

WHAT IS COGNIMEM?

CogniMem stands for Cognitive Memory and is a breakthrough technology for cognitive computing including pattern recognition and classification, as well as anomaly and novelty detection, etc. CogniMem is a parallel neural network which implements classifiers suitable for both fuzzy matching and exact matching.

A CogniMem recognition engine can be considered as an expert system which can recognize and classify patterns and make instantaneous decisions based upon accumulated knowledge. The patterns can derive from any type of data source such as images, sound, signal, discrete measurements, etc.

A CogniMem recognition engine is easy to deploy

- Learns by examples
- Recognizes by association
- No programming, no modeling

A CogniMem recognition engine can solve complex problems

- Addresses non-linear or ill-defined problems
- Adapts to context variations
- Parallel architecture allows expanding the network as needed

A CogniMem recognition engine can solve real-time problems

- Compares one pattern among virtually any number of patterns in microseconds
- Learns a new pattern in a few microseconds

A CogniMem recognition engine can be cloned

- The contents of the neurons represent a knowledge (built by the neurons themselves)
- It can be viewed meaning that the neural network is not a "black box"
- It can be saved which makes it portable

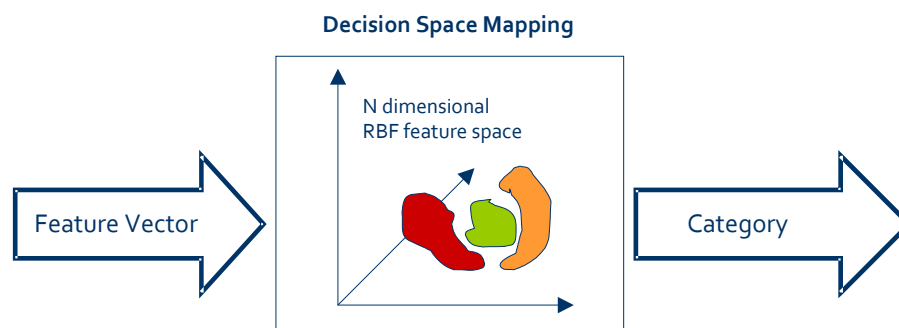
THE ORIGINAL SPECIFICATIONS OF THE CHIP

A component capable of automatic learning and recognition just like the human brain

- Neurons are identical cells with their own memory, recognition logic and learning logic
- Neurons work simultaneously without any controller or supervisor
- Neurons calculate simultaneously the distance between the model stored in their memory and a new input pattern
- A neuron is capable of knowing if it holds the smallest distance and is consequently a "best match" for the input pattern
- Neurons are capable of adaptive learning
- A new neuron is committed only when an example represents novelty
- Committed neurons contradicting a teacher correct themselves automatically
- The knowledge built by the neurons can be saved and expanded at any time

HOW DOES COGNIMEM WORK?

CogniMem implements the K-Nearest Neighbor (KNN) and Radial Basis Function (RBF) classifiers. The neural network is trained "by example" from data samples associated with user-defined categories. Its generalization capability allows it to react correctly to objects or situations that were not part of the learning examples. It is capable of additional learning while performing classification tasks.



The vectors fed to the engine result from the extraction of features of interest describing the objects or pattern to recognize. In the case of image recognition, these features can be rough pixel values in an $N \times N$ area, a histogram, the intensity profile along a cross-section, texture and spatial frequency quantifiers, etc.

LEARNING

Learning consists of mapping the space by prototypes and adjusting their influence fields according to all neighbors. It requires that the category of the vector be fed to the network. The learning mechanism rearranges the prototypes of the network as a function of the proximity between the new input and the existing space map. Several prototypes may be associated with the same category, and influence fields can partially overlap each other. The more vectors that are learned - the better the knowledge of the feature space.

In learning mode, presenting a vector and its category to the network can result in:

- No change in the network content
- The new prototype is stored in the network
- Modification (reduction) of the influence fields of one or more neurons

RECOGNITION

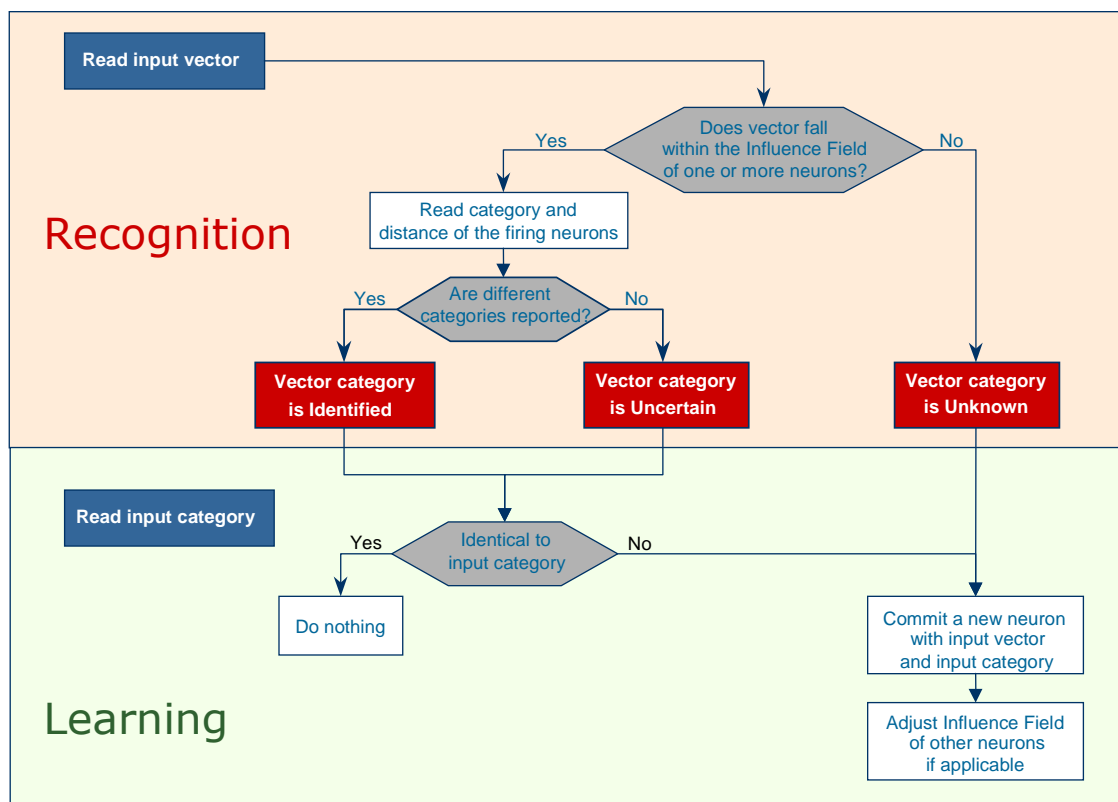
Recognition consists of evaluating whether or not an input vector lies within the influence field of any prototype stored in the network. This is done by computing the distance between the input vector and all stored prototypes, and comparing it to the influence field associated with the prototype.

CogniMem, from Technology to ASIC TECHNICAL BRIEF

In recognition mode, presenting a vector and its category to the network can result in the following decisions:

- The vector does not lay within any influence fields. It is not recognized.
- The vector lies within the influence field of one or more prototypes associated with one category. It is identified as belonging to that category.
- The vector lies within the influence field of two or more prototypes associated with different categories. It is declared as recognized but not formally identified.

CogniMem always attempts to recognize a vector prior to adding it to its existing knowledge



THE RELEASE OF THE CM₁K

The concept of CogniMem was invented in 1993 by Guy Paillet, one of the founders of CogniMemTechnologies, Inc. and implemented in a collaborative effort with IBM into an ASIC trademarked by IBM as the Zero Instruction Set Computer (ZISC) chip. Two generations of ZISC were released: ZISC36 with 36 neurons in 1993 and ZISC78 with 78 neurons in 1999. Unfortunately, IBM discontinued the manufacturing of the ZISC chip in 2001.

CogniMem, from Technology to ASIC TECHNICAL BRIEF

In 2007, Guy Paillet and Anne Menendez (also a founder of CogniMemTechnologies) started the design of a replacement for the ZISC. The goal was to fit one thousand (1K) neurons per chip and add features to the architecture. OKI was contracted to manufacture the ASIC and the first batch of CM1K chips was produced in January 2008.

Like its predecessors, the CM1K uses patents applied for jointly by Guy Paillet and IBM during the development of the ZISC chip.

Description	US
Improved neuron circuit architecture	US-5717832
Daisy chain circuit for serial connection of neuron circuits	US-5710869
Circuit for pre-charging a free neuron circuit	US-5701397
Circuit for searching/sorting data in neural networks	US-5740326

UNMATCHED SPEED PERFORMANCE

Thanks to the CM1K parallel architecture, the recognition of a vector is executed in a constant number of clock cycles regardless of the number of prototypes stored in the neurons. The recognition of a 256-bytes vector takes 3 µsec whether the entire network is composed of 1024 or one million neurons.

UNLIMITED NETWORK SIZE

Thanks to the CM1K parallel architecture, many chips can be daisy-chained and connected to the same parallel bus. This means no theoretical limit to the size of knowledge that the neurons can build. The expansion of the network does not require any external logic, only resistors and eventually re-powering the chips.

TWO WELL-KNOWN CLASSIFIERS IN A SINGLE CHIP

The neurons of the CM1K chip can classify a vector using a Radial Basis Function classifier or a K-Nearest Neighbor classifier. This selection is made through a bit of the CM1K status register. In either case, the recognition of a vector broadcasted to all the neurons is available after 1.3 µsec. The first response is considered the best match. Additional matches (up to K), if applicable, can be read every 1.3 µsec.

SAVE/RESTORE

The CM1K chip can operate in a save-and-restore mode which allows saving and loading the content of the neurons. As a consequence, the knowledge built by training the neurons of a CM1K chip can be transferred to the neurons of another chip.

NETWORK SUB-SETTING

The context attribute of the CM1K chip permits one to subdivide the network into independent sub-networks. This feature can be used to build multi-layer networks where decisions of one layer feed the vector input of a second layer, by time-multiplexing the inputs.