# NTU DOCTORAL SCHOOL

### NOTTINGHAM TRENT UNIVERSITY 📟

"Creating future innovators and impact for education, industry, the professions and society"

## Nottingham Trent University **Doctoral School** School of Science and Technology PhD Projects – 2016

Broad area of research – Computing and Informatics

### Welcome to the Nottingham Trent University Doctoral School

The Doctoral School provides a supportive environment and a thriving research culture that encourages you to reach your full potential as a research degree student.

#### Valuing ideas, enriching society

We encourage new ideas and new ways of thinking across the whole University through a culture of discovery and innovation. We believe our research has the potential to impact the world we live in and change lives.

#### **Research excellence**

Our research is recognised across the world. In the most recent Research Excellence Framework (Ref 2014) most of our research was considered internationally-excellent or world-leading.

The University is committed to developing and expanding its activity to increase the scope, quality and impact of our research.

#### Be part of our research

With MPhil, PhD and Professional Doctorate research degree opportunities across each of our academic schools, we support students conducting research in a diverse range of areas. Our research students form an important part of our research community and make a significant contribution to our activity.

We offer full-time, part-time and distance learning research degree opportunities.

Our Professional Doctorates offer you the opportunity to contribute to research in your profession while attaining a research qualification.

#### A supportive community

We are committed to supporting and developing our research students.

You will have academic, administrative and personal support throughout your studies and access to dedicated workspace and exceptional facilities.

### Excellent support throughout your studies

The Doctoral School aims to provide excellent personal and practical assistance for our research students creating a supportive and pro-active environment.

#### Support and guidance

Your main source of advice and support will be your own doctoral supervisory team, which will include a director of studies and at least one other supervisor. This team will be selected based on their experience in your chosen area of study or their background in relevant practice.

The Doctoral School Team will be available throughout your studies. Our dedicated team will offer advice and guidance for your initial enquiry and application and introduce you to the University and to your supervisory team.

#### **Outstanding facilities**

As a research student at NTU you will have access to a wealth of facilities and resources to aid and enhance your studies. The University is committed to providing the best possible facilities for all its students and we are constantly investing in new facilities and learning environments.

#### **Dedicated study areas**

All our research students are able to use study and writing areas giving you access to desks, laboratories and IT facilities when you need it.

#### Learning resources

Students at Nottingham Trent University have access to a wealth of library materials including over 480,000 books and 1,300 printed journals, as well as an extensive audio-visual collection of DVDs, videos and slides.

Electronic library resources are an increasingly important part of the support offered to research students, and more than 290 databases and 17,000 eJournals are accessible from any networked PC within NTU, or from your home or off-campus PC.

Our experienced and knowledgeable library staff will help guide you to the most useful sources of information.

### Developing the next generation of researchers

We aim to nurture research talent and help our students thrive through their research degrees and into their future careers.

#### **Researcher Development Programme**

All research students are expected to participate in a rolling programme of professional development. You will have the opportunity to attend a range of workshops and developmental activities mapped to the Vitae Researcher Development Framework (RDF).

Our Research Development Programme empowers you – in discussion with your supervisory team – to create an individualized package of activities to support your career development as a researcher.

A range of core activities will support your journey from enrolment at NTU as a research student, through to final submission of your thesis. These activities will be complemented by a series of electives that you will choose to pursue, depending upon your developmental needs as you progress in your research work.

#### **Developing your career**

We pride ourselves on equipping our students with knowledge and skills and encouraging initiative, innovation and excellence.

Our research students are encouraged to take part in conferences, seminars and external networks. These are an excellent opportunity for you to share your work, meet other researchers and build a network of contacts.

Our own research conferences and seminars offer you the opportunity to present and discuss your work among the NTU research community.

You may also have the opportunity to teach undergraduate students or supervise laboratory work.

### School of Science and Technology

Research in the School of Science and Technology is rich and diverse, with staff conducting internationally recognised and world-leading research. Research is clustered in Research Centres and units, providing a focus for different themes with their underpinning platforms:

#### Biomedical Sciences and the John Van Geest Cancer Research Centre

Internationally excellent research environment – Our Biomedical Research is worldleading and involves staff with broad academic backgrounds, including Biochemistry, Bioinformatics and Biomathematics, Analytical/Synthetic Medicinal Chemistry, Immunology, Microbiology and Pharmacology. In the recent REF2014 assessment (<u>http://www.ref.ac.uk/</u>) of University research quality the Biomedical Sciences Research Unit's submission (to UoA A03) was highly rated, having 86% of overall activity at the highest 3\* (internationally excellent) and 4\* (world-leading) grades. This included achieving 100% of its impact at 3\* and 4\* levels.

#### Materials and Engineering

Internationally excellent research environment – Our multidisciplinary Materials and Engineering Research is extremely strong in terms of high quality outputs, income generation, and international impact. In the recent REF2014 assessment of University research quality our Materials and Engineering Unit's submission (to UoA B15) was highly rated, having 84% of overall activity at the highest 3\* (internationally excellent) and 4\* (world-leading) grades. This included achieving a joint 7th rank out of 62 submitted UK institutions for the quality of our publications, which were judged as attaining 94.6% at 3\* and 4\* levels.

#### Computing and Informatics

Internationally excellent research impact- The multi-disciplinary research is directed to address important questions and is clustered under three themes: <u>Interactive Systems</u> for cognitive and physical rehabilitation and mental wellbeing; <u>Computational</u> <u>Intelligence and Applications</u> for computationally intelligent methods and techniques; and <u>Intelligent simulation</u>, <u>modelling and networking</u>. In the recent REF2014 assessment of University research quality the Computing and Informatics Research Unit's submission (to UoA B11) was highly rated achieving 80% of its impact at 4\* and 3\* levels.

#### • Sport, Health and Performance Enhancement (SHAPE) Research Centre

Internationally excellent research outputs- In the recent REF2014 assessment (http://www.ref.ac.uk/) of University research quality the Sport Sciences Research Unit's submission (to UoA C26) was highly rated, having 94% of the outputs rated at the 3\* (internationally excellent) and 2\* (internationally recognised) grades. Our Sports Science research is multi-disciplinary and is clustered under a number of themes, driven by the Musculoskeletal Physiology, Sports Performance, Exercise and Health and Sport in Society Research Groups.

#### **Research themes and areas**

These research units promote the research excellence and facilities within the School, and stimulate knowledge transfer, innovation and exploitation. They provide strategic direction in research planning and portfolio development, and ensure that mechanisms are in place to nurture research.

List of available projects and a summary description of them are provided in the following research categories.

- Biomedical Sciences and the John Van Geest Cancer Research Centre
- <u>Computing and Informatics</u>
- Materials and Engineering
- Sport, Health and Performance Enhancement Research Centre

Or they can be searched based on the following academic Departments.

- Biomedical and Biological Sciences
- <u>Chemistry and Forensic Sciences</u>
- <u>Computing and Technology</u>
- <u>Physics and Mathematics, and</u>
- Sport Science

#### Project Titles (descriptions below)

- 1. Dr. Tony Allen Hardware accelerator for On-device voice verification and speech recognition
- 2. Dr. Tony Allen Large vocabulary on-device speech recognition
- 3. Dr. Tony Allen Multi-lingual speech recognition using evolved Echo State networks
- 4. Dr. Georgina Cosma The Development of Novel Predictive Modelling Algorithms for the Early Diagnosis of Lung Cancer
- 5. Dr. Amjad Fayoumi Context Aware Process Modelling: Developing intelligent processes for ubiquitous technology
- 6. Dr. Amjad Fayoumi Enhancing business and IT services with big data analysis and visualization
- 7. Dr. Amjad Fayoumi Enterprise Modelling and Simulation: architecture and tool for future applications
- 8. Dr. Amjad Fayoumi Transformation Processes for Complex Sociotechnical System`s Evolution
- 9. Dr. Amjad Fayoumi Using model driven development for implementing multi-agent systems
- 10.Dr. Joanna Hartley Stochastic shortest path algorithms for travel planning in an urban environment
- 11.Dr. Eiman Kanjo A framework for open urban data analysis and visualization
- 12.Dr. Eiman Kanjo Tangible Affective Interfaces for Children with special Need
- 13.Prof. Ahmad Lotfi Application of Computational Intelligence into Diagnosis of Dementia from Analysis of Behaviour
- 14. Prof. Ahmad Lotfi Learning in Human Activity Recognition
- 15. Prof. Ahmad Lotfi Robotics for Healthcare
- 16.Dr. Xiaoqi Ma Ma User Identification and Authentication Across Cloud

### HARDWARE ACCELERATOR FOR ON-DEVICE VOICE VERIFICATION AND SPEECH RECOGNITION

Previous research has demonstrated that real-time on-device voice verification and speech recognition is possible using novel neural network solutions. However, these software solutions do place a very large computational overhead onto the mobile device. Consequently, embedded or pluggable/wireless hardware devices capable of independently performing the voice verification and speech recognition processing are desirable.

This project aims to investigate the suitability of existing and novel hardware acceleration techniques for ease of integration with commercial-off-the-shelf (COTS) mobile devices. The hardware accelerator should be capable of performing accurate voice verification and speech recognition processing, in real-time, and provide the result back to the connected mobile device either by wired or wireless connectivity.

#### References

- M. K. Mustafa, Tony Allen and Kofi Appiah (2015). A novel K-means Voice Activity Detection Algorithm using Linear Cross Correlation on the Standard Deviation of Linear Predictive Coding. 35th SGAI International Conference (AI-2015), Cambridge, UK, December 2015.
- M.K. Mustafa, Tony Allen and Lindsay Evett (2014). A Review of Voice Activity Detection Techniques for On-device Isolated Digit Recognition on Mobile Devices. 34th SGAI International Conference (AI-2014), Cambridge, UK, December 2014.

#### Supervisors: Dr. Tony Allen

#### Supervisor biogs

Dr. Allen is a Reader in the School of Science and Technology at NTU and a member of the Computational Intelligence and Applications Research Group. He has an international reputation for research excellence in speech-enabled and voice biometric systems and has successfully supervised 11 PhD candidates to completion. During a 17 year research career, Dr Allen has been influential in the development of several neural network based speech recognition and speaker verification techniques and he is the stated inventor on an International voice biometric patent. Recent journal publications include:

- Tashan, Allen, Nolle (2014), Speaker verification inspired by the physiology of hearing using spiking self-organising map. Expert Systems
- Tashan, Allen, Nolle (2013), Speaker verification using heterogeneous neural network architecture with linear correlation speech activity detection. Expert Systems
- Grau, Allen, Sherkat (2009), Silog: Speech input logon, Knowledge-Based Systems

#### **Entry requirements**

In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **Computer Science**.

**Contact details:** <u>tony.allen@ntu.ac.uk</u> for informal discussions.

### Large Vocabulary On-Device Speech Recognition

Unlike current implementations of mobile speech recognition systems (SIRI, Goole Play etc.), On-device speech recognition is performed completely on the mobile device without any connection to a remote server.

Previous research projects have developed novel voice activity detection and Dynamic Neural Network based word recognition algorithms that minimise the processing time overheads associated with on-device speech recognition whilst maintaining a high recognition accuracy.

This project aims to extend this work by investigating novel neural network techniques for performing large vocabulary speech recognition on a mobile device. Possible techniques include Deep Belief Networks, Echo Sate Networks & other Recurrent Networks, Support Vector Machines etc.

#### References

- M. K. Mustafa, T. Allen, and L. Evett, A Review of Voice Activity Detection Techniques for On-Device Isolated Digit Recognition on Mobile Devices, in M. Bramer, M. Petridis (eds.), Research and Development in Intelligent Systems XXXI, Springer International Publishing, 2014.
- M. K. Mustafa, T. Allen, and K. Appiah. (in press) A novel K-means Voice Activity Detection Algorithm using Linear Cross correlation on the standard deviation of Linear Predictive Coding, in M. Bramer, M. Petridis (eds.), Research and Development in Intelligent Systems XXXII, Springer International Publishing, 2015.

#### Supervisors: Dr. Tony Allen

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**Contact details:** <u>tony.allen@ntu.ac.uk</u> for informal discussions.

### MULTI-LINGUAL SPEECH RECOGNITION USING EVOLVED ECHO STATE NETWORKS

Echo State Networks have characteristics that make them suitable for consideration as a biologically plausible speech recognition system.

Previous research has developed an ESN based Arabic phoneme recognition system that outperforms other more conventional techniques using the Levatine Arabic Corpus. However, critical to its performance as a speech recognition system is the need to use non-biologically plausible algorithms to initially configure the ESN model such that is displays the required echo state behaviour.

This project aims to extend this system by investigating the use of evolutionary algorithms within the initial ESN model configuration process to produce a generic evolved ESN model that can be subsequently trained as a multi-lingual speech recognition system.

#### References

- Hmad, N. and T. Allen (2013). Echo State Networks for Arabic phoneme classification and recognition. The XXXIV. International Conference on Machine Learning and Pattern Recognition. World Academy of Science, Engineering and Technology. London, UK.
- N Hmad, T Allen "Biologically inspired continuous Arabic speech recognition". Research and Development in Intelligent Systems XXIX. M. Bramer and M. Petridis, Springer London.

#### Supervisor: Dr. Tony Allen

#### Supervisor biogs

Dr. Allen is a Reader in the School of Science and Technology at NTU and a member of the Computational Intelligence and Applications Research Group. He has an international reputation for research excellence in speech-enabled and voice biometric systems and has successfully supervised 11 PhD candidates to completion. During a 17 year research career, Dr Allen has been influential in the development of several neural network based speech recognition and speaker verification techniques and he is the stated inventor on an International voice biometric patent. Recent journal publications include:

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- Tashan, Allen, Nolle (2013), Speaker verification using heterogeneous neural network architecture with linear correlation speech activity detection. Expert Systems
- Grau, Allen, Sherkat (2009), Silog: Speech input logon, Knowledge-Based Systems

#### **Entry Requirements**

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**Contact details:** <u>tony.allen@ntu.ac.uk</u> for informal discussions.

### THE DEVELOPMENT OF NOVEL PREDICTIVE MODELLING ALGORITHMS FOR THE EARLY DIAGNOSIS OF LUNG CANCER

Lung cancer is the second most common cancer diagnosed in the UK. In particular, around 43,500 people were diagnosed with lung cancer in the UK in 2011, which accounts for approximately 120 people every day. Lung cancer has one of the lowest survival outcomes of any cancer because around 50 percent of patients are diagnosed at a late stage when curative treatment is not possible. When diagnosed at its earliest stage, around 73% of patients with non-small cell lung cancer and around 56% of patients with small cell lung cancer will survive their disease for at least one year after diagnosis (source: CRUK).

The proposed research aims to address the health need of detecting lung cancers at an earlier stage in order to offer curative treatment to as many of these patients as possible.

The project mainly involves the development of novel cancer prediction models using computational intelligence algorithms. These approaches are efficient in solving problems which require reasoning and decision-making, and which traditional statistical models often fail to handle. They have been specially developed for dealing with the uncertainty and imprecision which is typically found in clinical data.

The derived prediction algorithms which will be embedded in on-line web applications which physicians can access online for performing cancer predictive modelling tasks. The data obtained from the physicians will be stored in a 'big data' repository and will be used to improve the predictive accuracy and decision making. Data science techniques will be used for the analysis, interpretation and visualisation of this high-dimensional data used for making other healthcare related predictions.

#### References

- Balachandran, K.; Anitha, R., Ensemble based optimal classification model for pre-diagnosis of lung cancer, Computing, Communications and Networking Technologies (ICCCNT),2013 Fourth International Conference on , vol., no., pp.1,7, 4-6 July 2013
- Diaz, J.M.; Pinon, R.C.; Solano, G., Lung cancer classification using genetic algorithm to optimize prediction models, Information, Intelligence, Systems and Applications, IISA 2014, The 5th International Conference on , vol., no., pp.1,6, 7-9 July 2014
- Iyen-Omofoman B, Tata LJ, Baldwin DR, Smith JPS, Hubbard R, Using sociodemographic and early clinical features in general practice to identify people with lung cancer earlier, Thorax 2013, 68:451-459).

Supervisors: Dr. Georgina Cosma and Professor David Brown

#### Supervisor biogs

Dr Georgina Cosma: is a data scientist with expertise in predictive modelling using statistical, machine learning and computational intelligence approaches. Georgina has

designed and developed models for predicting prostate cancer, and also developed models for sentiment analysis tasks involving multidimensional data. Dr Cosma has experience is supervising students undertaking projects in data science, and cancer predictive modelling projects.

Professor David Brown, leader of the Interactive Systems Research Group, whose expertise is in the area of developing applications for health and social inclusion aimed at improving patient benefit. Examples include serious games applications for prostate cancer, rehabilitation, and the co-design of technology for improved mental health outcomes. Professor Brown has experience is supervising students undertaking projects in the development of novel applications and technologies for healthcare.

#### **Entry Requirements**

In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **Computer** science, computational intelligence, machine learning, data science, statistics and optimization, operational research.

**Contact:** <u>georgina.cosma@ntu.ac.uk</u> for informal discussions.

### CONTEXT AWARE PROCESS MODELLING: DEVELOPING INTELLIGENT PROCESSES FOR UBIQUITOUS TECHNOLOGY

In a global business network, the critical success factors of implementing ubiquitous technology lies in the socio-technical aspects of this network. the aim of integrating business network stakeholders' needs within a platform have faced many challenges. Some of these challenges are embedded in the social and business side of the enterprise where other challenges are actually driven by the way of thinking about how technology should be implemented (single platform rather than ubiquitous). Moving logistics and supply chain activities towards the ubiquitous form requires re-engineering the processes and re-thinking the business models; potentially innovating the business models while taking into account the social context and requirements.

This research will use the socially informed design approach. A good level of understanding of social modelling and requirement engineering methods, and design approaches is a great advantage to tackle the research activities. The design stage will focus on the conceptual approaches in addition to the logical formulations of the designed models, and then later, this will be integrated into all the models within the developed information system`s solution.

#### Supervisors: Dr. Amjad Fayoumi

#### Supervisor biogs

Dr Fayoumi is a Lecturer in IT management within the Computing and Technology team. He is researching in the information systems area focusing on enterprise modelling and simulation.

Dr Fayoumi was awarded his PhD in the information systems area from Loughborough University, his thesis focusing on the use of enterprise modelling and simulation for analysing and designing business strategy and operation.

Prior to his joining NTU, Dr Fayoumi worked as a researcher for the University of Nottingham and Loughborough University, and also taught at the Nottingham Trent International College (NTIC) at both foundation and diploma levels. Dr Fayoumi also has two years' industrial experience, particularly in ICT consultancy.

#### **Entry Requirements**

In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **Computer Science, software engineering, information systems or relevant area.** 

The applicant must have:

- Programming and software design skills
- Understanding of information capturing, decision making and requirements engineering
- Excellent communication and interpersonal skills.

Experience in one of the following areas also desired but not must:

- Experience in business process modelling and notation (BPMN)
- Experience in ontology modelling and development using tools such as Protégé
- Understanding of linear algebra and non-linear mathematical models
- Understanding of enterprise information systems environment
- Understanding of semantic technology and knowledge-based systems

**Contact:** <u>amjad.fayoumi@ntu.ac.uk</u> for informal discussions.

### ENHANCING BUSINESS AND IT SERVICES WITH BIG DATA ANALYSIS AND VISUALIZATION

Due to the extraordinary use of IT services as a result of the enormous engagement between people and machines in personal, social and professional levels and for different purposes. Business professional have realised that the data generated can be useful to understand some aspects of either the business, the product or the users themselves. In return the availability of the current IT paradigms such as Cloud computing and internet of things (IoTs) allowed for growth of the 'big data'; one of the extremely important values of the cloud is the potentiality of extracting knowledge from big data and feed this knowledge back into business processes, strategic planning, service design and IT development.

#### Supervisor: Dr Amjad Fayoumi

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The applicant must have:

- Familiar on "how to use database and knowledge-base systems.
- Java or C++
- Understanding of various analytics functions (over, impact, median, rank, etc.) and how to use them on various data sets
- Understanding of Big Data and large data sets aggregation, analysis and visualization.
- Understanding of data processing, analysis and optimization
- Understanding of machine learning, logs analysis and data mining algorithms (Mahout, Bayesian, Clustering, process mining, etc.)
- Correlation, Statistics, Predictive analytics and Data mining
- Understanding future prediction based on probability, dynamics and correlation

**Contact:** <u>amjad.fayoumi@ntu.ac.uk</u> for informal discussions.

### ENTERPRISE MODELLING AND SIMULATION: ARCHITECTURE AND TOOL FOR FUTURE APPLICATIONS

Enterprise modelling is a research area that rooted to 3 decades ago focuses on developing methods and applications for capturing, analysing and formalizing enterprise holistic knowledge. Such as captured knowledge will help to make-decisions about how enterprises should be designed and operated (for both business and technology).

Several modelling platforms were developed to support the development of enterprise modelling and simulation such as Eclipse Modeling Framework (EMF) and The ADOxx Metamodelling Platform. Enterprise modelling tools and notations can be designed and developed and deployed using such as platforms. the goal is to develop domain-specific modelling tools to fulfil particular enterprise needs using hybrid modelling perspectives of goals, processes, rules, organizations, actors, capabilities, resources, services, objects and technology.

The application can focus on specific industry, enterprise, public institute, smart cities, cyber-physical systems or complex systems

I am looking for research student with strong software engineering background. In particular, the student should have good knowledge in logical formulation and/or modeldriven engineering. experience in enterprise architecture, simulation and data analytic is desirable.

#### References

- Towards a Unified Meta-Model for Goal Oriented Modelling. Fayoumi A, Kavakli E and Loucopoulos P, Proceedings of the European, Mediterranean & Middle Eastern Conference on Information Systems (EMCIS 15), 2015, Athens, Greece
- Business Rules, Constraints and Simulation for Enterprise Governance. Fayoumi A and Loucopoulos P, Enterprise and Organizational Modeling and Simulation -10th International Workshop, EOMAS 2014, held at CAiSE 2014, Thessaloniki, Greece, selected Papers, 2014, 96-112
- Using Architecture Patterns to Architect and Analyze Systems of Systems. Kalawsky RS, Joannou D, Tian Y, Fayoumi A, Procedia Computer Science, 2013, 16, 283-292
- Hybrid Enterprise Modelling: Integrating Modelling Mechanisms for Socio-Technical Systems Analysis and Design. Fayoumi A, Loucopulos P and Ayham F, Journal of Software Engineering and Applications, 2013, 7, 6

#### Supervisors: Dr. Amjad Fayoumi

#### Supervisor biogs

Dr Fayoumi is a Lecturer in IT management within the Computing and Technology team. He is researching in the information systems area focusing on enterprise modelling and simulation. Dr Fayoumi was awarded his PhD in the information systems area from Loughborough University, his thesis focusing on the use of enterprise modelling and simulation for analysing and designing business strategy and operation.

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#### Entry requirements

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**Contact:** <u>amjad.fayoumi@ntu.ac.uk</u> for informal discussions.

### TRANSFORMATION PROCESSES FOR COMPLEX SOCIOTECHNICAL SYSTEM<sup>°</sup> S EVOLUTION

Nowadays, in the 21st century; almost all of the systems are heterogeneous, interconnected, and distributed. Systems are heterogeneous because they are composite of social, technical, informational, situational, or environmental systems. They are interconnected because they are tightly dependent on each other's operation, endurance, and evolution. Complex systems is a research failed that considers complexity theory to view the relation and behaviour of different interrelated systems. mainly here we focus on what is called socio-technical systems, and to understand this efficiently the analysis need to move toward non-linear computational formalisms. modelling of heterogeneous agent behaviour rather than the homogeneous agent behaviour is one of the key important elements to understand complex systems. From these models, they study how supra-agent structures are created (from micro to macro) emphasising the role of heterogeneous agents in the social order creation processes.

Complexity theory were widely adopted by other areas such as computer science, business and economics, organisational science, system engineering, and information systems. The new literatures of socio-technical systems` analysis and design argue that the deployment process is long and passive in handling the complex and rapid changes in organisational and technical requirements. Therefore, this process needs modernising to fit into the new advanced technical and business structures to facilitate its complexity and understand the changing nature of the new socio-technical environment in the information era. The proposal suggests the use of complexity theory principles to represent a framework to understand the requirements needed in handling modern and complex socio-technical systems.

#### References

• Fayoumi A. (2014) Enterprise Modelling Framework for Dynamic and Complex Business Environment: Socio-technical Systems Perspective. PhD thesis, Loughborough University.

#### Supervisors: Dr. Amjad Fayoumi

#### Supervisor biogs

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**Contact:** <u>amjad.fayoumi@ntu.ac.uk</u> for informal discussions.

### USING MODEL DRIVEN DEVELOPMENT FOR IMPLEMENTING MULTI-AGENT SYSTEMS

The continuous development of IT applications pushed the boundaries of software application development to become more in an abstract level. Many recent initiatives to address were in place to address this issue, such as development of model-driven development and the use of domain specific modelling notations.

The project focus on developing multi-agent systems interactions rules using modelling specifications called the semantic of business vocabulary and business rules (SBVR). The SBVR was initially developed to address a) business vocabulary b)business rules, policies and regulations. Our aim is to extend the use of the SBVR specification to write executable rules for agents interactions.

The candidate should have strong object oriented programming skills, good understanding of model-driven development, model transformation languages and model driven architecture (MDA), a good level of understanding of languages parsers, Multiagent Systems (MAS) such as JADE or JACK will be beneficial.

Supervisors: Dr. Amjad Fayoumi

#### Supervisor biogs

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**Contact:** <u>amjad.fayoumi@ntu.ac.uk</u> for informal discussions.

### STOCHASTIC SHORTEST PATH ALGORITHMS FOR TRAVEL PLANNING IN AN URBAN ENVIRONMENT

This research project is in the area of simulation and mathematical modelling of real world systems, in particular traffic/travel networks (Hartley, 2007). This project includes the development of efficient stochastic time-dependent shortest path algorithms for private transport (Polenta and Hartley, 2003) or scheduled public transport (Alhoula and Hartley, 2014; Wu et al., 2005a; Wu et al., 2005b). The project may build on some of the research carried out as part of the EU programme: Models for Optimising Dynamic Mobility (MODUM) that considers commuters using multi-modal transport who are faced with ever-changing conditions (caused by incidents, roadworks and congestion).

Previous research has included user preferences being considered for public transport travel (Wu and Hartley, 2004a; Wu and Hartley, 2004b). As part of this project, user preferences and driver behaviour may be incorporated as an integral part of the decision process in generating individual optimal routes for users of private transport. Another necessary feature is the improved prediction of future travel times on urban links (Hartley, 2003a; Hartley, 2003b).

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#### Supervisors: Dr. Joanna Hartley

#### Supervisor biogs

Dr Joanna Hartley has supervised 3 PhD projects (one as Director of Studies) and 1 MPhil project as Director of Studies, and is currently supervising another PhD project as Director of Studies.

Recent major grant and projects:

- 2011–2013: EU Seventh Framework Programme (£405000) Models for Optimising Dynamic Urban Mobility (MODUM)
- 2002-2006: Accommodating User Preferences in the Optimisation of Public Transport Travel (MPhil)

• 2000-2005: Incorporating Uncertainty in Real-Time Route Guidance Systems (PhD)

This project involved the development of stochastic time-dependent least time path (STDLTP) algorithms for use by a suitable real-time in-vehicle Route Guidance System (RGS). The algorithms were based upon different optimization criteria, which accommodate different levels of uncertainty associated with a path's traversal times. In parallel, several efficient heuristic STDLTP algorithms, based upon the chosen optimization criteria, were also developed.

#### **Entry requirements**

In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **computer science or mathematics.** 

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### A FRAMEWORK FOR OPEN URBAN DATA ANALYSIS AND VISUALIZATION

Big Data promises a better world where data will be used to make better decisions, from how we invest money to how we manage our healthcare to how we educate our children and manage our cities and resources. These changes are enabled by a proliferation of new technologies and tools that have the ability to measure, monitor, record, combine and query all kinds of data about us and the world around us.

This project will be focused on developing a framework for data analysis and visualization in order to come up with tools to analyze and visualize open urban data from various sources, such as traffic, health, finance and education, and combine multiple data sets including social media, live sensor data feed, pollution, events data and weather data. This framework will help citizens and policy makers to explore datasets related to their city in effective and intuitive fashion which will lead to better decision. The new development will help to provide new insights into how the city works and an opportunity to drive innovation.

#### References

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#### Supervisors: Dr. Eiman Kanjo

#### Supervisor biogs

Eiman Kanjo Ph.D. was an Associate Professor at the Department of Information systems, College of Computer and Information Sciences at King Saud University.

Also she worked for many years at the Computer Laboratory, University of Cambridge.

Eiman worked at the MRL (Mixed Reality Lab), Computer Science, University of Nottingham in the area of Pervasive Computing, location based games and mobile development.

She has also worked as a researcher and developer in ICCAVE (the International Centre for Computer Games and Virtual Entertainment, University of Abertay Dundee carrying out research work in the - Interactive Toys and board Games project - which is

sponsored by the Scottish Enterprise under the Proof of Concept Program. Eiman wrote many journal and conference papers and holds the patent Object Tracking System.

#### **Entry requirements**

In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **computing or related discipline**.

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### TANGIBLE AFFECTIVE INTERFACES FOR CHILDREN WITH SPECIAL NEED

There is a growing demand for designing innovative interactive technologies for people with special need. These technologies could be a unique platform for learning or affective interfaces to allow users to express their emotions. Also, these type of interfaces need to offer tangible and affordable mode of full participation, both as children in school and later on as adults, in the public domain. On the other hand, the use of smartphones for such interfaces is gradually increasing, however mobile phones cannot be modified for individuals who find it difficult either holding, touching or interacting with the device.

In this project we will examine the latest development in the field of Human Computer Interaction, in particular tangible user interfaces which offer special need users, new types of interaction opportunities for learning and communication.

Based on the initial study and investigation we will then work closely with users to design and develop various prototypes which can satisfy their needs. Our design will be based on of the shelf technologies including NFC tagging, accelerometers, and touch sensors. And Internet of Things in general. In order to come up with a novel interaction mode, to build our tools.

#### References

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#### Supervisors: Dr. Eiman Kanjo

#### Supervisor biogs

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**Contact:** <u>eiman.kanjo@ntu.ac.uk</u> for informal discussions.

### APPLICATION OF COMPUTATIONAL INTELLIGENCE INTO DIAGNOSIS OF DEMENTIA FROM ANALYSIS OF BEHAVIOUR

The project aims to investigate means of identifying dementia in its early stages using quantitative sensor data gathered from the home environment and wearable sensors. The former will provide data on movement within the home and the latter will provide gait information. The data collected, which indicates the behavioural/motion patterns, will be gathered at intervals over a period of months. This monitoring and data collection will be applied to both a control group and a group of the elderly who have already been given a tentative diagnosis of cognitive impairment. Interviews and standard assessment will be used to assess the information gathered from the sensor data analysis of both groups. This will allow the data to be normalised against the typical variation in a non-cognitive impaired population.

We intent to use detailed multi-factor sensor information to derive a confidence level for the degree of mild cognitive impairment. The project will in particular rely on behavioural/motion patterns, as output of automatic sensing, to supply the medical expert with an evidence-based assessment of the state of the person under observation. The study aims to show that the quantitative information derived from the sensors is sufficient to provide an initial diagnosis. The study will use qualitative assessment to validate the conclusions derived from the quantitative information, so that subsequently clinicians will have confidence that the quantitative data alone is sufficient. In contrast with standard tools, namely DSM5 and ICD10, for early identification and assessment for people with Alzheimer's disease and dementia, qualitative information is not part of the assessment. In this project, more reliable sources of data will be used to measure and quantify the activities. This is motivated by the knowledge that diagnosis of dementia is known to be difficult, particularly in the early stages, where symptoms are mild.

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- Sawsan Mahmoud, Ahmad Lotfi and Caroline Langensiepen, User Activities Outliers Detection; Integration of Statistical and Computational Intelligence Techniques, Computational Intelligence, 2014. doi: 10.1111/coin.12045

#### Supervisors: Prof. Ahmad Lotfi

#### Supervisor biogs

Ahmad Lotfi is a Professor of Computational Intelligence at Nottingham Trent University, where he is leading the research group in Computational Intelligence and Applications

(CIA). He has received external funding from Innovate UK, EU and industrial companies to support his research.

His current research focuses on the identification of progressive changes in behaviour of elderly people suffering from Dementia or any other cognitive impairments. Accurate identification of progressive changes through utilisation of unobtrusive sensor network or robotics platform will enable carers to intervene when deemed necessary. Research collaboration is established with world-leading researchers.

As part of our ongoing research, different techniques in human activity recognition are already investigated. The project supervisory team has extensive knowledge and experience in Ambient Assisted Living environment, machine learning techniques including fuzzy systems and human activity recognition.

#### **Entry requirements**

In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **Computer Science, Software Engineering, Computer Systems Engineering, mathematics or related disciplines.** 

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### 14. LEARNING IN HUMAN ACTIVITY RECOGNITION

The aim of this research is to apply the concept of fuzzy learning to human activity recognition to address the problem of learning and recognising Activities of Daily Living (ADL) in an Ambient Assisted Living environment. ADL is a term used in healthcare to refer to people's daily self-care activities. They are defined as the things we normally do, such as feeding ourselves, bathing, dressing, grooming, work, home making, and leisure.

Standard machine learning approaches including Artificial Neural Networks focus on a need for large training data for models to be developed from the same domain as the target task. This dependency in data could be reduced if tools and concept suitable for handling uncertainty are used. Fuzzy systems uses the concept of fuzzy membership, linguistic variable and conditional rules to represent the degree of uncertainty and this could be utilised to reduce the dependency to numerical data.

Healthcare professionals use a person's ability or inability to perform ADLs as a measurement of their functional status, particularly in regard to people with disabilities and the elderly. Activity recognition aims to identify activities as they occur based on data collected by sensors. Environment sensors such as PIR motion detectors or door entry magnetic sensors are used to gather information about more complex activities such as cooking, sleeping, and eating. These recognised activities are representing the ADL.

Considering the chaotic nature of the human activities, application of Bayesian framework, Hidden Markov Model (HMM) and other statistical techniques are already investigated. Non-statistical techniques including data mining and machine learning algorithms are also being used to model different human activities using a large training dataset.

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- Sawsan Mahmoud, Ahmad Lotfi and Caroline Langensiepen, User Activities Outliers Detection; Integration of Statistical and Computational Intelligence Technique, Computational Intelligence, 2014. doi: 10.1111/coin.12045

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### 15. ROBOTICS FOR HEALTHCARE

There are many applications of robotics in healthcare including robotised patient monitoring systems, robot-assisted cognitive and social therapy and assistive robotics. The health care systems in Europe and the most developed countries in the world are faced with challenging transition processes due to demographic change. The increase of the elderly population and the expectation of life brings about serious risks, with some profound socio and economic impact on our societies. To reduce the burden of social care, integration of existing unobtrusive, easy-to-use and transparent monitoring systems are proven to be an acceptable solution by the elderly and their careers. The ultimate goal of research is to replace the carer with a virtual intelligent carer capable of interpretation and understanding of their activities. This project aims to investigate deployment of empathetic and consciousness-based robotic system for 1) assisting the elderly and humans with learning and physical disabilities in an attempt to improve the level of care they receive and quality of life, and 2) supporting care staff in what can be an incredibly strenuous job

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#### Supervisors: Prof. Ahmad Lotfi

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#### 16. USER IDENTIFICATION AND AUTHENTICATION ACROSS

## CLOUD

Cloud computing provides dramatic benefits to organisations like companies and universities, such as lower cost, higher performance, productivity, reliability and scalability, and easier maintenance, but meanwhile it poses huge challenges to information security, including concerns in confidentiality, integrity and availability. A precondition of solving these security problems is accurately registering every user's identity and strictly verifying it when the user is accessing the system. Therefore, identity management becomes essential to security in cloud computing.

Identity management systems are information systems as well as technologies that are used to implement identity management strategies, policies, procedures and guidelines. A number of practical identity management systems have been proposed and developed, each of them with some drawbacks. A major problem is that it is difficult, if not impossible, to share such identity information on cloud in a secure and trustworthy way.

A new scheme is expected be proposed to securely enroll, register, store and share users' identity information and to create security credentials for them, which can be used across multiple systems in the cloud. It will be used to verify users' pre-registered identities and credentials with users' login information to authenticate them on different systems in the cloud.

#### Supervisors: Dr. Xiaoqi Ma Ma

#### Supervisor biogs

Dr Xiaoqi Ma is a senior lecturer in Computing and Technology at NTU. He has long-time experiences in information security. He holds BSc, MSc and PhD degrees in computer science. His PhD research focused on formal verification of security protocols. During his PhD study, he designed a novel knowledge-based framework to formally and systematically verify the correctness of security protocols. After PhD thesis submission, he moved to University of Oxford to participate in a new project, Generic Infrastructure for Medical Informatics (GIMI), a large-scale collaborative research project concerned with developing a secure IT infrastructure to support medical research, where his research focused on security and protection of medical information. This project helps NHS share medical information among hospitals/medical research centres across the UK in a secure way, conforming to human rights and ethics related laws. He joined NTU as a senior lecturer in Information Security in March 2009.

#### **Entry requirements**

In order to be eligible to apply, you must hold, or expect to obtain, a UK Master's degree (or UK equivalent according to NARIC) with a minimum of a merit, and/or a UK 1st Class/2.1 Bachelor's degree (or UK equivalent according to NARIC) in **Computer Science or related subject**.

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