CartPole-vπ:

The Rotary Inverted Pendulum

Project Goal: I plan to design, train, retrain, and test a deep reinforcement learning model in order to solve the rotary inverted pendulum problem.

Problem Description: Rotary pendulums, as pictured in Fig 1.1 [1], swing at the end of an arm rotated by a central motor. The central motor can swing an equal-elevation arc both clockwise and counterclockwise, depending on external voltage inputs. My model must carefully modulate its outputs (fed to a controller) to keep the pendulum upright for as long as necessary. Mathworks/MATLAB demonstrated one solution to this problem in 2015 [2], with the same Quanser workstation.

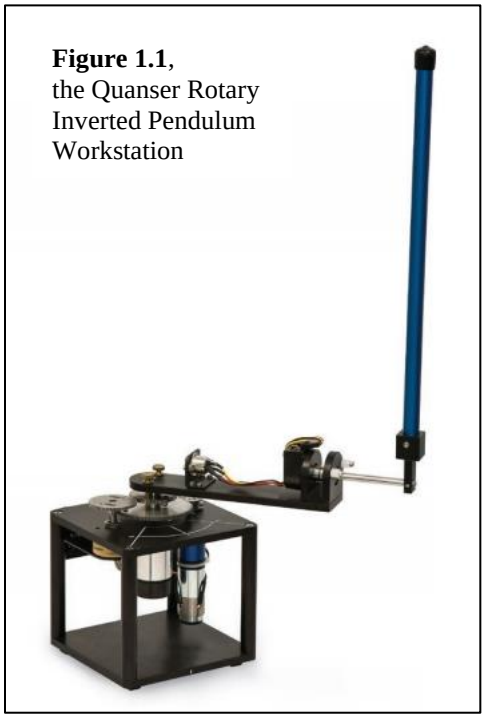

Figure 1.1, the Quanser Rotary Inverted Pendulum Workstation

Preceding Work: This problem has been tackled before, by researchers employing a range of machine-control techniques. Particular to my approach, at least one team [3] had attacked the problem from a reinforcement learning perspective. However, given the recency of the publication (20 January 2020), I feel confident that my approach has little precedent. The group did not make their code open-source and produced a paper that emphasized the electrical engineering and training practicalities of the problem. Their neural networks, for example, consisted of bare six-neuron hidden layers between input and output. While that decision may have been carefully considered, the authors do not discuss their design decisions in any depth. My product will stand apart from prior work by demonstrating the appropriateness of the model as I design it.

Dataset: My reinforcement learning model will train in a simulated environment, as employed by both Wu, et al. and MathWorks [2][3]. The model learns the data it creates as a physics engine simulates the rotary pendulum's movement. After extensive off-product training, I will port the model to a rotary pendulum controller and retrain as necessary.x

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[1] Quanser, "The Rotary Control Lab: A Modular Single Source Solution You Can Control," Quanser Inc., 2020. [Online]. Available: https://www.quanser.com/products/rotary-inverted-pendulum/. [Accessed: Feb. 6, 2020].

[2] MathWorks/MATLAB. "Inverted Pendulum Control with SimMechanics and QUARC," YouTube, 8 Sept., 2015. [Video file]. Available: https://www.youtube.com/watch?v=pOOndKlXvx8. [Accessed: Feb. 6, 2020].

[3] Wu, N.; Vincent,A.; Strukov, D.; Xie,Y. "Memristor Hardware-Friendly Reinforcement Learning," arXiv, 20 Jan., 2020. [Journal Article]. Available: https://arxiv.org/abs/2001.06930. [Accessed: Feb. 5, 2020].