

Deep Learning with Spiking Neural Networks



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“...maybe there's actually one learning algorithm that can process sight or sound or touch” - Andrew Ng

Hypothesis: each region in your cortex uses the same algorithm;
we can make a powerful learning algorithm by combining the
latest neuro- and computer science

Motivation

With the abundance of **neuroscience data** and the recent **success** of deep learning, brain and neural network **popularity** in CS research is booming.

Many contemporary problems like computer vision and speech recognition involve **hierarchical, spatiotemporal** data: the same kind the cortex processes.

The platform for solving these problems that a **single learning algorithm** for such data will provide offers the potential to **change our lives** inside technology such as automated cars, personalised robotics and Siri-like assistants.

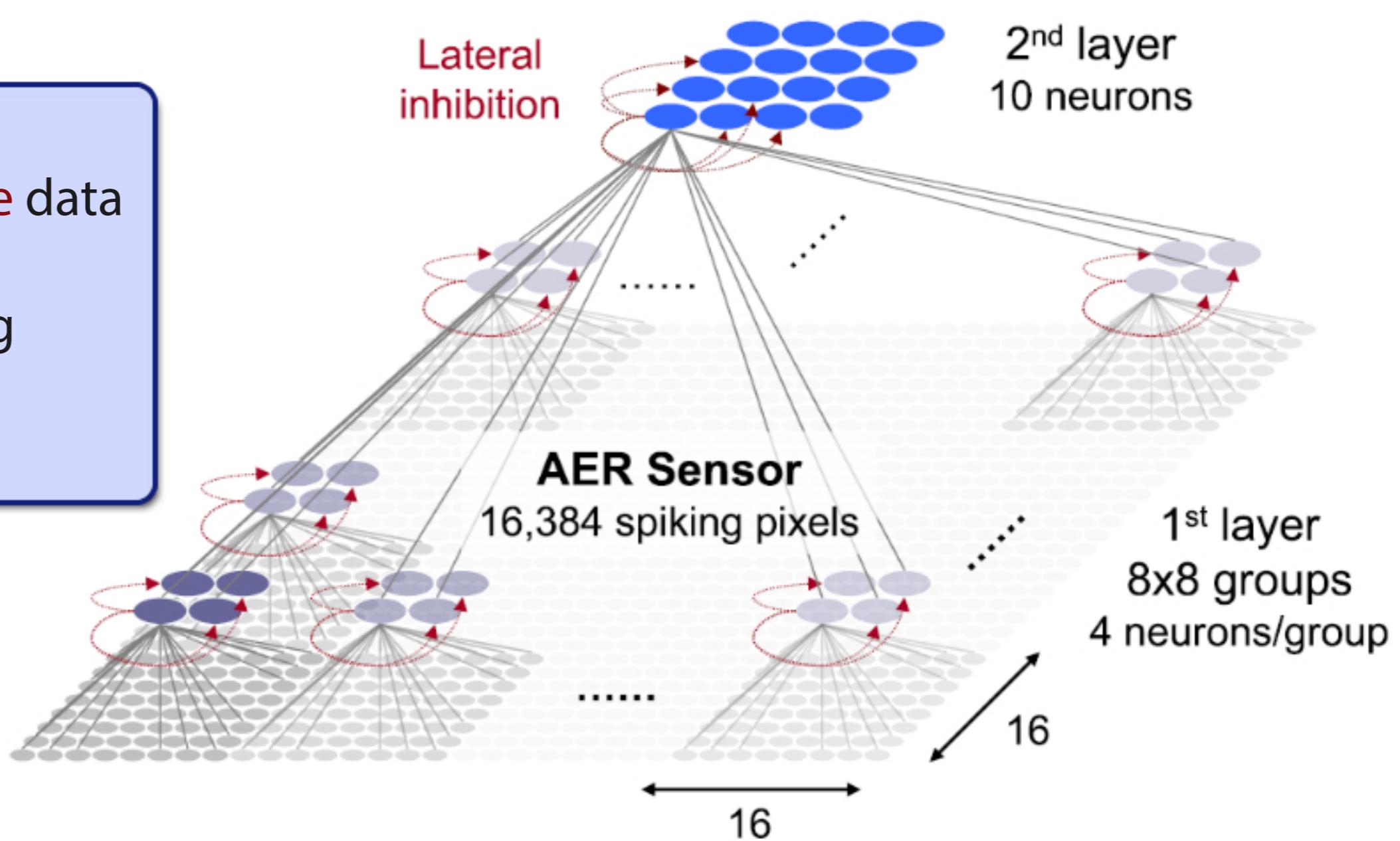


Spiking Neural Networks (SNNs)

Networks of neurons that **integrate** input from their synapses over time and only fire when a **threshold** is met.

Deep Learning

A sub-field of **machine learning** that uses “deep” **hierarchies** of neural networks to represent concepts at varying scales. Each layer learns classes that are larger in size and persist for longer in time. This forms **invariance to transformations** and makes learning new concepts **fast**.



Aims

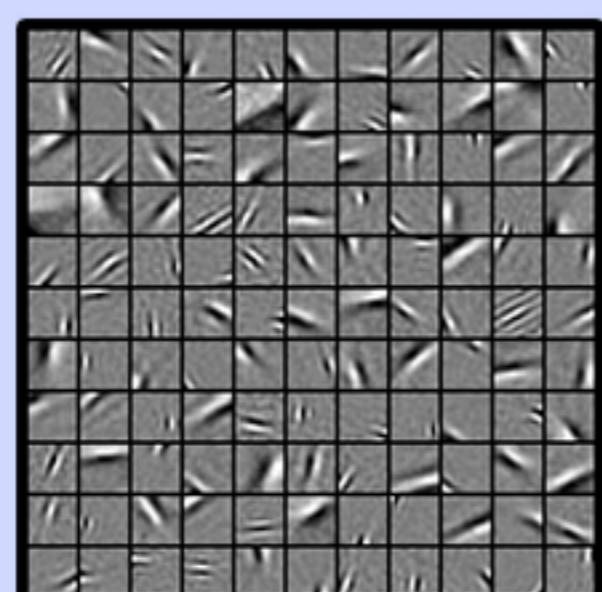
- Show that deep SNNs can be applied to **continuous** and **discrete** data
- Show that this approach can learn **multiple data types**
- Show that **motion** and **prediction** improve accuracy and training convergence rate
- **Improve** the work of Thorpe et al

Project so far...

- **Implemented** C++ SNN by Thorpe et al
- Rapidly prototyping **new features** in Matlab
- Observed that prediction **improves** my prototype

Problems and Challenges

- Data **representation**
- Output **interpretation**
- **Visualisation**
- Many **parameters**
- Covers **multiple research fields**
- Conflicting **neuroscience theories**
- How do you stop neurons learning the **same pattern**?

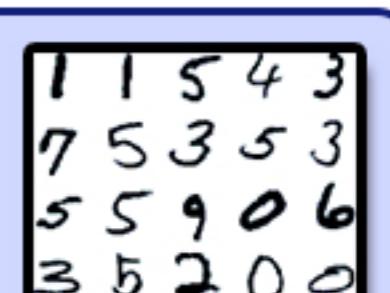


Future Work

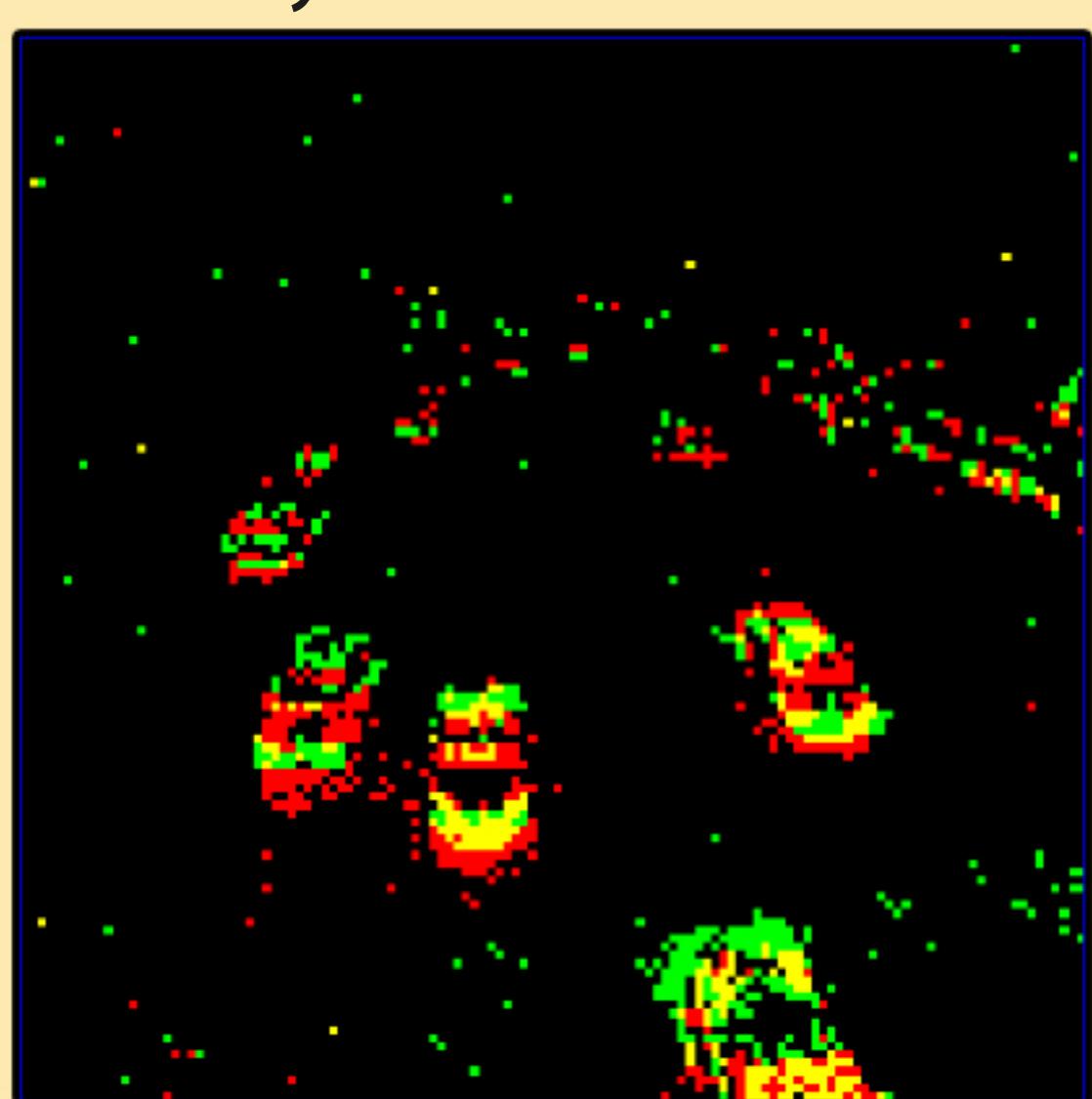
- **Evaluate** prototype on MNIST dataset
- **Improve** work by Thorpe et al with prediction and neuron re-use
- **Show** the algorithm is general purpose by classify audio data

Business Plan

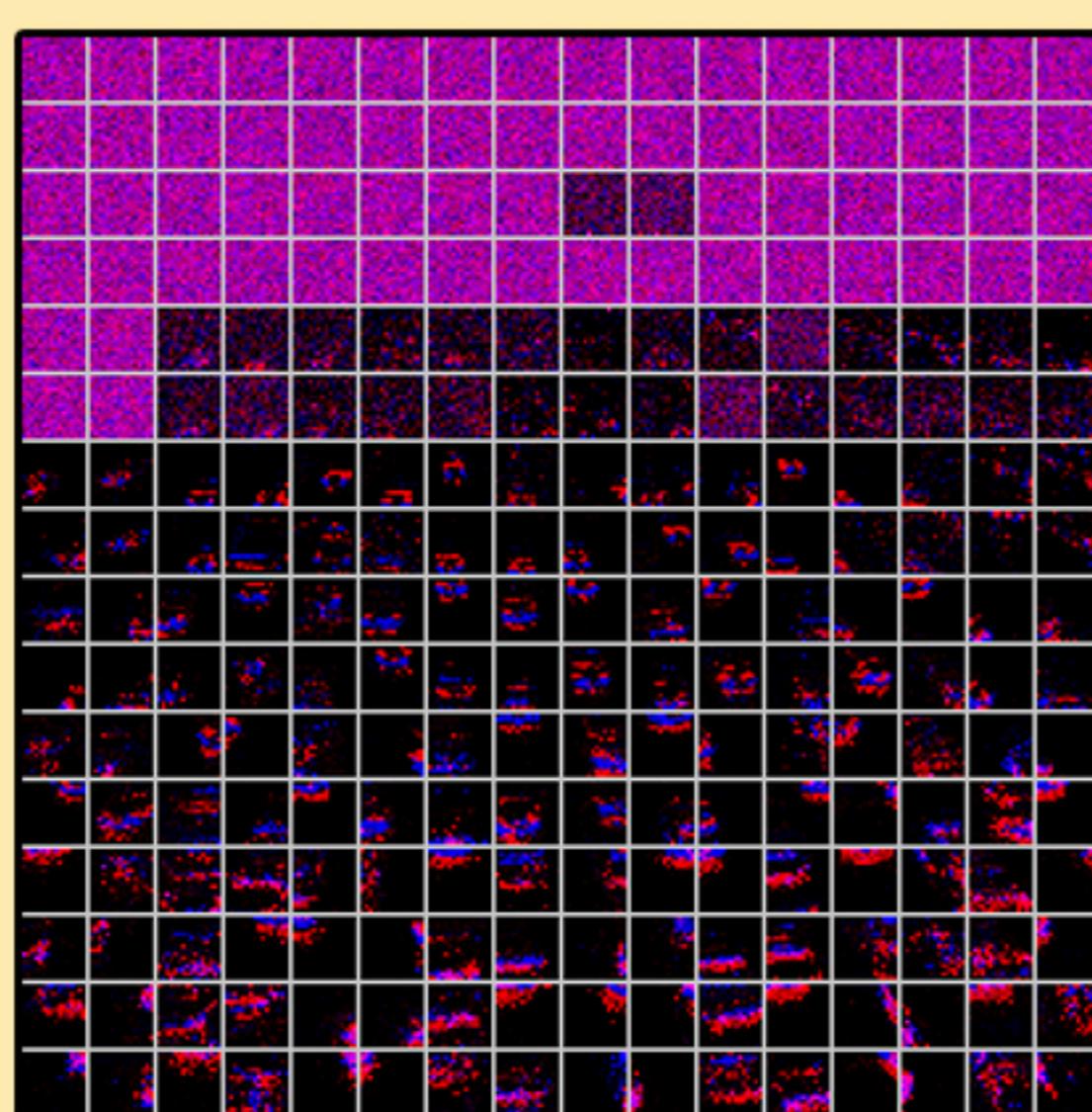
Offer a **cloud service** for data classification and prediction. Can you think of a **use**?



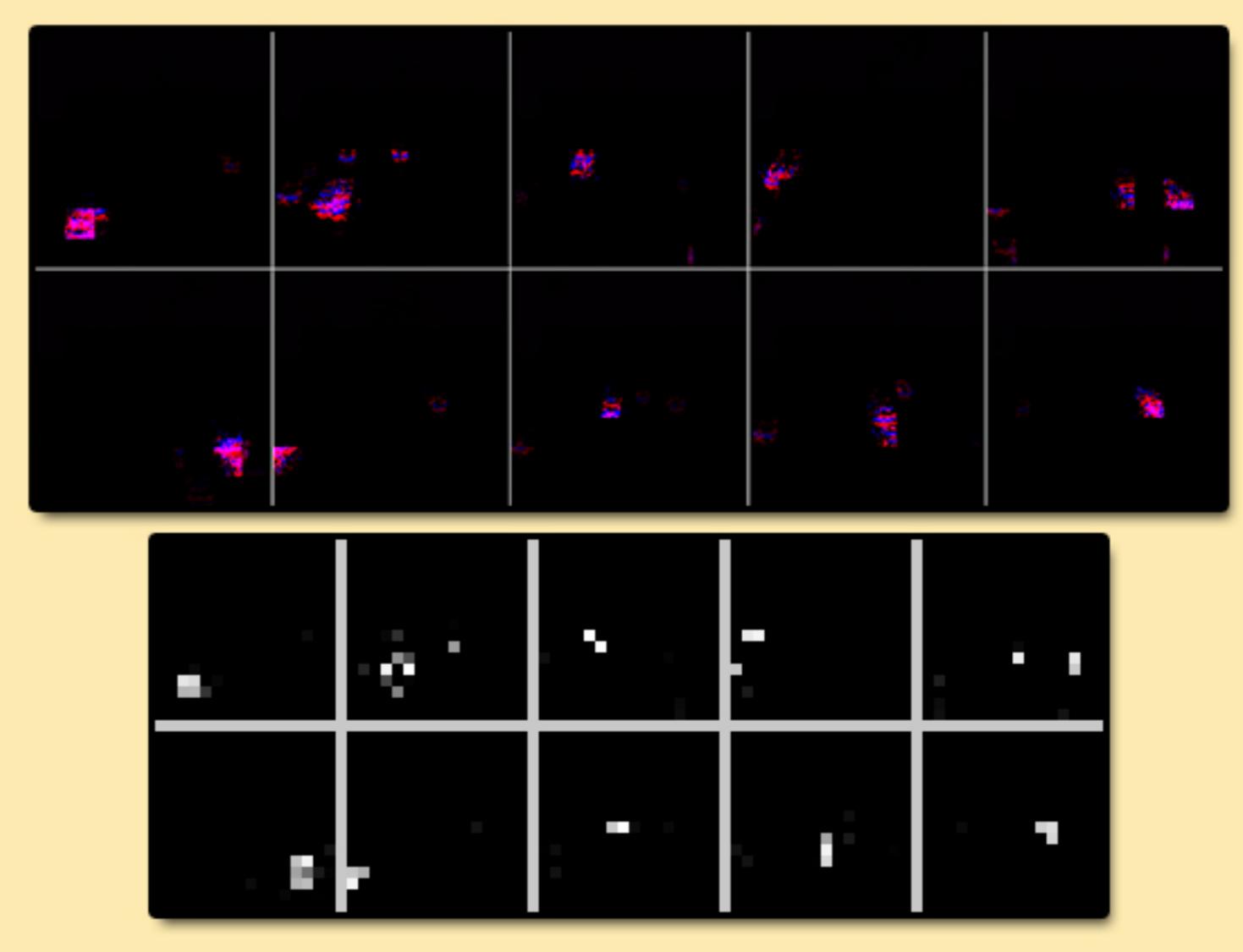
Preliminary Results



Input sample



Representation at layer 1



Representation at layer 2