Domenic Di Francesco, CEng (MIMechE)

Research Engineer

domenicdifrancesco@gmail.com | allyourbayes.com | DomDF | domenic-di-francesco-ceng-821792a2

Summary

Chartered engineer with professional experience in consultancies within the oil and gas engineering industry, working in technical and client-facing roles. Passionate about developing and communicating quantitative decision support tools for industry. Currently completing a PhD focused on applied Bayesian statistics, with a particular focus on multi-level models for *partial pooling of information* and multi-stage (preposterior) decision analysis for *quantification of the expected value of information*. This research has used probabilistic programming to build on existing guidance in industrial codes and standards.

Qualifications

PhD, *Bayesian Decision Analysis in Structural Integrity Management*

Currently completing an industrially funded PhD project. The work is primarily completed at the National Structural Integrity Research Centre (NSIRC) with industrial sponsorship and supervision from Lloyd's Register Foundation and academic supervision from Aalborg Universitet (Denmark) and the University of Surrey (UK).

Peer-Reviewed (First Author) Journal Publications and Conference Papers

- 'Consistent Treatment of Uncertainties and Dependencies in Fatigue Crack Growth Calculations Using Multi-Level Bayesian Models', Journal of Reliability Engineering and System Safety, Vol. 204, Dec. 2020 *link*.
- 'Evaluation of Inspection Features Including Exposure Risk Using a Value of Information Analysis', Submitted to Journal of Civil Engineering and Environmental Systems, under review.
- 'Bayesian Multi-Level Modelling for Improved Prediction of Corrosion Growth Rate Using Limited Data', Conference Paper & Presentation, 39th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2020.
- 'Inspection Planning of Hazardous Locations Using a Value of Information Analysis', Conference Paper & Presentation, 11th International Forum on Engineering Decision Making, IFED2019.
- 'Bayesian Fatigue Modelling: Application of Markov Chain Monte Carlo Sampling to Account for Variability and Dependency', Conference Paper & Presentation, 17th International Probabilistic Workshop, IPW2019.

MEng, *Mechanical Engineering*

Durham University, 2.1 (Hons)

Research project in 'Mechanical Characterisation of Ultra-High Molecular Weight Polyethylene (UHMWPE)'.

Professional Experience

Senior Engineer, Penspen Ltd.

2014 - 2017, Pipeline integrity engineer from 2014 - 2016

Delivering technical studies and training to international oil and gas operators based on guidance in relevant codes and standards. Managing projects, client relationships and reviewing work from junior engineers.

Graduate Integrity Engineer, DNVGL

2012 - 2014

Delivery of a software project for the risk-based integrity management of onshore coal seam gas pipelines in Australia. This included several long-term site-based secondments with the operator.

Praktikant (Engineering Internship), Alstom

2010 - 2011

Working in auxiliary systems for gas turbine power plant projects. Creation of an air-intake system selection calculation tool.

Skills

Project Management

As a senior engineer I was responsible for writing technical and commercial proposals, and managing awarded projects through to completion, ensuring work was delivered on time, within budget, and in accordance with quality assurance procedures. I presented regularly to both technical and non-technical representatives.

Bayesian Statistics

My PhD research has demonstrated industrial application of Bayesian methods such as value of information analysis for evaluating inspection activities, probabilistic quantification of inspection precision, bias, reliability and risk, as well as multi-level models for improved estimation of fatigue crack growth rates, and corrosion growth rate.

Programming

R

Statistic programming environment. Used for data analysis, visualisation, and evaluating statistical models. I am particularly familiar with the following packages:

- `tidyverse`: for transforming data and visualisation, see *link to examples*
- `tidymodels`: for fitting and evaluating machine learning models.
- `RMarkdown`: for producing live reports, which can readily be updated with new analysis.
- `RStan`: for pre-processing data, and extracting results from Bayesian models written in `Stan` (see below).
- `loo`: for various evaluation methods of probabilistic models.
- `shiny` for creating web-based, dynamic dashboards.

I have also created my own package (link) which includes a Markov Chain Monte Carlo sampler, traceplots, and a function for quantification of the expected value of perfect information, for a generic decision making under uncertainty problem.

Python

High level language used for object oriented programming. I am particularly familiar with the following packages:

- `Pandas`: for transforming data.
- `NumPy`: for manipulating data arrays.
- `Scikit-Learn`: for fitting and evaluating machine learning models.
- `PyStan`: for pre-processing data, and extracting results from Bayesian models written in `Stan` (see below).

Stan

`Stan` is a probabilistic programming language for Bayesian inference. It runs a state of the art Markov Chain Monte Carlo sampling algorithm, suitable for high dimensional and multi-level models.

Additional Courses and Training

I have also completed the below training courses to further develop my analytical and modelling skills:

Short Term Scientific Mission (STSM)

Aalborg University, February 2019

Bayesian Inference using RStan

Jumping Rivers, December 2018

Advanced Course on Systems Risk Modelling and Analysis in Engineering Decision Making

Joint Committee on Structural Safety (JCSS), May 2018

Training School on Quantification on the Value of Structural Health Monitoring

COST Action TU 1402, November 2017

Sheffield Fracture Mechanics

Fracture Training Associates, 2015