8. Other Deep Architectures

CS 519 Deep Learning, Winter 2016
Fuxin Li

With materials from Zsolt Kira
A brief overview of other architectures

• Unsupervised Architectures
  • Deep Belief Networks
  • Autoencoders

• Temporal Architectures
  • Recurrent Neural Networks (RNN)
  • LSTM

• We will carefully cover those items later
  • Right now just a brief overview in case that you might be tempted to use them in your project
Unsupervised Deep Learning

• CNN is most successful with a lot of training examples

• What can we do if we do not have any training example?
  • Or have very few of them?
Remember PCA: Characteristics and Limitations

- PCA works well when the data is near a linear manifold in high-dimensional space.
- Project the data onto this subspace spanned by principal components.
- In dimensions orthogonal to the subspace the data has low variance.
PCA as a “neural network”

- PCA goal:
  - Minimize reconstruction error

\[
\min_V \sum_{i=1}^{n} (x_i - VV^T x_i)^2
\]
Generalize PCA to multi-layer nonlinear network

• Deep Autoencoder
  • Same as other NN (linear transform + nonlinearity + linear transform etc.)
  • Only difference is that after decoding, strive to reconstruct the original input
  • Can have convolutional/fully-connected/sparse versions
Krizhevsky’s deep autoencoder

The encoder has about 67,000,000 parameters.

It takes a few days on a GTX 285 GPU to train on two million images (Tiny dataset)
Reconstructions of 32x32 color images from 256-bit codes
retrieved using 256 bit codes

retrieved using Euclidean distance in pixel intensity space
retrieved using 256 bit codes

retrieved using Euclidean distance in pixel intensity space
Restricted Boltzmann Machines

• Generative version of the encoder
• Binary-valued hidden variables
  • Define probabilities such as $P(h_i|X)$ and $P(x_i|H)$
  • You can generate samples of observed variables from hidden
• Think as an extension of probabilistic PCA
• Only if you are into generative models (PGM class)
• Unsupervised pre-training method to train it (Hinton, Salakhutdinov 2006)
• Convolutional and fully connected version available
Recurrent Neural Networks (RNNs)

- Temporal, Sequences
- Tied weights
- Some additional variants: Recursive Autoencoders, Long Short-Term Memory (LSTM)