Thomas Davies

Southampton - UK

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Education

PhD, Computer Science — **University of Southampton**
Southampton, UK — *September 2019 – Present*

- My research aims to combine tools from topological data analysis with techniques from machine learning to enable topology-driven deep learning.
- I'm interested in both the theoretical study of machine learning, with a focus on TDA-based algorithms, and applications of ML to other disciplines: in my first paper we apply a novel algorithm to achieve state-of-the-art classification of transformed materials science datasets.

MSci, Mathematics — **University of Birmingham**
Birmingham, UK — *September 2015 – July 2019*

- I graduated with a first class Mathematics MSci with honours, earning an overall mark of 80%.
- My master's thesis, *The Persistent Homology of Complexes from Point Data Sets*, studied the algebraic topology underpinning topological data analysis, attaining a mark of 83%.
- My bachelor's thesis was *Burnside's Theorem and Representations of Finite Groups* and achieved a mark of 84%.

Publications

Hypothesis classes with a unique persistence diagram are nonuniformly learnable, *Thomas Davies, Nick Bishop, Long Tran-Thanh*, NeurIPS 2020 TDA and Beyond workshop (spotlight paper)

- We show that the hypothesis class of functions defined by functions with a unique persistence diagram is nonuniformly learnable.
- This is the first statistical learning theoretic justification for the integration of persistence-based summaries into loss functions.

Fuzzy c-Means Clustering for Persistence Diagrams, *Thomas Davies, Jack Aspinall, Bryan Wilder, Long Tran-Thanh*, arXiv:2006.02796, NeurIPS 2020 TDA and Beyond workshop

- We developed an algorithm for fuzzy c-means clustering on the space of persistence diagrams, enabling unsupervised learning that automatically captures the topological structure of data.
- We use our algorithm to fuzzy cluster decision boundaries, showing that the membership values capturing information about model generalisation to unseen tasks.
- We show that our algorithm can classify transformed lattice structures from materials science where comparable algorithms fail.

Technical Experience

EPS EdTech/Maplesoft — **Birmingham, UK**
Team Lead — *July 2019 - September 2019*

- I led a team of five interns implementing mathematical questions in a computer algebra system (Maple) to allow for automated, randomised testing within an online assessment system (Maple TA/Möbius).
- As the team lead I was responsible for liaising with clients to confirm individual project requirements, organising the interns to ensure that we met the deadlines for deployment and testing, and dealing with any problems that arose.

Developer — *September 2017 – July 2019*

- I worked as a developer for the edtech team over a period of two years, most notably working full-time over Christmas 2017 and 2018.
- As well as implementing questions in Maple, this involved writing web applications in JavaScript (using bootstrap, jquery, and more) to act as learning aids.

Intern *July 2017 – September 2017*

- As an intern I was jointly funded by Birmingham University and Maplesoft, with the same responsibilities as when working as a developer.
- I developed a CNN in TensorFlow that successfully classified hand-sketched graphs as part of a project to automate marking. I presented this to a VP of Maplesoft.

Fusion Innovations **Birmingham, UK**

Data Scientist *July 2018 – September 2018*

- I created an end-to-end data science pipeline for Fusion Innovations, an automotive engineering start-up aiming to create smart car tyres. This involved cleaning, processing, visualising, and modelling large amounts of data.
- I successfully engineered features extracted from tyre-embedded piezoelectric sensor data to predict technical information about the state of the tyres.
- I developed a convolutional recurrent neural network to predict road surface from sensor input.
- I wrote and gave presentations to investors and was involved in patent applications for the company.

The R&A **St Andrews, UK**

Pace of Play Project *January 2017 – March 2017*

- I worked with The R&A on a research project into the pace of play, developing a model that could accurately predict the location of pins and tees given raw GPS data from transceivers worn by golfers.

Civil Service **UK**

Cybersecurity Intern *July 2016 – September 2016*

- I learned a large array of cyber skills such as penetration testing, reverse engineering/malware analysis, information assurance, secure coding, hardware hacking, and more.
- As an independent project, I wrote a chat client/server in C that implemented the WEP usage of the RC4 stream cipher, then broke it using the FMS attack. I was selected to present my project to senior management at the end of the internship.

Other Experience

University of Southampton **Southampton, UK**

Demonstrator *September 2019 – Present*

- Demonstrating for the following courses, which includes leading tutorials, marking, and helping in labs.
- Foundations of Computer Science: introductory mathematics for first year undergraduates.
- Software Security: penetration testing and software reverse engineering for masters students.
- Software Engineering Group Project: agile development for second year undergraduates.
- Foundations of Machine Learning: machine learning theory for third year undergraduates and masters students.
- Machine Learning Technologies: machine learning engineering for third year undergraduates and masters students.

University of Birmingham **Birmingham, UK**

Teaching Assistant *September 2018 – July 2019*

- TA for Data Science for Everyone: introductory python and data science for first year undergraduates.

Birmingham University Debating Society **Birmingham, UK**

President *February 2017 - February 2018*

- I was elected to a voluntary position overseeing a committee of 13 that: ran weekly workshops in public speaking and British parliamentary debating; regularly sent competitors to national and international tournaments; organised a competition attended by students from around Europe that ran at a profit of over £900; and organised a competition for secondary school students that promoted public speaking skills to attendees from around the UK, with a focus on providing opportunities for poorly performing schools.
- I have strongly developed my public speaking and communication skills through competitive debating.

Secretary *February 2016 - February 2017*

- I introduced and organised an end-of-year formal which sold out, running at a profit for the society.