Workshop GA3

The continuous GA

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*

Last updated: 22 March 2017

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

Contents

1 Workshop overview **2**
1.1 Topics 2
1.2 Reading material 2
1.3 Specific learning outcomes 2
1.4 Schedule 3

2 Exercises **3**
2.1 Components of the continuous GA 3
2.2 Implement your own continuous GA 4

3 Homework **4**

1 Workshop overview

1.1 Topics

Today's topics include:

- Components of the continuous (real-valued) GA, including selection, pairing, mating, and mutation.
- String learning and optimisation of 1D and 2D test functions using a continuous GA.

1.2 Reading material

Compulsory reading to be studied *before* this workshop is Chapter 3 in Haupt & Haupt (2004) on continuous (real-valued) GAs.

1.3 Specific learning outcomes

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

- explain the components and algorithmic flow of the continuous (real-valued) GA.
- demonstrate typical effects of changing parameters of the continuous GA.
- differentiate binary and continuous GAs with respect to selection, pairing, mating and mutation mechanisms.

- implement and modify their own continuous GAs, with particular attention to the choice of cost function, to suit a variety of problems.

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 The continuous GA.

10.30 Workshop rest of the day.

2 Exercises

2.1 Components of the continuous GA

Exercise 2.1: Draw a diagram of the algorithmic flow of the continuous GA. How does it differ from the algorithmic flow of the binary GA?

Exercise 2.2: Although a continuous GA uses continuous (real-valued) numbers, it still has a limitation in precision. Explain why.

Exercise 2.3: Normalisation/unnormalisation:

(a) Explain the process of normalisation and suggest some reasons why the values of variables (genes) need to be normalised.

(b) Suppose the upper bound on variables is 80 and the lower bound is -20, what does a normalised variable value of 0.5 correspond to?

Exercise 2.4: Explain why naiive single or multiple point crossover methods have limited use in a continuous GA.

Exercise 2.5: The blending method:

(a) Explain the blending method for mating and create an example to aid your explanation.

(b) Given an initial population of continuous variables, suppose the highest variable value for any individual (chromosome) is 0.8 and the lowest is 0.3. What can you say about the variable values for the next generations if you use the blending method for mating?

Exercise 2.6: Extrapolation method:

(a) Explain the extrapolation method for mating and create an example to aid your explanation.

(b) What is the main advantage of the extrapolation method versus the blending method?

Exercise 2.7: Extrapolation/crossover method of Haupt & Haupt (2004):

(a) Explain the extrapolation/crossover method of Haupt & Haupt (2004) for mating and create an example to aid your explanation.

(b) The method limits variables to the bounds of their parents. How would you modify the method to allow variable values outside parent bounds?

2.2 Implement your own continuous GA

Using the binary GA that you have implemented previously as a starting point, create a continuous GA. You need to reconsider (at least) the implementation of chromosomes, cost function evaluation, mating, and mutation. Work incrementally, e.g., begin with a naiive single point crossover method for mating rather than more advanced methods. You should test the GA, for example by solving the string learning problem you did for the binary GA, or by optimising the test functions given in the appendix of Haupt & Haupt (2004), which is available on Fronter.

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 by reading the paper *Genetic Algorithm Solution of the TSP Avoiding Special Crossover and Mutation* (Üçoluk, 2002) which is available on Fronter with the filename `tspnew.pdf`.

References

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.