Department of Computer Science
Faculty of Engineering

Research Associate in Time Complexity Analysis of Bio-Inspired Computation

Pursue the extraordinary
The Department of Computer Science was established in 1982 and has since attained an international reputation for its research and teaching. In the most recent Research Excellence Framework, 45% of the research in the Department was recognised internationally excellent in terms of originality, significance and rigour, and another 47% is internationally world-leading. These results place the Department among the top 5 UK computer science departments for research excellence.

Our research activities are split into the following research groups: Computational Biology, Computer Graphics and Virtual Reality, Machine Learning, Natural Language Processing, Neurocomputing and Robotics, Organisations, Information and Knowledge, Speech and Hearing and Verification and Testing. As such there is a substantial cross- and interdisciplinary research activity in many areas. We attract substantial external funding from the Research councils, European Community and Industry. Our record for leadership in collaborative research is outstanding, particularly in European programmes. Further information on the department can be accessed via the Departmental web link www.shef.ac.uk/dcs.

Bio-inspired optimisation research in the Department is led by Dr. Pietro Oliveto and Dr. Dirk Sudholt and covers general-purpose optimisation paradigms that draw inspiration from biological systems. Popular examples include evolutionary algorithms, ant colony optimisation and artificial immune systems. The team works towards providing a theoretical foundation for understanding the working principles of these heuristic algorithms by quantifying how quickly they find satisfactory solutions for various problems, thus explaining when and why they are efficient. This understanding exposes how performance depends on algorithmic parameters, enables informed choices as to when to use what kind of heuristic and allows the design of better bio-inspired algorithms. Further information can be accessed via Pietro Oliveto’s webpage (www.shef.ac.uk/dcs/research/groups/compbio/oliveto).

The post holder will work on the time complexity analysis of bio-inspired computation techniques. The position is funded by EPSRC as part of the “Rigorous Runtime Analysis of Bio-Inspired Computing” project led by Dr. Pietro Oliveto.
The aim of the project is to develop the mathematical methodology for explaining and predicting the performance of bio-inspired search heuristics, such as evolutionary algorithms, ant colony optimisation and artificial immune systems. The methodology will be used in the project to:

i) Perform runtime analyses of realistic population-based heuristics for combinatorial optimisation problems, highlighting the relationships between the solution quality and the exploration capabilities of the population.

ii) Rigorously prove the benefits of parallelisation towards the search ability of the algorithm’s population.

iii) Understand the theoretical working principles of genetic programming towards the effective evolution of computer programs.

iv) Develop a computational complexity classification that correctly characterises problem hardness for bio-inspired search heuristics.

The post holders will undertake research as defined by the project proposal and will work with other members of the team to achieve the objectives of the project. The role will also require collaboration with project partners with world-leading reputations in bio-inspired computing, such as DTU-Denmark, University of Adelaide, University of Birmingham and the EU-funded SAGE project team at Sheffield, amongst others. Engagement with industrial partners to maximise the impact of the results will also be required. This is an opportunity to work in a well-connected international team at The University of Sheffield with expertise in bio-inspired computing.

### Job Description

**Main Duties and Responsibilities**

- Contribute to the development of new mathematical techniques for the time complexity analysis of population-based bio-inspired heuristics. Additionally, extend standard techniques to effectively allow the analysis of realistic population-based algorithms.

- Perform runtime analyses of population-based bio-inspired heuristics for combinatorial optimisation problems with the aim of understanding their advantages over traditional problem specific algorithms.

- Perform runtime analyses of parallel evolutionary algorithms with the aim of highlighting the benefits of parallelisation compared to sequential evolutionary algorithms and understanding how to use parallelism most effectively in bio-inspired computing.

- Contribute to the development of the mathematical methodology to analyse the time
complexity of genetic programming, with the aim of gaining insights towards the achievement of the effective evolution of functions with desired properties.

- Contribute to the development of a computational complexity model of bio-inspired heuristics for the suitable classification of problem hardness.
- Investigate the impact of the algorithmic parameters on the overall performance.
- Carry out the computational experiments required for the achievement of the project goals.
- Collaborate closely and drive the interaction with project partners and other colleagues in bio-inspired computation towards the achievement of the goals of the project.
- Plan work activities to ensure deliverables and deadlines are met while continuously monitoring progress.
- Disseminate the results via project meetings, conference papers, conference presentations and journals of the highest quality.
- Contribute to the administration of the project in terms of reporting obligations and impact activities (for example, through workshop and special session organisation, tutorials, social networking and blog entries).
- Undertake activities to increase own leadership capabilities and standing in the community on an international scale.
- Contribute to the development of further research objectives and grant proposals for own or joint research.
- Any other duties, commensurate with the grade of the post.

**Person Specification**

Applicants should provide evidence in their applications that they meet the following criteria. We will use a range of selection methods to measure candidates' abilities in these areas including reviewing your on-line application, seeking references, inviting shortlisted candidates to interview and other forms of assessment action relevant to the post.

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<th>Criteria</th>
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<td>Qualifications and experience</td>
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<td>1. PhD (or close to completion) or equivalent experience in computer science or closely related area.</td>
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2. Experience with some or all of the following:
   - Theory of bio-inspired computation
   - Algorithm analysis and computational complexity
   - Computational complexity analysis of randomised algorithms
   - Analysis of stochastic processes

3. Computer programming skills.

4. A publication record commensurate with career stage in high-impact journals and conference proceedings.

5. Experience of writing scientific reports in LaTeX and collaborative reports in SVN or analogue.

Management skills

6. Potential to develop leadership and management skills appropriate to take on a supporting role within the research group.

7. Ability to co-supervise PhD students and other researchers associated with the project.

8. Experience of motivating and communicating with a research team and administrative staff.

Communication skills

9. Effective communication skills, both written and verbal and experience of delivering presentations in a clear, interesting, yet concise and understandable manner.

10. Excellent interpersonal skills to communicate effectively with project partners and to conduct effective working relationships.

Team working

11. Excellent team working skills.

Supporting staff performance

12. Ability to motivate high performance in others.

Problem solving and decision making

13. Ability to develop creative approaches to problem solving.


Project management

15. Ability to assess and organise resources, and plan and progress work activities meeting deadlines effectively.

16. Ability to organise own research work and meet deadlines for research deliverables.
17. Ability to organise project administration duties and impact activities to specified deadlines and keep related documents and web-pages up to date. | X

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18. Experience of developing and maintaining a network of contacts throughout own work area. | X

19. Experience of adapting own skills to new circumstances. | X

20. Ability to meet deadlines and cope with demands. | X

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**Further Information**

**This post is open-ended** subject to funding, with funding confirmed for 4 years and 6 months. Employment beyond this date will be conditional upon the University securing and retaining further funding for the role.

**This post is full-time:**

This role has been identified as a full-time post, but we are committed to exploring flexible working opportunities with our staff which benefit both the individual and the University (See [http://www.sheffield.ac.uk/hr/guidance/flexible/arrangements](http://www.sheffield.ac.uk/hr/guidance/flexible/arrangements)). Therefore, we would consider flexible delivery of the role subject to meeting the business needs of the post. If you wish to explore flexible working opportunities in relation to this post, please contact the recruiting department via the contact details provided below.

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**Reward and Recognition – The Deal**

**Terms and conditions of employment:** Will be those for Grade 7 staff.

**Salary for this grade:** £29,552 - £37,394 per annum. Potential to progress to £40,847 per annum through sustained exceptional contribution.

The Deal is the pay, rewards and many benefits you earn for being a valued member of our University and by being ambitious and performing at your best.

If you join the University you will have access to The Deal and your own personalised pay, reward and benefits portal where you can access a comprehensive selection of benefits and offers to suit your changing lifestyle needs, for example childcare vouchers, Cycle to Work initiative, shopping discounts along with access to extensive development and training options – over a third of staff work in Investors in People (IiP)
To find out more visit www.sheffield.ac.uk/hr/thedeal/benefits

Through The Deal we are committed to making the University a remarkable place to work and we support this through a number of sector leading initiatives such as Juice and Sheffield Leader.

Our innovative Health and Wellbeing programme, Juice, promotes happiness and wellbeing through a broad range of inclusive activities (www.shef.ac.uk/juice)

Our leadership development has been designed to ensure that our leaders have the knowledge, skills and behaviours needed by the University (www.sheffield.ac.uk/hr/sld/sheffieldleader).

We are also proud of our award-winning equality and diversity action which enhances working life for all. 91% of staff tell us they are treated with fairness and respect (staff survey 2014) www.shef.ac.uk/hr/equality

In our staff survey (2014) 94% of staff said they were proud to work for the University and 87 % of our staff would recommend Sheffield University as an excellent place to work. To find out more about what it's like to work here have a look at our webpages, www.sheffield.ac.uk/staff/survey and www.sheffield.ac.uk/jobs/staffbenefits.

Closing date: For details of the closing date please view this post on our web pages at http://www.sheffield.ac.uk/jobs/

Informal enquiries:

For informal enquiries about this job and the recruiting department, contact: Dr Pietro Oliveto on p.oliveto@sheffield.ac.uk or on 0114 222 1812.

For administration queries and details on the application process, contact the lead recruiter: Mrs Monika Kus on com-recruiters@sheffield.ac.uk.

For all online application system queries and support, visit: https://www.sheffield.ac.uk/jobs/applying

Selection-Next Step

Following the closing date, we will contact you by email to let you know whether or not you have been shortlisted to participate in the next stage of the selection process. Please note that due to
the large number of applications that we receive, it may take up to two working weeks following
the closing date before the recruiting department will be able to contact you.

The University of Sheffield is committed to achieving excellence through inclusion.

The University of Sheffield is proud to be a Two Ticks employer
www.sheffield.ac.uk/hr/equality/support/twoticks

The University has achieved the Athena SWAN award for Women in Science, Engineering and
Medicine.

The Department has achieved the Athena SWAN Bronze award for Women in Science, Engineering
and Medicine.