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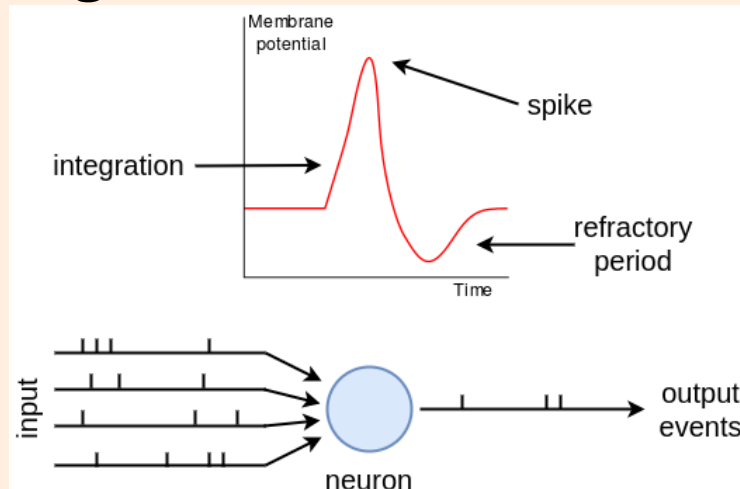
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# Bio-inspired visual attention for silicon retinas based on spiking neural networks applied to pattern classification

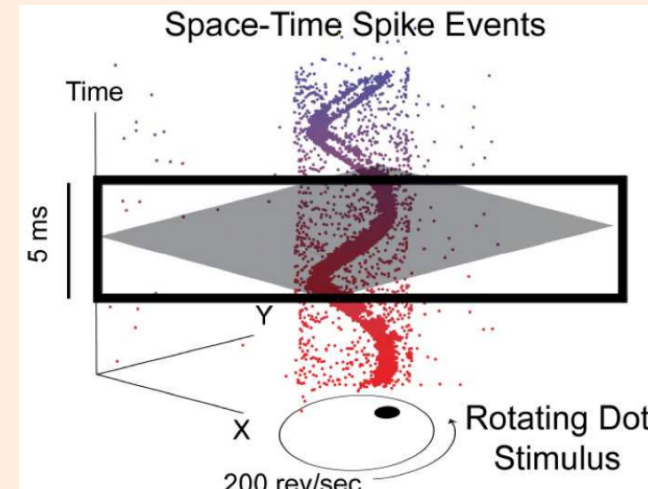
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**Visual attention:** behavioral and cognitive process of selectively focusing on a discrete aspect of sensory cues

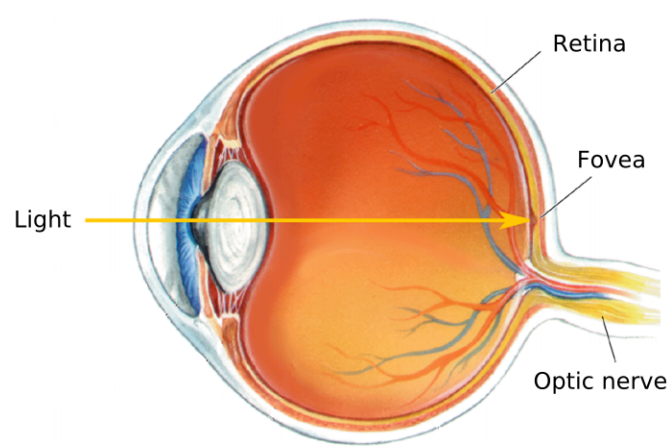
## Spiking neural network [Maass, 1997]



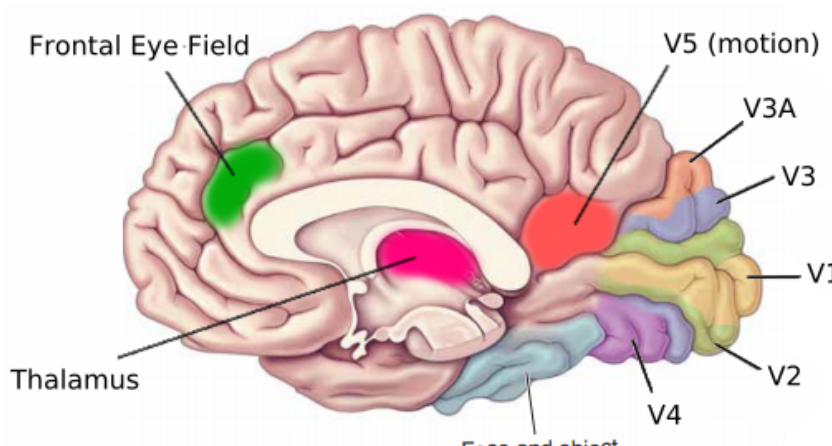
## Silicon retina [Lichtsteiner, 2008]



## Biological background



Human eye [Bear, 2007]



Visual cortex, adapted from [Bear, 2007]

3 dichotomies of visual attention [Moore, 2017]:

- top-down and bottom-up
- spatial, temporal and feature-based
- overt and covert

3 neuromodulators in visual attention [Moore, 2017]:

- acetylcholine
- dopamine
- norepinephrine

## Related work

### Attention in multimedia

[Itti, 2001] defines saliency as it is used by most of the multimedia domain.  
[Le Callet, 2013] reviewed the exploitation of visual attention in multimedia.

### Silicon retina

[Lichtsteiner, 2008] presents the first complete design of a silicon retina.  
[Gallego, 2020] surveys event-based vision and its various applications.

### Computational models of attention

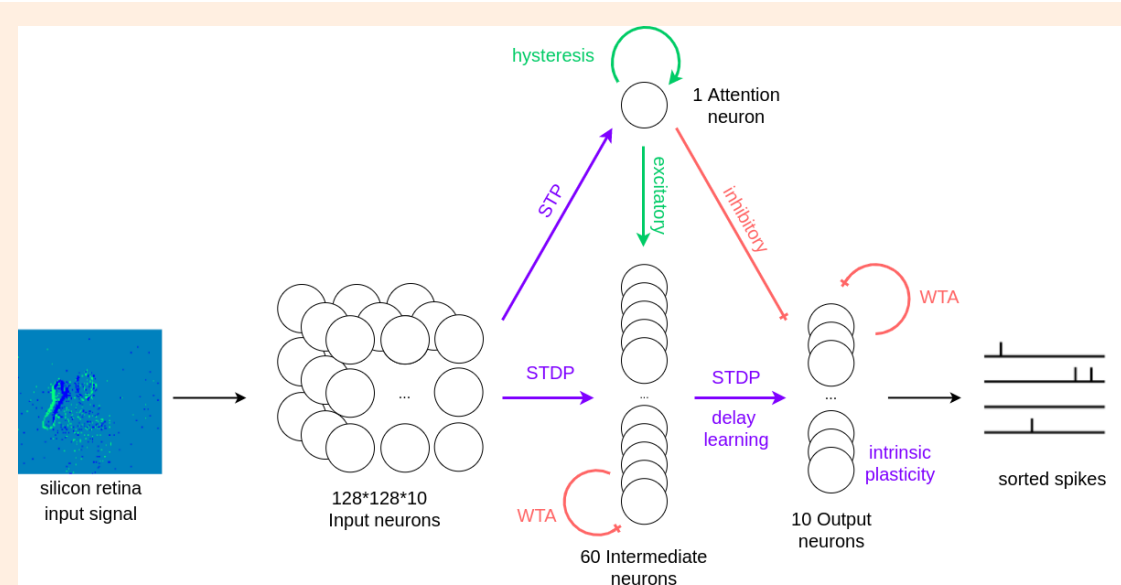
[Renner, 2019] combines spiking neurons and event data to perform object tracking.  
[Bernert, 2019] implemented an attention model for pattern recognition.

## From biological to computational attention

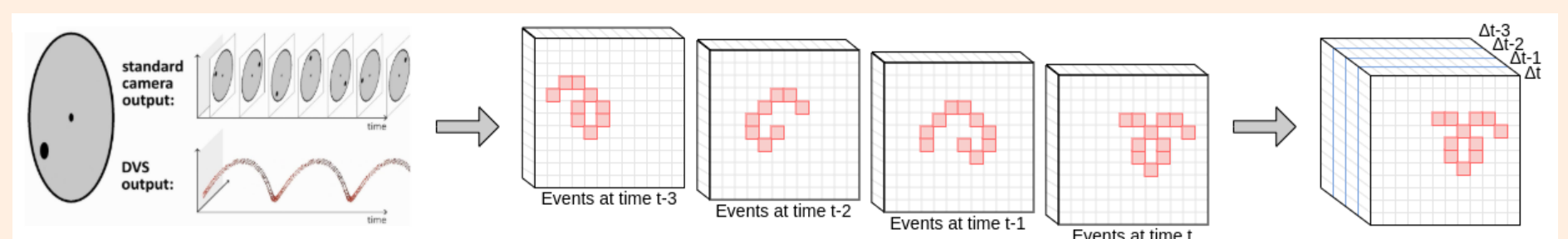
Our proposals :

- exploit forebrain mechanism to implement *top-down* attention
- explore the neuromodulators' modus operandi to increase the importance given to visual regions of interest
- harness the relationship between saccadic eye movements and *covert* attention to implement retinocentric maps of saliency

## Adapting an attention model to silicon retina



Network topology



Translation of event data produced by silicon retina, into activation of neurons on the 3D input layer

Bernert and Yvert, An Attention-Based Spiking Neural Network for Unsupervised Spike-Sorting (2019)

**References**  
[Maass, 1997] Wolfgang Maass (1997). Networks of Spiking Neurons: The third generation of neural network models. *Neural Networks*.  
[Gallego, 2020] Guillermo Gallego, Tobi Delbruck, Garrick Orchard, et al. (2020). Event-based Vision: A Survey. *IEEE PAMI*.  
[Bear, 2007] Mark F. Bear, Barry W. Connors and Michael A. Paradiso (2007). *Neurosciences, Exploring the brain. Wolters Kluwer Health*.  
[Moore, 2017] Tirin Moore and Marc Zirnsak (2017). Neural Mechanisms of Selective Visual Attention. *Annual Review of Psychology*.  
[Itti, 2001] Laurent Itti and Christof Koch (2001). Computational Modelling of Visual Attention. *Nature reviews, Neuroscience*.  
[Le Callet, 2013] Patrick Le Callet and Ernst Niebur (2013). Visual Attention and Applications in Multimedia Technologies. *Proceedings of the IEEE*.  
[Lichtsteiner, 2008] Patrick Lichtsteiner, Christoph Posch and Tobi Delbruck (2008). A 128x128 120 dB 15 us Latency Asynchronous Temporal Contrast Vision Sensor. *IEEE Journal of Solid-State Circuits*.  
[Renner, 2019] Alpha Renner, Matthew Evanusa and Yulia Sandamirskaya (2019). Event-based Attention and Tracking on Neuromorphic Hardware. *arXiv*.  
[Bernert, 2019] Marie Bernert and Blaise Yvert (2019). An Attention-Based Spiking Neural Network for Unsupervised Spike-Sorting. *International Journal of Neural Systems*.  
[Amir, 2017] Arnon Amir, Brian Taba, David Berg et al. (2017). A Low Power, Fully Event-Based Gesture Recognition System. *IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*

Simulation results of the network on DVS128 Gesture dataset [Amir, 2017] over 33 400 ms  
Hand gesture categories: right hand clockwise (cat. 4) twice then drums (cat. 8) twice

