0 Instructions

Homework is due Tuesday, April 16, 2024 at 23:59pm Central Time. Please refer to `https://courses.grainger.illinois.edu/cs446/sp2024/homework/hw/index.html` for course policy on homeworks and submission instructions.

1 GAN: 5pts

1. The problem will be:

$$\max_{\mathcal{D}} \mathbb{E}_{x\sim p_r(x)}[\log \mathcal{D}(x)] + \mathbb{E}_{x\sim p_g(x)}[\log(1-\mathcal{D}(x))]$$

   Hence, under the given x, the optimal choice of $\mathcal{D}(x)$ is:

$$\mathcal{D}(x) = \frac{p_r(x)}{p_r(x)+p_g(x)}$$

2. Plugged in the optimal $\mathcal{D}(x)$, Eq. 1 will turn into:

$$\min_{\mathcal{G}} \mathbb{E}_{x\sim p_r(x)}\left[\log \frac{p_r(x)}{p_r(x)+p_g(x)}\right] + \mathbb{E}_{x\sim p_g(x)}\left[\log \frac{p_g(x)}{p_r(x)+p_g(x)}\right]$$

3. When $\mathcal{D}$ perfectly classifies generated samples, the output of $\mathcal{D}$ will saturate and the gradient of $\mathcal{D}$ will be almost 0, which makes the gradient of $\mathcal{G}$ almost 0 as well.

2 Diffusion model: 11pts

3 Unsupervised learning / contrastive learning: 4 pts

1. True.
2. False. MAE is an approach for computer vision.
3. to be done
4. False. CLIP enables zero-shot classification with contrastive pre-training.

4 Coding: GAN, 10pts

5 Coding: Diffusion model, 10pts