Liam Brannigan

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I am a highly motivated self-starter with experience of developing simple models to describe complex phenomena. I use methods that range from machine learning to digital signal processing to mathematical solutions of partial differential equations. I enjoy telling the stories represented by these models using state-of-the-art visualisation techniques. My experience encompasses both financial consulting and research in physical oceanography.

Data Analysis Experience

Data gathering: Identifying data sources and building collaborations to access data from closed sources. Compressing and transferring multi-terabyte datasets.

Data cleaning: Creating suitable file architecture. Incorporating metadata and handling missing values. Developing reproducible workflow in Python for processing raw data. Converting from .csv to binary formats where necessary.

Data exploration: Developing interactive visualisation tools to explore parameter space more quickly. Visualising data as time series, scatter plots or histograms. Calculating descriptive statistics such as means, variances or correlations.

Model development: Selecting the appropriate type of model to use e.g. dynamical system, signal processing or statistical model. Exploring strengths and weaknesses of the model. Feature engineering to improve model performance.

Model evaluation: Identifying suitable metrics for model evaluation. Using cross-validation methods to assess out-of-sample performance. Developing tools to allow visual assessment of models. Creating tests to ensure models work as intended.

Communication: Preparing static or interactive (html) slideshows to display results. Writing up results as research papers or blog posts. Presenting results in seminars and at conferences.

Professional Experience

2016 – Feb 2018 **Post-doctoral fellow**, Stockholm University, Sweden
2015 – 2016 **Post-doctoral fellow**, University of Southampton & University of Oxford, UK
2006 – 2010 **Investment consultant**, Lane Clark & Peacock (LCP), London, UK

Education

2011 – 2015 **University of Oxford**, PhD Ocean Physics
2010 – 2011 **Bangor University,** MSc Applied Physical Oceanography, Distinction
2007 – 2009 Passed all three **Chartered Financial Analyst Institute** exams
2002 – 2006 **Edinburgh University,** MA Mathematics, First Class Honours

Awards in Education

2016-2018 Wenner-Grenn Research Fellowship, Stockholm University
2013 Werrett Prize for 2nd Year PhD report, University of Oxford
2012 Johnson Prize for 1st Year PhD report, University of Oxford
2005-2006 Horslie-Hill Scott Prize for performance in exams, University of Edinburgh

Teaching

"Introduction to programming with Python": One week course for new graduate students in environmental research at the University of Oxford in October 2017, co-developed with a teaching-focussed academic. Focus on practical examples and real datasets with an emphasis on using the Pandas package in Python.

"Better analysis with python": Three-hour interactive workshop in Stockholm University in November 2017 using Jupyter notebooks. Attendees learn how many common analysis problems in climate science can be solved using Python packages. Discussed time series analysis, just-in-time compilation, parallel analysis and climate model analysis. Available online as an open educational resource.

"Introduction to Bayesian statistics": Three-hour interactive workshop in Stockholm and Bergen in January/February 2018. Workshop will cover Bayesian probability, fitting statistical models and linear regression including how Bayesian methods relate to other forms of machine learning.

"Turbulence in the oceanic boundary layer": Two-hour lecture in Stockholm presented using a Flask-based mini web framework to allow interactivity during the lecture.

"Fluids, flows and complexity": Tutored in 3rd year Oxford physics course on fluid mechanics and dynamical systems (2012 & 2014). Emphasis on interpreting solutions to equations.

Professional Skills

Presentations: Extensive experience presenting complex ideas to diverse audiences. Developing presentations for small informal meetings to large conferences.

Writing: Experience producing focused reports for clients and scientific audiences using both Microsoft Office and Latex. Five first-author papers in leading scientific journals from my independent research and co-author on two papers on collaborative projects, including one in Nature.

Financial: Carried out research into fixed income investment managers to assess suitability for pension fund investments. Explained developments in fixed income and derivative markets to colleagues and clients. Advised on long-term investment strategy for pension schemes. Developing new investment models for individuals.

Workflow: Worked routinely to short deadlines in finance as part of adaptable client teams. Managed long-term solo projects in research. Pioneered reproducible workflow in oceanography using GitHub repositories. Established a monthly meeting in Stockholm for researchers to get feedback on their work-in-progress.

Client relations: Presented to clients and advised on issues in trustee board meetings. Prepared billing statements and discussed fee proposals with clients. Arranged transfers of client assets between investment managers.

Data projects

MSc. project on wind-driven turbulence in Drake Passage: My data consisted of ocean current observations made with sonar, synthesised from hundreds of separate crossings of Drake Passage. I applied Fourier and wavelet transforms to analyse the frequency content of the data. I adapted a simple dynamical model from the shallow ocean to apply to deep ocean conditions.

PhD. project on turbulence in the ocean's near-surface layer: I derived initial and boundary conditions for a numerical ocean simulation and ran the simulations in parallel. I developed a mathematical linear stability analysis to identify turbulent processes and created diagnostics to test my hypotheses. I presented my results internationally.

Postdoc project on melting around Antarctic ice shelves: I was invited to join an existing project that had made ship-based observations from around melting Antarctic ice shelves. I developed a set of numerical simulations to complement the observations. I advised on the physical processes driving the observations and co-authored the paper in Nature.

Postdoc project on Arctic vortices: I identified a process that could help to improve our understanding of vortices in the Arctic Ocean and carried out numerical simulations to test this idea. I used K-Means analysis on the outputs to track vortices. I derived a mathematical model with a collaborator that captured the essential results of the numerical simulations. I created an animation package using Matplotlib in Python to visualise the results.

Postdoc project on Arctic predictability: I wanted to understand whether ocean properties observed near Ireland can be used to predict events in the Arctic Ocean in subsequent years. I built a collaboration with researchers in the UK who had a suitable dataset. I extracted features from the dataset to use as outcome and predictor variables. For feature engineering I used deterministic and Bayesian correlation. I developed Bayesian linear regression models to predict outcomes in the Arctic. I compared models by varying hyperparameters. I also compared the results with other deterministic regression techniques such as elastic nets and lasso regression.

Communication

Outreach: Talks on oceanographic research and scientific careers at science fairs, departmental open days and town centre science events.

Blogging: Focus on data analysis and visualisation. My blog posts have covered Bayesian model fitting, correlation and just-in-time compilation. I make posts available as interactive Jupyter notebooks from my GitHub site. These posts also demonstrate interactive visualisation using the Bokeh and Holoviews plotting libraries.

Technical

Analysis: Extensive experience using packages such as NumPy, Pandas, Dask and Numba for data analysis. Long experience using Matlab for similar tasks, plus basic and growing experience using R.

Visualisation: Matplotlib, Seaborn, Bokeh and Holoviews for visualisation in Python.

Machine learning: Scikit-learn for regression. K-Means for cluster identification. Familiarity with TensorFlow and Keras for deep learning.

Bayesian analysis: PyMC3 and Stan packages for Bayesian analysis. Have used both R and Python

interfaces for Stan package.

Lower-level: Running numerical simulations in Fortran using pre-existing model code. Made minor modifications to code to include additional diagnostics. Basic familiarity with C++.

Operating systems: Extensive experience using Linux and Mac operating systems, including Bash scripts to handle files. Version control with Git to manage projects and my website.

Mentoring

Doctoral — Xiaolong Yu (U. Southampton, 2014 – 2017)
I provided guidance on research areas, discussed technical concepts and feedback on draft papers.

Professional — Mentoring new graduates at LCP (2008-2010)
I supervised their work, provided feedback on draft reports and demonstrated use of software such as Bloomberg terminals.

Research Grants

2016 - 2018 Wenner-Grenn Postdoctoral Fellowship (PI – 600,000 SEK)

Selected Publications

Brannigan L *et al***.** (2017) Generation of sub-surface anticyclones at Arctic surface fronts due to a surface stress, ***Journal of Physical Oceanography***

Naveira Garabato AC *et al* (2017) Vigorous lateral export of the meltwater outflow from a thinning Antarctic ice shelf. ***Nature*** doi:10.1038/nature20825

Brannigan L (2016) Intense submesoscale upwelling in anticyclonic eddies. ***Geophysical Research Letters*** doi:10.1002/2016GL067926

Buckingham CE *et al* (2016) Seasonality of submesoscale flows in the ocean surface boundary layer. ***Geophysical Research Letters*** doi:10.1002/2016GL068009

Brannigan L *et al.* (2015) The seasonal cycle of submesoscale flows. ***Ocean Modelling*** doi:10.1016/j.ocemod.2015.05.002

Brannigan, L, *et al*. (2013) Shear at the base of the oceanic mixed layer generated by wind shear alignment. ***Journal of Physical Oceanography*** doi:10.1175/JPO-D-12-0104.1