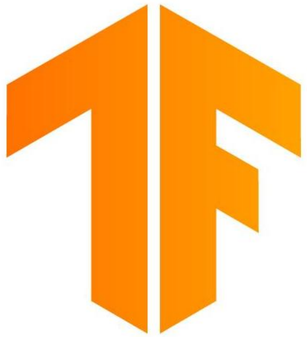
SNN and 3-V

intro



- Spiking Neuron Networks (SNN)
- Inspired by natural computation in the brain
- Accurate modeling of synaptic interactions between neurons
- Taking into account the *time* of spike firing

→*Fast adaptation & exponential capacity to memorize*

1. The human brain performs impressive feats (for example, simultaneous recognition, reasoning, control and movement), with a power budget of nearly 20 W. By contrast, a standard computer performing only recognition among 1,000 different kinds of objects expends about 250 W. (Hardware Chips)

2. Although the brain remains vastly unexplored, its remarkable capability may be attributed to three foundational observations from neuroscience: vast connectivity, structural and functional organizational hierarchy, and time-dependent neuronal and synaptic functionality.

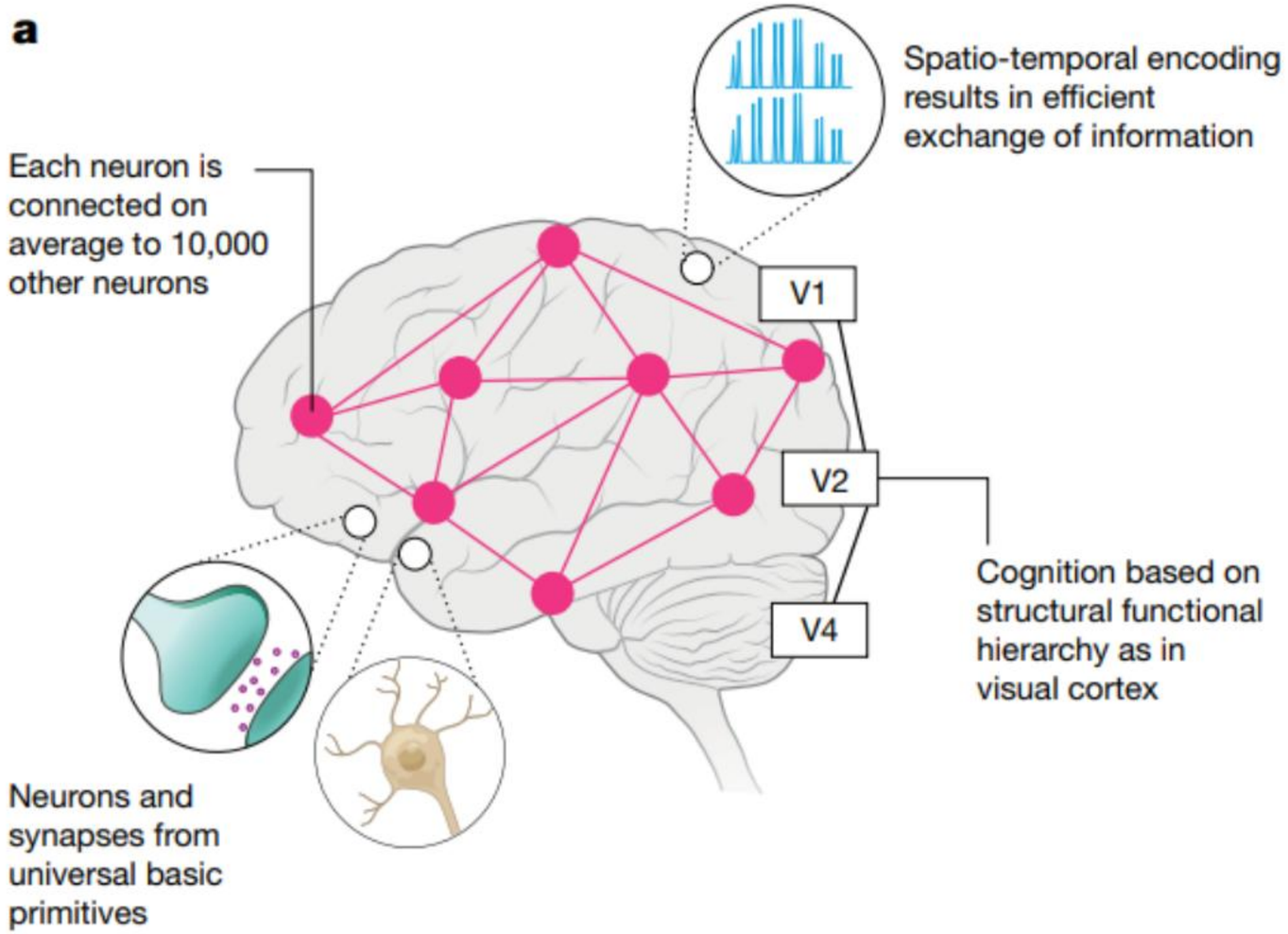
3. Neurons are the computational primitive elements of the brain that exchange or transfer information through discrete action potentials or ‘spikes’, and synapses are the storage elements underlying memory and learning.

4. The human brain has a network of billions of neurons, interconnected through trillions of synapses. Spike-based temporal processing allows sparse and efficient information transfer in the brain.

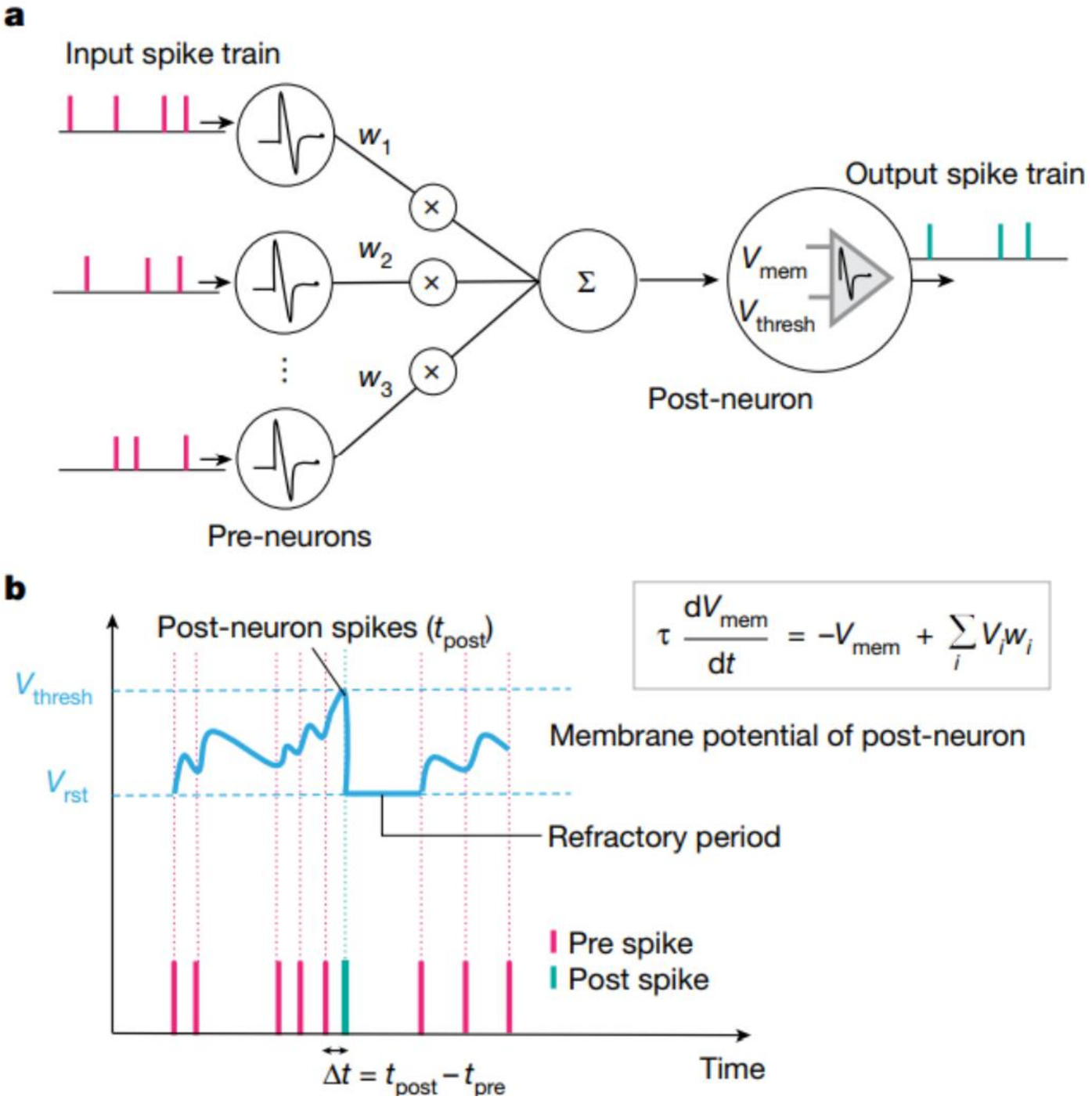
5. Studies have also revealed that the visual system of primates is organized as a hierarchical cascade of interconnected areas that gradually transforms the representation of an object into a robust format, facilitating perceptive abilities.

SNN

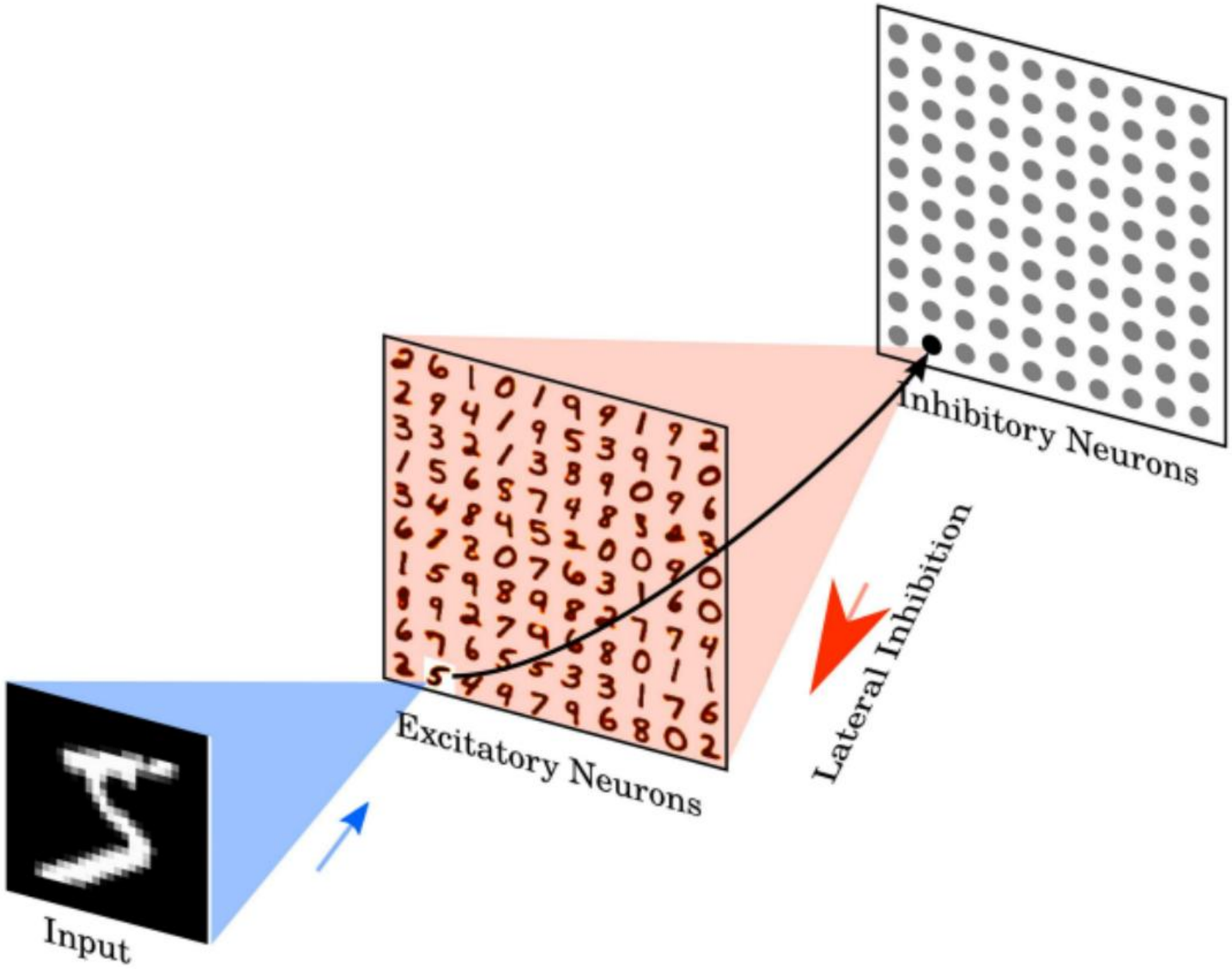
Spiking Neuron Networks



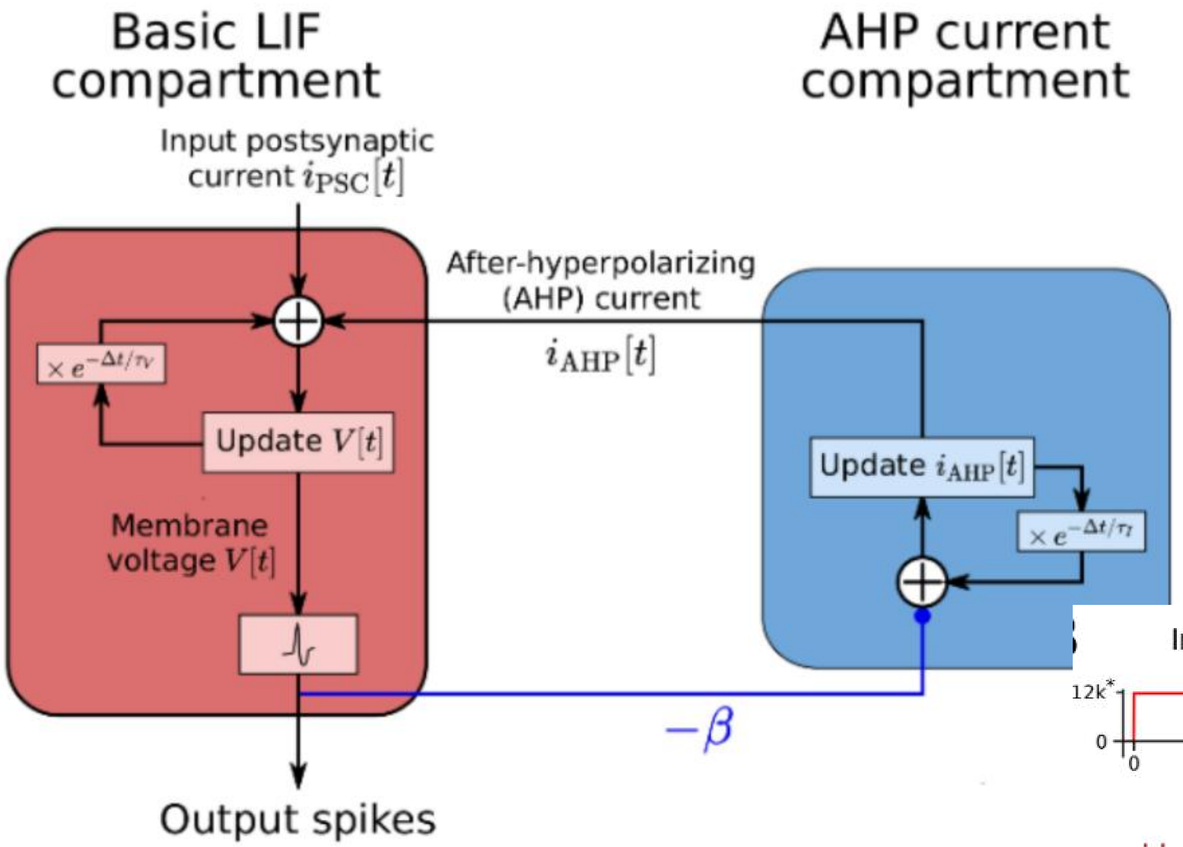
SNN

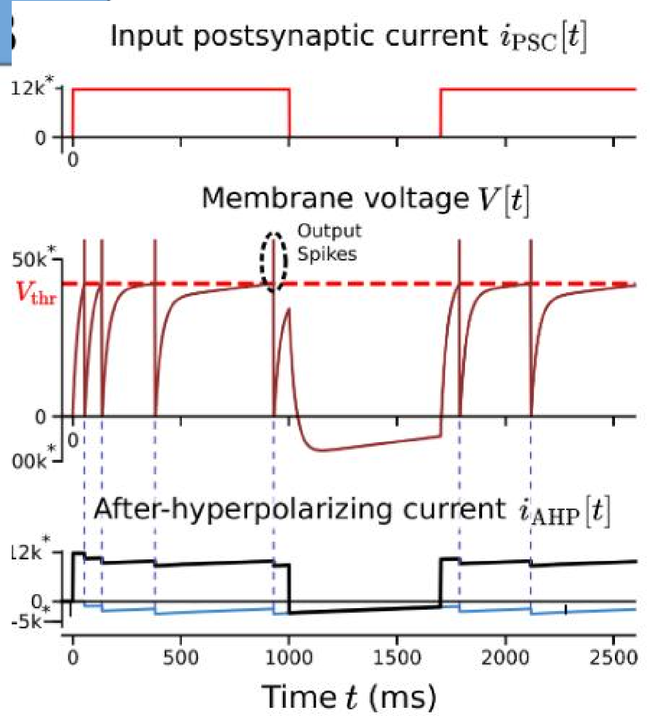

a
Input spike train
w_1
w_2
w_3
Σ
Output spike train
V_{mem}
V_{thresh}
Post-neuron
Pre-neurons
b
Post-neuron spikes (t_{post})
V_{thresh}
V_{rst}
$\tau \frac{dV_{mem}}{dt} = -V_{mem} + \sum_i V_i w_i$
Membrane potential of post-neuron
Refractory period
Pre spike
Post spike
$\Delta t = t_{post} - t_{pre}$
Time

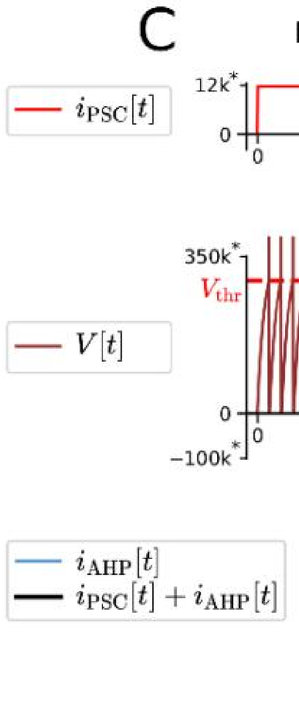
DiehlAndCook2015 -- mnist 95%



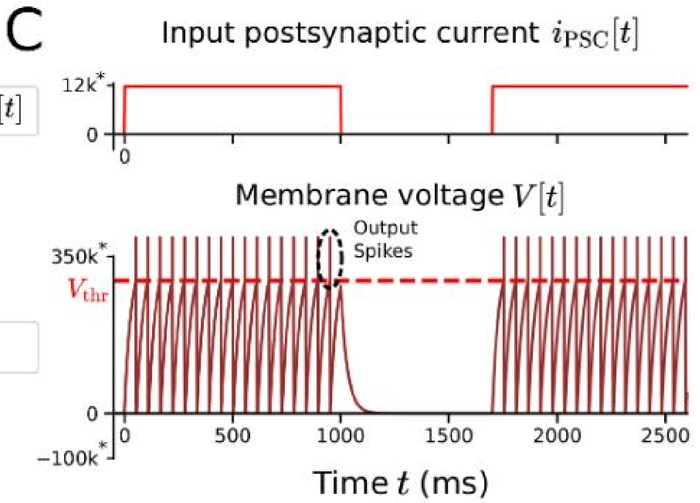
LSTM like SNN







C



*All voltage and current values are as seen in the Loihi registers (k = x1000)

3 kinds of Model

1. SNN. neuromorphic computing. Fully automatic. (unsupervised,adaptation to changing environment)
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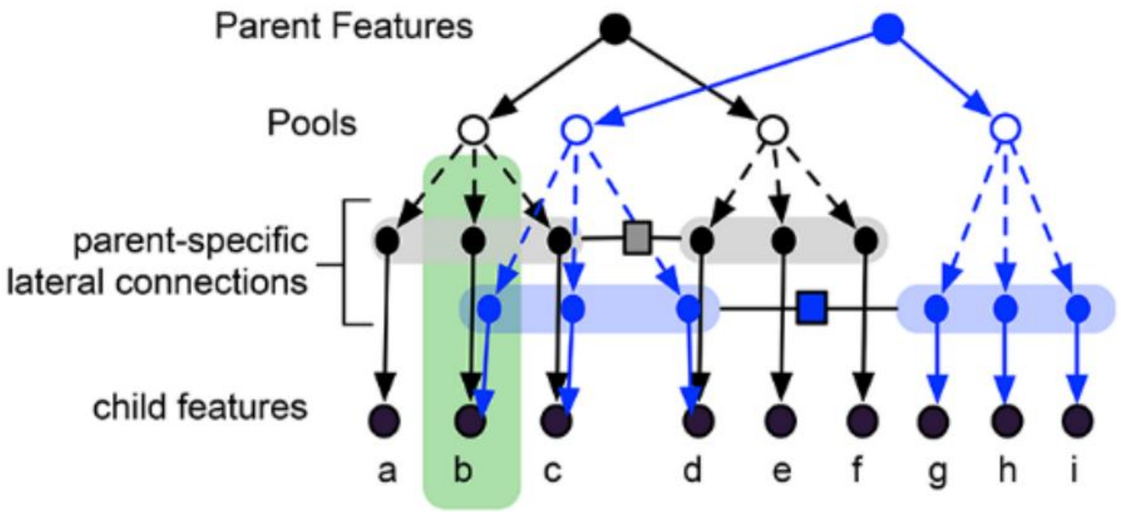
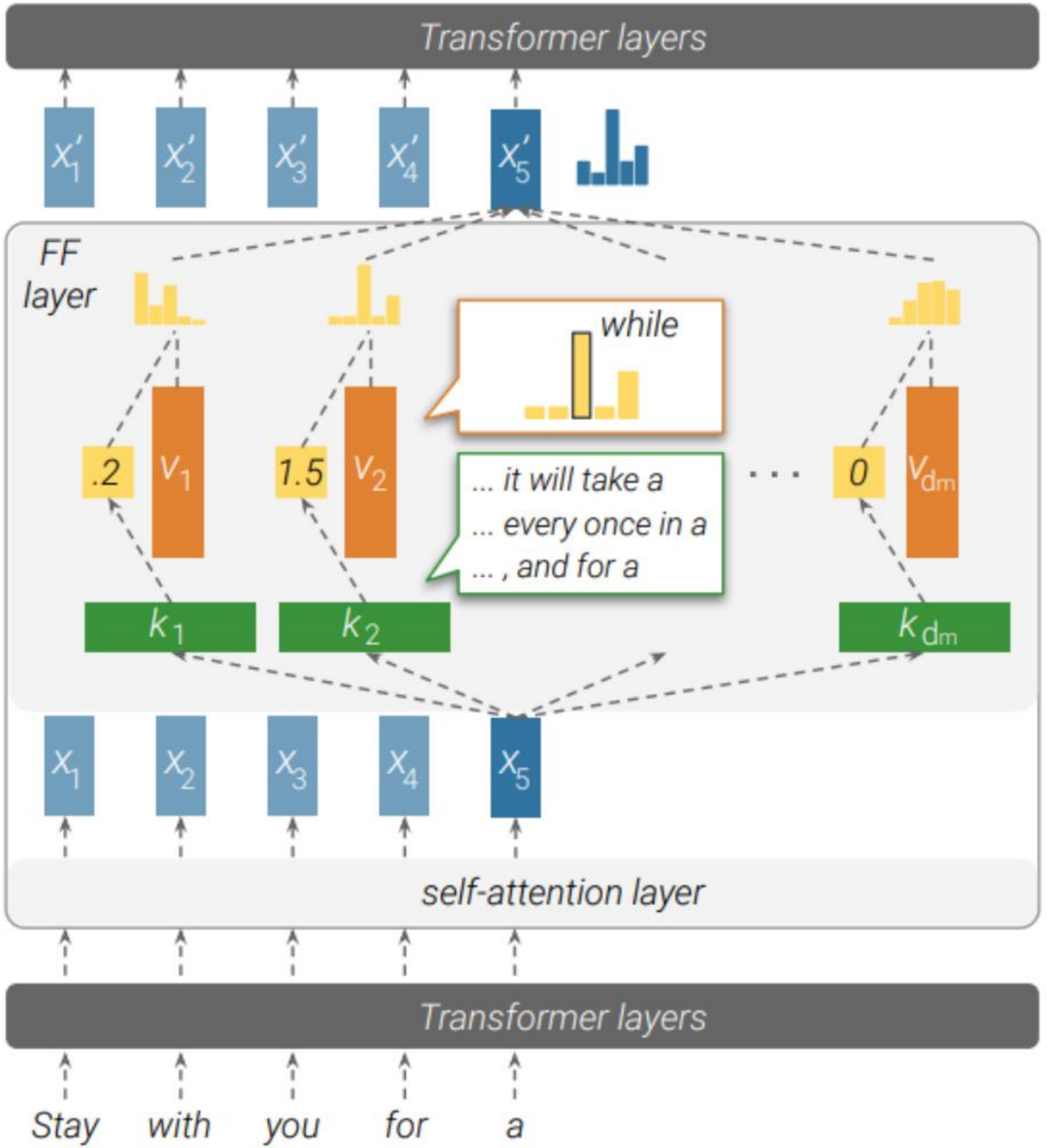
   (Event based, tightly coupled system)

2. Deep Learning. end-to-end learning. semi-automatic

3. Probabilistic model. hand design

AOG+

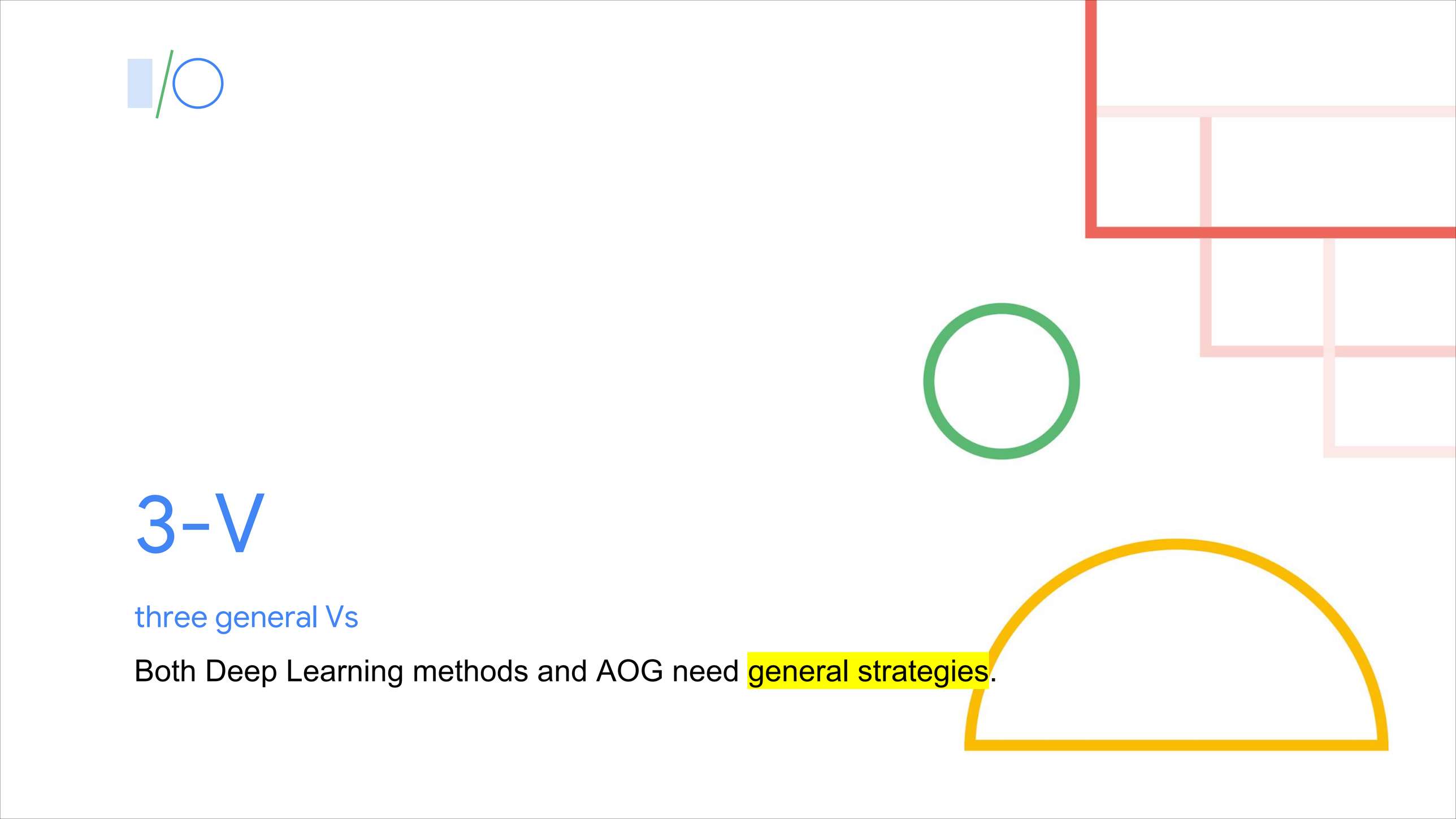




Proposition:

1. Encoder like -- AOG+CFR

2. Transformer like --
   AOG+ unsupervised clustering



3-V

three general Vs

Both Deep Learning methods and AOG need general strategies.

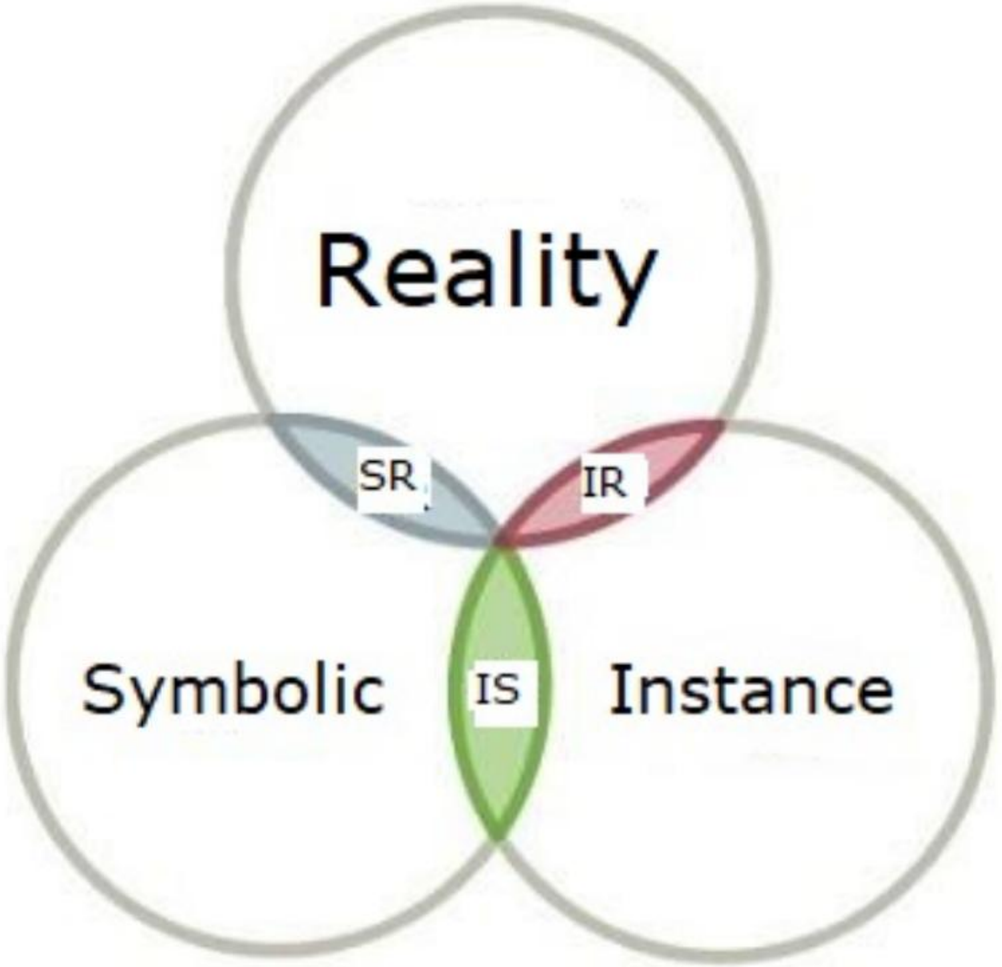
3-V

3 general Vs

1. R -- Consistent with the Reality

2. S -- Atom (Symbolic)

3. I -- instance distinguishable within the partial class group



Proposition:

1. “Two of Three”

2. different strategies based on different 3-V combinations using a multi-stage approach

Example:

MCTS+Learning:
Exploit (IS)
--> Explore (SR or IR)

Knowledge

what we have learned

Multi-stage Knowledge Learning

First Stage (SR and IR)
-->
Second Stage (IS)

Proposition:
Knowledge(or “Symbol” we have learned) is learned from contextual related environment, not individual embeddings, which is totally different from nowadays Deep Learning Models.