Template Week 4 – Software

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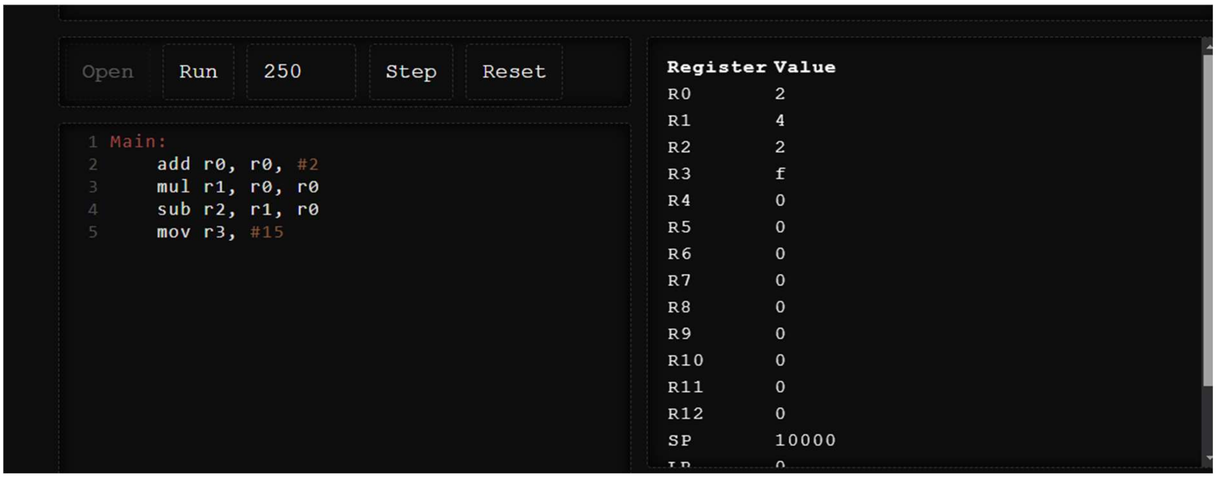
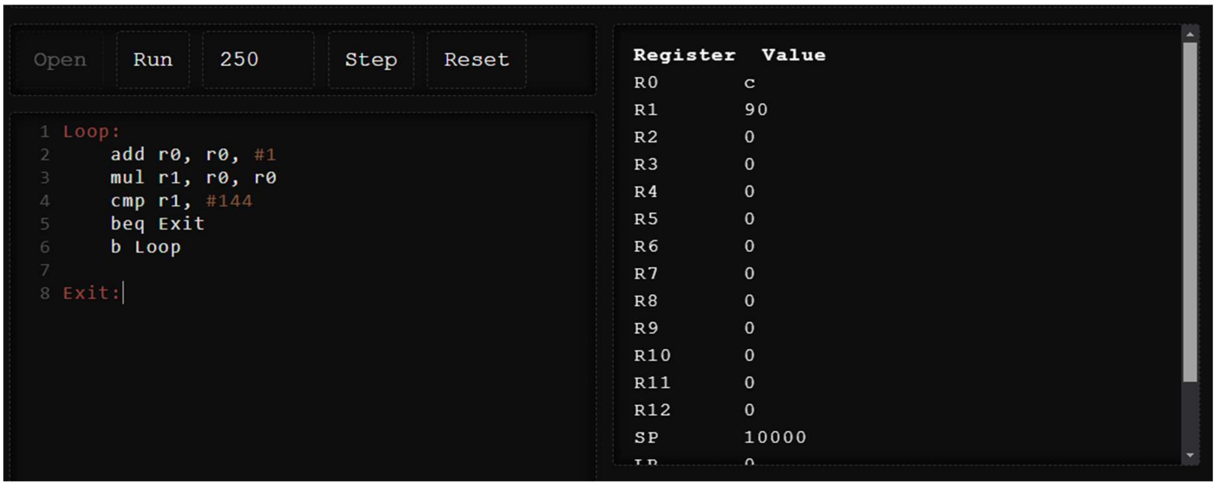
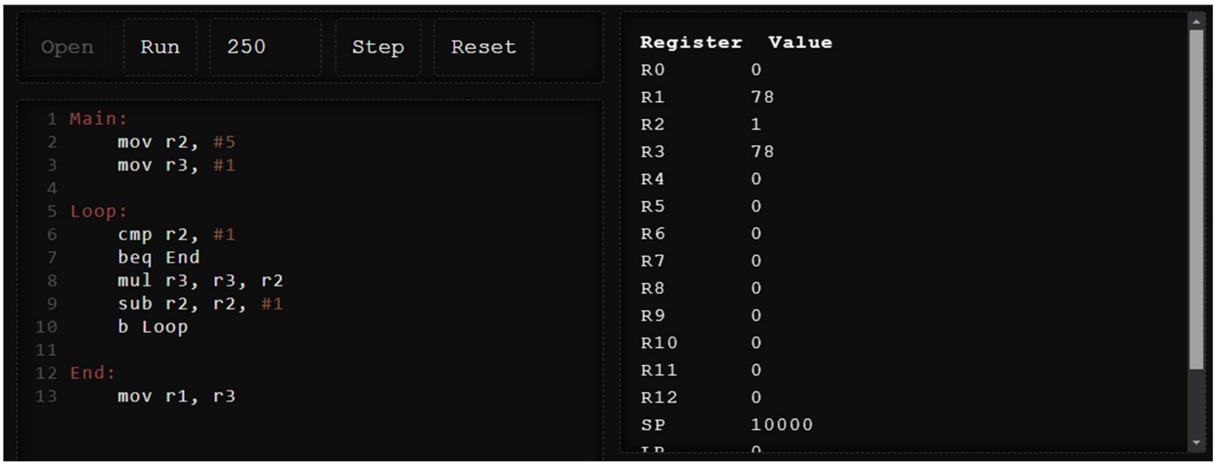
Assignment 4.1: ARM assembly

Screenshot of working assembly code of factorial calculation:







Assignment 4.2: Programming languages

Take screenshots that the following commands work:

javac –version

```
davin@davin-ubuntu-vm:~$ javac --version
javac 21.0.5
```

java –version

```
davin@davin-ubuntu-vm:~$ java --version
openjdk 21.0.5 2024-10-15
OpenJDK Runtime Environment (build 21.0.5+11-Ubuntu-1ubuntu124.04)
OpenJDK 64-Bit Server VM (build 21.0.5+11-Ubuntu-1ubuntu124.04, mixed mode, shar
ing)
```

gcc –version

```
davin@davin-ubuntu-vm:~$ gcc -v
Using built-in specs.
COLLECT_GCC=gcc
COLLECT_LTO_WRAPPER=/usr/libexec/gcc/x86_64-linux-gnu/13/lto-wrapper
OFFLOAD_TARGET_NAMES=nvptx-none:amdgcn-amdhsa
OFFLOAD_TARGET_DEFAULT=1
Target: x86_64-linux-gnu
Configured with: ../src/configure -v --with-pkgversion='Ubuntu 13.2.0-23ubuntu4' --with-bug
url=file:///usr/share/doc/gcc-13/README.Bugs --enable-languages=c,ada,c++,go,d,fortran,objc
,obj-c++,m2 --prefix=/usr --with-gcc-major-version-only --program-suffix=-13 --program-pref
ix=x86_64-linux-gnu- --enable-shared --enable-linker-build-id --libexecdir=/usr/libexec --w
ithout-included-gettext --enable-threads=posix --libdir=/usr/lib --enable-nls --enable-cloc
ale=gnu --enable-libstdcxx-debug --enable-libstdcxx-time=yes --with-default-libstdcxx-abi=n
ew --enable-libstdcxx-backtrace --enable-gnu-unique-object --disable-vtable-verify --enable
-plugin --enable-default-pie --with-system-zlib --enable-libphobos-checking=release --with-
target-system-zlib=auto --enable-objc-gc=auto --enable-multiarch --disable-werror --enable-
cet --with-arch-32=i686 --with-abi=m64 --with-multilib-list=m32,m64,mx32 --enable-multilib
--with-tune=generic --enable-offload-targets=nvptx-none=/build/gcc-13-uJ7kn6/gcc-13-13.2.0/
debian/tmp-nvptx/usr,amdgcn-amdhsa=/build/gcc-13-uJ7kn6/gcc-13-13.2.0/debian/tmp-gcn/usr --
enable-offload-defaulted --without-cuda-driver --enable-checking=release --build=x86_64-lin
ux-gnu --host=x86_64-linux-gnu --target=x86_64-linux-gnu
Thread model: posix
Supported LTO compression algorithms: zlib zstd
gcc version 13.2.0 (Ubuntu 13.2.0-23ubuntu4)
davin@davin-ubuntu-vm:~$
```

python3 –version

```
davin@davin-ubuntu-vm:~$ python3 --version
Python 3.12.3
```

bash –version

```
davin@davin-ubuntu-vm:~$ bash --version
GNU bash, version 5.2.21(1)-release (x86_64-pc-linux-gnu)
Copyright (C) 2022 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>

This is free software; you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
davin@davin-ubuntu-vm:~$
```

Assignment 4.3: Compile

Which of the above files need to be compiled before you can run them?
Java
C
Python

Which source code files are compiled into machine code and then directly executable by a processor?
Bash

Which source code files are compiled to byte code?
Java
Python

Which source code files are interpreted by an interpreter?
C is interpreter
Java is interpreted
Python is interpreted
Bash is interpreter

These source code files will perform the same calculation after compilation/interpretation. Which one is expected to do the calculation the fastest?
Bash

How do I run a Java program?
https://www.geeksforgeeks.org/how-to-run-java-program/

How do I run a Python program?
https://realpython.com/run-python-scripts/

How do I run a C program?
https://unstop.com/blog/how-to-run-c-program#:~:text=After%20downloading%20a%20C%20compiler,file%20to%20get%20the%20output.

How do I run a Bash script?
https://phoenixnap.com/kb/run-bash-script

If I compile the above source code, will a new file be created? If so, which file?
Java: Will create a .class file
Python: Will create a .pyc file
C: Will create a .out file

Take relevant screenshots of the following commands:

- Compile the source files where necessary
- Make them executable
- Run them
- Which (compiled) source code file performs the calculation the fastest?
  C runs the fasted

```
davin@davin-ubuntu-vm:~/Downloads/code$ sudo ./fib.sh
[sudo] password for davin:
Fibonacci(18) = 2584
Excution time 18350 milliseconds
davin@davin-ubuntu-vm:~/Downloads/code$
```

```
davin@davin-ubuntu-vm:~/Downloads/code$ javac Fibonacci.java
davin@davin-ubuntu-vm:~/Downloads/code$ ls
fib  fib.c  Fibonacci.class  Fibonacci.java  fib.py  fib.sh  runall.sh
davin@davin-ubuntu-vm:~/Downloads/code$ java Fibonacci
Fibonacci(18) = 2584
Execution time: 0.58 milliseconds
davin@davin-ubuntu-vm:~/Downloads/code$
```

```
davin@davin-ubuntu-vm:~/Downloads/code$ gcc fib.c -o fibc
davin@davin-ubuntu-vm:~/Downloads/code$ ls
fib  fib.c  fibc  Fibonacci.class  Fibonacci.java  fib.py  fib.sh  runall.sh
davin@davin-ubuntu-vm:~/Downloads/code$ ./fibc
Fibonacci(18) = 2584
Execution time: 0.04 milliseconds
davin@davin-ubuntu-vm:~/Downloads/code$
```

```
davin@davin-ubuntu-vm:~/Downloads/code$ python3 fib.py
Fibonacci(18) = 2584
Execution time: 0.98 milliseconds
davin@davin-ubuntu-vm:~/Downloads/code$
```

Assignment 4.4: Optimize

Take relevant screenshots of the following commands:

a) Figure out which parameters you need to pass to **the gcc** compiler so that the compiler performs a number of optimizations that will ensure that the compiled source code will run faster. **Tip!** The parameters are usually a letter followed by a number. Also read **page 191** of your book, but find a better optimization in the man pages. Please note that Linux is case sensitive.

b) Compile **fib.c** again with the optimization parameters

c) Run the newly compiled program. Is it true that it now performs the calculation faster?

d) Edit the file **runall.sh**, so you can perform all four calculations in a row using this Bash script. So the (compiled/interpreted) C, Java, Python and Bash versions of Fibonacci one after the other.

Bonus point assignment – week 4

Like the factorial example, you can also implement the calculation of a power of 2 in assembly. For example you want to calculate $2^4 = 16$. Use iteration to calculate the result. Store the result in r0.

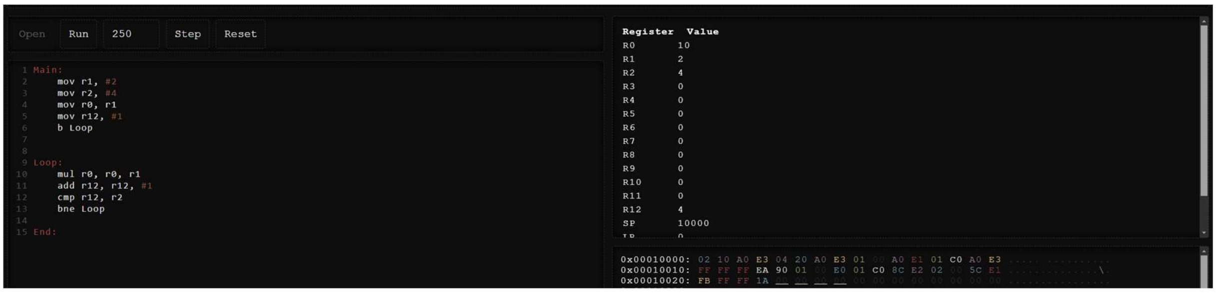
```
Main:
mov r1, #2
mov r2, #4

Loop:

End:
```

Complete the code. See the PowerPoint slides of week 4.

Screenshot of the completed code here.



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