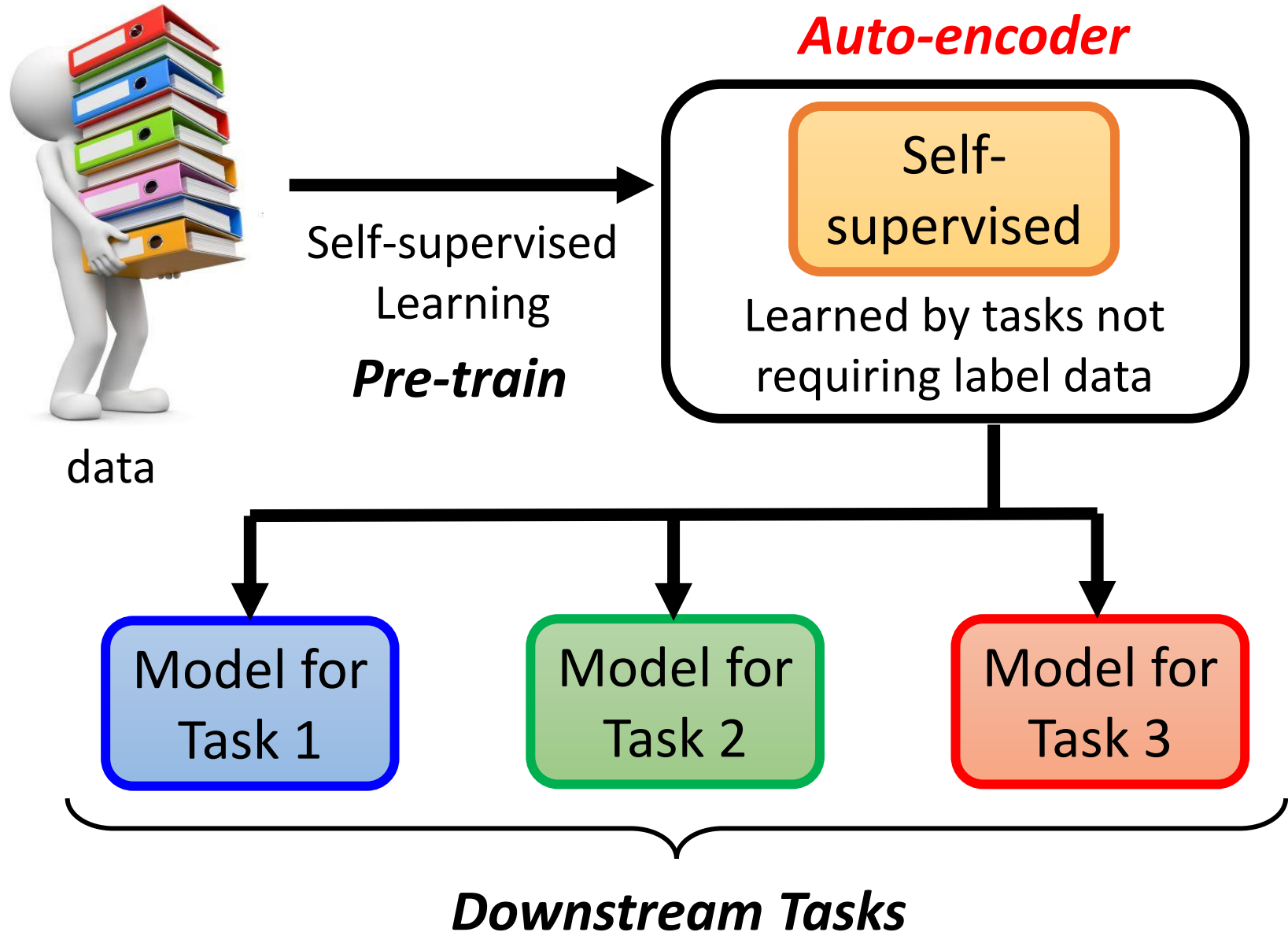




AUTO-ENCODER

Hung-yi Lee 李宏毅

Self-supervised Learning Framework



Outline

Basic Idea of Auto-encoder

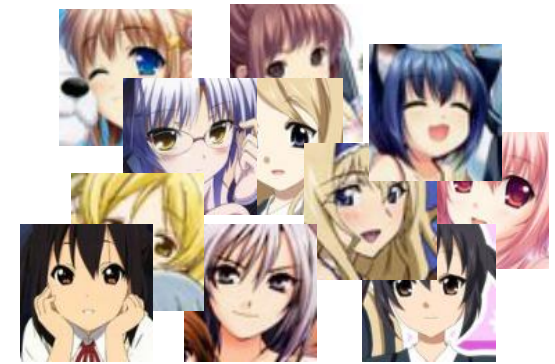
Feature Disentanglement

Discrete Latent Representation

More Applications

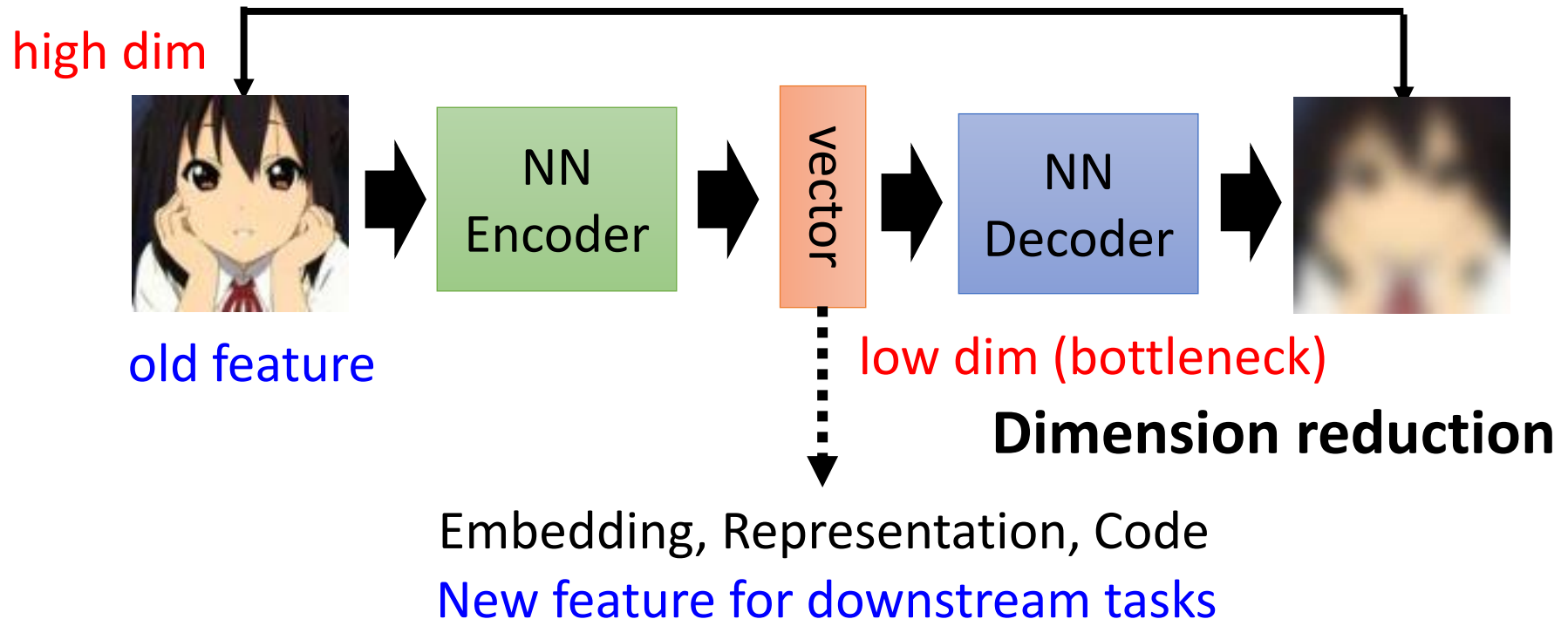
Auto-encoder

Unlabeled
Images



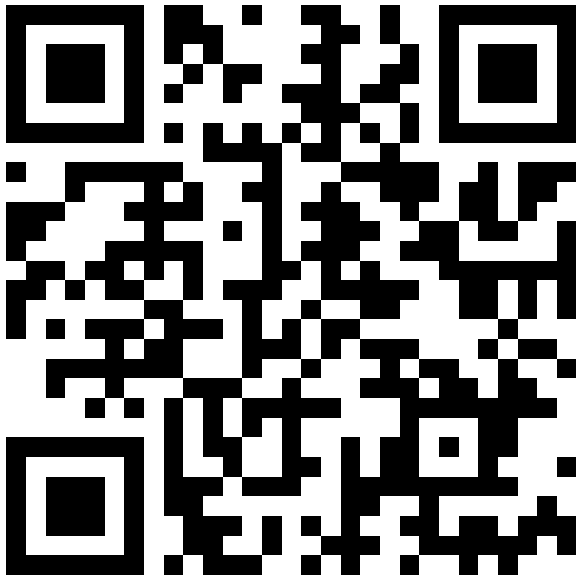
Sounds familiar? We have seen the same idea in Cycle GAN. 😊

As close as possible (reconstruction)



More Dimension Reduction

(not based on deep learning)



https://youtu.be/iwh5o_M4BNU

PCA



<https://youtu.be/GBUEjkpoxXc>

t-SNE

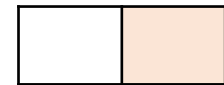
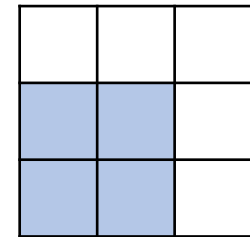
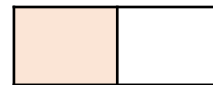
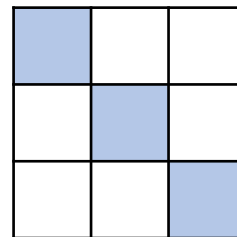
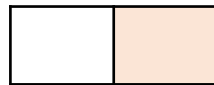
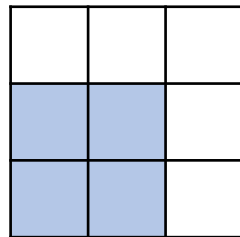
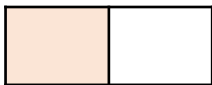
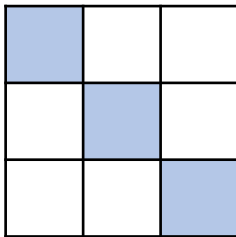
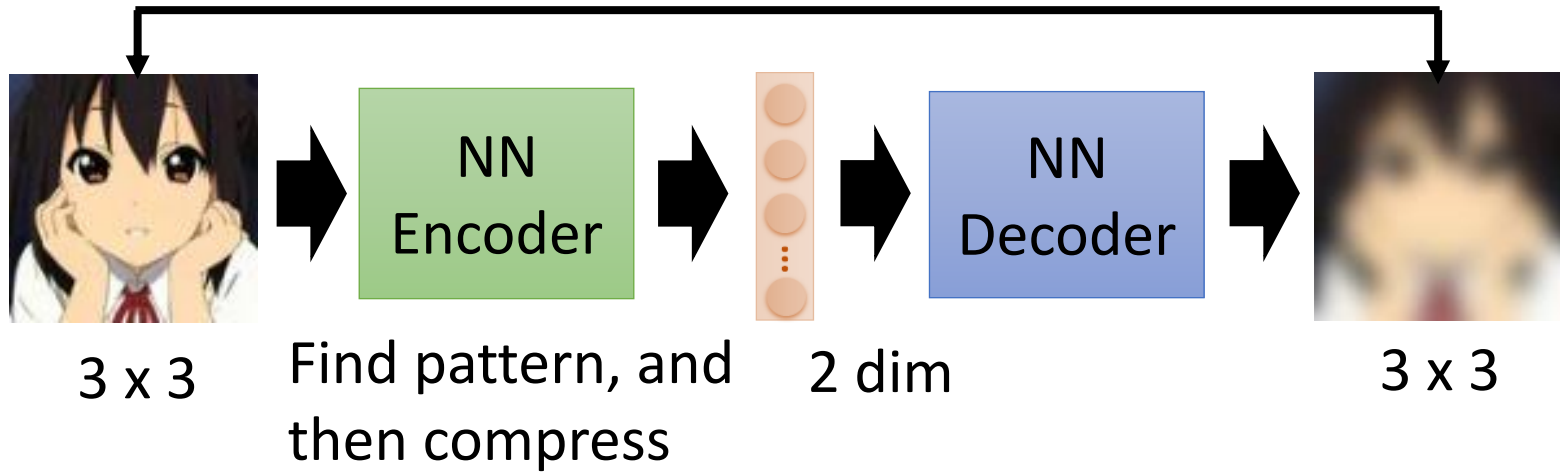
Why Auto-encoder?



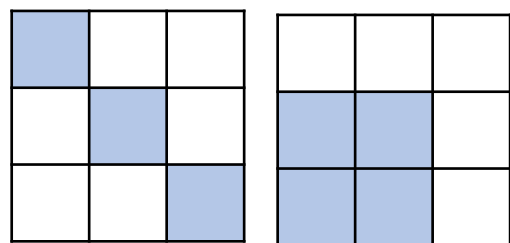
《神鵰俠侶》

Why Auto-encoder?

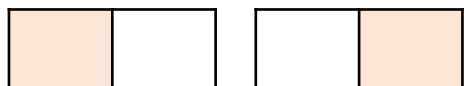
As close as possible (reconstruction)



Why Auto-encoder?



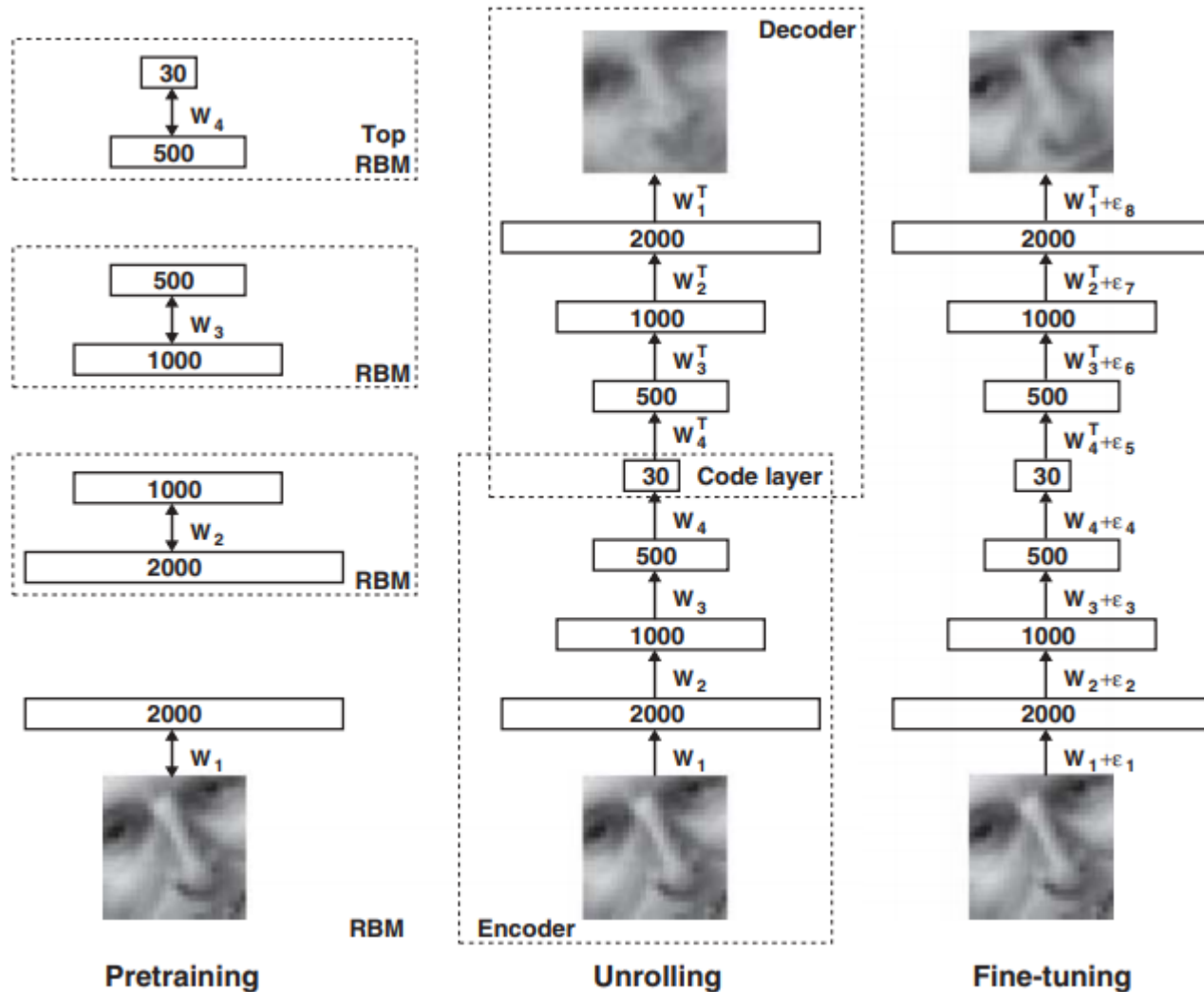
NN
Encoder



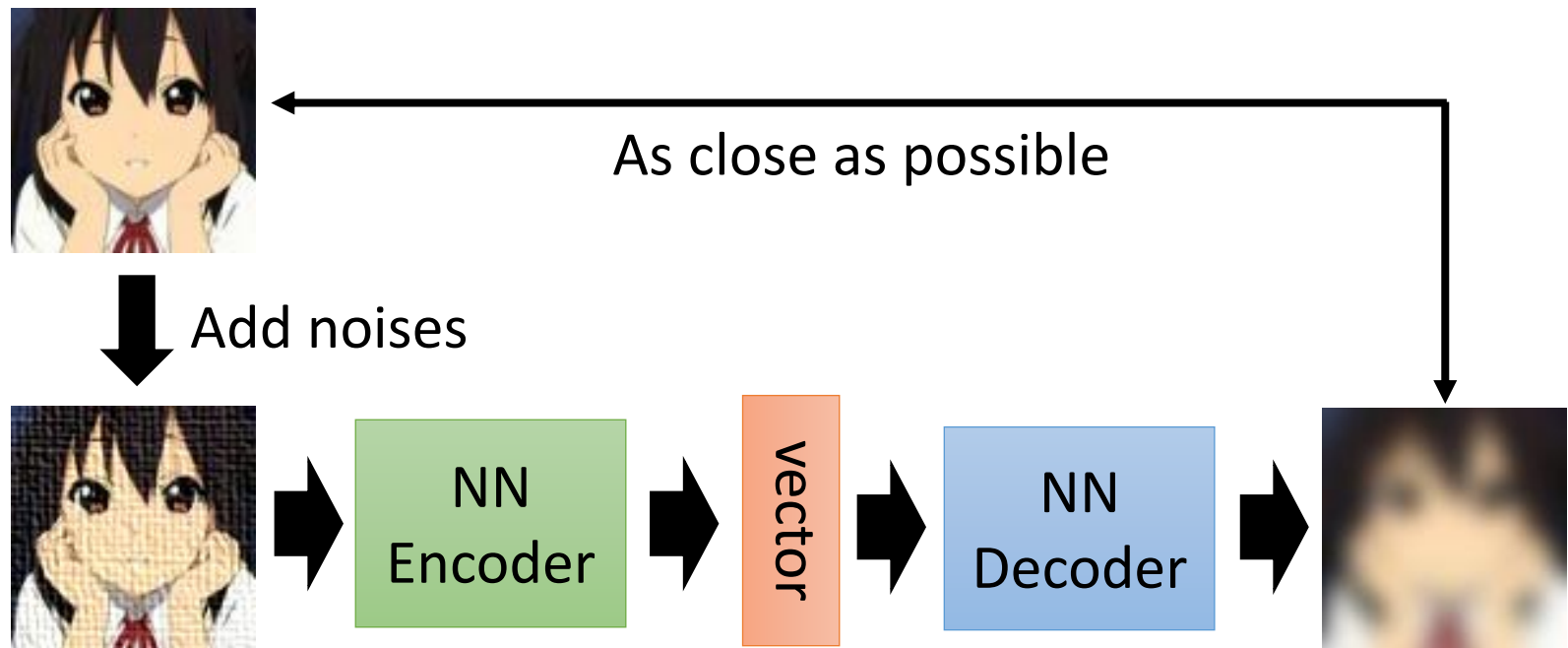
《神鵰俠侶》

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

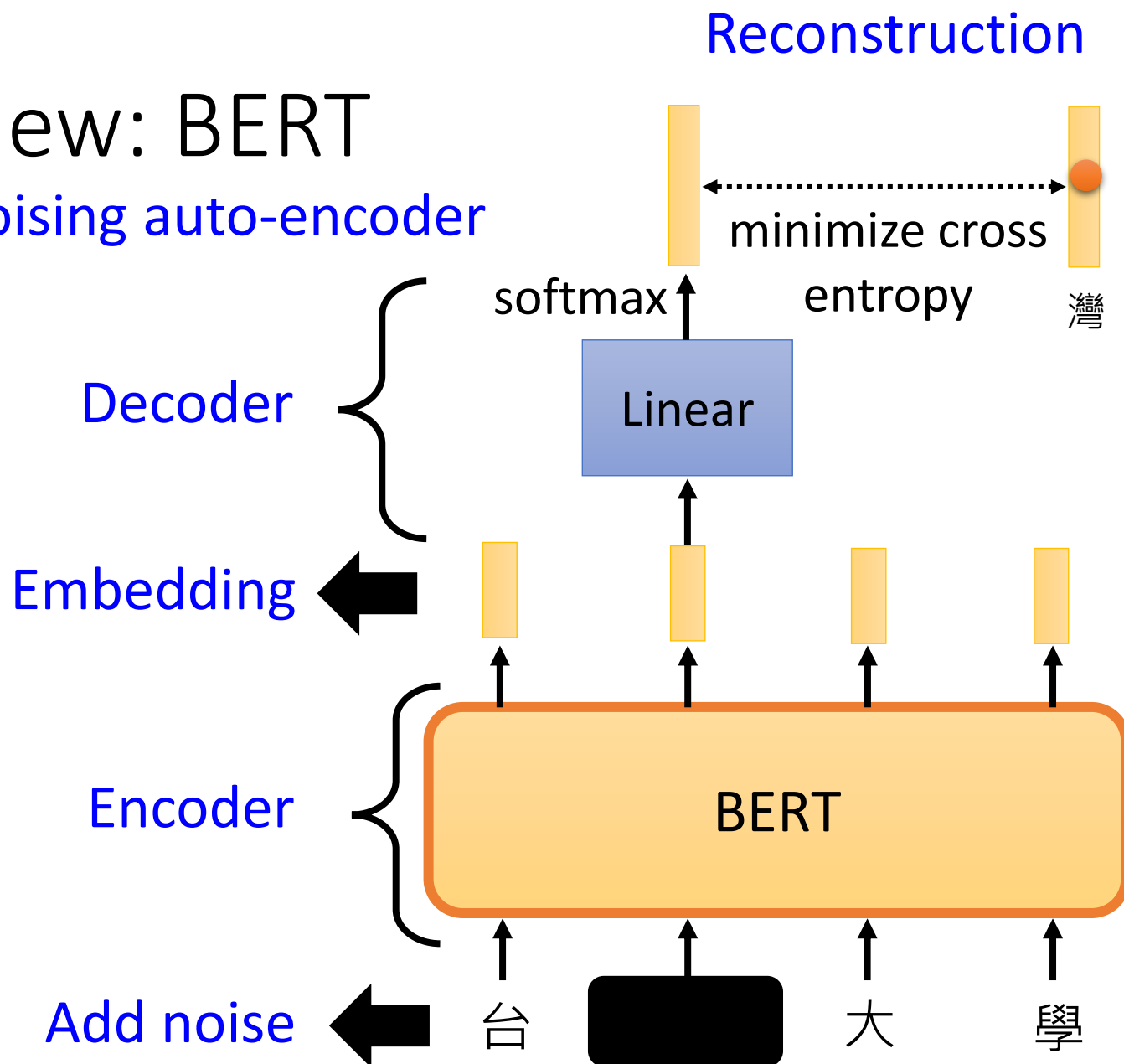


The idea sounds familiar? 😊

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

Review: BERT

A de-noising auto-encoder



Outline

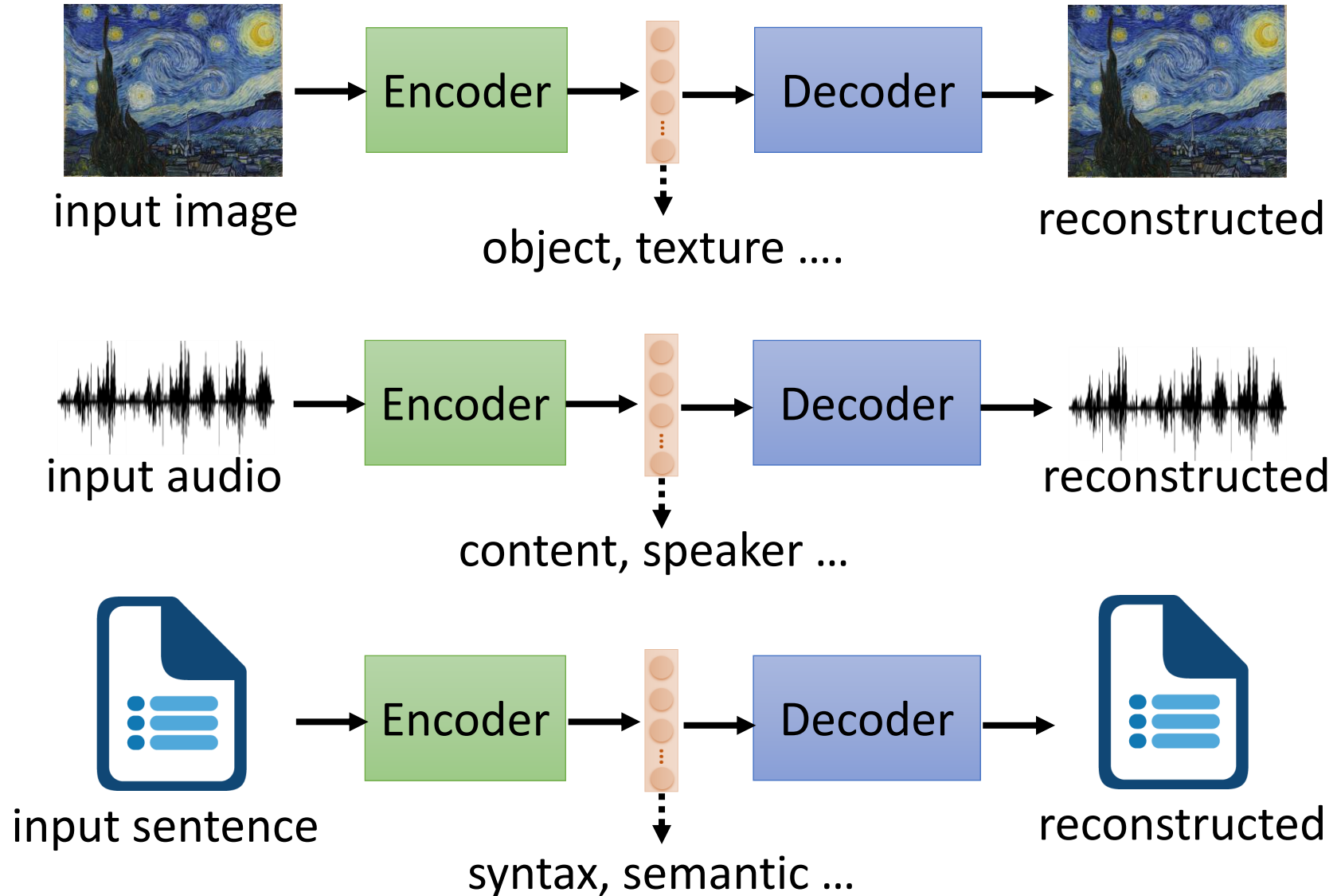
Basic Idea of Auto-encoder

Feature Disentanglement

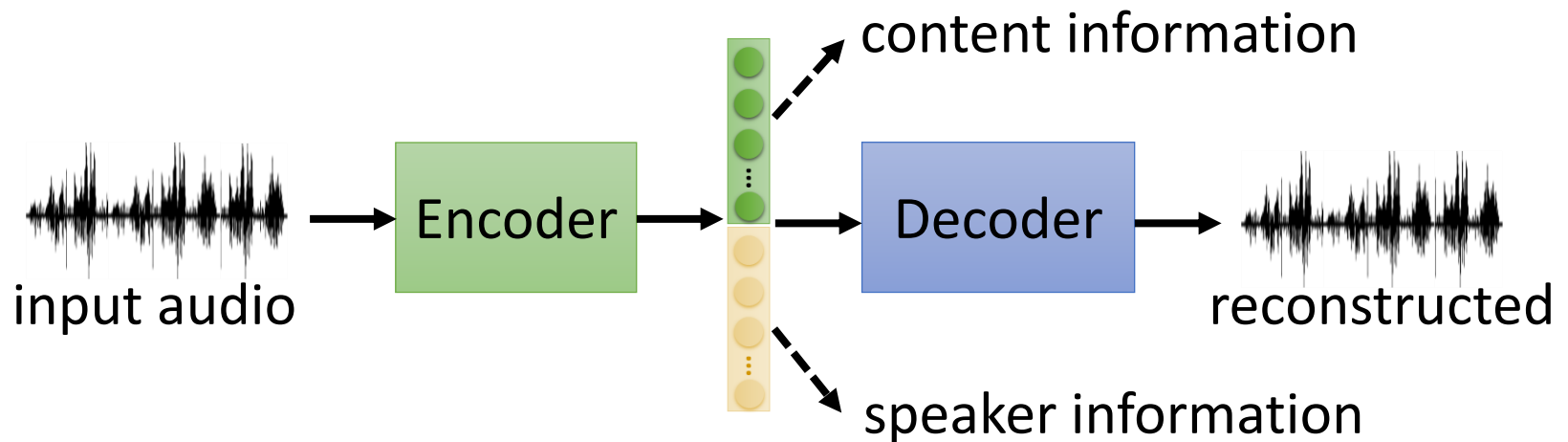
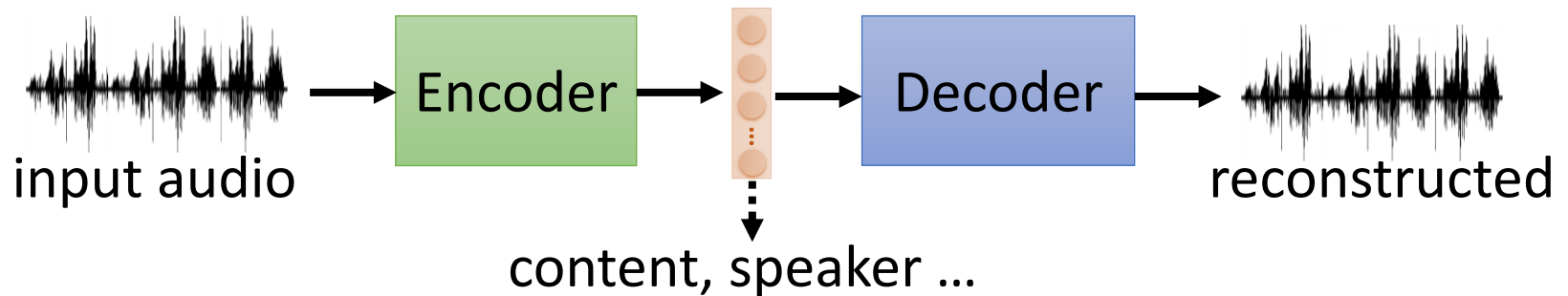
Discrete Latent Representation

More Applications

Representation includes information of different aspects



Feature Disentangle



<https://arxiv.org/abs/1904.05742>

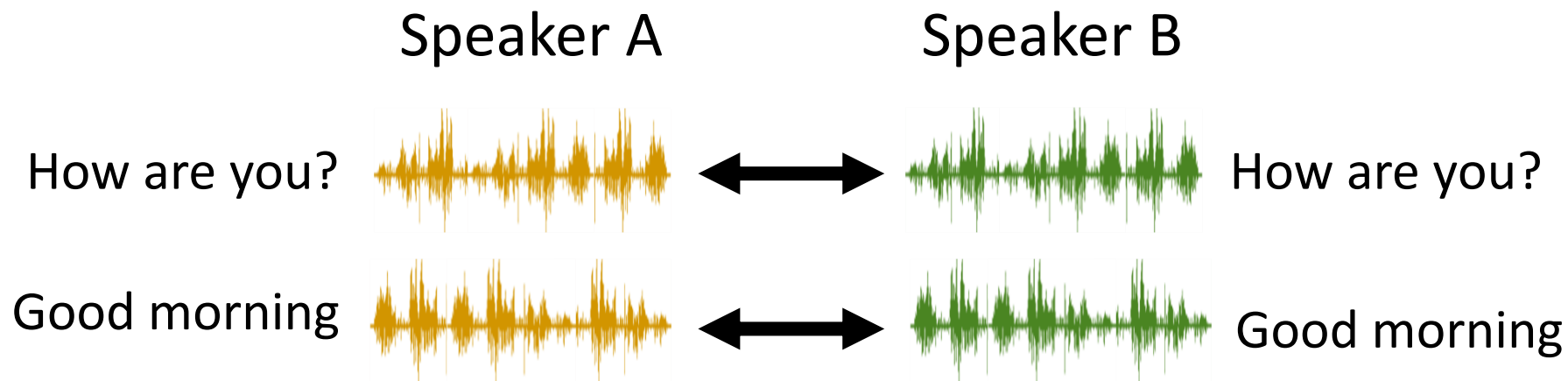
<https://arxiv.org/abs/1804.02812>

<https://arxiv.org/abs/1905.05879>



Application: Voice Conversion

In the past

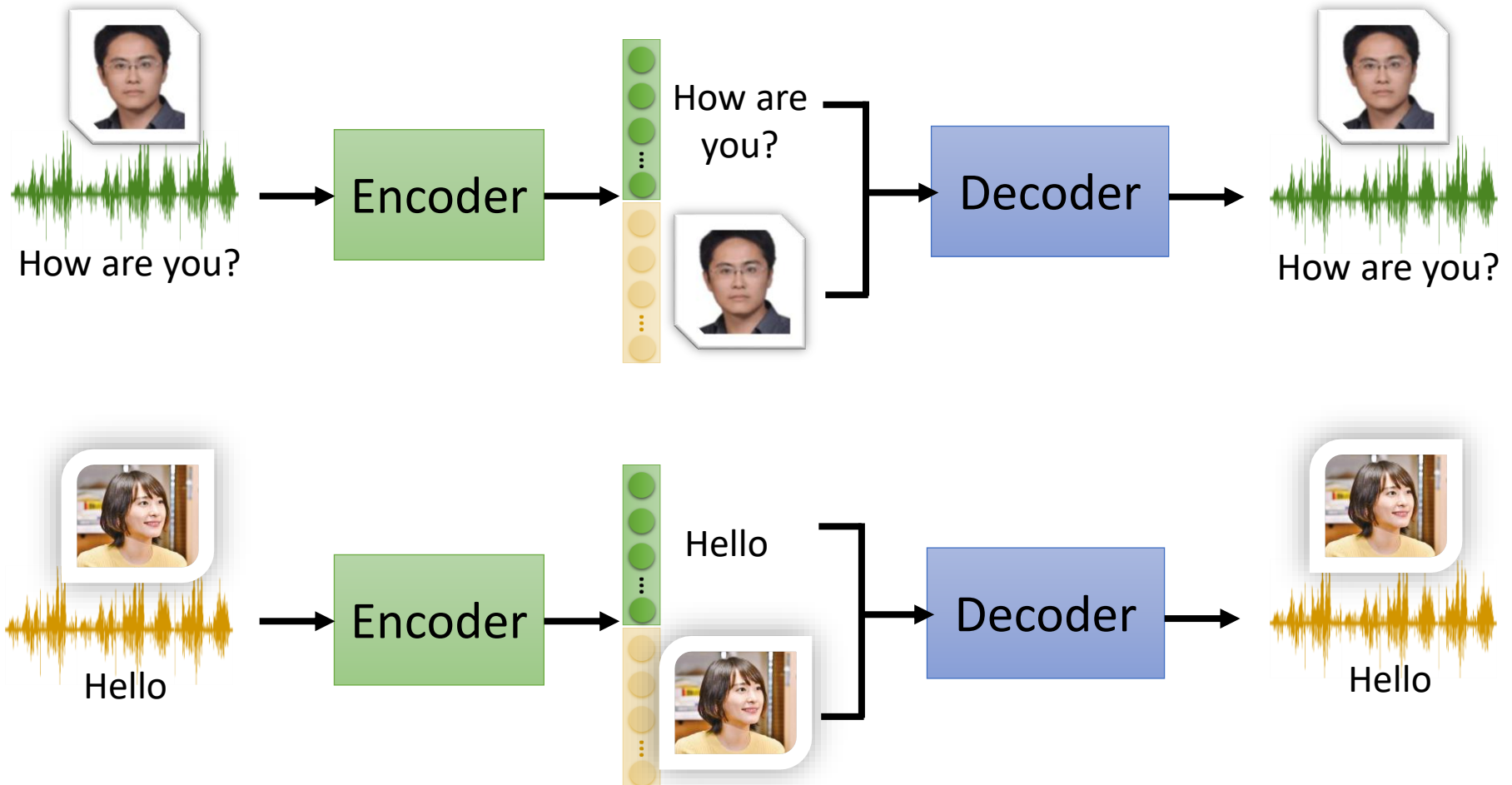


Today

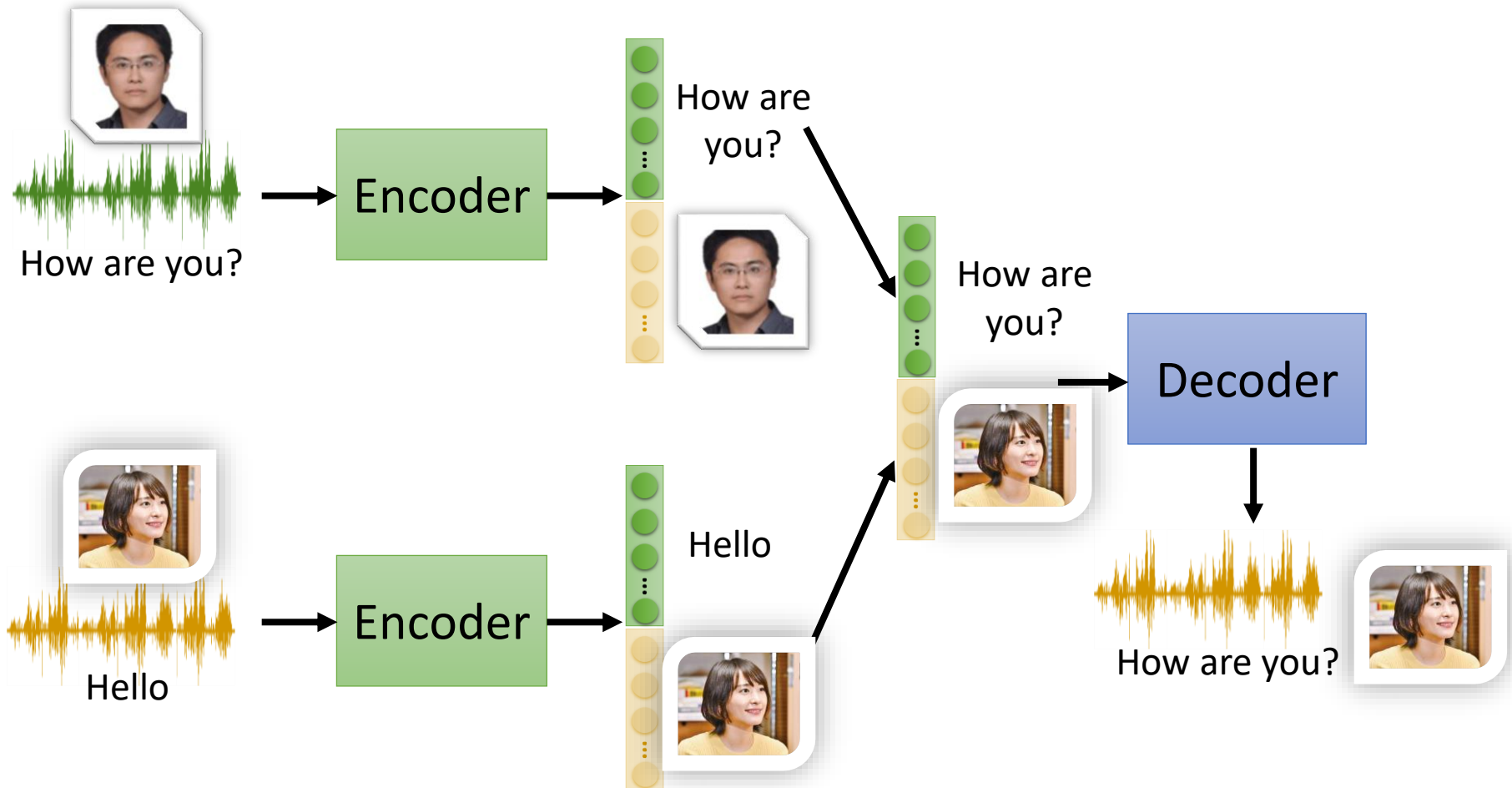


Speakers A and B are talking about completely different things.

Application: Voice Conversion

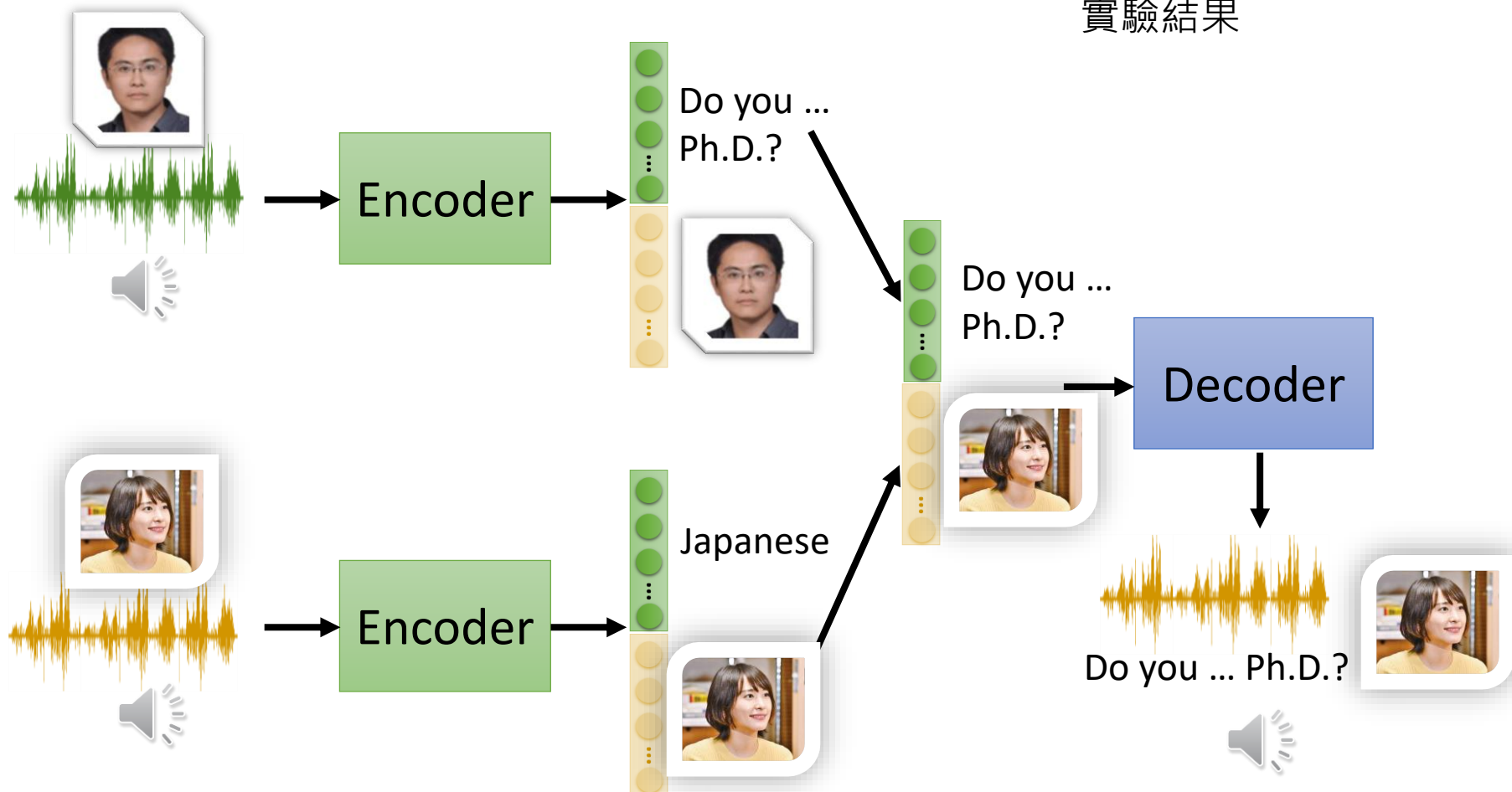


Application: Voice Conversion



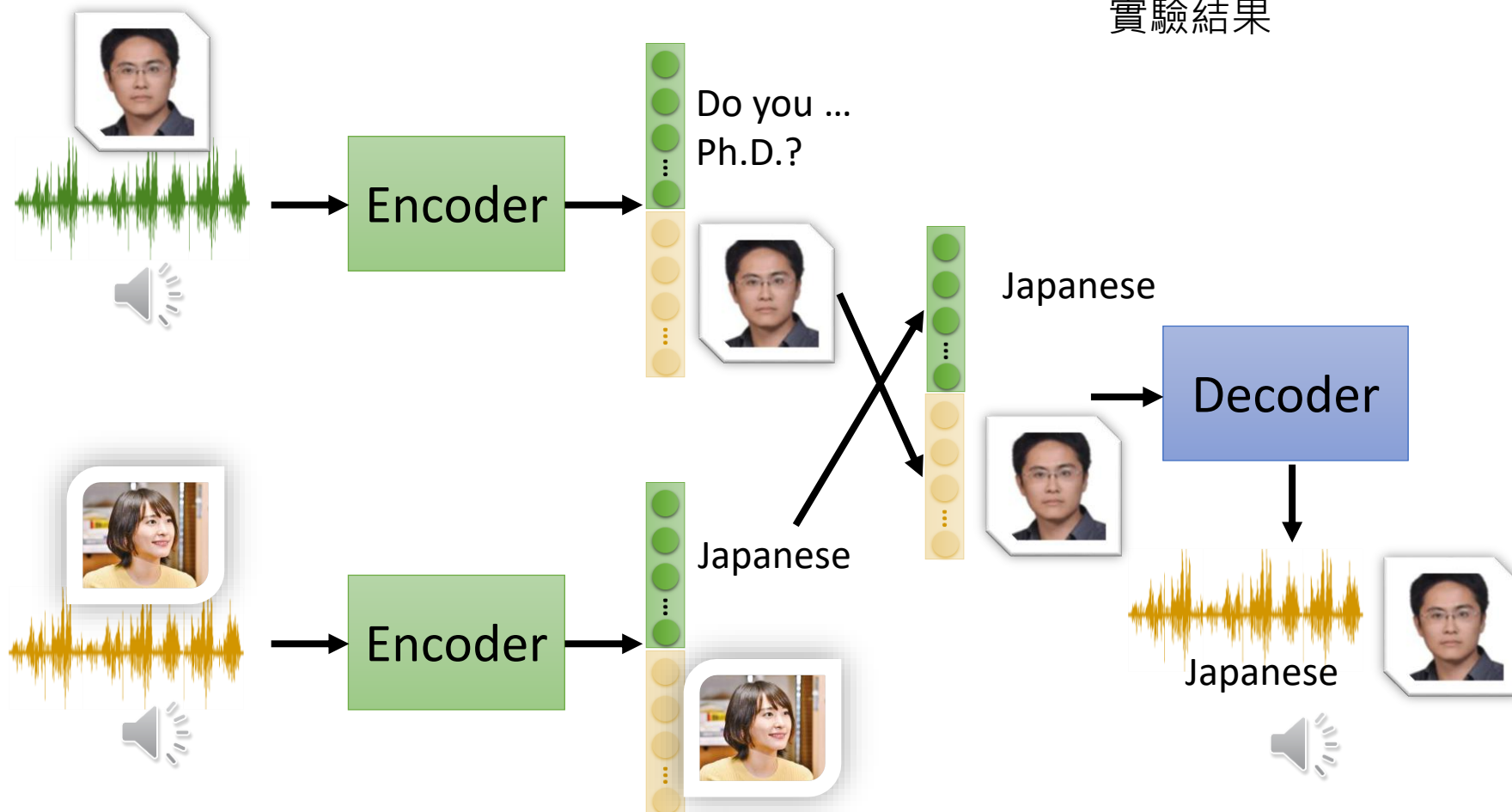
Application: Voice Conversion

感謝解正平同學提供
實驗結果



Application: Voice Conversion

感謝解正平同學提供
實驗結果



Outline

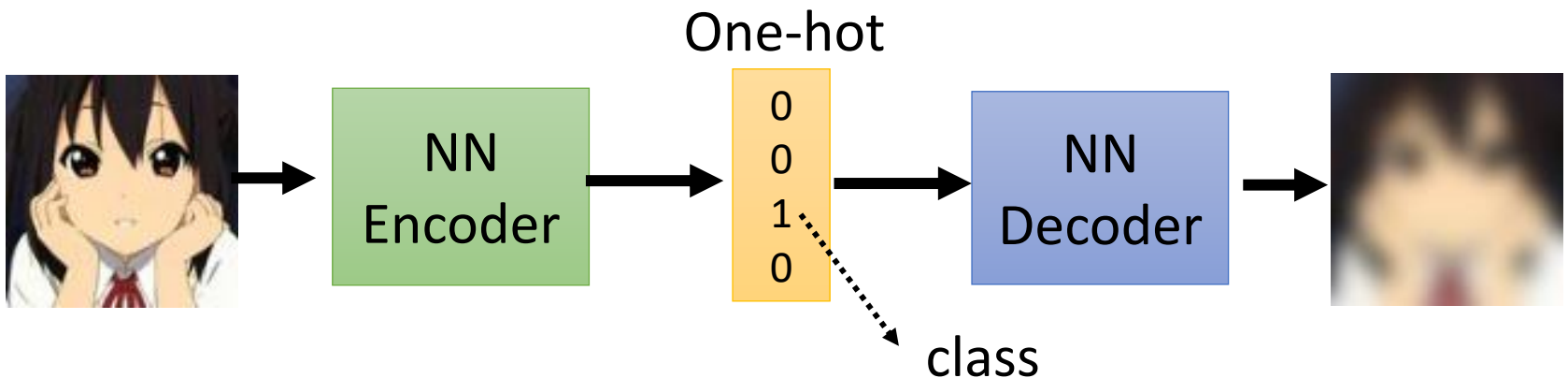
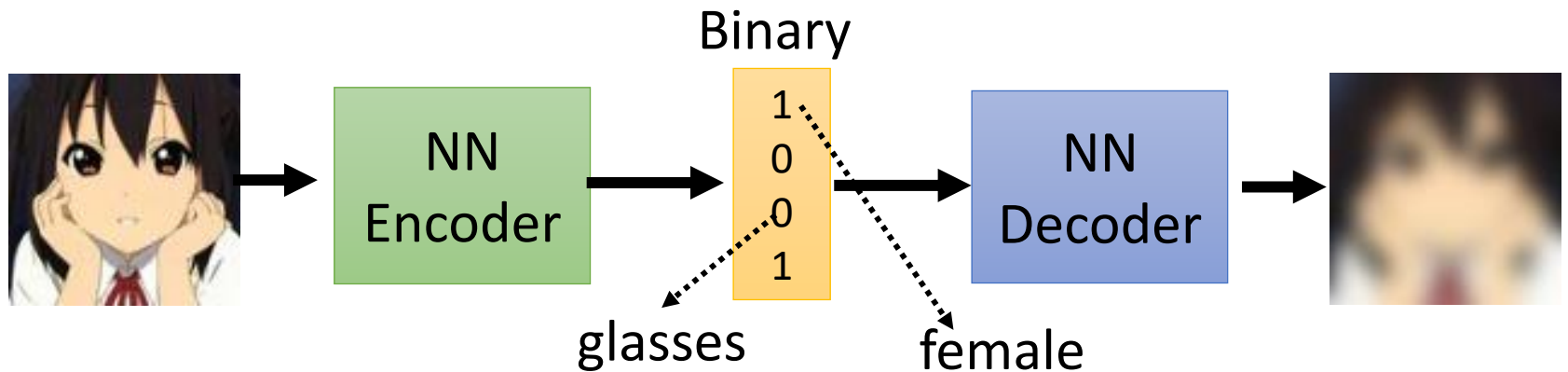
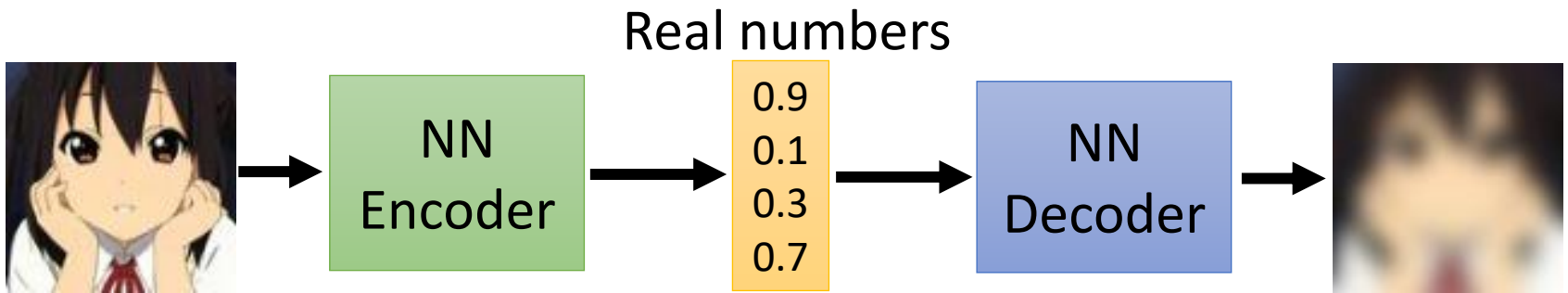
Basic Idea of Auto-encoder

Feature Disentanglement

Discrete Latent Representation

More Applications

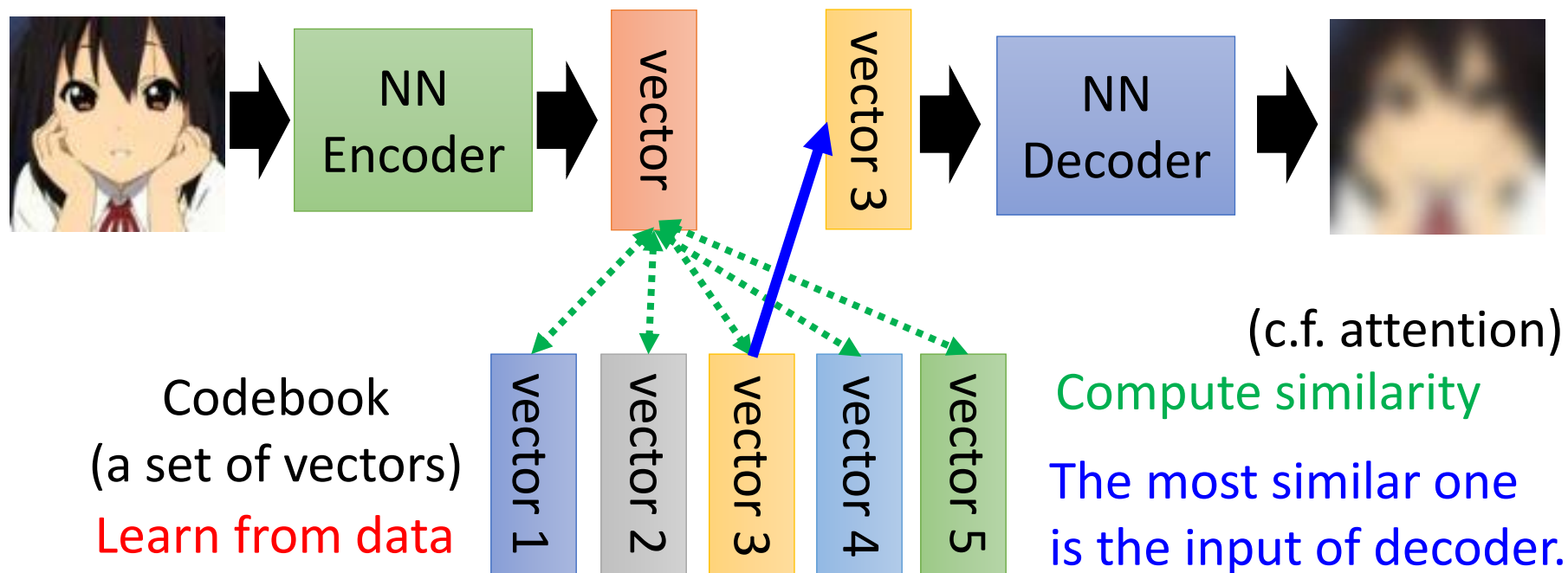
Discrete Representation



Discrete Representation

<https://arxiv.org/abs/1711.00937>

- Vector Quantized Variational Auto-encoder (VQVAE)



For speech, the codebook represents phonetic information

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

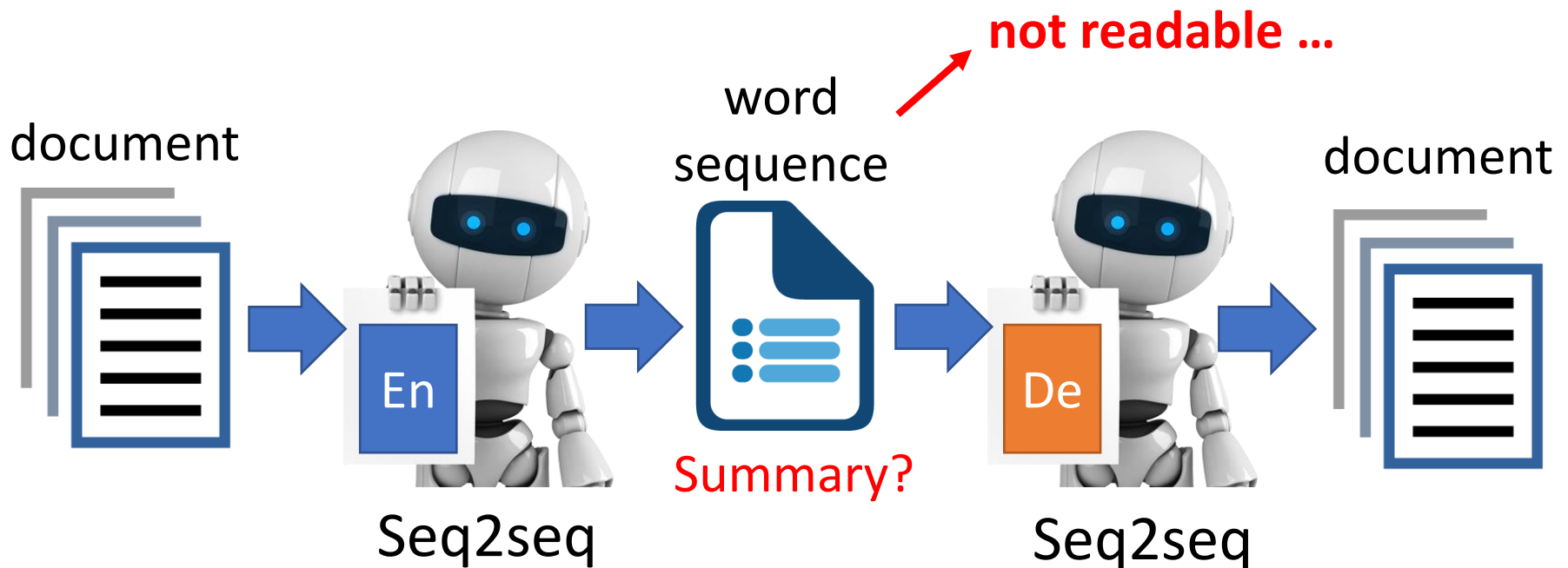
Text as Representation

Only need a lot
of documents to
train the model



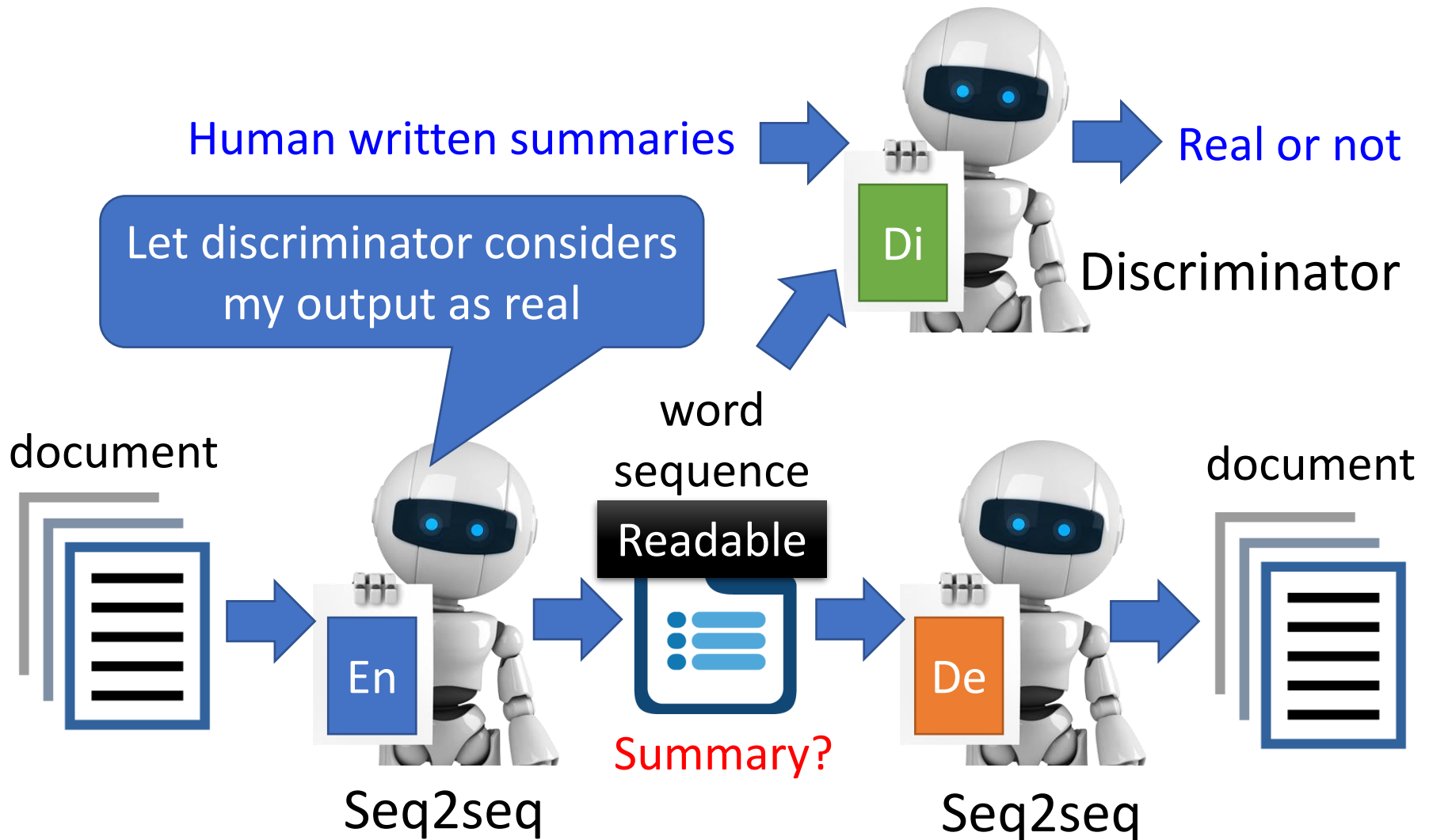
seq2seq2seq
auto-encoder

Unsupervised Summarization



This is cycle GAN 😊

Text as Representation



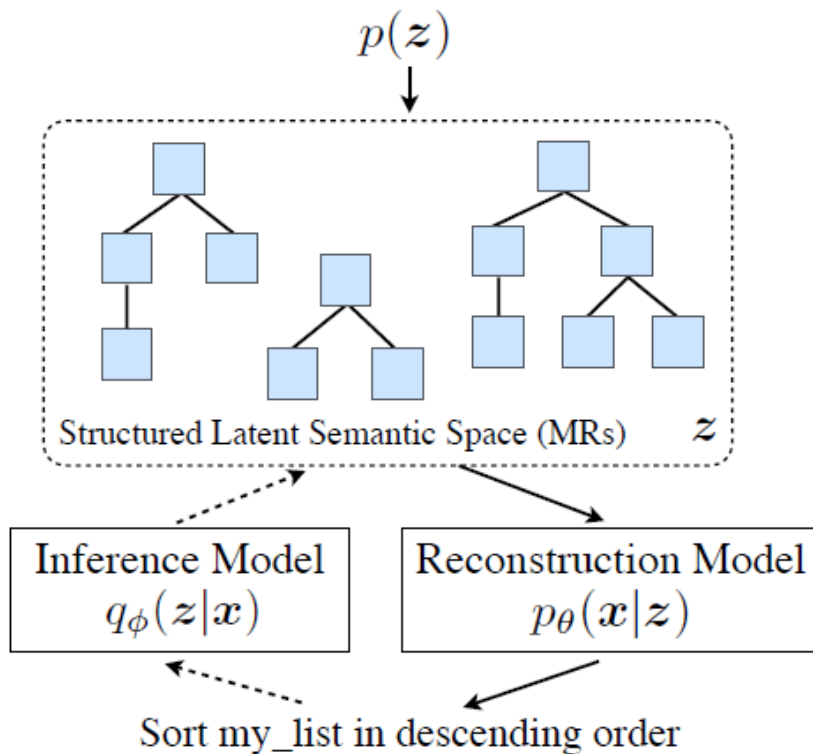
Text as Representation

- **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

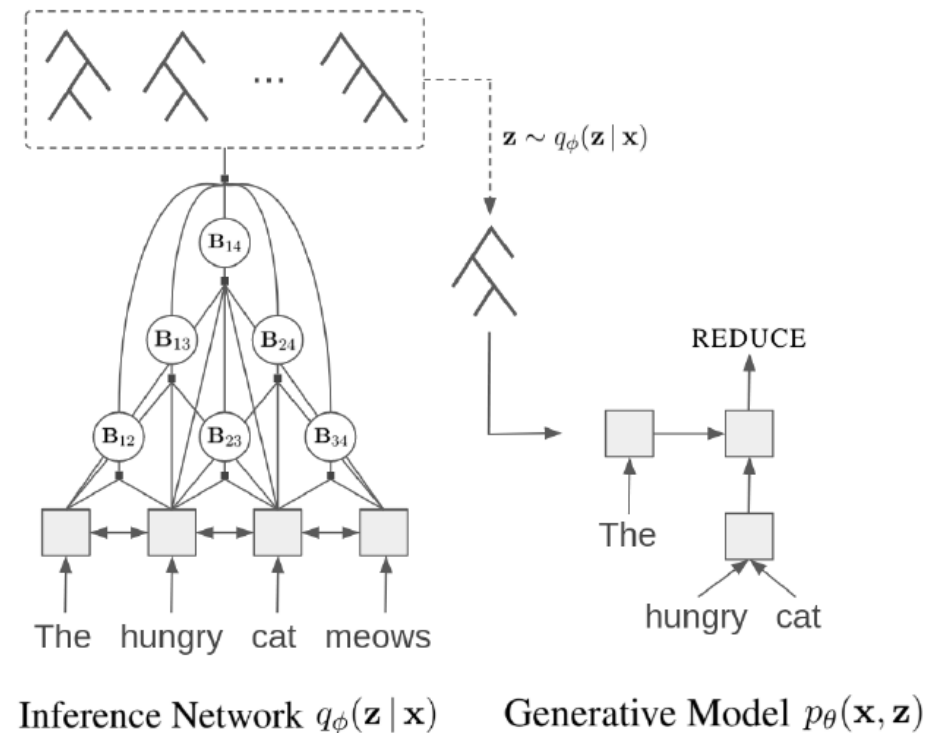
Text as Representation

- **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>

Outline

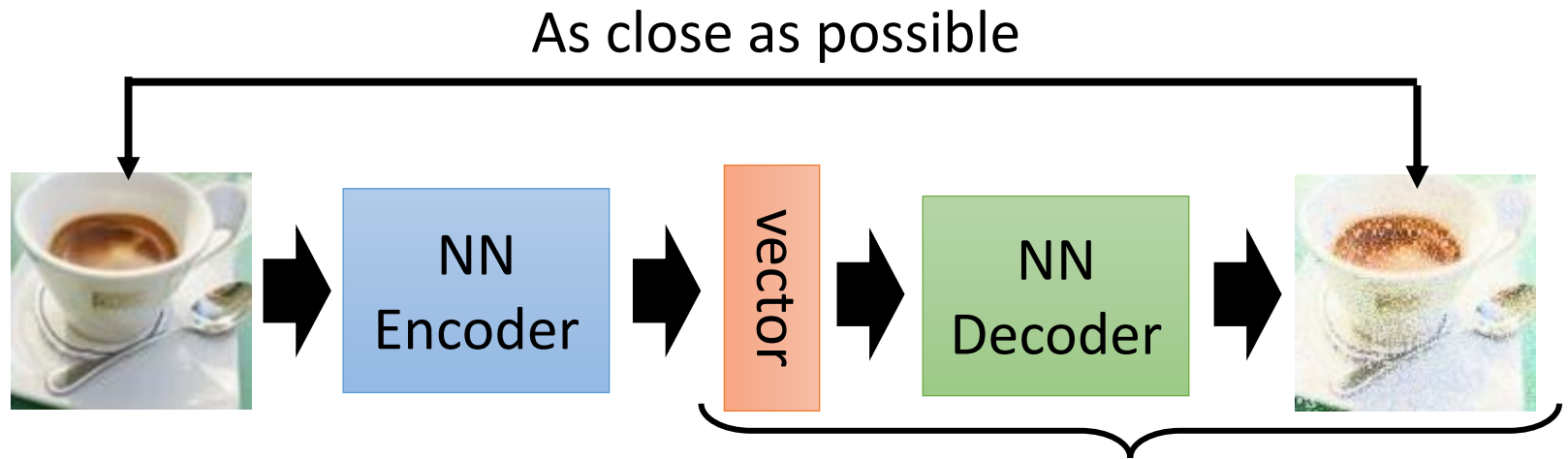
Basic Idea of Auto-encoder

Feature Disentanglement

Discrete Latent Representation

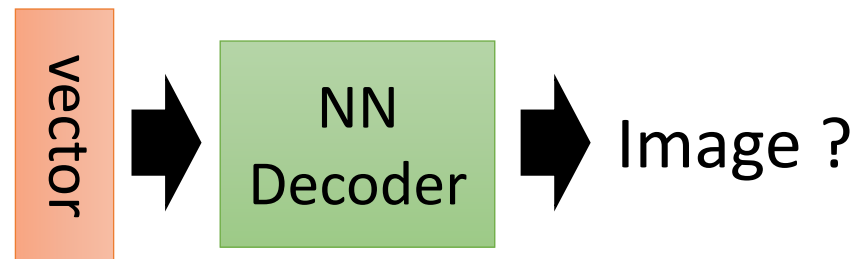
More Applications

Generator



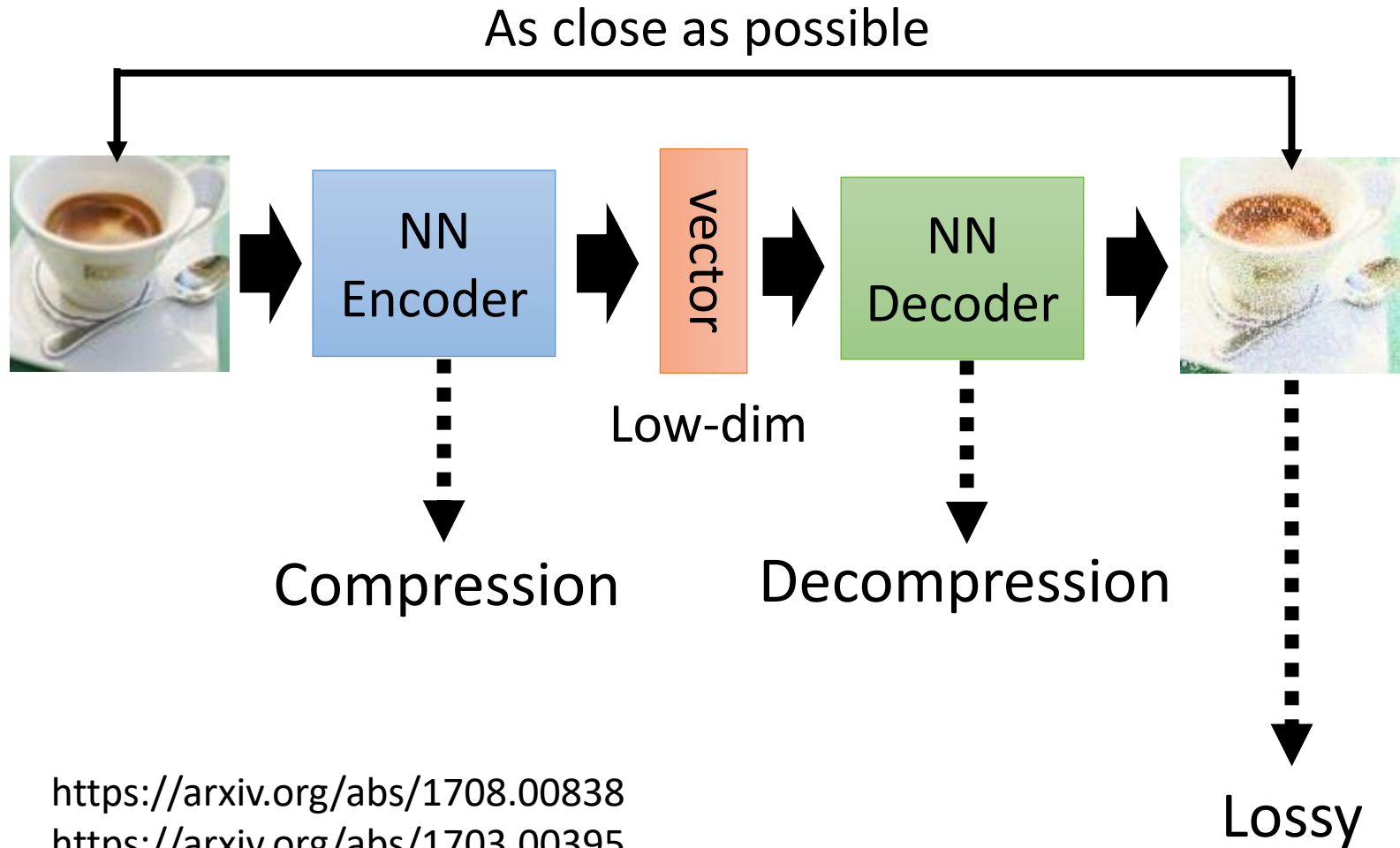
Is it a generator?

Randomly generate a
vector from a distribution



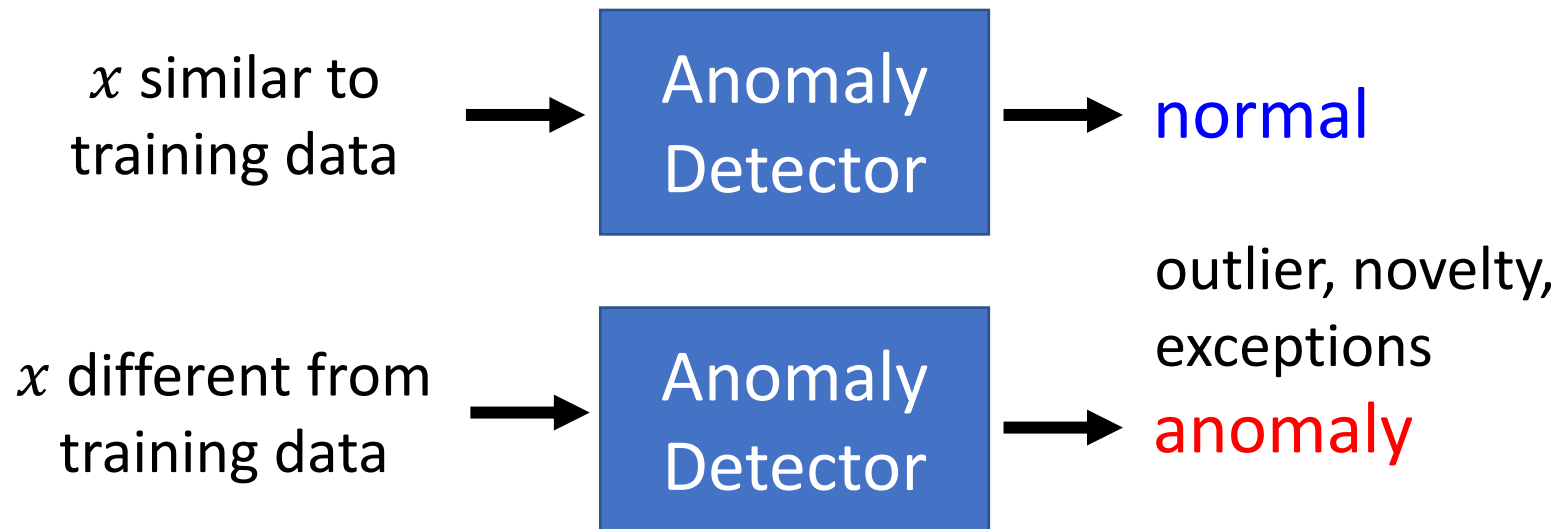
With some modification, we have **variational auto-encoder (VAE)**.

Compression



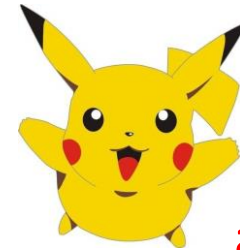
Anomaly Detection

- Given a set of training data $\{x^1, x^2, \dots, x^N\}$
- 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>

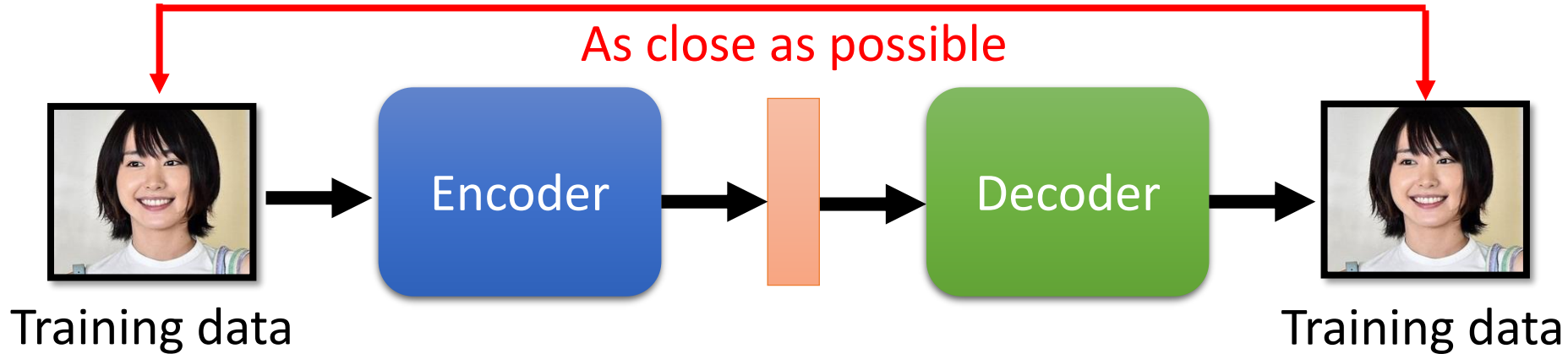
- Cancer Detection

- Training data: normal cells, x : cancer or not?
- Ref: <https://www.kaggle.com/uciml/breast-cancer-wisconsin-data/home>

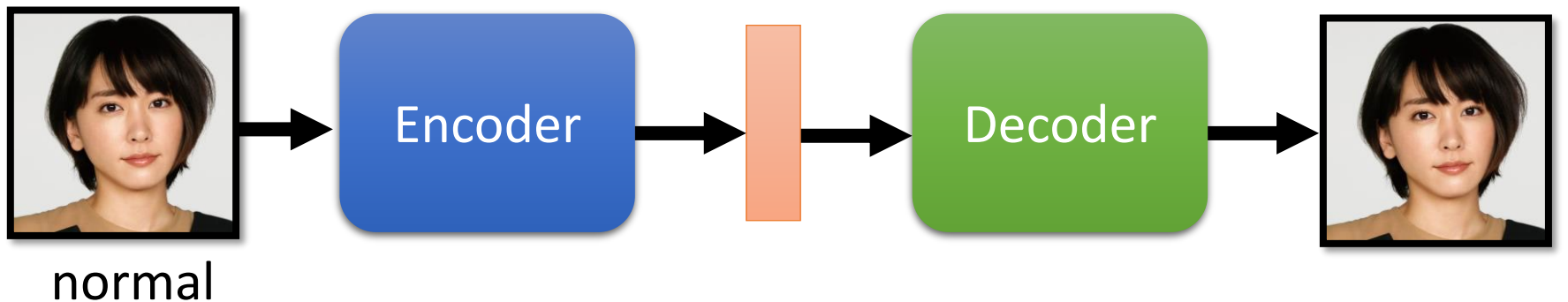
Approach: Auto-encoder

Training

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



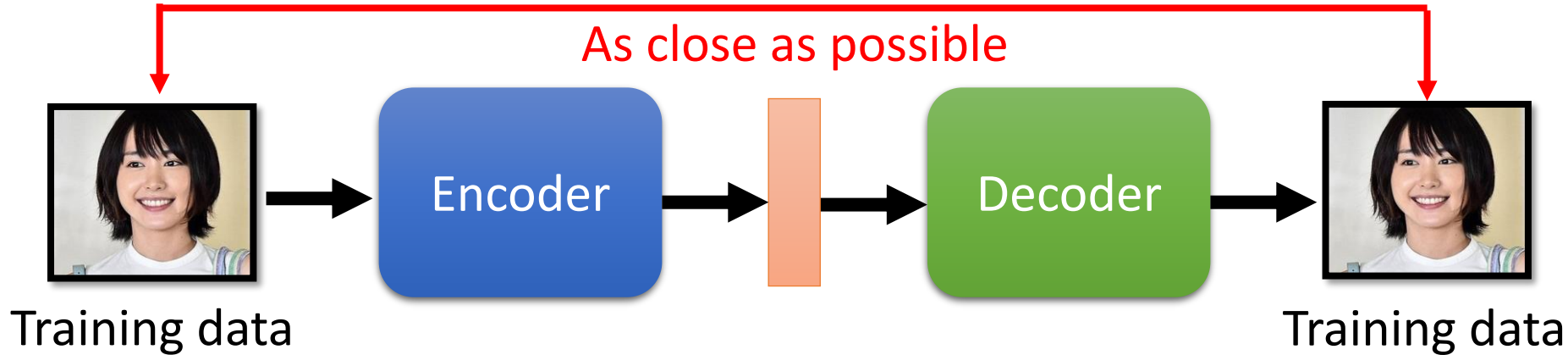
Testing



Approach: Auto-encoder

Training

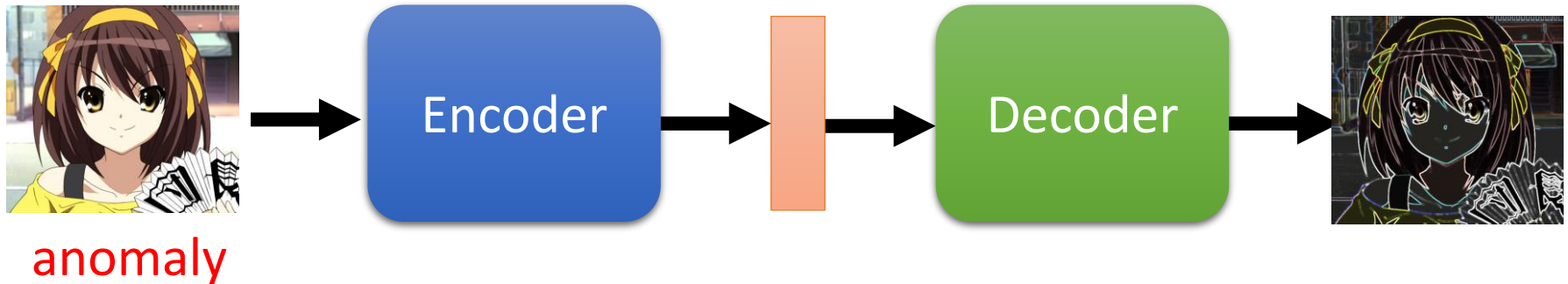
Using **real human faces** to learn an autoencoder



Testing

Large reconstruction loss \rightarrow anomaly

cannot be reconstructed



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

Feature Disentanglement

Discrete Latent Representation

More Applications