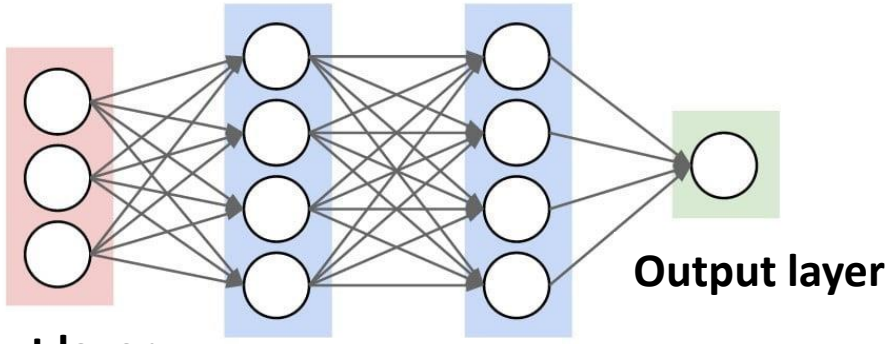
Environmental Impact of Deep Neural Network Training

Kawsar Haghshenas

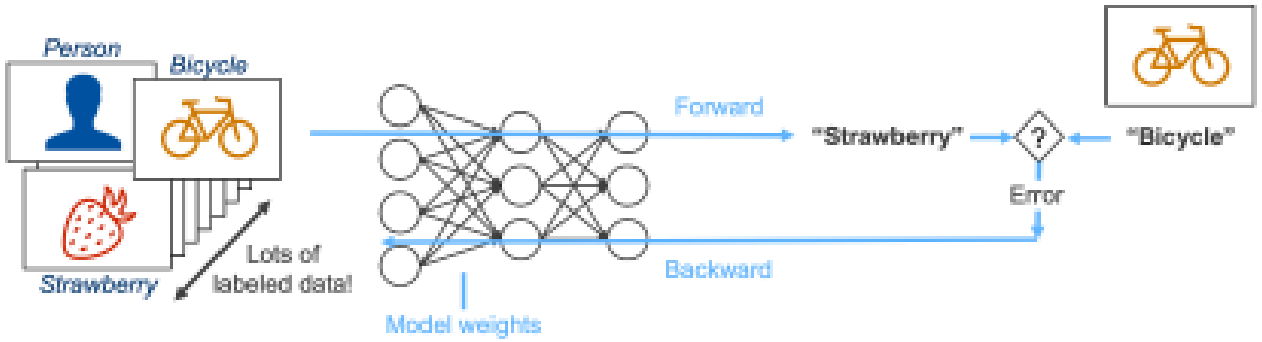
Distributed Systems Group, University of Groningen

Deep neural network training

Deep neural network



Training process

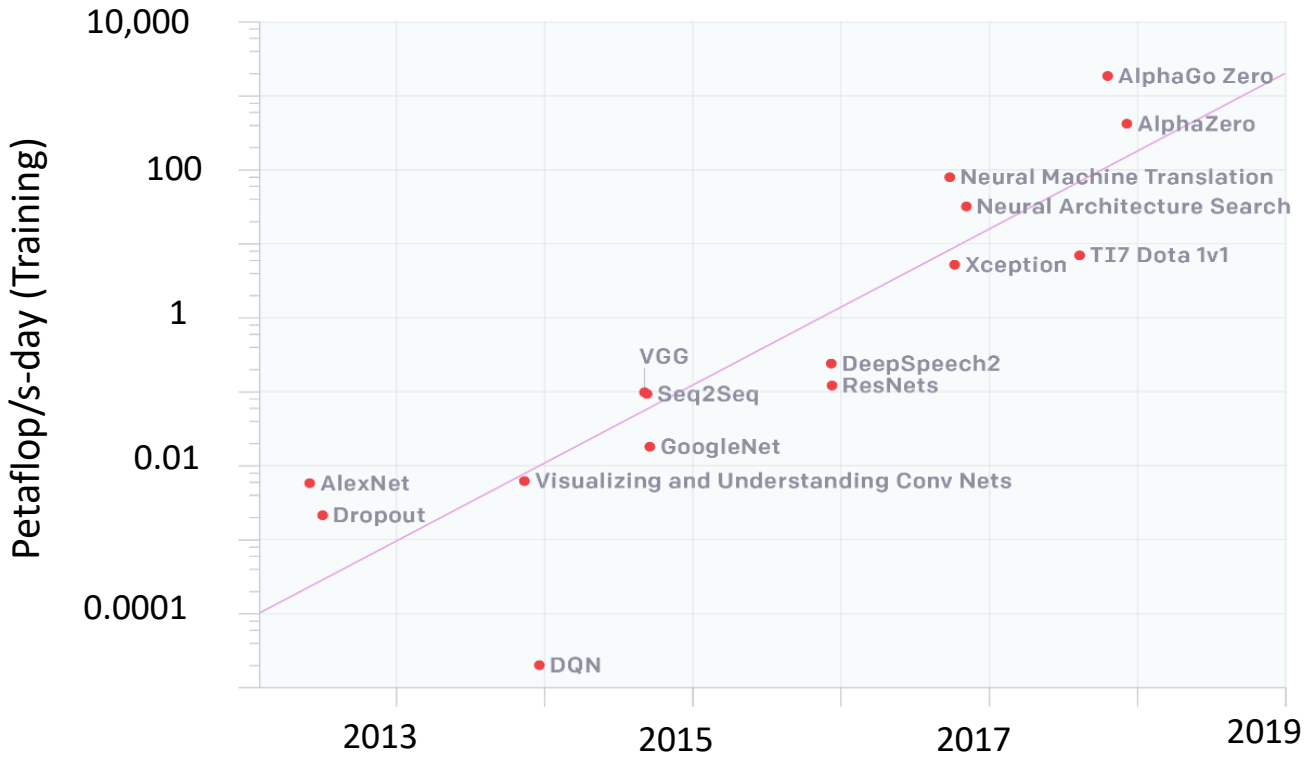


- ✓ Hundreds of millions of weights
- ✓ Hundreds of millions of raw examples

- ✓ Billions of floating-point operations
- ✓ Iterative
- ✓ Long-running

Why deep learning workload scheduling is required?

Training machine learning models



Required computation: **300,000x** increase since 2012
Computer resources: **double** every 100 days

Workload scheduling reduces

- ✓ Energy
- ✓ Carbon dioxide emission
- ✓ Cost

(2018) AI and Compute. [Online]. Available: https://openai.com/blog/ai-and-compute/

Energy and CO_2 emission measurements

Neural architecture search (NAS),
979M parameters

284,000 (Kg)

Car, avg include. Fuel, 1 lifetime

57,000 (Kg)

Air travel, 1 passenger, NY <->SF

900 (Kg)

$$\text{CO}_2 \text{ Emission} = [\sum_{t=1}^{t=n} P_{(job,t)} * CO_{2t}]/3600 * 10^6 \quad \text{(Kg)}$$

Average power consumption

Average CO_2 signal intensity

Effective factors

- ✓ Application model
- ✓ Hardware type
- ✓ Data center's PUE
- ✓ Time
- ✓ Geographical location

- E. Strubell, A. Ganesh, and A. McCallum, "Energy and policy considerations for deep learning in nlp," arXiv preprint arXiv:1906.02243, 2019
- K. Haghshenas, B. Setz, and M. Aiello. "CO 2 Emission Aware Scheduling for Deep Neural Network Training Workloads." 2022 IEEE International Conference on Big Data (Big Data).

Thanks for your attention.