Object oriented programming

- Introduction:

- Data and operators form a "class"

- But, class is abstract. We need objects to make any class functional.

- Theory, Java execution, multithreading, GUI and networks
  ↳ Both console based, GUI aka socket based

- Hello world program:

command line arguement

```
public class Demo {
public static void main (string args[])
{
 system.out println ("Hello world");
}
}
```

Everything (including main) is inside a class.
↳ Java is purely object oriented.

- To run/compile:

① Save the file as filename.java

② javac Demo.java (compilation)
↓
on successful compilation, a class called Demo is created.

③ java Demo (execution).

On saving, file name is that of that "class" if keyword is public.
↳ So make sure execution is appropriately named.

*** Procedure-oriented programming:** what to do

- List of instructions (in order)
- Eg. C, FORTRAN
- Divided into functions → which are accessible
- Data can be local/global
- Drawbacks:
  - Functions are reusable (only!)
    (In OOP, entire code itself is reusable)
  - Top down approach is used.

*** Object-oriented programming:** How to do

- Focus is on process rather than procedure
- Bottom top approach.
- Object : attribute + data } instance of class = obj
  $\downarrow$
  operation
- Class is abstract → so instances are created for use in program

- Class :
  - user-defined data type → inside which there are primitive datatypes
    (≈ structure, but we get to add ops. as well)

  - Eg: class car

```
{
  int price;          }  member
  string colour;      }      variable
  string brand;       }
  accelerate();  }        member
  break(); }     }  →  Functions
```

- general format for defining object : car obj

- Member functions only have the access to member variables], Like, external functions can access member variables thro' member fns. {only}
  ⇒ Data encapsulation

- Abstraction can be done using encapsulation
  ↳ hiding unnecessary details

- Inheritance : Deriving characteristics from a "super" class/ parent class → the attributes and methods basically.
  (Both parent/ grandparent)
  Only public/ protected variables are inherited
  (Not private variables).
  Types:
  ① single - one class

② Heirarchical : $A \rightarrow B \rightarrow C$

③ Multiple : $$\begin{tikzcd} A \arrow[r] & B \arrow[r] & C \\ X \arrow[ur] & & \end{tikzcd}$$ } Not supported by Java

④ Multi level : $$\begin{tikzcd} A \arrow[r] \arrow[d] & B \\ C & \end{tikzcd}$$

- Polymorphism : one fn. will act in diff. forms.
Eg. operator overloading (fn. too)
↳ Not supported in Java.
can be runtime / compile time
Basically Java removed ambiguities in C++

- Dynamic binding : late binding ; compilation during runtime

- Message passing ⇒ convo betn objs.

Stages in development :
↓

Software development lifecycle:

$$\begin{tikzcd}
\text{Requirement} \arrow[r] & \text{Analysis} \arrow[r] & \text{Design} \arrow[r] & \text{Implementation} \arrow[d] \\
 & & & \text{coding} \arrow[d] \\
 & & & \text{testing}
\end{tikzcd}$$

(UML class / object / activity / sequential / collaboration)

Note: common noun → class
proper noun → object
adjectives → attributes
verbs → methods / functions

} Techniques to identify

① "part of another class" → aggregation → A✗, B survives

Eg:

```
class A:                                  class B:
{                                         {
    int i; } primitive datatype               :
    int j; }
    obj B; } complex datatype             }
```

}

② composition: completely dependent on another class.
On deleting A, B dies as well.

③ Inheritance:
Eg:

Person {name, dob, ... }

$$\begin{tikzcd}[column sep=small] & \text{Person} \arrow[dl, dash] \arrow[dr, dash] & \\ \text{Student} & & \text{Staff} \end{tikzcd}$$

Student {etc.}   Staff {etc.}

Analysis and Diagram:

Proper noun	common noun	Adj.	verbs
zonal head off.	Bank	savings	open-specification
acc.,	Branch	current	
loans	zone		loans
	Account		

classes:

Bank

Role → head, normal

customer

Account → curr. ↘ savings

loans

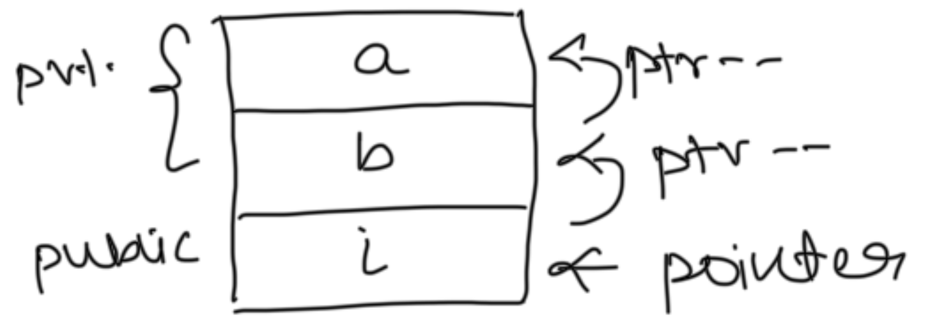
object oriented programming:

- Java is more of a correction / modification of C++
- Pointers are eliminated in JAVA
- satisfies all five major OOPS concepts.
- The byte code after compilation is platform-independent
- constructor → constructs the object and destructor → destroys objects

In C++ objects must be destructed manually
In Java, there is automatic garbage collection

- Error prone features like multiple inheritance (in C/C++) is abolished in Java. (not directly atleast)

- Java is more secure as compared to C++
  ↓
  C++ allows pointers:



Private variables accessed thro' public variable's pointers.

- Similarly, Java also provides virus protection by sacrificing its JRE (Java Runtime Environment)

- "simultaneous" → but @ one instant of time, only one program will run.

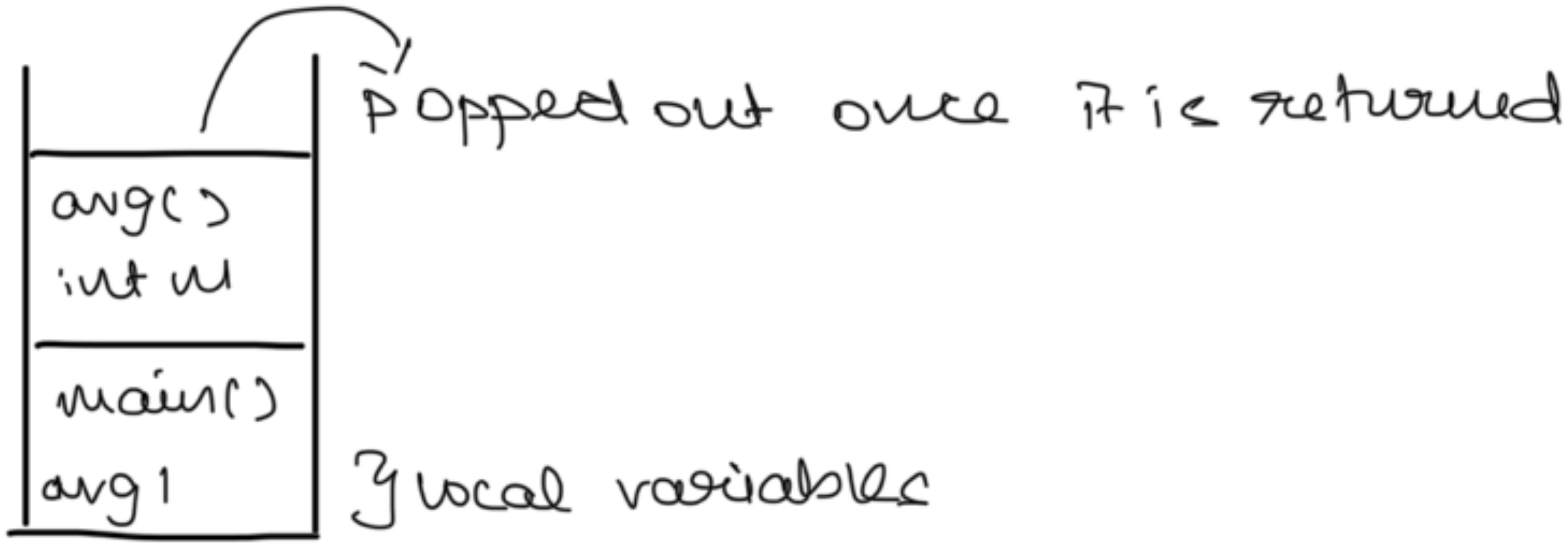
- JDK - Java Development Kit

Stack memory:

Eg.
```
main()
{
   avg();
   int avg1;
}

avg()
{
   int n;
}
```

Stack memory : static



Stack overflow occurs if program is not written properly.

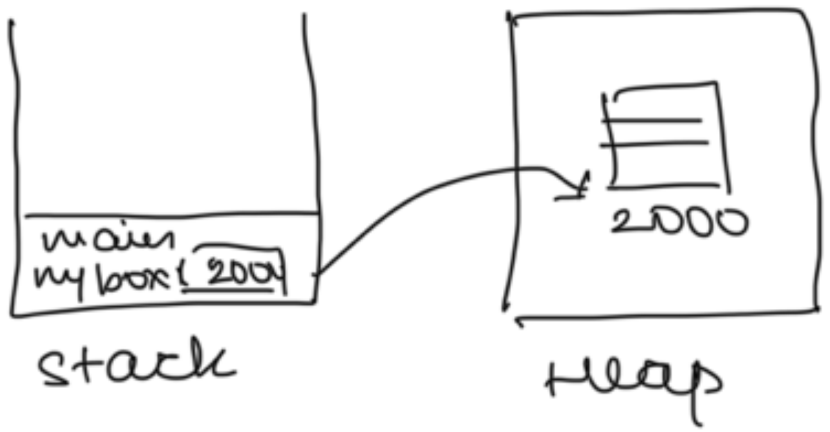
Heap memory: dynamic

Heap overflow occurs if program is not written properly. → in C++ esp. when prog. is not destructed properly

Object creation in Java:

Box mybox1;
mybox1 = new Box;

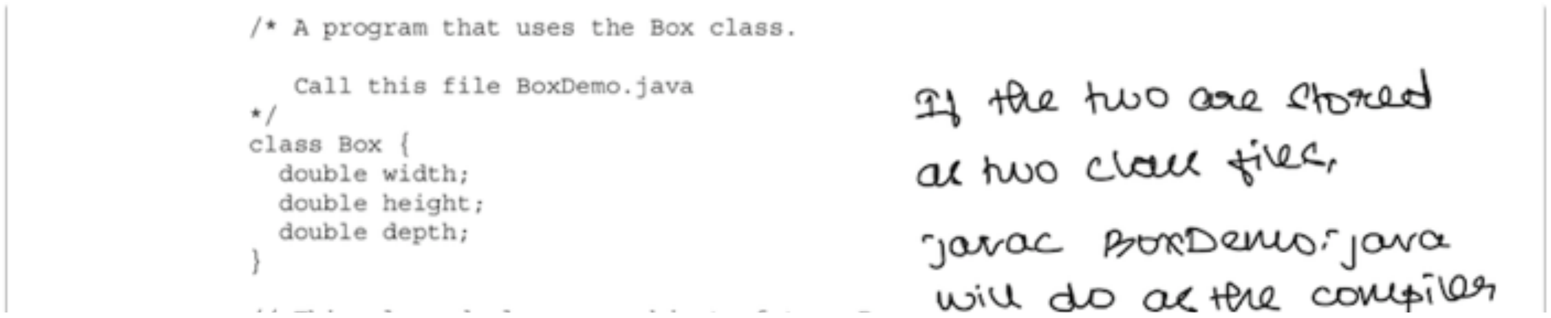
Memory:



Stack → local to a particular fn.

Separate space to access global/static variables
↳ accessible to everything

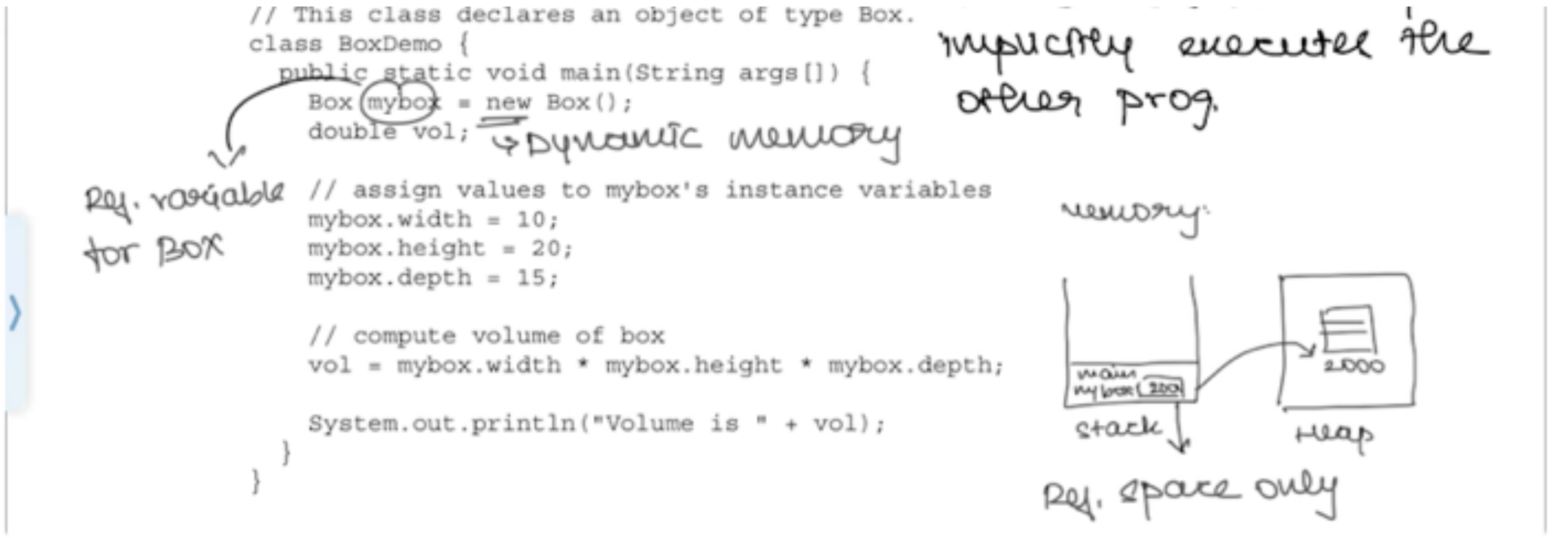
Here, say we declare width as static:



```
/* A program that uses the Box class.

   Call this file BoxDemo.java
*/
class Box {
  double width;
  double height;
  double depth;
}
```

If the two are stored
as two class files,
javac BoxDemo.java
will do as the compiler



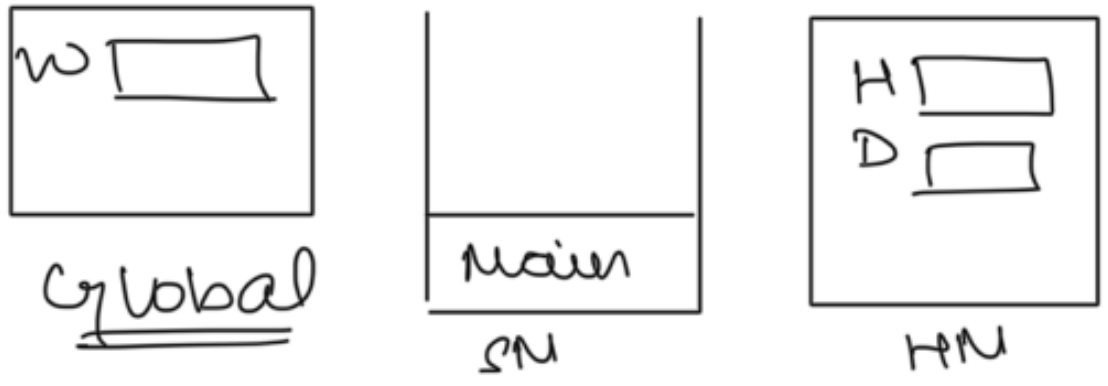
```
// This class declares an object of type Box.
class BoxDemo {
  public static void main(String args[]) {
    Box mybox = new Box();
    double vol;

    // assign values to mybox's instance variables
    mybox.width = 10;
    mybox.height = 20;
    mybox.depth = 15;

    // compute volume of box
    vol = mybox.width * mybox.height * mybox.depth;

    System.out.println("Volume is " + vol);
  }
}
```

Here, irr. of no, only one W => last given value is taken



static variable = Class variable (Not specific to object as opposed to instance variables).

Keywords:

* JRE itself cannot access private classes. hence: "public" part of main.

* It has to be static so that JRE does not

have to create a separate memory space/ alike each time. → class variable ↓
(Not specific to obj, specific to class)
other variables:
obj vari / Instance vari

* void → return type

* String args [ ] } CL Arguement. stored in the format of String array.
↓
variable name

* System.out. println
↳ Method

Inside lang package (comes by default)

↓
println is inside a predefined keyword: inside a class "output stream" → out is an instance of this class.

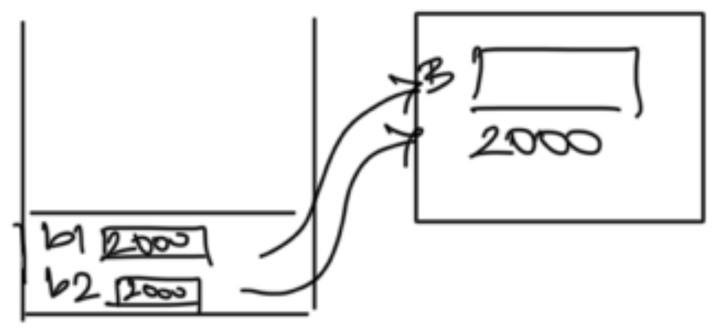
"system" can refer to any computer/ printer/ etc.
↳ to designate that it is a system basically.

Everything in Java is in a class!

Qn:

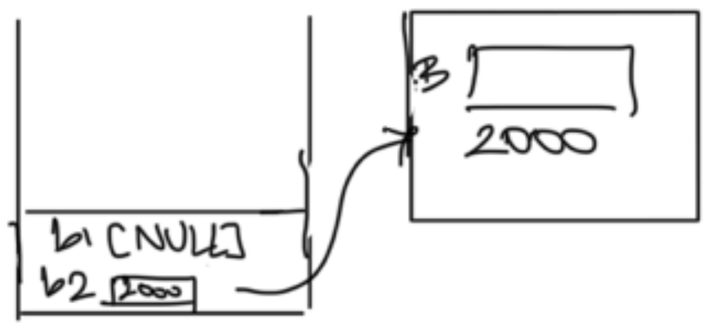
```
Box b1 = new Box;
Box b2 = b1;
```

one more copy will <u>not</u> be created.



(points to the same box)

Following this, if b1 = null,



Even if b2 = NULL, the object will still be in heap memory → automatic garbage collection will take care of it.

* Association :

(i.) Simple / Regular

(ii.) Aggregation
Class 'car' has an object of class 'Engine'

(iii.) Composition / whole - part relationship
On del. one, the other gets deleted as well.
(whole) (part)

* Inheritance :

Inheriting char. ≠ Aggregation

* Dependence :

Execution of one class is dependent on another

Remove my box → Address / ref. is test.

Note :

demo.java → filename

```
class A
{

 }
```

javac Demo.java → compile
java A → run

But, if access specifier is "public", filename must be equal to class name.

Advised to have filename and classname same

Method signature → Gives the return type of fn. and other details

fr

Ex. that method throws.
↓
Links different points of the code

Note:
this: my currently active instance.

Anonymous classes can be created in Java.

Class name → caps for every word.
Eg.
String, Float, String1
↓ ↓
Naming convention.

Method name: getName

Qn.: Write a java program to create class called "TrafficLight"
with attr. for colour and duration and

methods to change the colour and check for red/ green.

```
public class TrafficLight

{
    public String colour;
    private int duration;

    public String change-clr (String colour)
    {
        this. colour = colour;
        system. out. println (colour)

    }

}

public static void main (String args [])
```

```
{
    TraffLight obj = new Trafflight;

    System.out.println(Enter colour);

    // get input from user and pass to fn.

}
```

Qn: write a program to create a class called employee
↓
with name, job title and salary attbr.
methods to calc. and update sal.

```
Public class Employee

{
    private String name;
private string job;
private double sal;

public void get_sal (double sal)
{
    this. sal = sal
}
```

By default, java does pass by reference.

one for each → stk. frame

$\underbrace{\text{Box}}$ $\boxed{b}$ = new Box(); //Does the memory allocation

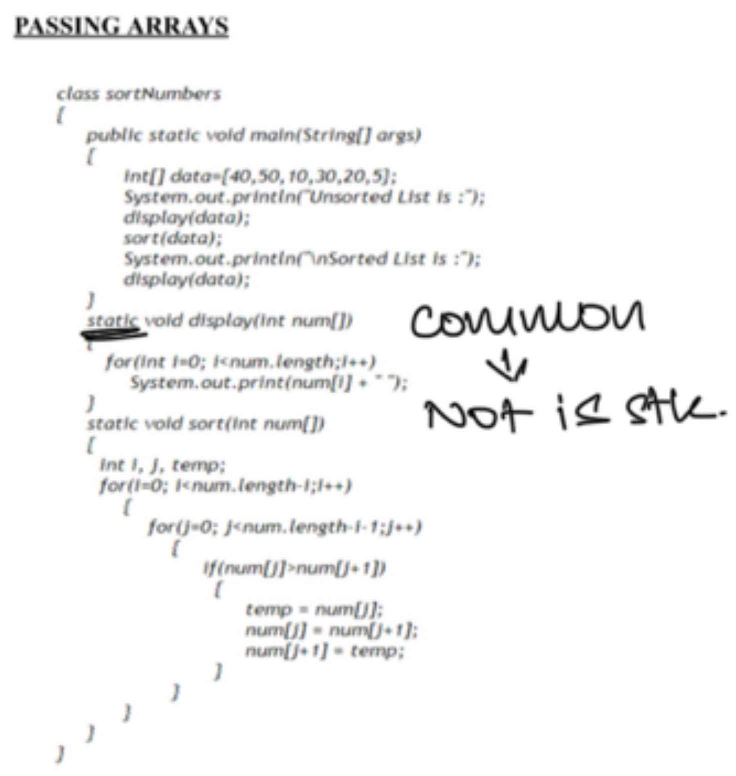
↳ Ready to store address of box variable

user def. complex datatype.

similar to int *i in C where i stores address of integer

- Array in java:

int a[] = new int[10]



PASSING ARRAYS

```
class sortNumbers
{
    public static void main(String[] args)
    {
        int[] data={40,50,10,30,20,5};
        System.out.println("Unsorted List is :");
        display(data);
        sort(data);
        System.out.println("\nSorted List is :");
        display(data);
    }
    static void display(int num[])
    {
      for(int i=0; i<num.length;i++)
         System.out.print(num[i] + " ");
    }
    static void sort(int num[])
    {
      int i, j, temp;
      for(i=0; i<num.length-i;i++)
         {
            for(j=0; j<num.length-i-1;j++)
               {
                  if(num[j]>num[j+1])
                   {
                        temp = num[j];
                        num[j] = num[j+1];
                        num[j+1] = temp;
                   }
               }
         }
    }
}
```

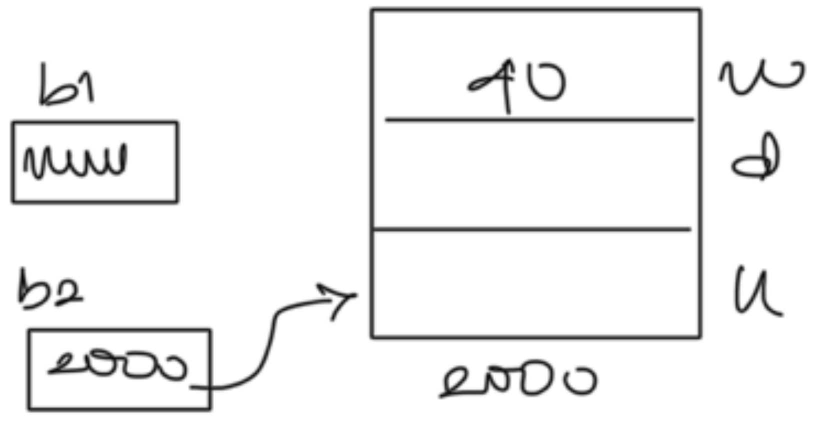
common
↓
Not is stk.

Box b1 = new Box()

Box b2 = b1

b1. width = 20

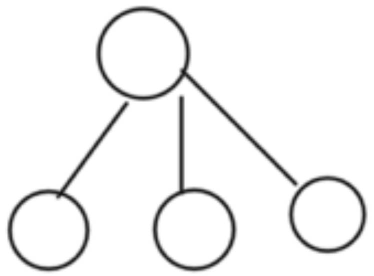
b2. width = 40



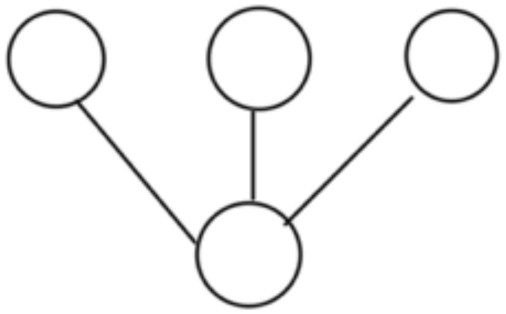
b1 = null

s.o.p. (b2.width) // Prints 40

One parent can inherit more than one child.

↳ 

However, multiple inheritance can be achieved using interface.



} using interface.

- super/this cannot be used inside 'static method'.

- super class ref. variable can be used to ref. subclass object.

- Aggregation: a class has the object of another class as its own attr. / member

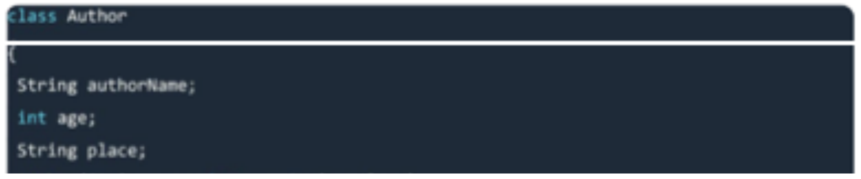
whole → one that is holding.

when whole is del, part is also del → composition
part is not del → Aggregation.

(ref. to object)

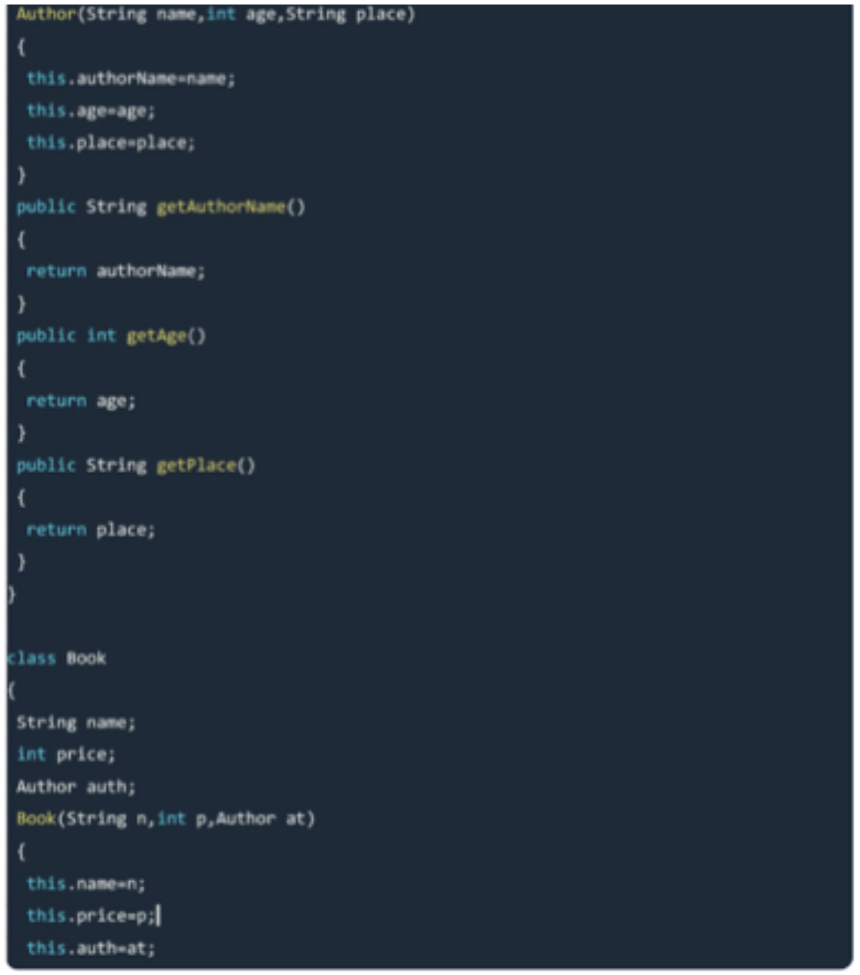
Modifying code

-



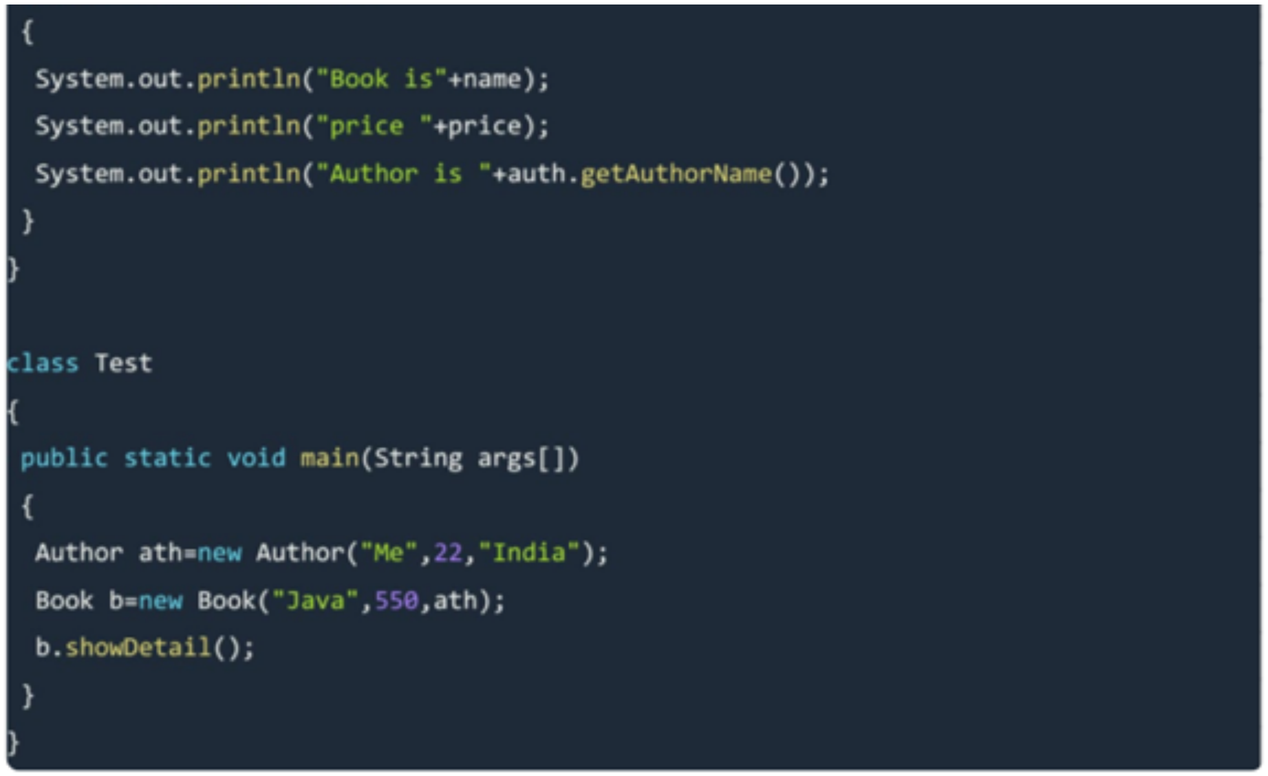
```
class Author
{
 String authorName;
 int age;
 String place;
```

```
}
public void showDetail()
```



```
Author(String name,int age,String place)
{
 this.authorName=name;
 this.age=age;
 this.place=place;
}
public String getAuthorName()
{
 return authorName;
}
public int getAge()
{
 return age;
}
public String getPlace()
{
 return place;
}
}

class Book
{
String name;
int price;
Author auth;
Book(String n,int p,Author at)
{
 this.name=n;
 this.price=p;
 this.auth=at;
```



```
 {
  System.out.println("Book is"+name);
  System.out.println("price "+price);
  System.out.println("Author is "+auth.getAuthorName());
 }
}

class Test
{
 public static void main(String args[])
 {
  Author ath=new Author("Me",22,"India");
  Book b=new Book("Java",550,ath);
  b.showDetail();
 }
}
```

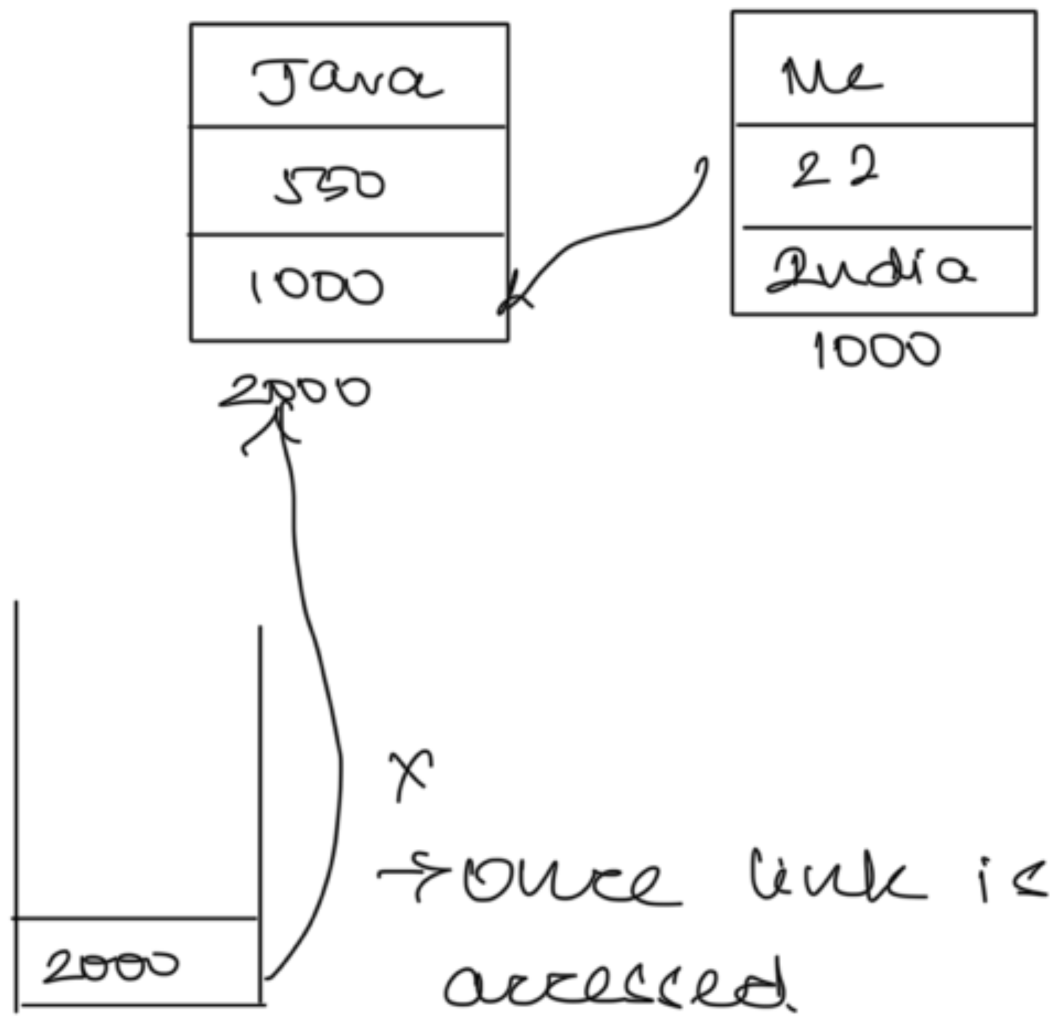
Two ways: change auth to NULL each time book is NULL.

```
Book (string name, int price, string authorName,
int age, string place)
{
    this. name = name;
    this. price = price;
    this. auth = new Author (authorName, age, place)
```

}

// Then author class is the same.

Before, loc in stack memory; now in heap:



→ Once link is cut, 1000 cannot be accessed.

Method overloading is possible in parent-child as well.

[class is abstract; obj. is only real]

Abstract class has abstract method

↓

Method w/o body : only method signature.

↓ uses

complex data type defn.

Local - no init; instance - init to 0

copy constructor ⇒ copy the constructor details.

shallow - ref. for something existing already

deep copy - separate obj. one created.

== checks for address } check:

equals checks for values

equals checks for values. }

' ' ⇒ treated as a character with ASCII value 32.

Anonymous object → no ref → so anon.

null + string = nulal.

Built in string class has constructor overloading
↓
Accepts various constructors of strings.

java api → api doc. of all classes in java.

Uneven arrays are possible.

Main can be overloaded } But JRE accesses one with string only.

super: accesses super class variables of immediate parent.

import.util. Scanner
↓
Built-in package

Include the line } : package (name);
as the first one } (code)

accessing: package.name.classname

```
compilation: javac /com/example/HelloWorld.java
```

```
Interpret: java com.example.Helloworld
```

(OR)

```
Javac -d <target-dir> <source file>
```

No modifier: package private.

import mypack.*

No specific qn. on packages.

Abstract method ⇒ defines method signature

Interface facilitates multiple inheritance

$$\begin{tikzcd}
A \arrow[d] \\
B \arrow[d] \\
C
\end{tikzcd}$$

Multilevel inheritance

$$\begin{tikzcd}
A \arrow[dr, dash] & B \arrow[d, dash] & C \arrow[dl, dash] \\
& D &
\end{tikzcd}$$

Multiple inheritance
(Not possible dir. in Java)

A

$$\begin{tikzcd}
 & \text{show() A} \arrow[dl, dash] \arrow[dr, dash] & \\
\text{show() B} \quad B \arrow[dr, dash] & & C \arrow[dl, dash] \quad \text{show() C} \\
 & D &
\end{tikzcd}$$

```
D obj = new D()

obj.show()
```

Ambiguity
(exists in C++)

Diamond
problem

Inheritance from multiple classes ✗ interfaces ✓

So, it now becomes D's responsibility.

Rewriting is compulsory (even for ones you do not need)
+ addn' methods if needed.

So, use do-nothing methods here.

Otherwise, compilation errors.

Eg. show (super/ callback ( ))
{

```
}

}

obj. show (client)
obj1. show (emp)
obj2. show (stu).
```

First extends then implements.

Interface methods → pub, abs.

Default → package pvt.

superclass → looks for immediate parent.

Anonymous obj → no ref.

Pass by ref.

[illegible]

File permission class must be activated
↳ security related file op.

Collection framework: storing (programming without API).

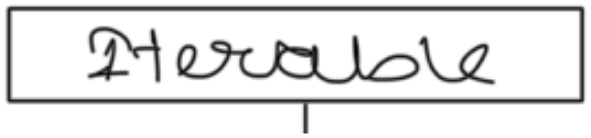
Collections in Java:

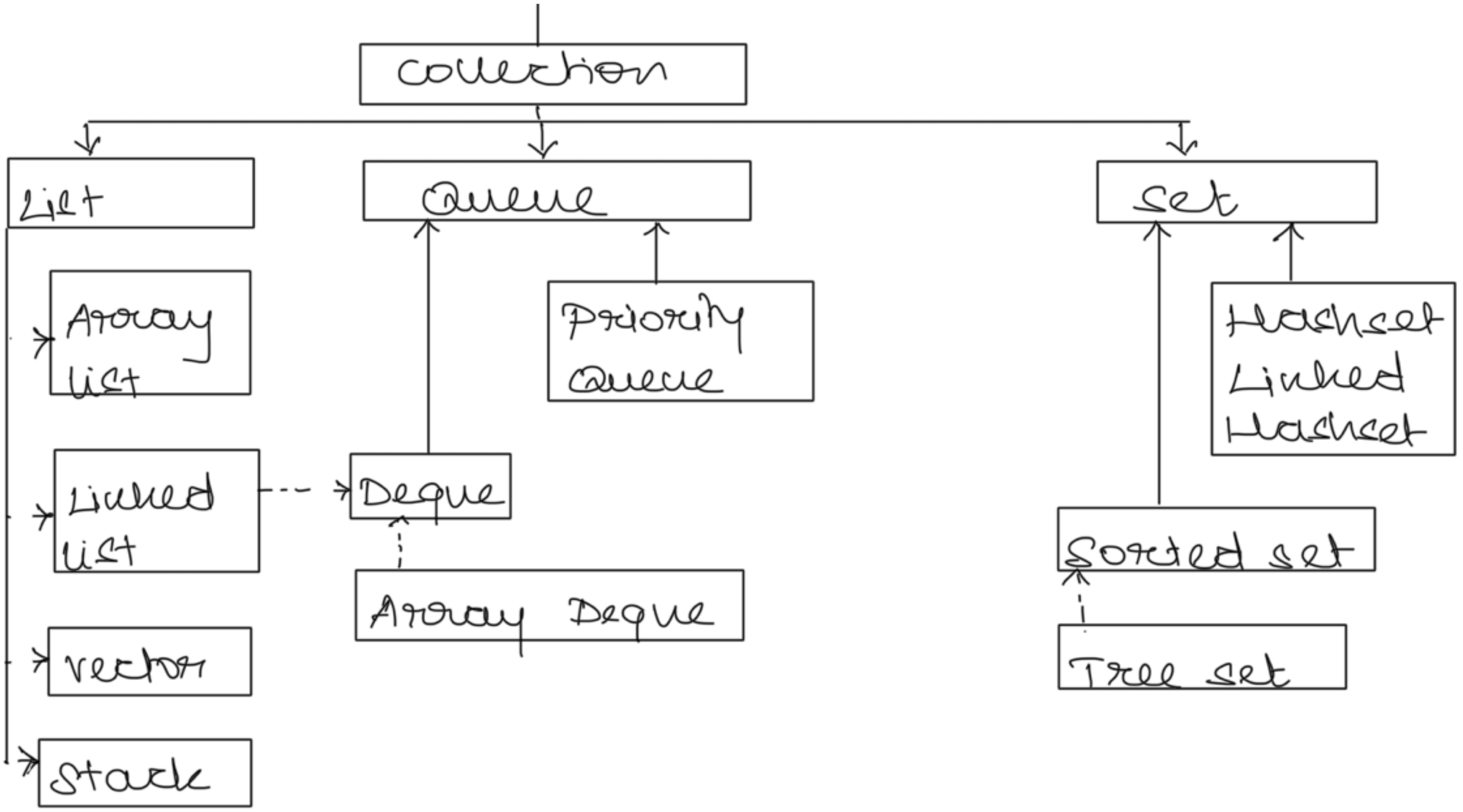
- storage and manipulation of data.

- Collections: single unit of objects. } objects array
  ↳ received as obj. type
  ↳ superclass

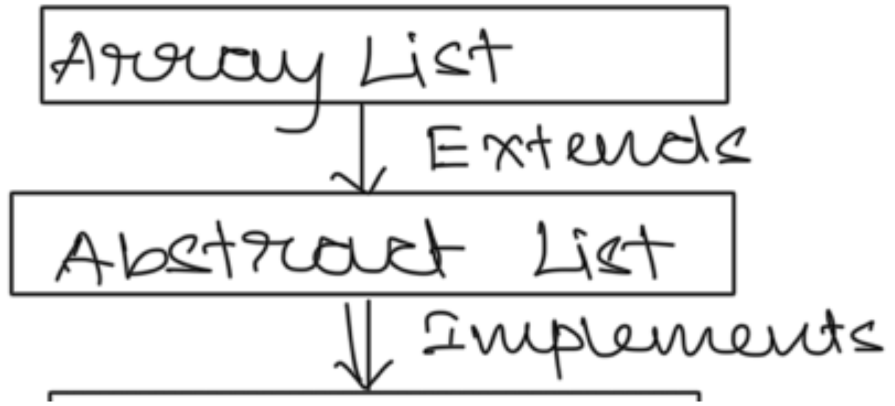
- Java collections has many interfaces: Set, List, Queue, Deque

☆ Hashtable, vector, stack, array, list and linked list





Representation Diagram



$$\begin{tikzcd}
\boxed{\text{List}} \arrow[d, "\text{Extends}"] \\
\boxed{\text{Collection}} \arrow[d, "\text{Extends}"] \\
\boxed{\text{Iterable}}
\end{tikzcd}$$

Generic class / Datatype
↓
Collection<? extends E> c

V → value ; K → key ; E → Elements in collection.

Note :
E : Type of element the linked list can hold.

Generic : Only elements of a particular type can be added to it; reducing the need for typecasting while retreiving elements.

Wrapper class and autoboxing

[illegible]

↳ create class and interface/methods.

Eg :

```
class Generic_Class <T> {
//variable of type T
private T data

public Generic_class {
    this.data = data;
    }

Generic_Class <Integer> int Obj = new
Generic_Class <> (5)
```

$\downarrow$

An integer has been passed as input.

Wild cards in Generics:

[illegible]

- Allows flexibility while dealing with unknown types.

◦ Unbounded wildcard	◦ Upper Bounded wildcard	◦ Lower Bounded wild card
<?>	<? extends type>	<? super type>

public void pC (collection <?> collection)
 	
for (Object : item)
	public void pN(list <? extends Number> list)	public void aN (List <? super Integer > list) {
		list.add (10);
		list.add (20); }

```
public class higher
{
  public void logEle (List <?> elements) {
      for (Object element : elements) {
      s.o.p. ("Logging:" + element);
    }
}
```

Iterators and hash methods : . x .

↳ list iterator is useful in traversing different elements.

↳ Methods in an iterator: hasNext(), next(), remove

Main collection	D	O	S	TS
ArrayList	✓	✓	x	x
Linked List	✓	✓	x	x
Vector	✓	✓	x	✓
Hashset	x	x	x	x
LinkedHashset	x	✓	x	x
Treeset	x	✓	✓	x
HashMap	x	x	x	x

Applets: GUI in Java } interface between logic and users.

<applet code = "Filename" >

component → container → panel → applet

Methods in applet : init(), start(), paint(),
stop(), destroy()

↓

must be overridden based on their functionality.

awt → abstract window tool

g. drawString ("A First Applet", $\underbrace{50, 100}_{\text{x and y}}$)

java api → graphics → drawing rectangle/circle/...

setBackground / foreground → in superclasses.
Color ⇒ class
↳ Red: predefined (final) in colour class

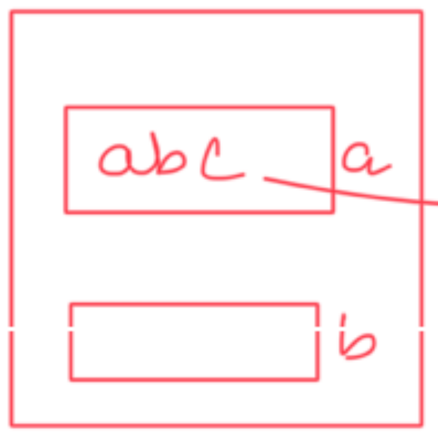
Methods → camel case $(ff)_{16} = (255)_{10}$

repaint() → calls paint() method one more time

destroy() ⇒ for finalize.

showStatus() to display in status bar

<PARAM Tab>
↳ request.getparam (variable name)
↳ value of variable entered



gives this

Here param is used in the same applet

Integer.parseInt ⇒ str to int.

Event Handling :

who generates the event will not handle that's why

Delegation event model

Events — Click of a mouse / particular item

Event object — The source object will not handle
The Listener object will handle the
event.

Event source → generates event

"Delegation event model" → source does not handle.

Add → to container obj.

"Type" → must be added

After reg. start. → registration for event listener

class A implements "Listener"
↳ whichever listener interface
Eg. Mouse, key

→ Define methods
Eg. Mouse click method

"Action Listener" → interface
getActionCommand, getSource
...several constructors
here
→ Action performed
then here

Steps: Implement → Define ALL the methods
→ Req. ones + Do nothing for others.

without "b" → recognized thro'out applet "this" → current event is recognized."

mouse is moved → mouse entered is triggered

Only the applet area is checked for mouse movement.

In case of applet, there are file restrictions
↳ "swing"

Form → logic to create object → write to file
(Front end)

Press → release → click.

Event source → Object
Add to container ⇒ Applet/panel, ...
Register to corresponding typelist → addMouseListener(this)
Implement method in listener interface.

↳ Steps to be followed

Adapter class:

↳ To avoid the do-nothing functions.
↳ use req. methods.

But it is a class ⇒ so extends applet and adapter class → not easy.

(Many interfaces can be implemented).

Anonymous class → for use in only one location
Obj. of inbuilt class itself.

'this' → recognizes all mouse-related activities
→ part. class → only that.

Swing → psvm → 'J'

↳ no life cycle.

Flow layout → same order → . set layout

Remove J for applet.

Create Event Source
Add Event Source
Register to Event Listener
Implement Methods.

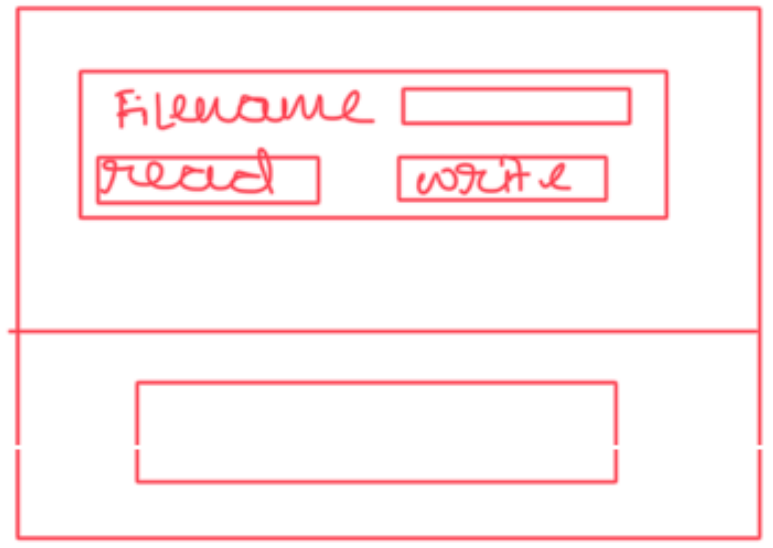
Anonymous class → (new Wadap( )) ↱ class defn. is given here

Layout for container classes.

// with this also.
↳ No adapter class here

Wrap: next line

"North" → north side of frame

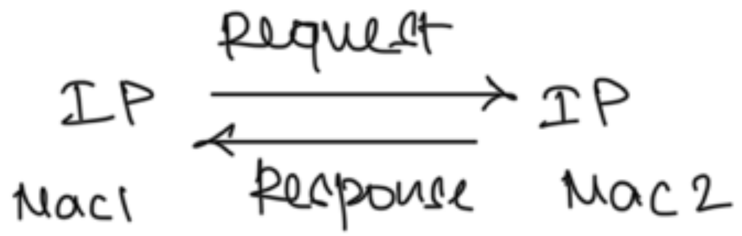


Source → button
command → on top of it

return byte → readline()

Network: more than one node is connected with each other

IP address → identify computer → unique
↳ to know who is being contacted



port number → identifies which run in the machine
IP address → identifies which machine

Socket: End pt. of communication → where info can be read / written.

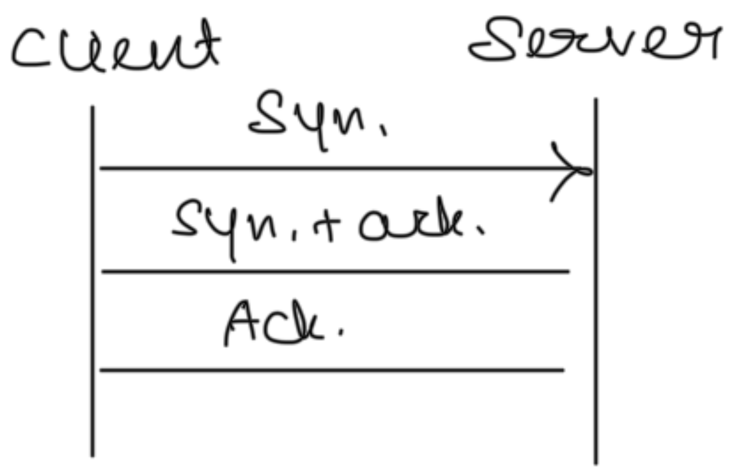
InetAddr : object with IP addr.
↳ Has many methods to create.

New keyword is not used
↳ constructor × } for obj. creation
Method ✓ }
↳ in that class

∴ Method ⇒ factory method

Factory methods are all static methods (converse is not true.)

Java Socket Programming



"Three-way handshake".

Loading...

running modified by any LOC → "volatile".