NYCU DLP

Lab5 - Conditional VAE for Video Prediction

謝宏笙

April 19, 2022

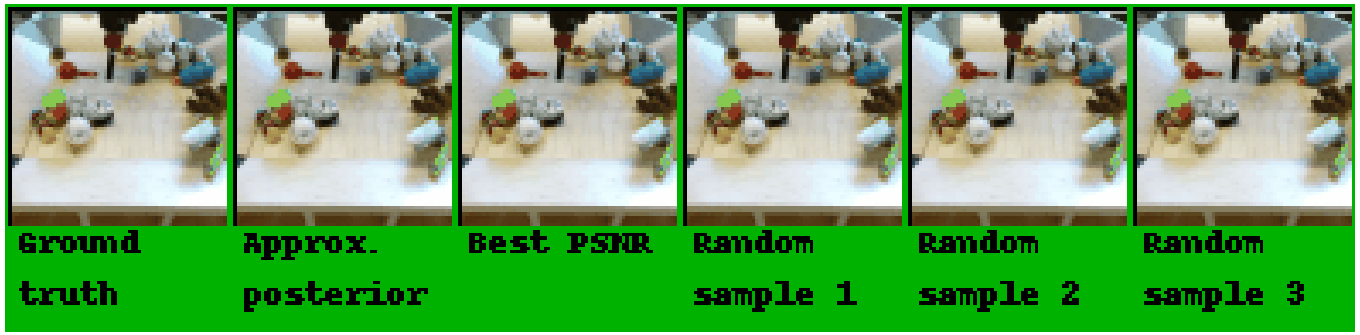
Outline

- Lab Objective
- Important Date
- Lab Description
- Scoring Criteria
- Implement Hints

Lab Objective

- In this lab, you need to implement a conditional Variational Autoencoder (VAE) for video prediction.

- Example:



Important Date

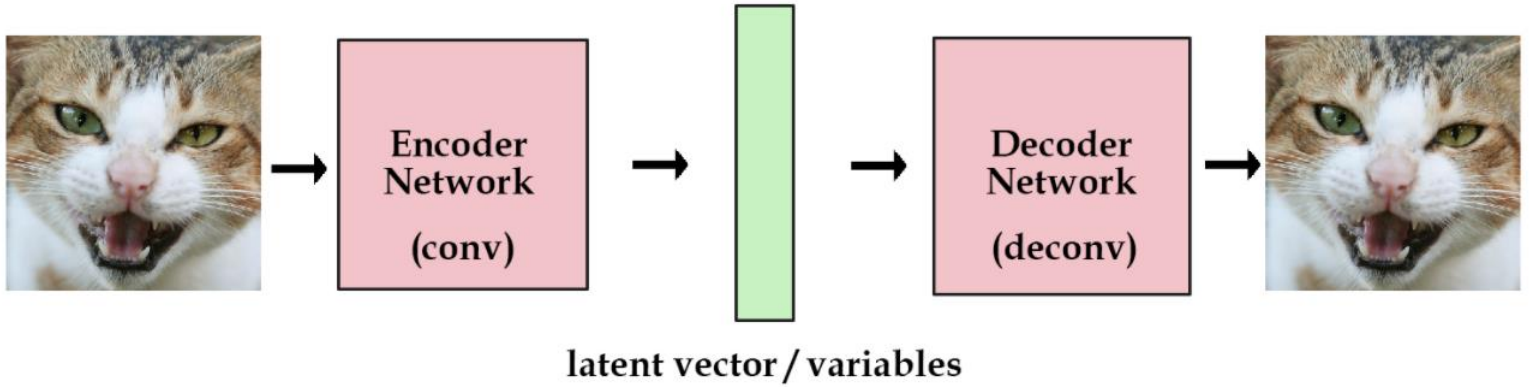
- Report Submission Deadline: 5/10 (Tue.) 11:59 a.m.
- Demo date: 5/10 (Tue.)
- Zip all files into one file
  - Report (.pdf)
  - Source code
- Name it like「DLP_LAB5_yourstudentID_name.zip」
  - ex:「DLP_LAB5_310551109_謝宏笙.zip」

Lab Description

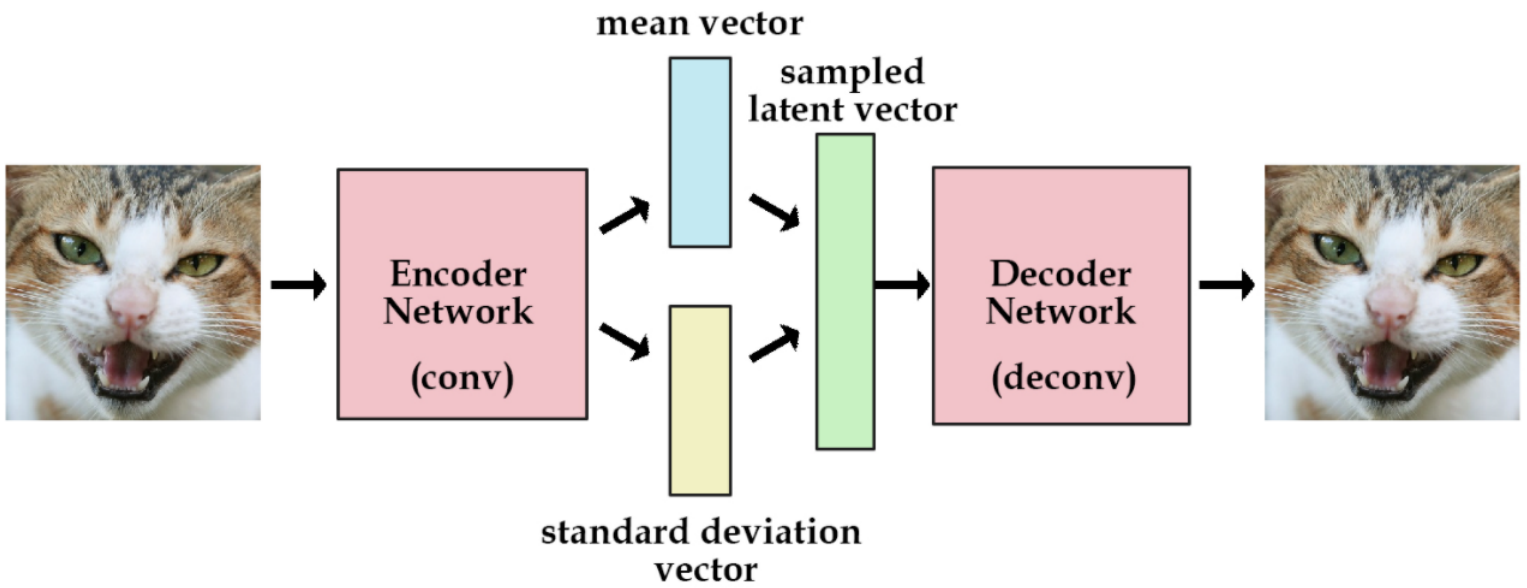
- Variational Autoencoder
- Reparameterization Trick
- Overall architecture
- KL Cost Annealing
- Dataset

Lab Description - VAE

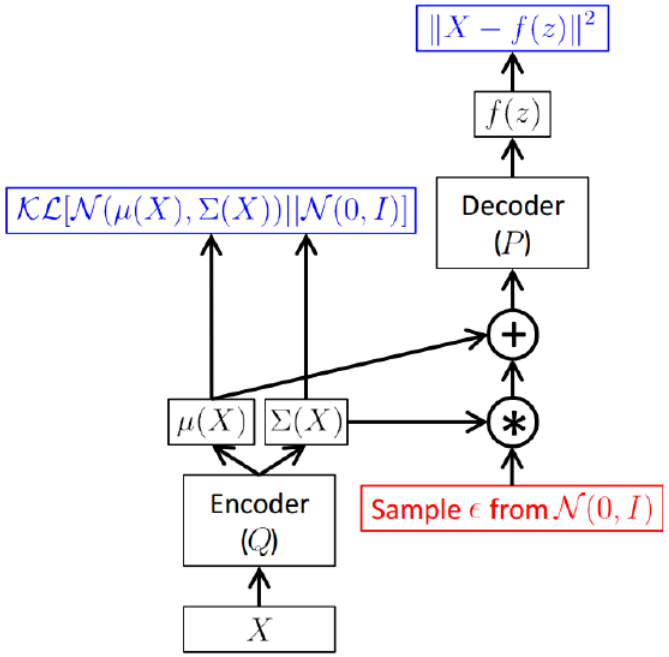
AE



VAE



Lab Description – Reparameterization Trick



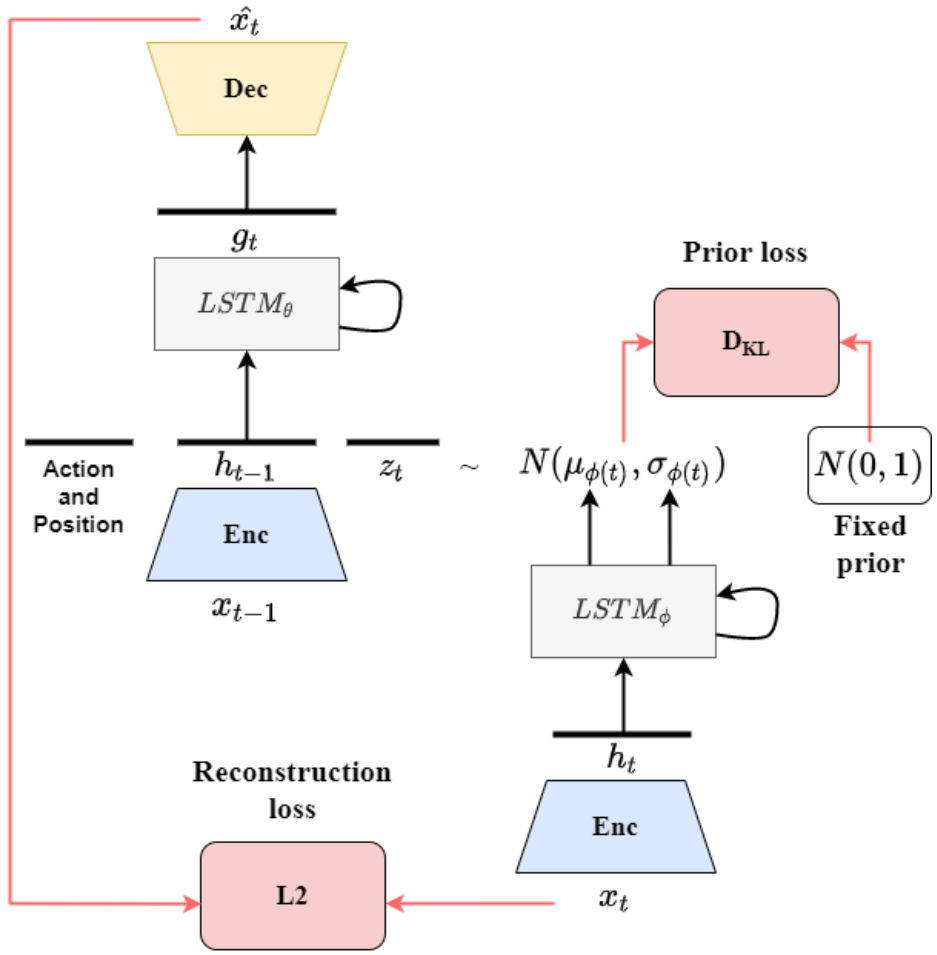
$$\mathcal{L}(\mathrm{X}, \mathrm{q}, \theta) = E_{Z\sim q(Z|X;\phi)} \log p(X|Z;\theta) - KL(q(Z|X;\phi)||p(Z))$$

where $q(Z|X;\phi)$ is considered as encoder and $p(X|Z;\theta)$ as decoder.

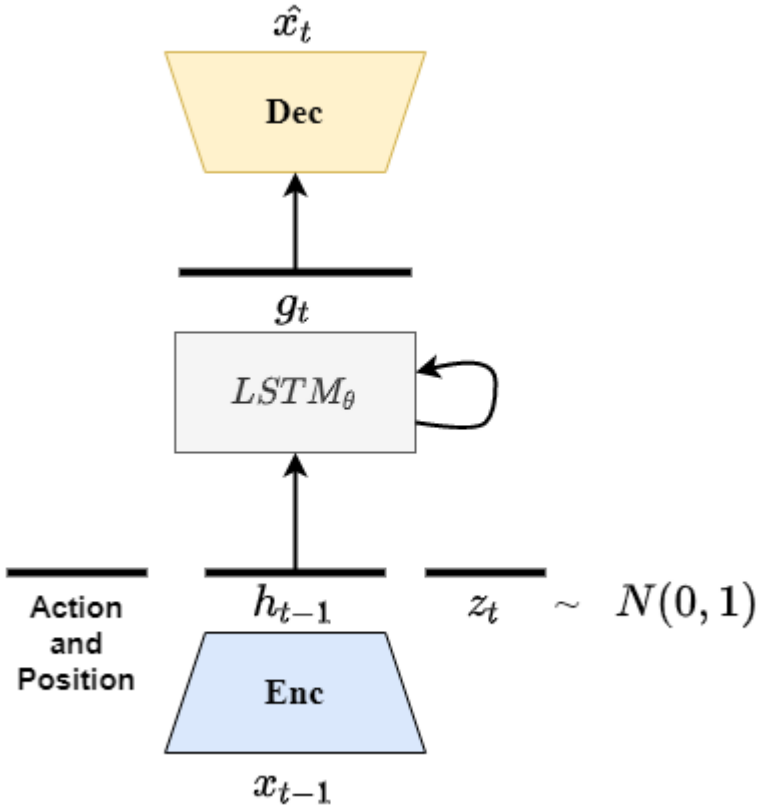
$$\underbrace{E_{\boldsymbol{Z}\sim q(\boldsymbol{Z}|\boldsymbol{X};\boldsymbol{\theta}')} \log p(\boldsymbol{X}|\boldsymbol{Z};\boldsymbol{\theta})}_{\text{Re-parameterization for end-to-end training}} - \mathrm{KL}(q(\boldsymbol{Z}|\boldsymbol{X};\boldsymbol{\theta}')||p(\boldsymbol{Z}))$$

- Log variance
  - Output should be log variance (not variance)

Lab Description – Overall architecture



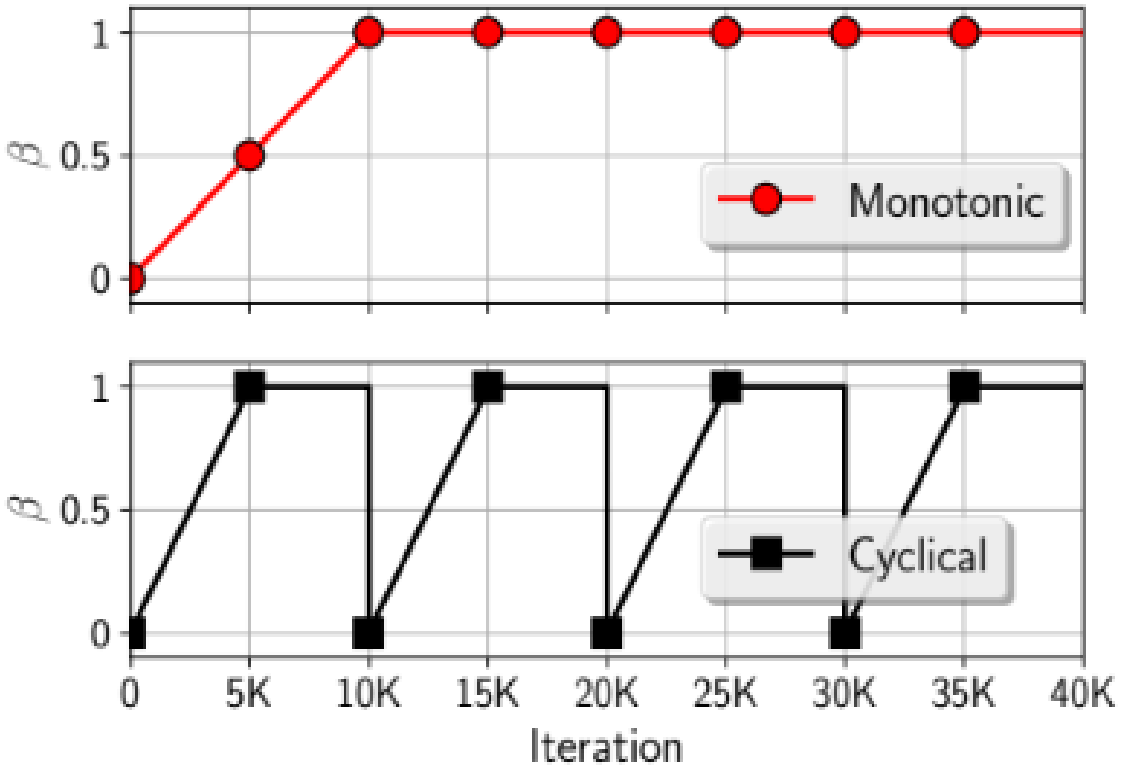
(a) Training procedure



(b) generating procedure

Lab Description - KL Cost Annealing

- Initially set your KL weight to 0
- Maximum value is 1



Lab Description - Dataset

- We use bair robot pushing small dataset to train CVAE
  - This data set contains roughly 44,000 sequences of robot pushing motions, and each sequence include 30 frames

Lab Description – Get dataset

- For Linux

```
pip install gdown

gdown https://drive.google.com/uc?id=1t8iOfBUYDFQH65RNWIgsEYenAo-HktAu

unzip processed data.zip
```

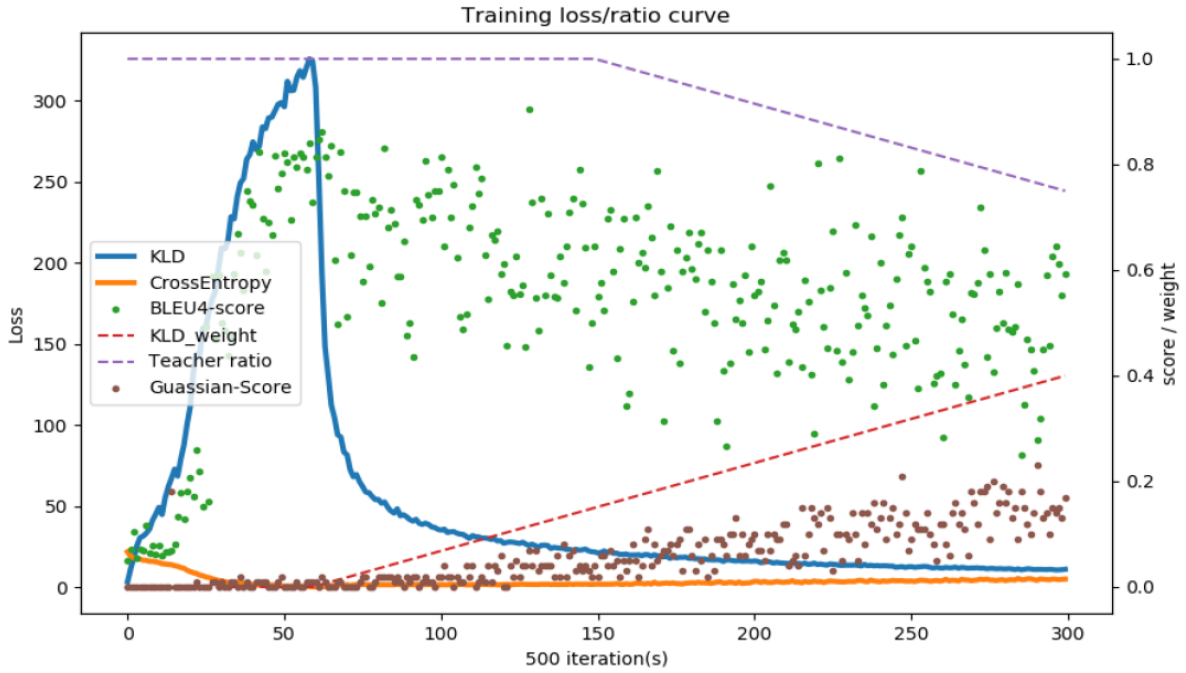
- For Windows
  - Click the following link and download it: https://reurl.cc/GoyZGd

Lab Description – Other details

- Adopt PSNR to evaluate the perceptual quality.
  - Provide in the sample (finn_eval_seq)
  - Given two past frame to prediction next ten frames (average PSNR)

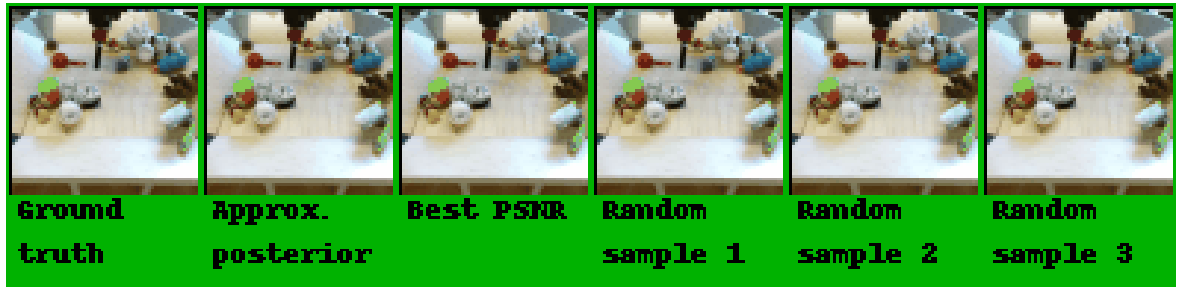
Lab Description – Requirements

- Modify encoder, decoder, and training functions
- Implement dataloader, and reparameterization trick.
- Adopt teacher-forcing and KL loss annealing in your training processing.
- Plot the losses, average PSNR and ratios.



Lab Description – Requirements

- Make videos or gif images for test result (select one sequence)



- Output the prediction at each time step (select one sequence)

Lab Description – Hints

- **Warning: You need to do the lab as early as possible** because you may take more than two days to train the model
- Model weights
  - Strongly recommend you save your model weights during training
- Teacher forcing ratio and KL weight
  - Influential to the performance of model
  - You can first set your KL weight to 0 to see whether your model works.

Scoring Criteria - Report (60%)

- Introduction(5%)
- Derivation of CVAE(10%)
- Implementation details(15%)
  - Describe how you implement your model. (e.g. dataloader, encoder, decoder, etc)
  - Describe the teacher forcing (including main idea, benefits and drawbacks)

    Notice: You must prove that you use previous predicted frame to predict next frame,

    i.e. teacher forcing ratio = 0 when testing (paste/screenshot your code)

Scoring Criteria - Report (60%)

- Results and discussion(30%)
  - Show your results of video prediction
    - Make videos or gif images for test result (5%)
    - Output the prediction at each time step (5%)
  - Plot the losses, average PSNR and ratios. (5%)
  - Discuss the results according to your settings. (15%)

    Notice: This part mainly focuses on your discussion, if you simply just paste your results, you will get a low score

Scoring Criteria - Demo(50%)

- Capability of video prediction.(20%)
  - Your model should use two past frames to predict the next ten frames
  - PSNR >= 25 ---- 100%
  - 25 > PSNR >= 24 ---- 90%
  - 24 > PSNR >= 23 ---- 80%
  - 23 > PSNR >= 22 ---- 70%
  - 22 > PSNR >= 21 ---- 60%
  - 21 > PSNR >= 20 ---- 50%
  - PSNR < 20 ---- 0%
- Questions (20%)

Scoring Criteria – Extra(30%)

- Implement learned prior(10%)
- Implement hierarchical structure(10%)
- Implement conditional convolution(10%)

Reference

- Yoojin Choi, Mostafa El-Khamy, and Jungwon Lee. Variable Rate Deep Image Compression With a Conditional Autoencoder. arXiv e-prints, page arXiv:1909.04802, Sept. 2019.
- Emily Denton and Rob Fergus. Stochastic video generation with a learned prior. CoRR, abs/1802.07687, 2018.
- Zhihui Lin, Chun Yuan, and Maomao Li. Haf-svg: Hierarchical stochastic video generation with aligned features. In Christian Bessiere, editor, Proceedings of the Twenty-Ninth International Joint Conference on Artificial Intelligence, IJCAI-20, pages 991–997. International Joint Conferences on Artificial Intelligence Organization, 7 2020. Main track.