Introduction to Deep Learning

Mnacho Echenim

Grenoble INP-Ensimag

2022-2023

Ensimag

Foreword

- There is an increasing concern on the environmental impact of deep learning

- Hardware concerns will not be addressed here

    ▸ https://bouveres.pages.ensimag.fr/jied/ressources/2021-2022/20211109-ImpactNumerique.pdf (in french)

- We will focus on energy consumption
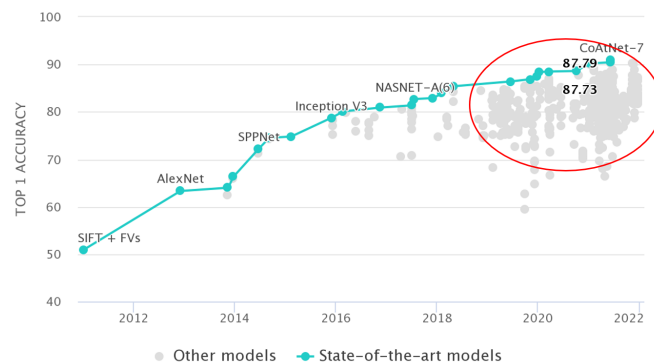
Ensimag

A focus on accuracy

- Image recognition: improve top N error
  - ▸ Principle: the correct category should be among the N guesses with the highest priority
- Results in December 2021
  (`https://paperswithcode.com/sota/image-classification-on-imagenet`):
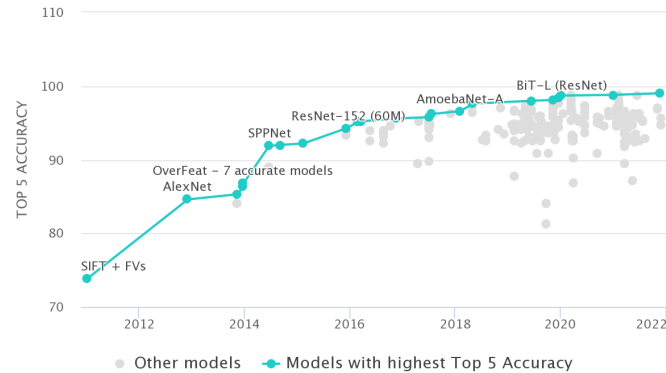
# A focus on accuracy (2)

- Still a lot of ongoing research

The requirements of an improved accuracy

A better accuracy is obtained using more complex models

- Models with billions of parameters...
  - ▶ Up to 40 billion in NLP models
- ... that require larger training sets
  - ▶ 3.5 billion images from Instagram for a model trained by Facebook
- Models require hyperparameter tuning
  - ▶ Sometimes thousands of hyperparameters are tested
- This has to be done for each tested network architecture
  - ▶ Google trained 12800 networks to improve object detection and language modeling

Source: Green IA (https://arxiv.org/pdf/1907.10597.pdf)
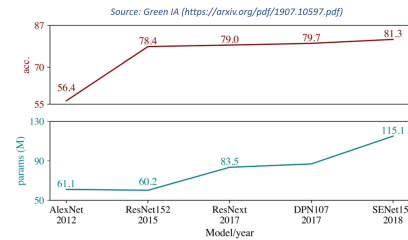
The computational cost of an improved accuracy

The search for more accurate models has entailed an **exponential growth** in **computational costs**

Source: https://openai.com/blog/ai-and-compute/
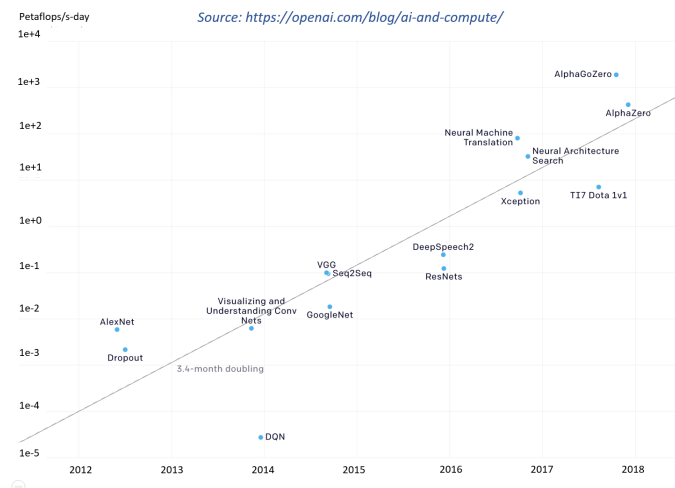
Notes

Notes

Towards efficiency

Suggestion (`https://arxiv.org/pdf/1907.10597.pdf`): we should distinguish Red AI and Green AI

- Goal of Red AI: improve the state of the art
  - ▶ Most common research domain
  - ▶ Little to no consideration for environmental impact
- Goal of Green AI: obtain new results without increasing computational costs
  - ▶ Ideally reducing computational costs
  - ▶ Improve global efficiency (model size, training effort, necessary amount of training data...)

How can we evolve towards more Green AI?

- By fully reporting efforts to obtain a model
  - ▶ Number of epochs
  - ▶ Number of hyperparameters to tune...
- By making the trained models publicly available

Transfer learning

- Some data sets have features that are reusable on other data sources
  - ▶ Text words
  - ▶ Images
- Principle: use a pretrained model on another data set as a starting point
  - ▶ No longer necessary to train a model from scratch
  - ▶ *Zoo of pretrained PyTorch models*: `https://pytorch.org/serve/model_zoo.html`

Notes

Notes

Conclusion

- This is a new topic, with questions that don't have a clear answer yet

  - ▶ What is the best measure of efficiency to use?
  - ▶ Is there even a single best measure of efficiency?

- It is a topic to be aware of

  - ▶ Especially during internships on applications of Deep Learning

- Additional resources

  - ▶ Lecture notes by Anne-Laure Ligozat (in french):
    `https://ecoinfo.cnrs.fr/wp-content/uploads/2021/04/Cours_`
    `CentraleSupelec_IA_responsable-1.pdf`

Notes

Notes