SC42050 Literature Assignment

Learning Poincaré maps

Gabriel Lopes

The stability of cyclic dynamical systems can be studied using the notion of a Poincaré map. However, such maps typically cannot be written in closed form. Reinforcement Learning can be used to approximate maps online and thus it is a candidate framework for approximating Poincaré maps. Please read (Morimoto et al., 2004) and carefully answer the following questions:

1. Do a small literature review and present the notion of a Poincaré map. Show why it is difficult to find close form descriptions for Poincaré maps (hint: consider a generic cyclic system $\dot{x} = f(x)$. Show that the Poincaré map requires the computation of an integral with non trivial intervals).
2. Explain intuitively the ideas behind the Receptive Field Weighted Regression (equations 1 to 5).
3. Do you think the solution proposed in (Morimoto et al., 2004) can cope with non-stationary environments? (e.g. walking on bumpy terrain or in a moving train.).
4. Try to enumerate the main problems of reinforcement learning for systems with continuous state space and actions.

References

Morimoto, J., Nakanishi, J., Endo, G., and Cheng, G. (2004). Acquisition of a biped walking pattern using a Poincaré map. In *Proceedings of the IEEE/RAS International Conference on Humanoid Robots*, pages 912–924.