Java

Java, an Imperative Language

- Imperative languages often **permit** the use of functional programming.
- e.g. sometimes just say “no” to side-effects.
- Better yet, use functions and side-effects articulately and to **best advantages of both**.

Java Jive[§]

(review)

[§] http://members.tripod.com/swingstyle/mlist/msts/msts07.html

James Gosling, Inventor of Java

James Gosling received a BSc in Computer Science from the University of Calgary, Canada in 1977. He received a PhD in Computer Science from Carnegie-Mellon University in 1983. He is currently a Distinguished Engineer at Sun Microsystems. He has built satellite data acquisition systems, a multiprocessor version of Unix, several compilers, mail systems and window managers. He has also built a WYSIWYG text editor, a constraint based drawing editor and a text editor called `Emacs' for Unix systems. More recently he has been the lead engineer for the Java/HotJava system.

http://java.sun.com/people/jag/

Java vs. rex

- The analog to *function* in rex is *method* in Java. Functions are applied as aFunction(x, y, z), while methods are applied like x.aMethod(y, z).

principal argument (an object)

- Argument and return **types** must be declared in Java, not in rex.
- Both allow recursion.
- A library ("package") Polya (http://www.cs.hmc.edu/~keller/polya) provides much of rex functionality in Java (and a similar package exists for C++).

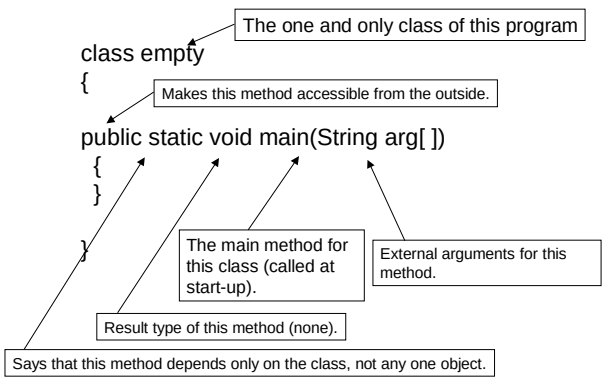
The empty Java program

```
class empty
{

public static void main(String arg[ ])
 {
 }

}
```

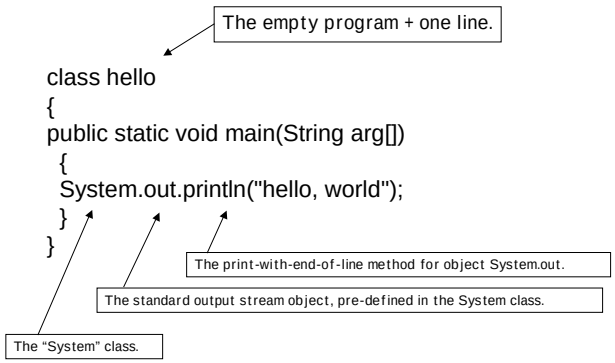
The empty Java program



The "hello, world" program in Java

```
class hello
{
public static void main(String arg[])
 {
 System.out.println("hello, world");
 }
}
```

The "hello, world" program in Java



Running Java on turing

- Current version is 1.3.1
- To compile:

UNIX convention for compiler, e.g. javac, cc

```
javac hello.java
```

- To execute:

No "c" here.

No ".class" here.

```
java hello
```

One-time setup for using Java on turing

In your .cshrc file, include these lines:

```
setenv JAVA_HOME /usr/local/jdk1.31

setenv CLASSPATH $JAVA_HOME/lib:/cs/cs60/java/:.
```

Note: additions don't take effect until next login *or* until you execute:

```
source ~/.cshrc
```

Running Java on turing

```
turing 101> ls hello.*
hello.java
```

Check what's there.

```
turing 102> javac hello.java
```

Compile it.

```
turing 103> ls hello.*
hello.class   hello.java
```

Check what's there now.

```
turing 104> java hello
hello, world
```

Run it.

Be astounded by results.

Useful Hacky Shortcuts

Since java is a prefix of javac, this tends to confound using command completion (e.g. **!j** in the Cshell).

Consider putting in your .cshrc the following command definitions:

```
alias jc 'javac \!$.java'              #compile java
alias je 'java'                         #execute
alias jx 'javac \!$.java ; java \!$'    #both
```

Example usage:

```
jc foo        # same as javac foo.java
je foo        # same as java foo
jx foo        # same as javac foo.java; java foo
```

Then use **!jc** or **!je** to re-do previous commands of same type.

Java Objects

- Java data items are either:
  - primitive, such as
    - int, long, float, double, char
  - Objects, such as
    - String, Long, Double
    - Arrays are sort of like objects too.

Purposes of Objects

- **Aggregate** various data objects together
- Allow mutation of the **state** of data objects
- Control use and access of data according to specific **disciplines**
- and other good stuff

Immutable Objects

- An Object is **immutable** if it state never changes once it is created.
- **Functional programming** deals with immutable objects almost exclusively
- The aggregating and disciplined access properties of Objects are still very useful.

Introducing Polya

- Permits rex-like computation within Java
- Name derives from 2 things:
  - George Polya, famous mathematician who wrote about problem solving ("How to Solve It")
    - Polya package *solves the problem* of rapidly prototyping list-handling programs
  - *Poly*list (polymorphic list) data structures, as in rex

Trivial Program using Polya

```
import polya.*;

class helloPolya
{
public static void main(String arg[])
  {
  System.out.println(Polylist.list("Hello", "Polya"));
  }
}
```

A list constructor.

Output of Trivial Program

```
(Hello Polya)
```

Parens that Polya puts around lists.

Polylist.nil

```
import polya.*;
```

`Polylist.nil` represents the empty list.

Using Polya to Implement Unicalc Functionality (a4)

- As in a3, we want to represent Quantities.
- In Java, instead of using a list of 3 things, we will use a little more structure:

```
public class Quantity
{
double Factor;
Polylist Num;
Polylist Denom;
      ... more stuff to come ...
}
```

Object Creation

- Objects are created using **constructors.**
- For a given Class of Objects, there can be multiple types of constructors, each providing different types of parameters to define the creation of an object.

Constructors for Quantities

- Constructors always take the same name as their Class.
- Therefore, all constructors for class `Quantity` will be called (you guessed it)
  `Quantity`
- Constructors will differ depending on types.
- One constructor can call another.

Basic Quantity Constructor

- To define a quantity, we need to give values to all three internal variables:

```
public class Quantity
{
            ... stuff you already saw ...
Quantity(double Factor, Polylist Num, Polylist Denom)
  {
  this.Factor = Factor;
  this.Num    = Num;
  this.Denom  = Denom;
  }
            ... more stuff to come ...
}
```

Variables in red represent values in *this* Quantity.
Variables in green represent values local to this constructor.
The latter go away when the constructor is left.

Convenience Quantity Constructor where the denominator is empty

```
public class Quantity
{
                ... stuff you already saw ...
Quantity(double Factor, Polylist Num)
  {
  this(Factor, Num, Polylist.nil);
  }
                ... more stuff to come ...
}
```

Variables in green represent values local to this constructor. **this(…)** means "call the constructor of this class with the indicated arguments.

Convenience Quantity Constructor where both numerator and denominator are empty

```
public class Quantity
{
                ... stuff you already saw ...
Quantity(double Factor)
  {
  this(Factor, Polylist.nil, Polylist.nil);
  }
                ... more stuff to come ...
}
```

Variables in green represent values local to this constructor. **this(…)** means "call the constructor of this class with the indicated arguments.

Convenience Quantity Constructor where the numerator is a single unit and denominator is empty

```
public class Quantity
{
                ... stuff you already saw ...
Quantity(double Factor, String NumUnit)
  {
  this(Factor, Polylist.list(NumUnit), Polylist.nil);
  }
                ... more stuff to come ...
}
```

Variables in green represent values local to this constructor. **this(…)** means "call the constructor of this class with the indicated arguments.

Convenience Methods

- In the skeletal solution to a4, we avoid having to prefix with
  `Polylist.`
  by defining local versions of functions:

```
/**
 * local cons for convenience
 */

static Polylist cons(Object F, Polylist R) { return Polylist.cons(F, R); }


/**
 * local list of 1 argument, for convenience
 */

static Polylist list(Object X1) { return Polylist.list(X1); }
```

Getters

- Attributes of objects should never be accessed within an object simply by referring to them:

```
Quantity x = new Quantity(…);
…
System.out.println(x.Num);
```

BAD

- **except** possibly for debugging purposes.
- Instead, use a **getter** method:

```
int getNum()
{
return Num;
}
...
System.out.println(x.getNum());
```

GOOD

Reasons?

Static?

- What is *static* all about?
- In Java, a method may or may not depend on the state of a specific Object:
  - methods that do not depend on this state should be annotated as **`static`**

Static can only call Static

- A static method can only depend on
  - variables local to the method
  - variables declared as static
  - other static methods
- A static method, therefore, **cannot** depend on:
  - variables not declared as static
  - other methods not declared as static
- The compiler will tell you, but maybe in a cryptic way.

Example

```
class myBad
{
int x;

myBad(int x)
  {
  this.x = x;
  }

getX()
  {
  return x;
  }

static int test()
  {
  getX() > 0;
  }
}
```

Polylist Operations

```
import polya.*;

class listOps
 {
 public static void main(String arg[])
  {
  Polylist L = Polylist.list(new Long(1), new Long(2), new Long(3));
  Polylist M = Polylist.list("apple", "banana", "grape", "kiwi");

  System.out.println("L                    = " + L);
  System.out.println("L.first()            = " + L.first());
  System.out.println("L.rest()             = " + L.rest());
  System.out.println("L.reverse()          = " + L.reverse());
  System.out.println("M                    = " + M);
  System.out.println("L.append(M)          = " + L.append(M));
  System.out.println("L.cons(new Long(0))  = " + L.cons(new Long(0)));
  System.out.println("M.nth(2)             = " + M.nth(2));
  System.out.println("Polylist.list(L, M)  = " + Polylist.list(L, M));
  }
 }
```

Polya List Operation Execution

reference: Polylist L = Polylist.list(new Long(1), new Long(2), new Long(3));
Polylist M = Polylist.list("apple", "banana", "grape", "kiwi");

L = (1 2 3)

L.first() = 1

L.rest() = (2 3)

L.reverse() = (3 2 1)

M = (apple banana grape kiwi)

L.append(M) = (1 2 3 apple banana grape kiwi)

L.cons(new Long(0)) = (0 1 2 3)

M.nth(2) = grape

Polylist.list(L, M) = ((1 2 3) (apple banana grape kiwi))