# Template Week 4 – Software

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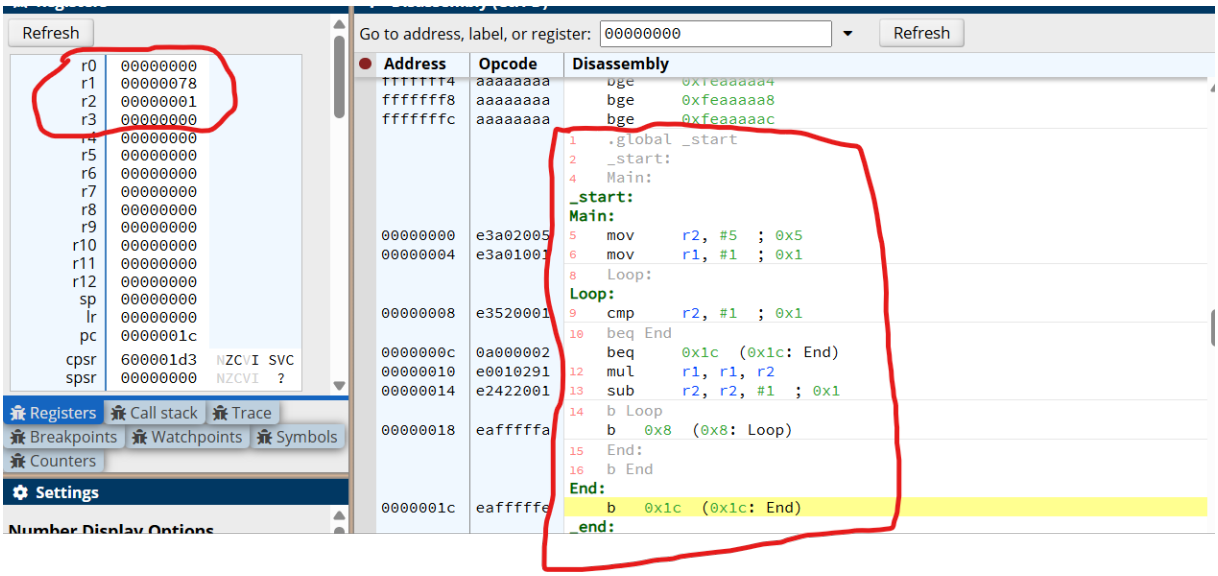
### Assignment 4.1: ARM assembly

Screenshot of working assembly code of factorial calculation:




**(OakSim was heel laggy, dus ik heb deze applicatie gebruikt, zelfde principe.)**

### Assignment 4.2: Programming languages

Take screenshots that the following commands work:

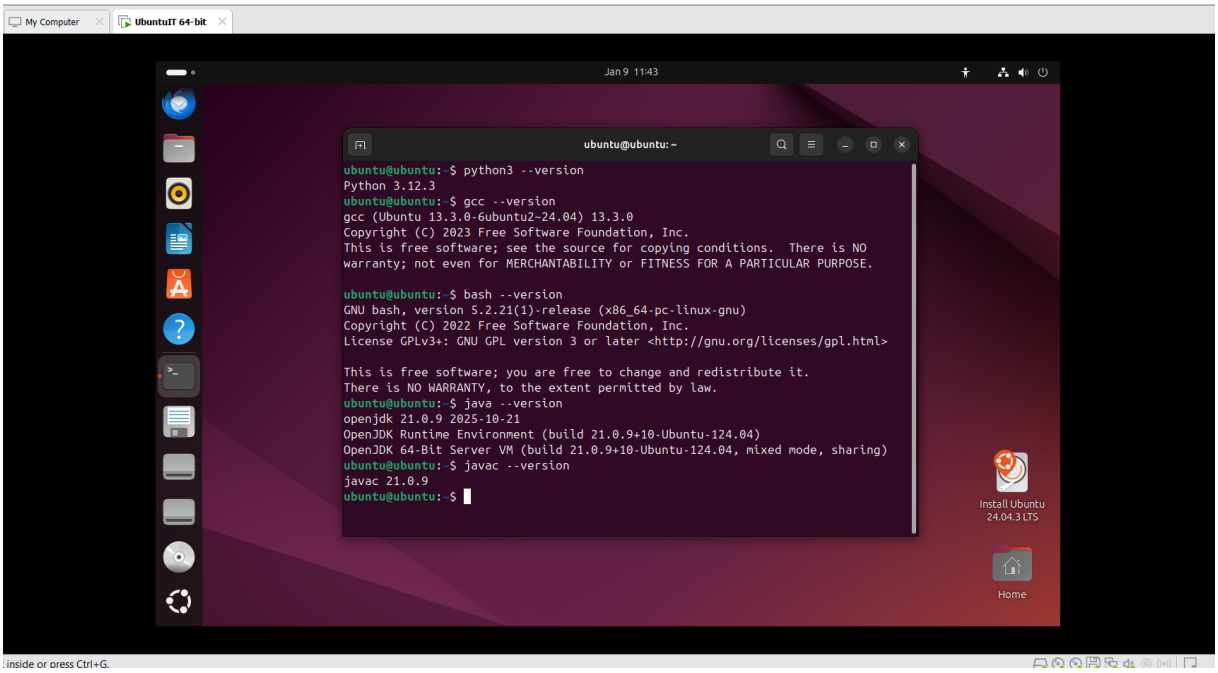
javac --version

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?

**fib.c en Fibonacci.java**

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?

**Fibonacci.java**

Which source code files are interpreted by an interpreter?

**fib.py en fib.sh**

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?

**Volgens mij moet je hem eerst omzetten naar Bytecode (een taal dat de computer wel kan verstaan), dan kan je hem wel runnen via Java Virtual Machine (JVM).**

How do I run a Python program?

**Deze hoef je niet te compilen, de interpreter kan verwezen worden naar de sourcecode, en dan kan je deze runnen.**

How do I run a C program?

**Fib.c wordt omgezet naar een leesbare file voor gcc's unieke interpreter (fib_c), daarna kan je weer hetzelfde dooen als Python.**

How do I run a Bash script?

**Mode veranderen, executable permissies geven, en dan kan je deze ook weer runnen.**

If I compile the above source code, will a new file be created? If so, which file?

**Python en Bash creeeren geen nieuwe file, maar Java wordt gecompiled naar een .class file en fib.c naar een fib_c.**

Take relevant screenshots of the following commands:

- Compile the source files where necessary

```
wbacon@wbacon-VMware-Virtual-Platform:~/Documents/code$ gcc fib.c -o fib_c
wbacon@wbacon-VMware-Virtual-Platform:~/Documents/code$ javac Fibonacci.java
```

- Make them executable
- Run them
- Which (compiled) source code file performs the calculation the fastest?

```
wbacon@wbacon-VMware-Virtual-Platform:~/Documents/code$ python3 fib.py
Fibonacci(18) = 2584
Execution time: 0.49 milliseconds
wbacon@wbacon-VMware-Virtual-Platform:~/Documents/code$ sudo chmod a+x fib.sh
[sudo] password for wbacon:
wbacon@wbacon-VMware-Virtual-Platform:~/Documents/code$ ./fib.sh
Fibonacci(18) = 2584
Excution time 10379 milliseconds
wbacon@wbacon-VMware-Virtual-Platform:~/Documents/code$ java Fibonacci
Fibonacci(18) = 2584
Execution time: 0.81 milliseconds
wbacon@wbacon-VMware-Virtual-Platform:~/Documents/code$ ./fib_c
Fibonacci(18) = 2584
Execution time: 0.02 milliseconds
```

**Gcc, is uiteraard het snelste.**

### 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?

```
wbacon@wbacon-VMware-Virtual-Platform:~/Documents/code$ gcc -Ofast fib.c -o fib_
ofast
wbacon@wbacon-VMware-Virtual-Platform:~/Documents/code$ ./fib_0fast
bash: ./fib_0fast: No such file or directory
wbacon@wbacon-VMware-Virtual-Platform:~/Documents/code$ ./fib_Ofast
bash: ./fib_Ofast: No such file or directory
wbacon@wbacon-VMware-Virtual-Platform:~/Documents/code$ time ./fib_ofast
Fibonacci(18) = 2584
Execution time: 0.01 milliseconds

real    0m0.004s
user    0m0.002s
sys     0m0.002s
wbacon@wbacon-VMware-Virtual-Platform:~/Documents/code$ time ./fib_c
Fibonacci(18) = 2584
Execution time: 0.02 milliseconds

real    0m0.006s
user    0m0.003s
sys     0m0.002s
```

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.

```
Running C program:
Fibonacci(19) = 4181
Execution time: 0.01 milliseconds


Running Java program:
Fibonacci(19) = 4181
Execution time: 0.54 milliseconds


Running Python program:
Fibonacci(19) = 4181
Execution time: 0.79 milliseconds


Running BASH Script
Fibonacci(19) = 4181
Excution time 16638 milliseconds
```

**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:
```

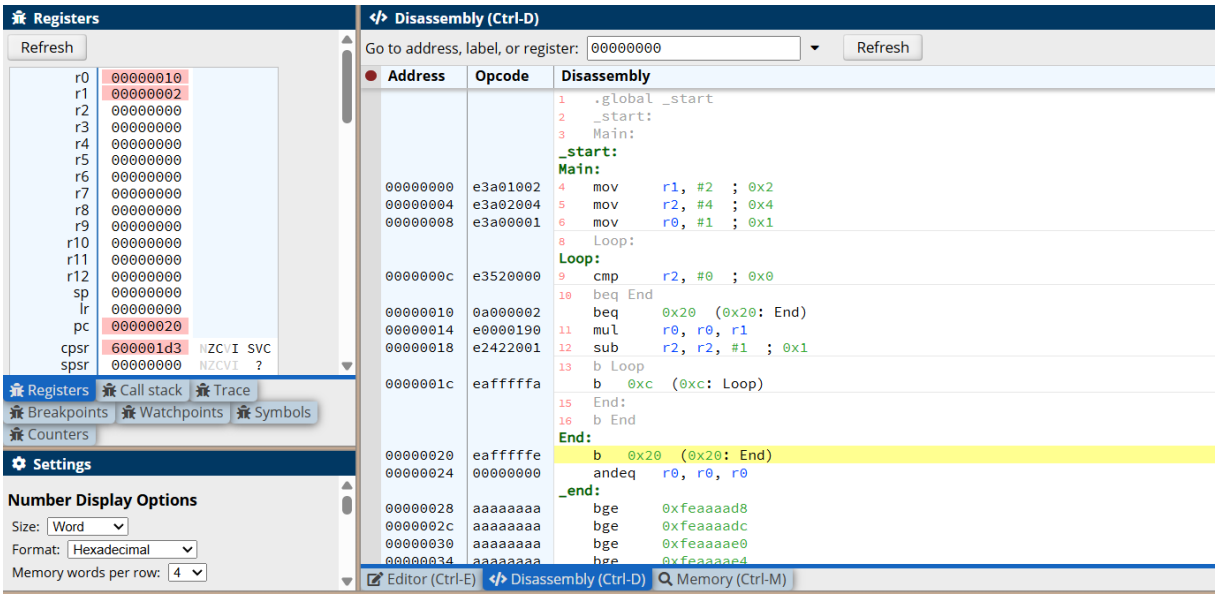
```
mov r1, #2
mov r2, #4

Loop:

End:
```

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

Screenshot of the completed code here.

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