Algorithms and Data Structures

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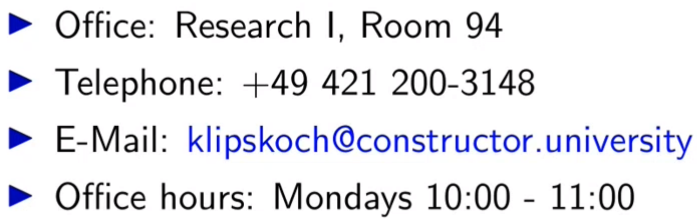
Organization stuff

Professor Kinga Lipskoch



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Lecture slides: https://grader.eecs.jacobs-university.de/courses/ch_231_a/2023_1/

Homeworks:

Use Grader for homework submission. Do not forget to change semester from Fall 2022 to Spring 2023.

Submit ZIP file containing one PDF file and source code fileswith makefile.

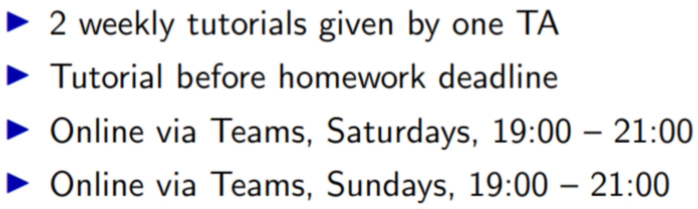
Homeworks are not mandatory.

VPN for remote access to Jacobs Net:

Source: https://teamwork.jacobs-university.de/display/ircit/VPN+Access

Domain name: vpnasa.jacobs-university.de (Jacobs VPN)

Tutorials:



- 2 weekly tutorials given by one TA
- Tutorial before homework deadline
- Online via Teams, Saturdays, 19:00 – 21:00
- Online via Teams, Sundays, 19:00 – 21:00

23-02-02

Templates

Templates allow to write generic code, i.e., code which will work with different types. Later a specific type will be provided and the compiler will substitute it.

Motivation for using templates is to eliminate snippets of code that differ only in the type and do not influence on the logic.

While using templates, operators for some types need to be overloaded.

Why function definitions are written in `.h` files?

Both declaration an definition are written in `.h` files! Otherwise, the code will fail. The reason is that, when instantiating a template, the compiler creates a new class with a definite type. Consequently, it has to instantiate methods. But it cannot find methods with an appropriate type, since they are written in another `.cpp` file.

If you still want to have declaration and definition of a template in different files, there are some options (but think twice).

One possible solution is to instantiate a template in the same file where methods are written:

```
// a.cpp
template <class T>
void MyTemplate<T>::do() {
    // do sth
}

template class MyTemplate<int>;
template class MyTemplate<std::string>;
```

Another solution is to include a `.cpp` file inside the header file (wtf??). Btw, you do not have to compile this file with others:

```cpp
// a.h
template <class T>
class MyTemplate {
    T prop;
public:
    void do() {}
}

#include a.cpp
```

Basic syntax

Type parameterization in classes:

```cpp
template <class T>
class MyClass {
    T i;
public:
    MyClass() = default;
    MyClass(T arg) : i(arg) {}
};

int main() {
    MyClass<int> aboba;
}
```

Type parameterization in functions:

```cpp
template <class T>
void my_function(T arr[], int size) {
    for (int i = 0; i < size; ++i) {
        std::cout << arr[i] << ' ';
    }
}
```

Note: `class` in `<class T>` can be replaced with `typename`.

Overloading an operator

```cpp
template <class T>
class MyClass {
    T array[size];
public:
    BoundedArray(){};
    T& operator[](int);
};

...

template<class T>
T& MyClass<T>::operator[](int pos) {
    if ((pos < 0) || (pos >= size))
        exit(1);
    return array[pos];
}
```

23-02-07

Fundamental Container Classes

- Sequence containers
  - vector
    - fast random access
    - fast inserting/removing at the end, slow inserting/removing in the middle
    - not efficient while resizing
  - deque
    - a dynamic array which can grow in both directions
    - random access with a constant complexity
    - fast inserting/removing at beginning/end, slow inserting/removing at the middle
  - list
    - no random access
    - fast inserting/removing at beginning/end, slow inserting/removing at the middle

- Associative containers
    - set
        - implemented as a BST
        - sorted
        - duplicates are not allowed
    - multiset
        - as a set, but duplicates are allowed
    - map
        - stores `key/value` pairs
        - the key is the basis for ordering
        - keys are not duplicated
        - called "associative array"
    - multimap
        - as a map, but keys can be duplicated
        - called "dictionary"
- Container adapters
    - stack
    - queue
    - priority queue