GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2016-2017

Computational Models (I001969)

Course size (nominal values; actual values may depend on programme)

Credits	5.0	Study time	125 h
Contact hrs	60.0 h		

Course offerings and teaching methods in academic year 2017-2018

A (semester 2)	English	lecture	12.5 h
		seminar: practical PC room classes	45.0 h
		guided self-study	2.5 h

Lecturers in academic year 2017-2018

De Baets, Bernard	LA26	lecturer-in-charge
Baetens, Jan	LA26	co-lecturer

Offered in the following programmes in 2017-2018	crdts	offering
Master of Science in Bioscience Engineering: Cell and Gene Biotechnology	5	A
Master of Science in Bioscience Engineering: Land and Water Management	5	A
Master of Science in Bioscience Engineering: Environmental Technology	5	A

Teaching languages

English

Keywords

Natural computing, computational intelligence, soft computing, fuzzy logic, heuristic optimization methods, genetic algorithms, neural networks, cellular automata

Position of the course

The aim of this course is to demonstrate that nature serves more and more as a source of inspiration for the design of new computational techniques, to teach the student to estimate which technique is relevant for a given problem and to apply this technique correctly. The goal is not to introduce the student to all of these techniques, but to open his mind for new developments. This fits into the life-long learning paradigm.

Contents

Natural Computing is a general term referring to computing going on in nature and computing inspired by nature. Viewing complex phenomena in nature as computational processes, our understanding of these phenomena as well as of the essence of computation can be enhanced. In this way one gains valuable insights into both natural sciences and computer science. Characteristic for man-designed computing inspired by nature is the metaphorical use of concepts, principles and mechanisms underlying natural systems. Fuzzy logic is based on the way human beings reason in natural language; evolutionary algorithms use the concepts of mutation, recombination and selection from biology; neural networks are inspired by the highly interconnected neural structures in the brain: molecular computing is based on paradigms from molecular biology; and quantum computing based on quantum physics and exploits quantum parallelism. This course is restricted to algorithms that are presently implemented on conventional computers.
The course has an interactive “selected topics” format, with considerable input from the students, and using reference works, recent literature and external sources such as the internet. Each year, 4 or 5 techniques will be explored and applied to real-world problems. The following topics are in the priority list:
1. Heuristic optimization methods (gradient based methods, hill climbing, simulated annealing, tabu search,...)

2. Evolutionary algorithms (genetic algorithms, genetic programming,...)
3. Swarm algorithms (swarm particle optimization, ant colony algorithms, ...)
4. Fuzzy logic and rule-based systems
5. Neural networks (backpropagation networks, self-organizing maps,...)
6. Cellular automata

Initial competences

Basic knowledge of mathematics and computer science.

Final competences

The ability to judge the relevance and applicability of a new computational technique, to learn to use in relatively short time and to apply it correctly.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Guided self-study, lecture, seminar: practical PC room classes

Learning materials and price

Presentations of the theoretical lectures, background study material, software code and data are available on Minerva.

References

1. Z. Michalewicz and D. Fogel, How to Solve it: Modern Heuristics, Springer, 2004
2. K. Passino, Biomimicry for optimization, control and automation, Springer, 2004
3. M. Berthold and D. Hand, Intelligent Data Analysis, Springer, 2003
4. J. Sousa and V. Kaymak, Fuzzy decision making in modeling and control, World Scientific, 2002

Course content-related study coaching

1. The lecturer announces office hours for problems related to the theory.
2. The lecturer and teaching assistant guide the practical exercises.
3. Interactive support through Minerva.

Evaluation methods

end-of-term evaluation and continuous assessment

Examination methods in case of periodic evaluation during the first examination period

Oral examination, assignment

Examination methods in case of periodic evaluation during the second examination period

Oral examination, assignment

Examination methods in case of permanent evaluation

Report

Possibilities of retake in case of permanent evaluation

examination during the second examination period is possible in modified form

Calculation of the examination mark

Reports (NPGE): 50%
Microteaching and oral exam (PGE): 50%
Students who eschew period aligned and/or non-period aligned evaluations for this course unit may be failed by the examinator.