Lecture 14 Summary

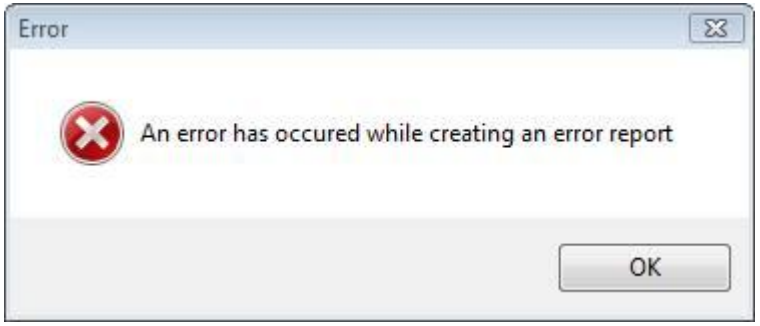
- Exceptions vs. Errors
- Exceptions vs. RuntimeExceptions
- `try…catch…finally`
- `throw` and `throws`

By the end of this lecture, you will be able to differentiate between errors, exceptions, and runtime exceptions.

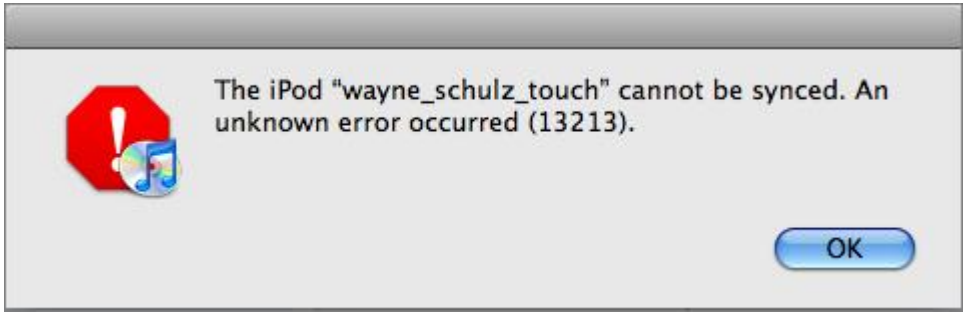
You will also be able to describe the class model for exceptions in Java.

You will also be able to create, throw and catch your own exceptions.

What's the worst/funniest error message you've seen on your computer?


Error
An error has occured while creating an error report
OK


Data Execution Prevention - Microsoft Windows
To help protect your computer, Windows has closed this program.
Name: Windows Explorer
Publisher: Microsoft Corporation
Close Message
Data Execution Prevention helps protect against damage from viruses and other security threats. What should I do?


The iPod "wayne_schulz_touch" cannot be synced. An unknown error occurred (13213).
OK

How have you handled errors in *your* programs so far?

Error Codes

- Did you run into any difficulties using atof?
  - what happens when you enter 0?
  - what happens when you enter “hello”?

- strtod: sets the value of a global variable called `errno` to something other than 0 (depending on the type of error).

If you considered all of the possible stuff someone could type into your program and handled it “nicely”, what would the code look like in C?

Reporting Errors (GNOME)

- GNOME Human Interface Guidelines 2.2
  - 11.2 Warning and Error Messages:

"A good warning or error message contains two elements:

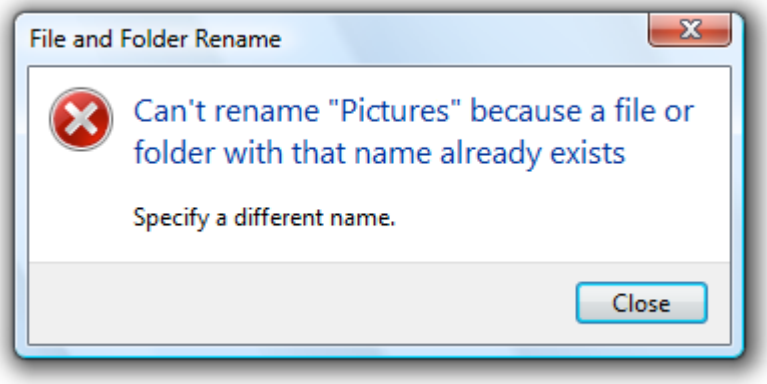
1. A brief description of the problem.
2. A list of ways the user can remedy the problem.

Both of these elements should be presented in non-technical, jargon-free language, unless your target audience is particularly technically-minded."

Reporting Errors (Vista)

- Windows User Experience Interaction Guidelines (Windows Vista)

“Effective error messages inform users that a problem occurred, explain why it happened, and provide a solution so users can fix the problem.”

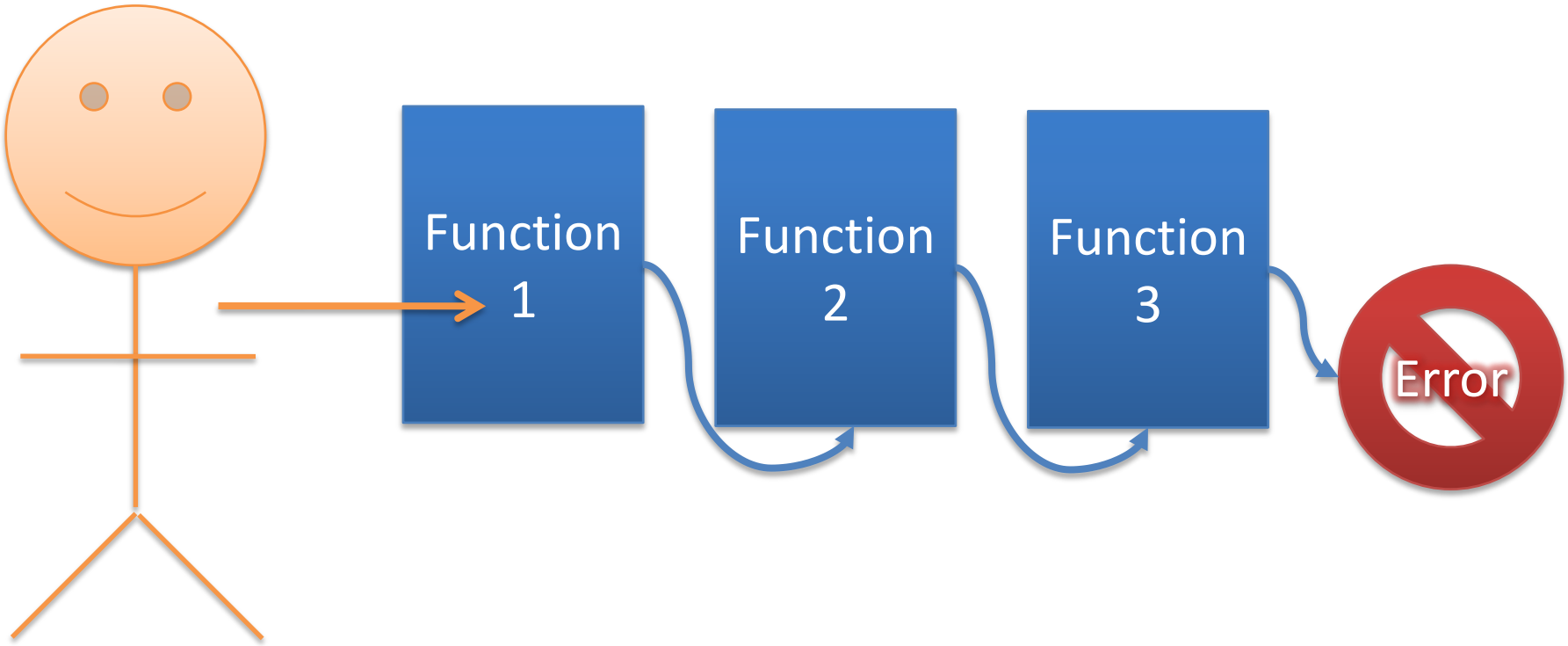


Reporting Errors (Apple)

- Apple Human Interface Guidelines

"Provide useful error messages to users when something does go wrong. An error message should clearly convey what happened, why it happened, and the options for proceeding."

Dealing with Errors



Where would you put the code to handle the error?

Possibilities

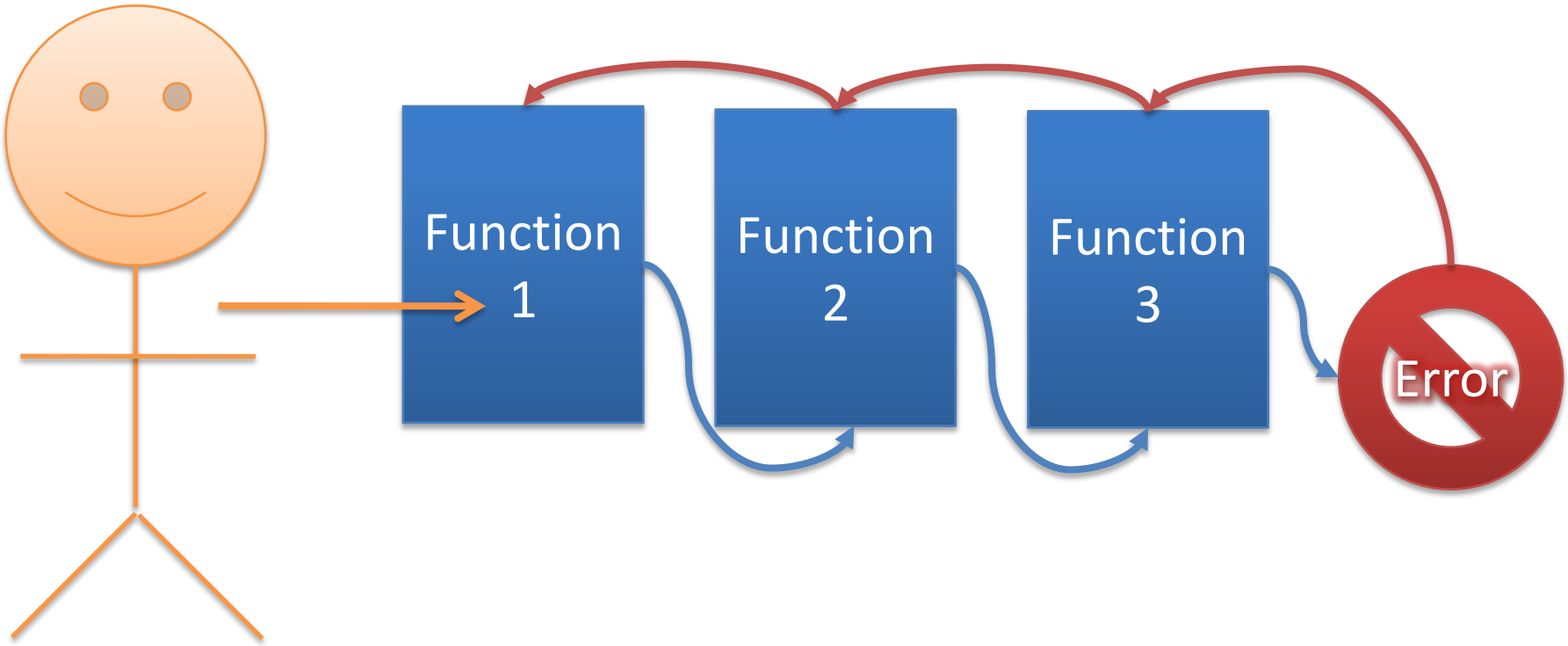
- Handled in Function 3:
  - Advantage: know specific reason for error
  - Disadvantage: don't know context

- Handled in Function 1:
  - Advantage: know about context
  - Disadvantage: need code added to Functions 1 & 2 to pass back info about reason for error

Exceptions

- Basic idea:
  - Program flows according to usual constructs (sequential, conditional, iterative execution, etc.)
  - Something *exceptional* happens
  - Interrupt normal behaviour by *throwing* an exception (an object with error information)
  - Somewhere (anywhere) up the call stack, this exception can be *caught* and handled
  - Transfer control to the catching method (removing everything below it from the call stack)

Throwing an Exception



Java Exception Handling Keywords

```
try
catch
finally

throw
throws
```

Catching an Exception

```
try
{
    // ... some code which might throw an exception
}
catch (Exception x)
{
    // ... code which handles the exception
}
finally
{
    // ... code which is executed no matter what
}
```

Example

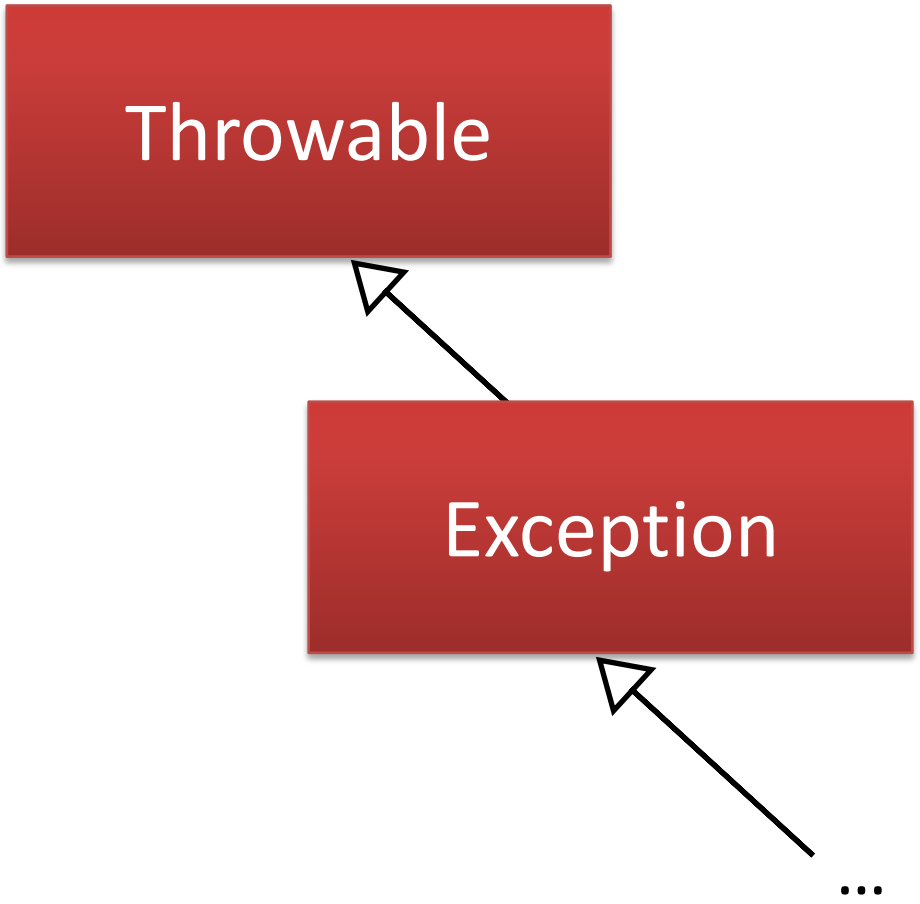
```
import java.util.ArrayList;

public class ExceptionExample
{
    public static void main(String[] args)
    {
        ArrayList<String> strs = new ArrayList<String>();
        String s = strs.get(100);
        System.out.println(s);
    }
}
```

What will happen?

Example

```
import java.util.ArrayList;

public class ExceptionExample
{
    public static void main(String[] args)
    {
        try
        {
            ArrayList<String> strs = new ArrayList<String>();
            String s = strs.get(100);
            System.out.println(s);
        }
        catch (Exception x)
        {
            System.err.println("An error occured");
            System.err.println(x.getMessage());
            x.printStackTrace(System.err);
        }
    }
}
```

Exceptions are Objects



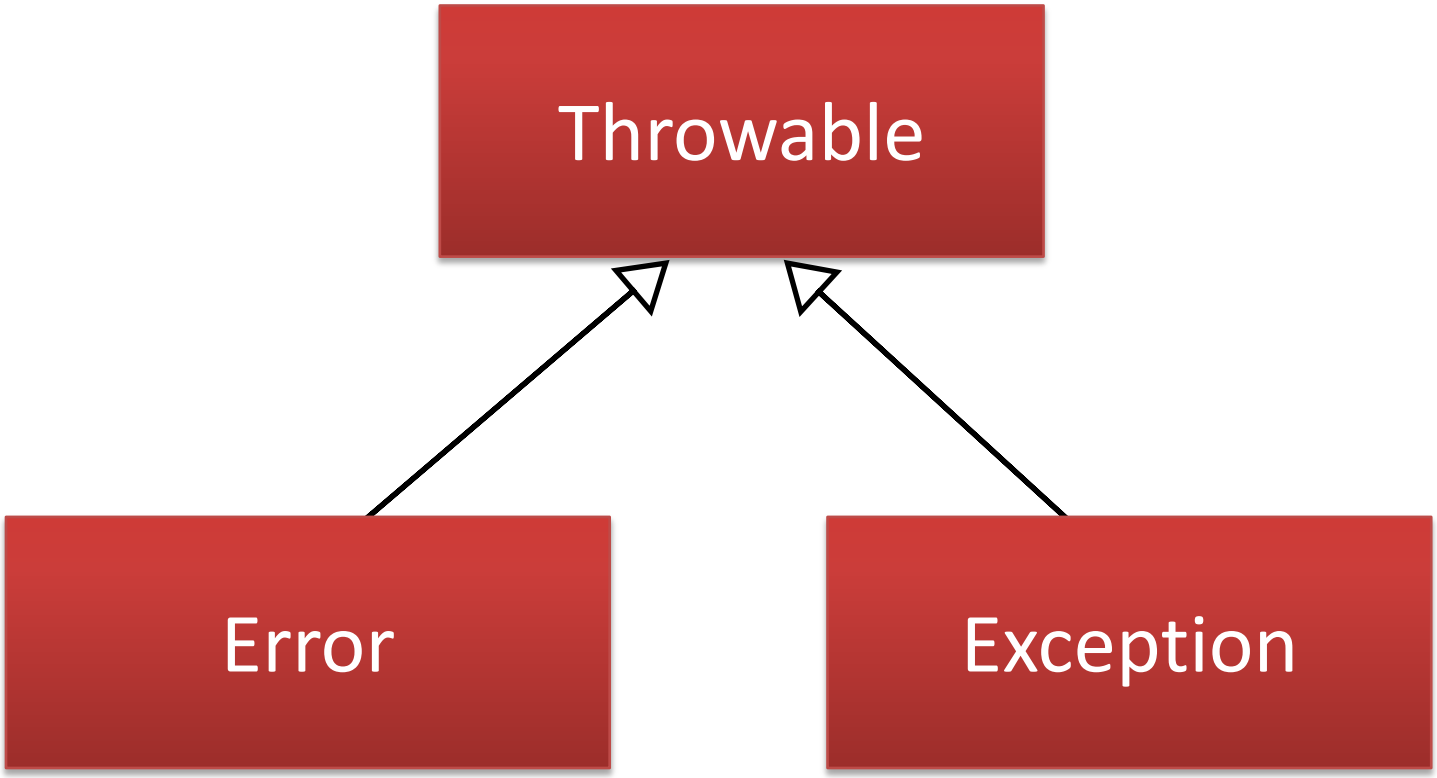
Example: Out of Bounds

```
import java.util.ArrayList;

public class ExceptionExample
{
    public static void main(String[] args)
    {
        try
        {
            ArrayList<String> strs = new ArrayList<String>();
            String s = strs.get(100);
            System.out.println(s);
        }
        catch (ArrayIndexOutOfBoundsException x)
        {
            System.err.println("An error occured");
            System.err.println(x.getMessage());
            x.printStackTrace(System.err);
        }
    }
}
```

Example: Parsing Integers

```
public class Number
{
    public static void main(String[] args)
    {
        int count = 0;

        while(count < args.length)
        {
            try
            {
                int x = Integer.parseInt(args[count]);
                System.out.println("Args[" + count + "] = " + x);
            }
            catch(NumberFormatException x)
            {
                System.err.println("Invalid parameter:" + count);
                System.err.println(x.getMessage());
                System.err.println("Stack trace:");
                x.printStackTrace(System.err);
            }
            count++;
        }
    }
}
```

Errors vs. Exceptions



Errors vs. Exceptions

- Errors
  - Something the programmer **should not** reasonably be expected to recover from.

- Exceptions
  - Something the programmer **should** reasonably be expected to recover from

Exercise: Error or Exception

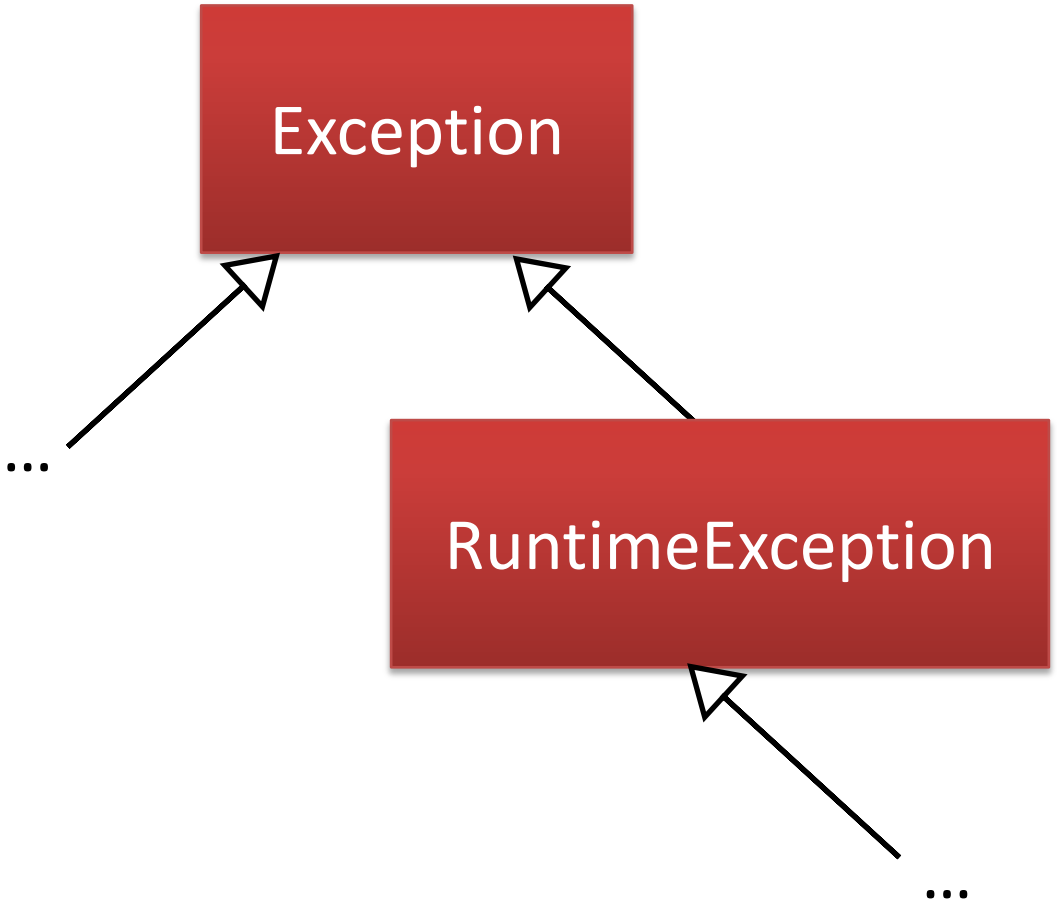
- Read data outside array boundary
- Heap is full (out of memory)
- Null pointer
- File does not exist
- Hard disk failure

Catching Multiple Exceptions

```
try
{
    // ... some code which might throw an exception
}
catch (ExceptionOne x)
{
    // ... code which handles ExceptionOne's
}
catch (ExceptionTwo x)
{
    // ... code which handles ExceptionTwo's
}
```

```
import java.io.*;

public class FileExample
{
    public static void main(String[] args)
    {
        try
        {
            FileReader reader = new FileReader(args[0]);

            int c = reader.read();
            reader.close();
        }
        catch (ArrayIndexOutOfBoundsException e)
        {
            System.err("Must specify an argument");
        }
        catch (FileNotFoundException e)
        {
            System.err("File not found: " + args[0]);
        }
        catch (IOException e)
        {
            System.err("Error reading file: " + args[0]);
            e.printStackTrace();
        }
    }
}
```

Checked vs. Unchecked Exceptions



Checked vs. Unchecked Exceptions

- Checked
  - Subclasses of Exception that **do not** inherit from RuntimeException
  - Compiler will complain if uncaught

- Unchecked
  - Subclasses of RuntimeException
  - Can be ignored by the programmer

Exercise

- Lookup ClassCastException in Java API
  - Is it checked or unchecked?

Creating Exceptions

```
public class DriverMismatchException
    extends Exception
{
    public DriverMismatchException(String message)
    {
        super(message);
    }
}
```

Throwing Exceptions

```
public class Driver
{
    private Car car;

    public Driver(Car car)
            throws DriverMismatchException
    {
        if (car.getDriver() != this)
        {
            throw new DriverMismatchException(
                    "Car does not match driver");
        }

        this.car = car;
    }
}
```

Creating & Throwing Exceptions

- Creating Exceptions
  - Inherit from Exception
  - Can inherit from subclass of Exception
    - e.g., IllegalArgumentException, RuntimeException

- Throwing Exceptions
  - Use **`throw`** command
  - If checked, requires a **`throws` declaration**

Example: Constructors

- Has no return value
- If an invalid state is reached, exceptions are a nice way to handle the error

- Is there another way?

Exercise

- Look up one of each of the following:
  - an Error
  - an unchecked Exception
  - a checked Exception

- Draw the class model starting at the Throwable class.

Lecture 14 Summary

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Next Class

- Collections