Evolutionary Computation

DISC - EISC-217 - Algorithmes évolutionnaires

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Pedagogical Objectives

The premise of evolutionary computation is simple: the simulation of natural selection used to solve a problem, where candidate solutions compete as individuals in order to influence future generations. From this simple premise, a multitude of algorithms have been developed, and evolutionary computation can be found in a number of domains. In this course, we'll give a broad overview of different evolutionary computation methods, focusing on the state of the art.

The objective of this course is that students gain:

- First hand experience with and detailed knowledge of evolutionary methods
- Broad knowledge of many evolutionary algorithms and their respective strengths
- The ability to write and use evolutionary algorithms for different tasks

As this is the first iteration of this course, we may change the following course material over time. Please keep up to date with the course website for any changes. This class will be given in French, although many of the course resources will be in English.

Course content and activities

The course is structured in two parts:

1. **Survey of evolutionary methods**
   In the first half of this class, we will cover in lectures a wide view of the current state of evolutionary computation, including some historical background. We will see examples of evolutionary algorithms (EA), evolutionary strategies (ES), genetic algorithms (GA), and genetic programming (GP). We will cover state of the art methods such as CMA-ES, NSGA-II, NEAT, and Deep Neuroevolution.

2. **Project on applying evolutionary methods**
   In the second part of the course, students will implement their own evolutionary methods to evolve agents to play games. Students will be evaluated based on their implementation, the performance of their evolved agents, and their final presentation. Students will have time during class to work on the project.

Course overview

Week 01, 13/04 - 17/04:

- Introduction to Evolutionary and Genetic Algorithms
- Evolutionary Strategies

Week 02, 20/04 - 24/04:

- Multi-objective Evolution
- Evolution of programs, graphs, and networks

Week 03, 27/04 - 01/05:

- Guest lecture by Sylvain Cussat-Blanc on Genetic representation and operator design
- Project Introduction

Week 04, 04/05 - 08/05:

- Evolution and behavior
- Guest lecture by Élise Vareilles on Evolution with constraints
- Project work time

Week 05, 11/05 - 15/05:

- Project work time

Week 06, 18/05 - 22/05:

- Project presentations

Textbook

De Jong, K. Evolutionary Computation: A Unified Approach. MIT Press, 2006.