Duncan Adamson

Postdoctoral Researcher at Reykjavik University

Personal Data

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Research Interests

My primary research interests are in Theoretical Computer Science and Discrete Mathematics, in particular related to:

- Combinatorics on Words.

- k-centre problem for implicitly defined objects (such as graphs and words).

- Crystal Structure Prediction.

- Stable Matchings.

These can be divided into two related themes, developing new combinatorial structures and building efficient algorithms using these structures.

Work and Education

September 2021 - Present	Postdoctoral researcher **Reykjavik Univseriy**, Iceland
September 2018 - December 2021	PhD in Computer science, **University of Liverpool**, UK Thesis: *Algorithmic and Combinatorial Problems in Crystal Structure Prediction* Supervisors: Prof. Igor Potapov (primary), Dr. Matthew Dyer, Dr Vladimir Gusev. Funded by the Leverhulme Research Centre for Functional Material Design
September 2013 - June 2018	2:1 Undergraduate Master of Science in Computer Science, **University of Glasgow**, UK Dissertation: *Maximum least-unstable matchings using integer programming* Advisor: Dr. David Manlove

Teaching

- Demonstrator, Efficient Sequential Algorithms
University of Liverpool, 2018-Present
Responsibilities: This role primarily involved small group teaching, both in person and

online. This involved weekly seminars going focused on proving the correctness of algorithmic concepts, and demonstrating the execution of algorithms. This required the preparation of teaching materials as well as marking assignments.

- Demonstrator, Software Engineering
  University of Liverpool, 2018
  Responsibilities: This role primarily involved lab teaching. This involved running large weekly labs covering the principles of software engineering. This required weekly preparation for each lab, helping students with solving problems with their code, and marking assignments.

- Demonstrator, Cyber Security
  University of Liverpool, 2019
  Responsibilities: This role primarily involved lab teaching. This involved running small weekly lab sessions covering the principles of Cyber security through practical exercises. This required weekly preparation for each lab, helping students with solving problems with their code, and marking assignments.

- *Demonstrator, Foundations of computer science*
  University of Liverpool, 2020
  Responsibilities: This role primarily involved lab teaching. This involved running large weekly lab sessions covering the algorithmic foundations of computer science. This required weekly preparation for each lab, helping students with the implementation of algorithms and marking assignments.

Research Schools

- Max Planck Advanced Course on the Foundations of Computer Science
  Max Planck Institute for Informatics, Saarbrücken, 2019
  Summer school covering various current research topics in Computer Science on the theme *Games, Brains, and Distributed Computing*.

- Caleidoscope : Complexity as a Kaleidoscope
  Institut Henri Poincaré, 2019
  Summer school covering current research in complexity theory, primarily proof and circuit complexity.

- Manycore Summer School
  MaRIONet, University of Glasgow, 2018
  Research school focused on using highly parallel (Manycore) systems for computational challenges.

- CERN Spring Campus.
  University of Glasgow, 2017
  Research school focused on the big data challenges faced by CERN.

Other Experience

September 2020 - May 2021	**Unofficial Co-Supervision of a final year student's Honours Dissertation.** *University of Liverpool, Co Supervised with Viktor Zamaraev* Responsibilities have included establishing the underlying theory for the project, helping with guiding the student with what work on and holding meetings with the student.
June - August 2016	**Intern Software Developer** *Thom Micro Systems Ltd.* Developed an online application to combine with existing tender managing software to allow tenders to be sent out and completed automatically. Learned the VB.net programming language and gained real world experience of software development.
January-April 2013	**IT Manager** *Teen Canteen - Finestripe productions* Developed a web platform for a takeaway service for documentary series Teen Canteen, also aided in the creation and development of the takeaway. Gained crucial knowledge in how to operate both as a business and within a larger organisation

Grants and Awards

- PhD Scholarship
  University of Liverpool, 2018 - 2021
  Fully funded scholarship to study at the University of Liverpool along with an annual research budget.

- Travel Grant to visit Royal Holloway, University of London
  Materials Innovation Factory, University of Liverpool, 2020
  Grant to visit Dr. Argyris Deligkas at Royal Holloway University of London

- Travel Grant to attend *Measurability, Ergodic Theory and Combinatorics* at the University of Warwick
  Grant for travel and accommodation to attend the symposium *Measurability, Ergodic Theory and Combinatorics* at the university of Warwick.

- Travel grant to attend the *One-Day Meeting in Combinatorics* at the University of Oxford
  Mathematical Institute, University of Oxford, 2019
  A grant covering travel costs to attend the one day meeting in combinatorics at the mathematical institute in the university of Oxford.

- Travel grant to attend ADFOCS 2019
  Max Planck Institute for Informatics, Saarbrücken, 2019
  Grant covering travel and accommodation costs to attend the 20th Max Planck Advanced Course on the Foundations of Computer Science.

- Accommodation grant to attend *Caleidoscope : Complexity as a Kaleidoscope*
  Institut Henri Poincaré, 2019
  Accommodation provided to attend to the *Caleidoscope : Complexity as a Kaleidoscope* summer school.

- Gridwars AI programming Challenge
  CERN Spring Campus, 2017
  First place prize at CERN Spring Campus Gridwars AI programming challenge.

Full Research Interests

Combinatorics on words: *My interest on combinatorics on words has been primarily motivated on representing real world objects within a discrete space. In particular, I am been interested in*

capturing symmetry on words, such as reflective [3] *and, in the multidimensional setting, translational symmetries* [2]. *Going forward I would like to extend more results from one dimension into the multidimensional setting.*

k-centre problem for implicitly defined objects (such as graphs and words): *Many classes of combinatorial objects can be represented as a weighted graph using some similarity measure to assign weights to the edges. For large graphs, for instance the set of all words of length n, generating the whole graph is impractical. To this end, we seek to take a set of representative samples from the graph. The idea behind the k-centre problem for implicitly defined graphs is to take k samples from some graph that allow the local properties to be determined. At present I have worked this problem for (multidimensional) words* [2, 4], *using the overlap distance between subwords as the distance. Going forward I would like to study more complex objects.*

Crystal Structure Prediction: *During my PhD I have focused on the problem of predicting the structures of Crystals from first principles. My main results has been on the hardness of this problem* [1], *and more recently on approaches to solving similarly motivated problems* [2]. *Move forward I would like to show undecidability for the general version of this problem.*

Temporal Graphs: *I have recently began working on the problem of harmonious colourings in the setting of temporal graphs. The initial results have shown that this is a highly challenging problem even when the underlying graph is a path. The next steps in the project would be to look at solutions to this problem when each time step has been solved. Additionally, I have begun studying the more classical problem of exploring temporal graphs with a fixed number of chords, which has resulted in a paper submitted to SAND 2022* [5].

Stable Matchings: *During my Masters, I worked on the stable matching problem for incomplete lists with ties. My main result was providing new bounds on the number of blocking pairs for maximum matchings in this setting. Moving forward I would be interested in obtaining similar results for more complex settings such as the kidney exchange problem.*

IT AND PROGRAMMING SKILLS

Programming Languages

Proficient with:	Java, Python, Gurobi, LaTeX
Competent with:	Haskell, JavaScript, C, Bash, VB.net, HTML, MiniZinc, D-Wave Leap

Other

Experience with:	Microsoft office suite, Linux, Windows

PROFESSIONAL MEMBERSHIPS

- Algorithms UK (AlgoUK).

- Association for Computing Machinery (ACM).

- Association Computability in Europe (CiE).

- European Association for Theoretical Computer Science (EATCS).

- London Mathematical Soceity (LMS).

Presentations

CPM 2021 - Wroclaw	*Ranking Bracelets*
BCTCS 2021 - Liverpool	*Ranking Bracelets*
BCTCS 2020 - Swansea	*Multidimensional Necklaces: Enumeration, Generation, Ranking and Unranking*
SOFSEM 2020 - Limassol, Cyprus	*Crystal Structure Prediction by Vertex Removal in Euclidean Space*
ACTO Seminar 2020 - Liverpool	*On the hardness of Crystal Structure Prediction*
ECO Seminar 2020 - Liverpool	*Maximum least-unstable matchings*
BCTCS 2019 - Durham	*Crystal Structure Prediction by Vertex Removal in Euclidean Space*

Publications

[1] D. Adamson, A. Deligkas, V. V. Gusev, and I. Potapov. On the hardness of energy minimisation for crystal structure prediction. In *46th International Conference on Current Trends in Theory and Practice of Computer Science (SOFSEM) 2020*, volume 12011 of *Lecture Notes in Computer Science*, pages 587–596, 2020.

[2] D. Adamson, A. Deligkas, V. V. Gusev, and I. Potapov. Combinatorial algorithms for multidimensional necklaces. *Submitted to the 54th Annual ACM Symposium on Theory of Computing (STOC)*, 2021.

[3] D. Adamson, A. Deligkas, V. V. Gusev, and I. Potapov. Ranking bracelets in polynomial time. *31st Annual Symposium on Combinatorial Pattern Matching (CPM)*, 2021.

[4] Duncan Adamson, Argyrios Deligkas, Vladimir V. Gusev, and Igor Potapov. The K-Centre Problem for Necklaces. *arXiv entry*, may 2020. URL: http://arxiv.org/abs/2005.10095, arXiv:2005.10095.

[5] Duncan Adamson, Vladimir V. Gusev, Dmitriy Malyshev, and Viktor Zamaraev. Faster exploration of some temporal graphs. *Submitted to 1st Symposium on Algorithmic Foundations of Dynamic Networks (SAND)*, 2021.

Two submitted manuscripts of [2, 3] can be found in the following DropBox folder here.

REFERENCES

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