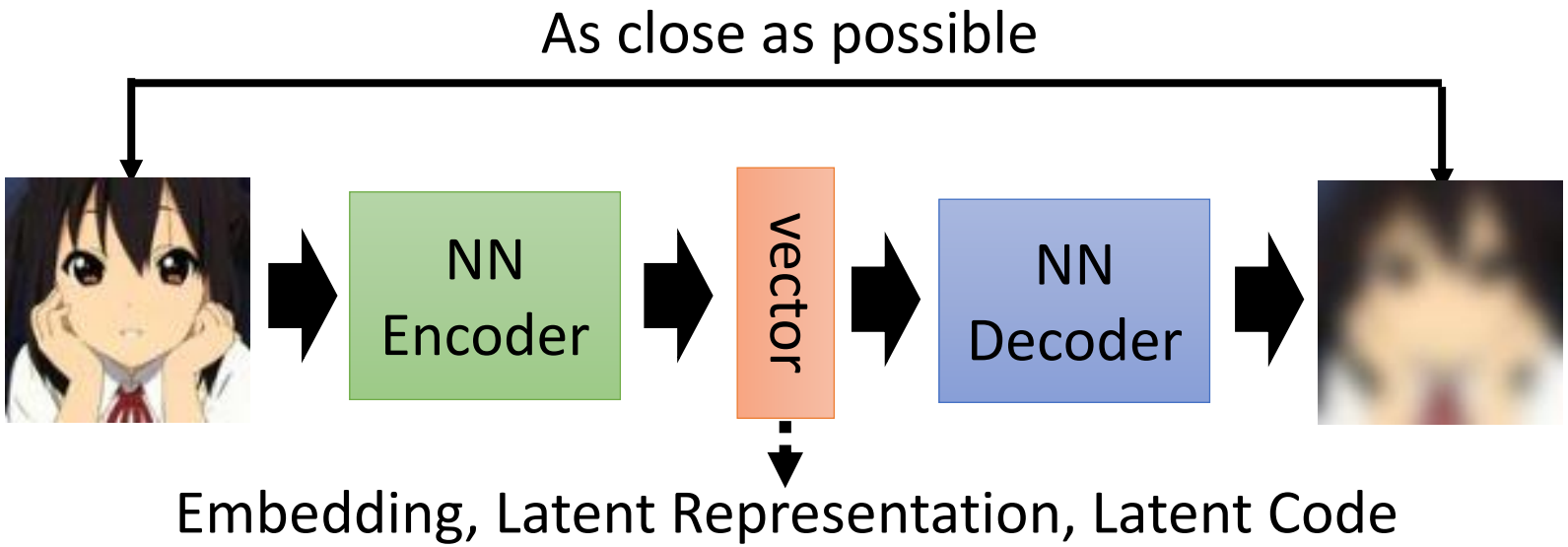
MORE ABOUT AUTO-ENCODER

Hung-yi Lee 李宏毅

Auto-encoder



- More than minimizing reconstruction error
- More interpretable embedding

What is good embedding?

- An embedding should represent the object.

是一對

不是一對

Beyond Reconstruction

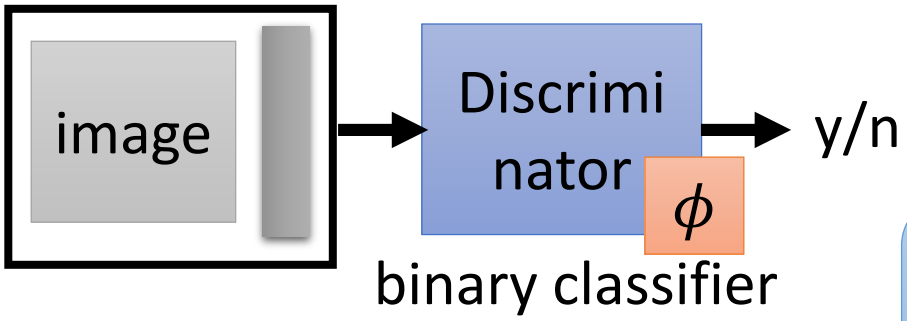
How to evaluate an encoder?

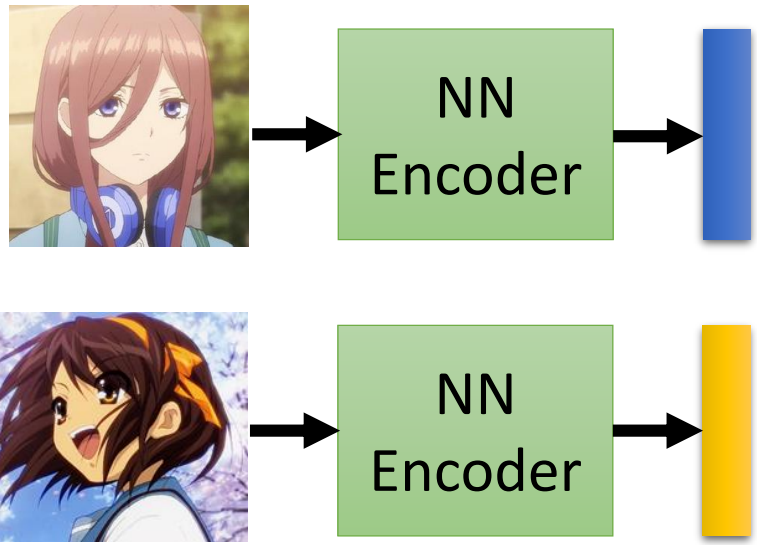
loss of the classification task is L_D

Train ϕ to minimize L_D

$$L_D^* = \min_{\phi} L_D$$

Small L_D^* ➡ The embeddings are representative.





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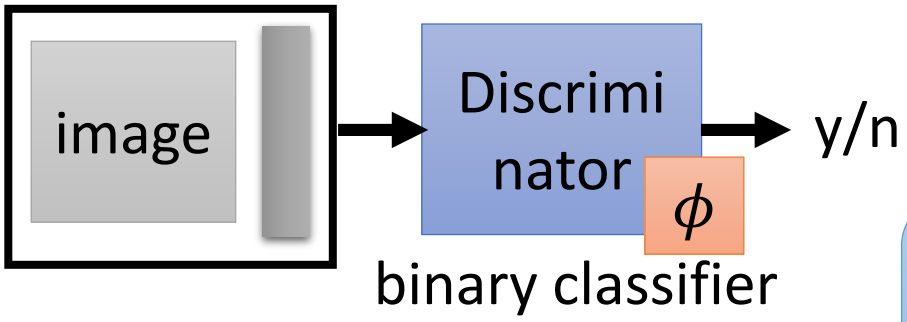
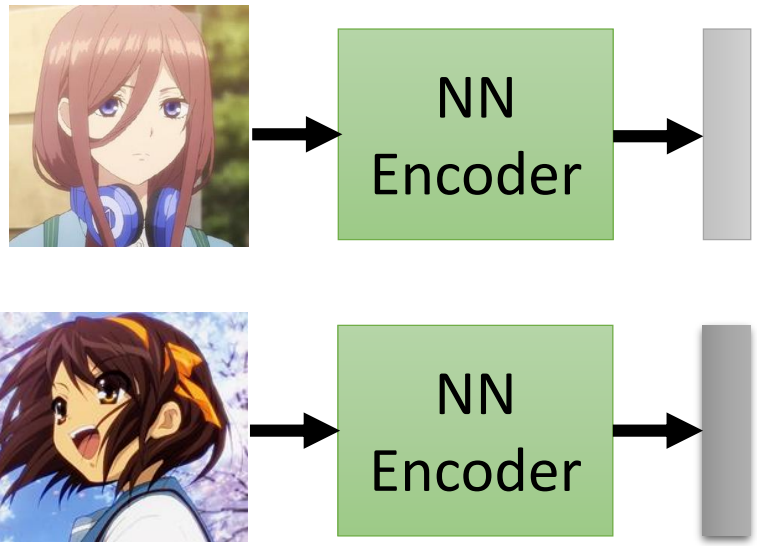
Large L_D^* ➡ Not representative





Beyond Reconstruction

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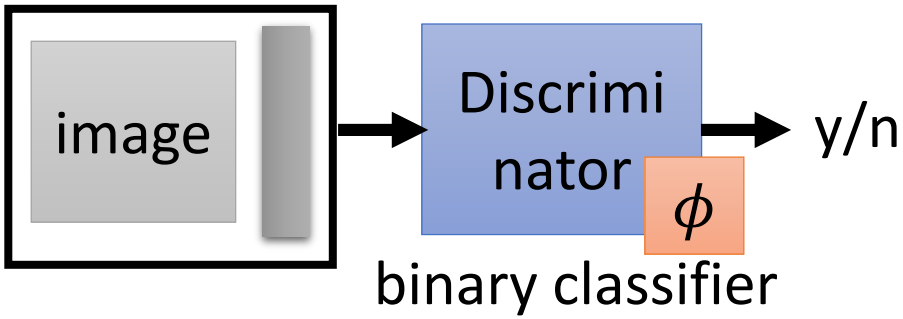


Train ϕ to minimize L_D

$$L_D^* = \min_{\phi} L_D$$

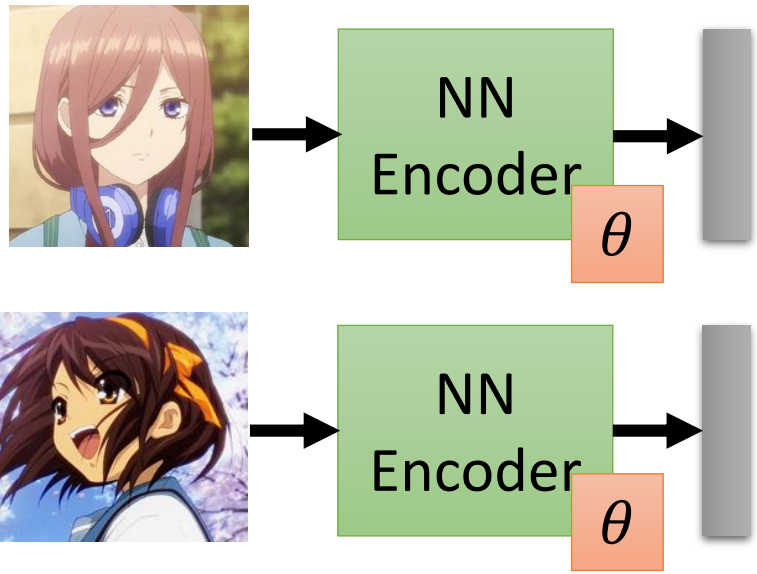
Small L_D^* ➡ The embeddings are representative.

Large L_D^* ➡ Not representative

Train θ to minimize L_D^*

$$\theta^* = arg \min_{\theta} L_D^*$$

$$= arg \min_{\theta} \min_{\phi} L_D$$

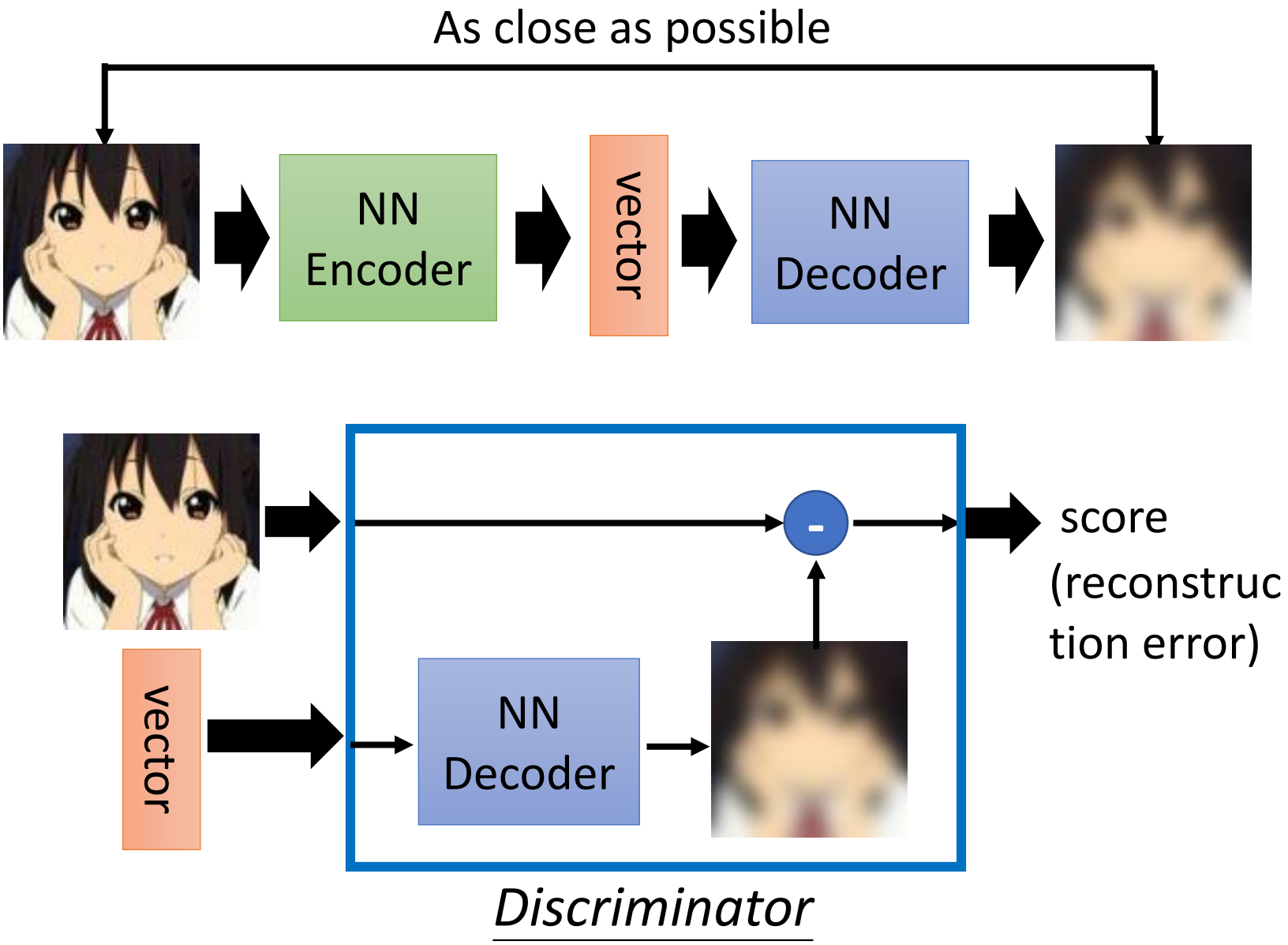


Train the encoder θ and discriminator ϕ to minimize L_D

Deep InfoMax (DIM)

(c.f. training encoder and decoder to minimize reconstruction error)

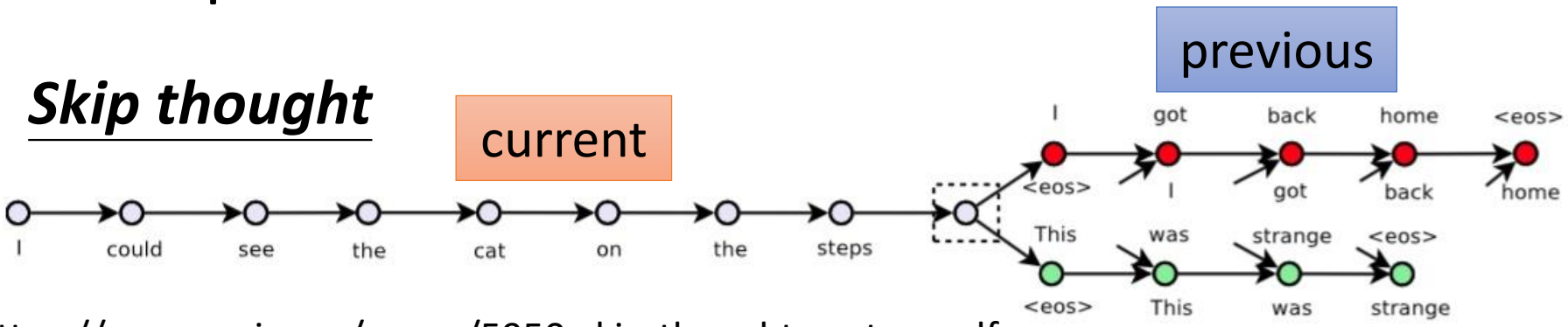
Typical auto-encoder is a special case



Sequential Data

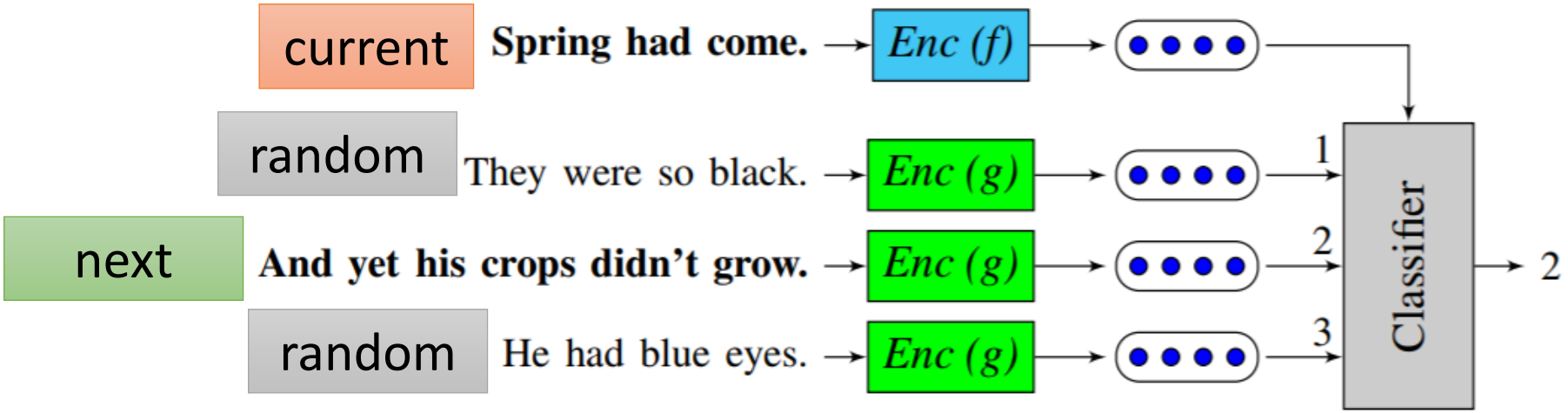
A document is a sequence of sentences.

Skip thought



https://papers.nips.cc/paper/5950-skip-thought-vectors.pdf

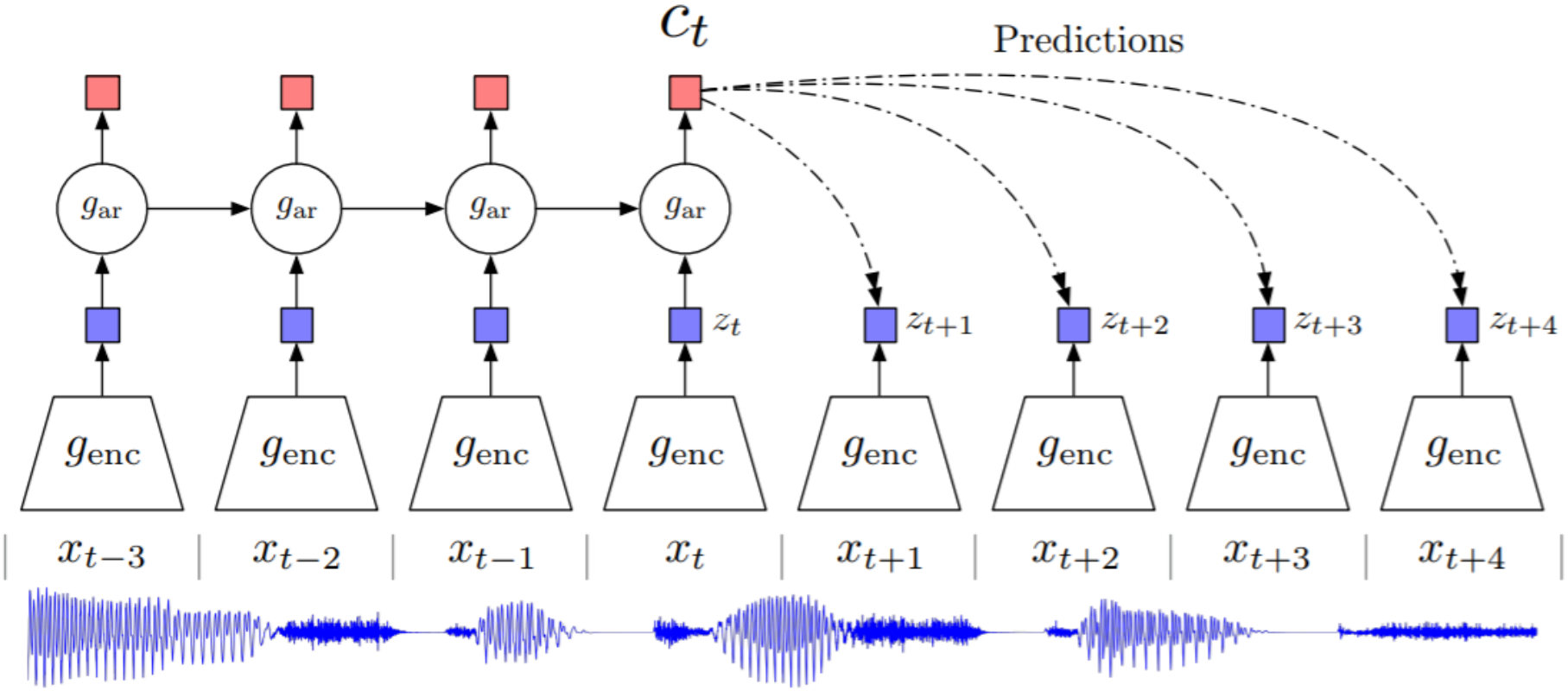
Quick thought



https://arxiv.org/pdf/1803.02893.pdf

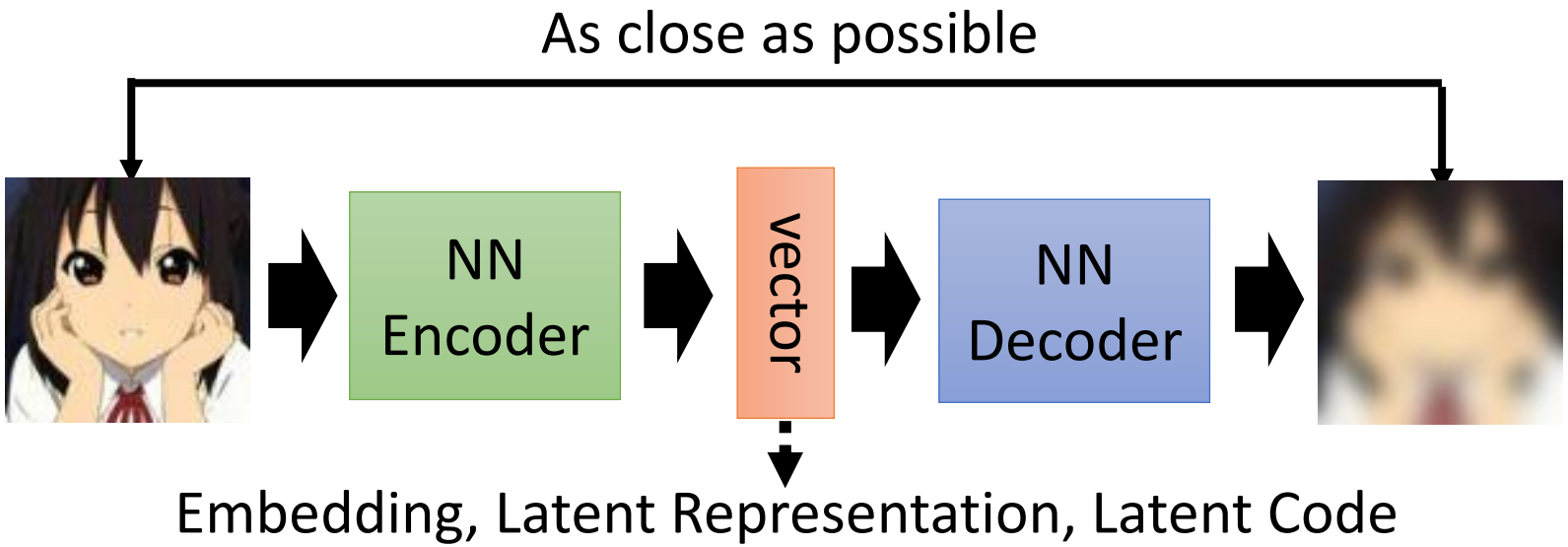
Sequential Data

- Contrastive Predictive Coding (CPC)



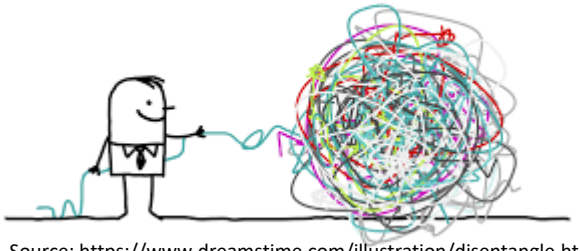
https://arxiv.org/pdf/1807.03748.pdf

Auto-encoder



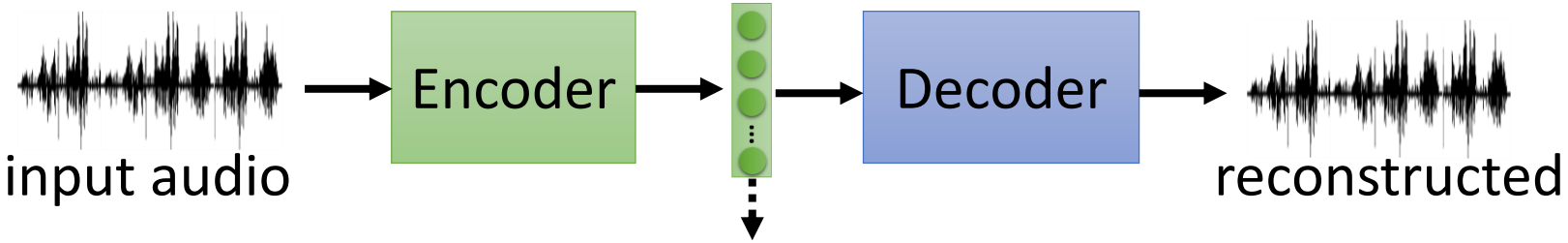
- More than minimizing reconstruction error
- More interpretable embedding

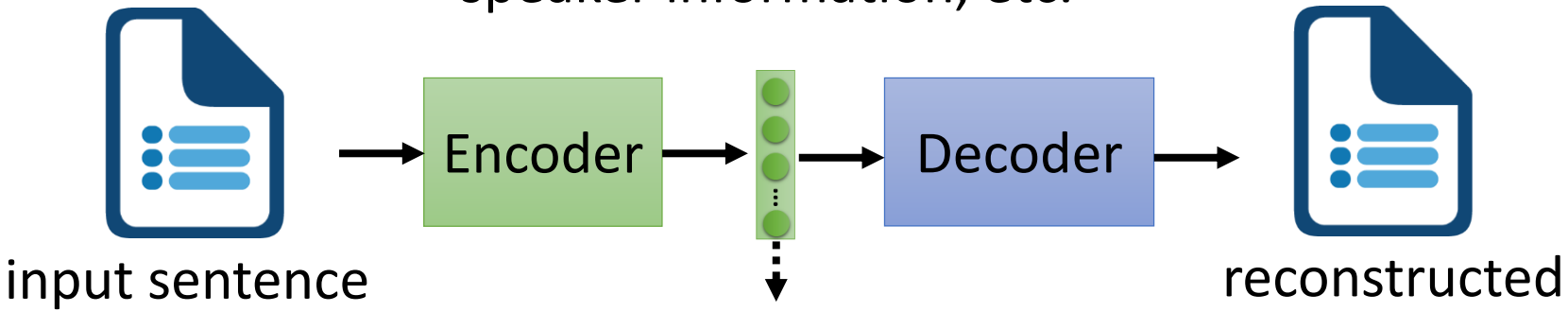
Feature Disentangle



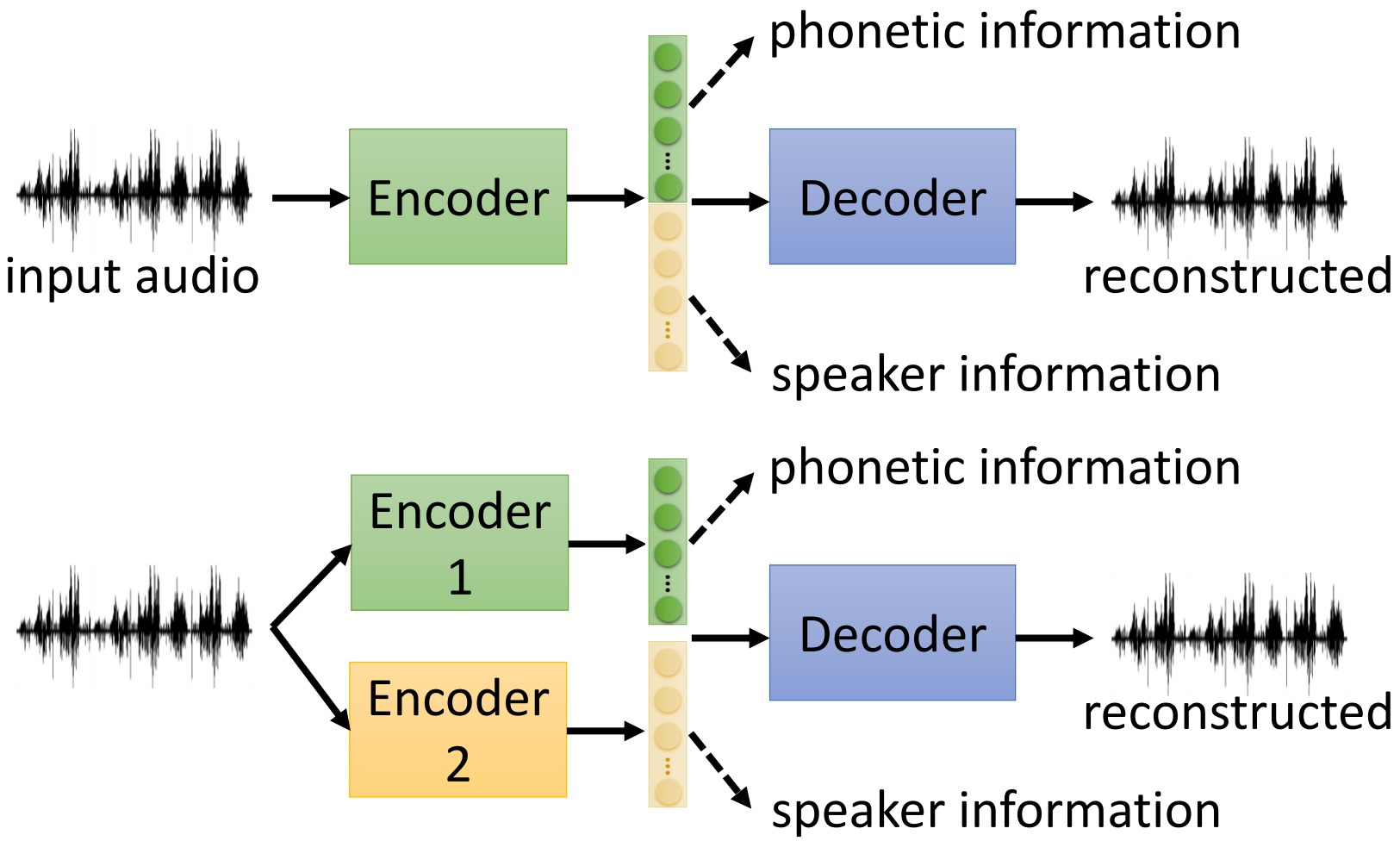
Source: https://www.dreamstime.com/illustration/disentangle.html

- An object contains multiple aspect information

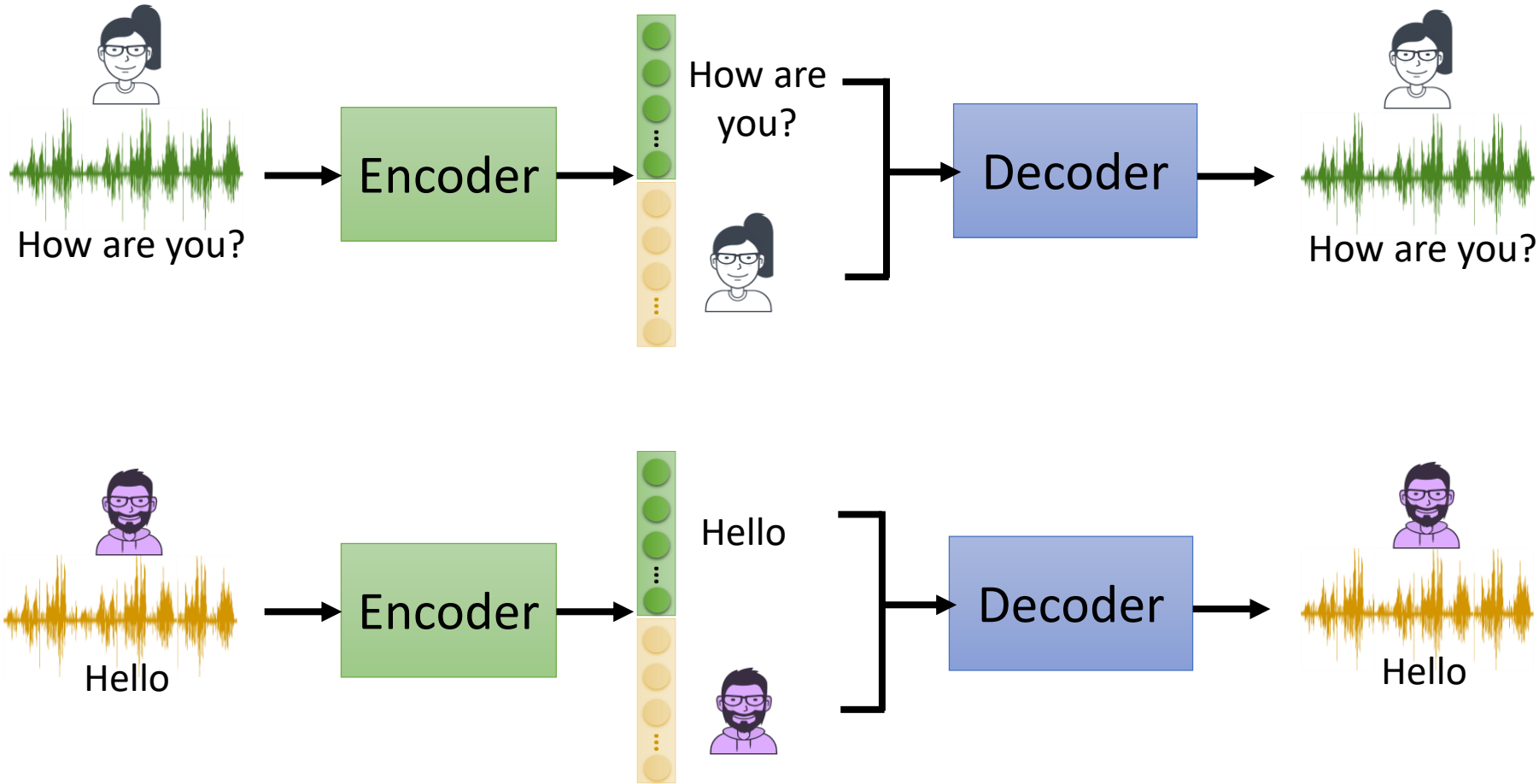




Feature Disentangle



Feature Disentangle - Voice Conversion



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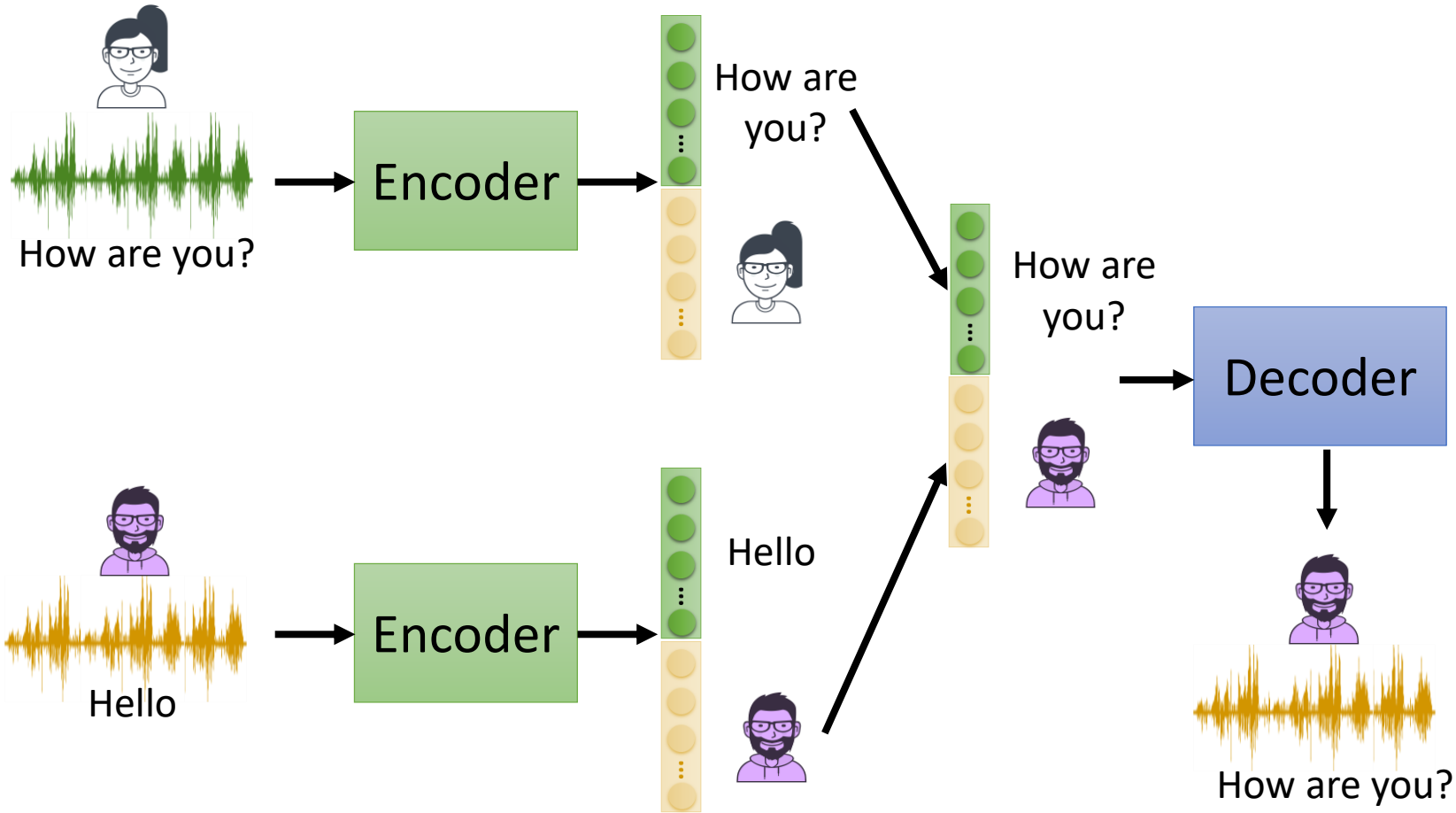
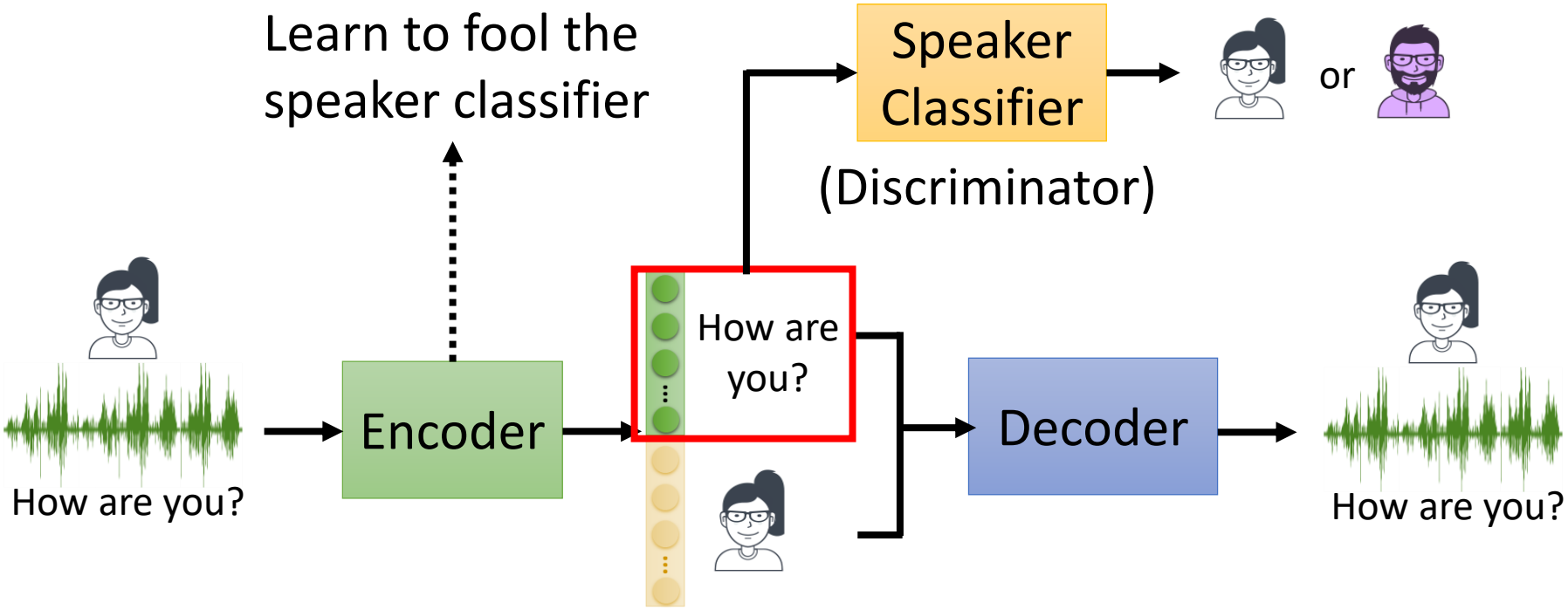


Feature Disentangle - Voice Conversion

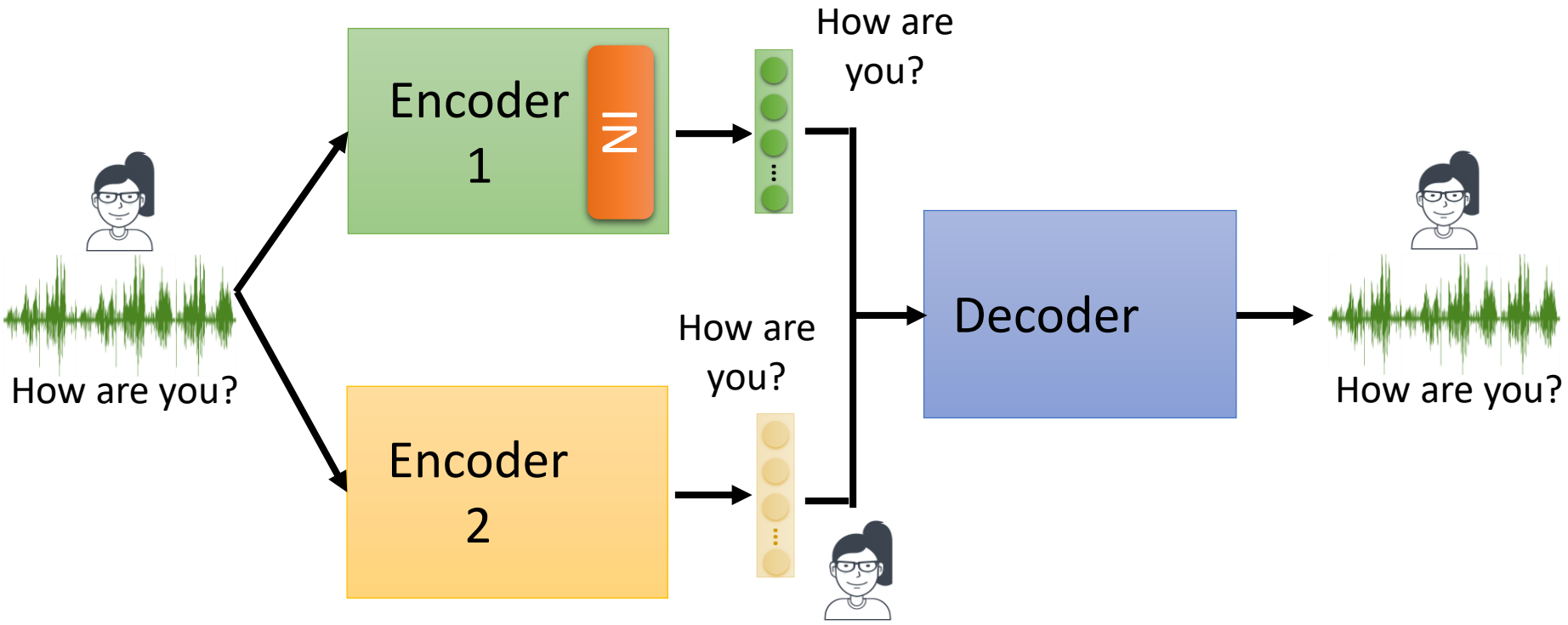
- The same sentence has different impact when it is said by different people.

Feature Disentangle - Adversarial Training



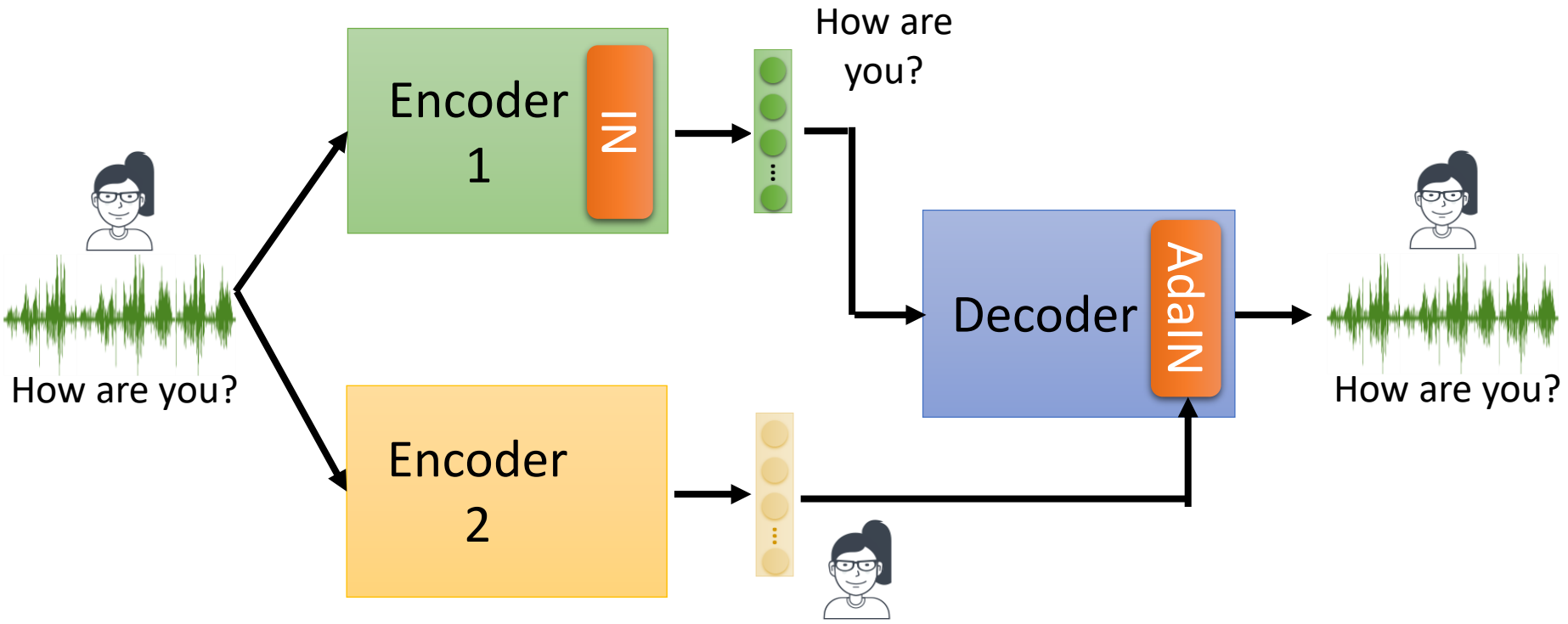
Speaker classifier and encoder are learned iteratively

Feature Disentangle
- Designed Network Architecture



IN = instance normalization (remove global information)

Feature Disentangle
- Designed Network Architecture



IN = instance normalization (remove global information)

AdaIN = adaptive instance normalization
(only influence global information)

Feature Disentangle - Adversarial Training

Target Speaker 

Source Speaker (Never seen during training!)	Source to Target
Me	
 Me	
 Me	
 Me	

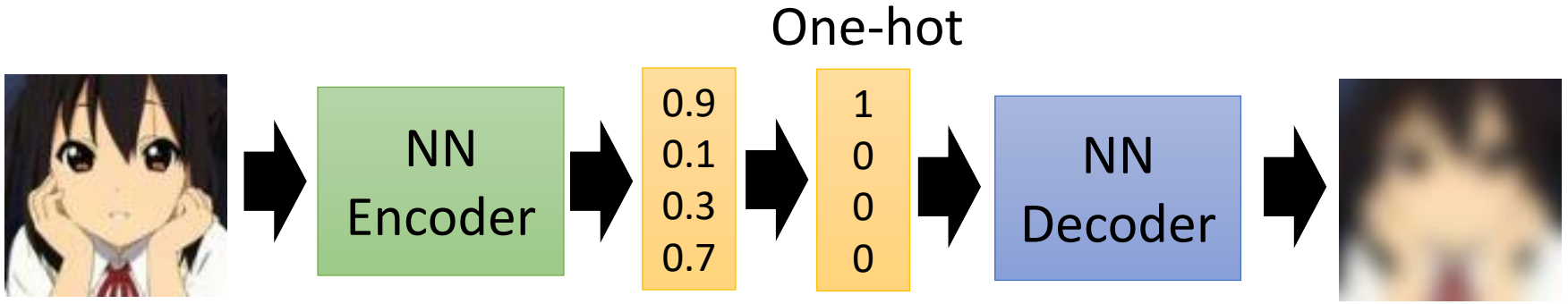
Thanks Ju-chieh Chou for providing the results.

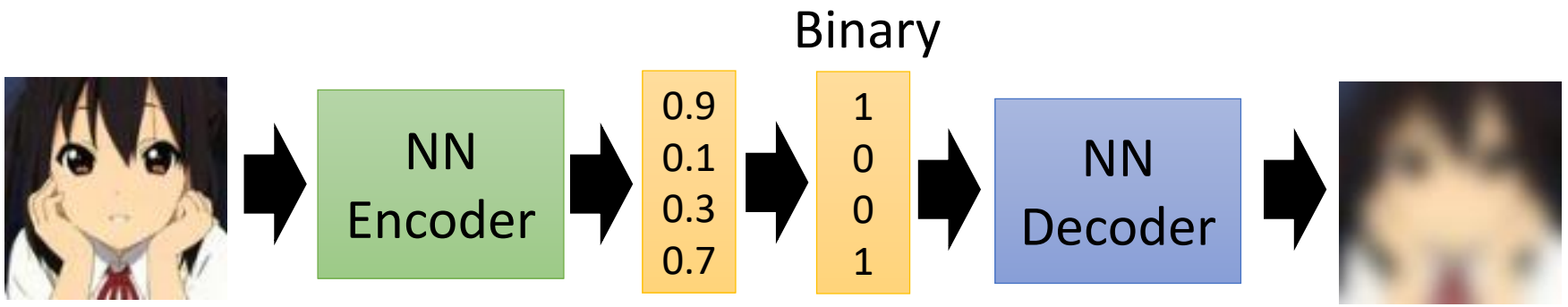
https://jjery2243542.github.io/voice_conversion_demo/

Discrete Representation

- Easier to interpret or clustering

non differentiable
https://arxiv.org/pdf/1611.01144.pdf

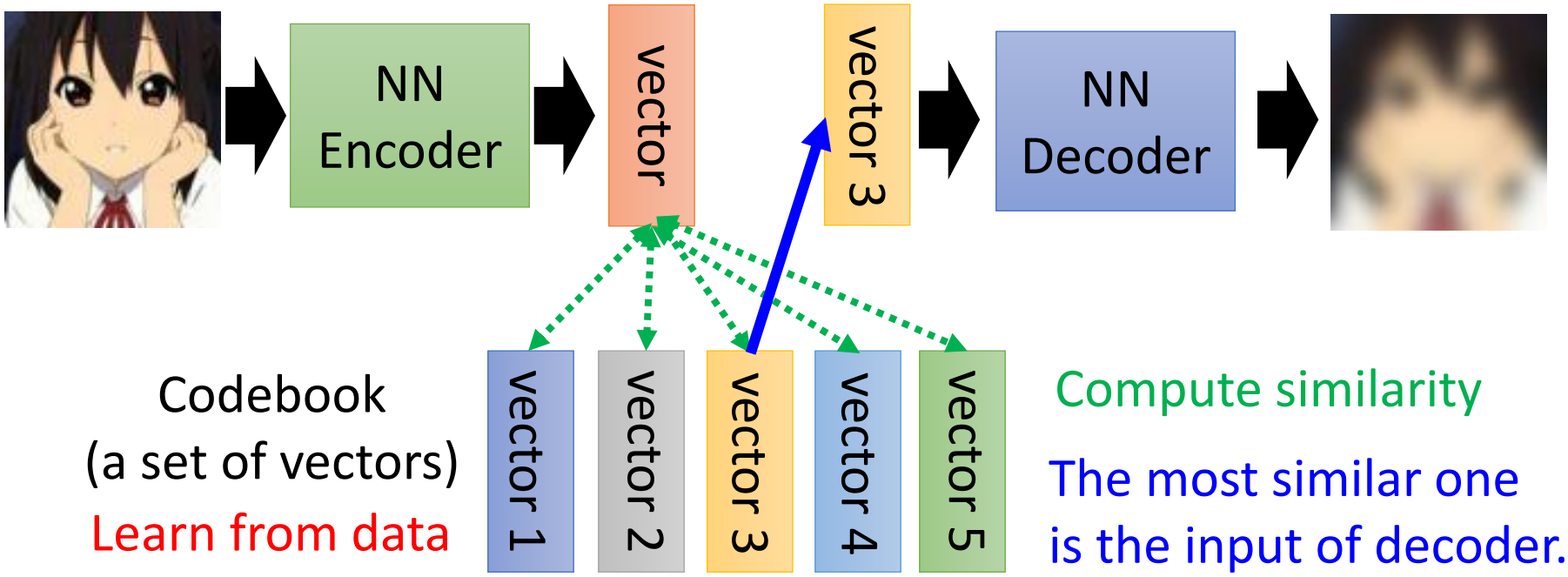




Discrete Representation

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

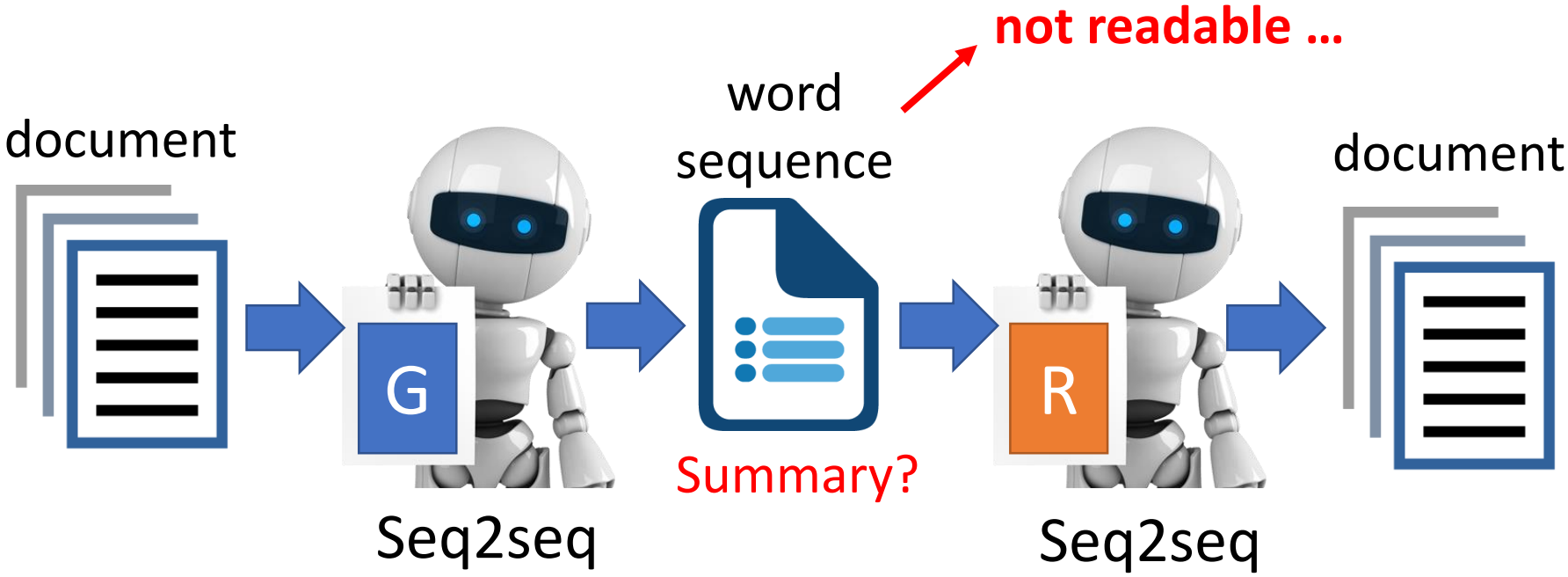
Sequence as Embedding

https://arxiv.org/abs/1810.02851

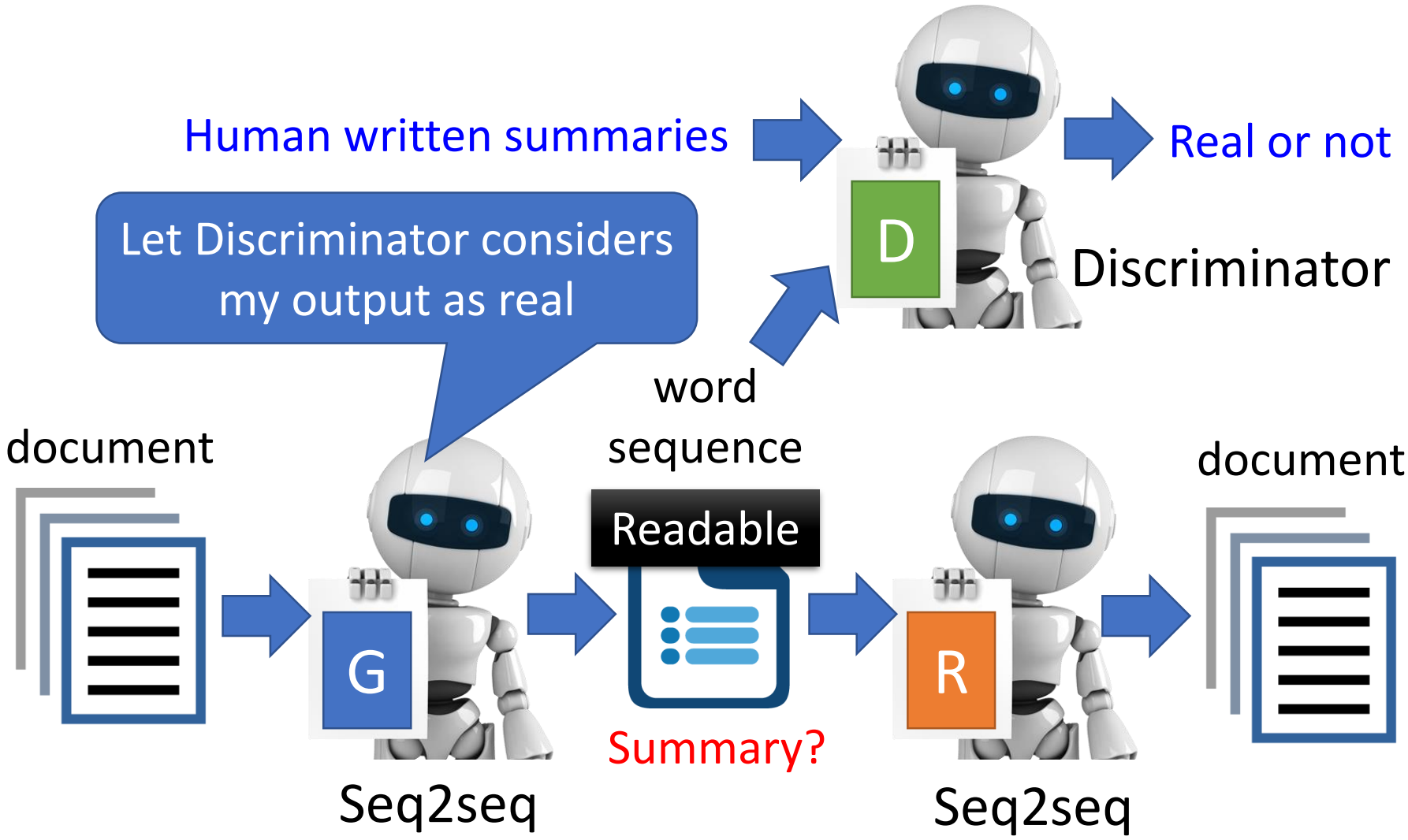
Only need a lot of documents to train the model

This is a ***seq2seq2seq auto-encoder***.

Using a sequence of words as latent representation.



Sequence as Embedding



感謝 王耀賢 同學提供實驗結果

Sequence as Embedding

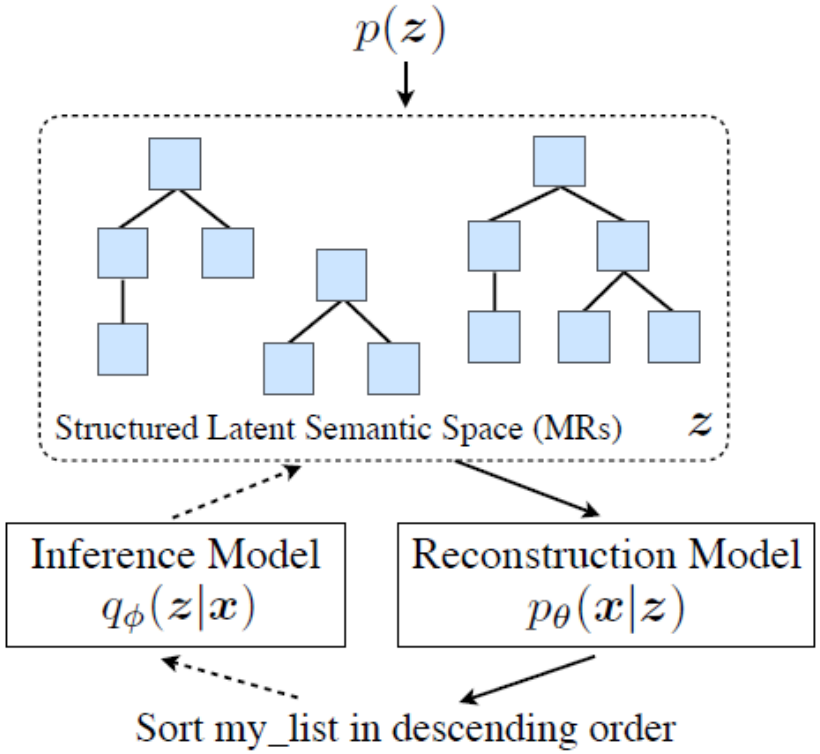
- ***Document***:澳大利亞今天與13個國家簽署了反興奮劑雙邊協議,旨在加強體育競賽之外的藥品檢查並共享研究成果 ……
- ***Summary***:
  - Human:澳大利亞與13國簽署反興奮劑協議
  - Unsupervised:澳大利亞加強體育競賽之外的藥品檢查
- ***Document***:中華民國奧林匹克委員會今天接到一九九二年冬季奧運會邀請函,由於主席張豐緒目前正在中南美洲進行友好訪問,因此尚未決定是否派隊赴賽 ……
- ***Summary***:
  - Human:一九九二年冬季奧運會函邀我參加
  - Unsupervised:奧委會接獲冬季奧運會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

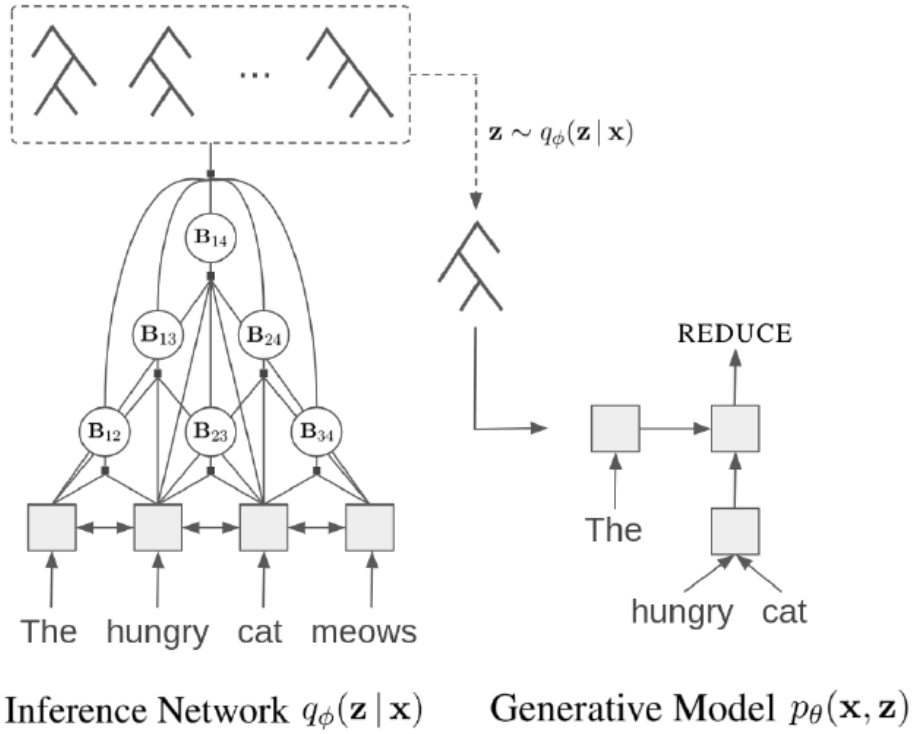
感謝 王耀賢 同學提供實驗結果

Sequence as Embedding

- ***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

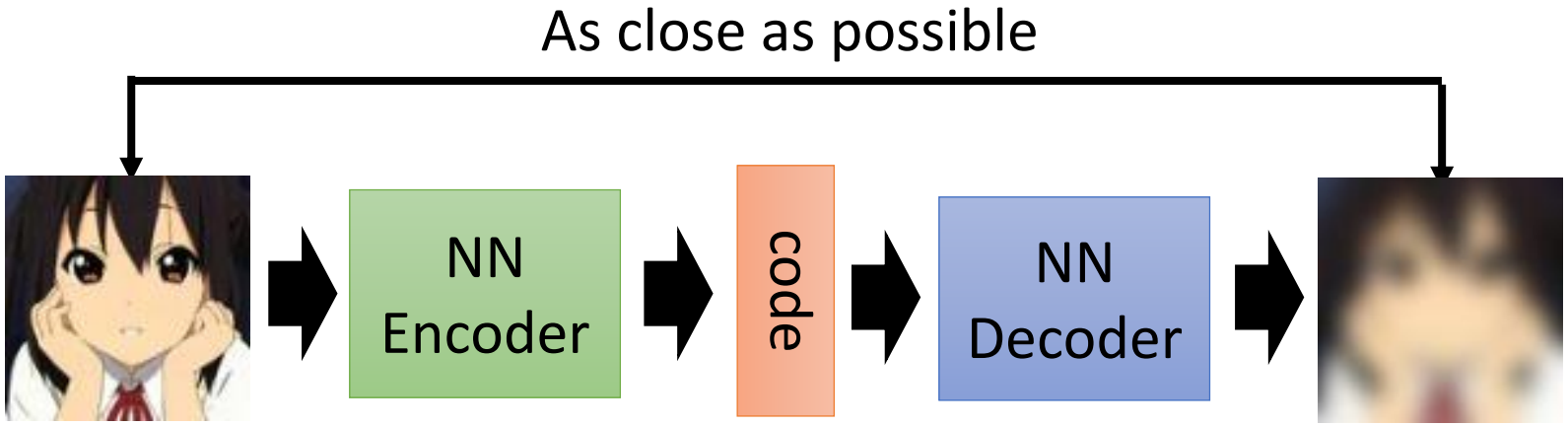




https://arxiv.org/abs/1806.07832

https://arxiv.org/abs/1904.03746

Concluding Remarks



- More than minimizing reconstruction error
  - Using Discriminator
  - Sequential Data
- More interpretable embedding
  - Feature Disentangle
  - Discrete and Structured