

New Methodologies for Modelling Individual Differences in Cognition

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Pluralitas non est ponenda sine necessitate.

[Plurality should not be posited without necessity.]

Ockham's razor

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Abstract

Many evaluations of cognitive models rely on data that have been averaged or aggregated across all experimental subjects, and so fail to consider the possibility of important individual differences between subjects. Other evaluations are done at the single-subject level, and so fail to benefit from the reduction of noise that data averaging or aggregation potentially provides. To overcome these weaknesses, new approaches to modelling individual differences have been developed. The first approach uses *families* of cognitive models in which different groups of subjects are identified as having different psychological behaviour. Separate models with separate parameterisations are applied to each group of subjects, and Bayesian model selection is used to determine the appropriate number of groups. Practical demonstrations of the approach using the ALCOVE model of category learning (Kruschke 1992) with data from four previously analysed category learning experiments (Kruschke 1993a) are reported. A second approach builds on the first by substituting a more complete Bayesian analysis for the Bayesian model selection. This latter approach has been developed and applied to a range of cognitive models by Lee (2008), and has also been applied in this present work, to a causal inferencing task (Steyvers, Tenenbaum, Wagenmakers & Blum 2003). Its results are contrasted with the application of the prior Bayesian model selection approach to the same task.

In both demonstrations presented in this thesis, meaningful individual differences are found and the psychological models are shown to be able to account for this variation through interpretable differences in parameterisation. These results highlight the value of extending cognitive models to consider individual differences.

Thesis Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution to Michael Roy Webb and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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My earliest inspiration for this work came from Professor Douglas Vickers. Doug was an exceedingly kind and thoughtful man, not only welcoming me into the world of cognitive psychology from my physical sciences background, but also welcoming Gill and I into his own home. He continues to be greatly missed.

The original impetus to undertake this work was given to me by Dr Chris Woodruff, who was keen to see my intuition that cognitive psychology was important to my work, better informed than it had been. Thank you Chris for your direction and support in those early days.

I especially owe both Professor John Kruschke and Professor Mark Steyvers, gratitude for making available the experimental data which underpins the work reported in this thesis.

Dedication

To the memory of Professor Douglas Vickers, a generous and thoughtful man,
the source of inspiration for many.