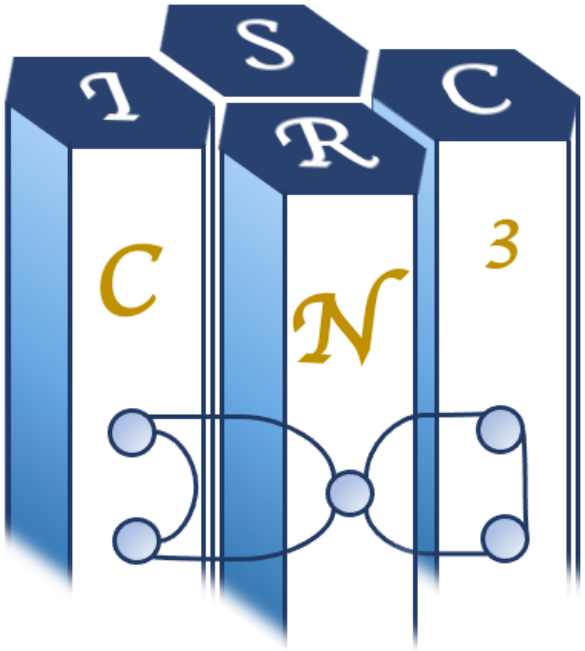


Ulster University

Intelligence Systems Research Centre

Computational Neuroscience, Neurotechnology and Neuro-inspired Artificial Intelligence (ISRC-CN^3)

Autumn School

25-29 October 2021

Background

There have been rapid advancements and investments in research and development in brain sciences, neurotechnology, neural data modelling and neuro-inspired artificial intelligence (AI). These advancements have not only led to deeper understanding of brain functions and disorders, but also the development and application of powerful AI and machine-learning algorithms that affect our everyday life.

The Computational Neuroscience, Neurotechnology and Neuro-inspired AI (CN^3) Autumn School (https://sites.google.com/view/isrc-cn3/home) aims to train the next generation of researchers on these state-of-the-art developments. This short course will touch on the areas of computational neuroscience, neural data science, neurotechnology and neuro-inspired AI. The School is unique in that important and timely topics either not delivered in other Schools or taught courses, or delivered only individually, will be delivered here in an integrated way. These topics include computational modelling of neural-glial systems, neuromodulators and cognition, neurotechnology, self-repaired intelligent machines and cognitive robotics. Moreover, although neural computation and neuro-inspired AI research are conducted in the island of Ireland, there is very little relevant training and taught courses, especially for early career researchers, in the region; this School aims to bridge this gap.

On this note, the organising committee warmly welcome you for attending the Autumn School!

ISRC-CN^3 Autumn School

The Autumn School will be held at the Intelligent Systems Research Centre (ISRC; http://isrc.ulster.ac.uk/), a major research unit within the School of Computing, Engineering and Intelligent Systems at Ulster University in Derry~Londonderry, Northern Ireland. The ISRC is dedicated to the creation of intelligent computational systems, taking inspiration from, and learning from, biology and neuroscience. Its research is focused on the design, development and implementation of intelligent computational systems that are capable of learning, reasoning, adapting and evolving and interacting with their environment in a manner which humans would consider "intelligent". The ISRC is housed in a large, purpose-built facility, with state-of-the-art resources, including neuroimaging, neurotechnology and robotic facilities, and high-performance computing (HPC) facility for big data analytics and large-scale computational simulations. The ISRC is multidisciplinary, with arguably the largest cluster of computational neuroscientists and neuro-inspired AI researchers in the island of Ireland, with strong collaborations with many clinical, biomedical, neuroscience, AI and mental health centres, and industrial partners, allowing its research output to quickly translate into applications.

Academic researchers at the ISRC and invited external speakers will contribute to the delivery of this 5-day School, which consists of lectures during the day and labs in the

evening. Tutorials and labs will consist of modelling and analysing data related to the lectures, resulting in 'mini' projects to consolidate the lectures' content and encourage active and creative participation. Attendees will have the opportunity to present and share their research work on the final day. Class materials will be made available in advance of the event. Required software (Python and MATLAB) should be downloaded and configured before the event. Foundational topics in mathematical techniques and computer programming will be provided.

Although the School will focus on research communities especially within the Island of Ireland due to its lack of such training, wider participations are welcomed. We particularly encourage applications from advanced undergraduate, masters, graduate diploma, early-stage career (Ph.D. students and postdoctoral) researchers, and research scientists and engineers in industrial and clinical sectors. Ideally, participants will have some mathematical background at the UK GCE A level / Irish Leaving Certificate level, some familiarity in computer/scientific programming in languages such as Python or MATLAB, or some background knowledge in biology, neuroscience, medicine or psychology.

The School aims to be inclusive by providing high accessibility including those who are underrepresented and/or with caregiving responsibilities, disabilities, and limited funds, and bursaries may be available. In light of the ongoing pandemic, the School will adopt a hybrid (physical and virtual) format, and if the pandemic situation becomes worse, it will be a completely virtual event.

Autumn School Structure

Given the tight schedule, this booklet and class materials, including mathematical and programming notes, have been made available in advance of the event for attendees to review or refresh (see GitHub link below).

Required software (Python and MATLAB) can be downloaded and configured before the event.

Blackboard Learn web links for joining online will be sent closer to the dates and prior to the sessions.

Unless mentioned for a last-minute change, the location of lecture room will be in the ISRC Boardroom (Room MS105) within the MS building. Computer lab sessions will be held in Room MG122 (MG building) at Magee campus (see more information at the end of this document).

Online attendees are themselves responsible for the access of reliable internet. When not speaking online, please remember to turn off the microphone and video camera to avoid echo effects and hanging up during video streaming. During the end of the lecture/talk, for questions and answers, you may turn on your microphone and video camera to ask questions or speak to the lecturer/speaker. During lab sessions, you can ask Teaching Assistants questions throughout the lab session. But please be mindful that we have limited Teaching Assistants per lab session.

Towards the end of the Autumn School, feedback from attendees will be requested. Anonymity of feedback is optional. This will be used in reviews and reporting, and for improving future versions of the Autumn School.

Lectures:

Lectures, including external speakers, will be delivered during the day, from about 9am to 6pm, with several breaks within this period. Each day of lectures will be categorised based on general themes.

Day 1 lectures will be on general topics such as introductory neuroscience, introductory cognitive neuroscience and mathematical techniques.

Day 2 will be focused on modelling biological neurons and neuronal networks, and neuroscience-based theories of cognition e.g. decision-making and learning.

Day 3 will discuss topics on neural signal processing, neuroimaging data analysis and neurotechnology.

Day 4 and the morning of Day 5 are focused on neuro-inspired artificial intelligence algorithms, especially artificial neural networks and reinforcement learning, and their applications (e.g. in robotics). Neuromorphic computing with spiking neural networks and research ethics will also be discussed. There will also be a presentation on research translation and entrepreneurship, and attendees will have the opportunity to

give a concise (5-minute) presentation or pitch of either their own research work or some of the group work done during the lab sessions.

Attendees are encouraged to attend as many of these lectures as possible. Lectures will be delivered both physically and online (live streaming). Physical lectures will be broadcast live to those attending the fully online version. Those attending online may ask questions via their own computer's videocam, microphone or type in the chat box in the web link. Lectures will be recorded to allow those who were unable to attend (e.g. due to different time zones, work-related or other personal responsibilities) or for revisits. We will provide the video clips' information on our GitHub link.

Lecture room

- Room **MS105 (Boardoom)** (Note: MS105 is in the MS building, the ISRC building)

Labs:

Each computer lab session, held in the evening from about 7pm to 9:30pm, aims to consolidate and reinforce the lectures' topics delivered during that day. Lab sessions, to be led by Teaching Assistants, will consist of 'mini' project-like assignments that involve computational modelling and data analysis. Additional exploration by attendees is highly encouraged, and they may be presented during the project pitches on the final day.

Computer labs will be conducted in Python and MATLAB. If MATLAB is not available, students joining online can download MATLAB's 30-day free trial version or MATLAB's online version (https://uk.mathworks.com/products/matlab-online.html). Codes will be provided by the Teaching Assistants and available on GitHub (see below). Data will be provided when needed. See Day 1 lab notes (provided in advance) for further details. We recommend attendees, especially online attendees, to download the relevant software to their own personal computer before the Autumn School. Attendees with limited mathematics and computer programming experience should check out the prepared mathematical notes or other sources such as https://www.datacamp.com/ before the Autumn School.

Attendees are recommended to attend as many of these lab sessions as possible. Labs will be delivered physically and broadcast online live. It will also be recorded. Those who are attending physically will be able to access our computer lab's machines and other computing facilities. Guest accounts will be given out in certain labs.

Physical lab sessions will be broadcast live to those attending online. Those who are attending online will be able to join live via Microsoft Teams (or Blackboard Learn) and may ask questions via their own computer's videocam, microphone or type in the chat box of the Microsoft Teams or Blackboard Learn.

Lab sessions will be partially recorded to allow those who were unable to attend (e.g. due to time zone differences, work-related or other personal responsibilities) or for revisits. We will provide the video clips' information on our GitHub link.

Computer lab:

- Room **MG122** (Note: MG122 is in the MG building, not MS building)

ISRC-CN^3 GitHub link:

Notes, codes, datasets and video clips will be made available at our ISRC-CN^3 GitHub link https://github.com/ISRC-CN3 .

For those who are not familiar with computer programming or mathematics, it is advisable that they read, revise or practise the provided materials (see Day 1 and References in GitHub) prior to the start of the Autumn School.

Project pitches:

On the final day (29th October, Friday), attendees will have the opportunity to present either their own ongoing research projects (e.g. M.Sc./Ph.D. theses or company based) or present a specific study explored during the Autumn School's lab session.

Reimbursements, claims and refunds:

If you are seeking (e.g. travel) reimbursements and claims, or refunds, please remember to save hard copies of your receipts. Then contact Louise Gallagher (see below) for a claim form to be filled.

Organising committee and contacts:

Dr. KongFatt Wong-Lin (k.wong-lin@ulster.ac.uk), Louise Gallagher (l.gallagher@ulster.ac.uk), Elaine Duffy (e.duffy@ulster.ac.uk), Cheryl Mullan (c.mullan@ulster.ac.uk), and Prof. Damien Coyle (dh.coyle@ulster.ac.uk).

Lecturers and speakers:

- Dr. Saugat Bhattacharyya (ISRC, Ulster University)
- Assistant Professor Áine Byrne (University College Dublin)
- Prof. Damien Coyle (ISRC, Ulster University)
- Amanda Fullerton (Knowledge Transfer Partnership, Ulster University)
- Prof. Jim Harkin (ISRC, Ulster University)
- Dr. Shane Harrigan (ISRC, Ulster University)
- Prof. Nikola Kasabov (Auckland University of Technology & ISRC, Ulster University)
- Associate Professor Simon Kelly (University College Dublin)
- Prof. J. A. Scott Kelso (Florida Atlantic University & ISRC, Ulster University)
- Dr. Mehdi Khamassi (Sorbonne Université & Centre National de la Recherche Scientifique)
- Prof. Liam McDaid (ISRC, Ulster University)
- Dr. Elaine K. Murray (Northern Ireland Centre for Stratified Medicine, Ulster University)
- Dr. Cian O'Donnell (University of Bristol & ISRC, Ulster University)
- Prof. Girijesh Prasad (ISRC, Ulster University)
- Dr. Savitha Ramasamy (Institute of Infocomm Research, A*STAR)
- Prof. Arleen Salles (Center for Research Ethics and Bioethics, Uppsala University & Neuroethics Program, Centro de Investigaciones Filosoficas)
- Dr. Jose M. Sanchez Bornot (ISRC, Ulster University)
- Dr. KongFatt Wong-Lin (ISRC, Ulster University)

See web links and later in the document for profiles.

Teaching assistants (ISRC, Ulster University):

- Day 1 - Farajollah (Fred) Tahernezhad-Javazm & Przemyslaw Cichy
- Day 2 - Marinus Toman
- Day 3 - Massoud Khodadadazadeh & Vahid Saranirad
- Day 4 - Aqib Javed & Niamh McCombe

See web links and later in the document for profiles.

DAY 1 (25th OCTOBER 2021, MONDAY)

Morning session

09:00-09:15	Welcome – *KongFatt Wong-Lin (Organiser)*
09:15-09:30	Opening speech – *Liam Maguire (UU PVC Research) & Damien Coyle (ISRC Research Director)*
09:30-12:00	Introductory neuroscience – *Elaine Murray (UU)*
12:00-13:00	Lunch

Afternoon session

13:00-15:30	Cognitive neural systems and behaviour – *Simon Kelly (UCD)*
15:30-15:45	Break
15:45-18:00	Mathematics for neuroscience – An overview (notes provided in advance) – *Áine Byrne (UCD)*
18:00-19:00	Dinner

Evening session

19:00-21:30	Lab on fundamentals of Python & MATLAB programming (notes provided in advance) – *Farajollah (Fred) Tahernezhad-Javazm and Przemyslaw Cichy*

DAY 2 (26th OCTOBER 2021, TUESDAY)

Morning session

09:00-11:00	Glia cells: Key to Autonomous Learning in AI? – *Liam McDaid & John Wade (UU)*
11:00-11:15	Break
11:15-13:00	Computational modelling of plasticity and learning in brains – *Cian O'Donnell (UU)*
13:00-14:00	Lunch & tour of some ISRC labs (in MS building)

Afternoon session

14:00-16:00	Neural network dynamics and modelling of cognitive functions – *KongFatt Wong-Lin (UU)*
16:00-16:15	Break
16:15-18:00	An introduction to model-free and model-based reinforcement learning and their application to cognitive neuroscience – *Mehdi Khamassi (Sorbonne Université and CNRS)* *[online]*
18:00-19:00	Dinner

Evening session

19:00-21:30	Lab on neural & cognitive modelling – *Marinus Toman*

DAY 3 (27th OCTOBER 2021, WEDNESDAY)

Morning session

09:00-11:00	Investigating time series neural data: Experimental design & processing – *Saugat Bhattacharyya (UU)*
11:00-11:15	Break
11:15- 13:00	Computational neuroimaging & brain-computer interface – *Girijesh Prasad (UU)*
13:00-14:00	Lunch

Afternoon session

14:00-16:00	Introduction to the statistical methodology for brain connectivity analysis – *Jose Sanchez Bornot (UU)*
16:00-16:15	Break
16:15-18:00	Decoding mental imagery from electroencephalography (EEG) and applications of AI-enabled wearable neurotechnology for communication and rehabilitation – *Damien Coyle (UU)*
18:00-19:00	Dinner

Evening session

19:00-21:30	Lab on neural data processing, neural data science & applications – *Massoud Khodadadazadeh & Vahid Saranirad*

DAY 4 (28th OCTOBER 2021, THURSDAY)

Morning session

09:00-11:00	Neuro-inspired computation: Spiking neural networks – *Nikola Kasabov (AUT & UU)* *[online]*
11:00-11:15	Break
11:15-13:00	Deep and metacognitive learning – *Savitha Ramasamy (Institute of Infocomm Research)* *[online]*
13:00-14:00	Lunch

Afternoon session

14:00-16:00	Building reliable and secure embedded systems with neuromorphic computing – *Jim Harkin (UU)*
16:00-16:15	Break
16:15-17:15	Towards responsible brain research and applications - *Arleen Salles (CRB, Uppsala University & Centro de Investigaciones Filosoficas)* *[online]*
15:15-15:30	Break (coffee/tea/snacks)
17:30-19:30	Lab on neuro-inspired AI and applications – *Aqib Javed & Niamh McCombe*

Evening session

19:30-	Dinner at Magee Hall, Derry Halloween dressing up, social event, etc.

DAY 5 (29th OCTOBER 2021, FRIDAY)

Morning session

10:15-11:15	Neuromorphic vision – *Shane Harrigan (UU)*
11:15-11:45	Break
11:45-12:05	Understanding the benefits of Knowledge Transfer Partnerships (KTPs) for businesses, academics and graduates – *Amanda Fullerton (KTP, UU)*
12:05-12:25,	Translating AI-enabled, neurotechnology research and experiences of developing an award winning neurotech startup – *Damien Coyle (NeuroConcise CEO & UU)*
12:30-13:15	Lunch

Afternoon session

13:15-15:45	Attendees' project pitches (5 minutes each + 1 minute Q&A)
15:45-16:00	Break
16:00-17:00	Closing talk – Coordination dynamics – *J.A. Scott Kelso (FAU & UU)*
17:15	Closing remark

See link (https://sites.google.com/view/isrc-cn3/home/isrc-cn3-synopses) and below for synopses of lectures and talks.

Profiles and presentation synopses of lecturers and speakers

Elaine Murray

Bio: Elaine Murray is a Lecturer in Personalised Medicine (Mental Health) at Ulster University. She received her undergraduate degree in Biomedical Sciences from Ulster University and her PhD in Neuroscience and Behaviour at the University of Massachusetts, Amherst, where she demonstrated that perinatal disruption of histone acetylation leads to long lasting changes in sexually dimorphic regions of the brain. She then joined the Translational Neuroscience group at the University of Aberdeen as a research fellow, where she worked on the genetic basis of major mental illness as part of a Pfizer Neuroscience Grand Challenge project. Elaine returned to Northern Ireland in 2013 to take up her current post within the Northern Ireland Centre for Stratified Medicine. Elaine's current research focuses on identifying novel biomarkers to improve diagnosis and treatment of psychiatric disorders. Elaine is a council member of Neuroscience Ireland, Northern Ireland local group representative for the British Neuroscience Association and is currently leading a CHITIN project investigating mental health among at-risk young people in a cross-border region funded by the EU's INTERREG VA Programme.

Lecture title: Introductory neuroscience

Synopsis: This session will provide an overview of the structure and function of the nervous system. The lecture will start with a review of the divisions of the nervous system and the main cell types, neurons and glia. An introduction to basic neuroanatomy will follow covering key external and internal structures of the brain and the main components of systems controlling movement, learning and memory, and emotional regulation. To understand neuronal processes and pathologies it is important to understand how neurons work. An overview of the action potential, the electrical signal used by neurons to carry information to their target, will be provided. Finally, the main steps involved in synaptic transmission, including the neurotransmitters responsible for chemical signalling in the nervous system, will be reviewed.

Simon Kelly

Bio: Simon Kelly is an Associate Professor in the School of Electrical and Electronic Engineering at University College Dublin. In his research he studies the perceptual and cognitive brain processes that allow people to interact effectively with their environment. He mainly employs a combination of electrophysiology, psychophysics and computational modeling to study the neural computations underlying perception, attention and decision making. Simon received his B.E. and Ph. D. degrees in Engineering from UCD in 2001 and 2005, respectively. He then worked as a postdoctoral researcher in the Nathan S. Kline Institute for Psychiatric Research, New York, and in the Columbia University Department of Neuroscience, and held an Assistant Professor position in the Department of Biomedical Engineering in the City College of the City University of New York for four years before joining UCD in Jan 2015.

Lecture title: Cognitive neural systems and behaviour

Synopsis: Our knowledge of the brain processes underlying perception, cognition and action has come from research using a spectrum of levels of analysis from the molecular, through single neurons and circuits, to behaviour. This lecture provides an introduction to the behavioural end of this spectrum. I will give a broad overview of basic methods of psychophysics - the systematic measurement of behaviour - and how these methods provide insights into properties and mechanisms of the neural systems for basic sensation and for cognitive functions such as attention, decision making and memory and learning. I will discuss how the principled measurement of behaviour helps to make sense of even the lowest-resolution forms of neural activity measurements amenable to human research, and conversely, how such neural activity measurements, once well-characterised functionally, can inform simple mathematical models that capture not just the observed patterns of behaviour but also the underlying algorithms the brain is using to generate them. A core thread running through all of these themes will be the importance of careful task design - what we ask our subjects to do and under what conditions.

Áine Byrne

Bio: Áine Byrne is an Assistant Professor in the School of Mathematics and Statistics, at University College Dublin. She obtained her PhD from the University of Nottingham in 2017, before receiving a Swartz Fellowship for her postdoctoral studies at the Center for Neural Sciences, New York University. Her research focus is coarse-grained models of neural activity. Starting with large networks of interacting neurons, she employs mean-field techniques to arrive at low-dimensional descriptions of these systems. Her next generation neural mass model successfully links the average population activity to the level of synchronisation within the underlying network of neurons, providing an explicit link between the microscopic and macroscopic dynamics. Byrne employs this model to study event-related changes in EEG/MEG spectral power and neurological disorders, such as schizophrenia, epilepsy and Parkinson's disease.

Lecture title: Mathematics for neuroscience: An overview

Synopsis: The use of mathematics has many historical successes, particularly in the realm of physics and engineering, where mathematical concepts are regularly employed to address challenges far beyond the context in which they were originally developed. More recently, mathematics has been employed to further our understanding of biological systems, such as the brain. Despite the immense complexity of the brain, mathematical modelling has allowed for major advances to be made towards understanding behaviour, consciousness and disease. This lecture introduces the mathematical tools needed for mathematically modelling the brain. We will review concepts from linear algebra, vector calculus and differential equations. We will learn how to describe neural systems using differential equations and how to simulate these equations computationally.

Liam McDaid

Bio: Liam McDaid, BEng, PhD (Liverpool), is Professor of Computational Neuroscience at Ulster University. His research focuses on hardware/software implementations of neural based computational systems with particular emphasis on modelling glia-neural interactions. He has secured funding from Higher Education Authority of Ireland, which focuses on inter-neuron on-chip communications and was Co-PI for the EPSRC project (EP/F05551X/1) to develop compact low power spiking neuron cells. Prof. McDaid was PI for a recent EPSRC eFutures (EFXD12011) project and CI on SPANNER (EP/N00714X/1). He also secured funding from the Human Science Frontiers Programme (HFSP) to model G-Protein signaling in astrocytes. He is guest editor for a special issue in the International Journal of Neural Systems and has co-authored over 120 publications.

Lecture title: Glia cells: Key to Autonomous Learning in AI?

Synopsis: This talk briefly discusses brain inspired intelligence or AI and why AI lags significantly behind human intelligence. A significant point discussed is whether AI can truly mimic human intelligence and what are the factors that may allow this to happen in the future. The talk then presents research carried out at Ulster on modelling brain function with significant focus on how different cell types interact. Of specific interest are glia cells and in particular astrocytes. Results from recent research Ulster will be presented and serves to illustrate our current understanding of the complexity of cellular signalling between neurons and astrocytes. Also why advancing our understanding on how these cell types exchange information is vital in our understanding of both low and high-level brain function.

Cian O'Donnell

Bio: Cian O'Donnell did a BSc in Applied Physics at Dublin City University, followed by an MSc and PhD in Neuroinformatics at University of Edinburgh where he studied biophysical models of electrical noise and synaptic plasticity in single neurons. He then worked for 3 years as a postdoc in the Salk Institute in La Jolla, California modelling synaptic plasticity in neural circuits, and analysing neural population activity data from mouse models of autism. In 2015 he became a lecturer at the University of Bristol, building a research group that works on three topics: 1) learning and memory in the brain; 2) neural circuit dysfunction in autism; 3) statistical methods for neuroscience data. The group currently has 7 PhD students and 2 postdoctoral researchers. In October 2021 Cian moved to Ulster University at Magee, joining the ISRC as a lecturer in data analytics. Website here: https://odonnellgroup.github.io.

Lecture title: Computational modelling of plasticity and learning in brains

Synopsis: This lecture will introduce the basics of how we think learning works in the brain, and common computational models of synaptic plasticity at the single synapse, single neuron, and neural circuit levels. It will cover classic models of Hebbian plasticity, spike-timing-dependent plasticity, and attractor networks. Finally, we will briefly discuss modern attempts to link brain learning to backpropagation and deep learning in artificial neural networks.

KongFatt Wong-Lin

Bio: KongFatt Wong-Lin is is a Reader at the Intelligent Systems Research Centre, School of Computing, Engineering and Intelligent Systems, Ulster University. Dr. Wong-Lin's research interests lie at the interface of computational modelling and mathematical analysis of systems and cognitive neuroscience, psychology, brain disorders, neural computation and engineering, AI and data science. Dr. Wong-Lin is Editorial Member for the Journal of Neuroscience Methods, and Associate Editor for Frontiers in Integrative Neuroscience. Before joining Ulster University, he was a research associate at Princeton University, USA, with affiliation to The Program in Applied and Computational Mathematics, Center for the Study of Brain, Mind and Behavior, and Princeton Neuroscience Institute. Prior to that, he received his Ph.D. in Physics with focus on Computational Neuroscience at Brandeis University, USA, with affiliation to the Volen National Center for Complex Systems. He received the 2011 IJCNN Best Paper Award (Overall), the 2016 Ulster University's Distinguished Research Fellowship Award, and the 2019 Ulster University Research Excellence Award. In 2017, he received the Moore Institute Visiting Research Fellowship at the National University of Ireland Galway, and from 2020, a Visiting Fellowship at University College at the University of Oxford.

Lecture title: Neural network dynamics and modelling of cognitive functions

Synopsis: This lecture will first discuss neural network models that are conducive for theoretical analysis and conceptual understanding. Then examples of how different neural network dynamics can lead to different cognitive functions will be discussed. A primary focus of this lecture is on understanding the network mechanism of decision-making, and it shall be demonstrated how neural network models can be adapted to produce different decision-making behaviour.

Mehdi Khamassi

Bio: Mehdi Khamassi is Research Director at the French National Center for Scientific Research (CNRS) in the Institute of Intelligent Systems and Robotics (ISIR) at Sorbonne Université (ex UPMC). He is also a Visiting Researcher in the Robotics Lab at the National Technical University of Athens, Greece. He obtained his PhD in Cognitive Sciences and his Habilitation to Direct Researches in Biology from UPMC respectively in 2007 and 2014. He is Co-director of Studies for the Cogmaster program at École Normale Supérieure, Paris. He also serves as Associate Editor at Frontiers in Neurorobotics, Frontiers in Decision Neuroscience, Intellectica, and Neurons, Behavior, Data analysis and Theory. His research interests include decision-making, reinforcement learning, performance monitoring, social interaction and reward signals in social and non-social contexts.

Lecture title: An introduction to model-free and model-based reinforcement learning and their application to cognitive neuroscience

Synopsis: The model-free reinforcement learning (RL) framework, and in particular Temporal-Difference learning algorithms, have been successfully applied to Neuroscience since about 25 years. It can account for dopamine reward prediction error signals in simple Pavlovian and single-step (instrumental) decision-making tasks. However, more complex multi-step tasks illustrate their computational limitations.

In parallel, the last 10 years have seen a growing interest in computational models for the coordination of different types of decision-making systems, e.g. model-free and model-based RL. Model-based here means that the subjects try to learn an internal model of the statistical structure of the task (like a cognitive map in spatial tasks), and can plan based on mental simulations within such a model.

Computational models for the coordination of multiple decision-making systems enable to explain more diverse behaviors and learning strategies in humans, monkeys and rodents. They enable to explain shifts between different modes of deliberation (fast responses versus long deliberations before responding). They also enable to clarify the respective roles of the prefrontal cortex areas, hippocampus, basal ganglia and dopaminergic system in different learning and decision-making tasks.

I will illustrate this line of research with a didactic presentation of first simple models, and then more complex models for the coordination of model-free and model-based reinforcement learning. I will then show a variety of behavioral and neurophysiological results in different paradigms (navigation tasks, classical conditioning tasks, instrumental learning tasks, working-memory tasks, social interaction tasks).

Saugat Bhattacharyya

Bio: Saugat Bhattacharyya is a Lecturer in Computer Science in the School of Computing, Engineering & Intelligent Systems. His research interests are in the area of Cognitive Neuroscience, Artificial Intelligence, Data Analytics and Machine Learning and its application in Human-Machine Interaction and Neuro-Rehabilitation. His research is primarily focussed on developing brain-computer interfacing systems based on robust signal processing, quantitative and machine learning algorithms to draw inference into an users' state of mind through their neural and other physiological signals. He has publications in 17 peer-reviewed journals, 32 international/national conferences, and 17 book chapters. He is also a recipient of GCRF pump-priming as co-investigator in and two PhD fellowships by CSIR, India and Erasmus Mundus. He is also an associate editor/section board member in Frontiers in Medical Technology and MDPI Brain Sciences, and served as guest editors in Frontiers in Neuroscience, MDPI Sensors and International Conference on Intelligent Robots and Systems (IROS).

Lecture title: Investigating time series neural data: Experimental design & processing

Synopsis: Recent advances in neuroscience technologies have paved the way to innovative applications in healthcare, rehabilitation, biometrics and brain-computer interfacing. These technologies are tuned to observe and influence brain activity to augment or assist in human motor or cognitive development. The neural activities are recorded using invasive or no-invasive technologies, albeit non-invasive technologies, such as electroencephalography (EEG), magnetoencephalography (MEG), functional near-infrared spectroscopy (fNIRS) and functional magnetic resonance imaging (fMRI) are the most popular form of recording amongst researchers and users. Non-invasive neural signals recorded from EEG or MEG devices are non-stationary, complex signals. Hence, it is vital to follow standard experimental design practices to evoke or induce the necessary task response among users and apply time-/frequency-/time-frequency domain processing methods to extract meaningful information about those task responses from the neural signals (EEG/MEG). In this lecture, you will be introduced to some standard practices and consideration while designing an experiment involving EEG/MEG recording, necessary pre-processing methods including temporal and spatial filtering, and artefact removal, and finally signal processing using time-frequency and inter-trial phase clustering techniques.

Girijesh Prasad

Bio: Girijesh Prasad is Professor of Intelligent Systems in the School of Computing, Engineering and Intelligent Systems. He is Director of Northern Ireland Functional Brain Mapping (NIFBM) facility at Intelligent Systems Research Centre, where he leads the Neural Systems and Neuro-technology research team. Girijesh received a BTech in Electrical Engineering from Regional Engineering College (now NIT) Calicut, India in 1987, an MTech in Computer Science and Technology from University of Roorkee (now IIT Roorkee), India in 1992, and a PhD in Electrical and Electronic Engineering from Queen's University Belfast, UK in 1997. He is a Chartered Engineer, a Fellow of IET, a Senior Member of IEEE, and a founder member of IEEE Systems, Man, and Cybernetics society's Technical Committee on Brain-Machine Interface Systems. Previously he worked in industry, first as a Digital Systems Engineer and then as a Power Plant Engineer in India, and as a Research Fellow on an EPSRC/industry project at Queen's University Belfast. His research interests are in intelligent systems, data engineering, brain modelling, brain-computer interfaces and neuro-rehabilitation, assistive technology, and biometrics. He has published over 210 research papers in journals, edited books, and conference proceedings and his research has attracted over £5M funding from national and international agencies including Invest Northern Ireland, Department of Employment and Learning, RCUK, Leverhulme Trust, Royal Society, UK India Education and Research Initiative, and Irish industry.

Lecture title: TBC

Synopsis: TBC

Jose M. Sanchez Bornot

Bio: Jose Sanchez Bornot is a Research Software Engineer at the Intelligent Systems Research Centre in Ulster University, Magee Campus. He achieved a PhD in Applied Mathematics in Havana University in 2011. His interests and research activities are mainly in neuroinformatics, computational neuroscience and artificial intelligence, trying to understand the basis and organization of neural processing using different neuroimaging modalities such as MRI/fMRI and EEG/MEG/ECoG data; although later his interests have gradually switched to understand how the brain organization subserves the emergence of human intelligence through the combination of artificial intelligence and computational neuroscience methods. In the past, Jose has completed two postdoc positions in Ulster University, during which he developed novel functional connectivity methods and conducted research on Alzheimer's disease using neuroimaging. Currently, beside his research activities, Jose is attending the Northern Ireland High Performance Computing (NIHPC) cluster (https://www.ni-hpc.ac.uk/), which is a collaboration project between Ulster University and Queen's University of Belfast.

Google Scholar: http://scholar.google.com/citations?user=edVTpxkAAAAJ

Ulster University**:** https://pure.ulster.ac.uk/en/persons/jose-sanchez-bornot/fingerprints/

Lecture title: Introduction to the statistical methodology for brain connectivity analysis

Synopsis: Research on brain functional connectivity is critical to improving our understanding of neural information processing. This is a very active area where many different approaches converge, e.g. based on information theory, time series analysis or dynamical systems, and where different conclusions can be achieved using different neuroimaging modalities. For example, MRI is used mainly to study anatomical/structural brain changes, whereas fMRI can reflect the brain functional connectivity changes with better spatial accuracy. Otherwise, the oscillation phenomena of neural dynamics cannot be studied without using EEG/MEG data. In this lecture, an introduction and discussion of the different challenges will be presented while discussing techniques such as Granger causality, imaginary coherence and dynamic causal modeling, as well as the challenges associated with the statistical analyses that involve different neuroimaging data.

Damien Coyle

Bio: Damien Coyle, Professor of Neurotechnology, is Director of the Intelligent Systems Research Centre at Ulster University's Magee Campus. He has published over 150 research papers in areas such as computational intelligence/AI, bio-signal processing, computational neuroscience, neuroimaging, neurotechnology and brain-computer interface (BCI) applications and has won a number of prestigious international awards for his R&D including the 2008 IEEE Computational Intelligence Society (CIS) Outstanding Doctoral Dissertation Award, the 2011 International Neural Network Society (INNS) Young Investigator of the Year Award and the IET and E&T Innovation of the Year Award 2018. He was an Ulster University Distinguished Research Fellow in 2011, a Royal Academy of Engineering/The Leverhulme Trust Senior Research Fellow in 2013, a Royal Academy of Engineering Enterprise Fellow in 2016-2017 and is currently a UKRI Turing AI Fellow 2021-2025. He is a founding member of the International Brain-Computer Interface Society, a Senior member of the IEEE, chairs the IEEE Computational Intelligence Society (CIS) UKIreland chapter, is the IEEE CIS representative and member on the steering committee of the IEEE Brain Technical Community and UK KTN Neurotechnology Innovation Network advisory board member. He is Ulster lead of the Spatial Computing and Neurotechnology Innovation Hub (SCANi-hub) and the Northern Ireland High Performance Computing Facility (NIHPC) and co-investigator in Northern Ireland Functional Brain Mapping Facility (NIFBM) and lead a number of industry led data analytics projects via Ulster's Cognitive Analytics Research Laboratory (CARL). He is Founder and CEO of NeuroCONCISE Ltd, an award-winning, AI-enabled, wearable neurotechnology company.

More information: https://pure.ulster.ac.uk/en/persons/damien-coyle ;https://www.neuroconcise.co.uk/

Lecture title: Decoding mental imagery from electroencephalography (EEG) and applications of AI-enabled wearable neurotechnology for communication and rehabilitation

Lecture synopsis: Research in the field of brain–computer interfaces (BCIs) and neurotechnology has proven that electrical signals in the brain, modulated intentionally by mental imagery, can relay information directly to a computer, where it is translated by intelligent algorithms (some inspired by the brain's neural networks) into control signals that enable communication and control without movement or can improve self- regulation of brain activity. This talk will present results from research at Intelligent Systems Research Centre that shows people with restricted abilities resulting from disease, injury or trauma may benefit from neurotechnology, including those who have prolonged disorders of consciousness or locked-in syndrome following traumatic brain injury, spinal injury, stroke and post-traumatic stress disorder.

Neural activity can be modulated by many kinds of mental imagery e.g., classical motor imagery BCIs distinguish between imagined hand/arm movements. This presentation will also show recent results in decoding imagined three-dimensional limb movements, imagined primitive shapes, emotion inducing imagery and silent/imagined speech from EEG. The presentation will attempt to address the question is it feasible to expect high and robust performance with these types of imagery in EEG-based BCIs and will highlight results which indicate user proficiency in BCI control is a matter of training time, machine learning/AI ability, application of the technology and maintenance of stable affective states. A number of neurogaming applications that enhance BCI user training will be demonstrated.

Talk title: Translating AI-enabled, neurotechnology research and experiences of developing an award winning neurotech startup

Talk synopsis: Training over multiple sessions is certainly key to learning how to modulate brain activity via a motor imagery and this involves the collection of large dataset from multiple users. An award-winning AI-enabled wearable neurotechnology platform that may enable this, developed by NeuroCONCISE Ltd, will be presented along with an overview of the challenges and opportunities of developing a neurotech startup.

Nikola Kasabov

Bio: Nikola Kasabov is Fellow of IEEE, Fellow of the Royal Society of New Zealand, Fellow of the INNS College of Fellows, DVF of the Royal Academy of Engineering UK. He is the George Moore Chair Professor of Data Analytics at the Intelligent Systems Research Center of the University of Ulster and also Professor of Knowledge Engineering at the School of Engineering, Computing and Mathematical Sciences at Auckland University of Technology, New Zealand. Kasabov is the Past President of the Asia Pacific Neural Network Society (APNNS) and of the International Neural Network Society (INNS). He is Editor of Springer Handbook of Bio-Neuroinformatics, Springer Series of Bio-and Neurosystems and Springer journal Evolving Systems. He is Associate Editor of several journals, including Neural Networks, IEEE TrNN, Tr CDS, Information Sciences, Applied Soft Computing. Kasabov holds MSc and PhD from TU Sofia, Bulgaria. His main research interests are in the areas of neural networks, intelligent information systems, soft computing, bioinformatics, neuroinformatics. He has published more than 650 publications. He has extensive academic experience at various academic and research organisations in Europe and Asia, including: TU Sofia Bulgaria; University of Essex UK; University of Otago, NZ; Advisory Professor at Shanghai Jiao Tong University and CASIA China, Visiting Professor at ETH/University of Zurich. Prof. Kasabov has received a number of awards, among them: Honorary Professor of the University of Auckland, NZ; Honorary Professor at the Teesside University UK; Doctor Honoris Causa from Obuda University, Budapest; INNS Ada Lovelace Meritorious Service Award; NN Best Paper Award for 2016; APNNA 'Outstanding Achievements Award'; INNS Gabor Award for 'Outstanding contributions to engineering applications of neural networks'; EU Marie Curie Fellowship; Bayer Science Innovation Award; APNNA Excellent Service Award; RSNZ Science and Technology Medal; 2015 AUT Medal; Honorable Member of the Bulgarian, the Greek and the Scottish Societies for Computer Science. More information: https://academics.aut.ac.nz/nkasabov ; https://www.ulster.ac.uk/staff/nk-kasabov

Lecture title: Neuro-inspired computation: Spiking neural networks

Synopsis: The lecture introduces the third generation of artificial neural networks, the spiking neural networks (SNN), as the latest methods and systems for neuro-inspired computation, along with their numerous applications. SNN are not only capable of deep learning of temporal or spatio-temporal data, but also enabling the extraction of knowledge representation from the learned data. Similarly to how the brain learns, these SNN models do not need to be restricted in number of layers, neurons in each layer, etc. as they adopt self-organising learning principles of the brain [ref. 1,2].

The lecture consists of 3 parts:

1. Fundamentals of SNN
2. Brain-inspired SNN architectures. NeuCube.
3. Design and implementation of selected applications

The material is illustrated on an exemplar SNN architecture NeuCube (free software and open source available from www.kedri.aut.ac.nz/neucube). Case studies are presented of brain and environmental data modelling and knowledge representation using incremental and transfer learning algorithms. These include: predictive modelling of EEG and fMRI data measuring cognitive processes and response to treatment; prediction dementia and AD [3]; understanding depression; predicting environmental hazards and extreme events; moving object recognition and control; brain-inspired audio-visual information processing.

It is also demonstrated that SNN allow for knowledge transfer between humans and machines through building brain-inspired Brain-Computer Interfaces (BI-BCI) [4]. These are used to understand human-to-human knowledge transfer through hyper-scanning and also to create brain-like neuro-rehabilitation robots. This opens the way to build a new type of AI systems – the open and transparent AI.

References:

1. N. K. Kasabov, "NeuCube: A spiking neural network architecture for mapping, learning and understanding of spatio-temporal brain data," Neural Networks, vol. 52, pp. 62-76, 2014.

2. N.Kasabov, Time-Space, Spiking Neural Networks and Brain-Inspired Artificial Intelligence, Springer, 2019, https://www.springer.com/gp/book/9783662577134.

3. M. Doborjeh, …, N.Kasabov, Personalised Predictive Modelling with Spiking Neural Networks of Longitudinal MRI Neuroimaging Cohort and the Case Study for Dementia, Neural Networks, vol.144, Dec.2021, 522-539, https://doi.org/10.1016/j.neunet.2021.09.013 (available from https://authors.elsevier.com/c/1dsCu3BBjKgGro

4. K.Kumarasinghe, N.Kasabov, D.Taylor, Deep Learning and Deep Knowledge Representation in Spiking Neural Networks for Brain-Computer Interfaces, Neural Networks, vol.121, Jan 2020, 169-185, doi: https://doi.org/10.1016/j.neunet.2019.08.029.

Savitha Ramasamy

Bio: Savitha Ramasamy is a Principal Investigator and research group leader at Institute for Infocomm Research, Agency for Science, Technology and Research, Singapore. Her current research interests are in Life-Long Learning (Lcube) in artificial neural networks, primarily focused on analysis of irregularly sampled, multi-variate and non-stationary time series data. She received her PhD from Nanyang Technological University, Singapore, in 2011. Thereafter, she was a post-doctoral research fellow at Nanyang Technological University until 2013. She is listed in the inaugural 100 Women in Technology, Singapore (https://www.scs.org.sg/awards/sg100wit-n-to-s).

Lecture title: TBC

Synopsis: TBC

Jim Harkin

Bio: Jim Harkin holds a Bachelor of Technology, MSc and PhD in Electronic Engineering. He was employed as a post-doctoral researcher in embedded system design at Ulster for 3 years before taking up the post of Lecturer in 2004. He is currently Head of the School of Computing, Engineering and Intelligent Systems at Ulster University on the Magee Campus. His research investigates the design of highly efficient, secure, and reliable embedded systems that emulate bio-inspired computational and fault tolerance capabilities. In particular, he focuses his efforts on the development of the brain-inspired EMBRACE architecture which aims to address electronic reliability challenges by investigating new paradigms of Networks-on-Chip interconnect and harnessing the principles of brain-like repair. His work also explores how neural networks in hardware can be used in Networks-on-Chip interconnect for security and traffic congestion awareness.

Lecture title: Building reliable and secure embedded systems with neuromorphic computing

Synopsis: The demand for increasingly more 'intelligent' computing systems has to be viewed through the explosion of their complexity. An important knock-on effect however, is degradation in reliability: designing reliable electronic systems is a major challenge. Self-repair is critical in hardware systems where long-term reliable performance is not guaranteed. Increasing gate densities, scaling to sub-nanometer geometries and variations in silicon manufacturing result in additional challenges.

Current self-repairing hardware approaches rely on a central controller, with constraints placed on the type and number of faults (e.g. open/short-circuits) and repair granularity. There is a pressing need to progress beyond these concepts and look for inspiration from biology.

While state-of-the-art hardware devices and neuromorphic chips replicate to an extent a brain information processing paradigm, they are not fault-tolerant and can develop faults due to incorrect operations in post manufacturing, wear-out failures, or radiation effects. Nonetheless, the human brain does exhibit high levels of distributed repair and more recently it has emerged that interactions between astrocyte cells and spiking neurons provide a distributed repair paradigm that has the potential to advance progress in establishing new approaches to reliable information processing in hardware.

This lecture establishes the current challenges in capturing self-repair capabilities in electronic hardware and outlines progress in addressing the interconnect complexity in the communication of vast quantities of information while enabling large-scale hardware implementations of self-repairing neural networks. In addition, methods for the acceleration of such neural networks in hardware will be discussed and remaining challenges in future deployment. Example applications of SNNs in hardware security for the detection of anomaly traffic and in the prediction of traffic congestion will also be presented.

Arleen Salles

Bio: Arleen Salles is a Senior Researcher in philosophy at the Center for Research Ethics and Bioethics (CRB) at Uppsala University and Director of the Neuroethics Program at CIF (Centro de Investigaciones Filosoficas) in Buenos Aires, Argentina. She is a tenured professor of philosophy at Universidad Argentina de la Empresa (Buenos Aires, Argentina) and is also affiliated to Weill Cornell Medical College, (NY, United States). She is the Deputy Leader of the Responsible Research and Innovation Work Package of the EU-flagship Human Brain Project where she is a researcher and leads the task Neuroethics and Engagement. She is also Board member of the International Neuroethics Society and serves as a member of the International Brain Initiative's Neuroethics Working Group. Salles received her M.A and Ph.D in philosophy from State University of New York at Buffalo, USA. Her current research focuses on neuroethics, particularly the normative, epistemic, and ontological implications of neuroscientific findings and its applications (including brain inspired artificial intelligence).

Lecture title: Towards responsible brain research and applications

Synopsis: Ethical assessment of scientific research and its applications, including anticipation of societal expectations, is central to participative approaches such as Responsible Research and Innovation (RRI) that have been developed to govern the ethical challenges of science and technology. The goal to identify and reflect upon scientific and technological impacts and to promote engagement with diverse stakeholders is aligned with the idea that neither science nor its products are value neutral. This lecture provides an overview of RRI and how it has been used as a framework to address the ethical, philosophical and societal issues raised by neuroscience and emerging neurotechnologies. I will focus on some of the advantages and limits of this approach and will introduce the notion of Responsibility by Design as a way to progress beyond RRI.

Shane “Shan” Harrigan

Bio: Shane “Shan” Harrigan of Ulster University obtained his PhD in 2020 on the topic of neuromorphic sensors and their processing with primary focus on interpreting neuromorphic vision sensor signals. Shane currently works as a research associate in the ISRC focussing on neuromorphic vision research, and has published extensively on the topics of low-level data structuring/processing and deep-learning applications to neuromorphic data. Before entering his current role Shane worked in a variety of industry roles and as a research partner with organisations such as the European Space Agency focussed on geomagnetic anomalies.

Lecture title: Neuromorphic vision

Synopsis: This lecture first presents and discusses the growing field of neuromorphic vision. Neuromorphic vision is concerned with the design and usage of neuromorphic vision sensors which emulate retinal neural behaviours exhibited in biological vision systems. These sensors are bio-inspired both in imaging acquisition and communication with asynchronous signals at-sensor level like retinal neural spikes. This lecture will then discuss these novel asynchronous signals, known popularly as events, and the past, current, and emerging trends in their processing for the purposes of information extraction and more complex operations. The lecture will conclude with a summary of the different aspects discussed over the lecture with some samples of current research applications undertaken at Ulster University. This lecture will blend the vision neuroscience, biophysics and computer science/engineering elements which form neuromorphic vision.

Amanda Fullerton

Bio: In 2004, **Amanda Fullerton** joined Ulster University's Knowledge Transfer Partnerships Office (KTP) to work with Northern Ireland industry partners and the University's research experts to help them develop high-quality, fundable, KTP proposals. Amanda was later appointed as the University's KTP Programme Manager (2013) where her main role has been to develop and grow the University's KTP portfolio, aligned with the University's overall focus to stimulate and support the development of commercial partnerships between academics and businesses, with particular emphasis on research capabilities and academic resources. Amanda continues to play a leadership role in the generation and management of KTPs across the University, and to manage the business and academic relationships during the delivery of each project.

Talk title: Understanding the benefits of Knowledge Transfer Partnerships (KTPs) for businesses, academics and graduates

Synopsis: For 45 years, Knowledge Transfer Partnerships (KTPs) have been helping businesses innovate for growth. They do this by connecting businesses that have an innovation idea with the university expertise to help deliver it. In effect, they link forward thinking businesses with world-class University researchers to deliver innovation projects led by inspired graduates.

Ulster University has been engaged in KTP since its inception, having continuously regarded the KTP programme as an excellent pathway for generating strategic knowledge transfer opportunities with business partners to improve their performance whilst also demonstrating the impact of the University's research.

The presentation will demonstrate the key benefits of KTP for businesses, academic researchers and graduates, and will describe the KTP journey and funding available. The presentation will conclude with a profile of a successful Ulster University KTP, led by the School of Computing, that won the 2019 Innovate UK national award for the "KTP with Best Social Impact.

J. A. Scott Kelso

Bio: Scott Kelso's research aims to understand how human beings (and human brains)—individually and together—control and coordinate their behavior on multiple levels, from cells to cognition to (most recently) social settings. Kelso's approach is to look for commonalities and differences in the way such complex systems are coordinated across scales with the goal of identifying common principles and mechanisms—an empirical, theoretical and computational modeling framework called Coordination Dynamics. From 1978 to 1985 Kelso was Senior Research Scientist at Yale University's Haskins Laboratories in New Haven, Connecticut. Since then, he has held the Glenwood and Martha Creech Eminent Scholar Chair in Science at Florida Atlantic University (FAU) in Boca Raton, Florida where he founded The Center for Complex Systems and Brain Sciences, obtaining the first NIH National Training Grant in this new interdisciplinary field. Kelso is also a Professor at The University of Ulster's Intelligent Systems Research Centre in his hometown of Derry where he continues to collaborate with colleagues and students. In 2016, Kelso was elected an Honorary Member of The Royal Irish Academy (Hon. MRIA). Trained in a specifically interdisciplinary setting, Kelso's PhD students and Postdoctoral fellows have gone on to careers in some of the top academic and research institutions in the world.

ORCID iD: https://orcid.org/0000-0001-7740-2487

WEBSITE: http://www.ccs.fau.edu/hbblab/index.php

Talk title: Understanding behavior and the brain from the perspective of a dynamical theory of coordination

Synopsis: As the last talk in the Autumn School, participants will be invited to consider the following question: what does it mean to "understand" a phenomenon regardless of the level of description one chooses to investigate it (e.g., micro-, meso-, macro- etc.)? Given that the usual categories of describing behavior and cognition are suspect with respect to their neural underpinnings (see, e.g. "The brain doesn't think the way you think it does", Quanta, August 24, 2021 https://www.quantamagazine.org/mental-phenomena-dont-map-into-the-brain-as-expected-20210824/?utm_source=pocket-newtab#), the focus here will be on *coordination*-- assumed to be crucial for complex systems regardless of how we categorize behavioral and cognitive function and their relation to structure. In that context, we will explore some of the main concepts, methods and messages of Coordination Dynamics. I offer a strategy aimed at understanding coordination and show how it can be implemented at both behavioral and brain levels.

Profiles of teaching assistants

Marinus Toman

Bio: Farajollah (Fred) Tahernezhadjavazm received his B.Sc in Electronic Engineering from Yazd University, Yazd, Iran. He received his M.Sc as the First-Ranked student in Mechatronics Engineering from the University of Tabriz, Tabriz, Iran. He is currently pursuing a PhD degree at Intelligent Systems Research Centre in the School of Computing, Engineering and Intelligent Systems at Ulster University, Derry~Londonderry, Northern Ireland. His research domain is the combination of Neuroevolution and Reinforcement Learning. In addition, his research interests include Evolutionary Computations, Reinforcement Learning, Artificial Neural Networks, and AI application in biomedical engineering.

Przemyslaw Cichy

Bio: Przemyslaw Cichy received the B.Eng. (Hons.) degree in Computer Engineering from Ulster University, Magee in 2018. He is currently pursuing a PhD degree at the Intelligent Systems Research Centre. His research is focussed on Deep Reinforcement Learning, with emphasis on environment modelling and imitation learning.

Marinus Toman

Bio: Marinus Toman received the B.Sc. (Hons.) degree in Cloud Computing from Letterkenny Institute of Technology, Donegal, Ireland in 2018. He is currently pursuing the PhD degree in Computational Neuroscience as part of the Computational Neuroscience and Neural Engineering Research Team at Ulster University, Derry~Londonderry, Northern Ireland. His primary research interests include modelling of glial and neuronal cells in the brain to investigate how memory and learning occurs at a cellular level in the brain. His other research interests include computer science, specifically indoor positioning and localisation.

Massoud Khodadadzadeh

Bio: Massoud Khodadadzadeh received the B.S. degree in electrical engineering from the Sadjad University of Technology, Mashhad, Iran, in 2010 and the M.Sc. degree in electrical engineering from the Shahrood University of Technology, Shahrood, Iran, in 2014. Since 2018, he has been working toward a PhD degree at Intelligent Systems Research Centre (ISRC) in the School of Computing, Engineering and Intelligent Systems at Ulster University, Derry~Londonderry, Northern Ireland, UK. His research focuses on advanced deep learning techniques, especially Capsule Neural Network (CapsNet) method and its application on Hyperspectral Imaging, EEG, and coordination dynamics.

Aqib Javed

Bio: Aqib Javed received the B.Eng. and M.Eng. degree in electrical engineering from the COMSATS Institute of Information Technology, Abbottabad, Pakistan, in 2014 and 2016, respectively. He is currently finalising his PhD in Computing Engineering from School of Computing, Engineering and Intelligent Systems at Ulster University, UK with the support of a Vice-Chancellor's Research Scholarship (VCRS). His research emphasis on HW/SW implementation and applications of spiking neural networks, and performance enhancement of on-chip interconnect networks.

Niamh McCombe

Bio: Niamh McCombe received a B.Sc. in Computer Science, Linguistics and a Language from Trinity College, Dublin and an M.Sc. in Economics also from Trinity College, Dublin. She is currently a PhD researcher and Research Associate at the Intelligent Systems Research Centre in the School of Computing, Engineering and Intelligent Systems at Ulster University. Additionally, she has worked in educational software development and in grant writing for third sector organisations. Her Ph.D. research with the Centre for Personalised Medicine focuses on a combination of cognitive data with health and lifestyle data to develop strategies for improving the care pathway for dementia patients

Vahid Saranirad

Bio: Vahid Saranirad is currently a PhD researcher at ISRC, Ulster University.

City of Derry~Londonderry in Northern Ireland

Some general information:

- https://www.visitderry.com/
- https://discovernorthernireland.com/information/product-catch-all/visit-derry-information-centre-p689591
- https://www.derrystrabane.com/What-s-On/Tourist-Information

Some nearby accommodations:

Ulster University has a rate with City Hotel, Derry of £85 Bed & Breakfast. If you would like to book, please email Louise at l.gallagher@ulster.ac.uk to let us know and we will forward your name to City Hotel so that you can avail of this preferred rate.

Other nearby accommodation include:

- Shipquay Hotel
- Holiday Inn Express Derry
- Maldron Hotel Derry
- Da Vinci's Hotel
- Bishop's Gate Hotel Derry
- Premier Inn Derry Hotel

and others. There are also several economical Bed and Breakfasts and Hostels.

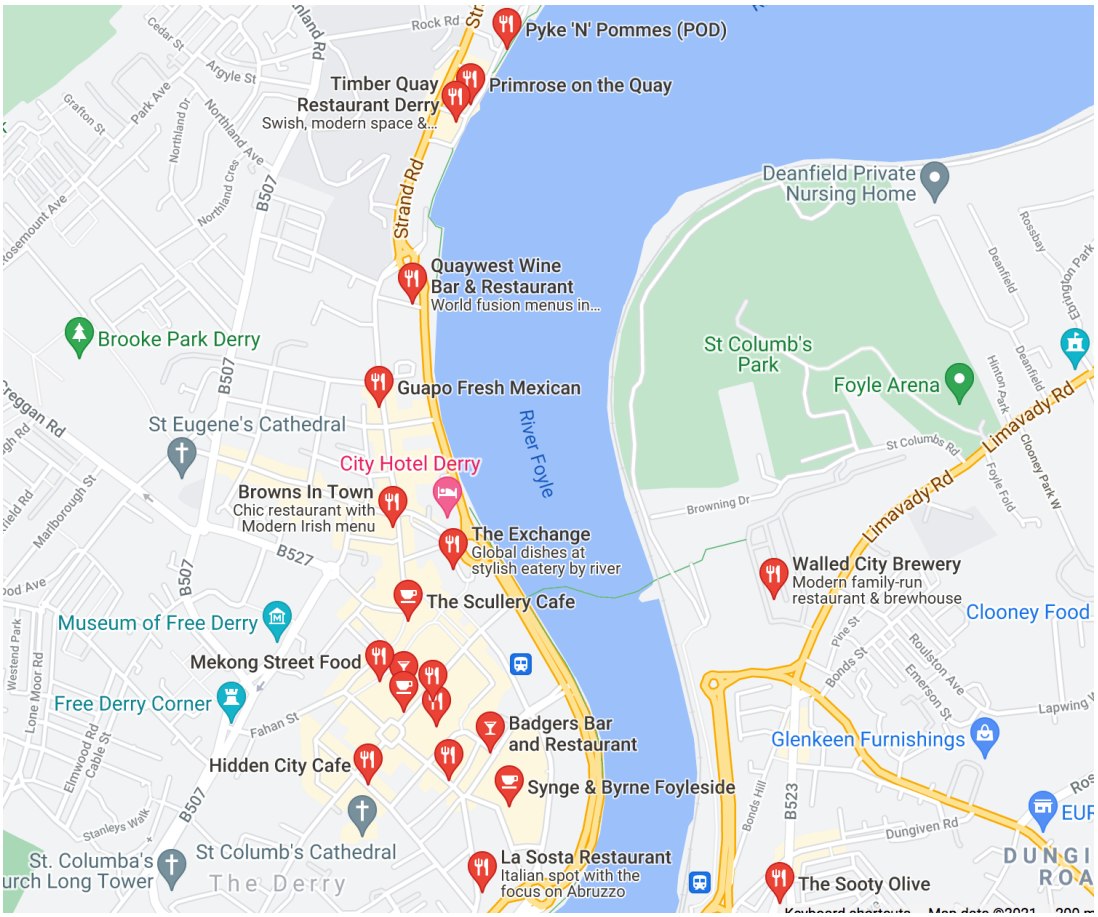
On campus eateries

- Jitters (in MG building)

- Scullery Magee (in MU building)

Nearby restaurants and eateries

- Guapo (Fresh Mexican)
- Florentini
- Quaywest
- Mama Masala
- Timber Quay Restaurant Derry
- Saffron Modern Indian Restaurant
- Pyke N' Pommes (one along Strand Road and another along Foyle River)
- Mandarin Palace
- Sandiwch company on the Quay (along Foyle River)
- Primrose on the Quay (along Foyle River)
- Patricia's Coffee House (along Foyle River)
- The Coffee Tree
- Zora's
- Domino's Pizza (cityside)
- Etc.



Derry Halloween (29-31 October, 2021):

- https://derryhalloween.com/
- https://www.visitderry.com/whats-on/derry-halloween-p754101
- https://www.independent.co.uk/travel/uk/derry-best-halloween-destination-world-europe-carnival-northern-ireland-a9156566.html

Ulster University, Magee campus

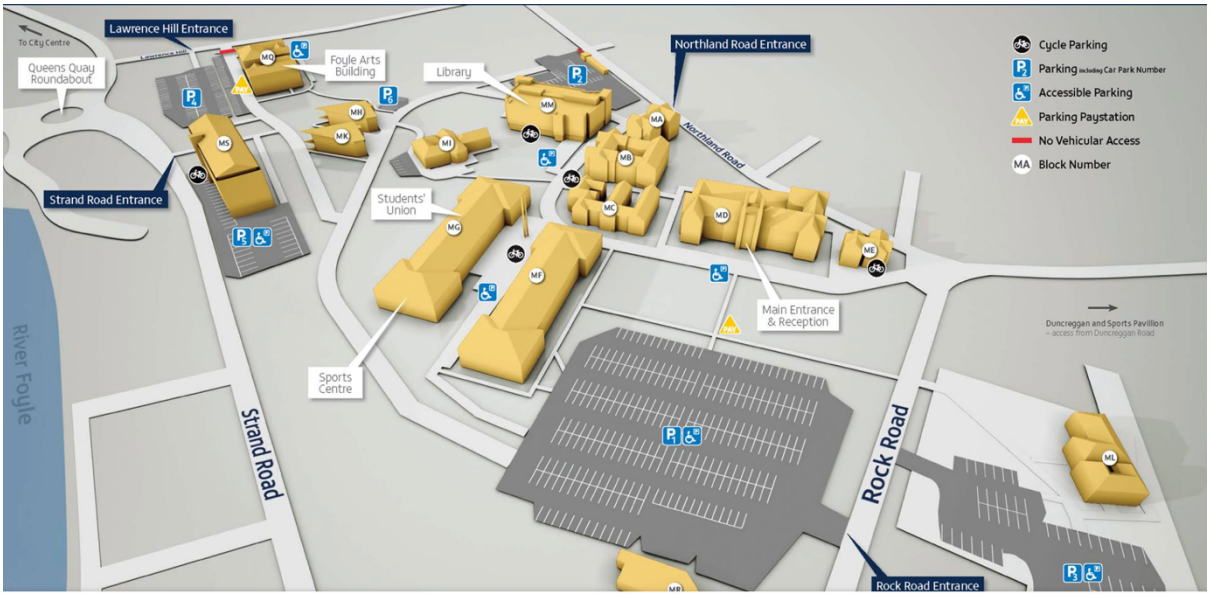
The Magee campus of Ulster University in the city of Derry~Londonderry, is one of four campuses in Northern Ireland:

https://www.ulster.ac.uk/campuses/magee

It is the oldest campus with a history, dating back to the year 1865.

Magee campus map:

- https://www.ulster.ac.uk/pdf/campus-maps/magee-campus-map.pdf
- Google map https://www.google.com/maps/d/viewer?mid=1gdsugbd1SrO_vMTlhmyxvojrR-I&ie=UTF8&t=h&oe=UTF8&msa=0&ll=55.00240881516382%2C-7.321874999999995&z=16



How to get to Derry~Londonderry and Magee campus?

The MS building at Magee campus lies on Strand Road opposite the Derry City and Strabane District Council.

By flight: Fly to either the City of Derry airport (https://www.cityofderryairport.com/), which is the nearest airport. Or you may fly to Belfast International Airport (https://belfastairport.com/), the next closest airport, or George Best Belfast City Airport (https://www.belfastcityairport.com/).

By train: Take the Translink (https://www.translink.co.uk/) NI Railways (https://www.translink.co.uk/corporate/monitoringresults/nirailways) and stop at Derry~Londonderry train station. For example, from Belfast Great Victoria train station, to Derry~Londonderry train station, it takes about 2 hours. To go from Dublin (Dublin City, Connolly Rail Station) to Derry~Londonderry train station, you have to change trains at Belfast Lanyon Place (formerly Belfast Central) train station. There is (some) wifi service on the trains but no food service. It is better to consume or takeaway food at a train station.

By Bus: There are many buses. For example, bus 212 takes you from Belfast's Europa bus station (besides Belfast Great Victoria Station) to Derry~Londonderry bus station

in about 1.5 hours. There are also buses (Dublin Coach Services https://www.translink.co.uk/usingtranslink/specialoffers/dublincoachwebsaver) straight from Dublin Airport to Derry~Londonderry bus station and back or from Dublin Busáras Bus (https://www.buseireann.ie/) to Derry~Londonderry bus station. This is about 4 hours of journey with a break halfway.

There is also an economic coach (Aircoach https://www.aircoach.ie/) from Dublin Airport straight to Belfast city, near the Belfast Great Victoria train station and Europa bus station (see above).

By Airporter (bus/coach): From the City of Derry airport, Belfast International Airport or George Best Belfast City Airport, a convenient way to travel is to take the Airporter coach (https://airporter.co.uk/).

By taxi:

Ask the taxi driver to stop at The Gatelodge, which is besides the MS building.

Driving from Strand Road / from Quayside roundabout

After turning in from Strand Road, please slow down and take a first turn on the left after the roundabout and after the traffic lights.

Driving from Foyle Bridge:

Pass the Derry City and Strabane District Council, then do a U-turn at a roundabout and slow down and take the first turn on the left right after the traffic lights.

Note: Please obey the COVID regulations when travelling. E.g. please put on a face mask, hand sanitizers or wash your hands regularly.

On campus parking:

To park at the ISRC / MS building (parking space P_5 – see campus map), collect a parking ticket and use an available parking space underneath the MS building.

Go back to the front entrance, please press the disabled door opener and register at the reception someone. Please take a seat and one of our team members will be with you shortly.

There are also other parking spaces. The largest on campus parking space is P_1 facing the neo-gothic-looking MD building.

Off campus parking:

To park outside the campus, nearby parking spaces include the Strand Road Car Park, Quayside Shopping Centre & Car Park, and Foyle Street Car Park. However, for the evening lab sessions, it is advisable to park on campus. For instance, if you happen to park outside campus e.g. due to lack of available on-campus parking space, then during dinner break, for convenience, you may wish to move your car and park on campus when it becomes less crowded.

Intelligent Systems Research Centre & Autumn School

Address of our Research Centre:

Intelligent Systems Research Centre,
School of Computing, Engineering and Intelligent Systems,
Faculty of Computing, Engineering and the Built Environment,
Ulster University,
Magee campus
Northland Road,
BT48 7JL,
Northern Ireland, UK

Note: The Intelligent Systems Research Centre is also the MS building on Magee campus.

COVID-19 – Health and Safety Guidelines

We greatly appreciate those who are attending this event in person, despite the ongoing COVID-19 pandemic.

For those intending to be physically present, the UK, Northern Ireland and Ulster University has several guidelines.

On 12th August, the Northern Ireland Executive announced that all Further Education and Higher Education would resume with face-to-face teaching on campus. See e.g.

- https://www.nidirect.gov.uk/information-and-services/coronavirus-covid-19/staying-safe

Ulster University guidelines e.g.

- https://www.ulster.ac.uk/coronavirus

Within the campus, please remember to follow the directions in placed, use hand sanitizers frequently, and cover your face with a face mask when indoor. If you have symptoms of COVID-19, please self-isolate. Whilst in line with NI Executive guidance, social distancing is no longer required in classrooms and teaching spaces, we do ask that staff and students try to keep their distance when moving around

campus. COVID-19 vaccination is highly encouraged before in-person attendance of the Autumn School.

Sponsors