

# Programming in C++

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<https://fan1x.github.io/cpp21.html>  
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# Programming in C++ - lab 2

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# Homework Feedback

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- Deadlines
  - Communication!
- Use functions
  - Don't put everything into `main()`
  - Function should do a single thing
- Don't put binaries into a repo
  - Source/header files, configs, project files, ...
  - Search what to put into repo on-line
- Use objects/structs
- Use (const) references for large objects

# Argument Passing - By Value

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- Creates a copy
- Use for small/elementary types (int, double)

```
int max(int x, int y);
```

# Argument Passing - By Const-reference

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- Doesn't create a copy
- Use for large objects (containers, e.g., vector, string, ...)

```
int find_max(const vector<int> &numbers);
```

# Argument Passing - By Reference

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- Doesn't create a copy
- Allows to change the passed object
- For output parameters
  - ! Is the function really doing a single things?
  - Could you use `std::pair`?
    - `pair<iterator, bool> map::emplace(...)`

```
void transform(Matrix &matrix);
```

```
pair<size_t, int> find_max(const vector<int> &numbers);
```

# Argument Passing - By R-value Reference

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- To transfer ownership
- Moves the object into a function
  - the object no longer lives outside the function
- Use `std::move()` on the caller side

```
vector<unique_ptr<int>>::push_back(unique_ptr<int> &&new_obj);
```

```
vector<unique_ptr<int>> vector_of_ints;  
vector_of_ints.push_back(move(make_unique<int>(x));
```

# Class/Struct

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- Put related things (data, functions, ...) together
  - OOP

```
class calculator {  
    void sum(); // private by default  
  
public:  
    // change internal attributes, cannot be const  
    void calc(const std::string &expression);  
  
    // doesn't change internals, should be const  
    void print() const;  
  
private:  
    // ...  
};  
};  
  
calculator c; // no need for `new`  
c.calc("1+2*3/4");
```

# Class vs. Struct

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- Use class if the class has an invariant; use struct if the data members can vary independently

```
struct coordinate {  
    int x;  
    int y;  
    int z;  
    void set(int x, int y, int z);  
};
```

# std::vector<T>

---

```
#include <vector>
int main() {
    std::vector<int> vi{1, 2, 3, 4, 5, 6};
    std::vector<float> vf{5, 0.0f};
    std::cout << vi[3] << " " << vf.at(3) << std::endl;
    std::cout << vi.size();
    vi[3] = 100; vi.at(6) = 600;
    vf.push_back(100.0f); vf.emplace_back(200.0f);
    vf.insert(3, 300.0f); vf.emplace(3, 300.0f);
    vi.pop_back();
    vf.erase(3);
    vi.clear();
    vi.resize(10); vi.reserve(100);
}
```

- Beware of time complexity
- `vector<bool>`

# Matrix for Integers

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- `set(x, y, value)`, `get(x, y)`, `print()`
- `set_width()`, `set_height()`, `get_width()`, `get_height()`
- `get_row(x)`, `get_column(x)`
- `get_rows()`, `get_columns()`
- `clear()` – set all values to 0 (zero)
- `fill_with_value(value)` – set all values to a given value
- `reverse()` – reverse values from  $[x, y]$  to  $[y, x]$
- `is_negative()` – are all numbers in the matrix negative?
- `zero_count()`

# Programming in C++ - lab 1

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# Basic information

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- Email: [tomas.faltin@matfyz.cuni.cz](mailto:tomas.faltin@matfyz.cuni.cz)
- Lab's web: <https://fan1x.github.io/cpp21.html>
- ZOOM for distance learning
  - <https://cuni-cz.zoom.us/j/94350923737>
  - Credentials in SIS/mail
- Mattermost
  - Invite link:  
[https://ulita.ms.mff.cuni.cz/mattermost/signup\\_user\\_complete/?id=z1knw5aq6p8nipop1i7icq a6a](https://ulita.ms.mff.cuni.cz/mattermost/signup_user_complete/?id=z1knw5aq6p8nipop1i7icq a6a)
    - Use ASAP, might expire eventually
  - Channel: `nprgo41-cpp-english`
- Gitlab
  - <https://gitlab.mff.cuni.cz/>
  - <https://gitlab.mff.cuni.cz/teaching/nprgo41/2021-22/eng>

# Communication is the key

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- Don't be afraid to ask
  - via email
  - on Mattermost (instant)
    - DM if related to you only
    - Into a channel if others can benefit from it
- If you struggle with something
- If you feel like you might miss a deadline
- Be proactive

# Labs credit

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- Submitted homeworks before Monday midnight (to Gitlab)
  - Even if not attending!
  - Won't be graded, for a feedback
- Two large homeworks in ReCodex (40 points)
  - Points are included in the final score from the course
  - Smaller HW – 15 points, ~November
  - Larger HW – 25 points, ~December
- Software project
  - Topic must be approved by 28/11/2021
  - First submission: 24/4/2022
  - Final submission: 22/5/2022
  - **All the steps typically mean multiple iterations within multiple days. If you wait for the last minute, there is a chance you won't make it**

# Code Requirements

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- Consistency
  - Be consistent within the code – keep a single code style
- Cleanliness, readability
  - Code doesn't contain commented/dead parts
  - Code should be readable on its own
- Safe, modern
  - E.g., prefer `std::vector<int>` to `new int[]`
- Working
  - OFC, if the code is not working, all the above points are not that important, but they will help you with debugging at least ☺

# Why C++

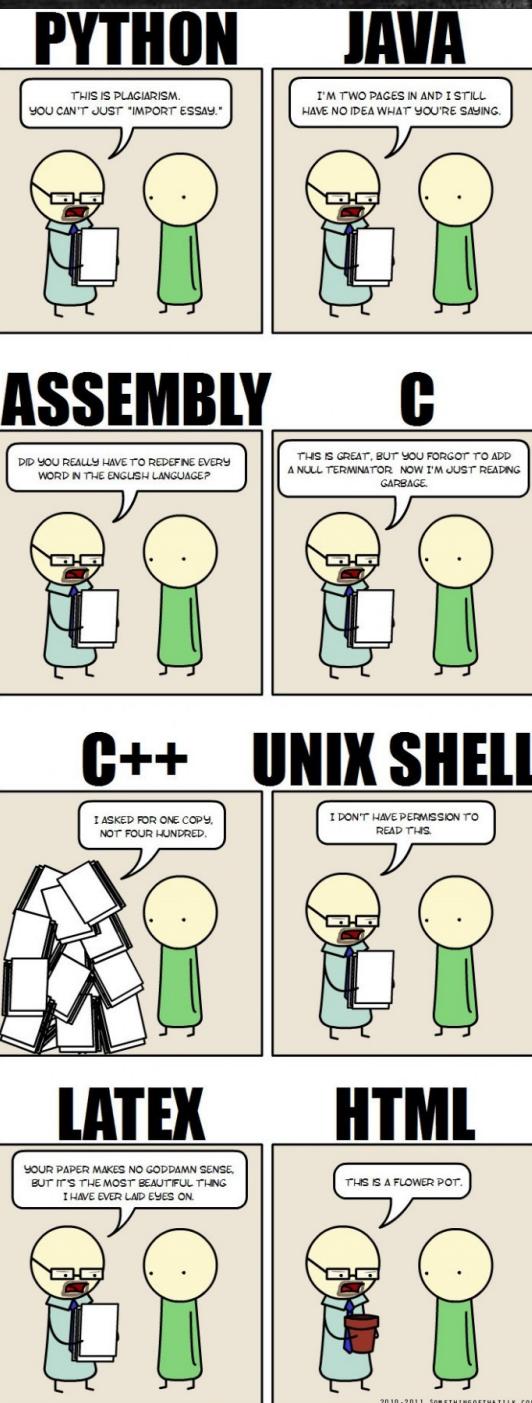
"C makes it easy to shoot yourself in the foot. C++ makes it harder, but when you do, it blows away your whole leg."

-- Bjarne Stroustrup

"It was only supposed to be a joke, I never thought people would take the book seriously. Anyone with half a brain can see that object-oriented programming is counter-intuitive, illogical and inefficient."

-- Stroustrup C++ 'interview' (<https://www-users.cs.york.ac.uk/susan/joke/cpp.htm>)

C++ != speed, C++ ~ control



# Working Environment

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- Use anything you like ☺
- IDEs
  - Visual Studio
    - License for students at [https://portal.azure.com/...](https://portal.azure.com/)
  - VS Code
  - Clion
  - Code::Blocks
  - Eclipse
  - ...
- Compilers
  - MSVC, GCC, Clang+LLVM, ICC, ...

# C++ (interesting) links

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- Reddit, Slack, ...
- <https://en.cppreference.com/w/>
- <http://www.cplusplus.com/>
- <http://isocpp.github.io/CppCoreGuidelines/CppCoreGuidelines>
- <https://www.youtube.com/user/CppCon>
- <https://isocpp.org/>
- <http://www.open-std.org/jtc1/sc22/wg21/docs/papers/>
- <https://gcc.godbolt.org/>
- ...

# Hello World

---

```
#include <iostream>
#include <string>

int main() {
    std::string name;
    std::cin >> name;
    std::cout << "Greetings from " << name << std::endl;
    return 0;
}
```

# Hello World

```
#include <iostream>
#include <string>

int main() {
    std::string name;
    std::cin >> name;
    std::cout << "Greetings from " << name << std::endl;
    return 0;
}
```

Include the libraries which implements the used STL constructs (`string, cin, cout`)

The main entry point/function for all programs. The execution starts here

Read from standard input (keyboard)

Write to standard output (screen)

All the STL constructs live inside 'std' namespace

# More Complex Program

---

```
#include <iostream>
#include <string>
#include <vector>

using namespace std;

int length(const string& s) { ... }

void pretty_print(const vector<string>& a) { ... a[i] ... }

int main(int argc, char** argv) {
    vector<string> arg(argv, argv+argc);
    if (arg.size() > 1 && arg[1] == "--help") {
        cout << "Usage: myprg [OPT]... [FILE]..." << endl;
        return 8;
    }
    pretty_print(arg);
    return 0;
}
```

# More Complex Program

```
#include <iostream>
#include <string>
#include <vector>

using namespace std;

int length(const string& s) { ... }

void pretty_print(const vector<string>& a) { ... }

int main(int argc, char** argv) {
    vector<string> arg(argv, argv+argc);
    if (arg.size() > 1 && arg[1] == "--help") {
        cout << "Usage: myprg [OPT]... [FILE]..." << endl;
        return 8;
    }
    pretty_print(arg);
    return 0;
}
```

Include the whole  
std namespace

Passing the  
argument by  
(const) reference

Arguments of the  
program on the  
command line

Transform the  
arguments into C++  
array of strings

# Homeworks

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1. Hello World
2. A greeting program (use names from arguments)
  - `hello.exe Adam Eve` → `Hello to Adam and Eve`
  - What is inside args[0]?
3. Summation of numbers from arguments
  - `sum.exe 1 2 3 4 5` → `15`
  - `stoi(), stod(), stoX()`
    - Functions for transformation from string **to** <something>
4. A simple calculator (only for operations +-)
  - `calc.exe 1+2+3-4` → `2`
  - to Gitlab
  - The previous programs are not needed, they should give you a lead