

37457

Advanced Bayesian Methods

## More Advanced Bayesian Methods

37457 Advanced Bayesian Methods has:  
4 topics,  
12 classes and 12 (pre-exam) assessment tasks

We Would Probably Add Something Like...

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### THOUGHT EXPERIMENT:

What would the lecturer add if we had

another 4 topics,  
12 classes and 12 assessments?

- Topic 5 Non-Gibbsian Markov Chain Monte Carlo
- Topic 6 Fast Approximate Bayesian Inference
- Topic 7 Bayesian Time Series/ Quant. Finance Models
- Topic 8 Bayesian Analysis of Streaming Data

## We Would Probably Add Something Like...

Topic 5 Non-Gibbsian Markov Chain Monte Carlo

Topic 6 Fast Approximate Bayesian Inference

Topic 7 Bayesian Time Series/ Quant. Finance Models

Topic 8 Bayesian Analysis of Streaming Data

Note that Topic 5 is particularly large, and could easily take up an entire subject or more.

### Topic 5 Non-Gibbsian Markov Chain Monte Carlo

For many important models we get stuck with

$$\beta_2 | \text{rest} \sim \begin{cases} \text{some weird distribution} \\ \text{that is not easy to sample from.} \end{cases}$$

Often the weird distribution is multivariate, which compounds the problem.

This gets us into non-Gibbsian MCMC (which we avoided in 37457).

## Topic 5 Non-Gibbsian Markov Chain Monte Carlo

In 37457 all of the MCMC examples we only had examples such as:

$$\beta_2 | \text{rest} \sim N(\square, \square)$$

$$\sigma^2 | \text{rest} \sim \text{Inverse-Gamma}(\square, \square).$$

and steps such as

$$\beta_2^{[g]} \sim N(\square, \square)$$

are easy.

This easy form of MCMC is labelled Gibbsian.

Some non-Gibbsian Markov Chain Monte Carlo topics are:

- Metropolis-Hastings sampling,
- Slice sampling,
- Hamiltonian Monte Carlo (used by rstan).

## Topic 6 Fast Approximate Bayesian Inference

MCMC is a post-1990s breakthrough for Bayesian inference. But it can be

**SLOW.**

Some **fast approximate Bayesian inference** topics are:

- Variational approximations,
- Expectation propagation.

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MCMC is a post-1990s breakthrough for Bayesian inference. But it can be

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**Fast approximate Bayesian inference** is an alternative paradigm that sacrifices some accuracy for

**SPEED.**

## Wand and Topic 6

Since around 2010 your lecturer has been involved in

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research with a

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An early overview paper is:

Ormerod, J.T. and Wand, M.P. (2010).

Explaining variational approximations.

*The American Statistician.*

## Topic 7 Bayesian Time Series/ Quant. Finance Models

As we said in Class 8:

About HALF of our class are

enrolled in QUANTITATIVE FINANCE degrees  
or degrees in related areas.

The second half of Class 8 had two time series/  
quantitative finance examples.

This could easily be expanded into a subject topic.

Non-finance time series applications (e.g. meteorology,  
political science) could also be included.

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## Topic 8 Bayesian Analysis of Streaming Data

All data analyses in 37457 involved data collected some  
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All data analyses in 37457 involved data collected some time ago and **processed together**.

This is sometimes called processing in **BATCH**.

How about data **STREAMING IN** in **REAL TIME**?

### Bayesian Analysis of Streaming Data

We need to replace **BATCH** processing by

**ONLINE** processing

with the estimates and credible intervals updated in **real time** as the data **stream in**.

Examples of **REAL TIME STREAMING** data:

- the **current price** of Qantas or BHP stock in the Sydney Stock Exchange,
- the **current temperature and atmospheric pressure** at the locations of each weather station in New South Wales,
- **Fitbit measurements** of one of your friends currently working out in a nearby gym,
- this morning's **comments posted on X** about the U.S. presidential election.

### Bayesian Analysis of Streaming Data

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with the estimates and credible intervals updated in **real time** as the data **stream in**.

The lecturer has some research articles on this (on his web-site) such as

Luts, Broderick & Wand (2014)  
Mentictas, Oates & Wand (2024)

