

CS100 Recitation 1

GKxx

Februrary 21, 2022

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Editors, Compilers and IDEs

- A **compiler** translates the program written in a high-level language so that the computer can run it.
 - GCC, Clang, Visual C++ compiler, ...
- An **editor** is something where you can edit text.
 - Notepad, Word, and even your phone memo.
 - But we need a **code editor** which provides more help for coding.
 - Visual Studio Code, Vim, Sublime Text, Notepad++, ...
- IDE: Integrated **D**evelopment **E**nvironment,
 - = editor + compilers + debuggers + ...
 - Visual Studio, Qt, CLion, Dev-C++, ...

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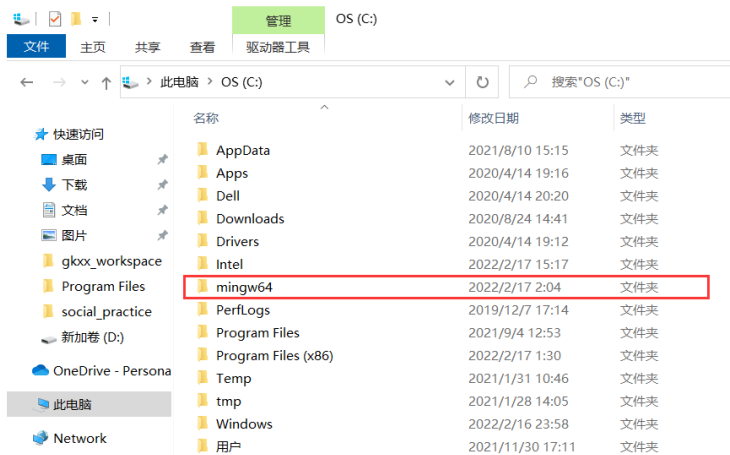
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GCC and MinGW

- **GCC** is the **GNU Compiler Collection**, an optimizing compiler produced by the **GNU Project** supporting various **programming languages**, **hardware architectures** and **operating systems**.
- **MinGW** is short for **Minimalist GNU for Windows**.
- For Linux, install GCC directly is ok.
- For Windows, you may need MinGW (or, probably MinGW-w64).

MinGW

- Download the package provided in the Resources page.
- Unzip it and place the mingw64 folder in the C drive.



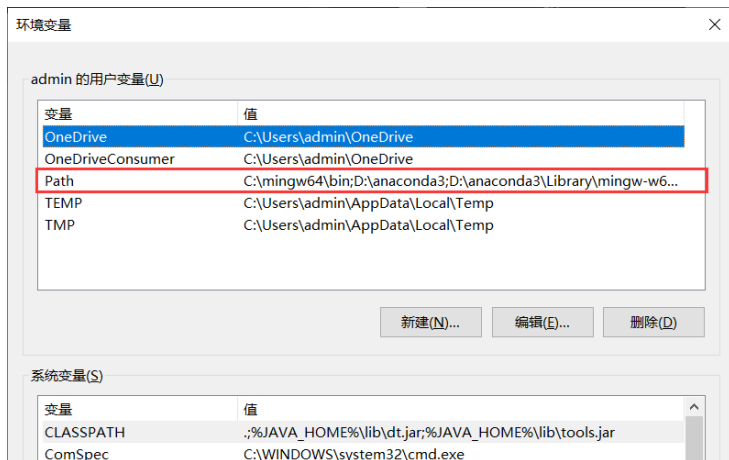
MinGW

- Now the compiler is installed, but it could not be invoked conveniently. We need to add it to the Path [environment variable](#).
- Press Win and search 'env'. Choose 'Edit the system environment variables'.



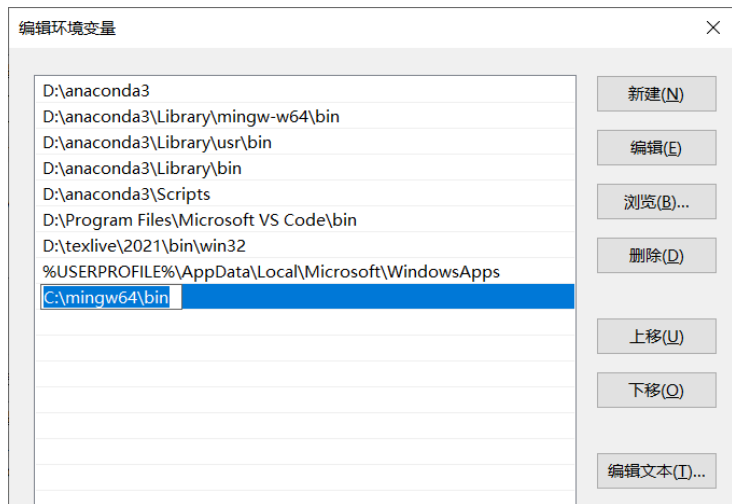
- Click the 'Environment variables ...' button.

MinGW



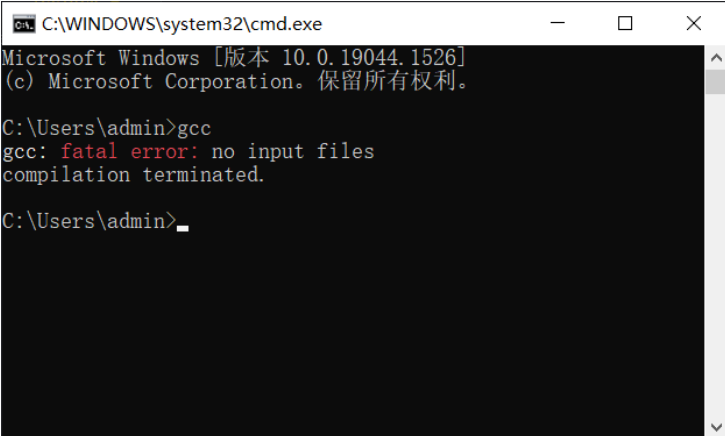
MinGW

- Add a new value 'C:\mingw64\bin'.



MinGW

- Press Win+r to open a cmd.
- Type 'gcc' and press Enter. The following shows that gcc is correctly invoked.



```
C:\WINDOWS\system32\cmd.exe
Microsoft Windows [版本 10.0.19044.1526]
(c) Microsoft Corporation。保留所有权利。

C:\Users\admin>gcc
gcc: fatal error: no input files
compilation terminated.

C:\Users\admin>_
```

MinGW

You can use `'--version'` to see more information about the compilers.



```
C:\WINDOWS\system32\cmd.exe
Microsoft Windows [版本 10.0.19044.1526]
(c) Microsoft Corporation。保留所有权利。

C:\Users\admin>gcc --version
gcc (MinGW-w64 x86_64-ucrt-posix-seh, built by Brecht Sanders) 11.2.0
Copyright (C) 2021 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.

C:\Users\admin>clang --version
(built by Brecht Sanders) clang version 13.0.0
Target: x86_64-w64-windows-gnu
Thread model: posix
InstalledDir: C:\mingw64\bin

C:\Users\admin>
```

For Linux (Ubuntu)

- 'sudo apt install build-essential' gets everything done.
- If you want compilers of newer version:

```
sudo add-apt-repository ppa:ubuntu-toolchain-r/test
```

```
sudo apt update
```

```
sudo apt install gcc-11
```

```
sudo apt install g++-11
```
- 'sudo apt install clang-12'. For the latest version Clang-13:

```
wget https://apt.llvm.org/llvm.sh
```

```
sudo chmod a+x llvm.sh
```

```
sudo ./llvm.sh 13
```
- You can search for more on your own.

For Mac OS X

Step #1: Install Xcode on a Apple Mac OS X

First, make sure Xcode is installed. If it is not installed on OS X, visit [app store and install Xcode](#).

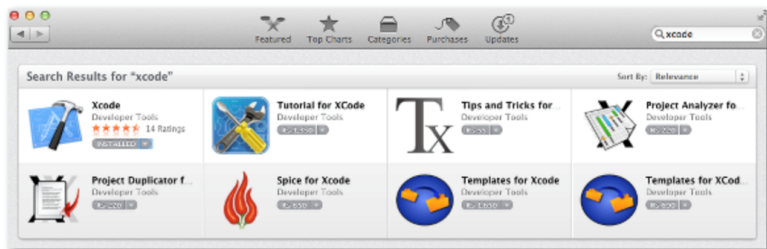


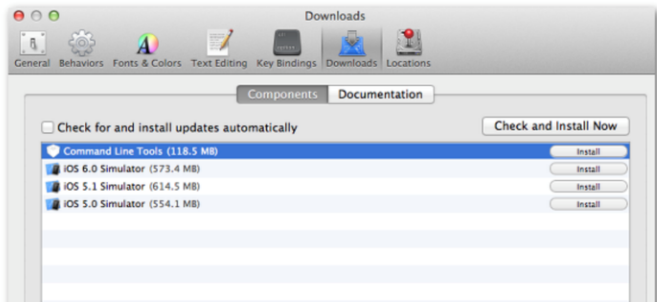
Fig.01: Make sure Xcode developer tools are install OS X

For Mac OS X

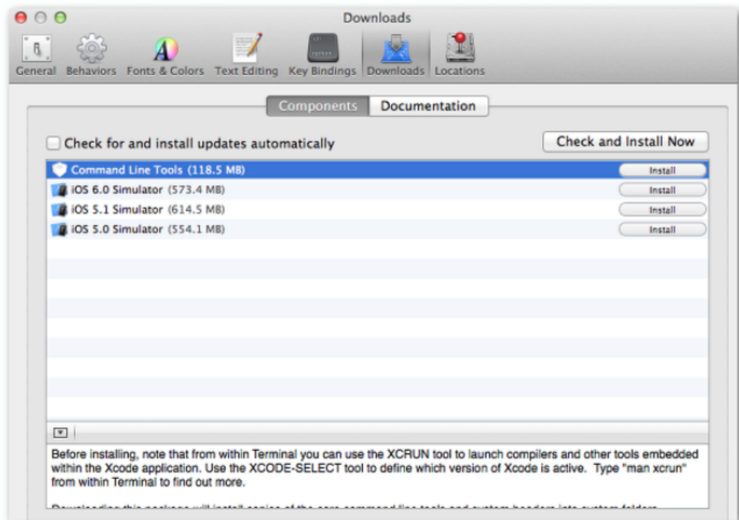
Step #2: Install gcc/LLVM compiler on OS X

Once installed, open Xcode and visit:

Xcode menu > Preferences > Downloads > choose "Command line tools" > Click "Install" button:

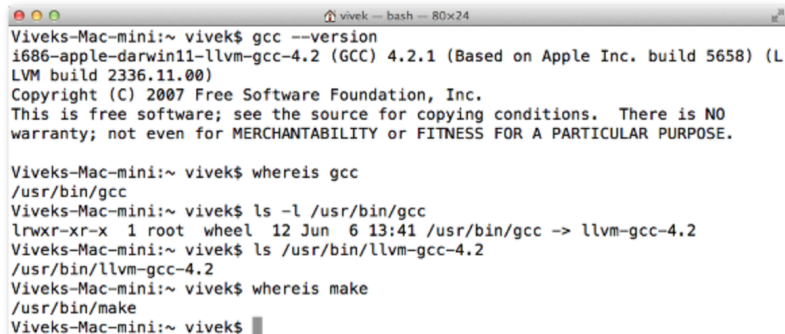


For Mac OS X



For Mac OS X

- Verify that it is working: 'gcc --version'



```
Viveks-Mac-mini:~ vivek$ gcc --version
i686-apple-darwin11-llvm-gcc-4.2 (GCC) 4.2.1 (Based on Apple Inc. build 5658) (L
VM build 2336.11.00)
Copyright (C) 2007 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.

Viveks-Mac-mini:~ vivek$ whereis gcc
/usr/bin/gcc
Viveks-Mac-mini:~ vivek$ ls -l /usr/bin/gcc
lrwxr-xr-x  1 root  wheel  12 Jun  6 13:41 /usr/bin/gcc -> llvm-gcc-4.2
Viveks-Mac-mini:~ vivek$ ls /usr/bin/llvm-gcc-4.2
/usr/bin/llvm-gcc-4.2
Viveks-Mac-mini:~ vivek$ whereis make
/usr/bin/make
Viveks-Mac-mini:~ vivek$
```

Fig.03: Verify gcc compiler installation on Mountain Lion OS X

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Installation

- Install VSCode from `code.visualstudio.com`.
- For Linux users, **DO NOT** install it via snap or you may encounter trouble.
- Run the installer. It is recommended to install it in the D or E drive, e.g. `D:\Program Files\Microsoft VS Code\`.

Extensions

Recommended extensions:

- Code Runner, C/C++, C++ Intellisense.
- Bracket Pair Colorization Toggler, vscode-icons.
- One Dark Pro and GitHub Theme: color themes.
- ~~GlassIt-VSC, Cloudmusic, QQ, Zhihu On VSCode, ...~~

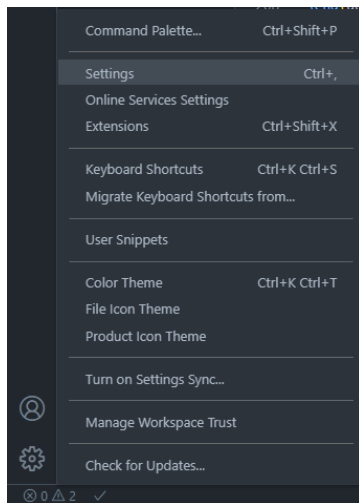
You may also need Chinese (Simplified) Language Pack for Visual Studio Code.

Configuration

- Create a folder for CS100, e.g. `D:\CS100`. This will be viewed as a [workspace](#).
- VSCode has ' $n + 1$ ' configurations, where n is the number of workspaces and the '+1' refers to the global (user's) one.
- The configuration of each workspace is done by some `json` files in a special folder `.vscode`.
- Remember to always [open VSCode first and then open the workspace](#), instead of open a single file directly. Otherwise your configuration for workspace wouldn't work.

Configuration

Global settings:



Configuration

- Code-runner: Save File Before Run `true`
- Code-runner: Run In Terminal `true`
- Code-runner: Ignore Selection `true`
- Editor: Format On Type `true`
- Editor: Accept Suggestion On Enter `off`

Configuration

- Create a folder `D:\CS100\.vscode` for your workspace configurations.
- Create two files `settings.json` and `c_cpp_properties.json`. Copy the contents from <https://www.luogu.com.cn/paste/scc7i5yq>.
- Create a hello-world program somewhere in this workspace, e.g. `D:\CS100\tmp\hello.c`.
- There will be a 'Run Code' button on the top-right corner. Or you can press `Ctrl+Alt+N` to run the code.

Configuration

- Pressing this button, the Code Runner extension runs the command we wrote in "code-runner.executorMap" in settings.json.
- It is running in the terminal of VSCode, which is the same as in cmd.
- The Code Runner extension gets you free from typing the same compilation command manually over and over again. (You may have a try of typing it manually.)
- If the terminal in VSCode cannot recognize the compiler, just reboot the computer.

Configuration

For the debugging part:

- Print statement debugging is effective, although VSCode says that it is 'a thing of the past'.
- To use the tools for debugging in VSCode, press F5.
- Choose 'GDB/LLDB', and then choose 'gcc'. If you wish to use the LLVM debuggers, you need to install 'lldb-mi' on your own.
- Wait a second and the default configuration files for debugging (`launch.json` and `tasks.json`) are generated automatically.

⇒ An example: the "A+B" problem.

Where Do I Learn Things?

- More about VSCode, you can visit the official website `code.visualstudio.com`.
- **You should get used to reading official documentations**, not only for VSCode, but also for most programming languages and tools.
- The official documentation for C/C++ is not suitable for newcomers. We recommend `cppreference.com`.

Where Do I Learn Things?

Apart from the course and slides, we can learn things from:

- stackoverflow.com, mostly for bug-fixing and trouble-shooting. (Also stackexchange.com)
- [cppreference.com](https://cpreference.com) and **authoritative** textbooks like *C++ Primer*. One may use them as a dictionary.
- books like *Effective C++*, which helps you solve common problems and develop good coding habits.

Where Do I Learn Things?

The following websites do offer some help, but are not recommended:

- Wikipedia and Baidu Baike: Everyone can edit, and some contents are checked by experts.
- Zhihu, CSDN, Luogu, and some other blogs. Everyone can edit and no one checks.
- Baidu Zhidao, Baidu Jingyan, Xiao Hongshu: No experts would be willing to write things there!

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Language Standards

- Standards of C: C89/90, C99, C11, C17, C23 (coming soon).
- Standards of C++: C++98/03, C++11, C++14, C++17, C++20, C++23 (coming soon),...
- A new version of standard C++ comes out every **three** years.
- To specify a standard for the compiler, use `-std=cx` or `-std=c++y`, e.g. `-std=c11`, `-std=c++17`.
- To see what language standard the compiler is using, check the macro `__STDC_VERSION__` in C and `__cplusplus` in C++. For example, `__cplusplus == 201703L` means that the program is compiled under C++17.

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Integer Types

- `short (int)`, `signed short (int)`, `unsigned short (int)`
- `int`, `signed int`, `unsigned int`
- `long (int)`, `signed long (int)`, `unsigned long (int)`
- `long long (int)`, `signed long long (int)`, `unsigned long long (int)` (since C99)

Integer Types

- What's the size of a short? int? long? long long?
short and int are at least 16-bit. long is at least 32-bit. long long is at least 64-bit.
 $1 == \text{sizeof}(\text{char}) \leq \text{sizeof}(\text{short}) \leq \text{sizeof}(\text{int}) \leq \text{sizeof}(\text{long}) \leq \text{sizeof}(\text{long long})$
- Do int and signed int name the same type? What about others?
For any integer type T, T and signed T name the same type.

Integer Types

Interesting fact

As with all the type specifiers, any order is permitted: `unsigned long long int` and `long int unsigned long` name the same type.

- For the exact choices made by each implementation about the sizes of the integer types, you may refer to https://en.cppreference.com/w/c/language/arithmetic_types.
- Exact-width integer types like `int32_t` are defined in `stdint.h` since C99.

Boolean Type

The boolean type in C is **different** than that in C++.

- The type `bool` (same as `_Bool`) is defined since C99, in the header `stdbool.h`.
- Type `bool` holds two possible values: `true` and `false`.
- `true` and `false` are `#defined` as 1 and 0 respectively (until C23), so they have type `int` instead of `bool`. Since C23, their type will become `bool`.
- How does the conversion between `bool` and integer types behave?
Nonzero \Rightarrow `true`, zero \Rightarrow `false`.
`true` \Rightarrow 1, `false` \Rightarrow 0.

Character Types

- `char`, `signed char`, `unsigned char`
- Other types for wide characters: `wchar_t`, `char16_t`, `char32_t`.
- Do `char` and `signed char` name the same type?
NO. The type `char` is neither `signed char` nor `unsigned char`. Whether `char` is signed depends on the implementation, but it is a **distinct type** (unlike the relationship between `int` and `signed int`). To know the exact choices made by each implementation, see <https://en.cppreference.com/w/cpp/language/types>.
- How do you save the returned value of `getchar`?
`int` is recommended because EOF is `-1`.

Which Type to Use?

- Use `int` for integer arithmetic. `int` should be integer type that target processor works with most efficiently. If `int` is not large enough, use `long long`.
- Use `bool` for boolean values, especially in C++.
- Use `double` for floating-point computations.
 - The precision of `float` is usually not enough.
 - The cost of double-precision calculations versus single-precision is **negligible**. (In fact, double-precision operations are even faster on certain machines.)
 - The precision offered by `long double` is usually unnecessary.

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Define a Function

- `return-type function-name(parameters) { function-body }`
- How to return a value?
The `return` statement.
- How to define a function without return-value?
Set the return-type to `void`.
- What happens when a function returns?
 - The control flow goes back to the caller.
 - Possibly a value is passed to the caller.

Define a Function

Notice

Be sure to discriminate between the **return** of a function and the **output** of a program! They have nothing to do with each other.

Notice

A **non-void** function without a **return** statement causes no error (although probably a warning) when it is compiled, but results in **undefined behavior** when running!

The main Function

- You might have seen some people/textbooks writing 'void main'...

The definition 'void main' is not and has never been in C++, nor has it even been in C. (Bjarne Stroustrup)

- You might have seen some people/textbooks leaving out the return-type...

In C89, the default return-type of a function is `int`. However, this rule is not in standard C++ and has been dropped since C99. **Don't be lazy!**

- You might have seen many people leaving out the return statement in `main`...

This is ok because the compiler will impose a return-value 0 if the program exits successfully.

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Precedence and Associativity

- How is $a + b * c + d$ evaluated?
- How is $a - b + c$ evaluated?
- How is $f() + g() + h()$ evaluated?

Note

The precedence and associativity do not necessarily determine the evaluation order!

Typical undefined behavior: `printf("%d %d", a, ++a);`

Operator Precedence Table

Apart from the precedence of operators, you should also remember the associativities.

Table 4.4. Operator Precedence

Associativity and Operator	Function	Use	See Page
L ::	global scope	::name	286
L ::	class scope	class::name	88
L ::	namespace scope	namespace::name	82
L .	member selectors	object.member	23
L ->	member selectors	pointer->member	110
L []	subscript	expr [expr]	116
L ()	function call	name (expr_list)	23
L ()	type construction	type (expr_list)	164
R ++	postfix increment	lvalue++	147
R --	postfix decrement	lvalue--	147
R typeid	type ID	typeid (type)	826
R typeid	run-time type ID	typeid (expr)	826
R explicit cast	type conversion	cast_name < type > (expr)	162
R ++	prefix increment	++lvalue	147
R --	prefix decrement	--lvalue	147
R ~	bitwise NOT	~expr	152
R !	logical NOT	!expr	141
R -	unary minus	-expr	140
R +	unary plus	+expr	140
R *	dereference	*expr	53
R &	address-of	&lvalue	52
R ()	type conversion	(type) expr	164
R sizeof	size of object	sizeof expr	156
R sizeof	size of type	sizeof (type)	156
R sizeof...	size of parameter pack	sizeof...(name)	700
R new	allocate object	new type	458
R new[]	allocate array	new type[size]	458
R delete	deallocate object	delete expr	460
R delete[]	deallocate array	delete[] expr	460
R noexcept	can expr throw	noexcept (expr)	780

Short-circuit Evaluation

Logical operators `&&` and `||` are short-circuited:

- Both `&&` and `||` evaluates their left operand first.
- If the left operand of `&&` evaluates `false`, the right operand will not be evaluated, and the whole expression evaluates `false`.
- If the left operand of `||` evaluates `true`, the right operand will not be evaluated, and the whole expression evaluates `true`.

How Do We Learn C/C++?

The key is to learn to **think in C/C++ way!**

- Is it even possible for the compiler to do this?
- What would happen if something is not like this?