

Image Retrieval with Deeplearning

Jeffrey Tang

Who am I ?

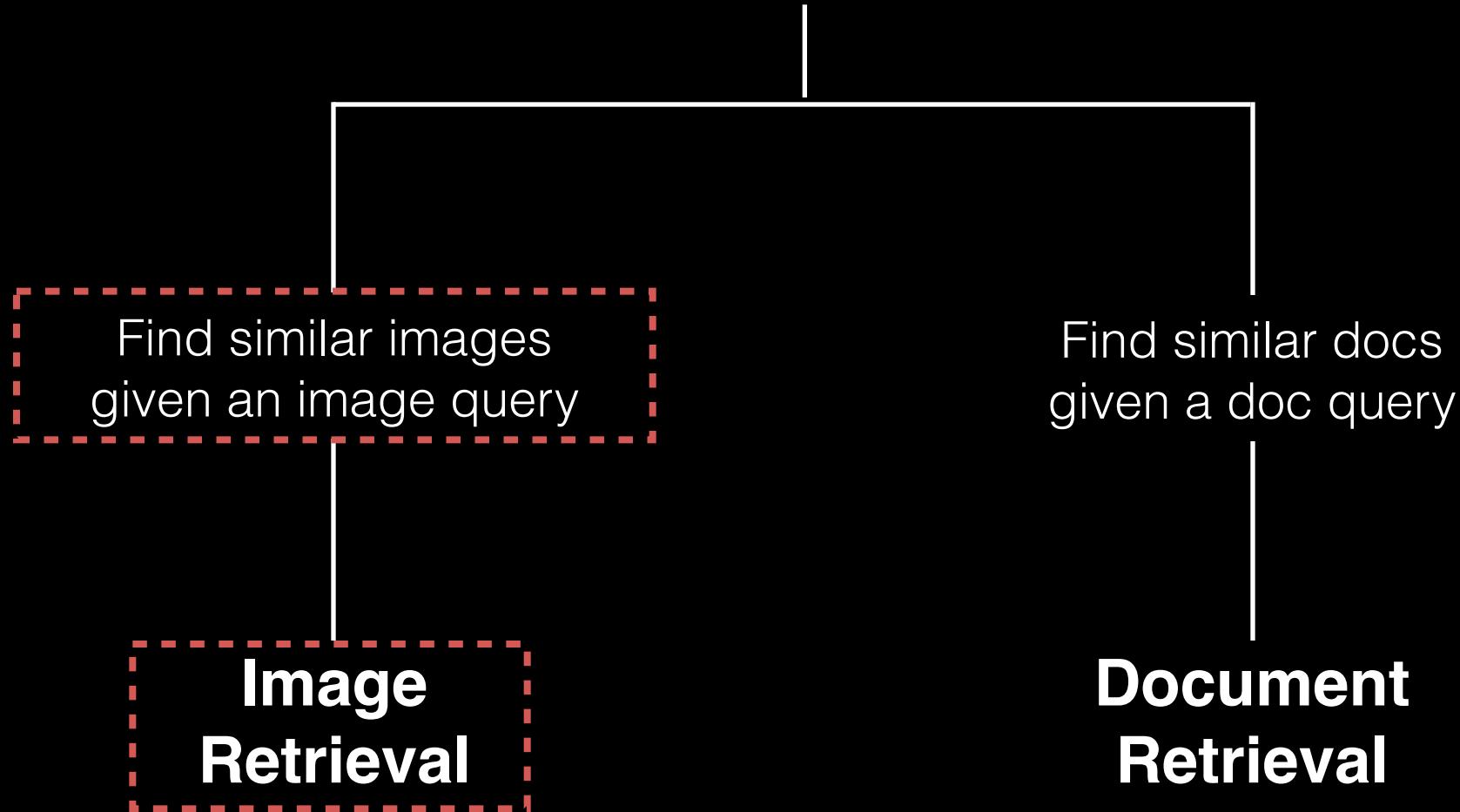
- **Software Engineer at Skymind.io**
 - Python Interface to deeplearning4j (Java)
 - Optimizing deep learning on Spark
- **(Ex-)Data Science Instructor at Galvanize**

Goals

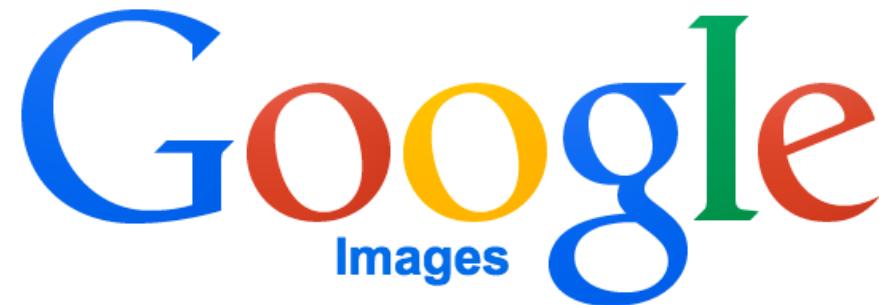
- **Image Retrieval**
 - ★ Application & Overview
- **Deep Learning**
 - ★ Image Retrieval using Auto-Encoders (unsupervised)
 - ★ Image Retrieval using Convolutional Net (supervised)
- **Deep Learning Ecosystem**

Image Retrieval Overview

Information Retrieval



Google Images



Search by image

X

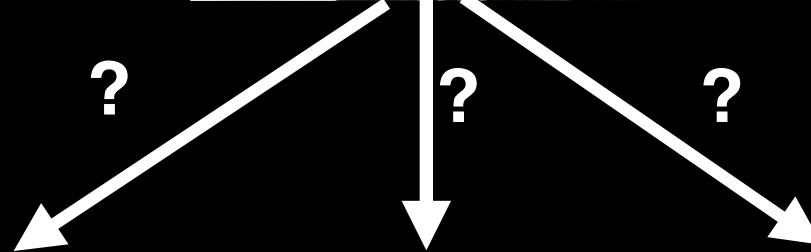
Search Google with an image instead of text. Try dragging an image here.

Paste image URL

Upload an image

No file chosen

Applications: Real Estate



Applications: Place Matching



?

?

?



Applications: Product Matching



High Level

- Image Retrieval == Image Recommenders
- Find similar images based on a query image
- Compare query to every stored image

Images



...

|
Resize/
Vectorize/
Scale



[0.92, 0.01, 0.64, 0.51, 0.47, 0.71 ...],
[0.84, 0.44, 0.88, 0.82, 0.35, 0.74 ...],
[0.09, 0.20, 0.59, 0.52, 0.78, 0.59 ...]

...

|
Dimensionality
Reduction
(PCA, SVD, AutoEncoder)



[0.25, 0.62, 0.18 ...], [0.36, 0.81, 0.87 ...]
[0.16, 0.3 , 0.07 ...],
[0.65, 0.53, 0.59 ...]

...

Query Image



|
Resize/
Vectorize/
Scale



[0.83, 0.42, 0.98, 0.13, 0.43, 0.88 ...]

|
Trained
Model



Cosine
Similarity

[0.25, 0.62, 0.18 ...], [0.36, 0.81, 0.87 ...]
[0.16, 0.3 , 0.07 ...],
[0.65, 0.53, 0.59 ...]

Why Reduce Dimension ?

- Yields a more **generalized (and better)** representation of the image
- More robust to noisy images
- **Faster computations**
(Comparing fewer dimensions)

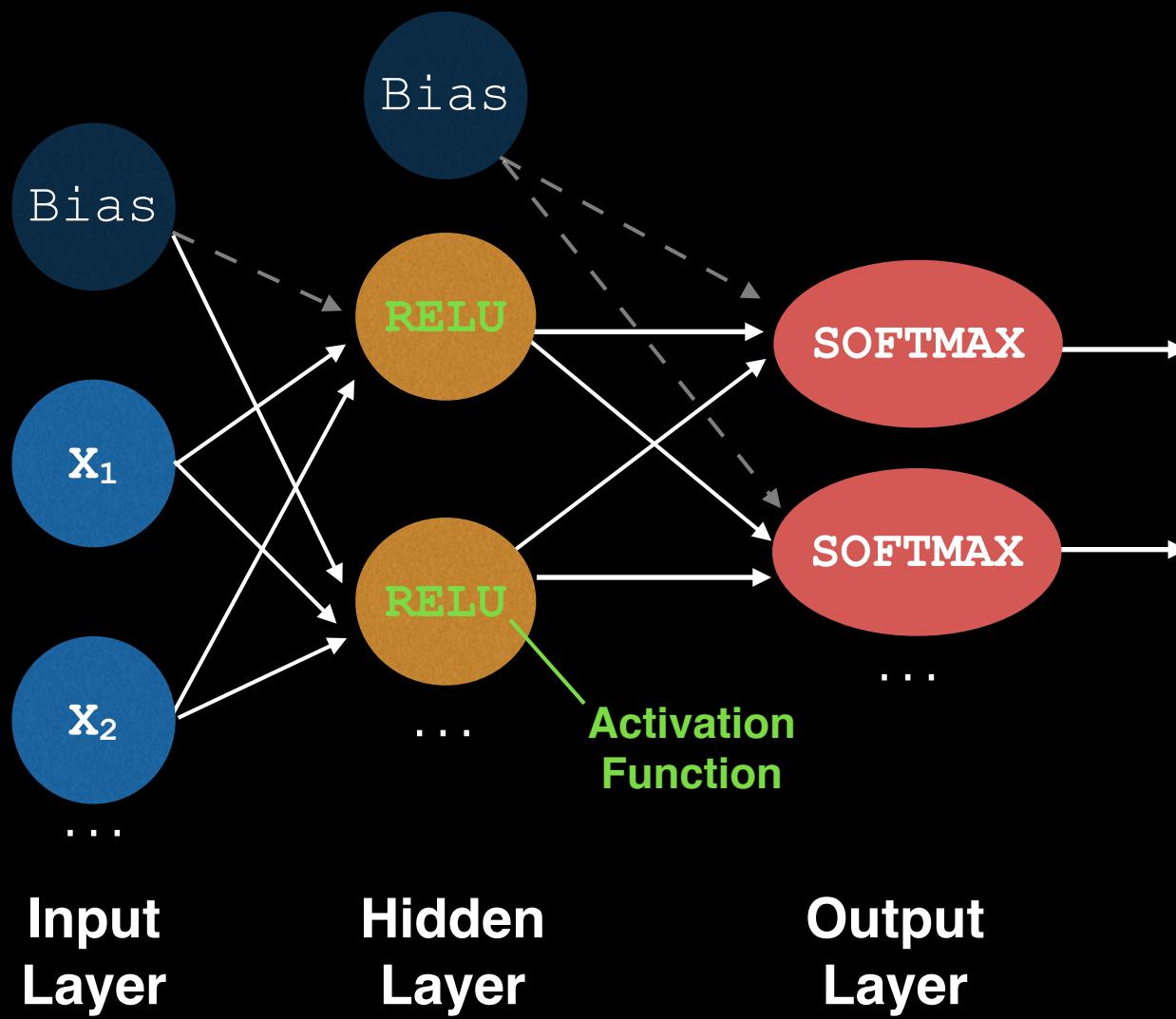
Why Deep Learning ?

- **PCA / SVD** reduces dimension assuming **linear manifold** of the original feature space
- **AutoEncoders** is capable of reconstructing a **non-linear manifold**
- AutoEncoders yield better representation

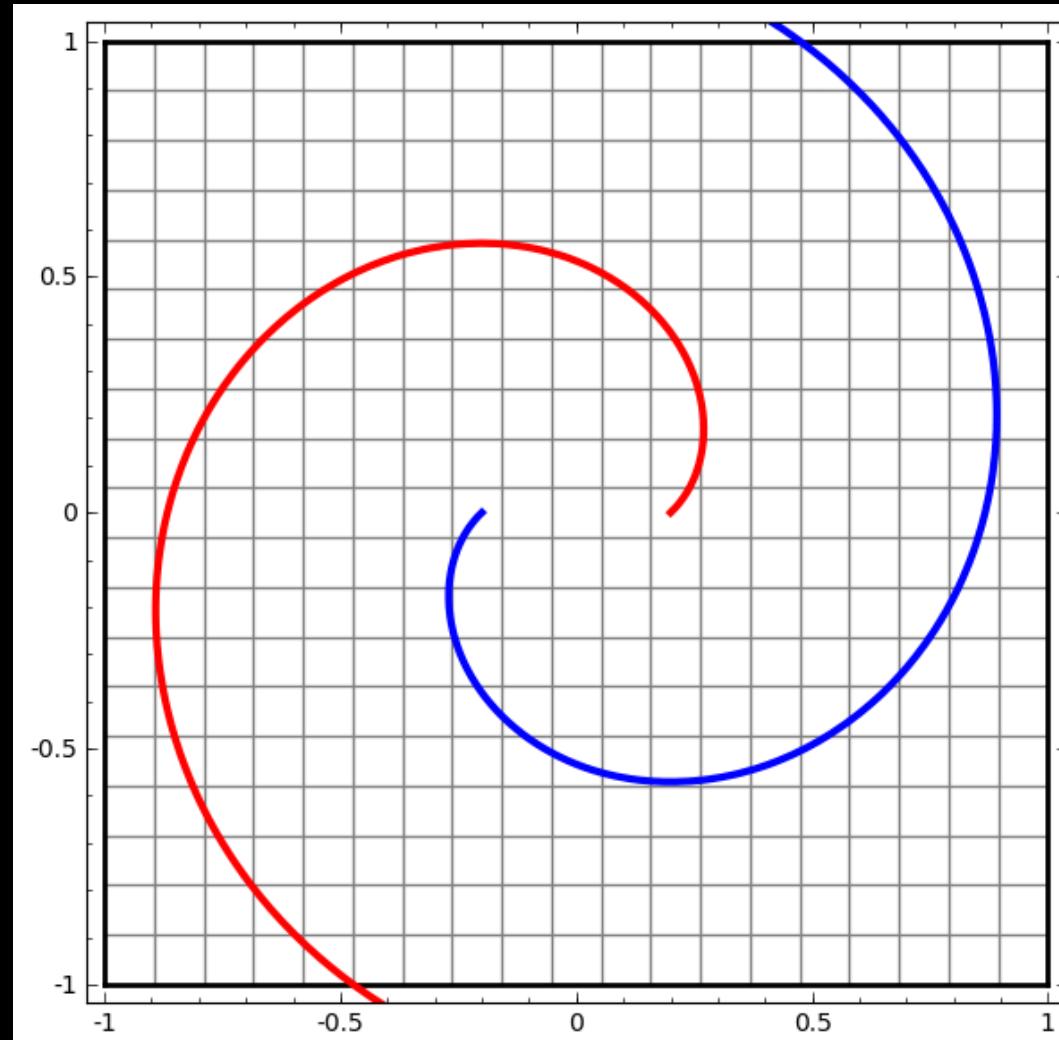
Deep Learning

Introduction

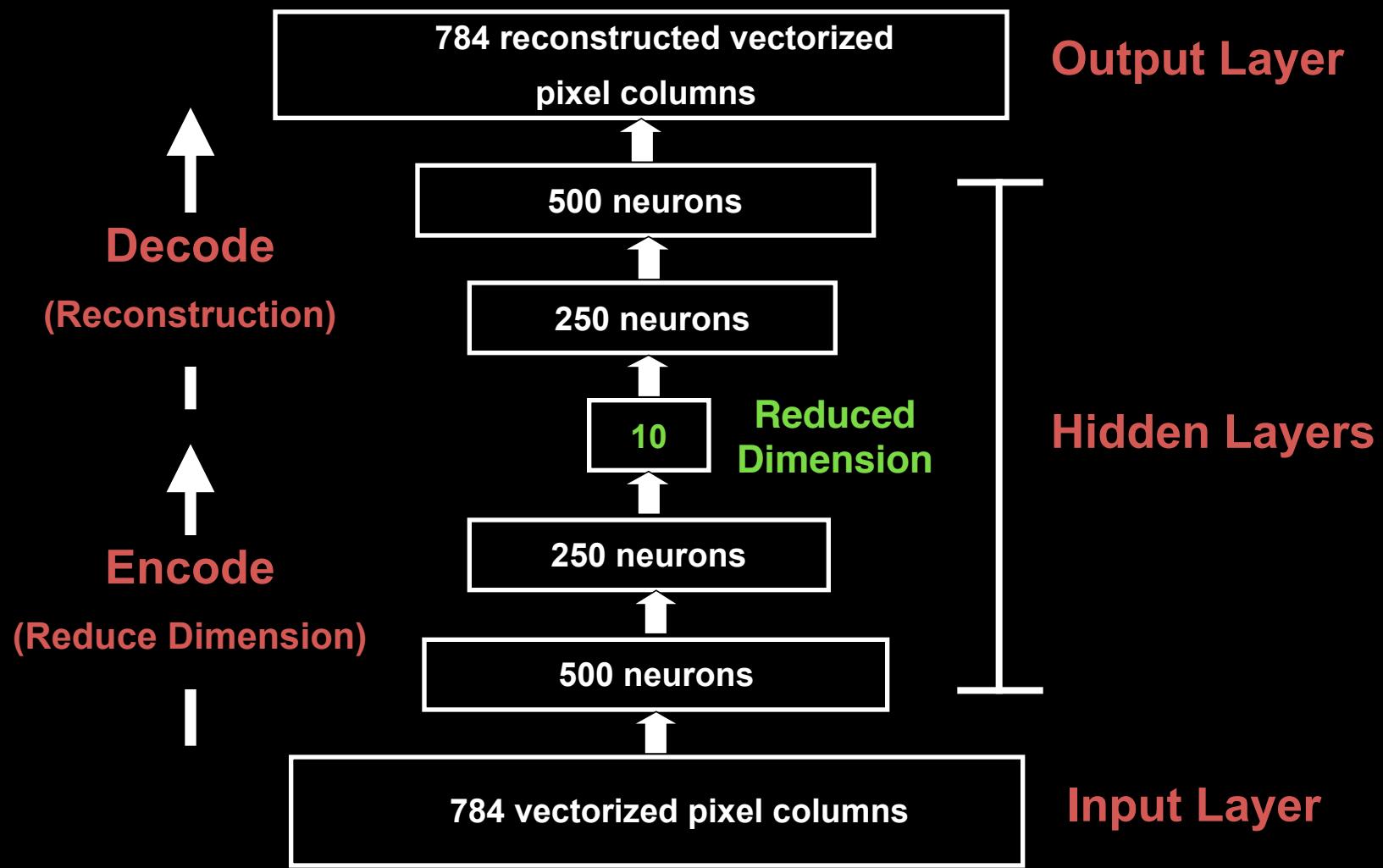
FeedForward Neural Network



Hidden Layer Transformation



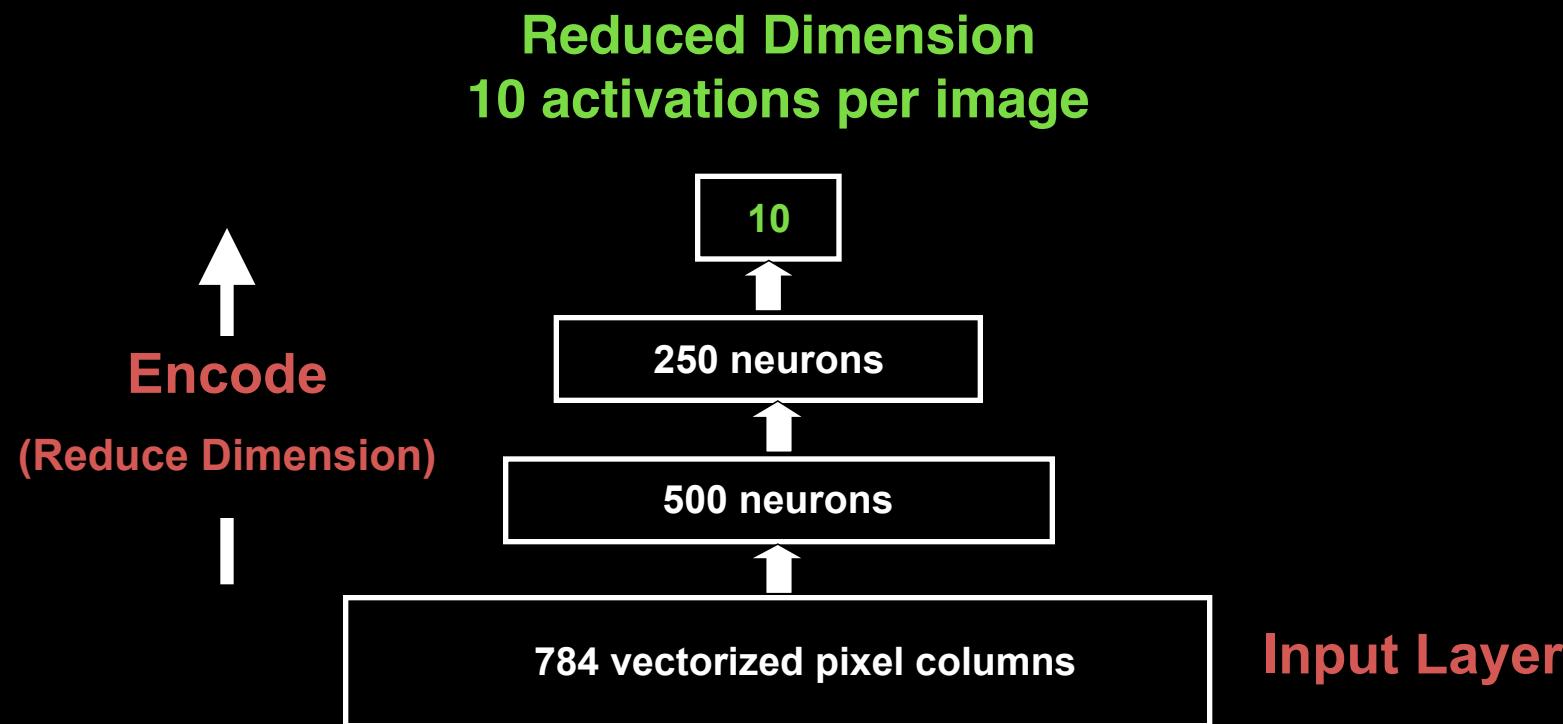
AutoEncoder



Training AutoEncoder

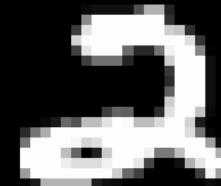
- **Output Layer reconstructs Input Layer**
- **Error** from reconstruction is **back-propagated through hidden layer** to update the weights
- Tricks for training deep AutoEncoders
(Geoffrey Hinton et al 2006 Science)

Using AutoEncoder

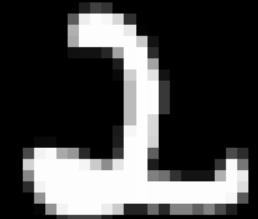
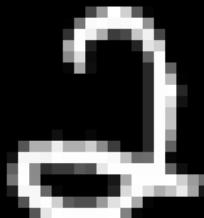
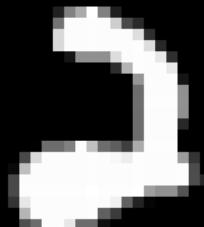
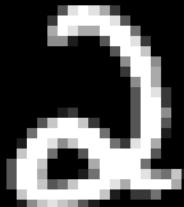


MNIST Example

Query Image

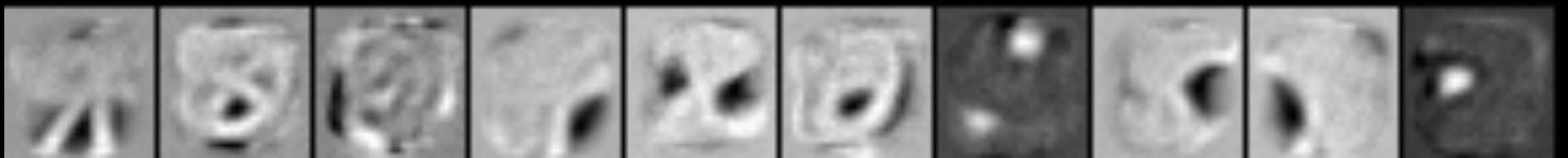


5 most similar images



[Link to code](#)

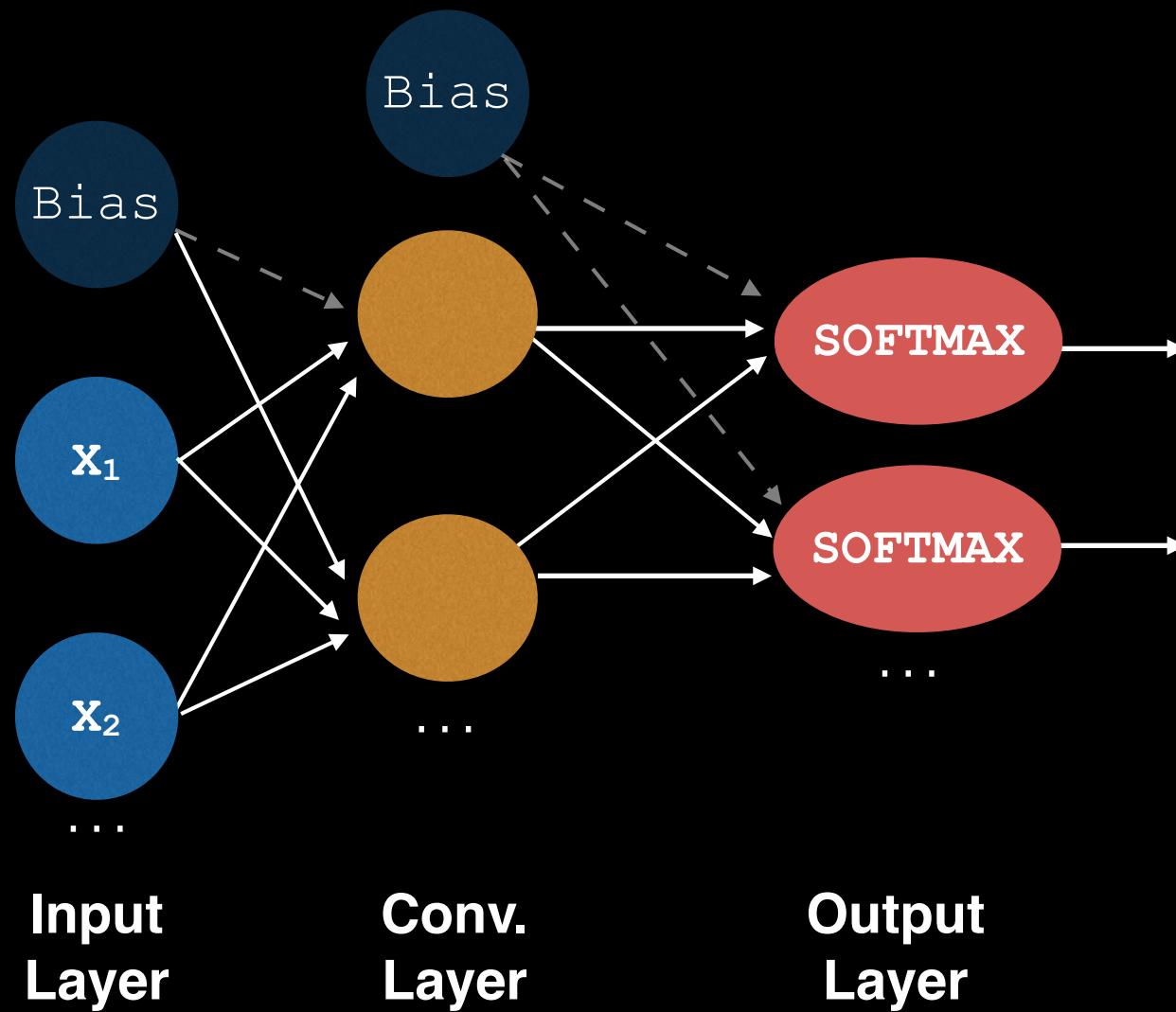
Visualizing Weights



Convolutional Network

- Supervised learning
- Use activations before output layer as reduced dimensions

Conv. Net Simplified



Disclaimer: Not a technically accurate depiction of convolution network

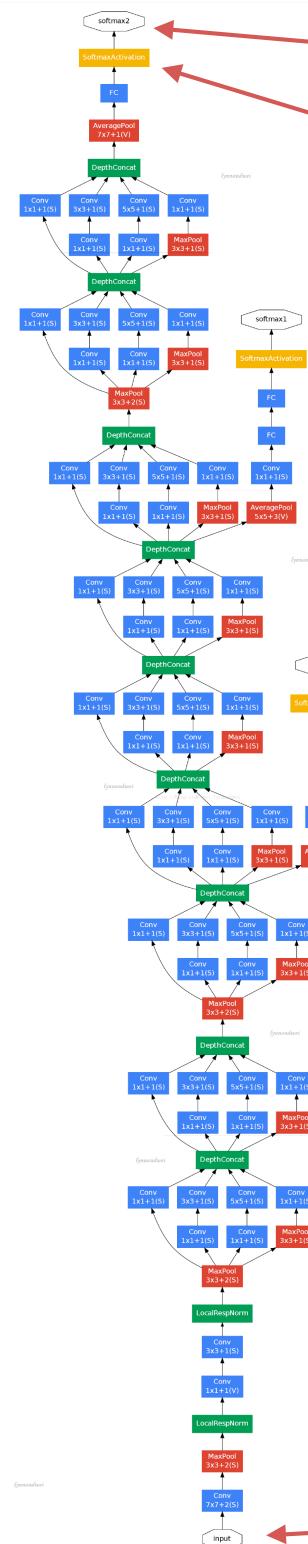
Pre-train Net !

- **GoogleNet with ImageNet data:**
A pre-trained convolutional network (1k labels)

ImageNet Data



GoogleNet



Output Layer

Activations before
Output Layer

Input Layer

Dato / GraphLab Pre-trained Convolutional Net

```
graphlab.neuralnet_classifier.  
NeuralNetClassifier.extract_feature
```

Convolution

35	40	41	45	50
40	40	42	46	52
42	46	50	55	55
48	52	56	58	60
56	60	65	70	75



0	1	0		
0	0	0		
0	0	0		



Input

Kernel

Output

Deep Learning Ecosystem

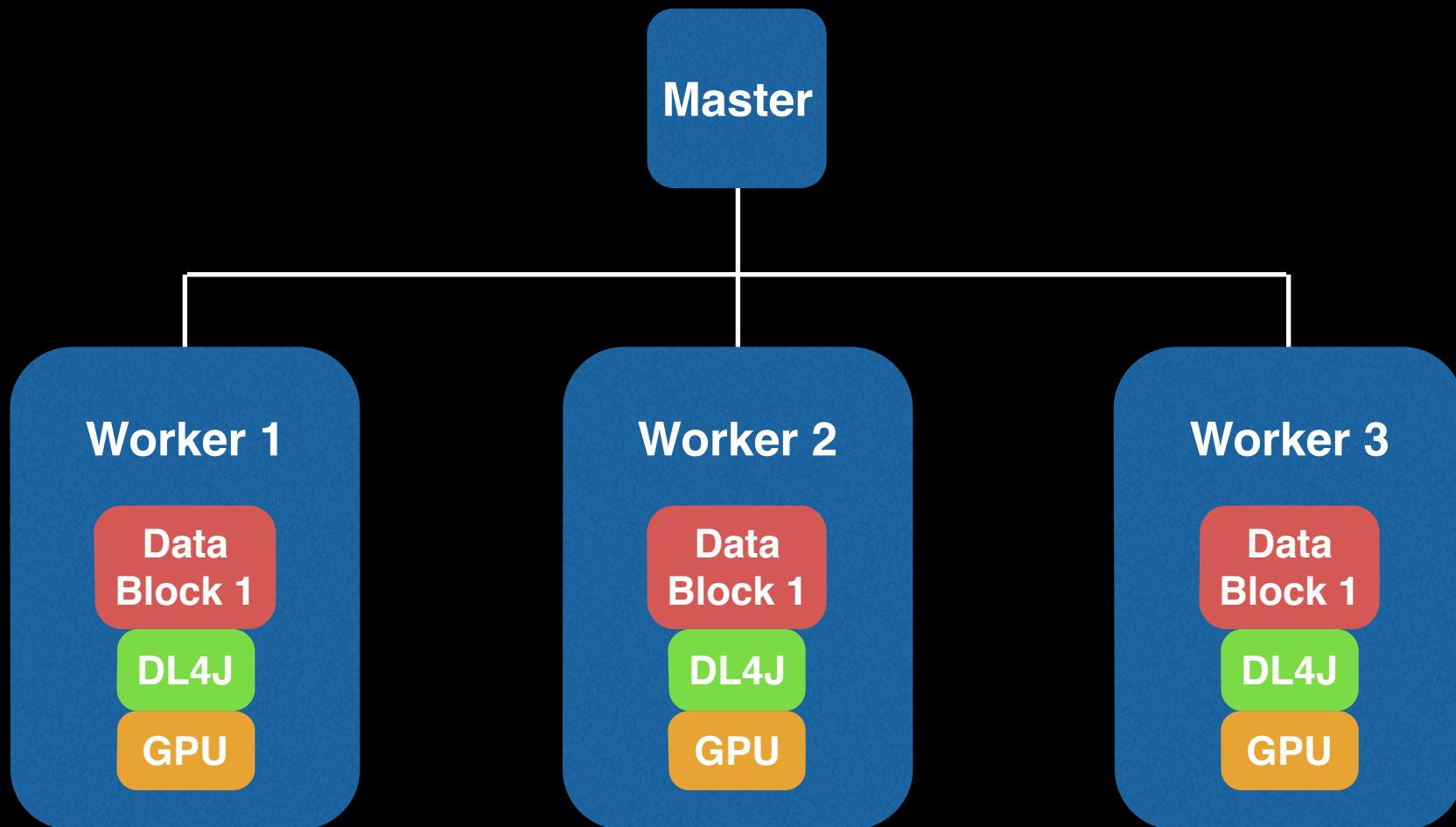
Deep Learning Libraries

Python	Java	C
Lasagne	Deeplearning4j	Theano
Sknn	Neuralnetworks (Example Based)	Caffe
Dato (GraphLab)		SINGA
OpenDeep		
Theano		
Caffe		
More ...		

Why DeepLearning4j

- **Java:**
Better integration with production systems
- **NN Features:**
AutoEncoder, Conv., RBM & Recurrent (LSTM)
- **Distributed:**
Training on distributed GPU (Spark)

Distributed Deep Learning



Road Map

- **Stable Release:** Aug / Sep, 2015
- **Optimized Release:** Oct / Nov, 2015
- **Python Interface:** Oct / Nov, 2015

DL4J Github Repo

 [deeplearning4j / deeplearning4j](#) Watch ▾ 188 Star 1,244 Fork 390

Deep Learning for Java, Scala & Clojure on Hadoop, Spark & GPUs <http://deeplearning4j.org> — Edit

 2,651 commits  53 branches  22 releases  36 contributors

 Branch: **master** 

Merge pull request #523 from deeplearning4j/ablayerfixes 

 nyghtowl authored 12 hours ago	latest commit 5157070aff 	
 deeplearning4j-cli	Changed name for remainder to max on numlinsearchiterations.	13 days ago
 deeplearning4j-core	Remove incorrect deprecated annotation	a day ago
 deeplearning4j-scaleout	fixed TextPipeline in Spark. Tests passed. Build Success	22 hours ago
 deeplearning4j-ui	fix compilation error on update filters	10 days ago
 dl4j-caffe	Fix straggler on descent name. Removed caffe stuff that is in progres...	14 days ago
 dl4j-test-resources	done lookupcache	2 days ago
 .gitignore	Minor cleanup	14 days ago

 **Code**

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Toady's Github Repo

https://github.com/jyt109/autoencoder_image_search