Computational Intelligence					AR-306
Rota annually WS	**Duration** 1 Semester	**Semester** 3rd (Semester)	**SWS** 3 SWS	**Credit Points** 5	**Workload** 150 h

1	**Modul Structure**				
	Course (Abbreviation)	**Type/ SWS**	**Presence**	**Self Study**	**Credit Points**
	a) Computational Intelligence (CI)	Lecture/ 2 SWS	25 h	65 h	3
	b) Computational Intelligence (CI)	Tutorial/ 1 SWS	15 h	45 h	2

2 Language:

English

3 Content

Since the course covers three different aspects of computational intelligence, the contents can best be described following this division into three parts:

1. After a brief introduction with reference to the biological paradigm, the foundations for neural networks are laid with an introduction to threshold logic. Then, traditional single- and multi-layer perceptrons as well as modern deep learning architectures such as convolutional and recurrent neural networks are covered. Various training algorithms are discussed. The content is presented in a way that focuses on the practical and implementation aspects as well as theoretical considerations such as limitation and complexity issues.
2. Evolutionary Algorithms: Again stemming from a natural source of inspiration evolutionary algorithms are introduced as an example from the class of general randomized search heuristics. After a description of the main modules (initialization, selection, crossover, and mutation) comes a discussion of typical parameter settings for population sizes and crossover and mutation probability. Then theoretical aspects are considered, the focus is on the analysis of the mean convergence rates.
3. Fuzzy Logic: This final part starts with an introduction to fuzzy sets and fuzzy logic using fuzzy relations and the concept of fuzzy inference. Applications like fuzzy clustering and fuzzy controllers are discussed.

Literature:

- A.E. Eiben and J.E. Smith: Introduction to Evolutionary Algorithms. Corrected 2nd printing. Springer 2007.
- Raul Rojas: Neural Networks - A Systematic Introduction. Springer 1996. Available online.
- Ian Goodfellow, Yoshua Bengio, and Aaron Courville: Deep Learning. MIT Press 2017.
- G.J. Klir und B. Yuan: Fuzzy Sets and Fuzzy Logic. Prentice Hall 1995.
- F. Höppner, F. Klawonn, R. Kruse und T. Runkler: Fuzzy Cluster Analysis. Wiley 1999.
- Amit Konar: Computational Intelligence: Principles, Techniques and Applications. Springer 2005.

4 Competencies

Computational Intelligence is used as an umbrella term for different approaches that deliver enhanced performance and applicability. It encompasses artificial neural nets, evolutionary algorithms, and fuzzy logic. This course gives a thorough introduction into all three aspects of computational intelligence from the perspective of computer science. It focuses on theoretical aspects as well as typical application scenarios. After attending the course students are expected to have a basic understanding of the working principles, application areas and limitations of the three approaches.

5 Examination Requirements

Mandatory prerequisite for an admission to the module examination is the successful solution of 50 % of the homework presented and discussed in the tutorial. Final module exam is a written exam (90 minutes).

6 Formality of Examination

☒ Module Finals ☐ Accumulated Grade

7	**Module Requirements (Prerequisites)**
8	**Allocation to Curriculum:** Program: Automation & Robotics, Field of study: Robotics, Process Automation, Cognitive Systems
9	**Responsibility/ Lecturer** *Prof. Dr. G. Rudolph/* Prof. Dr. G. Rudolph