Workshop GA5

Real-world applications
&
exam revision

Functional Programming and Intelligent Algorithms
Module: Genetic Algorithms

Spring 2017
Department of ICT and Natural Sciences
Norwegian University of Science and Technology

Robin T. Bye*

Revision date: 22 March 2017

*email: robin.t.bye@ntnu.no; website: www.robinbye.com; phone: 70 16 15 49; office: B315.

Contents

1 Workshop overview

1.1 Topics

Today's topics include:

- Intelligent computer-automated design of offshore cranes using GAs.
- A receding horizon genetic algorithm (RHGA) for tug fleet optimisation.

1.2 Reading material

Compulsory reading to be studied *before* this workshop are the following two scientific papers:

- *Intelligent computer-automated crane design using an online crane prototyping tool* (Hameed et al., 2016), and
- *Evaluation heuristics for tug fleet optimisation algorithms: A computational simulation study of a receding horizon genetic algorithm* (Bye & Schaathun, 2015),

which are available on Fronter with the filenames

- `ECMS_2016_Intelligent_VP_Matlab_final.pdf`
- `ByeSchaathun15_SpringerBook.pdf`.

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 GA-based methods used in a scientific papers.
- explain how a GA can be used for intelligent computer-automated product design such as offshore cranes.
- explain the principle of receding horizon control (RHC) and how it can be used in conjunction with a GA to solve dynamic optimisation problems such as tug fleet optimisation.

1.4 Schedule

NB! We begin at **8.15** (not at 9.15 as usual) with a status update and a recap. Today's workshop will then roughly follow the schedule below:

08.15 Status update/recap.

08.30 Lecture: GA for intelligent computer-automated crane design.

09.30 Workshop exercises.

10.30 Lecture: Receding horizon GA for tug fleet optimisation.

12.00 Exam revision.

2 Exercises

2.1 Examples of real-world applications using GAs

Exercise 2.1: Considering the paper by Hameed et al. (2016), 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 (with words) the cost functions used and how you could modify them to incorporate a penalty on total delivery price of a crane. Illustrate your explanation by modifying one of cost functions and provide the resulting mathematical formula.

(c) Explain the chromosome encoding used. How many design parameters are being optimised?

(d) Describe some possible limitations to the proposed approach, e.g., related to the number of design parameters to be optimised, the choice of cost function, processing and transmission times, and use of the software by domain experts who may not be computing experts.

Exercise 2.2: Considering the paper by Bye & Schaathun (2015), 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) What is Monte Carlo simulation?

(c) Explain the cost functions used and how you would modify them to incorporate a penalty on fuel consumption. Provide a mathematical formula for a modified cost function as an example.

(d) How would you encode the chromosomes?

(e) Explain the principle of receding horizon control (RHC) and the advantages of combining RHC with a GA.

(f) Why is Haskell good for parallelisation? Is the problem in this research paper suitable for parallelisation? Why/why not?

(g) 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.

3 Exam revision

From 12.00 to 13.30 the teacher will answer questions related to the GA curriculum, including previous years' exams, e.g., Spring 2015 exam, which is found along with the resit exam and some sample exam questions here: Previous exams.

Exam revision relating to the first part of the course (non-GA material) will be provided by Hans Georg and Que on Tuesday 9 May 2017. Please see Week 16 on the course website for more information.

4 Homework

This is the final workshop, so there is no homework. However, as preparation for the exam, you should probably do the following:

- 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 forward any questions you have to the lecturers.
- Prepare questions and study previous years' exams before the exam revision with teachers Hans Georg and Que on Tuesday 9 May 2017.

References

Bye, R. T., Osen, O. L., Pedersen, B. S., Hameed, I. A., & Schaathun, H. G. (2016). A software framework for intelligent computer-automated product design. In *Proceedings of the 30th European Conference on Modelling and Simulation (ECMS '16)*. Accepted for publication.

Bye, R. T., & Schaathun, H. G. (2015). Evaluation heuristics for tug fleet optimisation algorithms: A computational simulation study of a receding horizon genetic algorithm. In *Proceedings of the 4th International Conference on Operations Research and Enterprise Systems (ICORES'15)*, (pp. 270–282).

Hameed, I. A., Bye, R. T., Osen, O. L., Pedersen, B. S., & Schaathun, H. G. (2016). Intelligent computer-automated crane design using an online crane prototyping tool. In *Proceedings of the 30th European Conference on Modelling and Simulation (ECMS '16)*. Accepted for publication.

