

**Overview of  
structure and  
progression at  
the BSc (Hons)  
Computer  
Science**

This document explains the structure and the academic progression of the Bachelor (Hons) of Computer Science programme.

The first section will explain why modules are sequenced as they are at a specific level and the second section will explain why modules are placed at a specific level. An important part of why a module is at a specific level is how the academic prerequisites for later modules are expected to be fulfilled by the previous modules and therefore this is part of the second section as well. Finally, the third section will explain why modules are selected to be either core modules or electives.

The sequence of the modules at each level .....	3
Level 4 .....	4
Level 5 .....	5
Level 6 .....	5
Why modules are placed at a specific level .....	5
Database Design and Implementation.....	5
Fundamental Concepts of Computer Science.....	6
Computer programming .....	6
Operating systems and Networks.....	6
Object Oriented Design and Development.....	6
Data Structures and Algorithms.....	7
Web Application Development.....	7
Agile Development Team Project .....	7
Software Development: Methods and Standards .....	7
Big Data and Machine Learning .....	7
Development Project (The Bachelor project) .....	8
Electives .....	8
Overview of academic prerequisites for later modules.....	9
The selection of modules as either core or electives .....	10
Electives .....	10

## Level 4 (Study Year 1)

### Core modules:

Module code	Module title	Credit Value
CTEC1701N	Database Design and Implementation	30
CTEC1702N	Fundamental Concepts of Computer Science	30
CTEC1703N	Computer Programming	30
CTEC1704N	Operating Systems and Networks	30

### Supplementary (but still mandatory) module:

Module code	Module title	Credit Value
NB001	Mandatory Academic Workshop	0

## Level 5 (Study Year 2)

### Core modules:

Module code	Module title	Credit Value
CTEC2710N	Object Oriented Design and Development	30
CTEC2711N	Data Structures and Algorithms	30
CTEC2712N	Web Application Development	30
CTEC2713N	Agile Development Team Project	30

## Level 6 (Study Year 3)

### Core modules:

Module code	Module title	Credit Value
CTEC3701N	Software Development: Methods and Standards	30
CTEC3702N	Big Data and Machine Learning	30
CTEC3451N	Development Project	30

### Supplementary (but still mandatory) module:

Module code	Module title	Credit Value
NB002	Philosophy of Science	0

Please note that the modules CTEC3701N and CTEC3702N must be passed before you hand in the development project (CTEC3451N)

### Plus select one of the following:

Module code	Module title	Credit Value
CTEC3704N	Functional Programming	30
CTEC3705N	Advanced Web Development	30
IMAT3722N	Fuzzy Logic and Inference Systems	30
IMAT3711N	Privacy and Data Protection	30

Please note that the module CTEC2712N is a prerequisite for the module CTEC3705N

## The sequence of the modules at each level

### Level 4

The “Database design and implementation” module involves study of the relational model (including keys, foreign keys); ERDs; enterprise rules; many-many decomposition; table normalisation. The theory is supported by practical exercises in which an (Oracle) database is constructed, and SQL is used to query the database. The programming involved in the practical component of this module is *declarative*, using SQL which, itself, is based upon the underlying relational algebra. It is not necessary for an introduction to computer programming to precede this module because the fundamental *imperative programming* structures such as sequence, selection, and iteration are not required to use SQL.

Students use an Oracle database and learn about relational modelling, but they are not studying how database tables are physically implemented (e.g. using B-trees etc.). Whilst all experience is cumulative, there is no specific *requirement* to study the programming module before the database one, or, in fact, vice versa.

Historically, we have observed that students find the programming module particularly challenging, and this often holds irrespective of whether they have studied programming prior to university. Our rationale for putting the programming into the third block was to give the students a full semester of familiarity with the programme before commencing this topic.

The “Computer Programming” module introduces fundamental programming concepts across three contemporary paradigms: (1) traditional imperative programming structures (e.g. sequence selection and iteration, procedural abstraction, variables, assignment, arrays, etc.); (2) functional (declarative) programming (in particular the use of lists, with higher order functions such as maps and filters); and (3) object-oriented, introducing the use of classes and the message passing syntax common to all contemporary OO languages. The position of the programming module in the middle of year 1 (as opposed to the start of the year) means that a momentum in computer programming is begun in the second semester (year 1) and then maintained throughout the subsequent semesters in 2nd year. In fact, the ordering of topics within the programming module itself has been designed to facilitate this, with the emphasis at level 5 on OO design and development.

The module “Fundamental Concepts of Computer Science” is placed before the “Computer programming”. That way the students are able to apply the theoretical knowledge about the software lifecycle and gathering requirements for developing a system on a practical case. The module could also have been placed after the “Computer programming” module. If that was the case students would be able to illustrate the theoretical knowledge about the software lifecycle and gathering requirements with examples from the programming they did in the “Computer programming” module.

The “Operating Systems and Networks” module is placed in the last block of level 4. This module is not dependent on any of the other level 4 modules and none of those are dependent on this module. It is therefore our choice to place it in the last block at level 4.

In short, it is possible to arrange the first year modules into a different order: each has arguments one can put for or against. The university has adopted a purely sequential model of delivery, and we have, therefore, arranged an ordering that we feel will deliver the best overall student experience. The first year modules are sufficiently self-contained that they can be delivered in the order we have selected.

## Level 5

At level 5, the ordering is more specific to allow for the learning outcomes of the “Object Oriented Design and Development” module to be utilised in the modules that follow – each will benefit from this in some way (see below). Likewise, the skills learnt on both the “Object Oriented Design and Development” module and on the “Web Application Development” module can be used in the “Agile Team Development project” Module (which also incorporates server-side web development albeit in a different environment).

It could be argued that the order of the “Web Application Development” module and the “Data Structures and Algorithms” module could be switched since there are no direct dependencies between them. We have chosen to place the “Web Application Development” module immediately before the “Agile Development Team Project” module because students then will have web development fresh in mind while engaging in the agile development project.

## Level 6

At level 6, the “Development Project (The Bachelor project)” is placed at the 2<sup>nd</sup> semester (the last semester of the programme) to allow for students utilising all the knowledge they have obtained through the programme.

The “Software Development: Methods and Standards” module is placed as the first module at level 6 because the “Big Data and Machine Learning” module builds upon the introduction of AI and RPA given in this module.

The bachelor project spans one whole semester, that is 2 blocks, where other modules only span 1 block. This is to allow students to work with the project for a longer time span (12-13 weeks instead of 6-7 weeks) to have more time for immersion in the project.

The electives are placed in the same semester as the bachelor project. We have chosen that to allow students to utilise the knowledge obtained during their elective directly in the bachelor project because we believe that the students choice of elective reflects their interest – so should also be the case with the bachelor project – and therefore a kind of synergy could emerge.

## Why modules are placed at a specific level

Modules are specified at a given level to allow for foundational aspects and key skills to be delivered at level 4, and for these to be built on as students’ progress through to level 5 and 6. Part of the reason for placing a module at a specific level is how the academic prerequisites for later modules are expected to be fulfilled by the previous modules and it will be mentioned under the argumentation for each module. An overview of the academic prerequisites can also be found in Table 1 at page 9

## Database Design and Implementation

This module is placed at level 4 because databases and the possibility to retrieve data from a database via queries is part of the foundation for almost any computer system. Therefore, it is considered fundamental for understanding computer science and working with systems development. The application of databases is integrated into two level 5 modules (“Web Application Development” and “Agile Development Team Project”), and therefore these naturally build on the learnings at this module.

## Fundamental Concepts of Computer Science

This module is placed at level 4 because it gives the students a solid fundament to build upon in other modules. The mathematical thinking introduced in the module is apart from being a necessary underlying mindset in computer science in general explicitly used in the “Data Structures and Algorithms” module and serve as a part of the underlying foundation for other modules like computer programming and web development. The introduction to finding and documenting requirements to software systems need to meet and the introduction to the software development lifecycle is used in the development type modules like the “Object Oriented Design and Development”, the “Agile Development Team Project”, the “Software Development: Methods and Standards” and naturally the “Development Project (The Bachelor project)”. Introducing legal and ethical issues already at level 4 has multiple purposes.

- Modules like “Big Data and Machine Learning”, “Software Development: Methods and Standards”, and “Agile Development Team Project” includes specific legal and ethical aspects to get the students to consider the impact on the surrounding society and not just become skilled systems developers,
- Getting students to consider legal and ethical aspects of their profession from the start of their study helps them to adopt it as a natural part of their thinking which is an advantage since these aspects become increasingly important in the industry.

## Computer programming

This module is placed at level 4 because (as also described above) it introduces fundamental programming concepts. The programming skills learnt at this level 4 module act directly as a prerequisite for the more advanced level 5 software development module “Object Oriented Design and Development” and is part of skills needed for the “Agile Development Team Project” module. Finally, it will act as a natural part of the bachelor project at level 6 should the student choose to do a system development type of project.

## Operating systems and Networks

This module is placed at level 4 because it is considered as a foundation module for the understanding of Computer Science. Operating systems serve as the link between the computer hardware and the variety of applications installed on a computer. Therefore an understanding of operating systems is considered important for the development of applications in later modules. The security aspects of the module are directly used in the level 5 “Web Application Development” module and will be part of the other system development type of modules as well.

## Object Oriented Design and Development

This module is placed at level 5 because it is an advanced systems development module. It incorporates the skills students have obtained in the level 4 “Computer Programming” module and the level 4 module “Fundamental Concepts of Computer Science” and elaborate on these. Students will develop broader development skills including (but not limited to) advanced Object Orientated principles and UML-notation.

The module form part of the fundament for the remaining Level 5 modules where the “Data Structures and Algorithms” module makes use of the data structures presented in the module whilst the “Web Application Development” includes knowledge about systems development.

The module act as part of the fundament for the level 6 module “Software Development: Methods and Standards” and, further, development skills will be used in the “Agile Development Team Project” module.

### Data Structures and Algorithms

This module is placed at level 5 because it is an advanced module building upon the mathematical aspects introduced during the level 4 “Fundamental Concepts of Computer Science”. Further it elaborates upon the knowledge obtained about database searches and data structures at the level 4 modules and data structures from the level 5 “Object Oriented Design and Development” module. The module is a fundamental part of the foundation for the level 6 module “Big Data and Machine Learning” because manipulating Big Data is highly dependent on i.a. efficient algorithms.

### Web Application Development

This module is placed at level 5 because it is a module where the students explore web development by applying skills obtained in the level 4 “Computer Programming” module in combination with applying knowledge and skills from the level 4 module “Database Design and Implementation” in a development project. Further, the security aspects of the level 4 module “Operating systems and Networks” act as a fundament securing that students learn how to develop secure web applications whilst development skills from the “Object Oriented Design and Development” module are utilized for securing sound web system development.

This module further act as a prerequisite for the level 6 elective “Advanced Web Development”.

### Agile Development Team Project

This module is placed on level 5 (in the last block) because it allows and encourages students to apply all the skills obtained in previous modules to a real-world type of development project. Through the development project the students will e.g., demonstrate ability to produce well-structured and well documented code, and apply their ethical thinking upon areas in the development project – skills obtained in previous modules.

Further the module is part of the learning systems development preparing both students for the bachelor project at level 6 and life as a systems developer after their studies.

### Software Development: Methods and Standards

This module let the students immerse in the methodological, regulation environment in which software systems are developed. To do so students must have a solid foundation of computer science and a “backpack” of knowledge about both methodologies and systems development. Hence the location at level 6. The module incorporates skills and knowledge from the previous system development modules and the ethical and law aspects from the level 4 module “Fundamental Concepts of Computer Science”. Further the module introduces AI and Robotic process automation (RPA) and thereby serve as part of the foundation for the level 6 module “Big Data and Machine Learning”.

### Big Data and Machine Learning

This module is placed on level 6 because it is a highly advanced module. Students need to have a firm understanding of computer science with special focus on algorithms and their application in analytics – knowledge students have obtained in the level 5 module “Data Structures and Algorithms”. Further, the module builds upon the understanding of AI and RPA introduced in the “Software Development: Methods and Standards” module taught in the previous Level 6 block. Additionally, the module considers ethics in relation to AI, big data, and surveillance based on knowledge the students has obtained in the level 4 module “Fundamental Concepts of Computer Science”.

### Development Project (The Bachelor project)

The bachelor project has its natural place at level 6 in the last semester of the programme. The project allows students to demonstrate a thorough understanding of the skills they have learned through all the previous modules – when these skills are appropriate for the project.

### Electives

In this section we give arguments for why the optional modules (the electives) of the programme is placed at level 6. It has been important for the design of programme to place all electives in the same block so even though some electives (content and progression vice) could have been placed at the end at level 5 all electives are placed at level 6 mainly because of content dependencies of two modules.

The “Advanced Web Development” module builds on the outcomes of the level 5 module – Web Application Development and the “Privacy and Data Protection” module incorporates outcomes of i.a. the “Big data and Machine Learning” module at level 6.

Therefore the electives are placed at level 6.



Overview of academic prerequisites for later modules

Table 1 below shows in a schematic form which modules include learnings from which previous taught modules. So when it for the level 5 module “Object Oriented Design and Development” states “L4: Fundamental Concepts of Computer Science” and “L4: Computer Programming” it means that the two level 4 modules are part of the fundament for the level 5 module and that students therefore use important knowledge from the level 4 modules in this module.

Level 4	Level 5	Level 6
Database Design and Implementation	Object Oriented Design and Development <ul style="list-style-type: none"> <li>L4: Fundamental Concepts of Computer Science</li> <li>L4: Computer Programming</li> </ul>	Software Development: Methods and Standards <ul style="list-style-type: none"> <li>L4: Fundamental Concepts of Computer Science</li> <li>L5: Object Oriented Design and Development</li> </ul>
Fundamental Concepts of Computer Science	Data Structures and Algorithms <ul style="list-style-type: none"> <li>L4: Database Design and Implementation</li> <li>L4: Fundamental Concepts of Computer Science</li> <li>L4: Computer Programming</li> <li>L5: Object Oriented Design and Development</li> </ul>	Big Data and Machine Learning <ul style="list-style-type: none"> <li>L4: Fundamental Concepts of Computer Science</li> <li>L5: Data Structures and Algorithms</li> <li>L6: Software Development: Methods and Standards</li> </ul>
Computer Programming	Web Application Development <ul style="list-style-type: none"> <li>L4: Database Design and Implementation</li> <li>L4: Computer Programming</li> <li>L4: Operating Systems and Networks</li> <li>L5: Object Oriented Design and Development</li> </ul>	Development Project <ul style="list-style-type: none"> <li>All relevant previous modules</li> </ul>
Operating Systems and Networks	Agile Development Team Project <ul style="list-style-type: none"> <li>In principle all the previous taught modules dependent on the nature of the project</li> </ul>	Functional Programming <ul style="list-style-type: none"> <li>L4: Computer Programming</li> </ul>
		Advanced Web Development <ul style="list-style-type: none"> <li>L5: Web Application Development</li> </ul>
		Fuzzy Logic and Inference Systems <ul style="list-style-type: none"> <li>L4: Fundamental Concepts of Computer Science</li> </ul>
		Privacy and Data Protection <ul style="list-style-type: none"> <li>L4: Fundamental Concepts of Computer Science</li> <li>L6: Big data and Machine Learning</li> </ul>

Table 1: How the academic prerequisites for later modules are expected to be fulfilled by the previous modules

As argued above when we described the order of the modules at level 4 (please see page 4) these modules are sufficiently self-contained to not be dependent on each other. Therefore no dependencies are listed at level 4.

## The selection of modules as either core or electives

The syllabus reflects recent trends and demands of industry, with a focus on giving students both theoretical knowledge and the practical skills that they require to be successful in the workplace.

According to TechTarget (<https://www.techtarget.com/whatis/feature/Top-8-most-in-demand-IT-tech-jobs>) "The number of software developer jobs is projected to rise 25% between 2021 and 2031. This equates to the creation of 411,400 new jobs, according to data from the U.S. Bureau of Labor Statistics (BLS)". If this is combined with job demands for other IT-areas such as Data Scientist, AI specialist, Information Security Analyst, Computer Network Architect etc. there is no doubt that a Computer Science programme based upon the basic Computer Science disciplines is needed. Narrowing the view down to just cover Denmark then, according to The Danish Agency for Labour Market and Recruitment (<https://www.star.dk/en/>), there were 2020 job postings as either Programmer, Project Manager, Systems Developer and IT-Consultant in the period from December 2021 to May 2022. Of these approx. 25% ended without hiring a qualified applicant which also from a Danish perspective confirms the need for IT specialists.

The core modules in this programme reflects the needs described above. Because the industry needs "Software Developers" the modules "Computer programming", "Object Oriented Design and Development", "Web Application Development", "Agile Development Team Project", and "Software Development: Methods and Standards" are included as core modules. Because the industry needs "Computer Network Architect" the module "Operating Systems and Networks" is included as a core module etc.

It is, however, not all the core modules that have a one-to-one match with industrial needs. An example is the mathematical part of the "Fundamental Concepts of Computer Science" module. It is included as core both because it is used in the "Data Structures and Algorithms" module that again is used as a fundament for the "Big Data and Machine Learning" module.

## Electives

Under the new E2030 block delivery structure, there is a move to 30-credit modules (from 15-credit modules). Therefore, the number of optional subjects (electives) a student can choose is necessarily reduced. Given the diversity of the overall subject area and taking into consideration the number of computing programmes offered at DMU, the approach taken is that there is plenty of choice between programmes, and then more limited choice within programmes. This decision promotes individual course identity over a small set of very broad computing programmes with many electives shared between them. Within this context, each programme has decided upon a set of electives that represent the ethos of that particular programme, whilst offering a variety of relevant topics.

In any case, electives are reviewed annually across DMU because many of these are linked to individual staff member specialisms which, in turn, can represent both established and recent trends in the discipline. In the review process it would be natural to include partners, such as Niels Brock, and it might even be possible to contextualise an elective to fit a partner better. In short, we advise applicants that elective modules are indicative, and that we keep the portfolio under review. That said, changes are not made without cause, and some electives continue for many years because they become established and popular.

As already stated, the revalidation for E2030 entailed a move to 30-credit modules which, in turn, reduces the scope for offering electives. Furthermore, we are working within DMU's approach to offering a range of more specialised programmes, rather than a small number of programmes with a wide range of options. Within this context, for the final year of computer science we noted the following:

- The growing importance of Big Data and Machine Learning. In our view, this topic has now crossed the threshold from elective to core
- Elective topics were selected to cover the following range:
  - Functional Programming. This represents a growing and highly relevant paradigm used in industry today, and picks up on the foundations laid in the "Computer programming" module at level 4.
  - Fuzzy logic and inference systems. This module picks up on specific expertise within DMU which has researched in fuzzy logic for many years. The module is shared with the AI programme.
  - Advanced web development. Many students are drawn to web development and wish to study the topic to an advanced level. This opportunity is afforded by this elective. Again, this module reflects particular expertise within DMU which has been built up over a number of years.
  - Privacy and Data Protection. This module covers an important and highly relevant contemporary topic and was developed by colleagues from within the CCSR (Centre for Computing and Social Responsibility). It is not a technical module in the sense of requiring practical programming and, as such, provides a real alternative for those students who elect to focus on a non-technical computing subject to balance their final year.