Thematic Representation in Simple Recurrent Networks

Ricardo Basso Garcia (rbgarcia@gmail.com)
Edson Françozo (edson@unicamp.br)
Department of Linguistics, State University of Campinas
P.O.Box 6045, 13083-970 Campinas SP BRAZIL

Introduction

Simple recurrent networks (SRNs) are able to learn and represent lexical classes (Elman, 1990) and grammatical knowledge, such as agreement and argument structure (Elman, 1991), on the basis of co-occurrence regularities embedded in simple and complex sentences. In the present study, we address the question whether SRNs can represent differences in the thematic roles assigned by verbs.

The Simulation

An SRN with 30 input and output units, and 150 hidden and context units was trained on a set of 10,000 sentences generated with the same lexicon and grammatical rules given in Elman (1990). However, differently from the procedure adopted in that work, an end-of-period mark was added to each sentence. The analysis reported here is from an experiment in which the network became stable after four epochs of training. A cluster analysis performed on hidden units activations turned out to be highly similar to Elman´s (1990).

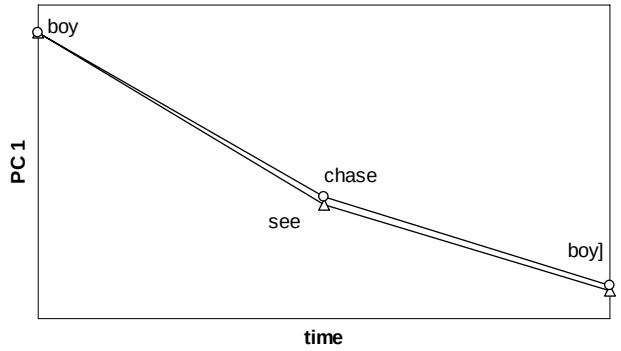

Figure 1: Trajectories in PC 1.

To check the learning of thematic role distinctions, sentences like *Boy see boy* and *Boy chase boy* were examined. As far as thematic assignment is concerned, such sentences differ because their verbs assign different roles (theme and patient, respectively) to the same noun (*boy*) in object position. Conceivably, such difference would appear as different trajectories through state space during sentence processing (as revealed by a principal components analysis). As can be seen in Figure 1, the first principal component seems to encode word order (N-V-N) in the same manner for both sentences (although lexically different, *see* and *chase* are placed close together in PC 1).

The most interesting result for our purposes, however, appears in Figure 2. Principal Component 11 seems to encode thematic role assignment. In this case, subjects and verbs are quite close in the representational space, while the two instances of the internal argument (the very same word, *boy*) are placed wide apart.

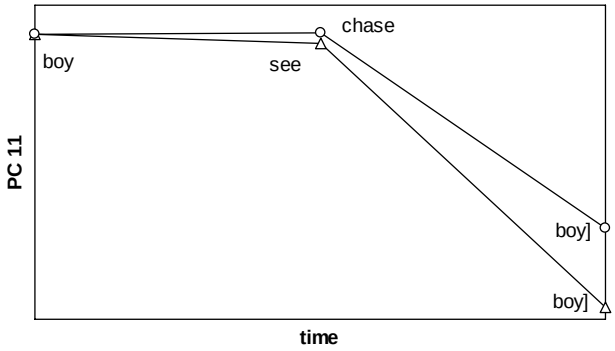

Figure 2: Trajectories in PC 11.

Discussion

The network thus seems able to distinguish and differentially represent structural information (word order). It also seems able to distinguish and differentially represent thematic assignment. Since thematic roles are semantic relations between a verb and its arguments, and since verb meaning and subcategorization frames are associated in distributional profiles in language (Hare, McRae & Elman, 2003), one could expect that such distributional profiles also show an association between thematic assignment and subcategorization frames, thus allowing for SRNs to acquire such knowledge. The next steps in the present project are to characterize distributionally such an association, and to develop an SRN to model such knowledge.

Acknowledgments

Research funded by CNPq and FAEPEX/UNICAMP.

References

Elman, J. L. (1990). Finding structure in time. *Cognitive Science, 14*, 179-211.

Elman, J. L. (1991). Distributed representations, simple recurrent networks and grammatical structure. *Machine Learning, 7*, 71-99.

Hare, M., Mc Rae, K. and Elman, J.L. (2003) Sense and structure: Meaning as a determinant of verb subcategorization preferences. *Journal of Memory and Language, 48*, 281-303