The Renaissance of Neural Networks

Prof. Anita Wasilewska
Group No. 1
Huidong Liu, ID: 110529130
Meng Luo, ID: 110464666
Cheuk On Chung, ID: 110386696
From where we’ve learned a lot...

- DeepFace: Closing the Gap to Human-Level Performance in Face Verification, CVPR, 2014.
- Delving Deep into Rectifiers: Surpassing Human-Level Performance on ImageNet Classification, ICCV’14
- Stanford CNN course: http://cs231n.stanford.edu/
Outline

• Deep Learning: A breakthrough
• Deep Learning vs Traditional Neural Networks
• Milestone1(‘06): Stacked Auto Encoders (SAE)
• Milestone2(‘12): Convolutional Neural Networks (CNNs) applied to image recognition.
Deep Learning

Definition:

- A branch of machine learning, which is able to train multi-hidden (>1) layer Neural Networks efficiently to learn information from data.
Why deep learning a breakthrough?

Face recognition

For real world face recognition (LFW), computer beats human.

- Human: 97.53%
- Deepface (facebook): 97.35%, 2014
- FaceNet (Google): 99.63%, 2015

Source:
Why deep learning a breakthrough?

Image classification

ImageNet: 1 million images collected from the web belonging to 1000 objects.

- Human: 94.9%
- PReLU (Microsoft): 95.06%, 2015
- ResNet-152 (Microsoft): 95.51%, 2015

Source:
[1] Delving Deep into Rectifiers: Surpassing Human-Level Performance on ImageNet Classification, ICCV’14
Why deep learning a breakthrough?

Playing the Game of Go

- Game of Go: 19-by-19 board. The most difficult game in the world.
- AlphaGo vs Lee Sedol
  Date: Mar 9 – 15, 2016
- AlphaGo beat Lee Sedol by 4-1

Cite: http://www.slideshare.net/ShaneSeungwhanMoon/how-alphago-works
Deep Learning vs Traditional Neural Networks (before 2006)

- Traditional NN (TNN): Non-convex, hard to optimize.
  DL: layer-wise greedy training for parameter initialization.

- TNN: Needs huge amount of data to train a good model.
  DL: We have huge amount of data now.

- TNN: Computers couldn’t bear huge computation at that time.
  DL: 1. Hardware are very fast now. 2. Code can run in parallel.
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Stack Auto Encoders (SAE)

NN is non-convex. Initialization is important.

Figure 1: Illustration of an objective function of a NN.

Stack Auto Encoders (SAE)

Suppose we want to train a NN with two hidden layers: H1 and H2.
Stack Auto Encoders (SAE)

SAE performs greedy layer-wise training.
Stack Auto Encoders (SAE)

When weights in previous layers are trained, they are frozen.
Stack Auto Encoders (SAE)

Move to the next layer and repeat this process.
Stack Auto Encoders (SAE)

When weights in all layers are trained, they are used as initialized weights when training the whole network.
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Recap of ordinary Neural Networks
A typical image

Red  Green  Blue  32 * 32 * 3
How image recognition is applied...

- NN: Weights for a single fully-connected neuron 32 * 32 * 3, if the image is larger, 200*200*3? (expensive)
- Convolutional NN
* Zero-padding = 1, stride = 2, Depth = 4 is a set of neurons connect to the same region.

Convolutional Layer

- Input volume is Locally-connected to neurons.
- The example is a single channel.
- Weights: 3*3*3*4;
- Neurons: 2*2*3*4;

* Image pixel
* Input layer
* Convolutional layer

**dot product**
RELU layer

* Elementwise non-linearity activation function
Pooling Layer

- Reduce the spatial size of the representation to reduce the amount of parameters.
- Robust to translation and rotation.
- Insert a Pooling layer in-between successive Conv-layers.

size = 2, stride = 2
CNN Architecture

- The fully-connected layer is similar to Neural Networks.

Cite: Stanford CNN course: http://cs231n.stanford.edu/
Thank you