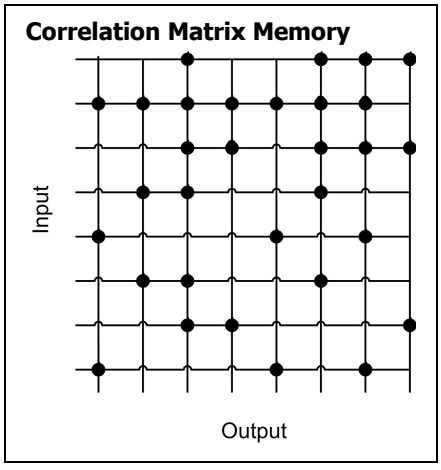
Improving Storage Capacity in Correlation Matrix Memories



Introduction

Correlation matrix memories (CMMs) are a method for efficiently storing information for retrieval. This is done by encoding each piece of information as a binary vector or 'code'. A binary vector or code is simply a string of 1s and 0s. For example to associate a name with a date both would be encoded as binary vectors and associated within the memory via what is called a Hebbian learning rule which mimics some of the mechanisms used within the brain.

To achieve this in the most efficient way the codes should be sparse (i.e. Be more 0s than 1s) and also have the same number of 1s for all pieces of information. For example a name 'Alan' could be encoded as 100001, and the name 'Bob' could be 110000 and all other names would also contain two 1s and 4 0s.

Baum et al.

If a large number of different pieces of information must be encoded then it is important to have a way of generating a set of codes that have certain useful properties which can maximise the storage efficiency of the correlation matrix memory, i.e. Increase the number of associations between pieces of information that can be stored.

Firstly, the set of codes used should be as different as possible. For exampe, {110000, 001100, 000011} is a very distinct set but {110000, 101000, 100100} is less so.

Secondly, where two pieces of information are related the codes should be somewhat related. E.g. The codes for 'Ian' and 'Iain' should probably be similar.

Work done by Baum, Wilczek and Moody in the 1980s [1] provided some useful algorithms to meet the first of these requirements.

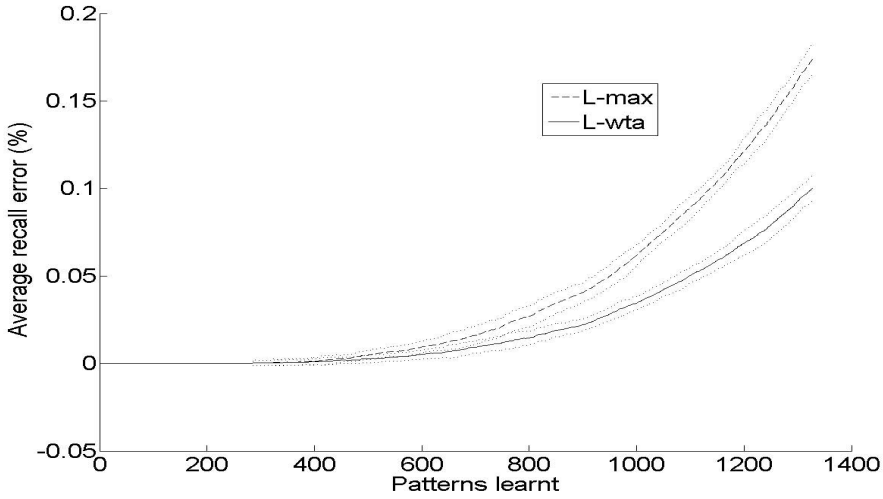
LMAX WTA

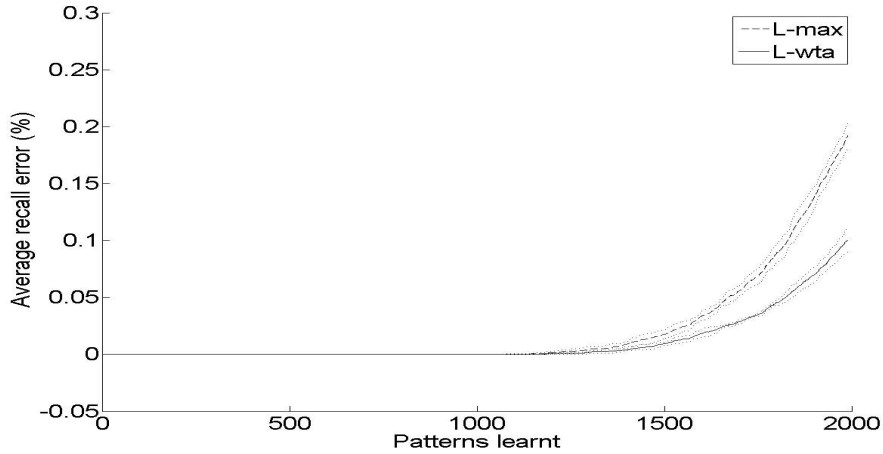
When retrieving information from a CMM technique used thresholding is used to cleanly retrieve it. This is biologically inspired and is similar to the activation potential in neurons in that the strength of response needs to be above a certain level before a piece of information is considered to have been retrieved.

LMAX thresholding seeks to specify the number of pieces of information that the system will try to retrieve.

The work conducted on the White Rose Grid was to look at an alternative mechanism for thresholding, called LMAX Winner-takes-all, or LMAX WTA [2]. This system considers different parts of a CMM to be providing different parts of the total information and modifies the thresholding strategy

Results





WRG Contribution

The WRG provided valuable support in providing a framework on which to conduct the simulations easily, quickly, and with sufficient resource.

References

[1] E. B. Baum, F. Wilczek, J. Moody, “Internal Representation for Associative Memories”, Biological Cybernetics, 1998, Vol. 59, pp. 217-228

[2] S. Hobson, J. Austin “Improved [2] Storage Capacity in Correlation Matrix Memories Storing Fixed Weight Codes”, Proceedings of the 19th International Conference on Artificial Neural Networks, Lecture Notes in Computer Science 5768, pp. 728-736, Springer-Verlag, 2009

Further Information

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