Day 13

Project Lombok

- Reference https://projectlombok.org/

External system resources

- Following are the operating system resources that we can use for the application development:
  - Memory
  - Processor
  - Input and Output devices
  - File
  - Socket
  - Network Connections
  - Database connections
  - Operating System API
- In the context of Java, all above resources are non Java resources. These are also called as unmanaged resources(except memory).
- In the context of Java, resource is any external system resource that we can use in the application.
- Since operating system resources are limited, we should use it carefully.

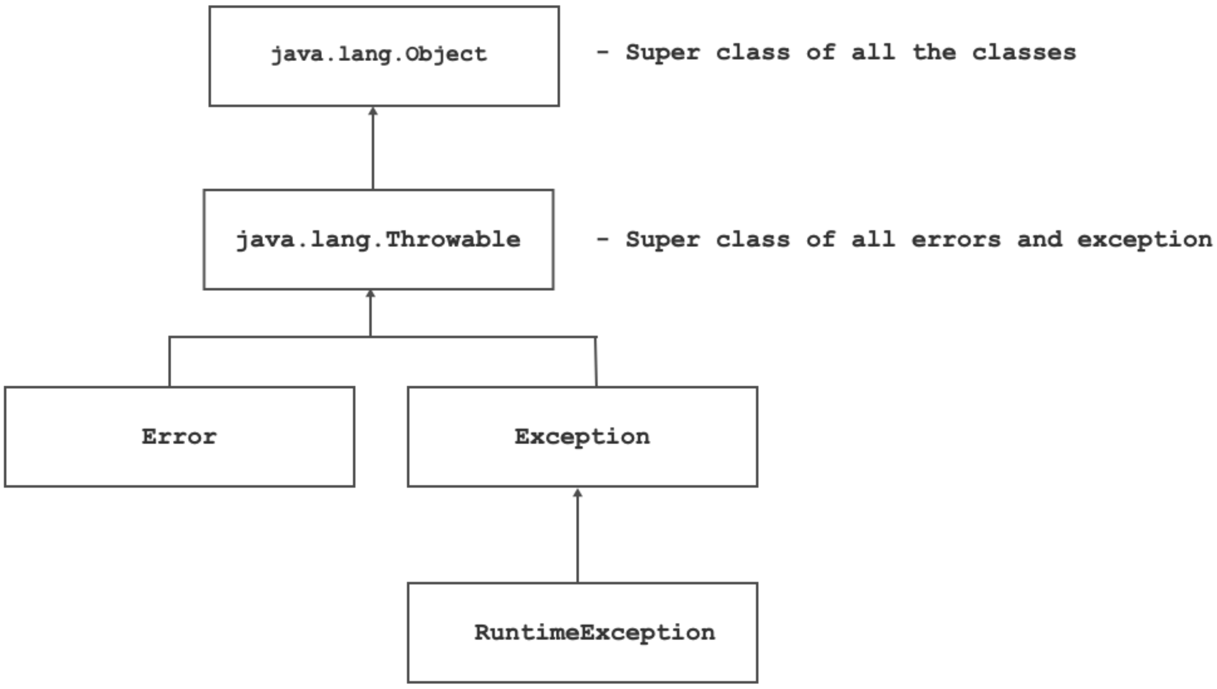
Exception Concept

- Definition
  - Exception is an issue / unexpected event / instance which occurs during execution of application.
  - Exception is an instance which is used to acknowledge user of the system if any exeption situation occurs in the code.
  - If we want to manages OS resources carefully then we should use exception handling in Java.

Throwable class Hierarchy

- java.lang.Object is ultimate super class of all the classes in Java language.
- Methods of java.lang.Object class:
  - public String toString( );
  - public boolean equals(Object obj);
  - public native int hashCode();
  - protected native Object clone( )throws CloneNotSupportedException
  - protected void finalize( )throws Throwable;
  - public final native Class<?> getClass();
  - public final void wait( )throws InterruptedException
  - public final native void wait(long timeOut)throws InterruptedException
  - public final void wait(long timeOut, int nanos)throws InterruptedException
  - public final native notify( );
  - public final native notifyAll( );

java.lang.Throwable:


java.lang.Object
- Super class of all the classes
java.lang.Throwable
- Super class of all errors and exception
Error
Exception
RuntimeException

- The Throwable class is the superclass of all errors and exceptions in the Java language.
- Only objects that are instances of Throwable class (or one of its subclasses) are thrown by the Java Virtual Machine or can be thrown by the Java throw statement.
- Consider code in C++

```
int main( void ){
  int num1;
  cout<<"Enter number : ";
  cin>>num1;

  int num2;
  cout<<"Enter number : ";
  cin>>num2;
  try{
    if( num2 == 0 ){
      //throw 0;  //OK
      //throw ArithmeticException( "Divide by zero exception");
//OK
      throw "Divide by zero exception";  //OK
    }else
      int result = num1 / num2;
      cout<<"Result : "<<result<<endl;
    }
  }catch( string &ex ){
    cout<<ex<<endl;
  }
  return 0;
}
```

- Consider code in Java

```
  class MyException{
    private String message;
    public MyException(String message) {
      this.message = message;
    }
  }
  public class Program {
    public static void main(String[] args){
      int num1 = 10;
      int num2 = 0;
      try {
        if( num2 == 0 )
          //throw 0;    //No exception of type int can be thrown; an
exception type must be a subclass of Throwable
          //throw "/ by 0"; //No exception of type String can be
thrown; an exception type must be a subclass of Throwable
          throw new MyException("/ by 0");//No exception of type
MyException can be thrown; an exception type must be a subclass of
Throwable
        int result = num1 / num2;
        System.out.println("Result  :   "+result);
      }catch( Exception ex ) {
        //TODO
      }
    }
  }
```

- Consider following code:

```
  public class Program {
    public static void main(String[] args){
      int num1 = 10;
      int num2 = 0;
      try {
        if( num2 == 0 ) {
          ArithmeticException ex = new ArithmeticException("Value of
denominator should not be zero");
          throw ex; //OK
        }
        int result = num1 / num2;
        System.out.println("Result  :   "+result);
      }catch( Exception ex ) {

      }

    }
  }
```

- Similarly, only Throwable class or one of its subclasses can be the argument type in a catch clause.
- Consider following code:

```
  public class Program {
    public static void main(String[] args) {

      String str = null;
      str.charAt(10);
      int num1 = 10;
      int num2 = 0;
      try {
        int result = num1 / num2;
        System.out.println("Result  :   " + result);
      } catch (ArithmeticException ex) {    //No exception of type
String can be thrown; an exception type must be a subclass of
Throwable

      }
    }
  }
```

- Consider following code:

```
public class Program {
  public static void main(String[] args) {

    String str = null;
    str.charAt(10);
    int num1 = 10;
    int num2 = 0;
    try {
      int result = num1 / num2;
      System.out.println("Result    :   " + result);
    } catch (ArithmeticException ex) {  //
      //TODO
    }
  }
}
```

- Constructor Summary
    - public Throwable()

    ```
      Throwable tw = new Throwable();
    ```

    - public Throwable(String message)

```
String message = "error message";
Throwable tw = new Throwable( message );
//or
Throwable tw = new Throwable( "error message" );
```

  - public Throwable(Throwable cause)

```
Throwable cause = new Throwable( "error message" );
Throwable tw = new Throwable( cause );
//or
Throwable tw = new Throwable( new Throwable( "error message" )
);
```

  - public Throwable(String message, Throwable cause)

```
Throwable cause = new Throwable( "error message" );
Throwable tw = new Throwable( "new error message", cause );
```

  - protected Throwable(String message, Throwable cause, boolean enableSuppression, boolean writableStackTrace)

```
Throwable cause = new Throwable( "error message" );
Throwable tw = new Throwable( "new error message", cause, false,
true );
```

- Method Summary
  - public String getMessage()
  - public Throwable initCause(Throwable cause)
  - public Throwable getCause()
  - public final void addSuppressed(Throwable exception)
  - public void printStackTrace()
  - public void printStackTrace(PrintStream s)
  - public void printStackTrace(PrintWriter s)
  - public StackTraceElement[] getStackTrace()

Error versus Exception

- Error and Exception are direct sub classes of java.lang.Throwable class.

Error

- An Error is a subclass of Throwable that indicates serious problems that a reasonable application should not try to catch.
- Most such errors are abnormal conditions.
- Runtime error which gets generated due to environmental condition(hardware failure / OS failure / JVM failure etc) is considered as error in java programming language.
- Consider following code:

```
  public class Program {
    public static void main(String[] args) {
      try {
        int[] arr = new int[ Integer.MAX_VALUE ];
        System.out.println( Arrays.toString(arr));
      }catch( OutOfMemoryError error ) {
        System.out.println(error.getMessage()); //Requested array size
exceeds VM limit
      }
    }
  }
```

- We can write try-catch block to handle errros. But we can not recover from errors hence it is not recommended to use try catch block for the errors.
- Example:
  - OutOfMemoryError
  - StackOverflowError
  - VirtualMachineError

Exception

- The class Exception and its subclasses are a form of Throwable that indicates conditions that a reasonable application might want to catch.
- Runtime error which gets generated due to application is considered as exception in java programming language.
- We can use try-catch block to handle exception.
- Example:
  - CloneNotSupportedException
  - InterrupedException
  - NumberFormatException
  - NullPointerExcption
  - NegativeArraySizeException
  - ArrayIndexOutOfBoundsException
  - ArrayStoreException
  - ClassCastException
  - ArithmeticException

Checked versus unchecked exception

- Checked exception and unchecked exception are types of exception in Java, which are designed for Java compiler(Not for JVM).

Unchecked Exception

- java.lang.RuntimeException is considered as super class of all the unchecked exception.
- java.lang.RuntimeException and all its sub classes are considered as unchecked exception.
- Examples of unchecked exception
  - RuntimeException
  - NumberFormatException
  - NullPointerExcption
  - NegativeArraySizeException
  - ArrayIndexOutOfBoundsException
  - ArrayStoreException
  - ClassCastException
  - ArithmeticException
- Compiler do not force developer to handle or to use try-catch block for unchecked exception.

Checked Exception

- java.lang.Exception is considered as super class of all the checked exception.
- java.lang.Exception and all its sub classes except java.lang.RuntimeException(and its sub classes) are considered as checked exceptions
- Examples of checked exception
  - java.lang.CloneNotSupportedException
  - java.lang.InterruptedException
  - java.io.IOException
  - java.sql.SQLException
- Compiler force developer to handle or to use try-catch block for checked exception.

AutoCloseable and Closeable

- Closeable is an interface which is delcared in java.io package.

  - Method: void close() throws IOException

- It is introduced in JDK 1.5

- Consider following code:

```java
import java.io.Closeable;
import java.io.IOException;
import java.util.Scanner;

class Test implements Closeable{
  private Scanner sc;
  public Test() {
    this.sc = new Scanner(System.in);
  }
```

```
    @Override
    public void close() throws IOException {
      this.sc.close();
    }

  }
  public class Program {
    public static void main(String[] args) {
      try {
        Test t = new Test();

        t.close();
      } catch (IOException e) {
        // TODO Auto-generated catch block
        e.printStackTrace();
      }
    }
  }
```

- "void close() throws IOException" is a method of java.io.Closeable interface which is used to clean/release resources.
- If any class implements Closeable interface then that class has a ability to close resources using close method.
- AutoCloseable is an interface which is declared in java.lang package.
    - Method: void close()throws Exception
- It is introduced in JDK 1.7
- AutoCloseable is same as Closeable with gurantee of calling close method automatically.

```
//Class Test => Resource Type
class Test implements AutoCloseable{
  private   sc;
  public Test() {
    this.sc = new Scanner(System.in);
  }

  @Override
  public void close() throws Exception {
    this.sc.close();
  }

}
public class Program {
  public static void main(String[] args) {
    try {
      Test t = new Test();  //new Test()  => Resource
      t.close();
    } catch (Exception e) {
      // TODO Auto-generated catch block
      e.printStackTrace();
    }
  }
```

- Any class which implements AutoCloseable / Closeable interface is called as resource type and its instance is called resource.
- If we use try with resource then close() method gets called automatically.

Exception handling using try catch throw throws and finally

- If we want to handle exception then we should use 5 keywords in java:
  - try
  - catch
  - throw
  - throws
  - finally
- While performing arithmetic operation, if we get any exception condition like "divide by zero" then JVM throws ArithmeticException.

try

- It is a keyword in Java.
- If we want to keep watch on single statement or group of statements for exception then we should use try block / handler.
- we can not define try block after catch/finally block.
- Try block must have at least one catch block or finally block or resource statement.
- Consider following syntax:

```
  public static void main(String[] args) {
    try{
      //TODO
    }catch( Exception ex ){
      //TODO
    }
  }
```

```
  public static void main(String[] args) {
    try{
      //TODO
    }finally{
      //TODO
    }
  }
```

```
    public static void main(String[] args) {
      try(Scanner sc = new Scanner()){  //try-with-resource
        //TODO
      }
    }
```

throw

- It is a keyword in java.
- If we want to generate new exception then we should use throw keyword.
- Only objects that are instances of Throwable class (or one of its subclasses) are thrown by the JVM or can be thrown by the Java throw statement.

```
    String ex = new String("Divide by zero exception");
      throw ex;//No exception of type String can be thrown; an exception
  type must be a subclass of Throwable
```

- throw statement is a jump statement.

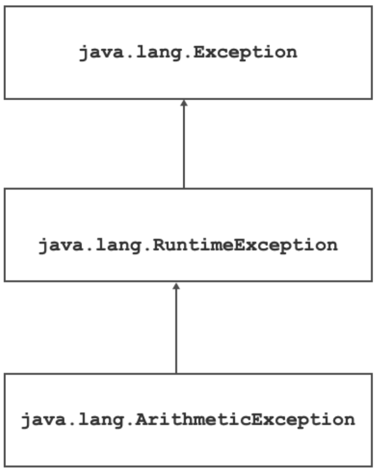
catch

- It is a keyword in Java.
- To handle exception, we should use catch block / handler.
- We can not define catch block before try and after finally block.
- Catch block can handle exception thrown from try block only.
- For single try block, we can provide multiple catch block. In this case, JVM can execute only one catch depending on the situation.
- In a single catch block, we can handle multiple specific exception.

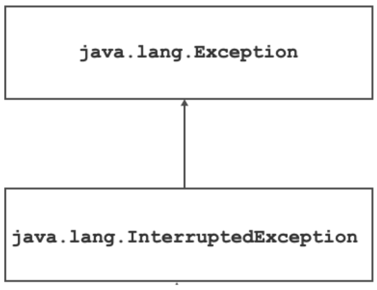
```
    catch ( ArithmeticException | InputMismatchException ex ) {
  //Multi catch block
        ex.printStackTrace();
    }
```

- Do not Repeat Yourself(DRY).
- If we want to handle multple execptions of super and sub types then first we must handle sub types exception.

```java
    public static void main(String[] args) {
    Scanner sc = null;
    try {
      System.out.println("Opening resource");
      sc = new Scanner(System.in);

      System.out.print("Num1    :   ");
      int num1 = sc.nextInt();

      System.out.print("Num2    :   ");
      int num2 = sc.nextInt();

      if( num2 == 0 )
        throw new ArithmeticException("Divide by zero exception");
      int result = num1 / num2;
      System.out.println("Result    :   "+result);
    }catch ( ArithmeticException  ex) {
      ex.printStackTrace();
    }catch ( RuntimeException  ex) {
      ex.printStackTrace();
    }catch ( Exception  ex) {
      ex.printStackTrace();
    }
  }
```



```
ArithmeticException ex = new ArithmeticException();

RuntimeException ex = new ArithmeticException();//Upcasting

Exception ex = new ArithmeticException(); //Upcasting
```



```
InterruptedException ex = new InterruptedException(); // OK

Exception ex = new InterruptedException(); // Upcasting
```

- Using java.lang.Exception class we can define catch block which can handle any checked as well as uncheked exception.

```
try{
  //TODO
}catch( Exception ex ){ //Generic catch block
  ex.printStackTrace();
}
```

- Generally, generic catch block comes after all specific catch blocks.

finally

- It is a keyword in Java.
- If we want to close or release local resources then we should use finally block.
- For given try block we can provide only one finally block.
- We can define block after all try and catch blocks.
- JVM always execute finally block.

try with resource

```
public static void main(String[] args) {
        //try ( Program p = new Program()) {    //Not Ok: The resource
type Program does not implement java.lang.AutoCloseable
        try( Scanner sc = new Scanner(System.in)){
            System.out.print("Num1  :   ");
            int num1 = sc.nextInt();

            System.out.print("Num2  :   ");
            int num2 = sc.nextInt();

            if( num2 == 0 )
                throw new ArithmeticException("Divide by zero exception");
            int result = num1 / num2;
            System.out.println("Result  :   "+result);

        }catch ( Exception  ex) {
            ex.printStackTrace();
        }
    }
```

throws

- It is a keyword in Java
- If we want delegate exception from method to the caller method then we should use throws keyword/clause.

```
  public class Program {
    public static void displayRecord( ) throws InterruptedException {
      for( int count = 1; count <= 10; ++ count ) {
        System.out.println("Count   :   "+count);
        Thread.sleep(500);
      }
    }
    public static void main(String[] args) {
      try {
        Program.displayRecord();
      } catch (InterruptedException e) {
        e.printStackTrace();
      }
    }
}
```

Custom exception and its need.

- JVM do not understand exceptional conditions in the business logic. To handle it we should define user defined / custom exception class.
- How to define custom unchecked exception class?

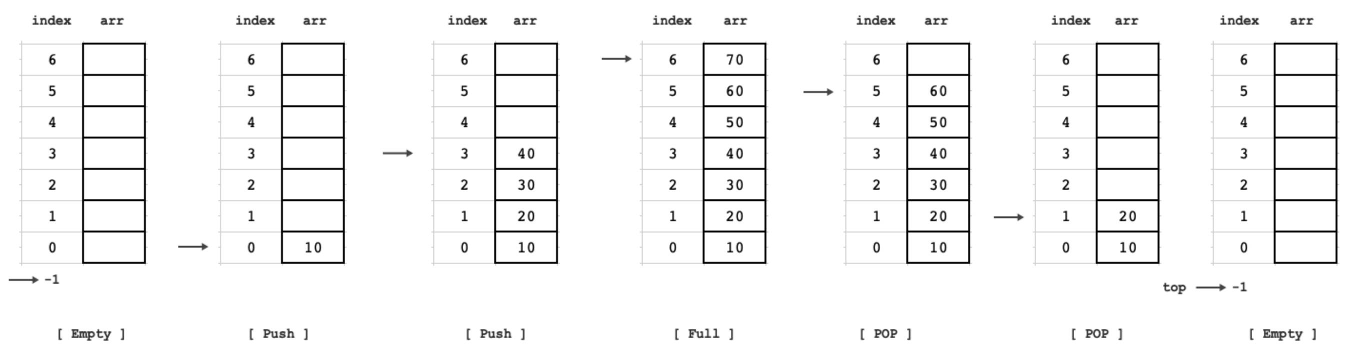
```
class StackOverflowException extends RuntimeException{
  //TODO
}
```

- How to define custom checked exception class?

```
class StackOverflowException extends Exception{
  //TODO
}
```

Exception chaining

Stack: **L**ast **I**n **F**irst **O**ut (**LIFO**) operations



- Process of handling exception by throwing new type of exception is called as exception chaining.

- Consider following code:

```java
package org.example;
abstract class A{
  public abstract void print( );
}
class B extends A{
  @Override
  public void print() throws RuntimeException{
    try {
      for( int count = 1; count <= 10; ++ count ) {
        System.out.println("Count :   "+count);
        Thread.sleep(250);
      }
    } catch (InterruptedException cause) {
      throw new RuntimeException(cause);  //Exception Chaining
    }
  }
}
public class Program {
  public static void main(String[] args) {
    try {
      A a = new B();
      a.print();//Dynamic method dispatch
    } catch (RuntimeException e) {
      //e.printStackTrace();
      Throwable cause = e.getCause();
      System.out.println(cause);
    }
  }
}
```