Description of advisors

Dr David Walker

David Walker is a Lecturer in Computer Science at the University of Plymouth. He has a PhD in Computer Science from the University of Exeter, where he conducted work on the visualisation of the mutually non-dominating sets generated by many-objective evolutionary algorithms. During his postdoctoral work he conducted research on the development of novel hyper-heuristics and interactive methods for solving optimisation problems. He joined the School of Computing, Electronics and Mathematics at the University of Plymouth in 2018, and is a member of both the Centre for Robotic and Neural Systems and Big Data Group. His research focuses on improving user understanding of nature-inspired algorithms using visualisation techniques, and incorporating humans as components of nature-inspired approaches using interactive evolution. He has organised a GECCO workshop on visualisation for the last eight years, and is active in reviewing for a range of journals.

Dr Matthew Craven

Matthew Craven is a Lecturer in Applied Mathematics at the University of Plymouth. His research interests lie in AI, simulation, cryptology, high performance computing, and visualisation. He has been involved with collaborative projects in the UK, Germany and Japan, regularly contributing to top-tier conferences such as GECCO and EVOSTAR and actively reviewing for prestigious journals such as Journal of the Operational Research Society and Applied Soft Computing. He is the PI for the Plymouth GPU Research Centre, leader of the Big Data Group in Plymouth, and extensively utilises the High Performance Computing facility at the university.

Research Group

The student will join the Plymouth Optimisation Group, which is a research group run by members of the Centre for Robotics and Neural Systems (CRNS), Centre for Mathematical Sciences, and the Plymouth Big Data Group. The group is led by:

- Dr David Walker, Lecturer in Computer Science
- Dr Matthew Craven, Lecturer in Applied Mathematics

The group currently supervises two full-time PhD students, working on the optimisation of cryptographic systems and the visualisation of evolutionary processes, respectively.

Additionally, the group has led masters-level and undergraduate dissertation projects in both Computer Science and Mathematics, covering topics such as:

- Offshore renewable energy farm optimisation.
- Visualisation of many-objective Pareto fronts.
- Search-based software testing.
- Optimisation in financial mathematics.
- Optimisation of strategies for breaking group-based cryptographic primitives.

The group holds regular meetings and encourages a collaborative atmosphere. The student will therefore be working with a range of other researchers.

Potential Projects

Students can work on a range of potential projects that align to the research interests of the group. These broadly include:

- **Visualisation:** The group has expertise in the visualisation of high-dimensional solution sets, evolutionary search processes and benchmarking evolutionary algorithms with visualisation. Current work includes exploring explainable AI as it

applies to EC. Projects in this area would explore techniques for visualising the data arising from the use of a metaheuristic or hyper-heuristic to optimise a problem. Interactive visualisations are of particular interest.

- **Benchmarking:** Recent work from the group[1] proposed a visual method for benchmarking the performance of multi- and many-objective evolutionary algorithms. This work resulted in a flexible framework that takes a range of performance indicators, and allows the user to compare their algorithm under a range of parametrisations. Several further avenues of work in this area have been identified, including: a more comprehensive evaluation of many-objective optimisers; exploiting GPU processing to achieve faster visualisations; and applying the tool to a wider range of industrially-relevant problems.
- **Industrial optimisation:** The group has worked on industrial optimisation problems from a range of sectors. Current interests include the offshore renewable energy industry, the water industry, finance and cryptographic primitives.
- **Hybrid optimisation:** The group has interests in hybridising EC and machine learning approaches to study real world problems. This may have applicability in hyperheuristics and, in particular, the automated design of algorithms.

Further Information

The University of Plymouth is situated on the UK's south-west peninsular. The student will be hosted within the School of Engineering, Computing and Mathematics, part of the Faculty of Science and Engineering, which includes a wide range of diverse subject areas. Plymouth is known as "Britain's Ocean City" due to its position on the coast and its historical maritime heritage. The city itself is diverse and welcoming, and the University is a central part of it. In 2020 the city is celebrating the 400th anniversary of the Pilgrim Fathers' departure for America, and is hosting a wide range of events throughout the year. Other regular events, such as the annual British Fireworks Championships, are held annually in Plymouth.

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[1] D.J. Walker and M.J. Craven (2020). "Identifying good algorithm parameters in evolutionary multi- and many-objective optimisation: A visualisation approach", Applied Soft Computing.