Reconhecimento de Caracteres

Segundo Seminário

BCC448

Reconhecimento de Padrões

Alunos:

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Paper

- “Reducing the Dimensionality of Data with Neural Networks”

- Autores:
  - G. E. Hinton
  - R. R. Salakhutdinov
    - Department of Computer Science, University of Toronto, Toronto, Ontario, Canada.

Paper

- Quales: A1(Engenharia II e III)
  - ISSN: 0036-8075
- Cited by 1663
- Science, 2006
- 504-507.

Motivation

- *"High-Dimensional"* to *"Low-Dimensional"* data
  - Classification
  - Visualization
  - Communication
  - Storage
- PCA

What's PCA?

- Principal Component Analysis
- Way of identifying patterns in data
- Highlight similarities and differences of data
- Reduce the number of dimensions, without much loss of information

What's PCA?

- Mathematical procedure
  - Uses an orthogonal transformation
  - Possibly correlated variables
  - Linearly uncorrelated variables
- Usages
  - Find patterns
  - Image Compression

What's a RBM?

- Restricted Boltzmann Machine
  - Smolensky, 1986

- First
  - What's Boltzmann Machine?

What's BM?

- Boltzmann Machine
  - Hinton
  - Sejnowski, 1983
- Network of symmetrically connected neuron
- Neurons make stochastic decisions On/Off

What's BM?

- Learning algorithm
  - Discover interesting features
  - Complex regularities in the training data
  - Slow in network with many layers of feature(equilibrium distribution)

- Usage
  - Search problem
  - Learning problem

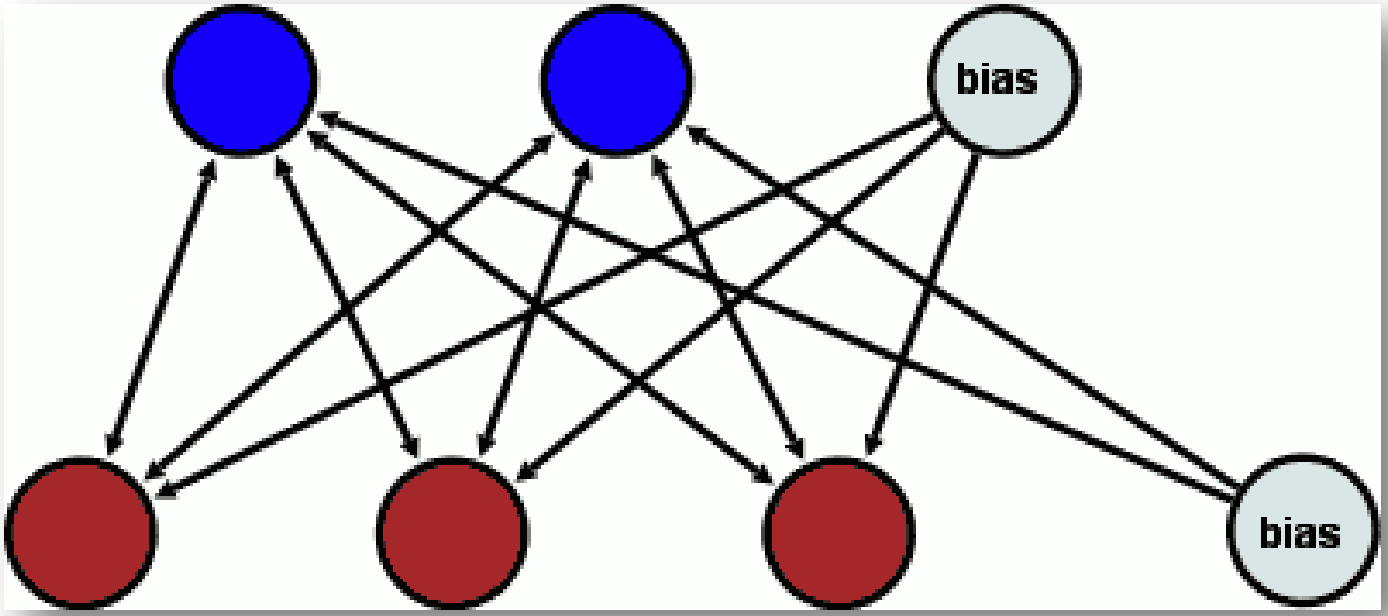
What's a RBM?

- Now we can define it
- Special case of BM
  - Fast than BM, single layer of feature detectors
- Stochastic Neural Network
  - Network of neurons
  - Random behavior when activated

What's a RBM?

- Neurons
  - Visible neurons
  - Hidden neurons
  - Connections bidirectional and symmetric
    - Information
    - Weight

RBM



Visible/Hidden

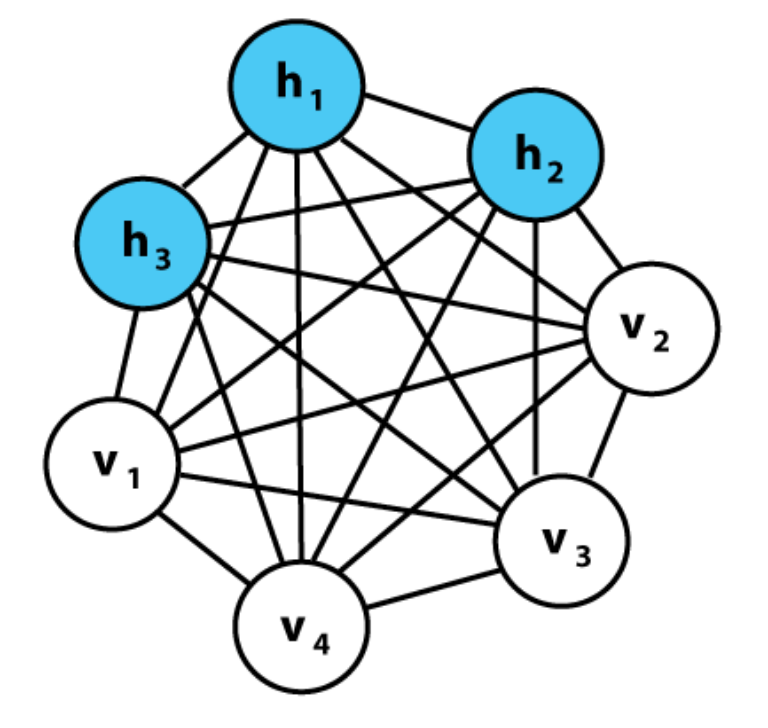
Energy

RBM operation

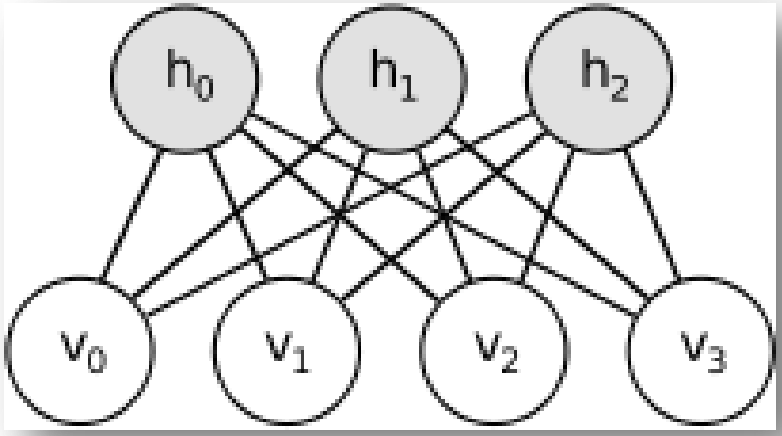
- First
  - Train
  - Match data points in this data set
- Second
  - New unknown data
  - Classification(unsupervised learning)

What changes?

BM



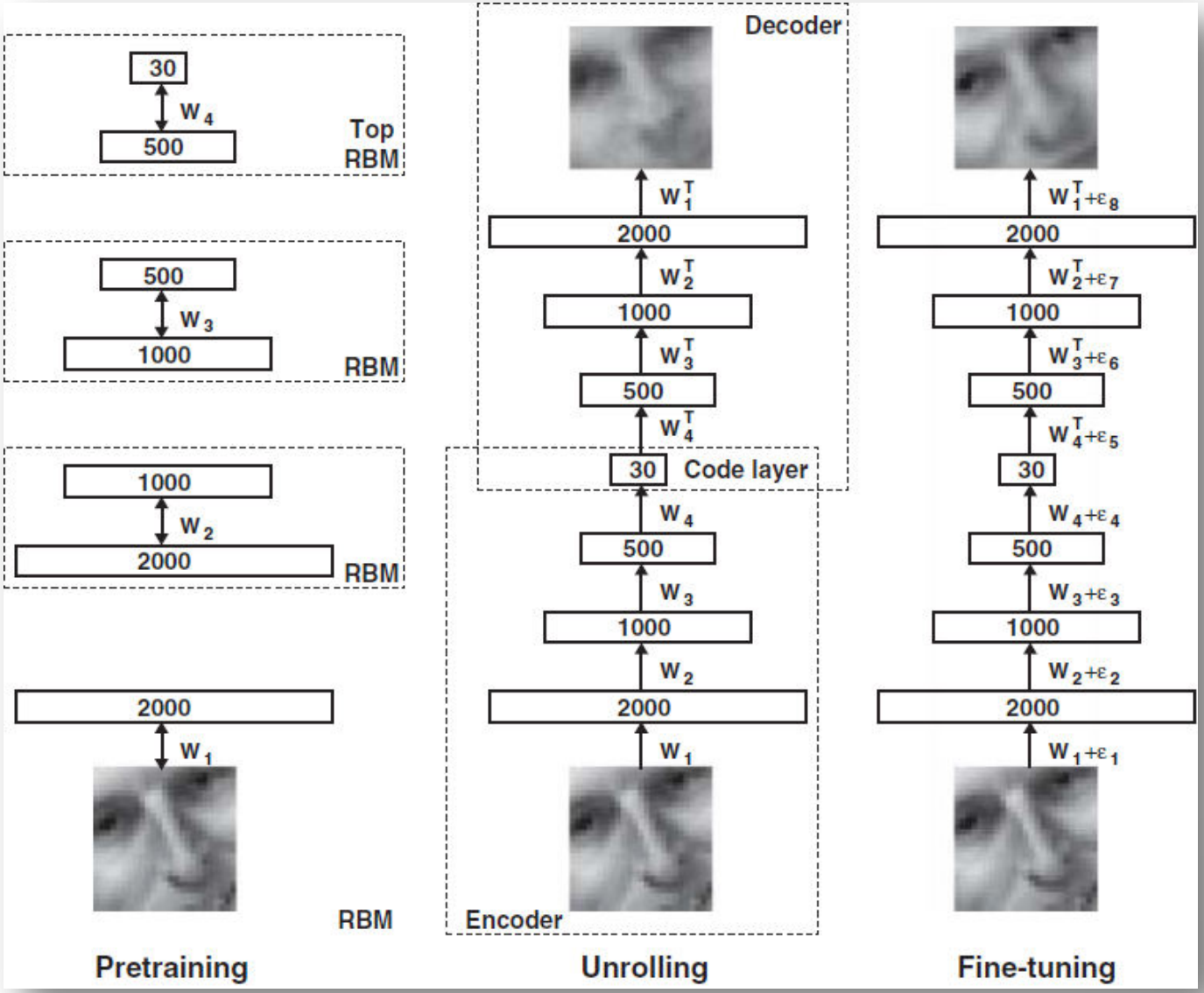
RBM



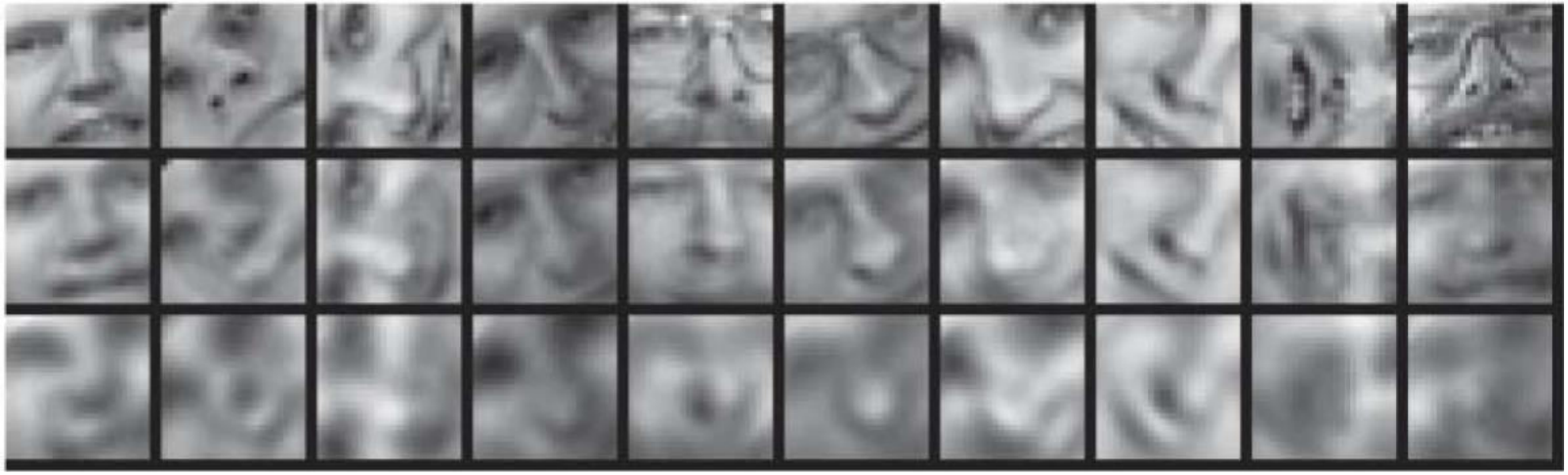
Now came back to our problem

- RBM
  - Modeling a set of binary vectors
- Pixels correspond "visible" units
  - State are observed
- Feature detectors correspond to "hidden" units

Method


30
W4
500
Top RBM
500
W3
1000
RBM
1000
W2
2000
RBM
2000
W1
RBM
Pretraining
Decoder
W1T
2000
W2T
1000
W3T
500
W4T
30
Code layer
W4
500
W3
1000
W2
2000
W1
Encoder
Unrolling
W1T+ε8
2000
W2T+ε7
1000
W3T+ε6
500
W4T+ε5
30
W4+ε4
500
W3+ε3
1000
W2+ε2
2000
W1+ε1
Fine-tuning

PCA X Autoencoder



1. Imagem real
2. Autoencoder
3. PCA

Autoencoder

- Encoder with layers of size (28 28)-400-200-100-50-25-6
- symmetric decoder

- 784-1000-500-250-30 autoencoder

Classification

- Train 20,000 images
- Test 10,000 new images.
- Discovered how to convert each 784-pixel image into 6 real
- numbers that allow
  - Almost perfect reconstruction
- PCA gave much worse reconstructions

Classification

- Shallower autoencoders with a single
- hidden layer between the data and the code
- can learn without pretraining, but pretraining
- greatly reduces their total training time.

Classification

- Base: Handwritten digits in the MNIST training set

- fine-tuning on all 60,000 training images
- tested on 10,000 new images
  - produced much better reconstructions than did PCA

Classification

- MNIST recognition task
  - the best reported error rates are 1.6% for randomly initialized backpropagation
  - 1.4% for support vector machines (SVM)

- After layer-by-layer pretraining in a 784-500-500-2000-10 network
  - backpropagation using steepest descent and a small learning rate achieves 1.2%(8).

References

- Hinton, Geoffrey E., and Ruslan R. Salakhutdinov. "Reducing the dimensionality of data with neural networks." *Science* 313.5786 (2006): 504-507.
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