***Software Engineering***

***By Damric Dobric/Andreas Pech***

*Migration of video learning project*

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*Abstract*: This paper represents an improving machining learning algorithm Hierarchical Temporal Memory (HTM) which is using Spatial pooler for learning Video data. The SP model shows how neurons learn by feedforward connections and form effective classification of the input frame. It converts binary input pattern into space distributed representation (SDR) by using Cortical Learning rules and homeostatic plasticity control for frame pattern prediction. The result of the learning is tested by giving the trained model an arbitrary image, the model then tries to recreate a video with proceeding frame after the input frame.

Keywords—homeostatic plasticity controller, formatting, division into frames, prediction, training & testing

# **Introduction**

The HTM (Hierarchical Temporal Memory) is based on “Thousand Brains Theory” which explains how an object behaviors and high-level concepts gets tightly replicated across a cortical column but not only on the top layer and gets distributed throughout the neocortex. Here spatial pooler involves different computational principles of the cortex. It depends on competitive Hebbian learning, homeostatic excitability control, topology of connections in sensory cortices and structural plasticity. The HTM Spatial pooler is developed in such a way to achieve a set of computational properties which includes 1. Preserving topology of the input space by mapping similar inputs to similar outputs 2. Continuously adapting to changing statistics of the input stream 3. Forming fixed sparsity representations 4. Being robust to noise and 5. Being fault tolerant that supports computations with SDRs (Sparse Distributed Representations). The output of the SP which is the integral component of HTM can be easily recognized by downstream neurons and contribute to improved performance in the end-to-end HTM system.

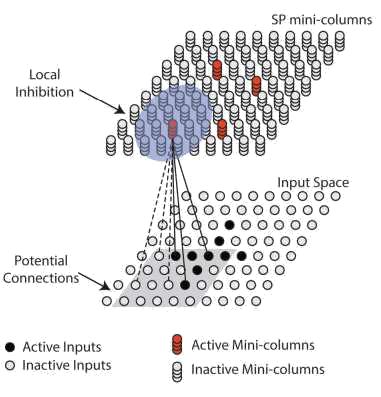


Figure 1. The process of spatial pooling

SP plays a vital role in HTM networks. The task of SP is to transforms input patterns into Sparse Distributed Representation in a continuous way in end-to-end HTM system. The temporal sequences of these SDRs is learned by the HTM and do some prediction for the upcoming inputs. A single layer in HTM network is consist of a set of mini-columns which is consist of cells. Here the figure 1. shows that the HTM spatial pooler converts inputs at bottom to SDRs at top. Each SP mini-column (Active mini-columns and inactive Mini-columns) forms synaptic connections to a subset of the input space which is consist of gray square and potential connections. A local inhibition technique gives confirmation that within the local inhibition radius (shaded blue circle) a small fraction of the SP mini-columns that receive most of the inputs are active. According to the Hebbian rule Synaptic permanences are adjusted like this for each active SP mini-column, active inputs (black lines) are reinforced and inactive inputs (dashed lines)are punished.

At the time of building intelligent systems to mimic human intelligence and cognition, we must pay serious attention to sequences, including sequence learning as sequential behavior is essential to intelligence. In the task of time series prediction, video analysis and musical information retrieval, a model must learn from inputs that are sequences. Another important concern in sequence learning is hierarchical structuring of sequences. Many real-world problems that have sequences are involved with clear hierarchical structures like a sequence is made up of subsequences and they in turn are made up of sub subsequences and so on. By removing the difficulty to identify automatically these subsequences and deal with them accordingly which is related to temporal dependences, learning hierarchical structures help to reduce or eliminate temporal dependencies. It helps to compress the description or sequences.

Sequence learning is not a easy task. Sequence learning are needed powerful algorithms. Sequence learning which indicates either generation, prediction or recognition is usually based on the models of legitimate sequences which can be developed through training with exemplars. Hierarchical Temporal Memory proposed new computational learning models, Cortical Learning Algorithms (CLA), that is inspired from the neocortex which offer a better understanding of how our brains function. CLA mimics the procedure of human brain how to achieve pattern recognition and make intelligent predictions. The CLA processes the streams of information, classify them, learning to identify the differences and using time-based patterns to make predictions as like as performed by the neocortex in humans. But the place of time is significant in case of learning, inference and prediction. The temporal sequence is achieved from HTM algorithm from the stream of input data. Here Afterwards the result of the learning is tested by giving the trained model an arbitrary image, the model then attempts to recreate a video with proceeding frame after the input frame.

This type of works forecasting that Machine Learning (ML) or statistical modelling emphasis here is to enable the reader to understand on some of ML or statistical techniques actively used in past and till the present moment.

# Mthods

## Creating Video Files

There are different ways to create training videos of object recognition but we chose to create our object videos. As we worked on the previous “[**neocortexapi-videolearning**](https://github.com/ddobric/neocortexapi-videolearning)” project we had video data set for recognizing circle, triangle and rectangle. With the help of previous python [codes](https://github.com/ddobric/neocortexapi-videolearning/tree/main/DataGeneration) we created training video-set for a line moving around the 120x120 frame.

## Reading Video

To train a video to a machine learning program one has to divide it into picture frames. As like brain, frames are the point of reference to the recognition program.

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may use the solidus ( / ), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in:

*a**b* 

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* In your paper title, if the words “that uses” can accurately replace the word “using”, capitalize the “u”; if not, keep using lower-cased.
* Be aware of the different meanings of the homophones “affect” and “effect”, “complement” and “compliment”, “discreet” and “discrete”, “principal” and “principle”.
* Do not confuse “imply” and “infer”.
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* There is no period after the “et” in the Latin abbreviation “et al.”.
* The abbreviation “i.e.” means “that is”, and the abbreviation “e.g.” means “for example”.

An excellent style manual for science writers is [7].

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| Table Head | Table Column Head | | |
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2. Example of a figure caption. (*figure caption*)

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##### Acknowledgment *(Heading 5)*

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B. G. thanks...”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

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