PhD Project Proposal

ECIT Interdisciplinary PhD Programme

Proposed Project Title: Efficient Graph Analysis in Bio-Medicine

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Principal Supervisor(s): Dr Hans Vandierendonck, Dr Ian Overton

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Project Description:

Bioinformatics builds on the analysis of rich data sets to gain insights in fundamental bio-medical processes. Of particular interest is the network approaches that can elucidate molecular mechanisms underpinning normal biology and disease. These approaches include prediction of causality and community detection. Existing software in the Overton group involves multi-step procedures that build upon computationally expensive (NP-complete) graph algorithms such as minimum cut and maximal weighted clique. The performance and memory consumption of these graph algorithms limits the size of networks that may be analysed, and hence restricts the data set sizes and detail of analysis that can be performed in a reasonable amount of time.

The goal of this PhD project is to revisit relevant graph problems and to explore efficient heuristic solutions to the selected problems. These heuristics will be tuned to the application domain, leveraging the specific structure of the graphs that appear in relevant bioinformatics data. Moreover, the project will characterise the quality of the solution found and investigate the feasibility of algorithms that incrementally improve an initial solution, allowing to trade-off accuracy against computation time as well as exploration of enhancements to the quality of results on existing benchmark datasets.

Objectives:
- To develop efficient, heuristic algorithms for important graph analysis problems in bioinformatics by leveraging relevant domain-specific information
- To develop 'anytime' algorithms that incrementally improve the quality of the solution found
- To analyse and theoretically bound the optimality of the heuristic algorithms compared to established heuristic algorithms and optimal results
- To explore algorithmic performance enhancements on bioinformatics benchmark datasets.
- To demonstrate the effectiveness of these algorithms in terms of speed and memory consumption and the impact on accuracy of analysis and predictions when applied to bioinformatics analyses

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Academic Requirements:

Students entering the programme will normally be required to have a 2.1 BSc/BEng in Computer Science, Electrical and Electronic Engineering, or a maths based engineering or physical science degree, or equivalent qualification recognised by the University. Students holding an appropriate MEng or MSc (Software conversion) will normally be required to have a 2.1 or commendation (distinction) respectively. Furthermore, additional criteria may be applied. All applicants must have significant mathematical and programming experience.

GENERAL INFORMATION:
This 4 year PhD studentship, potentially funded by the Department for Employment and Learning (DEL), commences on 1 October 2019.

Eligibility for both fees and maintenance depends on the applicants being either an ordinary UK resident or those EU residents who have lived permanently in the UK for the 3 years immediately preceding the start of the studentship. Non UK residents who hold EU residency may also apply but if successful may receive fees only.

Applicants should apply electronically through the Queen's online application portal at: https://dap.qub.ac.uk/portal/

Deadline for applications: Friday 1 March 2019

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