Week 4 – Software

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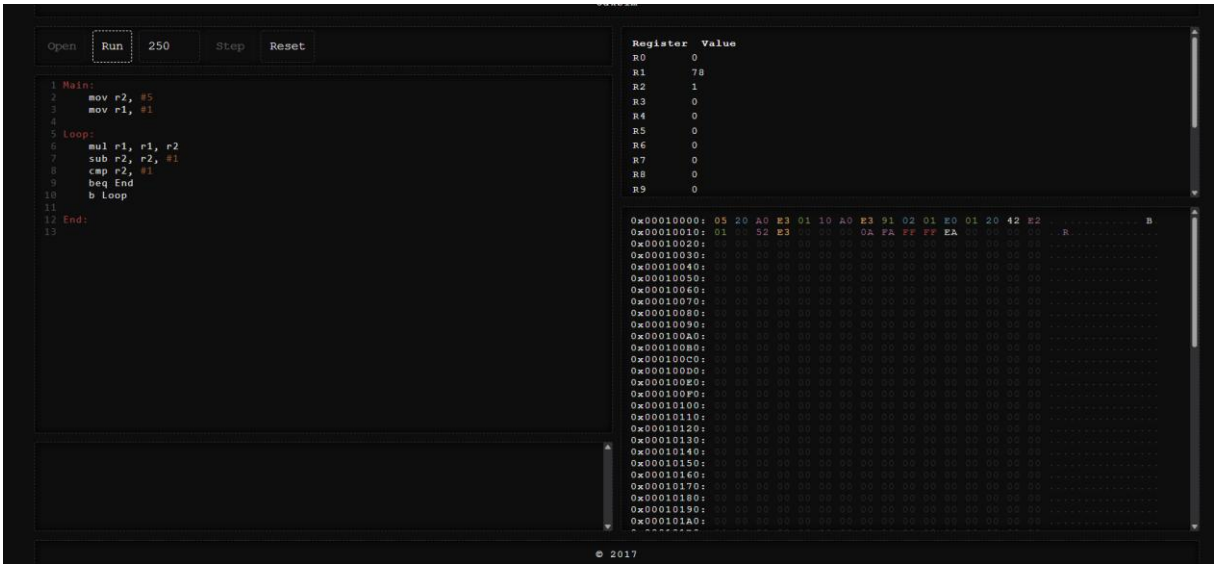
Assignment 4.1: ARM assembly

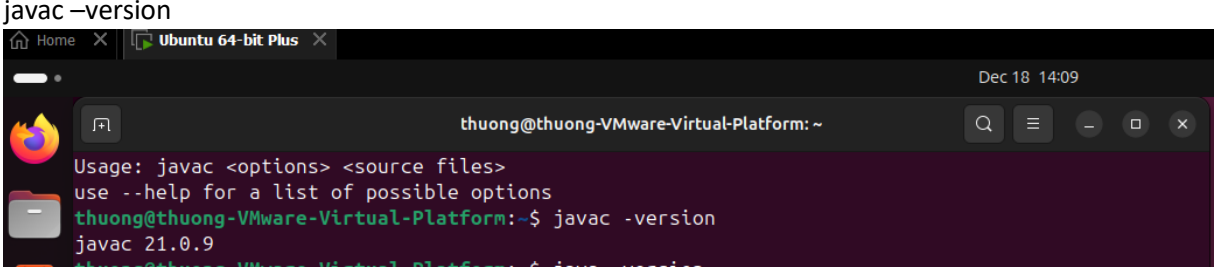
Screenshot of working assembly code of factorial calculation:



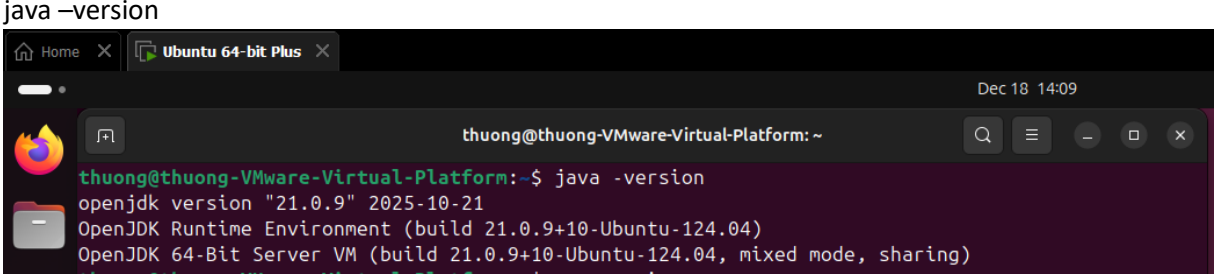
Assignment 4.2: Programming languages

Take screenshots that the following commands work:

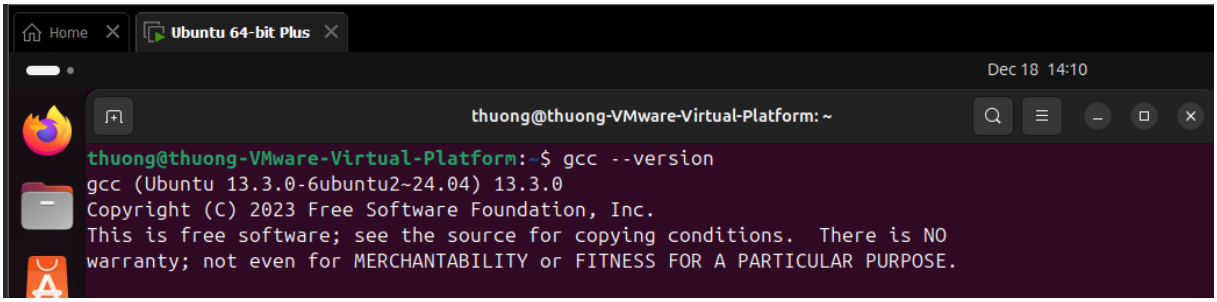
javac –version



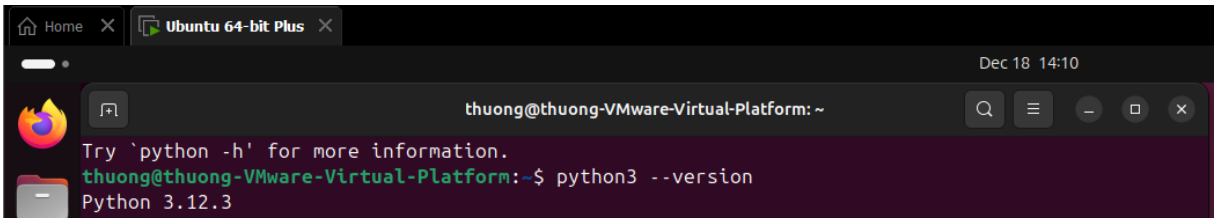
java –version



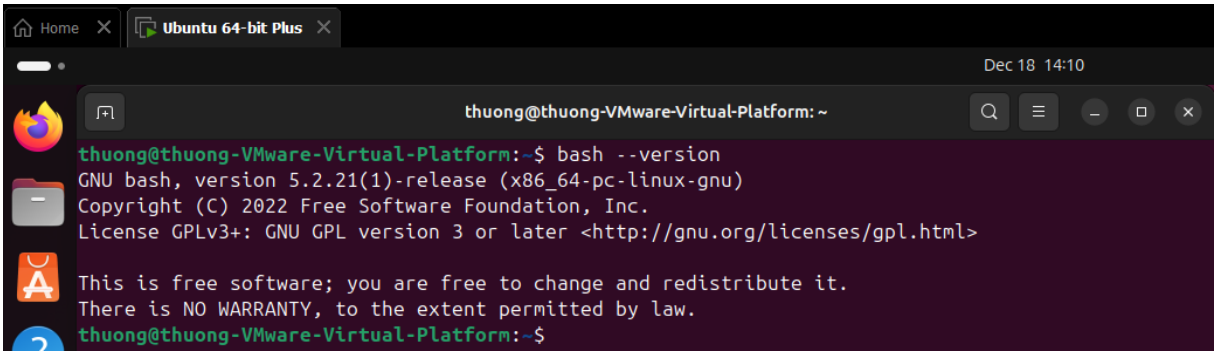
gcc --version



python3 --version



bash --version



Assignment 4.3: Compile

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

Fibonacci.java and fib.c (Java and C are compiled languages. Their source code must be compiled before execution)

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.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?

javac Fibonacci.java

or **java Fibonacci**

How do I run a Python program?

python3 fib.py

How do I run a C program?

gcc fib.c -o fib

./fib

How do I run a Bash script?

chmod +x fib.sh

./fib.sh

Or

bash fib.sh

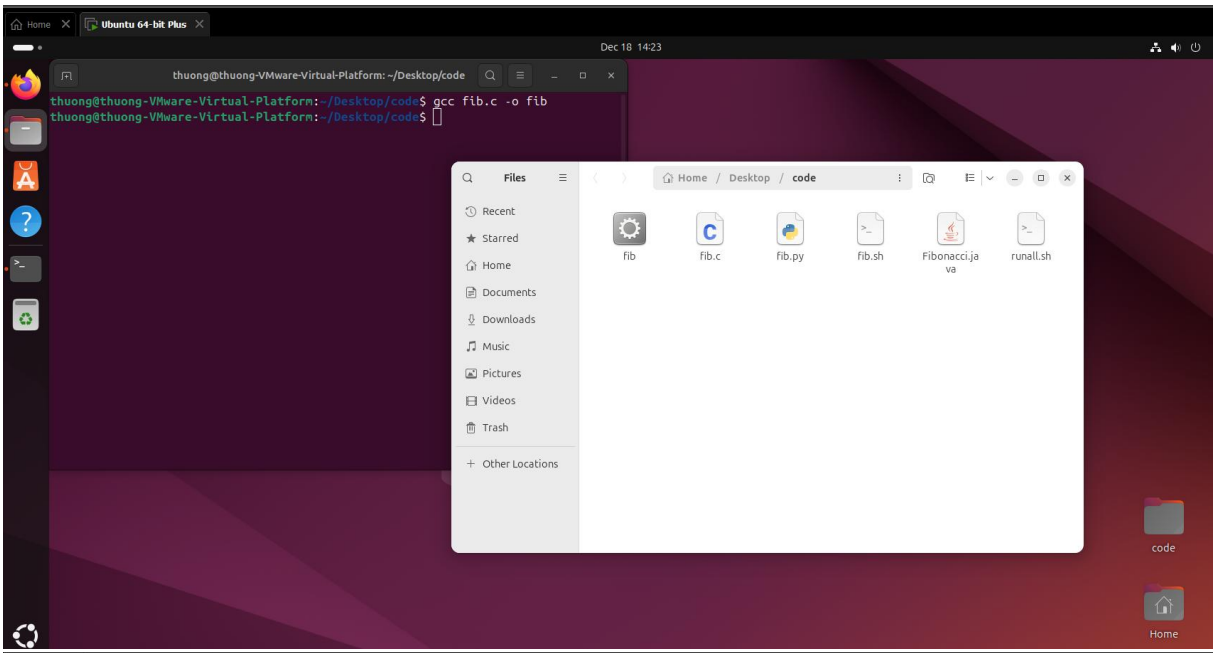
If I compile the above source code, will a new file be created? If so, which file?

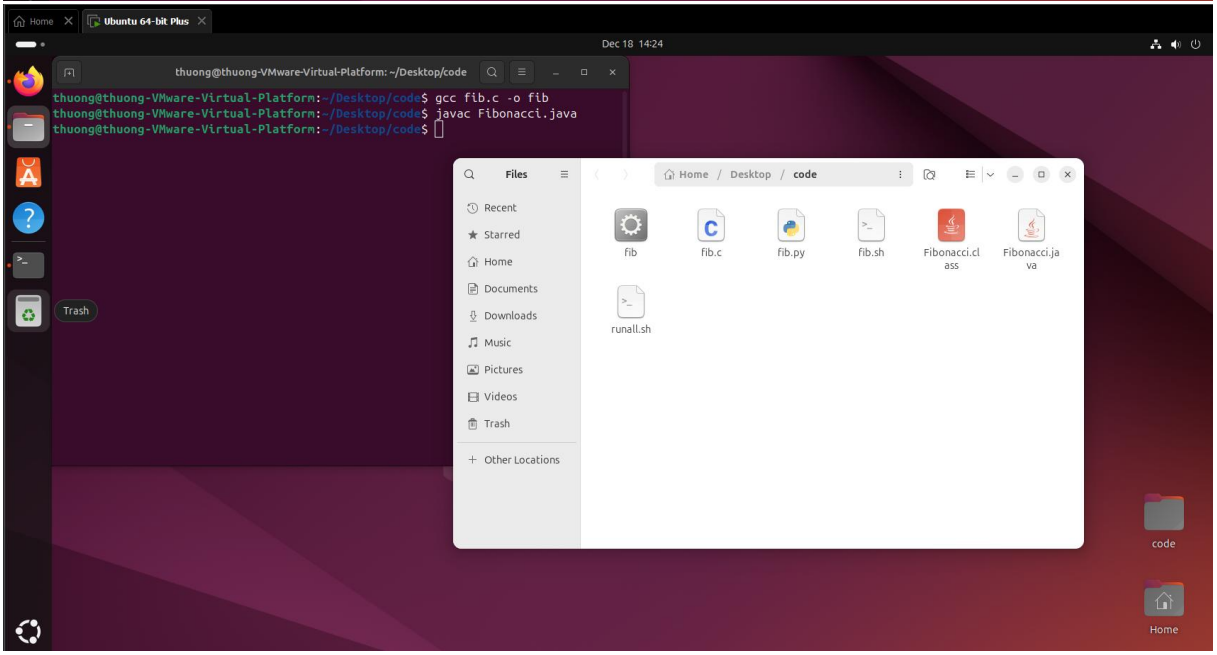
Java -> Fibonacci.class

C -> fib (executable binary)

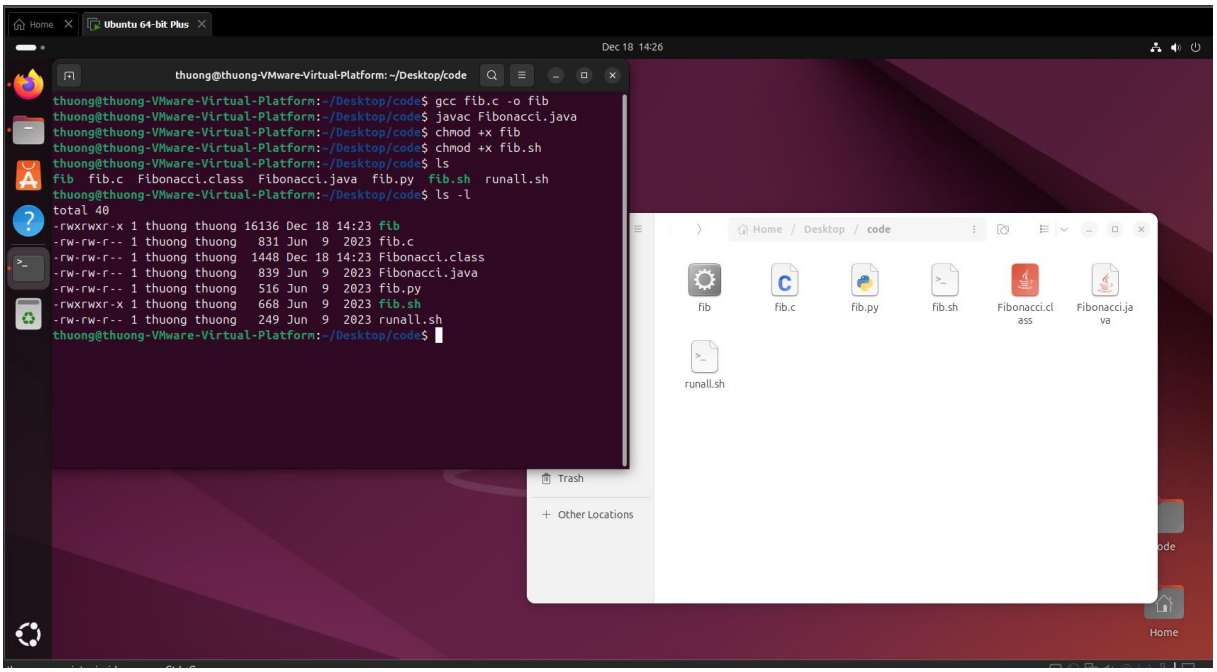
Take relevant screenshots of the following commands:

- Compile the source files where necessary

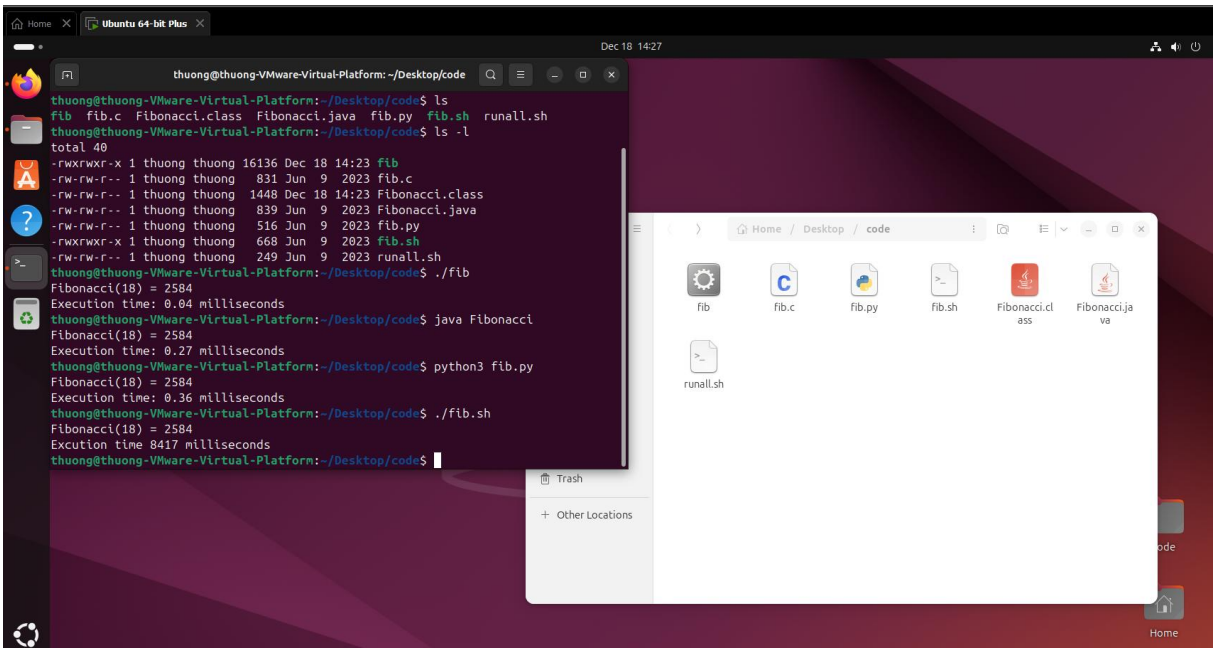




- Make them executable



- Run them

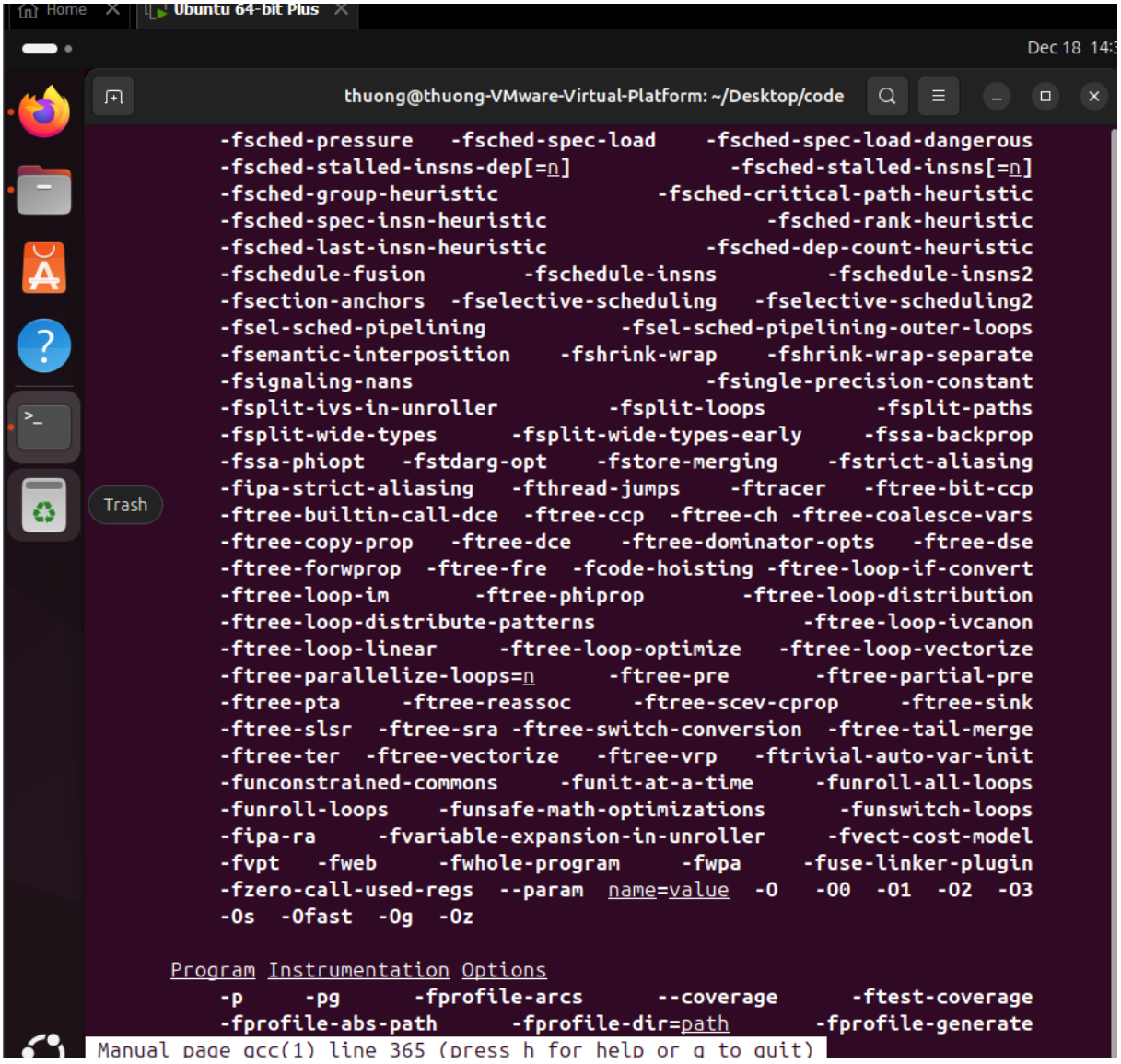


- Which (compiled) source code file performs the calculation the fastest?
  The C program (fib.c) performs the calculation the fastest because it is compiled into native machine code and executed directly by the processor

Assignment 4.4: Optimize

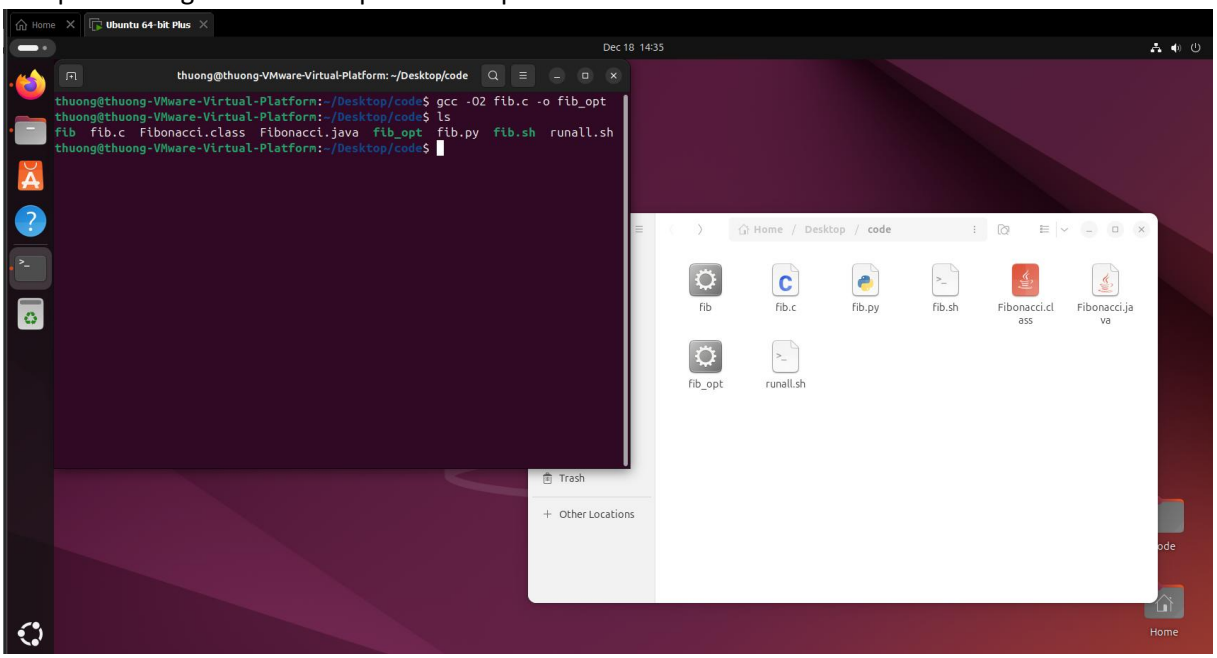
Take relevant screenshots of the following commands:

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.

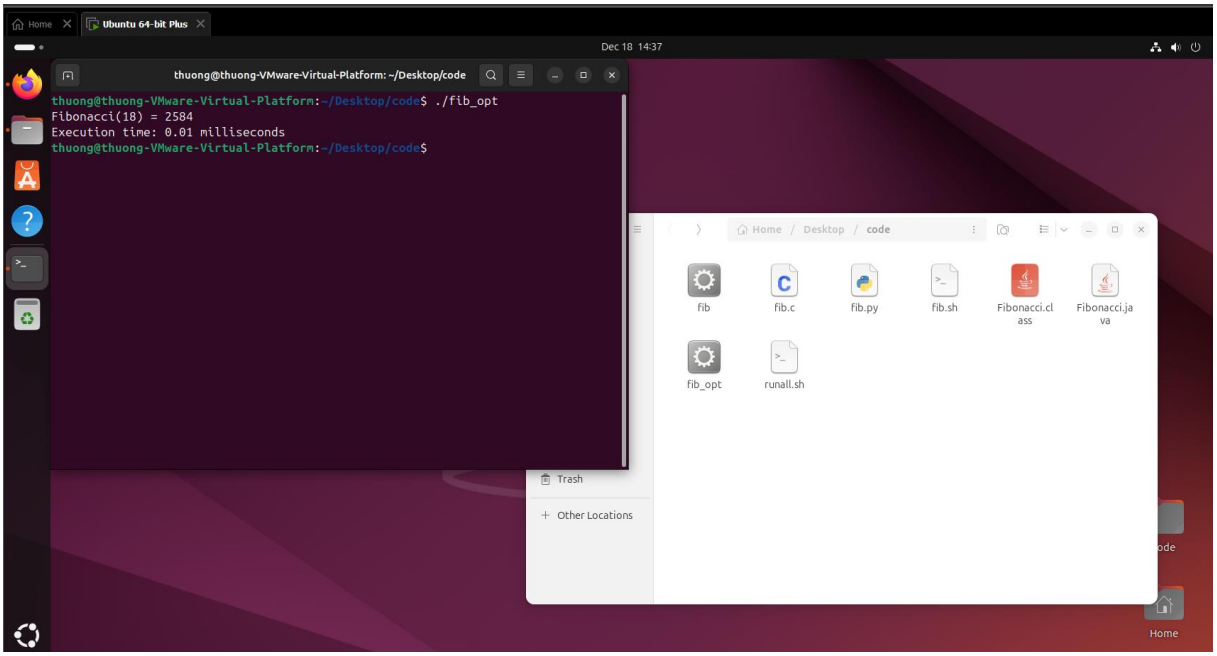


-02 is an optimization parameter for the gcc compiler that enables a high level of optimization and improves execution performance without sacrificing correctness

b) Compile **fib.c** again with the optimization parameters

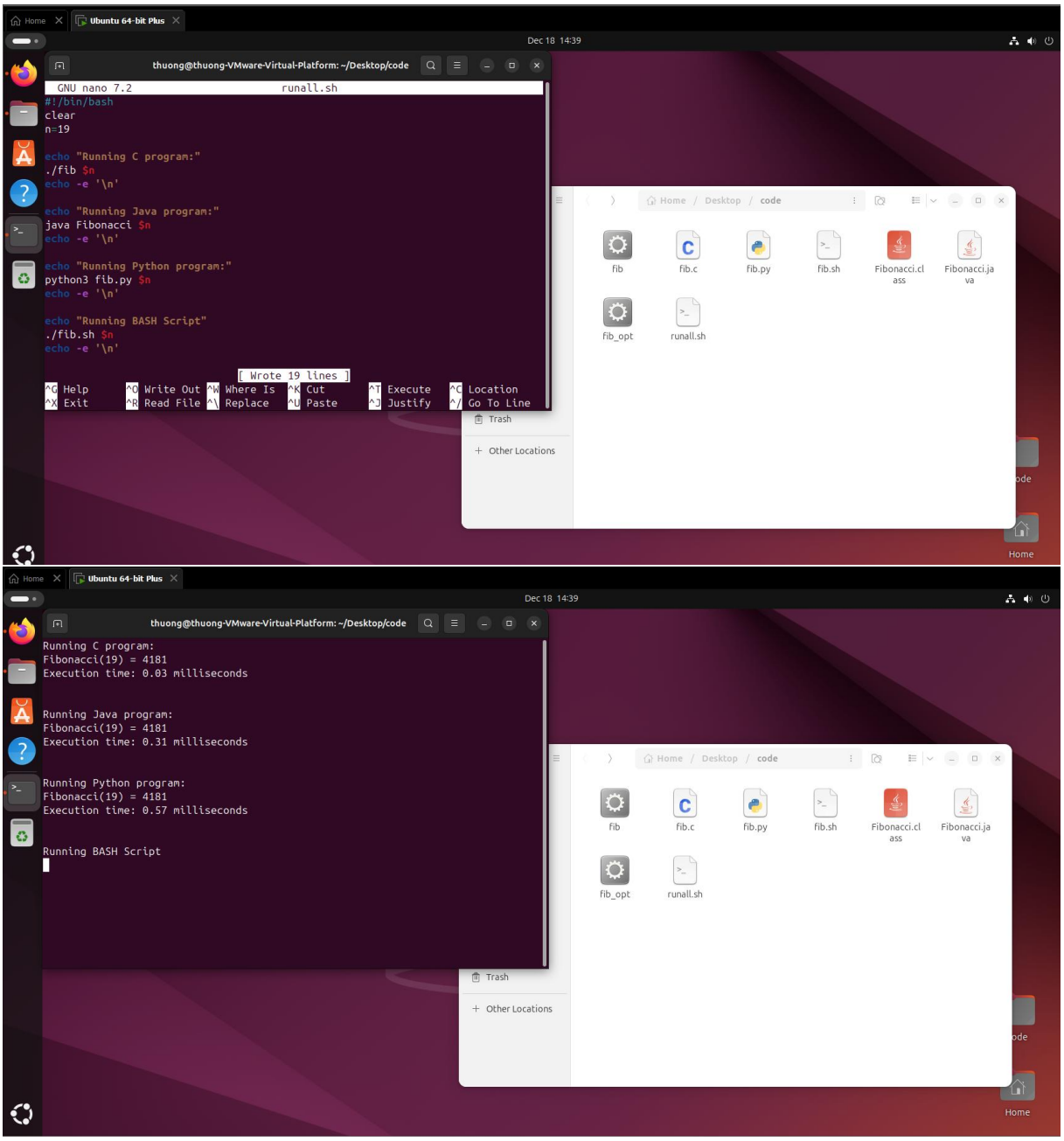


c) Run the newly compiled program. Is it true that it now performs the calculation faster?



Yes, the optimized C program performs the calculation faster.
After recompiling with the -02 optimization flag, the execution time decreased compared to the non-optimized version

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.

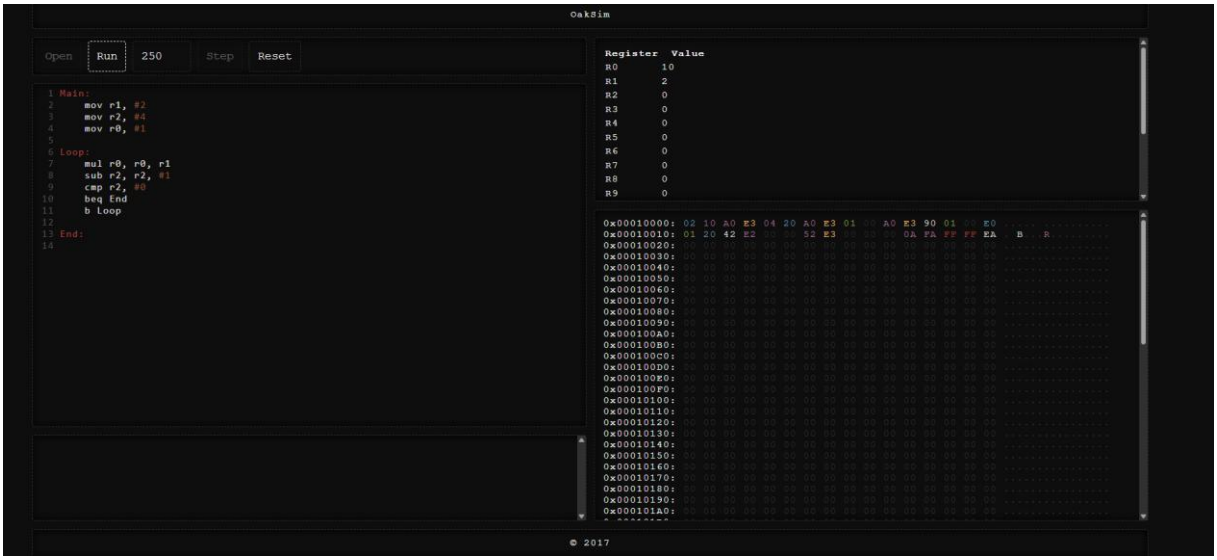
```
Main:
mov r1, #2
mov r2, #4

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**