Tutorial Proposal: Evolutionary Diversity Optimisation for Combinatorial Optimisation (Advanced tutorial, 2 hours)

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1 Introduction

In the classical setting evolutionary algorithms (EAs) are used to compute a single solution of high quality with respect to the objective function or a set of trade-off solutions in the field multi-objective optimisation where one deals with multiple, usually conflicting objectives. Here, diversity preservation is usually introduced as a means to prevent premature convergence.
In many applications and in the field of algorithm selection / configuration however, it is beneficial to produce a set of solutions that is (1) of high quality and (2) diverse with respect to the search space and/or some features of the given problem. Approaches such as *Evolutionary Diversity optimisation* and *Quality Diversity* enable the computation of a large variety of new and innovative solutions that are unlikely to be produced by traditional evolutionary computation methods for single-objective or multi-objective optimisation.
This tutorial gives an overview on this relatively new research area within evolutionary computation. We will point out design principles for the application of evolutionary diversity optimisation and quality diversity algorithms for combinatorial optimisation and discuss important components such as the design of mutation operators, features of solutions, and the impact of different diversity measures. During the tutorial we will concentrate on explaining these design principles for well known combinatorial optimisation problems such as the traveling salesperson problem (TSP), the knapsack problem (KP), and the multi-component traveling thief problem (TTP).

2 Outline

- Introduction and Motivation
- Evolutionary Diversity Optimisation (EDO)
- Quality Diversity (QD) Algorithms
- EDO for Evolving Diverse TSP Instances
- QD for Evolving Diversse TSP Instances

- EDO for TSP and KP
- QD for the TTP
- Topics for Future Research

3 Presenters

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Aneta Neumann graduated in Computer Science from the Christian-Albrechts-University of Kiel, Germany and received her PhD from the University of Adelaide, Australia. She presented invited talks at UCL London, Goldsmiths, University of London, University of Nottingham, University of Sheffield, Hasso Plattner Institut University of Potsdam, Sorbonne University, University of Melbourne, University of Sydney in 2016-22. She received the ACM Women scholarship, sponsored by Google, Microsoft, and Oracle, the Hans-Juergen and Marianna Ohff Research Grant in 2018, and the Best Paper Nomination at GECCO 2019 and GECCO 2021 in the track "Genetic Algorithms", GECCO 2022. Her main research interest focuses on bio-inspired computation, particularly dynamic and stochastic optimisation, submodular functions, evolutionary diversity optimisation, and optimisation under uncertainty in practice. She was co-chair of the "Real-World Applications" track at GECCO 2021 and 2022. She serves as a co-chair of the track "Genetic Algorithms" at GECCO 2023.

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Frank Neumann is a professor and the leader of the Optimisation and Logistics group at the University of Adelaide and an Honorary Professorial Fellow at the University of Melbourne. His current position is funded by the Australian Research Council through a Future Fellowship and focuses on AI-based optimisation methods for problems with stochastic constraints. Frank has been the general chair of the ACM GECCO 2016 and co-organised ACM FOGA 2013 in Adelaide. He is an Associate Editor of the journals "Evolutionary Computation" (MIT Press) and "ACM Transactions on Evolutionary Learning and Optimisation". In his work, he considers algorithmic approaches in particular for combinatorial and multi-objective optimisation problems and focuses on theoretical

aspects of evolutionary computation as well as high impact applications in the areas of cybersecurity, renewable energy, logistics, and mining.