Unsupervised Learning:
Deep Auto-encoder (深度自編碼)

來源 ttp://www.deeplearningbook.org/contents/autoencoders.html
(李弘毅) : http://speech.ee.ntu.edu.tw/~tlkagk/courses.html

Unsupervised Learning

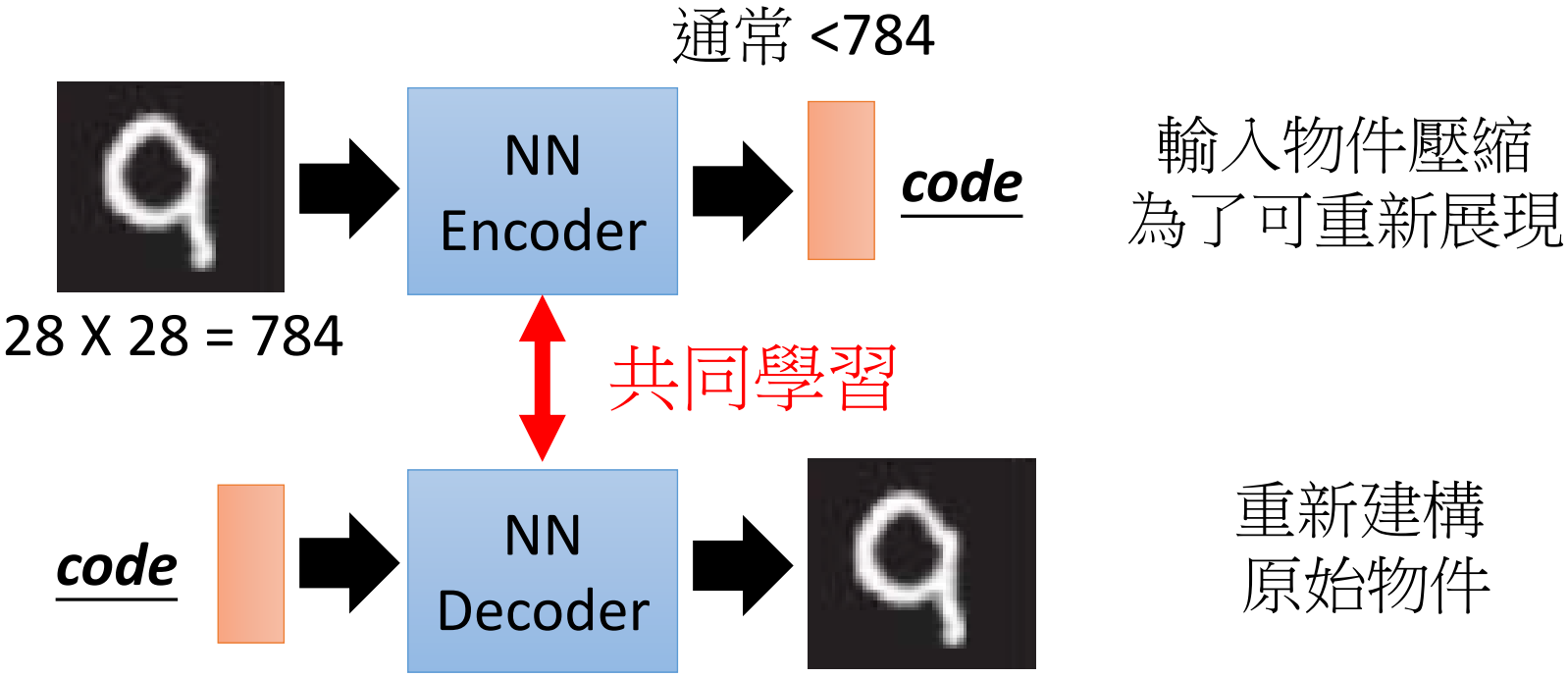
"We expect unsupervised learning to become far more important in the longer term. Human and animal learning is largely unsupervised: we discover the structure of the world by observing it, not by being told the name of every object."

– LeCun, Bengio, Hinton, Nature 2015

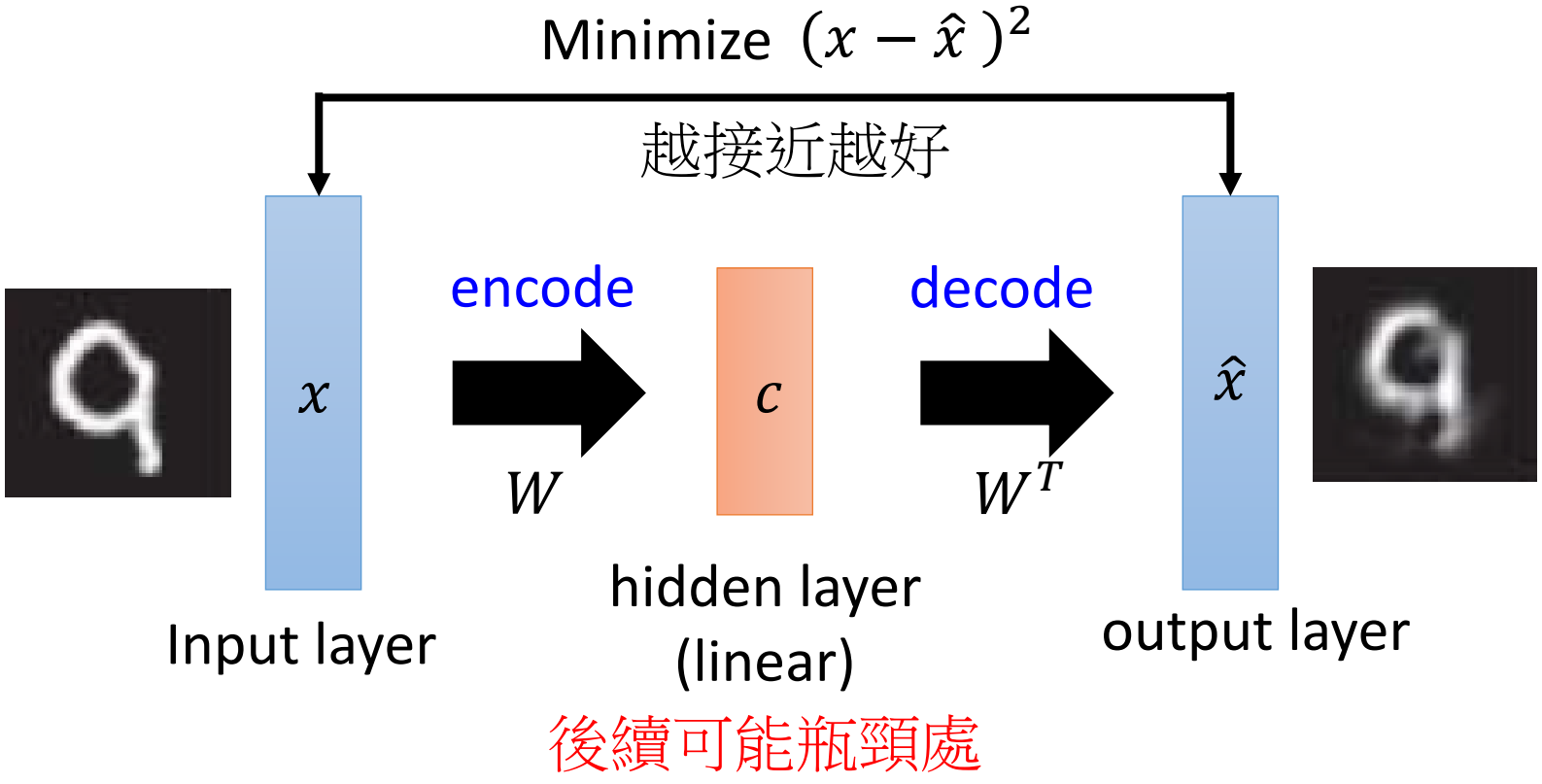
As I've said in previous statements: most of human and animal learning is unsupervised learning. If intelligence was a cake, unsupervised learning would be the cake, supervised learning would be the icing on the cake, and reinforcement learning would be the cherry on the cake. We know how to make the icing and the cherry, but we don't know how to make the cake.

- Yann LeCun, March 14, 2016 (Facebook)

Auto-encoder



Recap: PCA

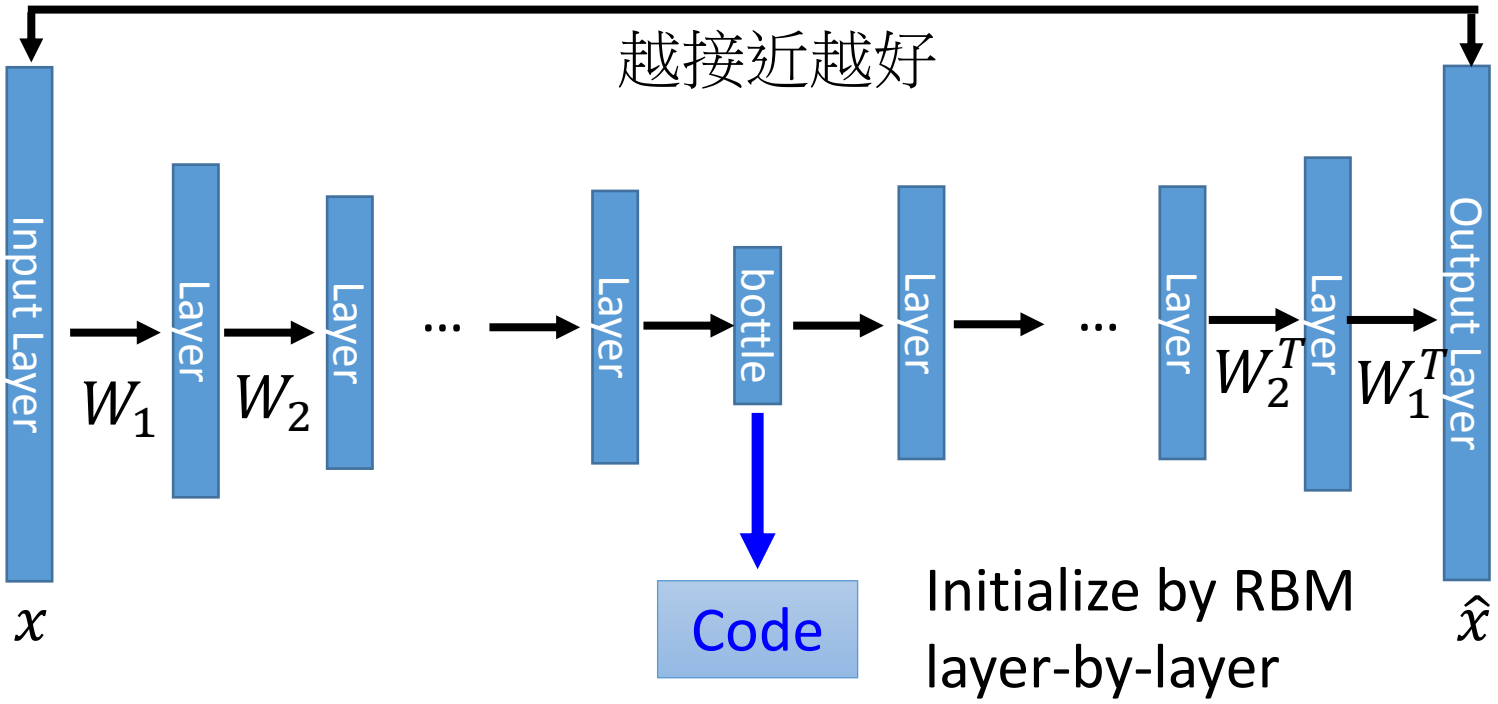


隱藏層的輸出是 code

Deep Auto-encoder

不一定需要對稱.

- 這 auto-encoder 架構可被深度化



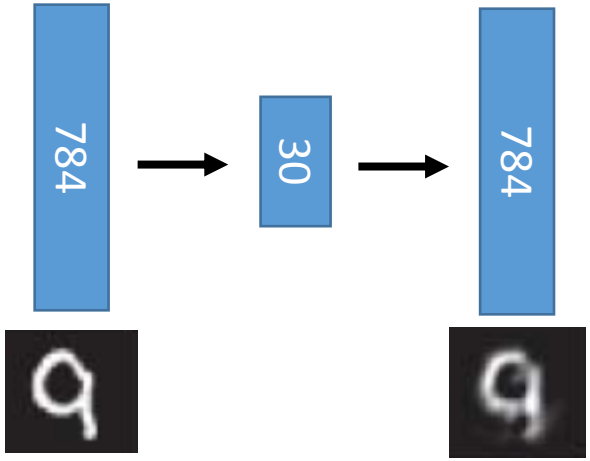
Reference: Hinton, Geoffrey E., and Ruslan R. Salakhutdinov. "Reducing the dimensionality of data with neural networks." *Science* 313.5786 (2006): 504-507

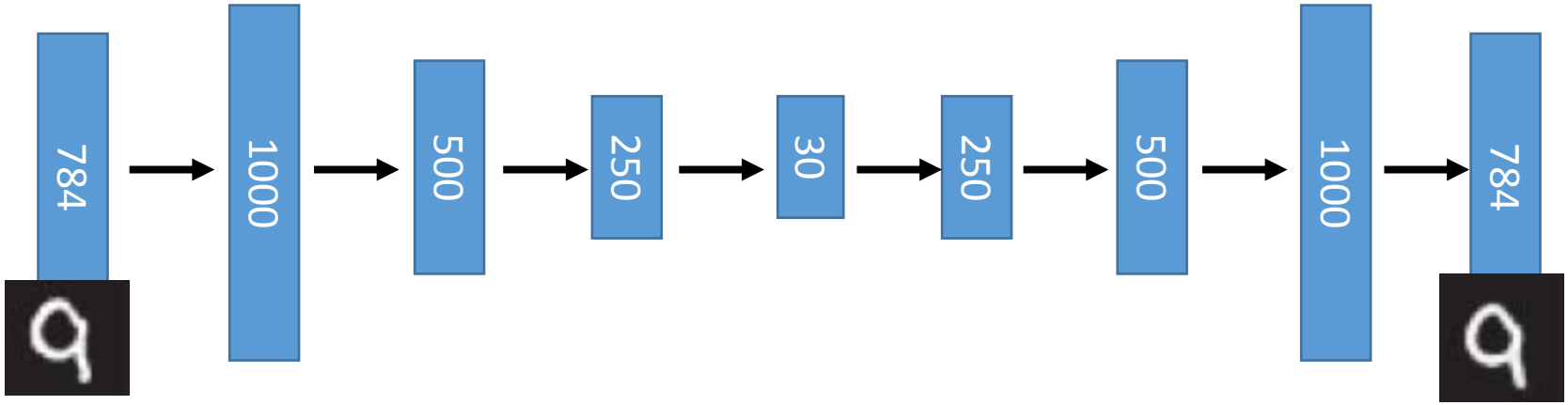
Deep Auto-encoder

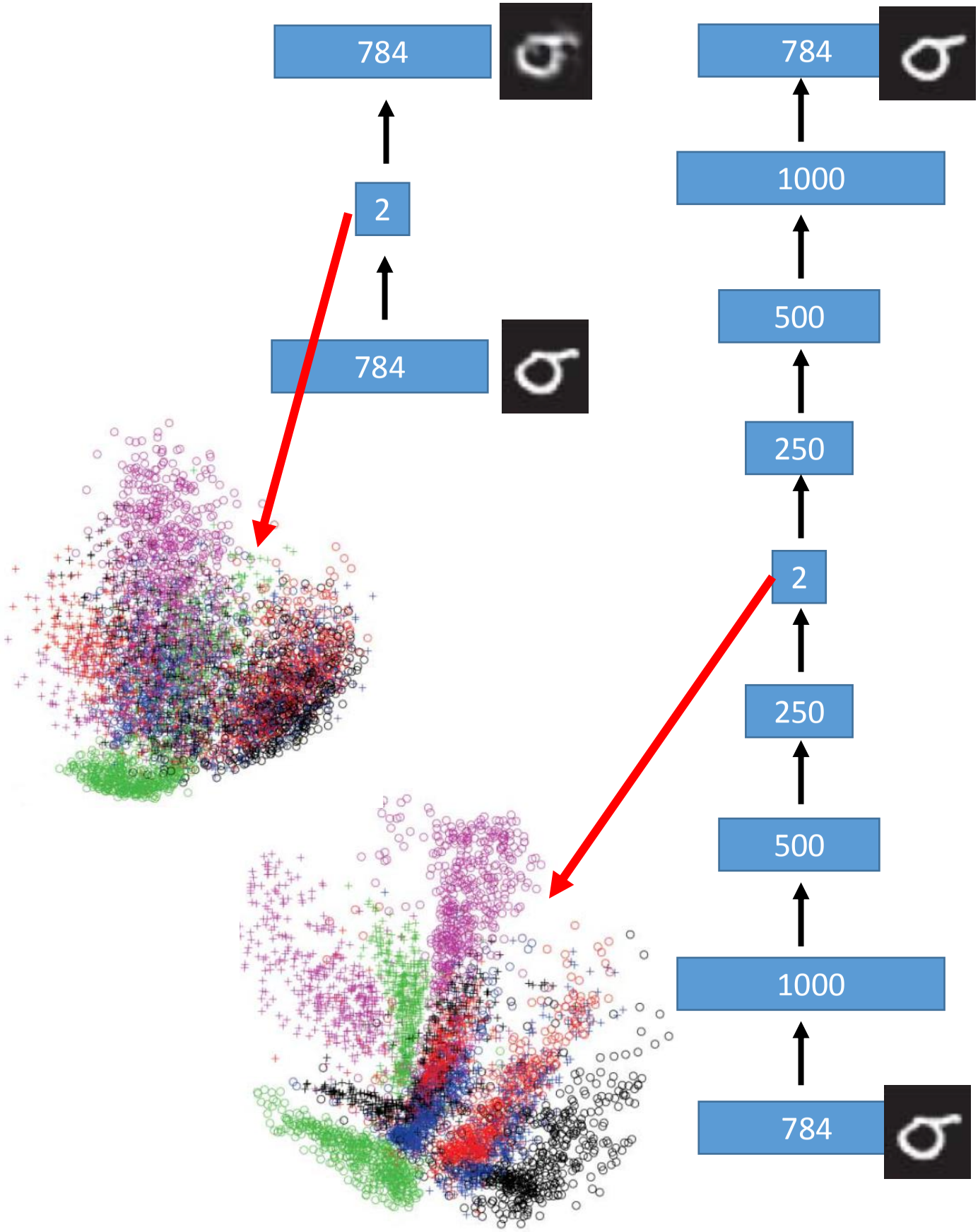
原始影像

PCA後影像

Deep Auto-encoder後影像





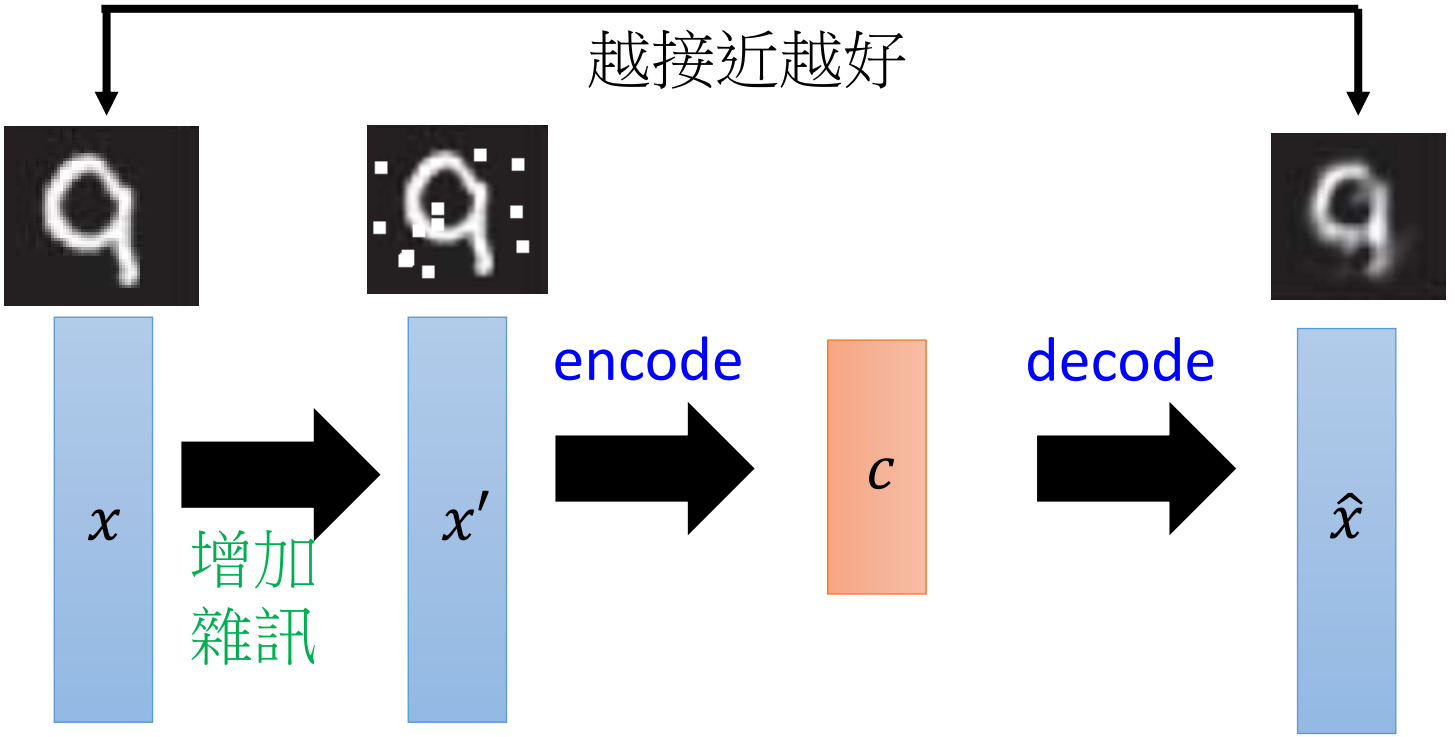

784
2
784
784
1000
500
250
2
250
500
1000
784

Auto-encoder

更多的auto-encoder 收縮架構

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

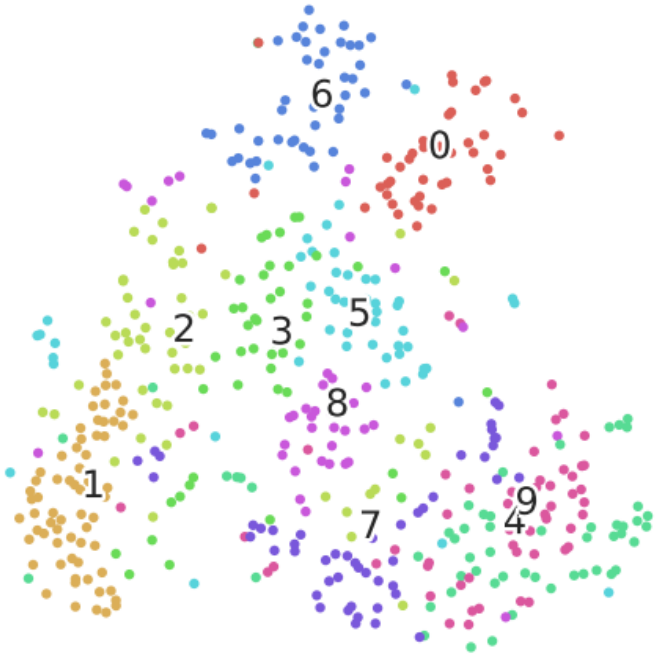


Vincent, Pascal, et al. "Extracting and composing robust features with denoising autoencoders." *ICML,* 2008.

Deep Auto-encoder – 範例

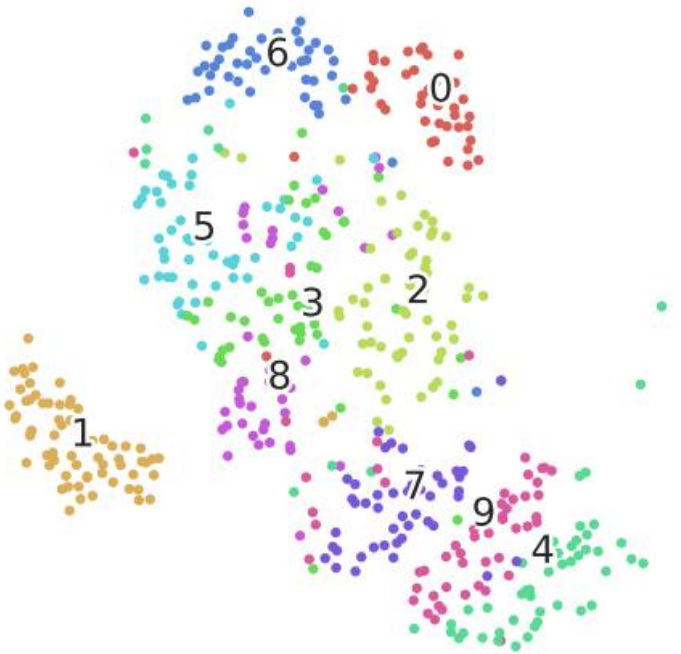
NN Encoder

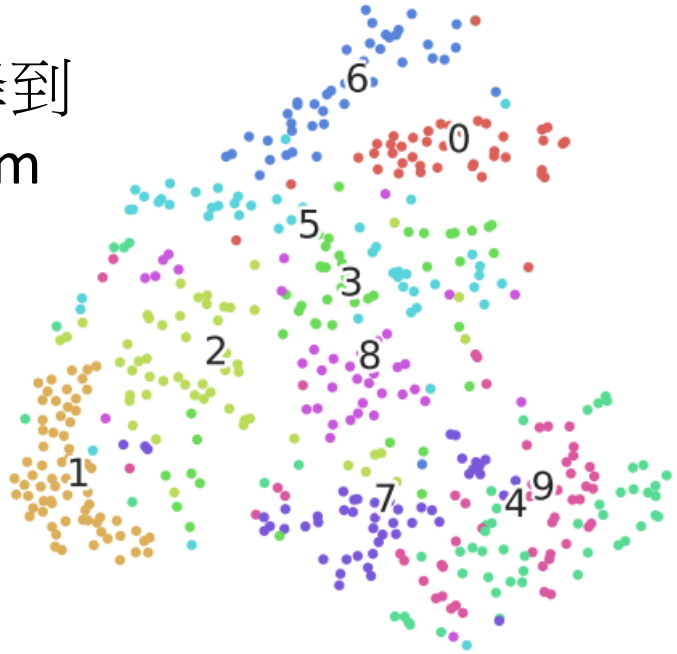
c



Pixel -> tSNE

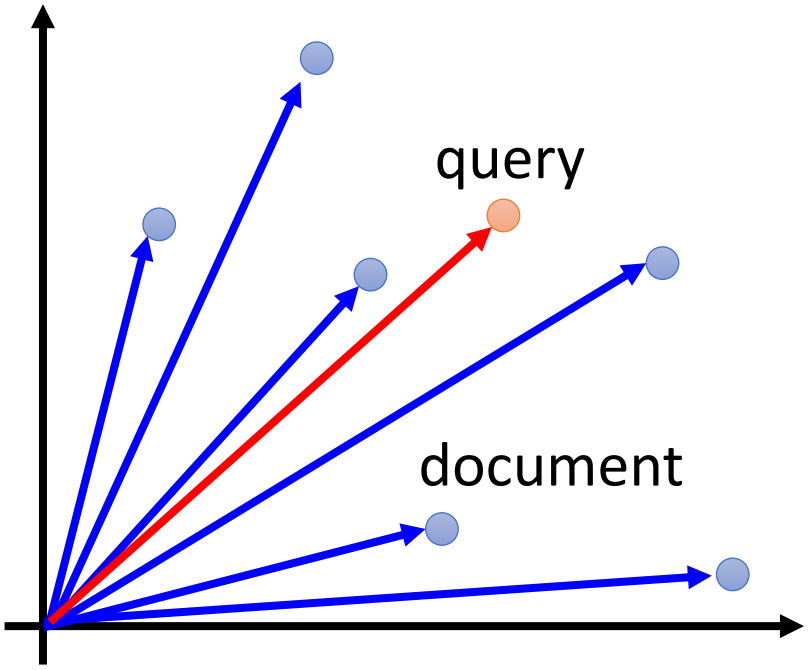
PCA 降到 32-dim





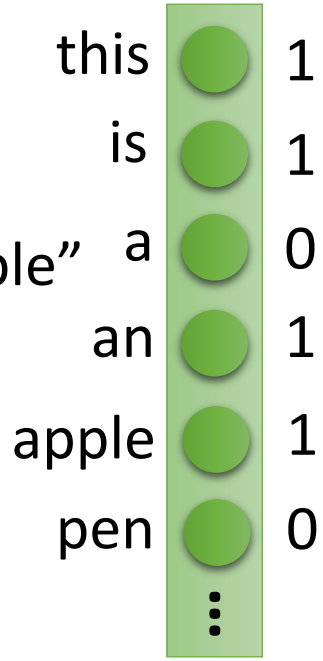
Auto-encoder – Text Retrieval (文字攫取)

向量空間 模型



Bag-of-word

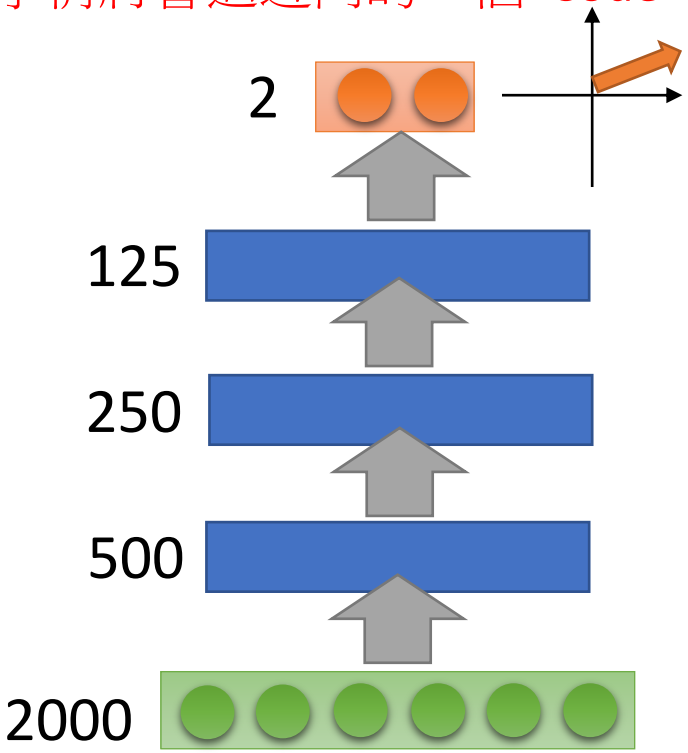
word string:
“This is an apple”



不考慮場景.

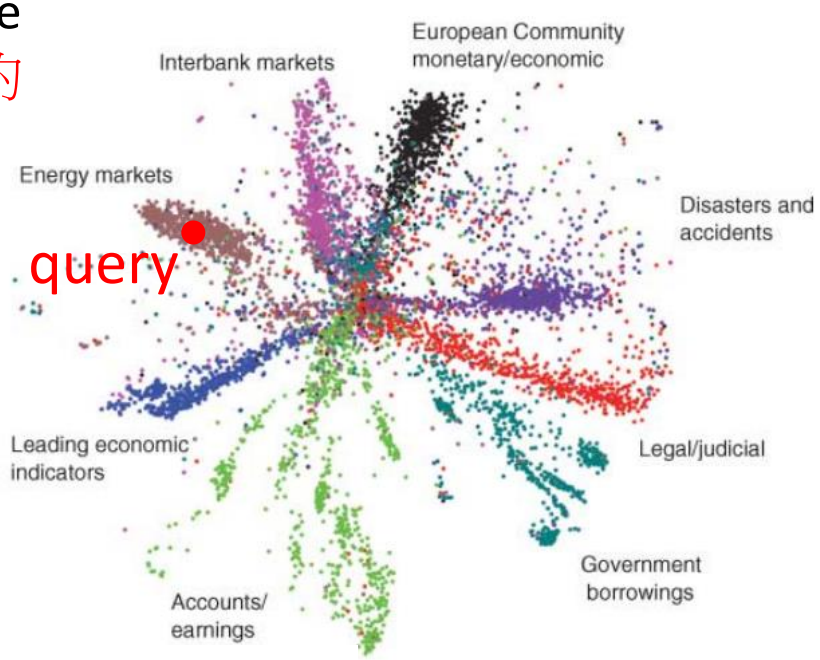
Auto-encoder – Text Retrieval(文字攫取應用)

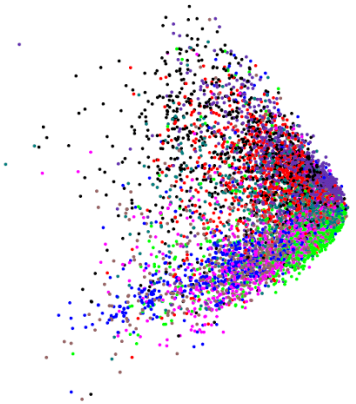
The documents talking about the same thing will have close code. 探討相同的事情將會逼近同的一個 Code



Bag-of-word 文字集

(document or query)





LSA: project documents to 2 latent topics

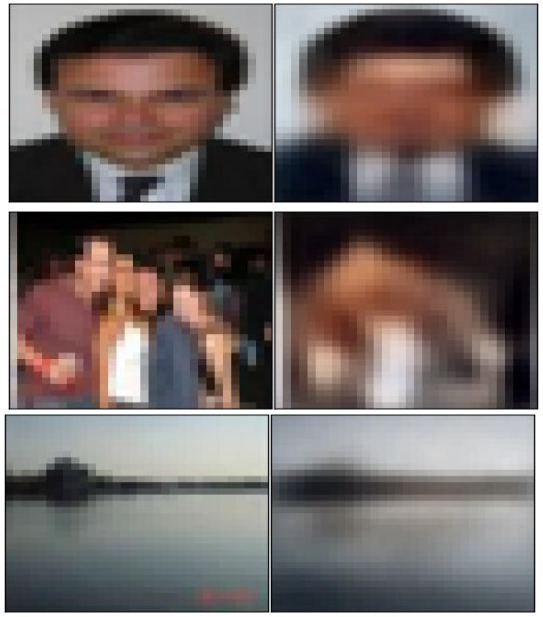
Auto-encoder – Similar Image Search (相似影像搜尋)

Retrieved using Euclidean distance in pixel intensity space
用像素的空間密度尤拉距離 攫取影像

(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 – 相似影像搜尋



32x32

8192

4096

2048

1024

512

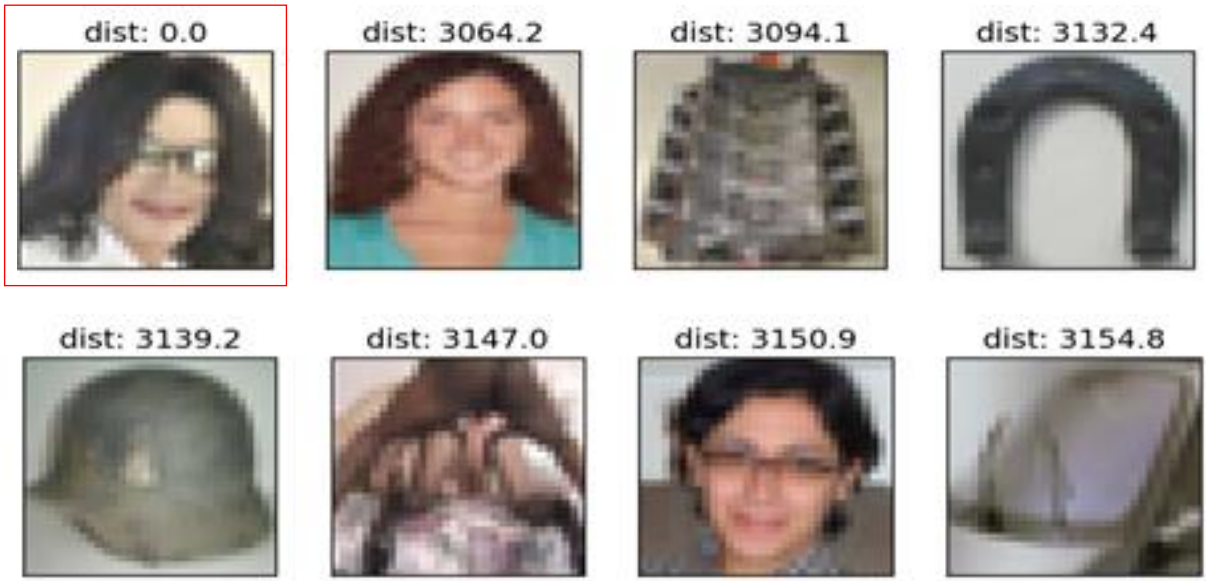
code

256

(crawl millions of images from the Internet)

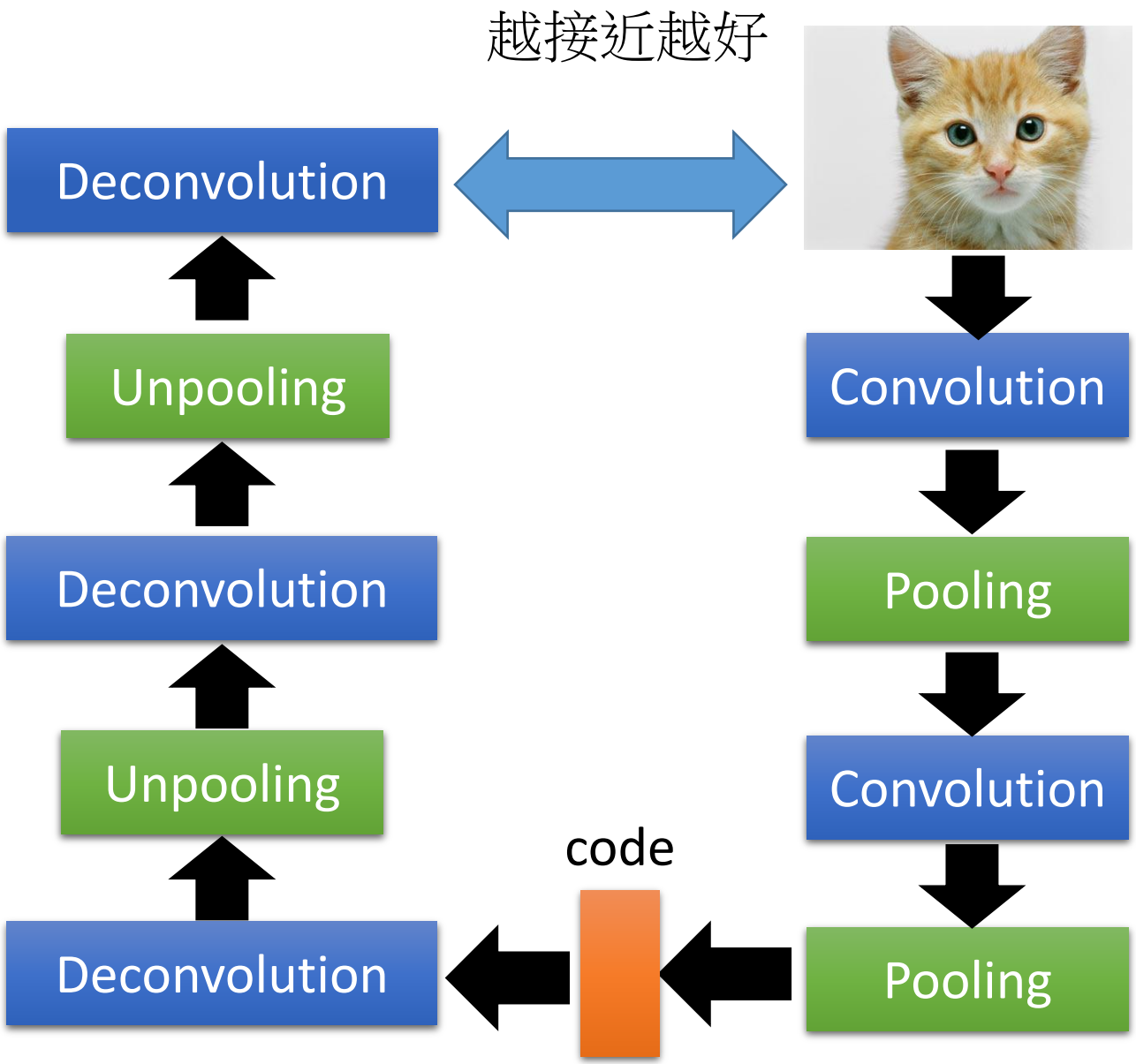
從網際網路數以萬計的影像

Retrieved using Euclidean distance in pixel intensity space

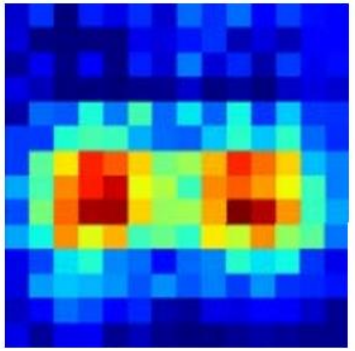


用256 codes 攫取相似影像

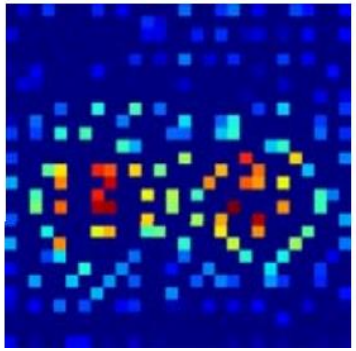
CNN 設計 Auto-encoder



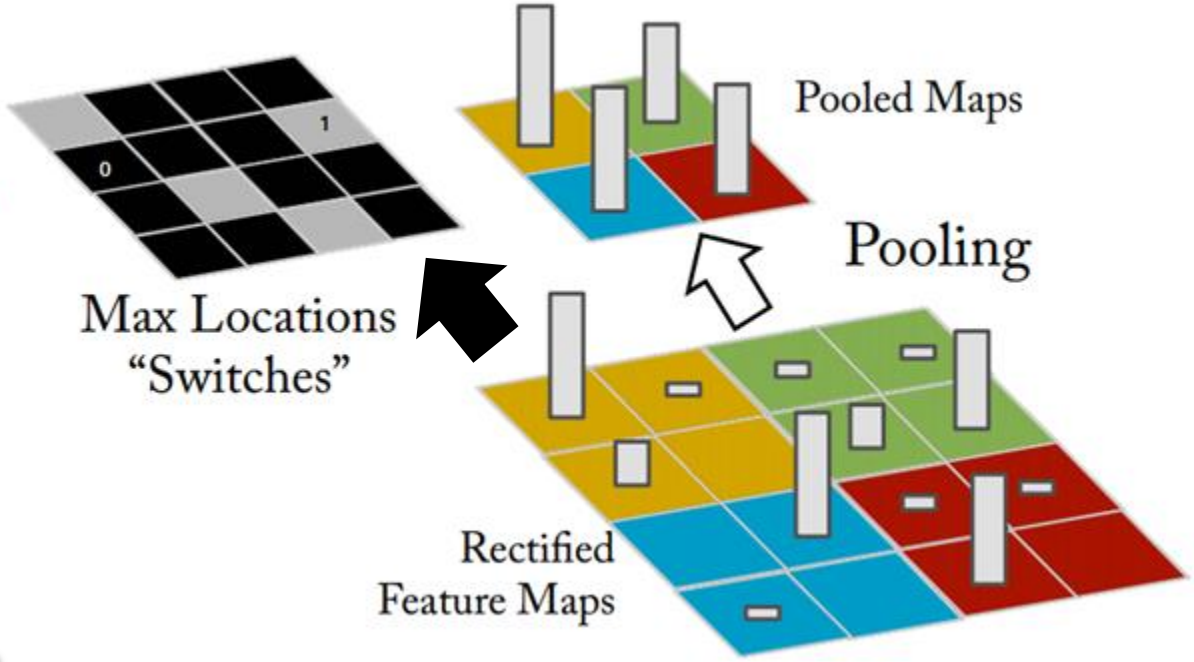
CNN –Unpooling 過程



14 x 14



28 x 28



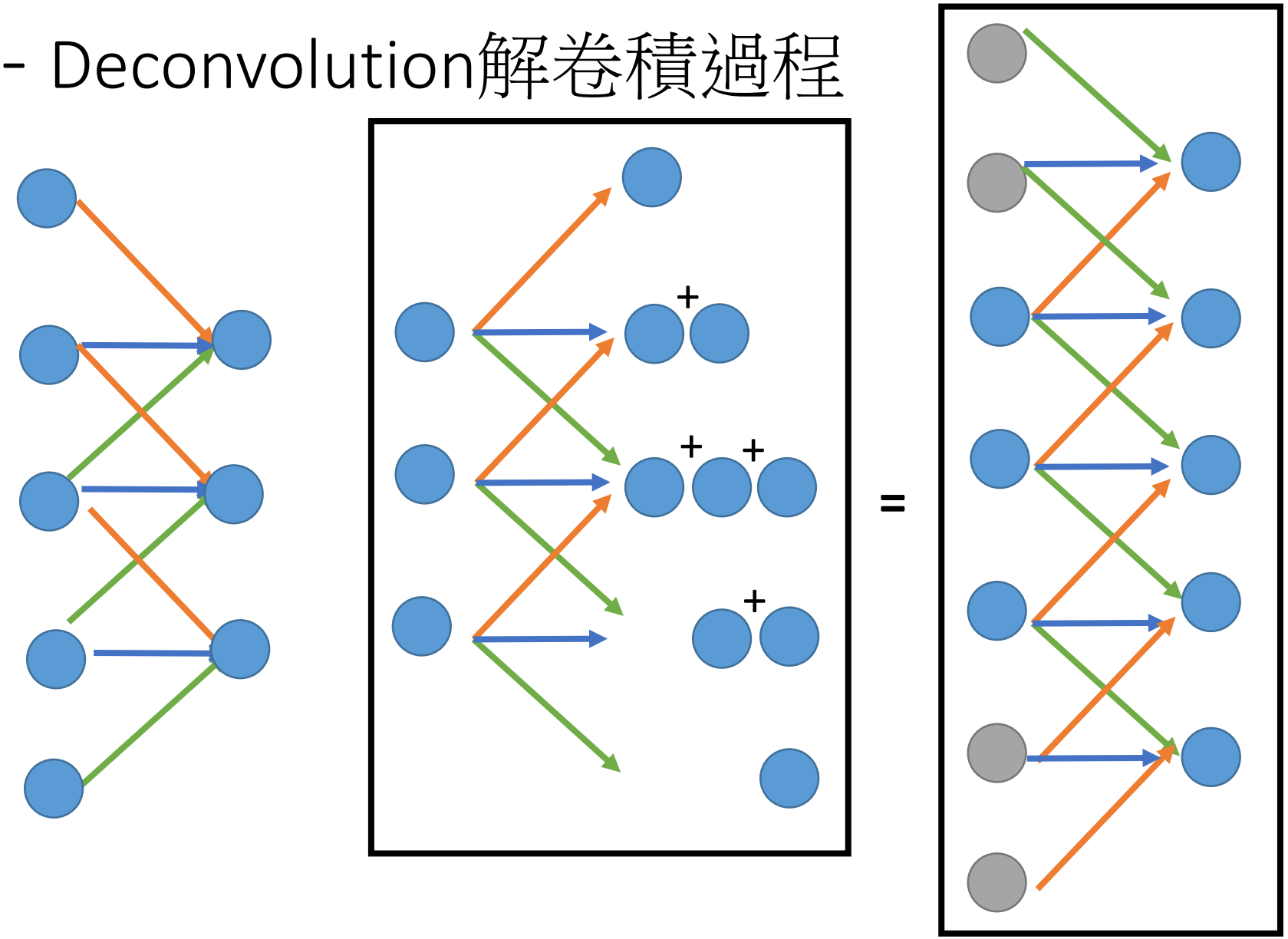
Alternative: simply repeat the values

Source of image : https://leonardoaraujosantos.gitbooks.io/artificial-inteligence/content/image_segmentation.html

CNN

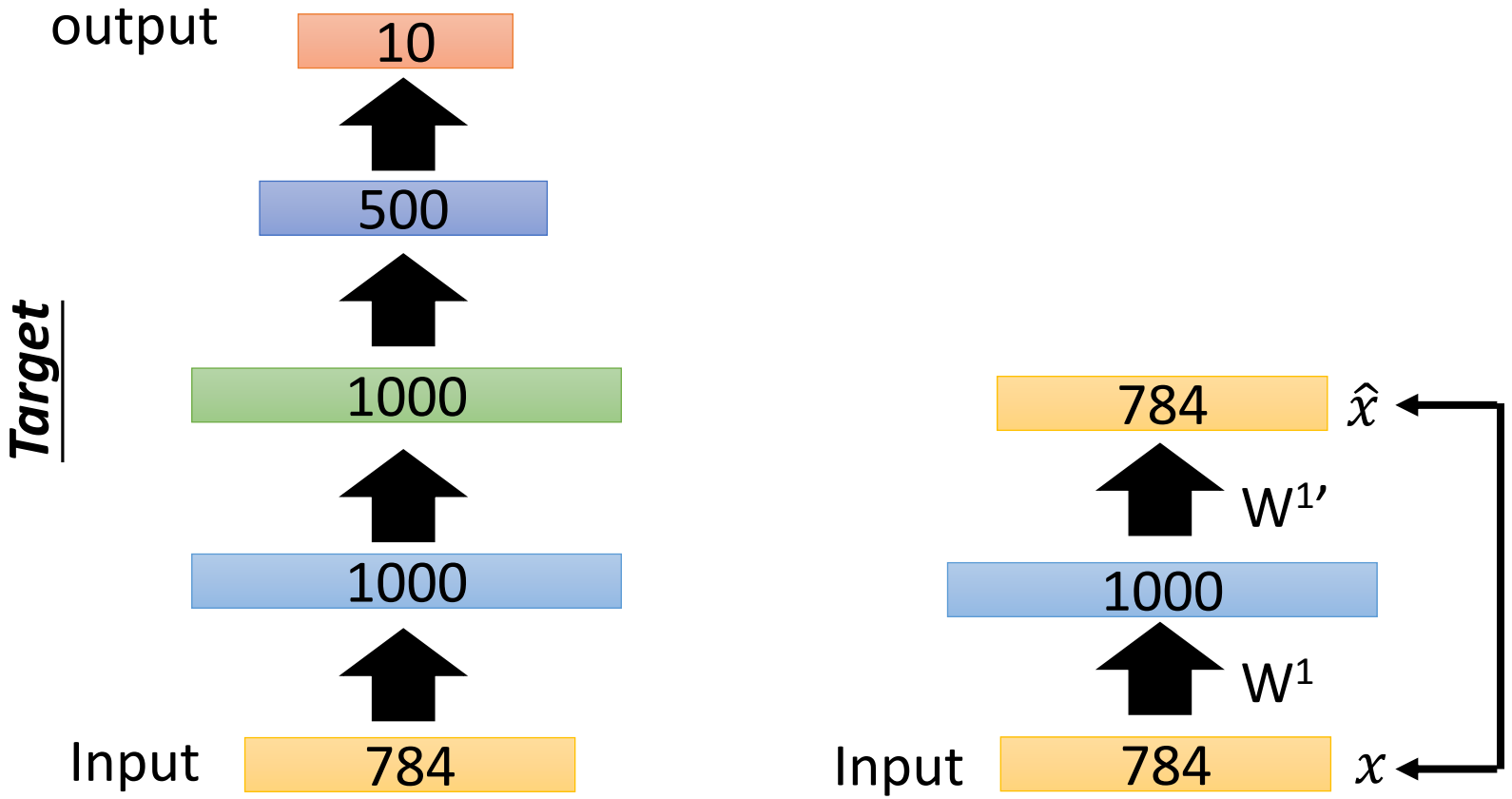
- Deconvolution解卷積過程

Actually, deconvolution is convolution.



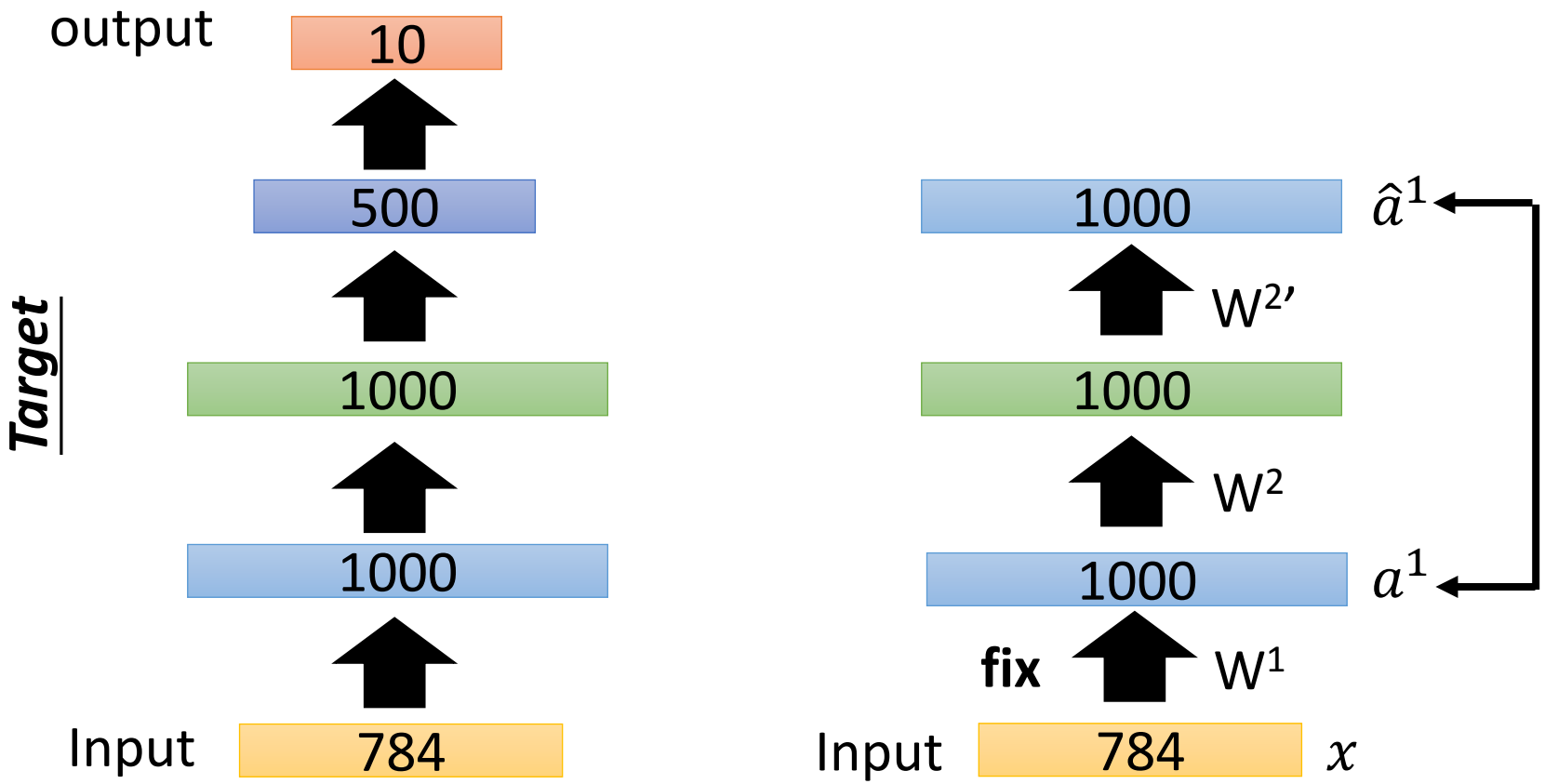
Auto-encoder – Pre-training DNN

- Greedy貪婪Layer-wise Pre-training *again* *透過預訓練處理*



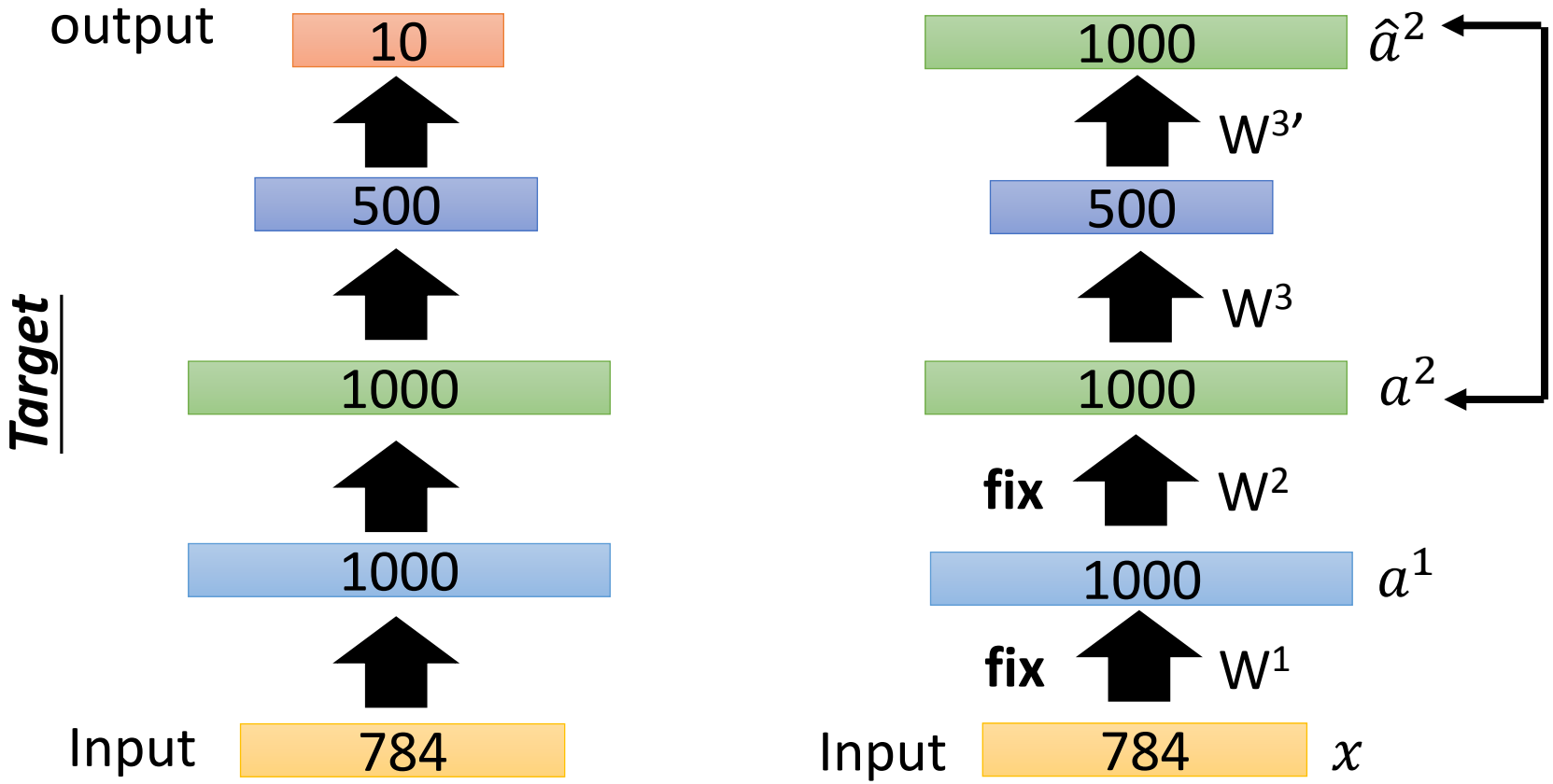
Auto-encoder – Pre-training DNN

- Greedy Layer-wise Pre-training *again*



Auto-encoder – Pre-training DNN

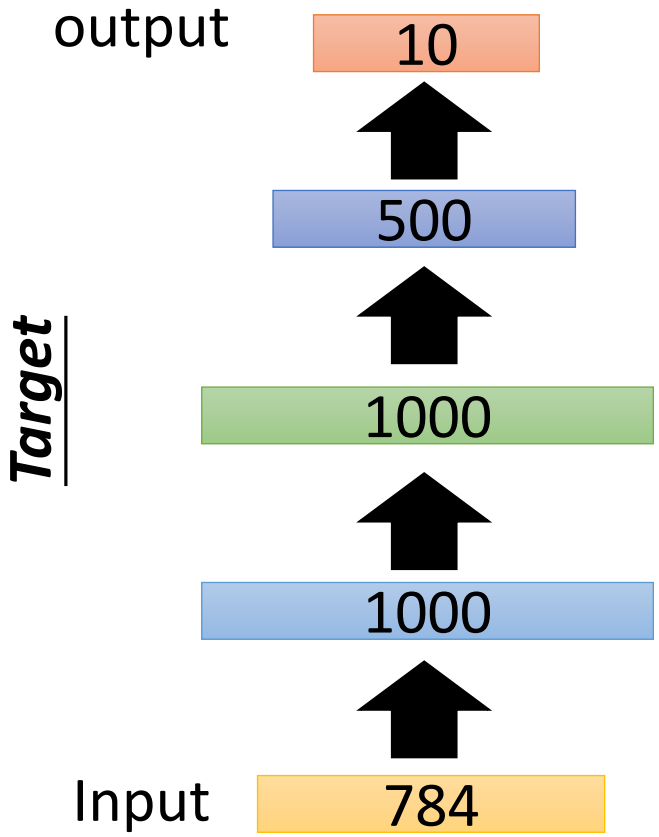
- Greedy Layer-wise Pre-training *again*

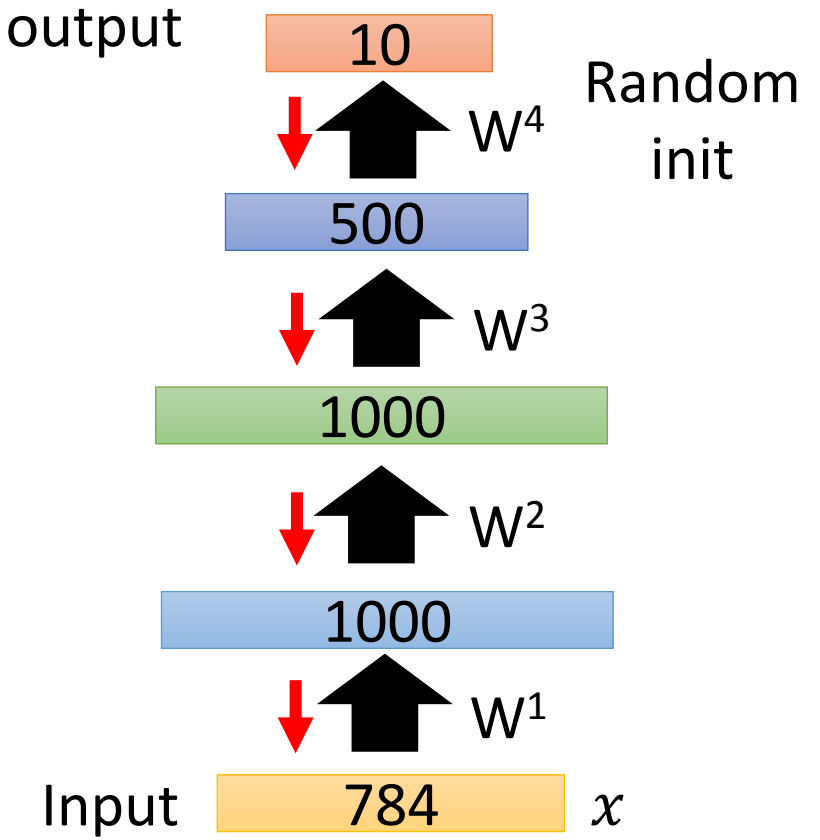


Auto-encoder – Pre-training DNN

- Greedy Layer-wise Pre-training *again*

精確調整
Find-tune by backpropagation





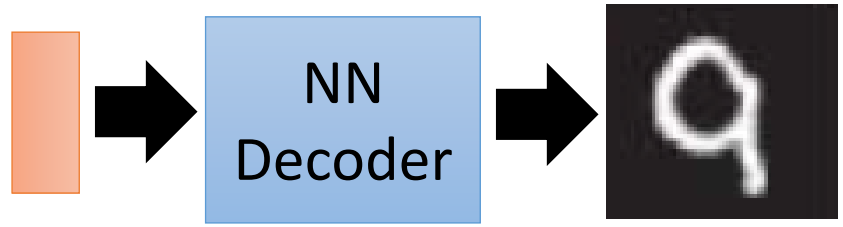
Learning More
- Restricted Boltzmann Machine

- Neural networks [5.1] : Restricted Boltzmann machine – definition
  - https://www.youtube.com/watch?v=p4Vh_zMw-HQ&index=36&list=PL6Xpj9I5qXYEcOhn7TqghAJ6NAPrNmUBH
- Neural networks [5.2] : Restricted Boltzmann machine – inference
  - 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

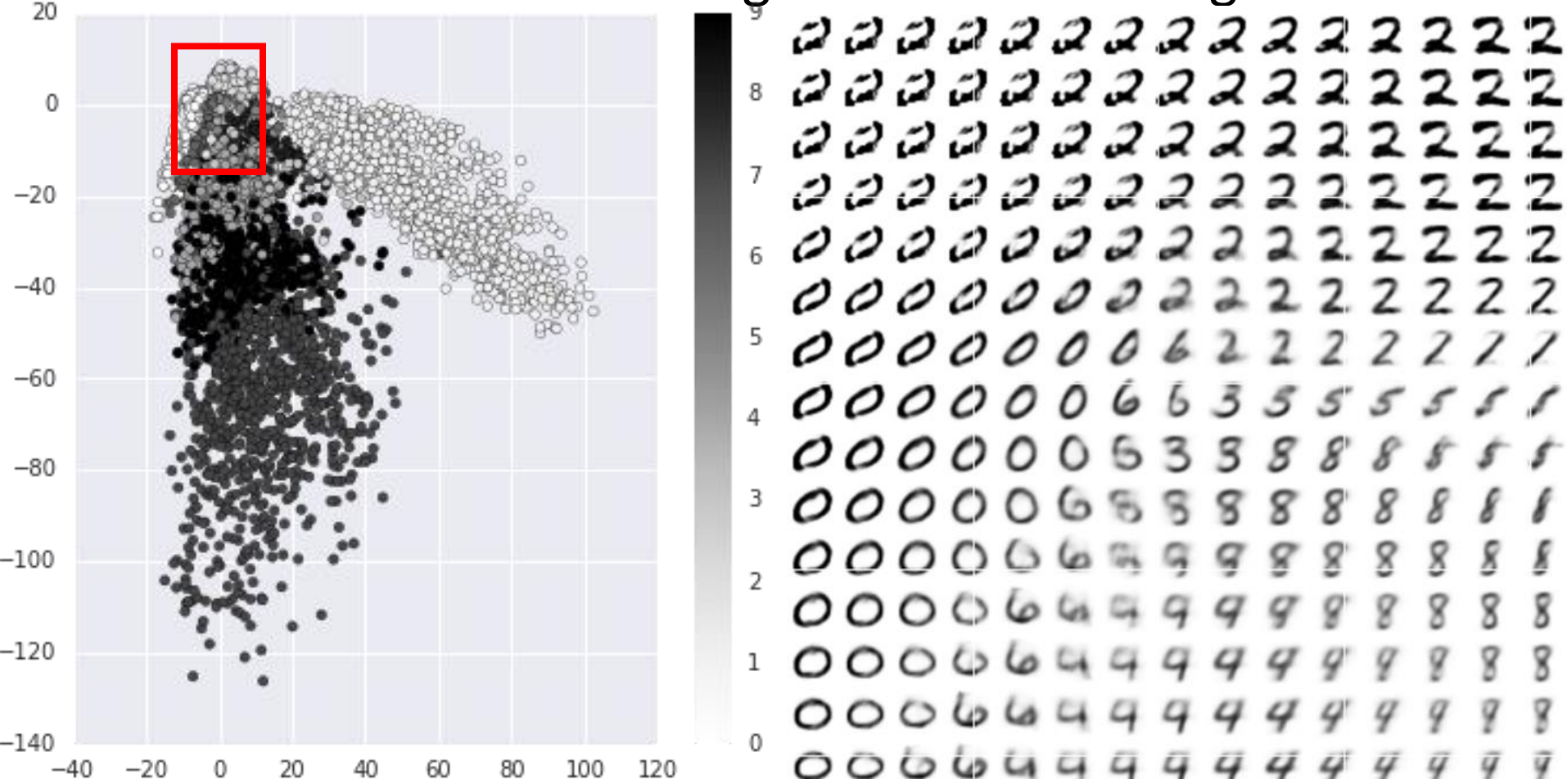
Learning More
- Deep Belief Network

- 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=35MUlYCColk&list=PL6Xpj9I5qXYEcOhn7TqghAJ6NAPrNmUBH&index=59

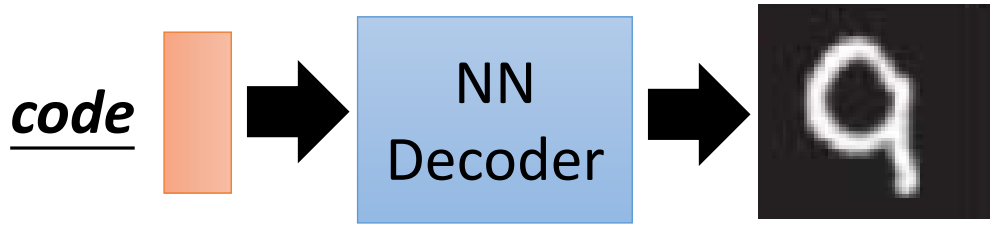
Next .....



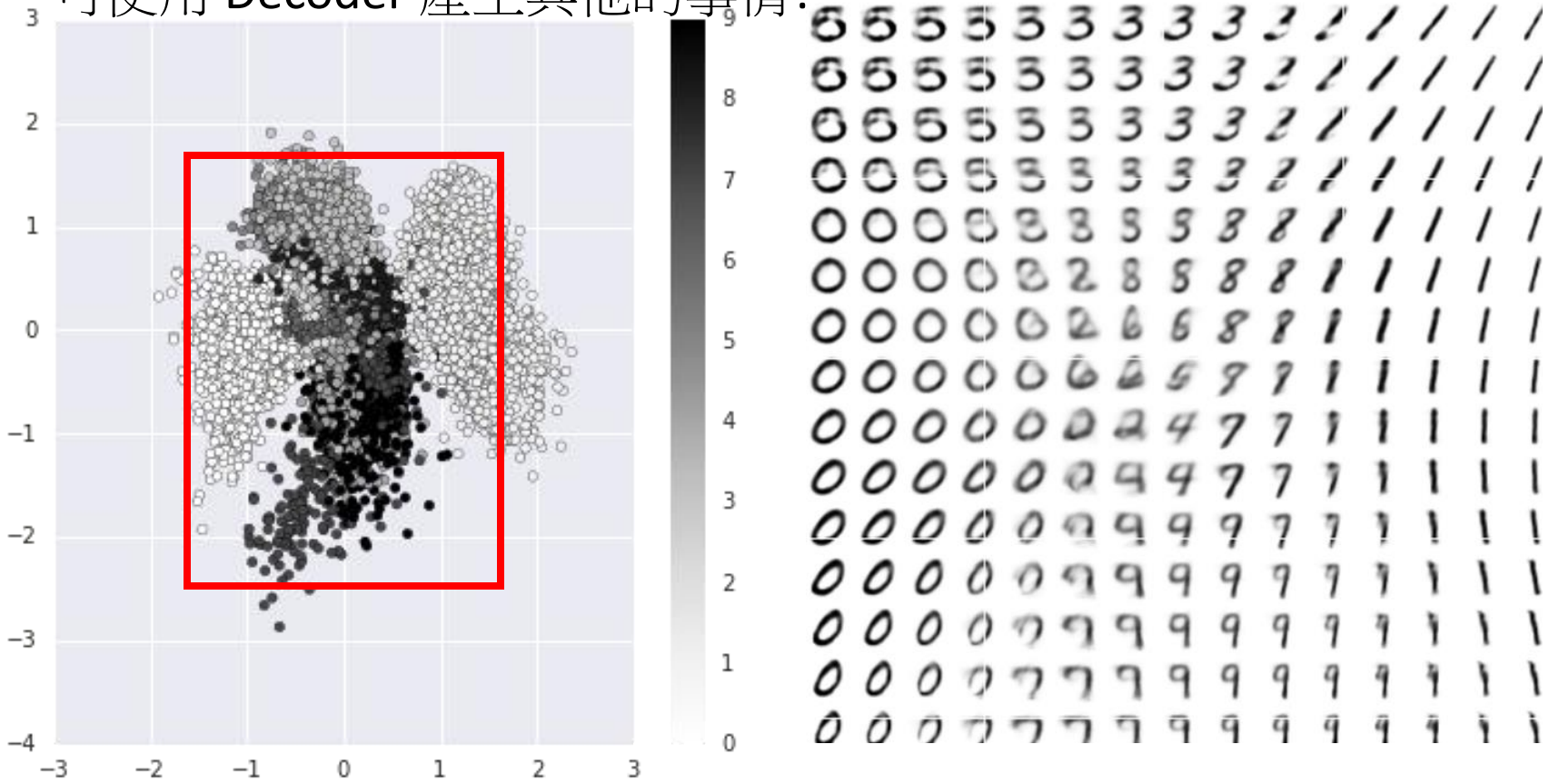
- Can we use decoder to generate something?



Next .....



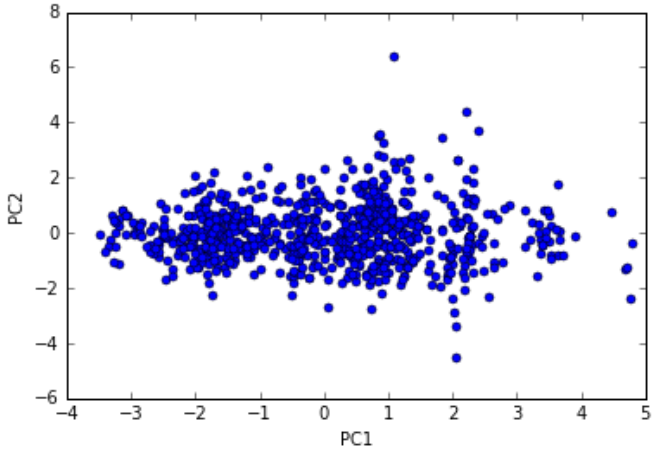
- Can we use decoder to generate something?
- 可使用 Decoder 產生其他的事情?

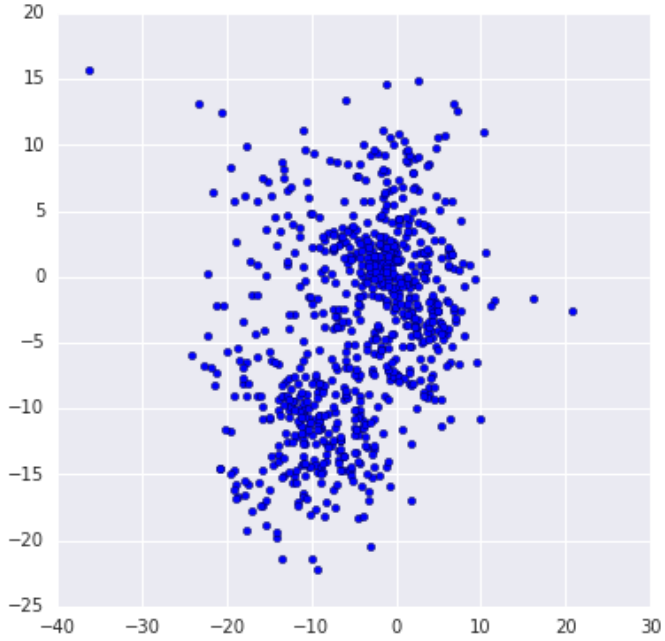


Appendix

Pokémon

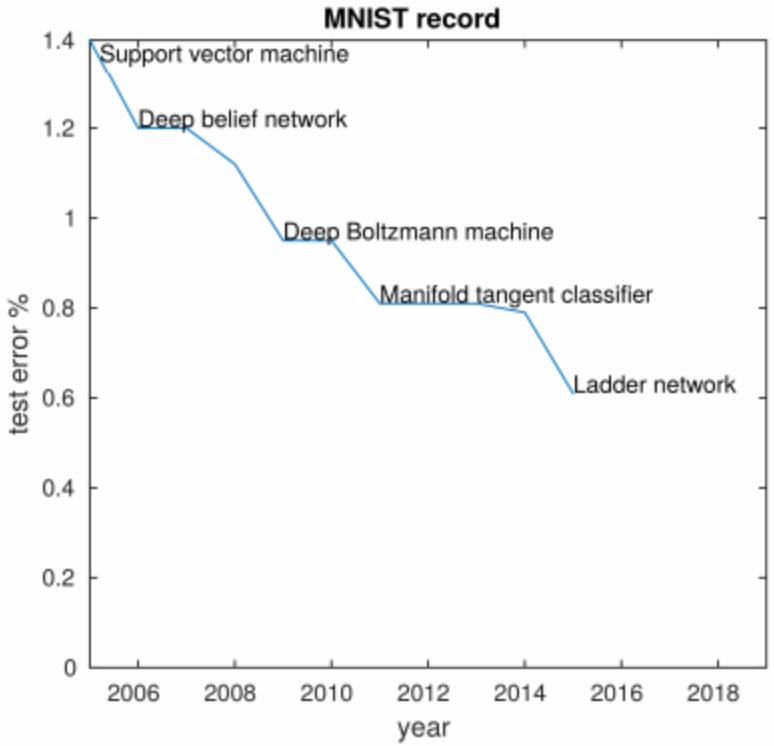
- http://140.112.21.35:2880/~tlkagk/pokemon/pca.html
- http://140.112.21.35:2880/~tlkagk/pokemon/auto.html
- The code is modified from
  - http://jkunst.com/r/pokemon-visualize-em-all/





Add: Ladder Network

- http://rinuboney.github.io/2016/01/19/ladder-network.html
- https://mycourses.aalto.fi/pluginfile.php/146701/mod_resource/content/1/08%20semisup%20ladder.pdf
- https://arxiv.org/abs/1507.02672



Yearly progress in permutation-invariant MNIST.

A. Rasmus, H. Valpola, M. Honkala, M. Berglund, and T. Raiko.

Semi-Supervised Learning with Ladder Network. To appear in NIPS 2015.