Template Week 4 – Software

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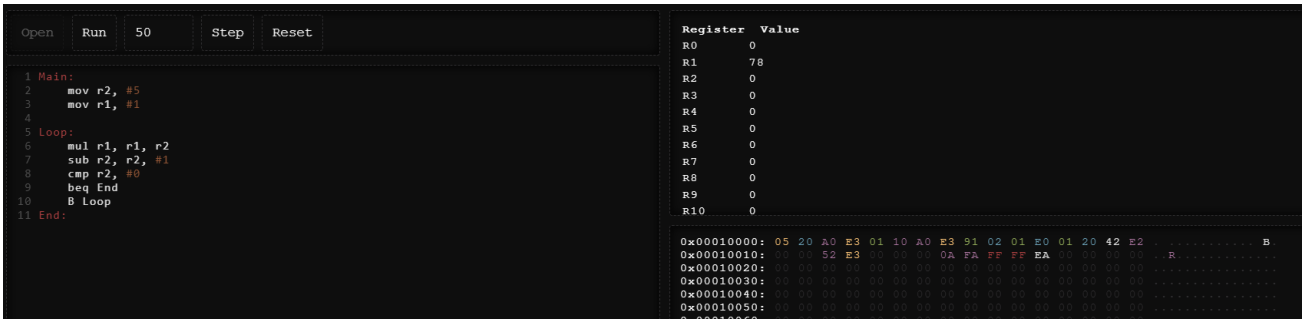
Assignment 4.1: ARM assembly

Screenshot of working assembly code of factorial calculation:



Assignment 4.2: Programming languages

Take screenshots that the following commands work:

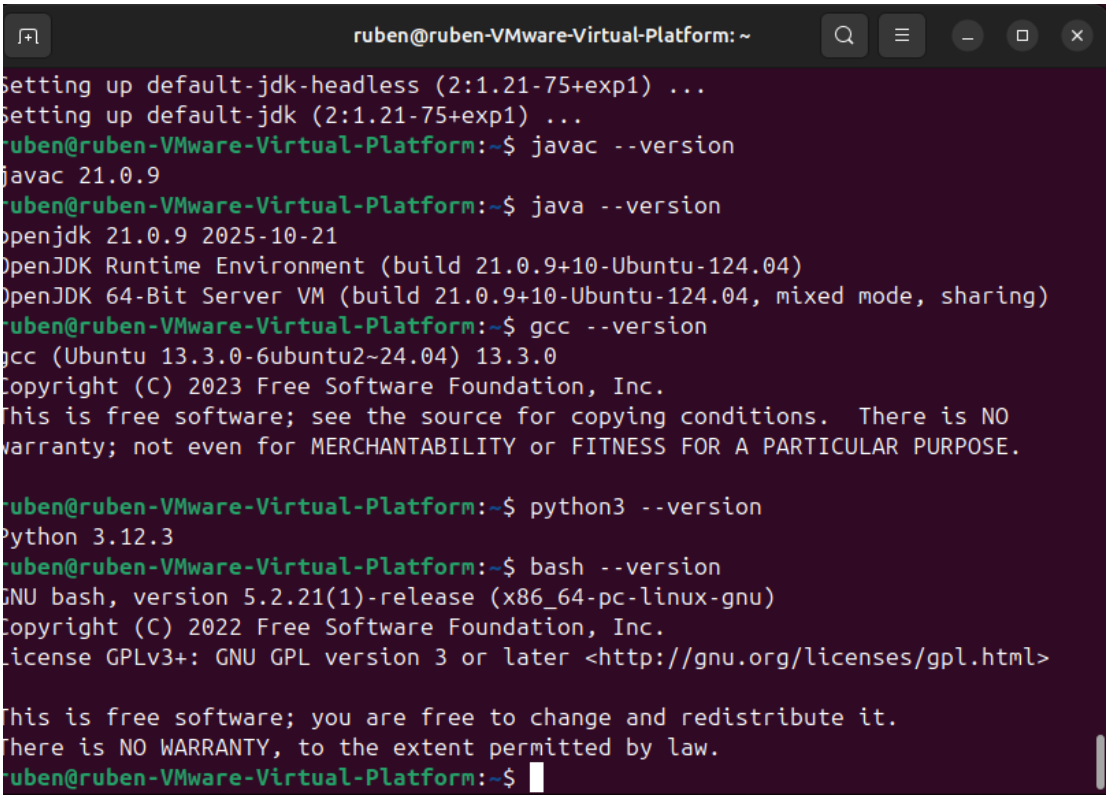
javac –version

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?
fib.py / fib.sh

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 / fib.sh

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

How do I run a Java program?
Typ in de terminal: javac 'filename'.java
deze command compileert de source code naar bytecode
Typ vervolgens java 'filename'
dit runt de code

How do I run a Python program?
Typ in de terminal: python3 'filename'.py
Python leest de source code en voert die dan uit

How do I run a C program?
Typ in de terminal: gcc -o fib fib.c
Dit compileert de source code en met -o geef je een naam aan het bestand de gecompileerde code
Typ vervolgens ./fib
dit runt de code

How do I run a Bash script?
Typ in de terminal: chmod +x fib.sh
Dit geeft veranderd de permissions van de file
Daarna kun je de source code runnen met ./fib.sh

If I compile the above source code, will a new file be created? If so, which file?
C: Ja, de naam in dit geval fib, de naam bepaal je zelf met -o
Java: Ja, volledige filename + .class
Bash: Nee
Python: Nee

Take relevant screenshots of the following commands:

- Compile the source files where necessary / Make them executable / Run them

  Java

```
ruben@ruben-VMware-Virtual-Platform:~/Downloads/code$ javac Fibonacci.java
ruben@ruben-VMware-Virtual-Platform:~/Downloads/code$ java Fibonacci
Fibonacci(18) = 2584
Execution time: 0.13 milliseconds
```

  C

```
ruben@ruben-VMware-Virtual-Platform:~/Downloads/code$ gcc -o fib fib.c
ruben@ruben-VMware-Virtual-Platform:~/Downloads/code$ ./fib
Fibonacci(18) = 2584
Execution time: 0.02 milliseconds
```

- Which (compiled) source code file performs the calculation the fastest?

  C, 0.02 milliseconds

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.

```
ruben@ruben-VMware-Virtual-Platform:~/Downloads/code$ gcc --help=optimizer
The following options control optimizations:
  -O<number>                  Set optimization level to <number>.
  -Ofast                      Optimize for speed disregarding exact standards compliance.
  -Og                         Optimize for debugging experience rather than speed or size.
  -Os                         Optimize for space rather than speed.
  -Oz                         Optimize for space aggressively rather than speed.
  -faggressive-loop-optimizations Aggressively optimize loops using language constraints.
```

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?

```
ruben@ruben-VMware-Virtual-Platform:~/Downloads/code$ gcc -O2 -o fib fib.c
ruben@ruben-VMware-Virtual-Platform:~/Downloads/code$ ./fib
Fibonacci(18) = 2584
Execution time: 0.00 milliseconds
ruben@ruben-VMware-Virtual-Platform:~/Downloads/code$
```

Ja het is nu sneller

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: 0.22 milliseconds


Running Python program:
Fibonacci(19) = 4181
Execution time: 0.30 milliseconds


Running BASH Script
Fibonacci(19) = 4181
Excution time 5851 milliseconds


ruben@ruben-VMware-Virtual-Platform:~/Downloads/code$
```

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 r0, #1
mov r1, #2
mov r2, #4

Loop:
mul r0, r0, r1
sub r2, r2, #1
cmp r2, #0
beq End
b 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**