EXCEPTIONS
OVERVIEW

WHAT ARE EXCEPTIONS?

- An *exception* is an event, which occurs during the execution of a program, that disrupts the normal flow of the program's instructions (e.g. accessing null reference, array access out of bound, etc.)
- An *exception* is an object that represents an error that occurred within a method and contains:
  - Information about the error including its type
  - The state of the program when the error occurred
- Exception objects can be *thrown* and *caught*

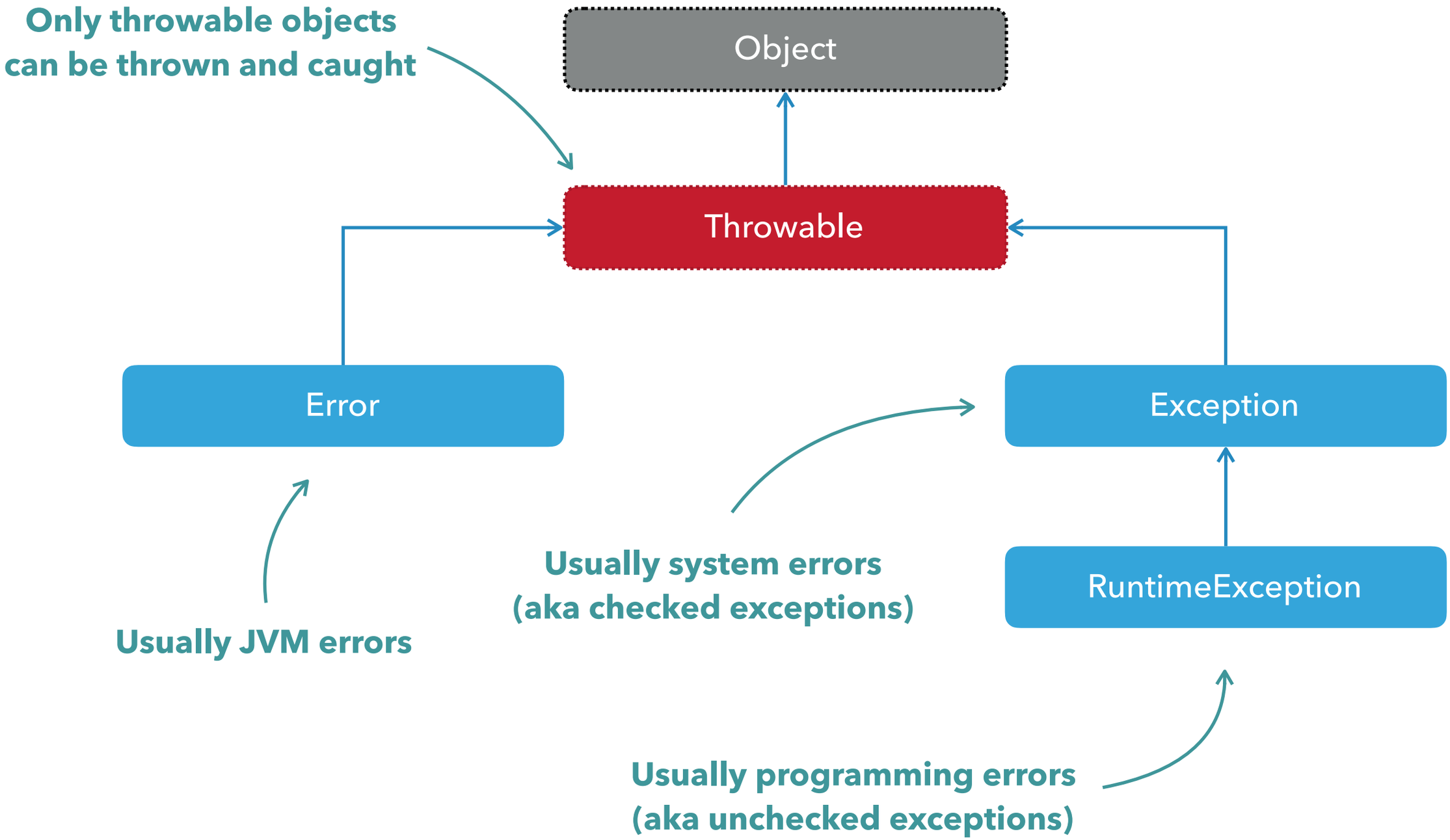
CLASSIFYING ERRORS AND EXCEPTIONS

- JVM errors
  - e.g. OutOfMemoryError, StackOverflowError, etc.
- System errors
  - e.g. FileNotFoundException, IOException, etc.
- Programming errors
  - e.g. NullPointerException, ArrayIndexOutOfBoundsException, ArithmeticException, etc.

WHY USE EXCEPTIONS?

- Exceptions separate error handling code from regular code
  - Algorithms become cleaner and less clutter
- Exceptions propagate errors up the call stack
  - Nested methods do not have to explicitly catch-and-forward errors
- Exception classes group and differentiate error types
  - You can group errors by their parent class (polymorphism)
  - Differentiate errors by their actual class
- Exceptions standardise error handling

EXCEPTION TYPES HIERARCHY



CHECKED EXCEPTIONS

- Normally used to denote expected system failures with reasonable recover (e.g. missing file on the file system or connection establishment failure)
- The compiler enforces that you handle them explicitly
- Methods that might produce checked exceptions must declare it in method signature
- Methods that invoke other methods that throw checked exceptions must either:
  - Handle them (i.e. they can be reasonably expected to recover)
  - Declare in method signature that it might produce checked exception thus allowing it to propagate
- Exception class and its derivatives are **checked** (except RuntimeException)

UNCHECKED EXCEPTIONS

- Normally used to denote unexpected programming or logical errors
- The compiler does not enforce that you handle them explicitly
- It is assumed that the application cannot do anything to recover from these exceptions at runtime
- Error and RuntimeException and its derivatives are **unchecked**

UNCHECKED EXCEPTION: CODE EXAMPLE

String does not reference to anything

```
String emptyString = null;
emptyString.isEmpty();
```

Calling method on something that does not exist is impossible and will raise NullPointerException

CHECKED EXCEPTION: METHOD SIGNATURE CODE EXAMPLE

Declaring that our method might throw exception and its type

```
public String readFile(String path) throws IOException {
    byte[] bytes = Files.readAllBytes(Paths.get(path));
    return new String(bytes);
}
```

Unsafe operation, because file might be broken or for some reason can't be read

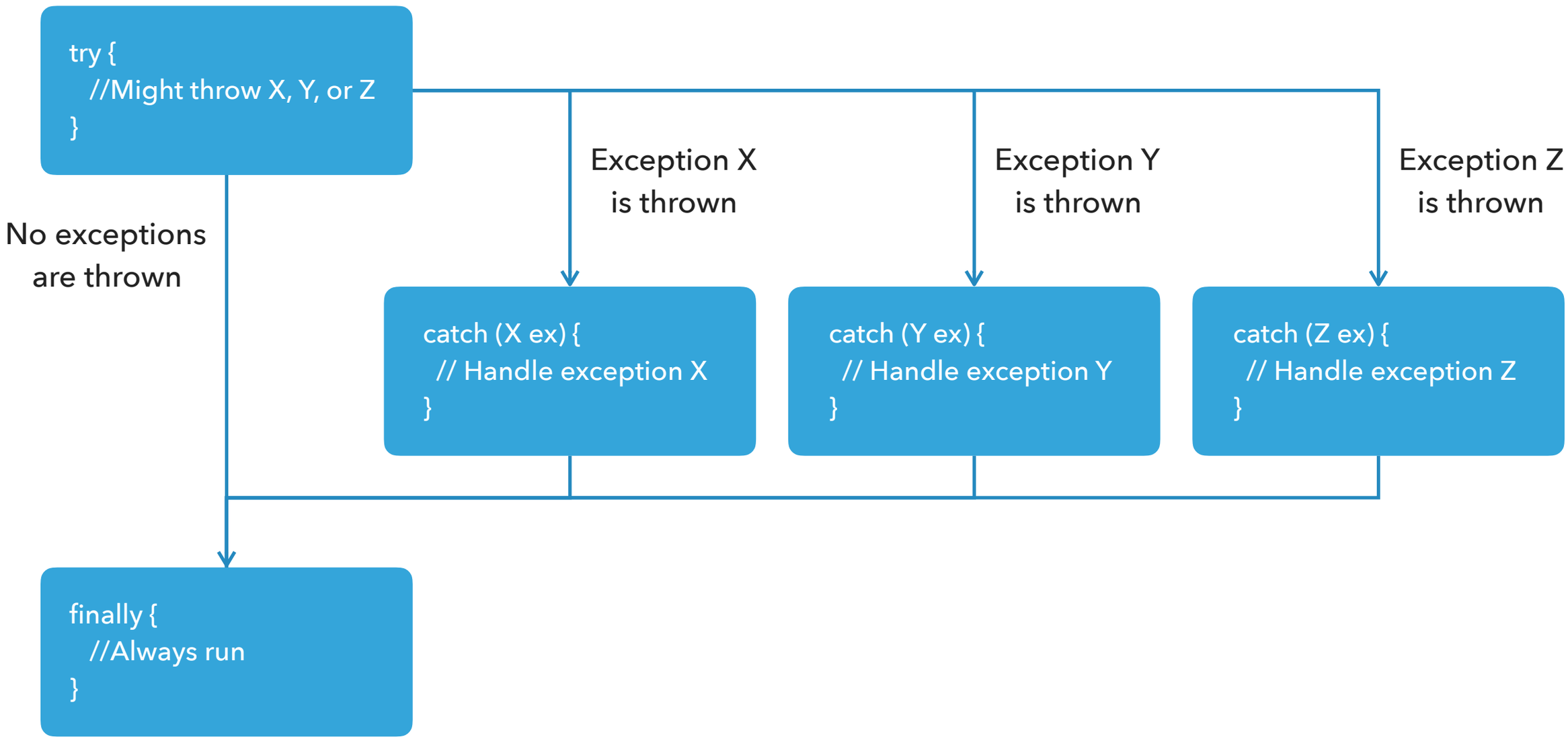
EXCEPTION LIFECYCLE

1. After an exception object is created, it is handed off to the runtime system (*thrown*)
2. The runtime system attempts to find a handler for the exception by backtracking the ordered list of methods that had been called (aka the call stack)
3. If a handler is found, the exception is *caught:*
    3.1. It is handled, or possibly re-thrown
4. If the handler is not found (the runtime backtracks all the way to the main() method):
    4.1. The exception stack trace is printed to the standard error channel
    4.2. Application aborts execution

HANDLING EXCEPTIONS

- Java supports special try-catch-finally control structure that allows to handle and recover from exceptions
- Consists of 3 blocks:
  - try block
    - Must be present when invoking unsafe method and declared only once
    - Specifies that executed code block will be handled if exception occurs
  - catch block
    - Must be present and can be declared as many times as required
    - Specifies how to handle concrete exception or group of exceptions
  - finally block
    - Optional and declared only once (Must be present if catch block is absent)
    - Always executes action after try and catch blocks (if any declared)

TRY-CATCH-FINALLY: FLOW CHART



TRY-CATCH-FINALLY: CODE EXAMPLE

Unsafe method is the one with throws declaration in signature

```
try {
    //Invoke unsafe method
} catch (Exception1 ex) {
    //Handle Exception1 type
} catch (Exception2 ex) {
    //Handle exception2 type
} finally {
    //This part always executed
    //after try and catch blocks
}
```

Handling all exceptions declared in the signature

REFERENCES

- https://docs.oracle.com/javase/tutorial/essential/exceptions/
- https://beginnersbook.com/2013/04/try-catch-in-java/
- https://www.tutorialspoint.com/java/java_exceptions.htm
- https://stackify.com/best-practices-exceptions-java/