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# Neuromorphic foveation applied to semantic segmentation

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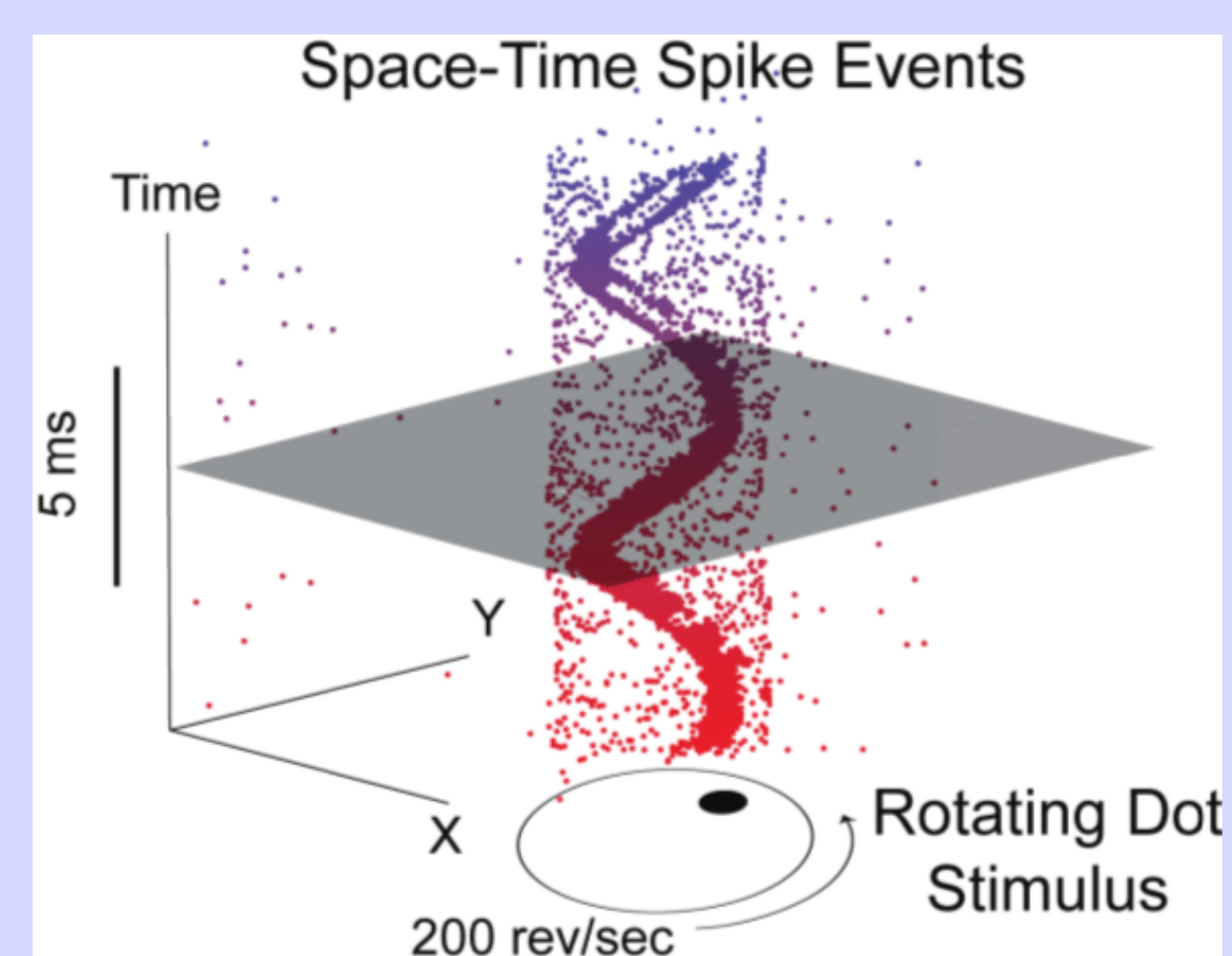
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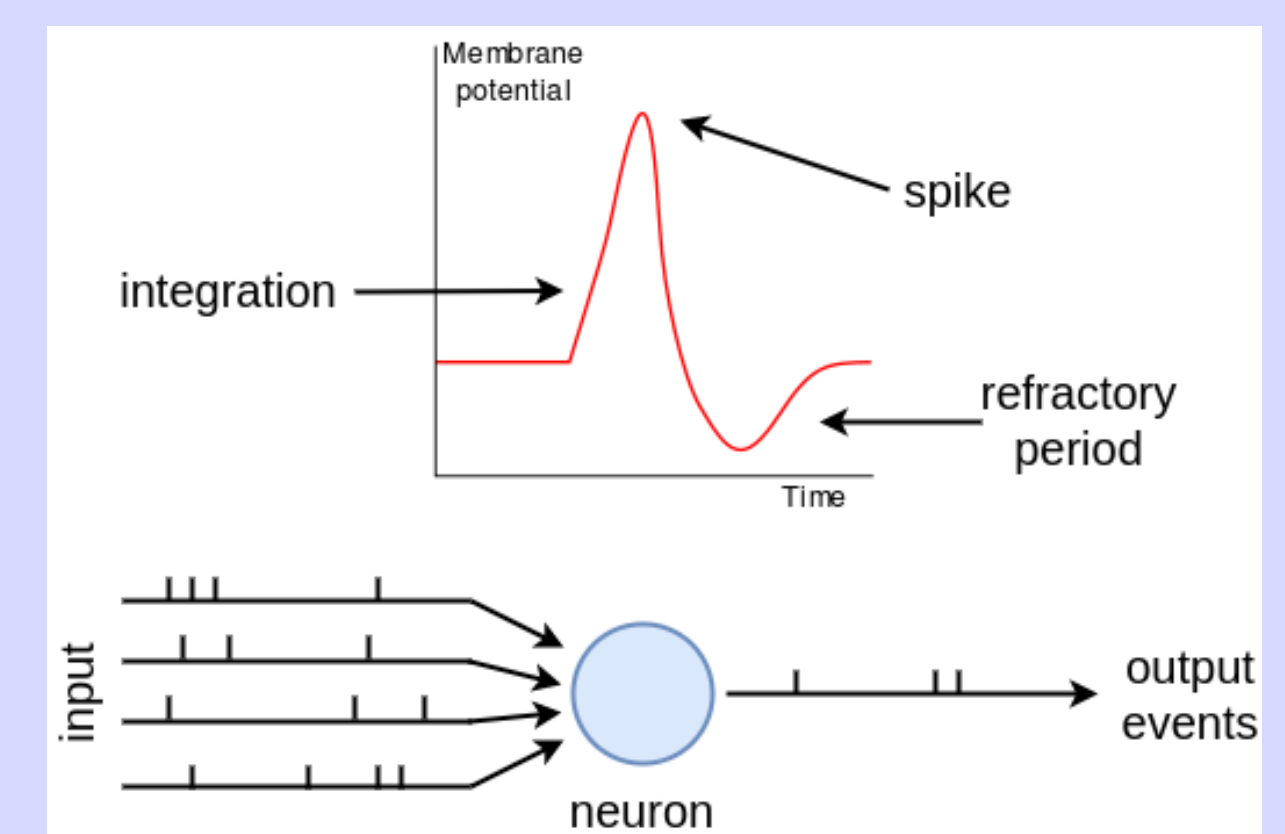
We present in this work the evolution of the performance of semantic segmentation with respect to the amount of event data used, to demonstrate the stakes of foveation. Semantic segmentation model: Ev-SegNet [Alonso, 2019] Dataset: DAVIS Driving Dataset 2017 [Binas, 2018]

## Event camera



[Lichtsteiner, 2008] & [Mueggler, 2015]

## Spiking neural network



[Maass, 1997]

**References**

[Alonso, 2019] I. Alonso and A.C. Murillo (2019). EV-SegNet : Semantic Segmentation for Event-based Cameras. *CVPR Workshops*.

[Bear, 2007] M.F. Bear, B.W. Connors and M.A. Paradiso (2007). *Neurosciences, Exploring the brain*. W. K. Health.

[Binas, 2018] J. Binas, D. Neil, S.C. Liu, and T. Delbruck (2017). DDD17 : End-To-End DAVIS Driving Dataset. *arXiv :1711.01458 [cs]*.

[Gruel, 2022] A.Gruel, A.Vitale, J.Martinet and M.Magno (2022). Neuromorphic event-based spatio-temporal attention using adaptive mechanisms. *AICAS*.

[Lichtsteiner, 2008] P. Lichtsteiner, C. Posch and T. Delbruck (2008). A 128x128 120 dB 15 us Latency Asynchronous Temporal Contrast Vision Sensor. *IEEE Journal of Solid-State Circuits*.

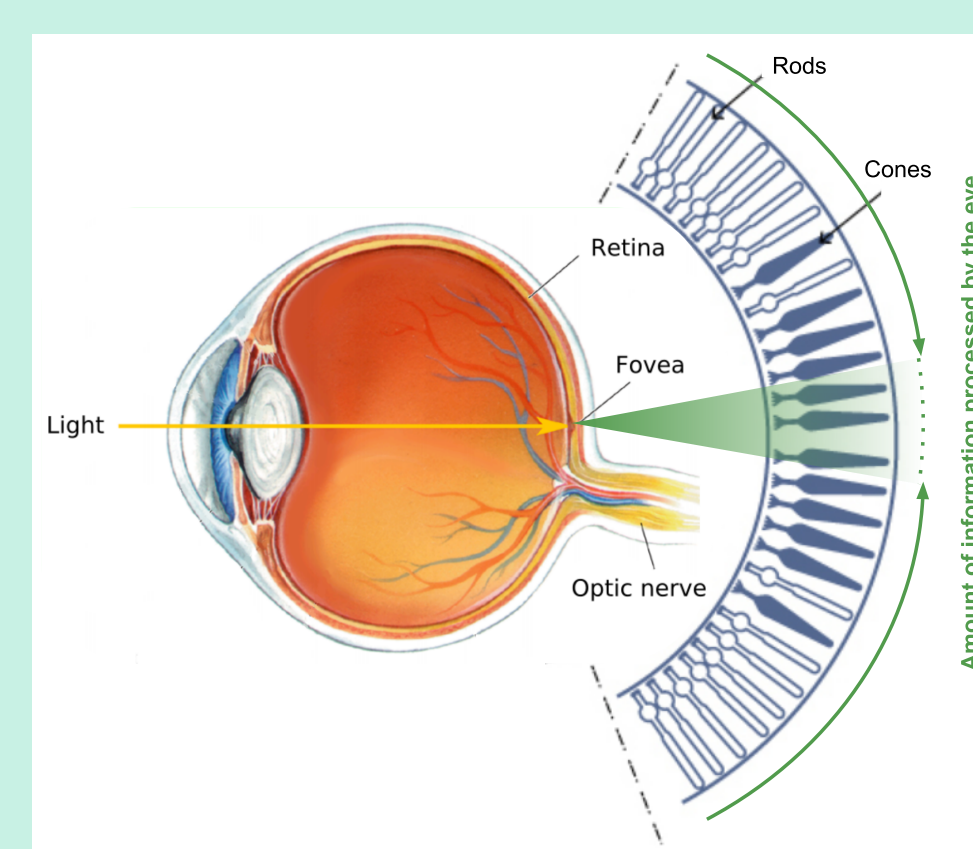
[Maass, 1997] W. Maass (1997). *Networks of Spiking Neurons: The third generation of neural network models*. *Neural Networks*.

[Mueggler, 2015] E. Mueggler, G. Gallego and D. Scaramuzza (2015). Continuous-Time Trajectory Estimation for Event-based Vision Sensors. *RSS*.

[Tobii Technology, 2020] Tobii Technology (2020). Principles of Foveation. url: [vr.tobii.com/sdk/learn/foveation/principles/](http://vr.tobii.com/sdk/learn/foveation/principles/)

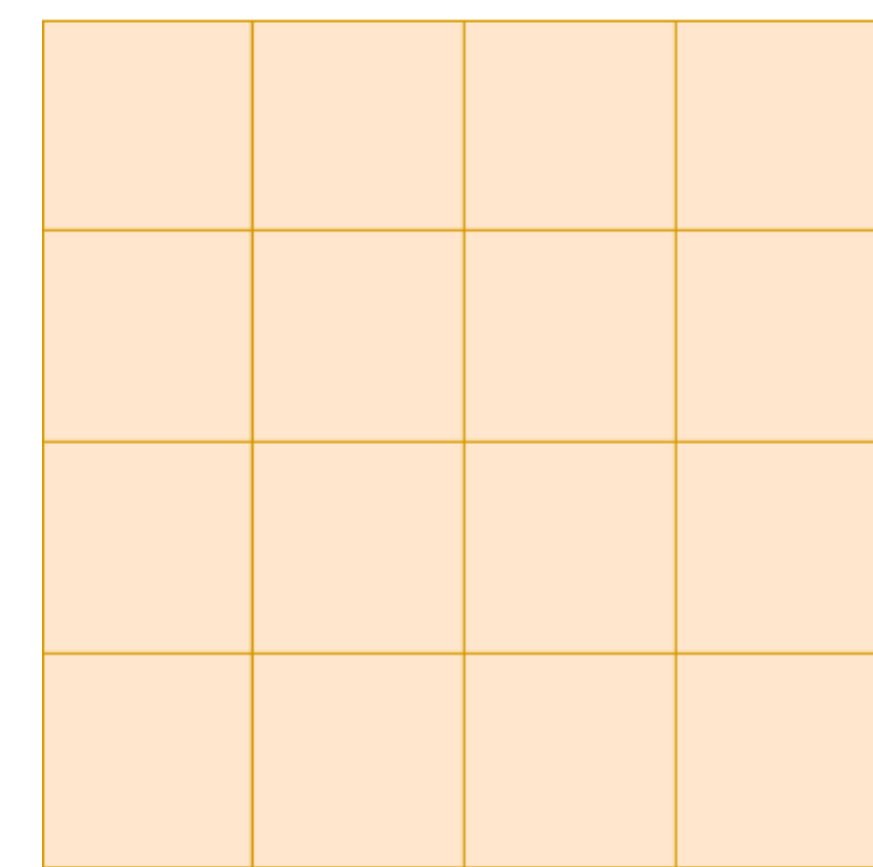
## Foveation methodology

### Biological foveation

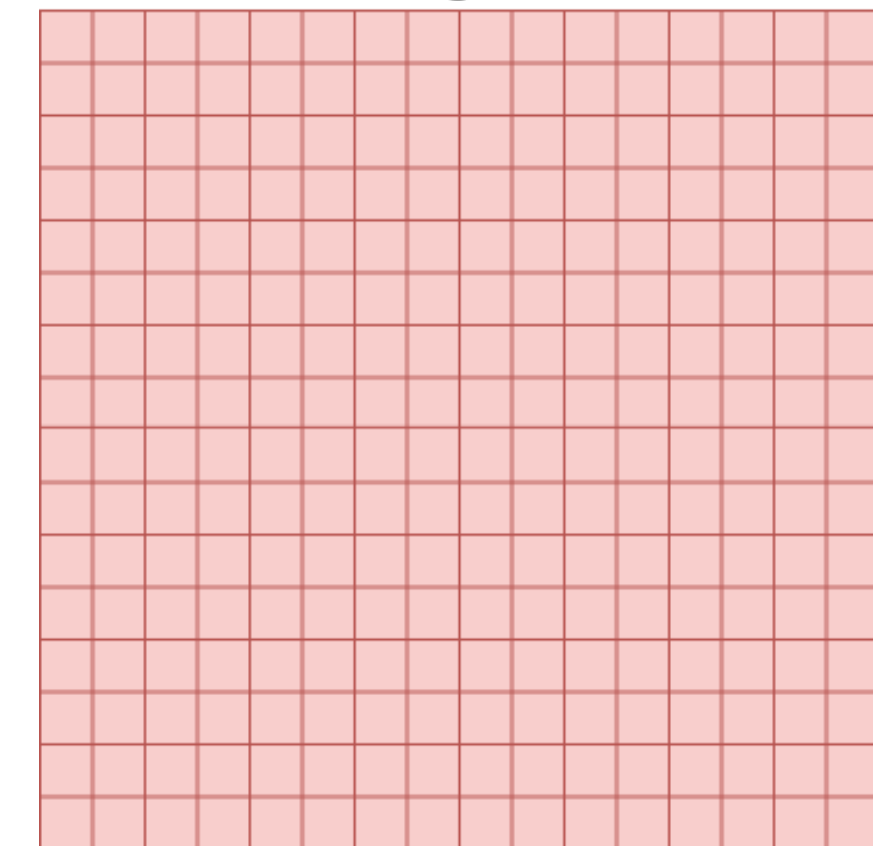


Adapted from [Bear, 2007] & [Tobii Technology, 2020]

Events in low resolution



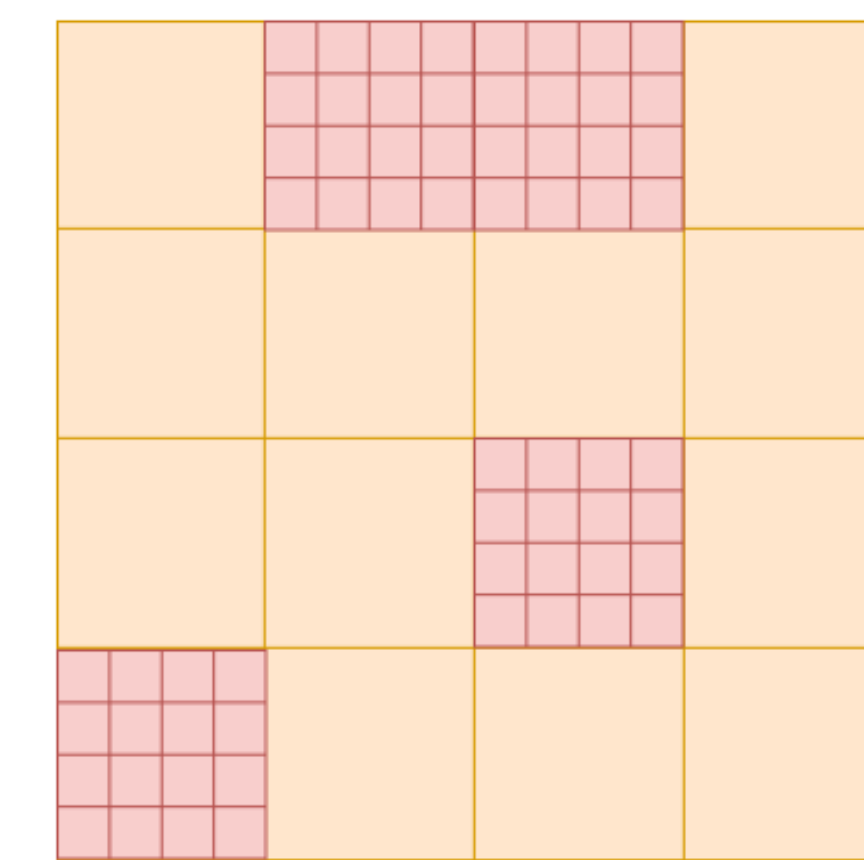
Events in high resolution



### Neuromorphic foveation

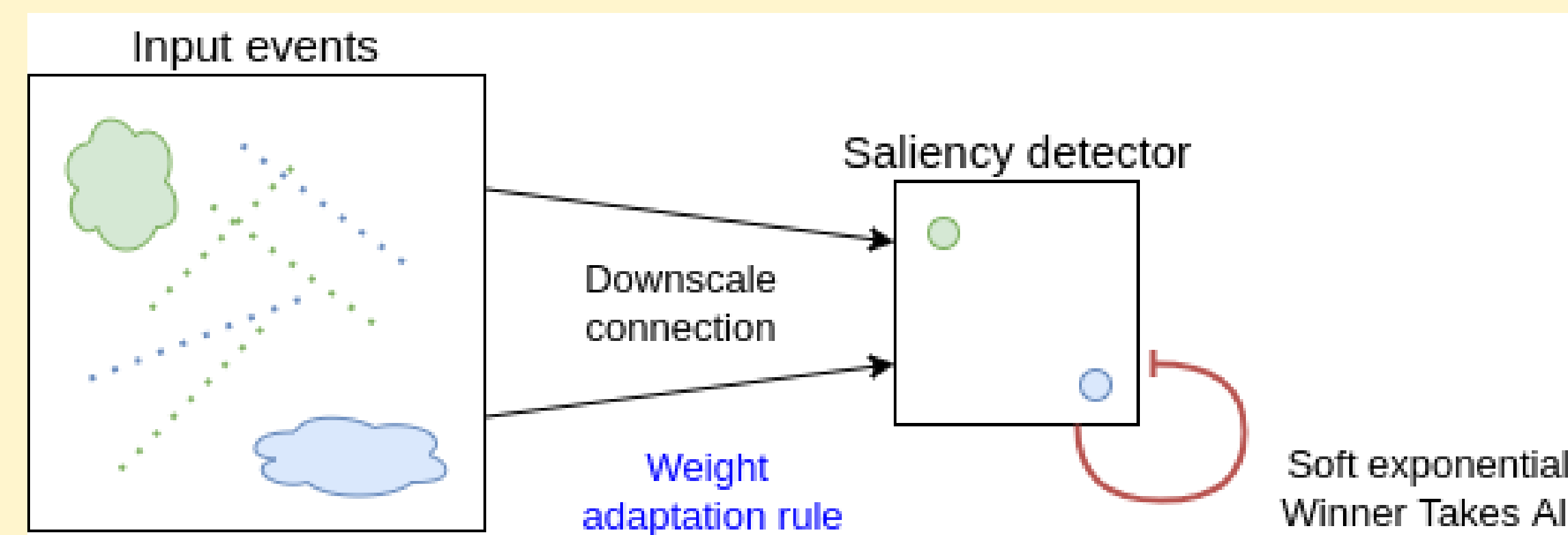
- Reduction of the amount of raw data to handle
- Preservation of relevant information
- Significant energy-efficiency

Foveated events



Regions of Interest

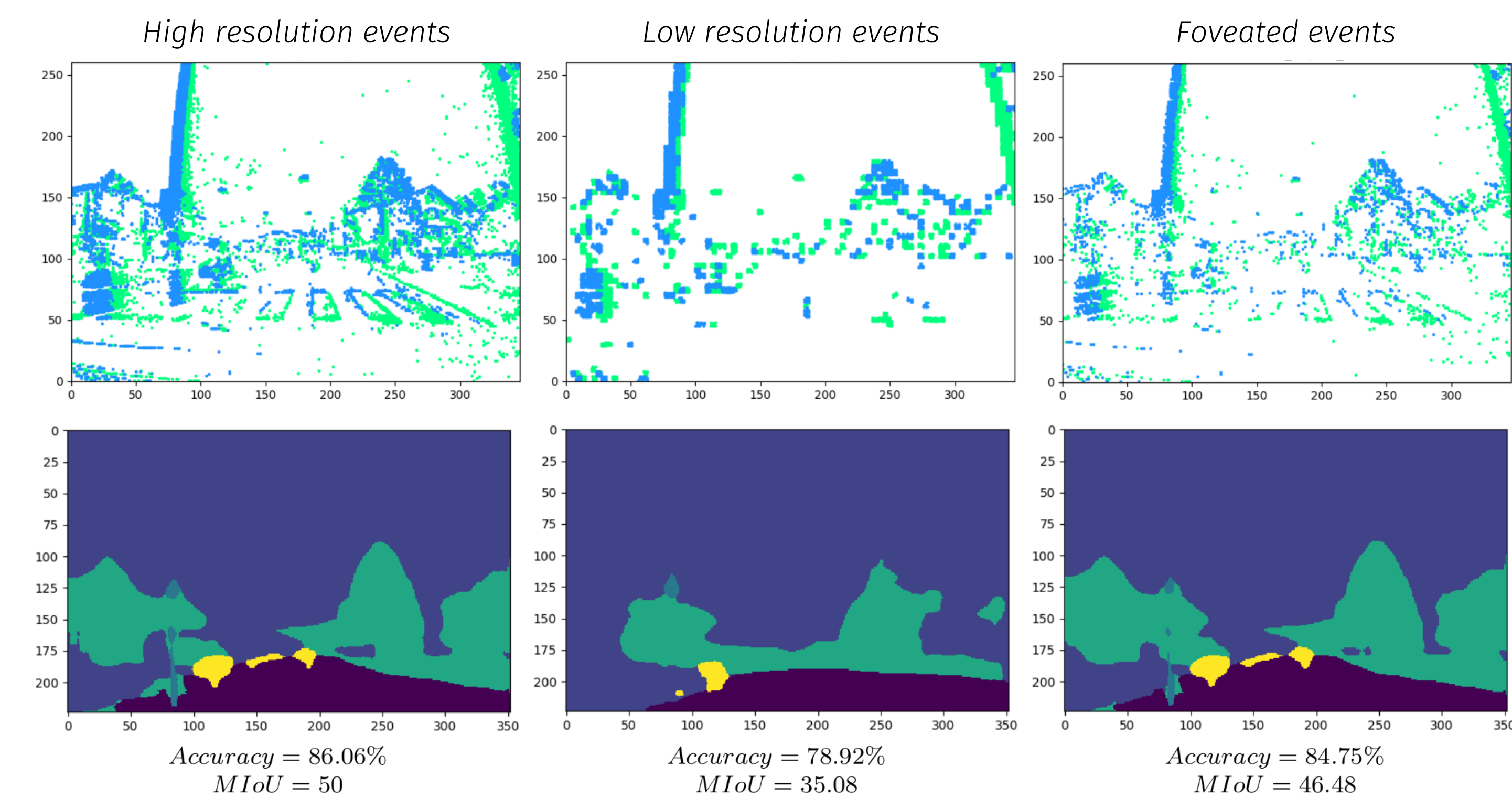
### Saliency detection by event density



Adapted from [Gruel, 2022]

## Experimental results

Visual representations of DDD17 samples: accumulated events (top) and Ev-SegNet segments (bottom).



Semantic segmentation accuracy according to the number of events (top) and its evolution according to the percentage of total events (bottom) in the dataset after processing

