

Workshop

Day 2:

Introduction to the genetic algorithm (GA)

Functional Programming and Intelligent Algorithms:

Genetic Algorithms

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1 Workshop overview

1.1 Topics

Today's topics include:

- Nature-inspired optimisation algorithms
- A gentle introduction to the genetic algorithm (GA)

1.2 Reading material

Compulsory reading to be studied *before* this workshop is Chapter 1 in [Haupt & Haupt \(2004\)](#) and Chapter 10 in [Marsland \(2015\)](#).

Supplementary reading include Chapter 9.5 in [Negnevitsky \(2005\)](#), Chapter 1 in [Goldberg \(1989\)](#), and Part I in [Russell & Norvig \(2010\)](#).

1.3 Specific learning outcomes

After completing this workshop, including self-study, reading and exercises, the students should be able to

- list examples of nature-inspired optimisation algorithms and explain the fundamental mechanisms behind such algorithms.
- demonstrate knowledge about the history of the GA and explain its basic principles.

- list a number of advantages of the GA and explain *why* they are advantages.
- define a variety of selection methods and parameters such as mutation rate and selection rate.

1.4 Schedule

Today's workshop will roughly follow the schedule below:

08.15 Status update/recap.

08.45 Nature-inspired algorithms and introduction to the GA.

09.45 Workshop rest of the day.

2 Exercises

2.1 Nature-inspired algorithms

Exercise 2.1: List five nature-inspired optimisation algorithms. Do a search and find at least one real-world problem that has been solved for each of the five algorithms.

Exercise 2.2: What are the two components of natural selection?

Exercise 2.3: Provide short explanations of gene, chromosome, and DNA.

Exercise 2.4: List four steps of simulating natural evolution.

2.2 Introduction to the GA

Exercise 2.5: Who is usually mentioned as the founding father of the GA and who popularised it?

Exercise 2.6: What does encoding in a GA mean?

Exercise 2.7: List five advantages of using a GA and explain *why* they are advantages.

Exercise 2.8: List the steps of a basic GA. You may draw a diagram if you prefer.

Exercise 2.9: Explain the following genetic operators and use diagrams to aid your explanation:

- (a) Crossover.
- (b) Mutation.

Exercise 2.10: Explain the following selection methods:

- (a) Single-point crossover.
- (b) Two-point crossover.
- (c) Uniform crossover.
- (d) Tournament selection.
- (e) Truncation selection.
- (f) Roulette wheel selection.

3 Homework

- Complete all the exercises above.
- Read through (again!) the specific learning outcomes in Section 1.3 to check which outcomes you have not attained yet. Study today's material and prepare questions for tomorrow about learning outcomes you have missed.
- Skim through the lecture notes for tomorrow's lecture and the suggested literature.

References

- Goldberg, D. E. (1989). *Genetic Algorithms in Search, Optimization and Machine Learning*. Addison Wesley Longman, Inc.
- Haupt, R. L., & Haupt, S. E. (2004). *Practical Genetic Algorithms*. Wiley, 2nd ed.
- Marsland, S. (2015). *Machine learning: an algorithmic perspective*. CRC press, 2nd ed.
- Negnevitsky, M. (2005). *Artificial Intelligence: A Guide to Intelligent Systems*. Addison-Wesley, 2nd ed.
- Russell, S., & Norvig, P. (2010). *Artificial Intelligence: A Modern Approach*. Pearson, 3rd ed.