Technical University of Crete
School of Electrical and Computer Engineering
Course: **Generative Artificial Intelligence**
Assignment 2
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Denoising Diffusion Probabilistic Models

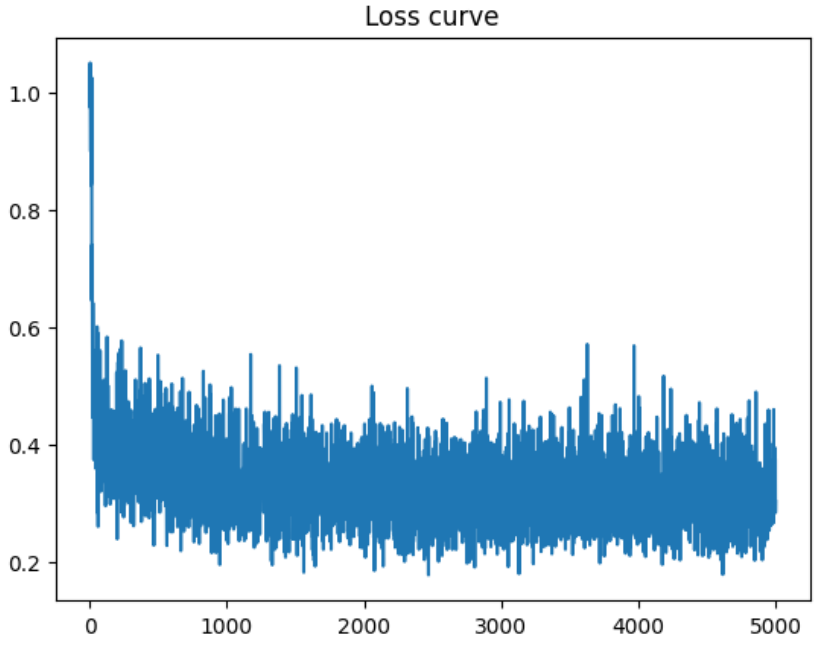
Denoising Diffusion Probabilistic Models (DDPMs) consist of a forward and a backward process. The goal is to minimize the KL distance between the distribution of the forward process ($q(\mathbf{x}_{t-1}|\mathbf{x}_t, \mathbf{x}_0)$ and the backward process ($p_{\boldsymbol{\theta}}(\mathbf{x}_{t-1}|\mathbf{x}_t)$) at a given time instance t and consequently predict $\mathbf{x}_{t-1}$. To achieve that, we define the simplified loss that is based on the KL divergence, as follows

$$\mathcal{L} = \mathbb{E}_{t,\mathbf{x}_0,\boldsymbol{\epsilon}}[\|\boldsymbol{\epsilon} - \boldsymbol{\epsilon}_{\boldsymbol{\theta}}(\mathbf{x}_t(\mathbf{x}_0, t), t)\|^2]$$

where $\boldsymbol{\epsilon}$ is white Gaussian noise and $\boldsymbol{\epsilon}_{\boldsymbol{\theta}}$ is the neural network that predicts the noise.

Results

For some realization of the problem we got the following loss curve



While the DDPM Chamfer distance was computed to be $C(q, p_{\boldsymbol{\theta}}) = 16.2925$

Last but not least, for visualization of the sampled particles and for the specific realization of the problem, we got the following figure