Appendix: Master's degree programme in Computing Science 2019-2020

Appendix I Learning outcomes of the degree programme (art. 3.1)

The Master graduate in Computing Science:

- Is fully acquainted with the basic terms and techniques used in Computing Science, and is familiar with a number of classical problems and their solutions;
- Is experienced in the effective use of the tools available in solving Computing Science problems, such as compilers, theorem proofs, visualisation software, case-tools and domain specific software and hardware;
- Is familiar with Computing Science applications in several other scientific fields of study;
- Is capable of clear communication (both oral and in writing) on the subject of Computing Science and its applications;
- Is capable of working in a team and in various projects;
- Is sensitive to the social aspects of Computing Science applications and his/her own responsibilities therein;
- Has specialized knowledge of theories, methods and techniques in one of the following subfields of Computing Science:
    - Intelligent Systems and Visual Computing
    - Software Engineering and Distributed Systems
    - Data Science and Systems Complexity
    - Science, Business & Policy
- Is able, by using scientific data and assessments, to analyse problems in Computing Science or a related scientific field of study, to provide specified solutions to the problem, and – if possible – to materialise these solutions (in the shape of an algorithm or program or an implementation in software or hardware);
- Is able to critically read professional literature and to assess its correctness, usability and relevance;
- Is able to contribute to the enhancement of scientific understanding in a subfield of Computing Science;
- Has a proper understanding of the scientific relevance of problem definitions and results, and of the validity of the scientific method used.

The first six learning outcomes are similar to those of the Bachelor programme in Computing Science.

Some subfields in the Computing Science master degree have the following additional learning outcomes:

The Master in Computing Science graduated in the subfield of Software Engineering and Distributed Systems:

- Is capable of systematically designing and implementing software systems in cooperation with interested parties;
- Is capable of integrating existing and new software components into a system that meets the quality criteria that were agreed upon.

The Master in Computing Science graduated in the subfield of Science, Business & Policy (SBP):

- Has a full understanding of the way in which businesses and policy organisations are functioning (governments and nongovernmental organisations, NGO's);
- Understands the connections between natural science research, trade and industry and governmental policies;

- Is able to integrate aspects of natural science, business and management;
- Is able to translate a concrete problem definition in business or management into a natural science problem definition;
- Is able to connect problem aspects of natural sciences to other relevant subject fields;
- Is able to put research data and conclusions into a business or policy context;
- Has developed his/her social and communicative skills:
- Is able to write texts that are effective and to the point;
- Is able to draw up an innovation plan or management plan for either a business or a government organisation;
- Is able to give convincing oral presentation;
- Is able to deliver an active contribution to plenary discussions;
- Familiar with techniques used in business meetings and is capable of chairing a meeting;
- Is able to work on a project as part of a team;
- Is able to give and receive feedback concerning his/her way of functioning in a team;
- Can work in a project;
- Is able to fully consider the interests or objectives of the ordering customer;
- Is able to plan a project independently;
- Is able to cooperate with the relevant parties involved in the project;
- Is able to adequately deal with limitations in time, information and means;
- Is able to prepare the implementation of a project result;
- Is capable of taking professional responsibility;
- Is able to take responsibility on behalf of the organisation;
- Is able to recognize the strategic aspects of his/her own project;
- Is able to provide practical solutions in matters concerning the ethical and professional codes of his/her own field of expertise and of the professional organisation.

Appendix II Tracks/Specializations of the degree programme (art. 3.5)

The Master Computing Science has four tracks:
- Intelligent Systems and Visual Computing (ISVC)
- Software Engineering and Distributed Systems (SEDS)
- Data Science and Systems Complexity (DSSC)
- Science, Business & Policy (SBP)

Appendix III Content of the degree programme (art. 3.6)

Below, the name of the module is followed by the load of study and the form of examination (p=practical, e=written exam).

The compulsory programme for **ISVC** is:
 Web and Cloud Computing (5 ECTS, pe);
 Introduction to Data Science (5 ECTS, pe);
 Modelling and Simulation (5 ECTS, p);
 Image Processing (5 ECTS, pe);
 Pattern Recognition (5 ECTS, pe);
 Neural Networks and Computational Intelligence (5 ECTS, pe);
 Student Colloquium (5 ECTS, p);
 Scientific Visualisation (5 ECTS, pe);
 Computer Vision (5 ECTS, pe);

In-company or Research Internship (15 ECTS, p);
Advanced Computer Graphics (5 ECTS, p);
Master Thesis (30 ECTS, p).

The compulsory programme for **SEDS** is:
Web and Cloud Computing (5 ECTS, pe);
Introduction to Data Science (5 ECTS, pe);
Software Architecture (5 ECTS, p);
Software Maintenance and Evolution (5 ECTS, p);
Software Patterns (5 ECTS, p);
Information Systems (5 ECTS, pe);
Student Colloquium (5 ECTS, p);
Scalable Computing (5 ECTS, pe);
Formal Modelling of Communicating Systems (5 ECTS, p);
In-company or Research Internship (15 ECTS, p);
Enterprise Application Integration (5 ECTS, pe);
Master Thesis (30 ECTS, p).

The compulsory programme for **DSSC** is:
Web and Cloud Computing (5 ECTS, pe);
Introduction to Data Science (5 ECTS, pe);
Modelling and Simulation (5 ECTS, p);
Pattern Recognition (5 ECTS, pe);
Neural Networks and Computational Intelligence (5 ECTS, pe);
Information Systems (5 ECTS, pe);
Student Colloquium (5 ECTS, p);
Scientific Visualization (5 ECTS, pe);
Scalable Computing (5 ECTS, pe);
In-company or Research Internship (15 ECTS, p);
Advanced Topics in Security and Privacy (5 ECTS, pe)
Master Thesis (30 ECTS, p).

The compulsory programme for **SBP** is:
Web and Cloud Computing (5 ECTS, pe);
Introduction to Data Science (5 ECTS, pe);
Student Colloquium (5 ECTS, p);
In-company or Research Internship* (15 ECTS, p);
Introduction Science and Business (10 ECTS, pe);
Introduction Science and Policy (10 ECTS, pe);
Internship and Thesis (40 ECTS, p).

*For the SBP-track this internship needs to take place in a CS research group (and not in a company)

Appendix IV Electives (art. 3.7)

Below, the name of the module is followed by the load of study and the form of examination (p=practical, e=written exam).

Optional modules in the programme for **ISVC** are:
15 ECTS are free choice
10 ECTS are chosen from:
Advanced Topics in Security and Privacy (5 ECTS, pe)
Modelling and Simulation (5 ECTS, p);
Robotics for IEM (5 ECTS, p);
Computational Physics (5 ECTS, pe);
Cognitive modeling: basic principles and methods (5 ECTS, p);

Computational Semantics (5 ECTS, p);
Numerical Mathematics II (5 ECTS, pe);
Statistical Signal Processing (5 ECTS, pe);
Machine Learning (5 ECTS, pe);
Scalable Computing (5 ECTS, pe);
Formal Modelling of Communicating Systems (5 ECTS, p);
Natural Language Processing (5 ECTS, p);
Statistical Genomics (5 ECTS, pe);
Numerical Mathematics I (5 ECTS, pe);
Handwriting Recognition (5 ECTS, p);
Advanced self-organisation of social systems (5 ECTS,pe);
Logical Aspects of Multi-Agent Systems (5 ECTS, p).

Optional modules in the programme **SEDS** are:
15 ECTS are free choice
10 ECTS are chosen from:
Advanced Topics in Security and Privacy (5 ECTS, pe)
Robotics for IEM (5 ECTS, p);
Pattern Recognition (5 ECTS, pe);
Process Aware Information Systems (5 ECTS, pe);
Machine Learning (5 ECTS, pe);
Scientific Visualisation (5 ECTS, pe);
Logical Aspects of Multi-Agent Systems (5 ECTS, p);
Systems Engineering (5 ECTS, p).

Optional modules in the programme **DSSC** are:
15 ECTS are free choice
10 ECTS are chosen from:
Robotics for IEM (5 ECTS, p);
Learning from Data (5 ECTS, p);
Software Maintenance and Evolution (5 ECTS, p);
Big Data in a Digital Society (5 ECTS, p).
Image Processing (5 ECTS, pe);
Statistical Signal Processing (5 ECTS, pe);
Machine Learning (5 ECTS, pe);
Fitting dynamical models to data (5 ECTS, pt);
Natural Language Processing (5 ECTS, p);
Statistical Genomics (5 ECTS, pe);
Contemporary Statistics with Applications (5 ECTS, pe);
Advanced self-organisation of social systems (5 ECTS, pe);
Systems Engineering (5 ECTS, p);

Optional modules in the programme **SBP** are:
30 ECTS are chosen from any of the compulsory or guided choice courses of the other tracks.

Appendix V Entry requirements and compulsory order of examinations (art. 4.4)

The entry requirement for the Master Thesis is successful completion of at least 60 ECTS of the Computing Science master's degree programme, including the In-company or Research Internship. The supervisor of the Master Thesis reserves the right to require successful completion of specific courses.

There are no additional entry requirements for computing science courses.

The entry requirements of an Artificial Intelligence (AI), Industrial Engineering and Management (IEM), Mathematics (MM), Biology (BIO), Physics (PH) or Arts (A) course (optional modules), specified on Ocasys, are not always met by Computing Science students. If you do not meet the entry requirements for a particular AI, IEM, MM, BIO, PH or A course, please contact the study advisor of the programme concerned, or the course coordinator of the course you want to take to discuss the possibilities for your course entry.

Appendix VI Admission to the degree programme and different tracks/specializations (art. 2.1.1 + art. 2.2)

Holders of the following Bachelor's degrees from the University of Groningen are considered to have sufficient knowledge and skills and will be admitted to the Master's degree programme in Computing Science on that basis:
- BSc Computing Science

Appendix VII Transitional provisions (art. 7.1)

Transitional arrangement for the Master's programme in Computing Science:

Discontinued course units			Substitute course units				
Course unit code	*Course unit name*	*EC TS*	*Course unit code*	*Course unit name*	*EC TS*	*Note*	*Equivalent* Yes/No*
INMDL-08	Dynamic Logic	5	(other elective)	(other elective)	5	Students in the ISVC track who wanted to take Dynamic Logic as a guided choice course, can take any other course from the list of guided choice courses for ISVC instead.	No
WMCS16000	Visual Analytics for Big Data	5	INMMS-08; or WMCS19000	Modelling & Simulation; or Advanced Topics in Security and Privacy	5	Instead of Visual Analytics for Big Data, students in the **ISVC track** need to take Modelling & Simulation as a compulsory course unit, and students in the **DSSC track** need to take Advanced Topics in Security and Privacy as a compulsory course unit.	Yes

* It is also possible to substitute equivalent course units in the other direction. This can apply to students with a large backlog who want to fall under the new TER.

Appendix VIII Application deadlines for admission (art. 2.6.1 and 2.6.3)

Programme	Deadline of Application for 1 September	Deadline of decision for 1 September	Deadline of Application for 1 February	Deadline of decision for 1 February
Computing Science	1 May 2019	1 June 2019	15 October 2019	15 November 2019