

Auto Encoder (AE)

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

自编码器 Autoencoder, AE

- AE的诞生并非为了生成，而是为了无监督的表示学习（Representation Learning）与降维
- 深度学习早期，如何有效初始化一个深度网络是一个难题。AE通过一个“先压缩、后解压”的自监督任务，强迫网络学习数据中最重要的、最本质的特征，其核心目标是最小化重建误差，得到一个紧凑的编码（code）

AE概述

➤ 关键假设与前提

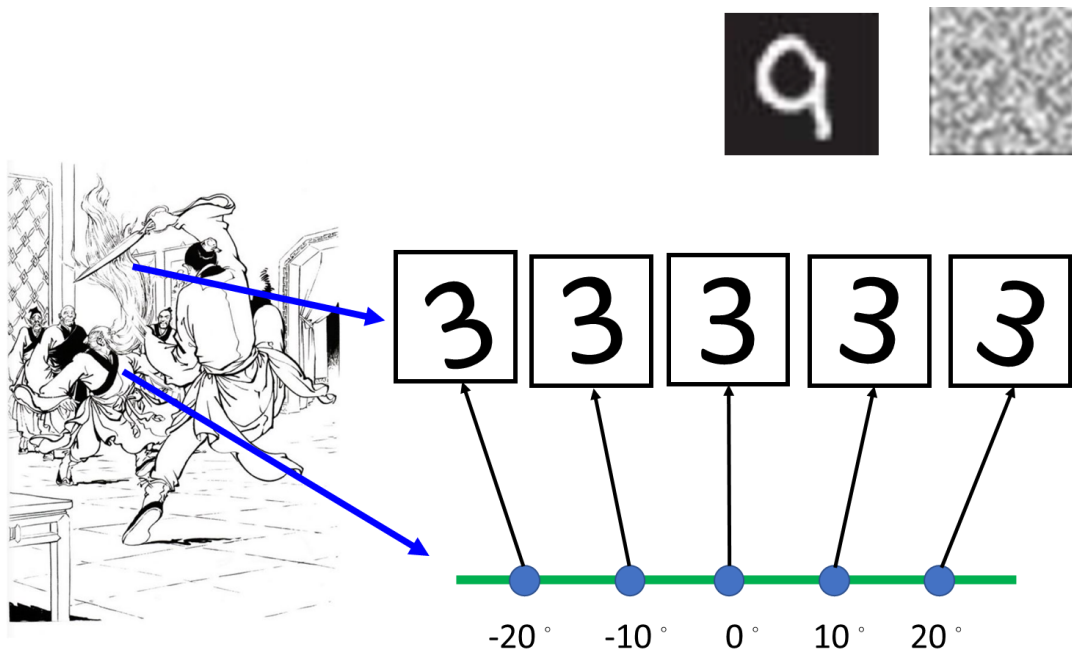
流形假设（Manifold Hypothesis）：即高维数据（如图片）实际上分布在一个低维的内在流形上。AE的目标就是找到这个流形的一个（非线性）坐标系

➤ AE存在缺陷，使其无法胜任真正的生成任务

➤ 潜在空间的“空洞”问题：AE的潜在空间 z 是不连续、无组织的。编码器只学会了如何将训练样本映射到空间中的一些孤立点上。如果你在两个编码点之间进行插值，解码器很可能生成毫无意义的、混乱的图像。因为它从未见过这些“无人区”的编码。AE的潜在空间没有被强制学习一个良好的概率结构

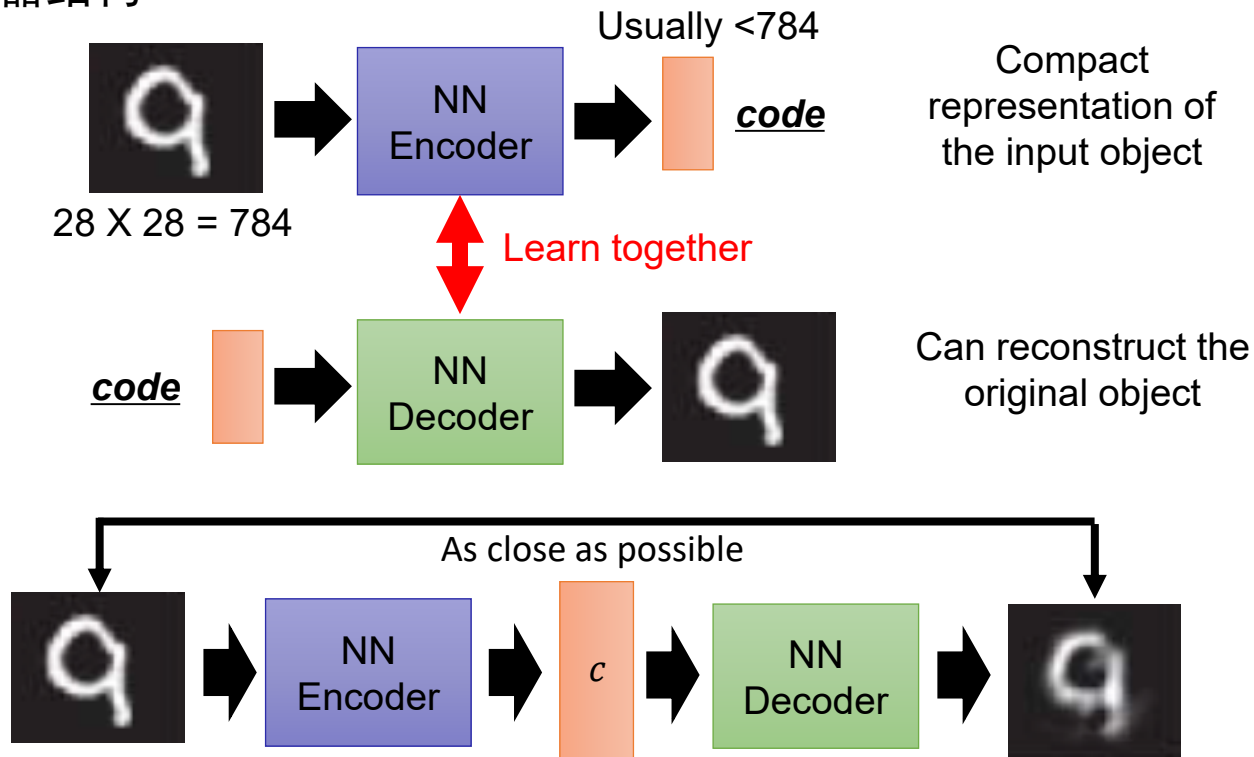
Motivation

- In MNIST, a digit is 28 x 28 dims
- Most 28 x 28 dim vectors are not digits



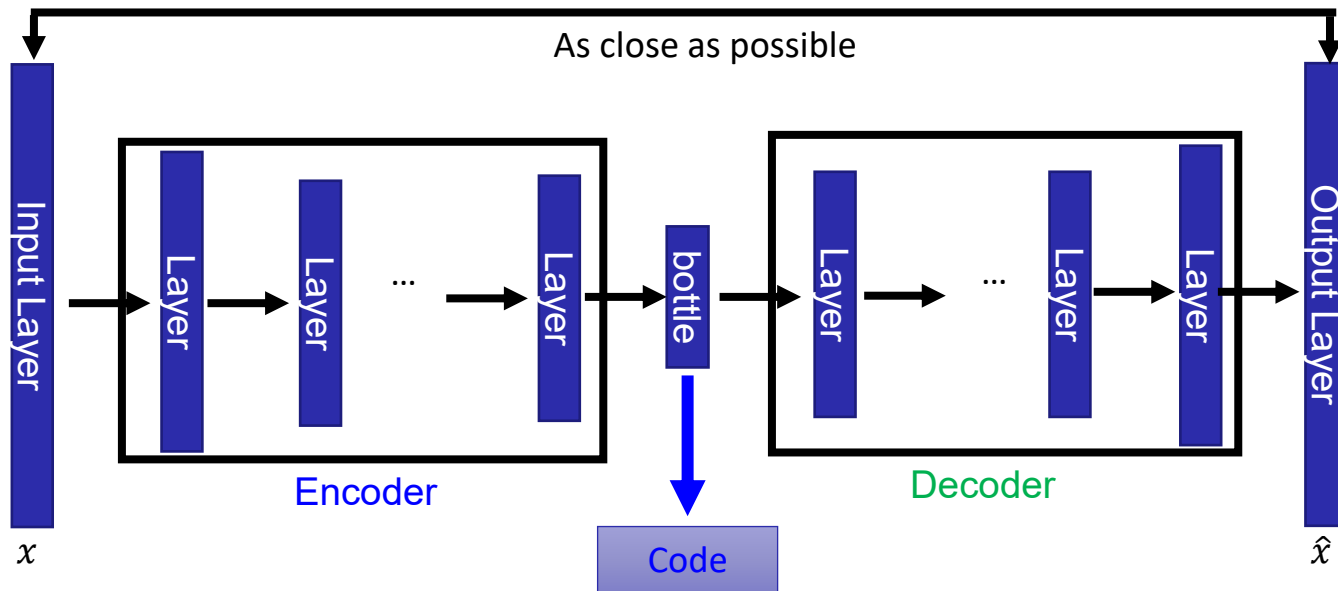
Auto-encoder

➤ 编码器-解码器结构



Deep Auto-encoder

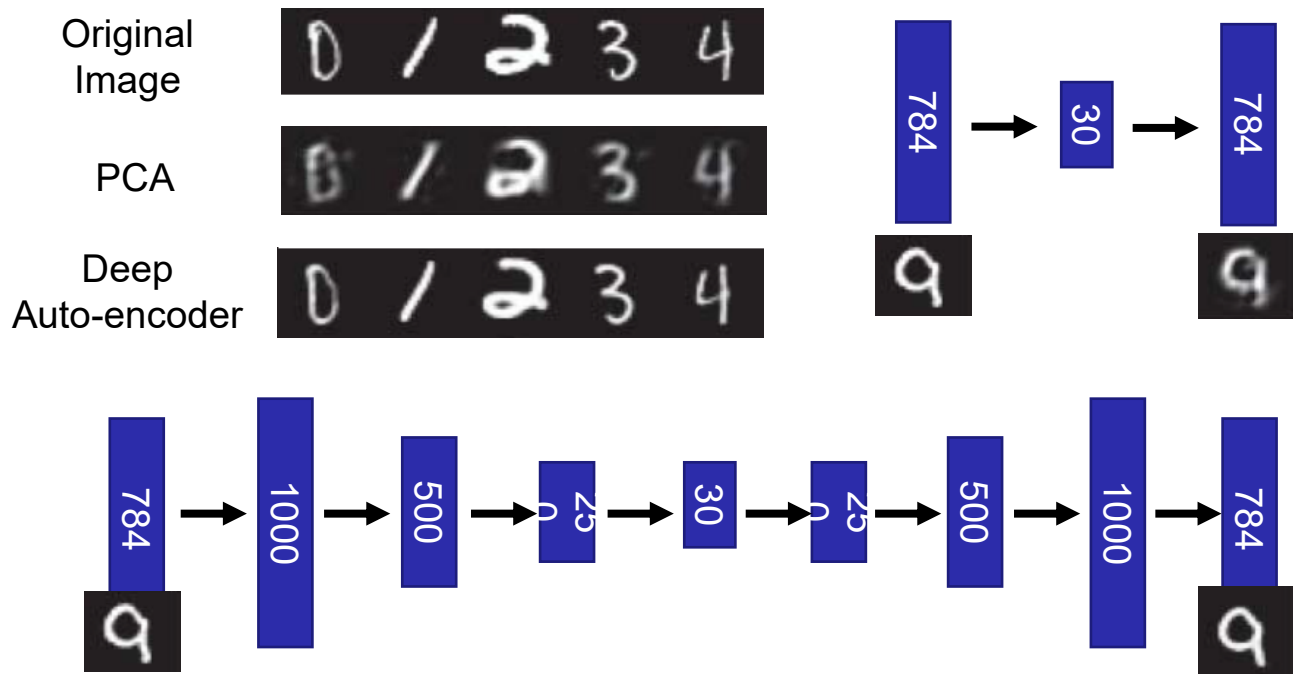
- NN encoder + NN decoder = a deep network

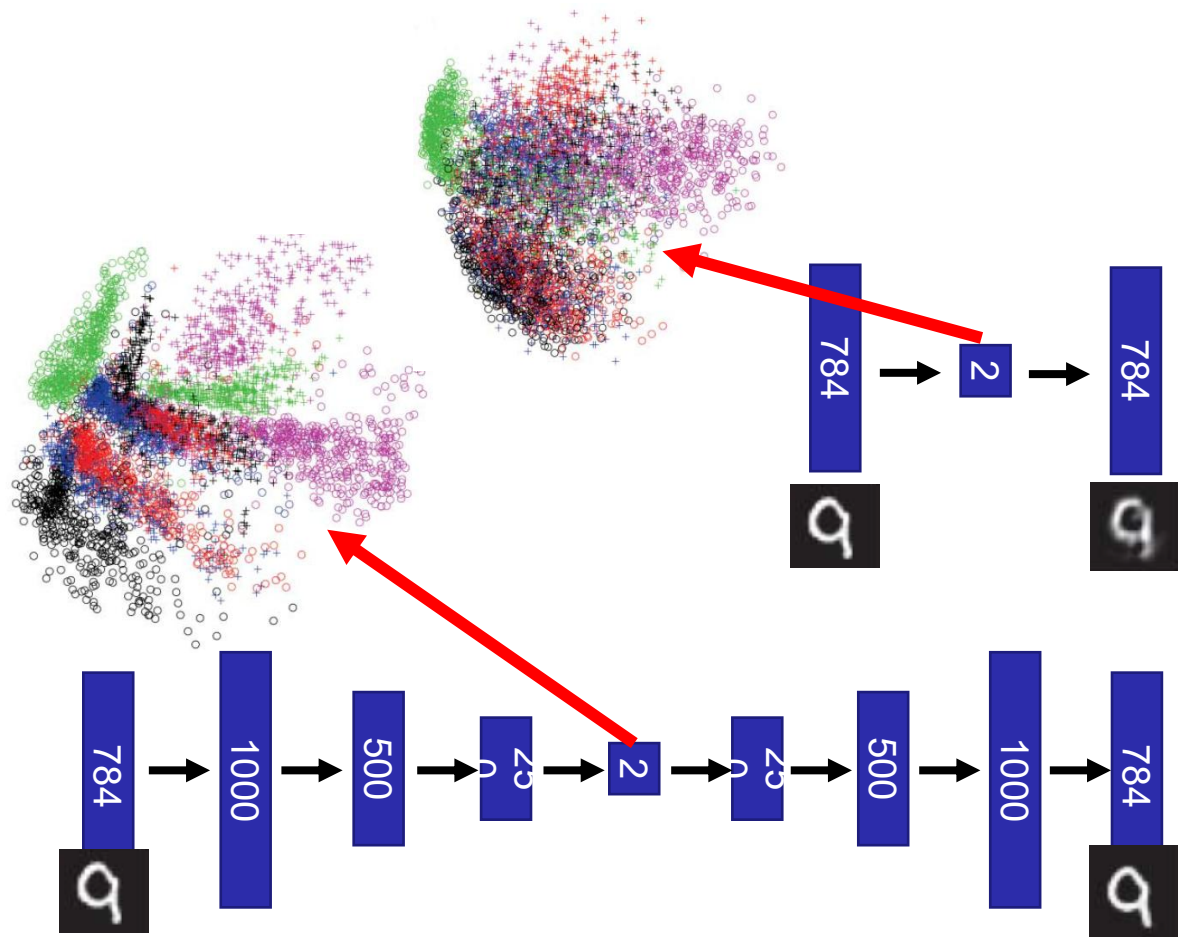


Reference: Hinton, Geoffrey E., and Ruslan R. Salakhutdinov. "Reducing the dimensionality of data with neural networks." *Science* 313.5786 (2006): 504-507

Deep Auto-encoder

➤ 和PCA比较



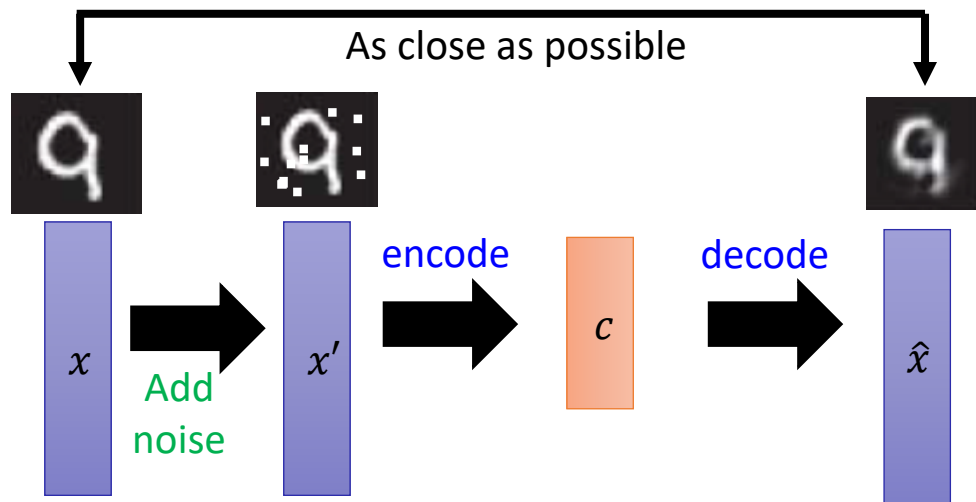


Auto-encoder

➤ De-noising auto-encoder

More: Contractive auto-encoder

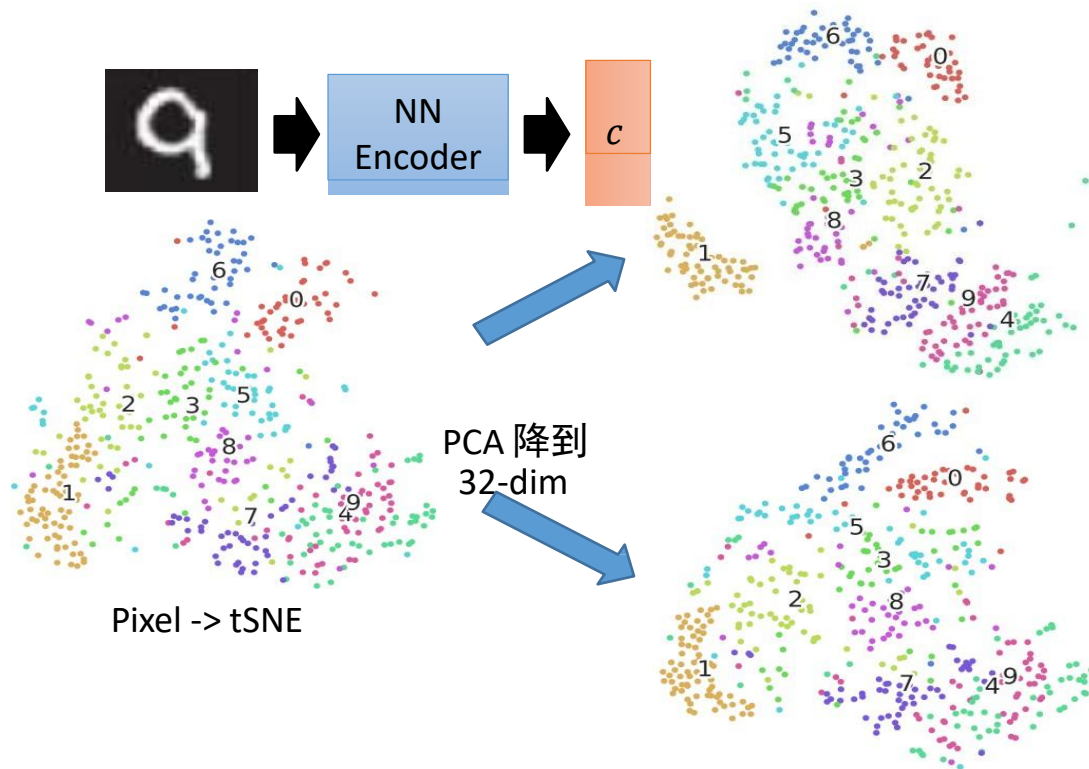
Ref: Rifai, Salah, et al. "Contractive auto-encoders: Explicit invariance during feature extraction." *Proceedings of the 28th International Conference on Machine Learning (ICML-11)*. 2011.



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

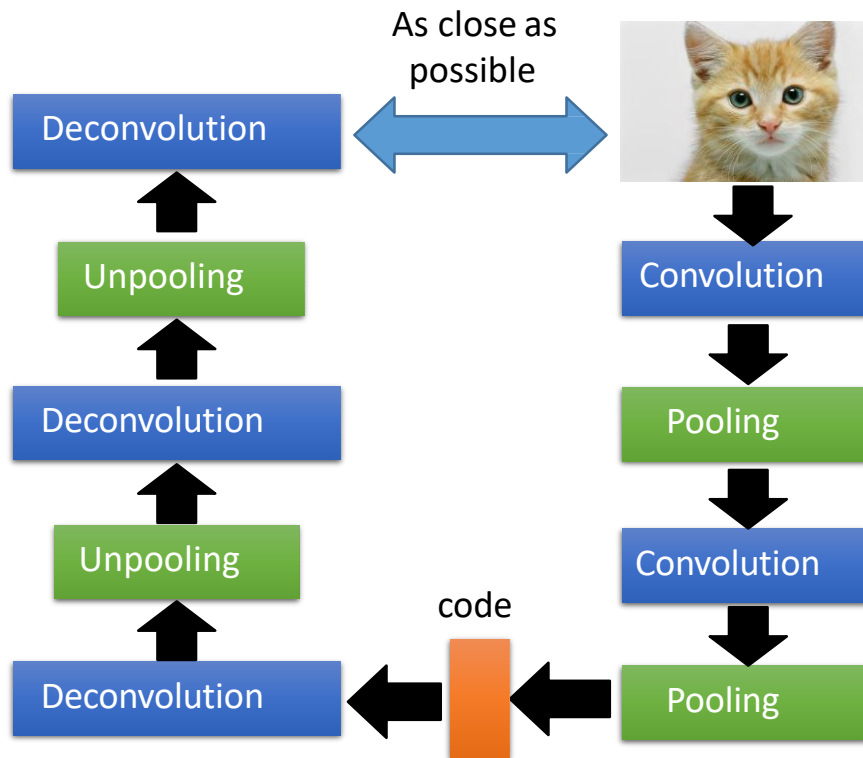
Deep Auto-encoder - Example

➤ 手写体数字分类



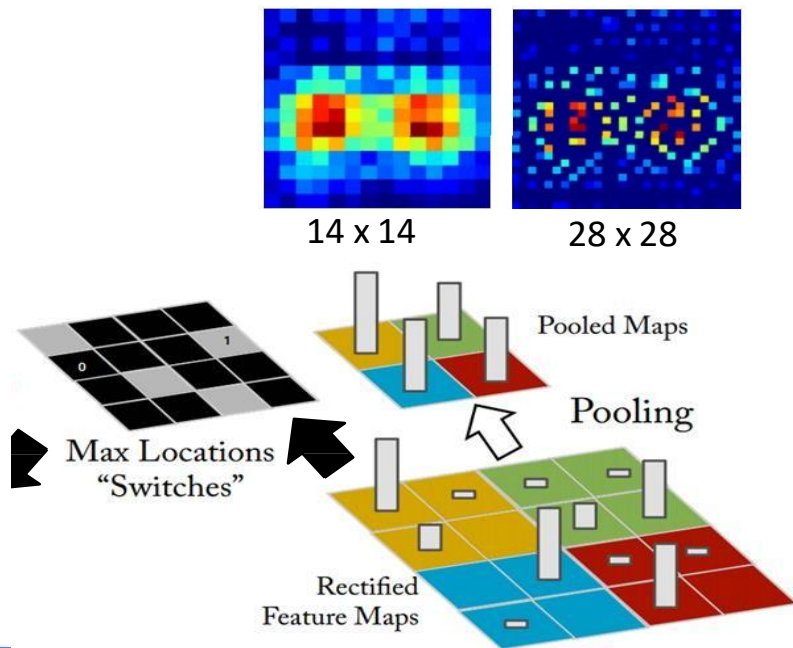
Auto-encoder for CNN

➤ 用CNN进行编码



CNN-Unpooling

➤ Pooling需要记住位置



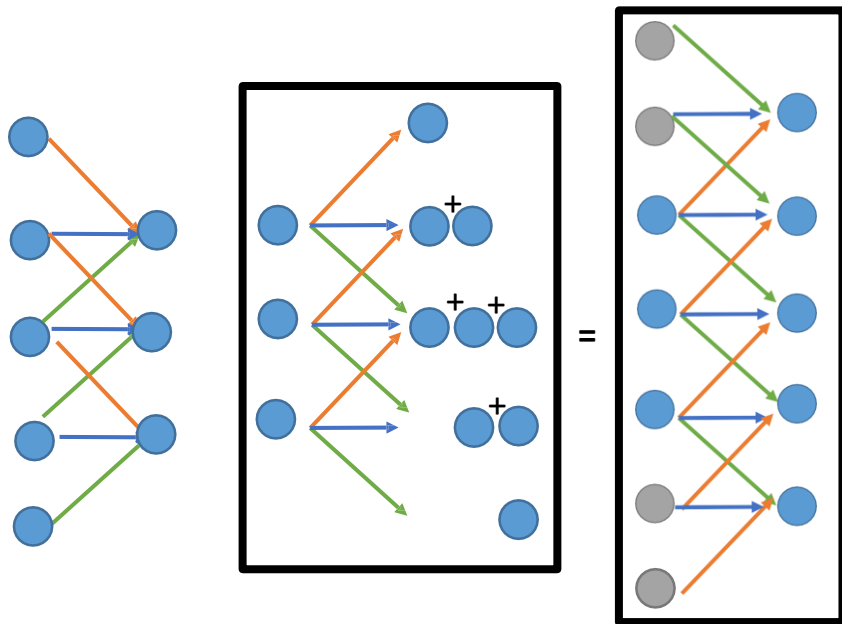
Alternative: simply
repeat the values

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

CNN-Deconvolution

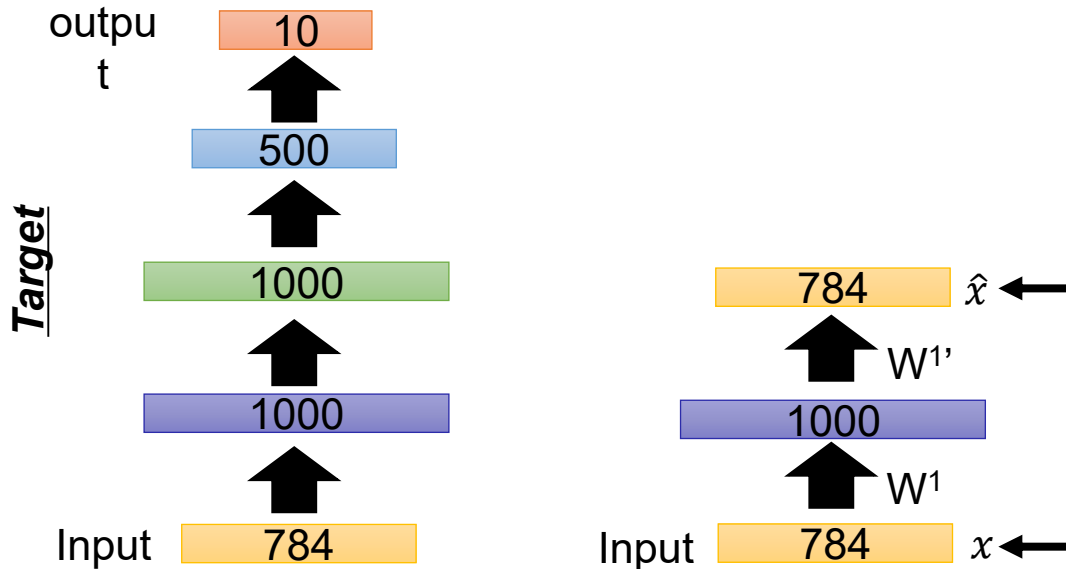
➤ Deconvolution 就是 convolution

Actually, deconvolution is convolution.



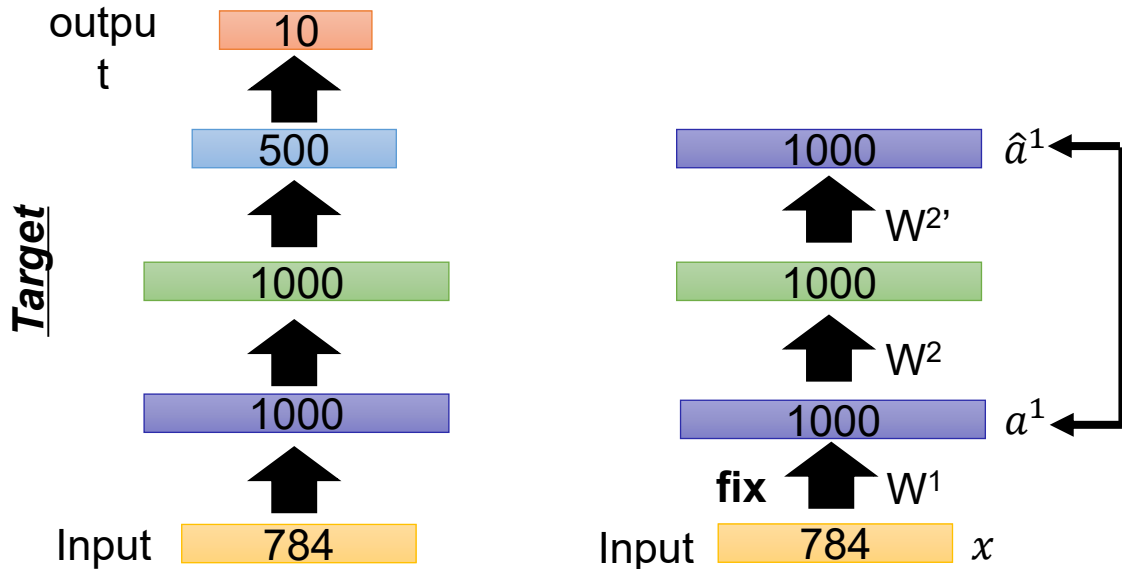
Auto-encoder – Pre-training DNN

- Greedy Layer-wise Pre-training again



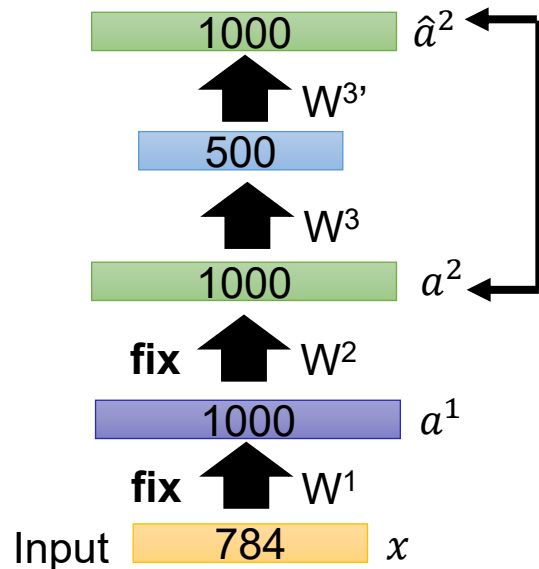
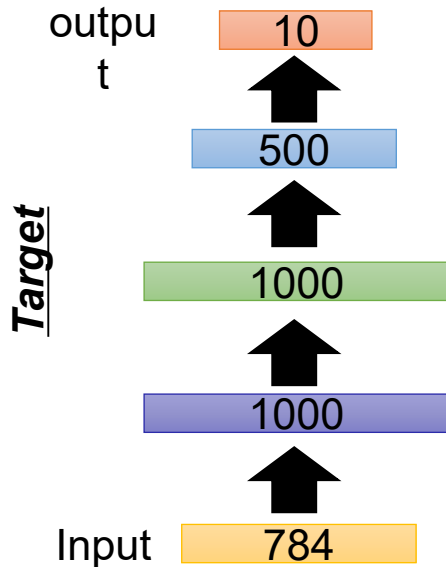
Auto-encoder – Pre-training DNN

- Greedy Layer-wise Pre-training again



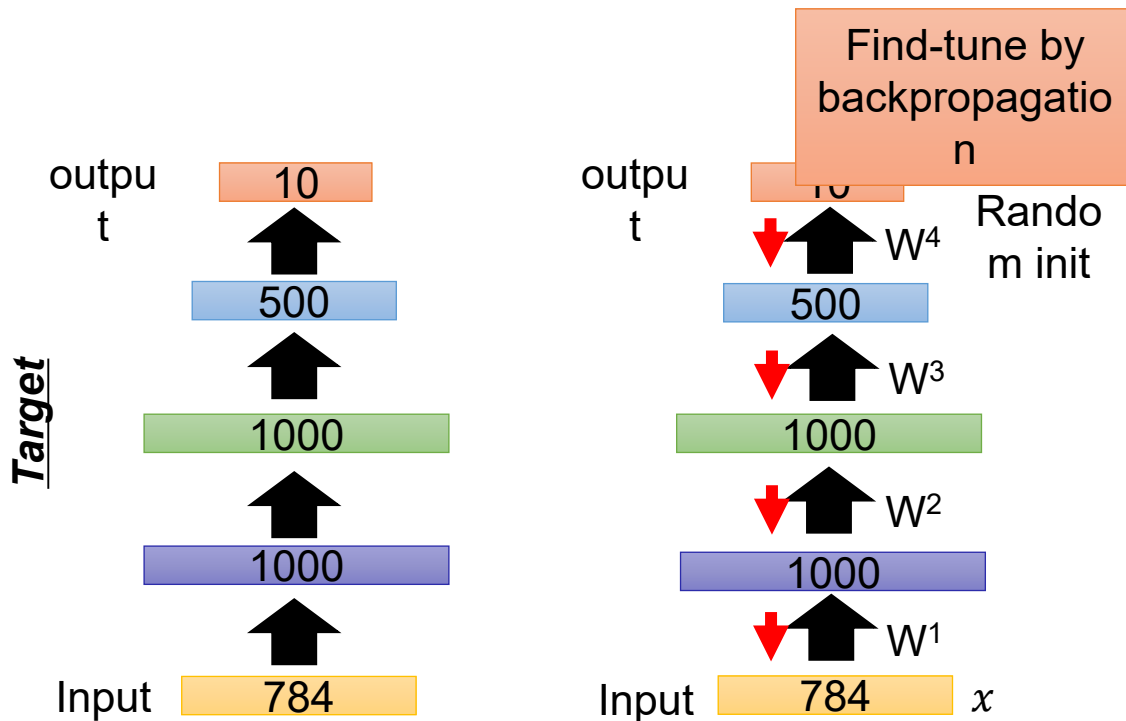
Auto-encoder – Pre-training DNN

- Greedy Layer-wise Pre-training again



Auto-encoder – Pre-training DNN

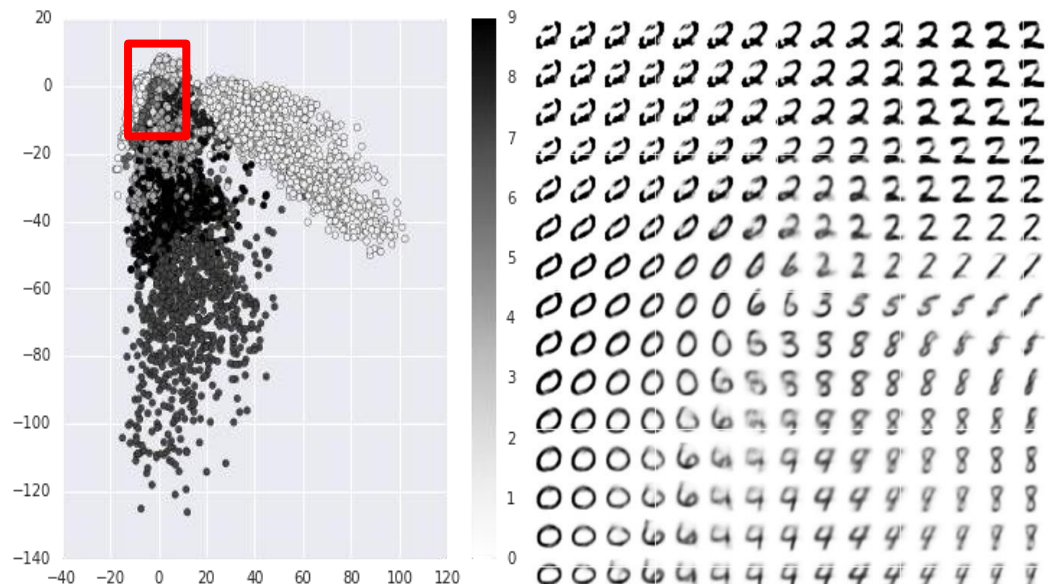
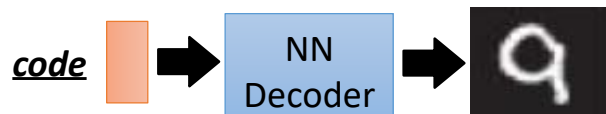
- Greedy Layer-wise Pre-training again



AE is not enough

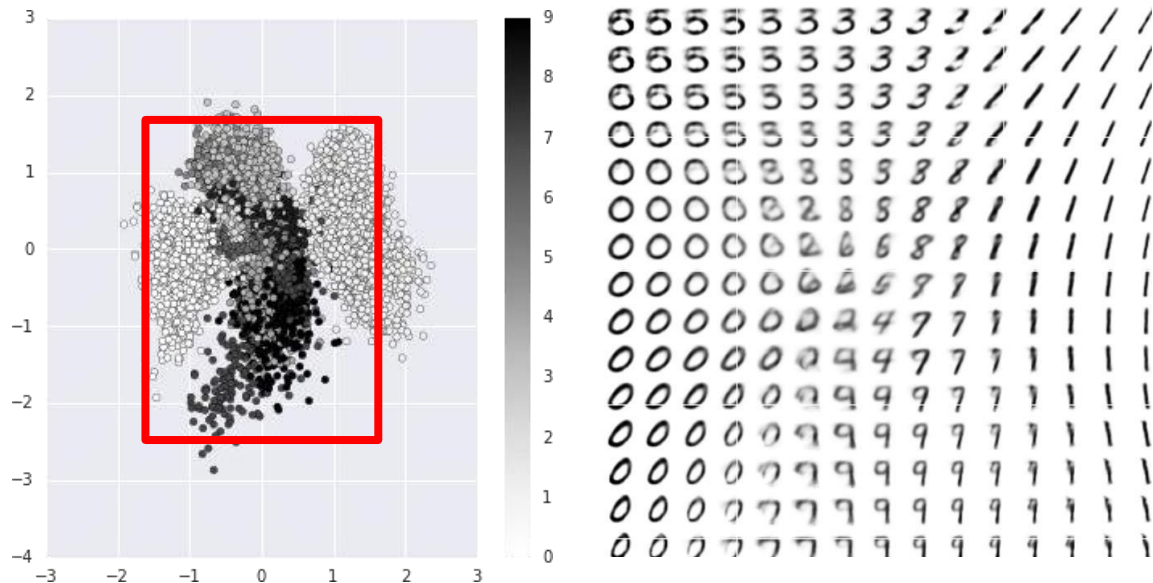
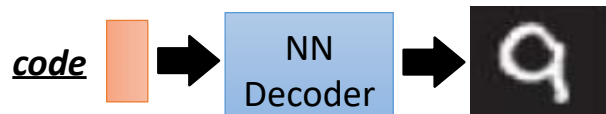
Next

➤ Can we use decoder to generate something?

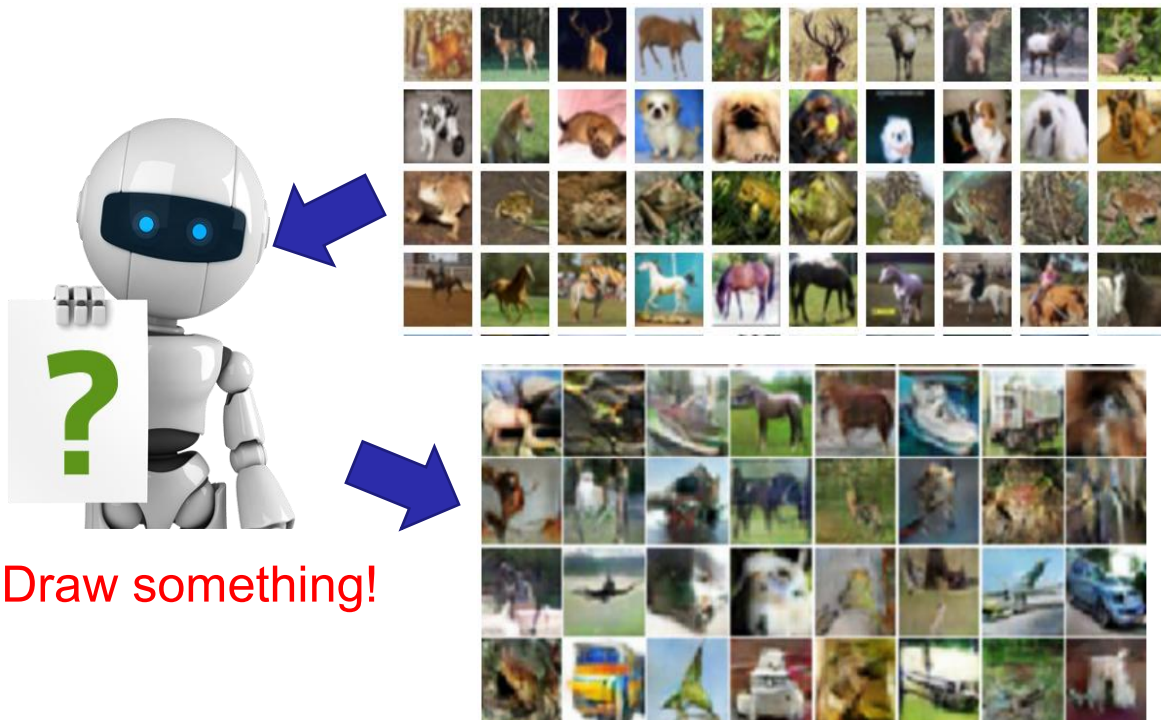


Next

➤ Can we use decoder to generate something?

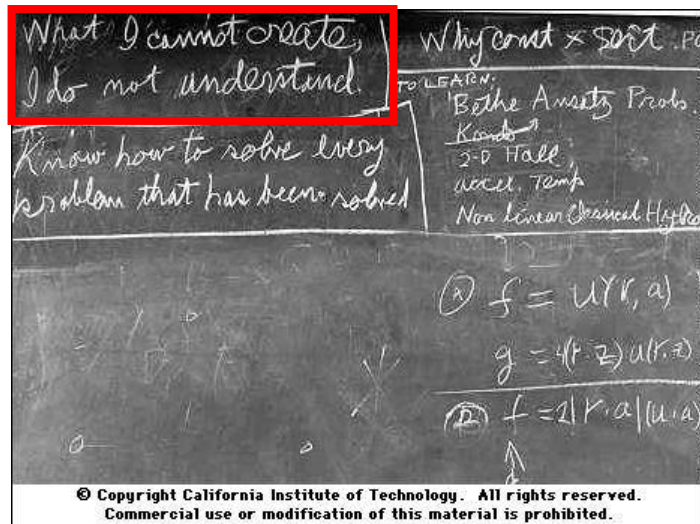


Creation



Creation

➤ Generative Models: <https://openai.com/blog/generative-models/>

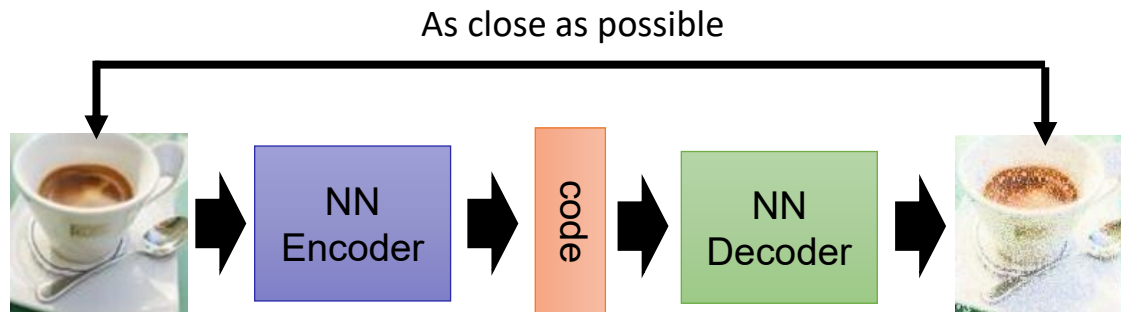


What I cannot create, I do not understand.

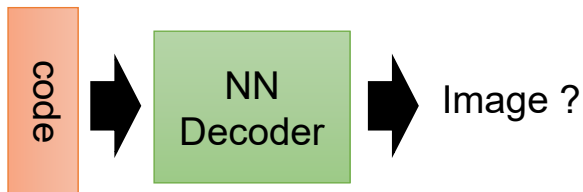
Richard Feynman

<https://www.quora.com/What-did-Richard-Feynman-mean-when-he-said-What-I-cannot-create-I-do-not-understand>

Auto-encoder



Randomly generate a
vector as code



Variation Auto-encoder (VAE)

Ref: Auto-Encoding Variational Bayes, <https://arxiv.org/abs/1312.6114>

Why VAE?

➤ code插值再解码

Intuitive Reason

