Template Week 4 – Software

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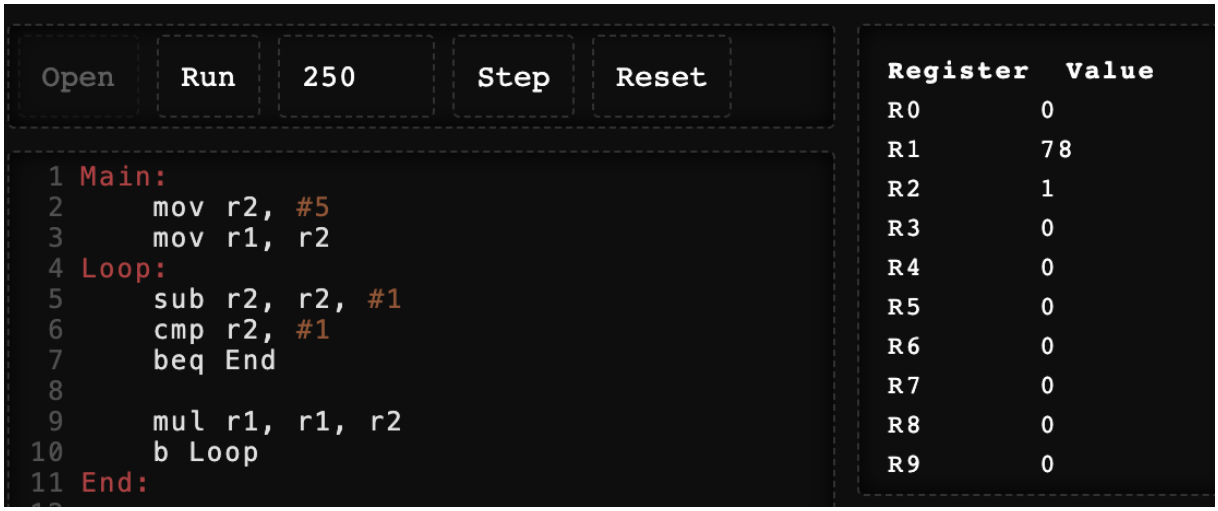
Assignment 4.1: ARM assembly

Screenshot of working assembly code of factorial calculation:



Assignment 4.2: Programming languages

Take screenshots that the following commands work:

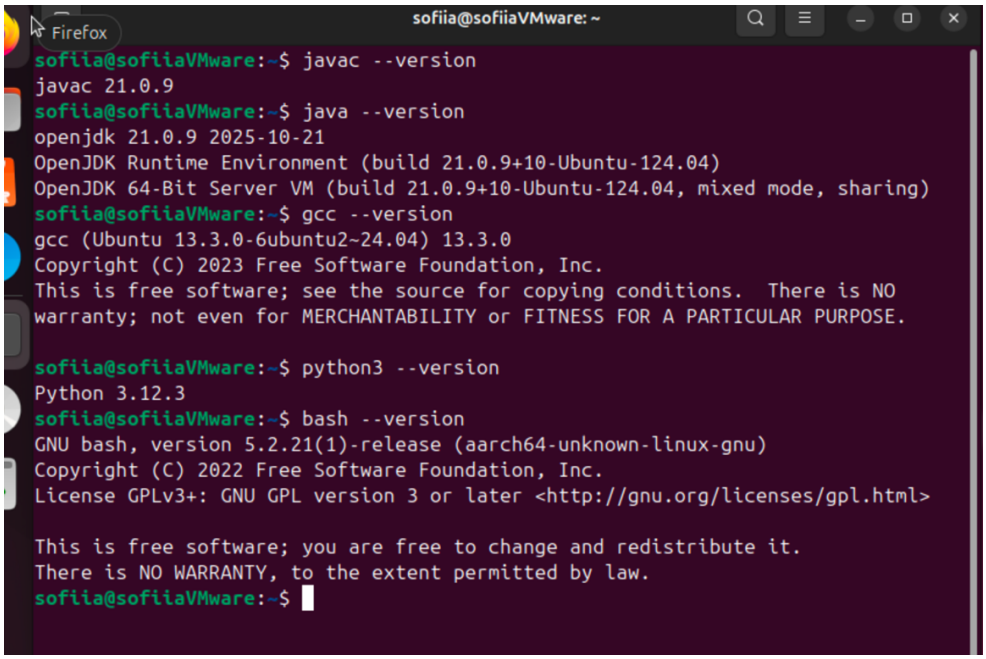
javac --version

java --version

gcc --version

python3 --version

bash –version



Assignment 4.3: Compile

Which of the above files need to be compiled before you can run them? Fibonacci.java, fib.c

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

Which source code files are compiled to byte code? fib.c, Fibonacci.java

Which source code files are interpreted by an interpreter? fib.py

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

How do I run a Java program? Through a compiler that compiles java code to bytecode and translated by java virtual machine to machine code directly readable by CPU.

How do I run a Python program?

How do I run a C program? Compile the file with .c extension with a gcc -o … command and run it.

How do I run a Bash script? it has to be made executable and then you can run it.

If I compile the above source code, will a new file be created? If so, which file? Yes, after fib.c compilation a new file fib was created and after java file compilation a file named Fibonacci.class was created.

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?

```
sofiia@sofiiaVMware:~/Downloads/code$ gcc -o fib fib.c
sofiia@sofiiaVMware:~/Downloads/code$ ls
fib  fib.c  Fibonacci.java  fib.py  fib.sh  runall.sh
sofiia@sofiiaVMware:~/Downloads/code$ ./fib
Fibonacci(18) = 2584
Execution time: 0.01 milliseconds
sofiia@sofiiaVMware:~/Downloads/code$
```

```
sofiia@sofiiaVMware:~/Downloads/code$ javac Fibonacci.java
sofiia@sofiiaVMware:~/Downloads/code$ ls
fib  fib.c  Fibonacci.class  Fibonacci.java  fib.py  fib.sh  runall.sh
sofiia@sofiiaVMware:~/Downloads/code$ java Fibonacci
Fibonacci(18) = 2584
Execution time: 0.19 milliseconds
```

```
sofiia@sofiiaVMware:~/Downloads/code$ sudo chmod +x fib.sh
sofiia@sofiiaVMware:~/Downloads/code$ ls -l
total 40
-rwxrwxr-x 1 sofiia sofiia 70544 Dec  5 00:19 fib
-rw-rw-r-- 1 sofiia sofiia   831 Jun  9  2023 fib.c
-rw-rw-r-- 1 sofiia sofiia  1448 Dec  5 00:22 Fibonacci.class
-rw-rw-r-- 1 sofiia sofiia   839 Jun  9  2023 Fibonacci.java
-rw-rw-r-- 1 sofiia sofiia   516 Jun  9  2023 fib.py
-rwxrwxr-x 1 sofiia sofiia   668 Jun  9  2023 fib.sh
-rw-rw-r-- 1 sofiia sofiia   249 Jun  9  2023 runall.sh
```

```
sofiia@sofiiaVMware:~/Downloads/code$ ./fib.sh
Fibonacci(18) = 2584
Excution time 1913 milliseconds
```

```
sofiia@sofiiaVMware:~/Downloads/code$ python3 fib.py
Fibonacci(18) = 2584
Execution time: 0.42 milliseconds
```

```
Running C program:
Fibonacci(19) = 4181
Execution time: 0.03 milliseconds


Running Java program:
Fibonacci(19) = 4181
Execution time: 0.45 milliseconds


Running Python program:
Fibonacci(19) = 4181
Execution time: 0.39 milliseconds


Running BASH Script
Fibonacci(19) = 4181
Excution time 3135 milliseconds


sofiia@sofiiaVMware:~/Downloads/code$
```

The .c file runs the fastest.

Assignment 4.4: Optimize

Take relevant screenshots of the following commands:

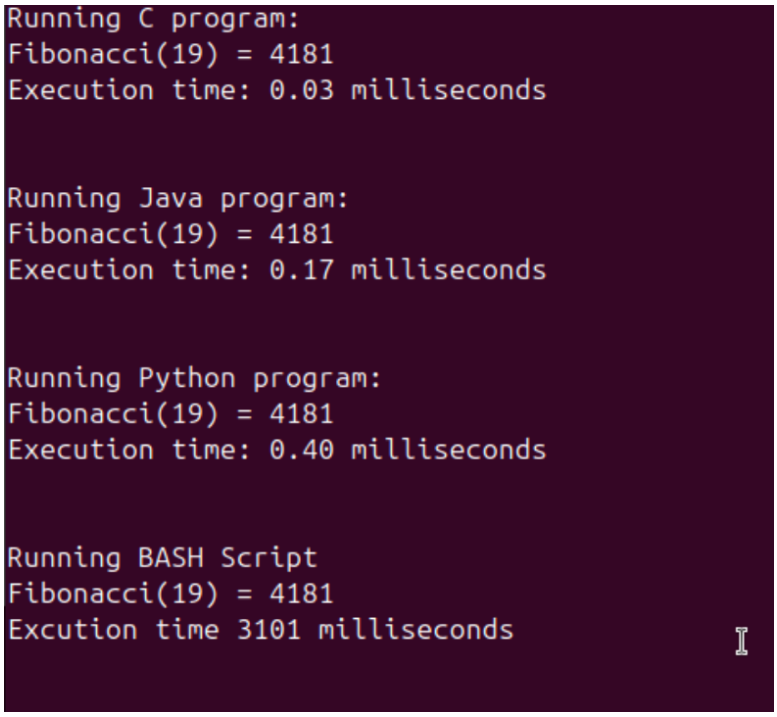
a) Figure out which parameters you need to pass to **the gcc** compiler so that the compiler performs a number of optimizations that will ensure that the compiled source code will run faster. **Tip!** The parameters are usually a letter followed by a number. Also read **page 191** of your book but find 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? Yes, it performs the calculation slightly faster (0.01 to 0.03 milliseconds) while the fib file sometimes takes around 0.01 to 0.06 milliseconds

```
sofiia@sofiiaVMware:~/Downloads/code$ gcc -O3 fib.c
sofiia@sofiiaVMware:~/Downloads/code$ ls
a.out  fib  fib.c  Fibonacci.class  Fibonacci.java  fib.py  fib.sh  runall.sh
sofiia@sofiiaVMware:~/Downloads/code$ ./a.out
Fibonacci(18) = 2584
Execution time: 0.01 milliseconds
```

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.



Assignment 4.5: More ARM Assembly

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.

Ready? Save this file and export it as a pdf file with the name: **week4.pdf**