AUTO-ENCODER

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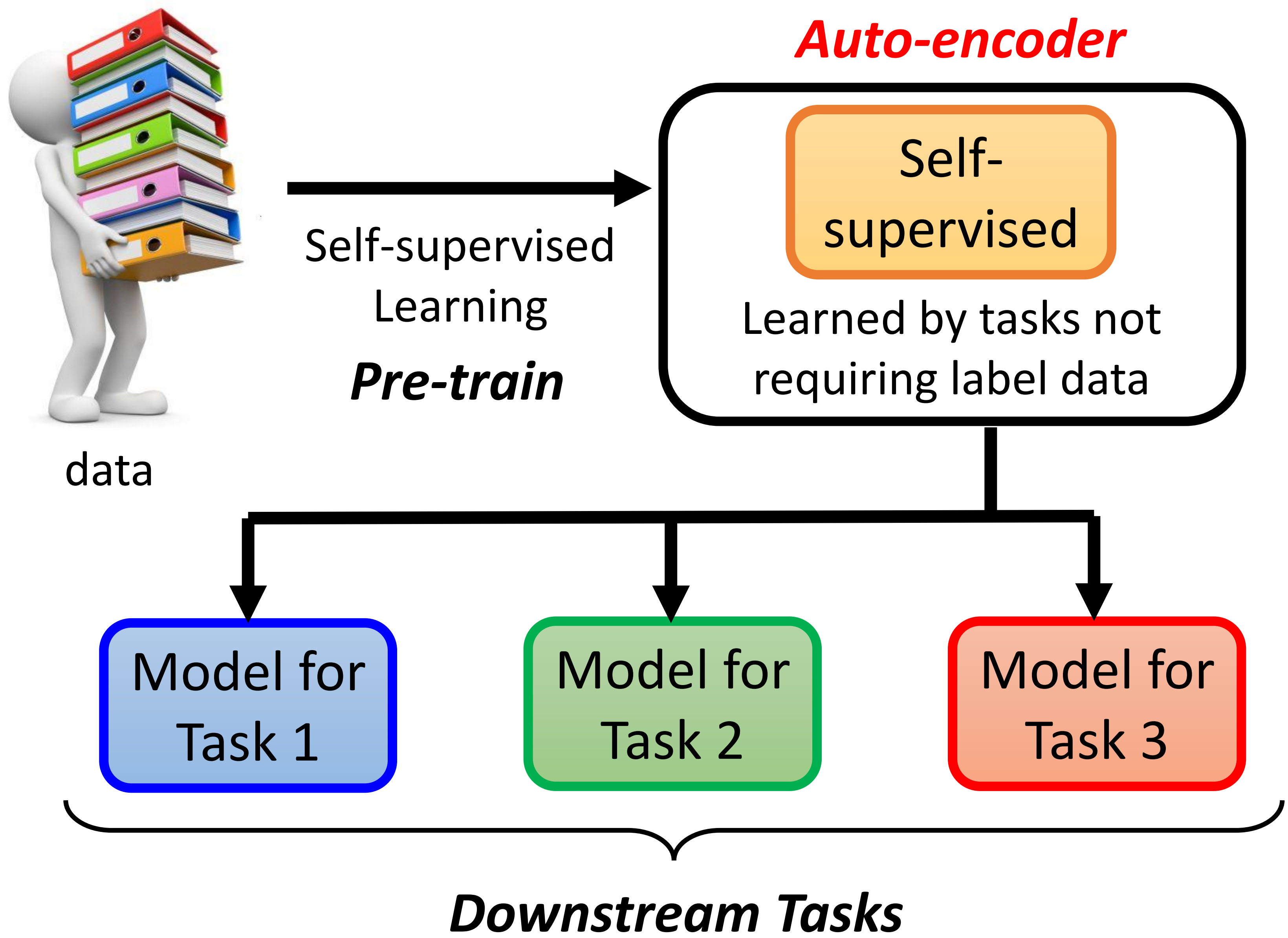
Self-supervised Learning Framework



Outline

- Basic Idea of Auto-encoder
- Feature Disentanglement
- Discrete Latent Representation
- More Applications

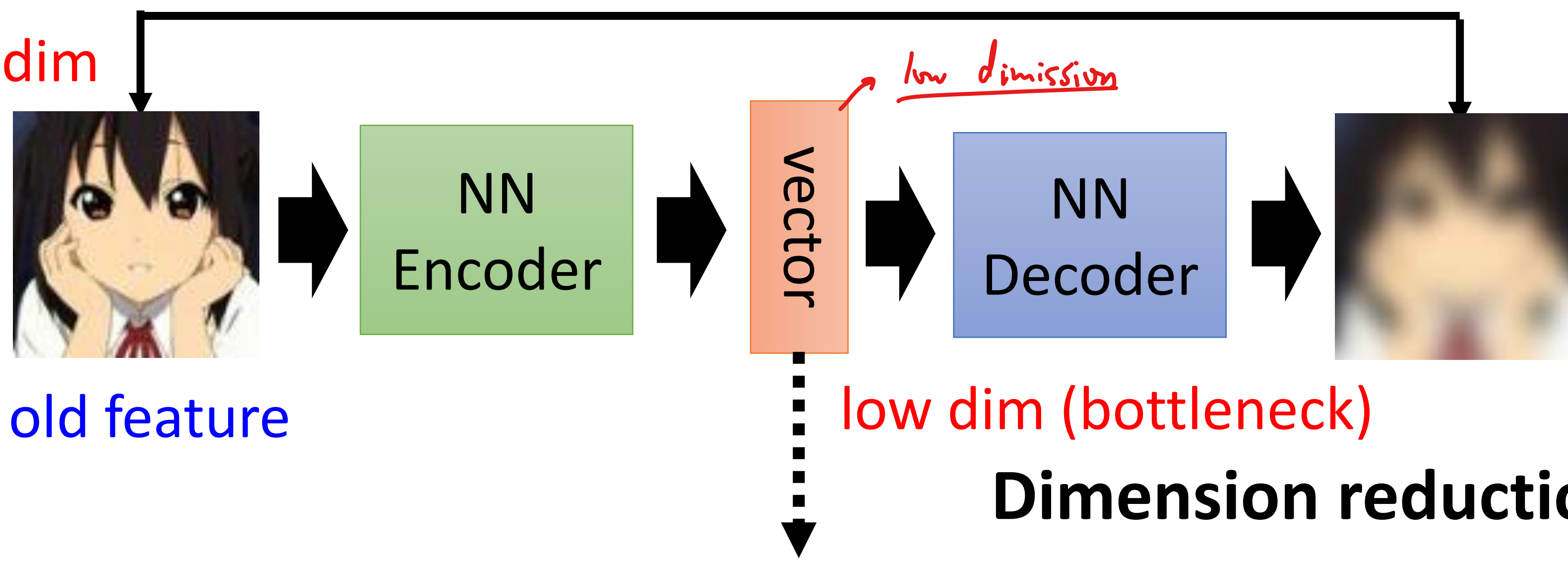
Auto-encoder

Unlabeled Images

Sounds familiar? We have seen the same idea in Cycle GAN. ☺

As close as possible (reconstruction)

high dim



old feature

low dim (bottleneck)

Dimension reduction

Embedding, Representation, Code

New feature for downstream tasks

More Dimension Reduction

(not based on deep learning)

https://youtu.be/iwh5o_M4BNU

PCA

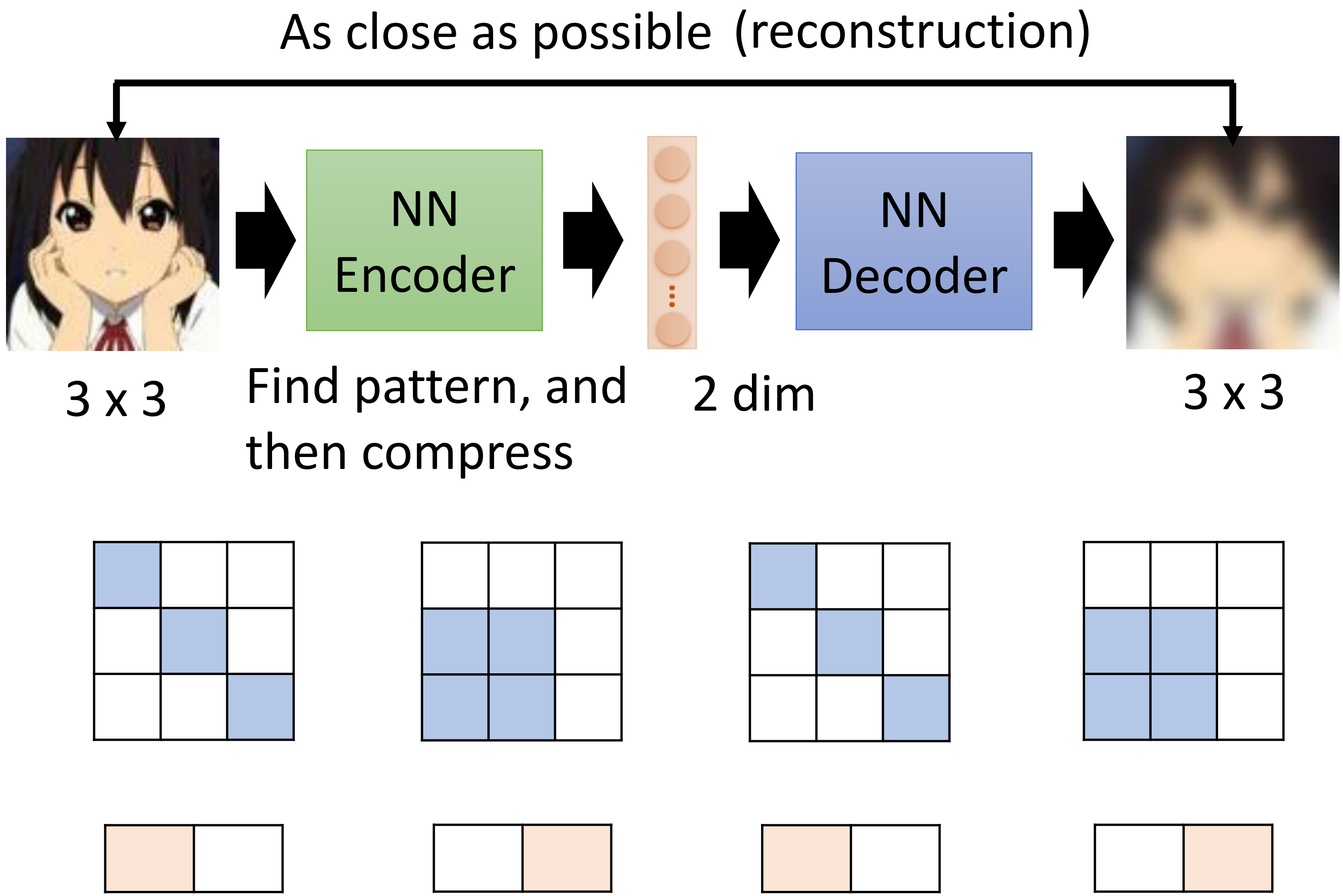
https://youtu.be/GBUEjkpoxXc

t-SNE

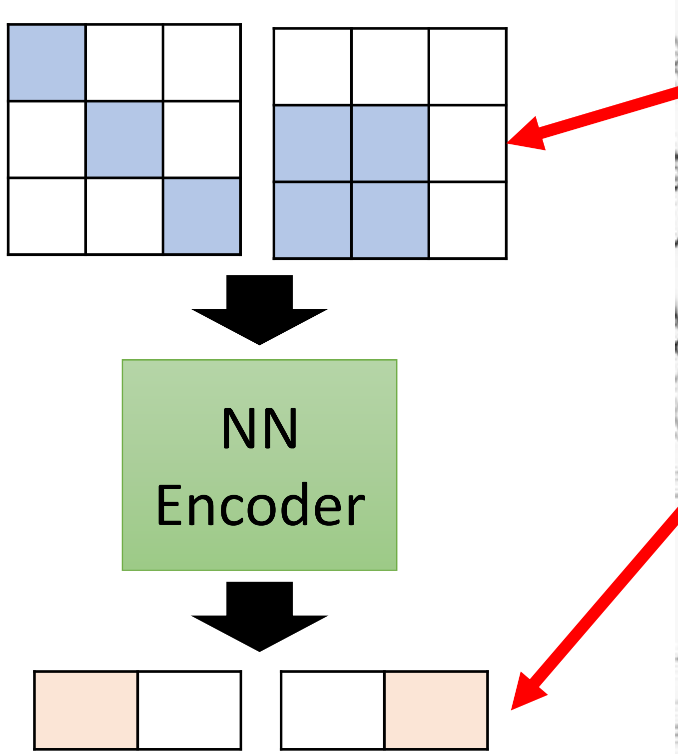
Why Auto-encoder?

《神鵰俠侶》

Why Auto-encoder?

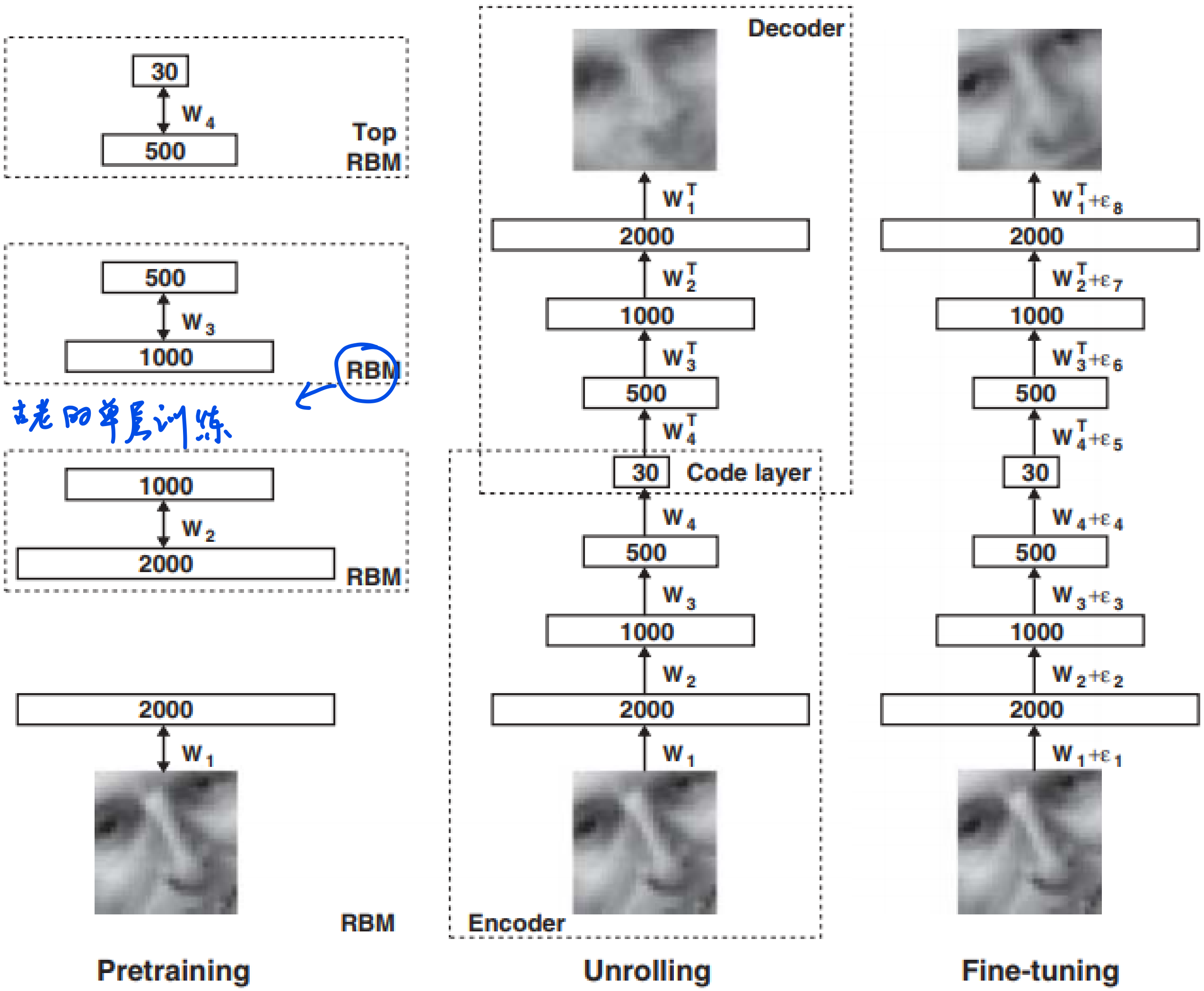


Why Auto-encoder?

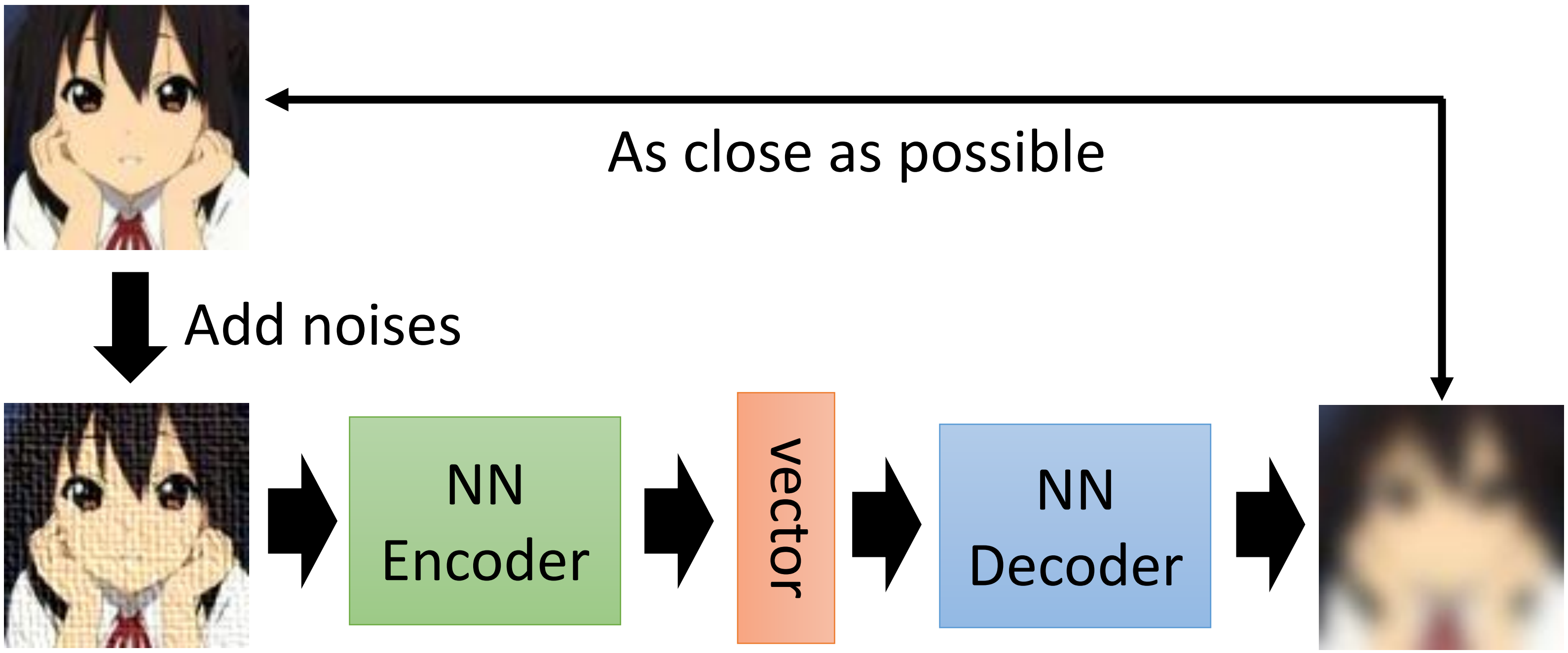


Auto-encoder is not a new idea

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



De-noising Auto-encoder

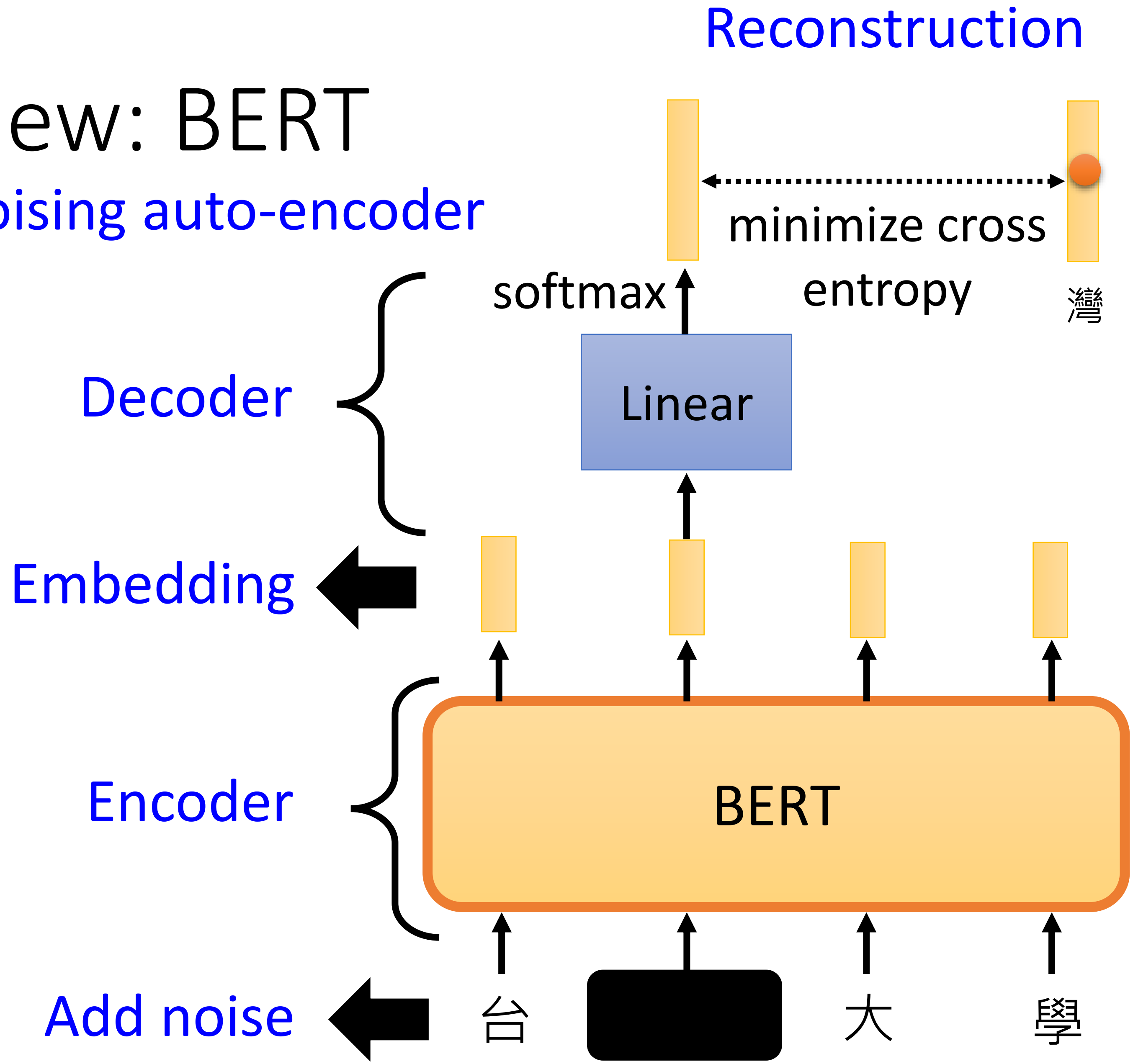


The idea sounds familiar? ☺

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

Review: BERT

A de-noising auto-encoder



Outline

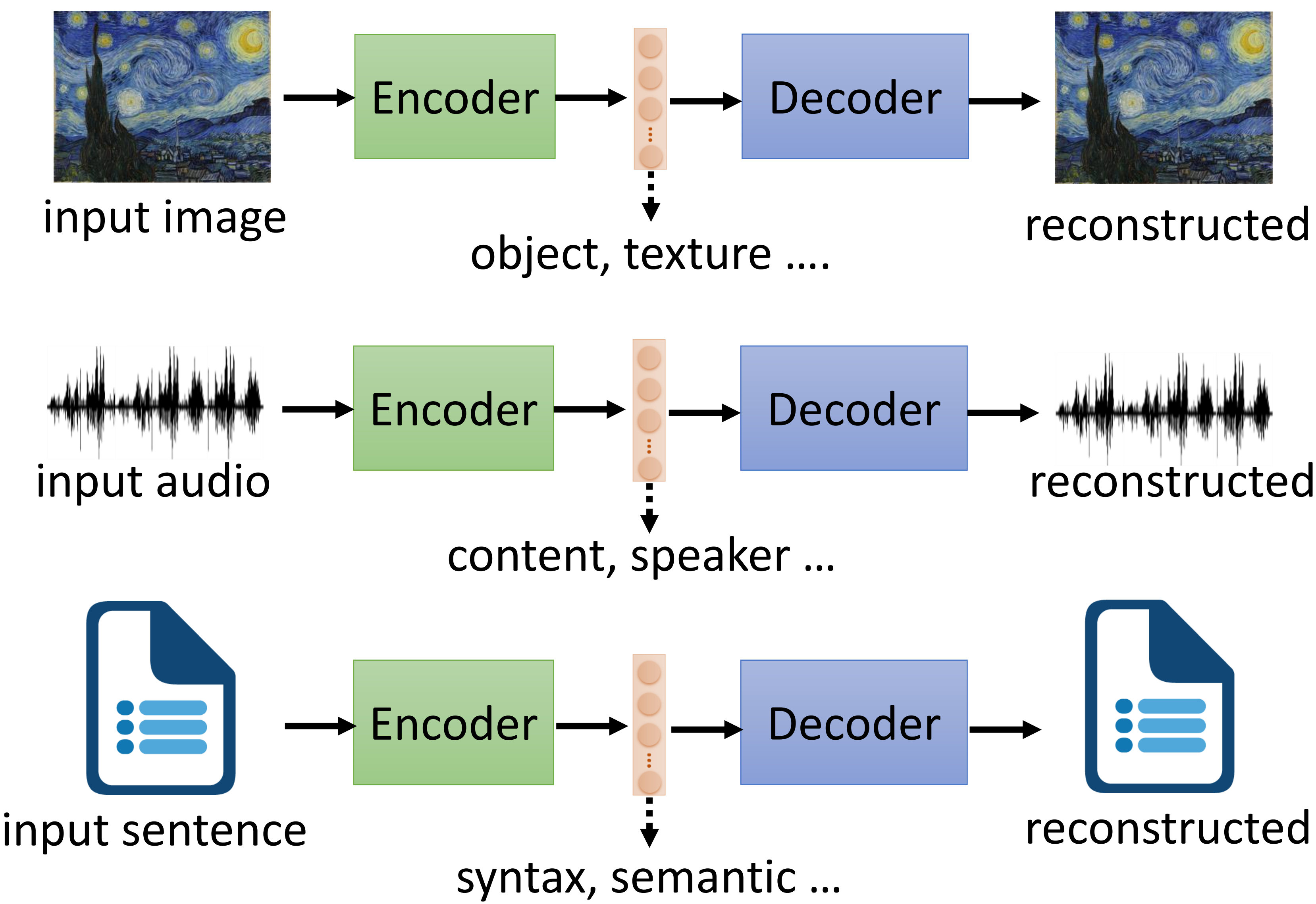
Basic Idea of Auto-encoder

Feature Disentanglement 分开

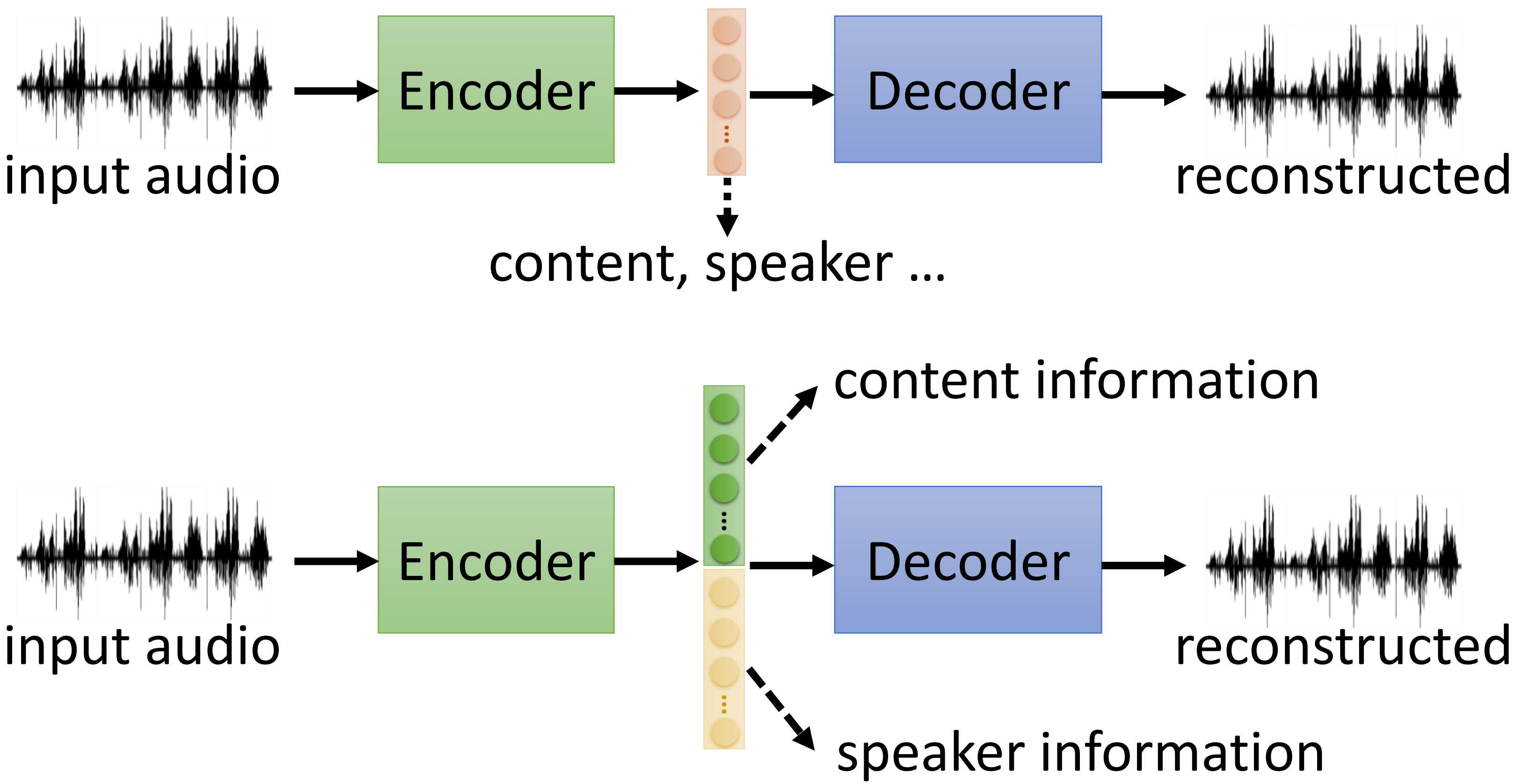
Discrete Latent Representation

More Applications

Representation includes information of different aspects



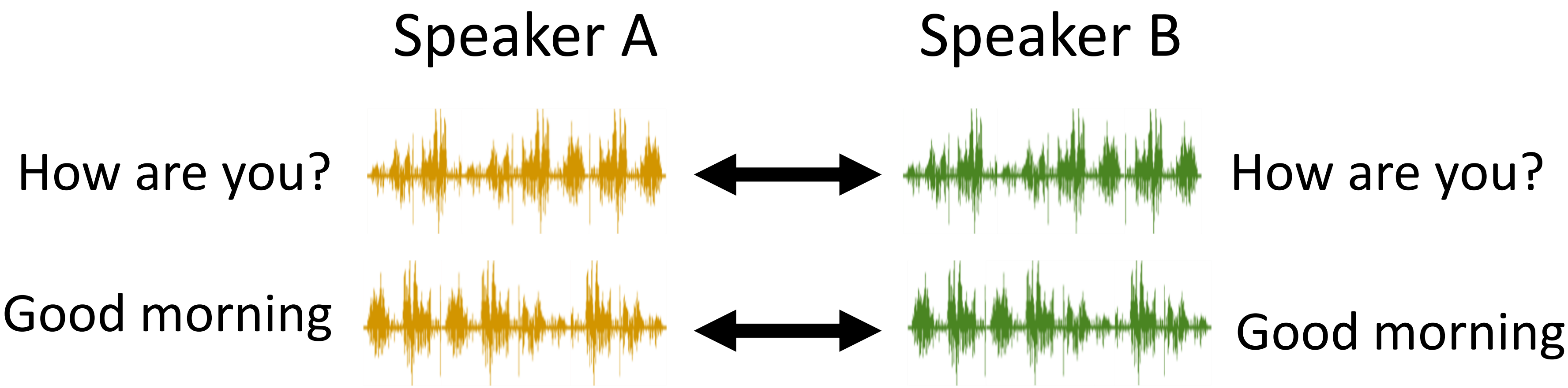
Feature Disentangle



https://arxiv.org/abs/1904.05742
https://arxiv.org/abs/1804.02812
https://arxiv.org/abs/1905.05879

Application: Voice Conversion

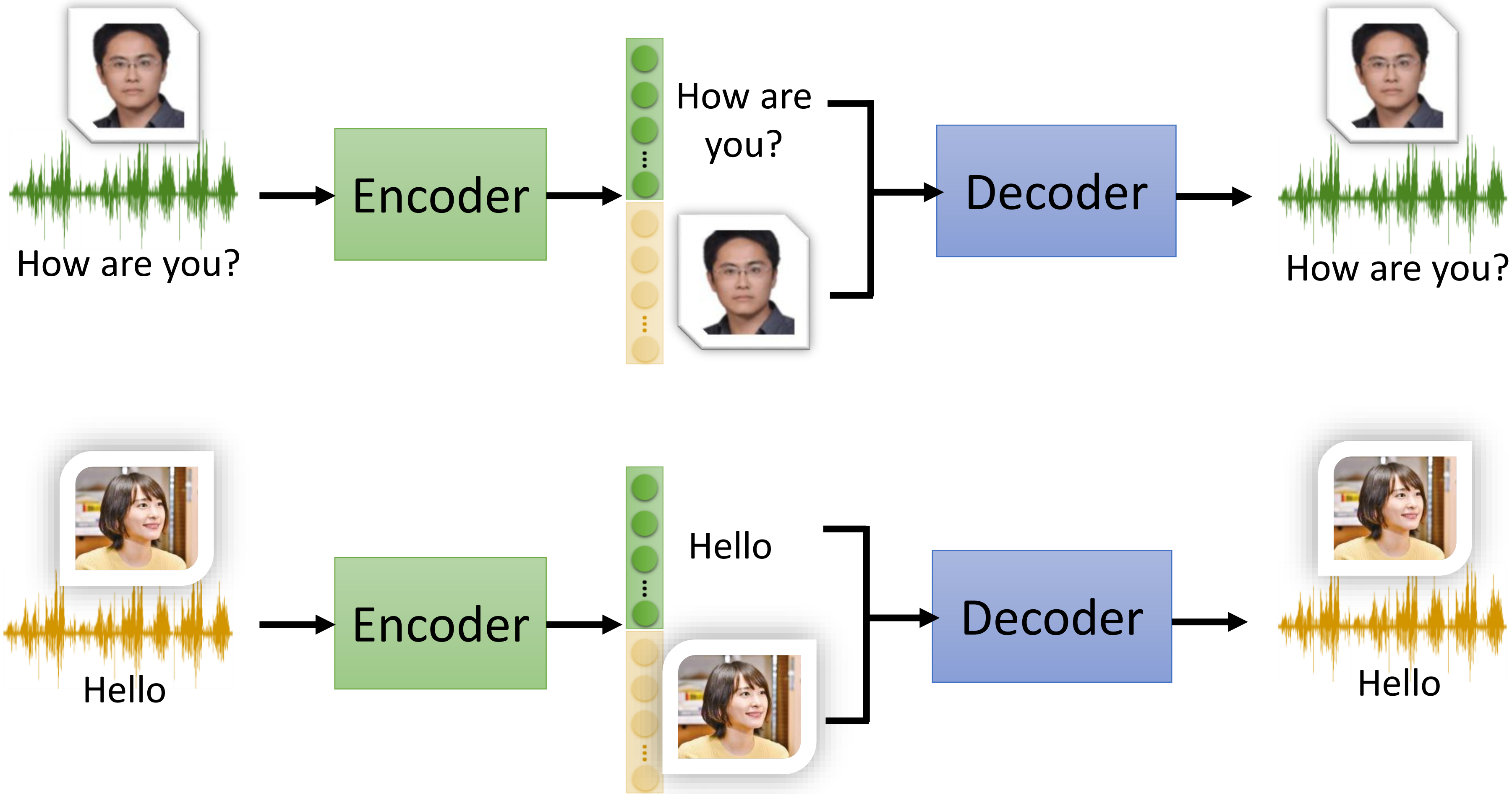
In the past



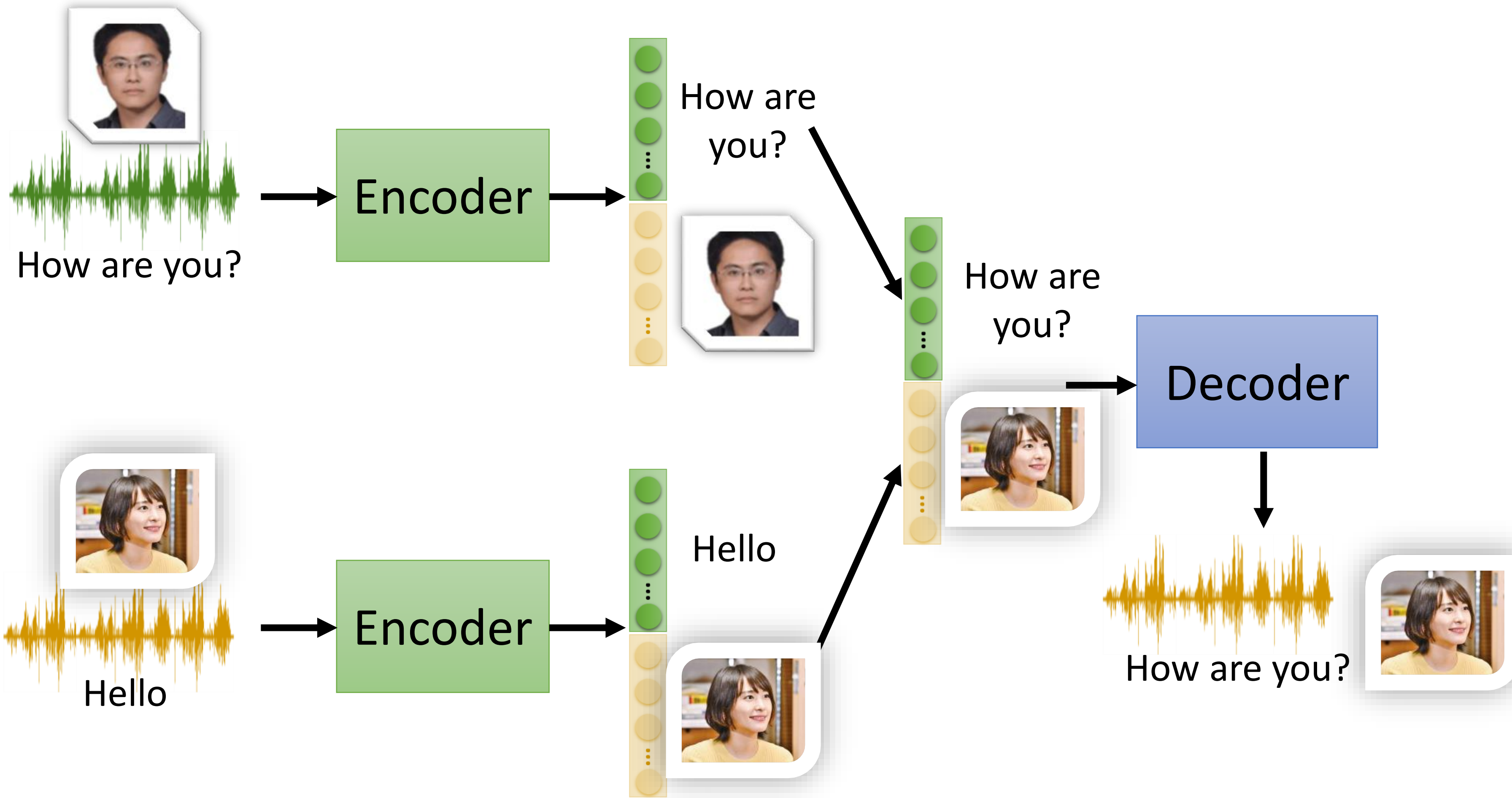
Today

Speakers A and B are talking about completely different things.

Application: Voice Conversion

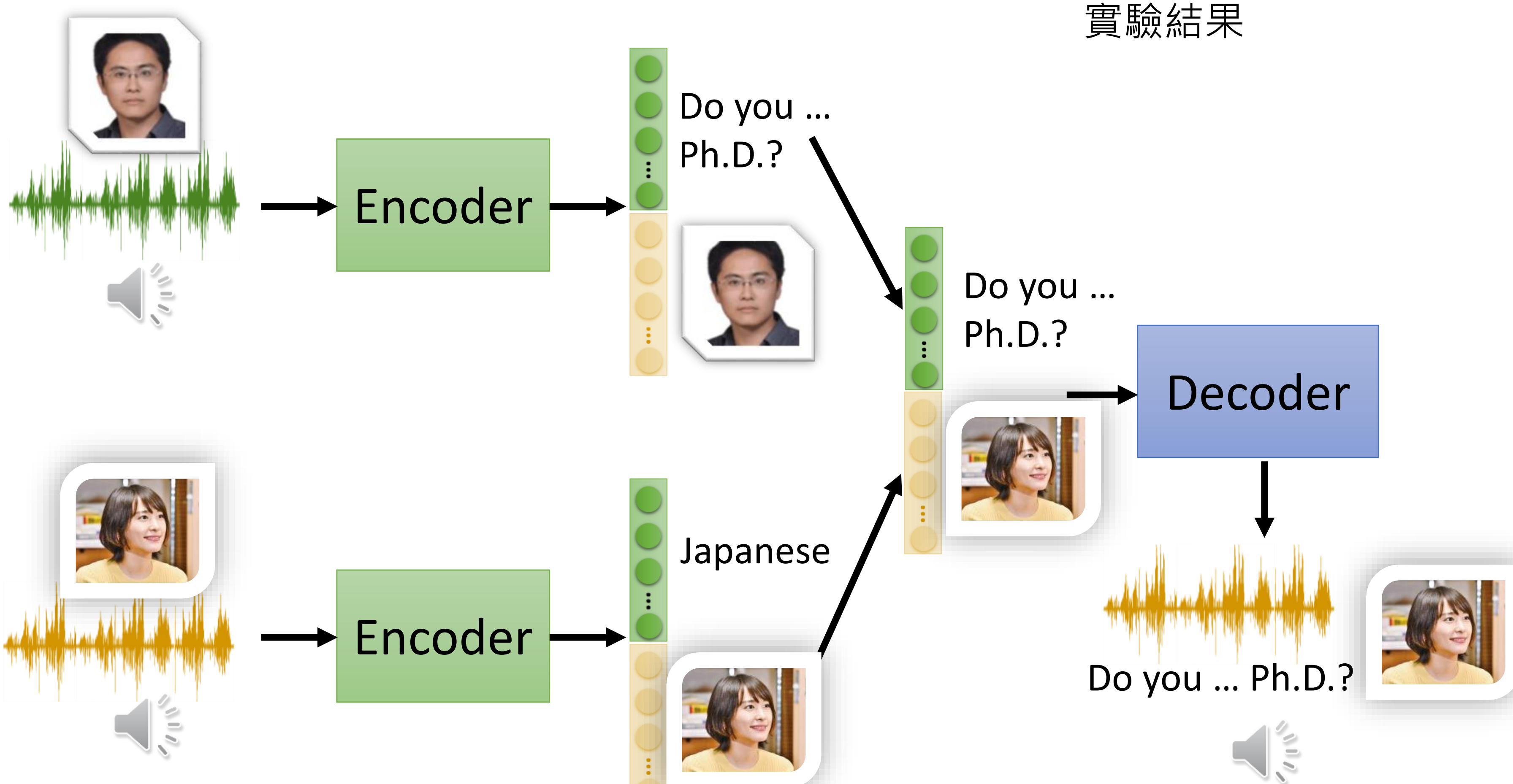


Application: Voice Conversion



Application: Voice Conversion

感謝解正平同學提供
實驗結果



Application: Voice Conversion

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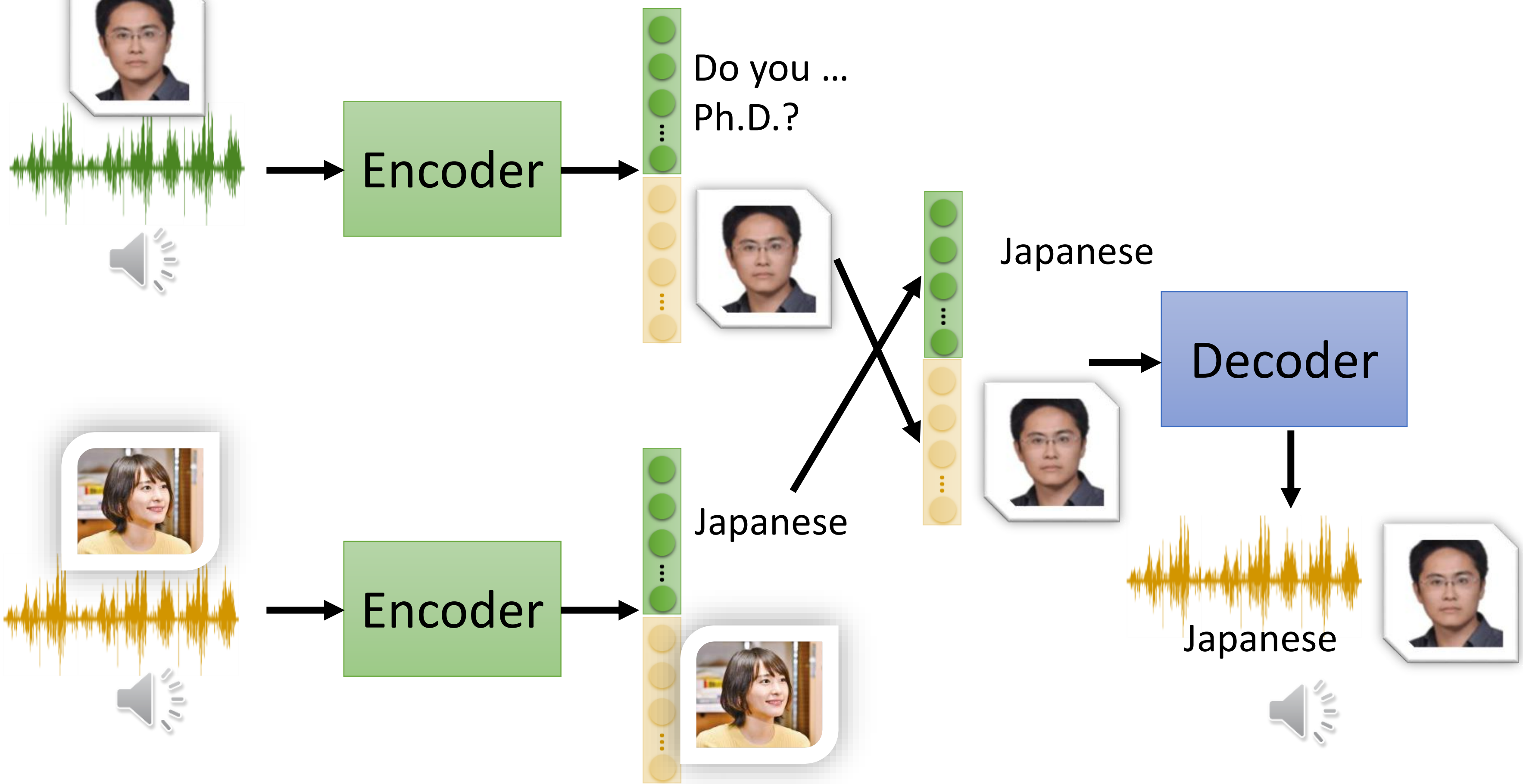

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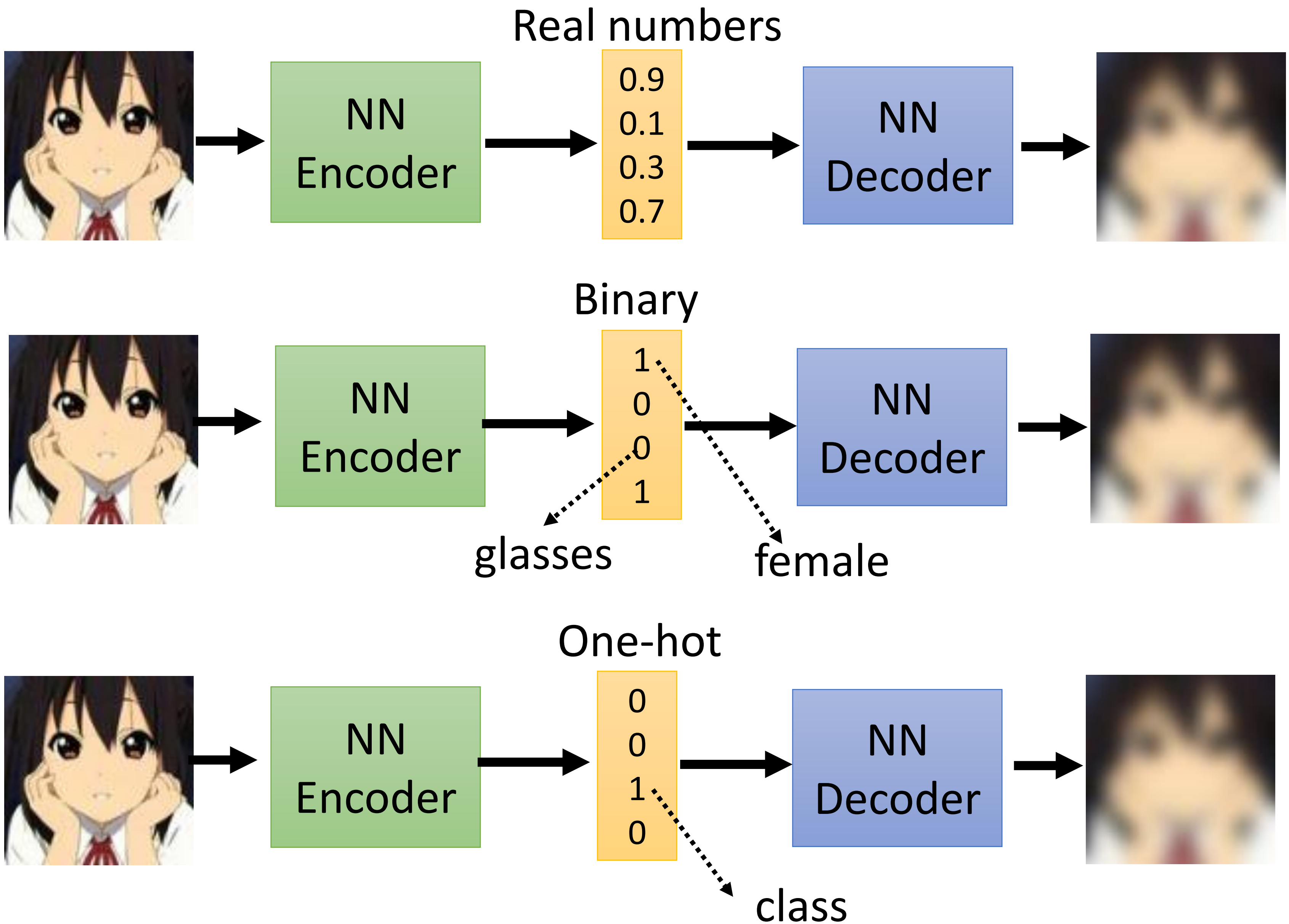
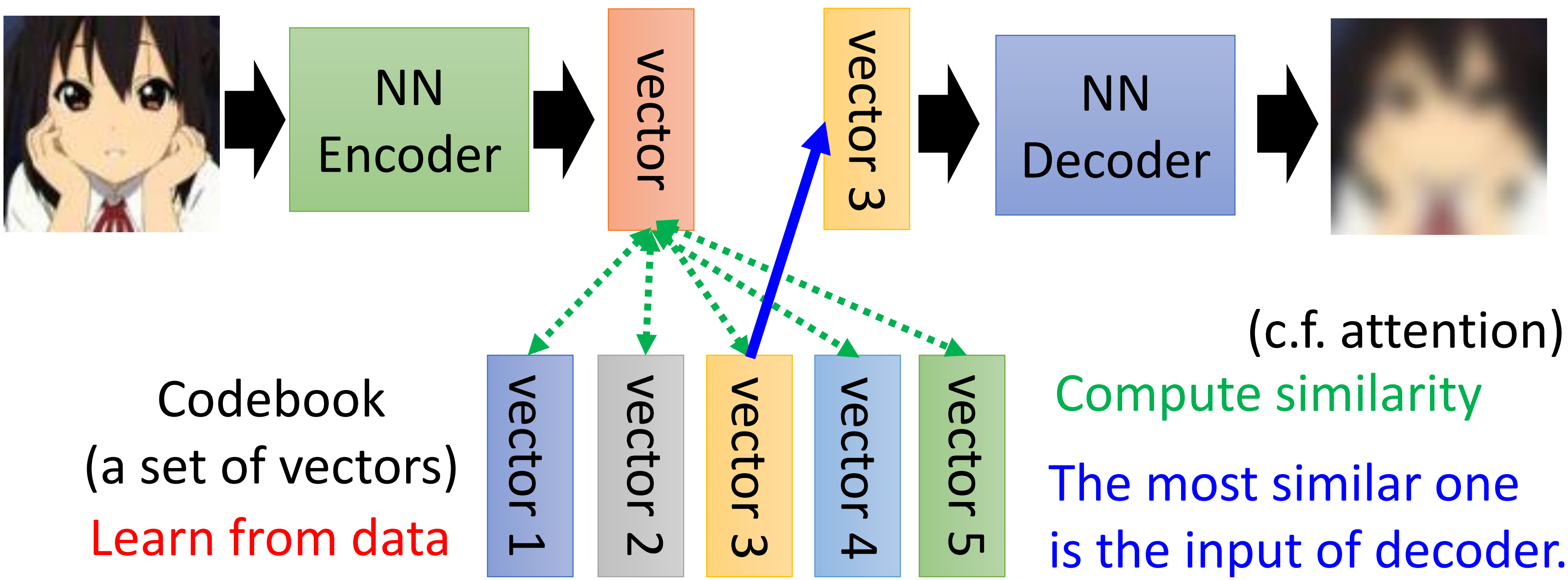
Discrete Representation



Discrete Representation

https://arxiv.org/abs/1711.00937

- Vector Quantized Variational Auto-encoder (VQVAE)



For speech, the codebook represents phonetic information

音素

https://arxiv.org/pdf/1901.08810.pdf

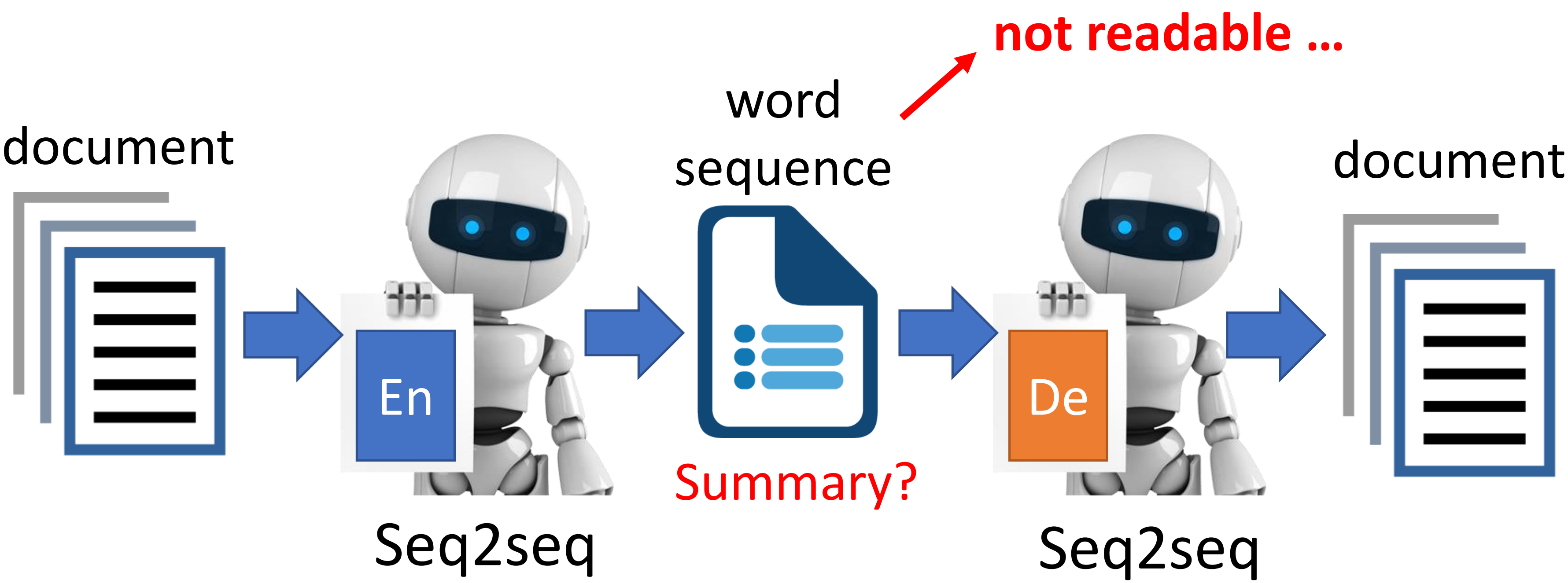
https://arxiv.org/abs/1810.02851

Text as Representation

Only need a lot of documents to train the model

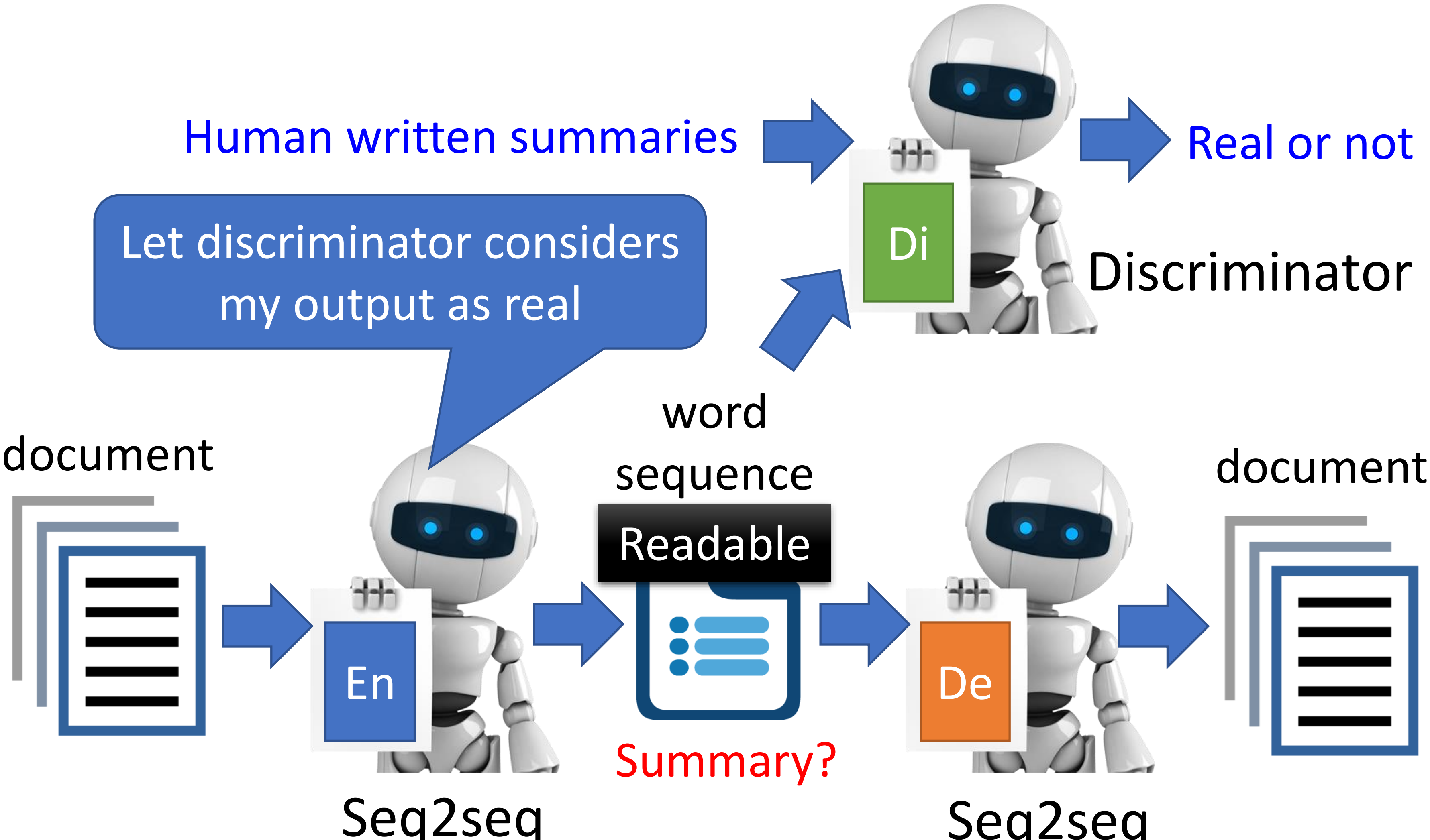
Unsupervised Summarization

seq2seq2seq auto-encoder



This is cycle GAN ☺

Text as Representation



感謝 王耀賢 同學提供實驗結果

Text as Representation

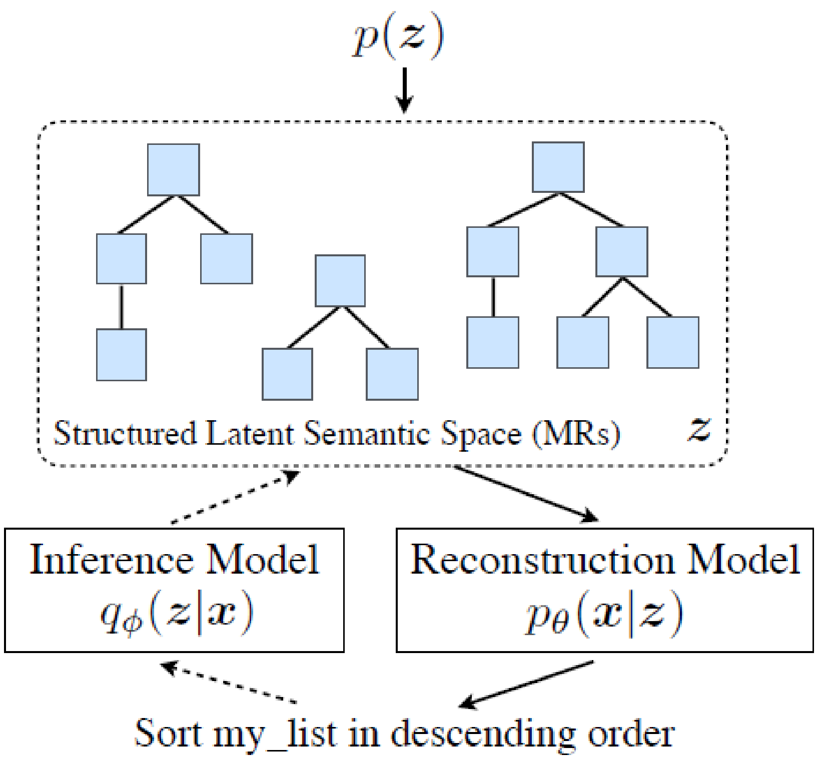
- ***Document***:澳大利亞今天與13個國家簽署了反興奮劑雙邊協議,旨在加強體育競賽之外的藥品檢查並共享研究成果 ……
- ***Summary***:
  - Human:澳大利亞與13國簽署反興奮劑協議
  - Unsupervised:澳大利亞加強體育競賽之外的藥品檢查
- ***Document***:中華民國奧林匹克委員會今天接到一九九二年冬季奧運會邀請函,由於主席張豐緒目前正在中南美洲進行友好訪問,因此尚未決定是否派隊赴賽 ……
- ***Summary***:
  - Human:一九九二年冬季奧運會函邀我參加
  - Unsupervised:奧委會接獲冬季奧運會邀請函

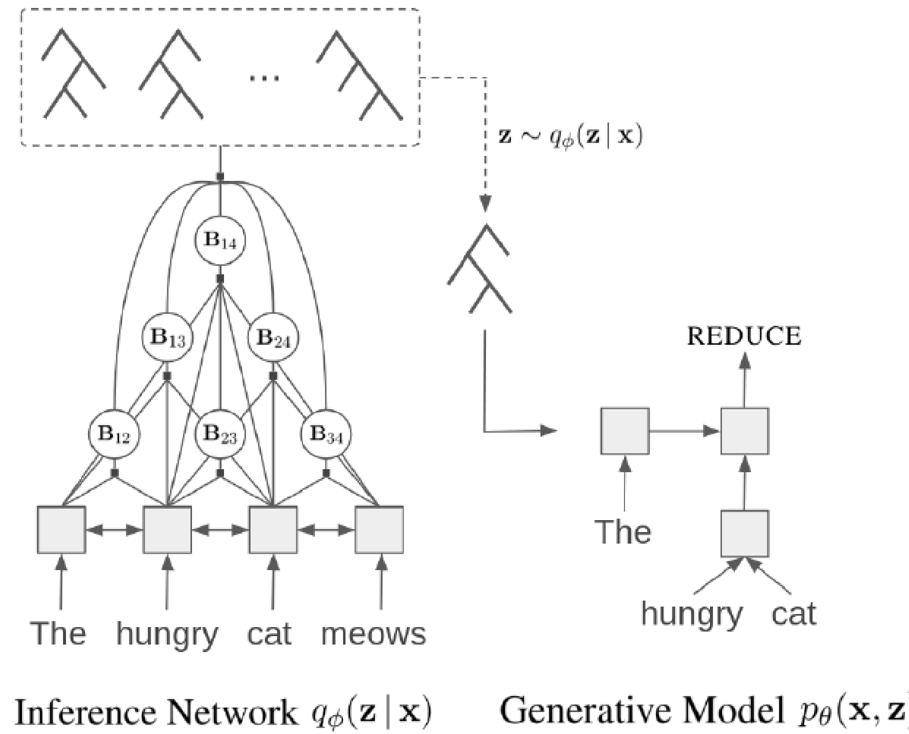
感謝 王耀賢 同學提供實驗結果

Text as Representation

- ***Document***:據此間媒體27日報道,印度尼西亞蘇門答臘島的兩個省近日來連降暴雨,洪水泛濫導致塌方,到26日為止至少已有60人喪生,100多人失蹤 ……
- ***Summary***:
  - Human:印尼水災造成60人死亡
  - Unsupervised:印尼門洪水泛濫導致塌雨
- ***Document***:安徽省合肥市最近為領導幹部下基層做了新規定:一律輕車簡從,不準搞迎來送往、不準搞層層陪同 ……
- ***Summary***:
  - Human:合肥規定領導幹部下基層活動從簡
  - Unsupervised:合肥領導幹部下基層做搞迎來送往規定:一律簡

Tree as Embedding





https://arxiv.org/abs/1806.07832

https://arxiv.org/abs/1904.03746

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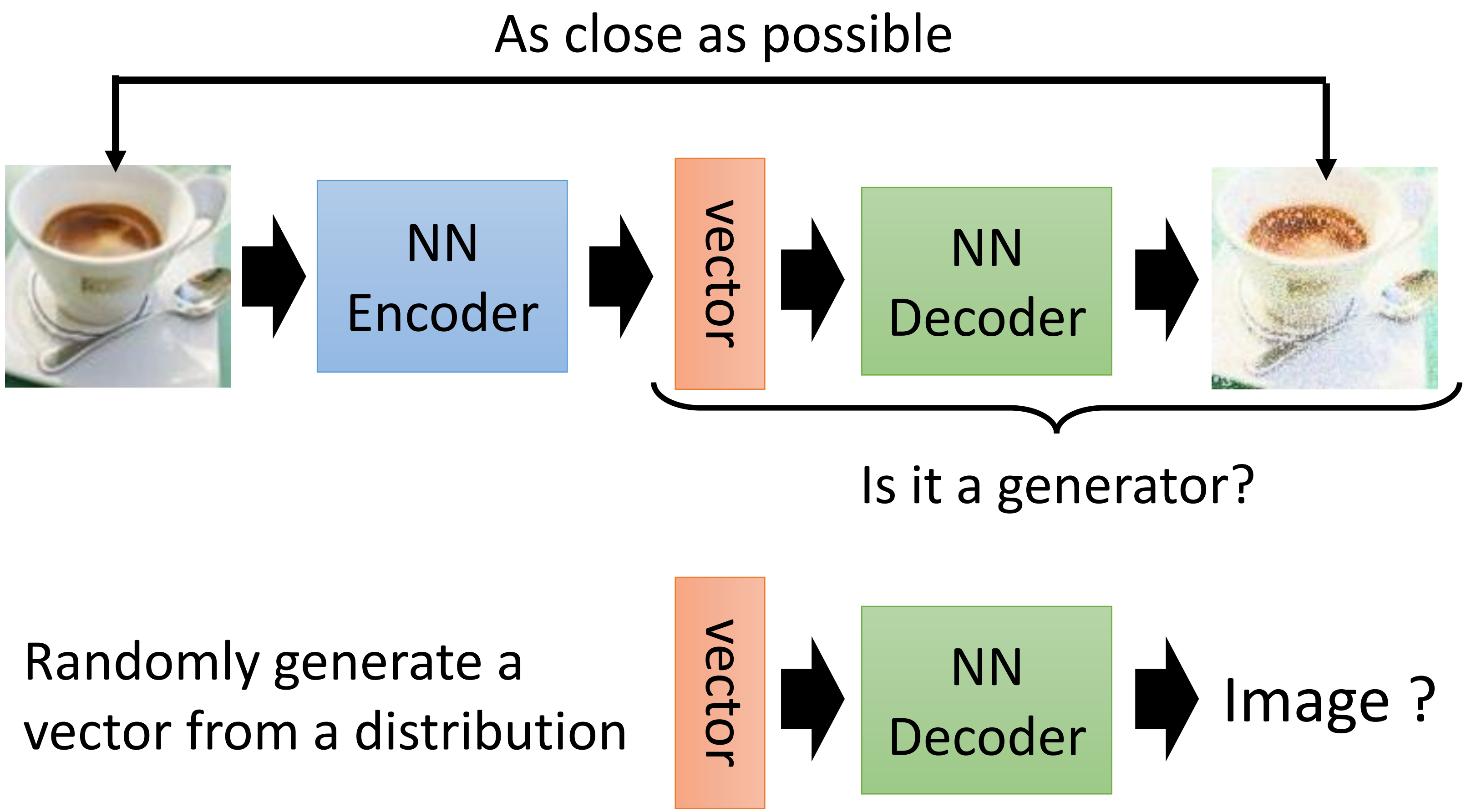
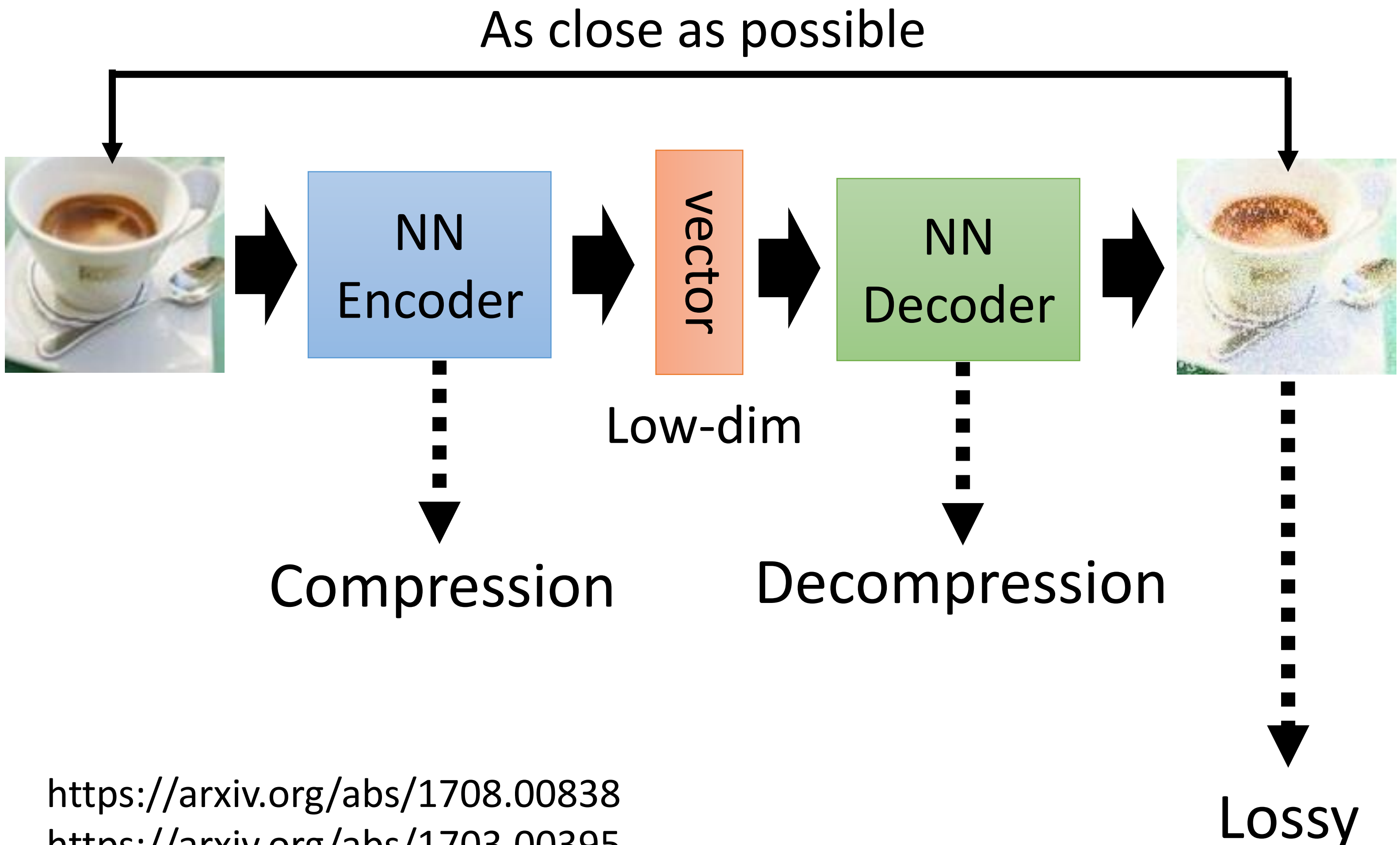
Generator



With some modification, we have **variational auto-encoder (VAE).**

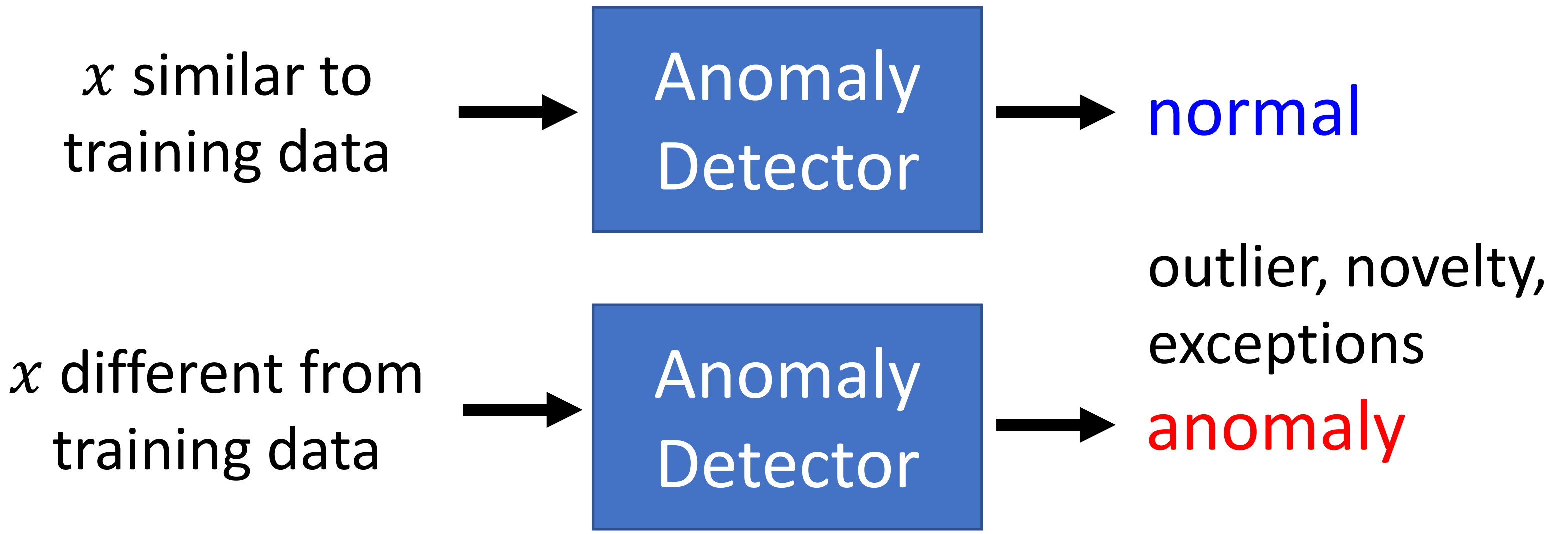
Compression



https://arxiv.org/abs/1708.00838
https://arxiv.org/abs/1703.00395

Anomaly Detection

- Given a set of training data $\{x^1, x^2, \cdots, x^N\}$
- Detecting input x is *similar* to training data or not.



Anomaly Detection

Training Data:

anomaly

Training Data:

anomaly

Training Data:

anomaly

Anomaly Detection

Binary Classification?

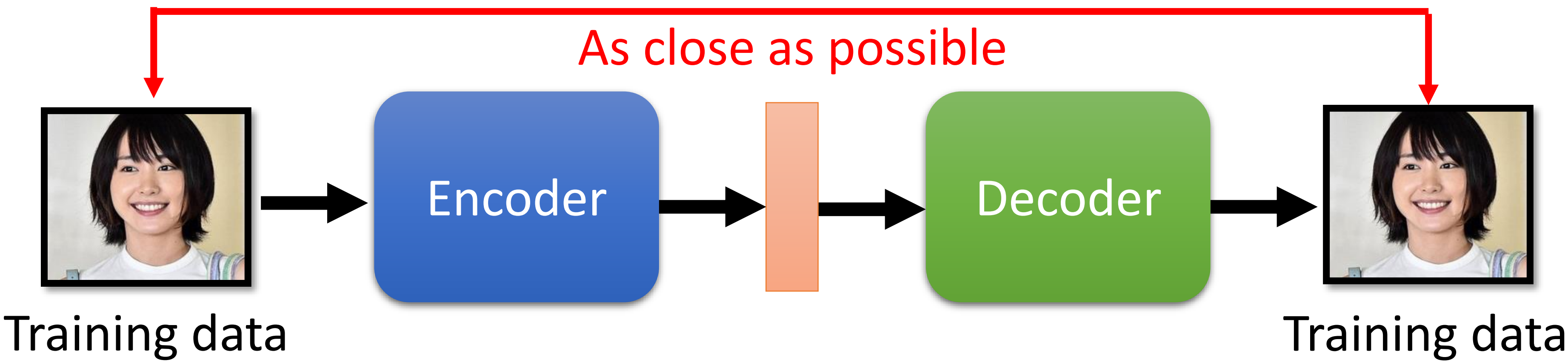
We only have one class.

Training auto-encoder

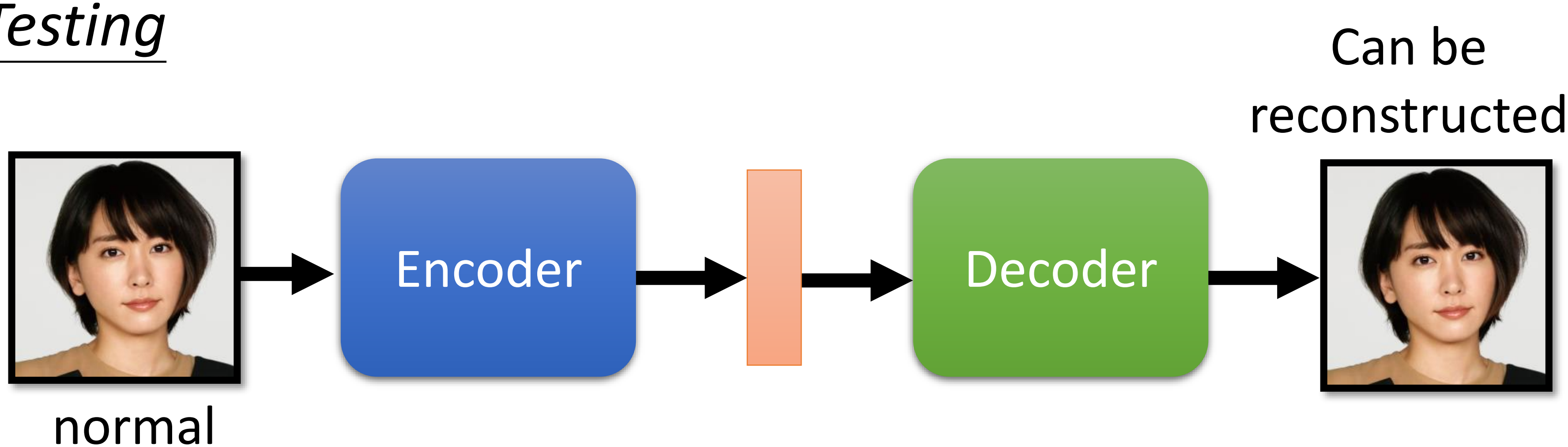
- Fraud Detection
  - Training data: credit card transactions, x: fraud or not
  - Ref: https://www.kaggle.com/ntnu-testimon/paysim1/home
  - Ref: https://www.kaggle.com/mlg-ulb/creditcardfraud/home
- Network Intrusion Detection
  - Training data: connection, x: attack or not
  - Ref: http://kdd.ics.uci.edu/databases/kddcup99/kddcup99.html
- Cancer Detection
  - Training data: normal cells, x: cancer or not?
  - Ref: https://www.kaggle.com/uciml/breast-cancer-wisconsin-data/home

Approach: Auto-encoder

Training Using **real human faces** to learn an ***autoencoder***



Testing



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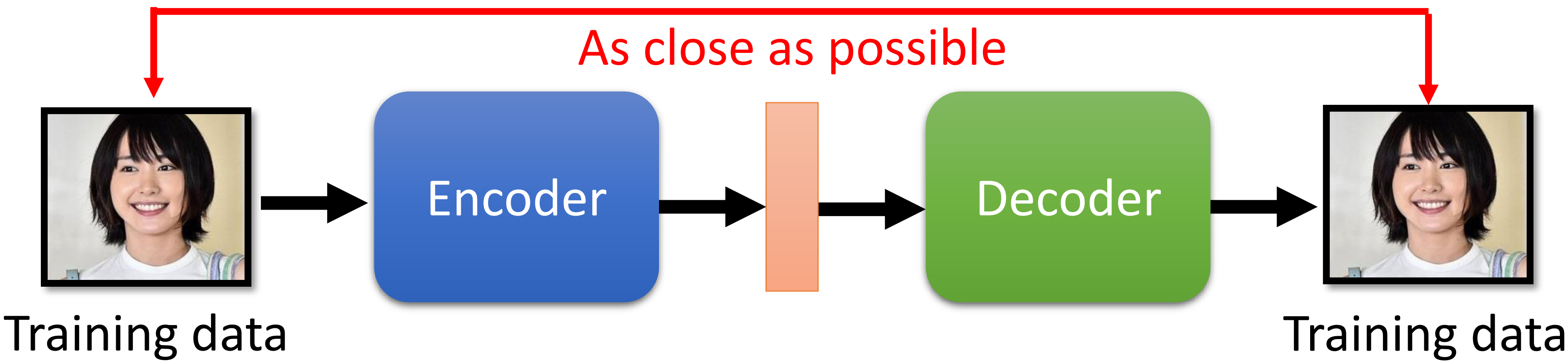
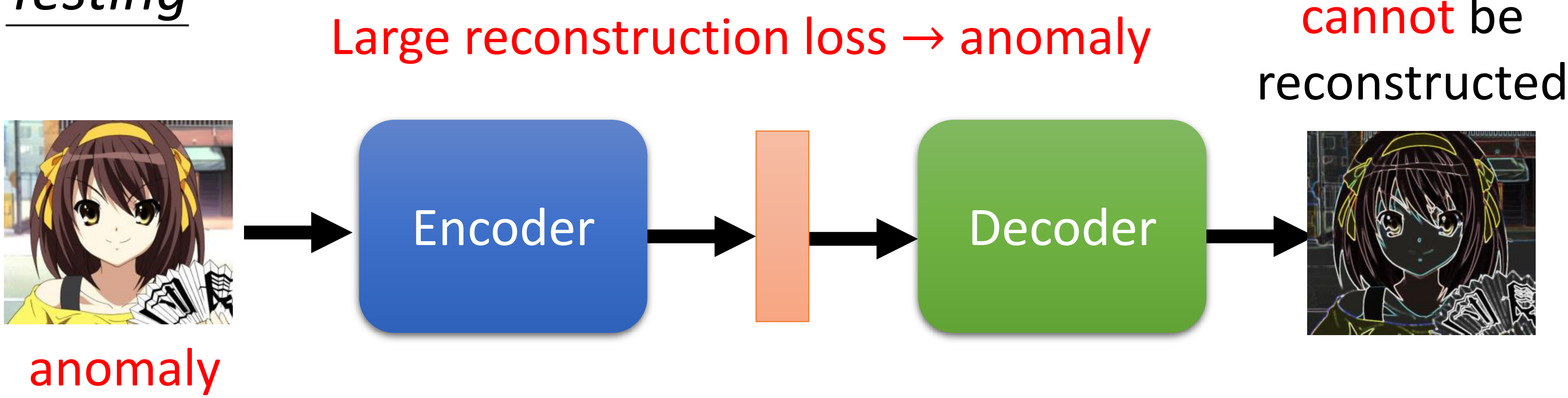


Testing



More about Anomaly Detection

- Part 1: https://youtu.be/gDp2LXGnVLQ
- Part 2: https://youtu.be/cYrNjLxkoXs
- Part 3: https://youtu.be/ueDlm2FkCnw
- Part 4: https://youtu.be/XwkHOUPbc0Q
- Part 5: https://youtu.be/Fh1xFBktRLQ
- Part 6: https://youtu.be/LmFWzmn2rFY
- Part 7: https://youtu.be/6W8FqUGYyDo

Concluding Remarks

Basic Idea of Auto-encoder

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Discrete Latent Representation

More Applications