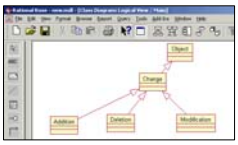
CPSC 233: Introduction to Computers II

Object-oriented programming



Object-oriented design

And a whole lot ole fun (you'll have a …)

Administrative Information For James Tam

Contact Information

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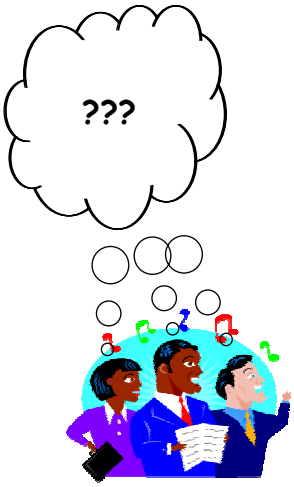
- Phone: 210-9455
- Email: **tamj@cpsc.ucalgary.ca**

Office hours

- Office hours: MW 12:00 – 12:50
- Email: (any time)
- Appointment: phone or call
- Drop by for urgent requests (but no guarantee that I will be in!)

Feedback



How You Will Be Evaluated

- **Assignments (30%)**
  - —Assignment 1 (Due Wednesday September 22, worth 2% of overall grade): *Writing a simple Java program*
  - —Assignment 2 (Due Wednesday September 29, worth 2% of overall grade): *Introduction to classes*
  - —Assignment 3 (Due Wednesday October 13, worth 5% of overall grade): *Dynamic memory allocation through an array of references*
  - — Assignment 4 (Due Friday October 29, worth 7% of overall grade): *Writing larger programs with multiple classes*
  - —Assignment 5 (Due Friday November 26, worth 8% of overall grade): *Inheritance and exceptions*
  - —Assignment 6 (Due Wednesday December 8, worth 6% of overall grade): *Designing a simple graphical-user interface, file input and output*

How You Will Be Evaluated (3)

- **Exams (70%)**
  - Midterm exam (30%): Written in-class on **Friday October 29**.
  - Final exam (40%): Scheduled by the Registrar's Office sometime between December 13 – 22.

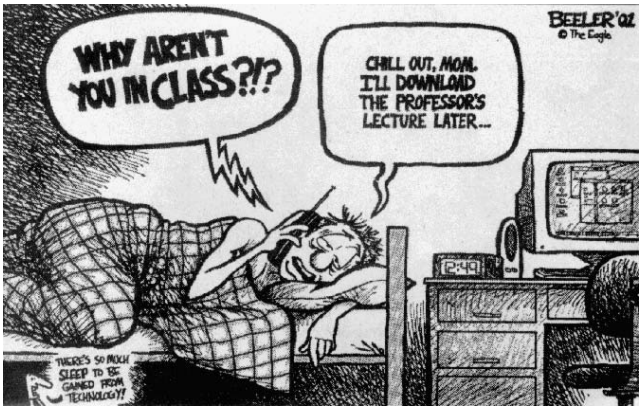
Note: You must pass both the assignment component (30%) and the exam component (70%) in order to get a C- or higher in the course.

Course Resources

- Course website:
  - http://www.cpsc.ucalgary.ca/~tamj/233
- Course textbook:
  - Big Java by Cay Horstmann (Wiley)
- Another good website (from the creators of Java):
  - http://java.sun.com/j2se/1.4.2/docs/index.html

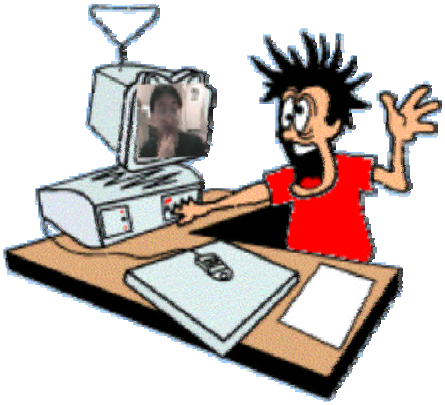
How To Use The Course Resources

- They are provided to support and supplement lectures
- Neither the course notes nor the text book are meant as a substitute for regular attendance to lecture and lab



CPSC 231: What Was It Like

A whole lot of work!



CPSC 233: What To Expect

Even more work!!!

Pascal-Java Transition

- History behind Java
- Creating, compiling and executing programs
- Basic program structure (smallest program)
- Common mistakes when going from Pascal to Java
- Documentation
- Text based output
- Variables and constants
- Operators
- Some Java libraries
- Text based input
- Decision making
- Loops

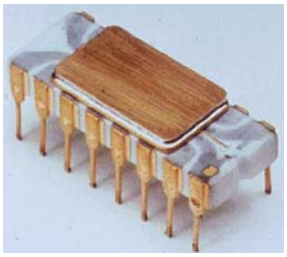
Java: History

•Computers of the past

Picture from "The History of Computing Technology" by Michael R. Williams

Java: History (2)

•The invention of the microprocessor revolutionized computers



Java: History (3)

- It was believed that the next step for microprocessors was to have them run intelligent consumer electronics

Java History (4)

- Sun Microsystems funded an internal research project "Green" to investigate this opportunity.
  - Result: A programming language called "Oak"

Blatant advertisement: James Gosling was a graduate of the U of C Computer Science program.

Wav file from "The Simpsons" © Fox, Image from the website of Sun Microsystems

Java History (5)

—Problem: There was already a programming language called Oak.

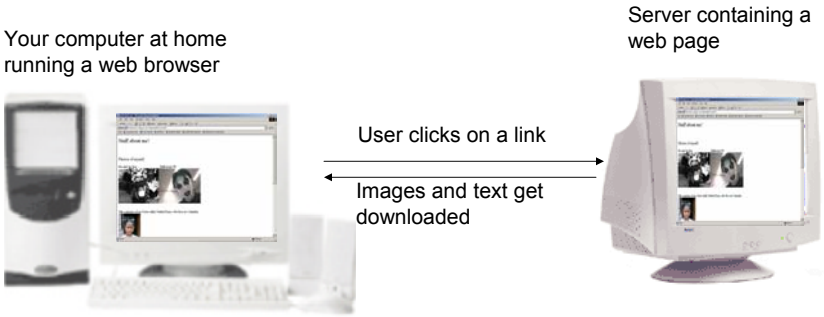
—The "Green" team met at a local coffee shop to come up with another name... Java

Java: History (6)

- The concept of intelligent devices didn't catch on
- Project Green and work on the Java language was nearly canceled

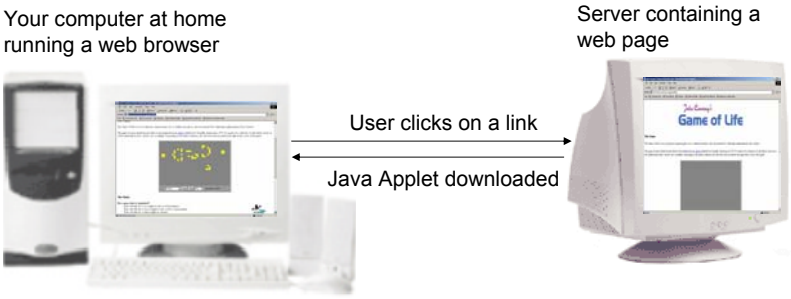
Java: History (7)

- The popularity of the Internet resulted in Sun's re-focusing of Java on computers.
- Prior to the advent of Java, web pages allowed you to download only text and images.



Java: History (8)

- Java enabled web browsers allowed for the downloading of programs (Applets)



Java version of the Game of Life: http://www.bitstorm.org/gameoflife/

Online checkers: http://www.darkfish.com/checkers/index.html

Java: Write Once, Run Anywhere

- Consequence of Java's history: platform-independence

Mac user running Netscape

Click on link to Applet

Byte code is downloaded

Web page stored on Unix server

Byte code (part of web page)

Virtual machine translates byte code to native Mac code and the Applet is run

Windows user running Internet Explorer

Java: Write Once, Run Anywhere

- Consequence of Java's history: platform-independent

Mac user running Netscape

Web page stored on Unix server

Click on link to Applet

Byte code is downloaded

Windows user running Internet Explorer

Virtual machine translates byte code to native Windows code and the Applet is run

Java: Write Once, Run Anywhere (2)

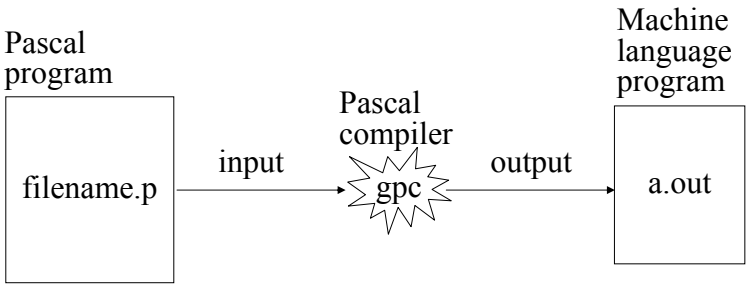
- But Java can also create standard (non-web based) programs

Dungeon Master (Java version)

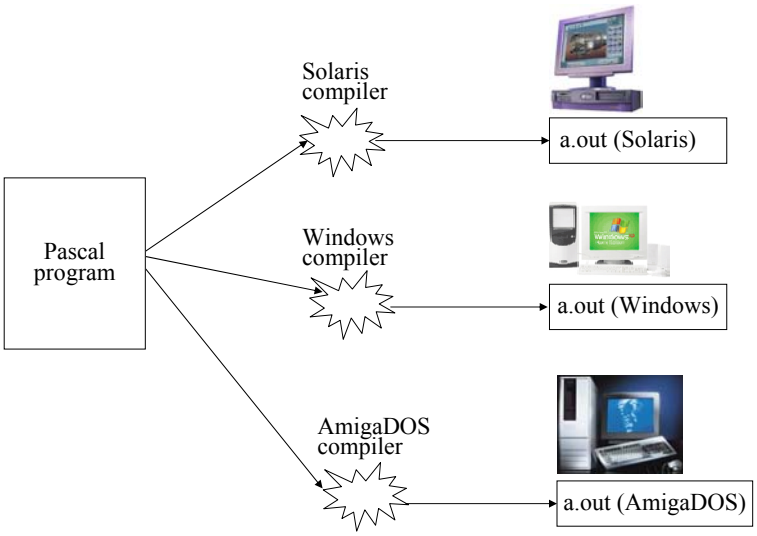
http://www.cs.pitt.edu/~alandale/dmjava/

Don't play this game on the CPSC network!

Review: Compiling Pascal Programs



Compiling Pascal Programs On Different Operating Systems



Java Vs. Java Script

Java (*this is what you need to know for this course*)

- A complete programming language developed by Sun
- Can be used to develop either web based or stand-alone software
- Many pre-created ode libraries available
- For more complex and powerful programs

Java Script (*not covered in this course*)

- A small language that's mostly used for web-based applications
- Good for programming simple special effects for your web page e.g., roll-overs
- e.g., http://www.discoverit.co.uk/webdesign/javascript.htm

Which Java?

- Java 2 SDK (Software Development Kit), Standard Edition 1.4.2. includes:
  - JDK (Java development kit) – for developing Java software
  - JRE (Java Runtime environment) – only good for running Java software
    - Java Plug-in – a special version of the JRE designed to run through web browsers

http://java.sun.com/j2se/1.4.2/download.html

Which Java?

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http://java.sun.com/j2se/1.4.2/download.html

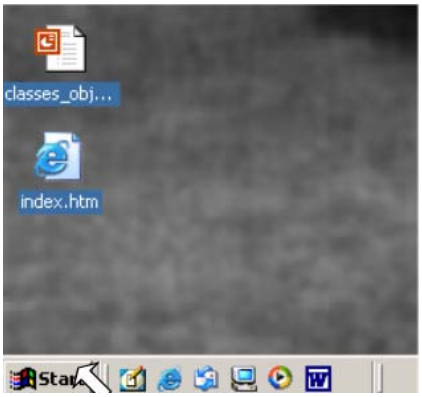
After Installation: Getting The Compiler And Interpreter Working (Windows 2000+)

- You need to set the path to the compiler and the class paths for your code
  1. Path – when a program is run (e.g., the Java compiler) it indicates the folder that the program resides.
  2. Class path – when a Java program is being compiled or run it indicates where to find the code.

Knowledge of paths and classpaths is not necessary for the exam. You only need to do this if you don't want to use a remote connection (e.g., ssh) when working from home. Note: We are not responsible if you accidentally damage your system settings on your operating system while setting the paths and classpaths. On your Computer Science account all of this has already been preconfigured for you.

Setting The Path And Classpath

•Click the start button



Setting The Path And Classpath

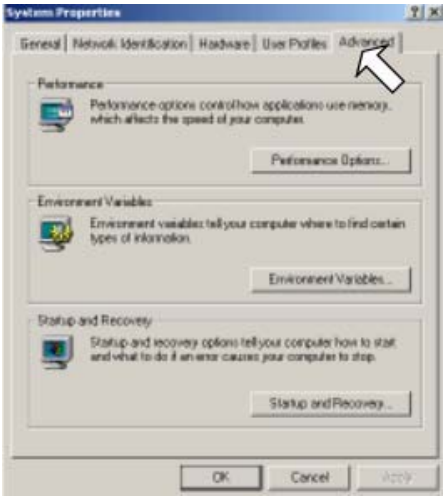
•Select the “Settings” and then the “Control panel” menu

Setting The Path And Classpath

•Select the “System” icon

Setting The Path And Classpath

•Select the “advanced” tab



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Setting The Path And Classpath

•Click on the “Environment variables” button.

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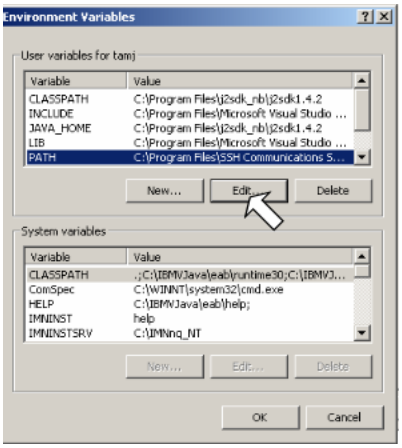
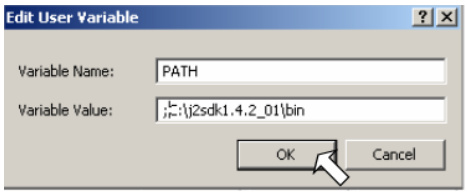
Setting The Path

- Select the “path” option for the first list (should be labeled as “User variables for <name of the user that you are logged in as>”).
- Click on the edit button.



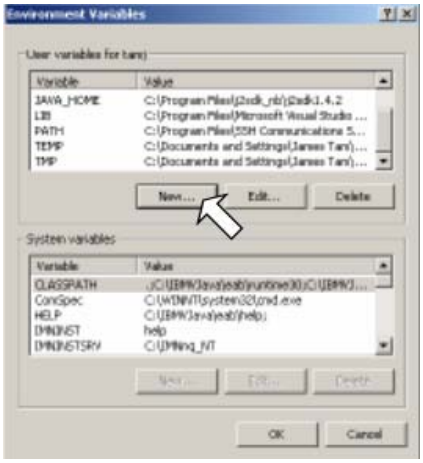
Setting The Path

- In the dialog box that comes up, select the input field labeled “Variable value”.
- Go to the end of the text string and enter in the path where you installed Java. If you installed it in the default location enter “;C:\j2sdk1.4.2_01\bin”. The semicolon is needed to separate the path of one installed program from another.
- Take care that you do not delete any existing text or other programs will not work properly!
- Then click on the “OK” button and you are now finished setting the path
- You’ve now finished setting the path for the java compiler and interpeter



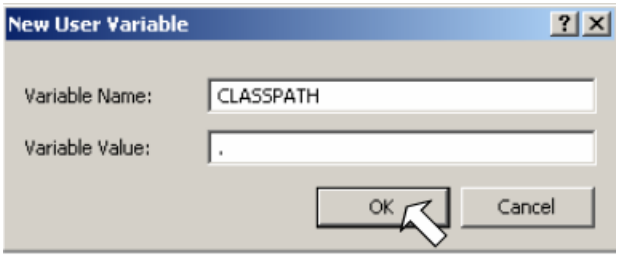
Setting The Classpath

- Now click the “New” button just under the first list (the same one that you just selected when setting the path).



Setting The Classpath

- For the input field labeled “Variable name” enter in “CLASSPATH”
- For the input field labeled “Variable value” enter in “.” (a period).
- The period indicates that when you run the Java compiler or interpreter that it should look in the current folder for the code (you can add additional folders as you desire).
- You’ve now finished setting the classpath.
- Reboot your computer and the settings should take effect for that user.



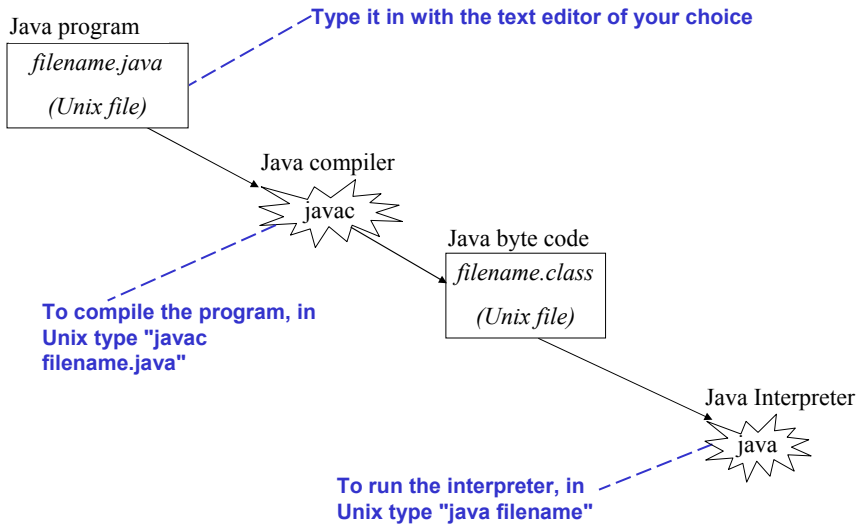
Smallest Compilable And Executable Pascal Program

```
program smallest;
begin
end.
```


Smallest Compilable And Executable Java Program

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

Creating, Compiling And Running Java Programs On The Computer Science Network



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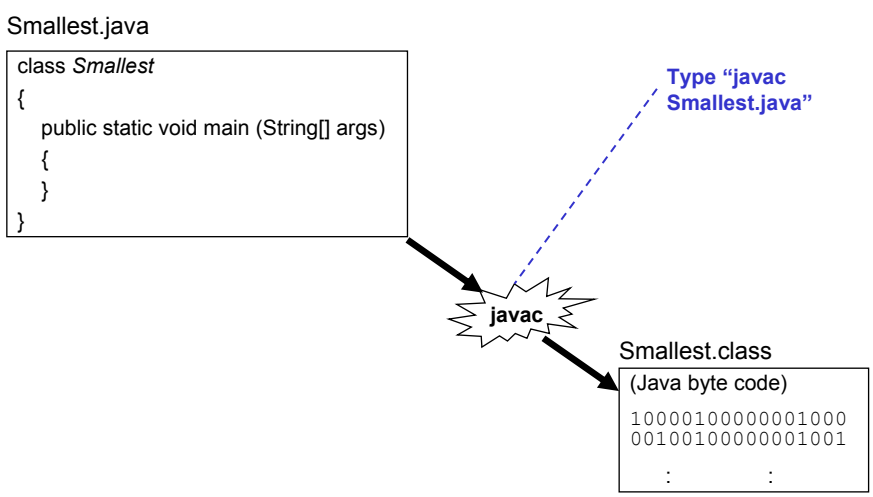
Compiling The Smallest Java Program



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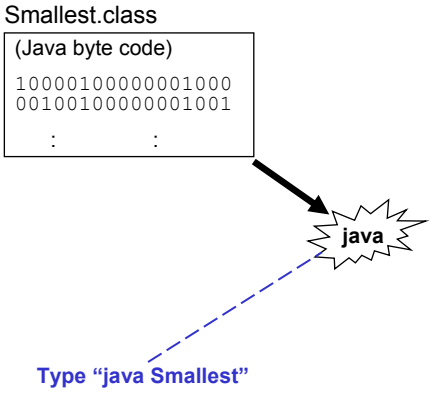
Running The Smallest Java Program



The Semicolon In Pascal

- Pascal
- Used to separate statements within a block of statements
- This is okay in Pascal:

```
program test (output);
begin
  writeln("one");
  writeln("two")
end.
```

The Semicolon In Java

- Java
- Follows each statement
- This is not okay in Java:

```
class BadExample
{
    public static void main (String [] args)
    {
        System.out.println("one");
        System.out.println("two")
    }
}
```


Braces In Java

- Unlike with Pascal, curly braces are not used for documentation.
- They are used to enclose a block of code

```
program smallest;
begin
end.
```

Encloses the starting point of a Pascal program

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

Encloses the starting point of a Java program

Documentation / Comments

Pascal

(* Start of documentation

*) End of documentation

Java

- Multi-line documentation

  /* Start of documentation

  */ End of documentation

- Documentation for a single line

  //Everything until the end of the line is a comment

Output In Pascal And Java

Pascal

```
write('...');
writeln ('...');
```

Java

```
System.out.print("…");
System.out.println("…");
```

Java Output

- Format:

  System.out.println(<*string or variable name one*> + <*string or variable name two*>..);

- Examples (Assumes a variable called num has been declared.):

  System.out.println("Good-night gracie!");

  System.out.print(num);

  System.out.println("num=" +num);

Output : Some Escape Sequences For Formatting

Escape sequence	**Description**
\t	Horizontal tab
\r	Carriage return
\n	New line
\”	Double quote
\\	Backslash

Some Built-In Types Of Variables In Java

Type	Description
byte	8 bit signed integer
short	16 but signed integer
int	32 bit signed integer
long	64 bit signed integer
float	32 bit signed real number
double	64 bit signed real number
char	16 bit Unicode character
boolean	1 bit true or false value
String	A sequence of characters between double quotes (“”)

Java Vs. Pascal Variable Declarations

Pascal

Format:

<*variable name*> : variable type;

Example

num : integer;

Java

Format:

variable type <*variable name*>;

Example:

long num1;
double num2 = 2.33;

Location Of Variable Declarations

```
class <name of class>
{
   public static void main (String[] args)
   {
         // Local variable declarations occur here

         << Program statements >>
                :          :

   }
}
```


Constants In Pascal Vs. Java

Pascal:

Format:

```
const
   <CONSTANT NAME> = <Value>;
```

Example:

```
const
   SIZE =  5;
```

Java

Format:

```
final <constant type> <CONSTANT NAME> = <value>;
```

Example:

```
final int SIZE = 100;
```

Location Of Constant Declarations

```
class <name of class>
{
   public static void main (String[] args)
   {
         // Local constant declarations occur here
         // Local variable declarations

         < Program statements >>
               :          :

   }
}
```


Java Keywords

abstract	boolean	break	byte	case	catch	char
class	const	continue	default	do	double	else
extends	final	finally	float	for	goto	if
implements	import	instanceof	int	interface	long	native
new	package	private	protected	public	return	short
static	super	switch	synchronized	this	throw	throws
transient	try	void	volatile	while		

Variable Naming Conventions In Java

- Compiler requirements
  - Can't be a keyword nor can the names of the special constants true, false or null be used
  - Can be any combination of letters, numbers, underscore or dollar sign (first character must be a letter or underscore)
- Common stylistic conventions
  - The name should describe the purpose of the variable
  - Avoid using the dollar sign
  - With single word variable names, all characters are lower case
    - e.g., double grades;
  - Multiple words are separated by capitalizing the first letter of each word except for the first word
    - e.g., String firstName = "James";

Constant Naming Conventions In Java

- Compiler requirements
  - Can't be a keyword nor can the names of special constants true, false or null be used
  - Can be any combination of letters, numbers, underscore or dollar sign (first character must be a letter or underscore)
- Common stylistic conventions
  - The name should describe the purpose of the constant
  - Avoid using the dollar sign
  - All characters are capitalized
    - e.g., float SIZE = 100;
  - Multiple words are separated with an underscore between each word.
    - e ,g, float CORPORATE_TAX_RATE = 0.46;

Common Java Operators / Operator Precedence

Precedence level	Operator	Description	Associativity
1	expression++ expression--	Post-increment Post-decrement	Right to left
2	++expression --expression + - ! ~ (type)	Pre-increment Pre-decrement Unary plus Unary minus Logical negation Bitwise complement Cast	Right to left

Common Java Operators / Operator Precedence

Precedence level	Operator	Description	Associativity
3	* / %	Multiplication Division Remainder/modulus	Left to right
4	+ -	Addition or String concatenation Subtraction	Left to right
5	<< >>	Left bitwise shift Right bitwise shift	Left to right

Common Java Operators / Operator Precedence

Precedence level	Operator	Description	Associativity
6	< <= > >=	Less than Less than, equal to Greater than Greater than, equal to	Left to right
7	= = !=	Equal to Not equal to	Left to right
8	&	Bitwise AND	Left to right
9	^	Bitwise exclusive OR	Left to right

Common Java Operators / Operator Precedence

Precedence level	Operator	Description	Associativity
10	|	Bitwise OR	Left to right
11	&&	Logical AND	Left to right
12	||	Logical OR	Left to right

Common Java Operators / Operator Precedence

Precedence level	Operator	Description	Associativity
13	=	Assignment	Right to left
	+=	Add, assignment	
	-=	Subtract, assignment	
	*=	Multiply, assignment	
	/=	Division, assignment	
	%=	Remainder, assignment	
	&=	Bitwise AND, assignment	
	^=	Bitwise XOR, assignment	
	|=	Bitwise OR, assignment	
	<<=	Left shift, assignment	
	>>=	Right shift, assignment	

Post/Pre Operators

```
class Example1
{
   public static void main (String [] args)
   {
      int num = 5;
      System.out.println(num);
      num++;
      System.out.println(num);
      ++num;
      System.out.println(num);
      System.out.println(++num);
      System.out.println(num++);
   }
}
```

Post/Pre Operators (2)

```
class Example1A
{
   public static void main (String [] args)
   {
      int num1, num2;
      num1 = 5;
      num2 = ++num1 * num1++;
      System.out.println("num1=" + num1);
      System.out.println("num2=" + num2);
   }
}
```


Unary And Casting Operators

```
class Example2
{
   public static void main (String [] args)
   {
      int num = 5;
      float fl;
      System.out.println(num);
      num = num * -num;
      System.out.println(num);
      fl = num;
      System.out.println(num + " " + fl);
      num = (int) fl;
      System.out.println(num + " " + fl);
   }
}
```

Some Useful Java Libraries[1]

Library	Purpose
java.lang	The core part of the Java language e.g., Math functions, basic console (screen) output.
java.util	Extra utilities e.g., Random number generators, automatically resizable arrays
java.io	Input and output
java.awt	The original library for developing GUI's (graphical user interfaces)
:	: :

1 Note: The use of the code in any of these libraries (except java.lang) requires the use of an import statement at the top of the file:

Format: import <library name>

Example: import java.util.*;

Advanced Output (*Optional*)

- You can employ the predefined code in TIO (http://www.cse.ucsc.edu/~charlie/java/tio/)
- To use:
  - (In Unix):
    - Create link from the directory where your Java code resides to the following directory /home/233/tio
    - Do this by typing the following in that directory:

      ln -s /home/233/tio

- (At the start of the Java program include the following statement):

  import tio.*;

Advanced Output (2)

Statement	Effect
Console.out.printf(<*variable or string1* > + <*variable or string 2*> …); ***MUST EVENTUALLY BE FOLLOWED BY A PRINTFLN!***	Prints contents of field
Console.out.printfln((<*variable or string1* > + <*variable or string 2*> …);	Prints contents of field and a new line
Console.out.setWidth(<*integer value*>);	Sets the width of a field
Console.out.setDigits(<*integer value*>);	Sets the number of places of precision
Console.out.setJustify(Console.out.LEFT); Console.out.setJustify(Console.out.RIGHT);	Left or right justify field

Advanced Output: An Example

```
import tio.*;
class Output1
{
   public static void main (String [] args)
   {
      int num = 123;
      double db = 123.45;
      Console.out.setJustify(Console.out.LEFT);
      Console.out.setWidth(6);
      Console.out.setDigits(1);
      Console.out.printf("Start line");
      Console.out.printf(num);
      Console.out.printf(db);
      Console.out.printf("End of line");
      Console.out.printfln("");
   }
}
```

Text-Based Java Input

- You can employ the predefined code in TIO
- (http://www.cse.ucsc.edu/~charlie/java/tio/)

- To use:
- (In Unix):
  - Create link from the directory where your Java code resides to the following directory /home/233/tio
  - Do this by typing the following in that directory:

    ln -s /home/233/tio

- (At the start of the Java program include the following statement):

  import tio.*;

Text-Based Java Input (2)

1	Console.in.readChar()	Reads in a character Returns an integer
2	Console.in.readInt()	Reads some characters Returns an integer
3	Console.in.readLong()	Reads some characters Returns a long
4	Console.in.readFloat()	Reads some characters Returns a float
5	Console.in.readDouble()	Reads some characters Returns a double

Text-Based Java Input (3)

6	Console.in.readWord()	Reads in a word Returns a String
7	Console.in.readLine()	Reads in a line Returns a String

Text-Based Java Input (4)

- Caution! The input routines (2 – 6) accept a series of characters that end with white space but *the white space is still left* on the input stream. Leading white space is removed.
- Work-around: Follow each of these input statements with a readLine() as needed.

Text-Based Java Input: An Example

```
import tio.*;
class Input1
{
   public static void main (String [] args)
   {
      int in;
      float fl;
      String st;

      System.out.print("Type in an integer: ");
      in = Console.in.readInt();
      System.out.print("Type in a float: ");
      fl = Console.in.readFloat();

      System.out.print("Type in a sentence: ");
      st = Console.in.readLine();
}
```

Problem at this point

Text-Based Java Input: An Example

```
import tio.*;
class Input1
{
   public static void main (String [] args)
   {
      int in;
      float fl;
      String st;

      System.out.print("Type in an integer: ");
      in = Console.in.readInt();
      System.out.print("Type in a float: ");
      fl = Console.in.readFloat();
      st = Console.in.readLine();

      System.out.print("Type in a sentence: ");
      st = Console.in.readLine();
}
```

Work-around

Decision Making In Java

- Pascal
  - If-then
  - If-then, else
  - If-then, else-if
  - Case-of
- Java
  - If
  - If, else
  - If, else-if
  - Switch

Decision Making: If

Format:

```
if (Boolean Expression)
    Body
```

Example:

```
if (x != y)
    System.out.println("X and Y are not equal");

if ((x > 0) && (y > 0))
{
    System.out.println("X and Y are positive");
}
```

Decision Making: If, Else

Format:

```
if (Boolean expression)
    Body of if
else
    Body of else
```

Example:

```
if (x < 0)
    System.out.println("X is negative");
else
    System.out.println("X is non-negative");
```


If, Else-If

Format:

```
if (Boolean expression)
    Body of if
else if (Boolean expression)
    Body of first else-if
    :     :          :
else if (Boolean expression)
    Body of last else-if
else
    Body of else
```

If, Else-If (2)

Example:

```
if (gpa == 4)
{
    System.out.println("A");
}
else if (gpa == 3)
{
    System.out.println("B");
}
else if (gpa == 2)
{
    System.out.println("C");
}
```


If, Else-If (2)

```
else if (gpa == 1)
{
   System.out.println("D");
}
else
{
   System.out.println("Invalid gpa");
}
```

Alternative To Multiple Else-If's: Switch

Format:

```
switch (variable name)
{
   case <integer value>:
   Body
   break;

   case <integer value>:
   Body
   break;
        :
   default:
   Body

}
```

1 The type of variable in the brackets can be a byte, char, short, int or long

Alternative To Multiple Else-If's: Switch (2)

Format:

```
switch (variable name)
{
   case '<character value>':
   Body
   break;

   case '<character value>':
   Body
   break;
        :
   default:
   Body

}
```

1 The type of variablein the brackets can be a byte, char, short, int or long

Loops

Pascal Pre-test loops

- For-do
- While-do

Java Pre-test loops

- For
- While

Pascal Post-test loops

- Repeat-until

Java Post-test loops

- Do-while

While Loops

Format:

while (*Expression*)
  Body

Example:

```
int i = 1;
while (i <= 1000000)
{
    System.out.println("How much do I love thee?");
    System.out.println("Let me count the ways: ", + i);
    i = i + 1;
}
```

For Loops

Format:

```
for (initialization; Boolean expression; update control)
    Body
```

Example:

```
for (i = 1; i <= 1000000; i++)
{
    System.out.println("How much do I love thee?");
    System.out.println("Let me count the ways: " + i);
}
```


Do-While Loops

Format:

```
do
    Body
while (Boolean expression);
```

Example:

```
char ch = 'A';
do
{
    System.out.println(ch);
    ch++;
}
while (ch != 'K');
```

Do-While Loops

Format:

```
do
    Body
while (Boolean expression);
```

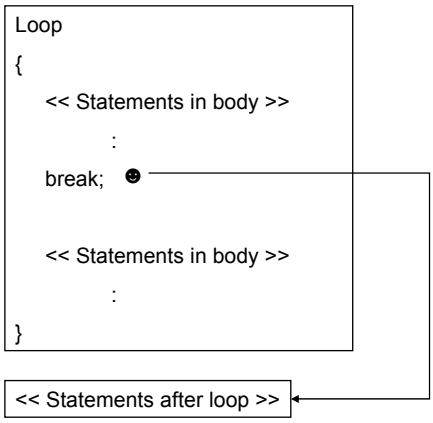
Unlike Pascal the loop body executes while the expression is true

Example:

```
char ch = 'A';
do
{
    System.out.println(ch);
    ch++;
}*
while (ch != 'K');
```


Ending Loops Early: Break

- When this statement is reached the loop ends. (You "break out of" the loop).



Ending Loops Early: An Example

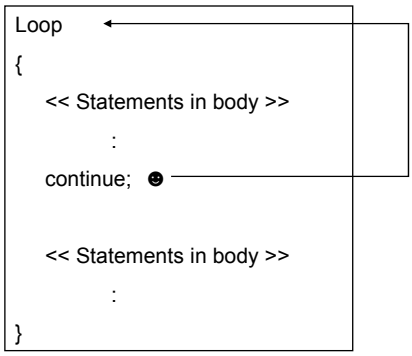
```
import tio.*;
class BreakExample
{
   public static void main (String [] args)
   {
      int number, sum;
      sum = 0;
```


Ending Loops Early: An Example (2)

```
      while (true)
      {
         System.out.print("\tPositive number (negative to quit): ");
         number = Console.in.readInt();
         Console.in.readLine();
         if (number >= 0)
            sum += number;
         else
            break;
      }
      System.out.println("Sum is..." + sum);
   }
}
```

Skipping An Iteration Of A Loop: Continue

- When this statement is reached control returns to the beginning of the loop. (You swing back up to the top of the loop).



Skipping An Iteration of A Loop: Continue

```
for (i = 1; i <= 10; i++)
{
  if (i % 2 == 0)
  {
      continue;
  }
  System.out.println("i=" + i);
}
```

Statements That Results In Abnormal Execution Of Loops Should Be Used Sparingly

- They make the program harder to trace

```
class Test
{
   public static void main (String [] args)
   {
      for (int i = 1; i < 10; i++)
      {
         if ( i == 5)
            break;
         System.out.print(i);
      }
   }
}
```

- Typically a break is only used for exiting nested loops cleanly

You Should Now Know

- How Java was developed and the impact of it's roots on the development of this language
- The basic structure required in creating a simple Java program as well as how to compile and run programs
- Methods of documenting a Java program
- How to perform text based input and output in Java
- The declaration of constants and variables
- What are the common Java operators and how they work
- The structure and syntax of decision making and looping constructs