Deep Learning Crash Course

Hui Xue

Fall 2021

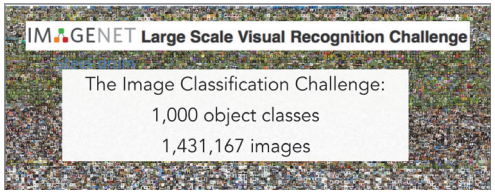
www.deeplearningcrashcourse.org

National Heart, Lung, and Blood Institute

Deep Learning (DL) is making impact in many fields

Google Cat Study -
1000 computers with 16000 cores to recognize human faces, cat faces, human bodies etc. 2012.

https://arxiv.org/abs/1112.6209



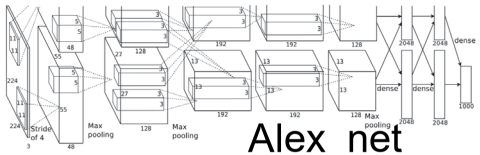
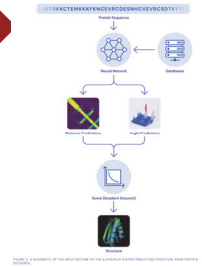


Figure 2: An illustration of the architecture of our CNN, explicitly showing the delineation of responsibilities between the two GPUs. One GPU runs the layer-parts at the top of the figure while the other runs the layer-parts at the bottom. The GPUs communicate only at certain layers. The network's input is 150,528-dimensional, and the number of neurons in the network's remaining layers is given by 253,440–186,624–64,896–64,896–43,264–4096–4096–1000.

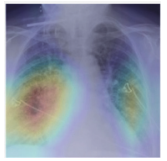
https://github.com/cs231n/cs231n.github.io

https://dl.acm.org/doi/10.1145/3065386

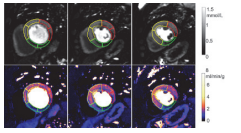
https://www.youtube.com/watch?v=tIThdr3O5Qo



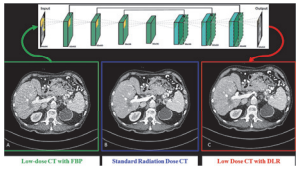
https://deepmind.com/blog/article/AlphaFold-Using-AI-for-scientific-discovery



https://pubs.rsna.org/doi/10.1148/ryai.2021190228

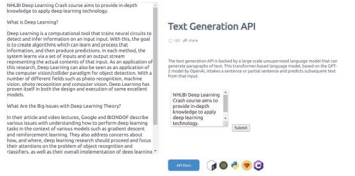


https://pubs.rsna.org/doi/10.1148/ryai.2020200009



https://www.sciencedirect.com/science/article/pii/S1120179720302866?via%3Dihub

https://medium.com/vsinghbisen/how-ai-based-drone-works-artificial-intelligence-drone-use-cases-7f3d44b8abe3



https://deepai.org/machine-learning-model/text-generator

Deep Learning is one set of core technique which can serve many purposes …

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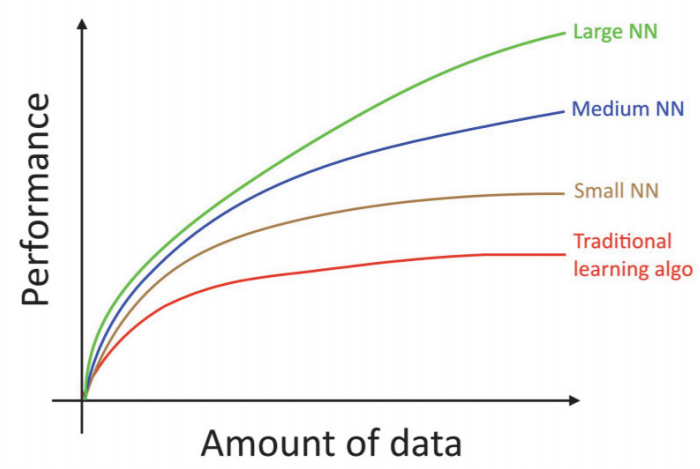
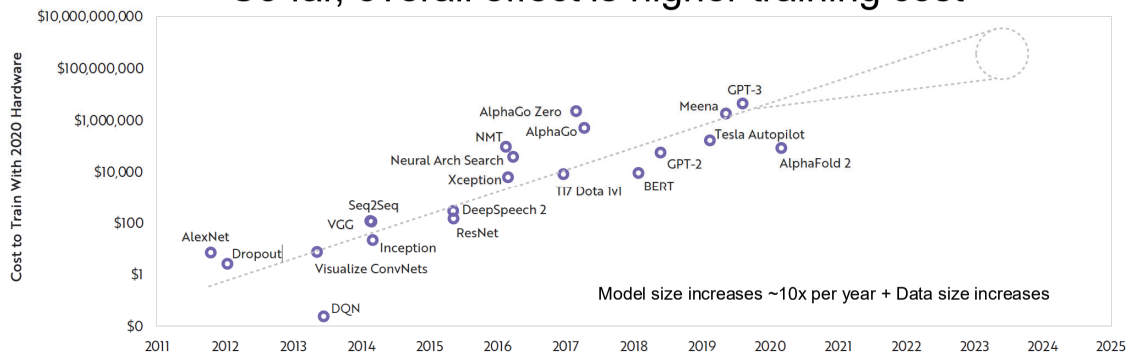
A combination of Data, Computing, Algorithm, Applications



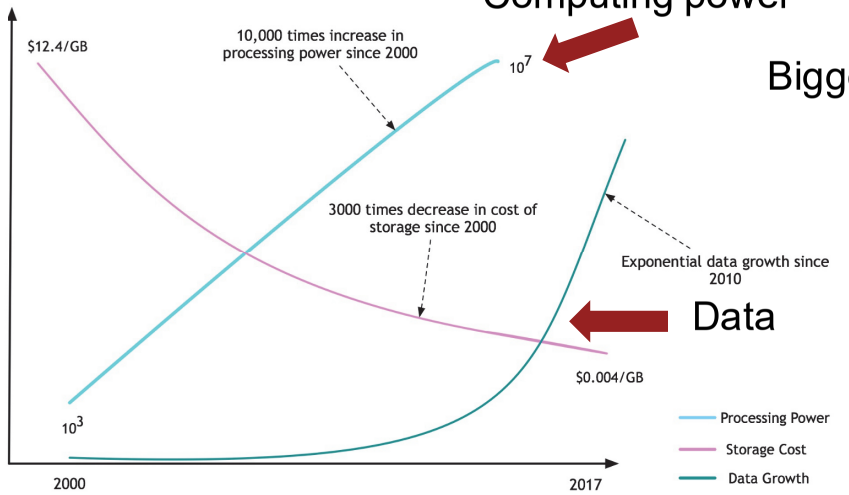
Why deep model is inevitable

So far, overall effect is higher training cost



Computing power

Bigger/better model



Data

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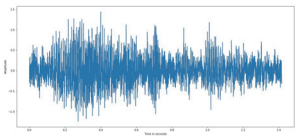
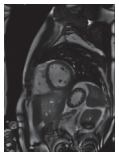
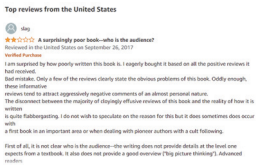
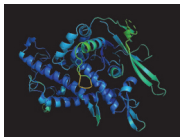
Why learn DL: same technology, widely applicable

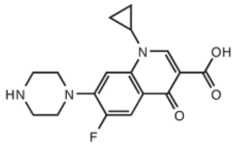
Multi-
modality data

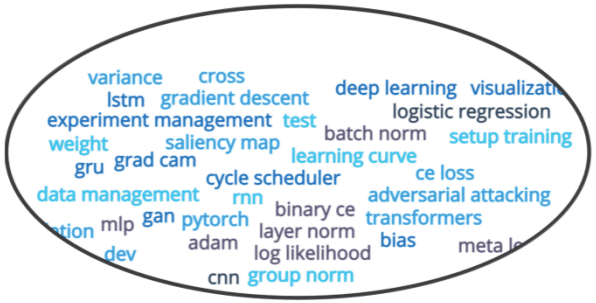












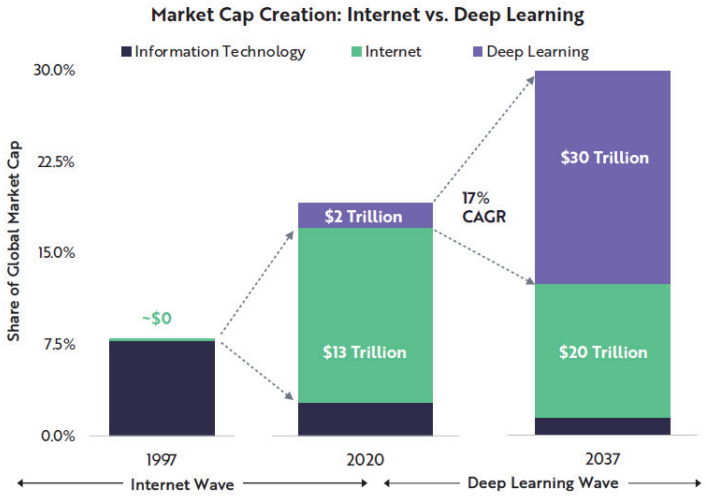
We will learn what is in the deep learning toolbox

- Automation
- AI assistant
- Prediction
- High duration system with 0% down time
- Super-human performance in some applications

- … still rapidly evolving

https://www.nature.com/articles/d41586-020-03348-4
https://towardsdatascience.com/review-deep-learning-in-drug-discovery-f4c89e3321e1

Bright future with a long-way to go: not too late to get in



According to ARK's research, deep learning will add $30 trillion to the global equity market capitalization during the next 15-20 years.

-- Big Idea 2021, https://ark-invest.com/big-ideas-2021/

AI ADOPTION by INDUSTRY & FUNCTION, 2020

Source: McKinsey & Company, 2020 | Chart: 2021 AI Index Report

Industry	Human Resources	Manufacturing	Marketing And Sales	Product and/or Service Development	Risk	Service Operations	Strategy and Corporate Finance	Supply-Chain Management
All Industries	8%	12%	15%	21%	10%	21%	7%	9%
Automotive and Assembly	13%	29%	10%	21%	2%	16%	8%	18%
Business, Legal, and Professional Services	13%	9%	16%	21%	13%	20%	10%	9%
Consumer Goods/Retail	1%	19%	20%	14%	3%	10%	2%	10%
Financial Services	5%	5%	21%	15%	32%	34%	7%	2%
Healthcare/Pharma	3%	12%	16%	15%	4%	11%	2%	6%
High Tech/Telecom	14%	11%	26%	37%	14%	39%	9%	12%

% of Respondents

From a McKinsey survey to state whether AI has been adopted in at least one company function

https://aiindex.stanford.edu/wp-content/uploads/2021/03/2021-AI-Index-Report_Master.pdf

Just 16 percent of respondents say their companies have taken deep learning beyond the piloting stage.

Adoption of DL has a long-way to go and requires innovation.

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What we want to achieve

- Introduce the basics of deep learning
- Present in-depth how DL model works
- Provide practices to build your own model
- Grow interest and improve community awareness
- Prepare trainees and fellows for DL related jobs


After this course and assignments, start to apply DL to your field …

For 2021 Fall offering

- Course logistics

Information and Course Resources

- Website – www.deeplearningcrashcourse.org
- Discussion – Slack channels
- Assignment – Slack channels, you should receive invitation already!
- Office hours – Announced on course website and slack
- Course instructors:


Hui Xue (hui.xue@nih.gov)

More information

- For this offering – www.deeplearningcrashcourse.org/nhlbi2021
  - Detailed introduction for every lecture
  - Reading list
- Information for Setup

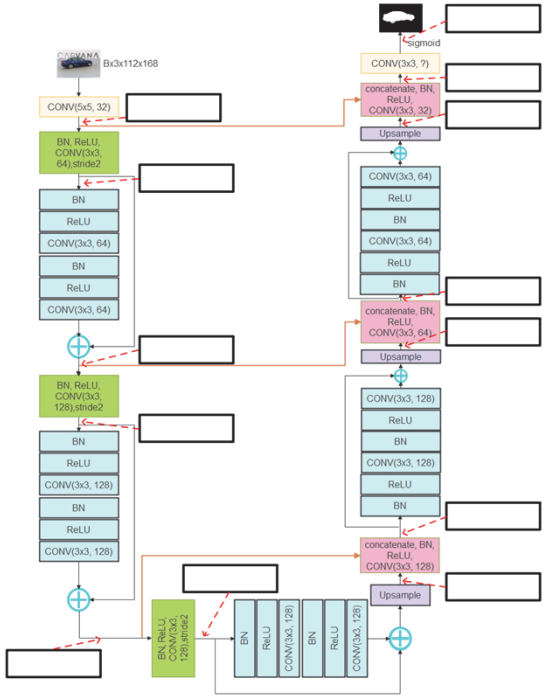
  https://deeplearningcrashcourse.org/setup_ubuntu/

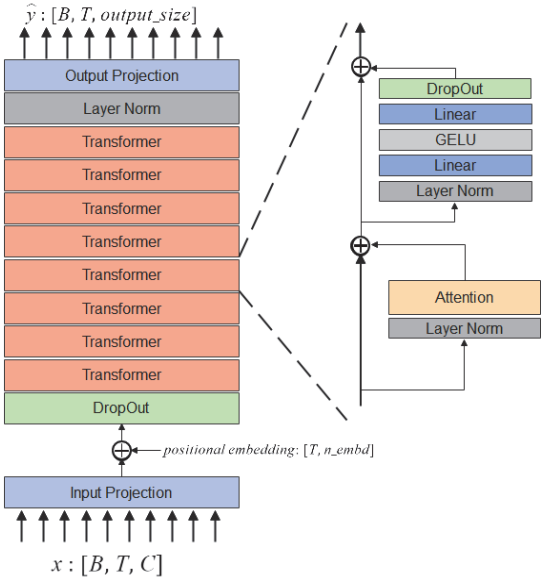
  https://deeplearningcrashcourse.org/setup_win10/
- Tech review session as we go
- Require to know python programming
  - Will demo some basics and how to debug the code
  - GPU resources
    - **Good news! If you need a GPU computer, we will provide ab Azure VM with 2x 1K80 GPU**
    - **Email hui.xue@nih.gov**

Assignments

- Five assignments

A1	Neural Network basics, Multi-layer Perceptron, Gradient descent
A2	Backprop, Hyperparameter searching, Setup training, Pytorch
A3	CNN, model training, Segmentation
A4	RNN, Attention, Transformer
A5	Model saving, saliency map, Adversarial attack, GAN, Transfer learning, Meta Learning





- Many coding problems
- Tooling for testing, experimental management, hyper-parameter searching …

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