

Brain-inspired AI: Spiking neural networks and neuromorphic hardware



Karlsruhe, 2. Oct 2020



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- Al advances were driven by hardware availability
- GPUs exploited for deep learning
- von Neumann architecture
 - Scalability
 - Latency
 - Energy usage

All of the issues above are related!









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Creating an AI can be five times worse for the planet than a car



WILL KNIGHT BUSINESS 01.21.2020 07:00 AM

AI Can Do Great Things—if It Doesn't Burn the Planet

The computing power required for AI landmarks, such as recognizing images and defeating humans at Go, increased 300,000-fold from 2012 to 2018.

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Home / Energy & Green Tech Home / Machine learning & Al	\$ 100	Ē

() JUNE 9, 2019 [WEBLOG]

Researchers show glare of energy consumption in the name of deep learning

by Nancy Cohen , Tech Xplore



Artificial intelligence / Machine learning

Training a single AI model can emit as much carbon as five cars in their lifetimes

Deep learning has a terrible carbon footprint.

by Karen Hao

Back to the original inspiration for neural networks

Spiking neural networks tackle the **fundamental problems** of current deep learning solutions.

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Human brain does well on most of the ML tasks using only ~20 W of energy [1]

[1] https://www.munichre.com/topics-online/en/digitalisation/interview-henning-beck.html





Biological Neural Networks







Biological Neural Networks



Spiking Neural Networks







Biological Neural Networks



Spiking Neural Networks



- Event based / binary communication
- Implicit time
- Leaky accumulator
- Sparse output





Memory and processing separate



Spiking Neural Networks



Colocation of memory and processing





Principles of Neural Computation



Fine-grained parallelism



Event-driven computation





Low precision and stochastic

Adaptive, self-modifying



Neuromorphic hardware

- Intel Loihi (US)
- SpiNNaker 1 (UK)
- SpiNNaker 2 (Germany)
- BrainScaleS (Germany)
- Qualcomm Zeroth (US)

Sensors becoming widely available

• Samsung SmartThings Vision



Example: SNN in TensorFlow!

I made a spiking LSTM alternative:

Long short-term memory and learning-to-learn in networks of spiking neurons

G Bellec, D Salaj, A Subramoney, R Legenstein, W Maass

Advances in Neural Information Processing Systems, 787-797

Code:

dsalaj / GoogleSpeechCommandsRNN
IGITUGraz / LSNN-official



Vielen Dank

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