Template Week 4 – Software

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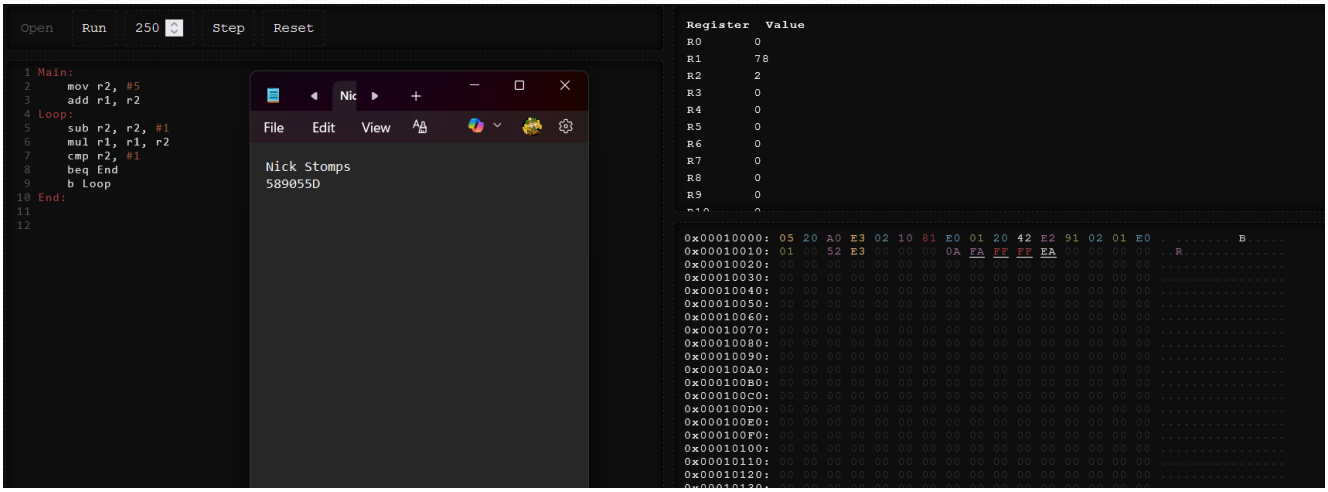
Assignment 4.1: ARM assembly

Screenshot of working assembly code of factorial calculation:



Assignment 4.2: Programming languages

Take screenshots that the following commands work:

javac –version

```
nick@helpdesk:~$ javac --version
Command 'javac' not found, but can be installed with:
sudo apt install default-jdk              # version 2:1.17-75, or
sudo apt install openjdk-17-jdk-headless  # version 17.0.16+8~us1-0ubuntu1~24.04
.1
sudo apt install openjdk-21-jdk-headless  # version 21.0.8+9~us1-0ubuntu1~24.04.
1
sudo apt install ecj                      # version 3.32.0+eclipse4.26-2
sudo apt install openjdk-19-jdk-headless  # version 19.0.2+7-4
sudo apt install openjdk-20-jdk-headless  # version 20.0.2+9-1
sudo apt install openjdk-22-jdk-headless  # version 22~22ea-1
sudo apt install openjdk-11-jdk-headless  # version 11.0.28+6-1ubuntu1~24.04.1
sudo apt install openjdk-8-jdk-headless   # version 8u462-ga~us1-0ubuntu2~24.04.
2
sudo apt install openjdk-25-jdk-headless  # version 25+36-1~24.04.2
```

java –version

```
nick@helpdesk:~$ java --version
Command 'java' not found, but can be installed with:
sudo apt install default-jre              # version 2:1.17-75, or
sudo apt install openjdk-17-jre-headless  # version 17.0.16+8~us1-0ubuntu1~24.04
.1
sudo apt install openjdk-21-jre-headless  # version 21.0.8+9~us1-0ubuntu1~24.04.
1
sudo apt install openjdk-19-jre-headless  # version 19.0.2+7-4
sudo apt install openjdk-20-jre-headless  # version 20.0.2+9-1
sudo apt install openjdk-22-jre-headless  # version 22~22ea-1
sudo apt install openjdk-11-jre-headless  # version 11.0.28+6-1ubuntu1~24.04.1
sudo apt install openjdk-8-jre-headless   # version 8u462-ga~us1-0ubuntu2~24.04.
2
sudo apt install openjdk-25-jre-headless  # version 25+36-1~24.04.2
```

gcc –version

```
nick@helpdesk:~$ gcc --version
Command 'gcc' not found, but can be installed with:
sudo apt install gcc
```

python3 –version

```
nick@helpdesk:~$ python3 --version
Python 3.12.3
```

bash –version

```
nick@helpdesk:~$ bash --version
GNU bash, version 5.2.21(1)-release (x86_64-pc-linux-gnu)
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License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>

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There is NO WARRANTY, to the extent permitted by law.
```

Assignment 4.3: Compile

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

Fibonacci.java en 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?

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?

Eerst javac myProject.java doen, daarna java myProject

How do I run a Python program?

Met de command python3 myProject.py

How do I run a C program?

Eerst gcc myProject.c -o fib , daarna ./myProject

How do I run a Bash script?

Eerst chmod +x myProject.sh, daarna ./myProject.sh

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

Ja, de file Fibonacci.class wordt aangemaakt en de excecutable voor C

Take relevant screenshots of the following commands:

- Compile the source files where necessary

```
nick@helpdesk:~/Downloads/code$ ls -a
.  ..  fib  fib.c  Fibonacci.class  Fibonacci.java  fib.py  fib.sh  runall.sh
nick@helpdesk:~/Downloads/code$
```

- Make them executable

```
nick@helpdesk:~/Downloads/code$ ls -a
.  ..  fib  fib.c  Fibonacci.class  Fibonacci.java  fib.py  fib.sh  runall.sh
nick@helpdesk:~/Downloads/code$
```

- Run them

```
Running C program:
Fibonacci(19) = 4181
Execution time: 0.02 milliseconds


Running Java program:
Fibonacci(19) = 4181
Execution time: 0.20 milliseconds


Running Python program:
Fibonacci(19) = 4181
Execution time: 0.34 milliseconds


Running BASH Script
Fibonacci(19) = 4181
Excution time 5651 milliseconds


nick@helpdesk:~/Downloads/code$
```

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

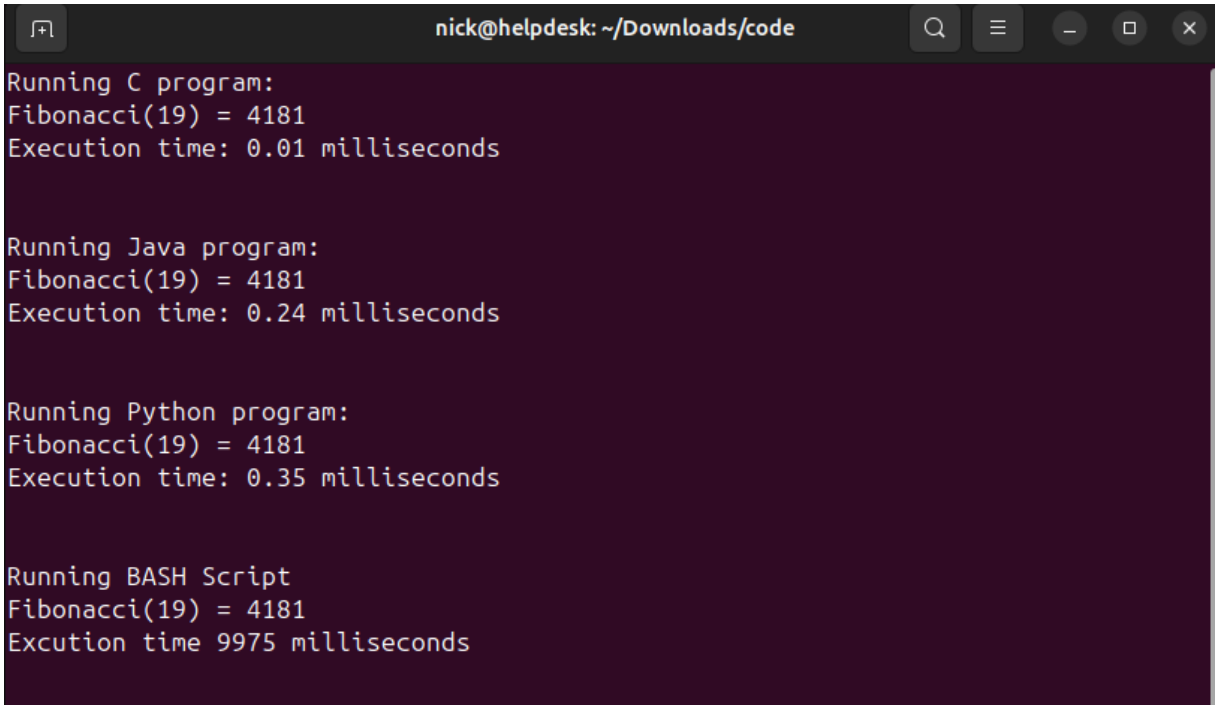
  De fib.c file

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.
Met -O3 kan je veel optimizations laten runnen

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?

Hij runt het C programma 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.

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.

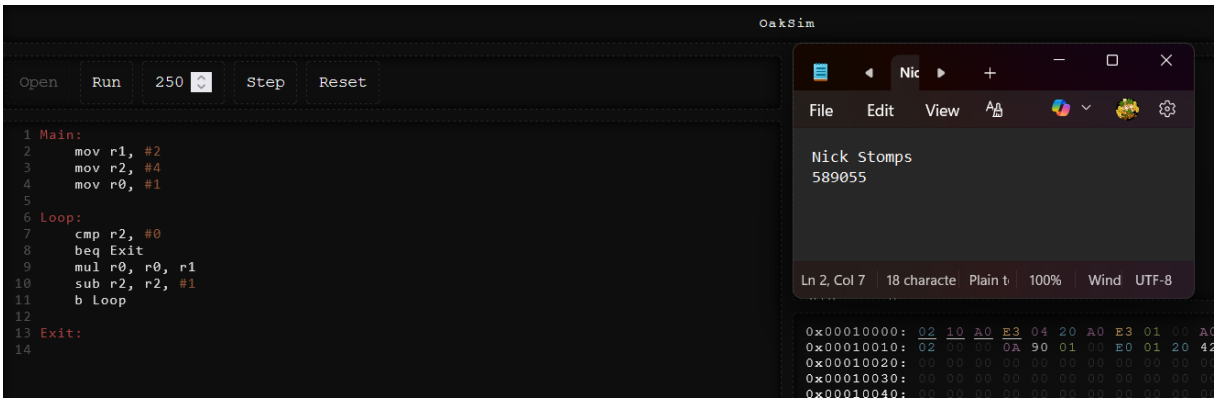
```
Main:
mov r1, #2
mov r2, #4
```

Loop:

End:

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

Screenshot of the completed code here.



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