In this exercise we consider **Chapters 6** of the book 'Deep Learning' (Feedforward networks). It contains some theoretical but especially a lot coding exercises. This makes **two weeks of work, so start early**. You will learn a lot of concepts which make the foundation for all future exercises.

1. **Pen & Paper Backpropagation**

   Answer the questions without python code.

   (a) Backpropagation algorithm. (4)

   (b) Gradient descent. (3)

   (c) For course improvements, we would like your feedback about this question. At least tell us how much time you did invest, if you had major problems and if you think it's useful.

   Points for Question 1: 7

2. **MLP Implementation**

   Complete the given code where required.

   (a) Nonlinearities. (2)

   (b) Linear Layer. (2)

   (c) Cost Functions. (2)

   (d) Sequential Network. (2)

   (e) One hot encoding. (1)

   (f) Gradient Check. (1)

   (g) Optimizer. (2)

   (h) Training. (2)

   (i) For course improvements, we would like your feedback about this question. At least tell us how much time you did invest, if you had major problems and if you think it's useful.

   Points for Question 2: 14

3. **Experiments**

   After having completed the code, run the required experiments by following the instructions in the notebook and do some considerations.

   (a) Experiments. (2)

   (b) Conclusions. (2)

   (c) For course improvements, we would like your feedback about this question. At least tell us how much time you did invest, if you had major problems and if you think it's useful.

   Points for Question 3: 4

You can achieve a total of **25 points** for this exercise. Additionally you can achieve **2 bonus point** for answering the feedback questions.

Please send the **solution notebooks of your group of three** via ILIAS until **05.11.2018 12 pm**.

Note: Jupyter notebooks will be executed **from top to bottom**. To **avoid point deduction** check your notebook by the following steps: 1. Use the python 3 kernel (`Kernel > Change kernel > Python 3`), 2. Run the full notebook (`Kernel > Restart & Run All`), 3. Save (`File > Save and Checkpoint`).