Map Recall based on Hierarchical Associative Memories

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Abstract

During recent years, artificial neural networks turned to be quite popular even in areas like cartography or navigation where processing of huge amounts of high-dimensional spatial data is needed. In this context, the data may represent geographical maps, plans of buildings, etc., which lead us straight to use similar ideas for autonomous devices operation and control.

When a person moves along a scenery, he/she can usually see only a very close surrounding. Based on his/her previous knowledge about the whole area, he/she might be able to recall also some part of environment which he/she does not see yet, but will see soon as he/she moves. We call such a recall process "path prediction". If we could formalize and algorithmize this process, we might nicely use it when building an autonomous robot. It would help a lot with robot localization and thus its better overall control in usage tasks where repetitive action in known environment is needed, e.g. an autonomous "warehouse keeper", a postman in a factory, automatic hoover etc.

In our paper, we show how strategies for path prediction in spatial maps can be based on associative memories, for which purpose a model of the so-called Hierarchical Associative Memory model (HAM) was designed.

We started with standard associative memory (AM) model, but because of the nature of this problem we had to change this direct approach. To avoid the limitations which made the AM model nearly useless (correlated data and high number of stored patterns), we used an idea similar to a Cascade associative memory (CASM) layout. Based on it, we have built a hierarchy of associative memories which we call the Hierarchical Associative Memory model.

The HAM-model comprises an arbitrary number of associative memories grouped hierarchically in several layers. A suitable strategy applied during training the networks by dynamical adding of "local" associative memories to existing layers can allow a reliable storage and recall of larger amounts of spatial data. At the same time it enables storage of mutually highly correlated data, in contrast with standard associative memory models which work well with orthogonal data but easily fail when the data loses orthogonality.

Some experimental results will be briefly discussed, too.