# CPSC 213: Assignment 1

**Due: Monday, January 16, 2011 at 6pm.**

Late assignments are accepted until Saturday, January 21 at 6pm with a 20% penalty per day (or fraction of a day) past the due date. This rule is strictly applied and there are no exceptions.

## Goal

The goals of this assignment are for you to get some of the preliminary stuff under your belt:

- familiarize yourself with the Unix command line
- write, compile and run a very simple C program
- understanding endianness and how to detect it using a program
- install the SimpleMachine simulator on your machine
- implement the MainMemory class used by the SimpleMachine simulator.

## Unix Development

Much of the programming you will do in this course will be in Java using Eclipse. But, for some of what you will do you will need a Unix development environment. One of the requirements of this first assignment is that you get a Unix environment set up and become familiar with it. You have some choices.

You can use the departmental machines, if you like. Machines with names linXX.ugrad.cs.ubc.ca, where XX is a two-digit number like '02' or '12', are IA-32 machines running Linux, as is remote.ugrad.cs.ubc.ca. A SPARC machine running SunOS is galiano.ugrad.cs.ubc.ca. Any of these will be fine. You can access these machines remotely using ssh or Xshell (google to find downloads for these).

If you want to use a Windows machine you need to install Cygwin (Microsoft's C Visual Studio environment and their C development tools will not work for this class). Cygwin provides your Windows machine with a Unix command line and various development tools. Be sure to specify that you want "gcc" included when you install it.

If you want to use a Mac you need to install Apple's Development Tools (Xcode and related command line tools). This is an optional install included on the MacOS distribution DVD and is also available for download from Apple by joining their developer network (which is free); details at developer.apple.com.

## C and Endianness

In class I gave you the outline of a C program that casts an **`int`** into an array of bytes. Modify this program (or start from scratch) to create a program that prints "Big Endian" on big-endian architectures and "Little Endian" on little-endian architectures. Test your program by compiling

and running it on an IA32 (Intel) machine and on a Sparc machine, as discussed in the previous section. Recall that IA32 and Sparc have different endianness.

A part of the goal here is to get comfortable with the UNIX command line, with editing, compiling and running C programs etc. by starting with a simple example. Here are some useful commands.

| command | purpose |
|---|---|
| `uname -a` | display the ISA and other characteristics of the current system |
| `emacs` | a text editor for writing source code (Eclipse will work too) |
| `gcc` | compile a program into an executable |
| `man` | display the manual page (documentation) for a unix command |
| `gdb` | the gnu symbolic debugger (for debugging C programs) |

# SimpleMachine Installation

The next part of the assignment is to create an Eclipse (or similar) development environment for the SM213 simulator. Included in the lab material on the course home page is a zipped file sm213-eclipse.zip that includes two Eclipse projects: one for the SM213 code that you will write yourself, and a reference implementation of SM213 that you can check your work against. There is also a link to instructions that describe how to install these in Eclipse. You are given the stubs for MainMemory.java and CPU.java, and you will gradually implement these over the course of the next several assignments. The reference implementation of the SM213 simulator has the classes obfuscated so that you can't decompile it to see the implementations of these classes.

As an alternative to Eclipse, you can use Apple's Xcode development environment, or any other tool you like. In that case, you will want the full version of the code, in the alternative zip file sm-student-213.zip

# Implementation of Memory Class

Finally, implement the missing methods of the Memory class, in MainMemory.java. In doing so, you will implement accessor methods for access to memory (set and get), implement a method that determines whether an address is aligned, and implement methods that convert between an array of bytes and four-byte Big Endian integers. This class will be used for all memory access in subsequent assignments by the SM213 machine implementation that you will build.

To do these things, modify the class MainMemory in the package arch.sm213.machine.student. The full simulator has a large number of other classes that you can completely ignore for this

assignment. (If you installed the Eclipse package version of the code, you will see only the two classes that you need to edit.)

The get and set methods read and write directly to the given memory location and do not need to check for alignment. However, they should check for out-of-bounds accesses.

Implementing Big Endian conversion requires the use of Java's bit shifting operators (**`>>`** and **`<<<)`** and bit-wise logical operators (**`|`** and/or **`&`**). You can tell Java that you only want the low order byte of an integer by casting it to a byte (e.g., **`byte b = (byte) (i);`**).

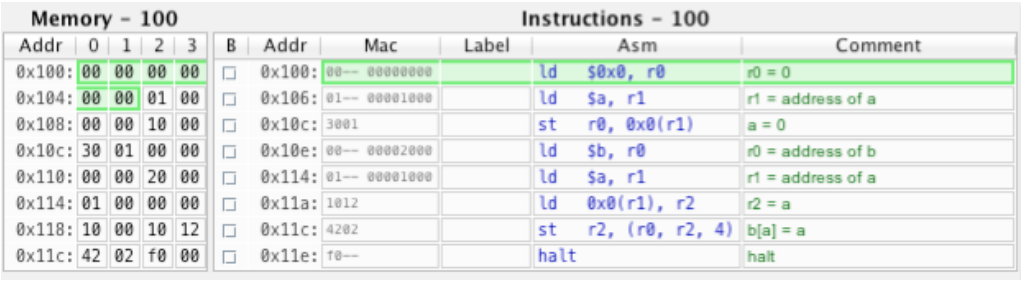
One caution is that Java bytes are signed numbers and so shifting to the right or assigning a **`byte`** into an **`int`** will sign extend the number, which might not be what you want. For example:

```
byte b = (byte) 0xff;
int i = b;
```

results in **`i`** storing **`-1`** which in hex is **`0xffffffff`** not **`0x000000ff`**.

Add a "Main" method to this class so that you can test the methods you implement. Be sure to test your code fully, including error cases in that should throw InvalidAddressException.

Now, to further test your implementation you will run the actual simulator with it now using your MainMemory implementation (directions for how to run it are in the install.pdf handout). Run the simulator, select "Open" from the menu and load the file S1-global-static.s. You should see the code for this file displayed in the simulator and you should be able to modify it. You will not be able to execute the code until you implement the Machine itself in subsequent assignments. It should look like this:




# Material Provided

On the course web page you will find the following additional material for this assignment.

1. sm213-eclipse.zip (alternative: sm-student-213.zip)
2. install.pdf (also included as an appendix to the Companion)
3. code.zip which includes S1-global-static.s

# What to hand in

Use the **`handin`** program to hand in the following:

1. A single file called "README.txt" that includes your name, student number, four-digit cs-department undergraduate id (e.g., the one that's something like a0b1), and all written material required by the assignment as listed below.

2. A statement explaining which type of Unix environment you will use for this course and saying that you've got it set up and working in the README file.

3. The C program you write.

4. A list of the machines on which you ran your C program and what it said about their Endianness. For each of these machines, use the **`uname`** program to determine the ISA of the machine and include this in your report. Include this in the README file.

5. Your implementation of the arch.sm213.machine.student.MainMemory.java, including your test code. Carefully comment your test code to indicate why it provides test coverage.

6. A description of the results of your testing. If your test cases provide full coverage and all tests passed, it is sufficient to just say this. But, if certain things do not work, you must indicate this. Include this in the README file.

The handin assignment directory name for this assignment is **`a1`**.