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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. As all concepts will be explained and illustrated, this tutorial also makes an excellent introduction to cognitive modelling for those new to the field.

Cognitive scientists aim to develop theories which can explain and predict complex behavioural phenomena. One way of developing such theories is through detailed process models, which may be compared with data gathered from experiments. Various approaches have been taken through the history of computational models. Models of single phenomena, such as Young and O'Shea's model of substraction, may be contrasted with integrated models covering many phenomena, such as Soar or ACT-R. Finally, approaches such as connectionism, or embodied cognition, use over-arching principles to develop models in disparate domains.

Within this tutorial, we present the principles behind a tradition of computational modelling which has been providing significant models of human behaviour since 1959. We focus on CHREST, which is derived from the EPAM (Elementary Perceiver and Memorizer) model of Feigenbaum and Simon (1984). 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. EPAM and CHREST place a great emphasis on learning, and specifically how information is acquired 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.

Both EPAM and CHREST rely on a discrimination network to store learnt information. Although both use similar mechanisms for creating and elaborating a network, CHREST additionally includes mechanisms for creating schemata and 'lateral links', which can be used to form elementary productions or semantic links, supporting the model's application to multiple kinds of domains. 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).

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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