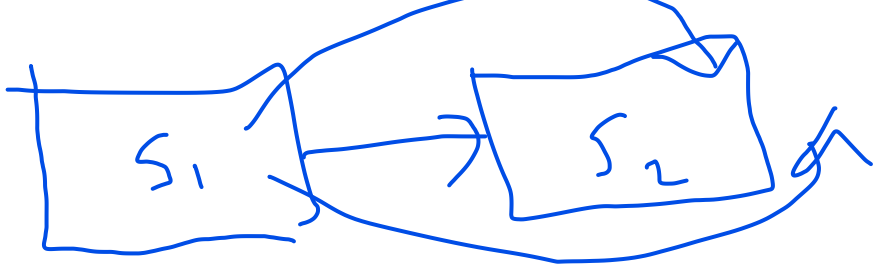
Inheritance in Java



Inheritance in Java is a mechanism in which one object acquires all the properties and behaviors of a parent object. It is an important part of OOPs (Object Oriented programming system).

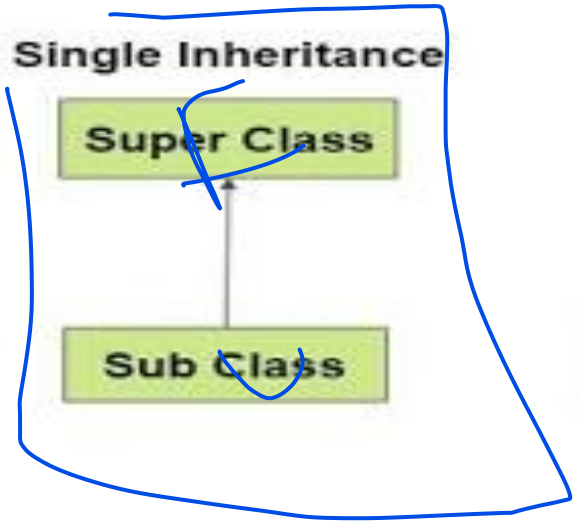
Why use inheritance?

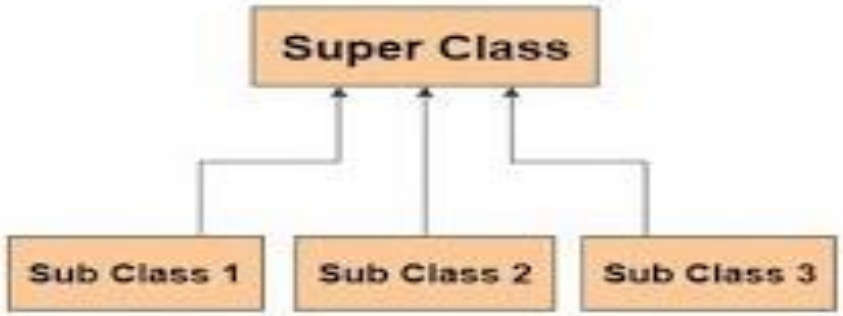
- For Method Overriding (so **runtime polymorphism** can be achieved).
- For Code Reusability.

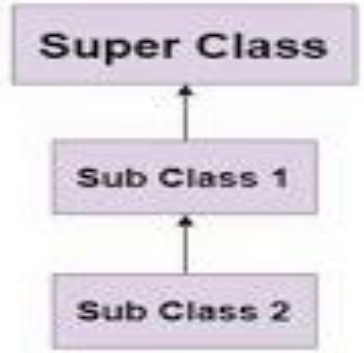
Terms used in Inheritance

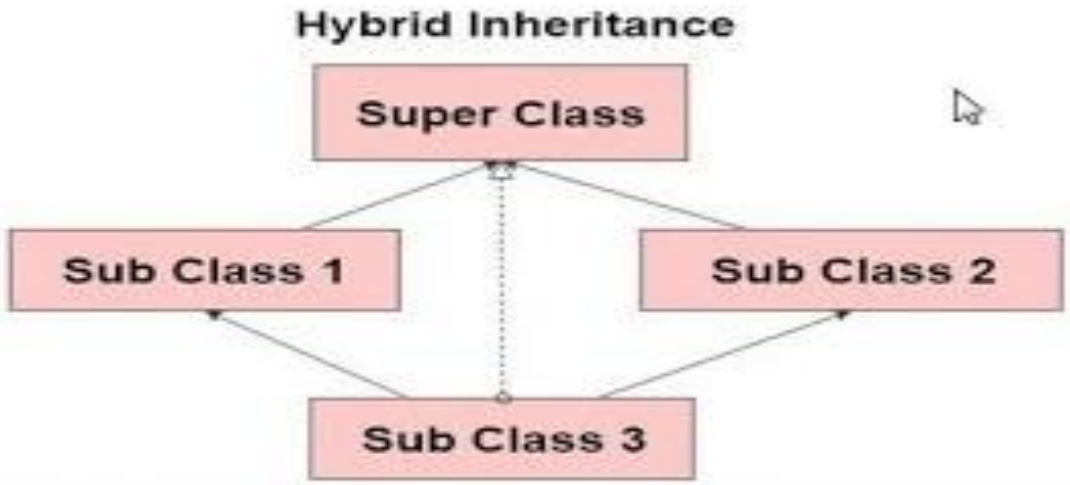
- **Class:** A class is a group of objects which have common properties. It is a template or blueprint from which objects are created.
- **Sub Class/Child Class:** Subclass is a class which inherits the other class. It is also called a derived class, extended class, or child class.
- **Super Class/Parent Class:** Superclass is the class from where a subclass inherits the features. It is also called a base class or a parent class.
- **Reusability:** As the name specifies, reusability is a mechanism which facilitates you to reuse the fields and methods of the existing class when you create a new class. You can use the same fields and methods already defined in the previous class.

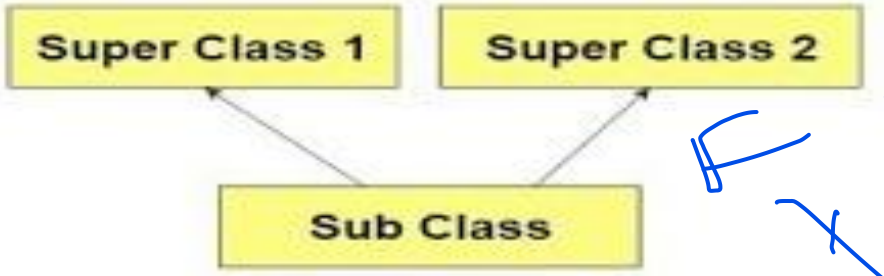
Types of Inheritance



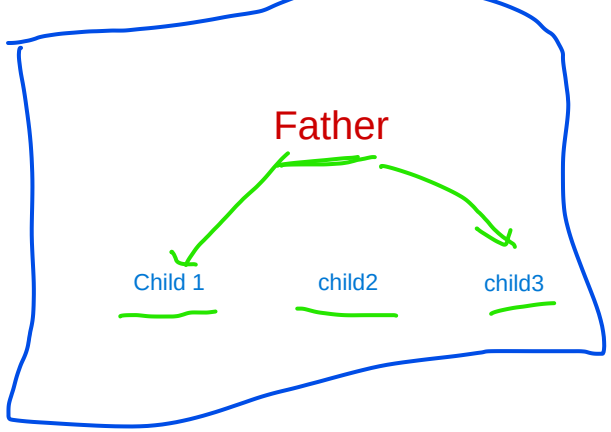








Multiple Inheritance

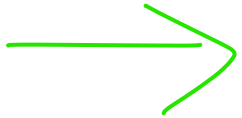


In **Java**, you **cannot inherit from more than one class** directly:

```java
class A {}
class B {}
class C extends A, B {} // ❌ Not allowed!
```

So to implement **Multiple Inheritance in Java**, we use **interfaces**.

ABSTRACT CLASSES IN JAVA



A class is said to be an abstract class in which it's having at least one abstract method.

A method that is just declared without definition is said to be an abstract method.

```
abstract class ex
{
      void display()    // concrete method
      {
          System.out.println("hello");
       }

      abstract void show();          //abstract method
}
```

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INTERFACES IN JAVA

An Interface is similar to a class which contains collection of variables and methods where all the methods in interface are by default abstract methods and all variables in methods are static and final variables.

We no need to specify any method or interface with abstract keyword because by default these are abstract. All the methods in interface are implemented in sub classes of this interface.

As no methods are having definition we cannot create objects for interfaces.

```
interface A
{
        int p = 10; //static and final variables

        //abstract methods
        void show();
        void display();

}
```

Interfaces can be extended

While inheriting an interface from other interface we use extends keyword. In below example interface B is inherited from interface A. As these two are interfaces we used extends keyword here.

Example

```
//program to demonstrate interfaces
interface A{
        int p = 10; //static

  void showA();
}

interface B extends A
{
         //int p = 10;
        //showA from A
        void showB();
}
```

🔰 1. What is Association?

> Association is a relationship between **two classes**.
> It is mainly of two types:

- "**HAS-A**" (Car has an Engine)
- "**IS-A**" (Doctor is a Human)

Association (realtionship)

Engine

car

main

HAS_A (Weak and Strong)

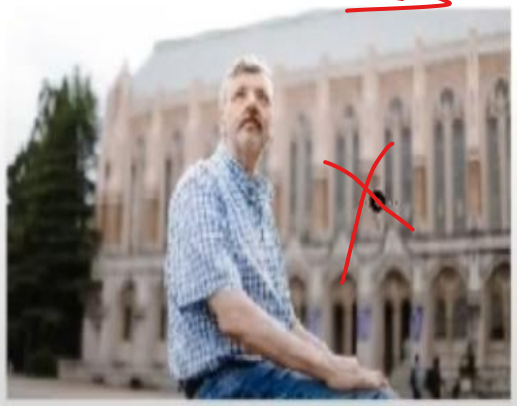
Composition (stronger)

HAS_A:

```
class A
{
  B b = new B();
}
```

Car has an Engine

Aggregation (weak)



University has a Professors

IS_A

Inheritance

Doctor is a Human

IS_A:

```
class A
{

}
class B extends A
{

}
```

🧩 PART 1: HAS-A Relationship

Means one class uses another class.

It has two types:

- Composition (Strong)
- Aggregation (Weak)

✅ A. Composition (Strong "HAS-A")

If Class A owns Class B — when A is destroyed, B is also destroyed.

📌 **Example**: A `Car` **has an** `Engine`

If Car is destroyed, Engine is destroyed too.

🧠 **Think**: Without a Car, Engine has no life here — tightly coupled.

✅ B. Aggregation (Weak "HAS-A")

Class A uses Class B, but does not own it.

If A is destroyed, B can live independently.

📌 **Example**: `University` **has** `Professors`

But professors can exist without the university.

Think: Even if `University` is closed, the professor still exists.

🧩 PART 2: IS-A Relationship

Means Inheritance (Class A extends Class B)

📌 **Example:** `Doctor` **is a** `Human`

🧠 **Think**: Doctor is a special type of Human — so inherits behavior.

```java
class Human {
    void walk() {
        System.out.println("Human walks");
    }
}

class Doctor extends Human {
    void treat() {
        System.out.println("Doctor treats patient");
    }
}

 public class Main {
     public static void main(String[] args) {
         Doctor doc = new Doctor();
         doc.walk();   // inherited method
         doc.treat();  // own method
     }
 }
```

EXCEPTION HANDLING IN JAVA

Errors in Java Program

mistake done prog
syntax
login errors llogical

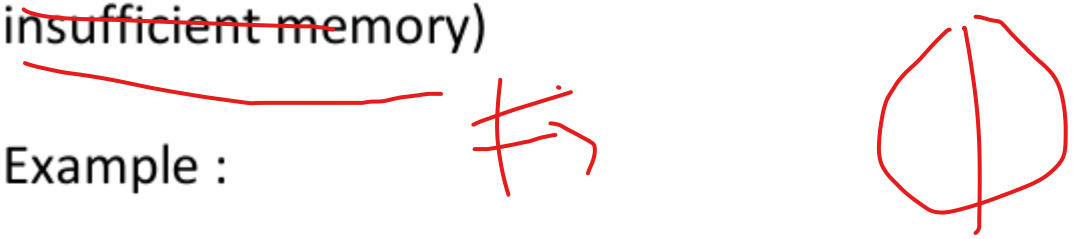
There are 3 types of errors

1) compile time errors : These are syntactical errors found in the code

Examples:

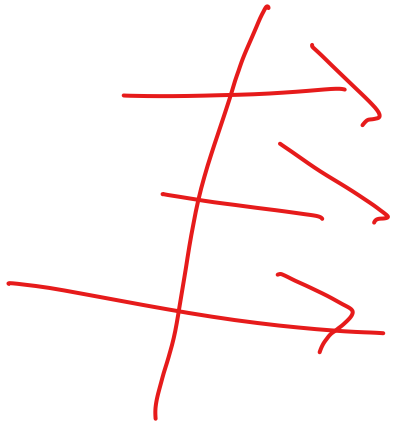
1) if we write system.out.println() instead of System.out.println() it will generates a compile time error.
2) if we forgot semicolon at the end of any statement in our program

2) runtime errors : These errors will occur due to inefficiency of the computer system (ex : insufficient memory)



Example :

if we forgot to write string array inside main method as follows



```
class A
{
  public static void main()
   {

       System.out.println("Welcome");

   }
}
```

3) logical errors: These errors depict flaws in the logic of the program. It may give some output but not as expected.

```
void add()
{
   int a =10;
   int b=20;
   System.out.println(a*b);

}
```

Exceptions:

Exceptions are Runtime errors. Whenever an exception occurs then the java system stops the program's execution. so, exception is defined as

"An Exception is an abnormal condition which stops the normal execution of a program ".

Exceptions are Two types:

1) Checked Exceptions — compile time
2) Unchecked Exceptions — Runtime

All exceptions are occurred at runtime only. But some are detected at compile time and some are detected at runtime. The exceptions that are checked at compile time are said to be checked exceptions and the exceptions that are checked at runtime are said to be unchecked exceptions.

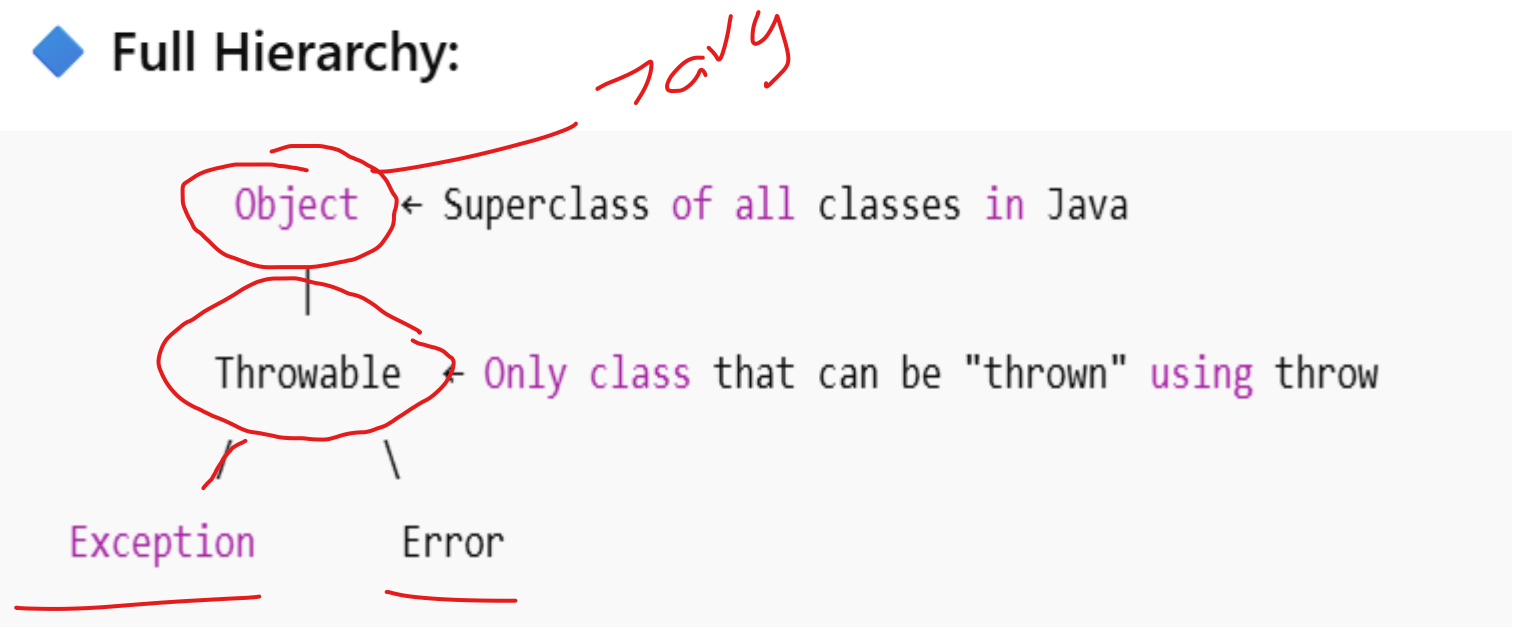
All these exception related classes and interfaces are belongs to java.lang package

All these exception related classes and interfaces are belongs to java.lang package

The following classes are top in the errors and exceptions class hierarchy.

Throwable: Represents all errors and exceptions in java
Exception: This is super class of all exceptions in java.

Full Hierarchy:



`ArrayIndexOutOfBoundsException`

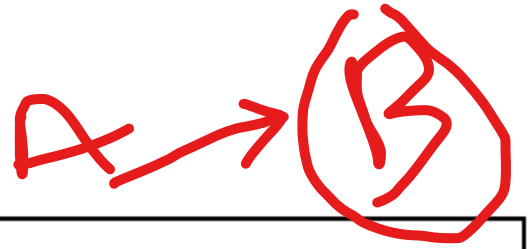
```
public class ArrayExample {
    public static void main(String[] args) {
        int[] numbers = {10, 20, 30, 40, 50};

        // Let's print all elements properly
        for (int i = 0; i <= numbers.length; i++) {
            System.out.println("Element at index " + i + ": " + numbers[i]);
        }
    }
}
```

Exception Handling:

We can handle exceptions in java by using 5 keywords

1) try
2) catch
3) throw
4) throws
5) finally

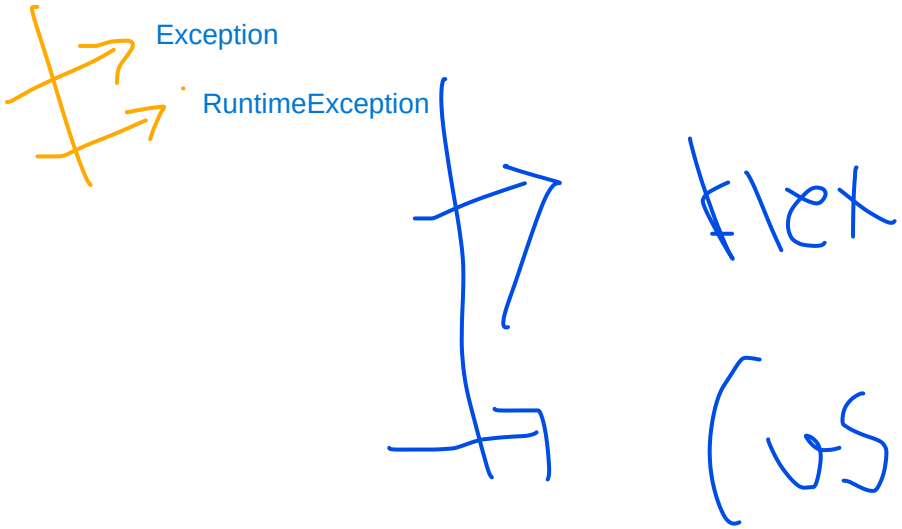
The following are the list of checked exceptions and unchecked exceptions.



Unchecked Exceptions	Checked Exceptions
ArithmeticException	ClassNotFoundException
IndexOutOfBoundsException	InstantiationException
ArrayIndexOutOfBoundsException	NoSuchMethodException
StringIndexOutOfBoundsException	IOException
NullPointerException	FileNotFoundException
	InterruptedIOException

User Defined Exceptions

We can create our own user defined exception classes and use them as per our requirements in our programs.



To create user defined exceptions

1) create a class that extends Exception class

```
class MyException extends Exception
{
```

2) We may define constructor / toString method in it

```
MyException(){
    System.out.println("Our own message");
}
```

or

```
public string toString(){
    System.out.println("Our own message");
}
```

3) Now as per our conditions, throw our own exception by using throw keyword

2. ✅ Ways to Create Custom Exception

`extends Exception`

`extends RuntimeException`

1️⃣ Create a class that extends `Exception`

java

```
class MyCheckedException extends Exception {
```

2 We may define constructor / toString method in it

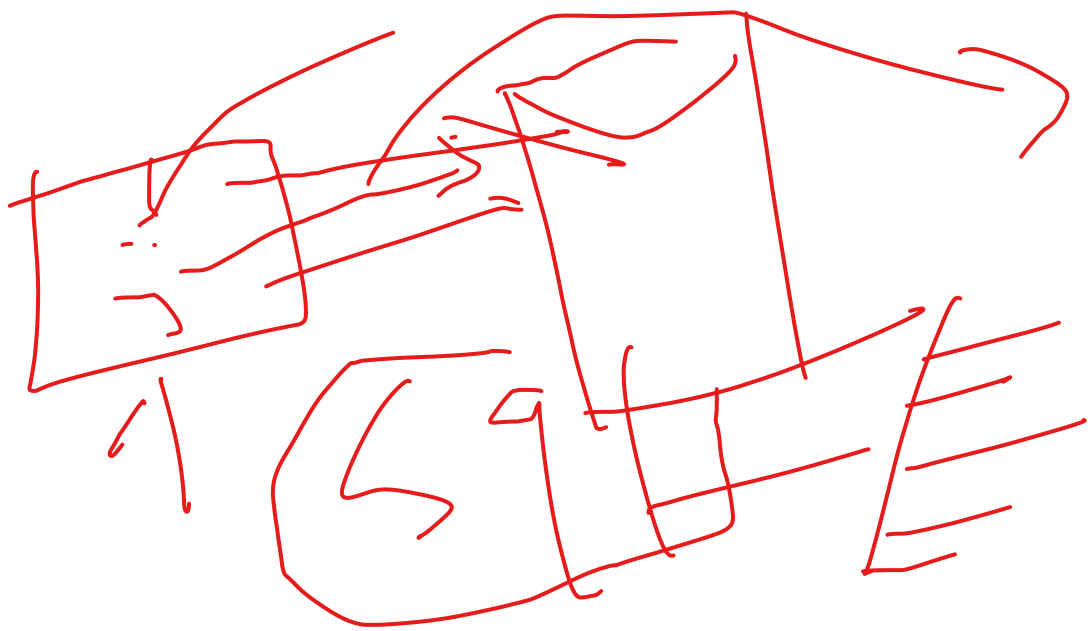
```java
    // Option 1: Constructor with default message
    MyCheckedException() {
        System.out.println("This is a default checked exception message.");
    }

    // OR

    // Option 2: Constructor with custom message
    MyCheckedException(String msg) {
        super(msg);
    }

    // OR

    // Option 3: Override toString()
    public String toString() {
        return "Custom Checked Exception occurred";
    }
}
```

Log

```
log.error("FGHHH ");
log.warn(" ");
log.info(" ");
log.debug(" ");
```

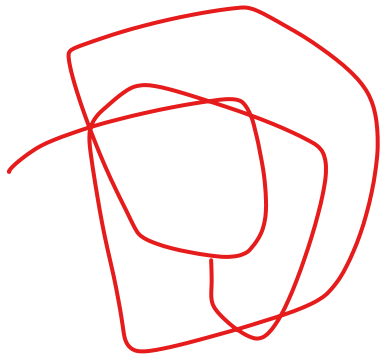
3 Now as per your condition, throw it manually using `throw` keyword

```java
if (age > 10) {
    throw new MyCheckedException("Age should be 10 or below.");
}
```

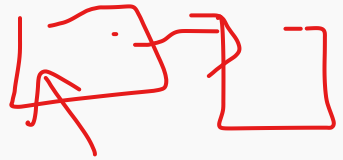


✅ Java Error Hierarchy – Like a Family Tree

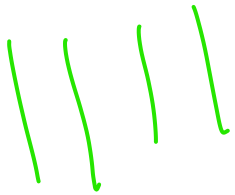
halt



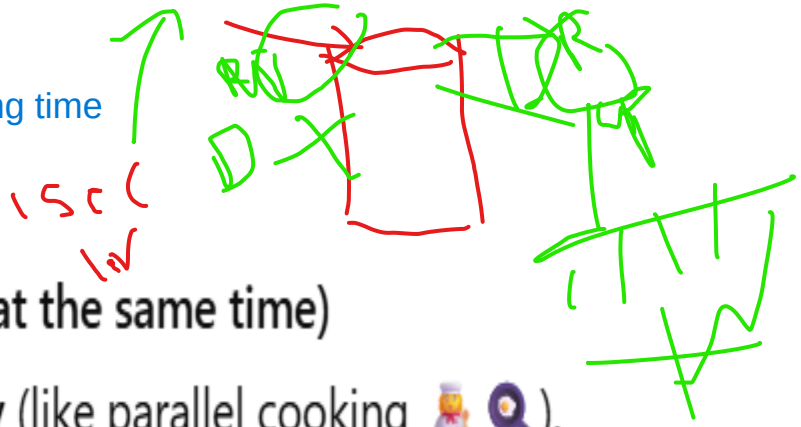
```
java.lang.Throwable          ← Top-level parent of all errors and exceptions
├── java.lang.Error          ← 💥 Serious issues (JVM errors) → DO NOT HANDLE
│   ├── OutOfMemoryError         ← No memory left
│   └── StackOverflowError       ← Infinite recursion
│
└── java.lang.Exception      ← ✅ Things you CAN handle (via try-catch)
    ├── Checked Exceptions       ← ❗ Must handle using try-catch or throws
    │   ├── IOException          ← File/stream issues
    │   └── SQLException         ← Database issues
    │
    └── Unchecked Exceptions     ← ❓ Optional to handle (logic errors)
        └── RuntimeException
            ├── NullPointerException      ← Accessing null object
            ├── ArithmeticException       ← Divide by zero
            ├── ArrayIndexOutOfBoundsException
            └── IllegalArgumentException
```



What is Concurrency?



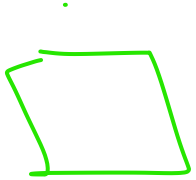
Save time
Efficiency
less waiting time



Concurrency = doing multiple things at the same time (or seemingly at the same time)

In Java, this means **running multiple parts of a program independently** (like parallel cooking 👩‍🍳🍳).

🧵 Thread = Small independent task



- In Java, `Thread` is the unit of concurrency.
- Each thread runs **separately** from others.

Example:

1 thread reads a file

1 thread sends an email

1 thread updates the UI

➡️ All at once.

1. Using Thread Class

java

```
class MyTask extends Thread {
    public void run() {
        System.out.println("Task running in a separate thread");
    }
}

public class Main {
    public static void main(String[] args) {
        MyTask task = new MyTask();  // Create thread
        task.start();                // Start thread (calls run())
    }
}
```

Jvm will create a Thread for us

2. Using Runnable Interface

java

```java
class MyRunnable implements Runnable {
    public void run() {
        System.out.println("Runnable task is running");
    }
}

public class Main {
    public static void main(String[] args) {
        Thread t = new Thread(new MyRunnable()); // Pass runnable to thread
        t.start();
    }
}
```

Step 1: implements Runnable

Step2: overide Run method

Step 3: create object for Thread class

Step 4:- pass your custom thread object to Thread Object

Step 5:start the thread

3. Using ExecutorService (Advanced, Better Way)

java

```java
import java.util.concurrent.ExecutorService;
import java.util.concurrent.Executors;

public class Main {
    public static void main(String[] args) {
        ExecutorService service = Executors.newFixedThreadPool(2);

        service.submit(() -> System.out.println("Task 1 running"));
        service.submit(() -> System.out.println("Task 2 running"));

        service.shutdown();
    }
}
```

create **2 worker threads**

Giving 2 tasks

After shutdown

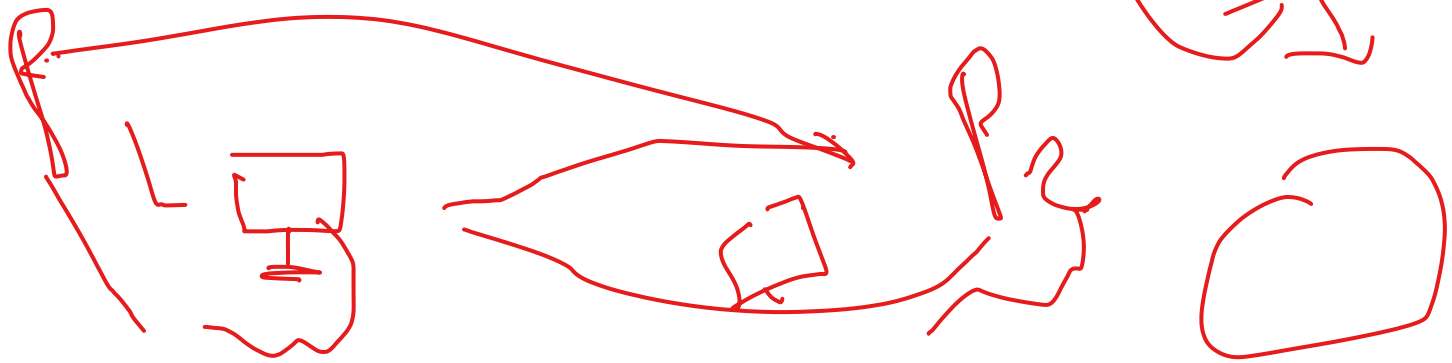
⚠️ Important Concepts in Concurrency

1. Race Condition

> Two threads changing the same data at the same time = 🧨 bug

Solution: Use `synchronized` keyword

```java
public synchronized void increment() {
    count++;
}
```



2. Deadlock

> Two threads wait for each other → both stuck forever

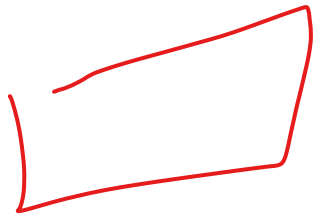
---

3. Thread Safety

> Code that works fine even when used by multiple threads at once

Use:

- `synchronized` keyword
- `AtomicInteger`, `ConcurrentHashMap`
- Thread-safe collections



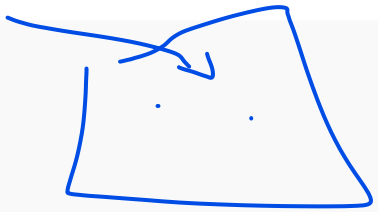
Java Files

✅ 1. `CreateFile.java`

java

```java
import java.io.FileWriter;

public class CreateFile {
    public static void main(String[] args) throws Exception {
        FileWriter writer = new FileWriter("sample.txt");
        writer.write("Hello, this is a sample file.");
        writer.close();
        System.out.println("✅ File created and written.");
    }
}
```

📖 2. `ReadFile.java`



Reads **one character** at a time ,until last character

```java
import java.io.FileReader;

public class ReadFile {
    public static void main(String[] args) throws Exception {
        FileReader reader = new FileReader("sample.txt");
        int ch;
        System.out.print("📖 File content: ");
        while ((ch = reader.read()) != -1) {
            System.out.print((char) ch);
        }
        reader.close();
    }
}
```

🔍 `reader.read()` doesn't return a `char` — it returns an `int`

Even though the file has characters (like `A`, `B`, `C`), Java reads them **one-by-one as their ASCII/Unicode number**.

❌ 3. `DeleteFile.java`

java

```java
import java.io.File;

public class DeleteFile {
    public static void main(String[] args) {
        File file = new File("sample.txt");
        if (file.delete()) {
            System.out.println("❌ File deleted successfully.");
        } else {
            System.out.println("File not found or can't delete.");
        }
    }
}
```

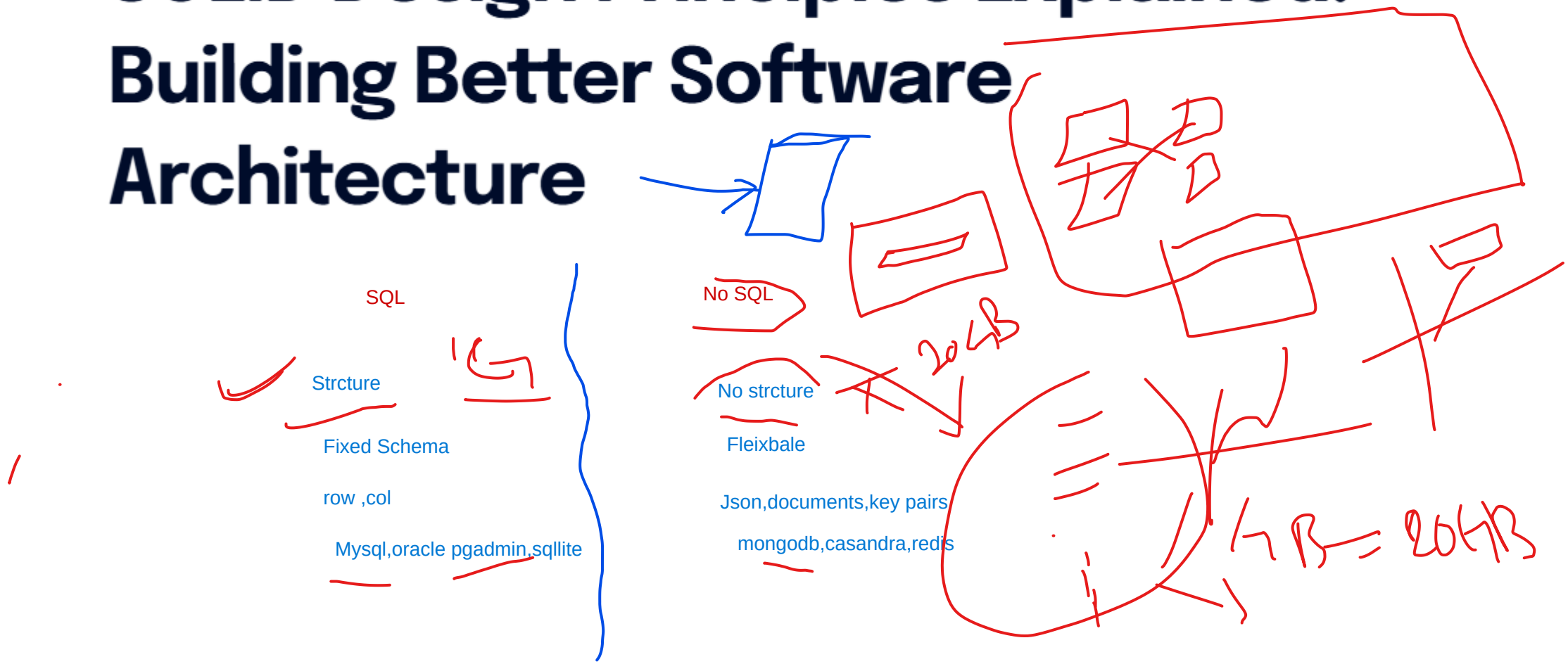
🔐 What is **Try with Resources**?

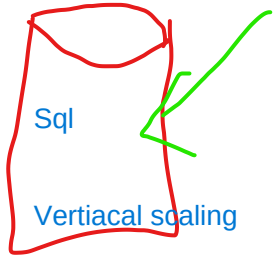
Try with Resources is a special way in Java to **automatically close files, readers, writers, etc.**

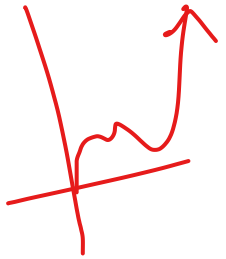
So you **don't need to manually write** `close()` — Java does it for you ✅

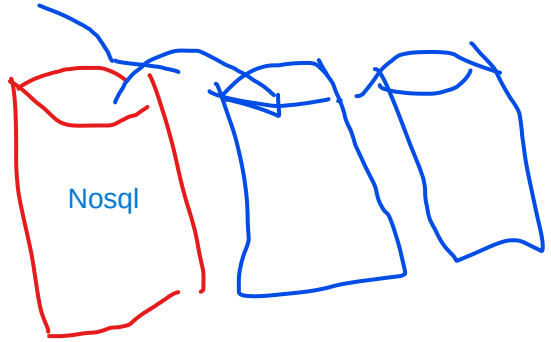
```java
import java.io.FileReader;

public class ReadFileWithTryResources {
    public static void main(String[] args) throws Exception {
        // 👇 Try with resources – reader auto-closes after this block
        try (FileReader reader = new FileReader("sample.txt")) {
            int ch;
            System.out.print("📖 File content: ");
            while ((ch = reader.read()) != -1) {
                System.out.print((char) ch); // 🔄 Convert int to char
            }
        } // ✅ FileReader is closed automatically here!
    }
}
```

SOLID Design Principles Explained: Building Better Software Architecture









SOLID stands for:

- **S** - Single-responsibility Principle
- **O** - Open-closed Principle
- **L** - Liskov Substitution Principle
- **I** - Interface Segregation Principle
- **D** - Dependency Inversion Principle

Single-Responsibility Principle

Single-responsibility Principle (SRP) states:

> A class should have one and only one reason to change, meaning that a class should have only one job.

Open-Closed Principle

Open-closed Principle (OCP) states:

> Objects or entities should be open for extension but closed for modification.

This means that a class should be extendable without modifying the class itself.

Liskov Substitution Principle

Liskov Substitution Principle states:

> Let q(x) be a property provable about objects of x of type T. Then q(y) should be provable for objects y of type S where S is a subtype of T.

This means that every subclass or derived class should be substitutable for their base or parent class.

Interface Segregation Principle

The interface segregation principle states:

> A client should never be forced to implement an interface that it doesn't use, or clients shouldn't be forced to depend on methods they do not use.

This principle emphasizes that large, general-purpose interfaces should be broken down into smaller, more specific ones. This way, client classes only need to know about the methods that are relevant to them.

Dependency Inversion Principle

Dependency inversion principle states:

> Entities must depend on abstractions, not on concretions. It states that the high-level module must not depend on the low-level module, but they should depend on abstractions.

This principle allows for decoupling.