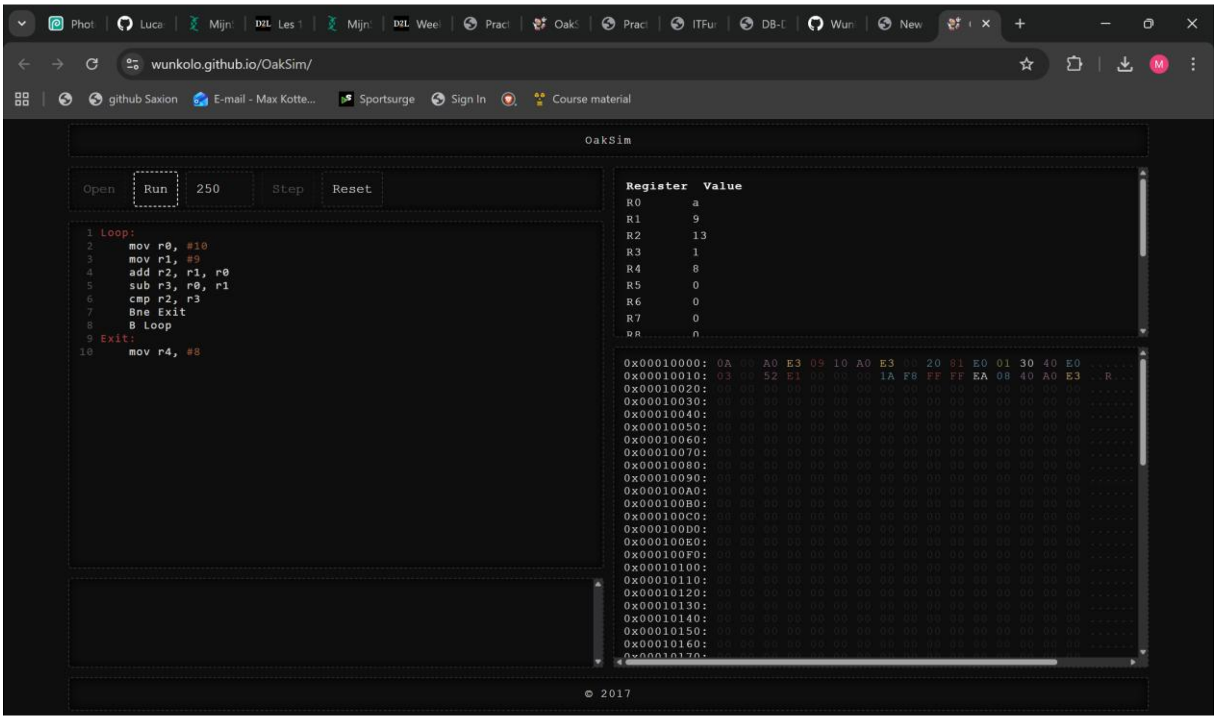
Template Week 4 – Software

Student number: 589671

Assignment 4.1: ARM assembly

Screenshot of working assembly code of factorial calculation:



```
Loop:
    mov r0, #10
    mov r1, #9
    add r2, r1, r0
    sub r3, r0, r1
    cmp r2, r3
    Bne Exit
    B Loop
Exit:
    mov r4, #8
```

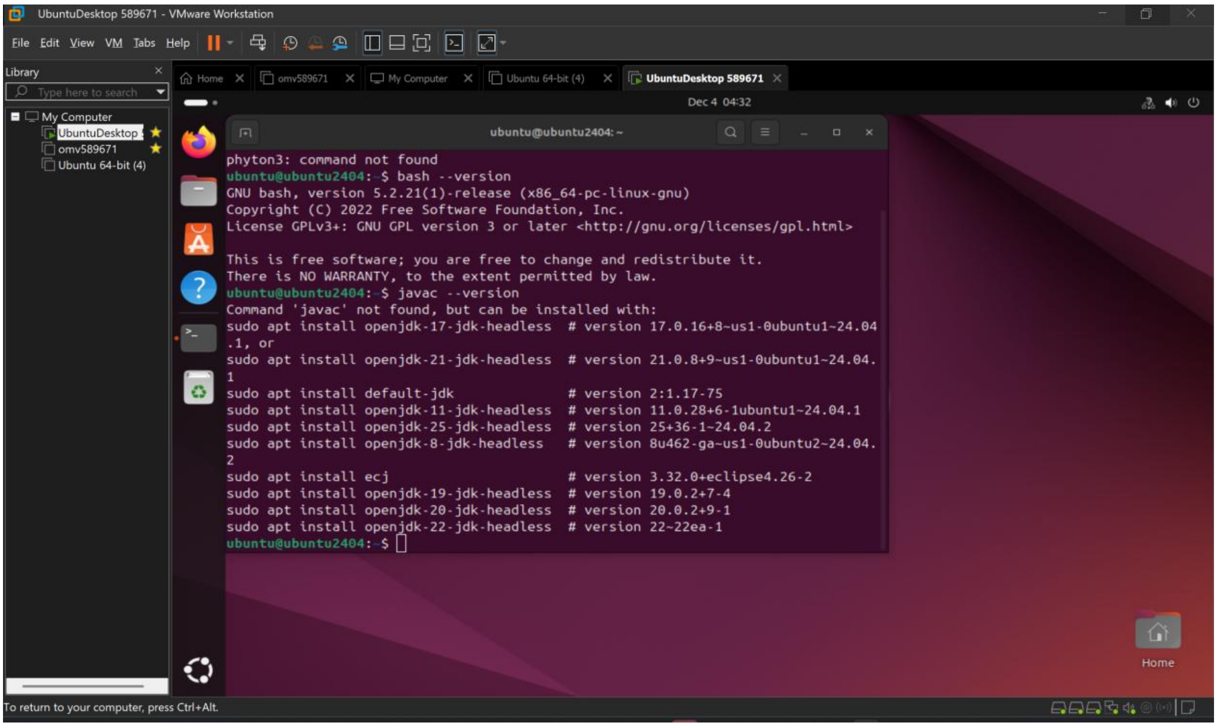
```
Register  Value
R0        a
R1        9
R2        13
R3        1
R4        8
R5        0
R6        0
R7        0
R8        0
```

```
0x00010000: 0A 00 A0 E3 09 10 A0 E3 00 20 81 E0 01 30 40 E0
0x00010010: 03 00 52 E1 00 00 00 1A F8 FF FF EA 08 40 A0 E3
0x00010020: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x00010030: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x00010040: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x00010050: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x00010060: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x00010070: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x00010080: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x00010090: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x000100A0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x000100B0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x000100C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x000100D0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x000100E0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x000100F0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x00010100: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x00010110: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x00010120: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x00010130: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x00010140: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x00010150: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x00010160: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

Assignment 4.2: Programming languages

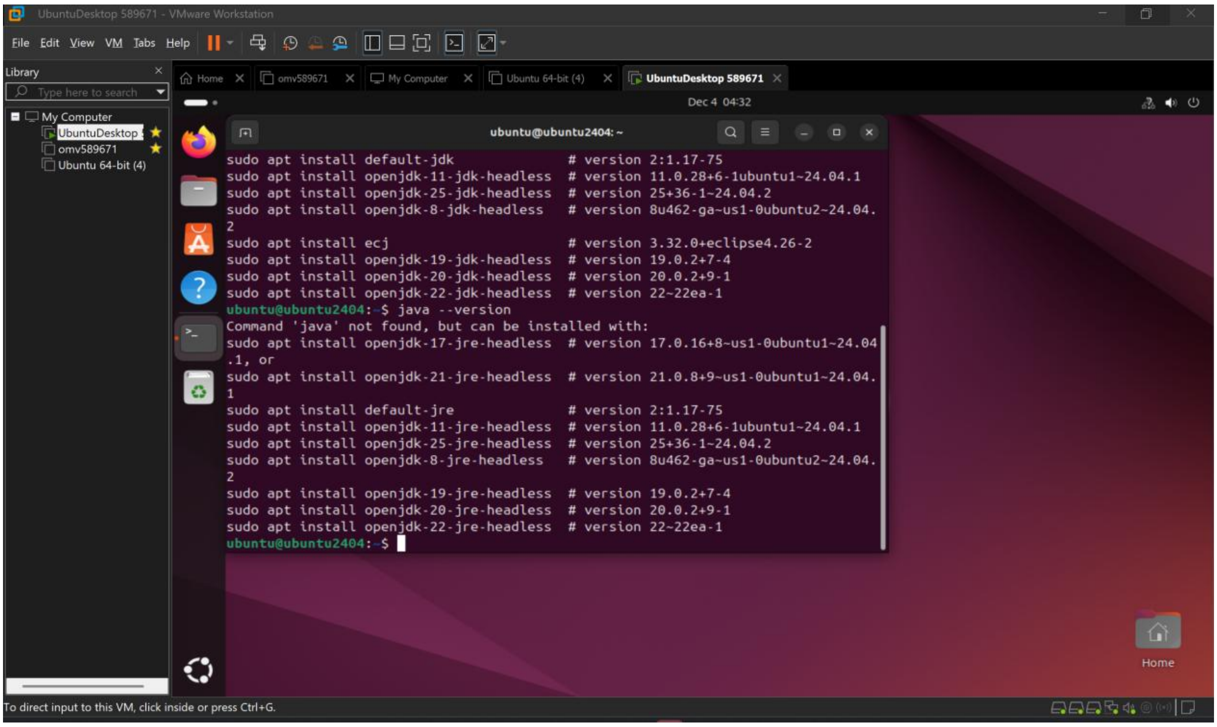
Take screenshots that the following commands work:

javac –version



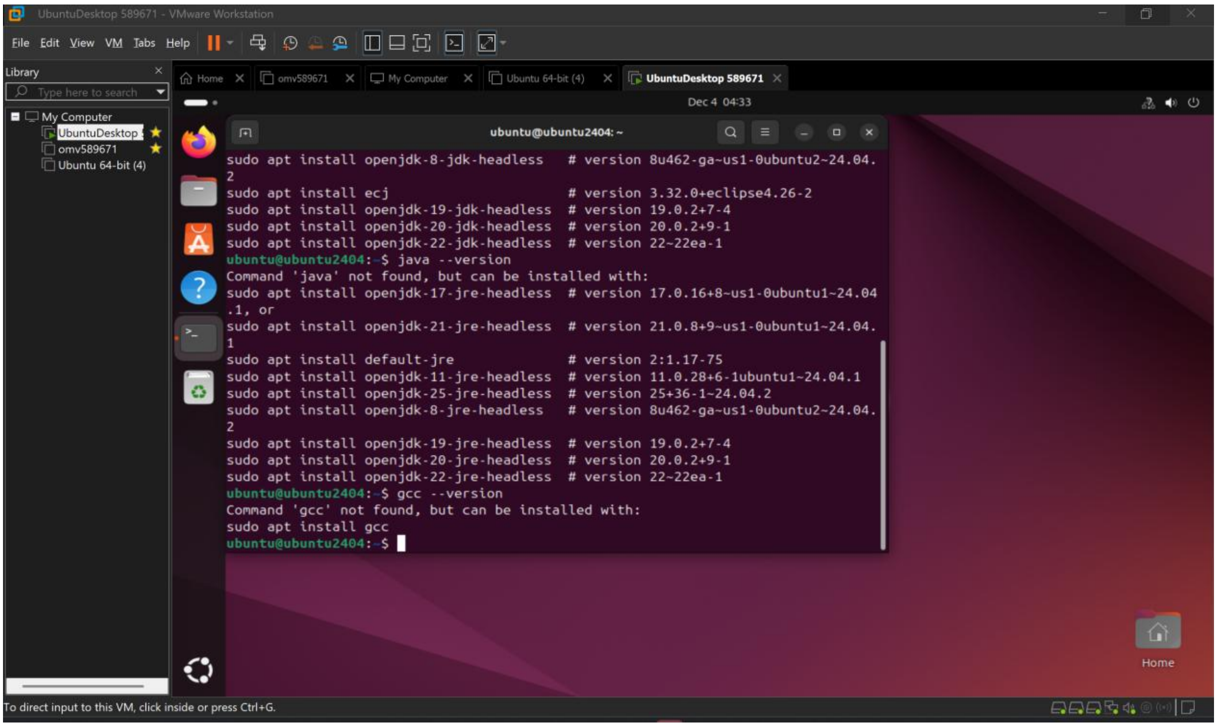
```
phyton3: command not found
ubuntu@ubuntu2404:~$ bash --version
GNU bash, version 5.2.21(1)-release (x86_64-pc-linux-gnu)
Copyright (C) 2022 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>

This is free software; you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
ubuntu@ubuntu2404:~$ javac --version
Command 'javac' not found, but can be installed with:
sudo apt install openjdk-17-jdk-headless  # version 17.0.16+8~us1-0ubuntu1~24.04
.1, or
sudo apt install openjdk-21-jdk-headless  # version 21.0.8+9~us1-0ubuntu1~24.04.
1
sudo apt install default-jdk              # version 2:1.17-75
sudo apt install openjdk-11-jdk-headless  # version 11.0.28+6-1ubuntu1~24.04.1
sudo apt install openjdk-25-jdk-headless  # version 25+36-1~24.04.2
sudo apt install openjdk-8-jdk-headless   # version 8u462-ga~us1-0ubuntu2~24.04.
2
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
ubuntu@ubuntu2404:~$ 
```

java –version



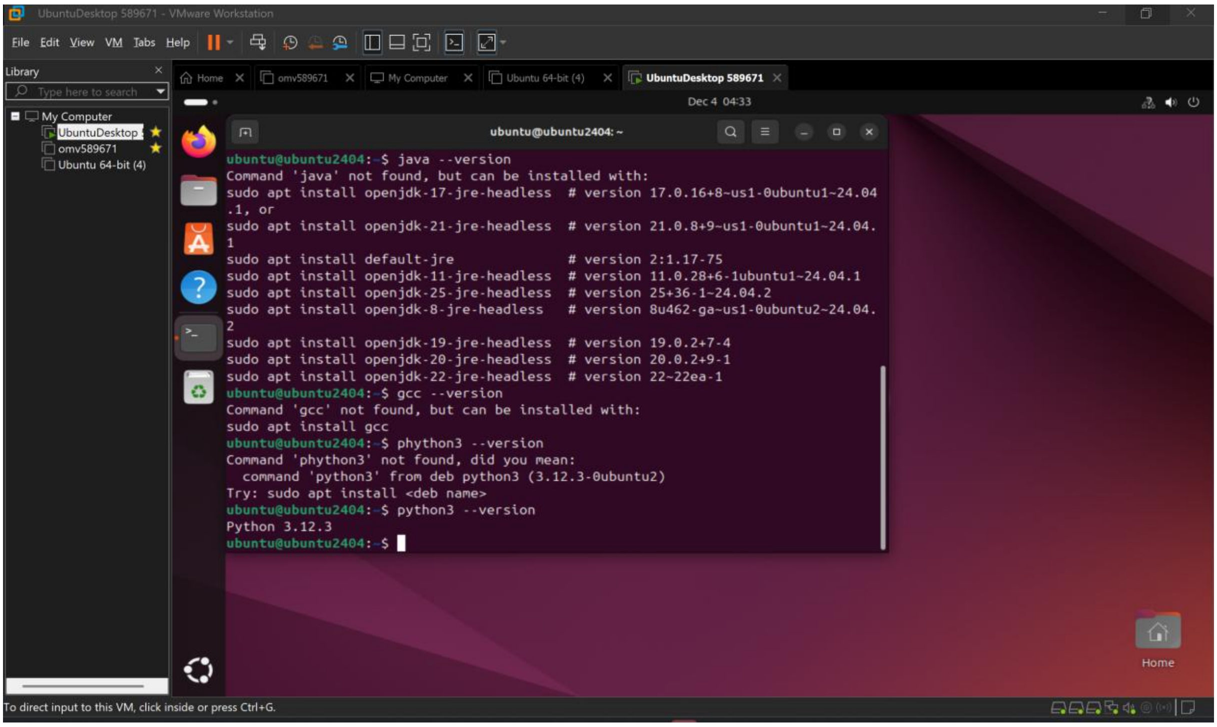
```
sudo apt install default-jdk              # version 2:1.17-75
sudo apt install openjdk-11-jdk-headless  # version 11.0.28+6-1ubuntu1~24.04.1
sudo apt install openjdk-25-jdk-headless  # version 25+36-1~24.04.2
sudo apt install openjdk-8-jdk-headless   # version 8u462-ga~us1-0ubuntu2~24.04.
2
sudo 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
ubuntu@ubuntu2404:~$ java --version
Command 'java' not found, but can be installed with:
sudo apt install openjdk-17-jre-headless  # version 17.0.16+8~us1-0ubuntu1~24.04
.1, or
sudo apt install openjdk-21-jre-headless  # version 21.0.8+9~us1-0ubuntu1~24.04.
1
sudo apt install default-jre              # version 2:1.17-75
sudo apt install openjdk-11-jre-headless  # version 11.0.28+6-1ubuntu1~24.04.1
sudo apt install openjdk-25-jre-headless  # version 25+36-1~24.04.2
sudo apt install openjdk-8-jre-headless   # version 8u462-ga~us1-0ubuntu2~24.04.
2
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
ubuntu@ubuntu2404:~$ 
```

gcc –version



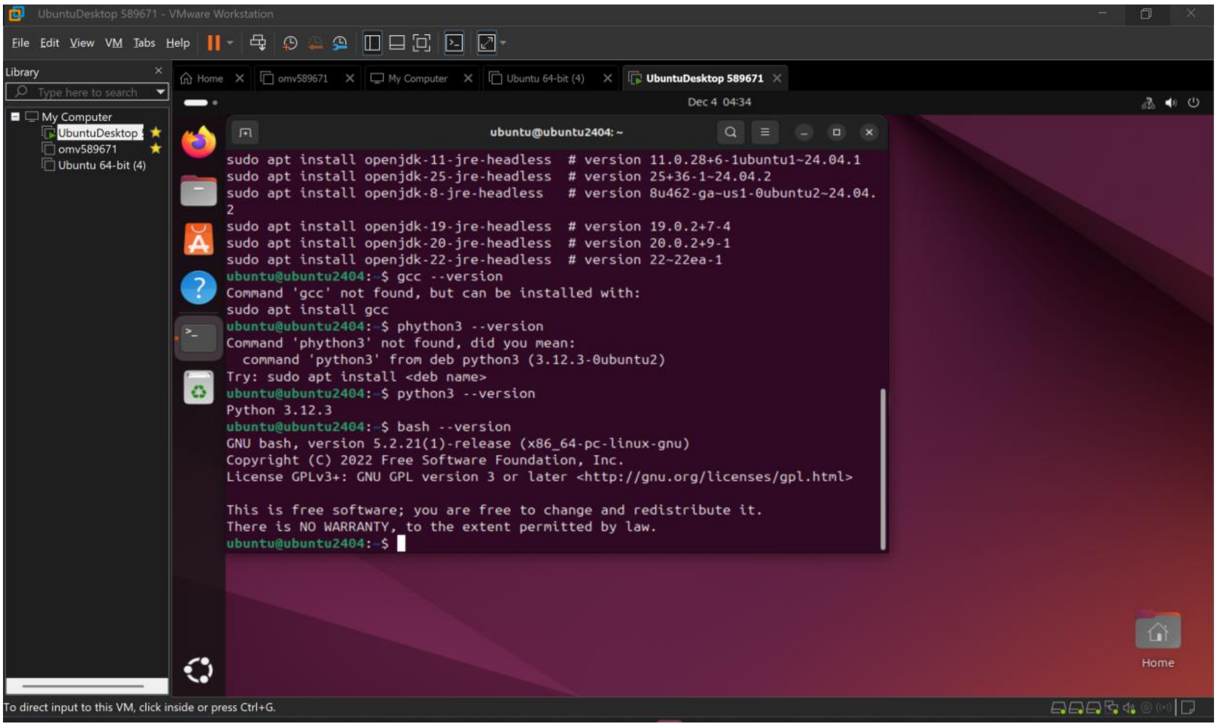
```
sudo apt install openjdk-8-jdk-headless   # version 8u462-ga-us1-0ubuntu2~24.04.
2
sudo apt install ecj                      # version 3.32.0+eclipse4.26-2
sudo apt install openjdk-19-jdk-headless  # version 19.0.2+7-4
sudo apt install openjdk-20-jdk-headless  # version 20.0.2+9-1
sudo apt install openjdk-22-jdk-headless  # version 22~22ea-1
ubuntu@ubuntu2404:~$ java --version
Command 'java' not found, but can be installed with:
sudo apt install openjdk-17-jre-headless  # version 17.0.16+8~us1-0ubuntu1~24.04
.1, or
sudo apt install openjdk-21-jre-headless  # version 21.0.8+9~us1-0ubuntu1~24.04.
1
sudo apt install default-jre              # version 2:1.17-75
sudo apt install openjdk-11-jre-headless  # version 11.0.28+6-1ubuntu1~24.04.1
sudo apt install openjdk-25-jre-headless  # version 25+36-1~24.04.2
sudo apt install openjdk-8-jre-headless   # version 8u462-ga-us1-0ubuntu2~24.04.
2
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
ubuntu@ubuntu2404:~$ gcc --version
Command 'gcc' not found, but can be installed with:
sudo apt install gcc
ubuntu@ubuntu2404:~$ 
```

python3 –version



```
ubuntu@ubuntu2404:~$ java --version
Command 'java' not found, but can be installed with:
sudo apt install openjdk-17-jre-headless  # version 17.0.16+8~us1-0ubuntu1~24.04
.1, or
sudo apt install openjdk-21-jre-headless  # version 21.0.8+9~us1-0ubuntu1~24.04.
1
sudo apt install default-jre              # version 2:1.17-75
sudo apt install openjdk-11-jre-headless  # version 11.0.28+6-1ubuntu1~24.04.1
sudo apt install openjdk-25-jre-headless  # version 25+36-1~24.04.2
sudo apt install openjdk-8-jre-headless   # version 8u462-ga-us1-0ubuntu2~24.04.
2
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
ubuntu@ubuntu2404:~$ gcc --version
Command 'gcc' not found, but can be installed with:
sudo apt install gcc
ubuntu@ubuntu2404:~$ phython3 --version
Command 'phython3' not found, did you mean:
  command 'python3' from deb python3 (3.12.3-0ubuntu2)
Try: sudo apt install <deb name>
ubuntu@ubuntu2404:~$ python3 --version
Python 3.12.3
ubuntu@ubuntu2404:~$ 
```

bash –version



```
sudo apt install openjdk-11-jre-headless  # version 11.0.28+6-1ubuntu1~24.04.1
sudo apt install openjdk-25-jre-headless  # version 25+36-1~24.04.2
sudo apt install openjdk-8-jre-headless   # version 8u462-ga~us1-0ubuntu2~24.04.
2
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
ubuntu@ubuntu2404:~$ gcc --version
Command 'gcc' not found, but can be installed with:
sudo apt install gcc
ubuntu@ubuntu2404:~$ phython3 --version
Command 'phython3' not found, did you mean:
  command 'python3' from deb python3 (3.12.3-0ubuntu2)
Try: sudo apt install <deb name>
ubuntu@ubuntu2404:~$ python3 --version
Python 3.12.3
ubuntu@ubuntu2404:~$ 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>

This is free software; you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
ubuntu@ubuntu2404:~$ 
```

Assignment 4.3: Compile

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

Javac en GCC. De andere zijn interpeters.

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

Gcc. Alle andere gebruiken iets van een tussenstap voordat het gerunt kan worden.

Which source code files are compiled to byte code?

Javac. Dit compiled het zodat java het kan runnen

Which source code files are interpreted by an interpreter?

Python en bash

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

Gcc, deze praat direct met de hardware zonder tussen stap

How do I run a Java program?

Een .java bestand word gecompiled door een java compiler. Deze gegevens worden omgezet naar bytecode die de can gerunt word op een JVM.

How do I run a Python program?

Een .py bestand staat ergens op de computer. Dan can deze gerunt worden door hem met python op te starten. Bijv python3 helloworld.py

How do I run a C program?

.c bestand word gerunt. Door GCC. Gcc maakt een uitvoerbaar bestand

How do I run a Bash script?

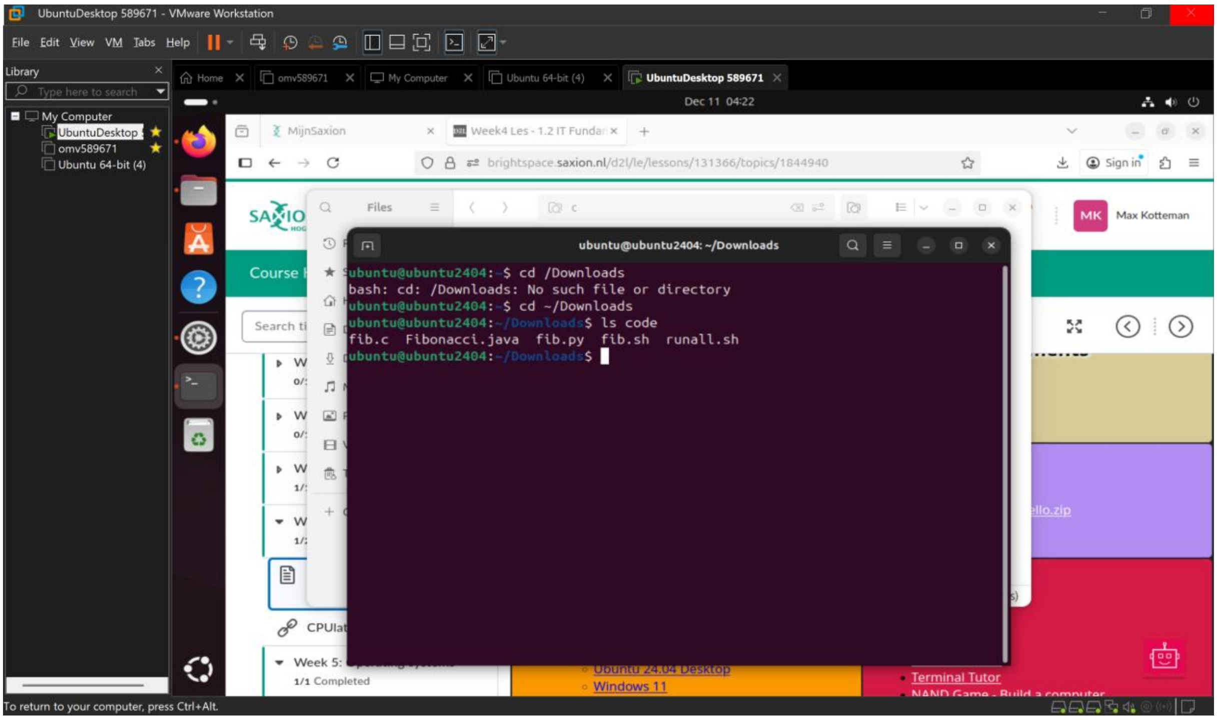
Een Bash-script maak je door een bestand met de extensie .sh te schrijven en bovenaan #!/bin/bash te zetten. Daarna geef je het uitvoerrechten met chmod +x script.sh en start je het met ./script.sh.

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

Ja, nieuwe bestanden ontstaan bij Java , C en soms bij Python.

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?



UbuntuDesktop 589671 - VMware Workstation
File Edit View VM Tabs Help
Library
My Computer
UbuntuDesktop 589671
omv589671
Ubuntu 64-bit (4)
Home
My Computer
Dec 11 04:22
MijnSaxion
Week4 Les - 1.2 IT Fundar
brightspace.saxion.nl/d2l/le/lessons/131366/topics/1844940
Sign in
Files
MK Max Kotteman
ubuntu@ubuntu2404: ~/Downloads
Week 5:
1/1 Completed
CPUlat
Ubuntu 24.04 Desktop
Windows 11
Terminal Tutor
To return to your computer, press Ctrl+Alt.

```
ubuntu@ubuntu2404:~$ cd /Downloads
bash: cd: /Downloads: No such file or directory
ubuntu@ubuntu2404:~$ cd ~/Downloads
ubuntu@ubuntu2404:~/Downloads$ ls code
fib.c  Fibonacci.java  fib.py  fib.sh  runall.sh
ubuntu@ubuntu2404:~/Downloads$ 
```

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.

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**