

Duncan Adamson

Postdoctoral Researcher at Reykjavik University

PERSONAL DATA

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NATIONALITY:	British Citizen	
DATE OF BIRTH:	12/10/1995	

WORK AND EDUCATION

OCTOBER 2022 - Present	Postdoctoral Researcher University of Göttingen, Germany Supervisor: Prof. Florin Manea
SEPTEMBER 2021 - SEPTEMBER 2022	Postdoctoral researcher Reykjavik Univseriy, Iceland Supervisor: Prof. Magnus M. Halldorsson
SEPTEMBER 2018 - DECEMBER 2021	PhD in Computer science, University of Liverpool, UK Thesis: <i>Algorithmic and Combinatorial Problems in Crystal Structure Prediction</i> 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: <i>Maximum least-unstable matchings using integer programming</i> Advisor: Prof. David Manlove

TEACHING

- Guest Lecturer, Computing using Randomisation
Reykjavik University, 2022
Responsibilities: I was invited to provide a lecture to the Masters-level course on computing using randomisation.
- Oral Examiner, Graph Theory
Reykjavik University, 2022
Responsibilities: This role required me to provide an oral examination to the students studying the graph theory course at Reykjavik University.
- Demonstrator, Efficient Sequential Algorithms
University of Liverpool, 2018-2021
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 - 2019
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 - 2020
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, 2019-2020
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*.
- Kaleidoscope : 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	<p>Unofficial Co-Supervision of a final year student's Honours Dissertation. <i>University of Liverpool, Co Supervised with Viktor Zamaraev</i></p> <p>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.</p>
JUNE - AUGUST 2016	<p>Intern Software Developer <i>Thom Micro Systems Ltd.</i></p> <p>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.</p>
JANUARY-APRIL 2013	<p>IT Manager <i>Teen Canteen - Finestripe productions</i></p> <p>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</p>

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.

RESEARCH INTERESTS

Combinatorics on words: My interest in combinatorics on words has been primarily motivated by the problem of representing real world objects within a discrete space. I am particularly interested in classes of cyclic words, such as Lyndon words, necklaces, and bracelets. So far my research has resulted in new algorithmic and combinatorial results for bracelets [1], multidimensional necklaces [8], and unlabelled necklaces [2]. Going forward with the motivation of representing real world objects in a discrete space, I would like to generalise more results from one dimension into the multidimensional setting. I would also be interested in studying further symmetries and combinations of symmetries, such as both the multidimensional reflective and translational symmetries (multidimensional bracelets).

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 on this problem for (multidimensional) words [8, 7], using the overlap distance between subwords as the distance. Going forward I would like to study more complex objects, such as graphs or permutations.

Distributed Colouring Problems One of the most fundamental problems in distributed computing is that of finding an algorithm to colour the graph. My current work has been focused on finding colourings in two distinct settings: the highly dynamic setting, where the structure of the graph changes each round [12]; and the hypergraph setting, where vertices are connected by hyper edges [9]. At present my work is focused on the $\Delta + 1$ -colouring problem, where Δ is the largest degree of any vertex in the graph. In the dynamic setting, this means fixing colourings in as few rounds as possible after the last change. In the hypergraph setting, we are interested in finding weak colourings, where no edge is monochromatic.

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 [3], [4], [5], [11], and more recently on approaches to solving similarly motivated problems [8]. Move forward I would like to either provide new approximation techniques for Crystal Structure Prediction, or to show that no such approximation can be found.

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 published at SAND 2022 [6].

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 Society (LMS).

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PRESENTATIONS

ACTO Seminar 2022 - Liverpool	<i>The k-centre problem for classes of cyclic words</i>
DCFS 2022 - Debrecen	<i>Ranking Binary Unlabelled Necklaces in Polynomial Time</i>
SAND 2022 - Online	<i>Faster exploration of some temporal graphs</i>
Málstífa í stærðfræði HÍ (University of Iceland)	<i>Combinatorial Structures for Crystal Structure Prediction</i>
CPM 2021 - Wrocław	<i>Ranking Bracelets</i>
BCTCS 2021 - Liverpool	<i>Ranking Bracelets</i>
BCTCS 2020 - Swansea	<i>Multidimensional Necklaces: Enumeration, Generation, Ranking, and Unranking</i>
SOFSEM 2020 - Limassol, Cyprus	<i>Crystal Structure Prediction by Vertex Removal in Euclidean Space</i>
ACTO Seminar 2020 - Liverpool	<i>On the hardness of Crystal Structure Prediction</i>
ECO Seminar 2020 - Liverpool	<i>Maximum least-unstable matchings</i>
BCTCS 2019 - Durham	<i>Crystal Structure Prediction by Vertex Removal in Euclidean Space</i>

PUBLICATIONS

- [1] **D. Adamson***, A. Deligkas, V. V. Gusev, and I. Potapov. Ranking bracelets in polynomial time. *31st Annual Symposium on Combinatorial Pattern Matching (CPM)*, June 2021.
- [2] **D. Adamson***. Ranking binary unlabelled necklaces in polynomial time. *24th International Conference on Descriptive Complexity of Formal Systems (DFCS)*, 2022.
- [3] **D. Adamson***, A. Deligkas, V. V. Gusev, and I. Potapov. On the hardness of energy minimisation for crystal structure prediction. *46th International Conference on Current Trends in Theory and Practice of Computer Science (SOFSEM) 2020*, 12011:587–596, January 2020.
- [4] **D. Adamson**, A. Deligkas, V. V. Gusev, and I. Potapov*. On the hardness of energy minimisation for crystal structure prediction. *Fundamenta Informaticae*, 184:1–23, February 2022.

- [5] **D. Adamson***, Vladimir V. Gusev, Igor Potapov, and Argyrios Deligkas. The Complexity of Periodic Energy Minimisation. 241:37:1–37:15, 2022.
- [6] **D. Adamson***, V. V. Gusev, D. Malyshev, and V. Zamaraev. Faster exploration of some temporal graphs. *1st Symposium on Algorithmic Foundations of Dynamic Networks (SAND 2022)*, April 2022.
- [7] **D. Adamson***, A. Deligkas, V. V. Gusev, and I. Potapov. The k-center problem for classes of cyclic words. *48th International Conference on Current Trends in Theory and Practice of Computer Science.*, 2023.

SUBMISSIONS

- [8] **D. Adamson***, A. Deligkas, V. V. Gusev, and I. Potapov. Combinatorial algorithms for multidimensional necklaces.
- [9] **D. Adamson**, M. M. Halldórsson, and A. Nolin*. Distributed algorithms for colouring hypergraphs.
- [10] **D. Adamson***, A. Deligkas, V. V. Gusev, and I. Potapov. Ranking bracelets in polynomial time (journal submission).
- [11] V. V. Gusev*, **D. Adamson**, A. Deligkas, D. Antypov, C.M. Collins, G.R. Darling, M.S. Dyer P. Krysta, I. Potapov, P. Spirakis, and M.J. Rosseinsky. Non-heuristic algorithms, guarantees and quantum computing for crystal structure prediction. 2022.

PREPARATION

- [12] **D. Adamson**, M. M. Halldórsson, and A. Nolin. Efficient algorithms for maintaining colourings in highly dynamic distributed graphs. *Under Preperation*, 2022.

*** denotes corresponding author**

Current versions of any manuscript under preparation or review can be presented upon request.

REFERENCES

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