CS1007: Object Oriented Design and Programming in Java

Lecture #3

T 1/24

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Outline

- Feedback
- Background
  - Arrays
  - Scopes
  - Static
  - Method Overloading
  - Basic classes
  - Constructors
  - Useful tools
  - Exception handling
  - File handles
- Reading: Chapter 1, and any relevant background reading

Feedback

- More clarification on THIS
- Practical java examples
  - Limited now, since we need to cover background material, but will be doing complex examples during class
- Practice homework online
  - Will make solutions available

Announcements

- Homework 1 out by next class
  - Start early
  - If you are having problems…you probably have not seen HW0
  - Will be doing snippets in class
  - Basic idea will be to create a multi class project and have fun.

Office hours

- My
  - T/Th 1-2pm, 4-4:30pm
  - By appointment
- Ohan
  - T 11-1 or 12-2
  - Fr 12-2

Announcements II

- Slides will be on website within 24hrs after class
- Privilege
- Don't want to see drop in attendance, being here allows a discussion to take place

This

```
public class student{
String name;
Date recordStart;
int idNumber;


public void setName(String name){
    this.name = name;
   }

}
```

Class objects

- Represents an idea/concept/construct

- Field variables
- Constructors
  - Default
- Public methods
  - Accessors
  - Mutators
- Private methods

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 Account
{
   private int id;

public Account(int id){
   this.id = id;
}

}
```

Default Constructor

- If we don't define a constructor the default constructor with not parameters will be created.
- So we can say:

```
Account m = new Account();
```

- Like other methods, the constructor can also be overloaded (more on this later)
- Can call one constuctor from another
  - `this(argument list);`
  - Must be the first statement in the method

Methods

- Methods are defined by their signatures
  - permissions
  - Return values
  - Argument values
  - modifiers

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 reference
- Virtual machine throws exception
- Unless there is a handler, program exits with stack trace

Exception in thread "main" java.lang.NullPointerException
at Student.setname(Student.java:15)
at StudentTest.main(StudentTest.java:20)

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

- Will ALWAYS execute code block
  - Even if return statement in try block
- 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();
}
```

Java packages

- Collection of similar classes
- Package names are dot-separated identifier sequences

java.util
javax.swing
com.sun.misc
edu.columbia.cs.robotics

Packages

- Unique package names: start with reverse domain name
- Corresponds to directory structure
  - Must match directory structure
- package statement to top of file
- Class without package name is in "default package“
- Full name of class = package name + class name

java.util.String

Importing Packages

- Tedious to use full class names
- import allows you to use short class name

```
import java.util.Scanner;
. . .
Scanner a; // i.e. java.util.Scanner
```

- Can import all classes from a package

```
import java.util.*;
```

Arrays

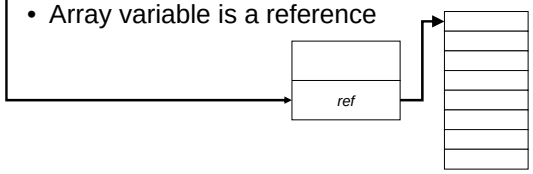
- Ordered list of objects can be organized in an array
- Array properties
  - Capacity
  - Size
  - Can be treated as a single object (to an extent)

Arrays

- 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)
```

Command Line Arguments

```
public static void main(String[] args)
```

- `args`, is an array of string.
- The elements of `args` are the command line arguments using in running this class.

```
Java testProgram –t –Moo=boo out.txt
0: ‘-t’
1: ‘-Moo=boo’
2: ‘out.txt’
```

Arrays

- Can have array of length 0; not the same as null:
- numbers = new int[0];
- Multidimensional array

Two dimensional arrays

- You can create an array of any object, including arrays
- int[][] table = new int[10][20];
- int t = table[i][j];
- An array of an array is a two dimensional array

```
public class TicTacToe{
  public static final int EMPTY = 0;
  public static final int x = 1;
  public static final int y = 2;

  private int[][] board =
  { {EMPTY, EMPTY, EMPTY},
    {EMPTY, EMPTY, EMPTY},
    {EMPTY, EMPTY, EMPTY}
  }
```

Two dimensions

- You can also initialize the inner array as a separate call.
- Doesn't have to be congruous memory locations

```
int [][]example = new int[5][];
for (int i=0;i<5;i++){
  example[i] = new int[i+1];
}
```

Multiple dimensions

- No reason cant create 4,5,6 dimension arrays
- Gets hard to manage
- Think about another way of representing the data
- Often creating an object is a better approach

Arrays further

- Need to explicitly copy contents of arrays
- ArrayList
- Vector
- Full object versions of arrays
- Capacity can grow over time

Scope

- Scope refers to where java programming objects variables/methods/classes can be accessed.
- Local
- Global
- Package
- Universal

Variables

- Variables declared within a method are local to that method
  - Local scope
- Variables declared within a class, are called field variables
  - Class wide scope
    - Including subclasses
  - Package wide scope
- 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?

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

- Should be aware if you forget to set values
- Compiler/IDE will let you know if you forgot to set values (warning)

Default Values

- By Default java assigns the following values:
- boolean false
- char 0
- byte, int 0
- float +0.0F
- double +0.0
- reference null

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 through scanners

- 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

```
01: import java.util.Scanner;
02:
03: public class InputTester
04: {
05:    public static void main(String[] args)
06:    {
07:       Scanner in = new Scanner(System.in);
08:       System.out.print("How old are you?");
09:       int age = in.nextInt();
10:       age++;
11:       System.out.println("Next year, you'll be "
   + age);
12:    }
13: }
```

Useful classes

- Arraylists
  - Overview of generics
- Linkedlists
- Iterators

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) . .

- 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

File handling

- Example3.java

Graphic programming

- Will have some basic review next class
- Will teach as we go