The Alan Turing Institute

Turing Enrichment Scheme
2018/9 Yearbook

Foreword

As The Alan Turing Institute continues to grow, we find ourselves having to adapt to the increasing academic diversity of those applying for our programmes. The 2018-19 cohort of Enrichment students were our largest cohort, and the first who have been able to take variable length placements, as well as having the option of starting in January.

As they have moved from across the UK to work in the London headquarters within the British Library, they have been able to experience new ways of working, and through those experiences develop their skills, knowledge and behaviours

The Enrichment students exemplify the position of The Alan Turing Institute as a multidisciplinary research environment. The academic diversity has included those studying everything from ancient languages through to medicine, all looking for ways in which new methodologies can accelerate their research and its impact on society.

They also exemplify the position of the Institute in training the leaders of tomorrow in data science and artificial intelligence. They have been involved in entrepreneurship, policy development, outreach and research strategy, as well as contributing to the ongoing development of the Institute's programmes.

The Enrichment scheme benefits everyone at the Institute and helps that knowledge flow back to universities in the UK. I am particularly pleased that the weight of evidence of the benefit of the scheme this year has helped shape our decision to expand the scheme in 2020 with an aim to double the number of students who can benefit.

Ben Murton

Head of Researcher Development and Training

Students

Note: Bertrand Nortier, University of Bristol was also a 2018/19 Enrichment student

Luis Abrego, UCL

Project title

Information processing in bio-inspired systems across different integrative levels

Supervisor

Alexey Zaikin

Main outcomes of my research

Using computational modelling based on signalling pathways regulating oscillatory gene expression in a cellular system, it was found that switching between different cellular fates enhances the integration of the causal influences of its constituents. Also, as the cellular system becomes synchronised, this integration is maximised in the sub-critical transition point.

These results suggest that cells, as a system of interacting genetic networks, show enough complexity to exhibit cause-effect influences as a whole above and beyond its parts when there is a balance between segregation and integration of its dynamics, a property needed to exhibit cognition in complex vertebrates.

Impact of my work

A practical application of information-theoretical methods to understand the information processing mechanisms behind self-organised criticality and emergent complexity of cells, modelled as nonlinear systems.

The main results have been submitted for publication.

Being a Turing Enrichment student

Being part of Turing provided me with a better insight to the cutting-edge tools needed to perform better in my research. In particular, I found invaluable practical and academic opportunities that make me feel confident about my skills. It is astonishing the diversity of seminar, conferences and activities that are hosted here.

It has been a pleasant experience being part of this community of leading researchers, universities and partners.

“I found invaluable opportunities that make me feel confident about my skills.”

Letizia Angeli, University of Warwick

Project title

Particle approximation of Feynman-Kac models for rare event simulation

Supervisors

Adam Johansen, Stefan Grosskinsky

Main outcomes of my research

My research is aimed at developing importance sampling techniques that make use of the idea of 'particle filters', in which replicas of a system are simulated in parallel so that their empirical distribution gives an estimate of the distribution of interest.

While at the Turing, I adapted already known convergence results from sequential Monte Carlo methodologies to a broader class of particle approximations in continuous-time, providing quantitative bounds for the estimators and developing a rigorous framework which allows to compare different procedures and improve their performance.

Impact of my work

My work can be applied in many data analysis tasks, where the goal is to estimate unknown quantities from systems changing at irregularly spaced continuous random times.

For instance, there are applications in finance to describe high-frequency trading or in automated target recognition for the implementation of computer algorithms able to track the targets of interest in a scene.

Being a Turing Enrichment student

My time at the Turing has been very stimulating and gave me the opportunity to gain new perspectives and investigate some real-world application areas for my PhD project, thanks to the vibrant interdisciplinary environment.

The Turing training classes were particularly interesting and covered a large spectrum of topics. I especially enjoyed the talk on reproducible research, indeed I believe that being able to communicate results efficiently is fundamental in our field, but it is often neglected by universities.

Finally, the financial and technical support provided by the Turing was excellent and really facilitated my research.

"I gained new perspectives thanks to the vibrant interdisciplinary environment."

Leonidas Aristodemou, University of Cambridge

Project title

Application of deep learning within technology, innovation and intellectual property management

Supervisor

Frank Tietze

Main outcomes of my research

Big data is increasingly available in all areas of manufacturing, operations and the digital economy. Increased data availability presents an opportunity for better strategic decision making, to identify the next generation of innovative and valuable technologies. In this research, we use a system design approach, where we design an intellectual property analytics decision support methodology for the early identification of valuable technologies.

This makes use of deep learning to analyse patent data and predict technological value. Technological value is realised from an early stage technology, based solely on the technological information available. It is a function of patent value, which in turn is associated to the inventive and novel nature of the technology disclosed within a patent.

Impact of my work

The research has been presented at the European Policy for Intellectual Property (EPIP) 2019 conference, at ETH Zurich, Zurich, Switzerland, where it has sparked a great interest and brought forward an interesting number of discussions, especially on how the methodology can be deployed to tackle challenges traditional methods currently face. The audience agreed that the research can make a valuable contribution to the field of artificial intelligence, intellectual property management, and technology management.

The identification of valuable technologies in early stages improves strategic decision making and technology development processes. The research has also been presented at the Strategic Technology and Innovation Management consortium (STIM), the Emerson Electric Technologies Webinar series, the European Patent Office (EPO), the European Industrial Research Management Association (EIRMA), and a number of other distinguished events and conferences.

Being a Turing Enrichment student

Studying in a multidisciplinary environment at the Turing offers unique opportunities for enhancing research. The constant friction within the data science environment with fellows, researchers, fellow PhD researchers, networking events, and academic and industrial seminars, enables value extraction and impact through applications of research.

The Institute is a place where one can explore problems and harness solutions and ideas beyond boundaries. This interdisciplinary environment allows one to deploy solutions from one field to others, which gave me the opportunity to explore my area more broadly, and learn a number of things from other areas.

“A place where one can explore problems and harness solutions and ideas beyond boundaries.”

Gabriele Beltramo, Queen Mary University of London

Project title

Persistence diagrams for the Outex database

Supervisors

Michael Farber, Primoz Skraba

Main outcomes of my research

My research focuses on topological data analysis (TDA) methods. The goal is to obtain representations of data summarising its geometric and topological information at different scales. In particular, during my time at the Turing I worked on the development of new TDA algorithms, both for the computation of Euler characteristic and persistence diagrams of image data. These where used to obtain new vectorial representations of greyscale image data, which in combination with machine learning algorithms led to improved classification of texture images of the Outex database.

Impact of my work

The classification of texture images is an important computer vision problem. My research provides further evidence that TDA methods can be successfully applied for the characterisation of greyscale images to be classified. Moreover, the algorithms I developed expand the already wide set of tools available to researchers interested in TDA methods, and could be applied in any setting where a vectorial representation of image (or point set) data is needed.

Being a Turing Enrichment student

Overall, I think the Turing helped me grow as a researcher.

During my time as an Enrichment student, I had the opportunity to expand my network and my research interests. In particular, reading groups organised with fellow students boosted my interest in statistics and machine learning in general. Also, the many workshops and the software development course provided were excellent for improving my coding and data science skills.

Furthermore, as a participant to the December 2018 Data Study Group week, I had a chance to collaborate on a hands-on data science project. Having a mathematical training, this was a very interesting experience, that made me understand the challenges involved when working with real-world data.

“The Turing helped me grow as a researcher.”

Alvaro Cabrejas Egea, University of Warwick

Project title

Reinforcement learning for traffic flow optimisation

Supervisors

Neil Walton, Colm Connaughton

Main outcomes of my research

During this year at the Turing, I have been working in reinforcement learning applied to urban traffic control.

Reinforcement learning is an area of machine learning that tries to imitate how knowledge is acquired in nature while trying to attain complex objectives. An agent must decide how to perform a task, and in the absence of training data, the agent learns from its own experience as it interacts with the environment. In this case, their goal is the minimization of delays in several traffic networks and the tools available to them are the control of the traffic lights in the junctions.

I have been working on different architectures for these agents based on recent advances in machine learning, as well as on the way these agents are rewarded and punished, how they incorporate new knowledge, and the effects of inter-agent communication.

Impact of my work

With growing urban traffic demand and the limitations of road infrastructure, current attempts at improving global flow involve the design of intelligent signal timing controllers at traffic junctions. This work provides a variety of agents capable of running different types of traffic intersections in increasing levels of complexity and compares their performance with current commercial and state-of-the-art solutions.

These agents learn how to perform their task in a matter of hours and can run indefinitely on low-specification hardware, while maintaining their ability to learn on the job. This makes them deployable into the real world with minimum investment in further infrastructure. The results show that these agents beat the commercial solutions currently in use, making a very strong contender for future urban traffic control systems.

Being a Turing Enrichment student

Being a Turing Enrichment student has been an amazing opportunity. The office is a nice relaxed place that encourages collaboration with other researchers. There is an abundance of seminars and events covering a wide range of topics, and there is always plenty of researchers with different interests and projects to learn from.

I have become particularly involved with the Data Study Groups that the Turing organises several times a year in the London office and the partner universities. As Science Liaison I had the opportunity to engage with external partners and work with their datasets and proposals, trying to shape them into challenges that were both scientifically stimulating and engaging for the participants.

Finally, the vast resources made available to us, the atmosphere and, more than anything, the people that I met here have made this last year an absolutely unforgettable experience.

“I had the opportunity to engage with external partners and work with their datasets.”

Abeer ElBahrawy, City, University of London

Project title

Quantifying and modelling online decentralised systems: A complex systems approach

Supervisor

Andrea Baronchelli

Main outcomes of my research

I worked mostly on quantifying cryptocurrency-related Wikipedia pages and their relevance to market dynamics. Our work showed the relevance of Wikipedia to the cryptocurrencies market through a successful investment strategy relying on Wikipedia views. We also showed that a limited community controls this valuable source of information. The paper is currently under review and available on arXiv.

I was also working on understanding the evolution of the Bitcoin transaction network. I investigated the evolution patterns focusing on different entities in the network.

Impact of my work

Cryptocurrencies have been gaining increasing attention, yet there is still a clear gap in terms of regulations. My work helps in understanding cryptocurrency evolution and nature, whether in the context of market competition or transaction networks. My work also shed light on public information provided on cryptocurrencies and their consumption.

Being a Turing Enrichment student

It allowed me to collaborate with researchers from different universities on a new project.

A casual conversation at the Turing about dark markets sparked a project. Together with Sam Miller (PhD at the Turing), Martin Dittus (University of Oxford) and other researchers, we we will investigate the usage of online data to understand dark market sales. While the project is not directly related to my current work it does add more depth and a unique dimension to my research.

The opportunity to meet brilliant, helpful and enthusiastic researchers on a daily basis was the greatest thing about being an Enrichment student.

“A casual conversation at the Turing sparked a project that adds more depth to my research.”

Yun Feng, University of Oxford

Project title

Next generation enabled clinics

Supervisor

Chris Yau

Main outcomes of my research

I have developed novel machine learning techniques for the analysis of genomic sequencing data. These methods focus on the mutation data collected from cancer patients. As cancer development is generally treated as an evolutionary process within patient body, these techniques help to understand the biological process underlying such development. As an outcome, these methods give geneticists and clinicians a better view of what happened on the patients' genome. These methods will be made into packages for us by the clinicians.

Impact of my work

My project on analysis of cancer patients' genome will hopefully give a better understanding to clinicians about the mutational mechanism behind cancer development. The results of the methods will deconvolute the complicated evolutionary process that marks the cancer genome. From these mutational processes, clinicians might be able to draw conclusions on either the cause of cancer or the biomarker of cancer.

These clinical results will help to improve future clinical practice on early diagnosis of cancer patients and better personalised treatment for some patients with certain types of mutations in their genome.

Being a Turing Enrichment student

Being an Enrichment student at the Turing is a wonderful experience. Though I have only been based at the Institute for half a year, I have gained plenty of knowledge and skills. As my usual field of study is computational genomes, I mainly collaborate with biomedical people and the focuses of topics are usually on the clinical aspect of my research. However, at the Turing, I have met people from totally different disciplines and the topics vary from statistical and machine learning methodology to financial application of functional analysis.

My six months stay at the Turing has not only deepened my understanding of statistical learning theory, but also given me more ideas on the application of these methods to my own field of study. Thus, I believe, the best part of the Turing is its multi-discipline culture and its environment that encourages discussion and collaboration between these people.

"My stay has given me more ideas on the application of statistical methods to my own field of study."

Sebastian Flennerhag, University of Manchester

Project title

Deep learning for dynamic systems

Supervisors

Mark Elliot, John Keane, Hujun Yin

Main outcomes of my research

My research focuses on developing novel methods for artificial intelligence that learn throughout their lives. Current applications of AI focus on a specific task, such as translation, but cannot learn other things. Together with collaborators, I develop algorithms that empower AI to autonomously infer how to learn new things. Such agents have the potential to learn in a never-ending stream of experiences. At the Turing, I got a chance to work with brilliant minds on these problems, resulting in a novel framework for this type of meta-learning.

Impact of my work

My research focuses on long-term developments of artificial intelligence that can go beyond the scope of so-called 'narrow AI.' An AI should be able to adapt to changes in its environment; for instance, if we send a robot into a burning building it needs to be able to adapt to the layout of the building if it is to be of any use. Such 'deep AI' has the potential to aid us in our daily lives by tailoring to our individual needs and can play a critical role in addressing climate change and other long-term challenges we face.

Being a Turing Enrichment student

At the Turing, I've had the luxury to meet many brilliant minds working on a diverse set of problems, ranging from geo-spatial analysis to understanding the darknet, how AI can improve our health, and anything in between.

The openness of the Turing has provided me with more interesting conversations than I can remember, multiple collaborations, and along the way many new friendships. The diversity of research interests has allowed me to broaden my perspectives and contribute to exciting research in a variety of fields.

Because of the Turing's openness, I've had the opportunity to collaborate on a diverse range of projects that goes far beyond my own core research. I've picked up new perspectives on research, hatched more ideas than I can possibly pursue, and been inspired more than once by the people I've met at the Turing. The Turing's research network is astounding and I encourage students to make as much use of it as they can; you meet more than collaborators. In all, it's a stimulating research environment that will pull you in and in the end, you'll be reluctant to let go.

"I've picked up new perspectives on research and hatched more ideas than I can possibly pursue."

Konstantin Klemmer, University of Warwick

Project title

Geospatial machine learning for urban policy making

Supervisor

Stephen Jarvis

Main outcomes of my research

My research is concerned with the modelling of spatial patterns in urban systems. I develop machine learning methods which are better at capturing these spatial processes and can thus be used for designing and evaluating policies. Beyond the methodological work, I work on case studies highlighting how machine learning can be used to understand and optimize urban processes, for instance in the areas of transportation and crime.

Impact of my work

My methodological work advances the representation of and learning from spatial structures. This is important as current machine learning methods often struggle with dependent data. However, many applications of machine learning use spatial data (e.g satellite data, point patterns), often leading to biased or overconfident outcomes. My applied work shows how the proper use of machine learning techniques can help cities tackle their most challenging problems.

Being a Turing Enrichment student

Being an Enrichment student allowed me to collaborate with other students from different academic areas. Changing perspectives and challenging your own views is always important; the Turing provides a great environment to meet with bright students from all around the country to work on projects outside of your usual “comfort zone”, while still being relevant to your PhD.

“The Turing provides a great environment to work on projects outside of your comfort zone.”

Adriano Koshiyama, UCL

Project title

Towards a certification of financial algorithms

Supervisors

Philip Treleaven, Nick Firoozye, Zeynep Engin

Main outcomes of my research

Building a protocol that can be used to certify financial algorithms used by banks, hedge funds, and ultimately by us. To do this, I've been developing a protocol that checks how well an algorithm's designer can answer questions linked to (i) performance, (ii) behaviour, and (iii) explainability.

During my period at the Turing I've been able to advance in the performance and behaviour point of view using generative adversarial networks. By interacting with the researchers and students in my cohort I've decided to prioritize performance and behaviour, and going forward, the next step is to build tools that can improve the explainability component of these financial algorithms.

Impact of my work

Aiding the financial algorithm's designers to understand its limitation, "shelf-life", and to provide the algorithm's user the transparency required when dealing with inputs and decision coming from a fallible financial algorithm.

For example, our methodology can help to answer questions such as: how well can your algorithm interact with the others in the ecosystem? Is it insulated to extreme movements in the market? Or, can your algorithm explain its decisions of asset allocation and positions? We hope that this research is used by financial institutions to build more safe and transparent products for end users.

Being a Turing Enrichment student

I haved advanced in my thesis, and made new friends and research partners. In relation to advances in my thesis, I was able to finish the second part of it, partially using the Turing's infrastructure and computing resources. Also, I'm more than glad to have made new research partners, such as Konstantin, Sebastian and Leonidas. We have been able to put forward three research papers, with one of them accepted and published.

This is probably one of the few recommendations I would give to anyone interested in taking part in this scheme: reserve some of your time – if not all – to finding new collaborators and do research outside of your original project. Undoubtedly without this period at the Turing it would have been hard, if not impossible, to achieve what I have achieved. I'm glad to have benefitted of this period in the Institute, and I would definitely advise any interested PhD student to apply for this scheme.

"Without the Turing it would have been hard, if not impossible, to achieve what I have achieved."

Markus Löning, UCL

Project title

Machine learning with time series

Supervisors

Paul Longley, Franz Kiraly, James Cheshire

Main outcomes of my research

My research is on machine learning with time series data. Data scientific tasks beyond the standard tabular setting are one of the major challenges of contemporary machine learning. Together with other researchers, I was able to design and implement sktime – a new open-source Python toolbox with a unified interface for several time series-related learning tasks.

The ambition of the project is to extend existing machine learning libraries to the temporal setting and thereby enable us to provide advanced time series analysis capabilities for researchers and practitioners based on an easily composable and statistically solid workflow.

Impact of my work

My goal is to provide a practical and well-established machine learning toolbox that is accessible to non-experts and reusable in various scientific areas. Through Data Study Groups and ongoing industry collaborations, I was able to apply the toolbox to several real-world data sets.

Projects included the prediction of bioreactor process outputs in drug manufacturing using state-of-the-art time series regression algorithms, the classification of whether or not a medical intervention will be successful given bedside monitor data from patients, and the prediction of the chemical composition of soil samples from mid-infrared spectroscopy data to guide fertiliser and crop choice in agriculture.

Being a Turing Enrichment student

The Enrichment scheme allowed me to get to know and collaborate with fellow students and researchers from various disciplines in an intellectually stimulating and high achieving learning environment. This led to several collaborative projects, including the development of sktime in conjunction with researchers from The Alan Turing Institute, UCL and the University of East Anglia.

In addition, I could engage in various applied projects such as the Data Study Groups and follow-up workshops with industry and academic partners.

“The Turing allowed me to collaborate in an intellectually stimulating and high achieving environment.”

Maxine Mackintosh, UCL

Project title

Phenotyping early dementia from UK primary care records

Supervisors

Spiros Denaxas, Martin Rossor, Arturo Gonzalez-Izquierdo, Kirstie Whitaker

Main outcomes of my research

The main outcomes of my research are to explore how the earliest stages of dementia manifest in electronic health records. My work at the Turing has focused primarily on exploring different ways in which to predict dementia in the future, as well as how to evaluate complex and potentially duplicative policies, as there have been so many applied to incentivise dementia recognition, particularly in primary care.

Whilst these were achieved, all the knowledge that seems tacit in data science, when you're in a different discipline, is what has actually improved my research and been the far more substantial outcome.

Impact of my work

The immediate real-world applications are still somewhat far off, however my work acts as a preliminary guide to what potential other diseases, symptoms and health care activities should be further investigated to understand the evolution of early dementia. The next steps would be to start to look at causal analyses and underpinning physiology in order to find the commonalities across a wide range of symptoms, over a 20 year period.

Being a Turing Enrichment student

Being an Enrichment student has been enormously valuable in many ways: I have used methods and approaches from other disciplines (bike sharing) and applied them to my own work; I have shifted my mindset from an epidemiology default to a more "data science" approach, which has changed everything from the language I use to the sorts of methods I want to experiment with.

I have learnt a lot more about reproducibility through the Turing Way, and through Kirstie's beady eyes my figures and visualisations for my PhD have enormously improved.

"The data science approach has changed the language I use and the methods I want to experiment with."

Xenia Miscouridou, University of Oxford

Project title

Networks models for sparse dynamic networks with reciprocating relationships and overlapping communities.

Supervisors

Francois Caron, Yee Whye Teh

Main outcomes of my research

I completed my project as specified originally in my research proposal, meeting my research goals in statistical network modelling. I have completed a paper on how to efficiently sample and implement my network models.

I have also initiated another research project with people at the Turing in a different topic and with people outside my group in Oxford. The project is in the area of deep learning and in particular non-parametric generative modelling in unsupervised learning. The advisor at the Turing for this work was Chris Holmes.

Impact of my work

The impact of my work emerged very quickly in the research community. Our paper was selected as a talk in ICML 2019, as a poster presentation for the Bayesian Nonparametric Conference, and as a poster in the Greek Stochastics conference.

In March 2019, I was invited to give a talk at the University of Cyprus on my work in the Data Science group of the Business Department. In September 2019 I was invited to give a talk at the University of Cyprus at the Statistics Department.

Regarding my additional project, our paper is not published yet. The significance of this work is very high though. This project brings the two worlds of Bayesian non-parametric (BNP) statistics and deep learning closer together. These two enjoy different properties and benefits but are still far from each other; this work is an attempt to bridge this gap.

Being a Turing Enrichment student

- Allowed me to collaborate in research with new people and initiate a project on a new topic outside my area of expertise.
- It gave me a better understanding of the real meaning of research and its objectives in a cross-disciplinary and diverse environment. The Turing is an oasis for science and research and focuses on problems with real world applications and impact.
- It shaped my objectives and future direction in research. I am now particularly interested in ethics in AI, and with some other women in the field we have founded a new group for Women in Data Science and Statistics.
- I helped promote Turing research during Communicating Research week, focusing on the benefits of studying AI, through a video interview. The video was promoted by Oxford University, and in Cyprus by news agencies, tech blogs and national newspapers. I feel proud to have created a great reputation for the Turing in Cyprus.

“I feel proud to have created a great reputation for the Turing in Cyprus.”

Martina Astrid Rodda, University of Oxford

Project title

Exploring the productivity of Homeric formulae through distributional semantics

Supervisors

Philomen Probert, Barbara McGillivray

Main outcomes of my research

My research at the Turing falls within the scope of my doctoral project on language variation and productivity in ancient Greek epic. The language of Greek epic is overwhelmingly made of formulae – recurring linguistic structures that were used to facilitate composition during oral performances. There is a limit to the variation that is allowed in both the form and meaning of these structures. Measuring the extent of this variation can tell us about how closely the linguistic patterns of Greek epic match natural language.

During my stay at the Turing, I focused on variation in meaning, and obtained some preliminary results that show promising correlations with productivity and variation in form.

Impact of my work

While the primary impact of my research is on Classics and on our understanding of early Greek epic, working on a sample of texts that are extremely rich in formulae also offers promising insights on modern languages, as formulaic language is prominent in specialised corpora (medical and legal texts among others).

Moreover, working on such a small and well characterised sample (about 10 million words, which is orders of magnitude smaller than most English-language corpora) helps us understand the limits and strength of computational methods for the analysis of language.

Being a Turing Enrichment student

My stay at the Turing has been hands-down the most productive research period in my PhD. I have had the opportunity to collaborate with one of the most prominent researchers in my (admittedly very small) field of specialisation, and to take advantage of her close supervision.

I arrived at the Turing with very limited knowledge of any programming languages; thanks to the training offered during my Enrichment stay, my knowledge of computational techniques has improved to the point that I have been able to code the necessary tools for my project from scratch. I have also achieved a better understanding of statistics, data analysis, and of the tools available for these purposes.

Moreover, I have been able to take part in the life of the Turing community by being a member of the EDI working group on Gender and LGBTQ+ inclusion, which has been in itself a rich and rewarding experience.

“My stay at the Turing has been hands-down the most productive research period in my PhD.”

Andrea Santoro, Queen Mary University of London

Project title

Information-theoretic approaches for multilayer networks

Supervisors

Vincenzo Nicosia, Lucas Lacasa

Main outcomes of my research

While at the Turing, I have worked and completed different projects related to my PhD project, which involves the use of multilayer networks to model and analyse real-world systems with multiple types of relations.

In many contexts, having more data is not always a blessing, since not all additional data available is informative. In particular, I worked on developing new methods to extract relevant features from large-scale networks, by filtering out noise and redundancies. The resulting manuscript is still under review in a high impact journal.

Impact of my work

Discriminating the informative information of a multi-dimensional system can become of paramount importance when speeding up new algorithmic solution to compute structural and dynamical descriptors. On the one hand, this is beneficial for a fast identification of the key components of a multi-dimensional network, on the other hand, this has a pivotal role in devising effective data-informed decisions to improve the resilience and performance of infrastructure and transportation networks.

Being a Turing Enrichment student

The Turing gave me the possibility to broaden and deepen my knowledge in many different research topics. The multi-disciplinary research environment is the perfect place to work and share experiences with the other PhD students. This has been extremely useful in many contexts since it allowed me to approach my research with multi-faceted perspectives.

The Turing hosts a vast amount of researchers and many events, such as workshops, seminars, and data science classes over the entire year. I am very grateful to the Research Software Engineering training sessions taking place at the Institute, since I improved my skills on how to construct reliable, readable, and efficient research software in a collaborative environment.

Moreover, the IT and technical assistance of the Turing staff has been extremely helpful in many situations, promptly solving any issues I was facing. Last but not least, the conference funding helped my research during the year, allowing me to share my work with many researchers around Europe.

“The Turing has allowed me to approach my research with multi-faceted perspectives.”

Cian Scannell, Kings College London

Project title

Quantitative myocardial perfusion MRI

Supervisor

Amedeo Chiribiri

Main outcomes of my research

My research aims at developing methods to process cardiac MRI scans in order to better identify patients with coronary artery disease without the need for an invasive procedure. This is done by modelling the blood flow that arrives in the heart's muscle. The main outcomes of this work so far have been the development of the requisite image processing and computer vision algorithms. This involves using deep learning to identify the relevant part of the heart in the images and correcting for breathing motion.

Furthermore, we have a Bayesian inference scheme for inferring the kinetic parameters, such as blood flow, from differential equations. This allows use of prior information which gives more robust parameter estimates and uncertainty quantification which is important in the clinical setting.

Impact of my work

Recent studies have shown that we can reduce the number of invasive (and dangerous) procedures performed on patients by sending them for a MRI scan first. The reality is though that this is not done as often as it should be as the interpretation of the MRI scans is complex and requires a lot of experience. However, as our software develops and we move towards an automated assessment of the data this will allow the technique to be rolled out in less specialised centres.

Being a Turing Enrichment student

Being an Enrichment student has allowed me to interact and learn from students in a wide range of fields with vastly different skills sets and approaches to research. The unique environment here has exposed me to methodological researchers whose interesting developments could potentially be applied to my work and allowed me to attend seminars, talks and classes from a wide range of topics, far outside of what I usually experience in a biomedical engineering department. This experience has already begun to push my research in directions that would have been hard to imagine a year ago.

"This has pushed my research in directions that would have been hard to imagine a year ago."

Ali Shahin Shamsabadi, Queen Mary University of London

Project title

Privacy in machine learning

Supervisor

Andrea Cavallaro

Main outcomes of my research

The outcomes of my Enrichment scheme are two papers, namely "QUOTIENT: Two-Party Secure Neural Network Training and Prediction", and, "PrivEdge: From Local to Distributed Private Training and Prediction". The former, which was the follow-up work from my internship at the Turing, has been accepted in one of the best conference in privacy called, The 26th ACM Conference on Computer and Communications Security (CCS), while the latter is under peer review of The IEEE Transactions on Information Forensics and Security (TIFS).

Impact of my work

'Machine learning as a service' (MLaaS) operators such as Google and Microsoft provide services in a range of privacy-sensitive applications including authentication through signature access control through face recognition, and annotation of pictures in social media. MLaaS applications often rely on centralized collection of user data which leads to significant privacy concerns when dealing with sensitive personal data.

Both QUOTIENT and PrivEdge suggest privacy-preserving machine learning models to safeguard the privacy of users who provide their data for training, as well as clients who use the prediction service.

Being a Turing Enrichment student

Apart from providing a fascinating environment, being a Turing Enrichment student allowed me to keep working on my Internship projects with my collaborators from the Turing and even start a new project which enriched my skill and techniques. It enables using Azure computing resources which are necessary for PhD students. The Enrichment scheme also makes it easy to access internal talks and workshops.

"Being a Turing Enrichment student allowed me to start a new project which enriched my skill and techniques."

Rajkarn Singh, University of Edinburgh

Project title

Data driven mobile network optimization for 5G with privacy preservation

Supervisor

Mahesh K. Marina

Main outcomes of my research

While at the Turing I worked on two related projects. The first project involved analysing mobile service usage data obtained at a nationwide scale. We clustered different regions (communes) of France based on the similarity of their service distributions. This project revealed multiple interesting insights and is now published in The Web Conference 2019 under the title 'Urban Vibes and Rural Charms'.

The second project, which I've since been working on, is focused on optimization of mobile networks in the context of cloud radio access networks. Researchers from Samsung are also a part of this project. We aim to find the optimal configuration of various parameters involved using AI in order to minimize energy consumption.

Impact of my work

Understanding the underlying patterns in mobile service consumption data is very relevant and has impact across disciplines like mobile networking (for infrastructure planning), sociology (to understand relationships between digital activity and social segregation), or urban planning (to correlate mobile service usage and city structures).

5G is seen as a key enabler to integrate various businesses under the canopy of mobile communications. Our work is a step towards this direction, where optimal functioning of mobile networks will reduce operational expenditure, thereby encouraging more technological fields to adopt mobile communications.

Being a Turing Enrichment student

Being at Turing has been a very rewarding experience, with the most significant aspect for me being that I was able to network with researchers working in my field across different universities in the UK. This has led to building long-term relationships with them and paved the way for possible future collaborations. I also got an opportunity to present my research work at a seminar series in QMUL as an invited speaker.

I think the Turing provides a very conducive environment for easily approaching and starting a conversation with anyone around. The discussions with my Enrichment and other PhD colleagues have also been enthralling at times given that we all come from different technical backgrounds, but still have ML and AI as the common ground.

Exposure to the Turing's guest lectures, lunch time socials, weekly news digest by the Communications team plus a crash course on Software Engineering were also a really good source of learning and made the workplace very active and social. And how can I forget the amazing experience of being part of the Turing Q&A video series for the Enrichment scheme.

"I was able to network with researchers working in my field across different universities in the UK."

Ranjith Soman, Imperial College London

Project title

Automated look-ahead planning in modular construction projects using dynamic constraint solving

Supervisors

Jennifer Whyte, Miguel Molina-Solana

Main outcomes of my research

The main contribution of my current work is the development of an information modelling approach to codify construction process information. To achieve this, codification challenges were identified by examining three construction projects and reported. Building upon the implications of the identified challenges, an information modelling approach using an ontology-based method was developed to generate interoperable and machine-readable construction process information. This information was used to generate a near-optimal look ahead schedules by solving dynamic constraints using Q learning.

This research paves the way for the next-generation methods in construction management that enable more rapid and agile forms of organizing.

Impact of my work

The information modelling approach developed in the current research supports the generation of machine-readable information to support the application of data science. Look-ahead schedules (LASs) for modular projects produced with developed algorithm making use of codified information can help prevent conflict, reduce rework, and enable a clear workflow for a crew. This work contributes to the strand of research in the architecture, engineering and construction (AEC) domain looking at enabling more rapid and agile forms of organizing to improve productivity.

Being a Turing Enrichment student

Turing offers a highly dynamic multidisciplinary work environment. During my Enrichment semester at Turing, I had the chance to engage in discussions with fellow researchers from different universities and backgrounds. This enables us to borrow ideas from different domains and apply it to our problem. This helped me shape my research problem around dynamic constraint solving with rigour. Being from a non-computing background, the training sessions on research software engineering and related seminars, and conversations on reproducible research helped strengthen my skills around machine learning and scientific research.

The social scene at the Turing is great. Lunchtime conversations and the random conversations over coffee help brighten up your day and keep you updated on different topics both academic and non-academic. In addition, the Turing seminars offer a great opportunity to meet and engage in conversation with like-minded professionals in London. Overall it has been a great six months at Turing and I will miss working in the second floor office.

“I had the chance to engage in discussions with fellow researchers from different backgrounds.”

Bogdan Toader, University of Oxford

Project title

Theory and algorithms for non-negative super-resolution

Supervisor

Jared Tanner

Main outcomes of my research

During my time at the Turing I started working on algorithms for super-resolution, which will complement my previous, mostly theoretical, work on the stability of non-negative super-resolution. This work will lead to two papers: one is an analysis of the solution of the problem when solved numerically with a certain accuracy and one in which I will use this analysis to improve an existing algorithm when applied to the super-resolution problem. The first of these papers is almost finished, and I have already submitted a part of it to present at a conference.

Impact of my work

The work on super-resolution is motivated by imaging problems arising in scientific applications where the imaging device has a limited resolution and the object being visualised has a sparse structure. One example comes from the field of fluorescence microscopy, where the image being visualised is given by sequential activation of fluorescent molecules that are part of the molecule of interest.

My theoretical work on stability provides an insight on the conditions under which the resolution of these images can be enhanced in the post-processing step, while the algorithms work could potentially lead to better ways of actually improving the resolution.

Being a Turing Enrichment student

Being based at the Turing allowed me to interact with students and researchers from various areas in data science. The environment here is very different from my home institute, which is a more traditional mathematics department, so it was definitely very useful and enlightening to meet people with different scientific backgrounds and in general to become aware of what career opportunities exist in this space.

On a more practical note, I was able to collaborate more closely with my industrial supervisor at the National Physical Laboratory, I attended regular data science seminars, in particular the Theory and Algorithms in Data Science seminar and Turing Optimization Club, and the course on Research Software Engineering has been one of the highlights.

Lastly, I'm leaving the Turing not only enriched from a scientific point of view but also with new healthy habits, as the easy access to free fruit allowed me to finally have my five a day regularly!

"I'm leaving the Turing not only enriched from a scientific point of view but also with new healthy habits!"

David Watson, Queen Mary University of London

Project title

Explaining high-dimensional algorithms: Epistemological challenges and machine learning solutions

Supervisors

Luciano Floridi, Matt Kusner

Main outcomes of my research

The main outcomes of my research are a collection of tools for testing the predictive impact of one or more variables either globally (i.e. across an entire dataset) or locally (i.e. near particular data points). General purpose solutions of this kind, intended to work in high dimensions and with any supervised learning algorithm, raise considerable technical and conceptual challenges. I am happy to report that I made solid progress this year on both the theoretical and applied portions of my project.

Impact of my work

I'm interested in developing tools that will help users better understand the predictions of black box models. This will promote greater fairness, accountability, and transparency in algorithmic decision-making, which is crucial in high-risk applications. These tools can also be used to validate and debug models prior to deployment, and even discover new properties of the underlying target system.

Toward that end, I have been working on general purpose methods for testing the predictive impact of feature subsets in supervised learning algorithms, with a focus on high-dimensional data.

Being a Turing Enrichment student

Being a Turing student allowed me to discuss my research with a wide range of leading academics, who were always happy to answer questions and help me think through some of the thorny problems that inevitably arise in statistical research. Following some especially fruitful meetings with a professor I met through the Turing, we decided to collaborate on an upcoming project. He is now serving as the second advisor for my PhD.

During my tenure at the Turing, I was lucky enough to be invited to a number of seminars and workshops on my topic, where I had the chance to present research and gather feedback from experts in the field. The student reading groups were also a great way to meet fellow doctoral candidates, learn more about their work, and explore new topics of interest.

"Being a Turing student allowed me to discuss thorny problems with a wide range of leading academics."

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