Introduction to Programming

Lecture 3 — Collections and sequences

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Université de Saint-Étienne | Year 2026/2027

digicrea digital creativity
Université Jean Monnet Saint-Étienne

-1 Recap time

About functions

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- In that case, the global variable is accessible by prepending `::`

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- Arguments can be accessed in `argv` by using `argv[argument number]`

00 Assignment review

01 Introduction

What do you see? 1/2

230	230	230	230	230	230	40	40	40	230	230	230	230	230	230
230	230	230	230	40	40	195	195	195	40	40	230	230	230	230
230	230	40	40	195	195	195	195	195	195	195	40	40	230	230
230	230	40	195	195	195	195	195	195	195	195	195	40	230	230
230	40	195	195	10	10	195	195	195	195	10	10	195	40	230
230	40	195	195	10	10	195	195	195	195	10	10	195	40	230
40	195	195	195	195	195	195	195	195	195	195	195	195	195	40
40	195	195	15	195	195	195	195	195	195	195	15	195	195	40
40	195	195	15	15	195	195	195	195	195	15	15	195	195	40
230	40	195	195	15	15	15	15	15	15	15	195	195	40	230
230	40	195	195	195	195	15	15	15	195	195	195	195	40	230
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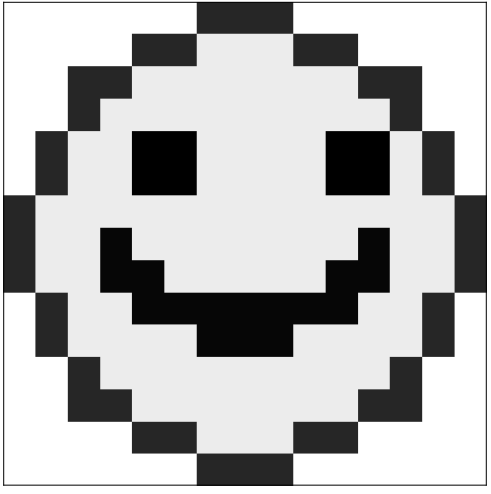
230	230	230	230	40	40	195	195	195	40	40	230	230	230	230
230	230	230	230	230	230	40	40	40	230	230	230	230	230	230

What do you see? 2/2



Arrays and matrices everywhere

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Images are stored as matrices

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Sound is stored as arrays

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Images are stored as matrices

Sound is stored as arrays

Even text files can be viewed as matrices

02 Matrices

Excel

Has everyone already used / opened excel once in their life?

O-Spreadsheet

Let’s explore matrices with O-Spreadsheet

Color theory

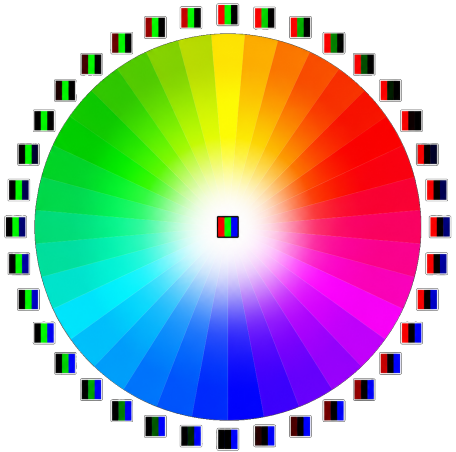

Figure: Color theory illustrated with a color wheel

Matrices shape and indexing

Matrices have a shape usually noted *(rows, columns)*.

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For a rgb-image, this translates to *(color channel(r,g,b), pixel x coordinate, pixel y coordinate)*.

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“knit” is at (3, 2)

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Practise time!

03 Arrays in C++

Arrays

An **array** is simply a one-dimensional matrix, that is, it's a matrix of shape *(array's length, 1)*.

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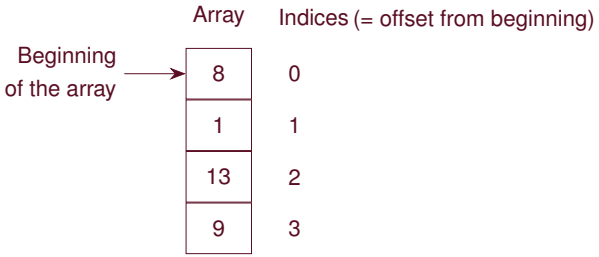

Figure: Example of an array and its indices

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How about some code?

Your favorite online editor

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- The element at position i can be accessed with the operator `[]`: `arr[i]`

Practise Time!

04 Matrices in C++

What about matrices?

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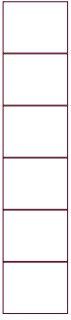
Matrices can be modelled by an *array of arrays*:

`std::array<std::array<type, column_count>, line_count>`.

Understanding array of arrays

- Take a classic array



Understanding array of arrays

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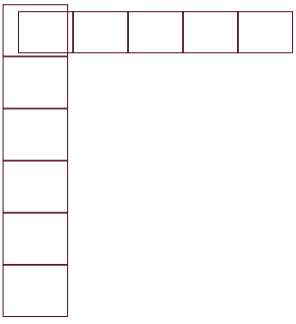

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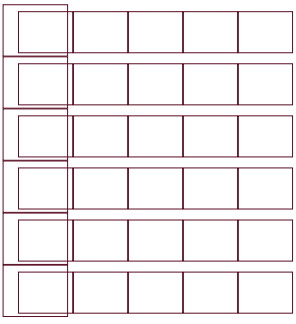

Understanding array of arrays

- Take a classic array
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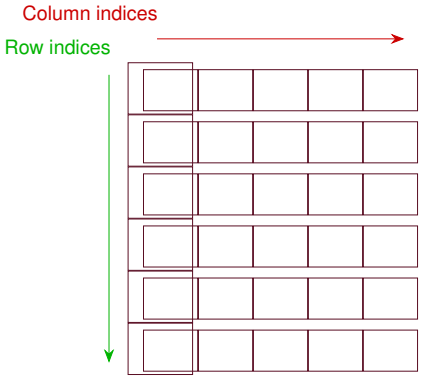
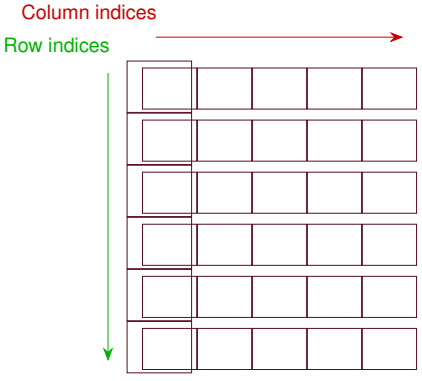
- And so on for each element
- The end result is a matrix: you can index elements with a row index and a column index



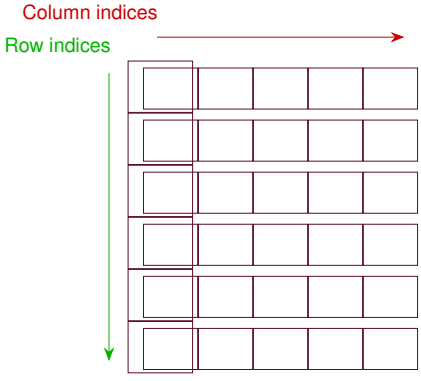
Indexing array of arrays

```
// declaration ?
```



Indexing array of arrays

```
// declaration
std::array<
  std::array<int, 5>, 6>
      the_array {};
```



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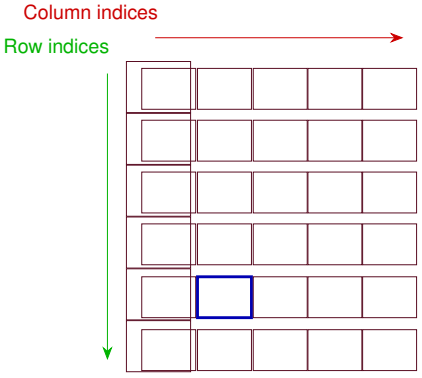

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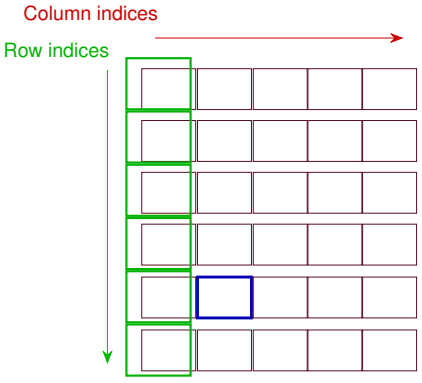
Find the row index



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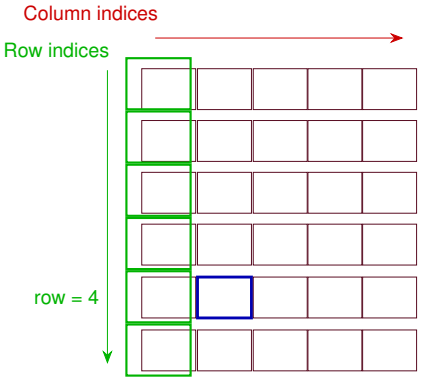

Indexing array of arrays

```
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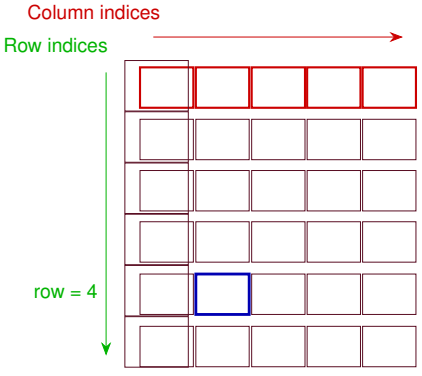
Find the column index



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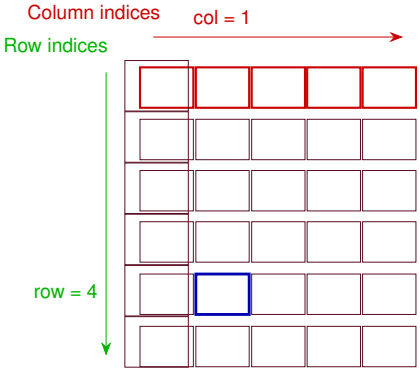
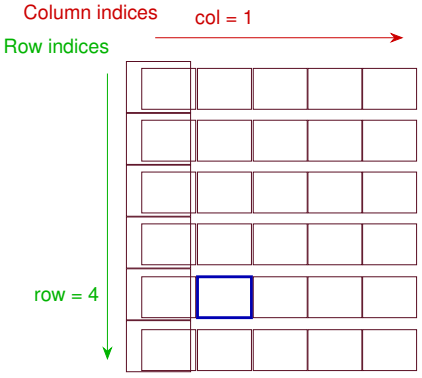


Indexing array of arrays

```
// indexing
the_array[4][1] = ...;
```



Traversing an array of arrays

We use **nested loops**: look here.

Practise Time!

05 Vectors

Variable-length sequences

What if our sequence size is unknown and / or varies through time?
What if we can’t know in advance the amount of values we’re going to need to store?

`std::vector` to the rescue

Have a look at this code.

Generalities on `std::vector`

- Their size can vary throughout the program
- You can had an element to `std::vector vec` with its *member function* `vec.push_back(the_elem_to_add);`
- You can remove the last element of `std::vector vec` with its *member function* `vec.pop_back();`
- You can remove all elements of `std::vector vec` with its *member function* `vec.clear();`

Matrices with vectors?

Because `std::vector` has a variable size, each element of a `std::vector<std::vector<...>>`, that is, each `std::vector<...>` in that `std::vector<std::vector<...>>` may have a different length than the others.

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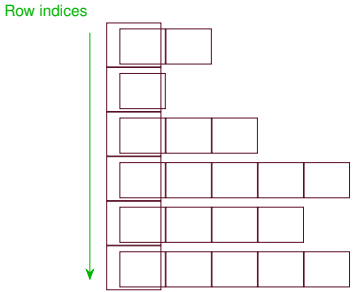

Figure: Example of a vector of vector

Nested loops for nested vectors

The inner loop range has to be recomputed at each line of the matrix by taking the size of that line.

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```
std::vector<std::vector<int>> vec {};
for(auto line = 0; line < vec.size(); ++line){
    for(auto col = 0; col < vec[line].size(); ++col){
        // ... do something ...
    }
}
```

Practise Time!

06 Little preparation for next time

For those with personal laptops

Try to install the following softwares:

- Visual Studio Code
- cmake
- clang

(Install instructions in the following slides.)

MacOS

Open a terminal and run the following commands:

```
xcode-select --install
/bin/bash -c "$(curl -fsSL https://raw.githubusercontent
    .com/Homebrew/install/HEAD/install.sh)"
brew install --cask visual-studio-code
brew install cmake
```

Windows

- Install VSCode by downloading the installer from here:
  `https://code.visualstudio.com/docs?dv=win`
- Download and run *Visual Studio Community Edition*:
  `https://visualstudio.microsoft.com/thank-you-downloading-visual-studio/?sku=Community&channel=Stable&version=VS18&source=VSLandingPage&passive=false&cid=2500`
  - Follow these installation steps:

Linux

If you’re on linux, I trust you know what you’re doing. Install vscode, cmake and clang/clang++.

If you did not succeed

Since everything is up and running on the uni's computers, if you were unable to install things on your personal laptop, you can practise the next sessions on the uni's computers.

See you next time!