Object Recognition - Project Proposal

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Chosen Topic

With the agreement from Professor I. Laptev, we chose to work on the paper *"Learning to Act by Predicting the Future"* by Dosovitskiy and Koltun (proposed in the 2017 list). In a few words, the paper proposed a new Reinforcement Learning approach in visual environments (or other sensory environments). This approach is based on Direct Future Prediction (DFP), a Convolutional Neural Network architecture which will predict the future stream of measurements involved in the reward function, from sensory inputs and past stream of measurements.

Motivations

First, we are eager to learn about how Deep Learning can help Reinforcement Learning to improve decision making in visual environments. Next, the model is quite flexible and can be extended in several exciting ways : which information to choose for sensory/measurements inputs, how to do the training ... Finally, we are excited as we can expect this model to be used as a baseline for real-life applications, such as robotics or autonomous driving.

Plan of Work

We plan to proceed in three steps :

1. **Experimental step -** We will make sure to understand the code associated to the article relative to DFP and to its training, and will try to reproduce some results presented on the VizDOOM data. We will focus on :
   — Comparing DFP and DQN algorithms in environments with increasing complexity (basic, navigation, battle)
   — Comparing the performances of DFP depending on the goals used for training (same as test/other/random)
   — Showing the impact of predicting measurements at several future times.
2. **Implementation step -** We will work to enrich in one or two ways the sensory and measurement inputs, implementing Object Recognition techniques presented in class. Regarding the sensory input, we will try to add to the images several informative channels, such as a segmented map of important objects, a depth map or a flow motion map. Similarly, we could also be able with similar techniques to enrich the measurement inputs : distance to health packs, speed, ...
3. **Implementation and experimental step -** We will try to apply this model the two following simulators :
   — T-Rex Chrome Offline Game simulator. In this simulator, the agent controls a dinosaur and needs to avoid obstacles in order to stay alive and maximize his reward. The data used would hence combine pixel images of the environment perceived by the agent, as well as measurement data (time and number of deaths).
   — CARLA, an open-source simulator for autonomous driving. More especially, we would like to adapt the implementation of the computer vision ideas of step 2 to this new environment, and assess their impact on the agent's behaviour. We would focus on a subset of the measurements provided by CARLA, including speed and impact of collisions, and restrict the action set to the steering angle and the acceleration.

We will try to keep an unbiased view when comparing the performances of the different models (eg. tuning the hyper-parameters for both DQN/DFP/with extensions described in 2). We will also dedicate a particular attention to assess the generalization power of the implemented extensions to different environments.

Group Work Policy

Since the two of us intend to have practice with implementation and experimental analysis, the work will be divided equally at each of the three steps.