Beth Jelfs

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My research focusses on adaptive signal processing especially statistical signal processing and signal characterisation. At the core of all my research is the belief that understanding more about the nature of signal generation mechanisms can aid and inform our choice of machine learning algorithms. I have worked on the theoretical foundations of this approach and have applied my work to a wide range of problems particularly with reference to biomedical and neural applications.

Education

PhD Electrical & Electronic Engineering
April 2010
Imperial College London, UK

Thesis: Collaborative Adaptive Filtering for Machine Learning

Awarded Engineering & Physical Sciences Research Council Doctoral Training Award

MEng Electronic & Software Engineering
July 2005
University of Leicester, UK

1st Class Honours

Awarded British Computer Society's prize for best graduating student

Research Experience

Lecturer (Assistant Professor)
March 2021 – Present
Vice-Chancellor's Research Fellow
March 2017 – March 2021
School of Engineering, RMIT University, Australia

My research is on adaptive signal processing algorithms for signal characterisation and machine learning, projects include:
- Development of time-varying delay estimation algorithms;
- Integration of image processing & machine learning for tracking cellular & tissue responses
- Simulation platform for prediction of station-keeping for high-altitude balloons.

Research Fellow
June 2015 – October 2016
Postdoctoral Fellow
August 2013 – May 2015
Dept. Electronic Engineering, City University of Hong Kong, Hong Kong

Coordinated project "Fingers Working in Coordination: Hierarchy of EEG, EMG and Kinematics" funded by the Hong Kong Research Grant Council.
Simultaneously developed a project as part of the Centre for Biosystems, Neuroscience, and Nanotechnology on computational methods for neural synchronization & information transfer.

Postdoctoral Research Associate
Dept. Medical Physics & Bioengineering, University College London, UK
June 2011 – June 2013

Responsible for designing the signal processing aspects of project "Integrating monitoring & modelling for real time tracking of cerebral circulation & metabolism" funded by Wellcome Trust Project Grant.

Postdoctoral Research Assistant
Dept. Chemistry & Dept. Physics, University of Oxford, UK
June 2010 – June 2011

Developed statistical signal processing techniques to study nanopore technology and the accuracy of classification for DNA sequencing.

Select Publications

Self-Recalibrating Surface EMG Pattern Recognition for Neuroprosthesis Control Based on Convolutional Neural Network
X. Zhai, **B. Jelfs**, R.H.M. Chan and C. Tin
Frontiers in Neuroscience
2017, vol. 11, no. 379.

While electromyography provides a valuable tool for classification of hand movements, slow training or the need to retrain are major limitations in the uptake and continued use of powered upper limb prosthetics. This paper proposed a method for recalibrating a classifier which reduces the need for lengthy training. By using the spectrogram of short segments of data we are able to provide reliable features and recalibrating using data from the previous session improves the classification performance while keeping the time delays below what is considered acceptable by users.

Impairment of Cognitive Function by Chemotherapy: Association with the Disruption of Phase-Locking and Synchronization in Anterior Cingulate Cortex
L. Mu, J. Wang, B. Cao, **B. Jelfs**, R.H.M. Chan, X. Xu *et al.*
Molecular Brain
2015, vol. 8, no. 32 pp. 200–210.

This paper was produced as part of a collaboration with neuroscientists to investigate novel methods to analyse the relationship between neural spiking and local field potentials (LFP) in electrophysiology data and highlights how computational techniques can aid our understanding of neurology. The study was the first to investigate the synaptic plasticity associated with a model of chemotherapy known to produce emotional and cognitive deficits, showing the phase locking of neural spiking was disrupted and the LFP between regions of the brain were desynchronized.

Modelling Noninvasively Measured Cerebral Signals During a Hypoxemia Challenge: Steps Towards Individualised Modelling
B. Jelfs, M. Banaji, I. Tachtsidis, C.E. Cooper and C.E. Elwell
PLoS One
2012, vol. 7, no. 6:e38297.

This paper shows how mathematical modelling can be used to interpret physiological data. Key to this is how differences between data and model can raise questions regarding physiology and the reliability and meaning of signals. We show that optimisation, informed by discussion with clinical collaborators, can be used to increase the predictive power of the model. This also allows us to identify discrepancies between the model and the data and determine the parameters of most clinical significance.

An Adaptive Approach for the Identification of Improper Complex Signals
B. Jelfs, D. Mandic and S. Douglas
Signal Processing
2012, vol. 92, no. 2, pp. 335–344.

Complex data occurs in a wide range of real-world situations and understanding the nature of this data allows us to select appropriate modelling/machine learning techniques. Despite this many methods are block-based or suitable only for off-line processing. To overcome this limitation an adaptive method for identification of improper complex signals in real-time is presented. As part of this study an overview of second order noncircularity (improperness) and widely linear autoregressive modelling is provided which highlights the need for the use of the full second order statistics.

An Augmented Echo State Network for Nonlinear Adaptive Filtering of Complex Valued Real World Signals
Y. Xia, **B. Jelfs**, M. Van Hulle, J. Principe and D. Mandic
IEEE Transactions on Neural Networks
2011, vol. 22, no. 1, pp. 74–83.

This paper presents an echo state network (ESN) for nonlinear adaptive filtering of the generality of complex-valued signals produced as part of the EU FP6 Neuroprobes project. The echo state architecture reduces the complexity of standard recurrent neural networks, augmented complex statistics allow the ESN to deal with a wide range of complex data and the introduction of a nonlinear output layer prevents slow convergence. This results in a framework with the ability to deal with data with large dynamics and process bivariate signals with strong component correlations.

Grants & Awards

Ideation Challenge
SmartSat Cooperative Research Centre
2020

Goal: Development of a vision based attitude estimation system for high altitude platforms.
Role: Successfully lead a project to rapidly conceive and produce a minimum viable product. This has been invited to be developed into a more complete system in a subsequent project.

Project for the Defence Artificial Intelligence Centre
Trusted Autonomous Systems Defence Cooperative Research Centre
2020-2021

Goal: Performance assessment for a self-organising low-cost, high altitude balloon constellation for persistent surveillance and communications.
Role: Development of a simulation platform to allow assessment of performance based on real and simulated data.

Maxwell Eagle Endowment Award
RMIT University
2020

Goal: Using machine-based learning to develop prognostics of CAR T cell outcomes in older patients.
Role: Developing image processing and predictive machine learning algorithms.

Capability Development Fund
RMIT University
2019

Goal: High throughput platform for tracking cellular response.
Role: Creating efficient image processing algorithms for development of high volume machine learning architecture.

Global Connections Fund Bridging Grant
Australian Academy of Technology Sciences and Engineering
2017–2018

Goal: Development of a wireless portable device to monitor muscle fatigue in collaboration with PLUX Wireless Biosignals a Portuguese SME.
Role: Successfully designed new algorithms to assess muscle status in real time.

Scheme for Teaching and Learning Research
RMIT University
2017

Goal: Developing the framework for problem based learning workshop style education.
Role: Design of framework.

Vice-Chancellor's Research Fellowship
RMIT University
2017–2021

Goal: To investigate the use of time-varying algorithms in the assessment of biomedical data for machine learning applications.
Role: Sole investigator, project design, management and dissemination of results.

Research Exchange Project
BayChina
2015

Collaboration with Neuroscientific Theory Group at TU München.

Best Student Paper Award
International Symposium on Neural Networks
2010

For paper "Modelling of Brain Consciousness based on Collaborative Adaptive Filters".

Academic Research Collaboration Project
British Council and DAAD
2008

Collaboration with TU München and the Max-Planck-Institute for Dynamics and Self-Organization.

International Travel Grant
Royal Academy of Engineering
2007

Awarded to attend IEEE International Conference on Acoustics Speech and Signal Processing.

Teaching Experience

Lecturer, Computer and Network Security
RMIT University
2021

Delivery & redesign of teaching materials for the computer security aspects of a technical elective for 4th year undergraduate and taught masters with ~50 students.

Tutor, Engineering Computing
RMIT University
2021

Delivering C++ tutorials as part of a core 2nd year undergraduate engineering course with ~200 students.

Lecturer, Signals & Systems 1
RMIT University
2019–2020

Offshore course taught at School for Higher and Professional Education, Vocational Training Council, Hong Kong.

Course Coordinator, Biomedical Signal Analysis
RMIT University
2018–2021

Design and delivery of a core 3rd year undergraduate course in biomedical engineering and technical elective for electronic engineering with ~50 students.

Guest Lecturer, Brain Machine Interface: Technology, Culture, and Society
City University of Hong Kong
2014–2015

Lecturing on BMI Technology & Neural Computation for a university elective with ~200 students.

International Transition Team Graduate Teaching Assistant
City University of Hong Kong
2013–2015

Providing English language support including student tutorials, proofreading of academic papers & preparation of teaching materials.

Tutor, Communications I
Imperial College London
2006–2008

Teaching study groups of ~30 students for a core 1st year undergraduate course in electronic engineering.

Service to Field

Associate Editor
Encyclopedia BRAIN
2021

Responsible for sourcing and reviewing content on signal & image processing

Steering Committee Member
SmartSat Cooperative Research Centre
2020–Present

AI4Space Research Network: to progress research and development in AI applied to space systems and technologies.

Special Session Organiser
APSIPA Annual Summit & Conference
2020

Multidimensional Biomedical Signal and Image Processing.

Special Session Organiser
APSIPA Annual Summit & Conference
2018

Emerging Technologies for Healthcare.

Vice-Chancellor's Fellows Advisory Group
RMIT University
2017–Present

Liasing with Research & Innovation Office to provide improved procedures for fellows.
Organising events to promote the fellows' research and collaboration between fellows.

Organising committee
"enGENEious" conference, Oxford, UK
2012

Student & Post-doc lead conference on microbial engineering.

Public Engagement & Invited Talks

Engaging for Impact
RMIT University, Australia
2020

Talk on Tissue Image Processing for Innovation in Healthcare with Precision Medicine session.

Biomedical Engineering Dept.
Shantou University, China
2019

Invited lecture series on biomedical signal processing.

Bioinformatics Network Symposium
RMIT University, Australia
2019

Talk on Machine Learning for High Throughput Cell Imaging.

Pint of Science
London, UK
2013

Event manager for science festival for the general public.

UCL Outreach
University College London, UK
2011–2013

Lead demonstrations and talks with school children for events including:
- Medical Physics Masterclass;
- Women in Engineering Taster Day;
- University Challenge Event.

Doctoral Training Centre
University of Oxford, UK
2011

Talk on DNA Nanopore Sequencing.

Faculty of Computer Science
University of Applied Sciences
Schmalkalden, Germany
2008

Talk on Signal Modality Characterisation Using Collaborative Adaptive Filters.

Professional Associations

Asia-Pacific Signal & Information Processing Association (APSIPA)
2018–present

Member
- Member Biomedical Signal Processing & Systems Technical Committee

Institute of Electrical and Electronics Engineers
2006–present

Member
- Affiliate member of Bio Imaging and Signal Processing Technical Committee
- Member of Signal Processing Society
- Member of Engineering in Medicine and Biology Society