References

1 Koelsch, S. and Siebel, W.A. (2005) Towards a neural basis of music perception. *Trends Cogn. Sci.* 9, 578–584

2 Peretz, I. and Coltheart, M. (2003) Modularity of music processing. *Nat. Neurosci.* 6, 688–691

3 Patel, A.D. (2003) Language, music, syntax and the brain. *Nat. Neurosci.* 6, 674–681

4 Bigand, E. *et al*. (1996) Perception of musical tension in short chord sequences: the influence of harmonic function, sensory dissonance, horizontal motion, and musical training. *Percept. Psychophys.* 58, 124–141

5 Leman, M. (2000) An auditory model of the role of short-term memory in probe-tone ratings. *Music Percept.* 17, 481–509

6 Parncutt, R. and Bregman, A.S. (2000) Tone profiles following short chord progressions: top-down or bottom-up? *Music Percept.* 18, 25–57

7 Tekman, H.G. and Bharucha, J.J. (1998) Implicit knowledge versus psychoacoustic similarity in priming of chords. *J. Exp. Psychol. Hum. Percept. Perform.* 24, 252–260

8 Bigand, E. *et al*. (2003) Cognitive versus sensory components in harmonic priming effects. *J. Exp. Psychol. Hum. Percept.* 29, 159–171

1364-6613/$ - see front matter
doi:10.1016/j.tics.2006.03.008

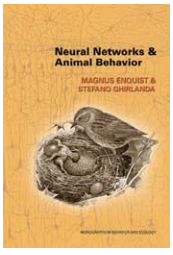
Book Review

Can neural nets capture animal behaviour?

Neural Networks and Animal Behavior by Magnus Enquist and Stefano Ghirlanda. Princeton University Press, 2005. $39.95/£26.95 (pbk) (256 pp.) ISBN 0-691-09633-3

Patrick Bateson

Sub-Department of Animal Behaviour, University of Cambridge, Madingley, Cambridge CB3 8AA, UK



The power of neural nets is that they can bring together data in ways that are comparable to those forms of multivariate statistics that extract patterns from seemingly confusing data. The nets can learn from experience by changing the weightings on the connections in the net. In this way they can make predictions about the performance of complex systems such as stock markets – so long as the past is a good guide to the future. If they work, it doesn't matter whether or not such neural nets bear any relationship to real nervous systems. Even so, just because what they do seem so clever and lifelike, they have excited the hope that they would provide aids to understanding the brain. It soon became obvious that, if they were to be of any use in biology and psychology, their rules of operation must be plausible at both the behavioural and the neural levels. Understandably, neural nets were taken up with especial enthusiasm by those interested in learning in its various forms. The authors of this new book would like to extend the use of neural nets to all aspects of animal behaviour (although presumably not to the behaviour of protozoa and other organisms that do not have nervous systems). For example, they argue for the use of neural nets in understanding evolutionary questions even though one of the main attractions of neural nets is their ontogenetic plasticity. On the face of it, claiming that neural nets can be used to explain phylogeny seems implausible. Undoubtedly small changes in the characteristics of a net can lead to big changes in behaviour (or big changes can still leave its performance robust). However, in those respects, neural nets are no different from many other dynamical systems.

Even though I sympathise with many of the authors' objectives, I do not think that Enquist and Ghirlanda mount particularly cogent arguments for generalising the use of neural nets across the board to all the questions that excite behavioural biologists. Also their book suffers because they are too inclined to give references to other writers without clarifying the nature of these writers' arguments. I suspect that the illustrative figures will mystify the uninitiated and irritate those who know something about neural nets. The authors make claims about the state of the literature that are without foundation. For example, they suggest casually that neural nets have yet to be brought into the animal behaviour literature and that neural nets have not been used to explain developmental phenomena such as sensitive periods. I was disappointed by this claim because I, for one, have spent a lot of time developing neural nets for application in behavioural imprinting [1]. Enquist and Ghirlanda cite this paper but do not address its implications. The overall impression of the book is that the crucial issues about neural nets have not been laid out carefully by the authors and they have not mounted a good enough case for using neural nets in studying all aspects of animal behaviour.

If neural nets are to be useful in understanding some aspects of animal behaviour, they must be used interactively with empirical research. But this raises an immediate problem. The simulations are forced by the programming structure and the computer architecture on which they depend to operate serially rather than in parallel. Therefore, without hardware implementations, the models do not operate in real time and smooth processes are broken up into a series of step-like episodes. This is not a crippling objection but it does mean that setting parameter values from data derived from real biological systems is difficult. Also difficult is simulating an important feature of real animals, namely the rapid interplay between the animal and its environment, the

Corresponding author: Bateson, P. (ppgb@cam.ac.uk).
Available online 3 April 2006

individual changing the surrounding conditions that in turn affect what the individual does next.

Neural net theoreticians are often tempted to introduce levels of complexity in the interests of making their models more realistic, but then are forced to perform experiments on their models in order to understand how they work. Even then, understanding does not always come easily. By keeping the number of modules down to the bare minimum and using simple mathematics in the algorithms, it is possible to understand much more easily than would otherwise have been the case why a neural net had performed in surprising ways – as often happens. Such are the realities of neural net modelling, but unfortunately they are not captured by Enquist and Ghirlanda. In general I felt that their book fell disappointingly between two stools – too simple to be of interest to the knowledgeable and too opaque to be useful to the uninitiated.

References

1 Bateson, P. and Horn, G. (1994) Imprinting and recognition memory: a neural net model. *Anim. Behav.* 48, 695–715

1364-6613/$ - see front matter
doi:10.1016/j.tics.2006.03.005