Master MVA- Generative Modeling **2025**

Assignment due for February 25th

For this assignment, you have to produce one single Jupyter notebook that contains the codes that you have written, your numerical results and the comments asked in the questions below. The outputs of the cells should be included in your notebook.

Your notebook should be named as

`YourFamilyName_dm2425.ipynb`

will be dropped in the folder

`https://partage.imt.fr/index.php/s/2fgLiWJHjdn7gHL`

We kindly ask you to avoid multiple drops (in this case, only the last version prevails).

Your notebook must allow for complete execution, in the cell ordering that you choose. The correctness and clarity of written codes, the choice of simulations, and the precision and relevance of comments will all be part of the notation. You should put particular care in the choice of diagrams/graphs (e.g. evolution of loss functions) that illustrate the behavior of the considered algorithms. In order to have codes of reasonable length, we advise you to write Python functions that may be used several times (in particular, when you compare several runs of the same algorithm with different parameters).

In the following, you will work on two "data distributions":

(2D-data) One synthetic 2D example (for example, the 6-point dataset used in the first part of the WGAN practical session, or another one that you may choose)

(MNIST-data) The MNIST dataset (used for the second part on the WGAN practical session)

For WGAN learning, you may use codes that you have written during the practical session of 04/02. For VAE learning, you may use the PyTorch tutorial given as a link in the course session of 28/01.

If you want to display a learned generative network, you can use diagrams that show sufficiently many samples of the output distribution.

1. For (2D-data), implement an alternate algorithm that learns a generative network by using the GAN loss function (see course session of Feb 21st). Answer the following questions:

1.a. Comment on the differences with respect to the WGAN learning algorithm.

1.b. Comment on the possible stability problems that you may encounter with the GAN algorithm.

2. For (2D-data), compute and display the three generative networks obtained with the algorithms based on GAN, WGAN and VAE.

Answer the following questions:

2.a. Comment on the possible difficulties encountered in the adjustment of the parameters of the learning algorithm.

2.b. Comment on the obtained configurations of generative networks: Is the data distribution well covered? Are the data points well interpolated?... (Here, we only expect some qualitative comments. You are not expected to perform precise quantitative evaluation in this question.)

3. For (MNIST-data), compute and compare the two generative networks obtained with the algorithms based on WGAN, and VAE.

3.a. Comment on the quality of generated images with these two networks.

3.b. Is there one of these learning strategies that you would favor? Why?

4. For (MNIST-data), you will design one quantitative criterion to evaluate the performance of a generative network.

4.a. Is the Fréchet inception distance (FID) appropriate to evaluate the performance of such generative networks? If not, can you propose an adaptation?

4.b. Propose a quantitative criterion that assesses the fact that the 10 classes of MNIST (corresponding to each figure between 0 and 9) are well represented by the generative network.

4.c. Comment on the benefits and drawbacks of the quantitative criteria discussed in 4a and 4b.