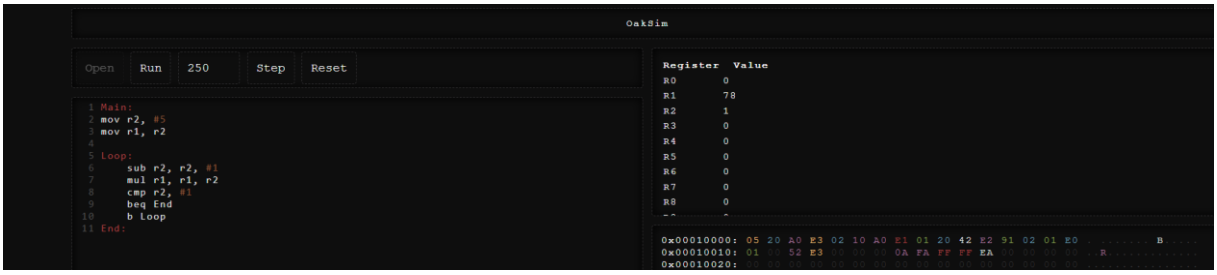
Template Week 4 – Software

Student number: 564595

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

```
reza-hekmatirad@reza-hekmatirad-VMware-Virtual-Platform:~$ javac --version
javac 21.0.9
reza-hekmatirad@reza-hekmatirad-VMware-Virtual-Platform:~$ python3 --version
Python 3.12.3
reza-hekmatirad@reza-hekmatirad-VMware-Virtual-Platform:~$ 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.
reza-hekmatirad@reza-hekmatirad-VMware-Virtual-Platform:~$ gcc --version
gcc (Ubuntu 13.3.0-6ubuntu2~24.04) 13.3.0
Copyright (C) 2023 Free Software Foundation, Inc.
This is free software; see the source for copying conditions.  There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.

reza-hekmatirad@reza-hekmatirad-VMware-Virtual-Platform:~$ java --version
openjdk 21.0.9 2025-10-21
OpenJDK Runtime Environment (build 21.0.9+10-Ubuntu-124.04)
OpenJDK 64-Bit Server VM (build 21.0.9+10-Ubuntu-124.04, mixed mode, sharing)
reza-hekmatirad@reza-hekmatirad-VMware-Virtual-Platform:~$
```

Assignment 4.3: Compile

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

-Fibonacci.java and 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 and 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?

-First compile it via javac (file name.java) then run it via java(file name)

How do I run a Python program?

-It does not need to be compiled since Python is interpreted so just do the python3 (file name.py)

How do I run a C program?

-First compile it via gcc -o (file name)(file name.c) then run it via ./(file name)

How do I run a Bash script?

-It does not need to be compiled since it is interpreted so first make it executable(chmod + x (file name)) and then just do the bash(file name.sh)

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

For .c files → Yes → fib.c turns into fib

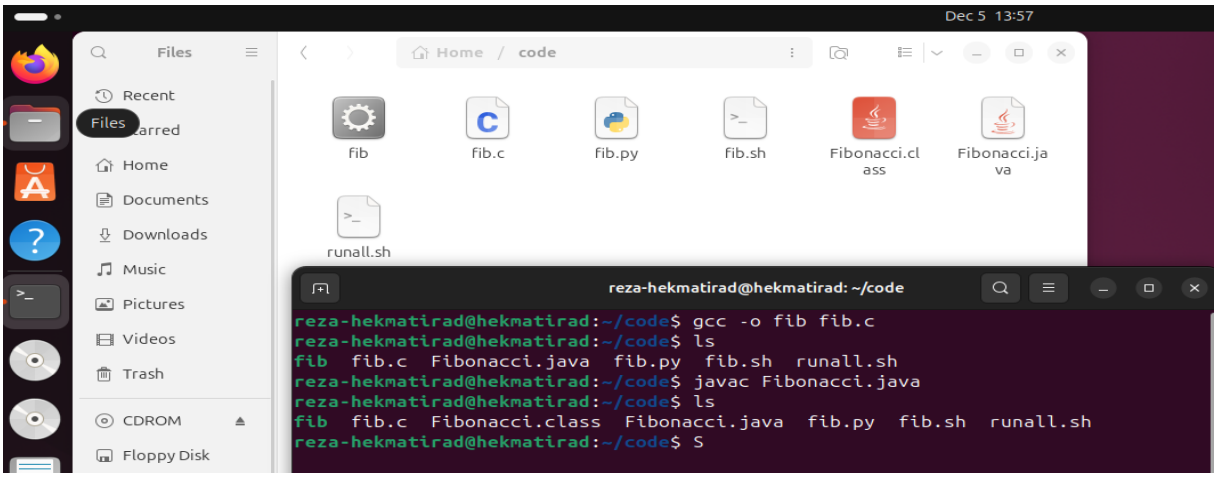
For .java → Yes → Fibonacci.java turns into Fibonacci.class

For .py → No

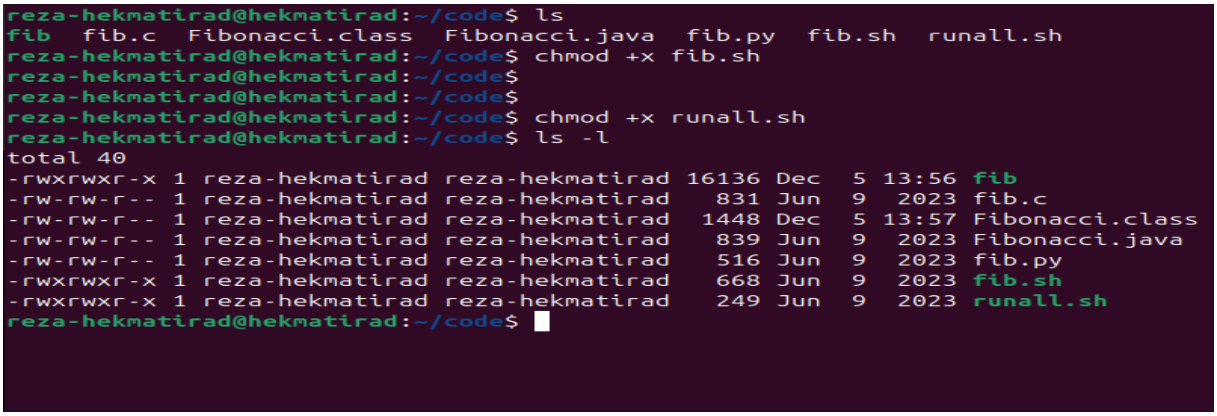
For .sh or .bash → No

Take relevant screenshots of the following commands:

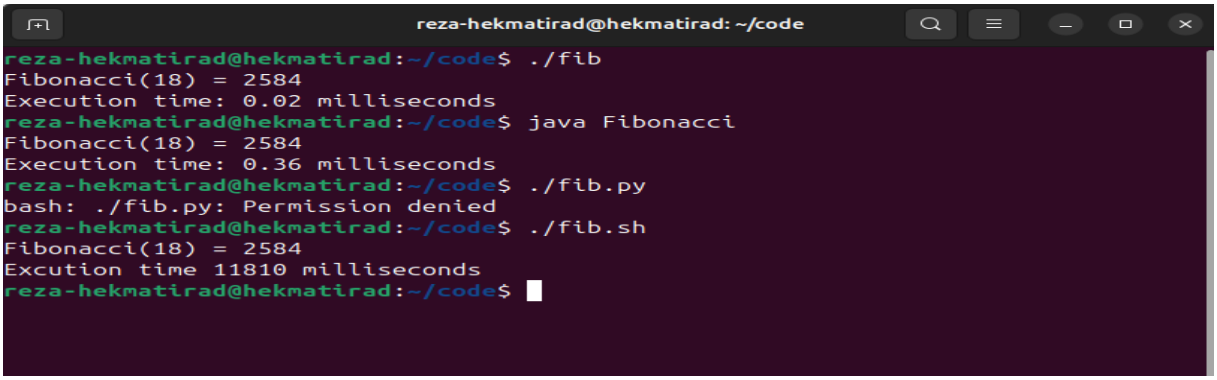
- Compile the source files where necessary:

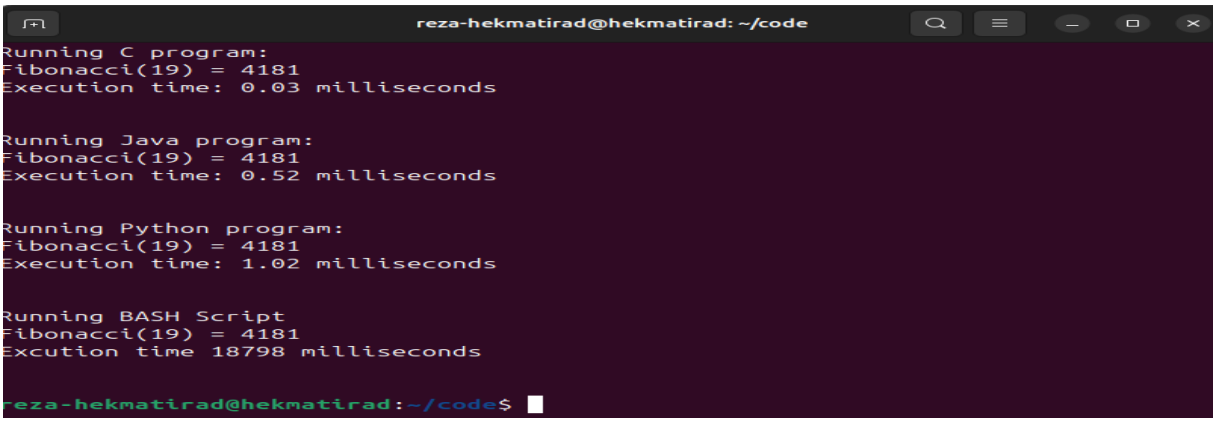


- Make them executable



- Run them





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

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.
   -gcc -O3 -o fib fib.c

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

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.

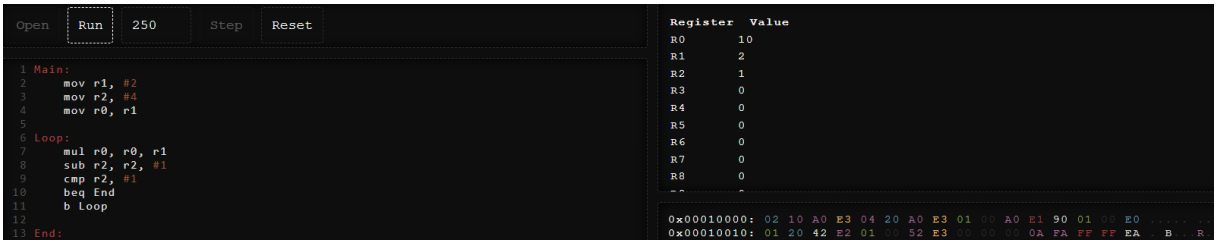
Assignment 4.5: More ARM Assembly

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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