POLYTECH
DIJON

2024/2025

ITC313

Mastering Object-Oriented Programming in C++: From Fundamentals to Best Practices

Pr. Dominique Ginhac
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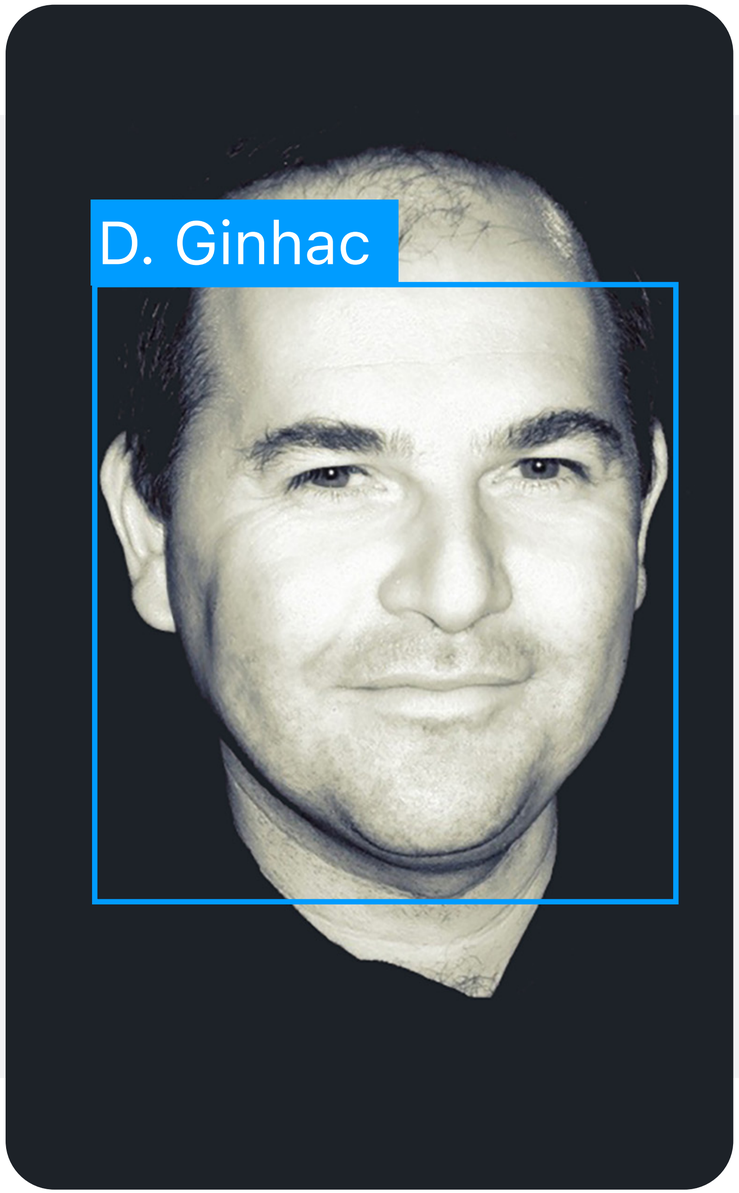
Last updated on September, 18, 2024 by dG



$ ~ whoami

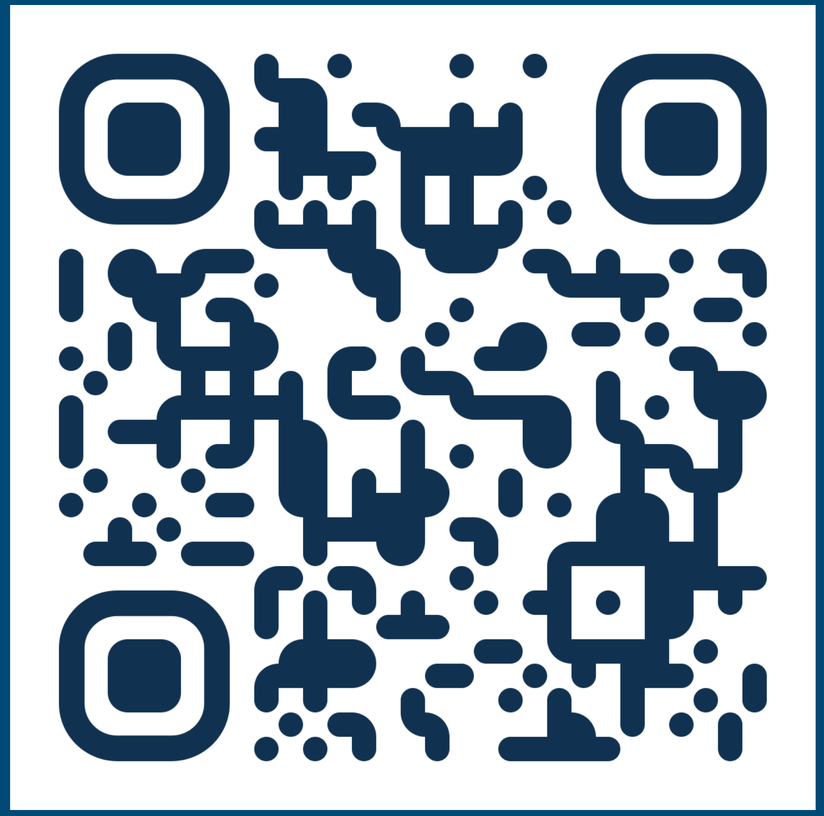
HI, I'M D. GINHAC

I will be your instructor for some Computer Programming lectures this year.

I'm conducting research in Computer Vision, and more specifically on how to embed Artificial Intelligence in real-time vision systems.

I'm also a national IT expert for the French Ministry of Higher Education and Research.

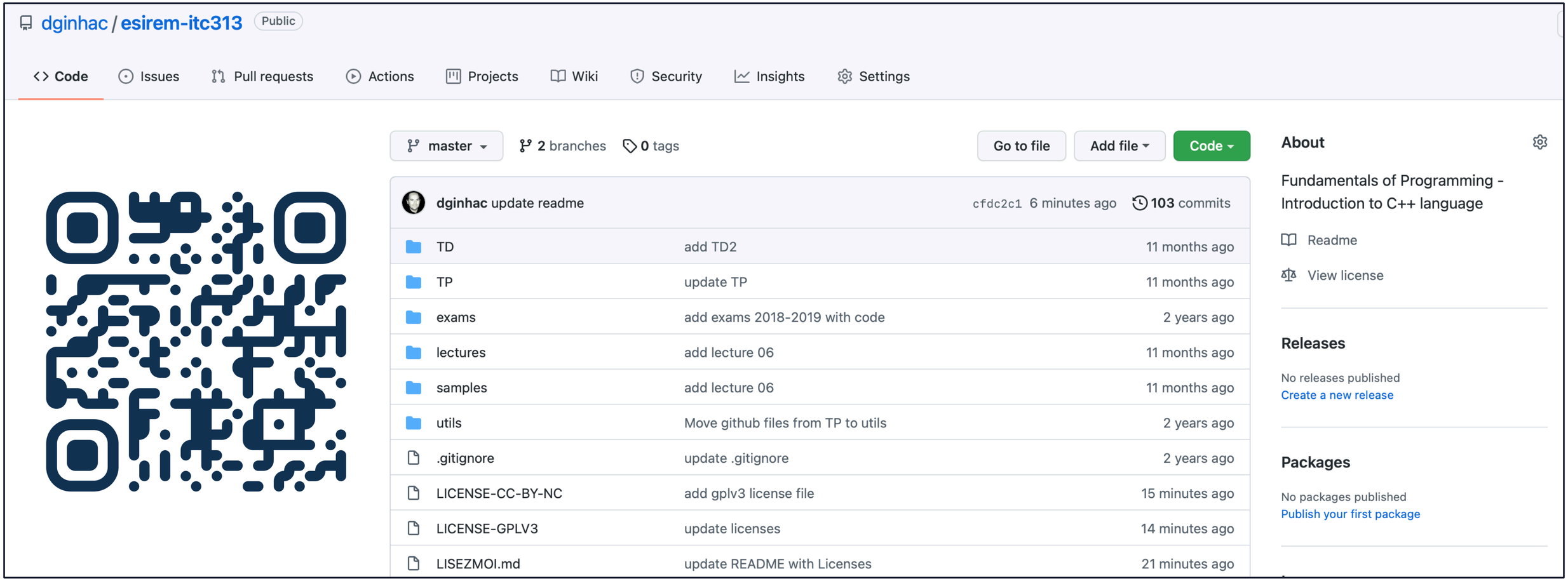
dginhac@u-bourgogne.fr dginhac dginhac



https://ginhac.com/ITC313/00-intro.pdf

Everything else available on GitHub.

https://github.com/dginhac/esirem-itc313



A quick survey to get to know you!

https://app.wooclap.com/ITC313


This is your captain speaking
please put your phone in
airplane mode

Today

Lecture #00
Course Introduction

Lecture #01
User-defined Data Types
Abstraction/Encapsulation

Lecture #02
Inheritance

Lecture #03
Polymorphism

Lecture #04
STL Containers

Lecture #05
Templates

...

Lecture #00

https://ginhac.com/ITC313/00-intro.pdf

Course Introduction

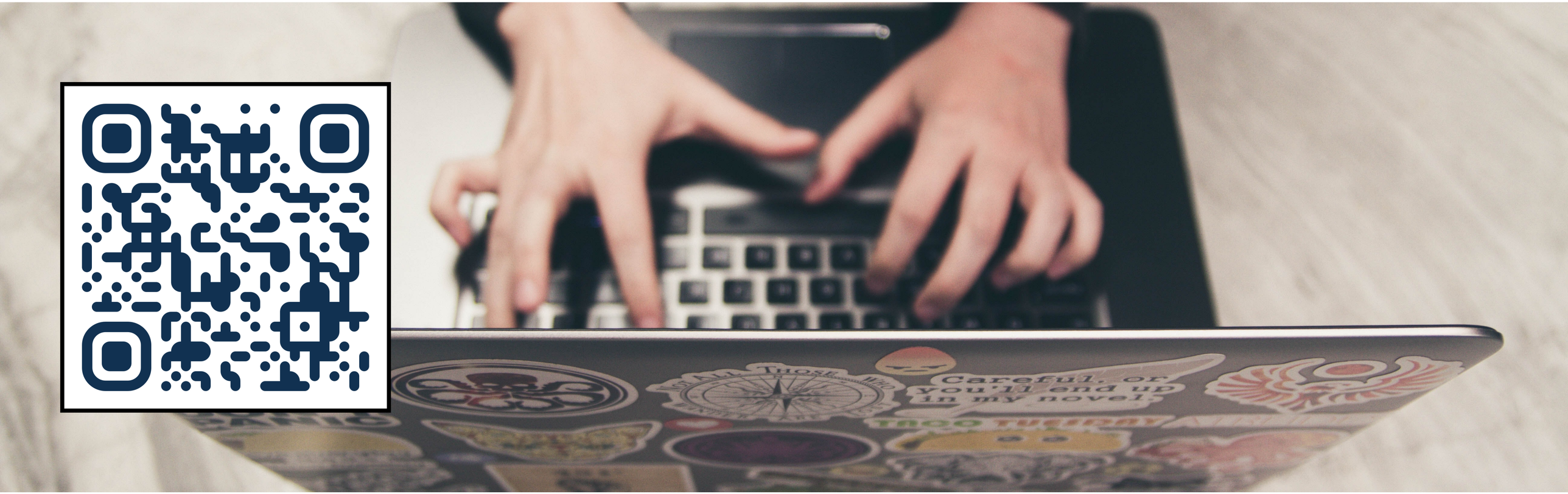


Photo by NeONBRAND on Unsplash

Give an overview of the main topics and
introduce the objectives of the ITC313 course.

AGENDA

00 - Course Introduction

1. About ITC313
2. Why learning C++?
3. The art of Programming
4. hello, world

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The ITC313 course scheduling

Photo by Xin Wang on Unsplash

Lectures (CM)

Starting Week 38

13 x 1.75 h
D. Ginhac

Tutorials (TD)

Starting Week 40

6 x 1.75 h
D. Ginhac

Labs (TP)

Starting Week 43

12 x 2 h
Other instructors

Exams

To be defined

Grading = Midterm + Final + Labs

Find your learning objectives

Beginner
(aka Padawan)

“Start small, think big!”

No prior knowledge of C++? No problem!

This course is designed to guide you step by step in learning object-oriented programming.

Intermediate
(aka Jedi Knight)

“Level up your C++ skills!”

Want to deepen your C++ skills and optimize your code?

This course will allow you to discover the best practices and most commonly used design patterns.

Expert
(aka Jedi Master)

“Be a C++ virtuoso!”

Are you ready to tackle complex challenges and optimize your code to the maximum?

This course will equip you with advanced techniques and cutting-edge strategies.

What you'll gain by the end of this course: OOP Skills you didn't have before !

How to achieve these learning objectives?

YOU GET MORE
AUTONOMY

WORK TO GAIN
SKILLS

KEEP
MOTIVATED

How to achieve these learning objectives?

Listen carefully.

Lecture slides, Code examples, Tutorials, Lab works, … are all available on **GitHub**.

You are strongly encouraged to attend and participate actively in the **lectures**, the **tutorials**, and the **labs**.

Be proactive.

My **slides** are always **very sparse**. So, take notes to keep track of my talk.

Use **your smartphone** to take screenshots of the blackboard.

Use **your laptop** to download, review, modify and test the C++ code examples.

Ask when unclear.

Learning / Teaching how to code in C++ is not really easy.

So, **be active** and ask me when anything appears unclear!

I will spend time to explain again and again.

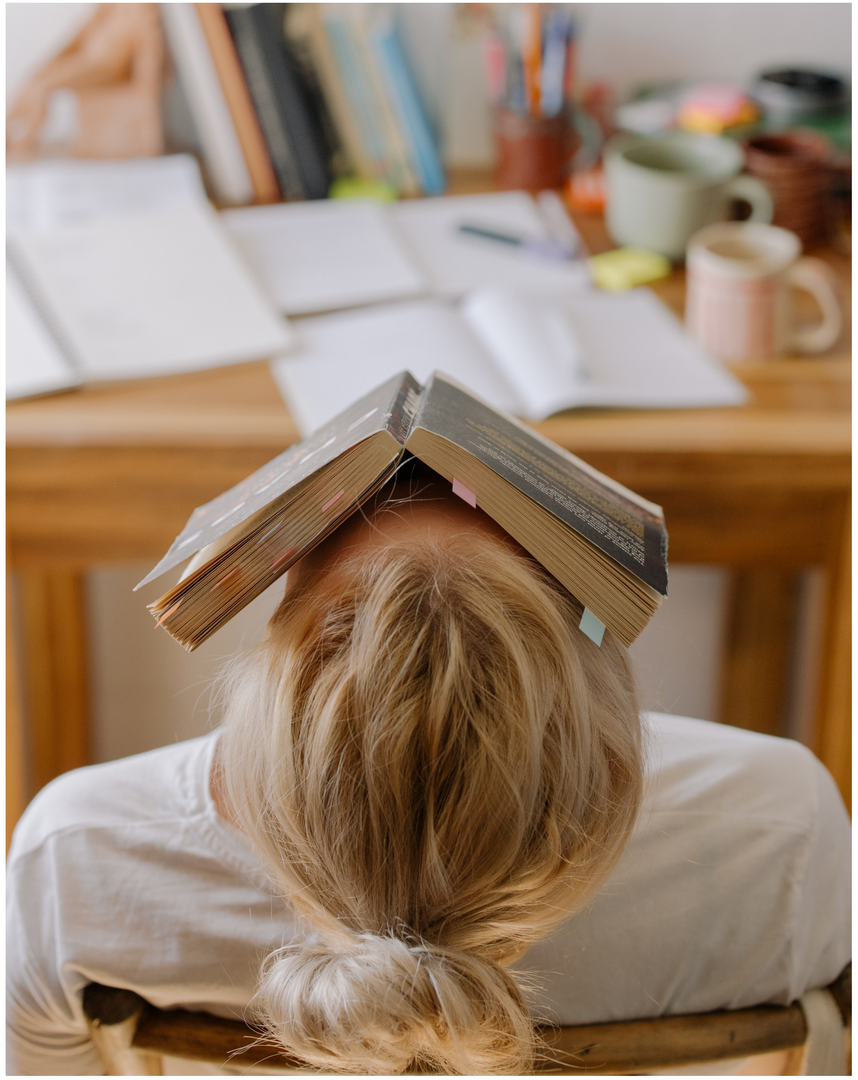
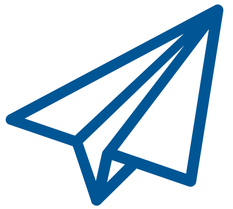


Photo by cottonbro from Pexels

#0

AN INITIAL TAKE HOME MESSAGE



Learning Computer Science has never been so accessible thanks to the broad range of resources available!

But, nobody became a software developer by registering a MOOC or watching tutorials on YouTube.

“Programming is a skill best acquired by practice and example rather than from books.” – Alan Turing

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Why learning C++?

Relevant

Powerful

Popular

Jobs

Is C++ relevant in 2024 ?

C++ is an Object Oriented programming (OOP).

OOP is a programming paradigm in which the programs are structured around objects rather than functions and logic (such as C).

The C language was born in 1972...

Closely tied to **the dev of** UNIX OS.

The C programming language has been developed to move the UNIX kernel code **from assembly to a higher level language** while guaranteeing **high performance**.

Photo by National Inventors Hall of Fame

Dennis RITCHIE
/ Inventor of C

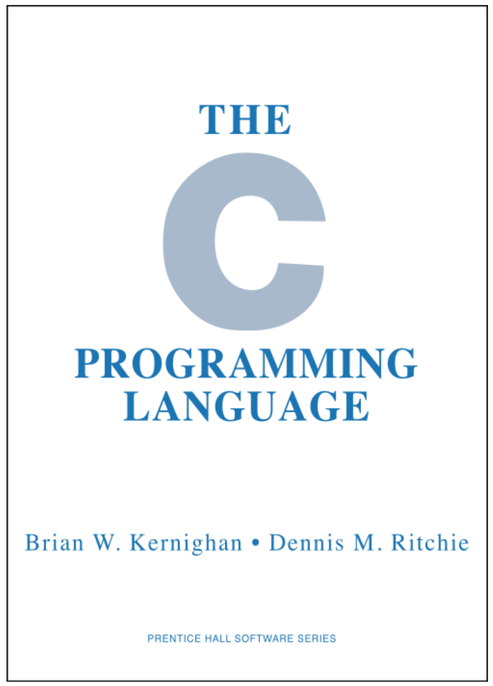


Photo by National Inventors Hall of Fame

Ken THOMSON
/ Designer of UNIX OS

... and C++ in 1983.

Originally defined as an extension of the C language
called “**C++ = C with Classes**”.

Photo by Bjarne Stroustrup

Bjarne STROUSTRUP
/ Inventor of C++

Standardization

Updated standard every 3 years.
C++23 is the current release (23/12), C++26 is in dev.

C++11 was a revolution

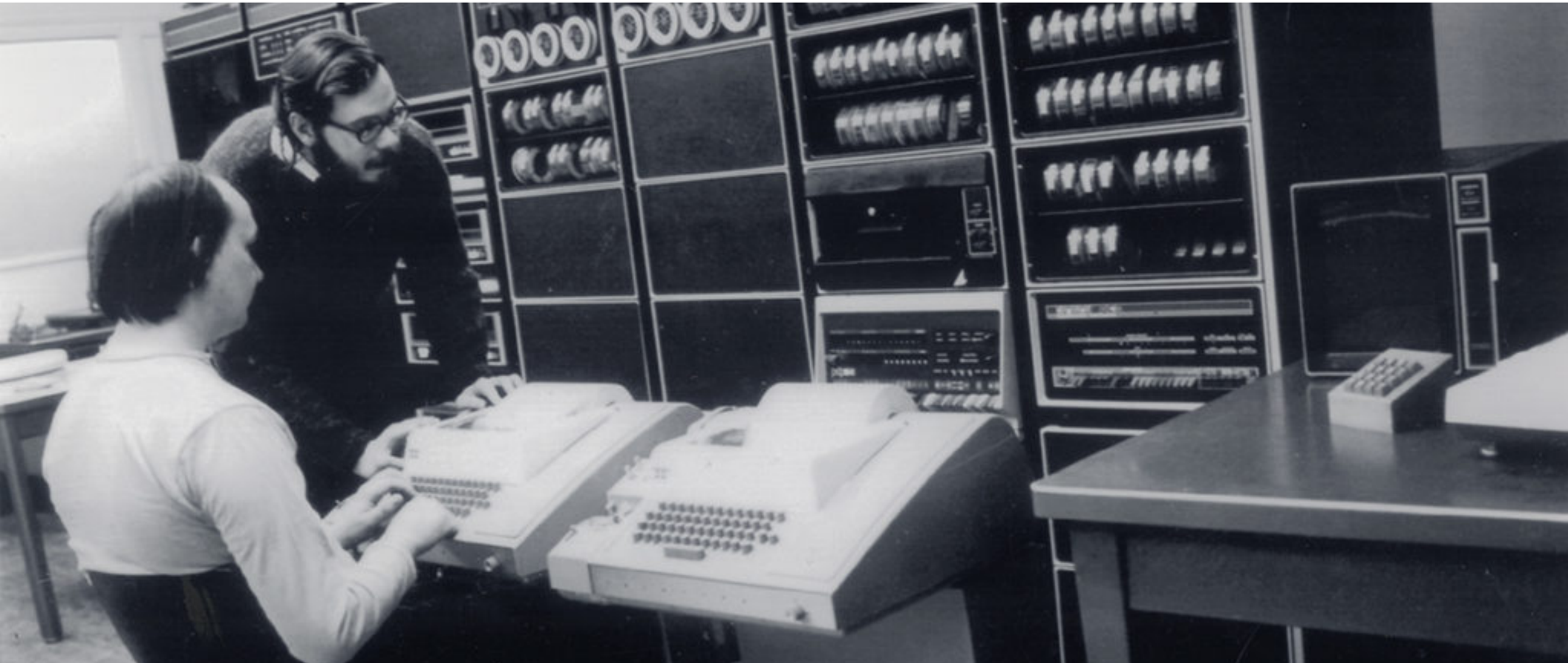
C++ before 2011 was C with classes.
C++ since 2011 is a new OOP language.

Modern C++

Modern C++ stands for C++ that is based on C++11 and beyond.
Most C++ compilers support C++11 to C++20 (23?) features.

C+/C++ are old languages from the last century that have probably been outdated by more modern languages.

Photo by Computer History - DEC - PDP-11- Ken Thompson and Dennis Ritchie







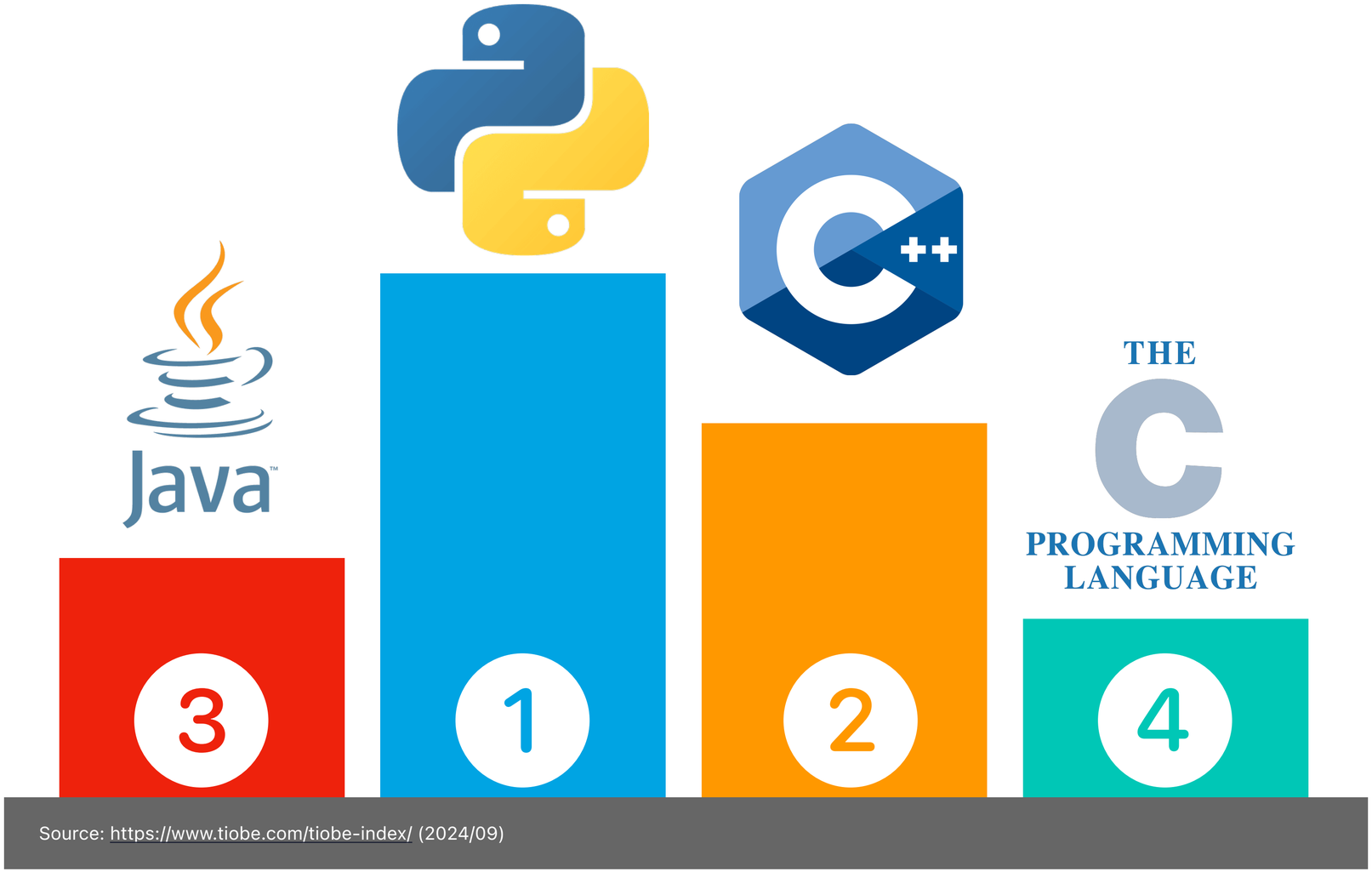


Welcome to the jungle!

About 700 notable languages (source wikipedia)

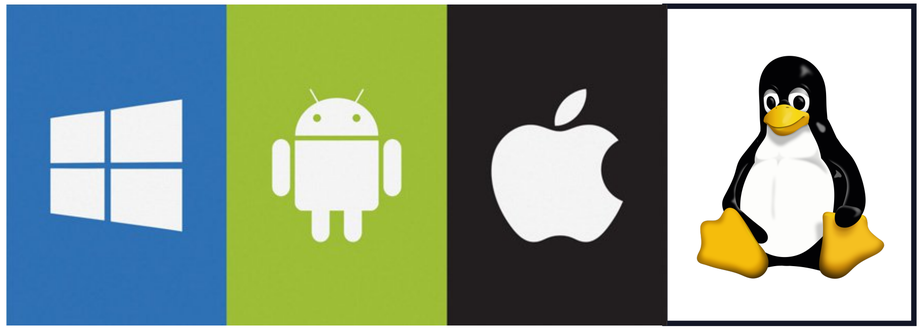




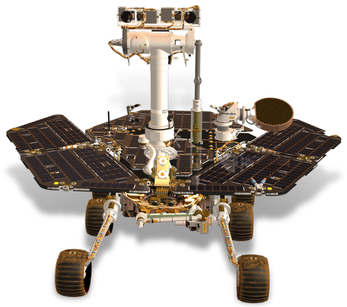


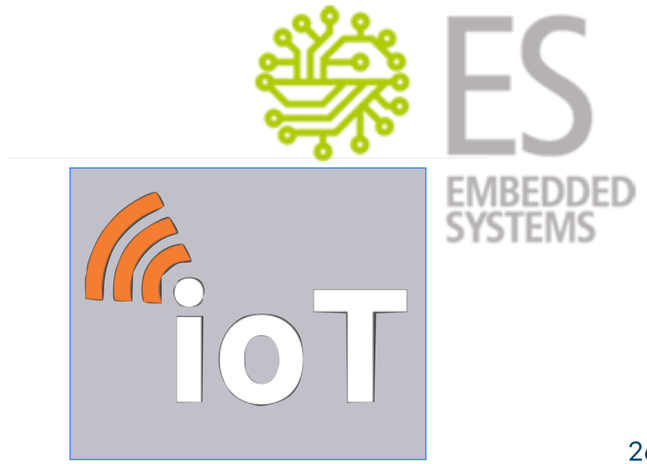
C++ is still relevant.

C++ is very popular in top companies ...



C++ is powerful for developing complex applications.





Mastering C++ is highly prized by companies

More than 1100 jobs on apec (2024/09)

WE ARE HIRING!

YES

Learning C++ is still relevant in 2024

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Programming is the art of telling another human what one wants the computer to do.

Donald KNUTH

/ The art of computer programming

Photo by Vivian Cromwell for Quanta Magazine

Art of Correctness

It is just a matter of syntax to write a correct sequence of instructions.

“Does the code you wrote (or someone else) compile and run?

Does the program behave correctly?”

01

Art of Design

Even bad code can work!

“How efficient is your program?”

02

03

Art of Style

Clean code is code that is easy to understand and easy to change.

“How understandable is your source code?

Can you make it more readable for humans?”

Make it work, make it right, make it clean

Correctness

Make your code run correctly.

Split your problem into short units and focus on one thing at a time.
Write well-organized classes containing only the required code.
Use the complete online reference for C++ and standard library https://en.cppreference.com
Use also C++ cheatsheets to help yourself https://github.com/mortennobel/cpp-cheatsheet

Design

Think code quality.

Test every piece of code.
Partition your code to prevent regressions.
Avoid duplication in the code - “Don’t repeat yourself!”
Consider code refactoring to get more efficient code.

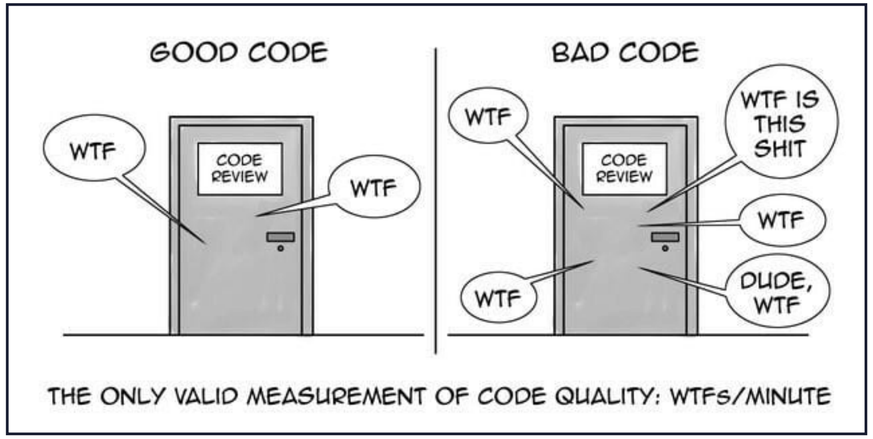

Photo by Elyess Eleuch on dev.to

Style

Increase readability.

Use descriptive names for variables, classes, functions. Express ideas directly in code.
Follow naming conventions. http://isocpp.github.io/CppCoreGuidelines/CppCoreGuidelines.html
Be careful: code says what is done, and comments what is supposed to be done.
Compilers don’t read comments and neither do many programmers.

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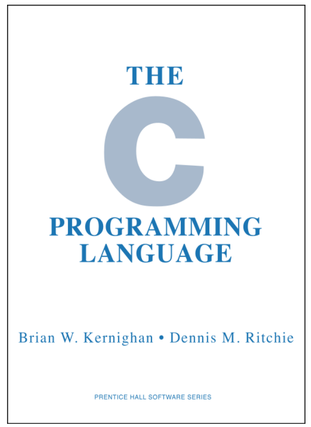
hello, world

needs more than just code.



In C, the program to print "hello, world" is

```
main( )
{
        printf("hello, world\n");
}
```

Just how to run this program depends on the system you are using. As an specific example, on Unix you must create the source program on a file whose name ends in ".c", such as *hello.c*, then compile it with the *cc* command

cc hello.c

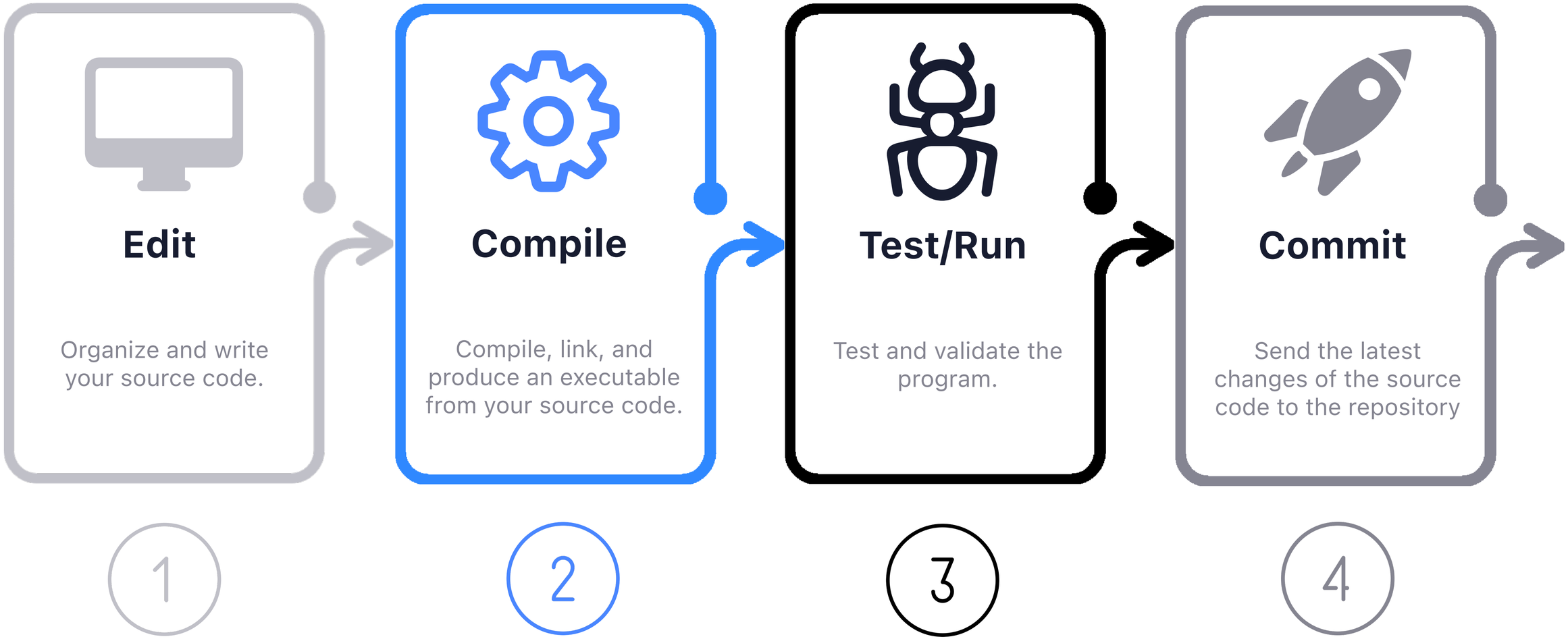
If you haven't botched anything, such as omitting a character or misspelling something, the compilation will proceed silently, and make an executable file called *a.out*. Running that by the command

a.out

will produce

hello, world

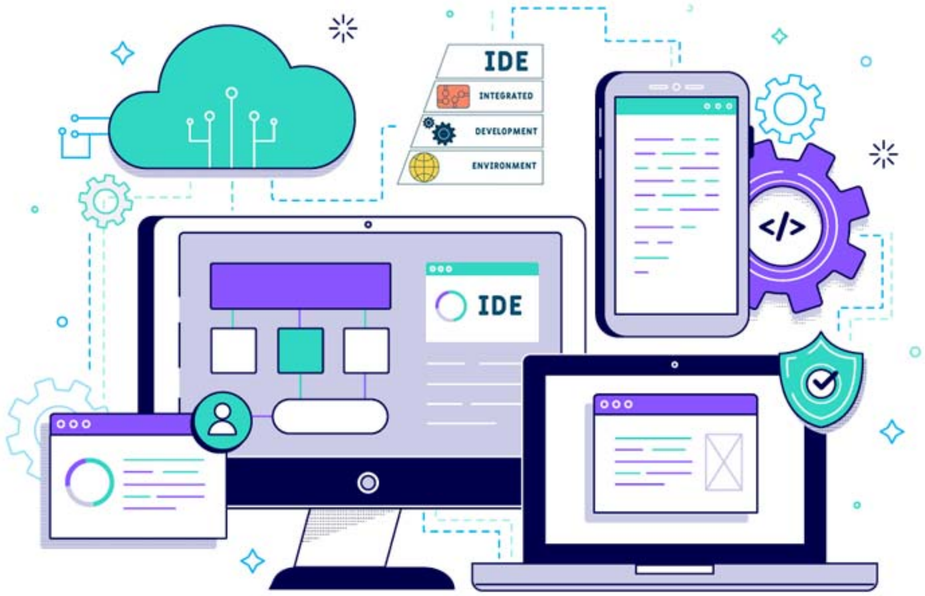
Automate your workflow to write your first “hello, world” program



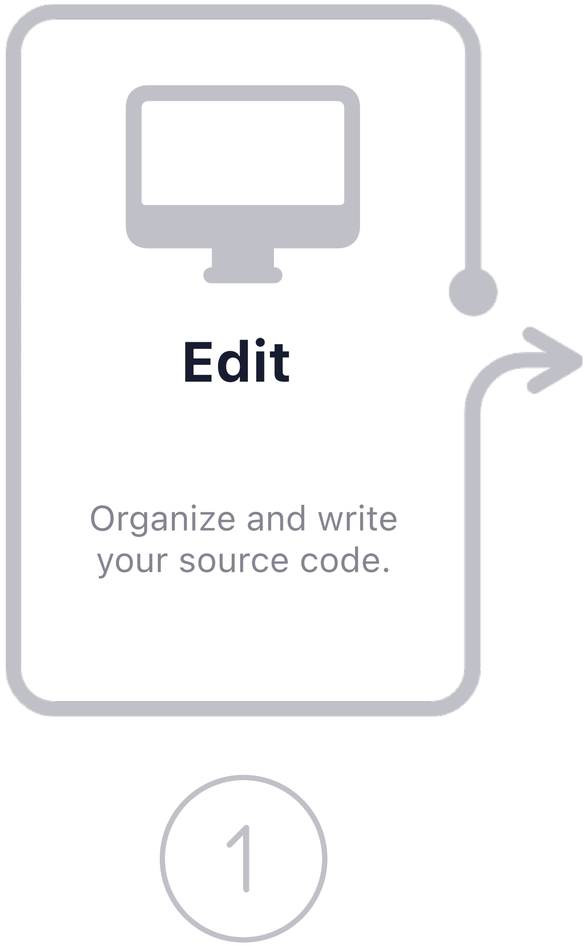
Use an IDE to “rule them all”

An integrated development environment (IDE) is a software application that helps programmers write code efficiently.

It increases developer productivity by combining capabilities such as software editing, building, testing, and packaging in an easy-to-use application.



Write source files with your editor



https://www.vim.org/

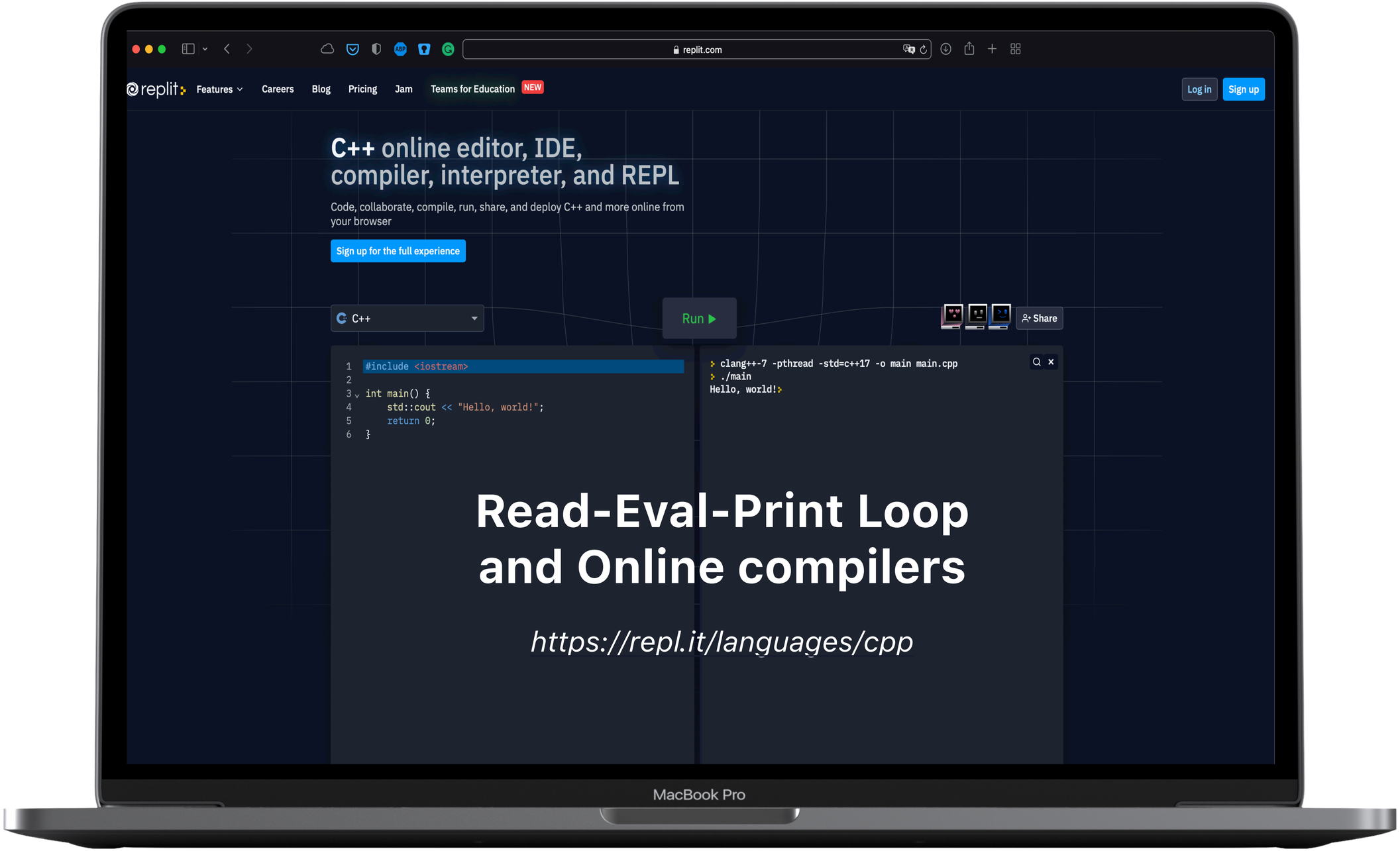
https://www.sublimetext.com

https://www.codeblocks.org

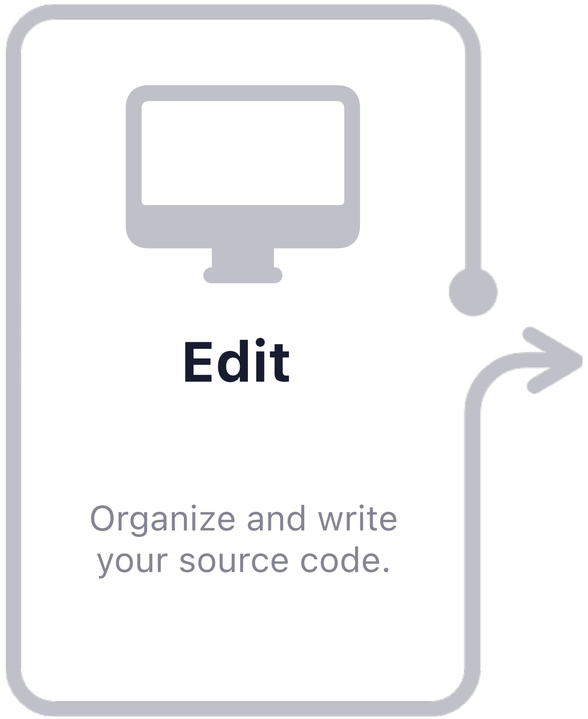
https://code.visualstudio.com

https://www.jetbrains.com/clion/

https://replit.com


replit.com
replit
Features
Careers
Blog
Pricing
Jam
Teams for Education
NEW
Log in
Sign up
C++ online editor, IDE, compiler, interpreter, and REPL
Code, collaborate, compile, run, share, and deploy C++ and more online from your browser
Sign up for the full experience
C++
Run
Share
#include <iostream>
int main() {
std::cout << "Hello, world!";
return 0;
}
clang++-7 -pthread -std=c++17 -o main main.cpp
./main
Hello, world!
Read-Eval-Print Loop and Online compilers
https://repl.it/languages/cpp
MacBook Pro

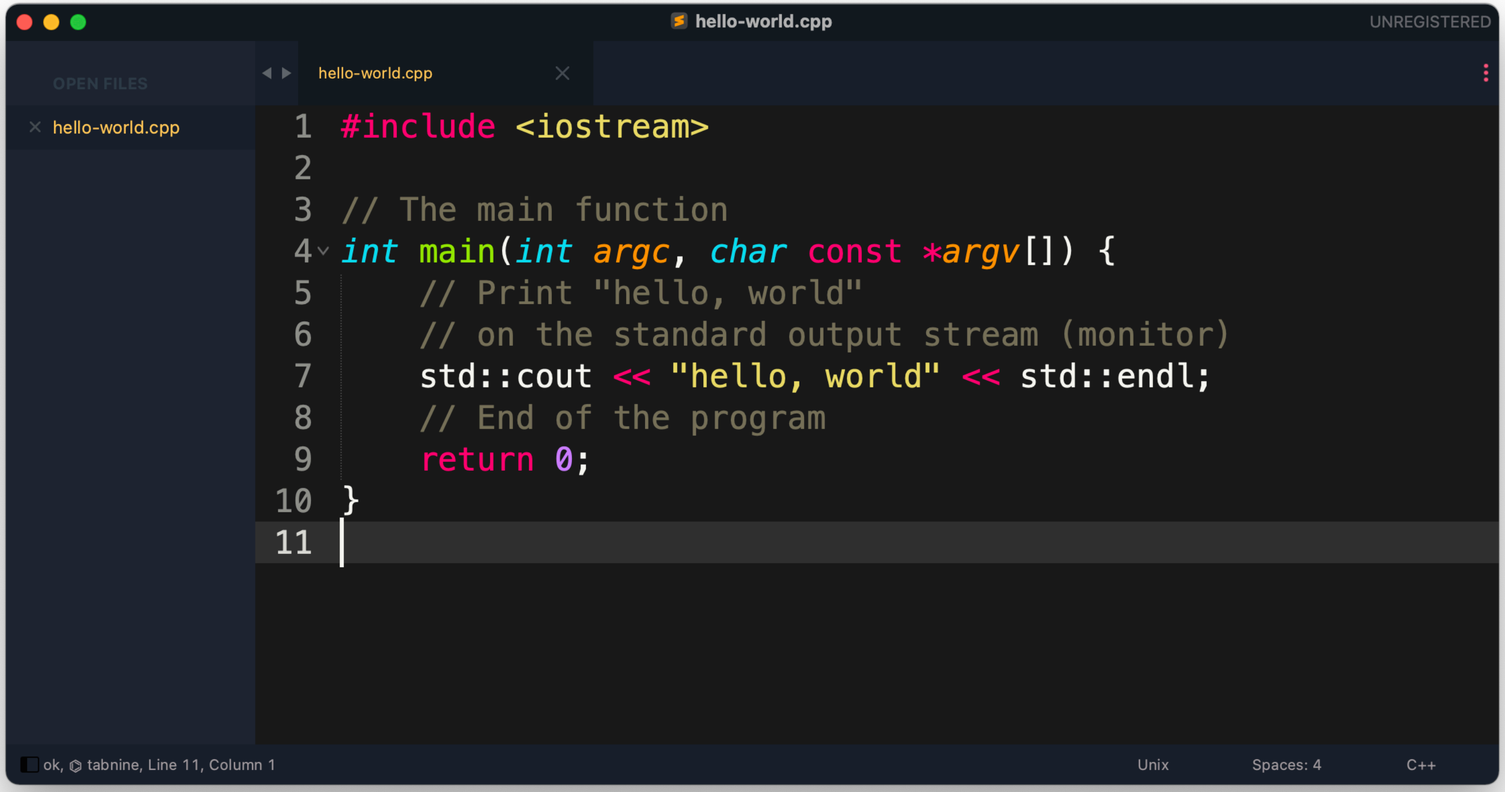
Your first “hello, world” C++ code



Edit

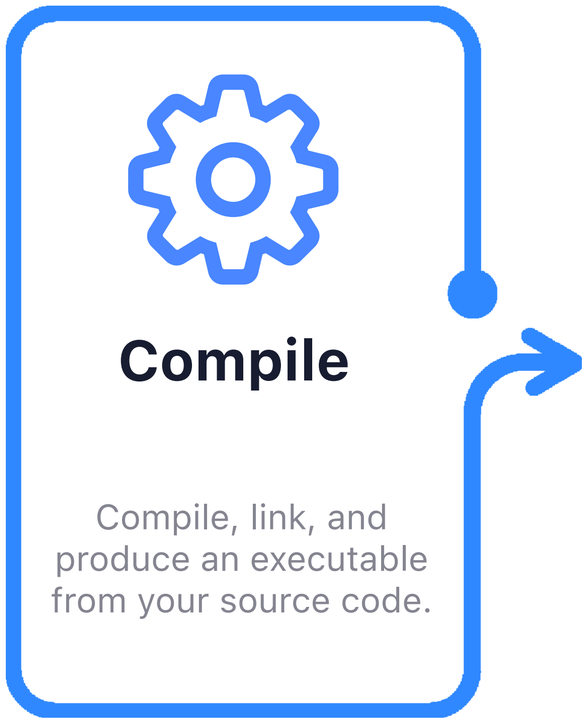
Organize and write your source code.

1



Written with

From Source files to Executable



Compile

Compile, link, and produce an executable from your source code.

2

GNU Compiler Collection

https://gcc.gnu.org

Minimalist GNU for Windows

http://www.mingw.org

LLVM Compiler Infrastructure

https://clang.llvm.org

The C++ compilation model

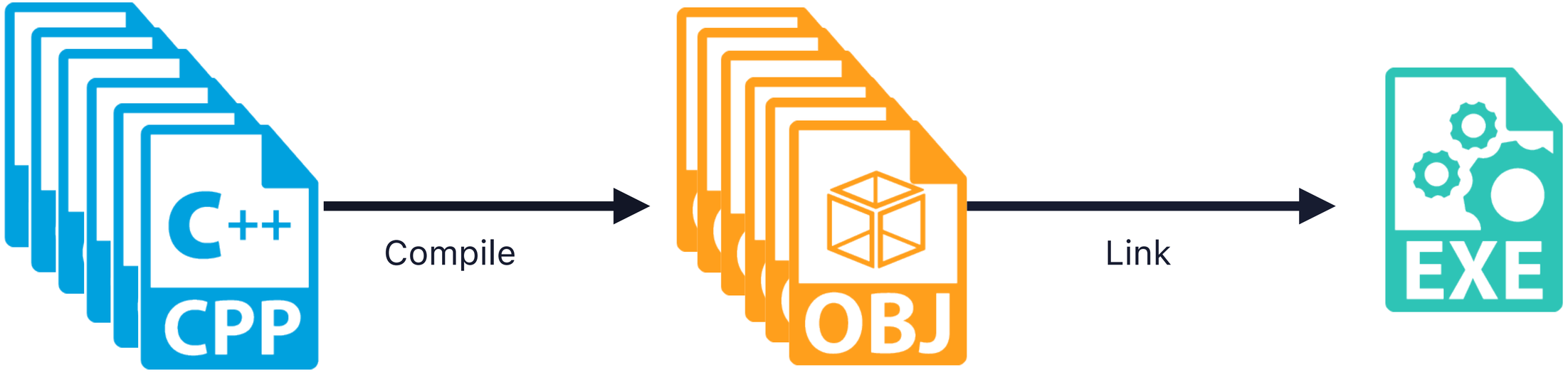

```
-zsh — d0m                                                    ⌥⌘1
➜  00-helloworld ls
hello-world.cpp
➜  00-helloworld clang++ hello-world.cpp
➜  00-helloworld ls
a.out           hello-world.cpp
➜  00-helloworld ./a.out
hello, world
➜  00-helloworld
```

The C++ compilation model

COMPILATION
= 4 steps

0. Code edition	-> .cpp	10 lines (246B)
1. Preprocessing	.cpp -> .cpp	55571 lines (2.6 MB)
2. Compilation	.cpp -> .s	1658 lines (65 KB)
3. Assembler	.s -> .o	12 KB
4. Linker	.o -> executable	39 KB

Dealing with multiple files



AUTOMATE
THE COMPILATION
with MAKEFILES

Make is a **build automation tool** that automatically builds executable programs and libraries from source code by reading files called Makefiles.

You specify into the Makefile "What you want to make" and "How it goes about making it".

And then, you just run "make" in your terminal.

Upcoming demo

Track bugs

3

The bug tracking process involves detecting bugs during testing, assessing their impact, determining their causes, and fixing them.

Using a **debugger** to **monitor** your program.

An interactive debugger analyzes how a program flows and helps identifying incorrect running code that can cause unexpected behavior or crash.

Key concepts are breakpoints, watchpoints, stepping, viewing data, ...

The most used C++ debuggers are gdb from GNU and lldb from LLVM.

Writing and running **unit tests** to **prevent bugs**.

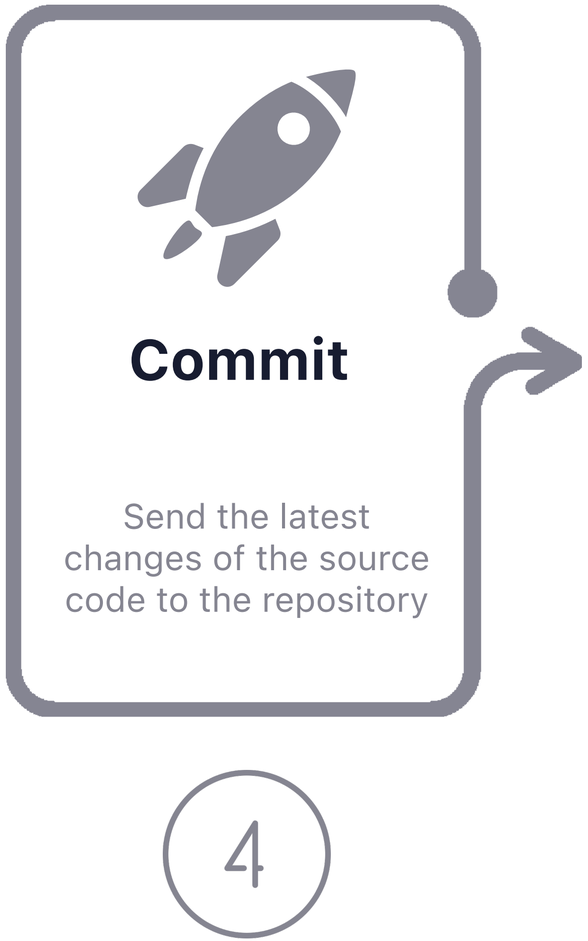
A unit test is an automated test that verifies a small piece of code in an isolated manner. It helps finding problems early in the development cycle and makes the final debug step easier.

Key concepts are assertions (boolean expressions).

The most used C++ testing frameworks are Google Test, Boost, Catch2.

Upcoming demo

Software versioning



Software versioning is the process of numbering different releases of a particular code source. It allows programmers to know when changes have been made and to track changes applied in the code.

What is git?

Git is the most commonly used version control system.

Git tracks the changes you make to files, so you have a record of what has been done, and you can revert to specific versions should you ever need to.

See https://githowto.com for a guided tour that walks through the fundamentals of Git.

Why using git is so crucial?

Git is the key to a successful and modern development workflow.

Git helps you to maintain the backup of your source code.

Git helps you to collaboratively work with other developers.

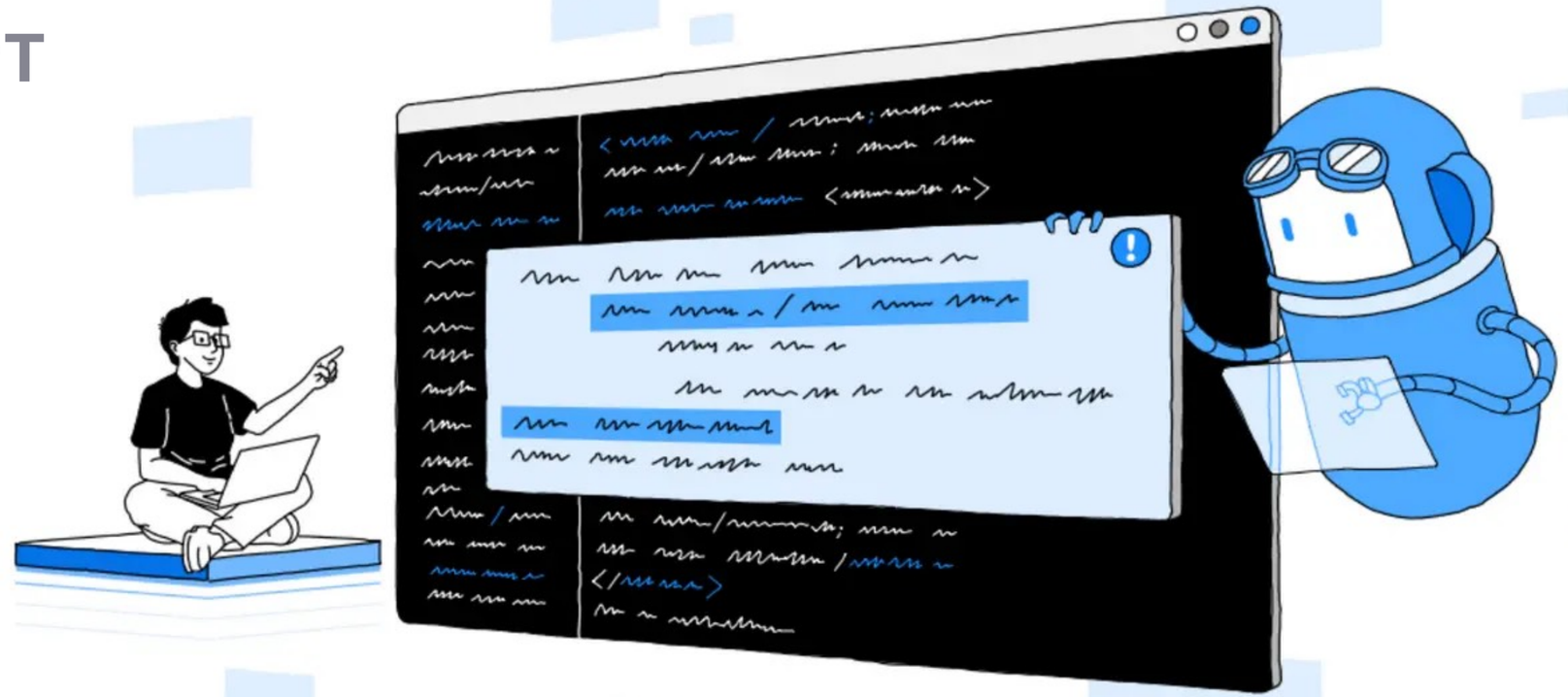
Upcoming demo

What about Artificial Intelligence for coding?

ChatGPT

MutableAI

Copilot



AskCodi

Codium

Codiga

Tabnine

CodeWhisperer

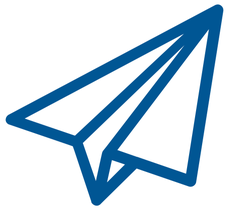
Will ChatGPT replace developers?

The short answer is **NO**

- However ChatGPT/Copilot has the potential to automate some aspects of programming, such as code generation, bug fixing, and documentation.
- ChatGPT/Copilot can learn from vast amounts of code and data, making it possible to generate new code similar to existing code.
- ChatGPT/Copilot cannot replace the human creativity and critical thinking required to design and develop complex software applications.

chatGPT/Copilot should become your perfect Pair Programming Partner.

A FIRST TAKE HOME MESSAGE



#1

Modern IDE and AI tools can help you write, compile, test and validate code quickly.

But high-quality C++ programming is more about a deep understanding of OOP principles than mastering the language syntax and software tools.

Questions

Contacts

Pr. Dominique Ginhac

dginhac@u-bourgogne.fr

Come visit us at

https://github.com/dginhac/esirem-itc313