CogniMem, Recognition Basics
TECHNICAL BRIEF

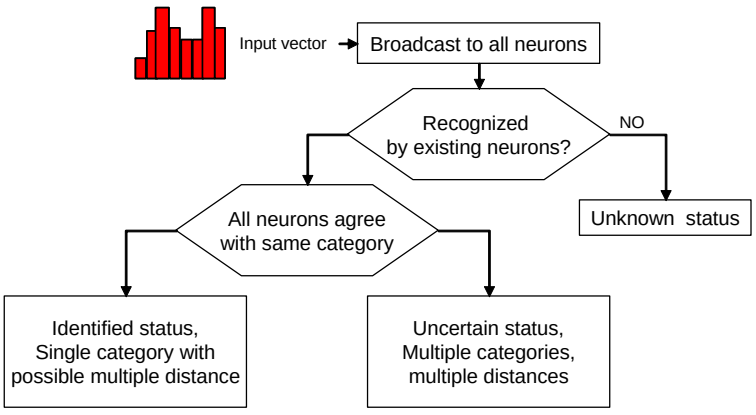
Using the neurons of the CogniMem chip to recognize a vector is very simple thanks to their parallel architecture. The operation consists of broadcasting to all the neurons at once the components of the vector and then read their replies in sequence. The first reply is the response of the neuron with the best match and it can read the neuron category, distance and identifier. The second reply comes from the neuron with the second best match, etc.

The purpose of this Technical Brief is to demonstrate how easy it is to recognize a pattern from a developer's standpoint, but you are welcome to refer to the CogniMem Decision Space Mapping Manual and CogniMem Reference Guide (see Reference Tab on CogniMem's website) for more information about the neural network concept and architecture, the use of multiple neural networks to address applications with a high cost of mistakes, and more.

A SIMPLE RECOGNITION MECHANISM

When a vector is broadcasted to the neurons, they automatically evaluate the distance between this vector and the one stored in their memory.

- If the distance is smaller than the neuron influence field, the neuron fires and is ready to report the values of its distance and category registers.
- If the distance is higher than the neuron influence field, the neuron removes itself from the list of firing neurons.
- Once a firing neuron has reported its distance and category, it removes itself from the list of firing neurons.
- A firing neuron reports its distance and category when it has the smallest distance in the list of the firing neurons (this intrinsic knowledge is a critical patent of the CogniMem chip).



THREE LEVELS OF RECOGNITION OUTPUTS

1. Best match: For applications with low cost of a mistake, the category of the neuron recognizing the input vector with the smallest distance can be sufficient.

2. Recognition status only: For applications such as novelty detection and predictive maintenance where the sole objective is to identify if the input vector is *recognized* or *unknown*. The status can be either *identified* (all firing neurons are in agreement), *uncertain* (several neurons fire but they do not report the same category), or u*nknown* (no neuron fires).

3. Detailed recognition with a readout of the reply of the N top firing neurons in order to detect redundancies and increase the confidence level of the response. For applications with high cost of a mistake, the response of several or all the firing neurons can be read out. A final classification can then be established using different rules and criteria such as probability of occurrences, dispersion of the distance values, etc.

CM1K SPECIFICS

Recognizing a vector of N components if made with N+1 Write commands is described in the following table:

Description	RTL Commands	Timings
Broadcast the N-1 components	For (i = 0; i<N-1; i++) Write CM_COMP, Vector(i);	N-1 clock cycles
Broadcast the last component	Write CM_LCOMP, Vector(N)	3 clock cycles
Read the Status Register	Read CM_NSR, value	1 clock cycle
Read the distance of top firing neuron	Read CM_DIST, value	18 clock cycles
Read the category of top firing neuron	Read CM_CAT, value	1 clock cycles if ID 19 otherwise
Read the identifier of top firing neuron	Read CM_NID, value	1 clock cycles