

Workshop

Day 5: Real-world applications

Functional Programming and Intelligent Algorithms

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Faculty of Engineering and Natural Sciences

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1 Workshop overview

1.1 Topics

Today's topics include:

- A receding horizon genetic algorithm (RHGA) for dynamic resource allocation.
- The travelling salesperson problem.

1.2 Reading material

Compulsory reading to be studied *before* this workshop is a paper by [Bye \(2012\)](#) on a case study on optimal positioning of tugs off the northern Norwegian coast.

Supplementary reading is Chapter 6.1 in [Haupt & Haupt \(2004\)](#) on the travelling salesperson problem.

1.3 Specific learning outcomes

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

- write a short high-level summary of a scientific paper, describing key elements such as the problem description, proposed solution, and the results.
- review and suggest modifications of technical aspects such as cost function, chromosome encoding and advantages and limitations of a GA-based method used in a scientific paper.

- explain the principle of receding horizon control (RHC) and how it can be used in conjunction with a GA to solve certain problems.
- perform literature reviews on well-known optimisation problems such as the travelling salesperson problem (TSP).
- recognise certain combinatorial problems as TSPs when appropriate and use a GA to solve them.

1.4 Schedule

We begin at 8.15 with a status update and a recap. Today's workshop will then roughly follow the schedule below:

08.15 Status update/recap.

08.45 Real-world application: Receding horizon genetic algorithm.

09.30 Workshop rest of the day.

2 Exercises

2.1 Example of a real-world application of a GA

Exercise 2.1: Considering the paper by [Bye \(2012\)](#), do the following:

- (a) Write a short summary (try to limit yourself to one page only), where you describe the problem that needs to be solved, the proposed solution and methodology, and the results. Keep your summary high level (more emphasis on detail follows in the questions below).
- (b) Explain the cost function used and how you would modify it to incorporate a penalty on fuel consumption. Provide a mathematical formula for your suggested cost function.
- (c) Explain the chromosome encoding used and the advantage of normalising the variables. Make up an example of a normalised control trajectory and decode it to a real speed trajectory to aid your explanation.
- (d) Explain the principle of receding horizon control (RHC) and the advantages of combining RHC with a GA.
- (e) Suppose you wanted to control a group soccer-playing robots using a receding horizon genetic algorithm (RHGA). Discuss potential challenges in implementing such a system.

2.2 The travelling salesperson problem

Exercise 2.2: Do a literature search and write a short review (maximum one page) of the travelling salesperson problem (TSP). Remember to provide references to your sources.

Exercise 2.3: Visit the following blog:

<http://mainisusuallyafunction.blogspot.no/2011/10/interfacing-haskell-to-concorde-solver.html>

Try to interface Haskell with the Concorde solver for the Traveling Salesperson Problem (TSP) as described in the blog. When you have familiarised yourself with the interface, try to write a GA for solving a TSP problem using the same data as the Concorde solvers. Compare your results.

3 Homework

- Complete all the exercises above.
- Read through (again!) all the specific learning outcomes for each of the workshops to check which outcomes you have not attained yet. Study the material, attempt as many exercises as you can, and prepare questions for tomorrow about learning outcomes you have missed and exercises that you have problems completing.

References

Bye, R. T. (2012). A receding horizon genetic algorithm for dynamic resource allocation: A case study on optimal positioning of tugs. *Series: Studies in Computational Intelligence*, 399, 131–147. Springer-Verlag: Berlin Heidelberg.

Haupt, R. L., & Haupt, S. E. (2004). *Practical Genetic Algorithms*. Wiley, 2nd ed.