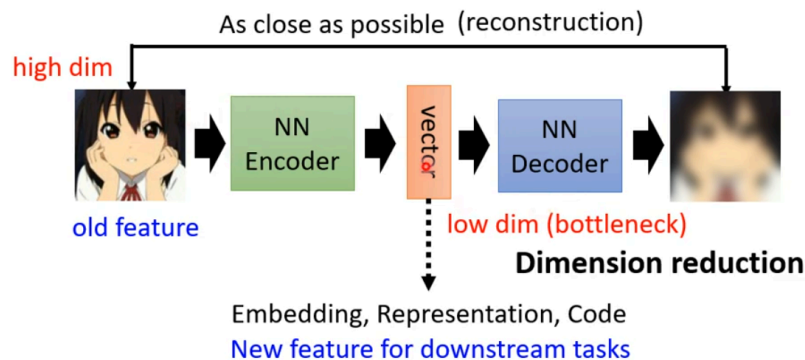


# Auto-encoder

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



Auto-encoder is composed of 2 NNs:

- Encoder: high dim --> low dim, compress the input and force the NN to capture the most salient features and discard noise
- Decoder: low idm --> high dim, reconstruct the original input

## De-noising Auto-encoder:

- add noises before the encoder compressing the input
  - the decoder aims to reconstruct the original input without noises (learn de-noising)
- Review on [BERT](#): BERT can be seen as a De-noising Auto-encoder
- Noise: some of the tokens are masked
  - Compress: BERT's transformer encoder processes the noisy embeddings and output the token embeddings
  - Decoder: the classifier (linear + softmax) which attempts to discover the masked token

## Feature Disentanglement

Decomposing the underlying factors of variation in the data (embeddings) into independent and interpretable components

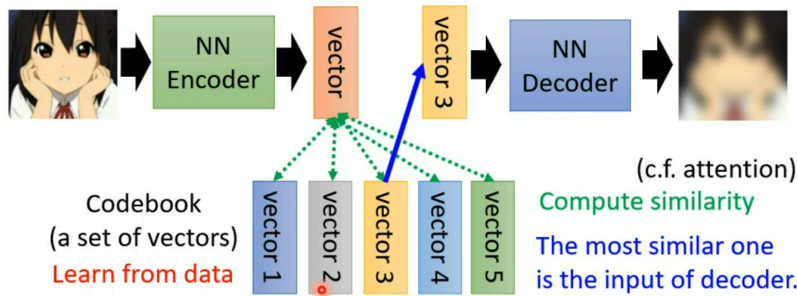
- e.g. Voice Conversion: exchange the dimensions that encodes the speaker information

## Discrete Representation

- Vector Quantized Variational Auto-encoder (VQVAE)

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

- Vector Quantized Variational Auto-encoder (VQVAE)



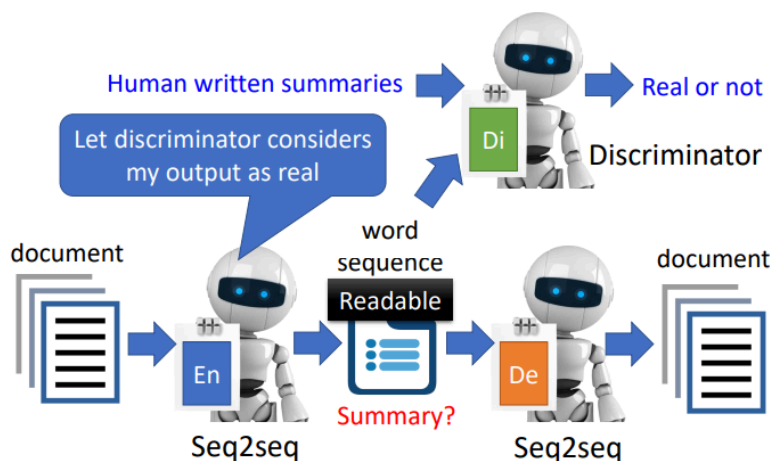
For speech, the codebook represents phonetic information

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

- **Latent Space Concept:** The latent space in VQVAE is a compressed representation of the input data. It's like a compressed, abstract version of the original data that captures its essential features. Unlike traditional autoencoders, VQVAE's latent space is not continuous but discrete.
- **Benefits of Discretization:** By discretizing the latent space, VQVAE ensures that each data point is represented by one of a limited number of vectors (from a codebook). This makes the representation more interpretable and easier to manipulate. Discretization is particularly useful for generative tasks, as it allows for the generation of new data by simply selecting and combining these discrete vectors.
- Text as Representation (CycleGAN)

This is cycle GAN 😊

## Text as Representation



- seq2seq encoder: produce a short word seq which can be considered as a summary.  
seq2seq: e.g. Transformer
- seq2seq decoder: reconstruct the document according to the summary
- discriminator: determine whether the summary are human-readable
- Tree as Embedding

## More Applications

- [Generator](#): the decoder in Auto-encoder can be used as a generator
  - Variational Auto-encoder (VAE)
- Compression: the low-dim representation can be seen as a lossy compression
- Anomaly Detection:
  - Given a set of training data, detecting a new input is similar to training data or not
  - How to apply Auto-encoder: train an Auto-encoder on normal data and then reconstruct the new data. If the reconstruction error is very large, the detected instance is considered as an anomaly.