Robotics Project Proposal

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Objective

I'd like to investigate the use of Deep Belief Networks (DBNs) [1] for online reinforcement learning in the robotics domain. The deep learning paradigm stands in contrast to more usual backpropagation-type neural networks by focusing on the intermediate representations ocurring between layers. DBNs have been successfully applied to a great variety of tasks [2].

Method

I've found one paper [3] which describes the use of a DBN as the function approximator in Neural Fitted Q Iteration [4] on a standard reinforcement learning benchmark problem (Mountain Car [5]). The main problem the authors encounter is that the network becomes biased towards the regions of the state space covered in the initial pre-training step. Since the trajectories used for pre-training come from a random policy, this leads to poor performance on problems (such as Mountain Car, and most real-world problems) where important regions of the state space are unlikely to be reached by a random walk.

I'd like to pursue two approaches to improving these results. The first is to try using an M-DBN (Modular DBN) architecture [6], which is designed to prevent "forgetting" of earlier training by creating separate modules within the network which each specialize on a region of the sample space. This may help address the training bias problem.

Secondly, it may be possible to exploit the fact that a DBN is a generative model to create a more effective exploration strategy than a random walk. I'm still thinking about this.

Evaluation

The algorithms will be evaluated on some standard benchmark tasks: Mountain Car, Puddle World, and Cart Pole [5]. If performance is good, I may consider a more difficult task.

References

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[4] Martin Riedmiller. Neural fitted Q iteration - first experiences with a data efficient neural reinforcement learning method. *Machine Learning: ECML 2005*, pages 317–328, 2005.

[5] Alain Dutech, Tim Edmunds, and Jelle Kok. Reinforcement learning benchmarks and bake-offs II. In *NIPS*, 2005.

[6] Leo Pape, Faustino Gomez, Mark Ring, and Jurgen Schmidhuber. Modular deep belief networks that do not forget. *The 2011 International Joint Conference on Neural Networks*, pages 1191–1198, July 2011.