Java System: Exceptions

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Revisiting Errors

- Previously, you learned about the three main types of errors:
  1. Syntax Errors: refers to errors in the structure of a program and the rules about that structure.
  2. **Runtime Errors**: refers to errors that occur during program execution
  3. Semantic/Logic Errors: refers to errors in the logic of a program

- Runtime Errors are also referred to as ***Exceptions***

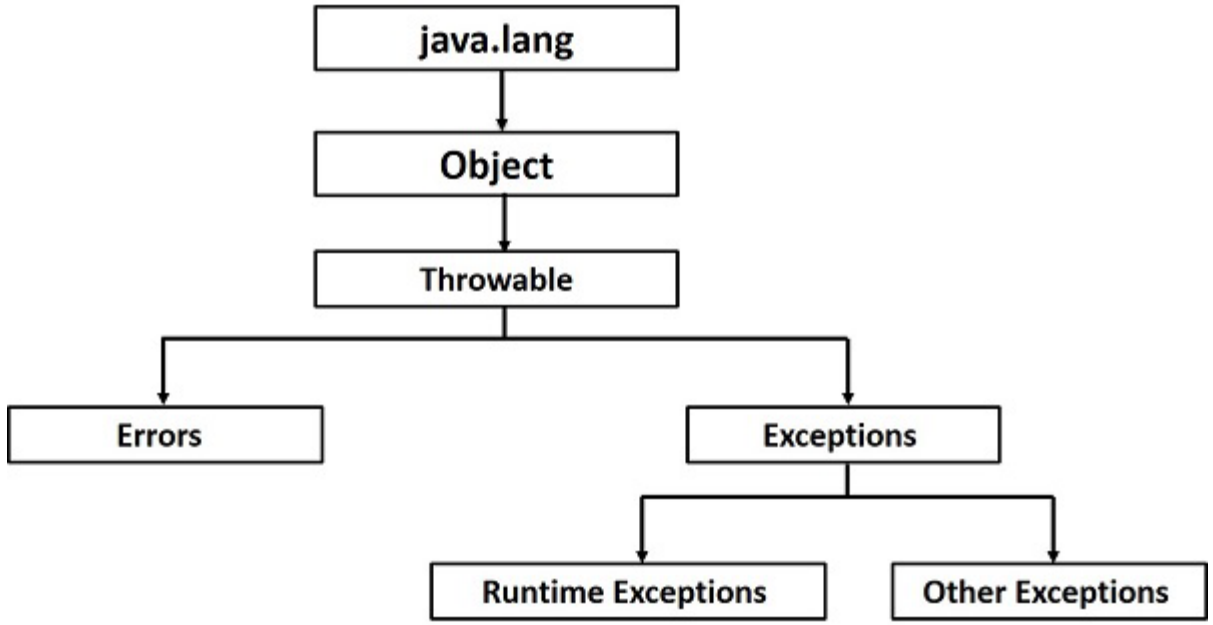
Exceptions

- An **exception** is an event that occurs during the execution of a program, which disrupts its execution.
- Exceptions can rise due to many reasons, including improper use of functions or operators, user input, logic errors, hardware and OS limitations, etc.
- Examples:
  - trying to access a list with an invalid index
  - trying to open a non-existent file
  - trying to parse a string using an invalid character
  - trying to converting a string to an integer
  - ...

Exception Hierarchy

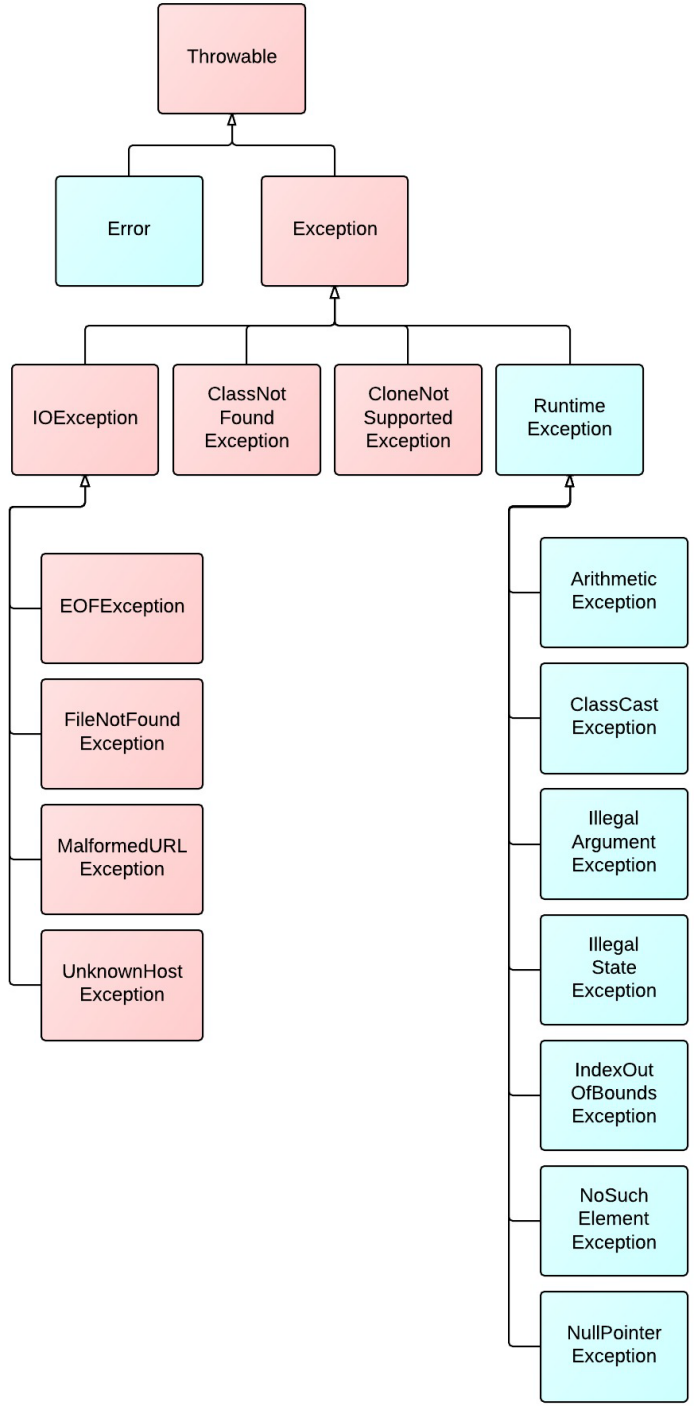
- All Exception are of Type Throwable
- Errors are for VM issues like OutOfMemory, NoSuchMethod
- https://www.tutorialspoint.com/java/lang/java_lang_errors.htm

- Exceptions are from things that your code does while running



Exception Hierarchy

- IOExceptions are encountered when dealing with files and other input/output libraries
- RuntimeExceptions are often from your internal methods
  - Invalid indices, math errors, data structure access errors, null pointer errors



Exceptions - Exception Handing

- Exceptions can be handled is several ways:
  - Using conditionals: the code handles scenarios where errors may occur.
  - Using **try/except** blocks: placing code that may fail within a try/except block.

Try/Except

Exceptions – Try/Except Block – (Python)

```
try:
      <code segment that may cause error>
except (<type>, <type>, ...) as <obj name>:
      <action to take when an exception occurs>
else:
      <action to take when no exception occurs>
finally:
      <action to take in any case>
```

optional: can target certain types of exceptions

optional: a named exception object for accessing info on exception

optional: executed only if no exceptions

optional: executed regardless of the code outcome

Exceptions – Try/Except Block – (Java)

required: a named exception object for accessing info on exception

required: one or more types of exception to target

```
try{
    //<code segment causing error>
} catch(<type> <obj_name>){
    //<action to take>
}
```

Exceptions – Try/Except Block – (Java)

```
try{
    //<code segment causing error>
} catch(<type> | <type> | ... <obj_name>){
    //<action to take>
} catch(<type> | <type> | ... <obj_name>){
    //<action to take>
}finally{
    //<action to always take>
}
```

required: one or more types of exception to target

optional: exceptions to handle if earlier block doesn't

optional: executed regardless of the code outcome

Exceptions – Try/Except Block – (Java)

```
try {
    FileReader file_reader = new FileReader(file);
    BufferedReader buffered_reader = new BufferedReader(file_reader);
    String line = buffered_reader.readLine();
    while (line != "") {
        System.out.println(line);
        line = buffered_reader.readLine();
    }
} catch (FileNotFoundException e) {
    System.err.println("Could not find file: " + file.getAbsolutePath());
    System.exit(1);
} catch (IOException e) {
    System.err.println("Error reading from file: " + file.getAbsolutePath());
    System.exit(1);
}
```

Exceptions and Closing Files

Closing File – With Finally

```
FileReader file_reader = null;
try {
    file_reader = new FileReader(file);
    /// ...
} catch (FileNotFoundException e) {
    System.err.println("Could not find file: " + file.getAbsolutePath());
    System.exit(1);
}  finally{
    try{
        file_reader.close();
    } catch (IOException e) {
    }
}
```

Closing File Using “with resources” Style

```
String filename = args[0];
File file = new File(filename);
try (FileReader file_reader = new FileReader(file); ){
   /// ...
} catch (FileNotFoundException e) {
   System.err.println("Could not find file: " + file.getAbsolutePath());
   System.exit(1);
} catch (IOException e) {
   System.err.println("Could not close file: " + file.getAbsolutePath());
   System.exit(1);
}
```

try (//with resources) {} - ensures that resource is closed at end of try

Closing File Using “with resources” Style

```
String filename = args[0];
File file = new File(filename);
try (FileReader file_reader = new FileReader(file);
    BufferedReader buffered_reader = new BufferedReader(file_reader);) {
   /// ...
} catch (FileNotFoundException e) {
   System.err.println("Could not find file: " + file.getAbsolutePath());
   System.exit(1);
} catch (IOException e) {
   System.err.println("Could not close file: " + file.getAbsolutePath());
   System.exit(1);
}
```

try (//with resources) {} - ensures that resources are closed at end of try

Debugging

Produce the stack trace from program crashing

- If you want the stack trace you usually saw (for debugging purposes)
- Use e.printStackTrace()

```
String filename = args[0];
File file = new File(filename);
try (FileReader file_reader = new FileReader(file);
    BufferedReader buffered_reader = new BufferedReader(file_reader);) {
   /// ...
} catch (IOException e) {
   e.printStackTrace();
   System.err.println("Could not close file: " + file.getAbsolutePath());
   System.exit(1);
}
```

- e.getMessage() also useful for accessing previous exception message

Throwing Exceptions

Other Exception Handling

1. **Functions Throwing Exceptions**
   - When you discover error, create an exception object and pass it to the system. Two steps:

   1. header says it might throw an exception

```
public void amethod() throws IllegalArgumentException
```

   2. if an error occurs, create the exception object and throw it

```
throw new IllegalArgumentException ("Invalid function parameter");
```

Example of throw processing

```
public static double div(double x, double y) throws IllegalArgumentException{
        if (y == 0){
                throw new IllegalArgumentException (“Can’t divide by 0”);
        }
        return x / y;
}
```

Your Own Exceptions?

This will be clearer when we reach Classes and Objects

```
//********************************************************************
//  OutOfRangeException.java       Java Foundations
//
// Represents an exceptional condition in which a value is out of
//  some particular range.
//********************************************************************

public class OutOfRangeException extends Exception
{
   // Sets up the exception object with a particular message.
   public OutOfRangeException (String message)
   {
      super (message);
   }
}
```

```
public static void main (String[] args) throws OutOfRangeException {
    final int MIN = 25, MAX = 40;
    Scanner scan = new Scanner (System.in);
    OutOfRangeException problem = new OutOfRangeException ("Input value is out of range.");
    System.out.print ("Enter an integer value between " + MIN + " and " + MAX + " : ");
    int value = scan.nextInt();
    // Determine if the exception should be thrown
    if (value < MIN || value > MAX)
        throw problem;
    System.out.println ("End of main method."); // may never reach
  }
}
```

Onward to … Classes and Objects.

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