

Dominic Williamson

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Education

Imperial College London
MSc Artificial Intelligence

2020 – 2021

The University of Manchester
BSc Physics with Theoretical Physics – 1st

2016 – 2019

- **Theory Computing Project:** Produced a range of Monte Carlo simulations in Python and an accompanying report investigating the 2D Ising model and 2D XY model from solid-state physics. This involved significant independent study into the statistical techniques required for the simulation before writing a final essay and presentation describing the physics, computational and statistical theory, and results. Helped to improve scientific writing and presentation skills as well as understanding of statistical concepts such as Markov chains and the bootstrap method for error determination.
- **Advanced Dynamics, Lagrangian Dynamics, Complex Variables and Integral Transforms, Fluid Mechanics, Electrodynamics:** These modules are considered by the university to be more mathematically involved, some of which are mandatory to satisfy the ‘theoretical’ aspect of the degree. Having scored highly these courses, this represents good mathematical aptitude and the ability to apply it under pressure in examinations.
- **Random Processes in Physics, Thermal and Statistical Physics, Courses in Quantum Mechanics:** These modules were important to understanding the theory underpinning the machine learning internship I completed – particularly probability, statistics, and linear algebra. The more advanced quantum mechanics courses, building on from Mathematics 1 and 2, covered linear algebra topics such as tensors and vector spaces, differential operators, and matrix decomposition. Meanwhile the statistics-based courses went into detail on common probability distributions and expectation, Bayesian probability, and random variables.

Oakbank School (now Beckfoot Oakbank School), Keighley, West Yorkshire
A level: **3A*** – Physics, Maths, Chemistry
AS level: **3A** – Biology, History & Extended Project Qualification
GCSE: **5A***, **Dist***, **3A**, **Dist**, **3B**

2009 – 2016

Research Experience

Internship (Full time)

10 weeks, June – Aug 2018

The University of Manchester, Quantum Chemical Topology Group

- Supervised by Prof Paul Popelier – studied the repulsive behaviour of topological atoms (due to steric interactions) as they are brought together and compressed.
- Initially designed and ran a set of computational experiments to investigate the hypothesis. These were developed into submission scripts using Python and ran in Gaussian, a chemistry software package. Bash was used to both run Gaussian and to analyse data on a high-performance computer cluster.
- Unexpected observations then prompted a more comprehensive range of experiments to be designed. This not only required the application of programming skills but also problem solving to help determine the most appropriate set of experiments to perform at each stage of the project.
- Alongside two other interns, used \LaTeX to write a paper detailing the final theory – submitted for publication alongside other members of the group. Producing work to this quality involved extensive

research into the current literature and thorough data analysis in presenting the results. Further developed scientific writing skills and critical thinking ability by helping to write sections of the paper.

Internship (Full time)

8 weeks, June – Aug 2019

The University of Manchester, School of Electrical and Electronic Engineering

- Supervised by Dr Fumie Costen – applied machine learning and transfer learning techniques to the detection of tumours in 3D magnetic resonance images of the brain.
- Designed and implemented a series of convolutional neural networks for the purposes of image classification. One of these networks included a stacked convolutional autoencoder pre-trained entirely on a larger Alzheimer's patient MRI dataset.
- Used Python with pytorch to both develop and analyse the performance of each network to determine which worked best. tcsh was used extensively throughout the project for both the pre-processing, alongside another intern, and the parsing of large amounts of data as well as the training of the networks on an external computer cluster.
- Prior to and throughout the internship, I was required to research both the statistical theory behind machine learning and the state of current research on transfer learning specifically.
- A thorough understanding of object-oriented design was important to produce software that could be easily modified and extended in the future.

Publications

Symons, B. C. B., Williamson, D. J., Brooks, C. M., Wilson, A.L., Popelier, P. L. A., *Does the Intra-atomic Deformation Energy of IQA Represent Steric Energy?*, ChemistryOpen 2019, **8**, 560.

Projects – see github.com/dominicwllmsn

Project 1 – Medical Image Classification

- Further developing on the neural network I worked on in my machine learning internship to improve on the accuracy of the decisions.
- Also attempting to test simplifications of the network design and the input data to determine the viability of shorter model training times.

Project 2 – Applying ML to the Ising Model

- Extending the software produced in the 'Theory Computing Project' module by assessing the feasibility of using machine learning models in the simulation of the Ising model – specifically to analyse its behaviour near the critical point.

Scholarships and Awards

2016	The University of Manchester Physics Entrance Scholarship for 3A* grades at A level.
2016	Oakbank School E.D. McDonald Prize for best all-round academic progress.
2015	Oakbank School S. Dunhill Prize for best all-round academic progress.

Interests

- Computer programming challenges, especially those which are mathematically based such as Project Euler. This encouraged me to develop my lateral thinking skills and programming ability.
- Taekwondo – in which I have achieved a black belt – which has required significant commitment and training.

References available on request.