Exception Handling

Introduction

- An exception is an abnormal condition that arises in a code sequence at run time.
- Java’s exception handling brings run-time error management into the object-oriented world.

Java exception

- A Java exception is an object that describes an exceptional condition that has occurred in a segment of code.
- When an exceptional condition arises, an object representing that exception is created and thrown in the method that caused the error.
- Exceptions can either be generated by the Java run-time system, or they can be manually generated by your code.
- Exceptions thrown by Java relate to **fundamental errors that violate the rules of the Java language or the constraints of the Java execution environment**.
- Manually generated exceptions are typically used to report some error condition to the caller of a method.

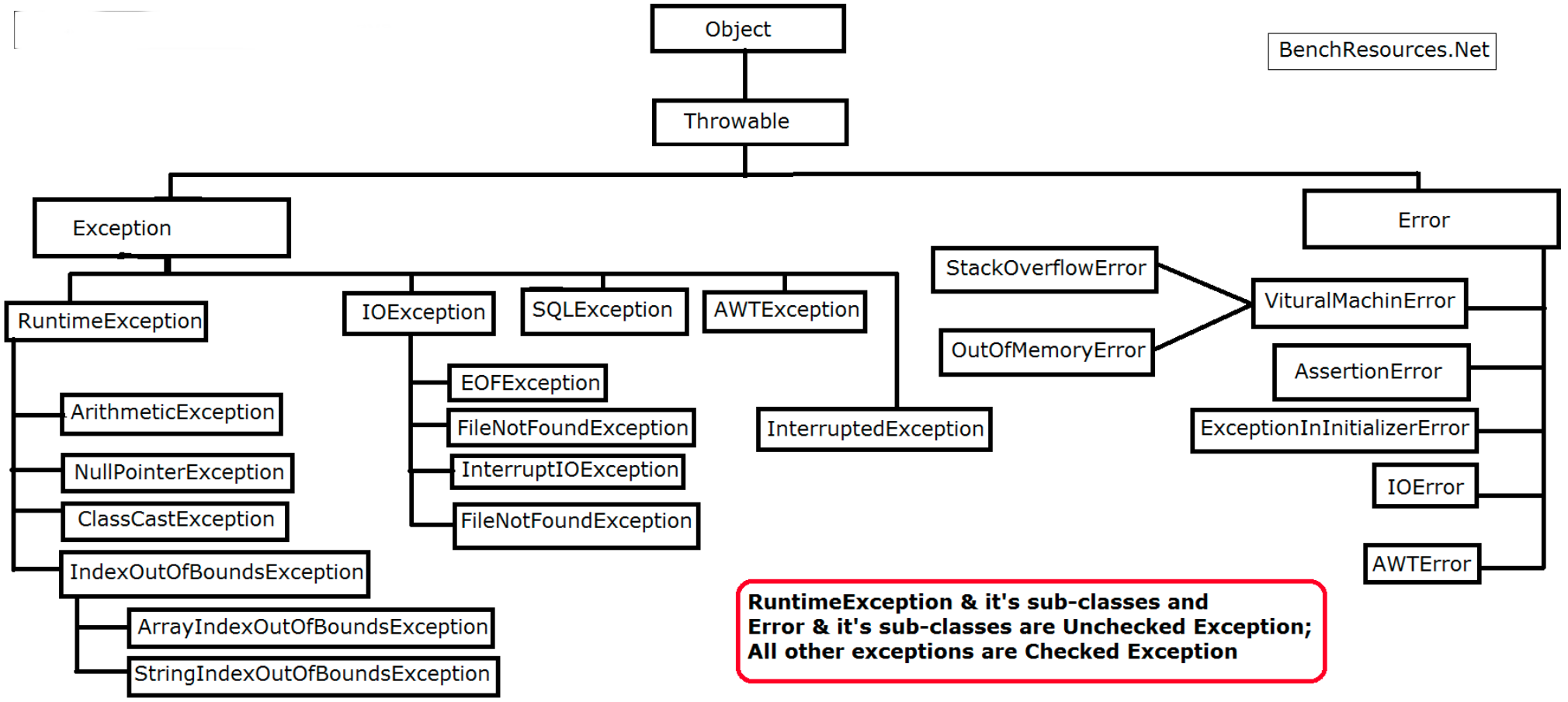
Exception Handling in Java

- Java exception handling is managed via five keywords: **try**, **catch**, **throw**, **throws**, and **finally**.
- Statements that is to monitor for exceptions are contained within a try block.
- If an exception occurs within the try block, it is thrown.
- System-generated exceptions are automatically thrown by the Java run-time system.
- To manually throw an exception, use the keyword **throw**.
- Any exception that is thrown out of a method must be specified as such by a **throws** clause.
- A **catch** block(or blocks) associated with a try block handles a thrown exception in a systematic manner.
- Any code that must be executed after a try block completes (under both normal and exceptional condition) is put in a **finally** block.

Syntax

```
try {
      // block of code to monitor for errors
} catch (ExceptionType1 exOb) {
      // exception handler for ExceptionType1
} catch (ExceptionType2 exOb) {
     // exception handler for ExceptionType2
}
// ...
finally {
      // block of code to be executed after try block ends
}
```

Exception class hierarchy



Checked vs. Unchecked Exceptions

- Exception which are checked at compile-time during compilation is known as Checked Exception
  - FileNotFoundException
- Exception which are NOT checked at compile-time is known as Unchecked Exception
  - ArithmeticException

try and catch block

```
class Exc2 {
	public static void main(String args[]) {
		int d, a;
		try {
			d = 0;
			a = 42 / d;
			System.out.println("This will be printed if no exception occurs.");
		} catch (ArithmeticException e) {
			System.out.println("Division by zero.");
			/* alternatively to show the description of exception use
			System.out.println("Exception: " + e); */

		}
		System.out.println("After catch statement.");
	}
}
```

Multiple catch

- More than one exception could be raised by a single segment of code.
- Accordingly, we can specify two or more catch blocks, each catching a different type of exception.
- When an exception is thrown, each catch statement is inspected in order, and the first one whose type matches that of the exception is executed.
- After one catch statement executes, the others catches are bypassed, and execution continues after the try/catch block.

Examples

```
class MultiCatch {
    public static void main(String args[]) {
        try {
            int a = args.length;
            System.out.println("a = " + a);
            int b = 42 / a;
            int c[] = { 1 };
            c[42] = 99;
        } catch(ArithmeticException e) {
                System.out.println("Divide by 0: " + e);
        } catch(ArrayIndexOutOfBoundsException e) {
                System.out.println("Array index oob: " + e);
        }
        System.out.println("After try/catch blocks.");
    }
}
```

There is a problem here!!

```
class SuperSubCatch {
  public static void main(String args[]) {
    try {
      int a = 0;
      int b = 42 / a;
    } catch(Exception e) {
          System.out.println(“Exception occurred: " + e);
    }
      catch(ArithmeticException e) {
          System.out.println("Array index oob: " + e);
    }
  }
}
```

Needs to remember!!

- While using multiple catch statements, exception subclasses must come before any of their superclasses.
- A catch statement that uses a superclass will catch exceptions of that type plus any of its subclasses.
- Thus, a subclass catch would never be reached if it came after its superclass.

Nested try statements

- A try statement can be inside the block of another try.
- Each time a try statement is entered, the context of that exception is pushed on the **stack**.
- If an inner try statement does not have a catch handler for a particular exception, the stack is unwinded and the next try statement's catch handlers are inspected for a match.
- This continues until one of the catch statements succeeds, or until all of the nested try statements are exhausted.
- If no catch statement matches, then the Java run-time system will handle the exception

Example

```
class NestTry {
    public static void main(String args[]) {
        try {
            int a = args.length;
            int b = 42 / a;
            System.out.println("a = " + a);
            try { // nested try block
                if(a==1) a = a/(a-a);
                if(a==2) {
                    int c[] = { 1 };
                    c[42] = 99;
                }
            } catch(ArrayIndexOutOfBoundsException e) {
                System.out.println("Array index out-of-bounds: " + e);
            }
            System.out.println("outside inner try block");

        } catch(ArithmeticException e) {
                System.out.println("Divide by 0: " + e);
        }
    }
}
```

throw

- We can throw an exception explicitly, using the throw statement.
  - **Syntax :** throw ThrowableInstance;
- Here, ThrowableInstance must be an object of type **Throwable** or a subclass of Throwable
- The flow of execution stops immediately after the throw statement; any subsequent statements are not executed.

Example of throw

```
class ThrowDemo {
    static void demoproc() {
        try {
            throw new NullPointerException("demo");
        } catch(NullPointerException e) {
            System.out.println("Caught inside demoproc.");
            throw e; // re-throw the exception
        }
    }

    public static void main(String args[]) {
        try {
            demoproc();
        } catch(NullPointerException e) {
            System.out.println("Recaught: " + e);
        }
    }
}
```

throws

- If a method is capable of causing an exception that it does not handle, it must specify this behavior so that callers of the method can guard themselves against that exception.
- This is done by including a **throws** clause in the method's declaration.
- A throws clause lists the types of exceptions that a method might throw.
- This is necessary for all exceptions, except those of type Error or RuntimeException, or any of their subclasses.

```
type method-name(parameter-list) throws exception-list
{
        // body of method
}
```

- Here, exception-list is a comma-separated list of the exceptions that a method can throw.

Example

```
class ThrowsDemo {
    static void throwOne() throws IllegalAccessException {
        System.out.println("Inside throwOne.");
        throw new IllegalAccessException("demo");
    }
    public static void main(String args[]) {
        try {
            throwOne();
        } catch (IllegalAccessException e) {
            System.out.println("Caught " + e);
        }
    }
}
```

finally

- “finally” creates a block of code that will be executed after a try/catch block has completed and before executing the statements following the try/catch block.
- The finally block will execute irrespective of occurrence an exception.
- If an exception is thrown, the finally block will execute even if no catch statement matches the exception
- Useful for closing and freeing up tasks.
- The finally clause is optional

Example

```
class FinallyDemo {
  // Through an exception out of the method.
  static void procA() {
    try {
      System.out.println("inside procA");
      throw new RuntimeException("demo");
    } finally {
      System.out.println("procA's finally");
    }
  }

  // Return from within a try block.
  static void procB() {
    try {
      System.out.println("inside procB");
      return;
    } finally {
      System.out.println("procB's finally");
    }
  }
```

```
  // Execute a try block normally.
  static void procC() {
    try {
      System.out.println("inside procC");
    } finally {
      System.out.println("procC's finally");
    }
  }

  public static void main(String args[]) {
    try {
      procA();
    } catch (Exception e) {
      System.out.println("Exception caught");
    }
    procB();
    procC();
  }
}
```

Some common built-in Exception classes

- ArithmeticException Unchecked
- ArrayIndexOutOfBoundsException Unchecked
- NullPointerException Unchecked
- ClassNotFoundException checked exception
- StringIndexOutOfBounds unchecked
- IndexOutOfBoundsException unchecked

- You can create your own exception subclass by just defining a subclass of Exception class

User defined exception

```
class MyException extends Exception {
	private int detail;
	MyException(int a) {
		detail = a;
	}
	public String toString() {
		return "MyException[" + detail + "]";
	}
}
class ExceptionDemo {
	static void compute(int a) throws MyException {
		System.out.println("Called compute(" + a + ")");
		if(a > 10)
			throw new MyException(a);
		System.out.println("Normal exit");
	}
	public static void main(String args[]) {
		try {
			compute(1);
			compute(20);
		} catch (MyException e) {
			System.out.println("Caught " + e);
		}
	}
}
```

Chained Exception

- Associates another exception with an exception
- Second exception describes the cause of the first exception.
- To allow chained exceptions, two constructors and two methods were added to Throwable.
  - The constructors:
    - Throwable(Throwable causeExc)
    - Throwable(String msg, Throwable causeExc)
  - The methods
    - Throwable getCause( )
    - Throwable initCause(Throwable causeExc)

Example of chained exceptions

```
// Demonstrate exception chaining.
class ChainExcDemo {
	static void demoproc() {
		// create an exception
		NullPointerException e = new NullPointerException("top layer");
		// add a cause
		e.initCause(new ArithmeticException("cause"));
		throw e;
	}

	public static void main(String args[]) {
		try {
			demoproc();
		} catch(NullPointerException e) {
			System.out.println("Caught: " + e);
			System.out.println("Original cause: " +e.getCause());
		}
	}
}
```