Vision and Perception
Third Part of the course on Generative Models

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Relevant indications:

1. Please save your work in your box as $firstname\_lastname.X$, where X can be pdf, Jupyter Notebook, Colab, whatever you prefer.

2. The deadline for these exercises is the 20th of July. I will start correcting those who have completed both the second and third part from the 6th of July.

3. Projects can be presented only if all exercises are concluded. If you have received grades for the first, second and third parts, you can agree with Paolo to decide the date of your project presentation.

4. For all those who are late and cannot commit to the deadlines (first set of exercises up to the 22nd of June, second up to the 5th of July, third up to the 20th of July) I will do the following:

   - Note that even if you have not completed the first part in time you can complete the second and third part in time.

   - For the first part I will change 5 exercises and submit a Late First Set the 15th of July.

   - For the second part and third part, I wll add new exercises the 21st of July, as Late Second and Third set of exercises.

   - For these late exercises there will be time up to the 15th of September.

   - According to the opening in September we shall decide if after this second turn of late exercises we shall begin to do the exams. There might be probably exams in October.

5. For this third set of exercises, listed below, you can use examples to show your explanations and proofs. In case you use examples remember to use samples which are realizations of random variables, for examples $x \sim \mathcal{N}(0, I)$. Where x can be for example x = (x1,...,xk). If this is not clear, look better at the videos and ask me.

6. If there are things not clear about what is written above, please ask.

List of exercises, for the third set

1. Exercise 3.2:

   - Why do we take the expectation of $\log p(x)$?
   - Explain why the reparametrization trick is needed.
   - Explain the difference between maximizing the lower bound and the log likelihood. What exactly is the role of KL in the implementation?
   - Explain the difference between cross entropy loss and maximum likelihood.
   - Looking at the loss function implemented in Tensorflow (shown in the video) explain what is effectively done.

2. Exercise 3.3:

   - Solve the two following 2 players zero-sum games:

   $$A_1 = \begin{pmatrix} -2 & 3 \\ 3 & -4 \end{pmatrix} \quad A_2 = \begin{pmatrix} 0 & -10 \\ 1 & 2 \end{pmatrix} \tag{1}$$

   - Show that if $x \sim Uniform(0,1)$ is a data sample of size 10×10, further vectorized, then:

   $$100 \leq \int_{\mathcal{Z}} p_g(z) \sum_{i=1}^{100} (2x_i^2 + 1) dz \leq 200 \tag{2}$$

   - Show that if $z \sim \mathcal{N}(0,1)$ is a data sample of size 10×10, further vectorized, then:

   $$0 \leq \int_{\mathcal{X}} p_{data}(x) \sum_{i=1}^{100} (z_i^2) dx \leq 200 \tag{3}$$

   Note that to comply with different generators of samples from a Normal distribution I have extended to 200 the upper bound of the above integral.

   - Show why if $p_g = p_{data}$ then JSD=0.
   - Explain in your words why GAN have convergence problems. List 7 major weaknesses of GAN, e.g mode collapsing.
   - Tell which application of GAN is your favorite one.