

# Data Structures, Algorithms and Programming Paradigms

Programme course

11 credits

Datastrukturer, algoritmer och  
programmeringsparadigm

TDDD86

Valid from: 2019 Spring semester

**Determined by**  
Board of Studies for Computer Science  
and Media Technology

**Date determined**  
2018-08-31

## Main field of study

Computer Science and Engineering, Computer Science

## Course level

First cycle

## Advancement level

G1X

## Course offered for

- Master of Science in Computer Science and Engineering
- Master of Science in Computer Science and Software Engineering

## Entry requirements

Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

## Prerequisites

Discrete mathematics, and basic knowledge of functional, imperative, and object-oriented programming.

## Intended learning outcomes

The purpose of the course is to give the student tools to be able to independently construct computer programs that use time and memory efficiently. Furthermore, the course gives deeper knowledge about programming, specifically procedural and object-oriented programming in the programming language C++, as well as an introduction to programming paradigms as a broader perspective on programming.

Upon completion of this course the student should be able to:

- Demonstrate the ability to analyze time and space complexity of iterative and simple recursive algorithms.
- Explain and use the most common abstract data types and sorting algorithms.
- Implement the most common abstract data types and sorting algorithms with different data structures and algorithms.
- Describe established methods for design (and analysis) of algorithms in general.
- Implement procedural and object-oriented programs in the programming language C++.
- Solve non-trivial computational tasks by using different components of the C++ standard library in combination.
- Describe and compare the most common programming paradigms and their underlying principles.
- Be able to apply effective algorithms to better understand social problems linked to sustainable development.

## Course content

- Basic notions
- Mathematical foundations for analysis of algorithms
- Fundamental abstract data types and data structures, such as lists, stacks, queues, search trees, heaps, hash tables, and graphs
- Efficiency analysis of algorithms
- Sorting and searching
- String algorithms
- Graph algorithms
- Algorithmic paradigms (dynamic programming, greedy algorithms, divide and conquer, brute force search)
- Procedural programming in C++ (variables, constants, declarations, expressions, statements, functions, fundamental data types and fundamental data structures)
- Pointers and dynamic memory management
- Object-oriented programming and classes in C++ (class declaration, data members, member functions, access specification for class members, constructors, destructor, inheritance, polymorphism, friends)
- Usage of the C++ standard library (input and output, character and string handling, containers, iterators, algorithms, user defined function objects and lambda expressions)
- Type parameterized functions and classes (templates) in C++
- Introduction to programming paradigms
- Introduction to efficient algorithms importance for society's goals of sustainable development

## Teaching and working methods

Lectures are used to present theory that is then tested and implemented in laboratory exercises. The lectures on data structures and algorithms introduce new concepts at a summary level, where after students are expected to obtain detailed knowledge through reading and practicing using a course specific version of the open, interactive, teaching aid OpenDSA.

## Examination

UPG2	Written assignment	1 credits	U, G
UPG1	Computer based exercises	2 credits	U, G
LAB1	Programming assignments	5 credits	U, 3, 4, 5
DAT1	Computer examination	3 credits	U, 3, 4, 5

The computer based exercises are performed in a course specific version of the open, interactive, teaching aid OpenDSA.

The computer exam tests the students knowledge about data structures and algorithms. The first part of the examination comprises assignments similar to the computer based exercises, giving a passing grade. For higher grades solving tasks from the second part of the examination is required.

The programming assignments train and test the student's skills and knowledge in programming in C++ and data structures and algorithms. By completing tasks besides those that are mandatory a higher than passing grade can be assigned. The written assignment trains and tests the student's skills and knowledge in programming paradigms.

The final grade assigned is the weighted average grade of the computer examination and the programming assignments.

## Grades

Four-grade scale, LiU, U, 3, 4, 5

## Department

Institutionen för datavetenskap

## Director of Studies or equivalent

Ola Leifler

## Examiner

Ahmed Rezine

## Course website and other links

<http://www.ida.liu.se/~TDDD86/>

## Education components

Preliminary scheduled hours: 90 h

Recommended self-study hours: 203 h

## Course literature

### Books

Lippman, Lajolie, Moo, (2012) "*C++ Primer*" fifth edition

### Websites

Course specific version of OpenDSA.

### Compendia

Lab compendium, C++ style guides, and other material available through the course web pages.

## Common rules

### Course syllabus

A syllabus has been established for each course. The syllabus specifies the aim and contents of the course, and the prior knowledge that a student must have in order to be able to benefit from the course.

### Timetabling

Courses are timetabled after a decision has been made for this course concerning its assignment to a timetable module. A central timetable is not drawn up for courses with fewer than five participants. Most project courses do not have a central timetable.

### Interrupting a course

The vice-chancellor's decision concerning regulations for registration, deregistration and reporting results (Dnr LiU-2015-01241) states that interruptions in study are to be recorded in Ladok. Thus, all students who do not participate in a course for which they have registered must record the interruption, such that the registration on the course can be removed. Deregistration from a course is carried out using a web-based form: [www.lith.liu.se/for-studenter/kurskomplettering?l=sv](http://www.lith.liu.se/for-studenter/kurskomplettering?l=sv).

### Cancelled courses

Courses with few participants (fewer than 10) may be cancelled or organised in a manner that differs from that stated in the course syllabus. The board of studies is to deliberate and decide whether a course is to be cancelled or changed from the course syllabus.

### Regulations relating to examinations and examiners

Details are given in a decision in the university's rule book:  
<http://styrdokument.liu.se/Regelsamling/VisaBeslut/622678>.

### Forms of examination

#### Examination

Written and oral examinations are held at least three times a year: once immediately after the end of the course, once in August, and once (usually) in one of the re-examination periods. Examinations held at other times are to follow a decision of the board of studies.

Principles for examination scheduling for courses that follow the study periods:

- courses given in VT1 are examined for the first time in March, with re-

examination in June and August

- courses given in VT2 are examined for the first time in May, with re-examination in August and October
- courses given in HT1 are examined for the first time in October, with re-examination in January and August
- courses given in HT2 are examined for the first time in January, with re-examination at Easter and in August.

The examination schedule is based on the structure of timetable modules, but there may be deviations from this, mainly in the case of courses that are studied and examined for several programmes and in lower grades (i.e. 1 and 2).

- Examinations for courses that the board of studies has decided are to be held in alternate years are held only three times during the year in which the course is given.
- Examinations for courses that are cancelled or rescheduled such that they are not given in one or several years are held three times during the year that immediately follows the course, with examination scheduling that corresponds to the scheduling that was in force before the course was cancelled or rescheduled.
- If teaching is no longer given for a course, three examination occurrences are held during the immediately subsequent year, while examinations are at the same time held for any replacement course that is given, or alternatively in association with other re-examination opportunities. Furthermore, an examination is held on one further occasion during the next subsequent year, unless the board of studies determines otherwise.
- If a course is given during several periods of the year (for programmes, or on different occasions for different programmes) the board or boards of studies determine together the scheduling and frequency of re-examination occasions.

### **Registration for examination**

In order to take an examination, a student must register in advance at the Student Portal during the registration period, which opens 30 days before the date of the examination and closes 10 days before it. Candidates are informed of the location of the examination by email, four days in advance. Students who have not registered for an examination run the risk of being refused admittance to the examination, if space is not available.

Symbols used in the examination registration system:

\*\* denotes that the examination is being given for the penultimate time.

\* denotes that the examination is being given for the last time.

### **Code of conduct for students during examinations**

Details are given in a decision in the university's rule book:  
<http://styrdokument.liu.se/Regelsamling/VisaBeslut/622682>.

### **Retakes for higher grade**



Students at the Institute of Technology at LiU have the right to retake written examinations and computer-based examinations in an attempt to achieve a higher grade. This is valid for all examination components with code "TEN" and "DAT". The same right may not be exercised for other examination components, unless otherwise specified in the course syllabus.

### **Retakes of other forms of examination**

Regulations concerning retakes of other forms of examination than written examinations and computer-based examinations are given in the LiU regulations for examinations and examiners,  
<http://stydokument.liu.se/Regelsamling/VisaBeslut/622678>.

### **Plagiarism**

For examinations that involve the writing of reports, in cases in which it can be assumed that the student has had access to other sources (such as during project work, writing essays, etc.), the material submitted must be prepared in accordance with principles for acceptable practice when referring to sources (references or quotations for which the source is specified) when the text, images, ideas, data, etc. of other people are used. It is also to be made clear whether the author has reused his or her own text, images, ideas, data, etc. from previous examinations.

A failure to specify such sources may be regarded as attempted deception during examination.

### **Attempts to cheat**

In the event of a suspected attempt by a student to cheat during an examination, or when study performance is to be assessed as specified in Chapter 10 of the Higher Education Ordinance, the examiner is to report this to the disciplinary board of the university. Possible consequences for the student are suspension from study and a formal warning. More information is available at  
<https://www.student.liu.se/studenttjanster/lagar-regler-rattigheter?l=sv>.

### **Grades**

The grades that are preferably to be used are Fail (U), Pass (3), Pass not without distinction (4) and Pass with distinction (5). Courses under the auspices of the faculty board of the Faculty of Science and Engineering (Institute of Technology) are to be given special attention in this regard.

1. Grades U, 3, 4, 5 are to be awarded for courses that have written examinations.
2. Grades Fail (U) and Pass (G) may be awarded for courses with a large degree of practical components such as laboratory work, project work and group work.

### **Examination components**

1. Grades U, 3, 4, 5 are to be awarded for written examinations (TEN).
2. Grades Fail (U) and Pass (G) are to be used for undergraduate projects and other independent work.

3. Examination components for which the grades Fail (U) and Pass (G) may be awarded are laboratory work (LAB), project work (PRA), preparatory written examination (KTR), oral examination (MUN), computer-based examination (DAT), home assignment (HEM), and assignment (UPG).
4. Students receive grades either Fail (U) or Pass (G) for other examination components in which the examination criteria are satisfied principally through active attendance such as other examination (ANN), tutorial group (BAS) or examination item (MOM).

The examination results for a student are reported at the relevant department.

### **Regulations (apply to LiU in its entirety)**

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at [http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning\\_pa\\_grund-\\_och\\_avancerad\\_niva](http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva).