



AN OLFACTORY NEURAL CIRCUIT IN LOIHI

Neuromorphic Computing Lab | Intel Labs

Nengo Summer School 2019

Rev. 0.5

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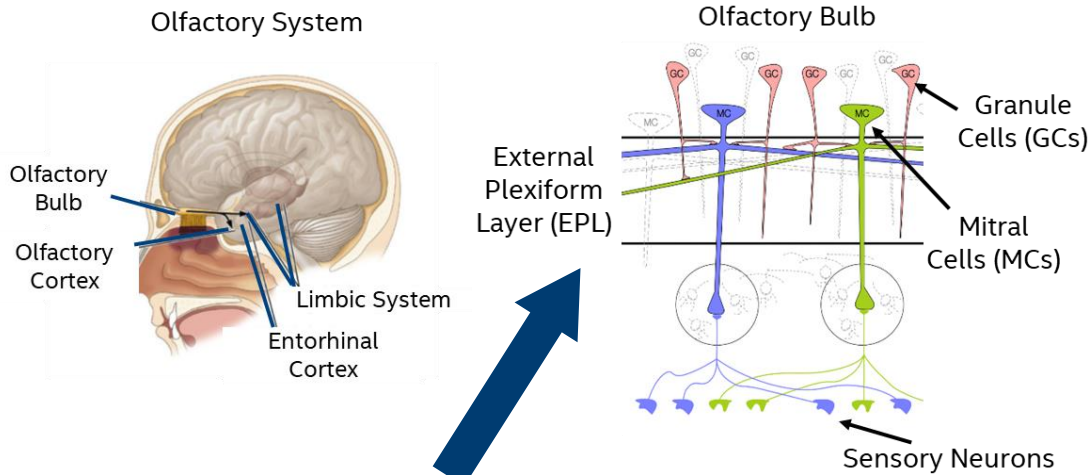
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Olfaction

Learning



Inference



Mapping the EPL to Loihi*

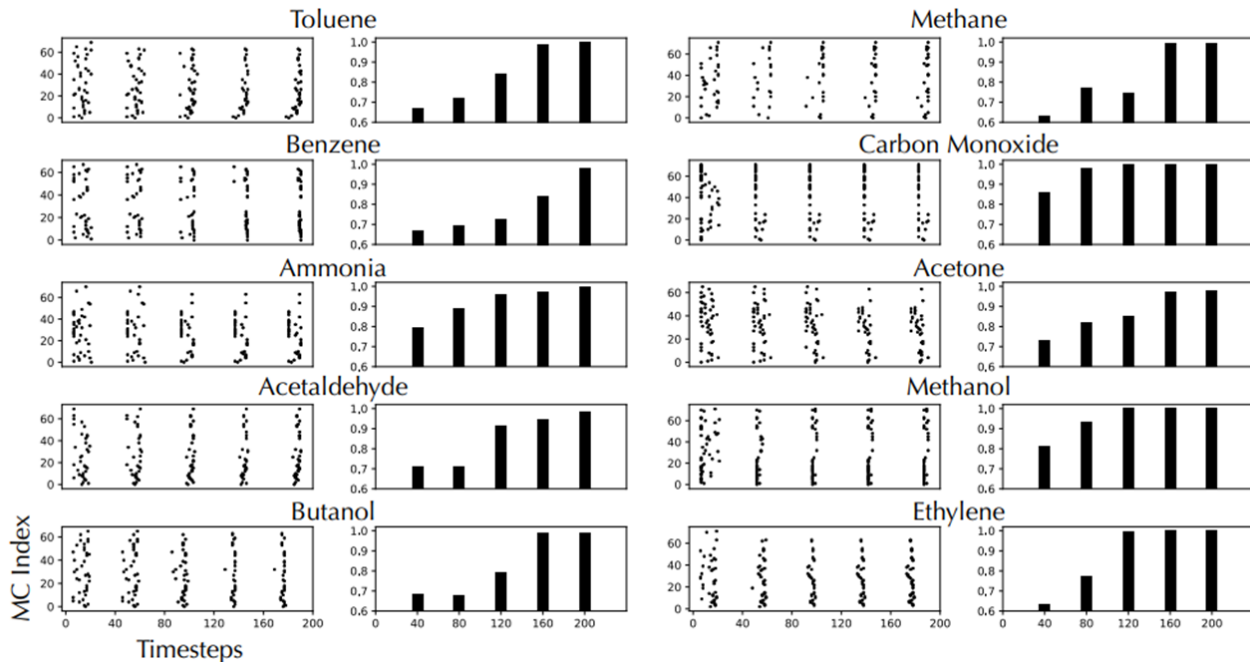
* Nabil Imam, Thomas Cleland, *Rapid Learning and Robust Recall in a Neuromorphic Olfactory Circuit*, In Review

Loihi EPL Input and Output

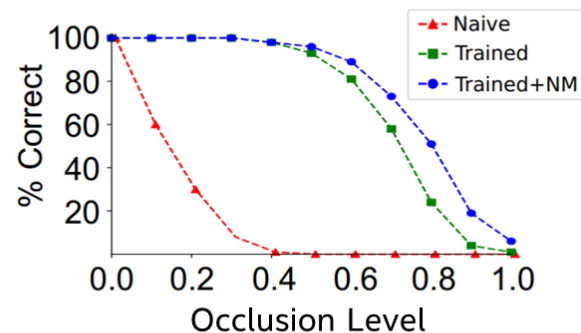
- Model Input
 - Chemosensor data
 - 72 dimensional vector, each element an integer from 0 to 15
 - Converted to bias current into mitral cell (MC) apical dendrite
- Model Output
 - MC soma spikes

Loihi EPL Behavior

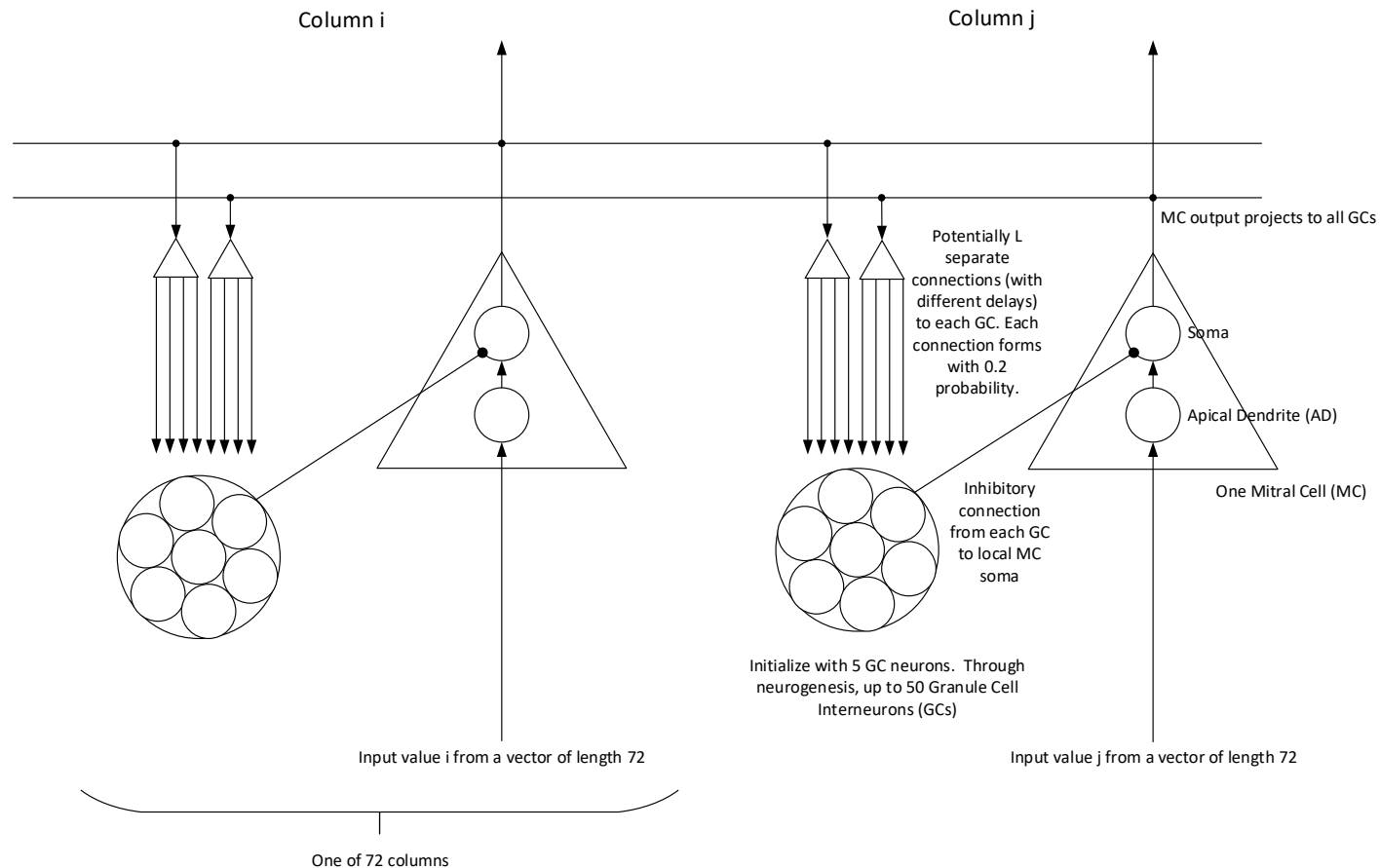
- Multi-Odor Results



10K test samples
10 odor classes

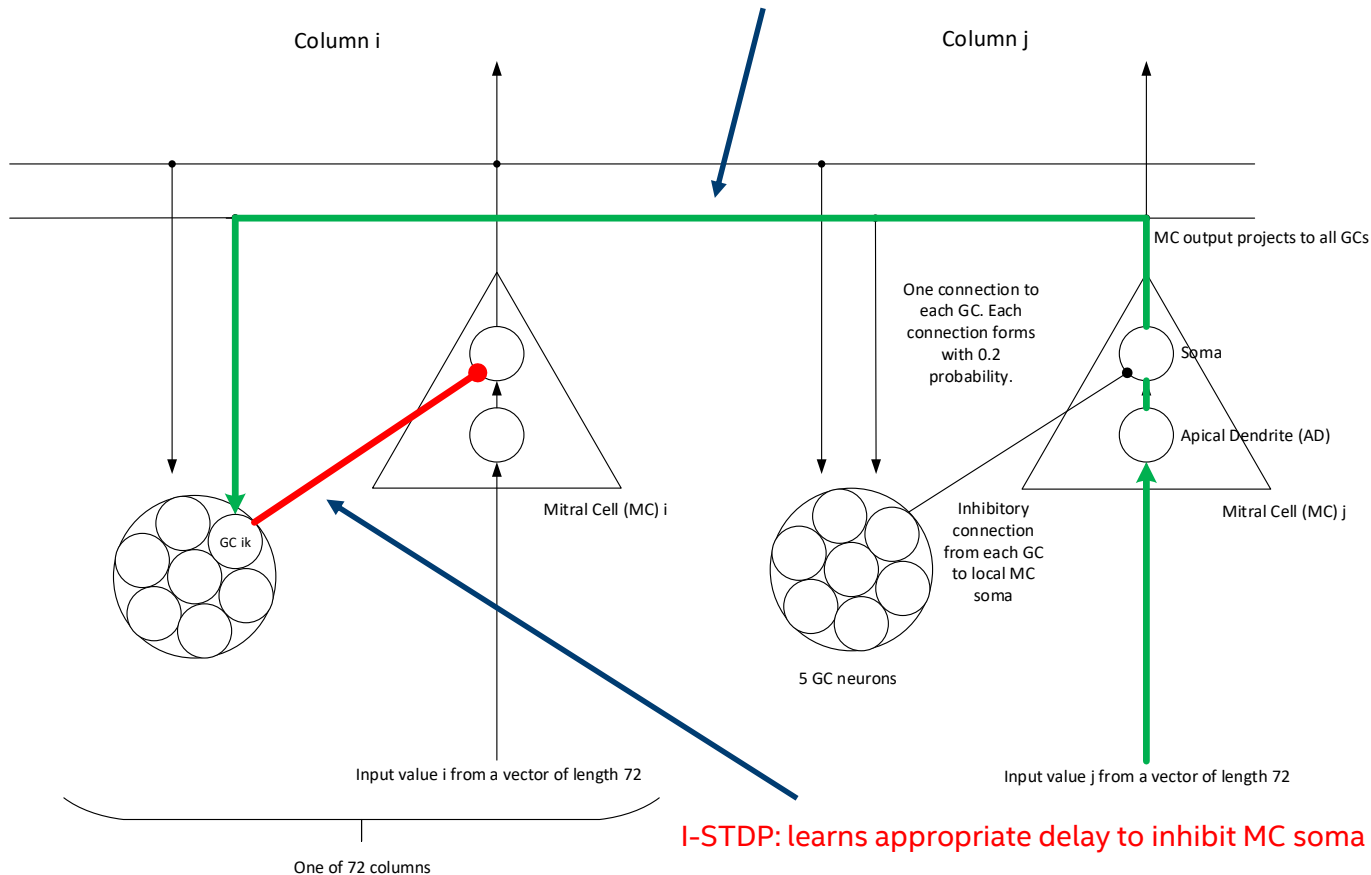


Loihi EPL Model



EPL Intuition

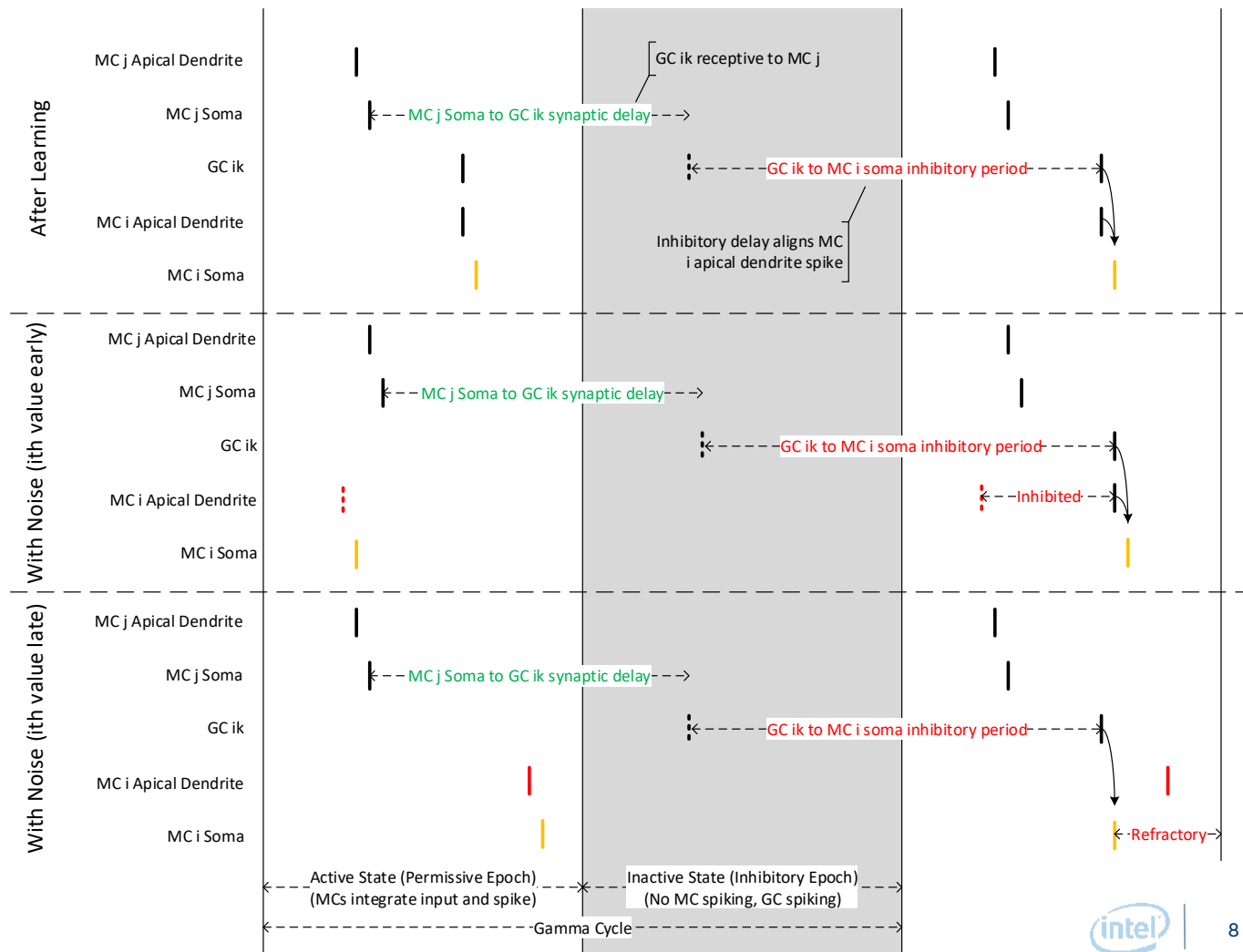
E-STDP: learns receptive field selective to odor features



I-STDP: learns appropriate delay to inhibit MC soma in column

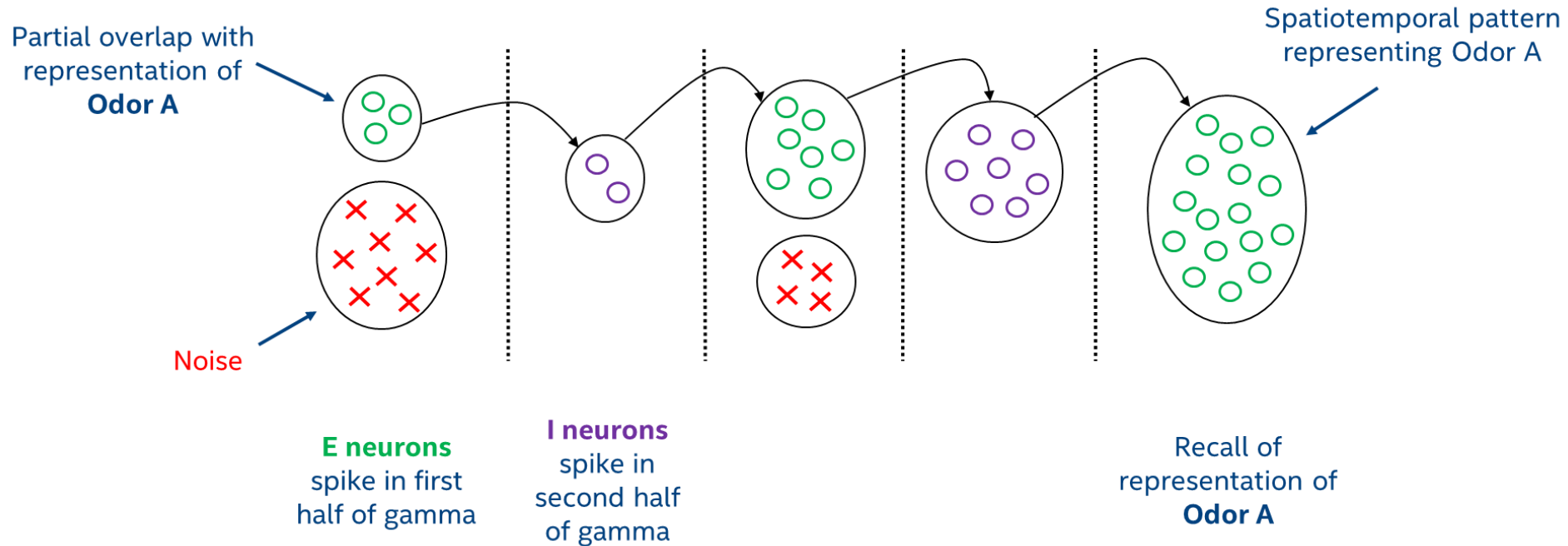
EPL Intuition

- Learns a pattern
- Spatio-temporal attractor network
- Tends towards learned pattern



EPL Intuition

- In practice, attractor takes affect over a larger scale



Loihi EPL Module

- Single-Pattern (Odor) Learning
 - Learn on a clean pattern
 - Generate noise corrupted test patterns
 - Occlusion factor is fraction of corrupted values in vector (length 72)
 - Corrupted values are randomly chosen from 0 to 15
 - Pattern is considered recovered if there is high “similarity”
 - Jaccard index as similarity: $\text{num spikes in intersection} / \text{num spikes in union}$

Tutorial: EPL Single Pattern Learning



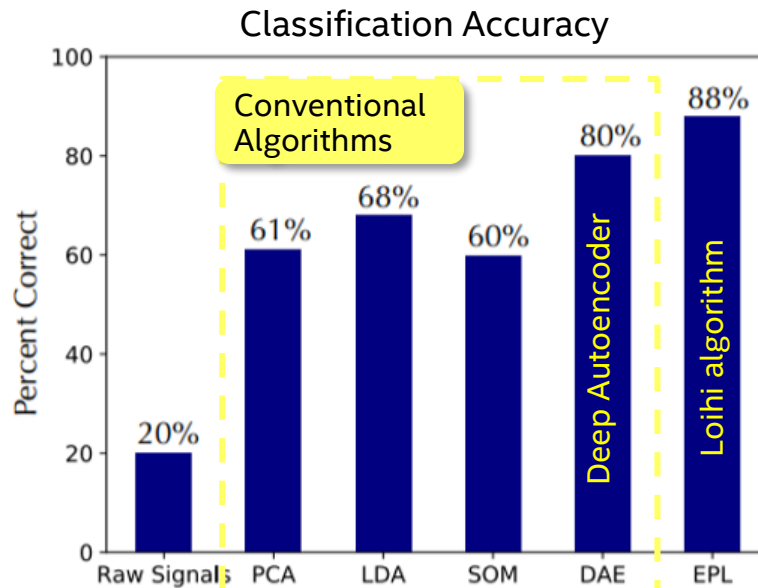
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Outperforms Conventional Algorithms

Provides average of **8% accuracy improvement** vs deep autoencoder

40x more data efficient learning vs backpropagation

Supports **online learning** (robust to catastrophic forgetting)



Excellent Scaling to Larger Network Sizes

