Appendices Master's degree programme Artificial Intelligence 2023 – 2024

Appendix I   Learning outcomes of the degree programme (Article 3.1)

1. The master demonstrates knowledge, understanding and the ability to evaluate, analyse and interpret relevant data, all on a level that builds on and surpasses the level of the bachelor Artificial Intelligence, in at least five of the research areas below. In one research area of Artificial Intelligence the master has specialised knowledge at an advanced level.

    a. The symbolic approach to Artificial Intelligence
    b. The numerical, non-symbolic approach to Artificial Intelligence
    c. Computational theories of perception and cognition
    d. Agent systems
    e. Linguistics and language technology
    f. Autonomous systems and robotics
    g. Machine learning and pattern recognition

2. The master demonstrates knowledge and understanding, on a level that builds on and surpasses the level of the bachelor Artificial Intelligence, in the empirical sciences (Psychology, Biology and Physics) and has experience applying and analysing results thereof.

3. The master demonstrates relevant knowledge and the ability to apply methods and techniques from mathematics and logic used in Artificial Intelligence.

4. The master demonstrates relevant knowledge and the ability to use algorithms, data structures and important programming languages used in Artificial Intelligence.

5. The master has the ability to, on an international academic level, analyse problems, critically and constructively review both one's own and other scientific results, even if incomplete, and communicate about this both individually as in a group, both oral and in written form, also in a broader societal context, to both specialists and nonspecialists.

6. The master has the ability to critically reflect on his/her own working method and knowledge and to recognize the need for continued learning on a high degree of autonomy, and is able to understand the scientific developments within the field of Artificial Intelligence.

Appendix II Tracks/Specializations of the degree programme (Article 3.6)

The Artificial Intelligence MSc Programme has no tracks.

The Artificial Intelligence MSc Programme has three specializations. These specializations are a mandatory direction that guarantees a student is able to take a graduation project in the relevant area by the end of the specialization.

Students must choose one of the following specializations:
a) Computational Learning
b) Multi-Agent Systems
c) Robotics

Appendix III Content of the degree programme (Article 3.8)

The master programme consists of mandatory courses (70 ECTS), specialization courses (15 ECTS) and elective courses (35 ECTS, see appendix IV). Course details including modes of instruction, and modes of assessment are described in OCASYS.

Mandatory course units

Course code	Course unit name	ECTS
WMAI017-05	Deep Learning	5
WMAI004-05	Design of Multi-Agent Systems	5
WMAI901-45	Final Research Project	45
WMAI010-05	Machine Learning	5
WMAI026-05	Methodology in Artificial Intelligence	5
WMAI025-05	Topics in Artificial Intelligence	5

In addition to the general mandatory programme, students have to take the mandatory course units of one of the three programme specializations.

Specializations and their mandatory course units

Computational Learning

Course code	Course name	ECTS
WMAI024-05	Deep Reinforcement Learning	5
WMAI019-05	Handwriting Recognition	5
WMAI021-05	Pattern Recognition	5

Multi-Agent Systems

Course code	Course name	ECTS
WMAI001-05	Arguing Agents	5
WMAI016-05	Computational Social Choice	5
WMAI020-05	Logical Aspects of Multi-Agent Systems	5

Robotics

Course code	Course name	ECTS
WMAI003-05	Cognitive Robotics	5
WMAI021-05	Pattern Recognition	5
WMAI011-05	Robotics for Artificial Intelligence	5

Appendix IV   Elective course units
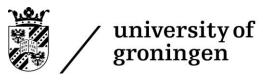## (Article 3.9.1)

In addition to the general mandatory course units and the specialization mandatory course units, the programme comprises elective course units (35 ECTS). Students can either choose pre-approved electives or free electives. For free electives they need to request the formal approval of the Board of Examiners.

Pre-approved elective course units from AI/CCS

Course code	Course unit name	ECTS
WMCC007-05	Applied Cognitive Engineering	5
WMAI001-05	Arguing Agents	5
WMCC001-05	Cognitive Engineering	5
WMCC006-05	Cognitive Modelling: Basic Principles and Methods	5
WMCC008-05	Cognitive Modelling: Complex Behaviour	5
WMAI003-05	Cognitive Robotics	5
WMAI023-05	Collective Intelligence	5
WMCC010-05	Computational Cognitive Neuroscience	5
WMCC009-05	Computational Simulations of Language	5
WMAI016-05	Computational Social Choice	5
WMAI024-05	Deep Reinforcement Learning	5
WMAI019-05	Handwriting Recognition	5
WMCC003-05	Language Modelling	5
WMAI020-05	Logical Aspects of Multi-Agent Systems	5
WMCC014-05	Models of Human-Syntax Processing	5
WMCC011-05	Neuro-ergonomics	5
WMCC016-05	Non-Invasive Brain-Computer Interfaces	5
WMAI021-05	Pattern Recognition	5
WMAI011-05	Robotics for Artificial Intelligence	5
WMCC004-05	User Models	5

Pre-approved elective course units from other degree programmes

Course code	Course unit name	ECTS
WMCS006-05	Advanced Computer Graphics	5
WMCS001-05	Advanced Topics in Security and Privacy	5
WMBC002-05	Auditory and Visual Perception	5
WMCS032-05	Cloud Computing and Cloud-Based Applications	5
LIX021M05	Computational Semantics	5
WMCS015-05	Computer Vision	5
WMCS030-05	Ethical Hacking	5
WMCS022-05	Fundamentals of Distributed Systems	5
WMCS002-05	Introduction to Data Science	5
WMSE001-10	Introduction Science and Business [a]	10
WMSE002-10	Introduction Science and Policy [a]	10
LIX025M05	Language Technology Project	5
WMCS027-05	Modal Logic and Proof Theory	5
LIX001M05	Natural Language Processing	5
WMCS010-05	Neural Networks and Computational Intelligence	5

WMPH044-05	Neuromorphic Circuit Design	5
WMCS029-05	Perception for Visual Computing	5
WMIE005-05	Robotics for Industrial Engineering and Management	5
WMEC006-05	Skills in Science Communication	5
WMCS018-05	Scientific Visualization	5
LIX002M05	Semantic Web Technology	5
WMCS028-05	Social Network Analysis	5

a) This course yields 10 ECTS credit points. One can take either Introduction Science and Business or Introduction Science and Policy, and will only be awarded credit points for one of the two course units.

Formal approval of the Board of Examiners is required, in case and before a student would like to choose electives which are not on the above lists of pre-approved electives.
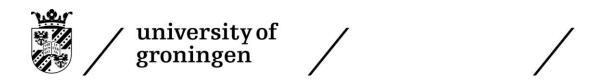
Appendix V Entry requirements and compulsory order of examinations
(Article 4.4)

Course unit name and code	Entry requirements
Deep Reinforcement Learning [WMAI024-05]	Deep Learning [WMAI017-05]
Final Research Project [WMAI901-45]	At least 60 ECTS credit points from the master's programme Deep Learning [WMAI017-05] Design of Multi-Agent Systems [WMAI004-05] Machine Learning [WMAI007-05] Methodology in AI [WMAI026-05] Topics in AI [WMAI025-05] Completion of the specialization relevant to the final research project

Handwriting Recognition [WMAI019-05] has Signals and Systems [WBAI016-05] as a strongly recommended course unit. Students who did not take the BSc Artificial Intelligence are advised to (have) take(n) a comparable course unit on signal processing.

Logical Aspects of Multi-Agent Systems [WMAI020-05] has Advanced Logic [WBAI017-05] as a strongly recommended course unit. Students who did not take the BSc Artificial Intelligence are advised to (have) take(n) a comparable course unit.

Collective Intelligence [WMAI023-05] has Introduction to Logic [WBAI012-05 or WBAI013-05] as a strongly recommended course unit, and Advanced Logic [WBAI017-05] as a recommended course unit. Students who did not take the BSc Artificial Intelligence are advised to (have) take(n) comparable course units.

Appendix VI Admission to the degree programme (Article 2.1A and 2.1B)

The Artificial Intelligence Master programme has a selection procedure. This means that an applicant must both meet the admission requirements and successfully complete a selection procedure in order to be admitted to the programme.

1. Requirements for admission to the selective Master's degree programme Artificial Intelligence

Applicants have to fulfil the following admission requirements:

- An academic Bachelor's degree in Artificial Intelligence or a related field including the following key subjects: Calculus, Linear Algebra, Probability & Statistics, Advanced Programming, Machine Learning, Advanced Logic, Neural Networks, Research Methodology Skills.
- Sufficient English proficiency: see basic TER Article 2.2

2. Application procedure

All candidates have to file an admission request via the FSE Application form, and upload the following documents before 1 May (start 1 September):

- ID card or passport
- Diploma of relevant Bachelor's degree programme (if possible); or if the diploma is not yet obtained, a document containing a description + planning of the remaining course units in the programme
- Official transcript of records
- Proof of English language proficiency
- Curriculum Vitae
- The completely filled-in Checklist for AI including appendices: reference contact/letter, motivation, relevant content Bachelor's degree programme, written report in English

After candidates have filed their admission request, applications will be processed in the following way:

For holders of a Dutch BSc diploma:

> 1. Admission Support FSE compiles the individual selection file
> 2. Admission Support FSE submits the individual selection file to the Admission Board of the individual programme

For holders of a non-Dutch BSc diploma:

> 1. Admissions Office compiles the individual selection file
> 2. Admissions Office validates individual Bachelor's degree diploma
> 3. Admissions Office submits the individual selection file to Admission Support FSE
> 4. Admission Support FSE submits the individual selection file to the Admission Board of the individual programme

3. Selection procedure

In order to select academically suited and motivated students, the Admission Board requires a complete selection file from all candidates. The Admission Board will review all individual applicants on the basis of their selection file. All admissible candidates will be rated on the selection criteria 'academic performance' and 'motivation', as specified below.

At least two members of the Admission Board score the applicants on the selection criteria. Scoring is on a 5-point scale from 1 to 5 (1 = insufficient, 2 = sufficient, 3 = amply sufficient, 4 = good, 5 = very good). If the scores on academic performance and/or motivation deviate 1 point or more between members, they have to confer, after which they grade a second time. This outcome constitutes the final score.

Candidates are selected if they receive an average score of at least 3.0 on both 'academic performance' and 'motivation', AND a weighted average score of at least 3.5.

1. Academic performance (60%)

The score on academic performance is the result of the scores on relevance (70%), and proficiency (30%).

- **Relevance and affiliation/fit** of the followed bachelor programme to the master programme (list of subjects/courses followed and grades obtained; brief description of the content of key subjects/courses demonstrating the knowledge and skill(s) acquired by the student).

  Key subjects:
  Calculus, Linear Algebra, Probability & Statistics, Advanced Programming, Machine Learning, Advanced Logic, Neural Networks, Research Methodology Skills

  Please consult our online catalogue www.rug.nl/ocasys/ for the intended learning outcomes of the course units that adhere to these subjects.

- **Proficiency** in: (1) formulating scientific research questions and completing an academic assignment in the context of the programme, and in individually producing a written report on the assignment topic. The report has to reflect the student's ability to produce a well-structured and concise report, adhering to the rules of scientific writing. The assignment handed in is free of choice, and can be a bachelor thesis; report on a practicum, experiment, or field-work; a literature review; a published peer-reviewed research paper, etc.[1] (2) programming for machine learning, image processing, robotics, and/or knowledge-based & multi-agent systems. (3) advanced statistical data analysis.

  [1]*If the student has not made an individually written report during the bachelor programme he/she should contact the selection committee to receive an assignment on the basis of which a written report can be prepared.*

2. Motivation (40%)

The candidate has to provide a motivation (500 words) for the application, by answering the following questions:

1. *Why did you choose this specific master's degree programme?*

2. *How did the bachelor's degree programme, extracurricular activities, and/or other experiences prepare you for this specific master programme?*

3. *In case it took you longer than nominal to acquire the bachelor degree, please briefly explain the cause(s) of the delay.*

4. *How does this master's degree programme prepare you for your future career and/or serve your ambitions?*

5. *The master programme contains a large research project of 45 ECTS. On what topic and under supervision of which researcher(s) at the University of Groningen would you like to carry out your project? Please motivate your choices.*

6. *Free space to mention anything you feel is relevant and is not addressed by the questions above.*

Timeline for the application and selection procedure

The application procedure for the start on the 1st of September will open on the 1st of October and close on the 1st of May. The details of the entire application procedure are published on the *Admission and Application* website for the individual Master's degree programme.

The Admission Board will carry out the selection procedure within six weeks after the application.

Candidates who are not selected can lodge a written appeal against this decision within four weeks of the date of sending, with the Board of Appeal for Examinations, P.O. Box 72, 9700 AB Groningen, the Netherlands.

Appendix VII   Transitional provisions
(Article 7.1)

To prevent negative effects of curriculum changes on students who were already registered in the programme before these changes were made, the following transitional provisions apply. The provisions are listed in reverse-chronological order. General provisions are described through text. Course units that are a direct replacement for discontinued course units are listed in table format.

Students who started in 2022-2023 or before:

From 23-24 onwards, Topics in AI (WMAI025-05) and Methodology in AI (WMAI026-05) are part of the mandatory programme. Students who started in 22-23 or before do not have to include these courses in their mandatory programme.

From 23-24 onwards, the specialization Computational Intelligence is replaced by the specialization Computational Learning.

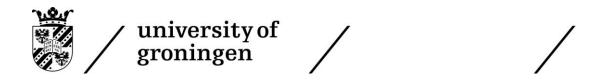| Specialization	Course code	Course unit name	ECTS
Computational Intelligence	WMAI003-05 WMAI019-05 WMAI021-05	Cognitive Robotics Handwriting Recognition Pattern Recognition	5 5 5
From 2023-2024 onwards replaced by			
Computational Learning	WMAI024-05 WMAI019-05 WMAI021-05	Deep Reinforcement Learning Handwriting Recognition Pattern Recognition	5 5 5

Students who started in 22-23 or before are allowed to include Cognitive Robotics instead of Deep Reinforcement Learning as part of the mandatory course package for the specialization Computational Learning.
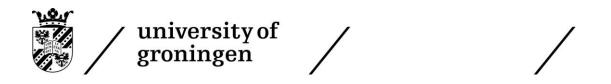
Students who started in 2021–2022 or before:

There are no transitional provisions for the year 2021–2022.

Students who started in 2020–2021 or before:

Discontinued course unit			Replacement course unit		
Course code	Course name	ECTS	Course code	Course name	ECTS
WMCS011-05	Pattern Recognition	5	WMAI021-05	Pattern Recognition	5

Cases not listed in the Teaching and Examination Regulations, through either the current curriculum or the transitional provisions, are to be treated by the Board of Examiners of the degree programme.

Appendix VIII   Additional requirements Open degree programmes
(Article 3.10)

Students are permitted to obtain a diploma in the Artificial Intelligence MSc programme without fully fitting the curriculum set out in Appendix III and Appendix IV. This can only happen in consultation with and after approval of the Board of Examiners of the degree programme. Students are required to finish a MSc Project, to guarantee they are able to function as a MSc level researcher in line with the Dublin level descriptors / Framework for Qualifications of the European Higher Education Area, and are required to fit the Learning Outcomes of the programme (set out in Appendix I). These Learning Outcomes have been established in accordance with the AI MSc Framework of Reference of the Netherlands.