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Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 26(26)

ISSN
1069-7977

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Publication Date
2004

Peer reviewed

CHREST Tutorial: Simulations of Human Learning

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Abstract

CHREST (Chunk Hierarchy and REtrieval STructures) is a comprehensive, computational model of human learning and perception. It has been used to successfully simulate data in a variety of domains, including: the acquisition of syntactic categories, expert behaviour, concept formation, implicit learning, and the acquisition of multiple representations in physics for problem solving. The aim of this tutorial is to provide participants with an introduction to CHREST, how it can be used to model various phenomena, and the knowledge to carry out their own modelling experiments.

Developing detailed process models of cognitive phenomena is important to the development of cognitive science, as only then can cognitive theories be used to generate quantitative predictions for complex phenomena. The history of computational modelling includes many diverse approaches, from models of single phenomena (such as Young and O'Shea's model of subtraction), to integrated models covering a wide range of different phenomena (such as Soar and ACT-R), to over-arching principles, which guide the development of models in disparate domains (e.g. connectionist approaches, or embodied cognition).

The EPAM/CHREST tradition, which forms the heart of this tutorial, has been providing significant models of human behaviour since 1959. Early models of EPAM provided the impetus to develop the chunking theory, which has been an important component in theories of human cognition ever since. Focusing on learning phenomena, EPAM and CHREST place a great emphasis on how the model's information is learnt through interactions with an external environment. Thus, EPAM/CHREST models are typically developed from large quantities of naturalistic input. For example, in modelling expert perception of chess players, actual chess games are used.

Historically, CHREST is derived from the EPAM (Elementary Perceiver and Memorizer) model of Feigenbaum and Simon (1984). In both models, learning happens as the creation and elaboration of a discrimination network. In addition, CHREST has mechanisms for the automatic creation of schemata and for the creation of 'lateral links', which can be used for creating elementary productions or elementary semantic links. CHREST can thus be situated between production systems such as Soar and connectionist systems. Just as EPAM was the computational embodiment of the key aspects of the chunking theory (Chase & Simon, 1973), CHREST implements the essential aspects of the template theory (Gobet & Simon, 2000). In spite of its historical and contemporary importance, and the diversity of domains in which modelling has been successfully carried out, the number of people who use or understand the principles and operation of an EPAM/CHREST model remains small.

The tutorial is structured so that participants will:

1. Acquire a comprehensive understanding of the CHREST computational model and its relation to the chunking and template theories of cognition;
2. Explore some key learning phenomena supporting the chunking theory by taking part in a verbal-learning experiment;
3. Attempt to match their own data with the performance of a CHREST model of verbal learning; and
4. Be introduced to the implementation of CHREST in sufficient detail to begin modelling their own data.

We have chosen a verbal-learning experiment (serial-anticipation method) for introducing participants to CHREST for the following reasons: the experiment is historically important; it was one of the motivations behind the development of EPAM; it can be carried out in a short period of time; striking learning phenomena are readily observable, in spite of the brevity of the experiment; the motivation and requirements for the experiment are generally clear; and, finally, it illustrates some key features of the EPAM/CHREST architecture.

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