MULTI-AGENT SYSTEMS (EMaCS-02-13)				
DEGREE PROGRAM:		Master in Computer Science for the Human-Centric and Sustainable Industry		
SEMESTER: Second	**TYPE:** Basic	**CREDITS:** 6 ECTS	**WORKLOAD:** 150 hours	**MENTORING:** 3 hours/week
LANGUAGE: English				

OBJECTIVES	
General	Providing theoretical and practical knowledge on designing intelligent systems by using parallel and distributed computing
Specific	• Study of multi-agent models and architectures. • Integrate various AI based analytics methods. • Be able to identify problems where distributed agent-based modelling is suitable. • Be able to design autonomous agent-based analytics platforms and solutions. • Be aware of AI/ML methods characteristics and fundamentals and how they relate to different agent-based solutions. • Be able to integrate agent-based solutions into existing solutions and platforms. • Be familiar with state-of-the-art agent platforms.

SUSTAINABILITY

- The students will learn how to use multi-agent systems to model complex interactions, optimize resource usage, facilitate collaborative decision-making, all of these being instrumental in developing sustainable practices and solutions.

RESILIENCE AND HUMAN-CENTRIC DEVELOPMENT

- The students will gather skills on creating recommender systems which relies on the user profile and adaptive user interfaces that adjust based on user behaviour, preferences, and context.
- The student will learn how to design resilient multi-agent systems, i.e. systems which adapt to changing conditions, uncertainties, and unforeseen events.

SUBJECT MATTER

Lecture:

- Overview of intelligent systems
- Distributed problem solving
- Parallel algorithms in AI (Knowledge representation; Rules compilation; Reasoning).
- Agent based systems
- Blackboard model (Distributed expert systems; Cooperation models; Classification of blackboard systems; Applications)
- Multi-agent models (Foundations; Agents classification; Interaction and cooperation; Communication; Collaboration and coordination, Mobile agents, Security)

Lab activity:

- Parallel algorithms and architectures for rule-based systems
- Expert systems / MAS developed on: Clips, Jess, FuzzyJess, GBB, BBClips, JADE, SpadeOAA, Cougaar etc.
- Application specific distributed agent-based software such as Serf and Consul developed by Hashicorp.

COMPETENCES

- C5: PROGRAMMING
- C6: USING MACHINE LEARNING AND A.I. TECHNIQUES
- C10: EXPLORATORY AND CRITICAL THINKING
- C11: PROBLEM FRAMING
- C13: CREATIVELY USING DIGITAL TECHNOLOGIES
- C17. COMMUNICATING EFFECTIVELY

LEARNING OUTCOMES	
Knowledge	• Know concepts related to distributed computational models. • Know concepts related to agents and multi-agent systems.
Skills	• Ability to design, implement and use multi-agent architectures. • Ability to use agent-based software in various practical contexts. • Ability to create solutions to complex problems with limited definition that are related to technical problems when operating devices and using digital environments.
Attitudes/values	• Consider ethics (including but not limited to human agency and oversight, transparency, non-discrimination, accessibility, and biases and fairness) as one of the core pillars when developing or deploying AI systems. • Take an active and curiosity driven approach to explore how digital technologies operate.

TEACHING METHODS

Method	Class Workload	Individual Workload	Total
Theoretical Sessions	28	28	56
Laboratory Sessions	14	42	56
Research and writing of an applied project	4	32	36
Written Examinations	2	0	2
TOTAL	**48 hours**	**102 hours**	**150 hours**

EVALUATION

- Written test (20%)
- Project (50%)
- Homework (30%)

PRECONDITIONS

- Basic knowledge on Artificial Intelligence and Distributed Computing
- Programming skills (Java, Python)
- Basic skill with Linux based Operating system

DEPARTMENT	Computer Science
LECTURERS	Gabriel Iuhasz
LITERATURE	• Michael Wooldridge - An Introduction to Multi - Agent Systems, John Wiley & Sons, 2009 • F. Bellifemine, G. Claire, D. Greenwood – Developing Multi-Agent Systems with Jade, John Wiley & Sons' 2007 • S.Russel, P. Norvig - Artificial Intelligence. A Modern Approach, second edition, Prentice Hall, 2010 • M. d'Inverno - Understanding Agent Systems, Springer Verlag, second edition, 2004 • Aggarwal, Ch.C., (2018) Neural Networks and Deep Learning, Springer, 978-3-319-94462-3, https://doi.org/10.1007/978-3-319-94463-0. • Shibakali Gupta et al, (2020) Multi Agent Systems, https://doi.org/10.1007/978-981-19-0493-6 • Aggarwal, Ch.C., (2016) Recommender Systems, https://doi.org/10.1007/978-3-319-29659-3 • Miroslav Kubat (2017) - An Introduction to Machine Learning, https://doi.org/10.1007/978-3-319-63913-0