Workshop GA4

The travelling salesperson problem (TSP)

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:

- The travelling salesperson problem (TSP).
- Alternative chromosome encoding for the TSP that allows repeated values for genes.
- Implementing and solving real-world TSP problems using a GA.

1.2 Reading material

Compulsory reading to be studied *before* this workshop are the Wikipedia article on the TSP, http://en.wikipedia.org/wiki/Travelling_salesman_problem, as well as a paper by Üçoluk (2002) (available on Fronter in the file `tspnew.pdf`) on an alternative encoding of chromosomes for permutation problems such as the TSP.

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

- understand and explain the limitations related to crossover and mutation of ordinary representations of permutations in GAs where offspring may have repeated values (cities).

- implement in a functional language such as Haskell simple iterative algorithms described in pseudocode in scientific papers
- recognise real-world combinatorial problems as TSPs when appropriate and how a GA can be used to solve them.
- implement a GA for solving sample TSPs.

1.4 Schedule

We begin at 9.15 with a status update and a recap. Today's workshop will then roughly follow the schedule below:

09.15 Status update/recap.

09.30 Lecture: Introduction to the TSP and the alternative chromosome encoding proposed by Üçoluk (2002).

10.15 Workshop rest of the day.

2 Exercises

2.1 The travelling salesperson problem

Exercise 2.1: 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 2.2: Implement a GA using the alternative chromosome encoding proposed in Üçoluk (2002) and try to solve the following TSPs, which are taken from www.math.uwaterloo.ca/tsp/world/countries.html:

- 29 cities in Western Sahara:
  - `wi29info.txt`: Information about problem and list of cities with (x,y) coordinates.
  - `wi29.txt`: Stripped file with list of cities with (x,y) coordinates only.
- 38 cities in Djibouti:
  - `dj38info.txt`: Information about problem and list of cities with (x,y) coordinates.
  - `dj38.txt`: Stripped file with list of cities with (x,y) coordinates only.

For motivation, we will run an informal competition to see who manages to get the shortest TSP distance..!

Exercise 2.3: (optional) 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!) 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 the next workshop about learning outcomes you have missed.
- Prepare for the next workshop, which also contains an exam revision, by reading the following 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`.
- Prepare questions related the GA curriculum and study previous years' exams, e.g., Spring 2015 exam, which is found along with the resit exam and some sample exam questions here: Previous exams.

References

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.

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

Üçoluk, G. (2002). Genetic algorithm solution of the TSP avoiding special crossover and mutation. *Intelligent Automation & Soft Computing*, *8*(3), 265–272.

