Neural Networks for Machine Learning

Lecture 15c
Deep autoencoders for document retrieval and visualization

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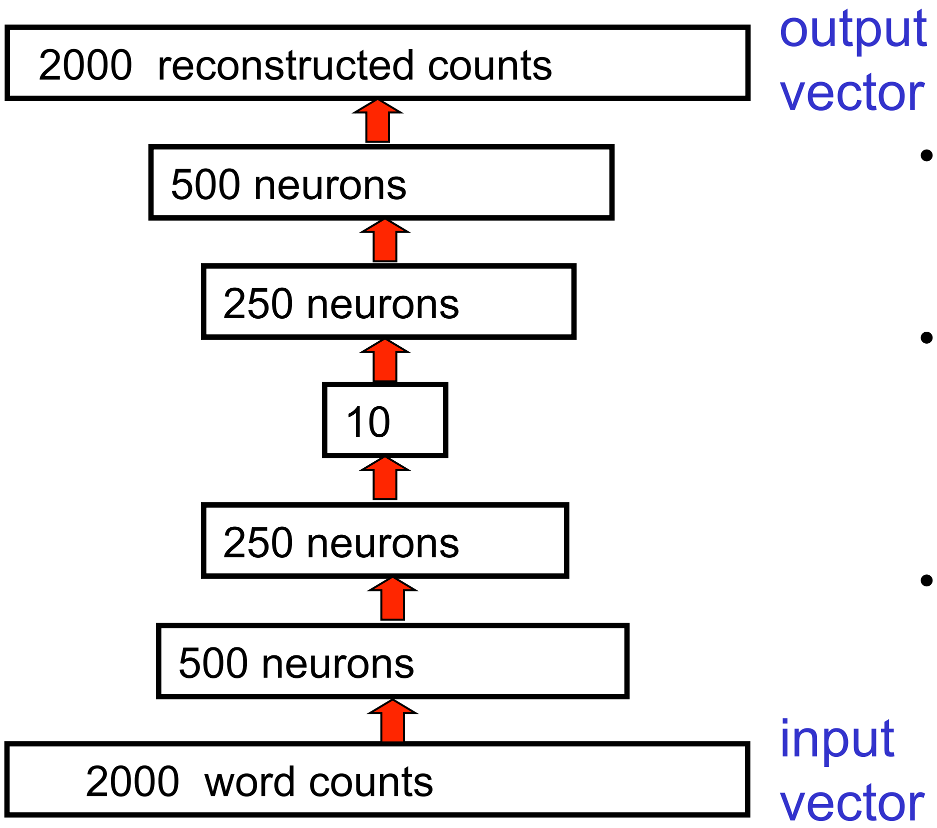
How to find documents that are similar to a query document

- Convert each document into a “bag of words”.
  - This is a vector of word counts ignoring order.
  - Ignore stop words (like “the” or “over”)
- We could compare the word counts of the query document and millions of other documents but this is too slow.
  - So we reduce each query vector to a much smaller vector that still contains most of the information about the content of the document.

0	fish
0	cheese
2	vector
2	count
0	school
2	query
1	reduce
1	bag
0	pulpit
0	iraq
2	word

How to compress the count vector



- We train the neural network to reproduce its input vector as its output
- This forces it to compress as much information as possible into the 10 numbers in the central bottleneck.
- These 10 numbers are then a good way to compare documents.

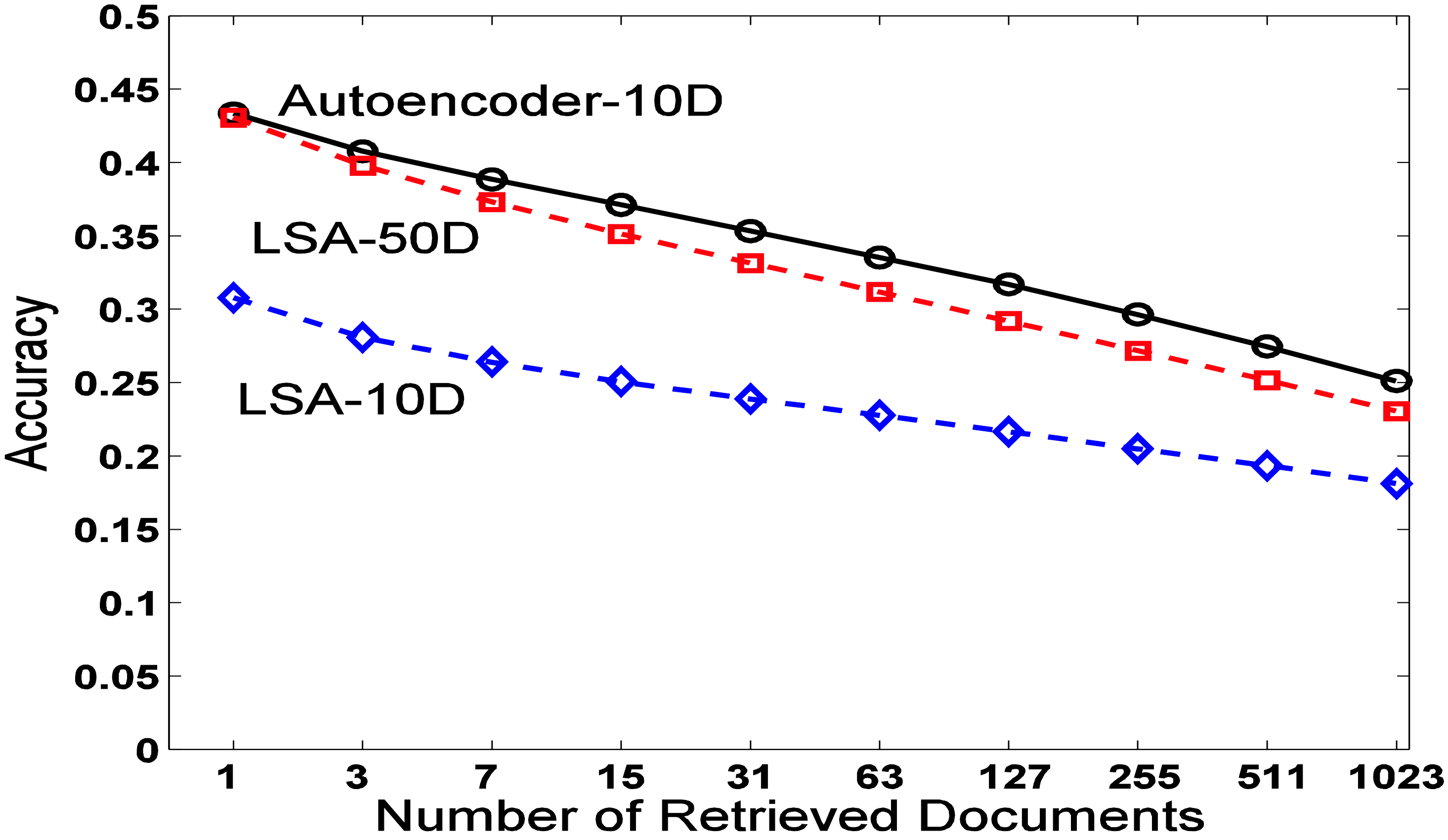
The non-linearity used for reconstructing bags of words

- Divide the counts in a bag of words vector by N, where N is the total number of non-stop words in the document.
  - The resulting probability vector gives the probability of getting a particular word if we pick a non-stop word at random from the document.
- At the output of the autoencoder, we use a softmax.
  - The probability vector defines the desired outputs of the softmax.
- When we train the first RBM in the stack we use the same trick.
  - We treat the word counts as probabilities, but we make the visible to hidden weights N times bigger than the hidden to visible because we have N observations from the probability distribution.

Performance of the autoencoder at document retrieval

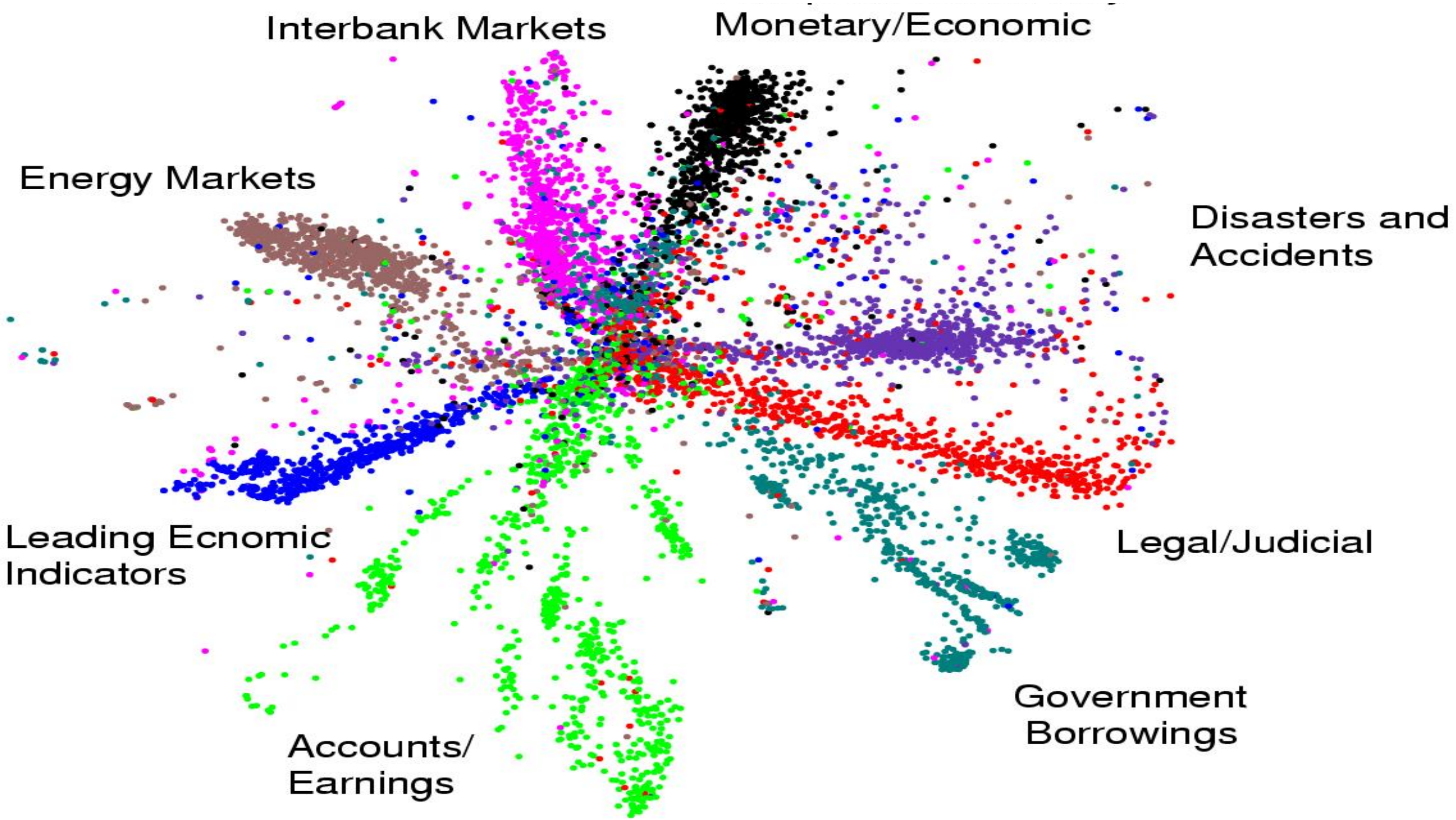
- Train on bags of 2000 words for 400,000 training cases of business documents.
  - First train a stack of RBM's. Then fine-tune with backprop.
- Test on a separate 400,000 documents.
  - Pick one test document as a query. Rank order all the other test documents by using the cosine of the angle between codes.
  - Repeat this using each of the 400,000 test documents as the query (requires 0.16 trillion comparisons).
- Plot the number of retrieved documents against the proportion that are in the same hand-labeled class as the query document. Compare with LSA (a version of PCA).

Retrieval performance on 400,000 Reuters business news stories



First compress all documents to 2 numbers using PCA on log(1+count). Then use different colors for different categories.

First compress all documents to 2 numbers using deep auto. Then use different colors for different document categories



Neural Networks for Machine Learning

Lecture 15d
Semantic hashing

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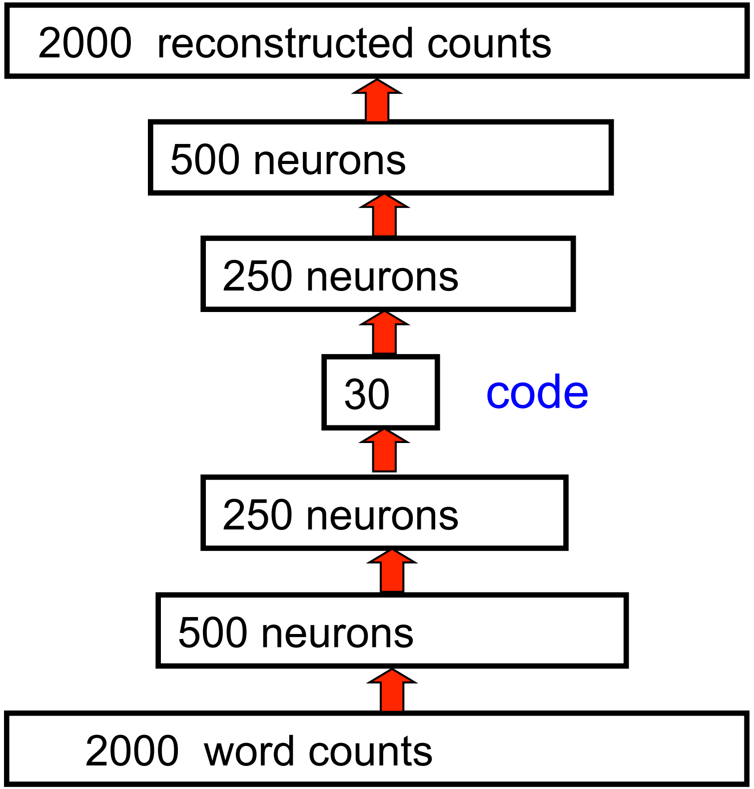
Finding binary codes for documents

- Train an auto-encoder using 30 logistic units for the code layer.
- During the fine-tuning stage, add noise to the inputs to the code units.
  - The noise forces their activities to become bimodal in order to resist the effects of the noise.
  - Then we simply threshold the activities of the 30 code units to get a binary code.
- Krizhevsky discovered later that its easier to just use binary stochastic units in the code layer during training.



Using a deep autoencoder as a hash-function for finding approximate matches