CS1007: Object Oriented Design and Programming in Java

Lecture #3

T 9/13

Shlomo Hershkop

shlomo@cs.columbia.edu

Outline

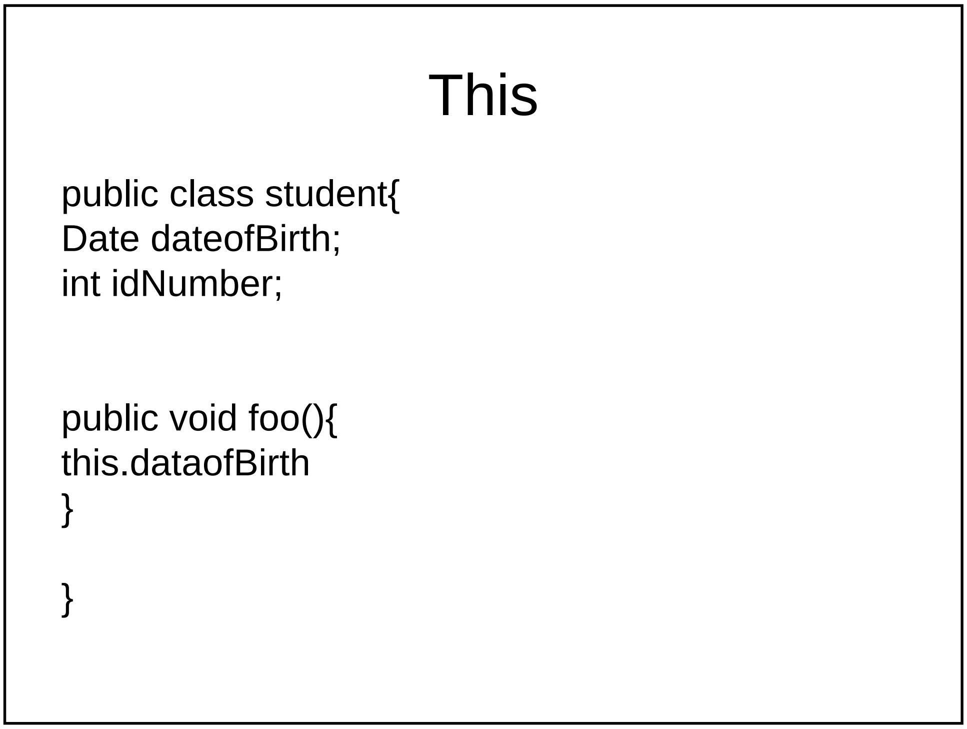
- Feedback
- Scopes
- Static
- Method Overloading
- Exception handling
- Basic classes
- Constructors
- Useful tools

Feedback

- More clarification on THIS
- Practical java examples
- More use of laptop screen for examples

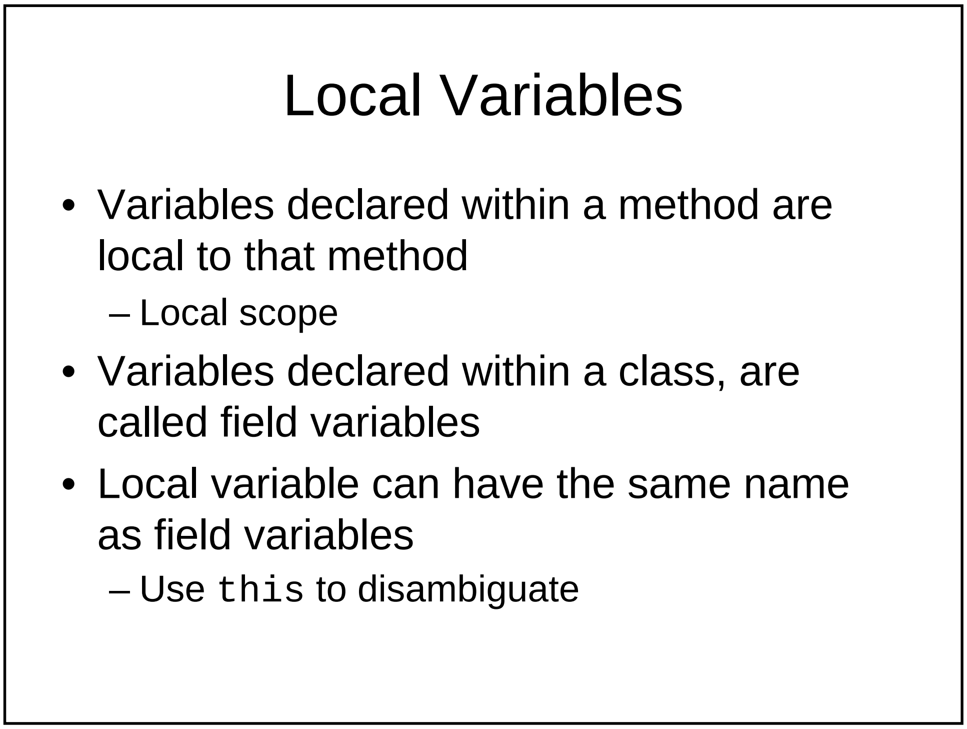
Announcements

- Homework 1 out
  - Start early
  - If you are having problems…you probably have not done HW0
  - Due Sept 27 midnight



This

```
public class student{
Date dateofBirth;
int idNumber;


public void foo(){
this.dataofBirth
}

}
```



Local Variables

- Variables declared within a method are local to that method
  - Local scope
- Variables declared within a class, are called field variables
- Local variable can have the same name as field variables
  - Use `this` to disambiguate

Instantiated vs static

- When you define a method in a class, every instance of the class has its own copy.

- static methods allows one copy to be accessed by all instances
  - So……what parts of the class should it be able to access?

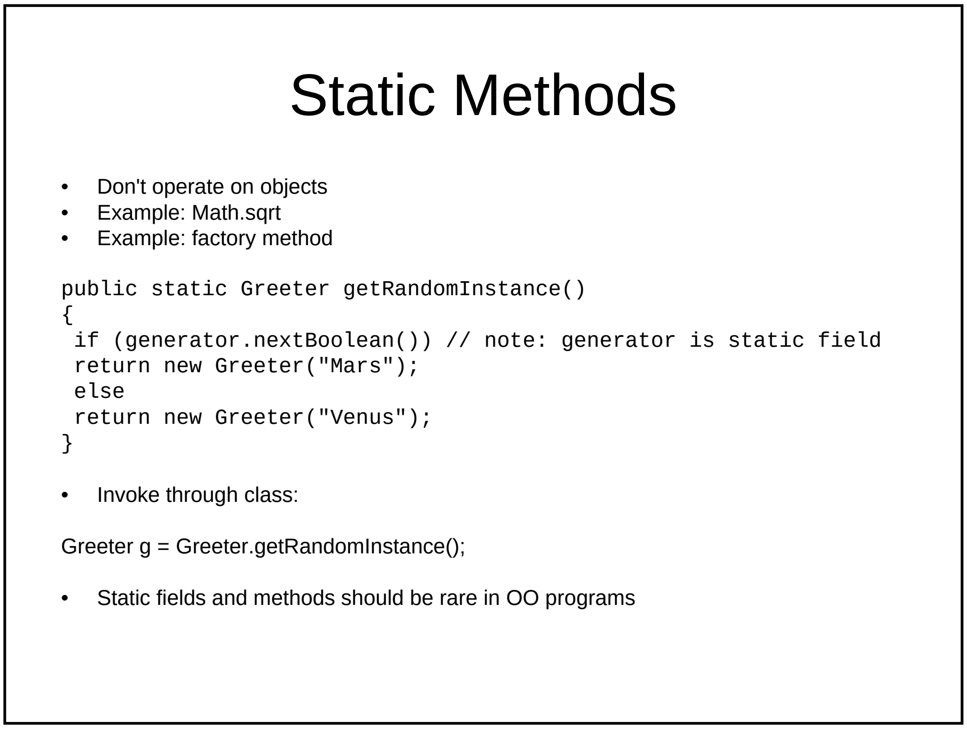
Static Fields

- Shared among all instances of a class
- Example: shared random number generator

```
public class Greeter
{
 . . .
 private static Random generator;
}
```

- Example: shared constants

```
public class Math
{
 . . .
 public static final double PI = 3.14159265358979323846;
}
```



Static Methods

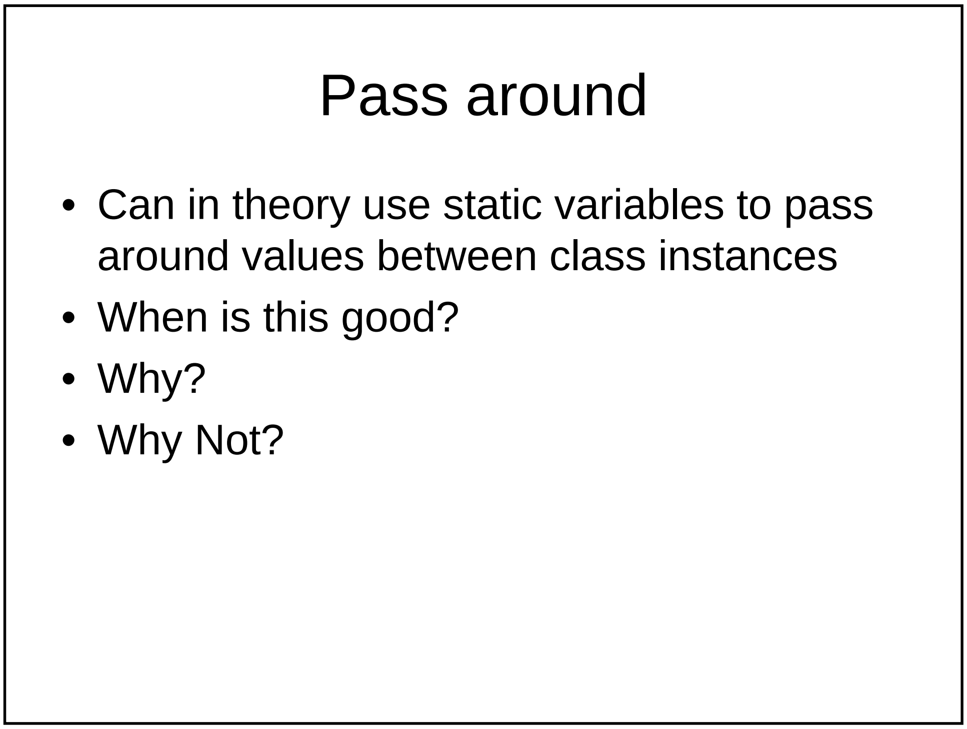
- Don't operate on objects
- Example: Math.sqrt
- Example: factory method

```
public static Greeter getRandomInstance()
{
 if (generator.nextBoolean()) // note: generator is static field
 return new Greeter("Mars");
 else
 return new Greeter("Venus");
}
```

- Invoke through class:

Greeter g = Greeter.getRandomInstance();

- Static fields and methods should be rare in OO programs



Pass around

- Can in theory use static variables to pass around values between class instances
- When is this good?
- Why?
- Why Not?

Methods

- Methods are defined by their signatures
  - Return values
  - Arguments values

```
public void foo()
public int foo()
```

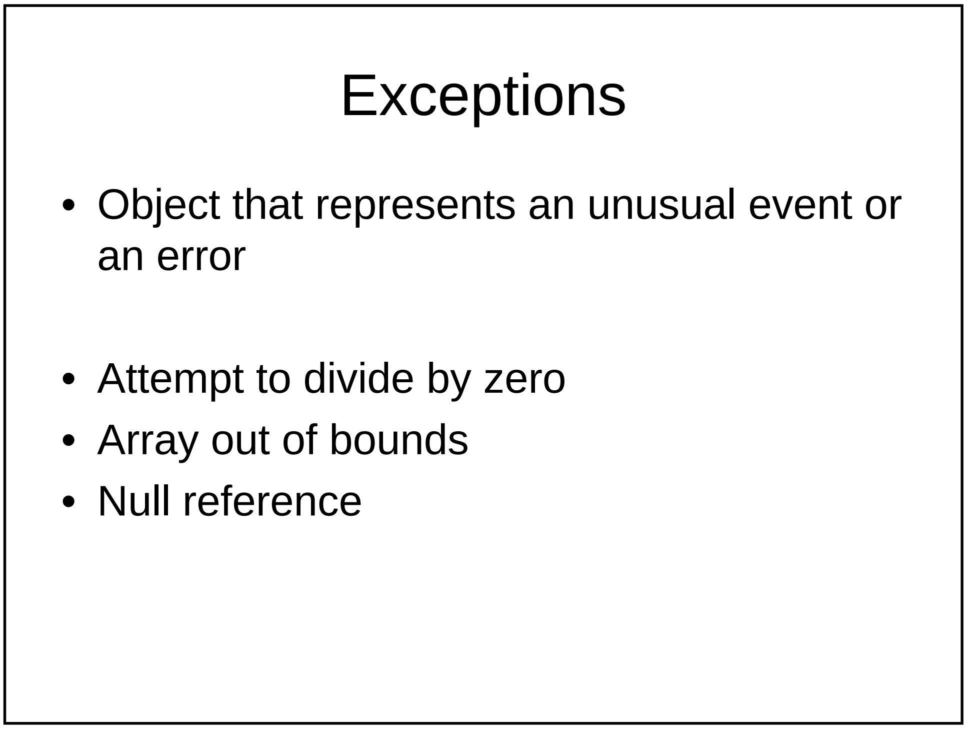
Method Overloading

- We can define two methods with the same name, as long as they have different signatures
  - Different input parameters

  or/and

  - Different return values

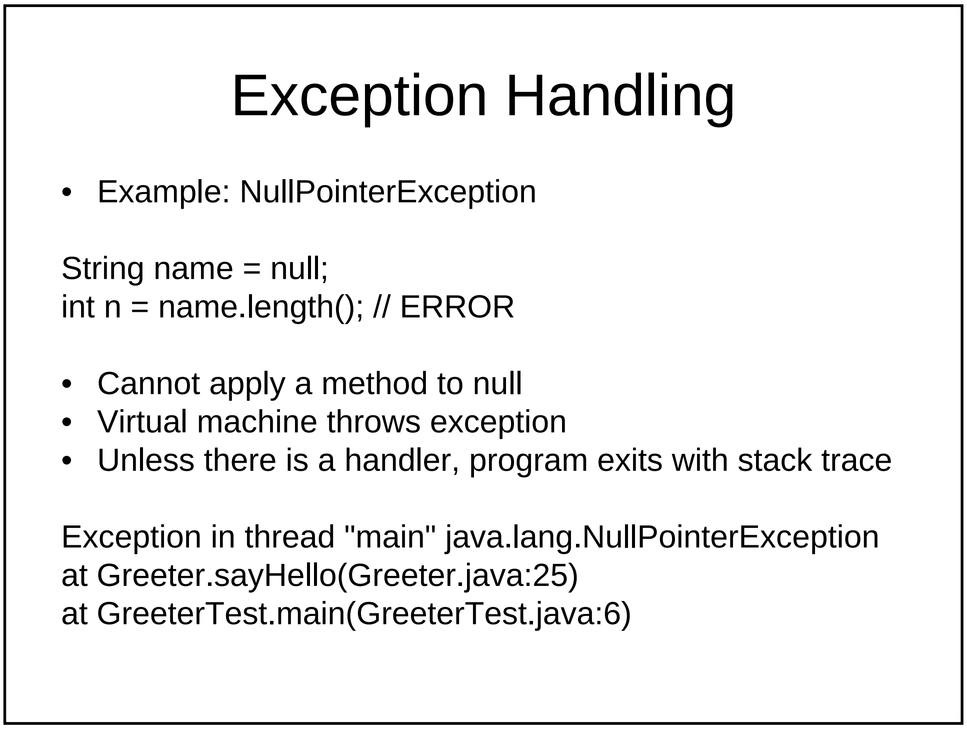
Java will know which one to use



Exceptions

- Object that represents an unusual event or an error

- Attempt to divide by zero
- Array out of bounds
- Null reference



Exception Handling

- Example: NullPointerException

```
String name = null;
int n = name.length(); // ERROR
```

- Cannot apply a method to null
- Virtual machine throws exception
- Unless there is a handler, program exits with stack trace

```
Exception in thread "main" java.lang.NullPointerException
at Greeter.sayHello(Greeter.java:25)
at GreeterTest.main(GreeterTest.java:6)
```

Checked and Unchecked Exceptions

- Compiler tracks only checked exceptions
- NullPointerException is not checked
- IOException is checked
- Generally, checked exceptions are thrown for reasons beyond the programmer's control
- Two approaches for dealing with checked exceptions
  - Declare the exception in the method header (preferred)
  - Catch the exception

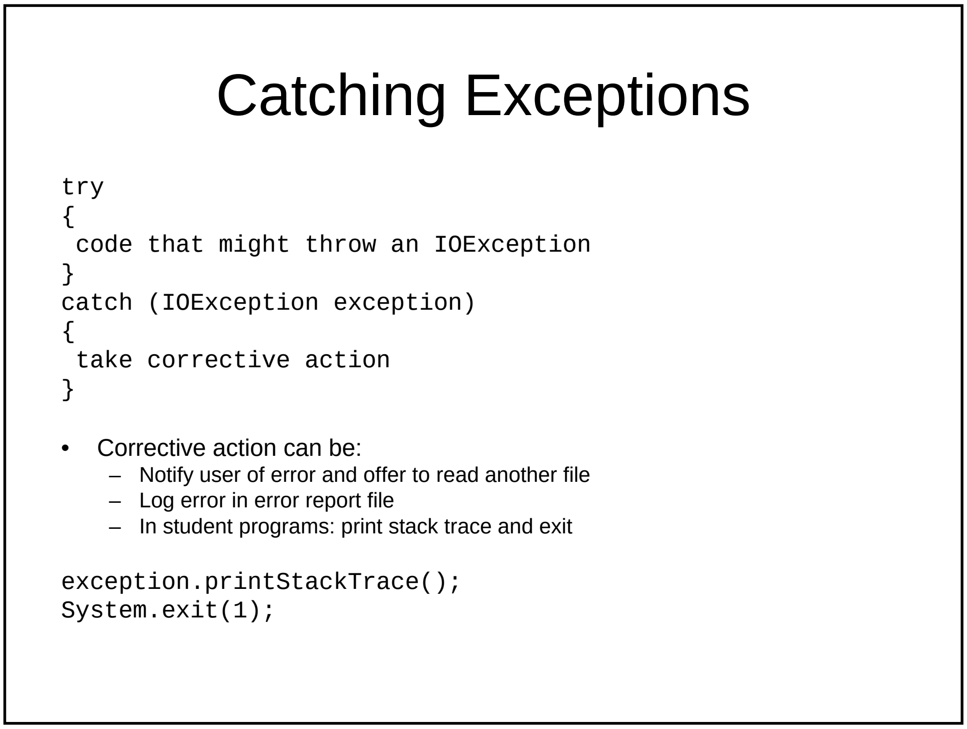
Declaring Checked Exceptions

- Example: Opening a file may throw FileNotFoundException:

```
public void read(String filename) throws
  FileNotFoundException
{
    FileReader reader = new FileReader(filename);
    . . .
}
```

- Can declare multiple exceptions

```
public void read(String filename)
throws IOException, ClassNotFoundException
public static void main(String[] args)
throws IOException, ClassNotFoundException
```

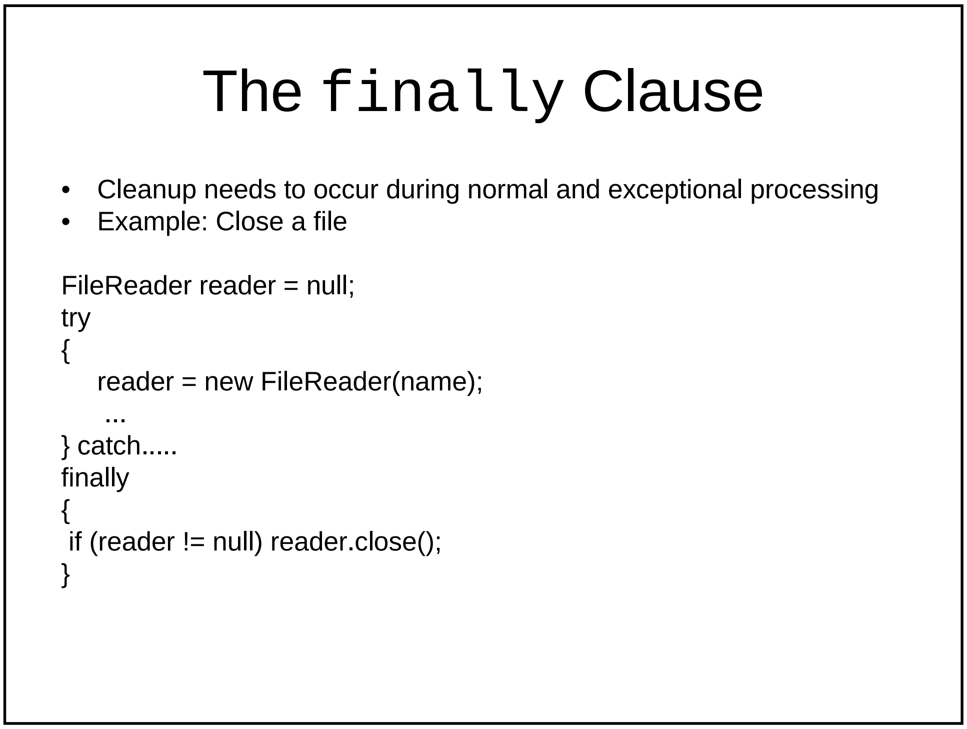


Catching Exceptions

```
try
{
 code that might throw an IOException
}
catch (IOException exception)
{
 take corrective action
}
```

- Corrective action can be:
  - Notify user of error and offer to read another file
  - Log error in error report file
  - In student programs: print stack trace and exit

```
exception.printStackTrace();
System.exit(1);
```



The `finally` Clause

- Cleanup needs to occur during normal and exceptional processing
- Example: Close a file

```
FileReader reader = null;
try
{
    reader = new FileReader(name);
     ...
} catch.....
finally
{
 if (reader != null) reader.close();
}
```

Strings

- Sequence of Unicode characters
  - (Technically, code units in UTF-16 encoding)
- `length` method yields number of characters
- "" is the empty string of length 0, different from `null`
- Special class in Java
  - Assigning a string literal to a string reference creates an instance!
- charAt method yields characters:

```
char c = s.charAt(i);
```

String II

- substring method yields substrings:
- "Hello".substring(1, 3) is "el“
- Use `equals` to compare strings

```
if (greeting.equals("Hello"))
```

- == only tests whether the object references are identical:

```
if ("Hello".substring(1, 3) == "el") ... // NO!
```

String concatenation

- + operator concatenates strings:
- "Hello, " + name
- If one argument of + is a string, the other is converted into a string:

```
int n = 7;
String greeting = "Hello, " + n;
// yields "Hello, 7"
```

- toString method is applied to objects

```
Date now = new Date();
String greeting = "Hello, " + now;
 // concatenates now.toString()
 // yields "Hello, Wed Jan 17 16:57:18 PST 2001"
```

Converting Strings to Numbers

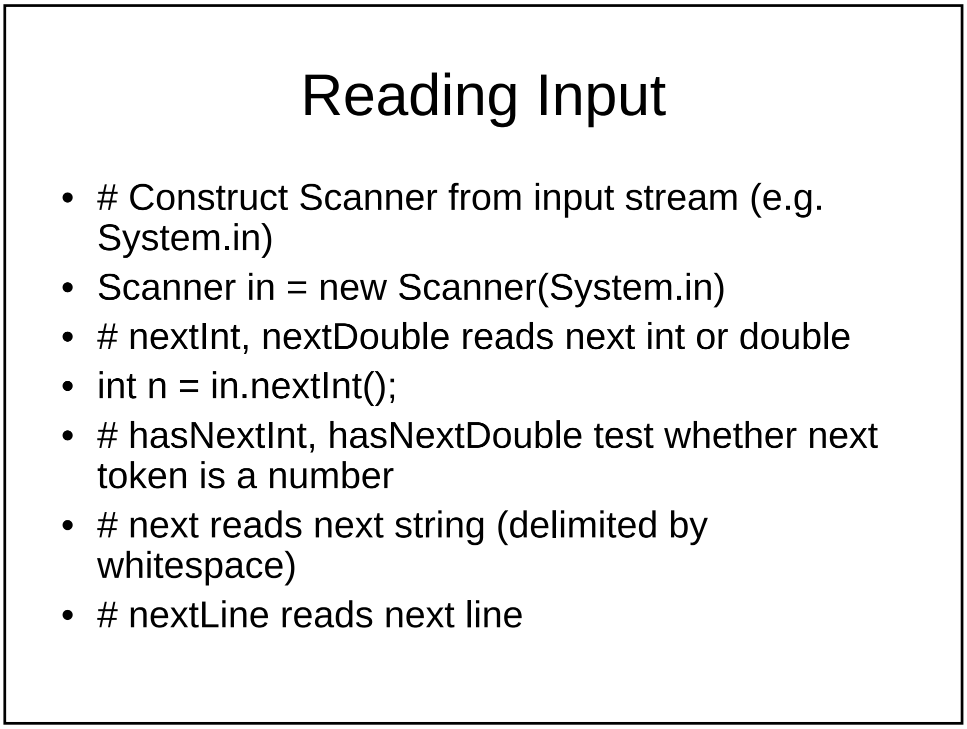
- Use static methods
  - WHY???

```
Integer.parseInt
Double.parseDouble
```

- Example:

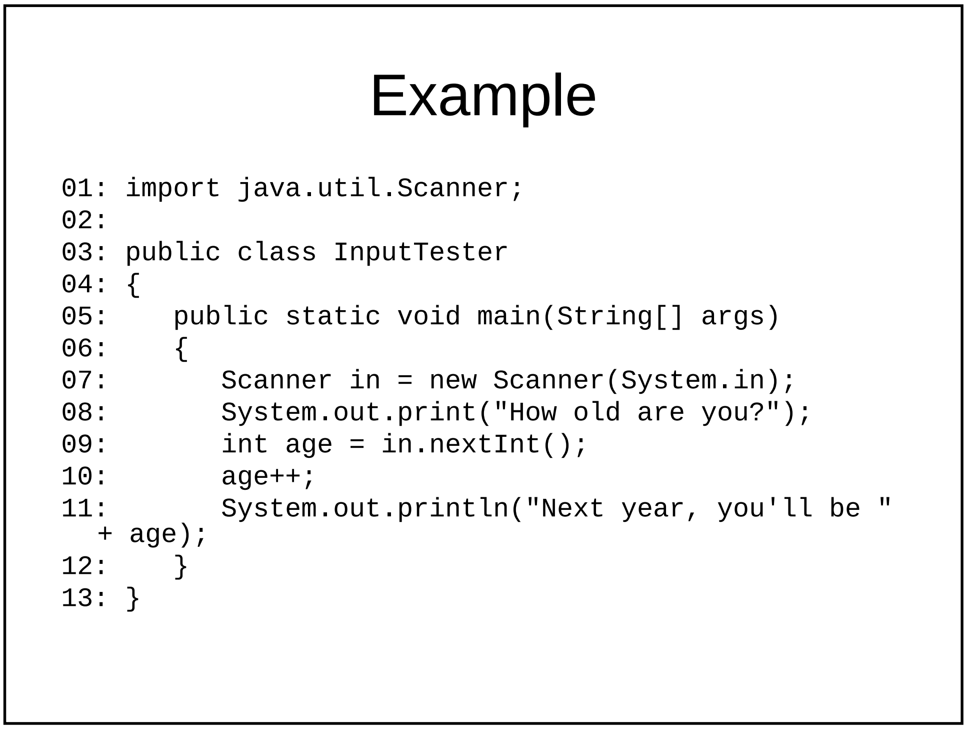
```
String input = "7";
int n = Integer.parseInt(input);
// yields integer 7
```

- NOTE:
  If string doesn't contain a number, throws a NumberFormatException(unchecked)



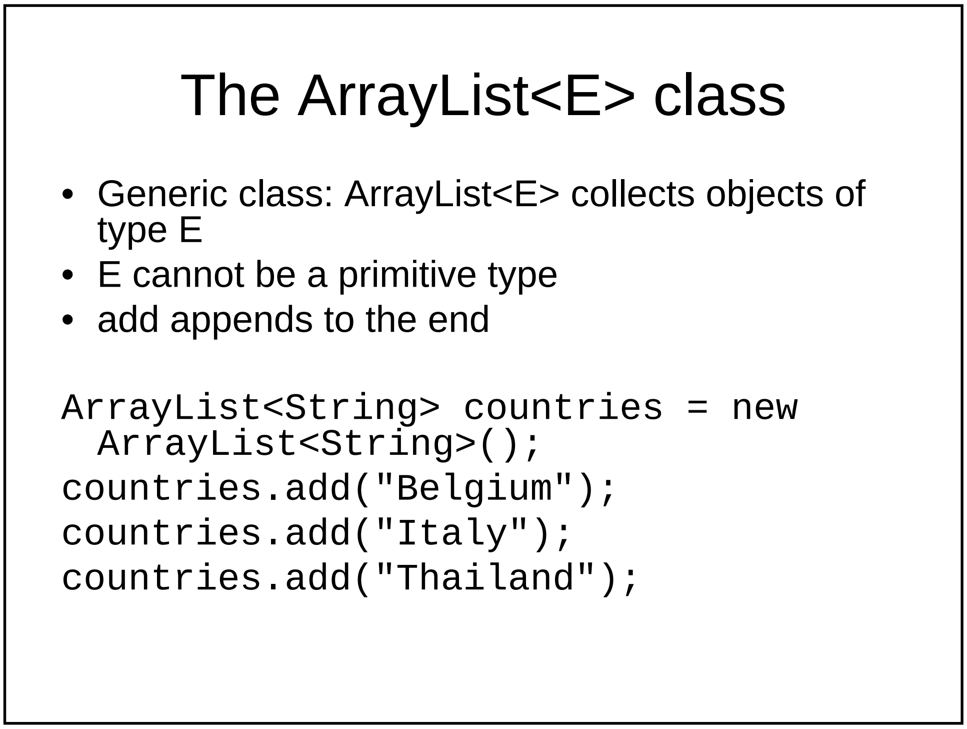
Reading Input

- # Construct Scanner from input stream (e.g. System.in)
- Scanner in = new Scanner(System.in)
- # nextInt, nextDouble reads next int or double
- int n = in.nextInt();
- # hasNextInt, hasNextDouble test whether next token is a number
- # next reads next string (delimited by whitespace)
- # nextLine reads next line



Example

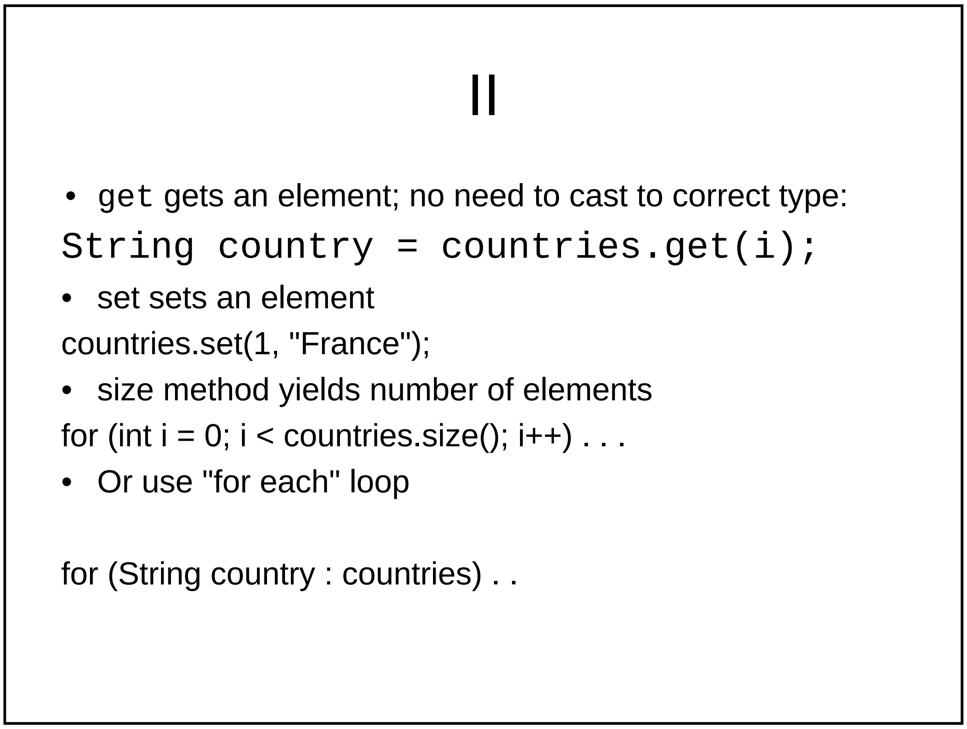
```
import java.util.Scanner;

public class InputTester
{
   public static void main(String[] args)
   {
      Scanner in = new Scanner(System.in);
      System.out.print("How old are you?");
      int age = in.nextInt();
      age++;
      System.out.println("Next year, you'll be "
 + age);
   }
}
```



The ArrayList<E> class

- Generic class: ArrayList<E> collects objects of type E
- E cannot be a primitive type
- add appends to the end

```
ArrayList<String> countries = new
  ArrayList<String>();
countries.add("Belgium");
countries.add("Italy");
countries.add("Thailand");
```



II

- `get` gets an element; no need to cast to correct type:

```
String country = countries.get(i);
```

- set sets an element

```
countries.set(1, "France");
```

- size method yields number of elements

```
for (int i = 0; i < countries.size(); i++) . . .
```

- Or use "for each" loop

```
for (String country : countries) . .
```

Arrays drawback

- Can insert and remove elements in the middle

```
countries.add(1, "Germany");
countries.remove(0);
```

- Not efficient--use linked lists if needed frequently

Linked List

- What ?
  - Efficient insertion and removal
- add appends to the end

```
LinkedList<String> countries = new LinkedList<String>();
countries.add("Belgium");
countries.add("Italy");
countries.add("Thailand");
```

- Use Listiterators to edit in the middle
  - Iterator points between list elements

List Iterators

- next retrieves element and advances iterator

```
ListIterator<String> iterator = countries.listIterator();
while (iterator.hasNext())
{
   String country = iterator.next();
   . . .
}
```

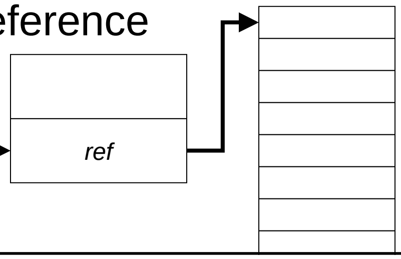
- Or use "for each" loop:
- for (String country : countries)
- add adds element before iterator position
- remove removes element returned by last call to next

Arrays

- Drawback of array lists: can't store numbers in a simple manner
- Arrays can store objects of any type, but their length is fixed

```
int[] numbers = new int[10];
```

- Array variable is a reference



Arrays

- Array access with [] operator:

```
int n = numbers[i];
```

- length member yields number of elements

```
for (int i = 0; i < numbers.length; i++)
```

- Or use "for each" loop

```
for (int n : numbers)
```

Arrays

- # Can have array of length 0; not the same as null:
- numbers = new int[0];
- # Multidimensional array
- int[][] table = new int[10][20];
- int t = table[i][j];

main

- The main method is declared public, static and void.
- Because it is static we often need to create an instance of the class inside its own main.
- Why?

main

- Every class can have a main method. If you five classes, with each one having a main, you need to tell java which one to run…
- How is this done?
- Can also use individual mains as testing areas, will be ignored when not run

Default Values

- By Default java assigns the following values:

boolean	false
char	0
byte, int	0
float	+0.0F
double	+0.0
reference	null

Constructor

- A constructor is a method that gets called when an object is created using `new`.
- We can use the constructor to initialize the fields of the object.
- A constructor can have as many parameters as necessary, but can not have a return type.

```
Public class Moo
{
   private int x;

Public Moo(int x){
   this.x = x;
}

}
```

Default Constructor

- If we don’t define a constructor the default constructor with not parameters will be created.

- So we can say:

```
Moo m = new Moo();
```

- Like other methods, the constructor can also be overloaded.
- Can call one constuctor from another
  - `this(something);`
  - Must be the first statement in the method

Remember

- Object: Three characteristic concepts
  - State
  - Behavior
  - Identity

- Class: Collection of similar objects

Program Design

- Analysis
- Design
- Implementation

Analysis Phase

- Functional Specification
  - – Completely defines tasks to be solved
  - – Free from internal contradictions
  - – Readable both by domain experts and software developers
  - – Reviewable by diverse interested parties
  - – Testable against reality

Design Phase

- Goals
  - Identify classes
  - Identify behavior of classes
  - Identify relationships among classes
- Artifacts
  - Textual description of classes and key methods
  - Diagrams of class relationships
  - Diagrams of important usage scenarios
  - State diagrams for objects with rich state

Implementation Phase

- Implement and test classes
- Combine classes into program
- Avoid "big bang" integration
- Prototypes can be very useful