SC42050 Literature Assignment

Learning to stand up using hierarchical reinforcement learning

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Consider the hierarchical reinforcement learning (RL) method developed by Morimoto and Doya (2001), and its application to learning stand-up control policies for a three-link robot. Write a brief paper about this topic, integrating answers to the following questions in the logical flow of your paper. Do not restrict your reading to this single article (Morimoto and Doya, 2001); e.g., some of the questions below will require further reading.

- Besides the approach proposed in (Morimoto and Doya, 2001), what other hierarchical RL methods exist? Include some of the methods reviewed by Morimoto and Doya (2001) in Section 5.1, but also other approaches that they do not mention.

- Highlight the differences between the RL algorithm used at the higher level of the hierarchy, and the RL algorithm used at the lower level.

- Explain the role of the eligibility traces. Can you formalize more concisely (using fewer equations) the algorithm given by Equations (1)–(6) of the paper?

- Explain in what ways *prior knowledge* about the problem is exploited by the authors in developing their approach. Where is prior knowledge used to a greater extent – in the higher level of the hierarchy, or in the lower level? Justify your answer.

- Explain why the authors did not apply RL directly to the real robot, but preceded the real-life experiments with a preliminary simulation stage.

- In Section 3.2, why does the experiment with $\Delta\theta_1 = 50$ deg fail?

References

Morimoto, J. and Doya, K. (2001). Acquisition of stand-up behavior by a real robot using hierarchical reinforcement learning. *Robotics and Autonomous Systems*, 36(1):37–51.