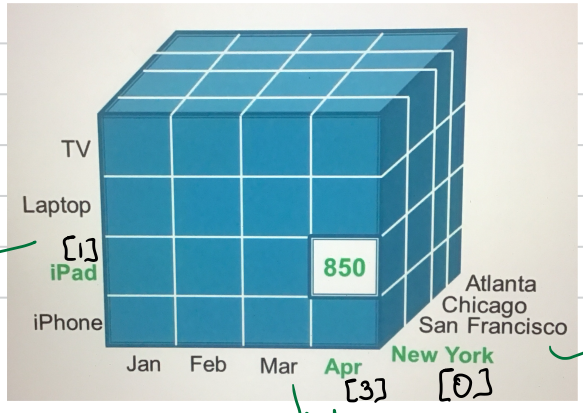
⇒ Useful for Symmetric matrix



→ 3D Arrays ⇒ rarely used

→ Syntax is same just add 1 more box for 3rd dimension

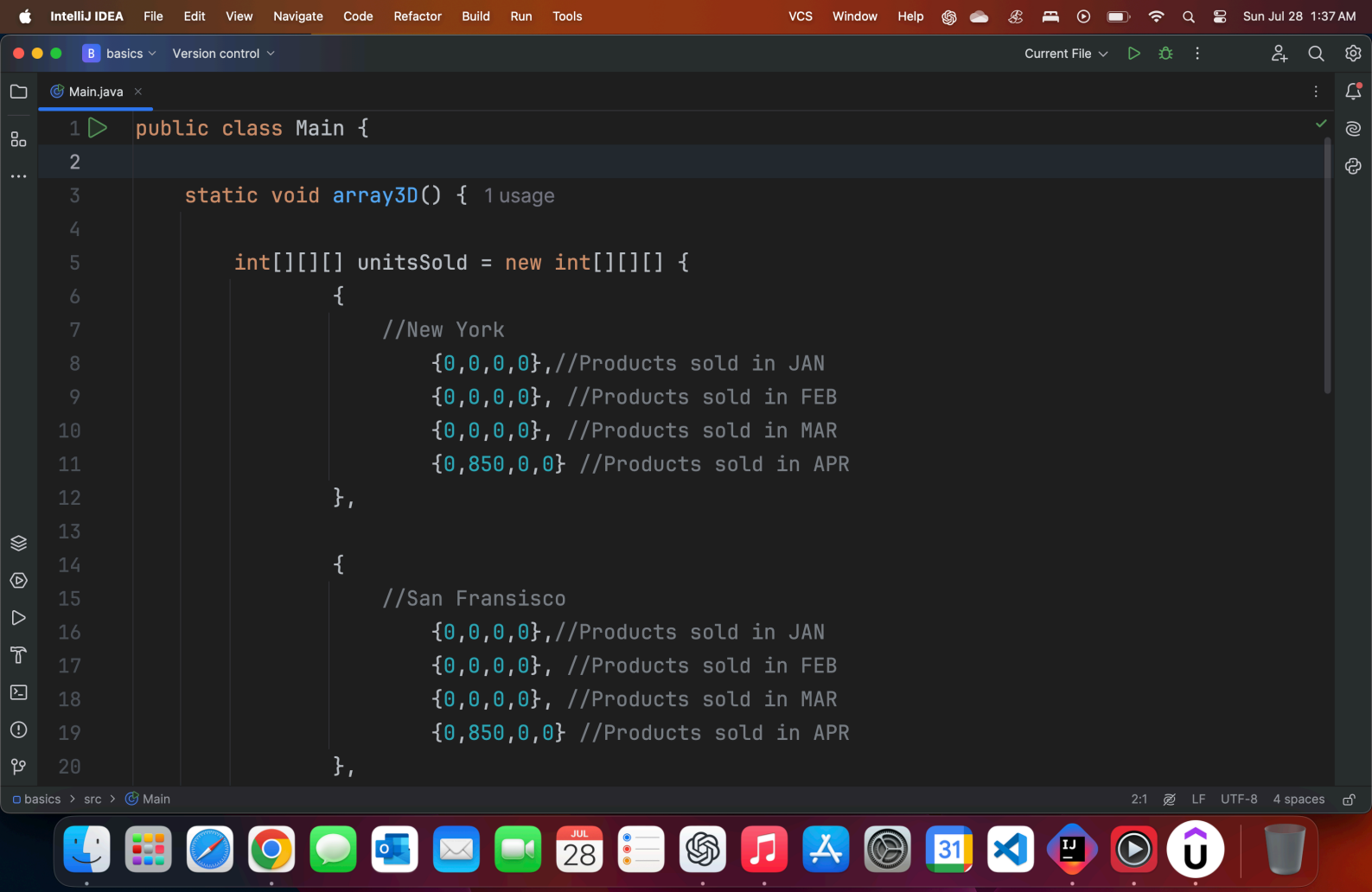




3rd dimension

1st dimension

2nd dimension

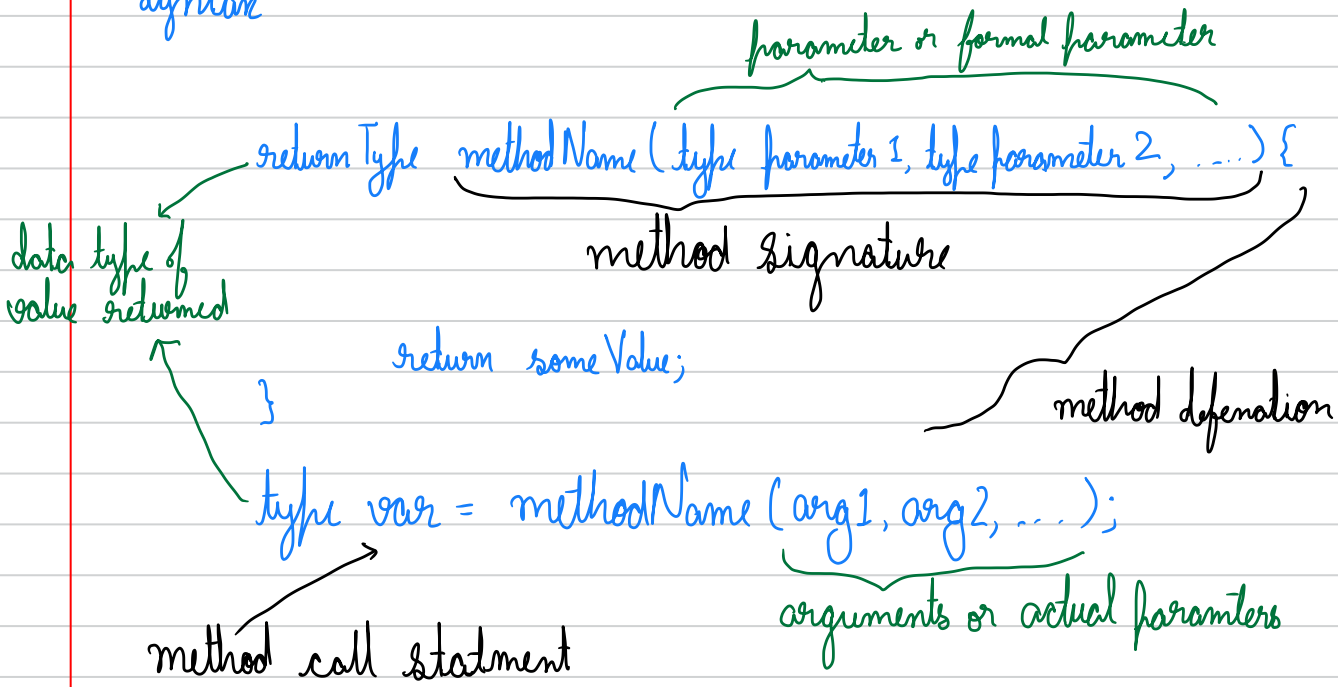

IntelliJ IDEA File Edit View Navigate Code Refactor Build Run Tools VCS Window Help Sun Jul 28 1:37 AM
basics Version control Current File
Main.java
public class Main {
static void array3D() { 1 usage
int[][][] unitsSold = new int[][][] {
{
//New York
{0,0,0,0},//Products sold in JAN
{0,0,0,0}, //Products sold in FEB
{0,0,0,0}, //Products sold in MAR
{0,850,0,0} //Products sold in APR
},
{
//San Fransisco
{0,0,0,0},//Products sold in JAN
{0,0,0,0}, //Products sold in FEB
{0,0,0,0}, //Products sold in MAR
{0,850,0,0} //Products sold in APR
},
basics > src > Main
2:1 LF UTF-8 4 spaces

```
                {

                        {0,0,0,0},//Products sold in JAN
                        {0,0,0,0}, //Products sold in FEB
                        {0,0,0,0}, //Products sold in MAR
                        {0,850,0,0} //Products sold in APR
                },

                {
                        {0,0,0,0},//Products sold in JAN
                        {0,0,0,0}, //Products sold in FEB
                        {0,0,0,0}, //Products sold in MAR
                        {0,850,0,0} //Products sold in APR
                }
        };

        System.out.println(unitsSold[0][3][1]);
    }
```

```
40
41      public static void main(String[] args) {
42          array3D();
43      }
44
45  }
```

→ Methods

→ Syntax



⇒ For void method call statement

```
methodName ( arg1, arg2, ... );
```

→ type and order of method parameters and arguments should be same

→ Methods cannot be called at class-level

→ Data type of method and method call statement should be same

⇒ returnType

→ must be a primative type or array, or class or interface or void

→ void

→ nothing to return

→ Other than void all methods must return

→ Type of Methods

→ Instance Method

→ They are object level methods

→ Invocation: objectreference.methodName();

→ Can access anything from an instance method. (static and instance variables or methods)

→ Static Methods

→ keyword static in declaration

→ They are class level methods

→ Invocation: className.methodName()

→ main method is a static method.

→ Cannot directly access instance variables/methods. Can access via object reference.

→ Can directly access static variables/methods.

→ Data changed within methods

→ Updating primatives within methods

```
void updateValue(int newId) {
        newId = 1001;
}
int id = 1000;
updateValue(id);
System.out.println(id); ⇒ prints 1000
```

→ Updating value using object reference

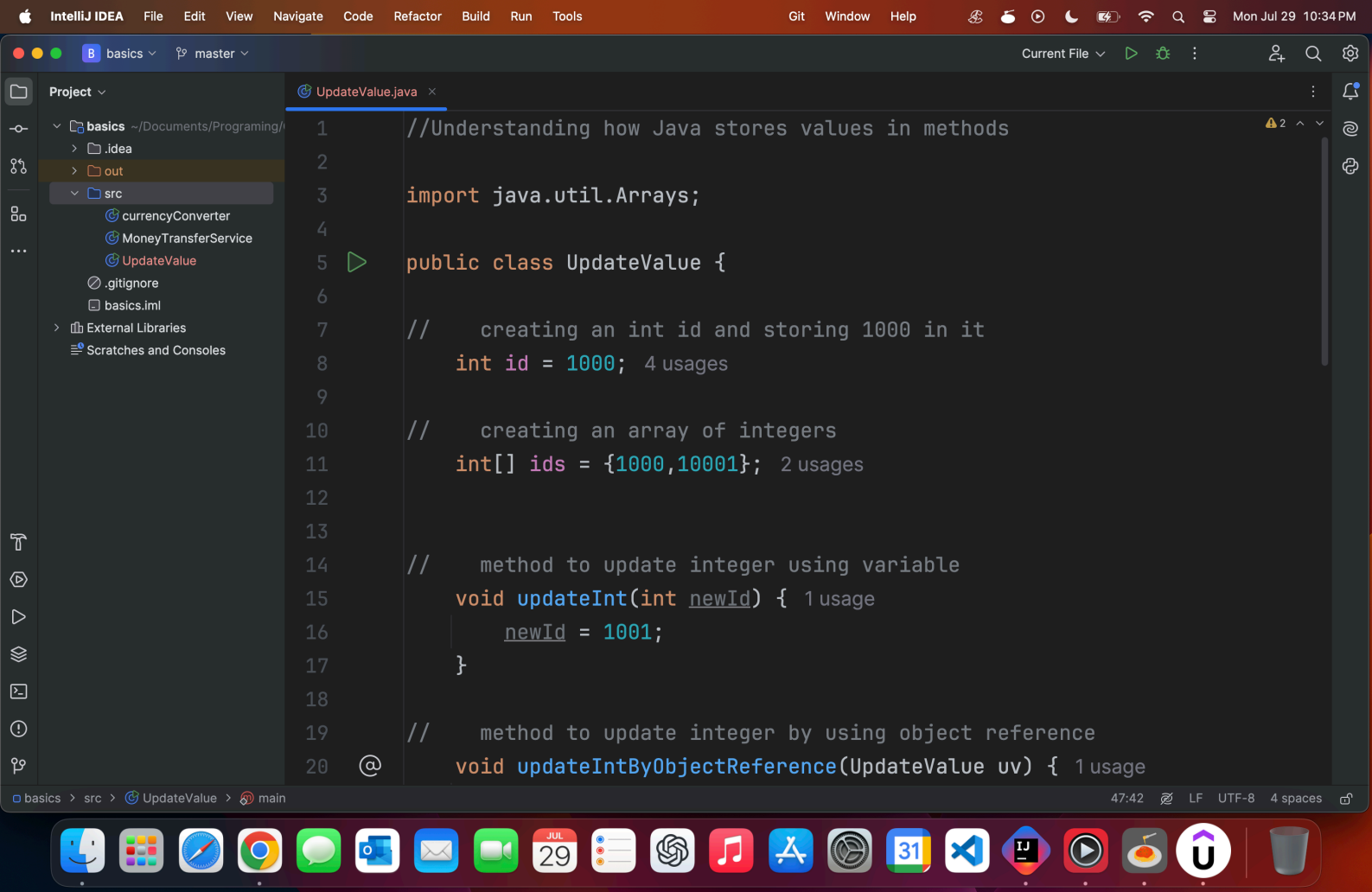
```
class Student {

    int id;

    void updateValue(Student s1){
        s1.id = 1001;
    }

Student s = new Student();
s.id = 1000
System.out.println(s.id); ⇒ prints 1001
```

→ when a primitive value is passed in a method java creates a new local variable with the copy of the value of primitive passed as argument, the local variable is then discarded. Thus, the value of primitive does not update

→ when an object reference is passed in a method it stores the memory address of the original object passed as argument. Thus, the value is updated.

→ Java is always pass by value i.e. method parameter stores a copy of the value passed in as argument.

Primitives always pass copy of the value
Object reference pass the copy of memory address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src
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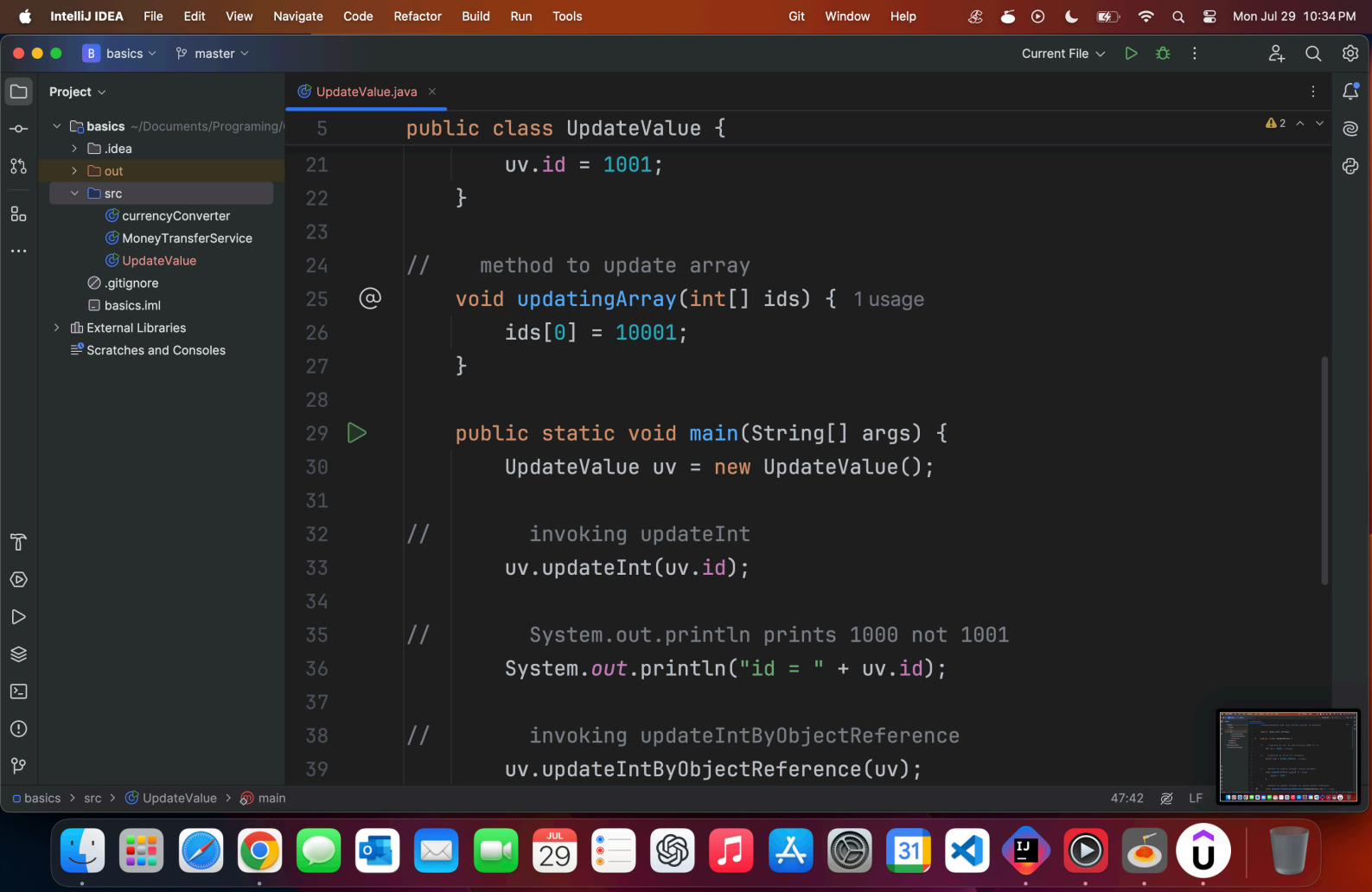
MoneyTransferService
UpdateValue
.gitignore
basics.iml
External Libraries
Scratches and Consoles
UpdateValue.java
//Understanding how Java stores values in methods
import java.util.Arrays;
public class UpdateValue {
// creating an int id and storing 1000 in it
int id = 1000; 4 usages
// creating an array of integers
int[] ids = {1000,10001}; 2 usages
// method to update integer using variable
void updateInt(int newId) { 1 usage
newId = 1001;
}
// method to update integer by using object reference
void updateIntByObjectReference(UpdateValue uv) { 1 usage
basics src UpdateValue main
47:42 LF UTF-8 4 spaces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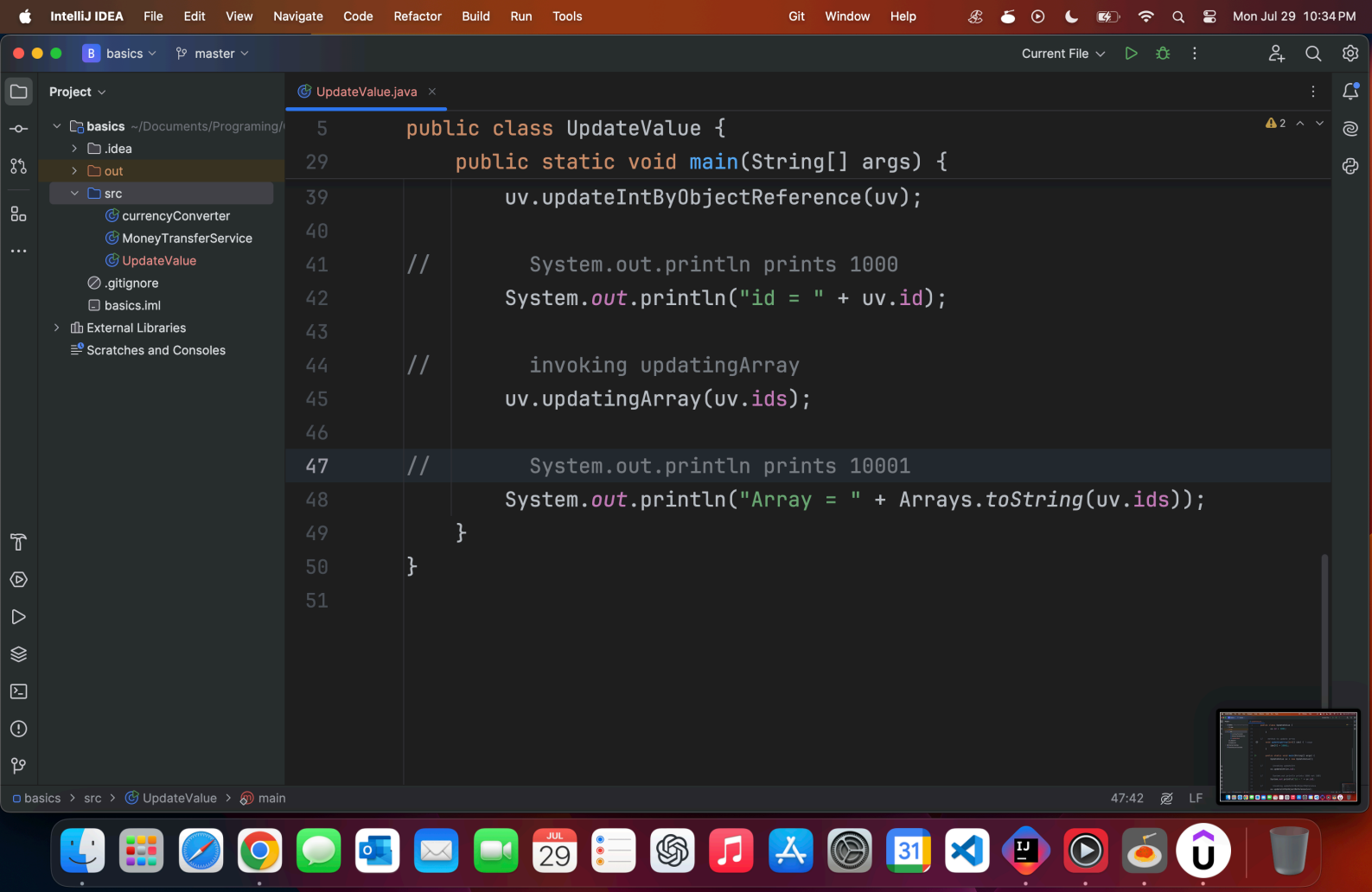
External Libraries
Scratches and Consoles
UpdateValue.java
public class UpdateValue {
uv.id = 1001;
}
// method to update array
void updatingArray(int[] ids) { 1 usage
ids[0] = 10001;
}
public static void main(String[] args) {
UpdateValue uv = new UpdateValue();
// invoking updateInt
uv.updateInt(uv.id);
// System.out.println prints 1000 not 1001
System.out.println("id = " + uv.id);
// invoking updateIntByObjectReference
uv.updateIntByObjectReference(uv);
basics > src > UpdateValue > main
47:42 LF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External Libraries
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UpdateValue.java
public class UpdateValue {
public static void main(String[] args) {
uv.updateIntByObjectReference(uv);
// System.out.println prints 1000
System.out.println("id = " + uv.id);
// invoking updatingArray
uv.updatingArray(uv.ids);
// System.out.println prints 10001
System.out.println("Array = " + Arrays.toString(uv.ids));
}
}
basics src UpdateValue main
47:42 LF

→ Method Overloading

→ In java multiple methods within the same class can have same name, but parameter list is different.

→ To overload a method we must change parameter list.

→ JVM selects the most appropriate method according to the passed argument

→ parameters, parameter types or order of parameters must change.

→ Changing only return type or making a method static doesn't work or vice versa making static instance.

→ Method overloading applies to both static and instance methods

→ Valid Examples:-

1) `void updateProfile(int newId){}`

2) `void updateProfile(int newId, char gender){}`

3) `void updateProfile(char gender, int newId){}`

4) `void updateProfile(short newId){}`

→ Invalid Examples:-

1) `boolean void updateProfile(int newId){}`

2) `void updateProfile(int Id){}`

3) `static void updateProfile(int newId){}`

→ Varargs Parameter in methods

→ varargs means variable length argument

→ It can take variable number of arguments

→ If the method has more than one parameter It has to the last parameter

→ It can be the only parameter too

→ Syntax

→ Three dots following data type.

Eg :- 1) go(int num, String name, int... items) {}

2) go(int... nums) {}

→ Invocation

→ An array or Comma sperated value can be passed to varargs.

Eg :- 1) go (new int[] {1, 2, 3})

2) go (1, 2, 3)

→ Compiler automatically converts varargs to array

→ varargs can be ommitted too.

Eg :- go ()

→ A method cannot have more than one varargs

→ A varargs parameter is simply an array but provides simpler and flexible invocation

→ Invalid varargs overload :-

```
foo (boolean, int... items)
foo (boolean, int[] items)
```

Both are same as varargs is an array too

→ In case of method overloading the method with varargs will be matched at last

→ Constructors

→ Constructors are used to initialize object state

→ Syntax

```
className (type parameter 1, type param2 ....) {
}
```

can have varargs

→ Example :-

```
class Student {
        int id;
        Student (int newId) {
          id = newId;
        }
}

public static void main (String[] args) {
        Student s = new Student (1001);
}
```

→ If class does not include constructor compiler inserts one with no parameters. This constructor is also known as no-args constructor

→ Constructors cannot return a value

→ You can invoke methods from within constructors

→ There can be multiple constructors ⇒ Constructor Overloading

→ Constructor Overloading & this invocation (this())

→ It is same as method overloading

→ methods can be created using any constructor

→ To reduce hassle of changing each constructor for small tasks we can create a primary constructor with all basic requirements and create overloaded constructor for specific task and invoke primary constructor using this();

→ this() has to be the first statement

↓

calls the constructor in case of overloaded matches the arguments and that constructor is called

→ a constructor can have only one this()

→ a this statement within a constructor cannot call the constructor in which it causes recursive invocation

↓

repeated invocation

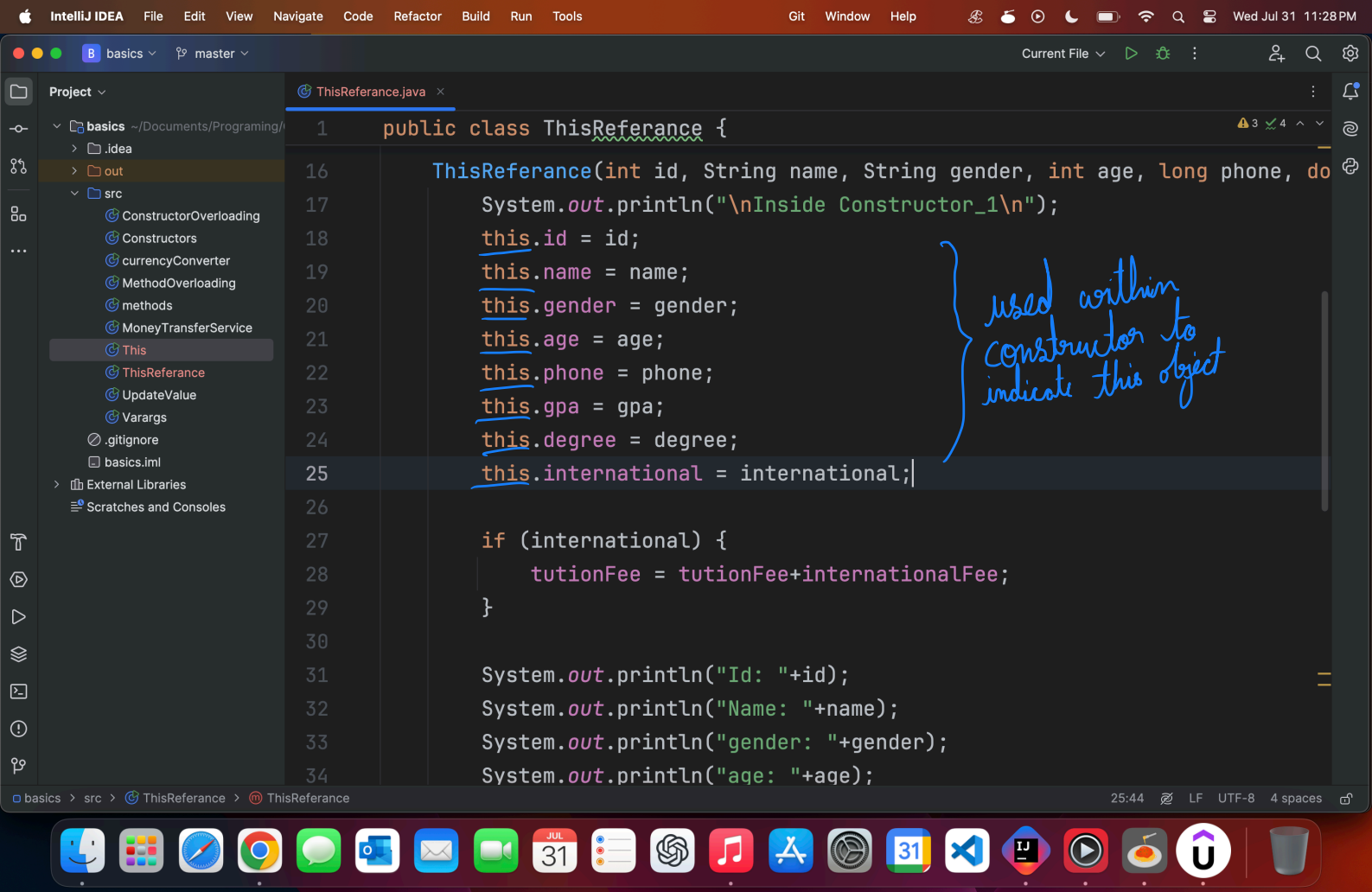
→ this statement cannot cause recursive invocation

→ this statement cannot have instance variables

→ this reference (this.something)

→ A this reference can be used inside constructors or an method to access a shadowed variable in this object.

In a method or constructor when the parameter and variable have the same name the parameter shadows or hides the instance variable as the parameter is a local variable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basics master Current File
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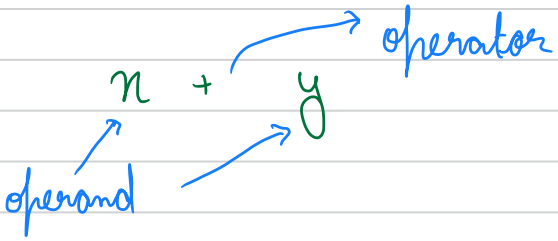
ConstructorOverloading
Constructors
currencyConverter
MethodOverloading
methods
MoneyTransferService
This
ThisReferance
UpdateValue
Varargs
.gitignore
basics.iml
External Libraries
Scratches and Consoles
ThisReferance.java
1 public class ThisReferance {
16 ThisReferance(int id, String name, String gender, int age, long phone, do
17 System.out.println("\nInside Constructor_1\n");
18 this.id = id;
19 this.name = name;
20 this.gender = gender;
21 this.age = age;
22 this.phone = phone;
23 this.gpa = gpa;
24 this.degree = degree;
25 this.international = international;
26
27 if (international) {
28 tutionFee = tutionFee+internationalFee;
29 }
30
31 System.out.println("Id: "+id);
32 System.out.println("Name: "+name);
33 System.out.println("gender: "+gender);
34 System.out.println("age: "+age);
used within constructor to indicate this object
basics > src > ThisReferance > ThisReferance
25:44 LF UTF-8 4 spaces

→ You cannot use this inside static methods as we cannot access instance variable inside static methods

→ Operators

→ Operators are symbols that perform operation on its operand and produce a result



→ There are three types of operators based on the number of operands.

1) Unary operator
   - → One operand
   - → Eg :- x++ ⇒ postincrement

2) Binary Operator
   - → Two operands
   - → Eg :- x + 3

3) Ternary operator (?:)
   - → Three operator
   - → Eg :- x > 3 ? x : 0 → executed if condition is false

Condition — Executed if condition is true

→ Arithmetic Operators

→ Addition (+)

→ int i = 5 + 2;

→ Unary plus: int i = +5;

→ String Concatination

→ Subtraction (-)

→ int i = 5 - 2;

→ Unary minus: int i = -5;

→ Multiplication (*)

→ int i = 5 * 2;

→ Division (/)

→ int i = 5/2;

→ Modulus (%)

→ int i = 5 % 2;

→ Arithmatic Operators apply only to primative numeric types

→ Pre and Post increment or decrement

→ applies to + and - only

→ ++ or --

Post: x ++

Pre: ++ x

→ Compound Arithmetic Assignment Operators

→ +=, -=, %=, /=, *=

→ Order of Precedence of Arithmetic Operators

1) Parantheses are evaluated first

2) Unary operators and increment and decrement

3) Multiplication

4) Division

5) Modulus

6) Addition

7) Substraction

→ Arithmetic Operation Rules

→ Types smaller than int are promoted to int before operation is carried.

Eg:- 127(byte) + 1(byte) → 127(int) + 1(int) → 128(int)

→ If both operands are int, float or double, then operations are carried in the same type and result will also be of that type.

Eg:- 5(int) + 6(int) → 11(int)

1/2 = 0 (not 0.5 as both 1 and 2 are int)

→ If operands belong to diff types, the smaller type is promoted to larger type.

Order of Promotion: int → long → float → double

Eg:- 1/2.0 or 2.0/1 → 1.0/2.0 → 0.5

→ Comparison Operators

→ They return true or false

- → Equal to (==)
- → not Equal to (!=)
- → Greater than (>)
- → less than (<)
- → Greater than Equal to (>=)
- → less than Equal to (<=)

→ Logical Operators

- → AND (&&)
- → OR (||)
- → NOT (!)

Short-Circuit Operators

→ AND (&&) → if left operand is false, returns false

→ OR (||) → if left is true, returns true

↓

If either of these case are true java doesn't check the other condition

→ due to && being a Short-Circuit Operator it helps in preventing NullPointerException

↓

When we try to access a variable of a null object reference. It stops program execution

→ Logical Operators Precedence Order

1) NOT (!)

2) AND (&&)

3) OR (||)

NOT (!) > Arithmetic Operators > Comparison Operators > AND (&&) > OR (||)

5000, 2, F, T, T, F, F, F

→ Bitwise Operator ⇒ Imp in DSA (Hash tables)

→ Works with individual bits of its operands

(1) Among bitwise operators, only &, |, and ^ can be used with boolean operands. **Bitwise NOT (~) will not even compile with boolean.** If we need such a behavior, then we would use **logical NOT (!)** operator, which we discussed in Logical Operators lecture.

(2) Also, strictly speaking *to be consistent with the Java Language Specification (JLS)*, the operators &, | and ^ when applied on ***boolean*** operands are referred to as **logical operators** and not bitwise. In other words, the operators &, |, ^, ~ are referred to as *bitwise* **ONLY** when they are applied on **integer operands** and this is the common scenario as we discussed. Also keep in mind that the logical operators && and || have the short-circuit property due to which JLS refers to them as **conditional AND** and **condition OR** respectively. With & and |, as discussed in the lecture, they do not have the short-circuit property, i.e., they always force JVM to evaluate both operands.

→ Bitwise AND (&)

→ Returns 1 if both input bits are 1

→ Bitwise OR (|)

→ Returns 1 if one of the input bits are 1

→ Bitwise XOR (^)

→ Returns 1 only one of the input bits is 1

→ Bitwise NOT (~)

→ Inverts bits

→ Bitwise assignment

→ &=

Eg:- boolean b = true;
b&= false;

→ |=

→ ^=

→ Bitshift Operators ⇒ Imp in DSA (Hash tables)

→ Works with individual bits of Operands

→ Shifts bits

→ Left-shift (<<)

→ Left shifts bits by # bits specified on right

▸ Example

6 → 00000000 00000000 00000000 00000110
6 << 1 → 00000000 00000000 00000000 00001100 → 12

→ Inserts zeroes at lower-order bits

→ Same as multiplying by powers of 2

Eg:- $6 << 1 \rightarrow 6 * 2^1 \rightarrow 12$
$6 << 2 \rightarrow 6 * 2^2 \rightarrow 24$

→ Unsigned Right-Shift (>>>)

→ right shifts bits by # bits specified on right

→ Inserts zeroes at higer order bits

▸ Example

12 → 00000000 00000000 00000000 00001100
12 >>> 1 → 00000000 00000000 00000000 00000110 → 6

→ Same as division by powers of 2

Eg:- $12 >>> 1 \rightarrow 12/2^1 \rightarrow 6$
$12 >>> 2 \rightarrow 12/2^2 \rightarrow 3$

→ Signed Right Shift (>>)

→ Same as >>>, but padded with MSB

due to which sign is preserved

▸ Example

-2,147,483,552 → 10000000 00000000 00000000 01100000
-2,147,483,552 >> 4 → 11111000 00000000 00000000 00000110
(-134,217,722)

→ Control Flow Statements

→ They do not require ; at the end of the block.

→ The statements inside control flow block require ;

→ If the statement is of one line {} is optional

↓

but always use {}

→ If there are statements after return in a block they become unreachable

→ Code in Github with Explaination

→ Switch block restrictions

Eg:-

```
switch (month) {                    → selector expression
    case 1 :
        ....
        break;
    case 2 :
        ....
        break;
    case 3 :                        → case labels
        ....
        break;
    :
}
```

→ The selector expression can be an int, byte, short, char, string, enum or any object reference.

→ Value of Case label should be known at compile time

→ The case label should be in range of data type of selector expression

→ Case label should be unique

→ Arrow Labels