

# 李宏毅 (Hung-yi Lee) · HYLEE | Machine Learning (2021)

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GAN

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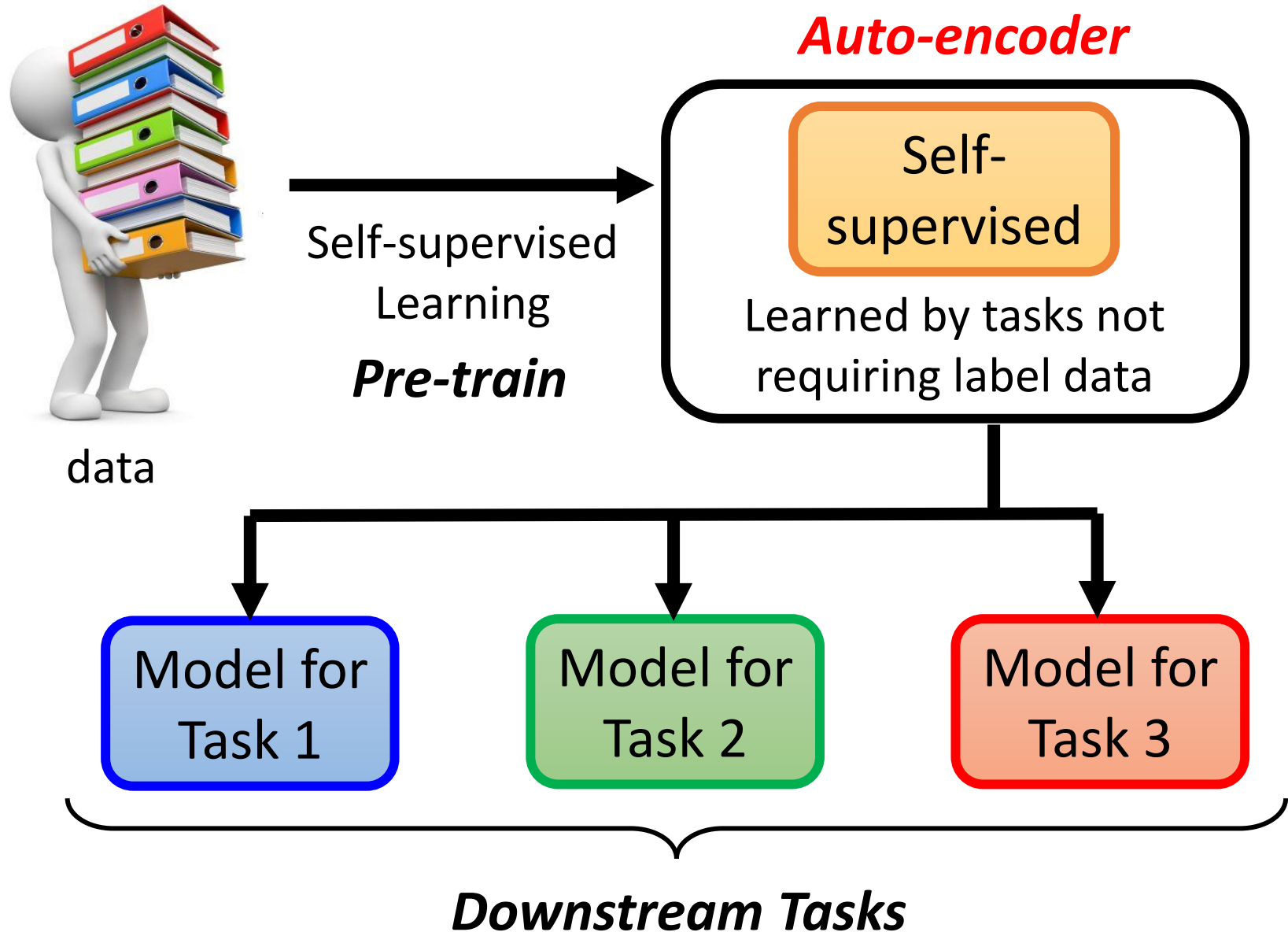
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# AUTO-ENCODER

Hung-yi Lee 李宏毅

# *Self-supervised Learning Framework*



# Outline

Basic Idea of Auto-encoder

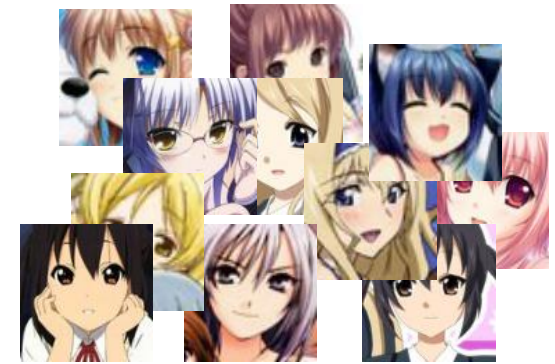
Feature Disentanglement

Discrete Latent Representation

More Applications

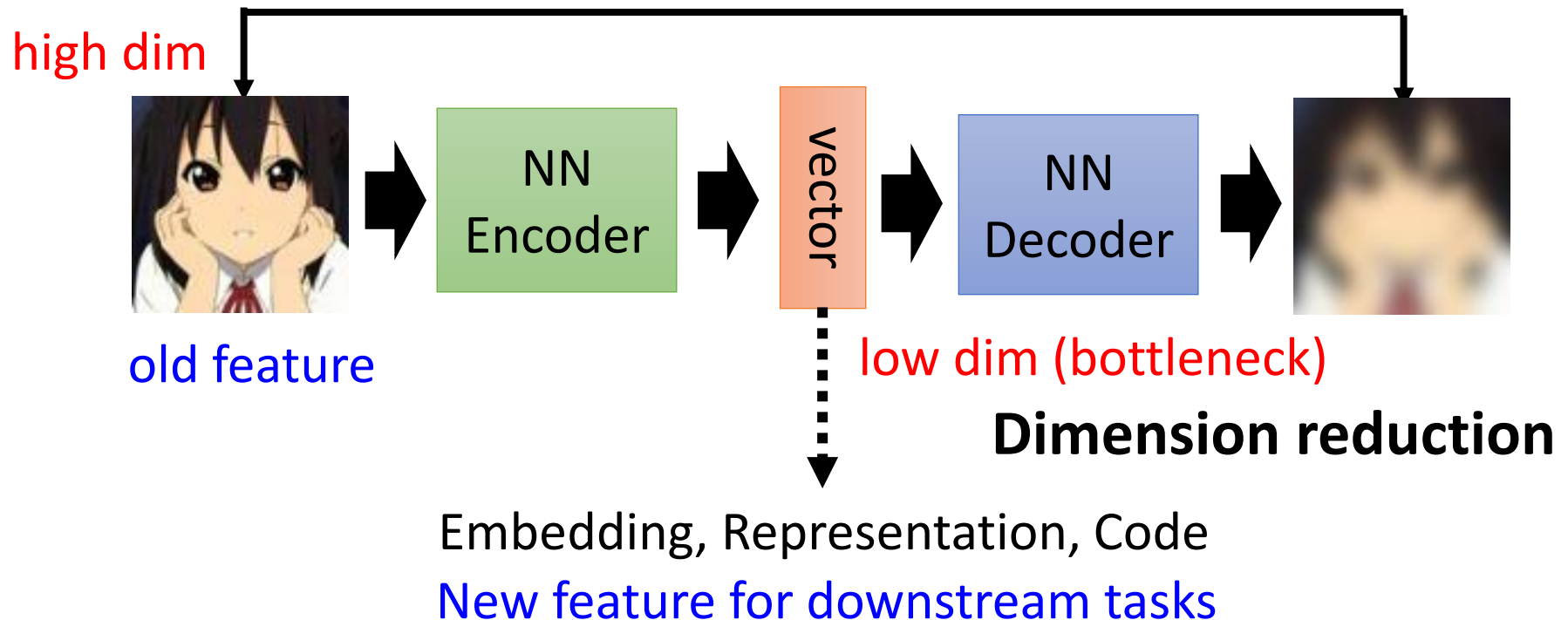
# Auto-encoder

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](https://youtu.be/iwh5o_M4BNU)

PCA



<https://youtu.be/GBUEjkpoxXc>

t-SNE

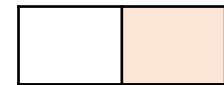
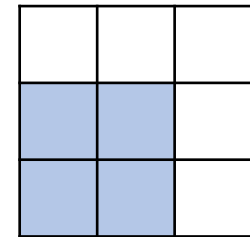
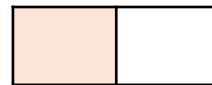
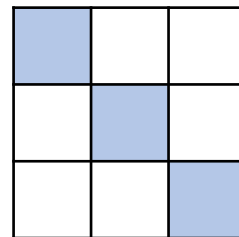
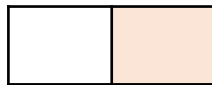
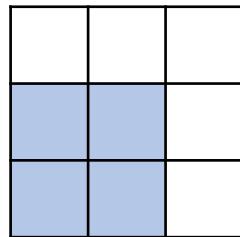
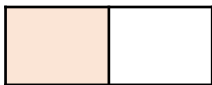
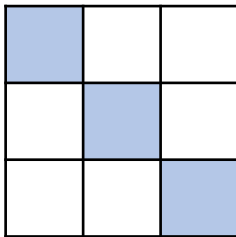
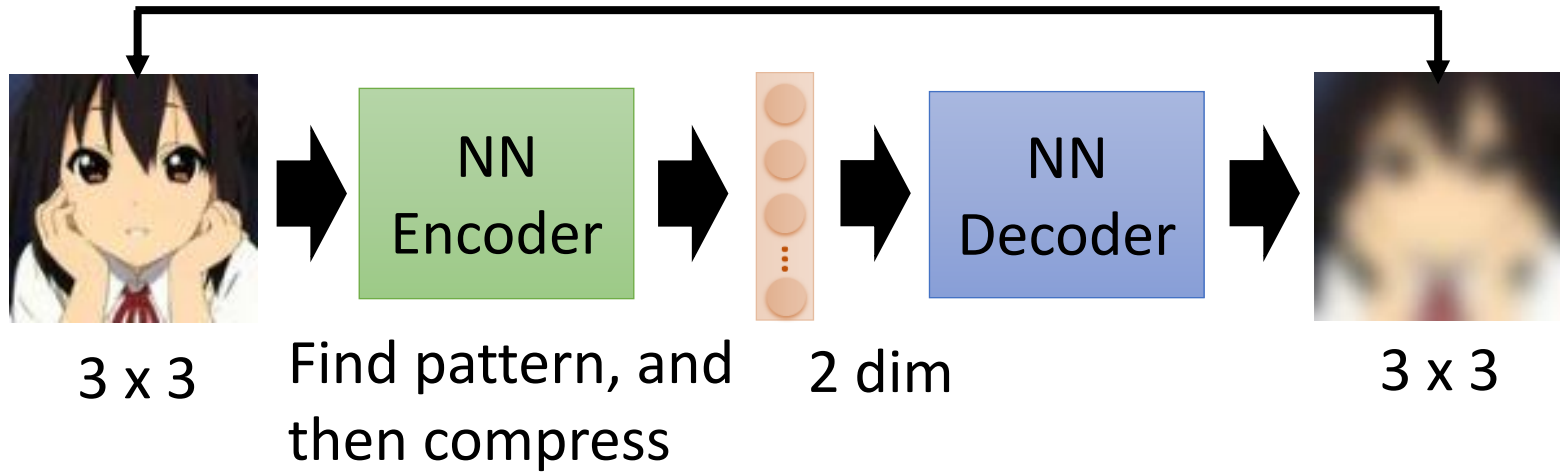
# Why Auto-encoder?



《神鵰俠侶》

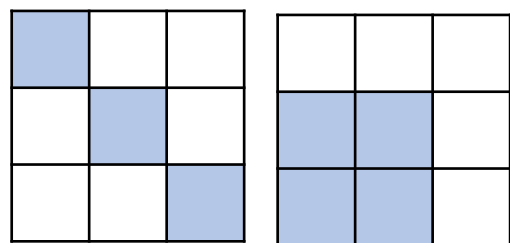
# Why Auto-encoder?

As close as possible (reconstruction)

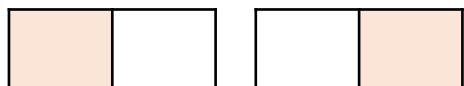




# Why Auto-encoder?



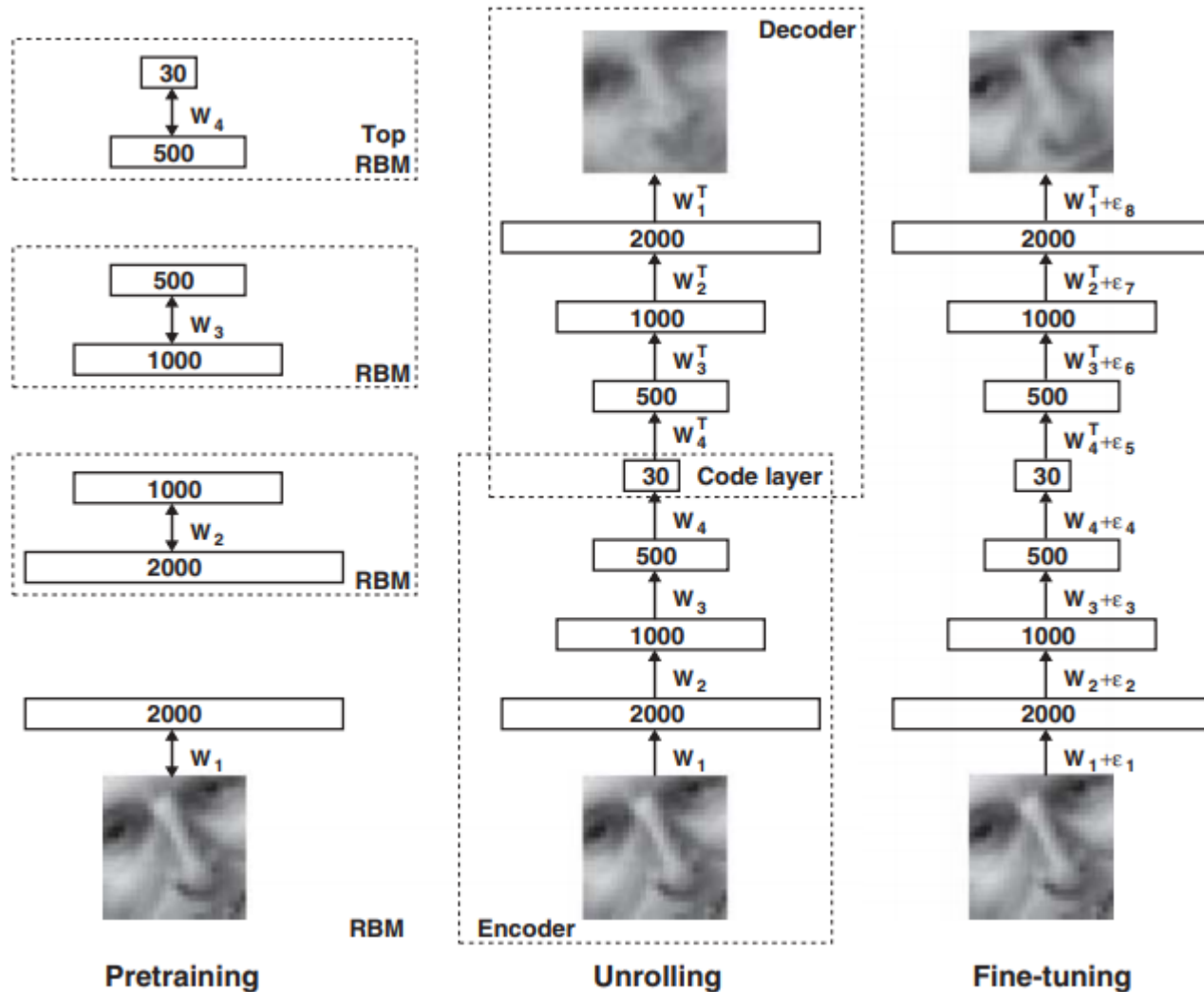
NN  
Encoder



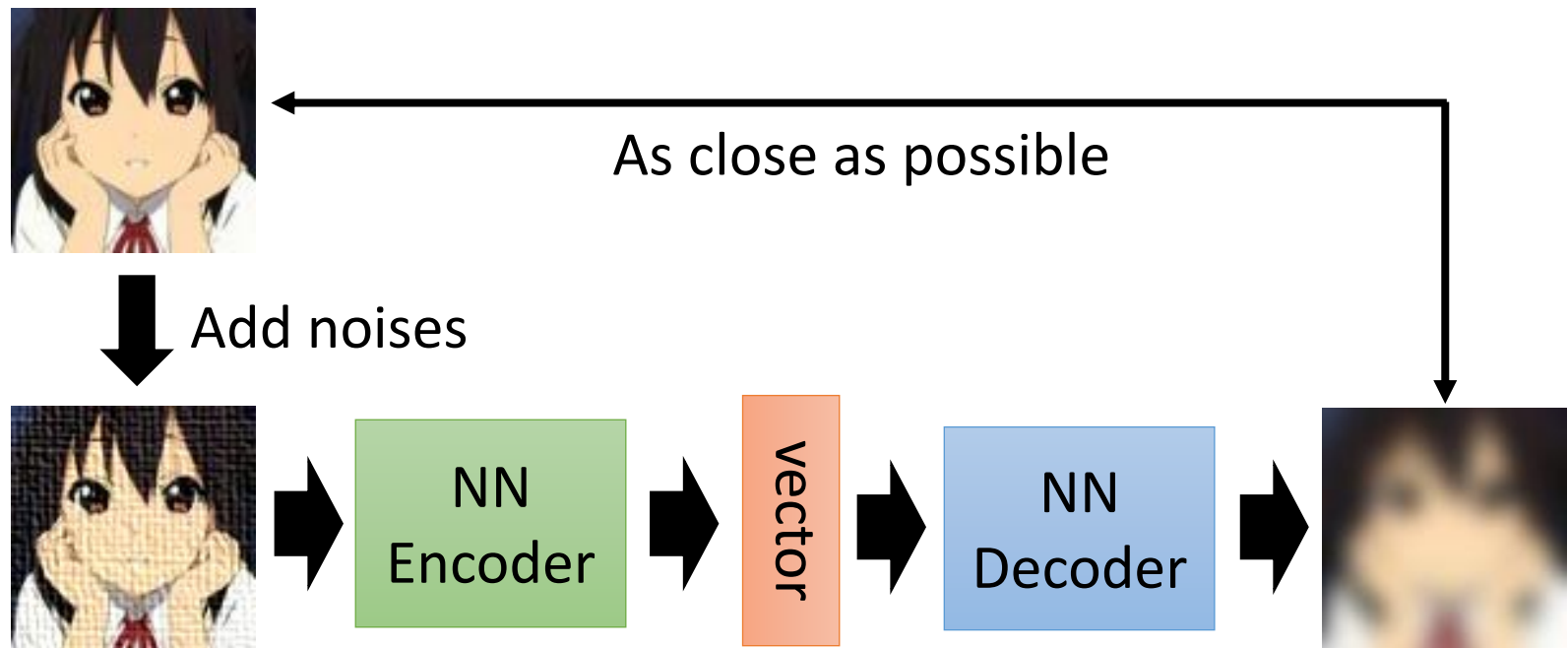
《神鵰俠侶》

# 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

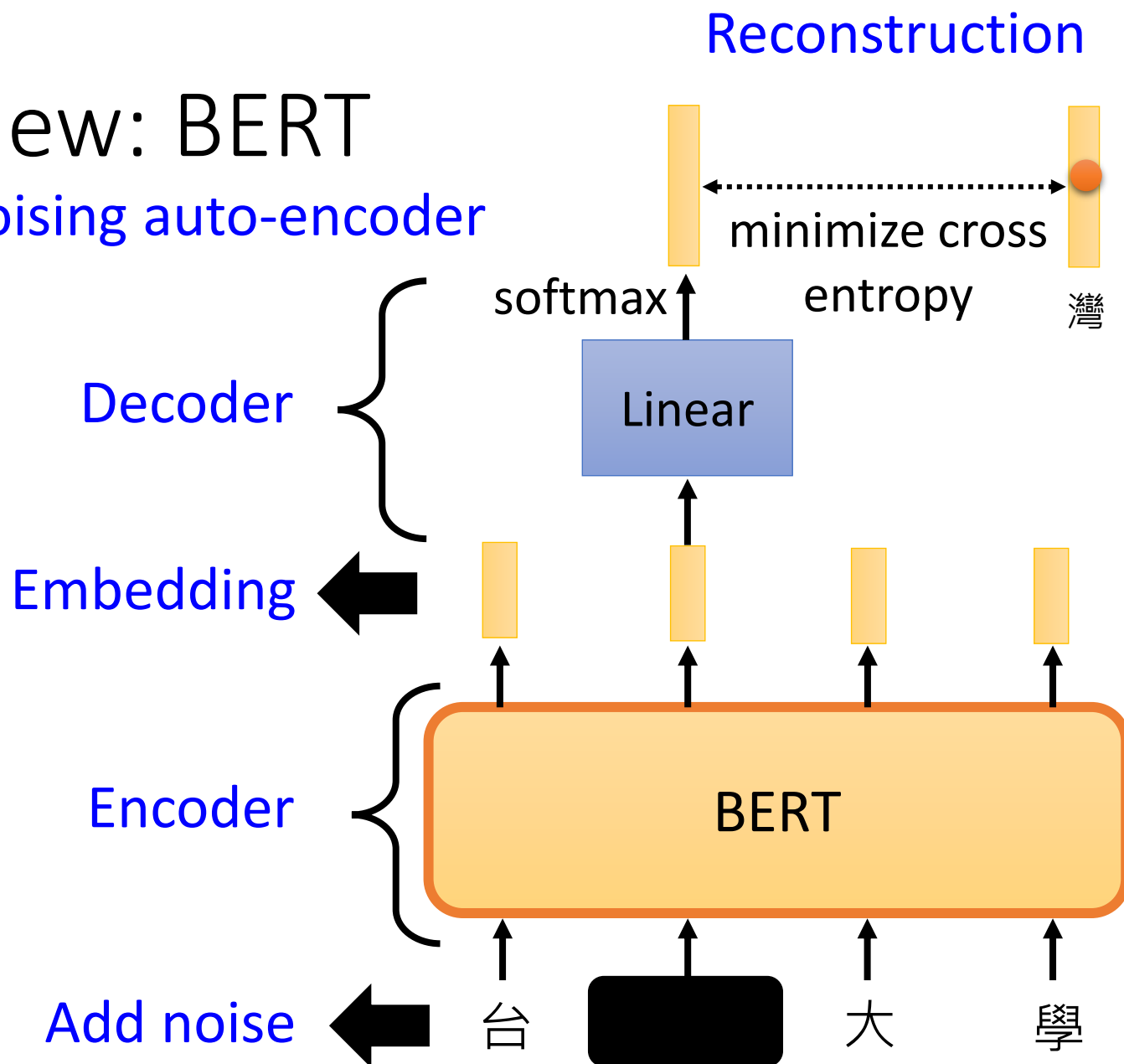


The idea sounds familiar? 😊

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

# Review: BERT

A de-noising auto-encoder



# Outline

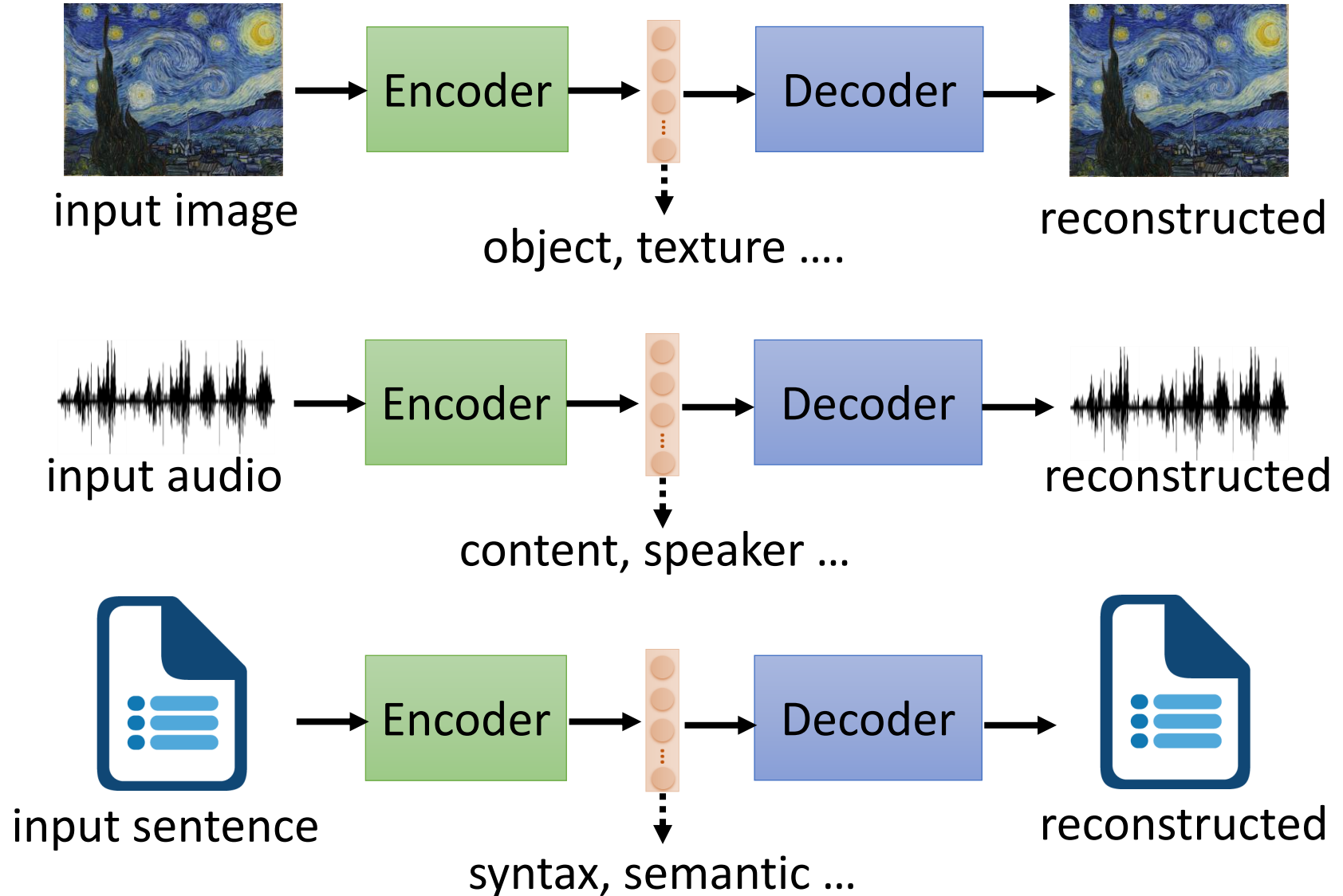
Basic Idea of Auto-encoder

Feature Disentanglement

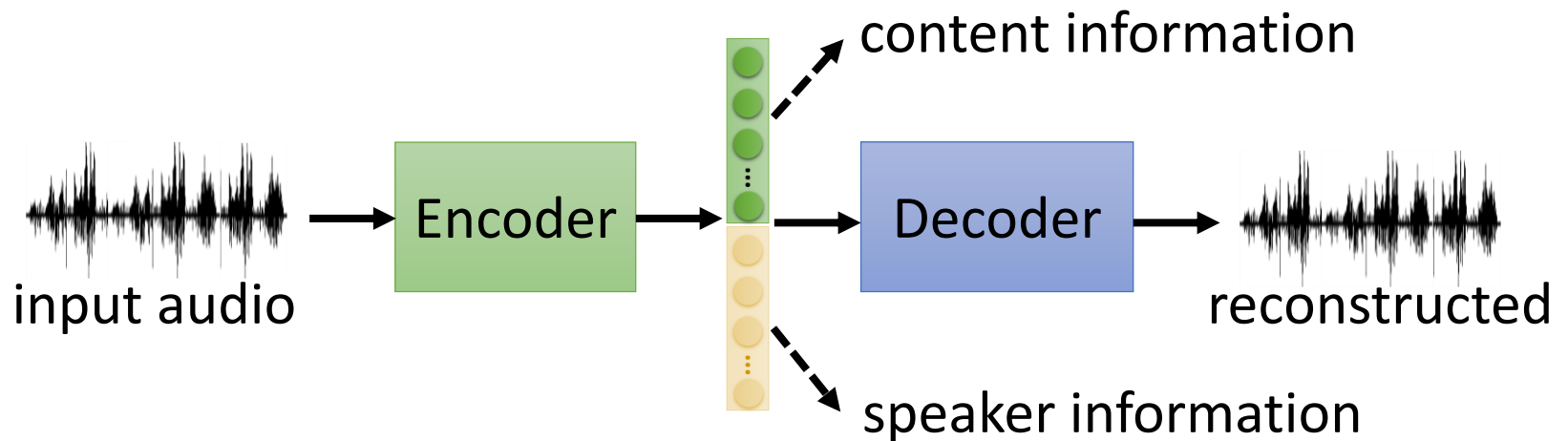
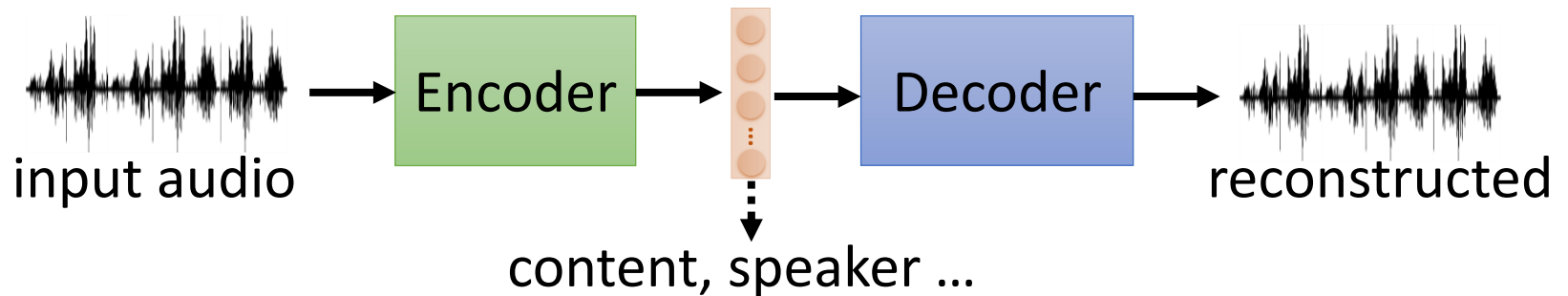
Discrete Latent Representation

More Applications

# *Representation includes information of different aspects*



# Feature Disentangle



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

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

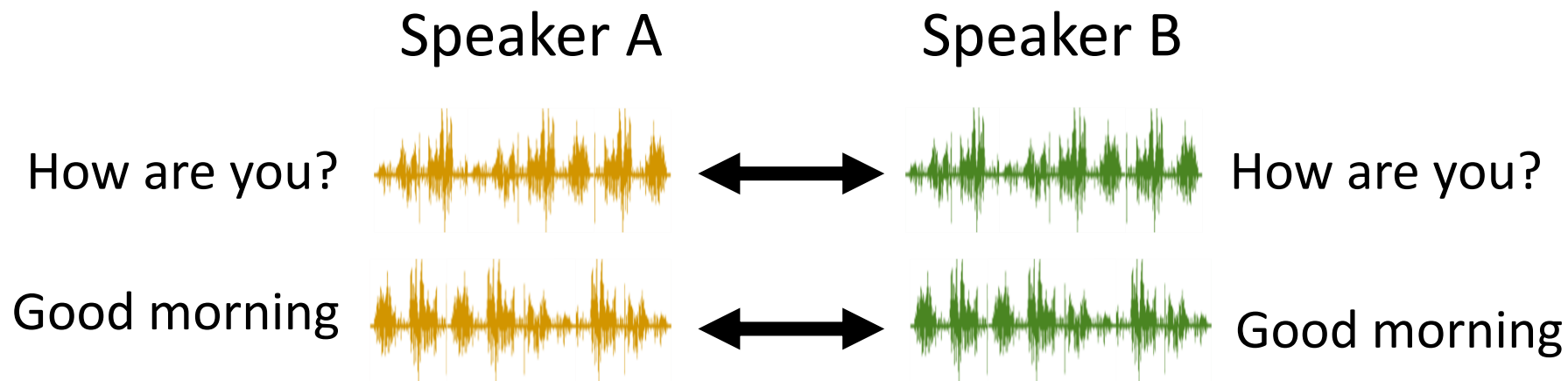
<https://arxiv.org/abs/1905.05879>



Application: Voice Conversion



## *In the past*

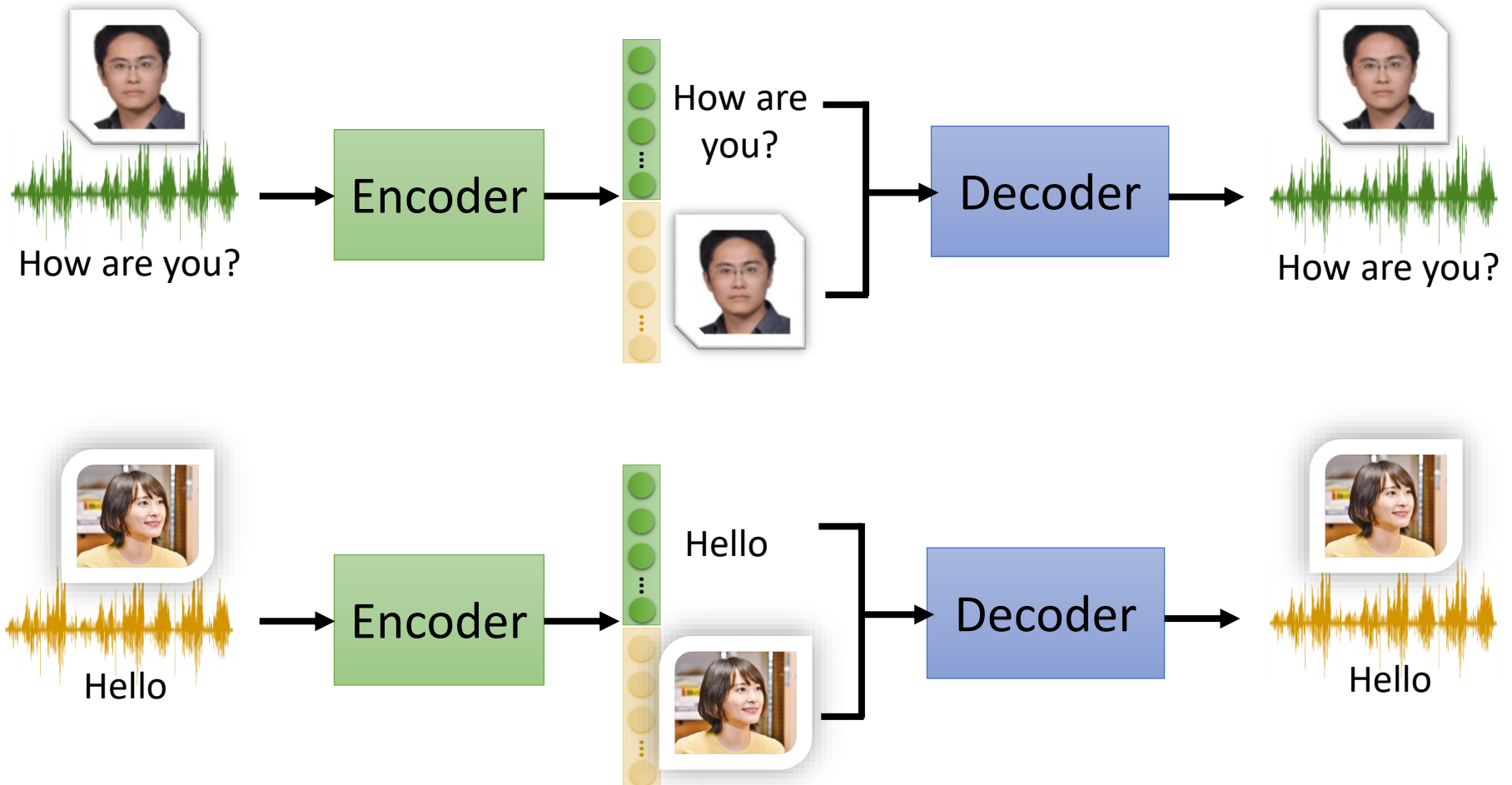


## *Today*

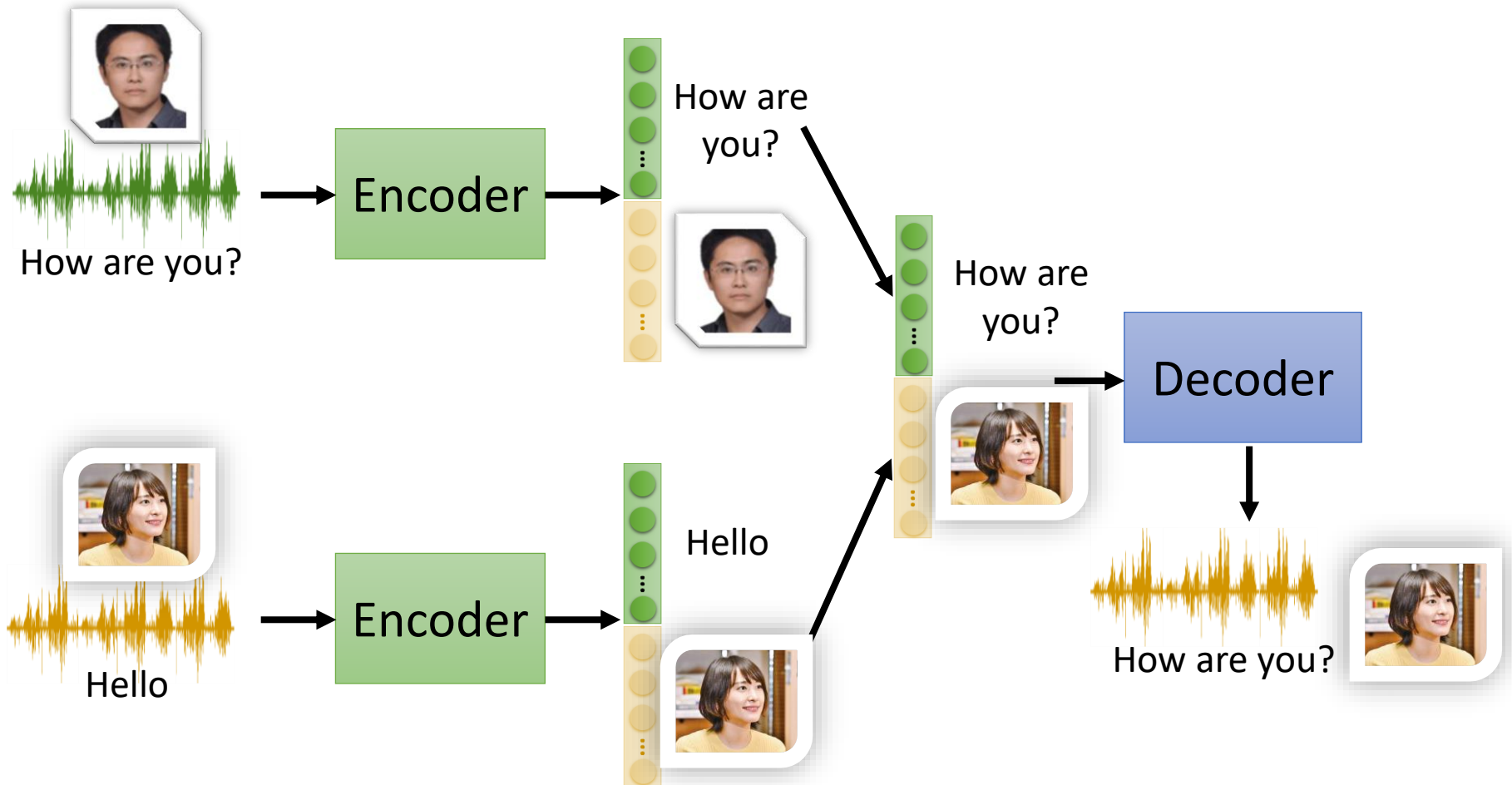


Speakers A and B are talking about completely different things.

# Application: Voice Conversion

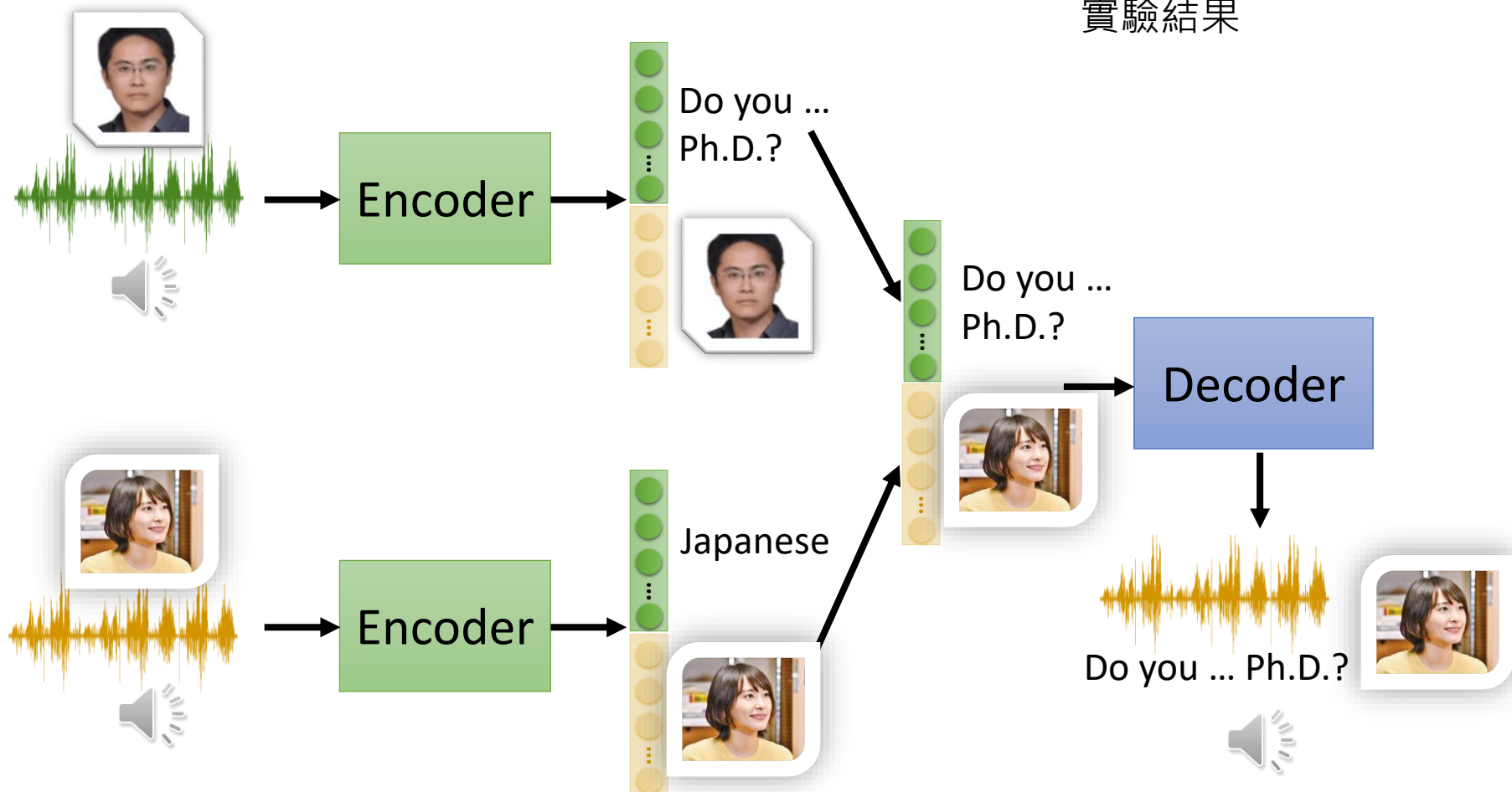


# Application: Voice Conversion



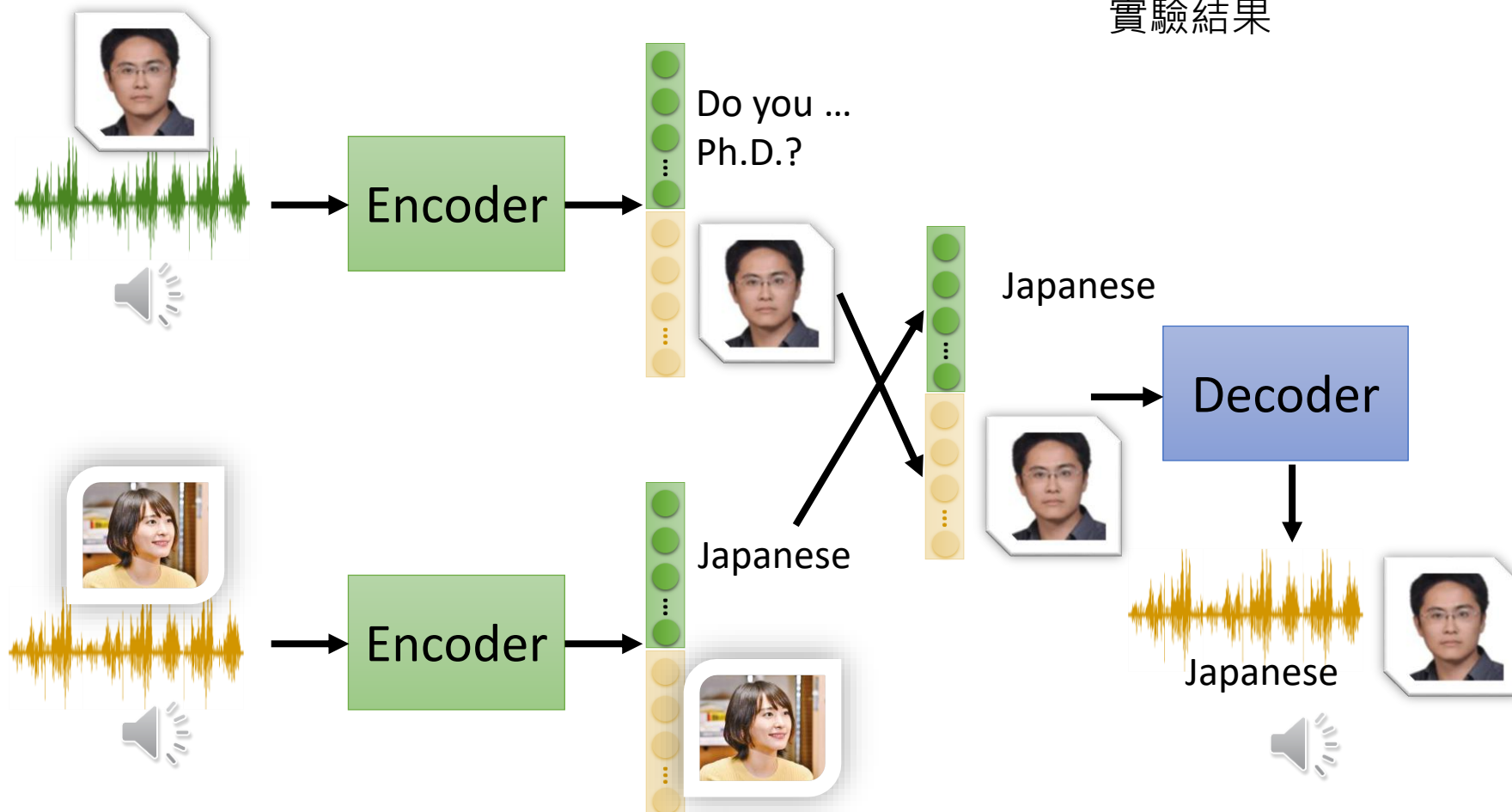
# Application: Voice Conversion

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

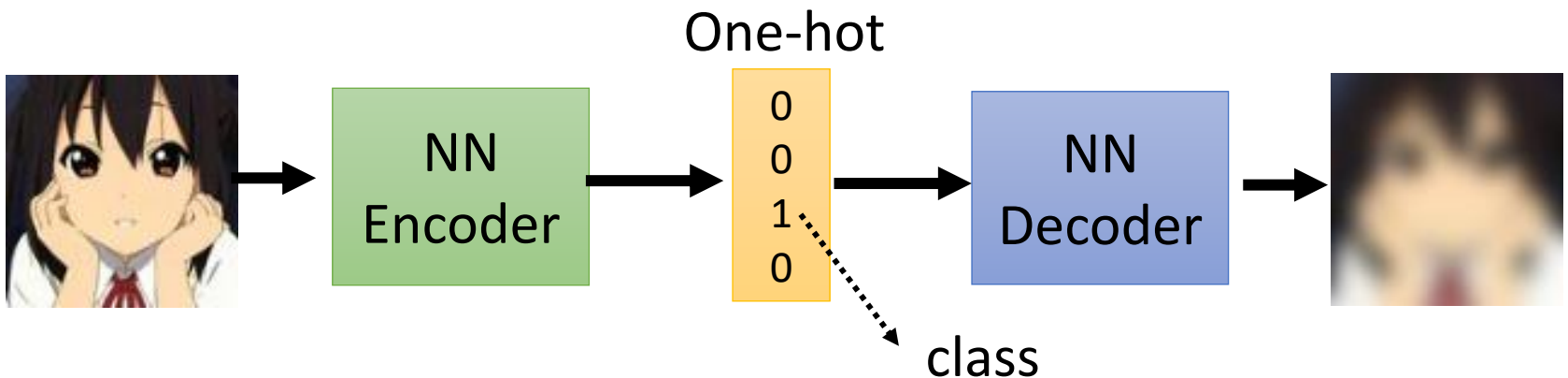
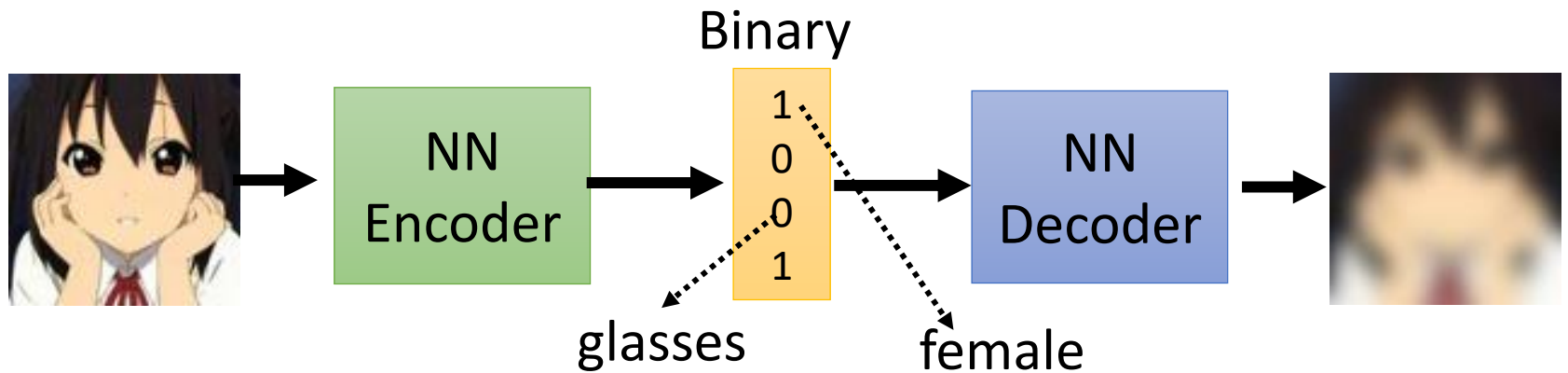
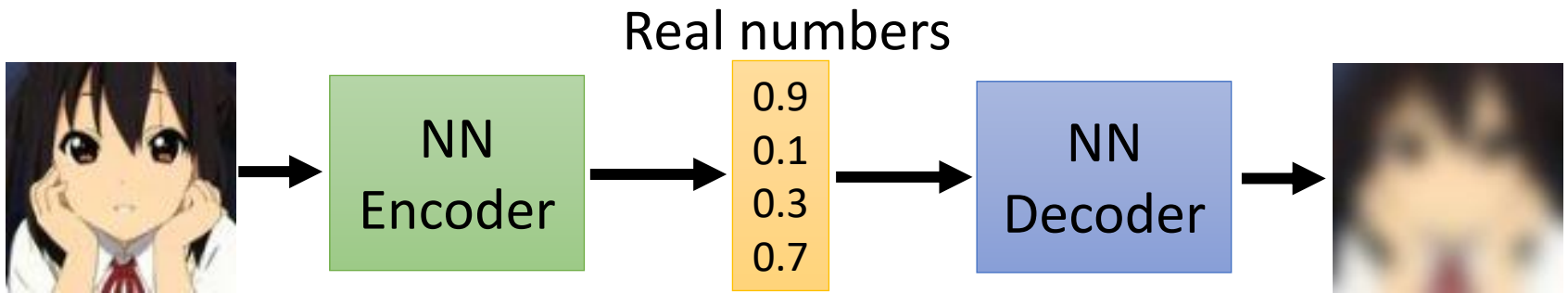
Basic Idea of Auto-encoder

Feature Disentanglement

Discrete Latent Representation

More Applications

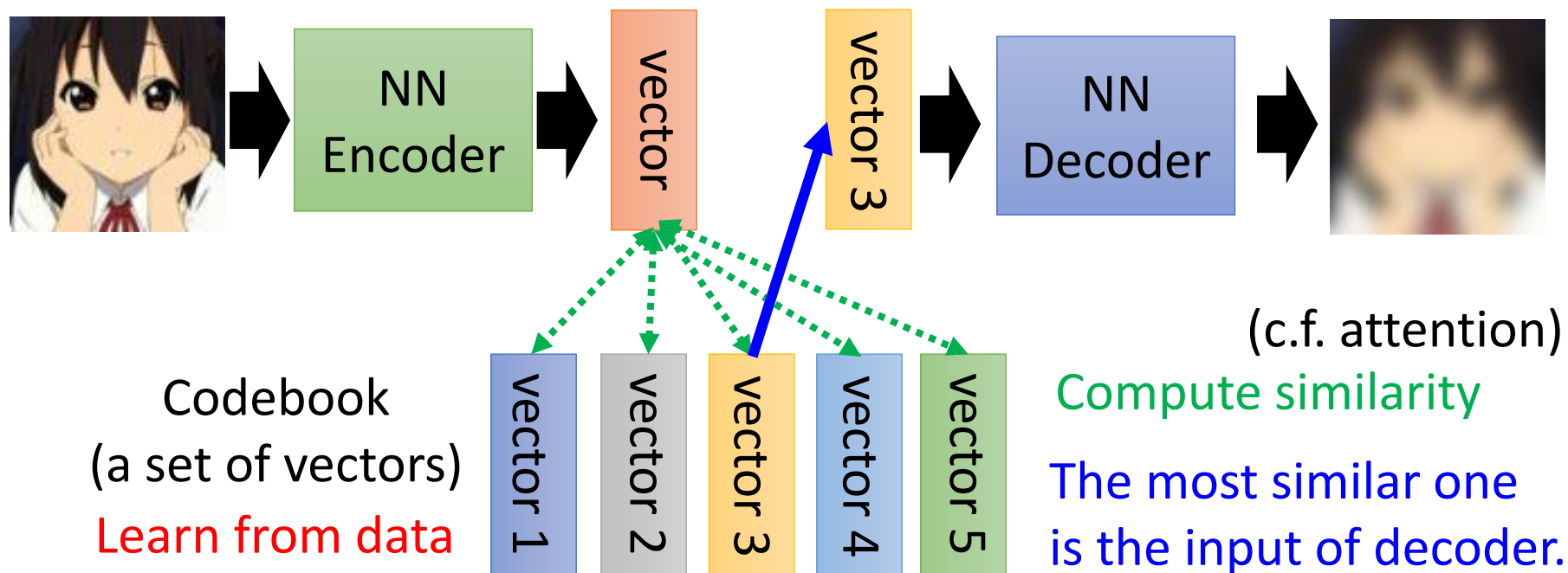
# Discrete Representation



# 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>



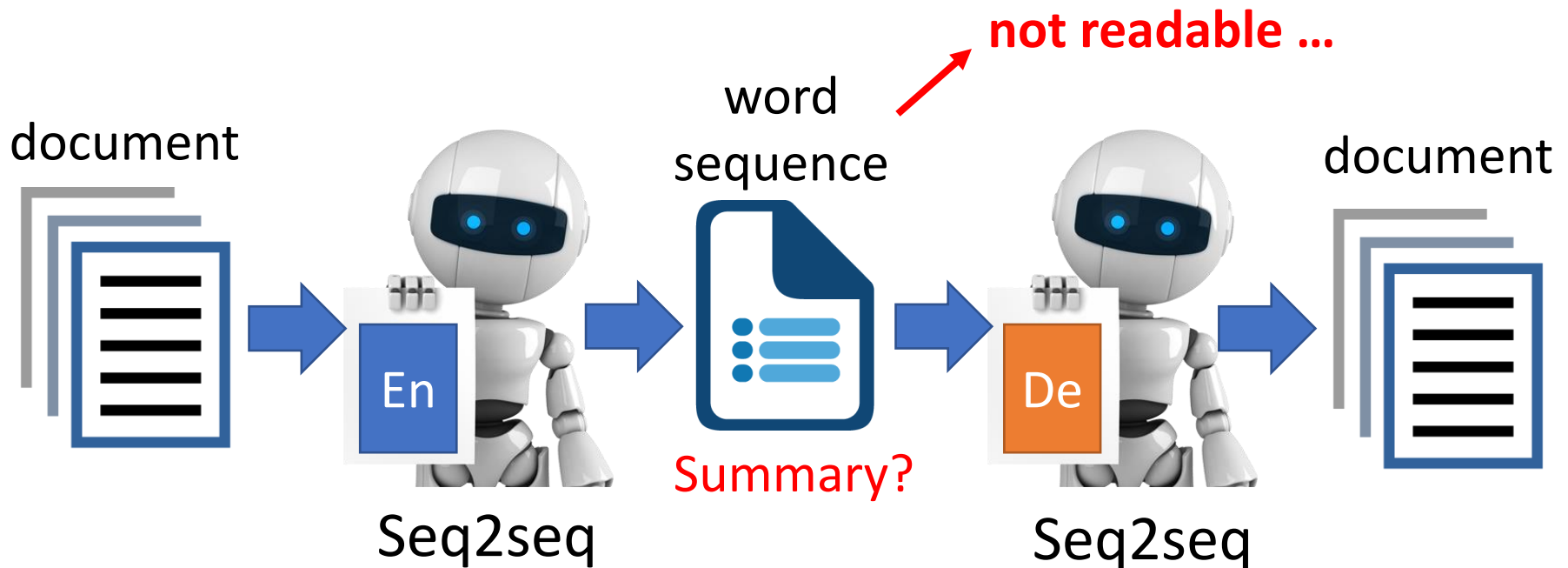
# Text as Representation

Only need a lot  
of documents to  
train the model



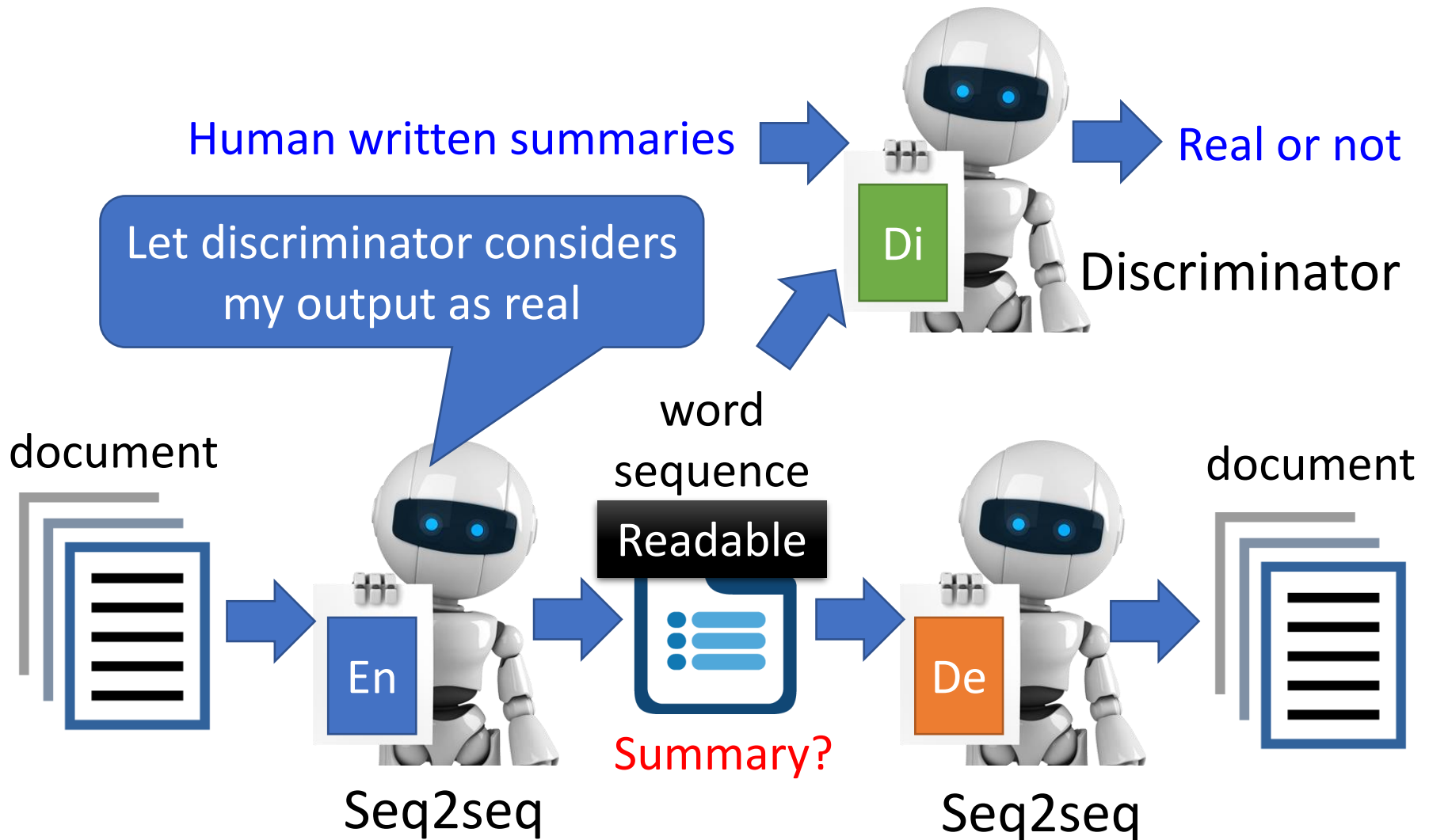
*seq2seq2seq*  
*auto-encoder*

**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



# Outline

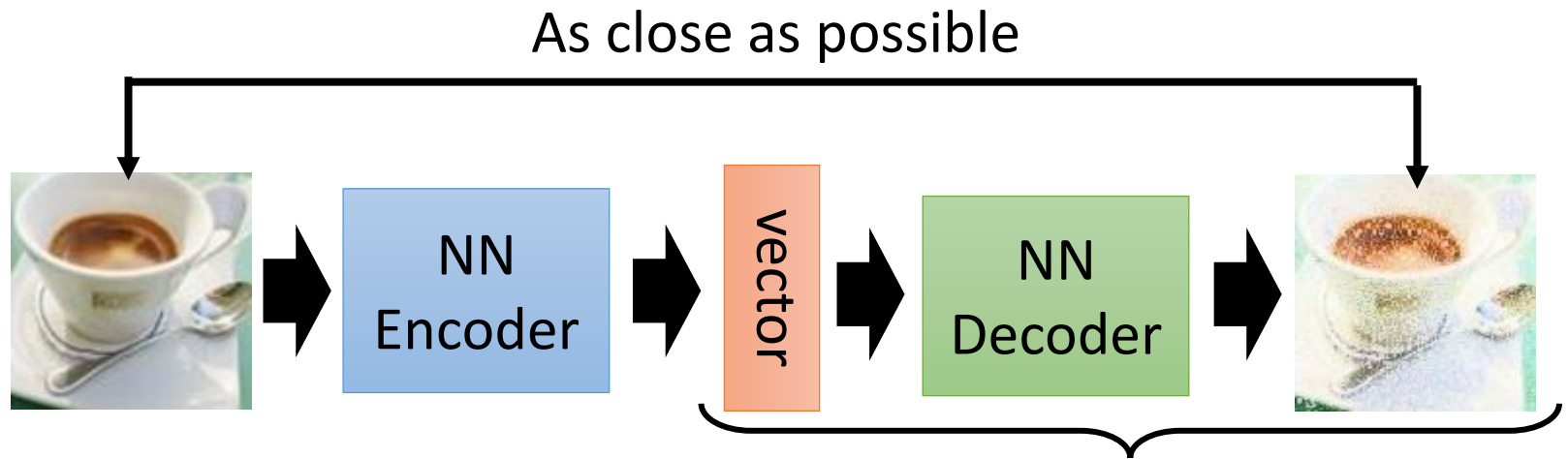
Basic Idea of Auto-encoder

Feature Disentanglement

Discrete Latent Representation

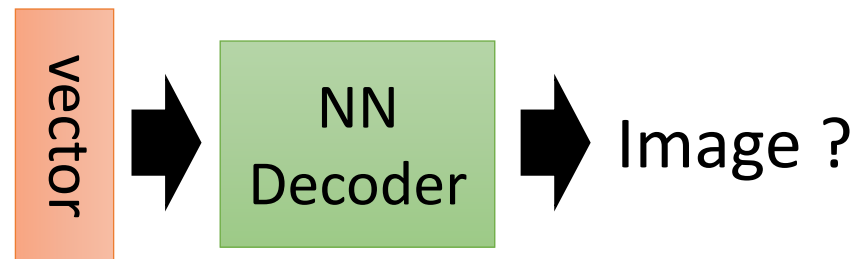
More Applications

# Generator



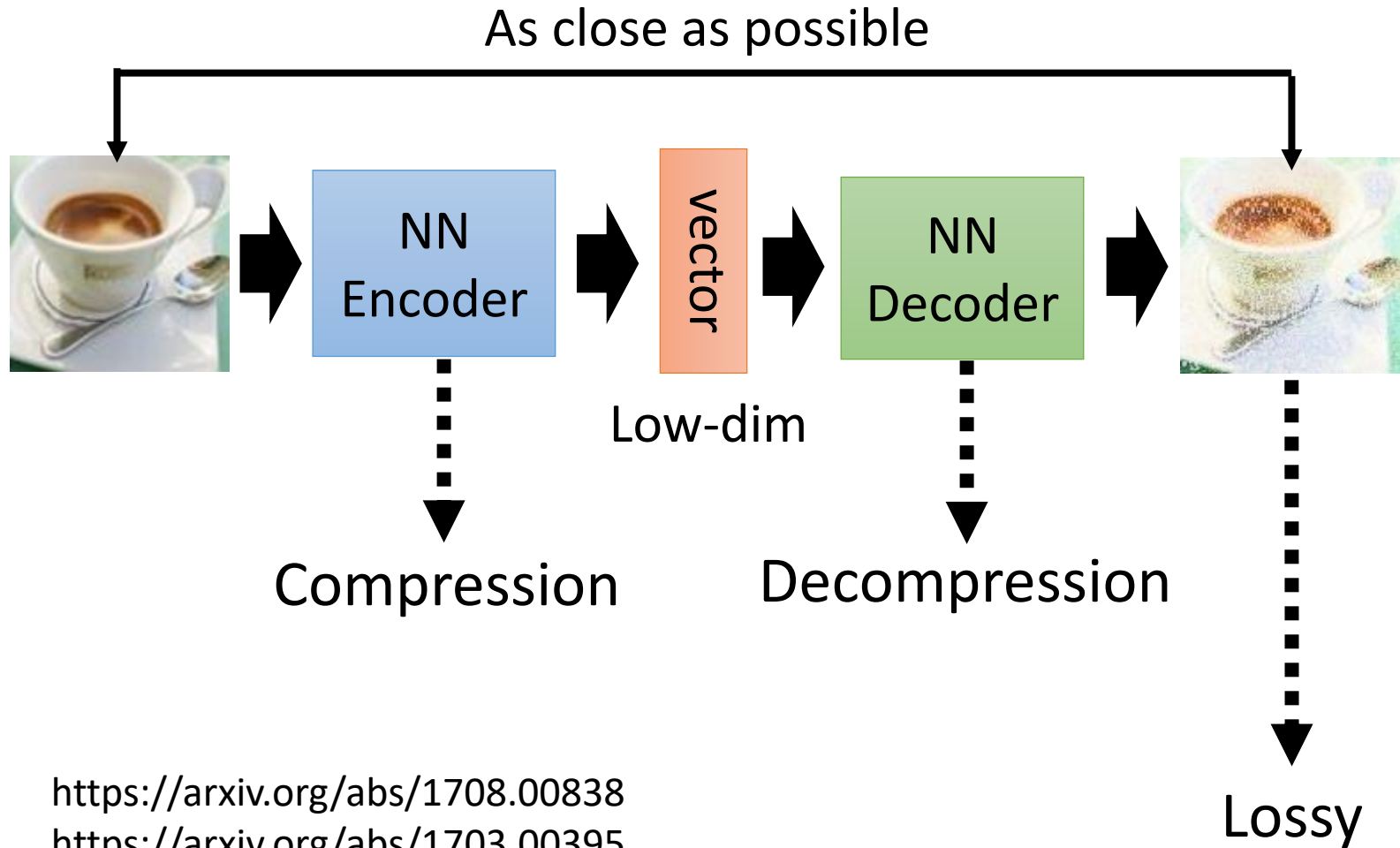
Is it a generator?

Randomly generate a  
vector from a distribution



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

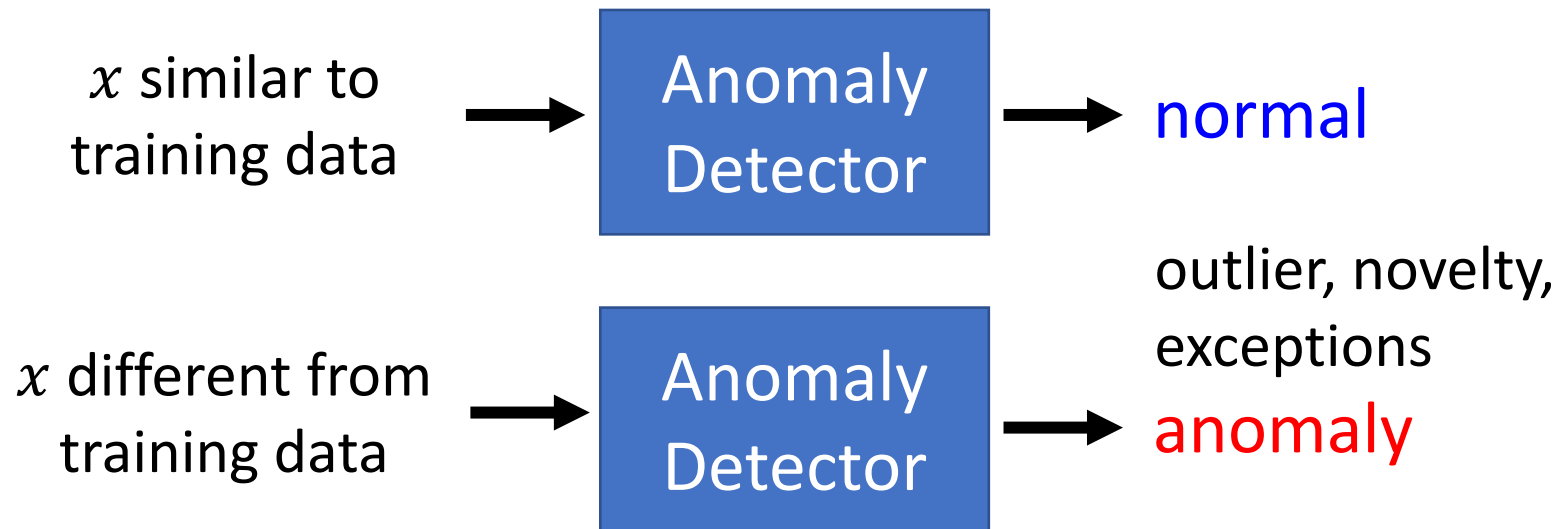
# Compression





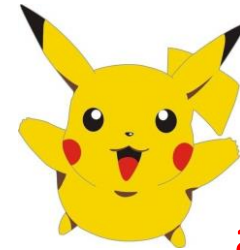
# Anomaly Detection

- 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>

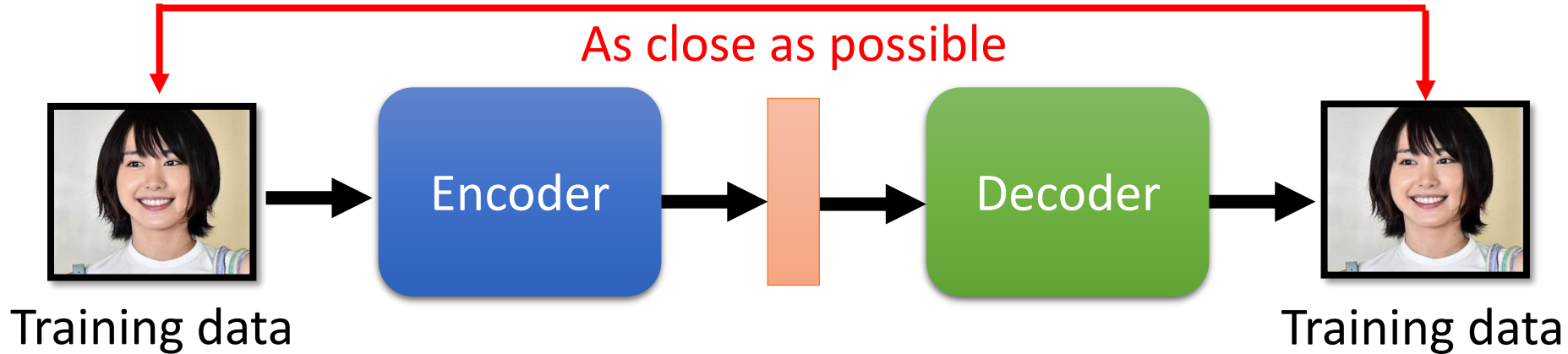
- Cancer Detection

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

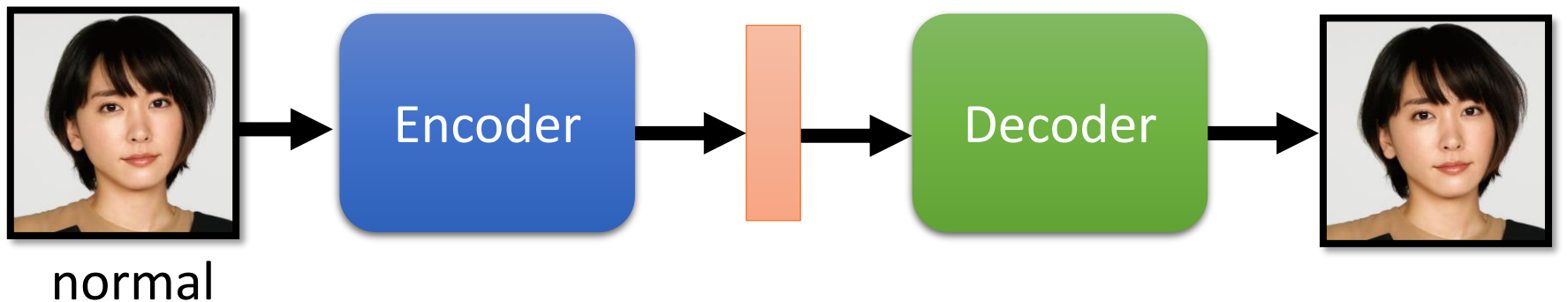
# Approach: Auto-encoder

## Training

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



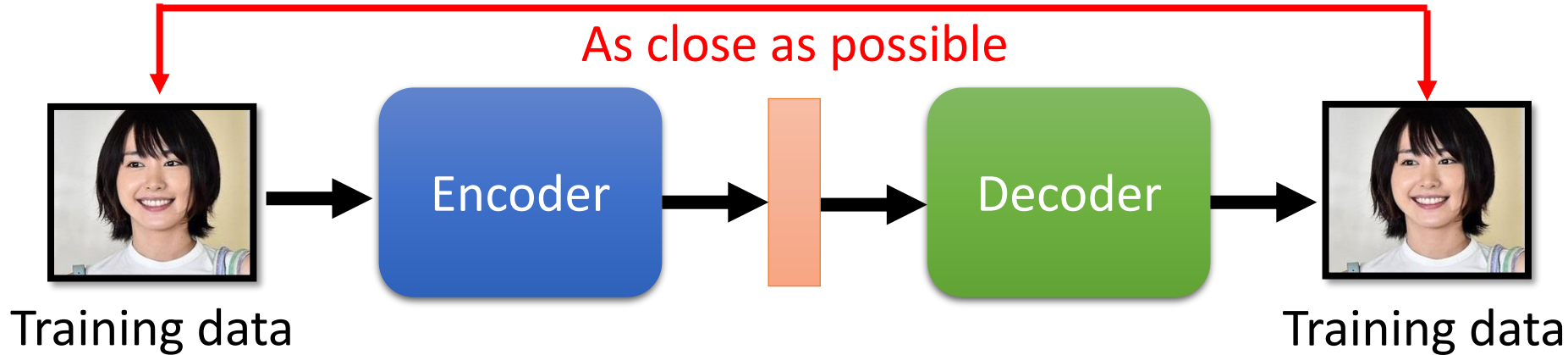
## Testing



# Approach: Auto-encoder

## Training

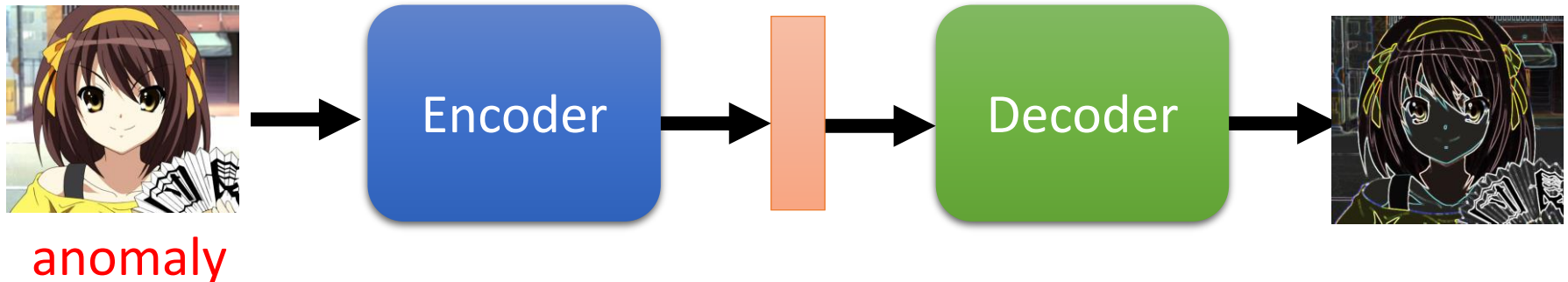
Using **real human faces** to learn an autoencoder



## Testing

Large reconstruction loss → 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

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