

Finding rules in implicit learning with hidden Markov models

Ingmar Visser

Department of Psychology
University of Amsterdam
op_visser@macmail.psy.uva.nl

Maartje Raijmakers

Department of Psychology
University of Amsterdam
op_raijmakers@macmail.psy.uva.nl

Keywords: implicit learning; generation task; hidden (latent) Markov model; rules.

Abstract

A major issue in implicit learning is how to characterize knowledge that subjects express in their responses in the absence of introspective or reportable knowledge. This issue is pervasive in different fields, notably in developmental psychology where children are able in many cases to perform according to some rational rule, but are nevertheless unable to provide justifications for their preferred course of action. In implicit learning, subjects are not made aware of contingencies that exist between stimuli, but they are nevertheless able to reproduce significant portions of presented sequences (Cleeremans and McClelland, 1991; Destrebecqz and Cleeremans, 2001). In this paper we use hidden Markov models (Rabiner, 1989) to arrive at a precise characterization of subjects' knowledge in terms of the underlying, abstract rules that subjects use in an implicit learning experiment (Visser et al., 2002a). Hidden Markov models can be seen as models for a set of grammatical rules specifying simple 'languages' such as those used for generating stimuli in implicit learning experiments. A number of issues will be discussed, such as the incorporation of constraints in fitting hidden Markov models, assessing model goodness-of-fit and the comparison of fitted models with a priorily specified models. This is particularly important in implicit learning in order to quantify the knowledge that subjects express in the so-called generation task (Visser et al., 2002b).

References

- Cleeremans, A. and McClelland, J. L. (1991), "Learning the structure of event sequences," *Journal of Experimental Psychology: General*, 120, 235–253.
- Destrebecqz, A. and Cleeremans, A. (2001), "Can sequence learning be implicit? New evidence with the process dissociation procedure," *Psychonomic Bulletin & Review*, 8(2), 343–350.
- Rabiner, L. R. (1989), "A tutorial on hidden Markov models and selected applications in speech recognition," *Proceedings of IEEE*, 77–2, 267–295.
- Visser, I., Raijmakers, M. E. J., and Molenaar, P. C. M. (2002a), "Associations and dissociations between direct and indirect measures of sequence knowledge," *Submitted for publication*.
- Visser, I., Raijmakers, M. E. J., and Molenaar, P. C. M. (2002b), "Fitting hidden Markov models to psychological data," *Scientific Programming*, 10(3), 185–199.