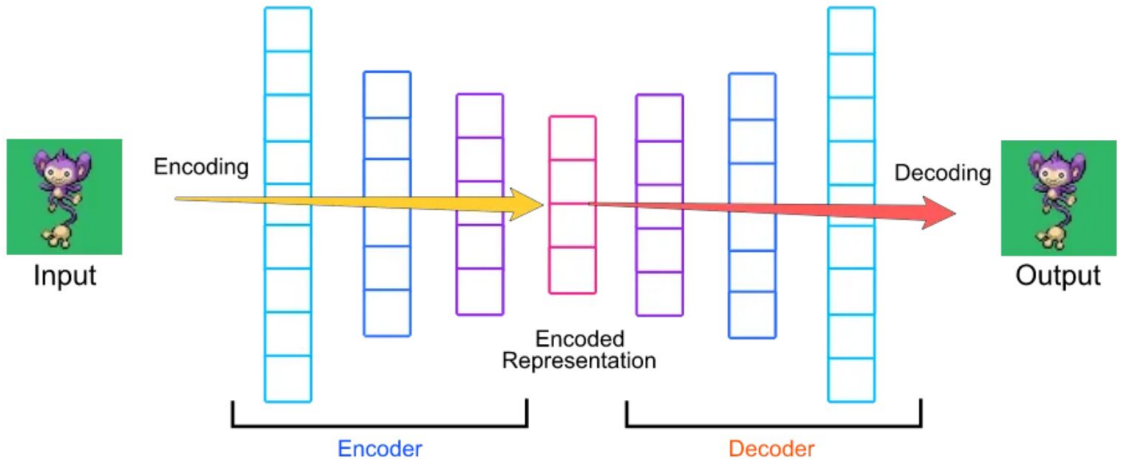
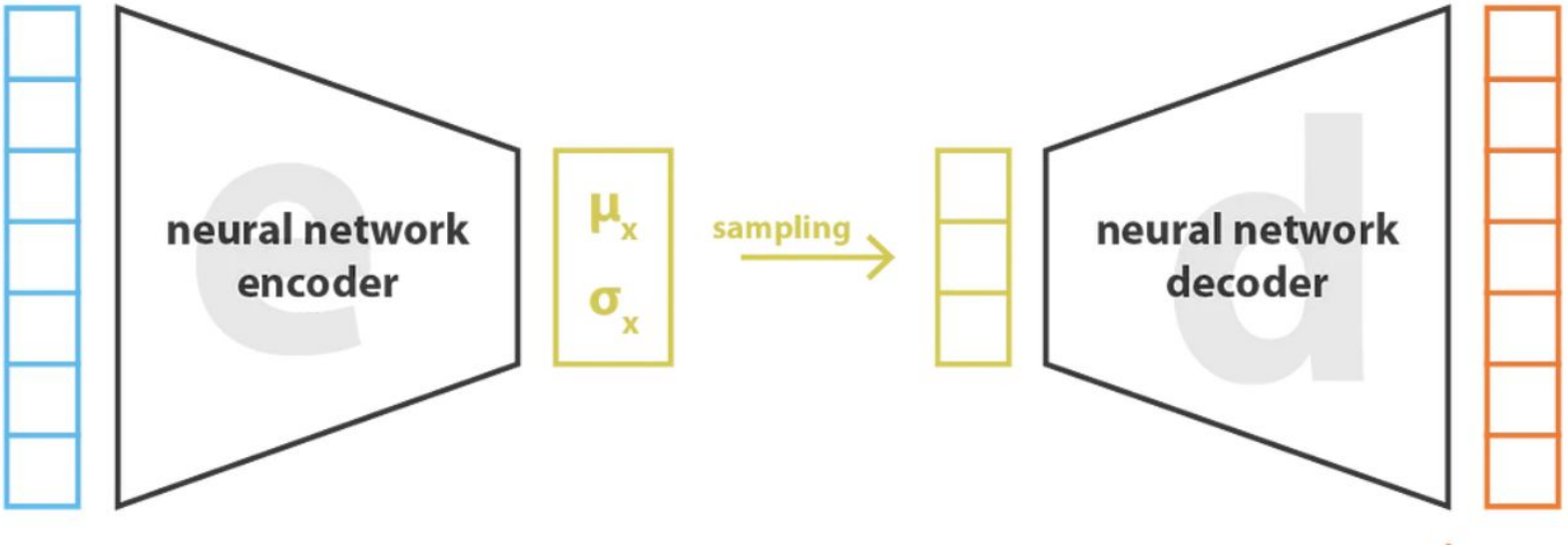
Variational Autoencoders for Collaborative Filtering

VAE Model Highlights

- Unsupervised model
- Attempt to reconstruct its input data in the output layer
- Bottleneck layer is used as latent representation of the input data

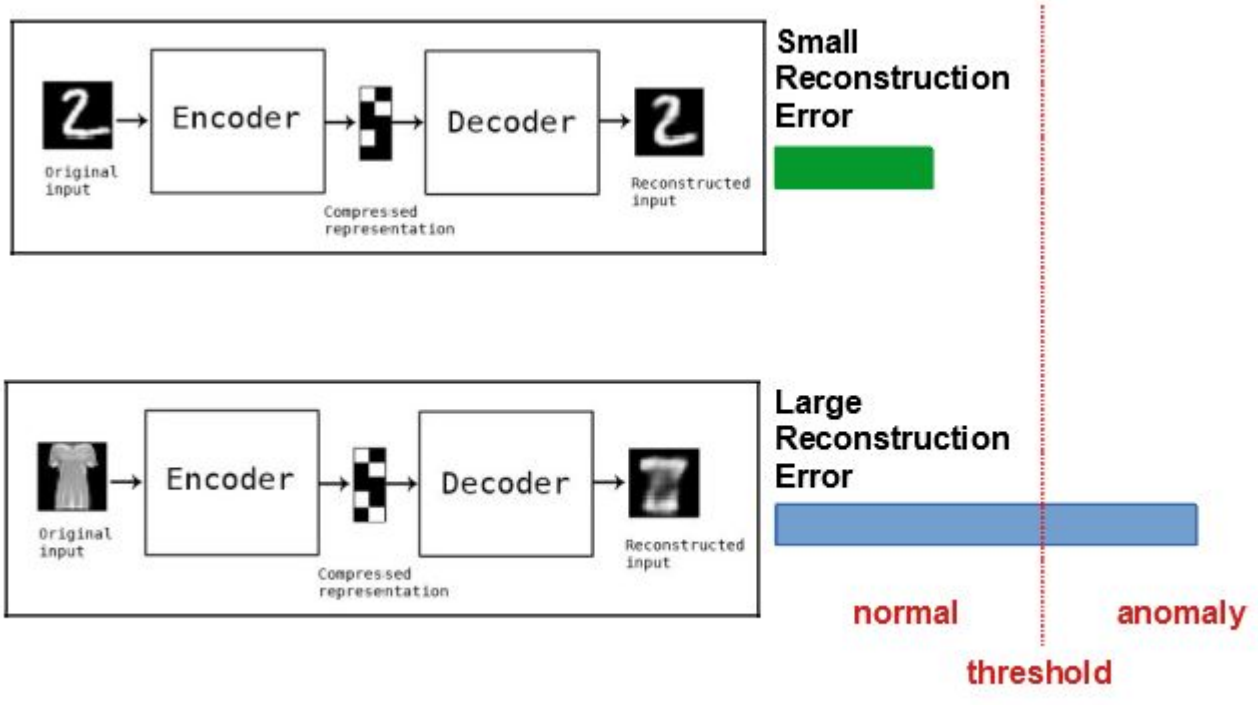


How VAE works



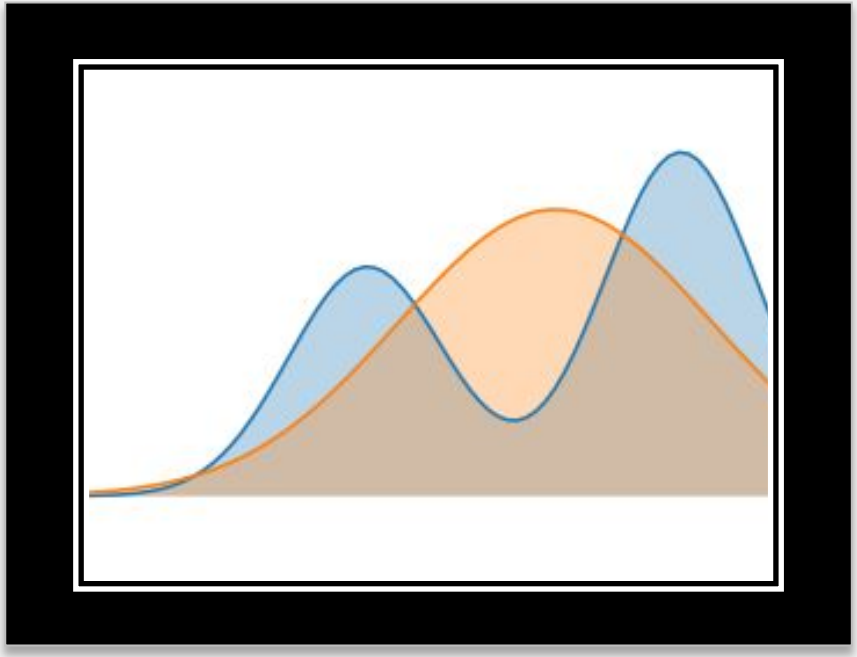
Loss function

- Reconstruction Error
- Regularization



KL Divergence is Used for Regularization

KL Divergence is derived between Latent Representation distribution and Latent representation given the user inputs



How VAE Works

User ratings in the form of a click matrix - The number of clicks for each item from the user

The inputs are encoded to learn the mean and standard deviation of the K-dimensional latent representation

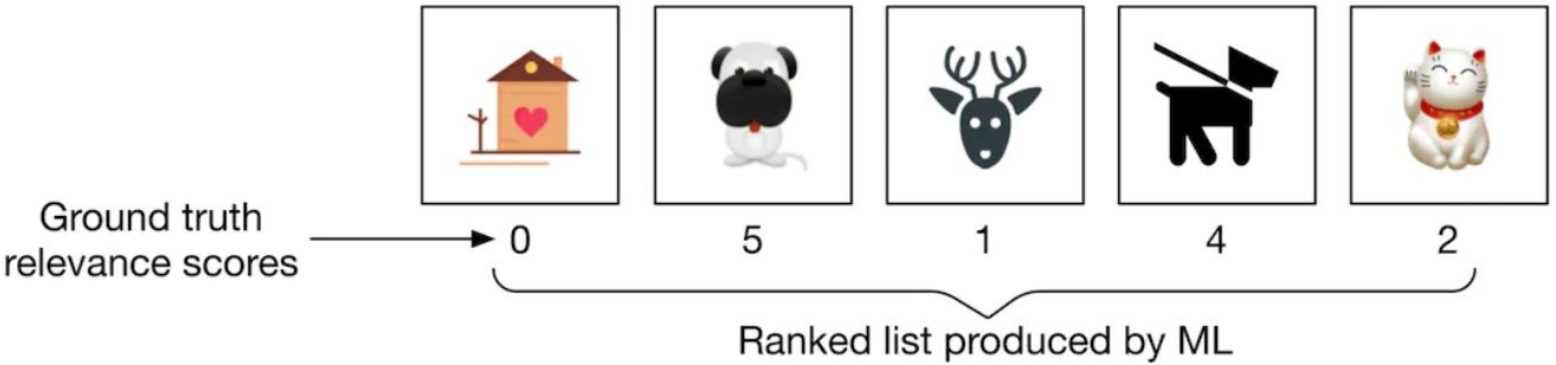
Decoder is used to decode the latent vector from K-dimensional space to the original N-dimensional space

As a result we get the probabilities for each movie or item being viewed by each user

Evaluating the Results

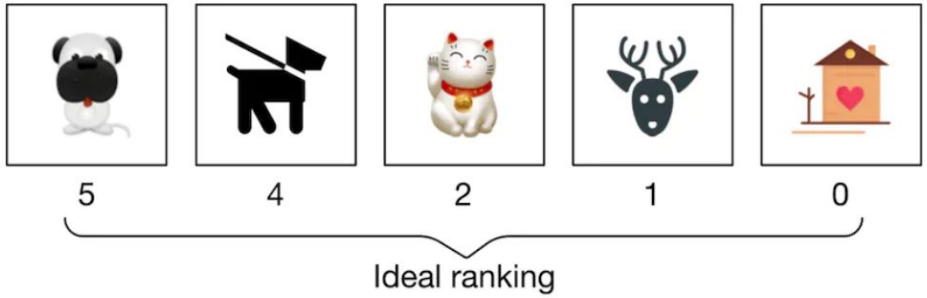
- Normalized Discounted Cumulative Gain (NDCG) is used for evaluating the results
- Steps to calculate NDCG
  - Calculate DCG
  - Calculate IDCG
  - Divide DCG by IDCG

Calculate DCG



$$\text{DCG}_p = \sum_{i=1}^{p} \frac{rel_i}{\log_2(i+1)} = \frac{0}{\log_2(2)} + \frac{5}{\log_2(3)} + \frac{1}{\log_2(4)} + \frac{4}{\log_2(5)} + \frac{2}{\log_2(6)} = 6.151$$

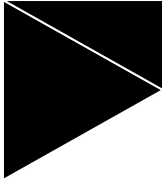
Calculate IDCG



$$\text{IDCG}_p = \sum_{i=1}^{\nu} \frac{rel_i}{\log_2(i+1)} = \frac{5}{\log_2(2)} + \frac{4}{\log_2(3)} + \frac{2}{\log_2(4)} + \frac{1}{\log_2(5)} + \frac{0}{\log_2(6)} = 8.9543$$

Calculate NDCG

$$\text{nDCG}_p = \frac{DCG_p}{IDCG_p} = \frac{6.151}{8.9543} = 0.6869$$



Summary

- Use latent representation to get probabilities for the items
- Minimize the reconstruction loss
- KL Divergence is used as regularization
- Evaluate the results using NDCG