ZiCAM™ Technology Presentation

ZiCAM™ - Thinks like a human, Works like a machine

Introduction

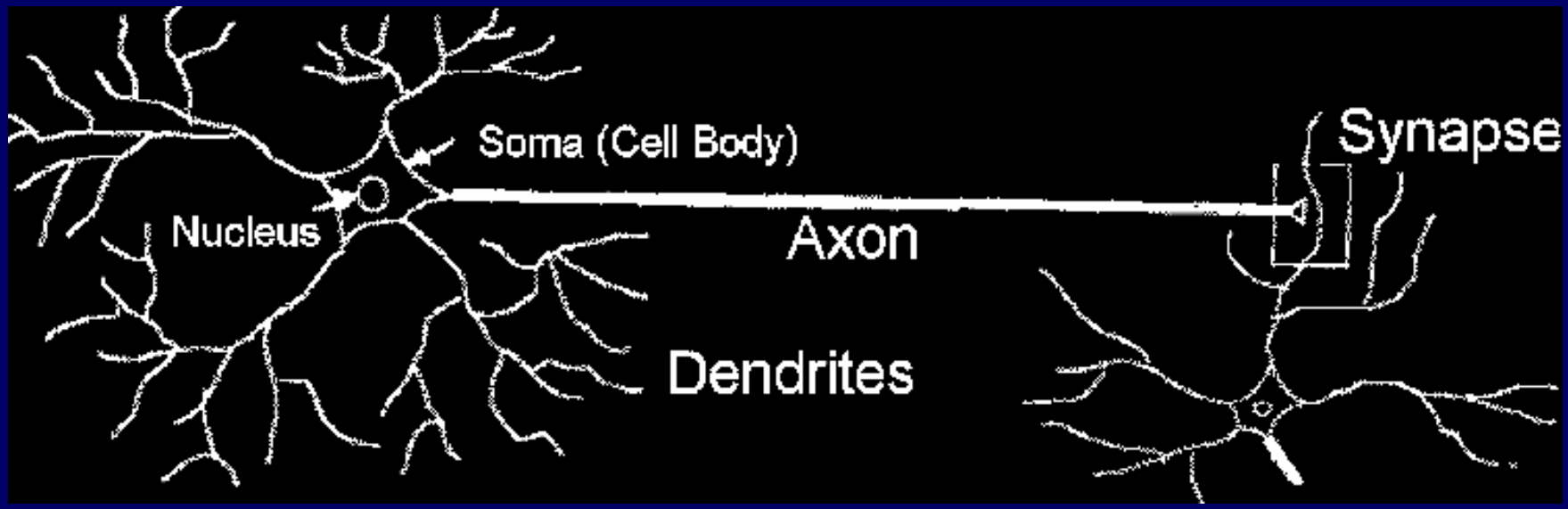
- Because of pressures to increase productivity and decrease costs, machine vision has been widely adopted by manufacturing operations.
- A limit to machine vision's acceptance has been the complexity of system training, coupled with the system's inability to perform inspections similarly to a human.
- A new neural network based "smart camera" is now available that:
  - Is taught by showing examples rather than programming
  - Mimics a humans ability to make "subjective" inspections.

ZiCAM™

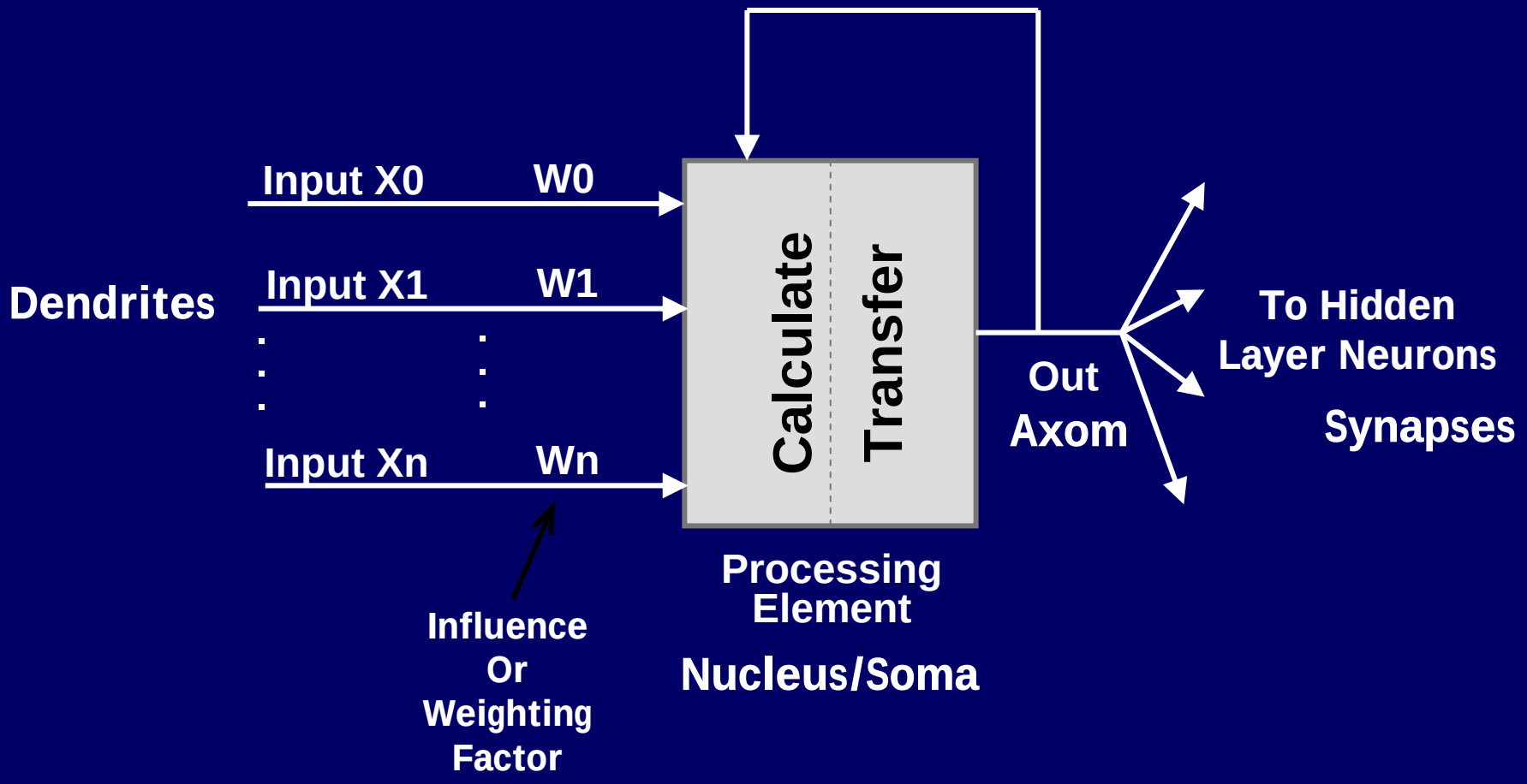
- The ZiCAM™ is a member of an entirely new family of neural network based Smart Cameras.
- The ZiCAM™ is architected on **Z**ero **I**nstruction **S**et **C**omputing or ZISC, which is a neural bank created on a single die of silicon.
- ZISC was developed and patented by Silicon Recognition Systems in partnership with IBM.
- The ZISC chips are implemented as part of a patented **Mu**lti-Media **Re**cognition **En**gine, or MUREN™

ZiCAM™ - Thinks like a human, Works like a machine

Biological Neuron

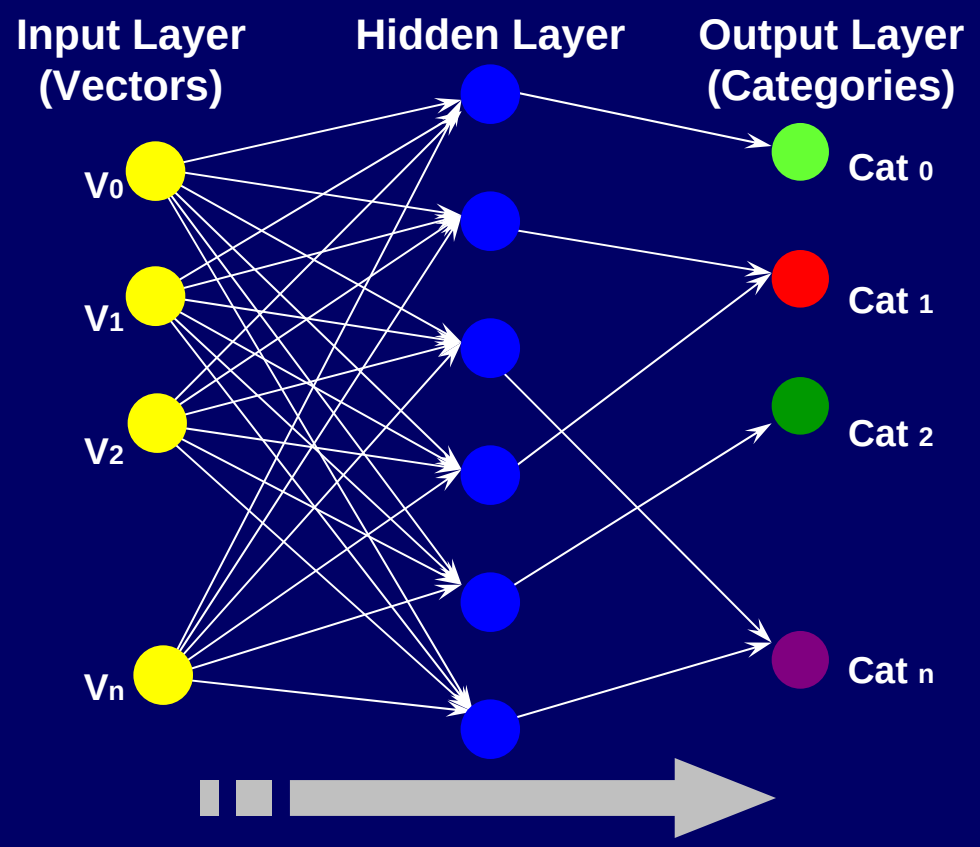


Hardware Neuron



ZiCAM™ Neural Network

- 3 Layer
  - Input
  - Hidden
  - Output
- Fully Connected
- Forward Propagating
  - (Feed forward)
- Reinforced, Supervised Learning



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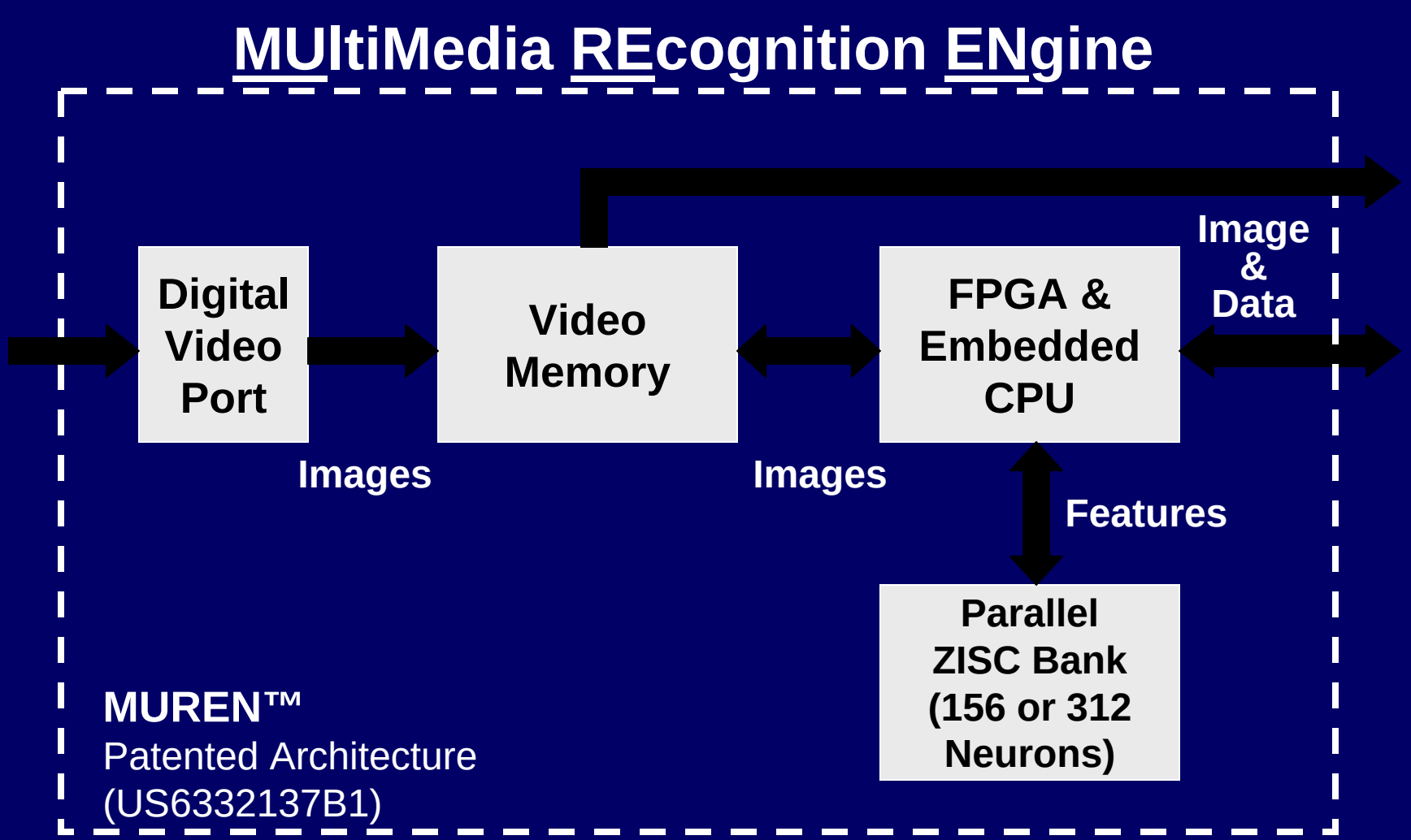
MUREN™ Engine



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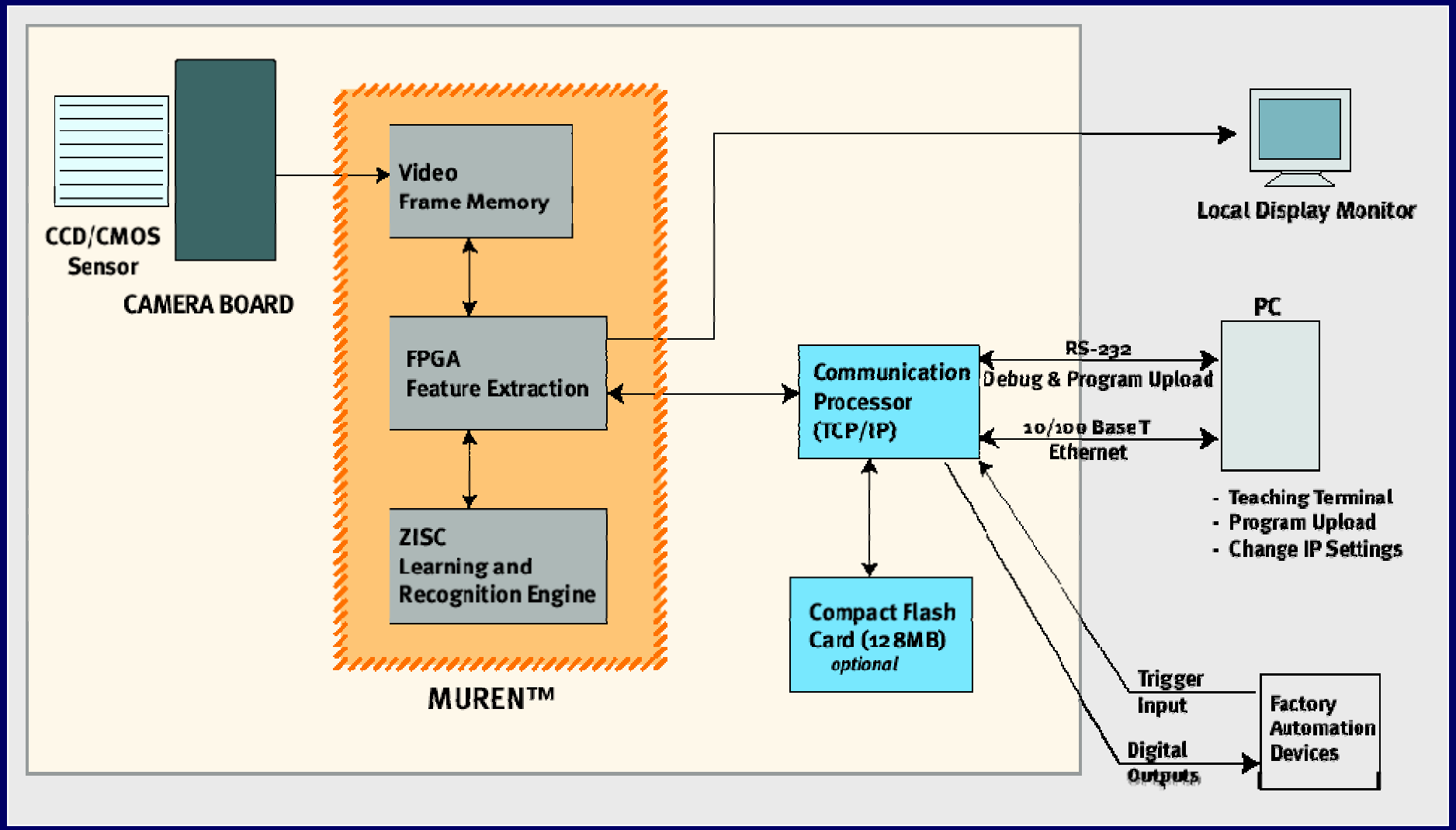
ZiCAM™ Block Diagram



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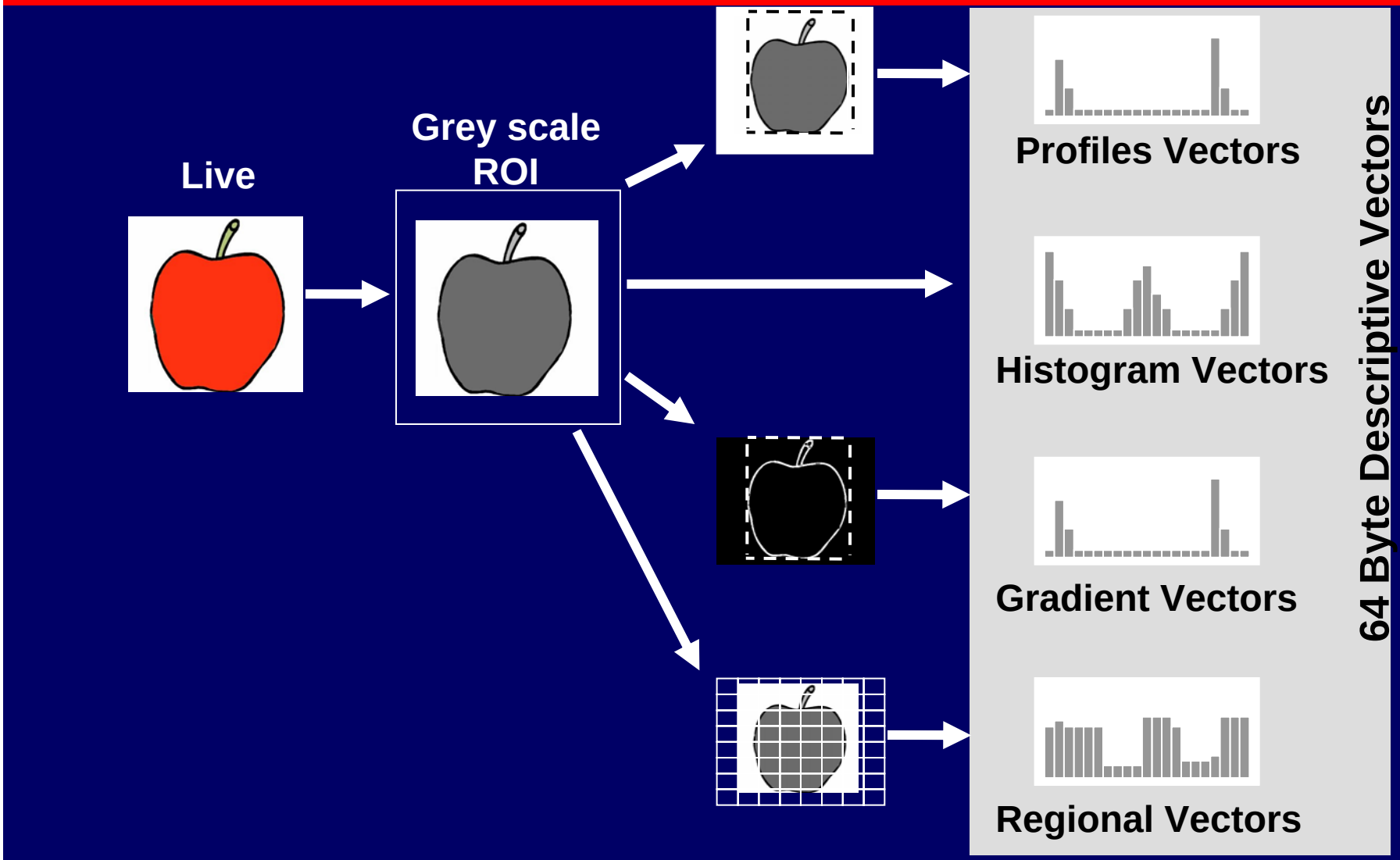
MUREN™ Vector Generation



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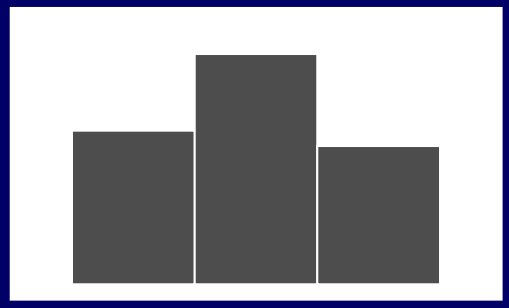
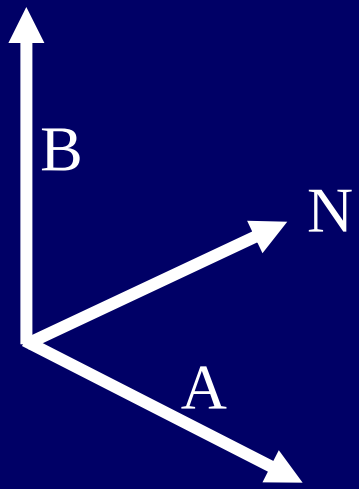
N-Dimensional Feature Space



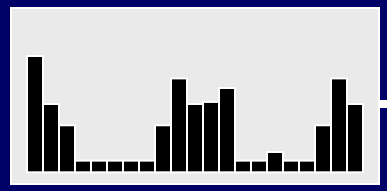
A B ... N

Vectors

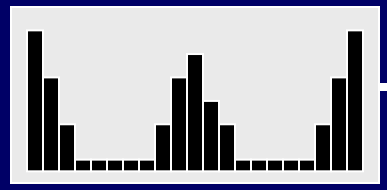
(Feature Space)



Hardware Implementation



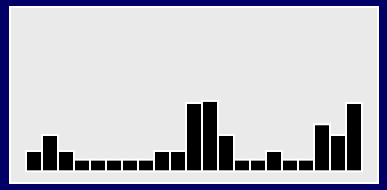
UUT Vector



Inputs

1) Prototype Model
2) Norm and Context
3) Category
4) AIF

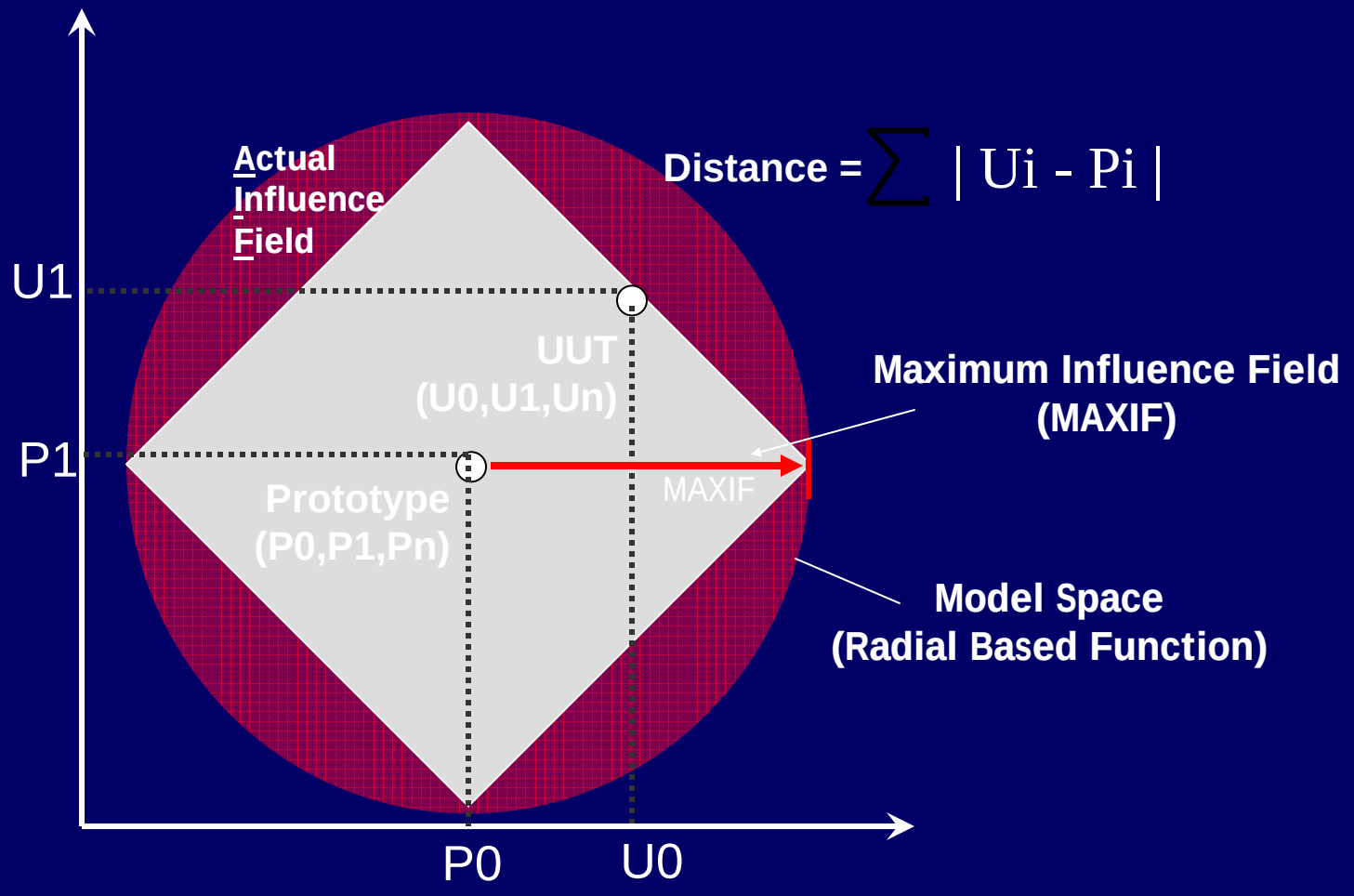
Neuron ALU



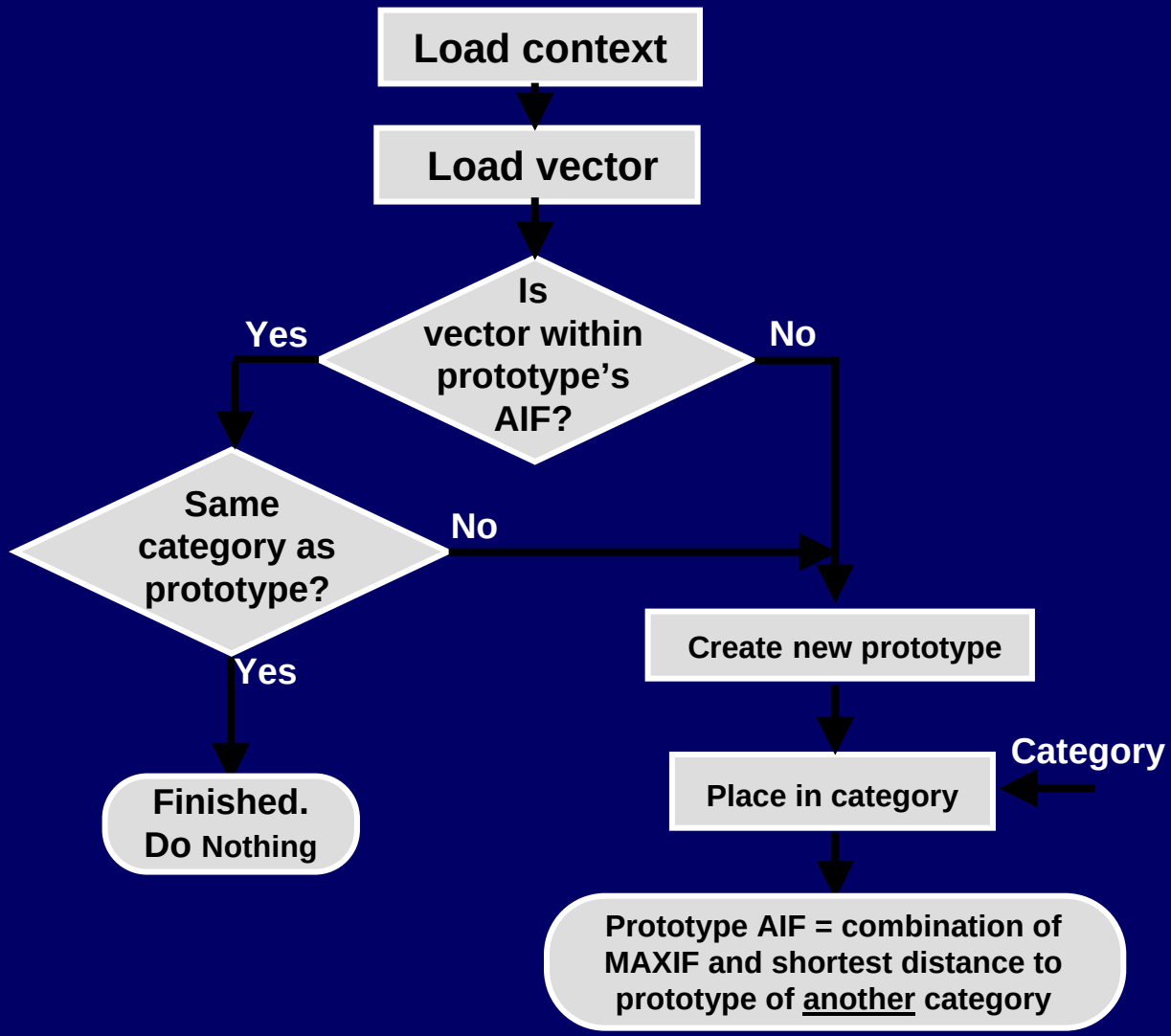
Result:
Total Calculated Distance

Single Neuron

Single Neuron
Distance Calculation



Teaching Process



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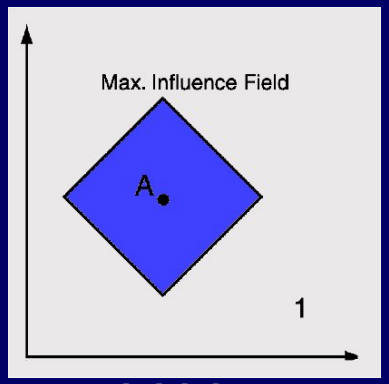
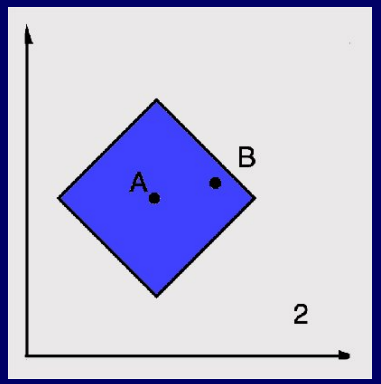
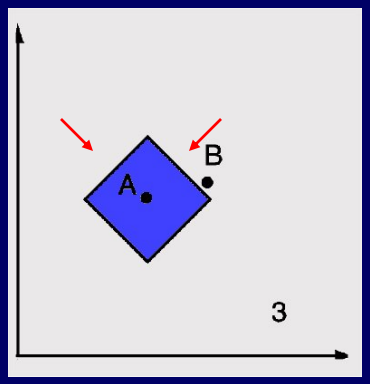
ZISC Learning Process



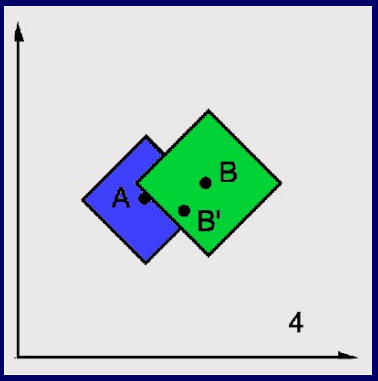
Create initial category A prototype with MAXIF.



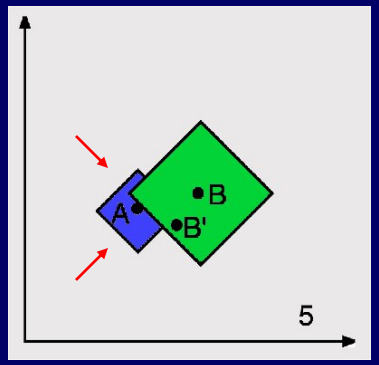
Introduce new prototype category B within A MAXIF



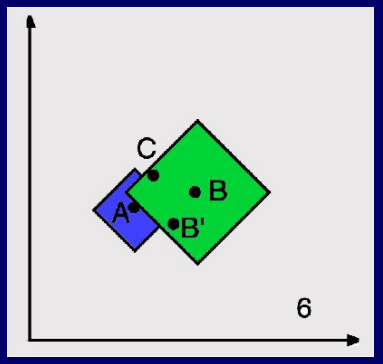
Shrink category A AIF until B is not included



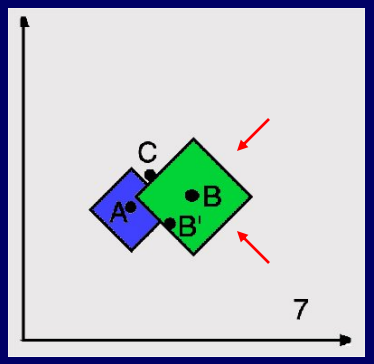
Introduce category B prototype with AIF set to exclude cat A.



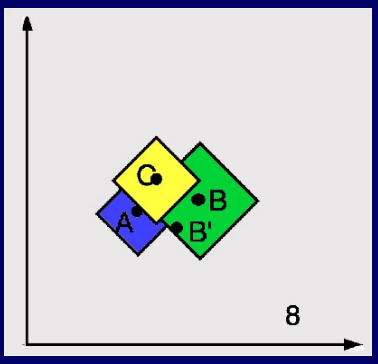
Shrink category A AIF until B' is not included



Introduce category C prototype which overlaps with cat B



Shrink cat B AIF until C is not included



Maximize category C prototype AIF to exclude cat A and B.

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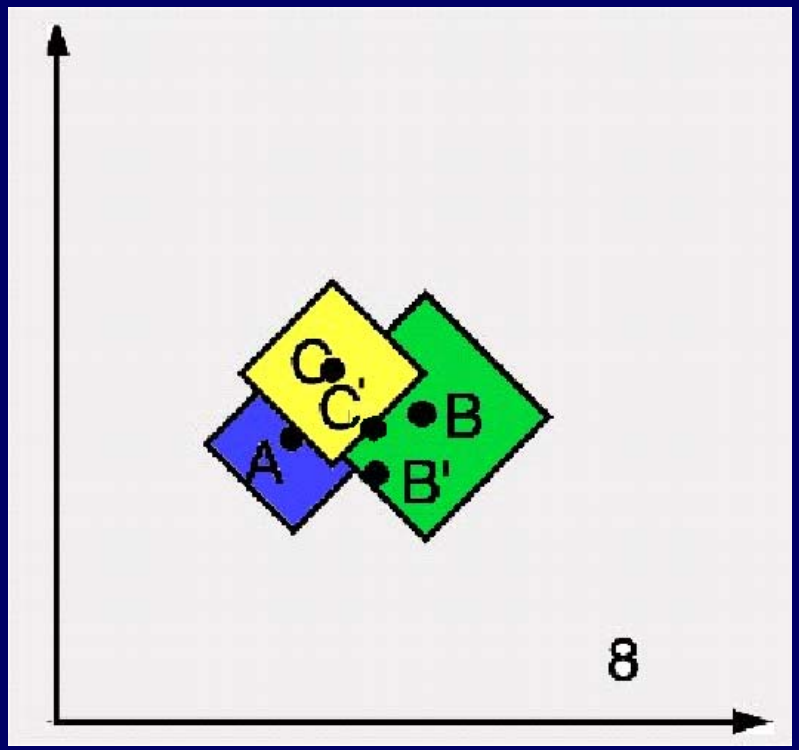
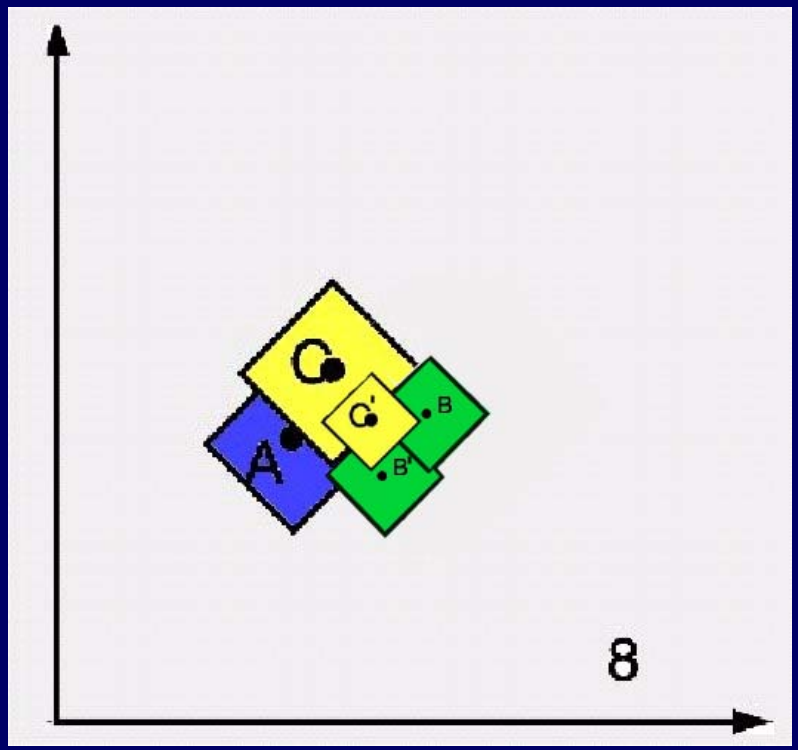
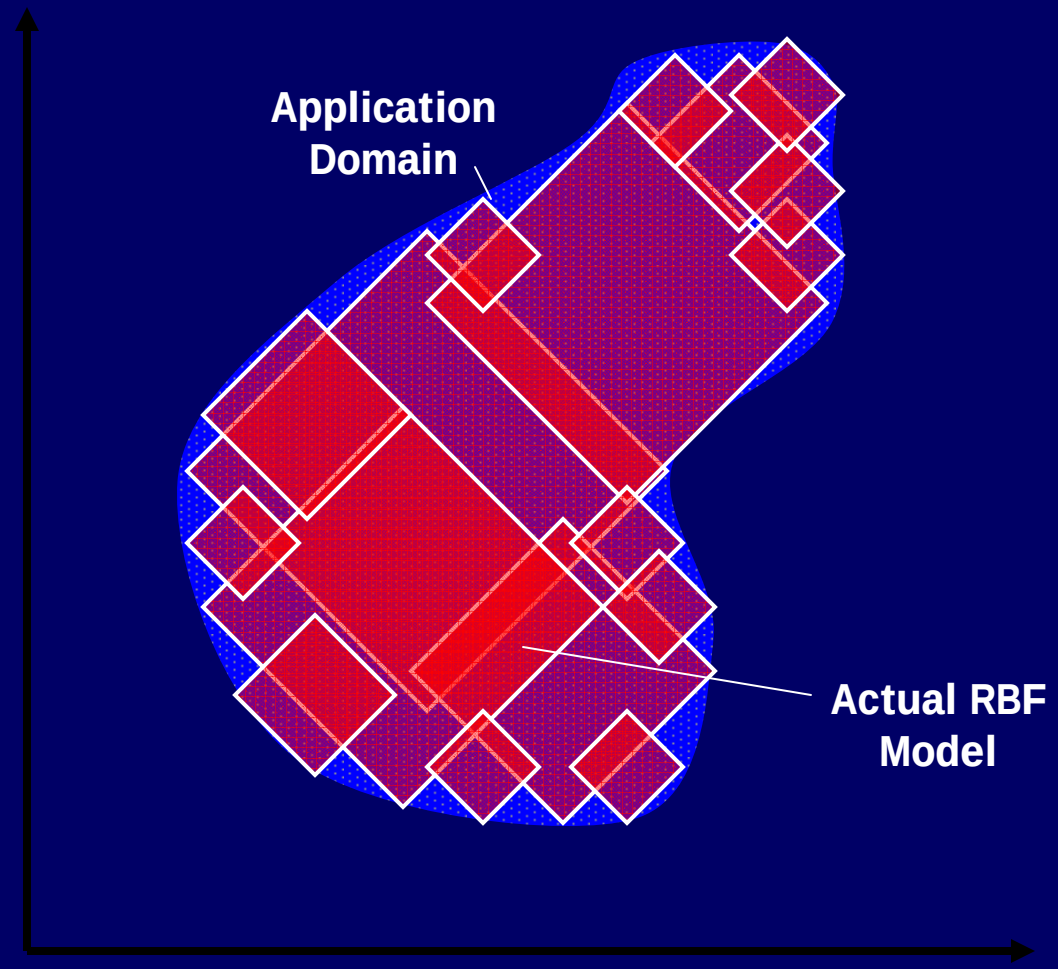
Automatic Neuron Addition

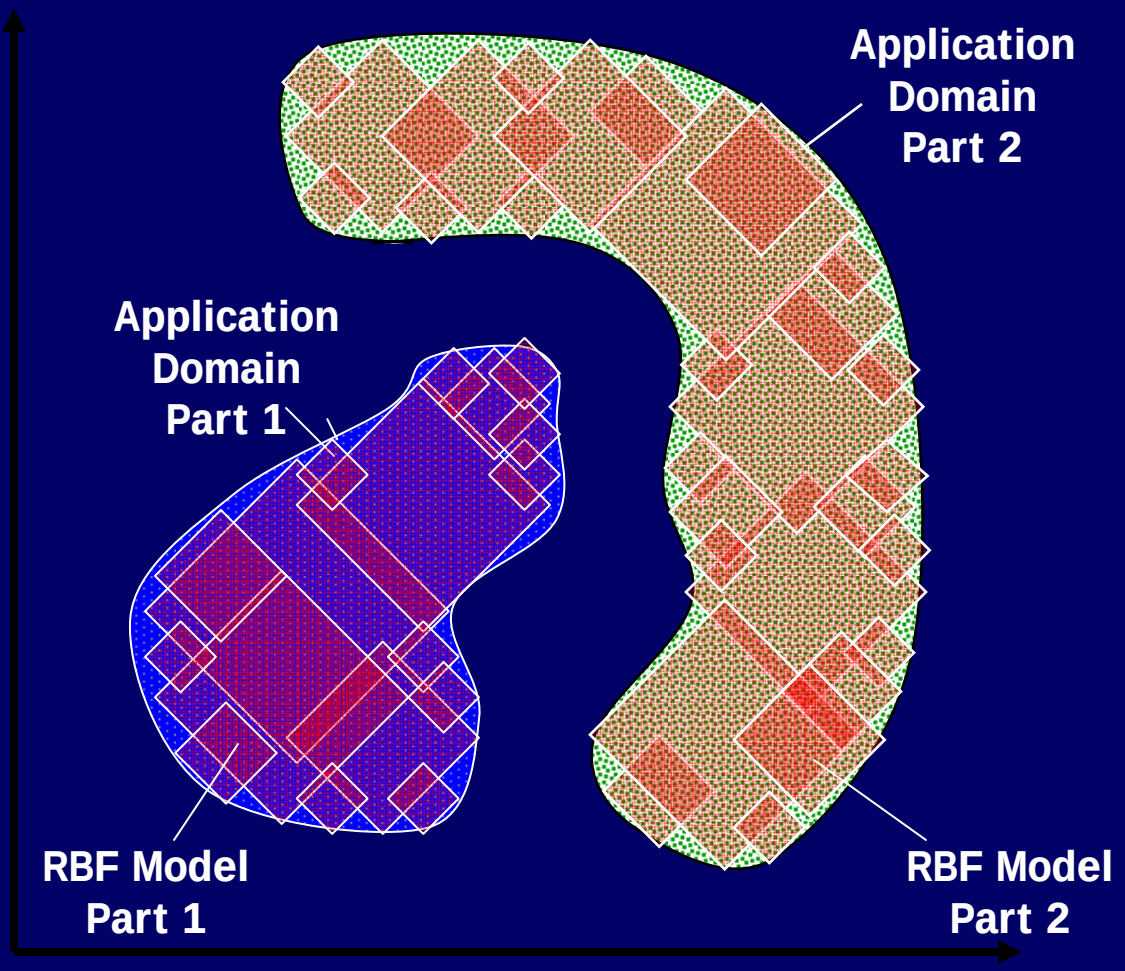




Radial Based Function Modeling

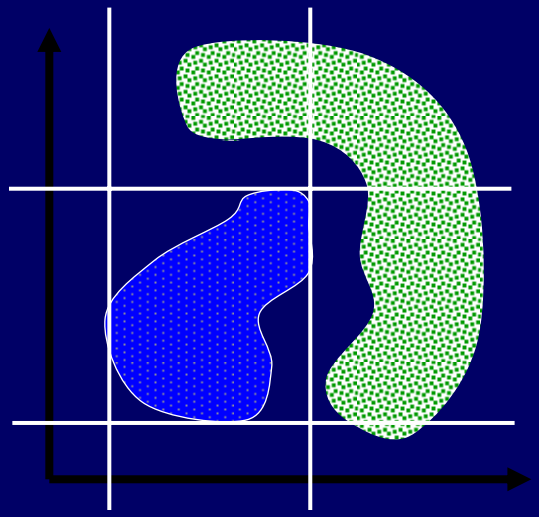


Radial Based Modeling



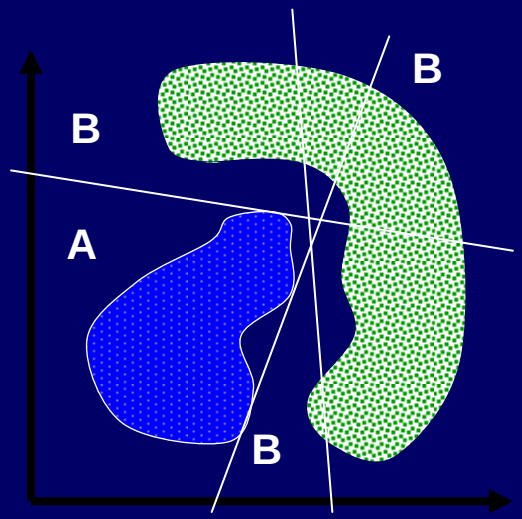
Separation Technique Comparison

Algorithmic Separation



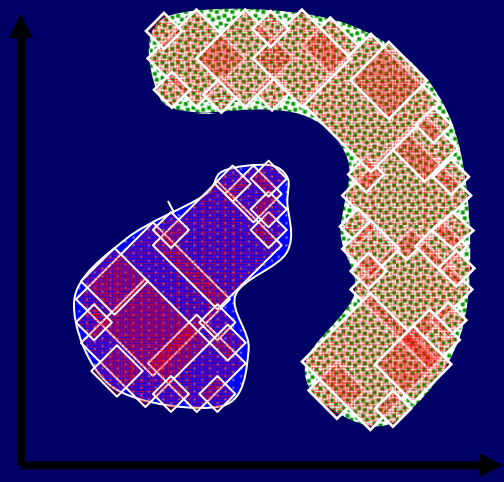
Traditional thresholding doesn't work.

Perceptionlike Separation



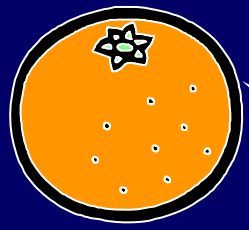
Perception thresholding works in limited cases.

ZISC RBF Separation

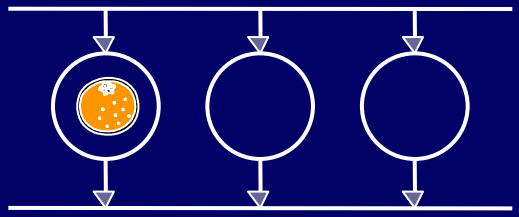


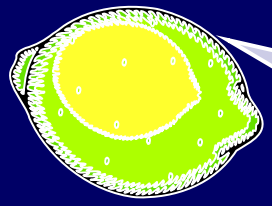
ZISC RBF can map arbitrary spaces.

Taught by examples…

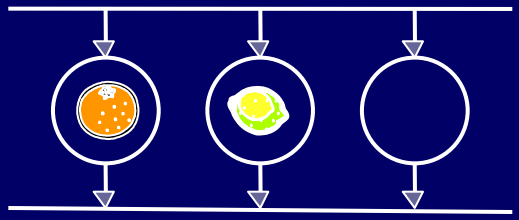


This is an orange

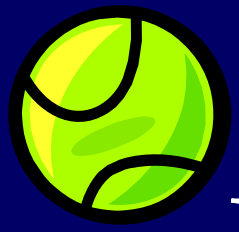




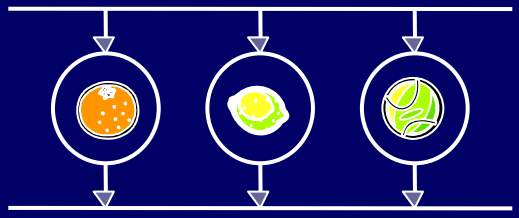
This is a lemon



Shape of an orange, Color of a lemon?



This is a tennis ball



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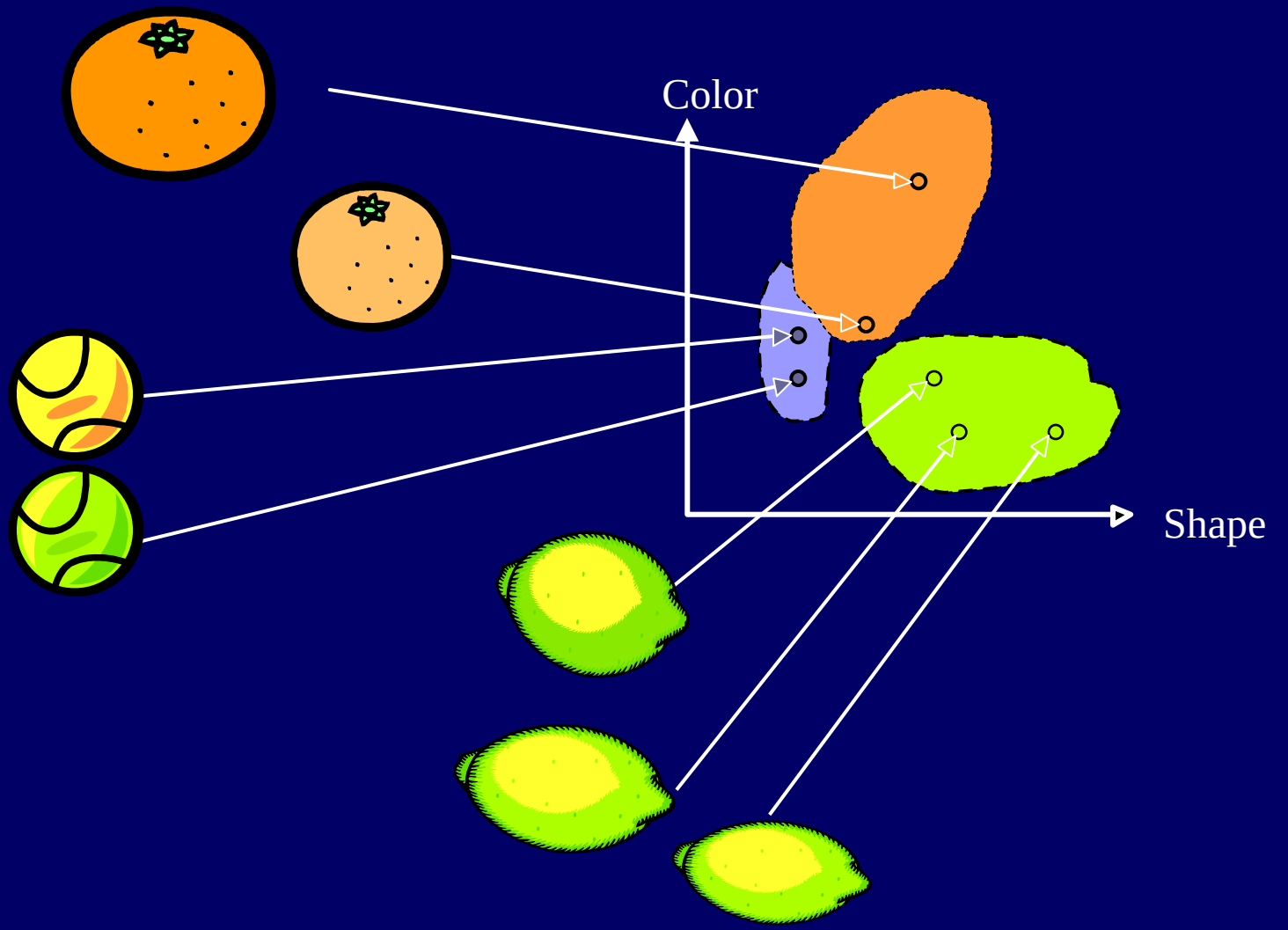
...to build a decision space



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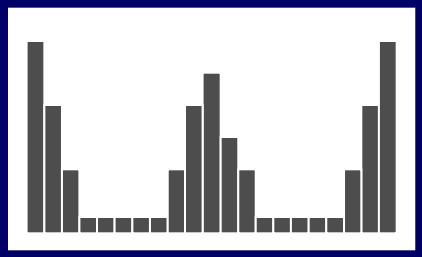
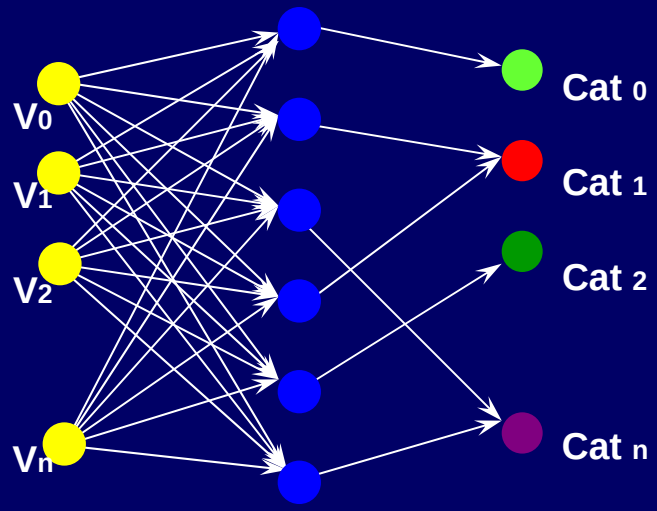
System Throughput



N Vectors
64 Components
8 Bytes Each



ZISC Neural Network

Result

Start → **850 Nanoseconds !** → Finish

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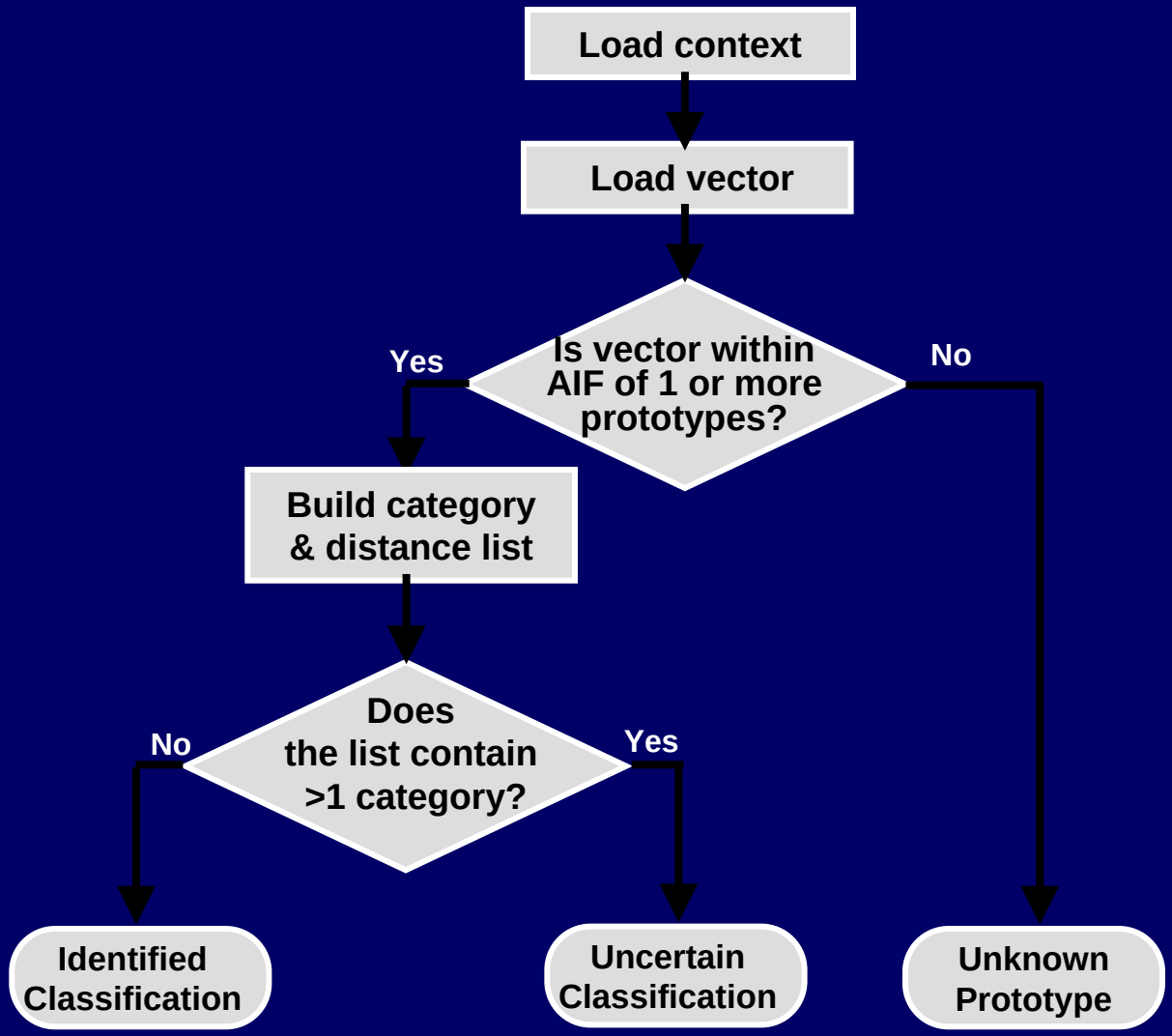
Recognition Process



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Summary

- ZISC neural network technology, coupled with the MUREN™ engine, enables the ZiCAM™ to:
  - Be trained by example rather than programming,
  - Mimic inspection techniques used by human inspectors
  - Separate application domains that were previously impossible,
  - Process at speeds far exceeding traditional machine vision,

and…

Think like a human, Work like a machine!

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