COGNITION AND COMPUTATION

A.A. 2021/22 – Prof. Marco Zorzi, Dr. Alberto Testolin

Guidelines for preparing the individual essay

General notes:

1. Please report your full name, student ID and date on the first page of the essay.
2. The essay must be saved as a PDF file and submitted through the course Moodle at least one day before the chosen exam date.
3. The essay is individual, which means that plagiarism and collaborative writing are strongly discouraged (essays are automatically checked for plagiarism by the Moodle submission tool).
4. Succinctness is positively evaluated, so try to be clear and concise when elaborating your arguments. The word count should not exceed 3000 words (including references). Figures integrating the text are welcome.

Option 1. Review and critically examine the ideas presented in the following scientific papers and put them in relation to what has been discussed during the course:

- Lake, B. M., Ullman, T. D., Tenenbaum, J. B., & Gershman, S. J. (2017). Building machines that learn and think like people. *Behavioral and brain sciences*.
- Marcus, G. (2018). Deep learning: A critical appraisal. *arXiv preprint arXiv:1801.00631.*

Tips about how to write this type of essay:

- Start with a summary of the main ideas expressed in both papers.
- Try to put the concepts discussed in the papers in relation to the topics that have been explored during the course. Are the conclusions of the papers justified considering the current debate in cognitive modeling? In which way could the ideas presented in the papers further improve modern computational approaches in cognitive modeling?
- The discussion should be supported by at least a few citations of relevant, recent scientific articles that must be listed in the final bibliography.

Option 2. Implement simulations to explore computational models of visual concept learning. The easiest approach would be to base your simulations on the Python code presented during the lab practices; however, you might also explore you own ideas and implementations (get in touch by email for feedback).

- As training / testing datasets you could use one or more of the following:
    - EMNIST [https://github.com/aurelienduarte/emnist]
    - Omniglot [https://github.com/brendenlake/omniglot]
    - Caltech 256 [http://www.vision.caltech.edu/Image_Datasets/Caltech256/]
- The goal is to explore how the model learns to represent the data by:
    - Performing linear read-outs at different levels of the hierarchy to investigate whether representations become increasingly more disentangled at the deepest layers in the network.
    - Analyzing the internal representations developed by the model (e.g., by exploiting hierarchical clustering methods and/or feature visualization methods).
    - Analyzing confusion matrices / psychometric functions to investigate the kind of errors made by the model.
- Further possible explorations:
    - Explore the effect of adding noise to the test images to assess robustness of perception.
    - Explore the response to adversarial attacks and/or the capability of few-shot learning.

Tips about how to write this type of essay:

- Explain the details of your implementation (e.g., model architecture, training and testing methodology), but without spending too many words in describing the source code itself.
- Report the results in the form of graphs and tables, and critically discuss each finding in the text of the essay.