Scientists outline 10 simple rules for the computational modelling of behavioural data

November 26 2019

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New guidelines for scientists who use computational modelling to analyse behavioural data have been published today in the open-access journal *eLife*.

The goal of computational modelling in the behavioural sciences is to use precise mathematical models to make better sense of data concerning behaviours. These data often come in the form of choices,

but can also include reaction times, eye movements and other behaviours that are easy to observe, and even neural data. The mathematical models consist of equations that link the variables behind the data, such as stimuli and past experiences, to behaviour in the immediate future. In this way, computational models provide a kind of hypothesis about how behaviour is generated.

"Using computers to simulate and study behaviour has revolutionised psychology and neuroscience research," explains co-author Robert Wilson, Assistant Professor in Cognition/Neural Systems and Director of the Neuroscience of Reinforcement Learning Lab at the University of Arizona, US. "Fitting computational models to experimental data allows us to achieve a number of objectives, which can include probing the algorithms underlying behaviour and better understanding the effects of drugs, illnesses and interventions."

There are four key uses of computational modelling across the scientific literature, according to Wilson and his co-author Anne Collins, Principal Investigator at the Computational Cognitive Neuroscience (CCN) Lab, part of the Department of Psychology and the Helen Wills Neuroscience Institute at the University of California, Berkeley, US. Each of these practices has their own strengths and weaknesses and can be mishandled in a number of ways, potentially leading to incorrect and misleading conclusions and highlighting the need for them to be carried out responsibly.

To address this need, Wilson and Collins offer their 10 simple rules, designed for both beginners and seasoned researchers, to ensure that computational modelling is used with care and yields meaningful insights on what a model is saying about the mind.

Their rules encompass a number of principles that include: designing effective experiments with computational modelling in mind; generating,

simulating, comparing and validating models; extracting variables from models to compare with physiological data; reporting on the analyses; and, finally, advice on the next steps once the reporting is completed.

While these guidelines cover the simplest modelling techniques that can be used by beginners, they are also applicable more generally. Likewise, for clarity, the authors decided to focus on a single narrow domain—reinforcement learning models applied to choice data—as the same techniques used in this domain can be applied more widely to other observable behaviours.

"Our work highlights how to avoid common pitfalls and misinterpretations that can arise with computational modelling," Collins explains. "We learned many of these lessons the hard way, by actually making these mistakes for ourselves over a combined 20-plus years in the field.

"By following these guidelines, we hope other scientists will avoid some of the errors that slowed down our own research," she adds. "We would also hope to start seeing improvements in the quality of computational modelling in the behavioural sciences."

More information: Robert C Wilson et al, Ten simple rules for the computational modeling of behavioral data, *eLife* (2019). DOI: 10.7554/eLife.49547

Provided by eLife