

Advanced Topics in Artificial Intelligence: proposed assignment

Deadline: December 15th 2022

October 14th, 2022

Our visual system and brain work together in order to identify and recognize images and objects with a very high speed and accuracy, as long as they are not impaired. A very good source for visual perception from a clinical viewpoint is [Schwartz's book](#). A 2-year old child needs to see and be introduced to a small number of images and explanations in order to distinguish, say, a cat from a dog or any other animal, even if the image is blurred or the object is partially blocked. The state-of-the-art computational model to recognize images is based on neural networks, in particular, deep neural networks composed by a number of layers. In contrast to the human recognition model, deep neural network models require a large number of training instances in order to distinguish a cat from a dog, and if the images are noisy, they lose their predictive power.

In this assignment you will be practicing with neural networks that distinguish among animals and will add more methods trying to improve the model. The main objective is to understand why deep learning alone may not be a good learning model and explain how we could achieve a good computational human-like model (achieving the holy grail? ;).

Below you can find a list of your tasks.

1. Go to the tutorial [found here](#) and repeat the whole process.
2. Create new images containing noise (for example, Gaussian white noise) or mask the images placing some blocking artifact.
3. Repeat the tutorial with these new images added to the original ones: have the results improved or got worse?
4. Train your models with networks different from VGG (for example, resnet, rexnet or similar).
5. Add a new class of animals, for example, pandas (you can create new images using instructions on [this site](#)).
6. Train your models again: can you classify well when you add other classes of animals? What if the classes are imbalanced? Does it matter to the humans? Does it matter to the computational models?
7. Another way of training is using a description of the images (a very simple way of doing it is shown [here](#), but you can also fetch images and image metadata from [this kaggle competition](#)).
 - Train new models using the new way of describing the original images.
 - Add a new kind of animal and describe them: can the classifier improve or not?
 - Can the integration of images with annotated features improve results?

- Can you devise a better way of describing images/objects using any kind of knowledge representation (tabular, graph-based, logic-based, ontology-based, semantic-based, probabilistic-based etc)?
 - Does a new representation produce good results?
8. Try applying reinforcement learning to this problem. How would you represent it and what is the reward function?

You should deliver code and a report with detailed methodology (description of data used, representations etc, preprocessing steps, evaluation metrics, validation method etc), results and discussion comparing the various methods and explaining why some models work better than others and why some models fail to imitate human behavior (what is missing?). You should also discuss about what would be an ideal model that can learn as a child in this task.

This work can be done in groups of **maximum two students**.