Department	School of Computing
Supervisors	Kevin Sim
Project Title	Machine Learning and Hyper-heuristics

PROJECT DESCRIPTION

Hyper-heuristics (HH) have been successfully used to solve combinatorial problems from different problem domains, such as vehicle routing, bin packing and constraint satisfaction problems. HH were introduced under the acclaim that they are applicable to different problems without modification, in an attempt to produce more generalizable techniques that could be applied without the time consuming task of tailoring and tuning an algorithm specifically for the problem. Results on different problem domains indicate that HH suffer from the same issues as other biologically inspired search methods, namely that increasing performance on one problem domain, or a subset of problem instances from a domain has a negative effect on the performance on other problem domains, or different problem instances.

The task of tuning an algorithm is a complex task that often requires expert input, and a large amount of time and resources. Once tuned this information is typically disregarded and the algorithm needs retuned when faced with a different problem. The project will use machine learning to identify correlations between algorithm performance and problem attributes in an attempt to identify the best approach to be used for solving a particular problem. A background in biologically inspired search algorithms is essential as is a good knowledge of machine learning techniques and combinatorial search problems.

Perspective applicants are encouraged to contact the Supervisor before submitting their applications. Applications should make it clear the project you are applying for and the name of the supervisors.

Academic qualifications
A first degree (at least a 2.1) ideally in Computer Science or a closely related discipline with a good fundamental knowledge of Biologically Inspired Optimisation algorithms and combinatorial problems.

English language requirement
IELTS score must be at least 6.5 (with not less than 6.0 in each of the four components). Other, equivalent qualifications will be accepted. Full details of the University's policy are available online.

Essential attributes:

- Experience of fundamental computer science, with strong programming skills.
- Competent in statistical analysis and feature reduction techniques
- Knowledge of optimisation in combinatorial domains
- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management

Desirable attributes:
Knowledge of optimisation and/or problem solving techniques applied to real-world problems.

Indicative Bibliography	Hart, E., Sim, K.: A hyper-heuristic ensemble method for static job-shop scheduling. Evolutionary Computation 24(4), 609{635 (2016)

	Hart, E., Sim, K., Gardiner, B., Kamimura, K.: A hybrid method for feature construction and selection to improve wind-damage prediction in the forestry sector. In: GECCO. pp. 1121-1128. ACM (2017) Sim, K., Hart, E., Paechter, B.: A lifelong learning hyper-heuristic method for bin packing. Evolutionary Computation 23(1), 37{67 (2015) Alissa, M., Sim, K., & Hart, E. (2019). Algorithm selection using deep learning without feature extraction. In A. Auger & T. Stützle (Eds.), Proceedings of the Genetic and Evolutionary Computation Conference, GECCO 2019, Prague, Czech Republic, July 13-17, 2019 (pp. 198–206). ACM. https://doi.org/10.1145/3321707.3321845 Alissa, M., Sim, K., & Hart, E. (2020). A deep learning approach to predicting solutions in streaming optimisation domains. In C. A. C. Coello (Ed.), GECCO '20: Genetic and Evolutionary Computation Conference, Cancún Mexico, July 8-12, 2020 (pp. 157–165). ACM. https://doi.org/10.1145/3377930.3390224 Alissa, M., Sim, K., & Hart, E. (2021). A Neural Approach to Generation of Constructive Heuristics. IEEE Congress on Evolutionary Computation, CEC 2021, Kraków, Poland, June 28 - July 1, 2021, 1147–1154. https://doi.org/10.1109/CEC45853.2021.9504989 Alissa, M., Sim, K., & Hart, E. (2022). Automated Algorithm Selection: from Feature-Based to Feature-Free Approaches. CoRR, abs/2203.13392. https://doi.org/10.48550/arXiv.2203.13392 Hart, E., & Sim, K. (2018). On Constructing Ensembles for Combinatorial Optimisation. Evol. Comput., 26(1). https://doi.org/10.1162/evco_a_00203 Sim, K., & Hart, E. (2022). Evolutionary Approaches to Improving the Layouts of Instance-Spaces. In G. Rudolph, A. v Kononova, H. E. Aguirre, P. Kerschke, G. Ochoa, & T. Tusar (Eds.), Parallel Problem Solving from Nature - PPSN XVII - 17th International Conference, PPSN 2022, Dortmund, Germany, September 10-14, 2022, Proceedings, Part I (Vol. 13398, pp. 207–219). Springer. https://doi.org/10.1007/978-3-031-14714-2_15
Enquiries	For informal enquiries about this PhD project, please contact Dr Kevin Sim k.sim@napier.ac.uk
Web page	https://www.napier.ac.uk/research-and-innovation/research-degrees/application-process