

Image Retrieval with Deeplearning

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Who am I ?

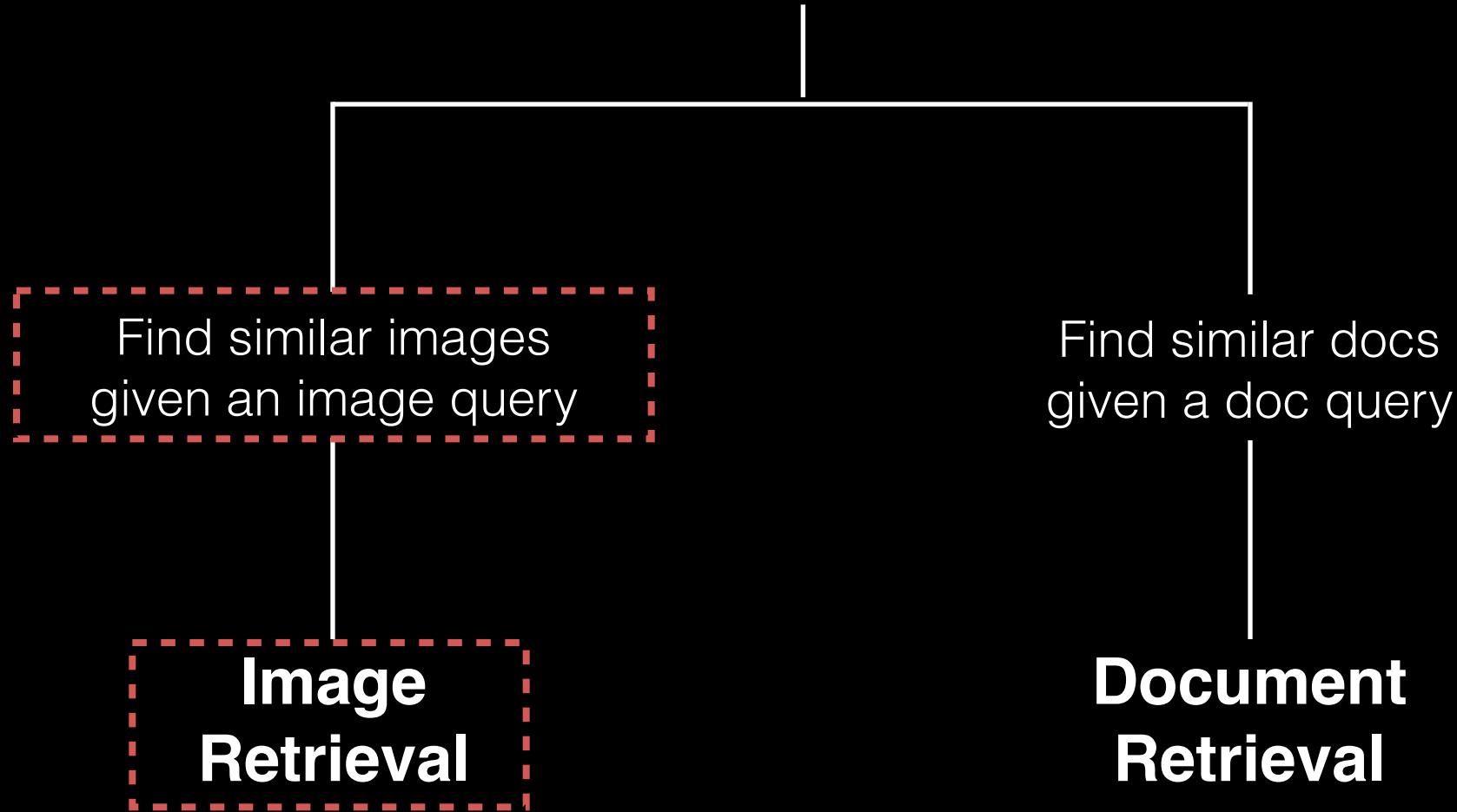
- **Software Engineer at Skymind.io**
 - Python Interface to deeplearning4j (Java)
 - Optimization of deep learning on Spark
- **(Ex-)Data Science Instructor at Galvanize**

Goals

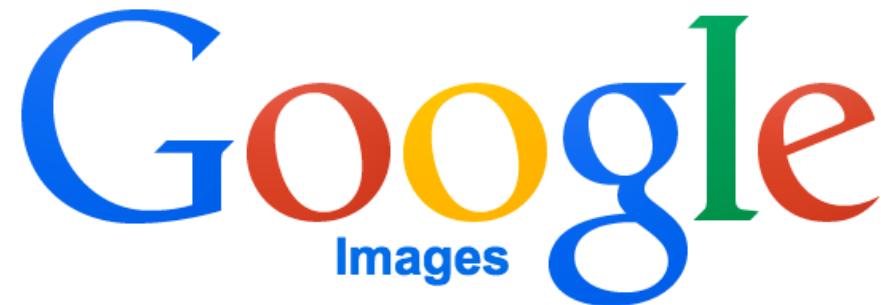
- **Image Retrieval**
 - ★ Application & Overview
- **Deep Learning**
 - ★ Image Retrieval using Auto-Encoders
 - ★ Code Example
- **Deep Learning Ecosystem**

Image Retrieval Overview

Information Retrieval



Google Images



Search by image

X

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

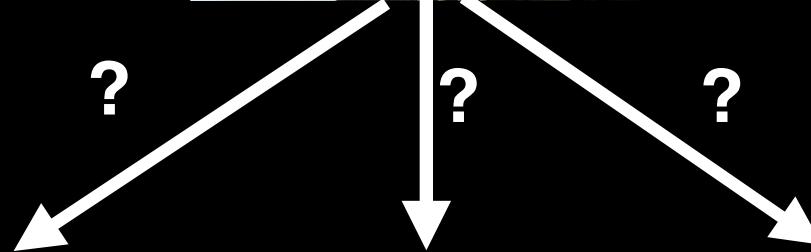
Paste image URL

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)

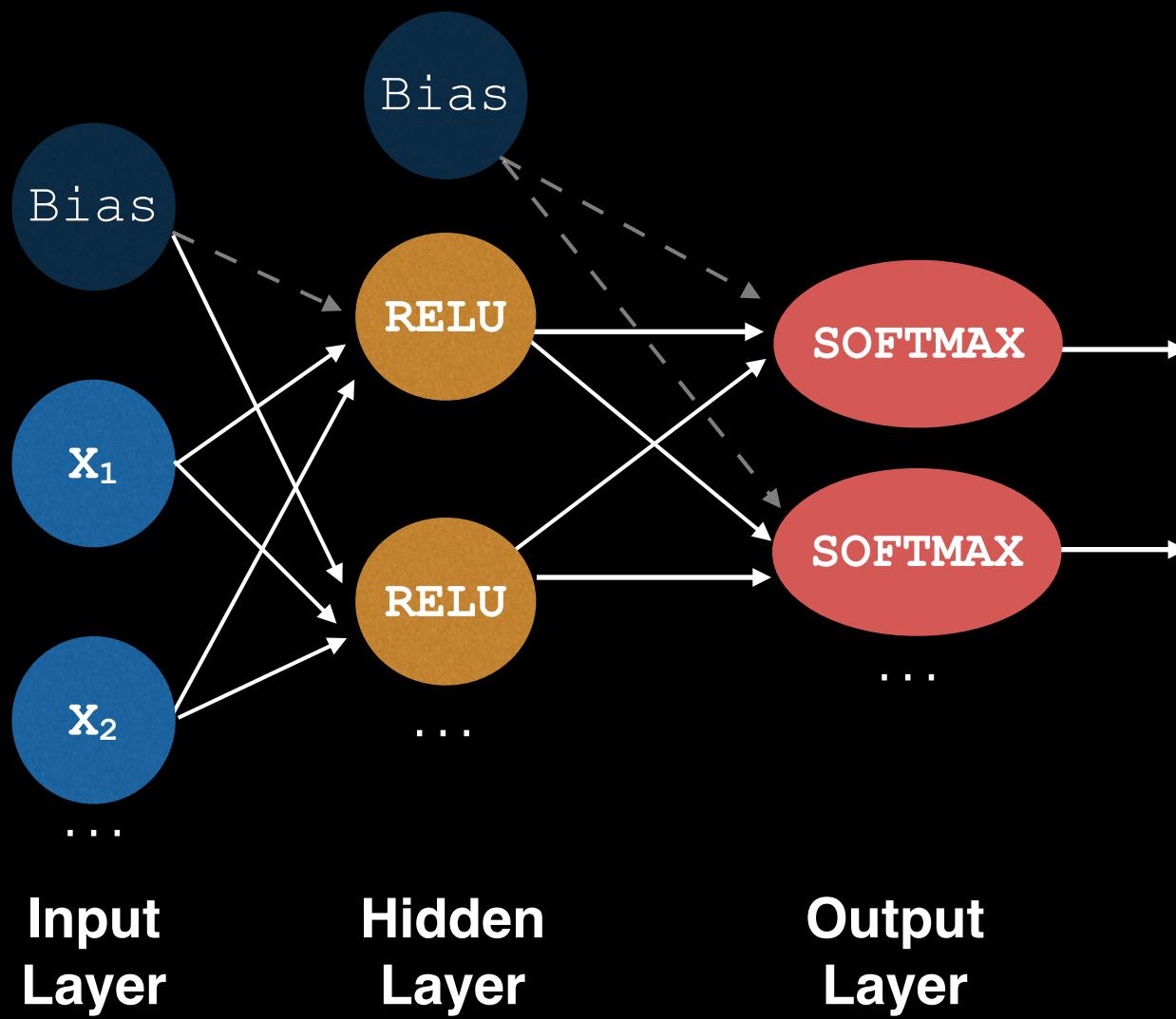
Why Deep Learning ?

- **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

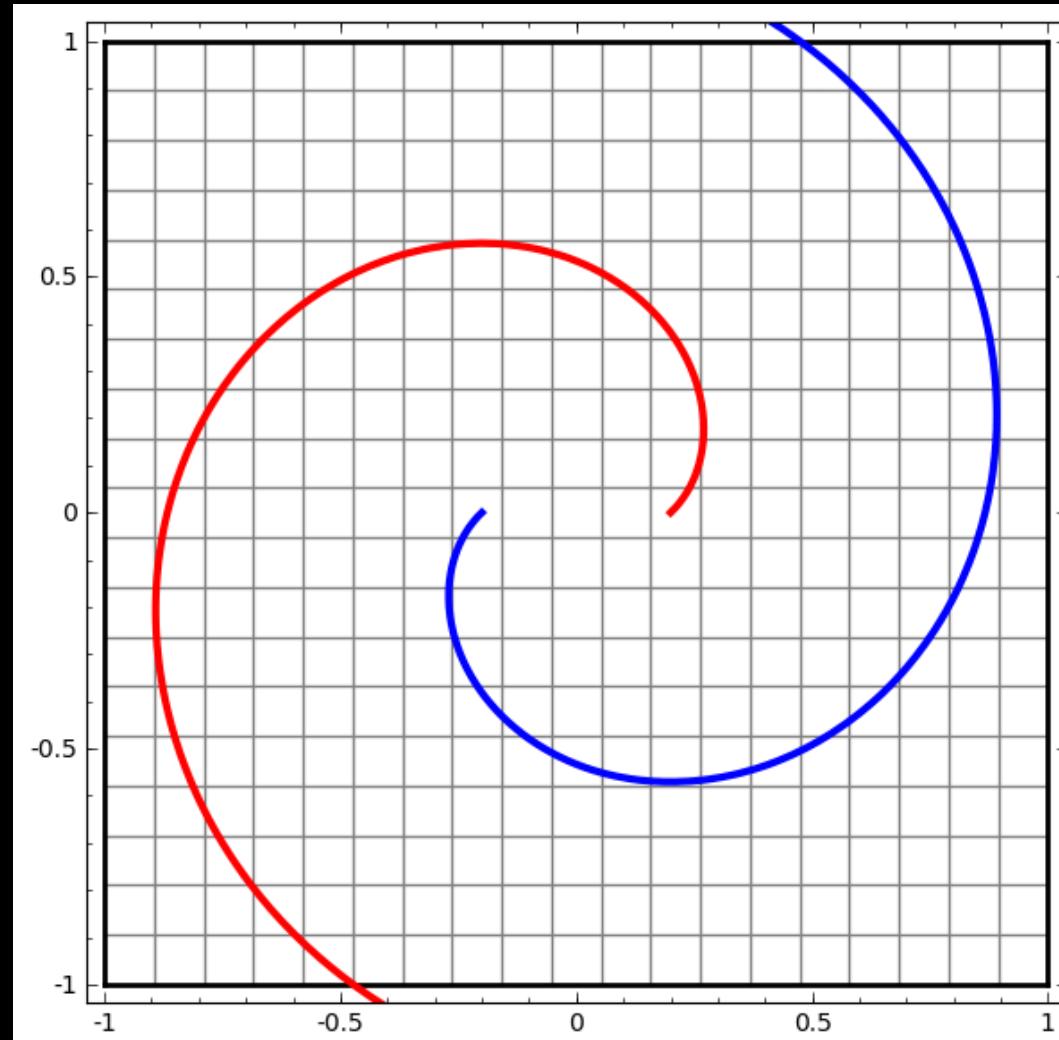
Deep Learning

Introduction

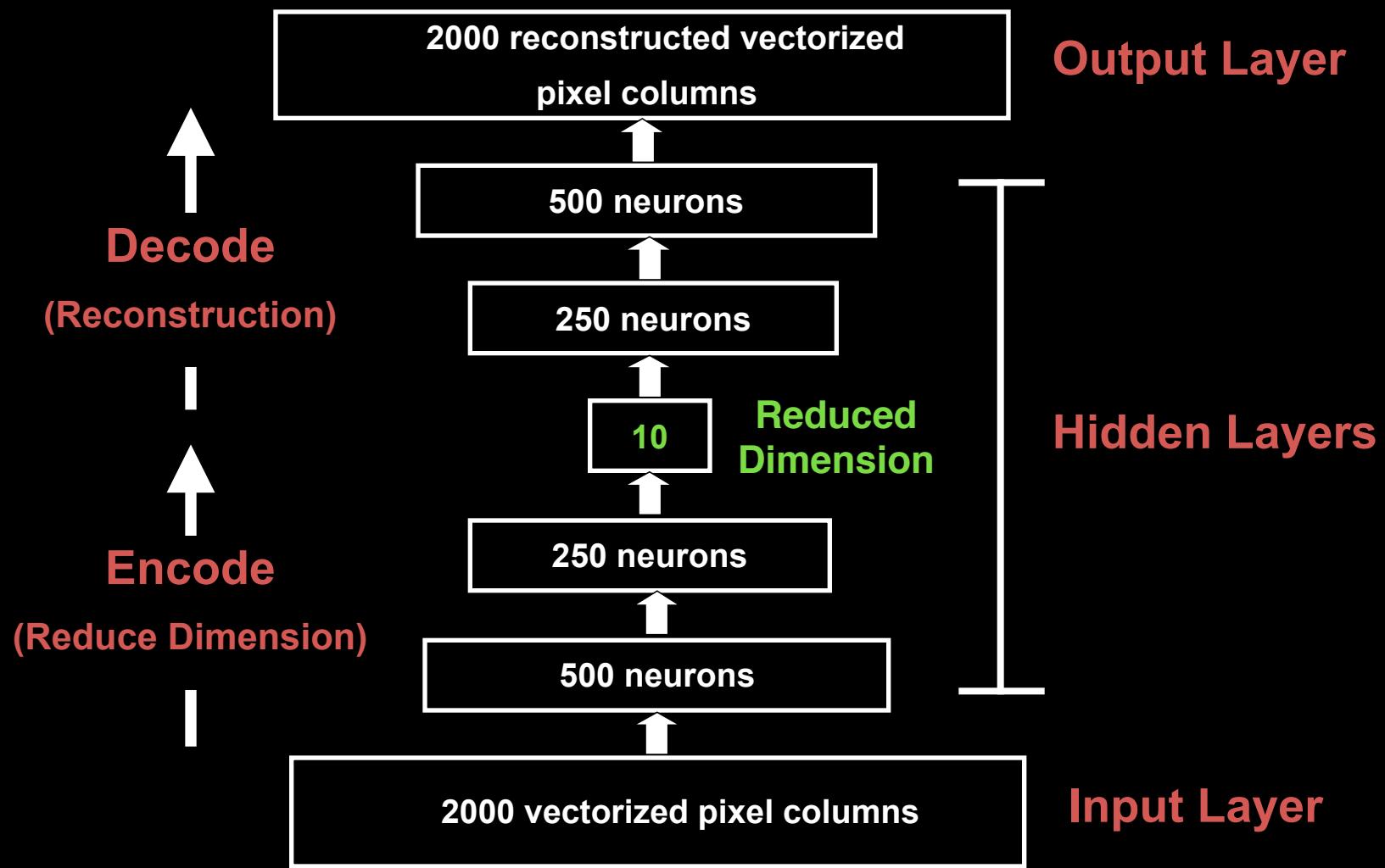
FeedForward Neural Network



Hidden Layer Transformation



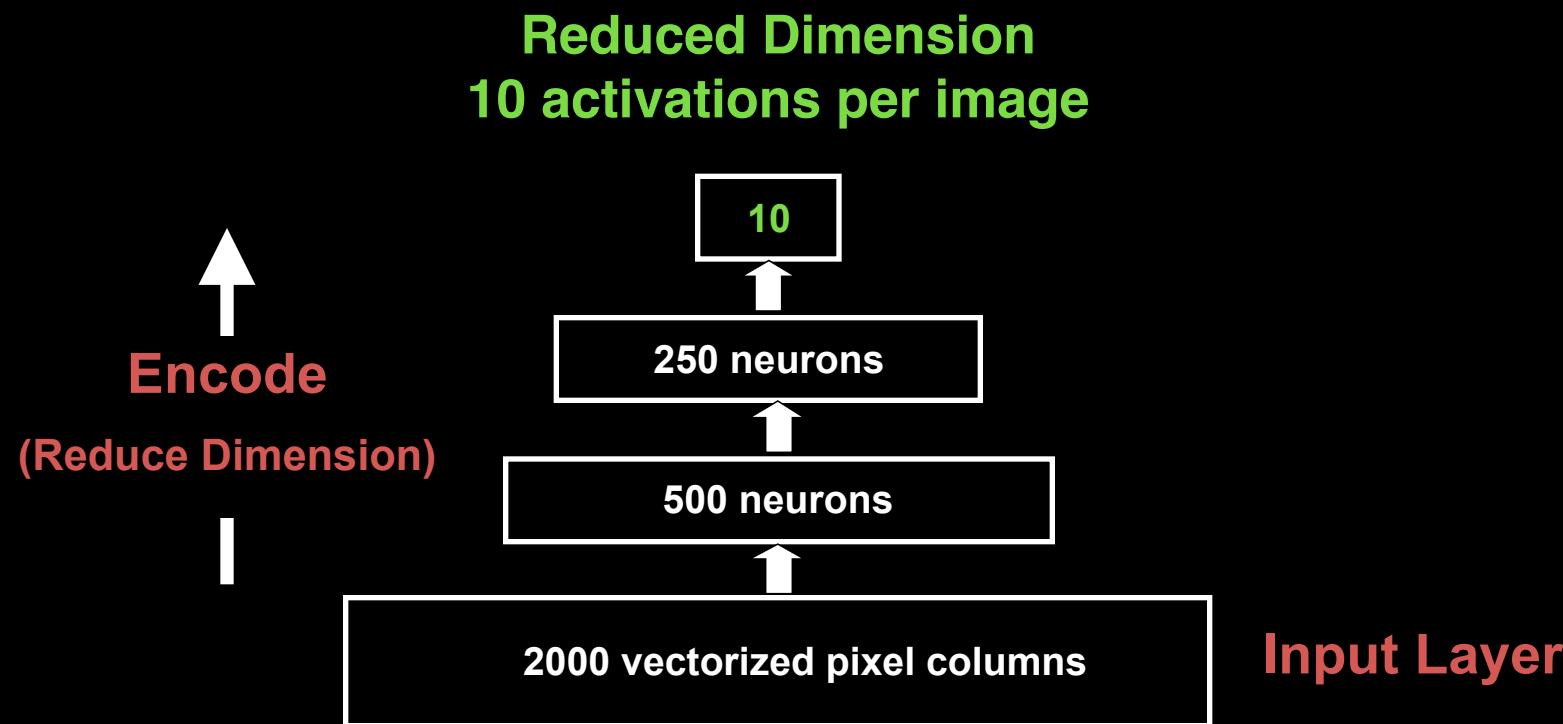
AutoEncoder



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

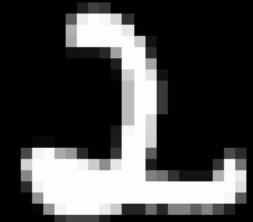
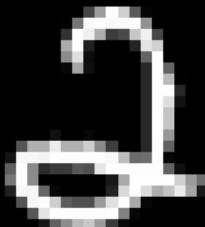
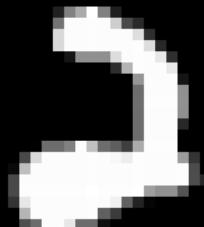
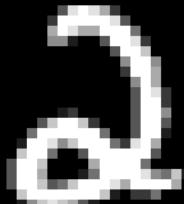


MNIST Example

Query Image

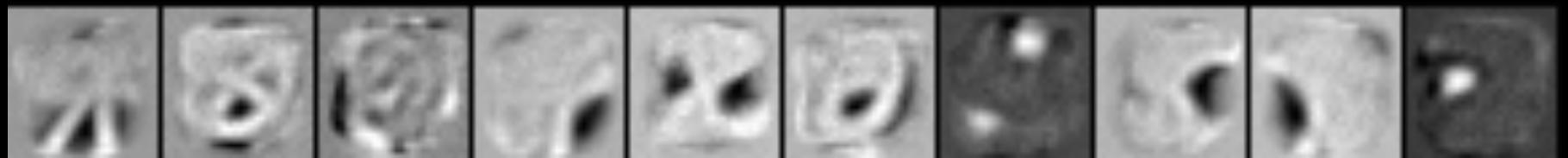


5 most similar images



[Link to code](#)

Visualizing Weights

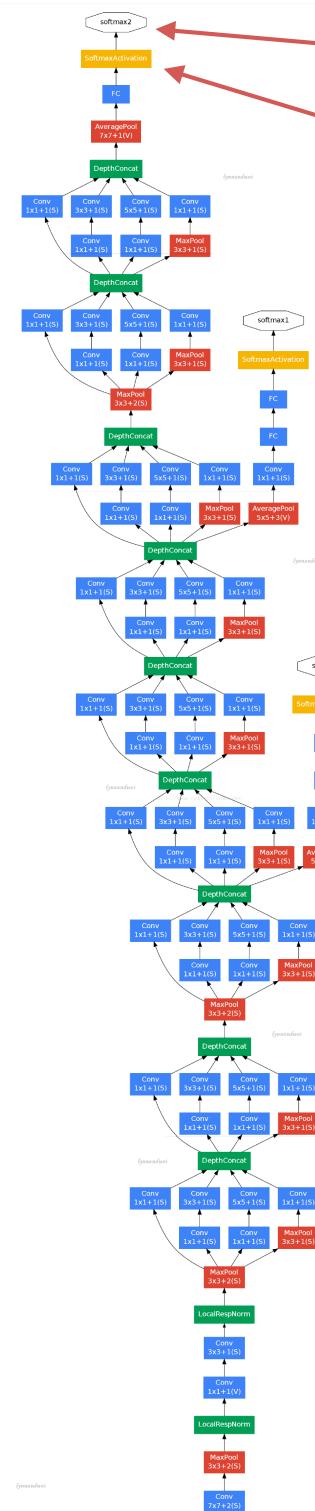


Alternative Approach

- Supervised learning
- With convolutional neural network
- Use activations before the output layer as reduced dimensions
- **GoogleNet with ImageNet data:**
A pre-trained convolutional network (1k labels)

ImageNet Data





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		



		42		

Input

Kernel

Output

Deep Learning Ecosystem

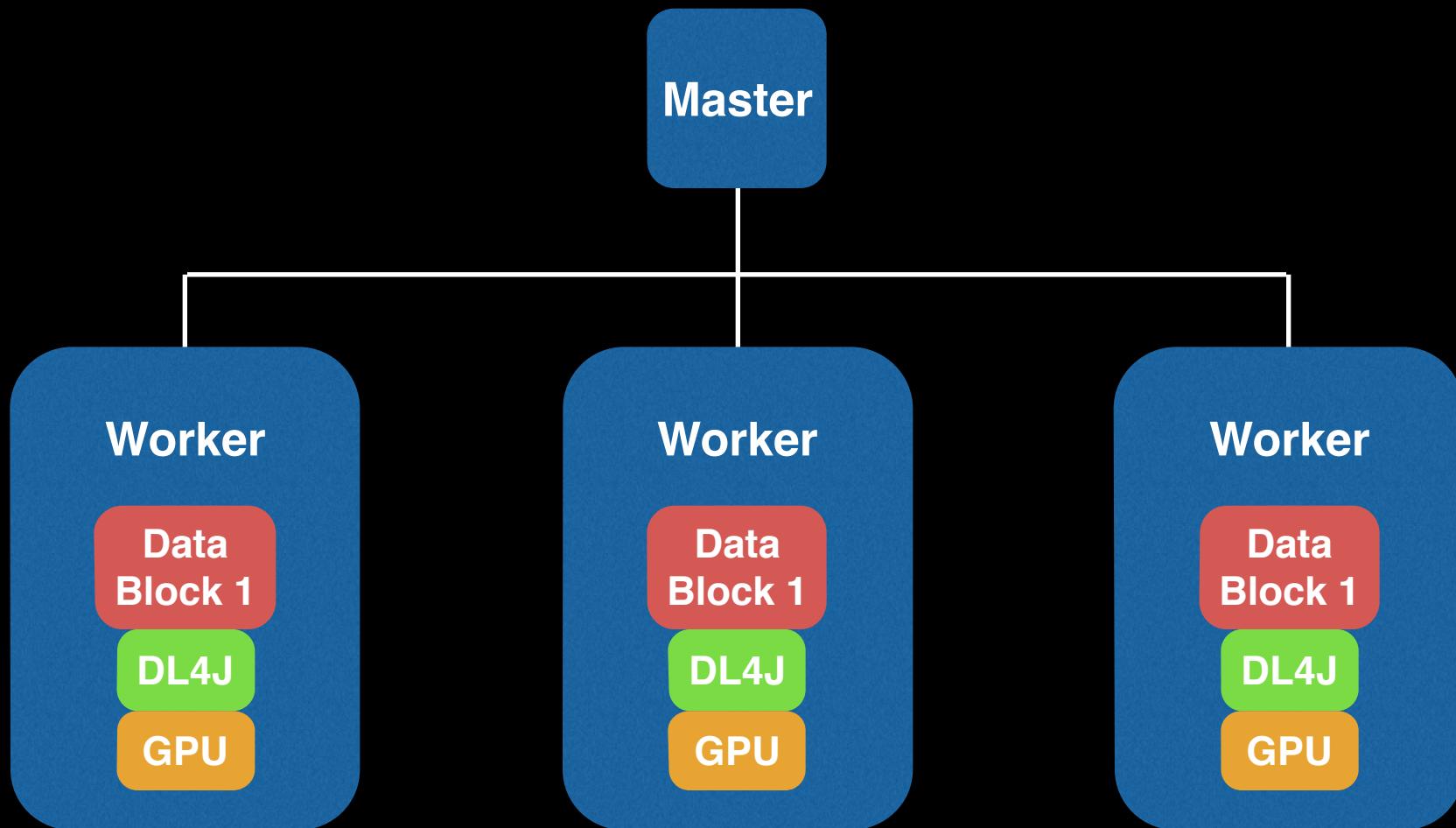
Deep Learning Libraries

Python	Java	C
Lasagne	Deeplearning4j	Theano
Sknn	Neuralnetworks	Caffe
Dato (GraphLab)		SINGA
OpenDeep		
Theano		
Caffe		

Why DeepLearning4j

- **Java:**
Better integration with production systems
- **NN Features:**
AutoEncoder, RBM and 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**

 **Issues** 31

 **Pull requests** 4

 **Wiki**

 **Pulse**

 **Graphs**

 **Settings**

HTTPS clone URL

<https://github.com> 

You can clone with **HTTPS, SSH,**

Toady's Github Repo

https://github.com/jyt109/autoencoder_image_search