Emergent Computing for Optimisation

Coursework Report

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Abstract

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1. Introduction

This report looks at the ability of evolutionary algorithms (EAs) to solve an optimisation problem. A team of female cyclists are participating in a track-cycling event. The cyclists can alternate the pace at which they cycle, and at which point they transition positions so that a new cyclist is in the front, but their abilities are fixed. Changing these strategies can result in increased performance as their energy usage and aerodynamic profile improves. Their performance, fitness in evolutionary terms, is measured by their finish time. This problem has many possible solutions due to the huge number of combinations of pacing and transition strategies available.

An EA was designed and implemented to evolve a population of cyclist teams. The transition and pacing strategies were evolved by algorithm simultaneously. Several different operators were experimented with and parameters of the evolutionary algorithm were tuned in order to optimise the cyclist’s finish time. By evolving both strategies, rather than for example evolving the transition strategy for set pacing values, a wider area of the search space is made available, it encourages diversity in the population, and treats each strategy with equal importance.

1. Method
   1. Implementation Details

Solutions to the track cycling problem were represented with two chromosomes for each individual member of the population. The chromosomes represented the pacing strategy, implemented as an array of 23 integers with values between the minimum and maximum power each cyclist can use, 200 and 1200 respectively, and the transition strategy, implemented as an array of 22 boolean values. By having two chromosomes different types of operators could be implemented that only work with certain types of values, for example uniform crossover cannot operate on booleans but can be used for the pacing strategy.

Fitness in the algorithm is defined as the time taken to complete the race, with a penalty for those that fail to finish the race at all. If a race is incomplete the fitness is a min-max normalised value, between 400 and 500, based on the proportion of the race complete. Being very near to completing the race gives a fitness close to 400, even a poor solution that completes the race would likely score at least in the 300s.

To optimise this problem an initial steady-state evolutionary algorithm was implemented, in order to be experimented on – which is discussed in Section 3. Steady-state refers to an EA in which an initial population is initialised and then evolved with a small number of new children, often only a single child, replacing the unfit members of the population. This is in contrast with a generational EA where in a whole new population is generated from the existing population. A generational EA is good for injecting diversity in to a

* 1. Operators

To optimise this problem a steady-state evolutionary algorithm was implemented. Steady-state refers to

1. Experiments & Analysis
2. Conclusions
3. Future Work
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References

1. R. Feynman, F. Vernon Jr., The theory of a general quantum system interacting with a linear dissipative system, Annals of Physics 24 (1963) 118-173. doi:10.1016/0003-4916(63)90068-X.
2. P. Dirac, The lorentz transformation and absolute time, Physica 19 (1-12) (1953) 888-896. doi:10.1016/S0031-8914(53)80099-6.