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Article on Bayes conference for Cognitive Bulletin

In September 2017, I attended 'Bayesian Data Analysis in the Social Sciences Curriculum', a one-day conference organised by Thom Baguley and Mark Andrews (Nottingham Trent University), marking the culmination of a 3-year ESRC funded programme on Bayesian Data Analysis. The core of this programme was an annual series of 4 workshops (www.priorexposure.org.uk), and the conference delegates included workshop graduates alongside Bayesian newbies like myself. Essentially, Bayesian data analysis is an alternative to 'classical' or 'frequentist' null hypothesis significance testing (NHST), based on probabilistic reasoning (Dienes, 2008, Andrews, 2016). Neither frequentist nor Bayesian analysis are right or wrong: they are different approaches to how scientific inference can be drawn from data sets.

In the first session, Andrews and Baguley gave an overview of the current status and role of Bayesian data analysis in social sciences. Although increasing in popularity, it is still rarely taught at either UG or PG level, and remains in use by a minority of social scientists. The workshops were briefly discussed, providing some idea of the extensive range of experimental designs open to Bayesian analysis. Although these workshops have now ended, there was some discussion of what future workshops might look like, were more funding secured.

Unlike most classical statistical analysis, proficiency in coding is necessary for all but the most basic Bayesian analysis, using one of various software packages and programming languages available, such as R, JAGS, Stan, and JASP. Similarly, reasonable mathematical competence is needed to fully appreciate Bayesian analysis and use it effectively, though the same is true for classical frequentist data analysis techniques. For either approach, the better your conceptual understanding of the methods, perhaps with some philosophical underpinnings (e.g. Dienes, 2008; Baguley, 2012), the better your appreciation of what you can and cannot infer from both your data and the resulting analyses.

Zoltán Dienes (University of Sussex) has been successfully teaching Bayes to psychology students since 2004. He outlined some of the differences between Bayesian and frequentist data analysis. Briefly, NHST, using p values, can quantify the extent to which the observed data is compatible with H0. But NHST cannot distinguish evidence for the null hypothesis (H0) from a lack of enough evidence to support H1. Bayesian inference, on the other hand, enables the researcher to evaluate both the evidence for H1 relative to H0, and the evidence for H0 relative to H1. To do this, a Bayes factor is calculated, which is where appropriate software or online calculators are necessary. Dienes also discussed criticisms of Bayes factors, or rather criticisms of their misuse - the important point being that users must understand how to correctly interpret their meaning.

The four talks sandwiching the lunch break were from graduates of the Bayes workshops over the last 3 years, from a variety of disciplines, although all had psychological relevance. Each short talk gave examples of how Bayesian data analysis had been used with specific data sets to address specific research questions. Helen Hodges (Swansea University) discussed risk assessment in young offenders and how Bayesian approaches can assist crime prevention by characterising the most likely reasons for recidivism. Oliver Clark (Manchester Metropolitan University) considered how Bayesian analysis can help demonstrate how interacting with or embodying an avatar can influence post-game behaviours; one application could be in promoting health related behaviours.

Colin Foster (Nottingham University) discussed using Bayes to investigate the effectiveness of an educational intervention (using mathematical 'etudes' - see www.mathematicaletudes.com) to help secondary school pupils develop their mathematical fluency. Finally, and perhaps the most relevant of the four to cognitive psychology, Jayne Pickering (Loughborough University) described how cold pressor pain (putting your hand in cold water) affected performance on the Attentional Networking Test, which evaluates alerting, orienting and executive control. Whereas NHST had failed to support the hypothesis that pain intensity influenced these attentional tasks, Bayesian analysis was able to demonstrate evidence for the null hypothesis, something NHST cannot do.

Richard Morey (Cardiff University) then talked engagingly about the misuse and misinterpretation of Confidence Intervals (CIs), which are used in classical data analysis. His view was that researchers try to do 'Bayes-lite' with them, interpreting them in probabilistic terms, which is not appropriate. Daniel Lakëns (Eindhoven University of Technology) ended the afternoon by presenting his personal journey through the frequentist and Bayesian approaches, illustrated along the way with his 'tragedies', realising that even Bayesian data analysis cannot give all the answers. Indeed, his main message was that in statistics teaching it is most important that students learn to ask the right questions, and that this is more important than giving the right answers without being able to interpret them.

Should Bayesian data analysis be taught at UG level? No consensus was reached on this, though it was generally felt suitable for PG students. Dienes feels that aspects of Bayes, perhaps related to scientific inference as a whole, could be relevant even to first year UG students. The BPS 2017 curriculum does allow for alternative approaches such as Bayes, and Baguley made the salient point that in this day of QAA and transparency (bureaucracy?) it can take time to approve changes to taught module specifications. Therefore, it is worth 'future proofing' the wording of such specifications so that statistical teaching is not restricted to SPSS and NHST, enabling R and Jags/JASP/Stan to be used for Bayesian data analysis if required.

Overall I found it an inspiring day. Though few in my department yet use Bayesian analysis, most are interested in doing so. Although the ESRC conference was not a hands-on experience of actually using Bayes, the talks clearly demonstrated the benefits (and some of the caveats and limitations) of taking a Bayesian approach, probably alongside a classical approach, to data analysis: Dienes, for example, always quotes both Bayes factors and p values in his articles, allowing a role for both approaches. Several universities offer Bayes workshops, so now is an ideal time to benefit from Baguley's, Andrews' and others' extensive experience, and bring Bayes into your own research programme.

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References

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