CH-231-A

Algorithms and Data Structures

ADS

Lecture 1

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Who am I?

- PhD in Computer Science at the “Carl von Ossietzky” University of Oldenburg
- University lecturer at the School of Computer Science and Engineering
- Joined this university in January 2013
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  Click to join Teams meeting

Agenda Today

- Introduction
  - Syllabus and Organization
  - Goals
- More C++ programming related to data structures

Online Resources

- Course website
  `https://grader.eecs.jacobs-university.de/courses/ch_231_a/2024_1/`
- Slides and homework will be uploaded there and also on Teams (under Files, Class Materials)
- Use Grader for homework submission (change semester to Spring 2024)
- Constructor Learning Management System:
  `https://learn.constructor.university`

Teaching Assistants and Grading Criteria

- Borsos, Matheas-Roland
- Founounou, Yassine
- Getahun, Raey Addisu
- Gudissa, Bati Lemma
- Jovanoska, Dora
- Lumi, Jon
- Lutaj, Xhesilda
- Madriaga, Ivanna Judea
- Marghidanu, Eliza
- Murariu, Vlad Filip
- Submit ZIP file containing one PDF file and source code files with makefile
- Grading criteria `https://grader.eecs.jacobs-university.de/courses/ch_231_a/2024_1/Grading_Criteria_ADS.pdf`

Grader not Publicly Visible

- You can access Grader from campus without any additional connection or software
- To access Grader from outside of campus you need to use a VPN (Virtual Private Network) connection
- Tutorials from the IRC IT team on how to install a VPN client: `https://www.youtube.com/user/jacobsircit`
- Instructions from the Jacobs IRC IT team on how to install the **Cisco AnyConnect** VPN client: `https://teamwork.constructor.university/display/ircit/VPN+Access`

Missing Homework, Quizzes, Exams according to AP

- `https://constructor.university/sites/default/files/2023-12/bachelor_policies_v6.pdf` (page 19 - 20)
- Illness must be documented with a sick certificate
- Sick certificates and documentation for personal emergencies must be submitted to the Student Records Office by the third calendar day
- Predated or backdated sick certificates will be accepted only when the visit to the physician precedes or follows the period of illness by no more than one calendar day
- Students must inform the Instructor of Record before the beginning of the examination or class/lab session that they will not be able to attend
- The day after the excuse ends, students must contact the Instructor of Record in order to clarify the make-up procedure
- Make-up examinations have to be taken and incomplete coursework has to be submitted by no later than the deadline for submitting incomplete coursework as published in the Academic Calendar

Content

- This course introduces a basic set of data structures and algorithms that form the basis of almost all computer programs
- The data structures and algorithms are analyzed in respect to their computational complexity with techniques such as worst case and amortized analysis = method for analyzing a given algorithm's complexity, or how much of a resource, especially time or memory, it takes to execute
- Topics: fundamental data structures (lists, stacks, trees, hash tables), fundamental algorithms (sorting, searching, graph traversal)

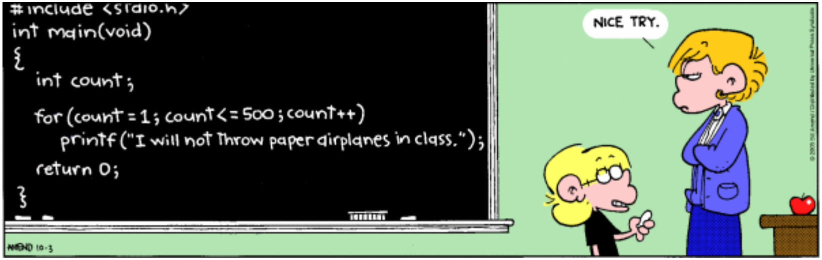
Objectives

Learn about:

- Fundamental algorithms for solving problems efficiently
- Basic algorithmic concepts
- Analysis of algorithms
- Fundamental data structures for efficiently storing, accessing, and modifying data

Requirements

Programming: freely choose between C or C++ or Python or Java if language is not enforced by the problem statement



```
#include <stdio.h>
int main(void)
{
  int count;
  for (count = 1; count <= 500; count++)
     printf("I will not throw paper airplanes in class.");
  return 0;
}
```

Lectures

- Time:
  - Tuesdays 8:15 – 11:00
  - Thursdays 11:15 – 12:30
- Location: Hybrid lectures in CNLH, RLH

Tutorials

- 2 weekly tutorials given by one TA
- Tutorials before homework deadline
- Online via Teams, Saturdays, 19:00 – 20:00
- Online via Teams, Sundays, 19:00 – 20:00

Homework

- Homework
  - The homework assignments include theoretical and practical problems that tackle topics from the lectures
  - The homework assignments are handed out on a regular basis
- Submitting your homework
  - Extensions are possible only with an official excuse
  - Submit via Grader
    `https://grader.eecs.jacobs-university.de/`
- Homework deadline: Mondays, 23:00 sharp

Final Exam

- Grading of the course: 100% final exam
- The final exam is a written exam
- Audit (not registered to module before)
    - Final exam cannot be written
    - Reach $>=$ 50% in homework then audit will be granted, otherwise audit will not be granted

Bonus for Final Exam

- Receiving a bonus of 5% on the top of passing final exam grade is possible
- Requirement: final homework grade $>=$ 70% (over all weekly homeworks)

Literature

- "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, 3rd edition, MIT Press, 2009
- "The Art of Computer Programming", volumes 1-3 by Donald E. Knuth, Addison-Wesley, 3rd edition, 1997

Syllabus of Course

- More C++ Programming
- Foundations
- Sorting and Searching
- Fundamental Data Structures
- Design Concepts
- Graph Algorithms
- Dynamic Programming
- Backtracking

Templates

- Templates allow to write generic code, i.e., code which will work with different types
  - Again those types could be unknown at code time
- A template tells the compiler that “what is following” will deal with an unknown type
- Later a specific type will be provided and the compiler will substitute it and generate ad-hoc code

Templates: Motivation

- Many times it is required to write different snippets of code which differ only in the types dealt with, but not in the underlying logic
  - Imagine the code to check for the existence of an element in an array of floats, or an array of pointers to a class, or an array of images
  - The logic is always the same
- So, why do not we write code which is parametric with respect to the possible types?

Searching in a Vector

- Assuming that a comparison operator is defined, the following code captures the logic to locate an element in a vector

```
int seek(sometype A[], int n, sometype toseek) {
  for (int i = 0; i < n; i++)
    if (A[i] == toseek)
      return i;
  return -1;
}
```

- Should write different versions if sometype is `int`, or `float`, or `Complex`, or ...?

Templates: Functions and Classes

Type parameterization can be introduced for:

- Functions: like in the previous example; this helps in developing "algorithms"; you can concentrate on the logic, rather than on type details
  - Also, this decreases your coding time
- Classes: helps in developing "generic" classes; think about an array: the underlying logic is the same, whether it holds elements of type `int`, `Car`, `Student`, `double`, etc.
  - Again: concentrate on developing a working generic version

Templates: Basic Syntax (1)

- Two keyphrases are involved: `template class` and `template typename`
- They are functionally equivalent
- Template function: `template_function.cpp`

```
template <class T>
class Something {
  T *p;
  public: Something() { p = new T[100]; }
};
```

- Here the type `T` is not known, it will (and must) be specified when declaring instances of the class `Something`

Templates: Basic Syntax (2)

- When declaring an instance, the type is provided between angular brackets

```
int main(int argc, char** argv) {
  Something<int> ints;
  Something<char*> chars;
  Something<student> studentsome;
}
```

- The complier will generate the code necessary for the three different types
- templatesone.cpp