Tirgul 1

Today's topics:
- Course's details and guidelines.
- Java reminders and additions:
  - Packages
  - Inner classes
  - Command Line Arguments
  - Primitive and Reference Data Types
- Guidelines and overview of exercise 1.
- Extra (to appear on webpage):
  - Cloning
  - I/O streams

Course Guidelines

- Two newsgroups are available for communication:
  - local.course.dast.stud – Followed by us (for detecting important questions), yet not moderated. Feel free to post into it.
  - local.course.dast.ta – Moderated by TAs. Used as the primary communication channel to update on exercise questions, dates etc…
  - You cannot publish directly to the moderated newsgroup. Send an e-mail instead to dast@cs.huji.ac.il.
  - We will do our best to respond within 48-72 hours.

Special requests

- All special requests (extensions etc…) are only valid if they received a written response with specific details of the decision.
- Please specify only one of the following in the topic:

1. Extension request for PHW/THW#?
2. Question about PHW/THW#?
3. Special request about ????

Packages

- Java classes are organized in packages to help organize and share programs and projects. Examples: `java.util, java.io.`
- The `import` keyword extends the scope of the program to contain (part of) a specific package.
- We can build our own packages, using these guidelines:
  - **Locate all package classes in a subdirectory with the same name as the package name.**
  - **The first line of a class of some package should be:** `package package_name;`
  - **Set the `CLASSPATH` variable to point to the directory where the package subdirectory resides. For example, to use the package `dast.util` that resides in the subdirectory** `/cs/course/2003/dast/www/public/dast/util` **you should add the path** `/cs/course/2003/dast/www/public/` **to your `CLASSPATH` variable.**

Inner classes

- Motivation:
  - Suppose you need an iterator class for your `LinkedList` class.
  - Defining a new class solely for this purpose complicates your package structure.
  - This class must get a handler to a specific `LinkedList` instance and it can't access its private data members.
  - There would be such a class for every data structure.
- Solution : Inner classes.
  - Useful for simple "helper" classes that serve a very specific function at a particular place in the program.
  - Not intended to be general purpose "top level" classes.
  - They make your code clearer, and prevent cluttering your package namespace.

Inner classes - Example & Syntax

```
public class LinkedList {
  private Node head;
     .  .  .
  public Iterator iterator() { return new ListIterator() };

  private class ListIterator implements Iterator {
      Node current;

      public ListIterator () {
             current  = head;
      }

      public boolean hasNext() {. . .}
      public Object next() { . . . }

  } // end class ListIterator

} // end class LinkedList
```

Command Line Arguments

- A way to pass parameters to a program.
- The method **`main()`** accepts a single argument that is an array of strings.
- Command line arguments (separated by blank(s)) are stored in this array (each argument is a string).
- For example, if we have:

```
class Test {
    public static void main(String[] args){...}
}
```

then, when we run the command:

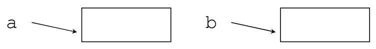
```
          java Test 1 abc -a – b
```

we'll have:

```
    args[0] = "1", args[1] = "abc", args[2]="-a",
    args[3]="-", args[4]="b"
```

Primitive and Reference Data Types

Primitive DT: (**`boolean`**, **`int`**, **`float`**, etc.) each is stored in a unique memory place:



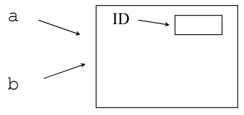
```
int a=5;
int b=a;
a = 6;
```

So after this command sequence **`b`** will have a value of 5.
(This is called copy "by value").

Primitive and Reference Data Types

Reference DT: (all objects) a variable points to a memory place created by the new command. Many variables may point to the same memory place

```
Employee a =
   new Employee();
a.ID = 5;
Employee b = a;
a.ID = 6;
```



So after this command sequence **`b.ID`** will have a value of 6.
(by changing **`a`** we also changed **`b`**).

Primitive and Reference DT

- When we pass an object as an argument to a method, a new reference to the same object is created. When we pass primitive DT to a method, a new variable is created.
- If an object variable has the value **`null`**, this actually means: "this variable does not point to any memory place"
- How do we make an actual copy of the object, not another reference to same object? This is called cloning.
- Cloning will not be discussed today, but details will appear in the lecture slides on the course's webpage.

Programming Exercise 1

- Handout date: Tuesday 2.03.2004
- Submission date: Sunday 28.03.2004, 12:00 Noon.
- Extensions: None.
- What is it about? An extremely advanced bookstore.
- Please make sure you read the entire exercise description, regulations, and follow all of them.
- You may ask questions through the newsgroup. Do not expect a response in less than 24-48 hours.

Some details

- Input and output is done through implementing interfaces – no parsing is needed for the input.
- However:
  - In order to efficiently test your program, we recommend designing your own generic test program, that accepts inputs.
  - An example of a non-generic test program will be given.
  - Details on how to use input and output streams appear in the tirgul slides on the webpage.

Internals

- A **`Map`** (as its name implies) is a mapping from keys to values. It is used for fast searches of items in a set.
- Question: What does that say about the keys?
- A **`SortedMap`** is…a sorted mapping of the above.

Theoretical Homework 1

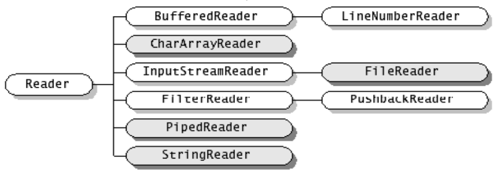
- Assigned: Tuesday 9.3.2004
- Due: Sunday 21.3.2004, 12:00 Noon.

Extra! Extra!

Java I/O Streams

- In order to import/export information to/from an external source (a file, a network, etc.) we open a ***stream*** on an information source.
- The **`java.io`** package contains all classes, interfaces, exceptions, etc. that involve I/O streams.
- Two types of I/O streams:
  - **Character**:
    - Information is represented by an encoding that gives a numeric value for each symbol.
    - Text is stored as a list of numbers. Java translates between internal Unicode representation and external representation (e.g. ASCII).
    - **Class hierarchy based in `Reader` and `Writer` abstract classes.**
  - **Binary** (byte):
    - Views information as a sequence of bytes (e.g. images, sound).
    - No translation occurs.
    - **Class hierarchy based in `InputStream` and `OutputStream` abstract classes.**

Hierarchy Structure



- **File streams**: **`FileReader`**, **`FileWriter`** (similarly, **`FileInputStream`** and **`FileOutputStream`**).
- **Layered streams**:
  - A Reader may operate on top of an **`InputStream`**.
  - **`BufferedReader`** on top of another **`Reader`**, to aggregate the reading (e.g. read an entire line).
  - **`PrintWriter`**, to format the output (prints integer, strings, etc.)
  - Many possibilities – see API.

Java streams - Example

```
import java.io.*;

.  .  .

public void doSomething throws IOException {
   FileReader in = new FileReader("results.txt");
   FileWriter out = new FileWriter("statistics.txt");

   BufferedReader r = new BufferedReader(in);
   PrintWriter p = new PrintWrite(out);
   String input, output;

   while ((input = r.readLine()) != null) {
          ... //do something interesting and create
                output string
        p.print(output);
   }
   r.close(); in.close();
   p.close(); out.close();
}
```

Default I/O Streams

- Class **`System`** has 3 default streams, available to every Java program:
- Input from the keyboard goes into the 'standard input'. This is the data member **`System.in`** of type **`java.io.InputStream`**
- Output (usually to the terminal window) written through 2 streams:
  - 'Standard output' – **`System.out`** of type **`java.io.PrintStream`**
  - 'Standard error' – **`System.err`** of type **`java.io.PrintStream`**

    [**`PrintStream`** is an exception - it is a stream, but allows character output through its **`print()`** and **`println()`** methods.]

Default I/O Streams

- The standard output and error are directed by the Operating System. By default - both to the terminal.
- The convention - standard error for error messages, standard output for regular output.
- In UNIX, the user can redirect to a file:
  - standard output by adding "**`> my_out.txt`**". For example: **`java MyClass param1 > out.txt`**
  - both to the same file, by adding "**`>& my_out.txt`**"
  - You can't redirect only the standard error, but redirecting to different files is possible (by outsmarting): **`(java MyClass > out.txt) >& err.txt`**

Cloning

- Cloning – The Java way of making a copy of an object.

```
Employee a = new Employee();
a.ID = 5;
if ( a instanceof Cloneable ) {
   Employee b = (Employee) a.clone();
   a.ID = 6;
}
```

- Now **`b`** is a reference to a new object (identical to **`a`**)
- A class that provides the **`clone()`** method should implement the **`Cloneable`** interface.
- We can check if a class is **`Cloneable`** by using the **`instanceof`** operator.

How to be "cloneable"

- Class **`Object`** contains the method **`clone()`**, which we override.
- Class **`Object`** implements **`clone()`** as a bit-by-bit memory copy.

```
public class Employee implements Cloneable {
  public int ID;

  public Object clone() {
    try {
      return super.clone();
    } catch (CloneNotSupportedExcetion e) { }
      // this catch is not supposed to happen.
}
```

Cloning

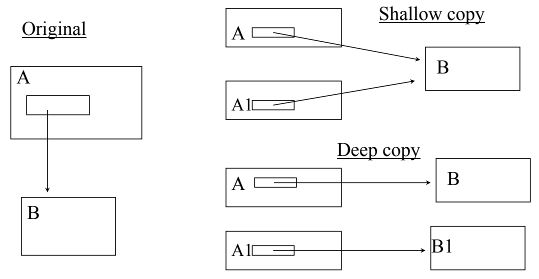
- Method **`Object.clone()`** throws **`CloneNotSupportedException`** if the class does not implement **`Cloneable`**. Therefore, if you want to use **`Object.clone()`** you should nest it in a **`try-catch`** block.
- Method **`Object.clone()`** is declared **`protected`**, therefore you must override the **`clone()`** method, declaring it **`public`**.

```
public class Employee implements Cloneable {
  public int ID;

  public Object clone() {
    try {
      return super.clone();
    } catch (CloneNotSupportedExcetion e) { }
      // this catch is not supposed to happen.
}
```

Cloning - "deep" and "shallow" copy

- Shallow/Deep copy – Copies by reference/value the object data members. For example:



“deep” and “shallow” copy

- Notice that **`Object.clone()`** performs shallow copy
- For example, Java’s **`Vector`** implements shallow copy:

```
Emp e1 = new Emp(); Emp e2 = new Emp();
e1.id = 1; e2.id = 2;
Vector v1 = new Vector();
v1.addElement(e1) ; v1.addElement(e2);
Vector v2 = v1.clone();
```

Then:

```
((Emp)v2.elementAt(0)).id = 3;
System.out.println(((Emp)v1.elementAt(0)).id);
```

will print 3, but:

```
v2.removeElementAt(0);
System.out.println(((Emp)v1.elementAt(0)).id);
```

will still print 3.

Cloning vs. Copy Constructor

- Copy constructors can be used to solve the same problem as cloning.
- They play an important role in languages (e.g. C++) where objects can be passed by value as well as by reference.
- In Java, although you can use both techniques, cloning is more general. For example, a deep copy of a list of objects of different types. There is no way of knowing what kind of copy constructor should be called for each element, but the **`clone()`** method makes sure you get the right copy of each.

Debugger

- We recommend using a debugger for debugging your program.
- There are currently two debuggers you can use, installed on the HUJI machines:
  - DDD: ‘*Data Display Debugger’* unix debugger installed on the HUJI machines, can be used for debugging C++/Java applications.
  - Jswat: a simple open source, multi-platform java debugger. Can be used anywhere.
    download from http://bluemarsh.com/java/jswat/

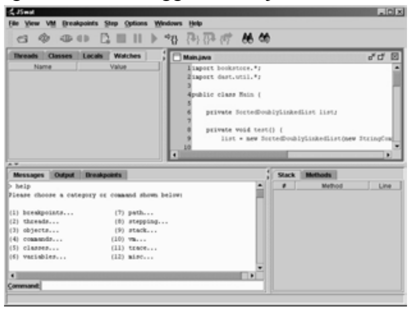
Debugger

- A debugger usually has the following basic features:
  - Defining *breakpoints*.
  - Using *watches*.
  - Stepping into a method.
  - Stepping over a method.
  - Stepping out of a method (frame).

- For using the DDD debugger:
  - Compile your program using the –g flag.
  - Run > ddd –gdb <main_class> &

Using a Debugger

- For using the Jswat debugger: run > jswat2 &


JSwat
File View VM Breakpoints Step Options Windows Help
Threads Classes Locals Watches
Name Value
Main.java
Messages Output Breakpoints
Stack Methods
# Method Line
Command:

```
import bookstore.*;
import dast.util.*;

public class Main {

    private SortedDoublyLinkedList list;

    private void test() {
        list = new SortedDoublyLinkedList(new StringCo
```

```
> help
Please choose a category or command shown below:

(1) breakpoints...          (7) path...
(2) threads...              (8) stepping...
(3) objects...              (9) stack...
(4) commands...            (10) vm...
(5) classes...             (11) trace...
(6) variables...           (12) misc...
```