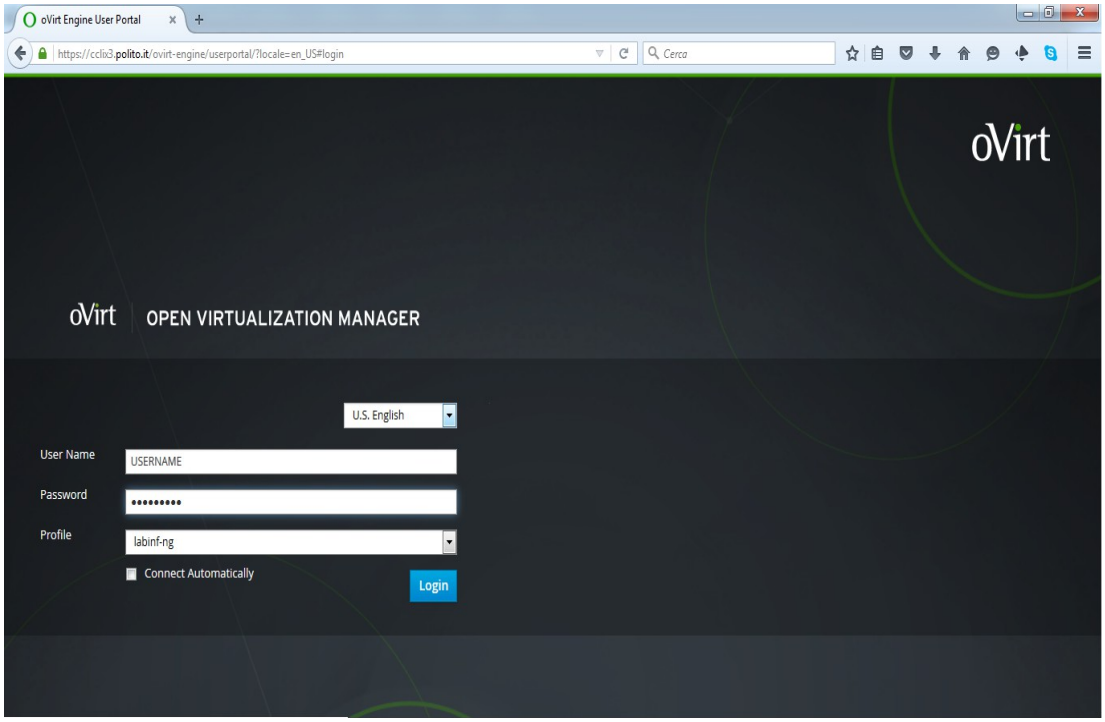
Computer Architectures
2nd part labs – lab 2
Introducing SimpleScalar

1) Working with SimpleScalar using the virtualization system:
   a. Open this site: cclix3.polito.it in your favorite browser
   b. Click on UserPortal and accept the web's security certificate
   c. log you in using your labinf credentials
      - use the profile: labinf-ng
      - disable the option: Connect Automatically

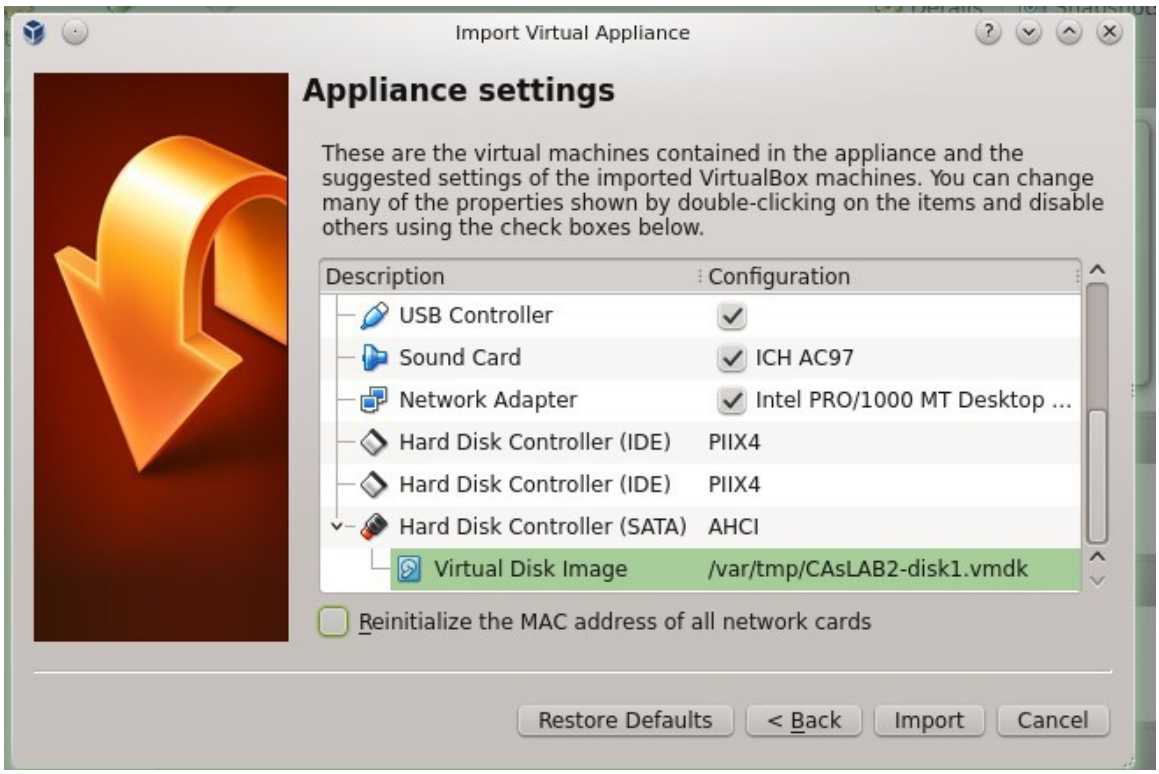


   d. start the CAsLABS3 virtual machine by clicking on "RUN VM"
   e. then, in the console menu, select Connect.

2) Working with the SimpleScalar virtual machine:
   a. the virtual machine (*CAsLABS2.ova*) for SimpleScalar labs is placed in the folder:

```
/var/tmp
```

   b. launch the virtual box tool
      Oracle VM VirtualBox
   c. import the SimpleScalar virtual machine by clicking on *import appliance* in the *file* menu, and select the virtual machine in the tmp folder
   d. in the appliance settings window, change the path of the *Virtual Disk Image* by the tmp folder used before (`/var/tmp`):



3) start the virtual machine
   - username: Student CAS
   - password: cas

4) launch a terminal
   - notice that the main folder for SimpleScalar is:

```
~/simplescalar/simplesim-3.0/
```

5) Using SimpleScalar:
   a. modify the hello.c program placed in:

6)
```
~/simplescalar/
```

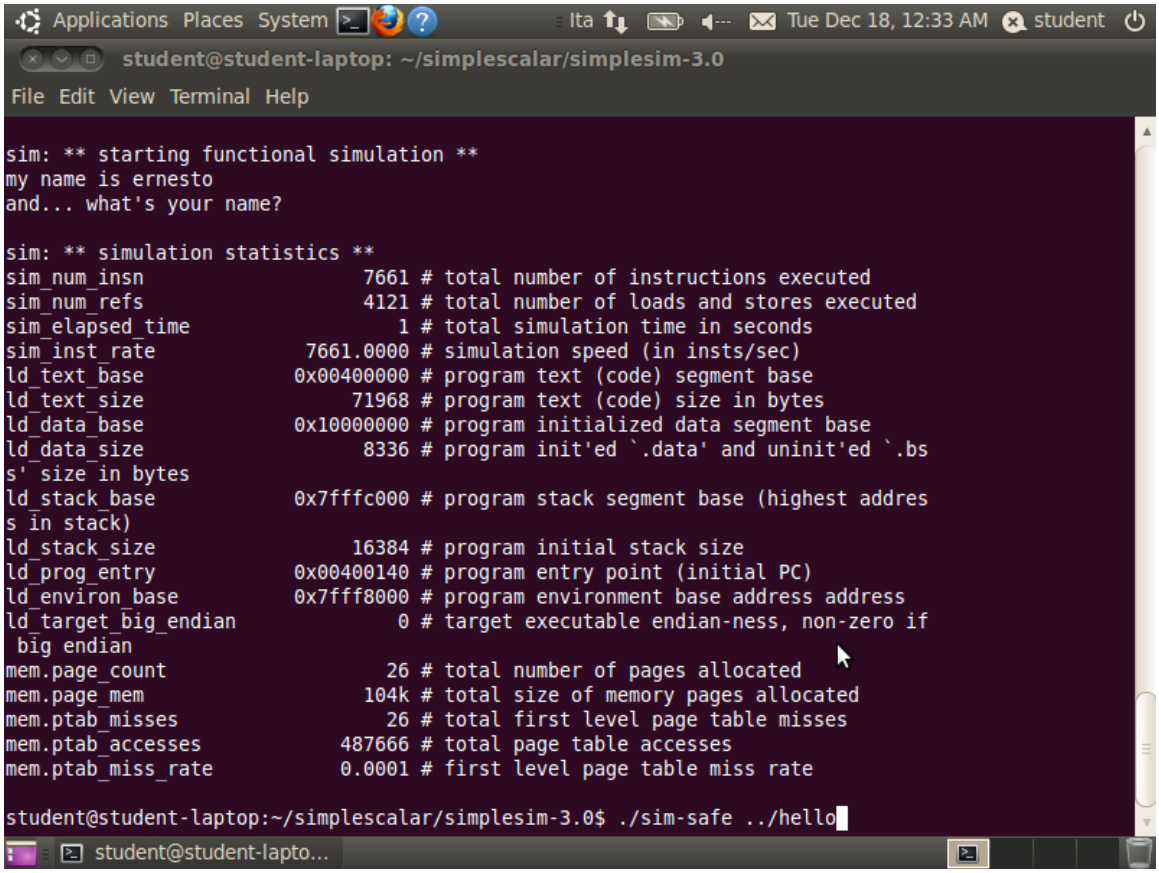
   b. compile the program, using gcc, by running this command:

```
student@student-laptop:~/simplescalar$ ./bin/sslittle-na-sstrix-gcc -o
hello hello.c
```

   c. execute the program using sim-safe:

```
student@student-laptop:~/simplescalar/simplesim-3.0$ ./sim-safe ../hello
```

   d. check the output with the following:



7) Execute the program using the superscalar version (out of order) of the simulator (`sim-outorder`):

```
student@student-laptop:~/simplescalar/simplesim-3.0$./sim-outorder ../hello
```

a. compare the output results using different simulators. Notice that the out of order simulator provides more information about processor performance.

8) Running tests-pisa programs
5 testing C programs (test-*.c) for the *pisa* version of simplescalar are placed in:

```
~/simplescalar/simplesim-3.0/tests-pisa/src
```

a. copy the source programs (test-*.c) in the folder *CAsLABs*
b. compile all the C programs (see 2.b)
c. run the test programs with the "superscalar out of order" version of the simulator using the the configuration file called *default.cfg* available in *CAsLABs*
example:

```
student@student-laptop:~/simplescalar/CAsLABs$ ../simplesim-3.0/sim-outorder
-config default.cfg test-math
```

d. check the program output, and collect for every program the following statistics parameters:
   - `sim_num_insn // total number of instructions committed`
   - `sim_cycle  // total simulation time in cycles`
   - `sim_IPC // instructions per cycle`
   - `sim_CPI // cycles per instruction`

Check the configuration in the *default.cfg* file, and notice that the provided configuration tries to use a very simplified processor architecture. The main parameters to consider are listed in the following:

```
# instruction fetch queue size (in insts)
-fetch:ifqsize                    1
```

```
# speed of front-end of machine relative to execution core
-fetch:speed                      1
```

```
# extra branch mis-prediction latency
-fetch:mplat                      1
```

```
# instruction issue B/W (insts/cycle)
-issue:width                      1
```

```
# instruction decode B/W (insts/cycle)
-decode:width                     1
```

```
# instruction commit B/W (insts/cycle)
-commit:width                     1
```

```
# run pipeline with in-order issue
-issue:inorder                true
```

```
# register update unit (RUU) size (this unit is similar to ROB)
-ruu:size                     2
```

```
# load/store queue (LSQ) size
-lsq:size                     2
```

```
# total number of integer ALU's available
-res:ialu                     1
```

```
# total number of integer multiplier/dividers available
-res:imult                    1
```

```
# total number of memory system ports available (to CPU)
-res:memport                  1
```

```
# total number of floating point ALU's available
-res:fpalu                    1
```

```
# total number of floating point multiplier/dividers available
-res:fpmult                   1
```

9) Performance comparison:
Modify the configuration file `default.cfg`, in order to improve the processor performance while running the test-pisa programs.
In particular, for every run change the parameters value following the directions provided in the table below:

conf	FP resources	-fetch: speed	-fetch: ifqsize	-lsq: size	-ruu: size	-issue: width	-commit: width	In order	sim_CPI
1	1	1	1	2	2	1	1	Y	
2	1	1	1	2	4	1	1	N	
3	4	1	1	2	4	1	1	N	
4	4	1	1	2	8	1	1	N	
5	1	4	4	4	8	4	4	N	
6	4	4	4	4	16	4	4	N	
7									

Simulate every *test-pisa* program gathering the `sim_CPI` value for every one of the proposed configurations.
Comment the results justifying the change in the performance.

10) Define your own configuration, (place it on table's row No 7) in order to perform better than in the proposed cases.