CS206

I/O Methods

Files/Exceptions

Inheritance

Strings

- Strings - "a", “abc" — double quotes
- Characters - ‘a' — single quotes
- Declaring String objects

```
String name;
String name = new String();
```

- Declaring String objects with initialization

```
String name1 = "Fred";
String name2 = new String(“Fred");
```

There are subtle differences between these two declarations.

`.equals:` Object Equality

- Use == only when comparing base types
  - int, float, …
- Otherwise use .equals

```
public class StringEquals {
  public static void main(String[] args) {
    String str1 = new String("one");
    String str2 = new String("one");
    System.out.println("str1==str2: "
            + str1 == str2);
    System.out.println("str1==str2: "
            + (str1 == str2));
    System.out.println("str1.equals(str2): "
            + str1.equals(str2));
  }
}
```

Wrapper Types

- Most data structures and algorithms in Java's libraries only work with object types (not base types).
- To get around this obstacle, Java defines a wrapper class for each base type.
- Implicitly converting between base types and their wrapper types is known as automatic boxing and unboxing.

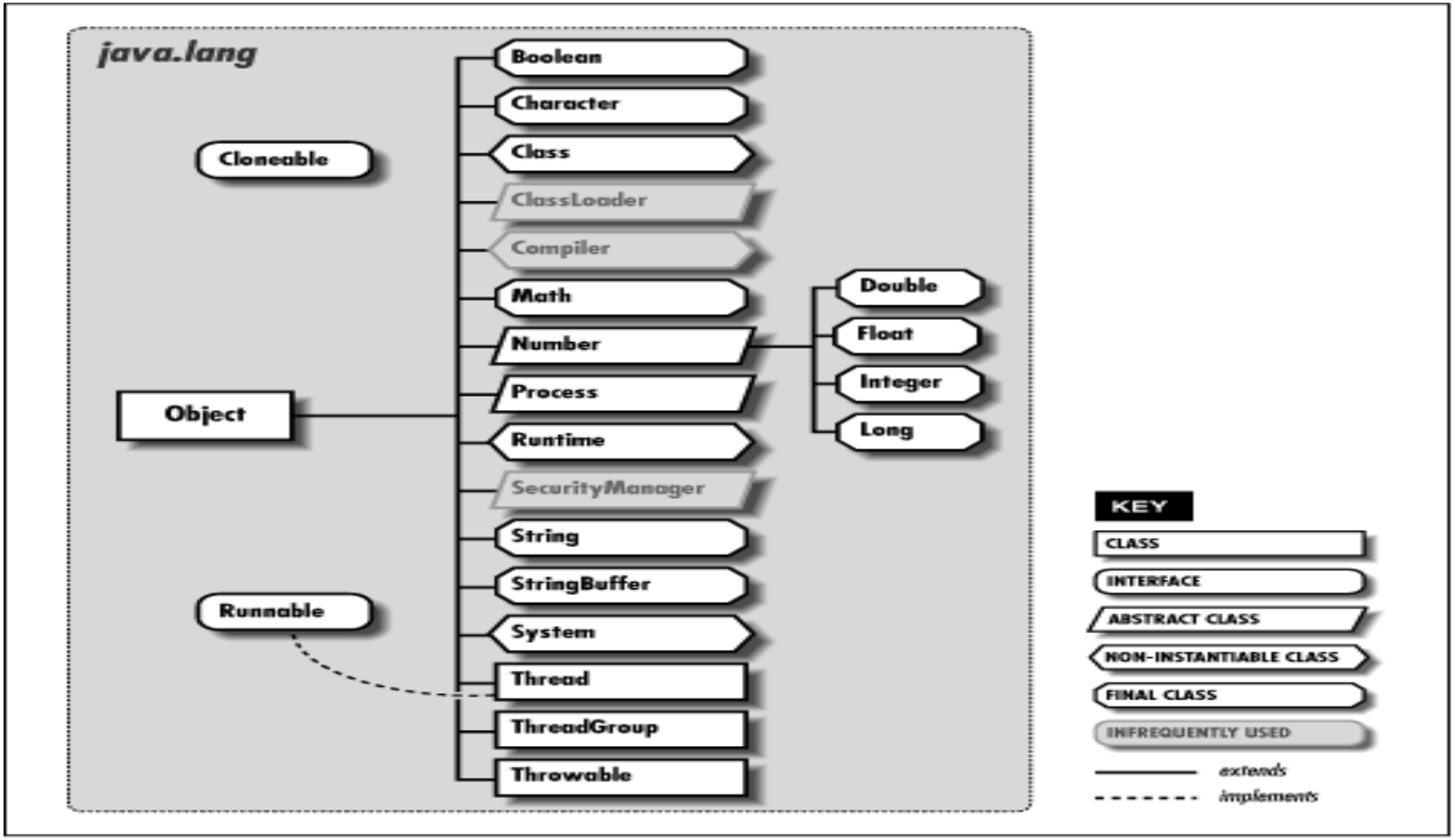
Autoboxing and unboxing

```
public class Wrapper
{
    public void w1(Integer ii) {
        System.out.println(ii);
        int i3 = ii; // auto unboxing
        System.out.println(i3*i3);
        System.out.println(i3*ii); // auto unboxing
    }
    public static void main(String[] args) {
        Wrapper w = new Wrapper();
        w.w1(5); // autoboxing
    }
}
```

What you should know/review

- variables
- expressions
- operators
- methods
  - parameters
  - return value
- conditionals
- `for`/`while` loops
- class design and object construction
  - instance variables
  - constructor
  - getters/setters
  - class methods
  - `new`
- arrays
- arrays of objects
- `String`

Start of the Java class hierarchy



http://web.deu.edu.tr/doc/oreily/java/langref/ch10_js.htm

Java Object Methods

- **public boolean equals(Object ob)**
- **public String toString()**
- public Class getClass()
- protected Object clone()
- protected void finalize()
- public int hashCode()
- public void notify()
- public void notifyAll()
- public void wait()
- public void wait(long l)
- public void wait(long l, int ii)

Casting, Classes and Inheritance

- Suppose: SPCA shelter for only dogs and cats
- Desire: A program that tracks all animals at shelter
- Approach
  - Create 3 classes, Dog and Cat that extend (inherit from) from Animal.
  - Use single array to hold all animals
  - But deal with dogs cats separately later

```
public class Animal {}
public class Dog extends Animal {}
public class Cat extends Animal {}

public class Shelter {
    Animal[] animals = new Animal[100];
    int animalCount=0;
    public void addAnimal(Animal animal) {
        animals[animalCount++]=animal;
    }
    public Animal getAnimal(int location) {
        return animals[location];
    }
   public static void main(String[] args) {
        Shelter shelter = new Shelter();
        shelter.addAnimal(new Dog());
        shelter.addAnimal(new Cat());
        Animal aa = shelter.getAnimal(1);
        if (aa instanceof Cat) {
            Cat c = (Cat)shelter.getAnimal(1
            System.out.println(c);
    }}}
```

Exceptions

- Unexpected events during execution
  - unavailable resource
  - unexpected input
  - logical error
- In Java, exceptions are objects
- 2 options with an Exception
  - "Throw" it
    - this says that the exception must be handled elsewhere
  - "Catch" it.
    - handle the problem here and now

Catching Exceptions

- Exception handling
- `try-catch`
- An exception is caught by having control transfer to the matching `catch` block

```
try {
    guardedBody
} catch (exceptionType1  variable1) {
    remedyBody1
} catch (exceptionType2  variable2) {
    remedyBody2
} ...
    ...
```

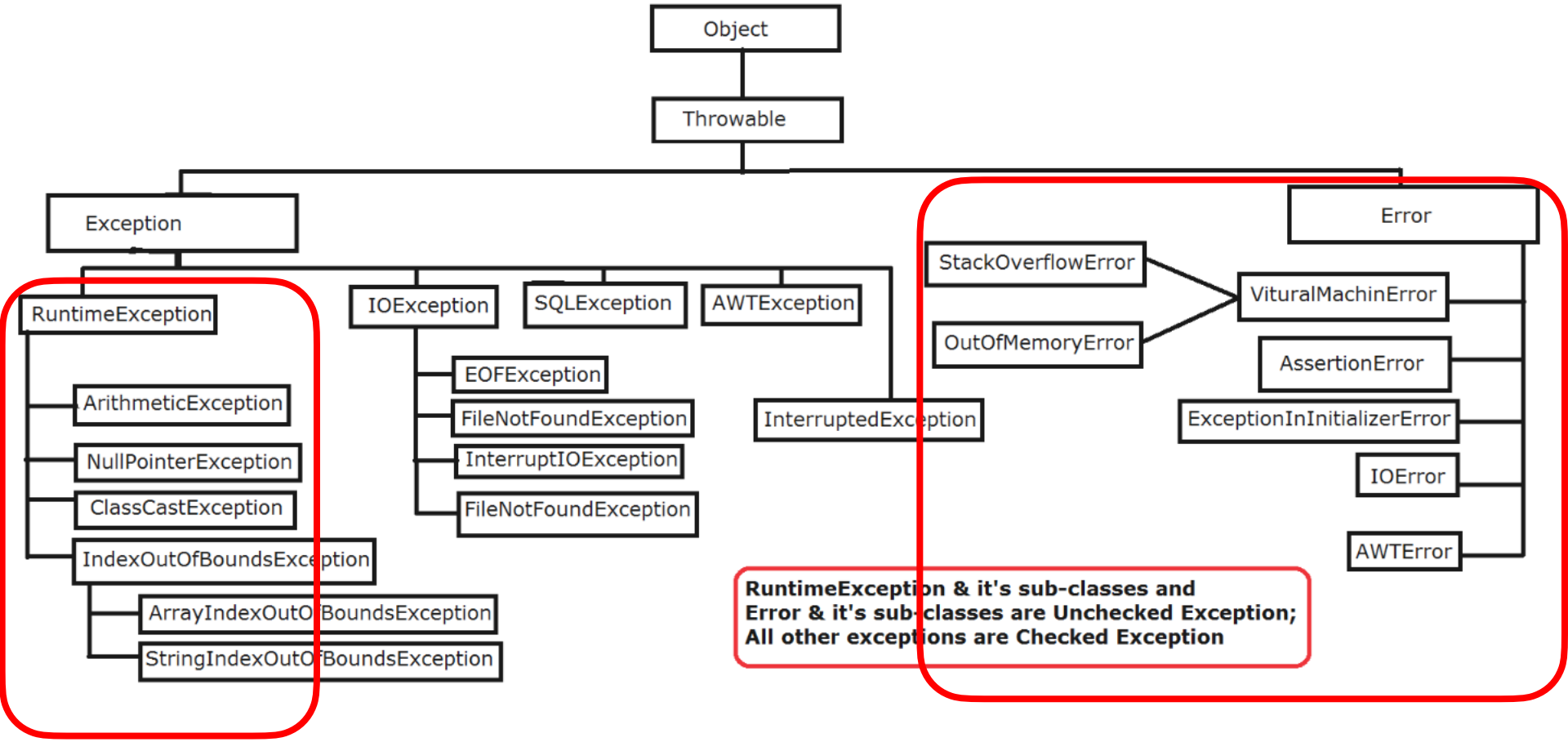
- If no exception occurs, all `catch` blocks are ignored

Throwing Exceptions

- An exception is thrown
  - implicitly by the JVM because of errors
  - explicitly by code
- Exceptions are objects
  - throw an existing/predefined one
  - make a new one
- Method signature – `throws`

```
public static int parseInt(String s)
throws NumberFormatException
```

Java's Exception Hierarchy



Reading the Keyboard

- `System.in` is, by default, set to receive keyboard input
- Use Scanner to read from keyboard
  - Do NOT use scanner otherwise

```java
public class Student {
    String name;
    int age;

    public Student(String n, int a) {
        name = n;
        age = a;
    }

    public String toString() {
        StringBuilder sb =
           new StringBuilder("Details.............");
        sb.append("\nName: “).append(this.name);
        sb.append(“\nAge:  ").append(age);
        return sb.toString();
    }
```

```java
public Student() throws IOException, InputMismatchException {
        this(); // call the default constructor to be sure that the variabl
        try (Scanner scanner = new Scanner(System.in);) {
            System.out.print("Enter student name: ");
            name = scanner.nextLine();
            System.out.print("Enter Age: “);
            age = scanner.nextInt();
        } finally {}
    }
```

Handling Exceptions
try-catch

```
public static void main2(String[] args) {
        Scanner scanner = new Scanner(System.in);
        String name;
        int age;
        System.out.print("Enter student name: ");
        name = scanner.nextLine();
        try {
            System.out.print("Enter Age: ");
            age = scanner.nextInt();
        } catch (InputMismatchException e) {
            System.err.println("problem " + e);
            return;
        }
        Student student = new Student(name, age);
        System.out.println("\n" + student.toString());
    }
```

main2 — looks like main but will not be exectuted.

Exceptions should be handled as soon as possible.

try-catch should enclose as little code as possible

Handling Exceptions
throws

Sometimes it is better to handle exceptions elsewhere ..

```
public Student(InputStream inStream) throws IOException,
InputMismatchException {
        this(); // call the default constructor to be sure that the
variables are initialized
        Scanner scanner = new Scanner(inStream);
        System.out.print("Enter student name: ");
        name = scanner.nextLine();
        System.out.print("Enter Age: ");
        age = scanner.nextInt();
    }

public static void main(String[] args) {
        try {
            Student student = new Student(System.in);
            System.out.println("\n" + student);
        } catch (IOException ioe) {
            System.err.println("problem " + ioe);
        } catch (InputMismatchException ime) {
            System.err.println("problem2 " + ime.toString());
        }
    }
```

Every throw must be caught

Never throw from main!!!!

Reading from Files

```
public void readOneLineTC()
 {
     BufferedReader br;
     try {
         br = new BufferedReader(
               new FileReader(fileName));
         br.readLine();
     } catch (FileNotFoundException fnf) {
         System.err.println("No file " + e);
     }  catch (IOException e) {
         System.err.println("Reading " + e);
     } finally {
         if (br!=null) {
             try {
                 br.close();
             } catch (IOException ioe) {
                 System.err.println("Close" + ioe);
             }
         }
     }
 }
```

```
public void readOneLineTCR(
    {
        try (BufferedReader br = new BufferedReader(
                        new FileReader(fileName));) {
            br.readLine();
            // close unnecessary in this formulation
        } catch (FileNotFoundException e) {
            System.err.println("Open " + e);
        } catch (IOException e) {
            System.err.println("Reading " + e);
        }
    }
```

finally == code that WILL be executed. Optional part of try-catch

Close can throw an exception so it too must be caught

if time, write program to demo try/catch/fianlly

Software Design Goals

- Robustness
  - software capable of error handling and recovery
  - programs should never crash
    - ending abruptly is not crashing
- Adaptability
  - software able to evolve over time and changing conditions (without huge rewrites)
- Reusability
  - same code is usable as component of different systems in various applications
  - The story of Mel — https://www.cs.utah.edu/~elb/folklore/mel.html

OOP Design Principles

- Modularity
  - programs should be composed of "modules" each of which do their own thing
    - each module is separately testable
  - Large programs are built by assembling modules
  - Objects (Classes) are modules
- Abstraction
  - Get to the core — non-removable essence of a thing
  - Most pencils are yellow, but yellowness does not required
- Encapsulation
  - Nothing outside a class should know about how the class works.
    - For instance, does the Object class have any instance variables. (Of what type?)
  - Allows programmer to totally change internals without external effect

OOP Design

- Responsibilities/Independence: divide the work into different classes, each with a different responsibility and are as independent as possible
- Behaviors: define the behaviors for each class carefully and precisely, so that the consequences of each action performed by a class will be well understood by other classes that interact with it.

Class Definition

- Primary means for abstraction in OOP
- Class determines
  - the way state information is stored – via instance variables
  - a set of behaviors – via methods
- Classes encapsulate
  - `private` instance variables
  - `public` accessor methods (getters)

Constructors

- Constructors are never inherited
- A class may invoke the constructor of the class it extends via a call to `super` with the appropriate parameters
  - e.g. `super()`
  - `super` must be in the first line of constructor
  - If no explicit call to `super`, then an implicit call to the zero-parameter `super` will be made
- A class make invoke other constructors of their own class using `this()`
  - `this` must be first
  - Cannot explicitly use both `super` and `this` **in single constructor**
  - See FileOpen.java for example