

Beth Jelfs

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
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.

- This paper aims to address some of the limitations of powered upper limb prosthetics;
- Slow training or the need to retrain is a big issue, hence, this paper proposes a method for recalibrating a classifier reducing the need for lengthy training;
- Reliable features from the EMG data are provided using the spectrogram of short segments of data while keeping any time delay to 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 highlights how computational techniques can provide both assessment of biological data and also aid our understanding of neurology;
- Part of a collaboration with biologists to investigate novel methods to analyse the relationship between neural spiking and local field potentials (LFP) in electrophysiology data;
- The relationship between the LFP in different regions of the brain was studied to provide insight on how they interact.

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;
- Optimisation was informed by discussion with clinical collaborators in order to 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;
- This paper presents an adaptive method for identification of improper complex signals in real time;
- To highlight the need for the full second order statistics an overview of second order noncircularity (improperness) and widely linear autoregressive modelling is provided.

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.

- By adapting to the nature of the data, the echo state network architecture presented in this paper can deal with a wide range of complex data;
- The architecture presented in this paper was produced while working at KU Leuven as part of the FP6 Neuroprobes project;
- One major advantage of this method is 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

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 2018–2020	Design and delivery of a core 3rd year undergraduate course in biomedical engineering and technical elective for electronic engineering with ~40 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

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.
Topic Editor Entropy 2020–Present	Leading special issues, suggesting new topics, and recommending Guest Editors for these new topics; supervising the editorial process.
Special Session Organiser APSIPA Annual Summit & Conference, Auckland, New Zealand 2020	Multidimensional Biomedical Signal and Image Processing.
Special Session Organiser APSIPA Annual Summit & Conference, Honolulu, USA 2018	Emerging Technologies for Healthcare.
Vice-Chancellor's Fellows Advisory Group RMIT University 2017–Present	<p>Liasing with Research & Innovation Office to provide improved procedures for fellows.</p> <p>Organising events to promote the fellows' research and collaboration between fellows.</p>

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