

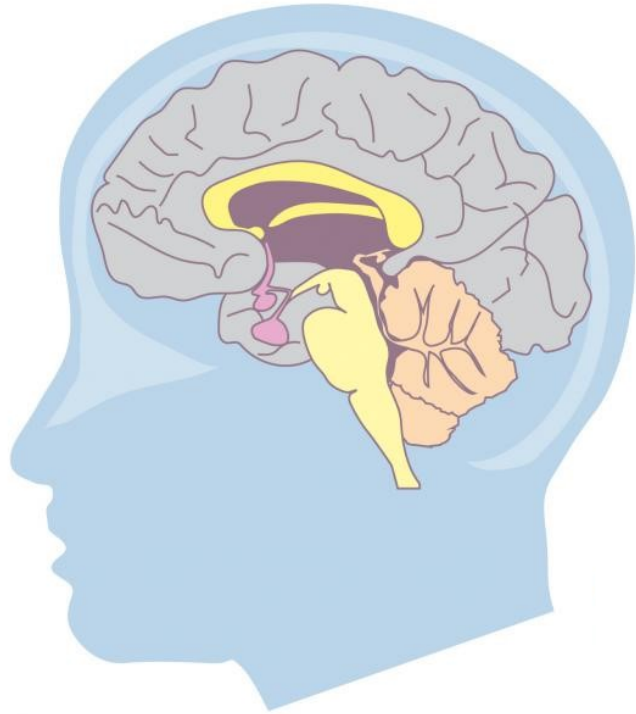
La Technologie Neuromorphique pour le Spatial

Gregor Lenz, UTIAS, April 5th 2024



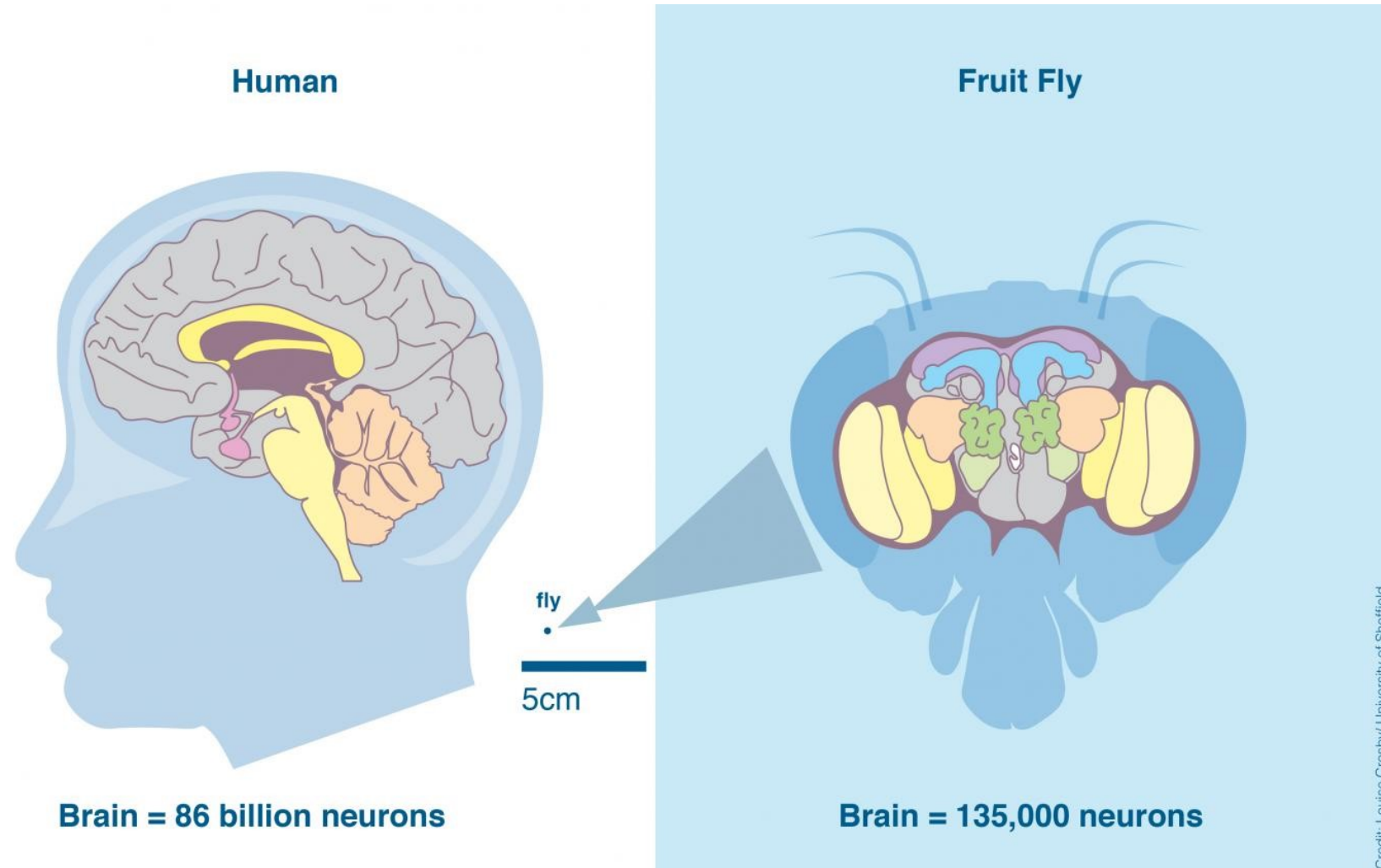
Brains and neural systems

Human

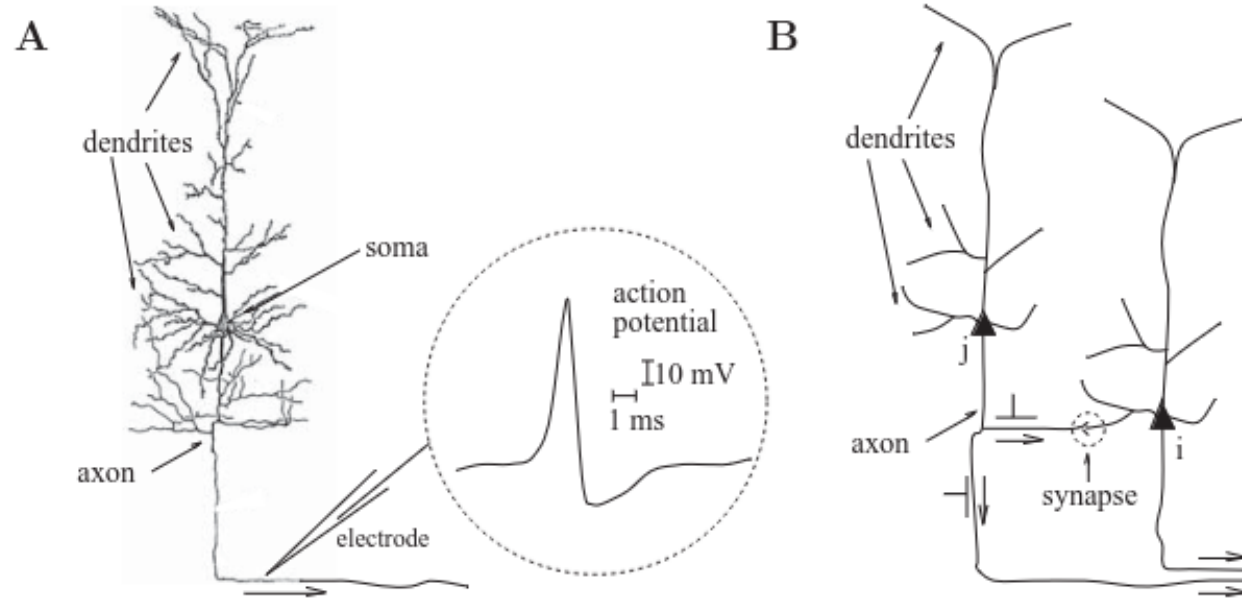


Brain = 86 billion neurons

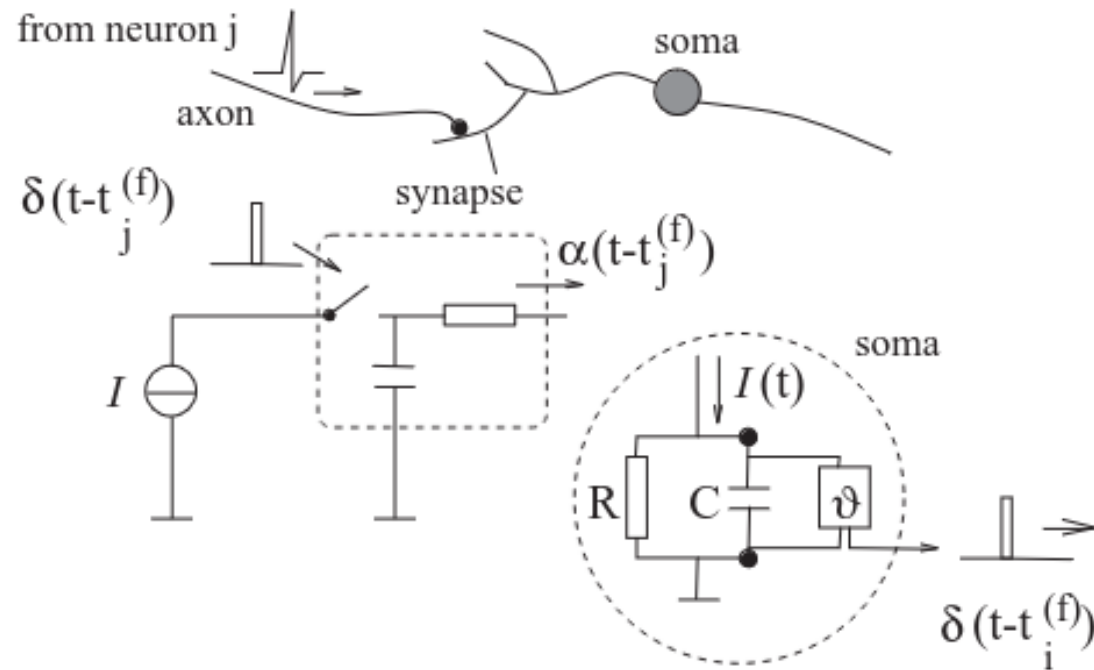
Brains and neural systems



Neural computation



Neuromorphic hardware



- Spiking communication
- Asynchronous
- In-memory computing

Neuromorphic hardware

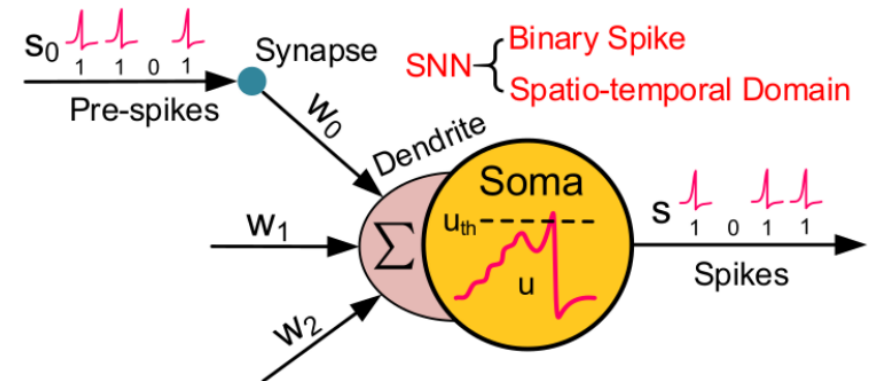
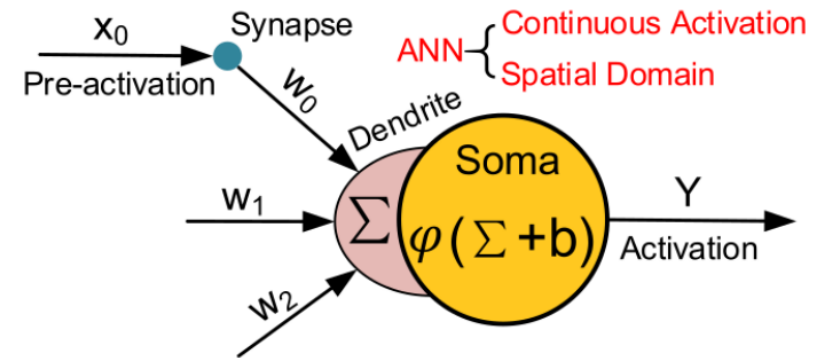
| Company/Lab | Chip type | #Neurons/ synapses | On-chip learning | Power | Software | Applications |
|--|--------------|--|------------------|--------|--------------------------|--|
| ROLLS (16) | Mixed-signal | 256/64 K | Y | ~5 mW | Custom python | Research |
| DYNAP-SE (15) | Mixed-signal | 4 K/4 M | N | ~5 mW | Custom python | Research |
| NeuroGrid (BrainDrop)/ Stanford (29) | Mixed-signal | 1 M/billions | N | ~3 W | NEF | Real-time SNN emulation |
| Innatera | Mixed-signal | 256/64 K | N | ~1 mW | PyTorch | Smart sensing |
| BrainScaleS 1/ Universität Heidelberg (17) | Mixed-signal | ~180,000/40 M (in 352 chips) | N | ~300 W | BrainScaleS OS | Accelerated SNN emulation; HPC |
| BrainScaleS 2/ Universität Heidelberg (30, 31) | Mixed-signal | 512/~130,000 | Y | ~1 W | BrainScaleS OS | Edge processing, robotics |
| TrueNorth/IBM (9) | Digital | 1 M/256 M (in 4 K cores) | N | ~0.3 W | Custom | DNN acceleration |
| SpiNNaker/University of Manchester (13) | Digital | 1B/10 kilobytes (in 64 K x 18 ARM cores) | Y | ~kW | PyNN, NEST | Real-time simulation of SNN; HPC |
| Loihi/Intel Labs (12) | Digital | ~128,000/128 M per chip (scalable) | Y | ~1 W | Lava | Research chip |
| Dynap-CNN/ SynSense | Digital | ~327,000/278,000 | N | ~5 mW | Rockpool, PyTorch | Smart sensing |
| BrainChip/Akida | Digital | Configurable, 8-Mb SRAM | Y | ~30 mW | TensorFlow, CNN → SNN | Smart sensing, one-shot learning |
| Tianjic/Tsinghua University (34) | Digital | 40,000/10 M (on 156 cores) | N | ~1 W | Custom | ANN/SNN acceleration |

Spiking Neural Networks

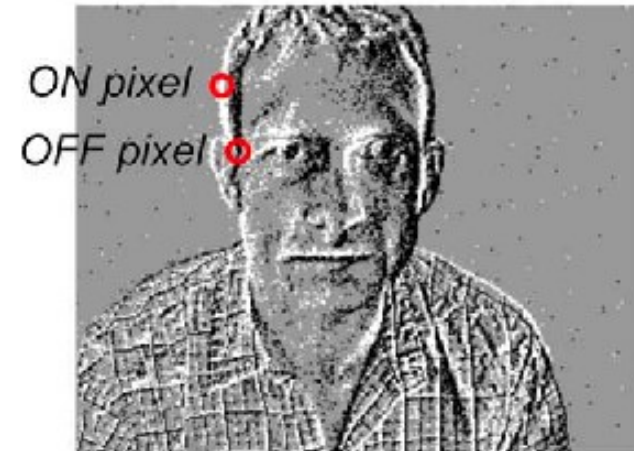
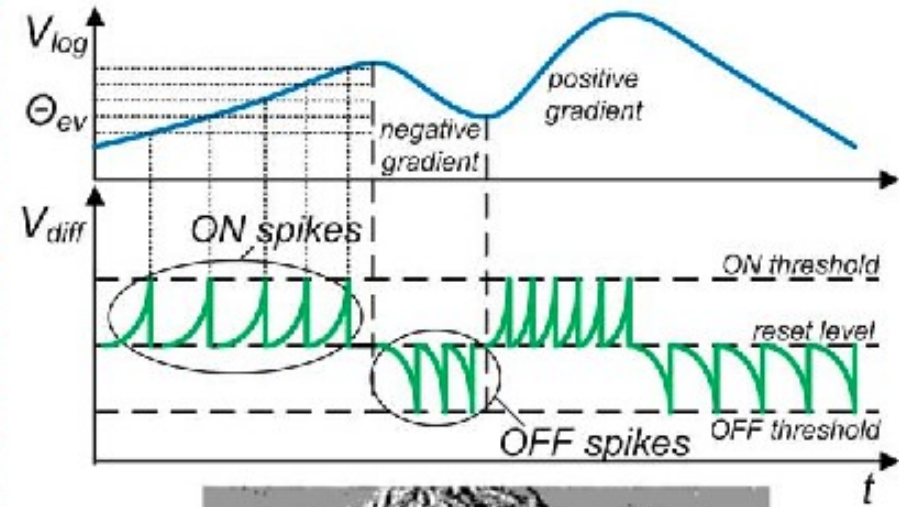
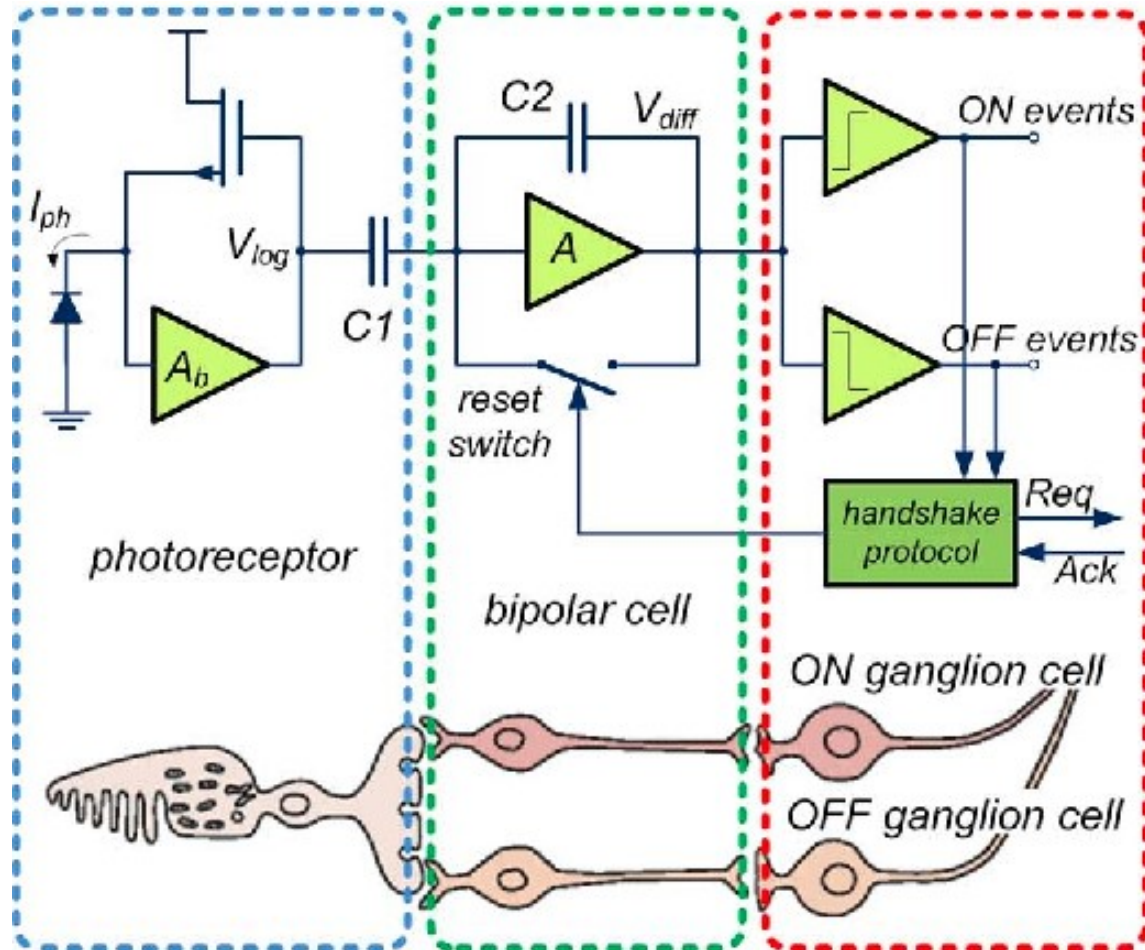
- Subclass of Recurrent Neural Networks (RNN)
- Binary, highly sparse activations
- Based on deep learning stack

Spiking Neural Networks

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- Binary, highly sparse activations
- Based on deep learning stack



Event cameras



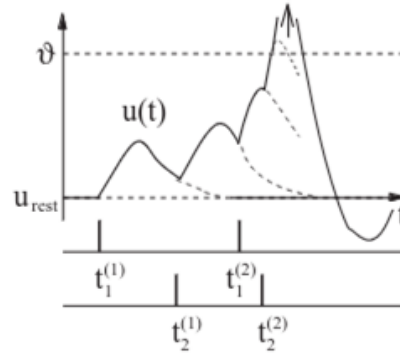
Event cameras



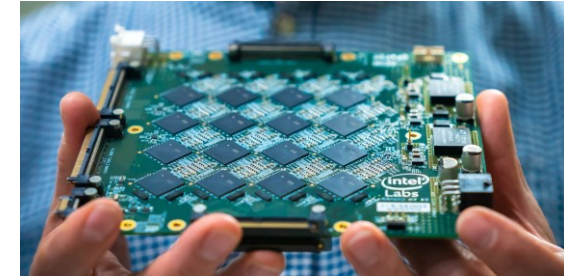
The Neuromorphic System



Optical Vision Sensor
Event-based
cameras



ML Model
Spiking Neural
Networks



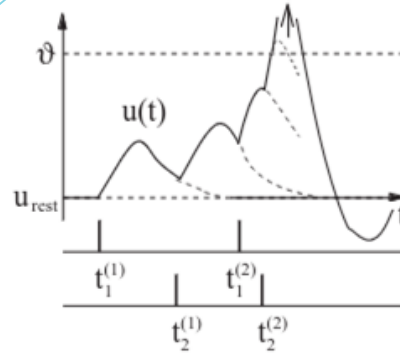
AI accelerator
Neuromorphic
processors

100x efficiency gain
Unlocks new capabilities

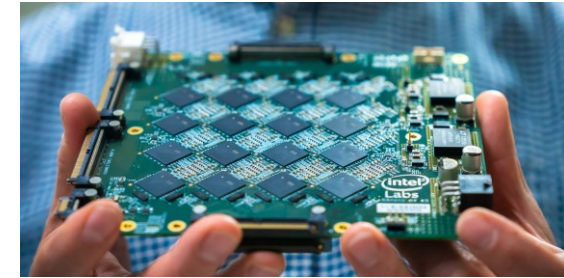
The Neuromorphic System



Optical Vision Sensor
Event-based
cameras



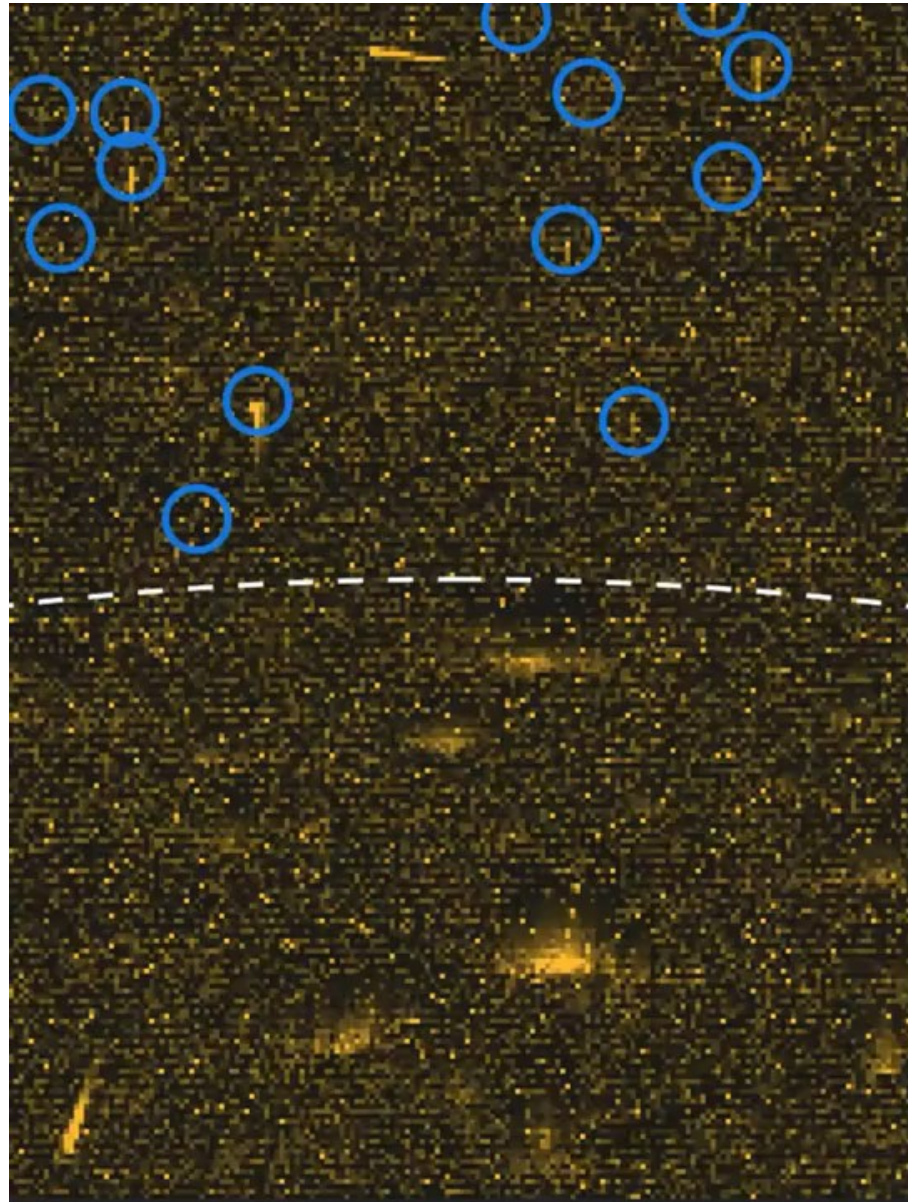
ML Model
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Space Situational Awareness



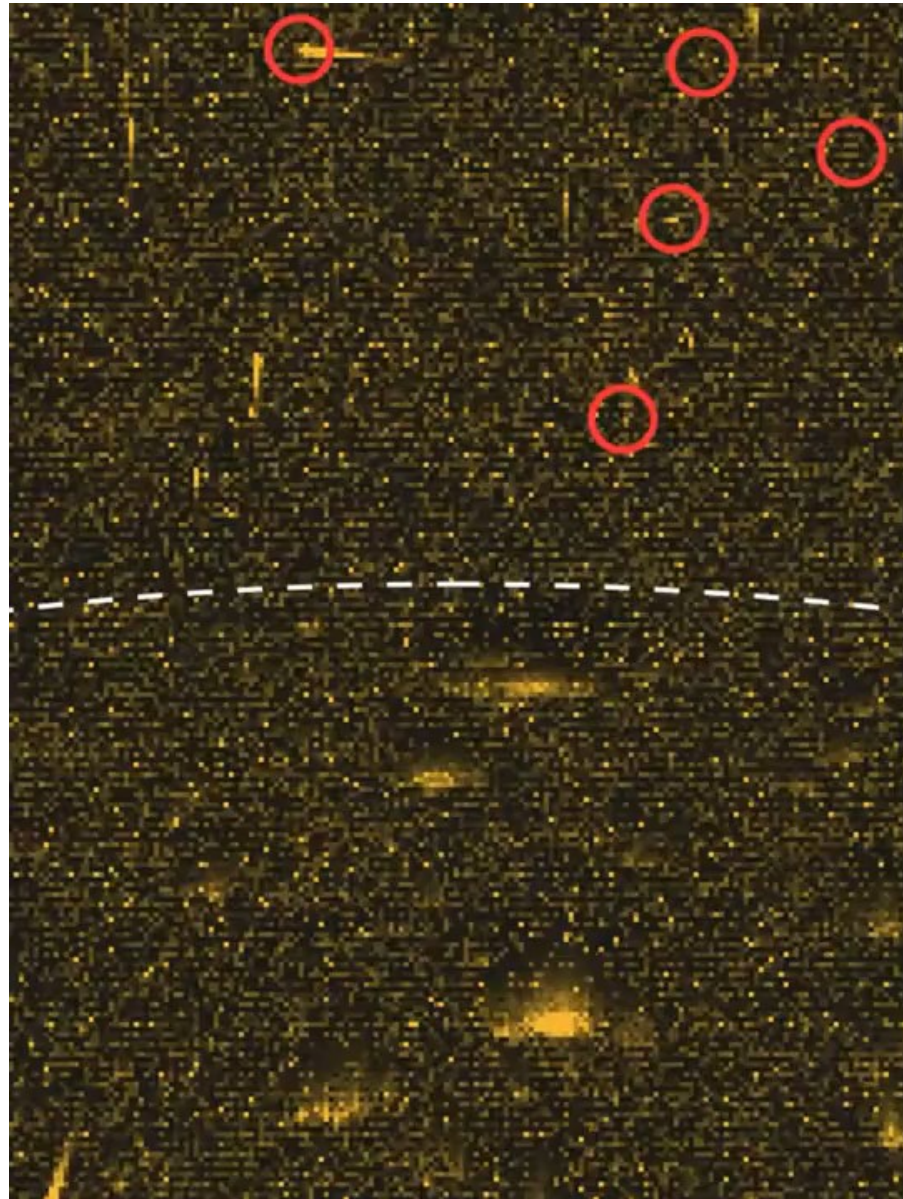
Stars

Horizon

Astrometric Fit

- There are enough stars to do an astrometric fit and measure in sky coordinates

Space Situational Awareness



RSOs

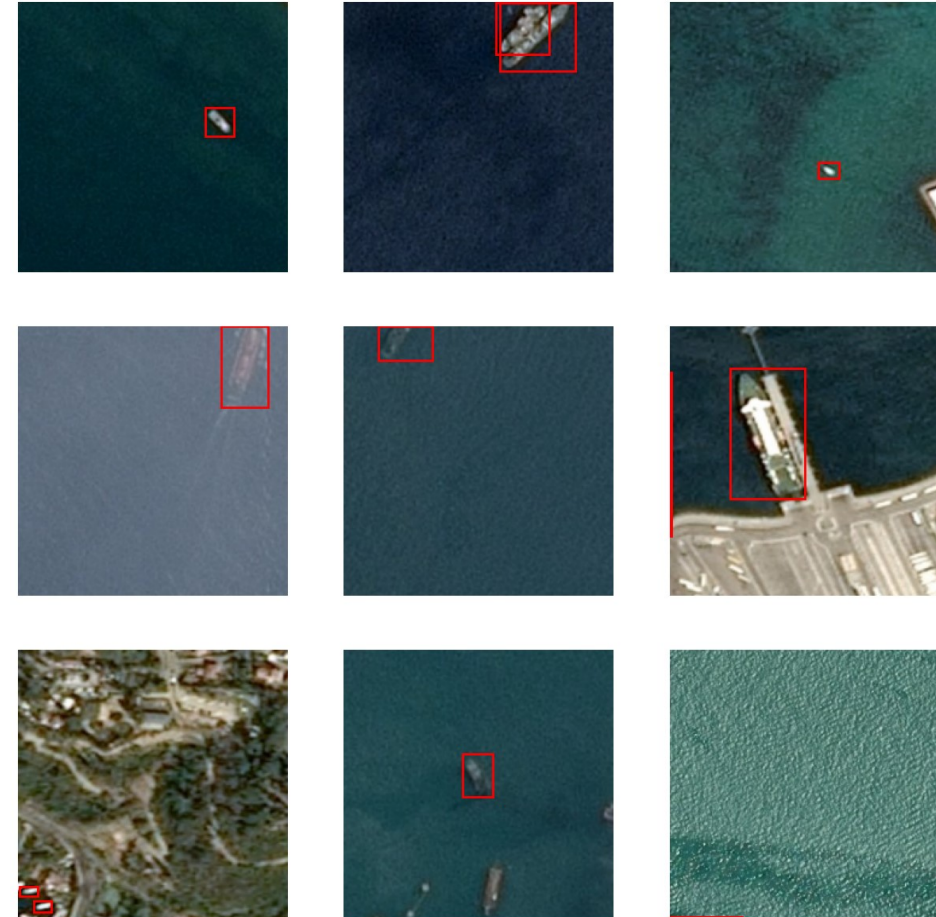
Horizon

Satellites / RSOs

- Did you spot them all?

Ship Detection on Neuromorphic Hardware

- Static power <1W
- Dynamic power <1W
- Energy consumed <50 mJ/frame



The screenshot shows the homepage of open-neuromorphic.org. At the top left is the logo, a brain with circuitry, followed by the text "Open Neuromorphic". To the right is a navigation menu with "Home", "Workshops", "Blog", and "About" with a dropdown arrow. Further right are a search icon, a dark mode toggle, and a "Join Discord" button. The main content area is divided into two columns. The left column features a heading "Neuromorphic Computing and Engineering Community" followed by a bulleted list of resources: educational content, events, software frameworks, and a code platform. Below this is a section "Ways to Get Involved" with four colored boxes: Content (blue), Workshop (green), Code (yellow), and Discord (purple). The right column features a "Next Workshop" section with a promotional card for the "Spyx Hackathon" on December 13th, including a "Why is it so fast?" callout and a surprised emoji. Below the card is the title "Spyx Hackathon: Speeding up Neuromorphic Computing" and details about the host (Kade Heckel), date (December 13, 2023), and time (6:00 - 8:00 CEST). A short description follows.

Open Neuromorphic

Home Workshops Blog About ▾

🔍 🌙 Join Discord

Neuromorphic Computing and Engineering Community

- [Educational content](#) to get you started in the neuromorphic world.
- [Events about neuromorphic research and software](#), with contributions from both academia and industry.
- A curated list of open source [software frameworks](#) to make it easier to find the tool you need.
- [A platform for your code](#). If you wish to create a new repository or migrate your existing code to ONM, please get in touch with us.

Ways to Get Involved

Content

Contribute to [website content](#), [blogs](#), [newsletters](#), and [technical guides](#).

Workshop

Participate in [workshops to share your expertise and insights](#).


Code

Contribute to [ONM projects](#) or [host your own project with ONM](#).

Discord

Join our [welcoming and collaborative community on Discord](#).

Next Workshop



Open Neuromorphic
Spyx
HACKATHON
December 13 - 6PM CET
Why is it so fast? 🤖
Overview - Coding - Q&A - Collaboration

Spyx Hackathon: Speeding up Neuromorphic Computing

👤 Kade Heckel
📅 2023, December 13
🕒 6:00 - 8:00 CEST

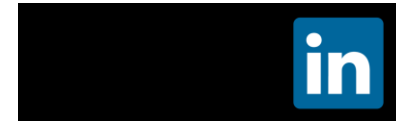
Explore the power of Spyx in a hands-on hackathon session and dive into the world of neuromorphic frameworks with Kade Heckel.



neurobus.space



Gregor Lenz
CTO & Co-Founder



open-neuromorphic.org