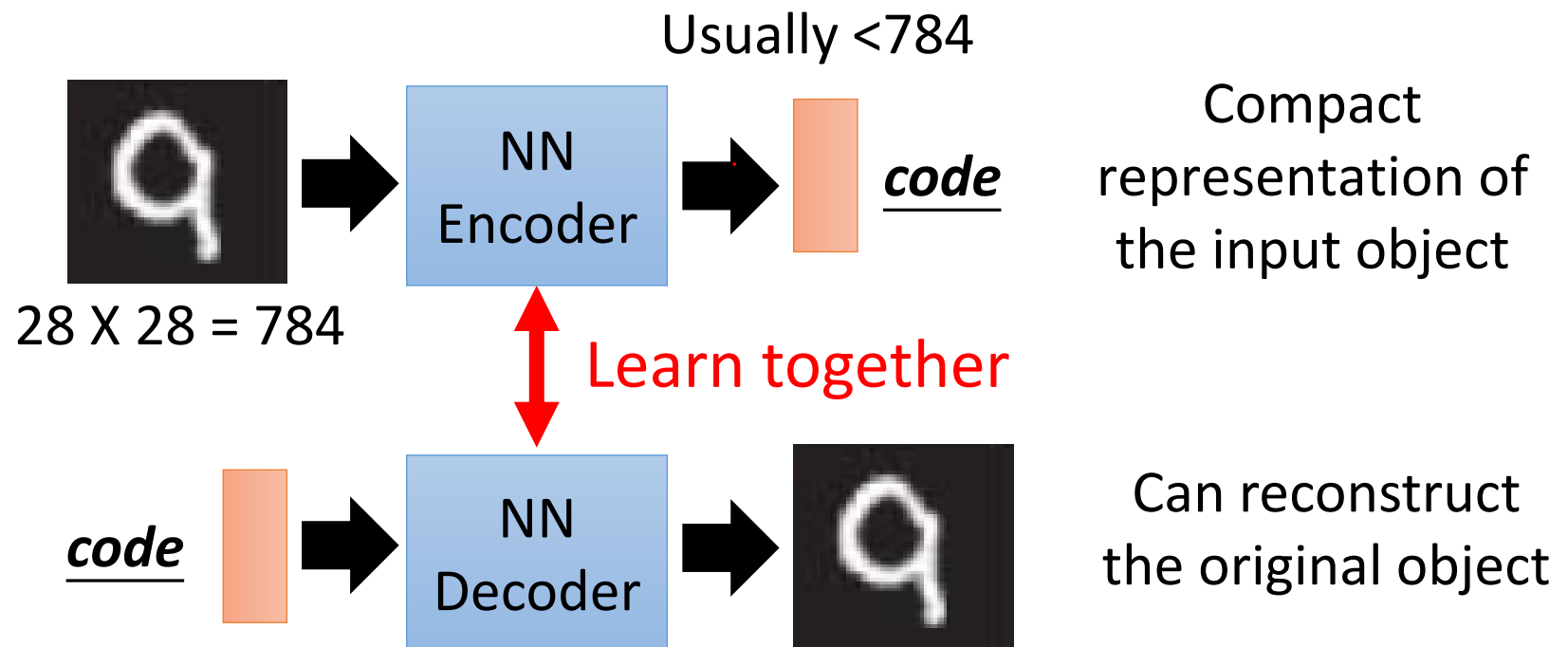


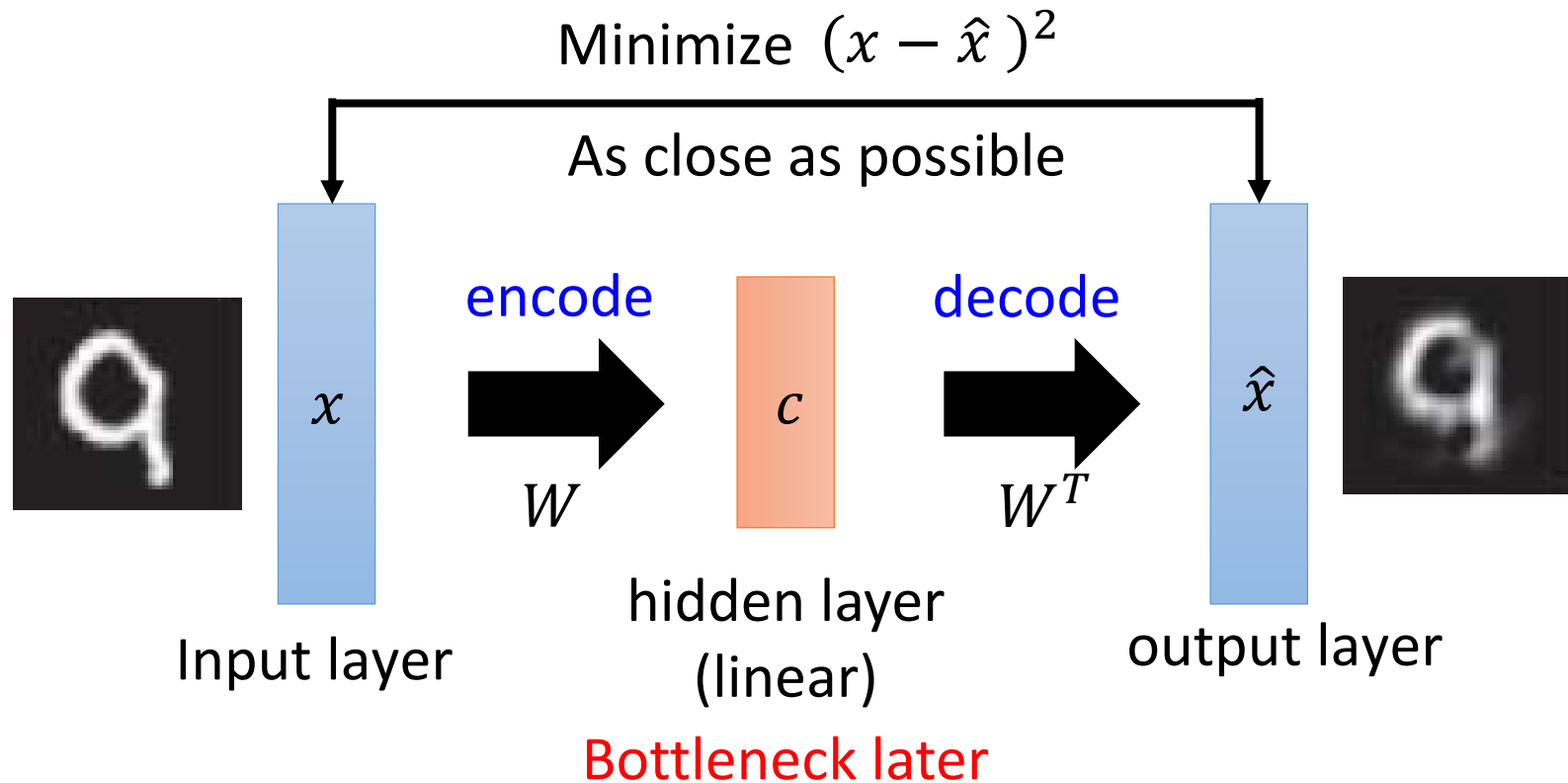
# Unsupervised Learning:

## Deep Auto-encoder

# Auto-encoder



# Starting from PCA

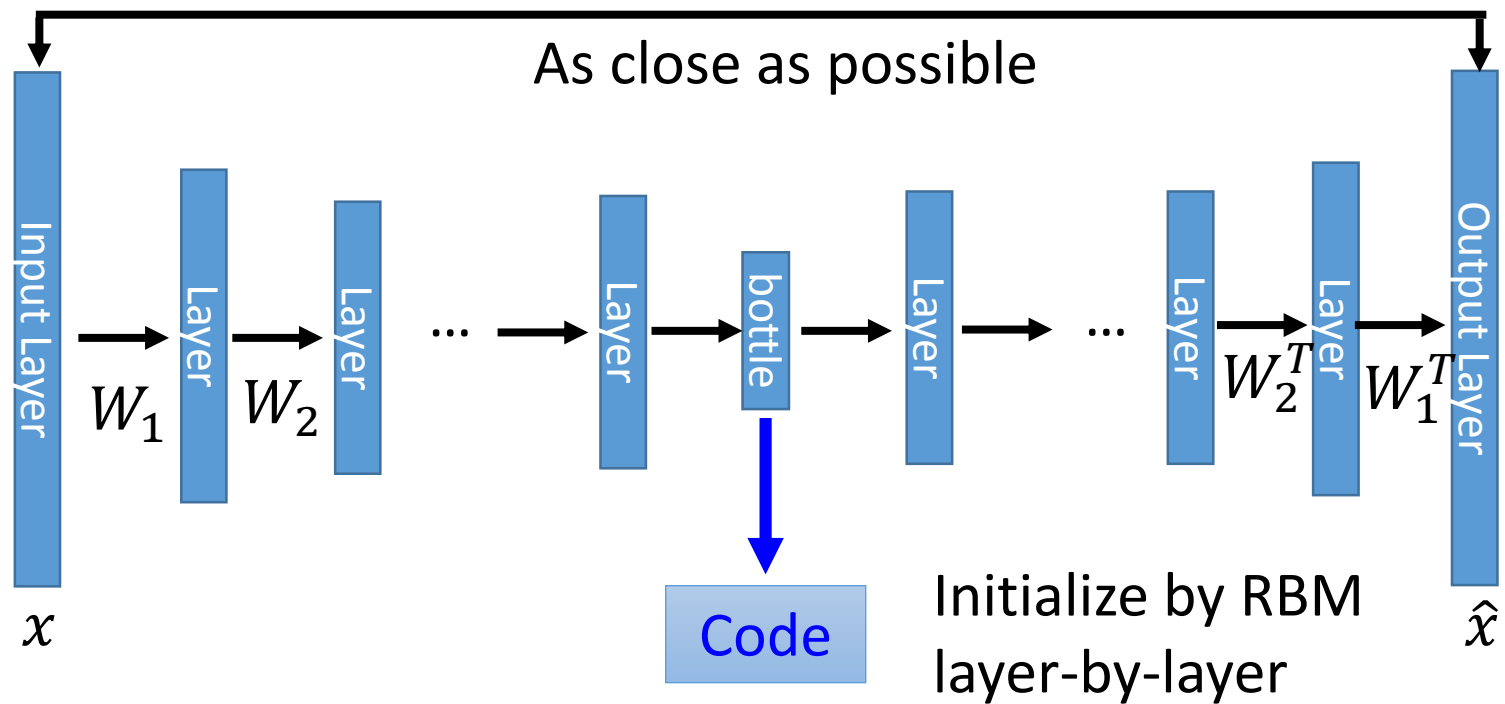


Output of the hidden layer is the code

# Deep Auto-encoder

Symmetric is not necessary.

- Of course, the auto-encoder can be deep



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

# Deep Auto-encoder

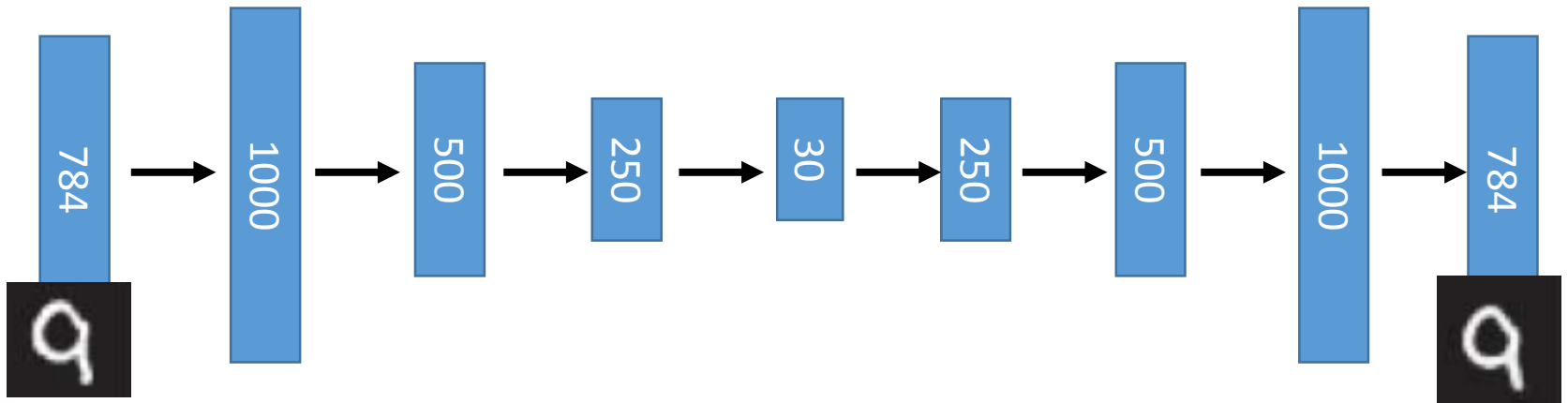
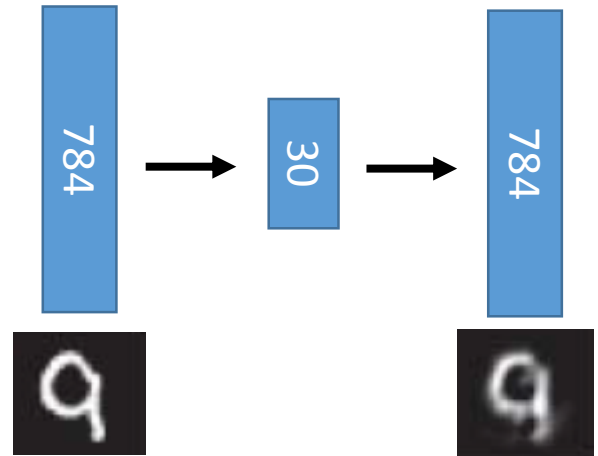
Original  
Image

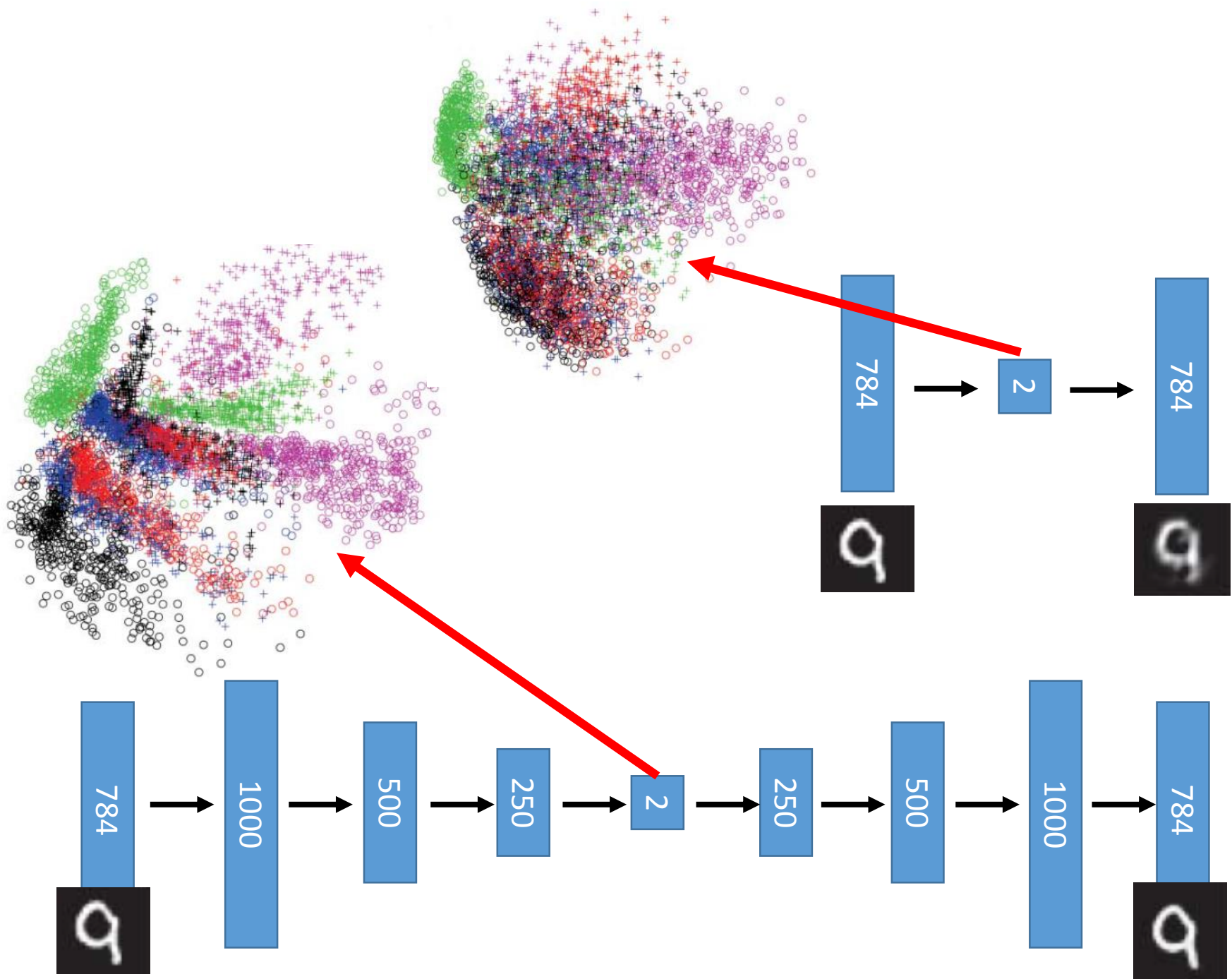


PCA



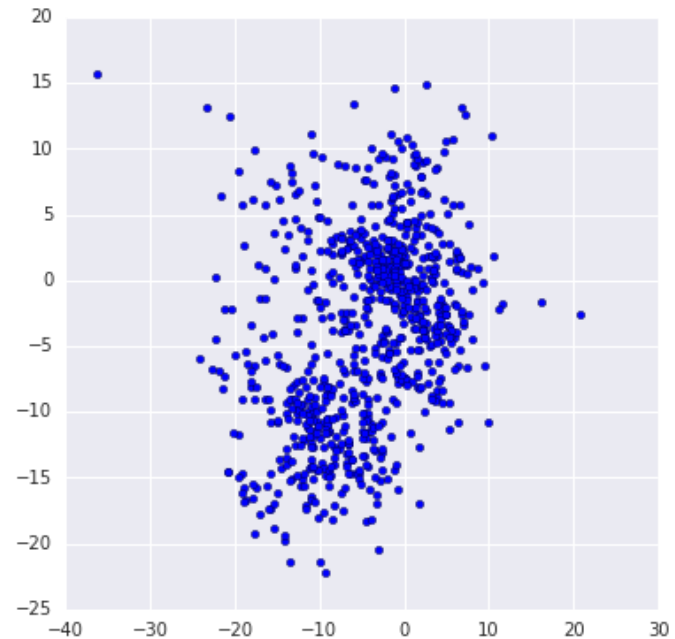
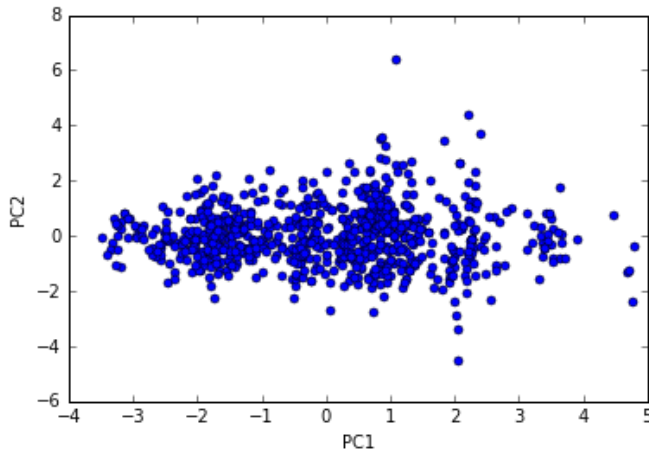
Deep  
Auto-encoder





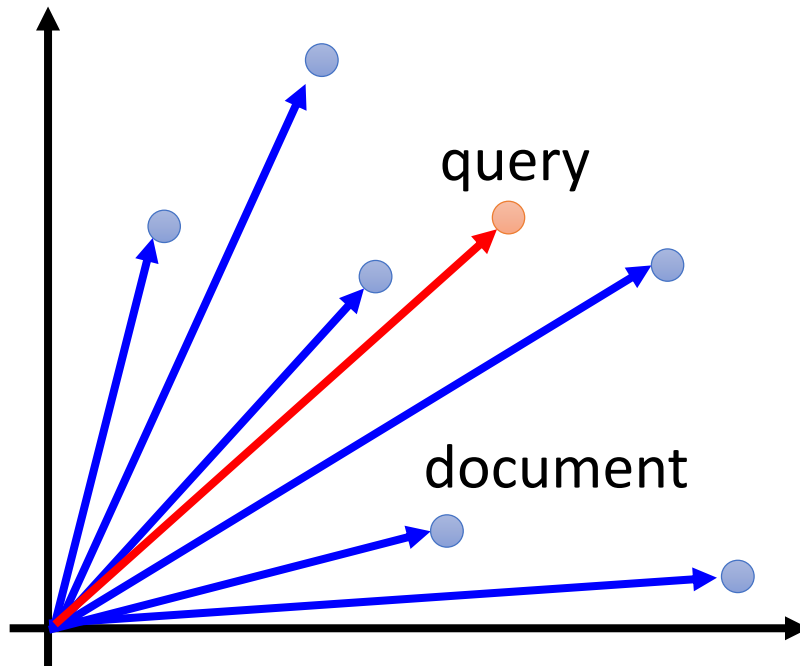
# Pokémon

- <http://140.112.21.35:2880/~tlkagk/pokemon/pca.html>
- <http://140.112.21.35:2880/~tlkagk/pokemon/auto.html>
- The code is modified from
  - <http://jkunst.com/r/pokemon-visualize-em-all/>



# Auto-encoder – Text Retrieval

## Vector Space Model



## Bag-of-word

word string:  
"This is an apple"

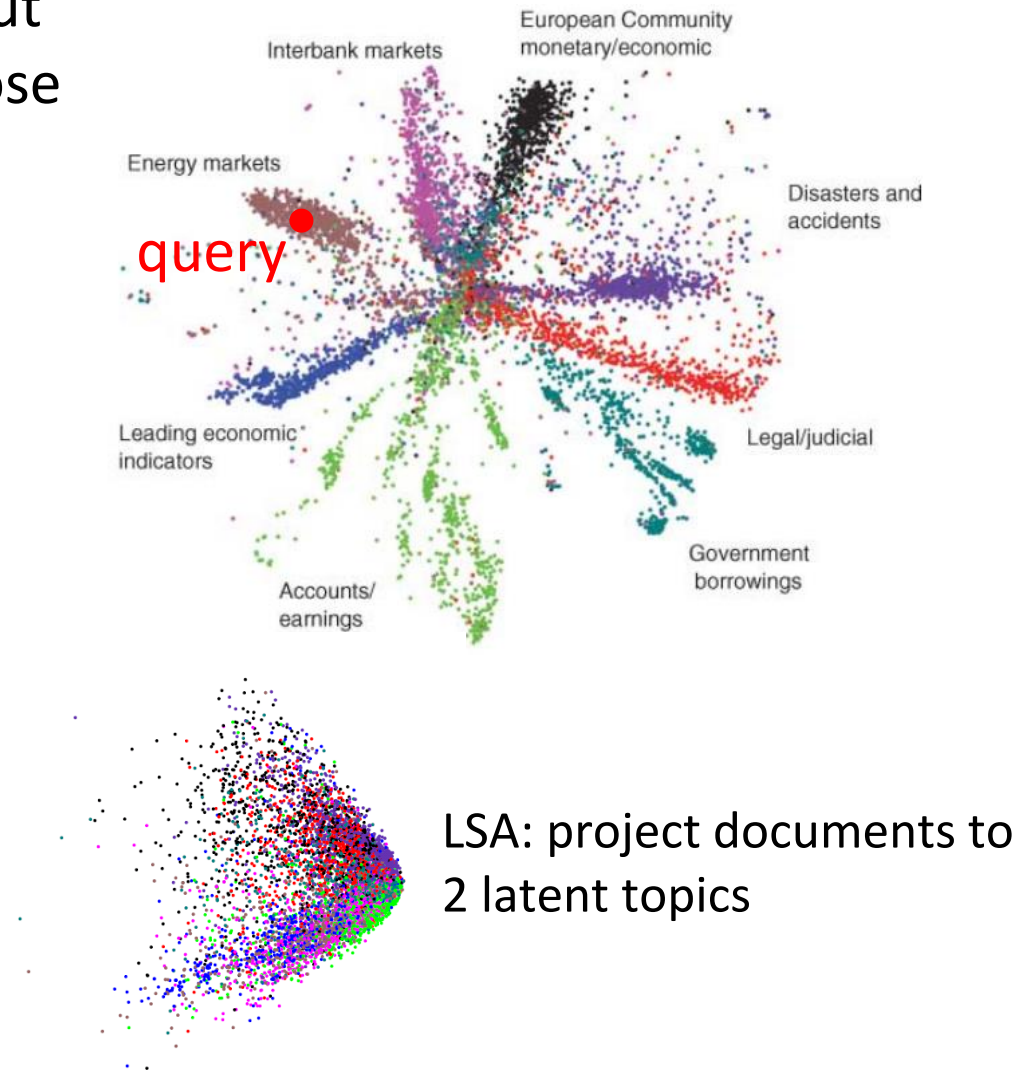
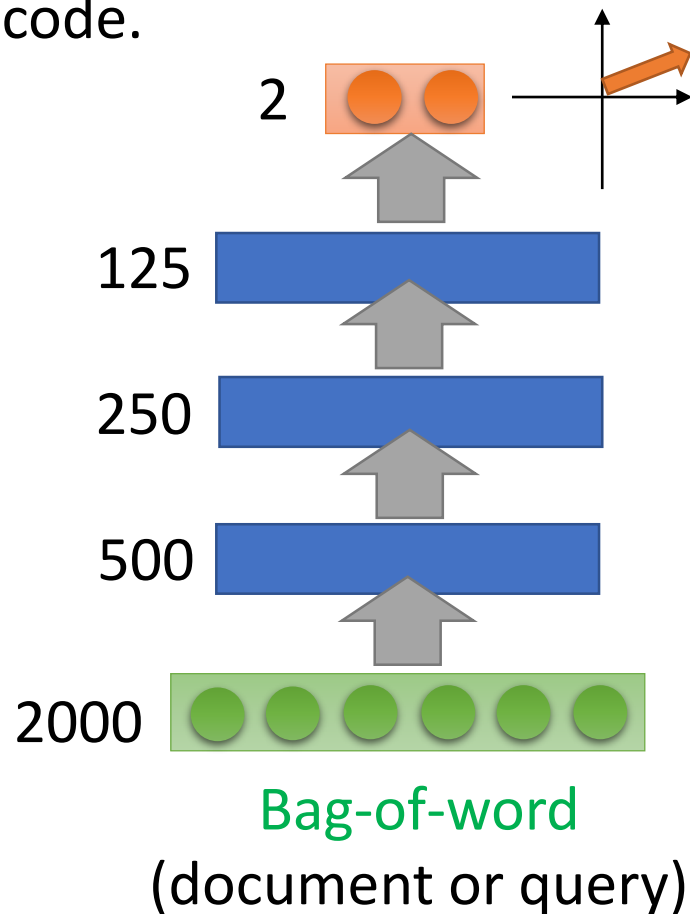
this	●	1
is	●	1
a	●	0
an	●	1
apple	●	1
pen	●	0
⋮	●	

Semantics are not considered.



# Auto-encoder – Text Retrieval

The documents talking about the same thing will have close code.



# Auto-encoder – Similar Image Search

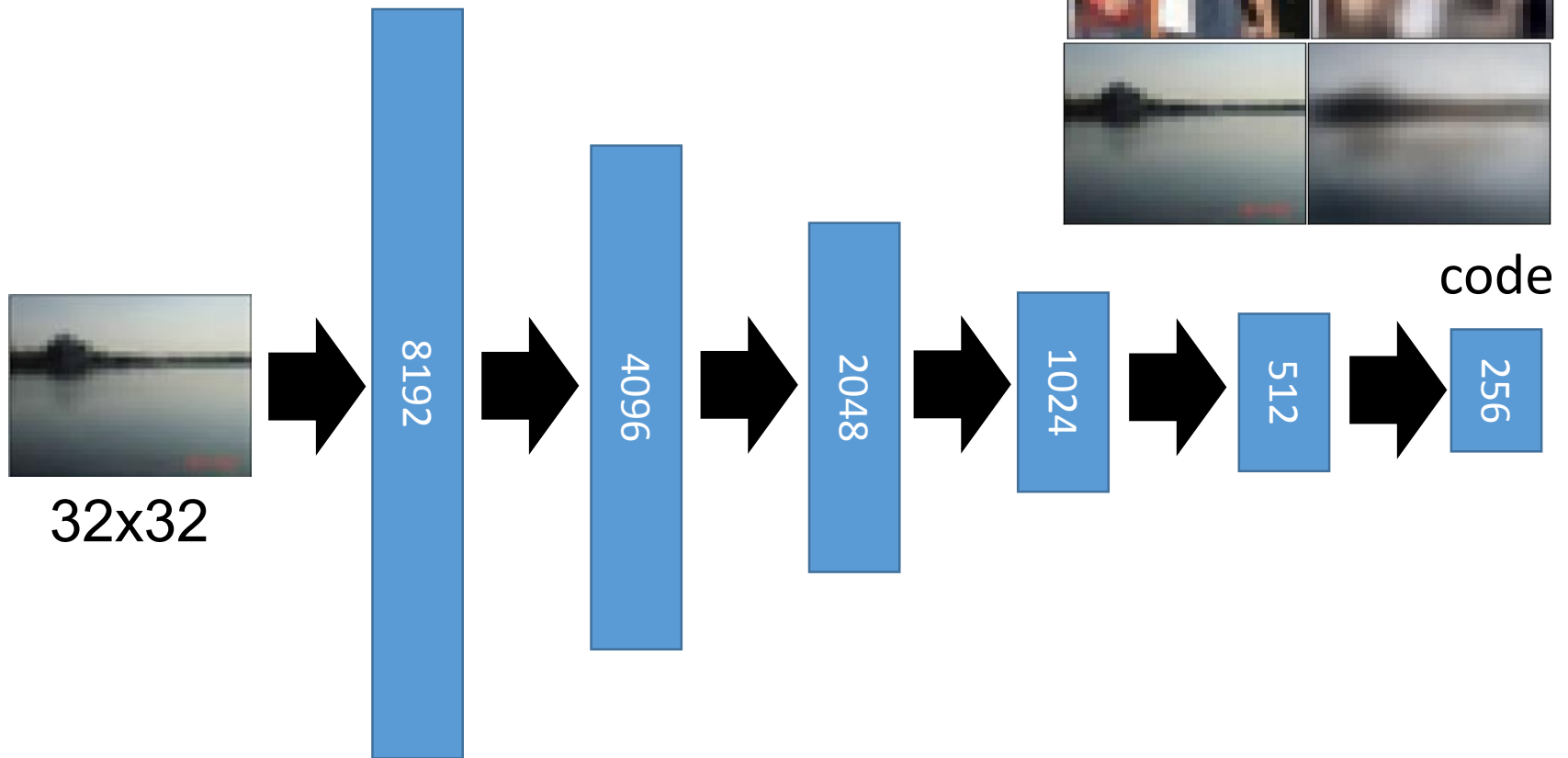
Retrieved using Euclidean distance in pixel intensity space



(Images from Hinton's slides on Coursera)

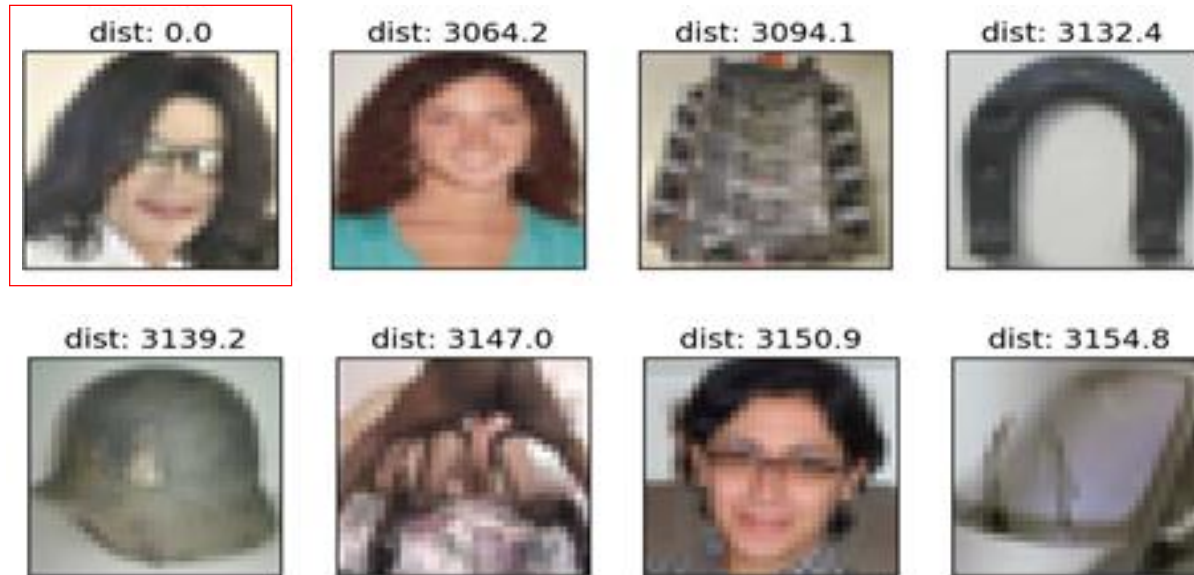
Reference: Krizhevsky, Alex, and Geoffrey E. Hinton. "Using very deep autoencoders for content-based image retrieval." *ESANN*. 2011.

# Auto-encoder – Similar Image Search



(crawl millions of images from the Internet)

# Retrieved using Euclidean distance in pixel intensity space

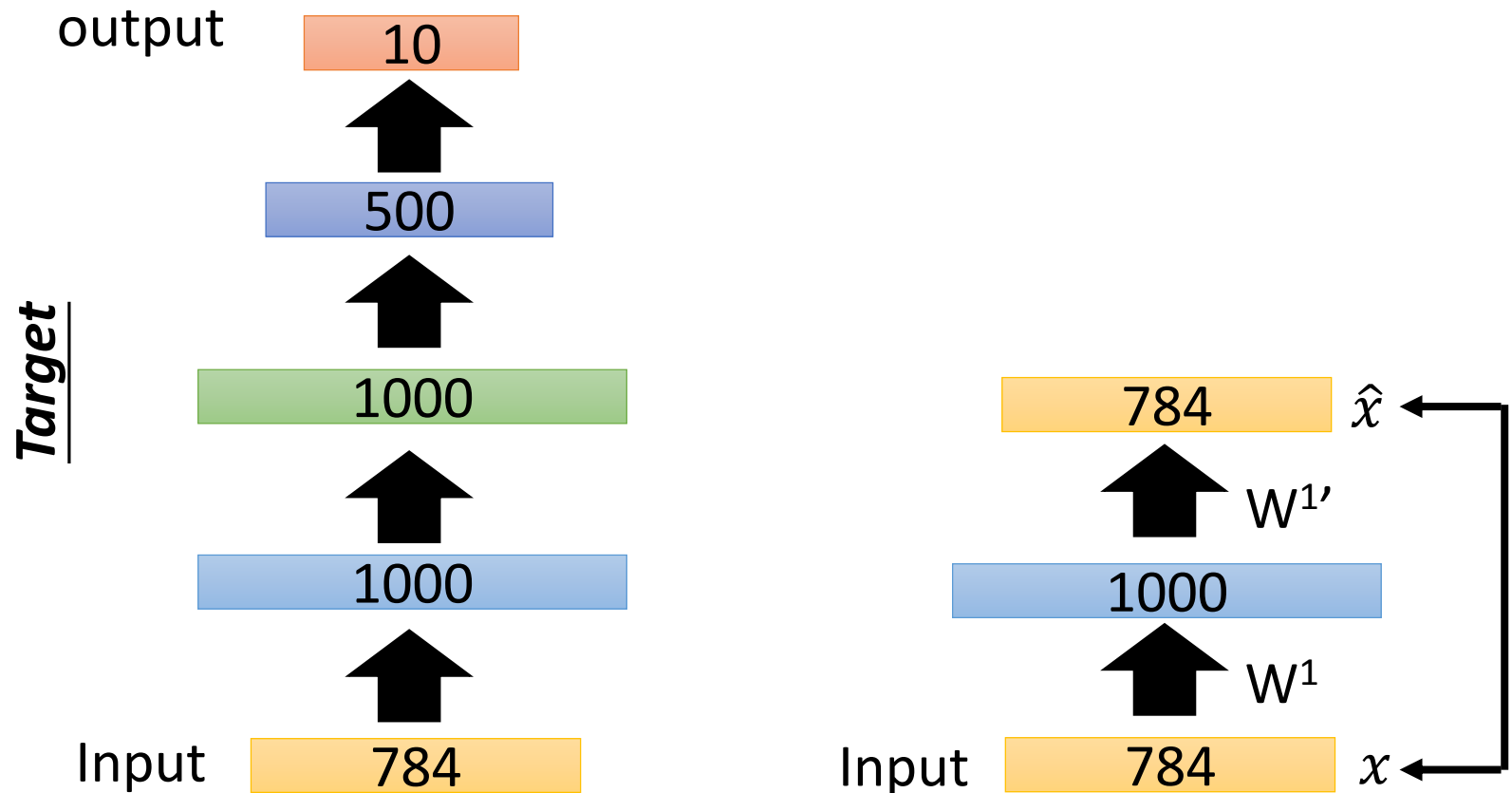


retrieved using 256 codes



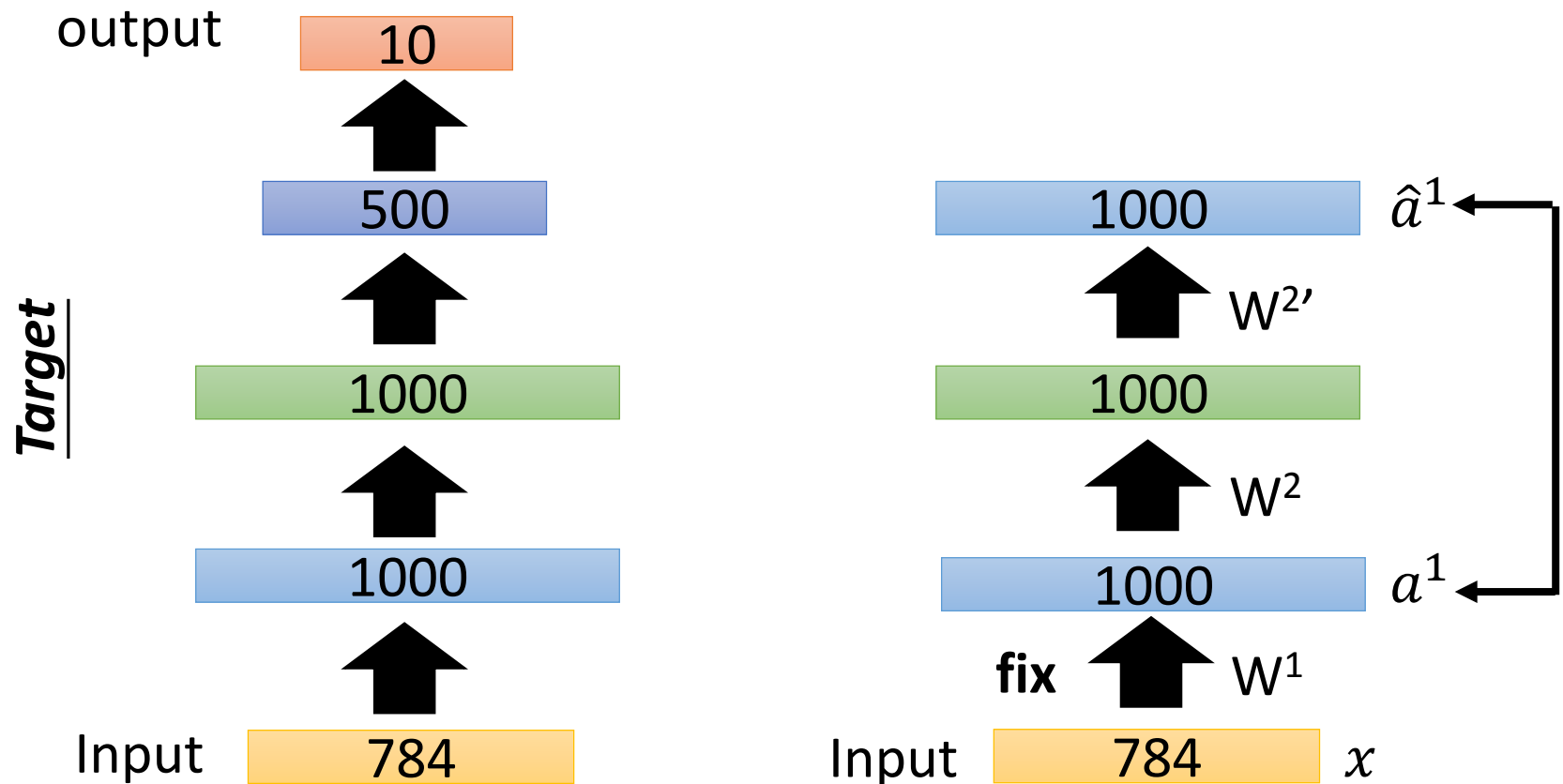
# Auto-encoder – Pre-training DNN

- Greedy Layer-wise Pre-training *again*



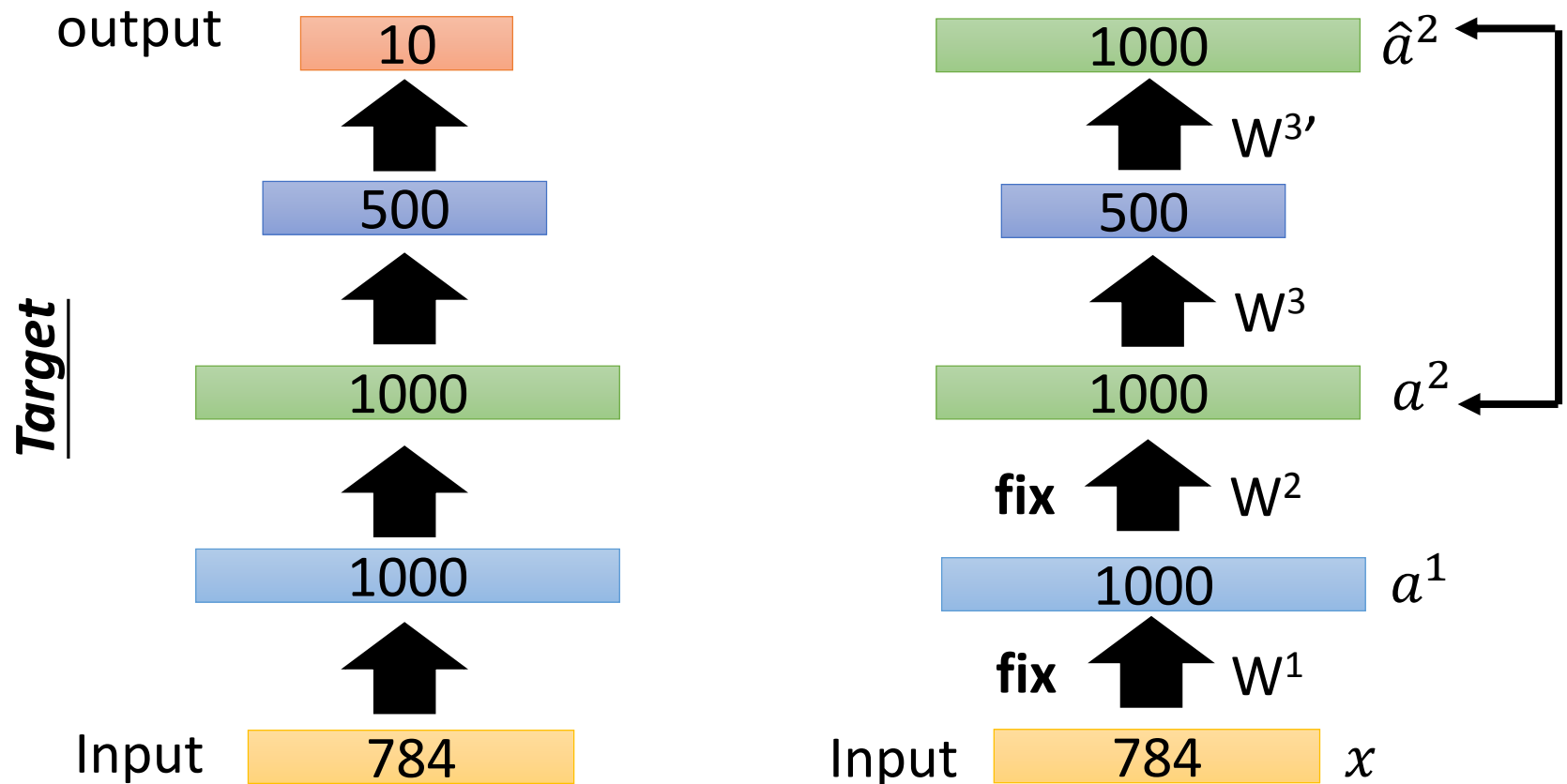
# Auto-encoder – Pre-training DNN

- Greedy Layer-wise Pre-training *again*



# Auto-encoder – Pre-training DNN

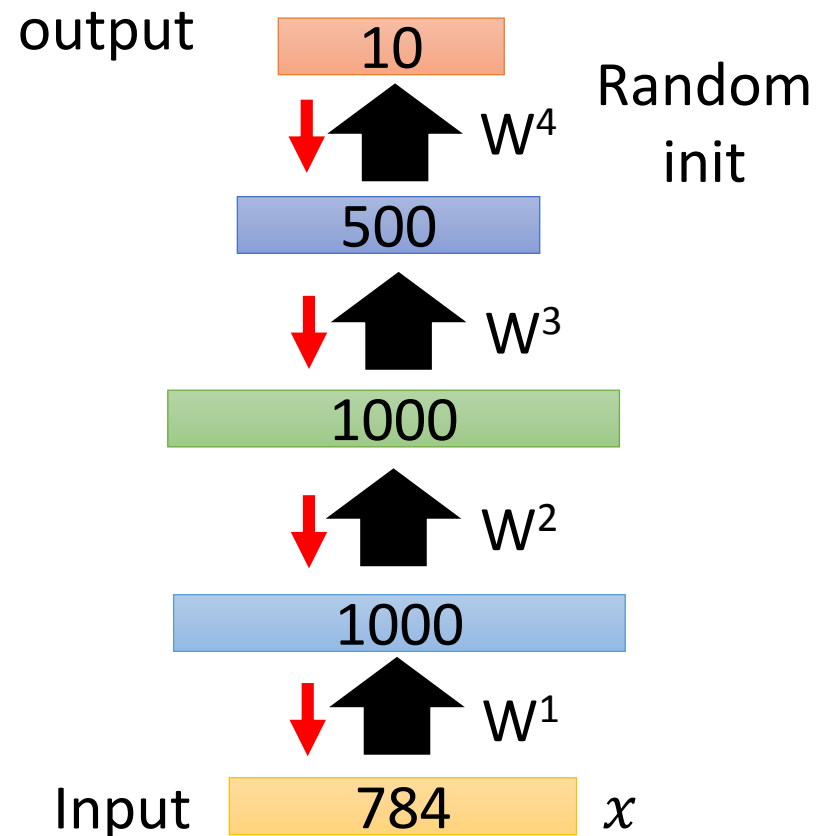
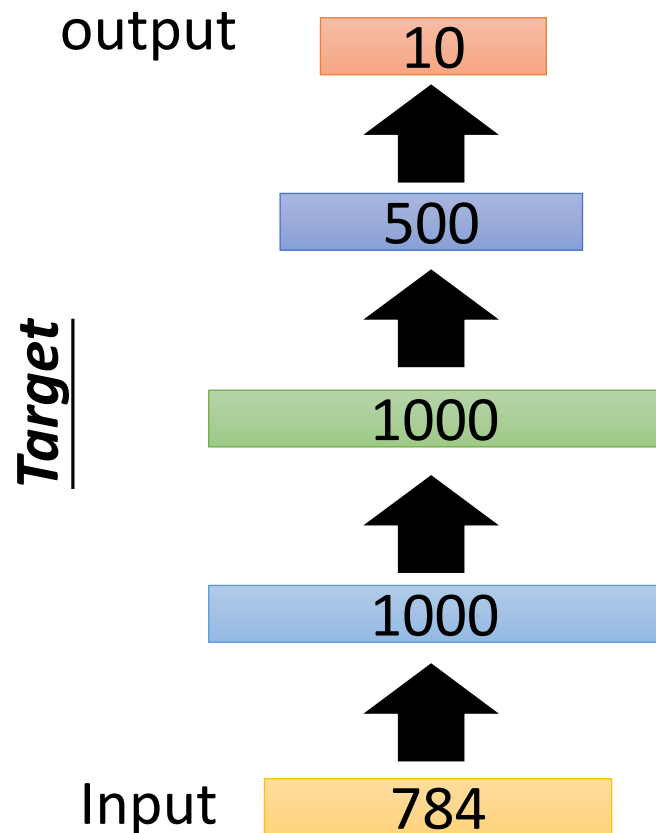
- Greedy Layer-wise Pre-training *again*



# Auto-encoder – Pre-training DNN

- Greedy Layer-wise Pre-training *again*

Find-tune by  
backpropagation



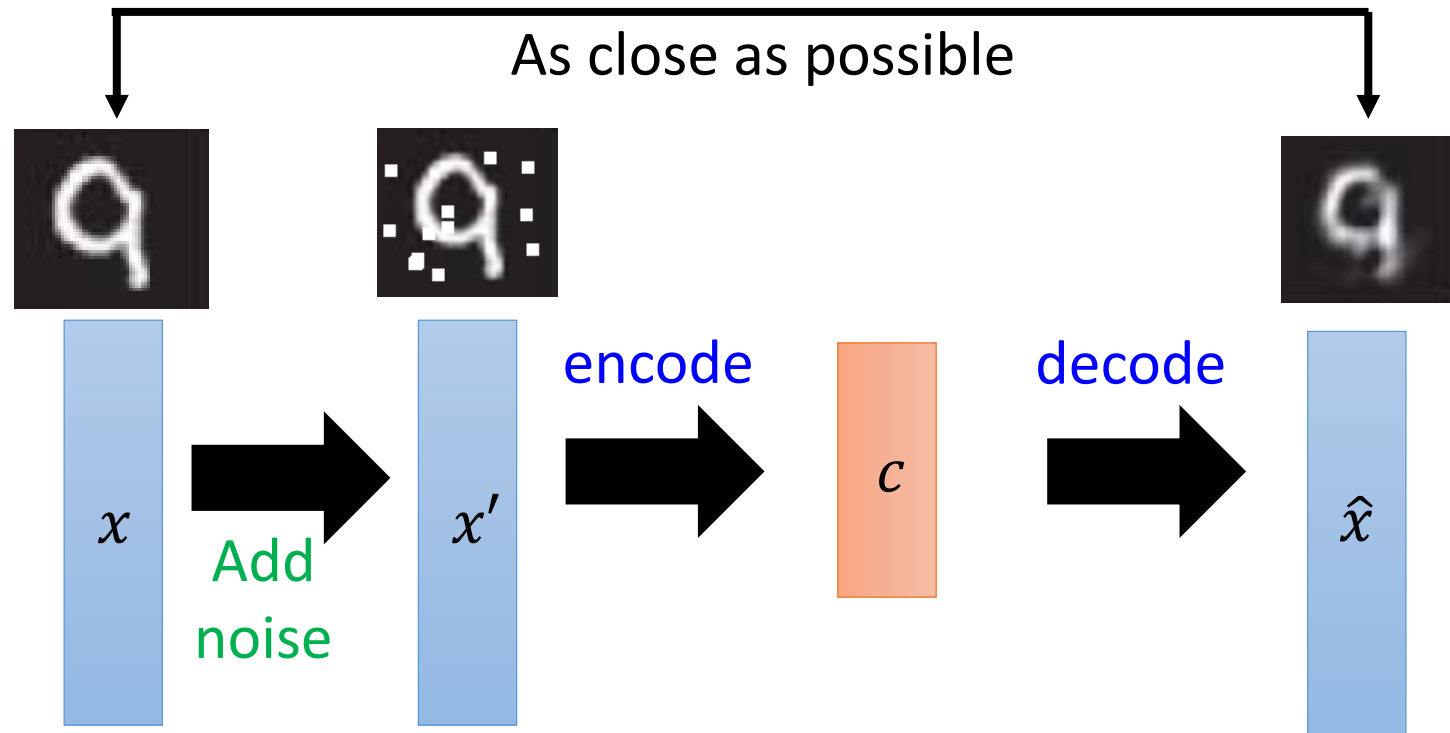


## More: Contractive auto-encoder

# Auto-encoder

Ref: Rifai, Salah, et al. "Contractive auto-encoders: Explicit invariance during feature extraction." *Proceedings of the 28th International Conference on Machine Learning (ICML-11)*. 2011.

- De-noising auto-encoder



Vincent, Pascal, et al. "Extracting and composing robust features with denoising autoencoders." *ICML*, 2008.

# Learning More

## - Restricted Boltzmann Machine

- Neural networks [5.1] : Restricted Boltzmann machine – definition
  - [https://www.youtube.com/watch?v=p4Vh\\_zMw-HQ&index=36&list=PL6Xpj9I5qXYEcOhn7TqghAJ6NAPrNmUBH](https://www.youtube.com/watch?v=p4Vh_zMw-HQ&index=36&list=PL6Xpj9I5qXYEcOhn7TqghAJ6NAPrNmUBH)
- Neural networks [5.2] : Restricted Boltzmann machine – inference
  - [https://www.youtube.com/watch?v=lekCh\\_i32iE&list=PL6Xpj9I5qXYEcOhn7TqghAJ6NAPrNmUBH&index=37](https://www.youtube.com/watch?v=lekCh_i32iE&list=PL6Xpj9I5qXYEcOhn7TqghAJ6NAPrNmUBH&index=37)
- Neural networks [5.3] : Restricted Boltzmann machine - free energy
  - [https://www.youtube.com/watch?v=e0Ts\\_7Y6hZU&list=PL6Xpj9I5qXYEcOhn7TqghAJ6NAPrNmUBH&index=38](https://www.youtube.com/watch?v=e0Ts_7Y6hZU&list=PL6Xpj9I5qXYEcOhn7TqghAJ6NAPrNmUBH&index=38)

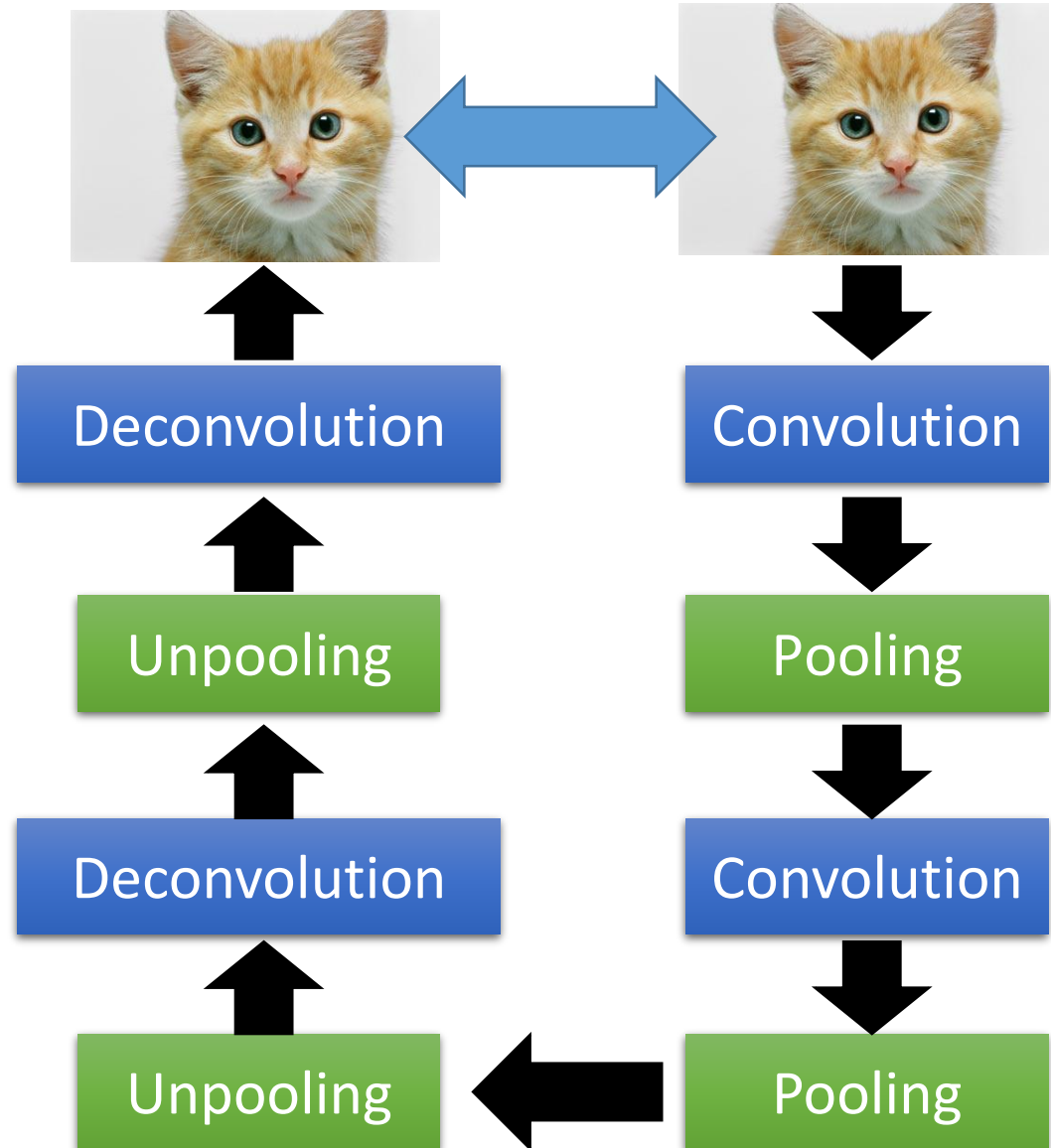
# Learning More

## - Deep Belief Network

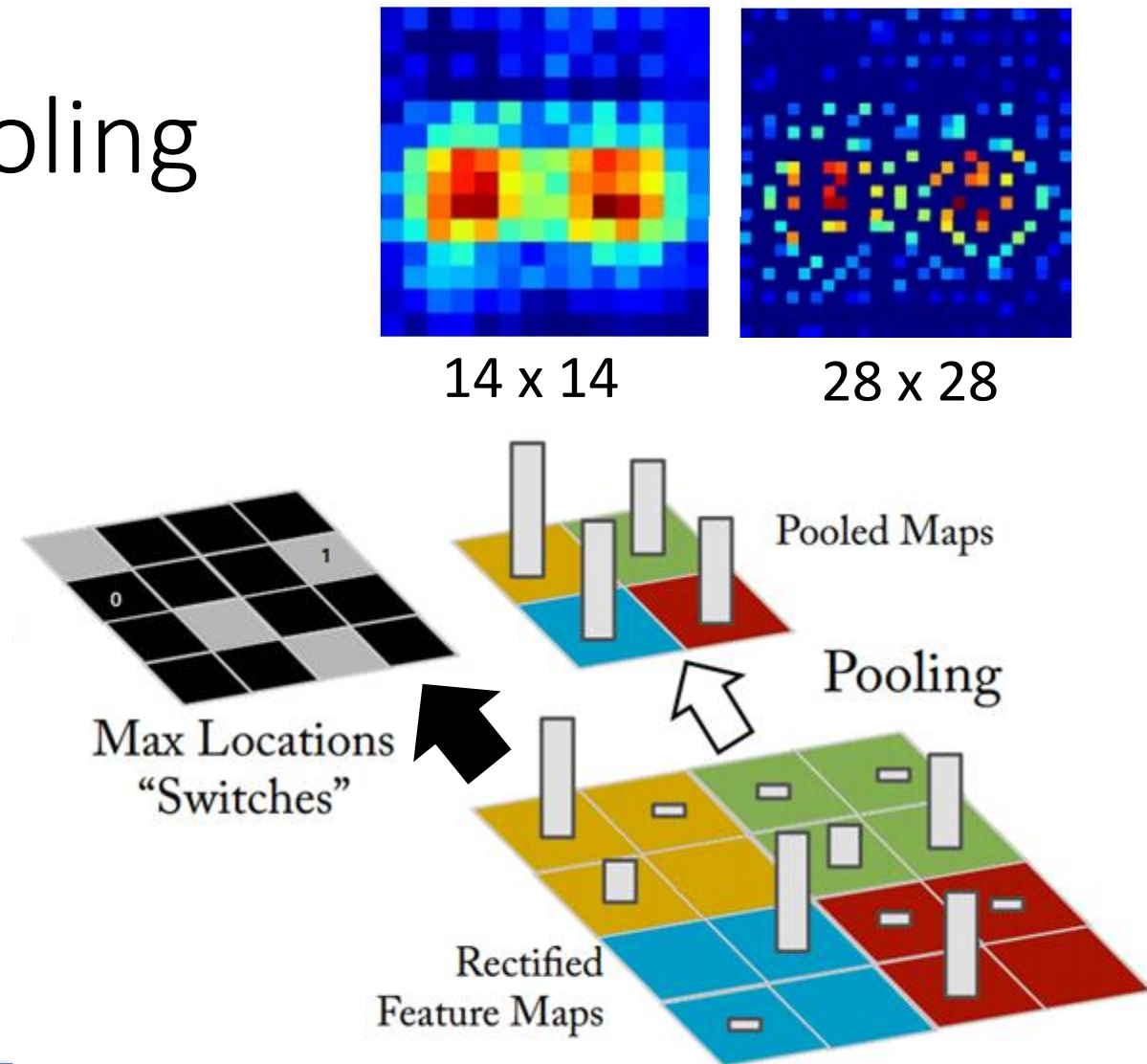
- Neural networks [7.7] : Deep learning - deep belief network
  - <https://www.youtube.com/watch?v=vkb6AWYXZ5I&list=PL6Xpj9I5qXYEcOhn7TqghAJ6NAPrNmUBH&index=57>
- Neural networks [7.8] : Deep learning - variational bound
  - <https://www.youtube.com/watch?v=pStDscJh2Wo&list=PL6Xpj9I5qXYEcOhn7TqghAJ6NAPrNmUBH&index=58>
- Neural networks [7.9] : Deep learning - DBN pre-training
  - <https://www.youtube.com/watch?v=35MUIYCColk&list=PL6Xpj9I5qXYEcOhn7TqghAJ6NAPrNmUBH&index=59>

# Auto- encoder for CNN

As close as possible



# CNN -Unpooling



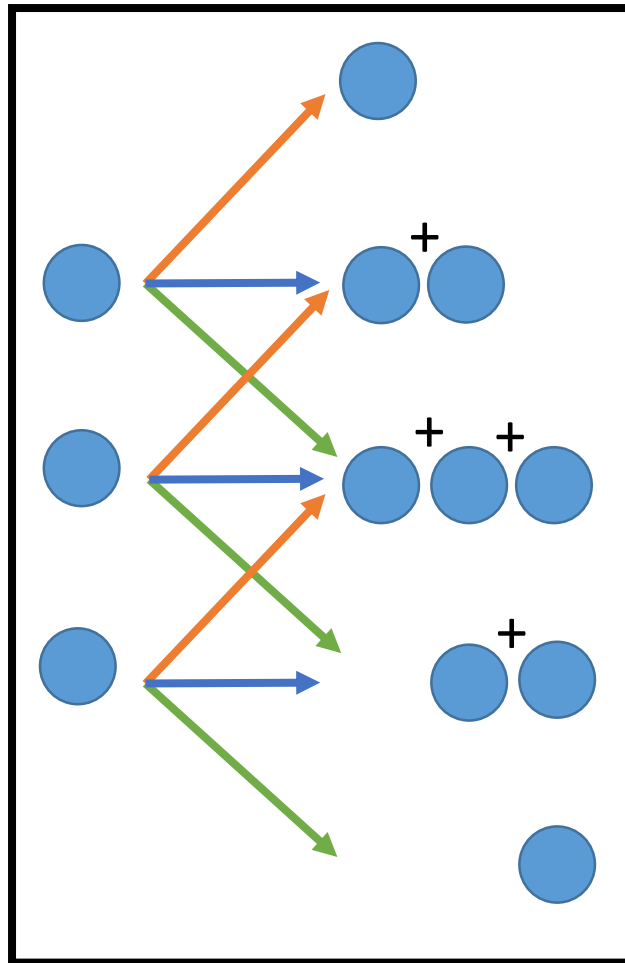
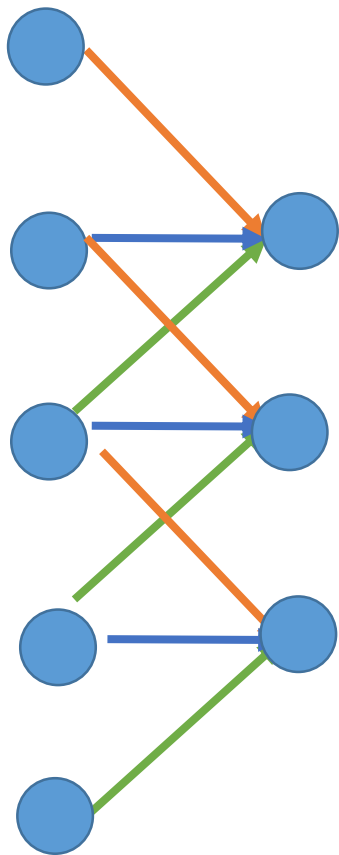
Alternative: simply  
repeat the values

Source of image :  
[https://leonardoaraujosantos.gitbooks.io/artificial-intelligence/content/image\\_segmentation.html](https://leonardoaraujosantos.gitbooks.io/artificial-intelligence/content/image_segmentation.html)

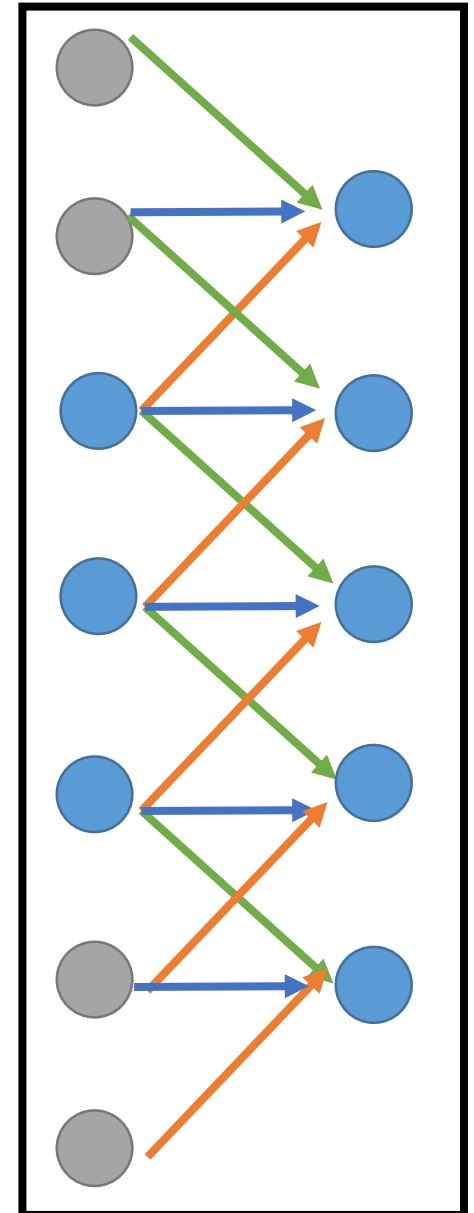
# CNN

## - Deconvolution

Actually, deconvolution is convolution.

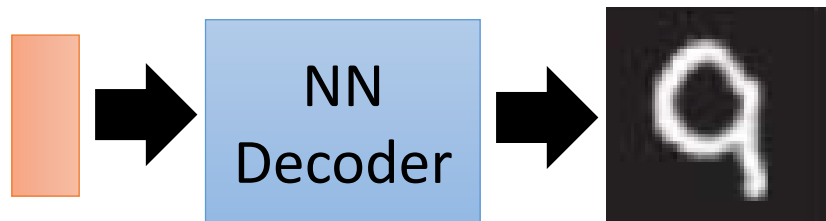


=

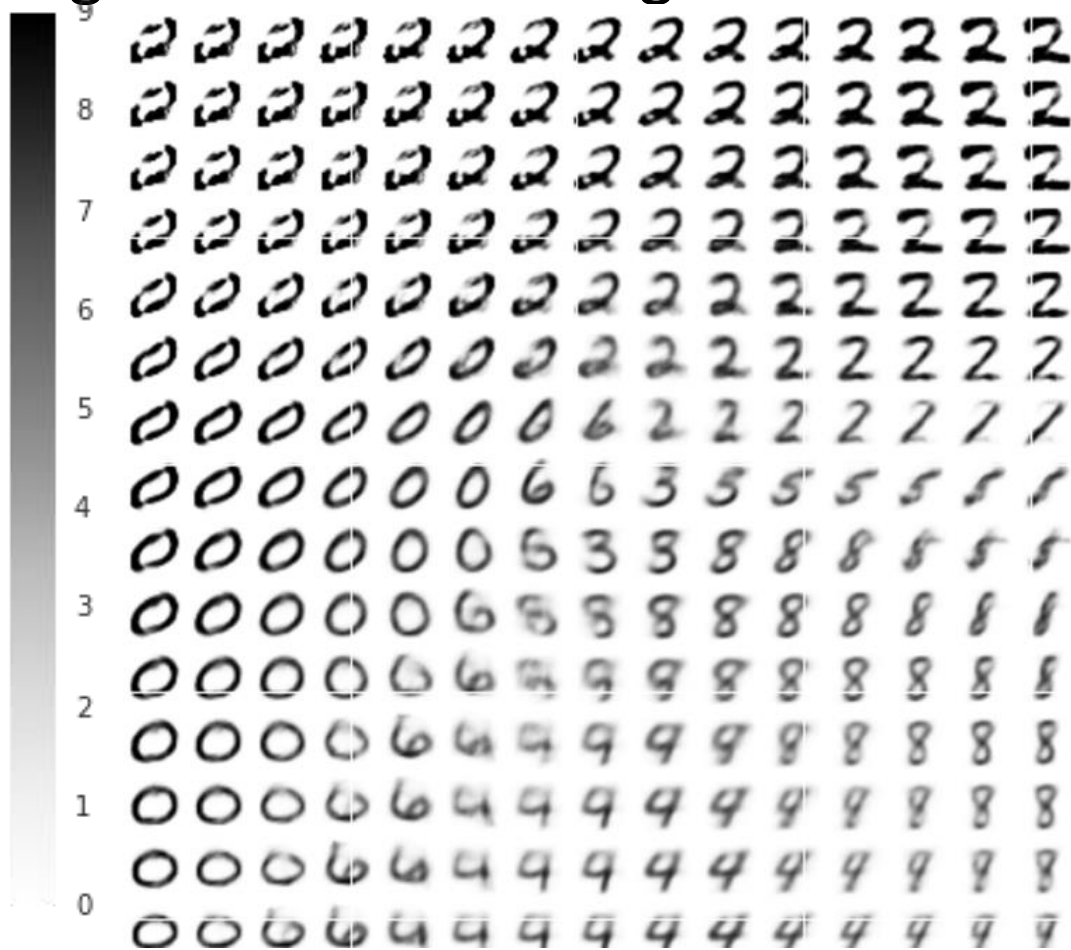
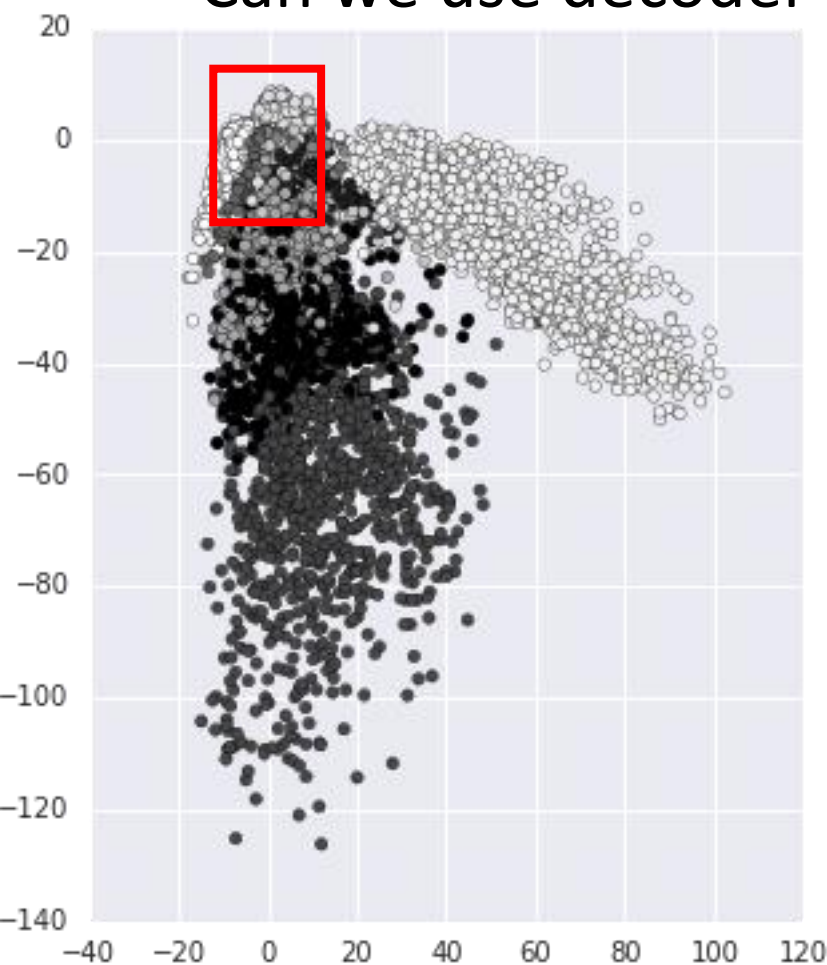


Next .....

code

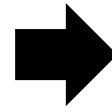


- Can we use decoder to generate something?

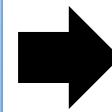


Next .....

code



NN  
Decoder



- Can we use decoder to generate something?

