

Modern Regression Techniques for Control Engineers

A short course to introduce model building in the world of big data for control applications.

The 2019 Australia & New Zealand Control Conference – ANZCC 2019
Auckland University of technology, Auckland, New Zealand
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Course presenters:

David Wilson, Wei Yu & Brent Young.
Industrial Information & Control Centre, Auckland New Zealand.

Rationale for the course

Historically control engineering has involved the design of small-scale controllers for single units using classical techniques. Reliable measurements were expensive and rare, and online computing resources at a premium. Of course that has now all changed, small, cheap sensors abound, delivering a “deluge of data” to a controller that has the capability to solve nonlinear optimisation problems at every sample time.

This course contains the new thinking, with associated computer tools, required to adequately extract value from the data, build appropriate, flexible model-based controllers in the current data-rich environment.

Key skills covered:

Big data handling, analytics and modelling; modern regression, clustering and classification; artificial neural networks and deep learning

Learning Outcomes

At the completion of this course, participants will be able to:

- Apply ways to effectively deal with high volumes of industrial data
- Build appropriate models from large data sets
- Use key Matlab & associated toolboxes to build, and analyse, data sets

Course content:

- (1) Introduction to big data analytics and the impact on industrial control systems
 - a. The changing landscape of Industry 4.0
 - b. The 5Vs of big data
 - c. How the “data deluge” changes model building
 - d. Lost in the data & Data visualisation
- (2) Classical Regression

- a. An introduction to basic statistics, least-squares fitting & computer tools
 - b. Validation and the bias/variance trade-off
 - c. Problems of the classical approach and a quick guide to Modern Regression
 - d. Industrial applications
- (3) How good is my model?
- a. Cross validation alternatives
 - b. Cross validation, k-fold, re-sampling/balancing
 - c. System Identification applications
- (4) Clustering & classification
- a. Introduction to basic methods i.e. K-means, PCA, Naïve bayes, Support vector machine, Classification trees, etc.
 - b. Evaluating classification model
 - c. Face recognition and coffee sensory applications
- (5) Small sparse models
- a. Advantages of reducing model dimension
 - b. PCA and PLS models
 - c. Shrinkage methods & Lasso
 - d. Random forests & regression trees
 - e. Modelling for controllers, e.g. MPC
- (6) Automated model building
- a. Introduction to automated modelling
 - b. ANNs
 - c. Deep learning and long short-term memory (LSTM) models
 - d. Industrial Application: Cheese fermentation

Workshop timetable

<i>Time</i>	<i>Speaker</i>	<i>Content</i>
8:30-9:30	BY	Introduction, Impact, 4Vs
9:30-10:30	DIW	Computer tools, data visualisation Classical Regression
10:30-10:45		Tea break
10:45-11:30	WY	Model Validation
11:30-12:15	WY	Clustering
12:14-1:15		Lunch
1:15- 2:00	BY	PCA
2:00-2:45	DIW	Lasso (regularisation)
2:45:3:00		Teak break
3:00-3:45		ANN & machine learning
3:45-4:00	All	Wrap-up

Workshop Fees*

- Students \$150
- Other \$250

*Meals are excluded except for morning and afternoon tea/coffee breaks

Presenter Bios:

Professor Brent Young



Brent Young is a full Professor in the Department of Chemical and Materials Engineering at the University of Auckland. He holds the position of Chair in Food and Process Systems Engineering and is Director of the Industrial Information and Control Centre (I²C²).

He received his BE (1986) and PhD (1993) degrees in Chemical and Process Engineering from the University of Canterbury. He is a registered professional engineer, a Fellow of the Institute of Chemical Engineers United Kingdom and Engineering New Zealand. He has co-authored over 200 refereed publications including the book "A Real-time Approach to Process Control", published by John Wiley (3rd Edition, 2014).

Brent's teaching, research and practice centre on process modelling, simulation, control and design. In 2014 he was the recipient of the Caltex Australasian Award of Excellence in Chemical Engineering (Teaching).

Dr Wei Yu



Dr. Wei Yu is a senior lecturer at the Chemical and Materials Engineering department at the University of Auckland and a senior academic within the at Industrial Information and Control Centre (I²C²) research center.

He received his B.E. (1993) degree in Chemical Engineering from Liaoning University of Petroleum and Chemical Technology, Fushun, P.R. China, a Masters in 2003 and a Ph.D. in 2007 from Queen's

University, Canada. He worked as a process engineer at West Pacific Petrochemical Company, Dalian, P.R. China from 1993-1999.

His main research interests include control performance assessment, analysis of variance, process control and system identification.

Associate Professor David Wilson



David Wilson is an Associate Professor in Electrical Engineering at Auckland University of Technology and director of the research-based Industrial Information and Control Centre (I^2C^2).

His main research interests are modelling, simulation and control of industrial processes and he manages multi-faceted research projects for international clients such as PETRONAS in Malaysia, and large New Zealand companies such as Transpower and Fonterra. He is also a founding director of Inverse Problem Ltd which is a start-up company developing and marketing small high-performance embedded controllers and optimisation software. This company recently won the inaugural AUT Enterprises Innovation Challenge for 2012.

From a control theoretic viewpoint, David has an interest in robust auto-tuners and model-predictive control. From a practical view, David likes to apply system engineering techniques, to build models that can be used for better control systems, to deliver a better product at less cost.