

UK 066/993

CURRICULUM FOR THE
MASTER'S PROGRAM IN
ARTIFICIAL INTELLIGENCE.



(in English)



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Contents

§ 1 Qualification Profile	3
§ 2 Admissions	4
§ 3 Structure and Outline	5
§ 4 Mandatory Subjects/Modules	5
§ 5 Elective Subjects/Modules	6
§ 6 Courses	6
§ 7 Master's Thesis	6
§ 8 Examination Regulations	7
§ 9 Academic Degree	7
§ 10 Legal Validity	7

§ 1 Qualification Profile

(1) Artificial Intelligence (AI) refers to the ability of machines to perform cognitive tasks commonly associated with human intelligence including perception, learning, reasoning, planning, speech and language, and taking actions. Conceived more than five decades ago with the vision of understanding and emulating human intelligence, AI has since evolved towards a broadly applicable engineering discipline in which algorithms and data are brought together in order to solve a variety of problems in pattern recognition, learning, and decision making. Currently, AI pervades commercial applications in an unprecedented manner and is fundamentally changing how businesses operate across virtually all sectors, including manufacturing, healthcare, education, information technology, finance, and transportation. Concerning the impact of AI on industry and economy, experts frequently state that “data is the new oil, while AI is the new electricity”.

(2) The recent surge of AI can mainly be attributed to advances in machine learning, in particular deep learning, where algorithms learn from examples and experience rather than relying on predefined rules. Artificial deep neural networks trained by modern learning algorithms on massive datasets can achieve outstanding and sometimes super-human performance in various fields such as computer vision, speech recognition, and medical applications. Modern developments in AI have created the current vision of a general artificial intelligence, a machine that could successfully perform any cognitive task by virtue of its sensory perception, previous experience, learned skills, and world knowledge. Such a general AI would affect every application area since it could be deployed as an intelligent and highly skilled raw model for learning or deducing specialized solutions for any problem.

(3) AI is, by its nature, an interdisciplinary subject drawing upon computer science, mathematics, robotics, psychology, linguistics, philosophy, and many other fields. The Master program in Artificial Intelligence at Johannes Kepler University (JKU) Linz offers a thorough and methodical education in modern developments in the field of AI, in particular in deep learning. In addition, the students will acquire practical training, learn about the connections of AI to the legal system as well as its sociological implications, and acquire in-depth knowledge in their chosen elective track, where they will be capable of solving complex problems using scientific methods.

(4) Students of the Master program choose one out of four possible elective tracks. These are “AI and Mechatronics – Robotics and Autonomous Systems”, “AI and Mechatronics – Embedded Intelligence and Signal Processing”, “Reasoning and Knowledge Representation”, and “AI and Life Sciences”.

1. “AI and Mechatronics – Robotics and Autonomous Systems”: In this elective track, students learn to apply AI techniques to robotics and autonomous systems. Robotics deals with the construction and operation of robots as well as computer systems for their control, sensory feedback, and information processing. Autonomous systems include self-driving cars, autonomous drones, and production systems that work independent of human control. Robots and other autonomous machines are steered by control techniques such as adaptive optimal control known as reinforcement learning in the field of AI. AI methods concerning the perception and model-building of the environment, planning, and self-localization are crucial for robotics and autonomous systems. These techniques can be complemented by learning a model from data in contrast to classical techniques in mechatronics.
2. “AI and Mechatronics – Embedded Intelligence and Signal Processing”: In this elective track, students learn skills and tools to embed AI into sensors and devices in order to make machines, production lines, and even factories more intelligent. AI techniques analyzing the data from these sensors and devices can optimize maintenance, logistics, scheduling, marketing, and many other processes. An important aspect is signal processing which analyzes the data coming from sensors and embedded devices that monitor the environment, such as cameras, radar, lidar, ultra sound, and chemical detectors.

3. "Reasoning and Knowledge Representation": Classical methods in AI rely on symbolic reasoning based on logic and mathematics. The focus of this elective track is on such deductive reasoning, including model checking and theorem proving. These techniques are also essential for software and hardware verification. Together with computer algebra they provide advanced tools to develop and reason about machine learning in a formal way.
4. "AI and Life Sciences": In this elective track, the students learn to apply AI techniques in medicine, biology, biotechnology, genomics, genetics, and other life science fields. In structural bioinformatics, AI methods like deep neural networks predict the structure and function of proteins. In drug design, AI techniques identify side effects of drug candidates. In medicine and health care, AI methods allow analyzing medical images, predicting the prevalence of diseases in certain regions, optimizing processes in hospitals, improving diagnosis, supporting treatment, and monitoring patients.

(5) All four elective tracks make use of existing academic excellence and infrastructure at JKU. The two elective tracks in mechatronics are tailored to the strong local industrial environment in manufacturing systems engineering, plant construction, and general engineering. Students will acquire skills to embed AI technologies into robots, autonomous systems, machinery, and equipment and to extract and analyze data from such devices.

(6) This Master program prepares its graduates both for subsequent PhD studies and for the immediate entry into the job market, where graduates will be able to develop AI solutions in many different sectors of industry and economy.

§ 2 Admissions

(1) In accordance with § 54 para. 1 UG the Master's program in Artificial Intelligence belongs to the category of engineering degrees and is taught in English.

(2) The Master's program in Artificial Intelligence is based on the Bachelor's program in Artificial Intelligence at JKU. Graduates of this Bachelor's program are admitted to the Master's program without any restrictions.

(3) Graduates of Artificial Intelligence or related programs at Universities, Universities of Applied Sciences, and other recognized national or international post-secondary educational institutions can be admitted to the Master's program in Artificial Intelligence if their degree programs are equivalent to the Bachelor's program in Artificial Intelligence at JKU. Differences between programs can be compensated by replacing one or more courses from the subject Area of Specialization with courses specified in the notification of admission.

(4) In addition, graduates of the JKU Bachelor's programs in "Informatik", "Technische Mathematik", "Technische Physik", "Mechatronik", "Elektronik und Informationstechnik", "NaWi-Tec", "Statistik", "Wirtschaftsinformatik", and "Bioinformatics" are admitted to the Master's program in Artificial Intelligence if they have completed the following courses at JKU (9 ECTS): "Machine Learning: Supervised Techniques" (VL, 3 ECTS), "Machine Learning: Unsupervised Techniques" (VL, 3 ECTS), and either "Statistics for AI" (VL, 3 ECTS) or "Statistik" (VO, 3 ECTS) or "Basic Methods of Data Analysis" (KV, 3 ECTS). If graduates of these studies have not completed these courses yet, they are nonetheless admitted to enroll to the Master's program but, as a condition, have to complete these courses within the Master's program. The corresponding acquired ECTS points can be used for the subject Area of Specialization or the Free Electives.

(5) Graduates of Bachelor's programs or related programs at Universities, Universities of Applied Sciences, and other recognized national or international post-secondary educational institutions can be admitted to the Master's program in Artificial Intelligence if their degree programs are equivalent to one of the Bachelor's programs at JKU listed in para. 4 under the same admission

condition as in para. 4. Differences between programs can be compensated by replacing one or more courses from the subject Area of Specialization with courses specified in the notification of admission.

(6) Graduates of programs that are not equivalent according to para. 3 or 5 can be granted admission on the condition to complete additional courses with up to 20 ECTS points during their Master's study.

(7) Graduates of a Diploma program with a longer duration than a Bachelor's program can obtain recognition for examinations of the Master's program (see § 78 UG) to the extent by which the Diploma program (excluding the diploma thesis) exceeds the Bachelor's program.

§ 3 Structure and Outline

(1) The Master's program in Artificial Intelligence covers 4 semesters and consists of 120 ECTS points, which are distributed among the following subjects:

Subjects	ECTS
Mandatory Subjects	66/64.75/64.5/67.5
Elective Tracks	16.5/17.75/18/15
Master's Thesis (incl. Master's Thesis Seminar)	24
Master's Examination	1.5
Free Electives	12
Total	120

(2) For Free Electives students have to pass examinations corresponding to 12 ECTS points, which can be chosen from any recognized national or international post-secondary educational institution. The Free Electives shall provide additional skills beyond Artificial Intelligence and can be taken anytime during the Master's study.

(3) The four recommended courses of studies are shown in the annex.

§ 4 Mandatory Subjects/Modules

The following subjects have to be completed successfully:

Code	Name	ECTS
993MLPE19	Machine Learning and Perception	34.5
993SEPT19	Seminar and Practical Training	10.5
993AISO19	AI and Society	10.5
993ARSP19	Area of Specialization	10.5/9.25/9/12

§ 5 Elective Subjects/Modules

Students have to choose one out of these four elective tracks:

Code	Name	ECTS
993TAMR19	AI and Mechatronics – Robotics and Autonomous Systems	16.5
993TAME19	AI and Mechatronics – Embedded Intelligence and Signal Processing	17.75
993TARK19	Reasoning and Knowledge Representation	18
993TALS19	AI and Life Sciences	15

§ 6 Courses

(1) The names and the types of all courses of the mandatory subjects and the elective tracks as well as their ECTS points, their duration in hours per week, their codes, their registration requirements, and their admission procedures (in case of limited availability of places) are described in the study handbook of JKU (studienhandbuch.jku.at).

(2) The possible types of courses as well as the examination regulations are described in §§ 13 and 14 of the JKU statute (Section "Studienrecht").

(3) Courses of mandatory subjects and of the elective tracks that have already been used for the admission-granting Bachelor degree can be substituted by courses from the subject Area of Specialization with at least the same amount of ECTS points. Each such substituting course from the subject Area of Specialization then belongs to the mandatory subject or elective track of the replaced course.

§ 7 Master's Thesis

(1) Students of the Master's program in Artificial Intelligence must write a Master's thesis according to § 81 UG and § 36 of the JKU statute (Section "Studienrecht").

(2) The Master's thesis is a written scientific document corresponding to an effort of 21 ECTS points.

(3) The Master's thesis serves as a proof that graduates are able to perform scientific work autonomously and systematically. The topic of the thesis must be taken from the mandatory subjects or elective tracks and must permit completion within 6 months.

(4) The Curricular Committee for Artificial Intelligence may specify guidelines for the formal structure of a Master's thesis.

(5) In addition to the Master's thesis, students must pass the "Master's Thesis Seminar in AI" with 3 ECTS points.

§ 8 Examination Regulations

(1) The regulations for subject examinations and course examinations are described in the study handbook of JKU.

(2) The Master's program in Artificial Intelligence is concluded by a Master's examination.

(3) The Master's examination consists of two parts: The first part is the successful completion of the mandatory subjects and the elective track according to §§ 4 and 5.

(4) The second part of the Master's examination is a comprehensive oral exam (worth 1.5 ECTS points) conducted by an examination committee. Prior to being admitted to the Master's examination, students must complete the first part of the Master's examination, the Master's thesis, the Master's thesis seminar in AI, and the free electives.

(5) The second part of the Master's examination starts with a presentation and defense of the Master's thesis, followed by an oral exam that covers content of the mandatory subjects and the chosen elective track. If courses are replaced by compensation courses as a result of the admission process (§ 2), the examination topics include the contents of the compensation courses.

(6) The examination committee consists of three members and is formed by the Vice Rector of Academic Affairs. The candidate may submit a proposal for the committee members. In general, the advisor of the Master's thesis is a member of the examination committee. The head of the committee suggests the assessment of the presentation and the defense of the thesis. The other two examiners suggest the assessment of the examinations in the mandatory subjects and the elective track, respectively.

§ 9 Academic Degree

(1) Graduates of the Master's program in Artificial Intelligence are awarded the academic degree "Master of Science", abbreviated "MSc" or "MSc (JKU)".

(2) The certificate about the academic degree is issued in English and in German.

§ 10 Legal Validity

This curriculum comes into effect on October 1st, 2019.

Annex 1: Global map of study subjects – Master's Program "Artificial Intelligence" (2019)

Elective Track: AI and Mechatronics – Robotics and Autonomous Systems

1 st Semester (WS)		2 nd Semester (SS)		3 rd Semester (WS)		4 th Semester (SS)		
Subject/Course	ECTS	Subject/Course	ECTS	Subject/Course	ECTS	Subject/Course	ECTS	
Machine Learning and Perception Computer Vision (4.5 KV) Deep Learning and Neural Nets I (3 VL) Deep Learning and Neural Nets I (1.5 UE) LSTM and Recurrent Neural Nets (3 VL) LSTM and Recurrent Neural Nets (1.5 UE)	13.5	Machine Learning and Perception Deep Learning and Neural Nets II (3 VL) Deep Learning and Neural Nets II (1.5 UE) Deep Reinforcement Learning (4.5 KV) Theoretical Concepts of Machine Learning (3 VL) Theoretical Concepts of Machine Learning (1.5 UE)	13.5	Machine Learning and Perception Explainable AI (3 KV) Probabilistic Models (3 VL) Probabilistic Models (1.5 UE)	7.5			34.5
AI and Society AI and Law I (3 VL) Artificial Intelligence in Society (1.5 KV)	4.5	AI and Society AI and Law II (1.5 VL) Robopsychology (3 KV)	4.5	AI and Society Communicating AI (1.5 KV)	1.5			10.5
				Seminar and Practical Training Seminar in AI (Master) (3 SE) Practical Work in AI (Master) (7.5 PR)	10.5			10.5
Elective Track: AI and Mechatronics – Robotics and Autonomous Systems Control Systems (3 VL) Control Systems (1.5 UE) Production Automation Systems (3 VL)	7.5	Elective Track: AI and Mechatronics – Robotics and Autonomous Systems Introduction to Autonomous Systems (3 VL) Introduction to Autonomous Systems (1.5 UE) Introduction to Robotic Systems (3 VL) Introduction to Robotic Systems (1.5 UE)	9.0					16.5
Area of Specialization	1.5	Area of Specialization	1.5	Area of Specialization	7.5			10.5
Free Electives	3.0	Free Electives	1.5	Free Electives	3.0	Free Electives	4.5	12.0
						Master's Thesis Seminar	3.0	3.0
						Master's Examination	1.5	1.5
						Master's Thesis	21.0	21.0
	30.0		30.0		30.0		30.0	

Total ECTS: 120.0

Annex 2: Global map of study subjects – Master's Program "Artificial Intelligence" (2019)

Elective Track: AI and Mechatronics – Embedded Intelligence and Signal Processing

1 st Semester (WS)		2 nd Semester (SS)		3 rd Semester (WS)		4 th Semester (SS)		
Subject/Course	ECTS	Subject/Course	ECTS	Subject/Course	ECTS	Subject/Course	ECTS	
Machine Learning and Perception Computer Vision (4.5 KV) Deep Learning and Neural Nets I (3 VL) Deep Learning and Neural Nets I (1.5 UE) LSTM and Recurrent Neural Nets (3 VL) LSTM and Recurrent Neural Nets (1.5 UE)	13.5	Machine Learning and Perception Deep Learning and Neural Nets II (3 VL) Deep Learning and Neural Nets II (1.5 UE) Deep Reinforcement Learning (4.5 KV) Theoretical Concepts of Machine Learning (3 VL) Theoretical Concepts of Machine Learning (1.5 UE)	13.5	Machine Learning and Perception Explainable AI (3 KV) Probabilistic Models (3 VL) Probabilistic Models (1.5 UE)	7.5			34.5
AI and Society AI and Law I (3 VL) Artificial Intelligence in Society (1.5 KV)	4.5	AI and Society AI and Law II (1.5 VL) Robopsychology (3 KV)	4.5	AI and Society Communicating AI (1.5 KV)	1.5			10.5
				Seminar and Practical Training Seminar in AI (Master) (3 SE) Practical Work in AI (Master) (7.5 PR)	10.5			10.5
Elective Track: AI and Mechatronics – Embedded Intelligence and Signal Processing Pervasive Computing: Systems and Environments (3 VL) Pervasive Computing: Systems and Environments (1.5 UE) Optimale und Adaptive Signalverarbeitungssysteme (3 VL) Optimale und Adaptive Signalverarbeitungssysteme (1.5 UE)	9.0			Elective Track: AI and Mechatronics – Embedded Intelligence and Signal Processing Pervasive Computing: Design and Development (3 VL) Pervasive Computing: Design and Development (1.5 UE) Radarsignalverarbeitung (3 VL) Radarsignalverarbeitung (1.25 UE)	8.75			17.75
Area of Specialization	1.5	Area of Specialization	7.75					9.25
Free Electives	1.5	Free Electives	4.25	Free Electives	1.75	Free Electives	4.5	12.0
						Master's Thesis Seminar	3.0	3.0
						Master's Examination	1.5	1.5
						Master's Thesis	21.0	21.0
	30.0		30.0		30.0		30.0	

Total ECTS: 120.0

Annex 3: Global map of study subjects – Master's Program "Artificial Intelligence" (2019)

Elective Track: Reasoning and Knowledge Representation

1 st Semester (WS)		2 nd Semester (SS)		3 rd Semester (WS)		4 th Semester (SS)		
Subject/Course	ECTS	Subject/Course	ECTS	Subject/Course	ECTS	Subject/Course	ECTS	
Machine Learning and Perception Computer Vision (4.5 KV) Deep Learning and Neural Nets I (3 VL) Deep Learning and Neural Nets I (1.5 UE) LSTM and Recurrent Neural Nets (3 VL) LSTM and Recurrent Neural Nets (1.5 UE)	13.5	Machine Learning and Perception Deep Learning and Neural Nets II (3 VL) Deep Learning and Neural Nets II (1.5 UE) Deep Reinforcement Learning (4.5 KV) Theoretical Concepts of Machine Learning (3 VL) Theoretical Concepts of Machine Learning (1.5 UE)	13.5	Machine Learning and Perception Explainable AI (3 KV) Probabilistic Models (3 VL) Probabilistic Models (1.5 UE)	7.5			34.5
AI and Society AI and Law I (3 VL) Artificial Intelligence in Society (1.5 KV)	4.5	AI and Society AI and Law II (1.5 VL) Robopsychology (3 KV)	4.5	AI and Society Communicating AI (1.5 KV)	1.5			10.5
				Seminar and Practical Training Seminar in AI (Master) (3 SE) Practical Work in AI (Master) (7.5 PR)	10.5			10.5
Elective Track: Reasoning and Knowledge Representation Computer Algebra (3 VL) Computer Algebra (1.5 UE) Model Checking (4.5 KV)	9.0	Elective Track: Reasoning and Knowledge Representation Symbolic AI (3 VL) Symbolic AI (1.5 UE)	4.5	Elective Track: Reasoning and Knowledge Representation Automated Reasoning (3 VL) Automated Reasoning (1.5 UE)	4.5			18.0
Area of Specialization	1.5	Area of Specialization	4.5	Area of Specialization	3.0			9.0
Free Electives	1.5	Free Electives	3.0	Free Electives	3.0	Free Electives	4.5	12.0
						Master's Thesis Seminar	3.0	3.0
						Master's Examination	1.5	1.5
						Master's Thesis	21.0	21.0
	30.0		30.0		30.0		30.0	

Total ECTS: 120.0

Annex 4: Global map of study subjects – Master's Program "Artificial Intelligence" (2019)

Elective Track: AI and Life Sciences

1 st Semester (WS)		2 nd Semester (SS)		3 rd Semester (WS)		4 th Semester (SS)		
Subject/Course	ECTS	Subject/Course	ECTS	Subject/Course	ECTS	Subject/Course	ECTS	
Machine Learning and Perception Computer Vision (4.5 KV) Deep Learning and Neural Nets I (3 VL) Deep Learning and Neural Nets I (1.5 UE) LSTM and Recurrent Neural Nets (3 VL) LSTM and Recurrent Neural Nets (1.5 UE)	13.5	Machine Learning and Perception Deep Learning and Neural Nets II (3 VL) Deep Learning and Neural Nets II (1.5 UE) Deep Reinforcement Learning (4.5 KV) Theoretical Concepts of Machine Learning (3 VL) Theoretical Concepts of Machine Learning (1.5 UE)	13.5	Machine Learning and Perception Explainable AI (3 KV) Probabilistic Models (3 VL) Probabilistic Models (1.5 UE)	7.5			34.5
AI and Society AI and Law I (3 VL) Artificial Intelligence in Society (1.5 KV)	4.5	AI and Society AI and Law II (1.5 VL) Robopsychology (3 KV)	4.5	AI and Society Communicating AI (1.5 KV)	1.5			10.5
				Seminar and Practical Training Seminar in AI (Master) (3 SE) Practical Work in AI (Master) (7.5 PR)	10.5			10.5
		Elective Track: AI and Life Sciences Artificial Intelligence in Life Sciences (3 KV) Genome Analysis & Transcriptomics (3 KV) Structural Bioinformatics (3 KV)	9.0	Elective Track: AI and Life Sciences Medical Imaging (4.5 VL) Medical Imaging (1.5 UE)	6.0			15.0
Area of Specialization	9.0	Area of Specialization	1.5		1.5			12.0
Free Electives	3.0	Free Electives	1.5	Free Electives	3.0	Free Electives	4.5	12.0
						Master's Thesis Seminar	3.0	3.0
						Master's Examination	1.5	1.5
						Master's Thesis	21.0	21.0
	30.0		30.0		30.0		30.0	

Total ECTS: 120.0