MATH-642

Artificial Life

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Cursus	Sem.	Type
Mathematics		Opt.

Language of teaching	English
Credits	2
Session	
Exam	Oral presentation
Workload	60h
Hours	**34**
Lecture	22
Practical work	12
Number of positions	

Frequency

Every year

Remark

Spring semester

Summary

We will give an overview of the field of Artificial Life (Alife). We study questions such as emergence of complexity, self-reproduction, evolution, both through concrete models and through mathematical results. We will describe some of the most influential Alife models, and learn to implement them.

Content

This course aims at giving an overview of the field of Alife and introduce both
practical tools and theoretical ideas relevant for the understanding of the emergence
life-like behaviors in various media. In particular, we will attempt to cover the following topics.
- What is life, goals of Alife, history of the field.
- Central examples: Von Neumann's self-reproducing machine, the Game of Life: zoology of objects, theorems and open problems; Quines; Langton's loop; Turing's reaction-diffusion models; KdV Equation; Smooth Life and Lenia, Neural Cellular Automata;
- Discrete cellular automata: basic theorems on cellular automata (reversibility, locality, Turing completeness); rule space; Wolfram's classification, latticegas models.
- Continuous cellular automata: reaction-diffusion models, pattern formation, discretization's, solitons, chaos.
- Computational theory: Turing machines, quines and the Kleene's fixed point theorem, applications to self-reproduction, program/hardware tradeoff, Turing completeness in discrete and continuous media.
- Soliton theory: examples, scattering transforms, conservation laws.
- Genetic information: mathematical models; evolution, mutation, and selection; error correction; genetic algorithms; error threshold and Eigen's paradox

Keywords

Alife, cellular automata, self-reproduction, computational theory, solitons, gliders, game of life, statistical mechanics, consensus mechanisms

Learning Prerequisites

Required courses

No specific pre-requisites, except a bit of analysis and a little experience with code.

Assessment methods

Prepare a short project related to anything taught in the course.

Resources

Websites

- https://vassi.life/teaching/alife