Introduction

- Task: Prediction of pushing affordances with polyflaps: predict a sequence of polyflap poses given a pushing motor command of a Katana6M™ simulated arm.
- Approach: Offline and Active Learning using Recurrent Neural Networks, specifically Long Short-Term Memory (LSTM).
- During the pushing movement, a sequence of rigid body poses are stored and used for learning. The LSTM then learns a regression function.

Scenario

Learning approach

- We first conducted offline experiments to test the generalization capability of the learners.
- Then, we used an active learning algorithm that selects an action to perform according to a learning progress measure maximization (c.f. Oudeyer et al.)
- We put the polyflap in a certain position and we define 18 different starting positions for the arm to start a pushing movement (i.e. 18 different sensorimotor regions).

Learning approach (LSTM)

Learning algorithms

Long Short-Term Memory

Recurrent neural network training algorithm that allows prediction of long sequences by using a gradient-descent approach.

Interesting features:

- Constant error carousel neurons: learn to get rid of non-relevant inputs or outputs by learning to close and open input and output gates.
- Forget gates: learn when previous inputs need to be forgotten.
- Peephole weights: improve the learner ability to predict exact timing during sequence processing.

Experimental Results for Offline Learning

Output neuron errors for a sequence

Active Learning (Intrinsic Motivation)

- The learning progress \( L(t) \) can be calculated as the difference between the mean error values \( e(t-\theta) \) and \( e(t) \).
- By using a \( \epsilon \)-greedy policy, given \( L(t) \), select an action \( a \) from the set of possible actions \( \{ a_i \} \) in 18 sensorimotor regions \( \{ R_i \} \) so that:
  \[
  a = \text{arg max} \{ L(t) \}
  \]
- Update the weights of the LSTM.

Preliminary results (active learning)

Conclusions

- LSTM convergence is shown by offline experiments.
- LSTM performs well for sequences processing, at least when data do not include noise.
- Straightforward implementation of active learning techniques like intrinsic motivation systems.
- A comparison of convergence between offline and active learning approaches might be carried out.
- Alternative offline training algorithms might be considered.