A new era for cognitive computing is around the corner

"Cognitive Computing"

Be part of the change!

View the video of the presentation
Given at Sonoma State, March 2013

What is computing (km-pyt)?

Blood to data

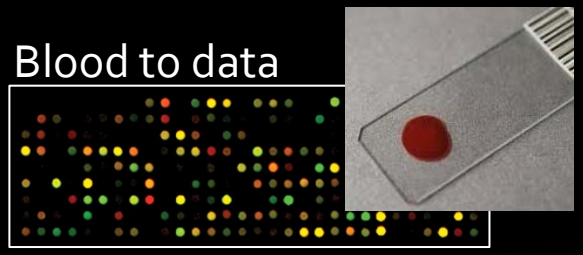
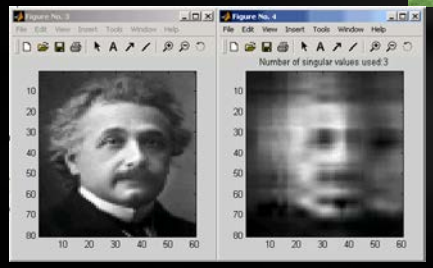


Image Analytics

3D rendering

Video Analytics/
Stereoscopy

Data Storage/
Compression/
De-Duplication



Data Transmission
Packet filtering

Sound/Vibration

EKG/EEG

Bioinformatics

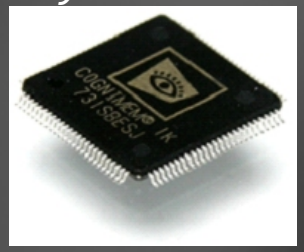
Intelligence “is memory”

The neo-cortex is a very large parallel database which is built during our lifetime and whose neurons react to queries or "auto-queries" (chain reaction of thinking) and indeed external stimuli by the senses

Today’s mainstream computer architecture is limited to imitate the biology
-centered around fast processors accessing memory locations at high speed but only one at a time.
-single pipe access and/or task distribution and synchronization with the "fetch/decode/execute model".

- IBM has recently re-embraced the Cognitive Computing approach, but…

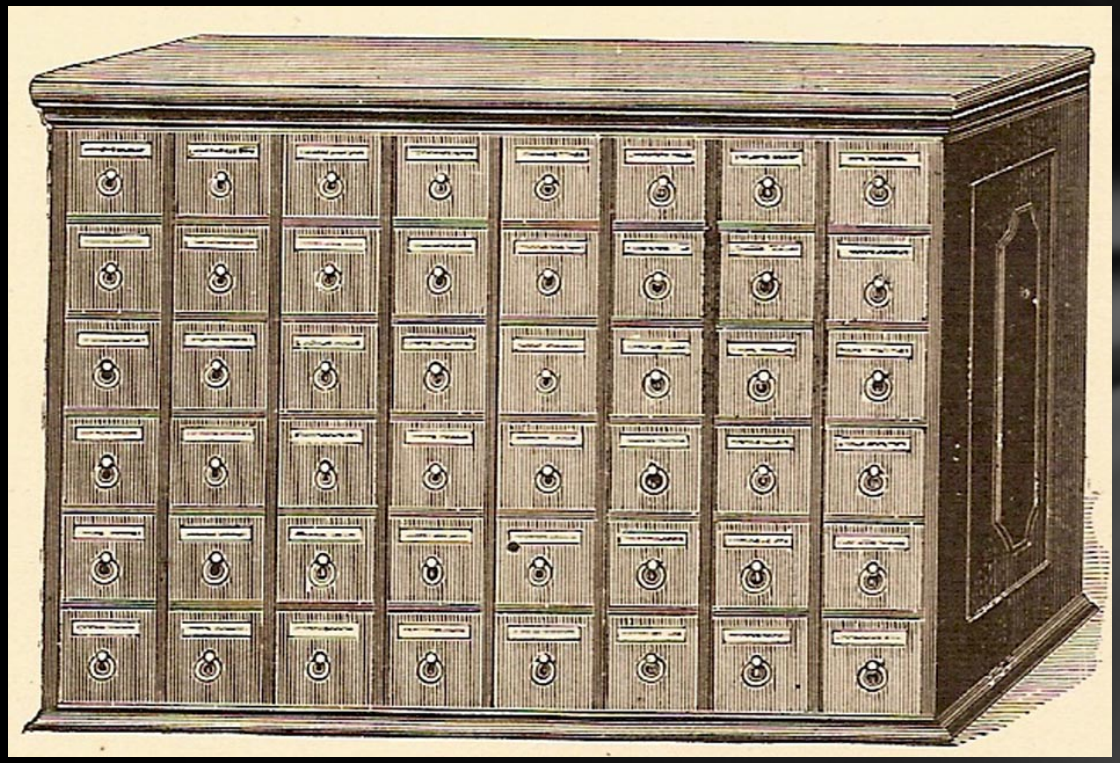
-A solution already exists: a Cognitive Memory chip (CM1K) where the information is stored into each memory node, but instead of being a "submissive memory" waiting being visited by the processor(s), it reacts to a query or stimulus which is broadcasted to all memory nodes in parallel.



The memory model misunderstanding

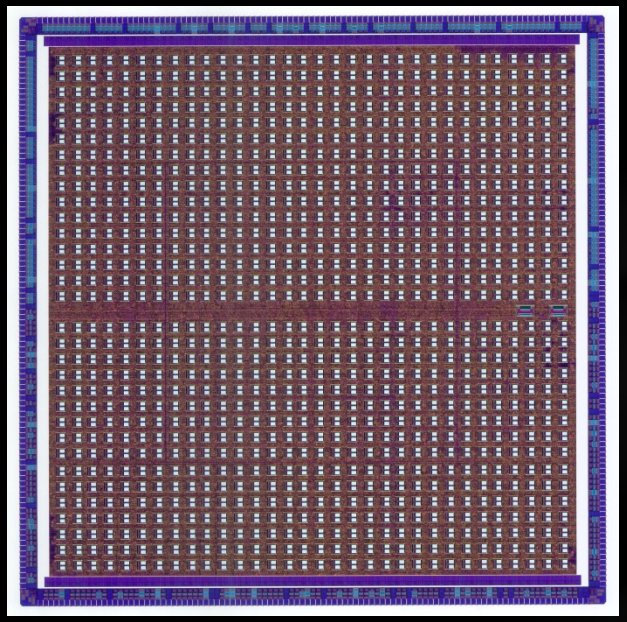
- In the neo cortex a stimulus or pattern is “broadcasted” to all the neurons of biological subsystem
- In the “modern” computer the processor(s) core visit one memory location at a time for checking/retrieving the content

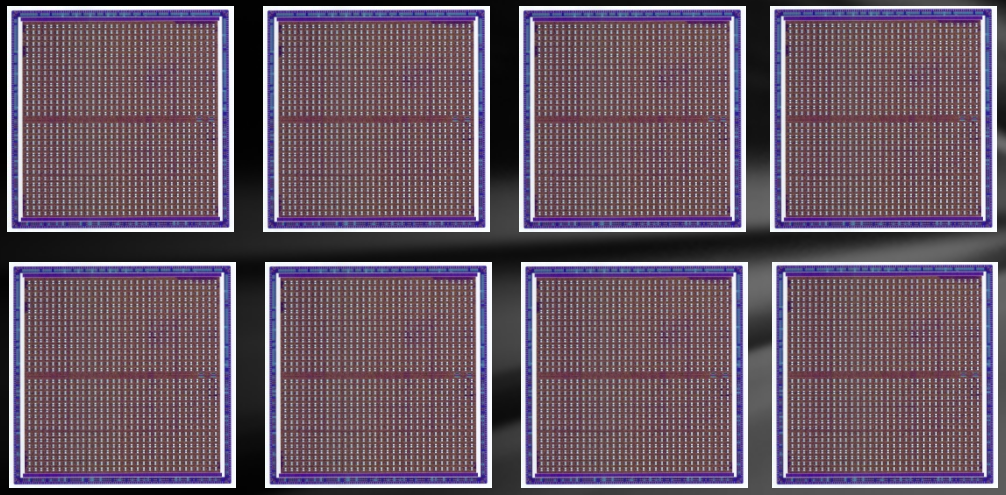
RAM (Random Access Memory) aka SAM (Single Access Memory)



You need to open each drawer sequentially until you find what you are looking for

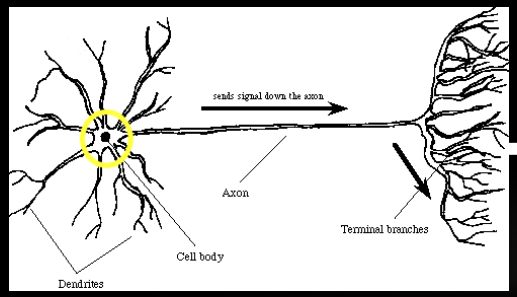
BAM (Broadcast Access Memory)





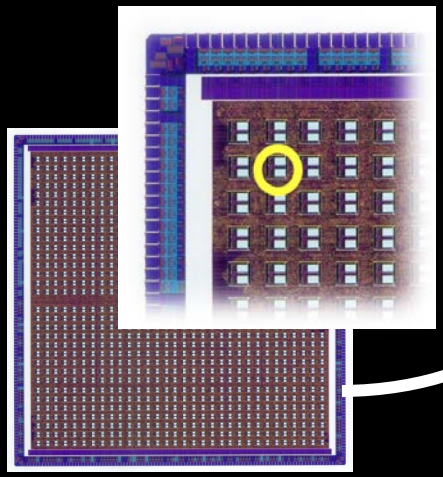
The memory cells with content matching your query will react.
Furthermore, if several cells react, they will politely order themselves per decreasing confidence value

Biology: Massively parallel wiring
Electronics: Time Domain Multiplexing

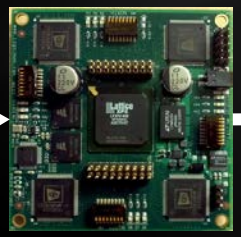


10 Billions neurons

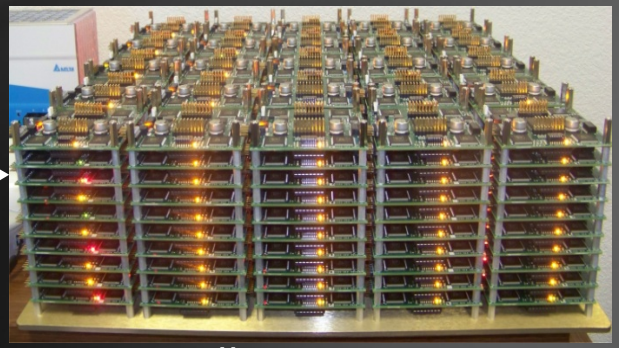
Low frequency, Low power



1024 neurons

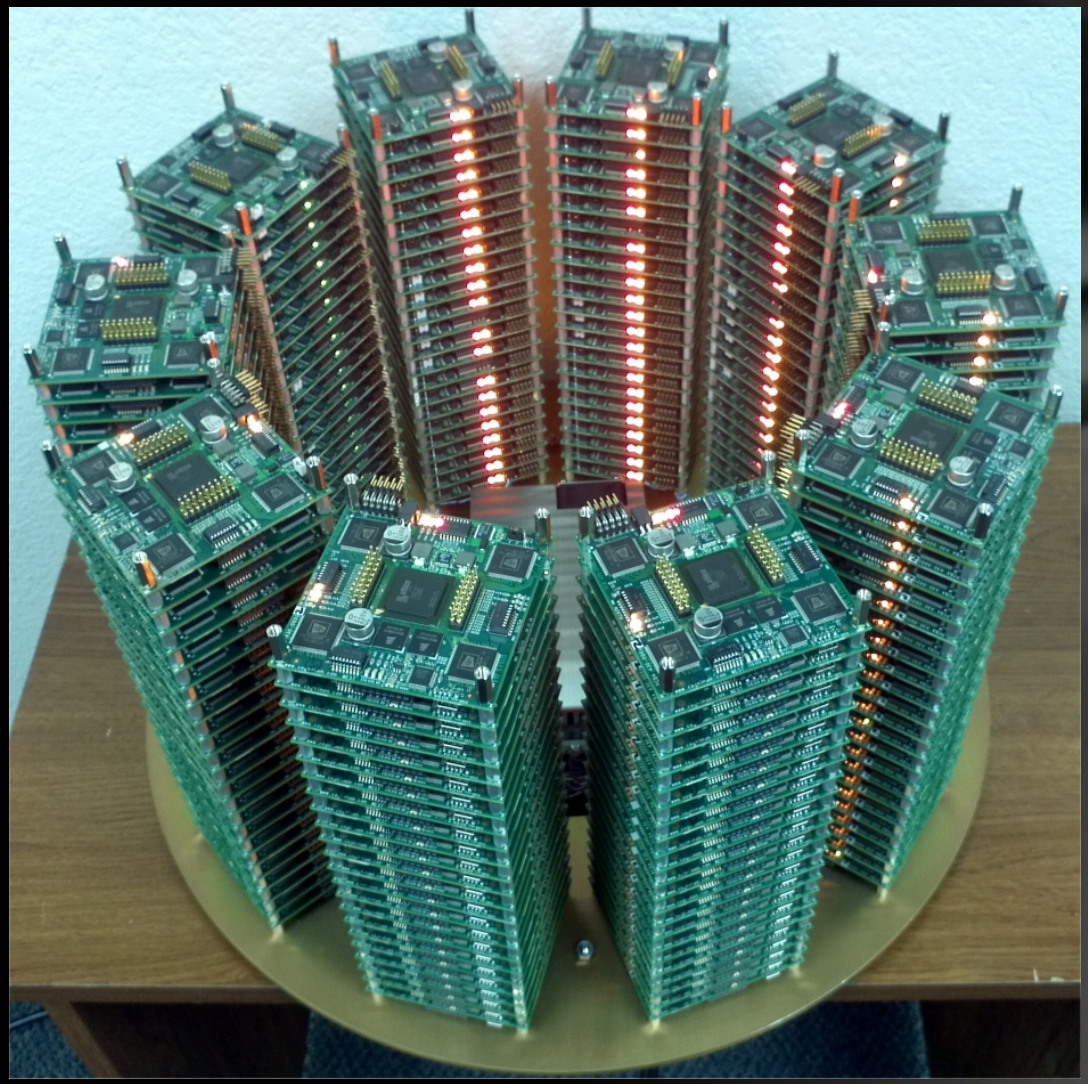


4096 neurons



1 Million neurons

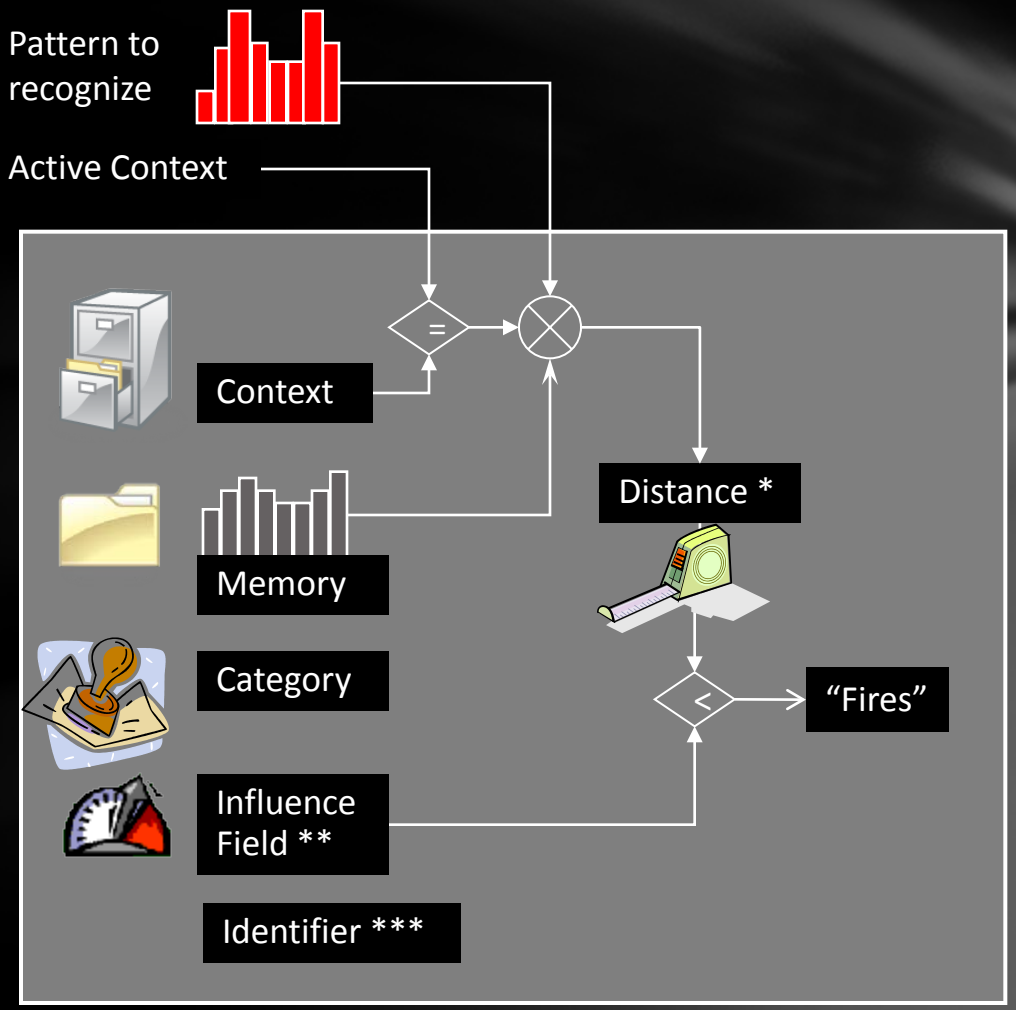
NeuroMem for high-end applications: for example, 1 million neurons (Cray style)



NeuroMem for embedded applications: Arduino UNO with 1024 neurons

What is a cognitive memory or neuron?

A neuron is a reactive memory which can autonomously evaluate the distance between an incoming vector and a reference vector stored in its memory. If this distance falls within its current influence field, it returns a positive classification.



• Calculated by the neuron during the broadcast of the input vector (read only)
•** Updated during the learning, if applicable
•*** Assigned automatically (read only)

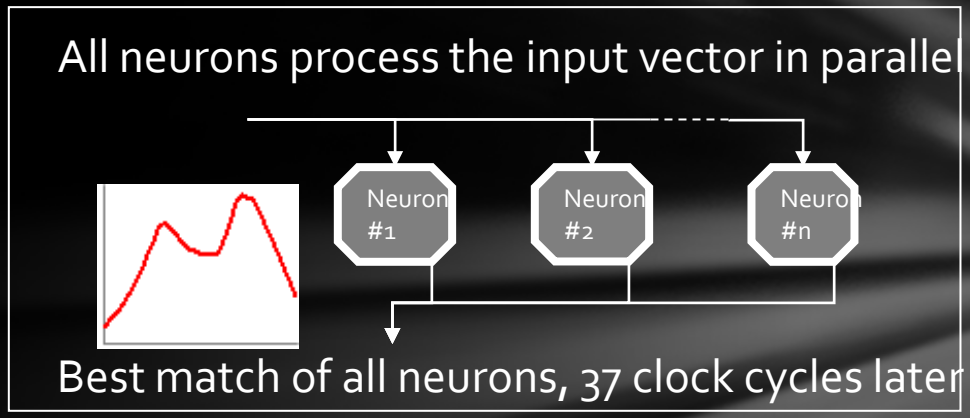
What is a neural network?

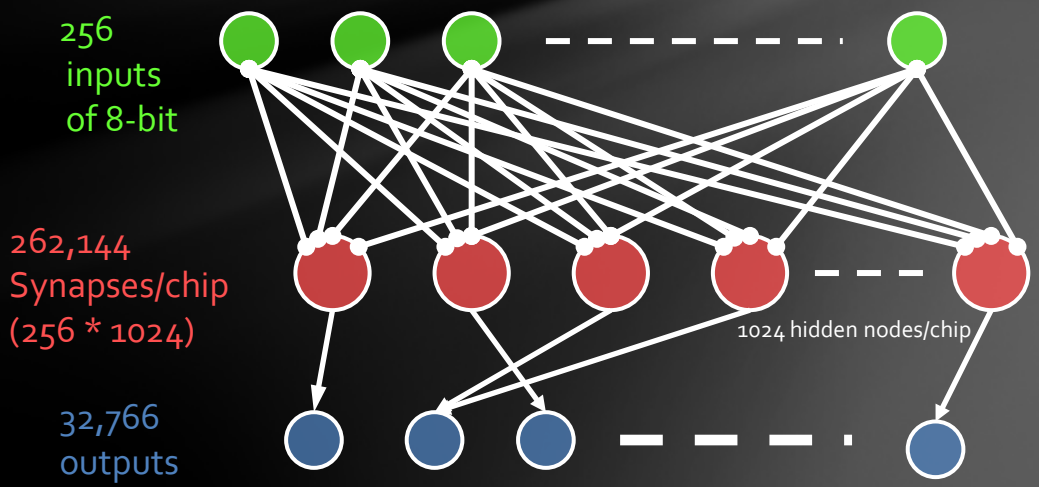
The true significance of a neuron is its arrangement into a parallel network and ability to Search-And-Sort for best match without sequential access.

The Winner takes All

→ Learn and recognize a vector in a constant amount of time independent from the number of neurons

→ Network can be expanded at will



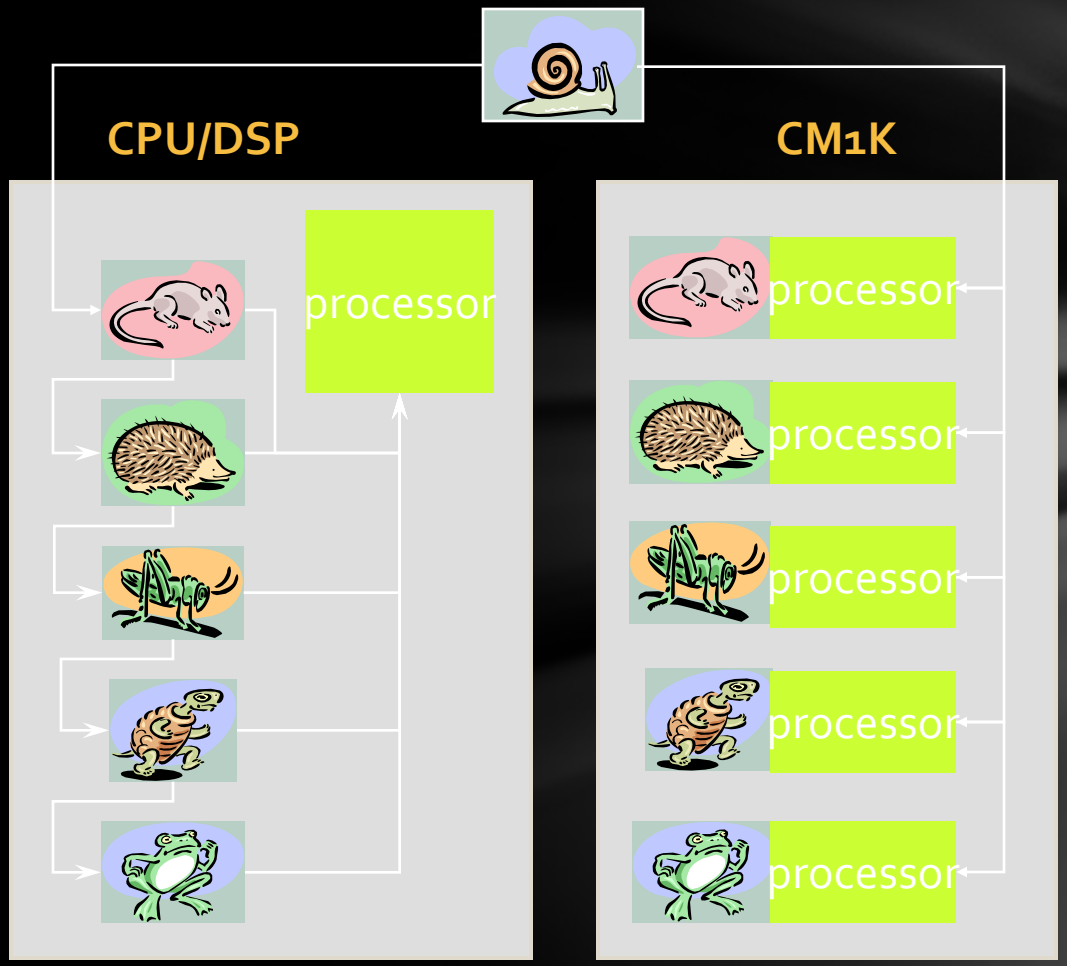


Equivalent to 3-layer network

CM1K, much faster than a CPU/DSP

1 processor for <u>many</u> memory entries

Recognition in n cycles per entry until the right one is found



1 processor for <u>each</u> memory entry

Recognition in m cycles ∀ number of entries