Duncan Adamson

Postdoctoral Researcher at Reykjavik University

Personal Data

Address:	(Icelandic) 5 Snæland 108 Reykjavik Iceland	(U.K.) 47 Acredales Linlithgow EH49 6HY United Kingdom
Phone:	+354 6111 253	+44 7411 305 237
work e-mail:	duncana@ru.is	
personal e-mail:	duncanadamson@protonmail.com	
Nationality:	*British Citizen*	
Date of Birth:	12/10/1995	

Work and Education

September 2021 - Present	Postdoctoral researcher **Reykjavik Univseriy**, Iceland Supervisor: Prof. Magnus M. Halldorsson
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: Prof. David Manlove

Teaching

- 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*.
- 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.

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 [6], 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 [6, 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 [10]; and the hypergraph setting, where vertices are connected by hyper edges [8]. 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], [9], [11], and more recently on approaches to solving similarly motivated problems [6]. 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 [5].

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).

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

SAND 2022 - Online	*Faster exploration of some temporal graphs*
Málstifa í stær fræ i HÍ (University of Iceland)	*Combinatorial Structures for Crystal Structure Prediction*
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. 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 Descriptional 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. 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***, 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.

Submissions

[6] **D. Adamson***, A. Deligkas, V. V. Gusev, and I. Potapov. Combinatorial algorithms for multidimensional necklaces.

[7] **D. Adamson***, A. Deligkas, V. V. Gusev, and I. Potapov. The k-center problem for classes of cyclic words.

[8] **D. Adamson**, M. M. Halldórsson, and A. Nolin*. Distributed algorithms for colouring hypergraphs.

[9] **D. Adamson***, A. Deligkas, V. V. Gusev, and I. Potapov. Undecidability and intractability of pairwise energy minimisation in periodic structures.

Preparation

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

[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. *Under Prperation*, 2022.

*** denotes corresponding author**

Submitted manuscripts of [6, 9] and [5] can be found in the following DropBox folder here. Current versions of any manuscript under preparation can be presented upon request.

References

Prof. Igor Potapov
Department of Computer Science,
Ashton Building
Ashton Street,
Liverpool
L69 3BX
UK
Phone: +44 151 795 425
Email:potapov@liverpool.ac.uk

Prof. Magnus M. Halldorsson
Department of Computer Science
Reykjavik University
Menntavegur 1
102 Reykjavik
Iceland
Telephone: +354 599 6384
Email: magnusmh@gmail.com

Prof. David Manlove
School of Computing Science
Sir Alwyn Williams Building
University of Glasgow
Glasgow
G12 8QQ
UK
Office:S151
Telephone:+44 141 330 2794
Email:david.manlove@glasgow.ac.uk

Dr. Argyrios Deligkas
Department of Computer Science
Royal Holloway, University of London
Egham Hill
Egham
Surrey
TW20 0EX
United Kingdom
Phone: +44 1784 443421
Fax: +44 1784 439786
Email:Argyrios.Deligkas@rhul.ac.uk

Dr. Viktor Zamaraev
Department of Computer Science,
Ashton Building
Ashton Street,
Liverpool
L69 3BX
UK
Email:Viktor.Zamaraev@liverpool.ac.uk