Programme-specific Section of the Curriculum for the MSc Programme in
Computer Science with a minor subject
at the Faculty of Science, University of Copenhagen
2010 (Rev. 2024)

Contents

1 Title, affiliation and language

A shared section that applies to all BSc, part-time MSc and MSc Programmes at the Faculty of Science is linked to this programme-specific curriculum.

1.1 Title

The MSc Programme in Computer Science with a minor subject leads to a Master of Science (MSc) in Computer Science and minor in [the minor subject] with the Danish title: *Cand.scient. (candidatus/candidata scientiarum) i datalogi med sidefag i [the minor subject]*

It will appear from the diploma that the study programme has been completed as an MSc in two subjects and, provided that the requirements pertaining to the Upper Secondary School course packages (*gymnasiefagpakkerne*) have been met, that academic qualifications (*faglig competence*) for teaching at the Danish Upper Secondary School in the subjects have been achieved.

1.2 Affiliation

The programme is affiliated with the Study Board of Mathematics and Computer Science, and the students can both elect, and be elected, to this study board.

1.3 Corps of external examiners

The following corps of external examiners is used for the central parts of the MSc Programme:

- Corps of External Examiners for Computer Science (*datalogi*).

1.4 Language

The language of this MSc Programme is English.

2 Academic profile

2.1 Purpose

Computer science (Danish: *datalogi*) is concerned with the systematic processing of information, particularly for automatic processing by computers. The concept corresponds to Informatik (German) and informatique (French). Students learn how to identify and analyse complex issues within computation and information processing on a scientific basis and at a high level of abstraction, and, through the application of relevant results and methodologies, to solve computer science problems, both of a theoretical and a practical nature, including, in particular, to design and implement correct, efficient and useful software.

2.2 General programme profile

The MSc programme in Computer Science with a minor subject is a research-based programme admission to which requires a BSc in Computer Science and a minimum of the subject elements from the minor subject. The minor subject must be within the fields taught in the Danish Upper Secondary School.

The programme includes a common compulsory part covering a broad range of core CS topics at a graduate level; a restricted elective part allowing deeper immersion in a chosen topic area, and a minor-subject part containing selected further courses from the minor subject.

Computer science is the key subject area of the programme. The programme also includes a large number of subject elements from the minor subject area.

2.3 General structure of the programme

The MSc Programme is set at 120 or 150 ECTS depending on whether the minor subject is within the field of sciences or not.

Exercise and Sport Sciences is in this regard considered as being outside the field of science.

The MSc Programme in Computer Science with a minor subject consists of the following elements:
- Basic study program, 120 ECTS including the thesis.
- Extension of the minor subject, 30 ECTS, if the minor subject is outside the field of science.

There are no defined specialisations in this MSc Programme

2.4 Career opportunities

The MSc Programme in Computer Science with a minor subject qualifies students to become professionals within business functions and/or areas such as:
- A PhD programme
- Research, development, and consulting within the Information and Communication Technology sector.
- IT development and support within other sectors, such as the financial or biomedical industry, or in public administration.
- Upper secondary school teacher in Computer Science and the minor subject.

3 Description of competence profiles

Students following the MSc Programme acquire the knowledge, skills and competences listed below. Students will also acquire other qualifications through elective subject elements and other study activities.

3.1 Competence profile

Graduates holding an MSc in Computer Science with a minor subject have acquired the following:

Knowledge about:
- State-of-the-art principles for program and system development, including appropriate use of structuring methodologies and programming paradigms.
- The relevant mathematical, statistical, and logical foundations for constructing effective and efficient solutions to a variety of computational problems.
- Academic literature, terminology, traditions and research methods within computer science in general, and their area of specialisation in particular.
- Relevant real-world applications of computer science and information technology, e.g. in business, cultural, health, environmental, and other societal contexts.

Skills in/to:
- Identify opportunities for principled application of theoretical or foundational computer-science results or methods within practical or applied contexts.
- Design, implement, and maintain large and/or complex programs or systems, subject to external quality and performance constraints.
- Adapt and apply general mathematical models for analysis and classification of data.

- Combine relevant computer-science and other knowledge in order to analyse a problem with a significant computational or information-processing component, as well as assess previous attempts at solving the same problem and related problems.
- Select, combine, and where appropriate develop or refine theories and methods, and use these to make a significant contribution to solving computer-science problems or to promoting a scientific understanding of the problems.
- Evaluate a proposed solution to a problem objectively and systematically, and – where appropriate involving experiments – analyse the areas in which the solution is successful and unsuccessful, and identify its weaknesses, strengths and consequences.
- Document their own research results and discoveries in a manner that meets the requirements for academic publications.
- Apply and disseminate knowledge about information technology and participate in general debates on the subject.

<u>Competences in/to</u>:
- Reflect on ethical issues and societal consequences of the application of computer-science methods, and choose the relevant methods based on such reflections.
- Acquiring a comprehensive overview of complex scientific or organisational contexts, identifying and analysing the computational or information-processing problems arising in such contexts, and decomposing or transforming the problems into a form amenable to solution by relevant computer-science methodology.
- Employing general theoretical results and methods to an extent and level of formality appropriate to the complexity and criticality of the concrete task at hand.
- Formulating, structuring, and running research-based projects, computer-science development work and other advanced assignments within information technology.
- Participating in larger program- or system-development teams, properly applying the relevant principles for modular software construction, and understanding how the correctness and performance of the full product follows from those properties of the individual components.
- Taking professional responsibility for the quality of a completed analysis, design, implementation, or evaluation task, based on a sound understanding and application of the relevant assessment methodologies.
- Acquiring new knowledge in an efficient and systematic manner, and familiarising themselves with evolving computer-science subject areas at a high scientific level.

4 Admission requirements

The admission requirements for the MSc Programme in Computer Science with a minor subject is the same as the admission requirements listed in paragraph 4 in "Programme-specific Section of the Curriculum for the MSc Programme in Computer Science" supplemented with the following:

- At least 105 ECTS from the Upper Secondary School course package (*gymnasiefagpakken*) are included in the BSc programme.
- At least 60 ECTS from the minor subject is included in the BSc programme.
  - If the minor subject is *within* the field of sciences (with the exception of Exercise and Sport Sciences) the 60 ECTS must be contained in the minor subject Upper Secondary School course package (*den reducerede gymnasiefagpakke*).

5 Prioritisation of applicants

With a Bachelor's degree in Computer Science, a Bachelor's degree in Computer Science and Economy, a Bachelor's degree in Machine Learning and Data Science or a Bachelor's degree in Cognitive Data Science from University of Copenhagen the student is granted reserved access and guaranteed a place on the MSc Programme in Computer Science if the student applies in time to begin the MSc Programme within three years of the completion of the Bachelor's degree.

If the number of qualified applicants to the programme exceeds the number of places available, the applicants will be prioritised according to paragraph 5 in "Programme-specific Section of the Curriculum for the MSc Programme in Computer Science".

6 Structure of the programme

The compulsory subject elements, restricted elective subject elements and the thesis constitute the central parts of the programme (Section 27 of the Ministerial Order on Bachelor and Master's Programmes (Candidatus) at Universities).

6.1 Programme components

The programme is set at 120/150 ECTS and consists of the following elements:
- Compulsory subject elements, 22.5 ECTS.
- Restricted elective subject elements, 22.5 ECTS
- The minor subject
  - 45 ECTS (minor subject within the field of science)
  - 75 ECTS (minor subject outside the field of science)
- Thesis, 30 ECTS

6.1.1 Compulsory subject elements

All of the following subject elements are to be covered (22.5 ECTS)				
Course code	**Course Title**	**Abbr.**	**Block**	**ECTS**
NDAA09013U	Advanced Programming	AP	Block 1	7.5 ECTS
NDAA09023U	Advanced Algorithms and Data Structures	AADS	Block 2	7.5 ECTS
NDAK15006U	Advanced Computer Systems	ACS	Block 2	7.5 ECTS

6.1.2 Restricted elective subject within the major subject

22.5 ECTS are to be covered as subject elements from the following lists:

1) 7.5 ECTS are to be covered as restricted elective subject elements from the following list (cases where any of the courses are passed as compulsory in the BSc programme will not result in an exemption from this):				
Course code	**Course Title**	**Abbr.**	**Block**	**ECTS**
NDAK24003U	Advanced Topics in Deep Learning	ATDL	Block 1	7.5 ECTS
NDAK15014U	Advanced Topics in Machine Learning	ATML	Block 1	7.5 ECTS
NDAK22000U	Machine Learning A	MLA	Block 1	7.5 ECTS
NDAK18000U	Natural Language Processing	NLP	Block 1	7.5 ECTS
NDAK24002U	Deep Learning	DL	Block 2	7.5 ECTS
NDAK22001U	Machine Learning B	MLB	Block 4	7.5 ECTS

2) 15 ECTS are to be covered as restricted elective subject elements from the following list				
Course code	**Course Title**	**Abbr.**	**Block**	**ECTS**
NDAK24003U	Advanced Topics in Deep Learning	ATDL	Block 1	7.5 ECTS
NDAK15014U	Advanced Topics in Machine Learning	ATML	Block 1	7.5 ECTS
NDAK10006U	IT Innovation and Change	ITIaC	Block 1	7.5 ECTS
NDAK22000U	Machine Learning A	MLA	Block 1	7.5 ECTS
NDAK10005U	Medical Image Analysis	MIA	Block 1	7.5 ECTS
NDAK18000U	Natural Language Processing	NLP	Block 1	7.5 ECTS
NDAK14008U	Programming Massively Parallel Hardware	PMPH	Block 1	7.5 ECTS
NDAK24002U	Deep Learning	DL	Block 2	7.5 ECTS
NDAK16009U	Visualisation	Vis	Block 2	7.5 ECTS
NDAK15012U	Advanced Topics in Human-Centered Computing	ATHCC	Block 3	7.5 ECTS
NDAA09007U	Computability and Complexity	CoCo	Block 3	7.5 ECTS
NDAK10009U	Computational Geometry	CG	Block 3	7.5 ECTS
NDAA09009U	Numerical Optimization	NO	Block 3	7.5 ECTS
NDAK21003U	Online and Reinforcement Learning	OReL	Block 3	7.5 ECTS
NDAA08006U	Semantics and Types	SaT	Block 3	7.5 ECTS
NDAA09027U	Signal and Image Processing	SIP	Block 3	7.5 ECTS
NDAK20001U	Software Engineering and Architecture	SEA	Block 3+4	15 ECTS
NDAK16001U	Approximation Algorithms	APX	Block 4	7.5 ECTS
NDAK12006U	Computational Methods in Simulation	CMIS	Block 4	7.5 ECTS
NDAK22001U	Machine Learning B	MLB	Block 4	7.5 ECTS
NDAK16004U	Mobile Computing	MC	Block 4	7.5 ECTS
NDAK20002U	Neural Information Retrieval	NIR	Block 4	7.5 ECTS
NDAA09031U	Proactive Computer Security	PCS	Block 4	7.5 ECTS
NDAK16005U	Program Analysis and Transformation	PAT	Block 4	7.5 ECTS
NDAK14005U	Randomized Algorithms	RA	Block 4	7.5 ECTS
NDAK16008U	User Interface Technology	UIT	Block 4	7.5 ECTS
NFKK14001U	Project outside course scope		Block 1-5	7.5 ECTS
NFKK14005U	Project outside course scope		Block 1-5	15 ECTS
	Thesis preparation project		Block 1-5	7.5 ECTS

6.1.3 Restricted elective subject elements within the minor subject

45 ECTS are to be covered as subject elements from the minor subject if the minor subject is within the field of science.

75 ECTS are to be covered as subject elements from the minor subject if the minor subject is outside the field of science.

If the student lacks less than 45 or 75 ECTS of the minor subject when the MSc Programme begins the difference must be covered as elective subjects.

6.1.4 Elective subject elements

The elective subjects are generally covered by the subject elements which the student follows on the minor subject.
- It is, however, possible to release elective subjects if the academic minimum requirements for the minor subjects have been met – this will, e.g., be the case if one or both of the following two conditions are present:
  - A subject element form part of both the major and minor Upper Secondary School course packages (*gymnasiefagpakker*). The subject elements should only be passed once, and the student has full freedom of choice in terms of the remaining ECTS.
  - If less than 45 or 75 ECTS within the minor subject are missing when entering the MSc Programme.

- BSc subject elements corresponding to 15 ECTS may be included in the MSc Programme as elective subject elements.
- Projects. See 6.1.5 Projects.

6.1.5 Projects

Projects outside the course scope and projects in practice may not exceed 22.5 ECTS of the programme.
- Projects outside the course scope may be included in the elective and restricted elective section of the programme with up to 15 ECTS**.** Projects outside course scope may not exceed 15 ECTS in total of the programme. Projects outside course scope may be written as a combination of the restricted elective and elective section of the programme. The regulations are described in Appendix 5 to the shared section of the curriculum.
- Projects in practice may be included in the elective section of the programme with 15 ECTS. The regulations are described in Appendix 4 to the shared section of the curriculum.
- Thesis preparation projects may be included in the elective or restricted elective section of the programme with up to 7.5 ECTS. Thesis preparation projects may not exceed 7.5 ECTS in total on the programme. The regulations are described in Appendix 6 to the shared section of the curriculum.

6.1.6 Thesis

The MSc Programme in Computer Science with a minor subject includes a thesis corresponding to 30 ECTS, as described in Appendix 2 to the shared curriculum. The thesis must be written within the academic scope of the programme.

A thesis preparation project may be included in the elective or restricted elective section of the programme with up to 7.5 ECTS in total. The regulations are described in Appendix 6 to the shared section of the curriculum. Thesis preparation projects in Computer Science are evaluated with 7-point grading scale.

6.1.7 Academic mobility

The academic mobility is generally covered by the subject elements which the student follows on the minor subject.

The student has the possibility to arrange academic mobility in parts of the programme. This requires that the student follows the rules and regulations regarding pre-approvals and credit.

7 Exemptions

In exceptional circumstances, the study board may grant exemptions from the rules in the curriculum specified solely by the Faculty of Science.

8 Commencement etc.

8.1 Validity

This subject specific section of the curriculum applies to all students enrolled in the programme – see however Appendix 2.

8.2 Transfer

Students enrolled on previous curricula may be transferred to the new one as per the applicable transfer regulations or according to an individual credit transfer by the study board.

8.3 Amendments

The curriculum may be amended once a year so that any changes come into effect at the beginning of the academic year. Amendments must be proposed by the study board and approved by the Dean.

Notification about amendments that tighten the admission requirements for the programme will be published online at www.science.ku.dk one year before they come into effect.

If amendments are made to this curriculum, an interim arrangement may be added if necessary to allow students to complete their MSc Programme according to the amended curriculum.

Appendix 1 The recommended academic progression

The table illustrates the recommended academic progression. The student is allowed to plan an alternative progression within the applicable rules.

Table for students admitted to the programme in September (summer):

Table – MSc Programme in Computer Science with a minor subject within SCIENCE

	Block 1	Block 2	Block 3	Block 4
1st year	Minor subject	Minor subject	Minor subject	Minor subject
	Minor subject	Minor subject	Restricted elective	Restricted elective
2nd year	Advanced Programming	Advanced Computer Systems	Thesis	
	Restricted elective	Advanced Algorithms and Data Structures		

Table – MSc Programme in Computer Science with a minor subject outside SCIENCE

	Block 1	Block 2	Block 3	Block 4
1st year	Minor subject	Minor subject	Minor subject	Minor subject
	Minor subject	Minor subject	Minor subject	Minor subject
2nd year	Advanced Programming	Advanced Computer Systems	Minor subject	Minor subject
	Restricted elective	Advanced Algorithms and Data Structures	Restricted elective	Restricted elective
3rd year	Thesis			

Table for students admitted to the programme in February (winter):

Table – MSc Programme in Computer Science with a minor subject within SCIENCE*

	Block 1	Block 2	Block 3	Block 4
1st year	Minor subject	Minor subject	Advanced Programming	Advanced Computer Systems
	Minor subject	Minor subject	Restricted elective	Advanced Algorithms and Data Structures
2nd year	Minor subject	Minor subject	Thesis	
	Restricted elective	Restricted elective		

*This table is only relevant for students who begin the MSc Programme in February (block 3)

Table – MSc Programme in Computer Science with a minor subject outside SCIENCE*

	Block 1	Block 2	Block 3	Block 4
1st year	Minor subject	Minor subject	Minor subject	Minor subject
	Minor subject	Minor subject	Minor subject	Minor subject
2nd year	Minor subject	Minor subject	Advanced Programming	Advanced Computer Systems
	Restricted elective	Restricted elective	Restricted elective	Advanced Algorithms and Data Structures
3rd year	Thesis			

*This table is only relevant for students who begin the MSc Programme in February (block 3)

Appendix 2 Interim arrangements

The Shared Section of the BSc and MSc Curricula for Study Programmes applies to all students.

The interim arrangements below only consist of parts where the current curriculum differs from the rules and regulations that were previously valid. Therefore, if information about relevant rules and regulations are missing, it can be found in the curriculum above.

1 General changes for students admitted in the academic year 2023/24 and 2022/23

Students admitted to the MSc Programme in the academic year 2023/24 and 2022/23 must finish the programme as listed in the curriculum above with the following exceptions:

Restricted elective subject elements

37.5 ECTS are to be covered as restricted elective subject elements from the following two lists:

1) 7.5 ECTS are to be covered as restricted elective subject elements from list 1 offered as part of this curriculum (see above).				
2) 30 ECTS are to be covered as subject elements from the following list:				
Restricted elective subject elements offered as part of list 2 in this curriculum (see above)				
Course code	**Course Title**	**Abbr.**	**Block**	**ECTS**
NDAK22002U	Advanced Deep Learning	ADL	Discontinued*	7.5 ECTS

 *See course specific changes below.

2 General changes for students admitted in the academic year 2021/22

Students admitted to the MSc Programme in the academic year 2021/22 must finish the programme as listed in the curriculum above with the following exceptions:

Compulsory subject elements

All of the following subject elements are to be covered (30 ECTS):				
Course code	**Course Title**	**Abbr.**	**Block**	**ECTS**
NDAA09013U	Advanced Programming	AP	Block 1	7.5 ECTS
NDAA09023U	Advanced Algorithms and Data Structures	AADS	Block 2	7.5 ECTS
NDAK15006U	Advanced Computer Systems	ACS	Block 2	7.5 ECTS
NDAK15007U	Machine Learning	ML	Discontinued*	7.5 ECTS

 *See course specific changes below.

Restricted elective subject elements

15 ECTS are to be covered as subject elements from the following lists:				
1) <u>Up to 15 ECTS</u> in BSc subject elements from the following list must be followed, if they were not passed as part of the BSc programme:				
Course code	**Course Title**	**Abbr.**	**Block**	**ECTS**
NMAA09014U	Sandsynlighedsregning og statistik	SS	Block 2	7.5 ECTS
NDAB15003U	Interaktionsdesign	Inter	Block 3	7.5 ECTS
NDIA10001U	Grundkursus i de naturvidenskabelige fags didaktik	DidG	Block 4	7.5 ECTS
2) <u>The remaining credits (up to 15 ECTS)</u> are to be covered as subject elements from the following list:				
Restricted elective subject elements offered as part of this curriculum (see above)				
NDAB21009U	Advanced Deep Learning	ADL	Discontinued*	7.5 ECTS
NDAK17000U	Collaborative Computing	CollComp	Discontinued*	7.5 ECTS
NDAK22002U	Advanced Deep Learning	ADL	Discontinued*	7.5 ECTS

 *See course specific changes below.

3 General changes for students admitted in the academic year 2020/21

Students admitted to the MSc Programme in the academic year 2020/21 must finish the programme as listed in the curriculum above with the following exceptions:

Compulsory subject elements

All of the following subject elements are to be covered (30 ECTS):				
Course code	**Course Title**	**Abbr.**	**Block**	**ECTS**
NDAA09013U	Advanced Programming	AP	Block 1	7.5 ECTS
NDAA09023U	Advanced Algorithms and Data Structures	AADS	Block 2	7.5 ECTS
NDAK15006U	Advanced Computer Systems	ACS	Block 2	7.5 ECTS
NDAK15007U	Machine Learning	ML	Discontinued*	7.5 ECTS

*See course specific changes below.

Restricted elective subject elements

15 ECTS are to be covered as subject elements from the following lists:				
1) Up to 15 ECTS in BSc subject elements from the following list must be followed, if they were not passed as part of the BSc programme:				
Course code	**Course Title**	**Abbr.**	**Block**	**ECTS**
NMAA09014U	Sandsynlighedsregning og statistik	SS	Block 2	7.5 ECTS
NDAB15003U	Interaktionsdesign	Inter	Block 3	7.5 ECTS
NDIA10001U	Grundkursus i de naturvidenskabelige fags didaktik	DidG	Block 4	7.5 ECTS
2) The remaining credits (up to 15 ECTS) are to be covered as subject elements from the following list:				
Restricted elective subject elements offered as part of this curriculum (see above)				
NDAK15018U	Large Scale Data Analysis	LSDA	Discontinued*	7.5 ECTS
NDAB21009U	Advanced Deep Learning	ADL	Discontinued*	7.5 ECTS
NDAK17000U	Collaborative Computing	CollComp	Discontinued*	7.5 ECTS
NDAK22002U	Advanced Deep Learning	ADL	Discontinued*	7.5 ECTS

* See course specific changes below.

4 Discontinued courses

Course Code	Course Title	ECTS	Interim arrangement
NDAB21009U	Advanced Deep Learning	7.5	The course was restricted elective in the academic year 2021/22 and 2020/21. Offered for the last time: 2021/22 Last exam if applicable (cf. SCIENCE's Teaching and exam rules): 2022/23
NDAK22002U	Advanced Deep Learning (ADL)	7.5	The course was restricted elective in the academic year 2023/24 and earlier. Offered the last time: 2023/24 Last exam if applicable (cf. SCIENCE's Teaching and exam rules): 2024/25 The course is identical to Deep Learning (NDAK24002U), 7.5 ECTS.

Course Code	Course Title	ECTS	Interim arrangement
NDAK17000U	Collaborative Computing (CollComp)	7.5	The course was restricted elective in the academic year 2021/22 and earlier. Offered for the last time: 2020/21 Last exam if applicable (cf. SCIENCE's Teaching and exam rules): 2022/23
NDAK15018U	Large Scale Data Analysis (LSDA)	7.5	The course was restricted elective in the curriculum in the academic year 2020/21 to 2016/17. Offered for the last time: 2020/21 Last exam if applicable (cf. SCIENCE's Teaching and exam rules): 2021/22
NDAK15007U	Machine Learning	7.5	The course was compulsory in the academic year 2021/22 and earlier. Offered for the last time: 2021/22 Last exam if applicable (cf. SCIENCE's Teaching and exam rules): 2022/23. The course is replaced by NDAK22000U Machine Learning A (MLA), 7.5 ECTS.

Appendix 3 Description of objectives for the thesis

After completing the thesis, the student should have:

Knowledge about:
- The core subject area of the thesis, as well as - where applicable - any relevant auxiliary areas, both within and outside of computer science.
- General principles for scientific research work, including adaptive project planning, hypothesis generation and testing, and design and execution of experiments.
- General principles for scientific and technical writing, including an appropriate level of formality, and correct use of references and citations.

Skills in/to:
- Clearly formulate, delineate, motivate, and situate a scientific problem, containing a substantial computer-science component.
- Employ state-of-the-art methods and theories to analyse and decompose the problem, and to survey and evaluate previous attempts at solving the problem and/or related problems.
- Critically evaluate, select, and non-trivially combine or extend relevant results and techniques, to make significant contributions to the solution of the problem, or to the scientific understanding of the problem.
- Give a precise, operational description of all important aspects of the developed solution, with particular emphasis on own contributions.
- Objectively and systematically, and where appropriate involving experiments, assess to what extent the problem under study has been solved, and point out particular strengths, weaknesses, and consequences of the solution.
- Report the findings of the project in a well-structured, coherent, and comprehensive report, in accordance with academic standards for referencing and integrity, and including illustrations, tables, formulas, code, and other non-textual elements to an extent appropriate to the nature of the problem and its solution.
- Orally summarise and explain the main objectives, methods, results, and conclusions of the project; and interactively discuss and justify the chosen approach and resulting findings at a scientific level.
- Demonstrably meet the project-specific learning objectives stipulated in the thesis contract.

Competences in/to:
- Identifying and solving a non-trivial problem within computer science, or with a significant computational or IT content.
- Independently planning and executing, with limited supervision, a research project around the problem, and report its findings and conclusions to high standards of correctness and integrity.
- Assessing and discussing the significance and relevance of the obtained results to the scientific discipline of computer science, as well as any possible technological or societal implications.