

Quiz 7

Week 13, Nov/28/2022

CS 280: Fall 2022

Instructor: Lan Xu

Name: _____

On your left: _____

On your right: _____

Instructions:

Please answer the questions below. Show all your work. NO discussion/collaboration is allowed.

Problem 1. (10 points) **ELBO** The EM algorithm is to find maximum likelihood solution for probabilistic model having latent variables. First, give the lower bound of the objective function. (You should describe the definition of the variables you use). Then, explain and visualize E-step and M-step and why the EM algorithm finally converge.

Problem 2. (10 points) Given observation X , and assume a latent variable model according to

$$P(X) = \int_z P(X|z; \theta) P(z) dz$$

with latent variables z lying in high-dimensional space.

VAE deals with both the inference problem of the posterior $P(z|X)$ and the learning of the LVM.

Denote the approximating family Q , VAE finds a variational distribution $q \in Q$ most similar to $P(z|X)$, and learns $P(X|z; \theta)$ that explains the data.

1. (3) Derive the objective function of VAE. Use the notation provided above, and suppose you are optimizing w.r.t. q and θ . (Hint: Considering the second question, you'd better choose one specific derivation that involve no inequality)
2. (2) Explain why optimizing the objective deals with the inference problem of $P(z|X)$ and the learning problem of $P(X|z; \theta)$.
3. (2) Interpret VAE's objective in the view of autoencoders (with proper assumption on the probability distribution).
4. (1) Write down the reparameterization of $z \sim q(z|X)$ in which you introduce parameters ϕ .
5. (2) Explain why is the reparameterization trick necessary when learning nn-based VAE (Hint: what is the problem of learning without reparameterization and why does reparameterization solve this).