Balancing the cart-pole problem using Reinforcement Learning techniques. Modeling and Simulation with NX-RecurDyn and Simulink.

Programa de Doctorado en Automática, Robótica e Informática Industrial

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Introduction

Reinforcement Learning(RL) is a class of algorithms for solving problems in which an agent(controller) learn how to behave in an environment in order achieve a desired goal.

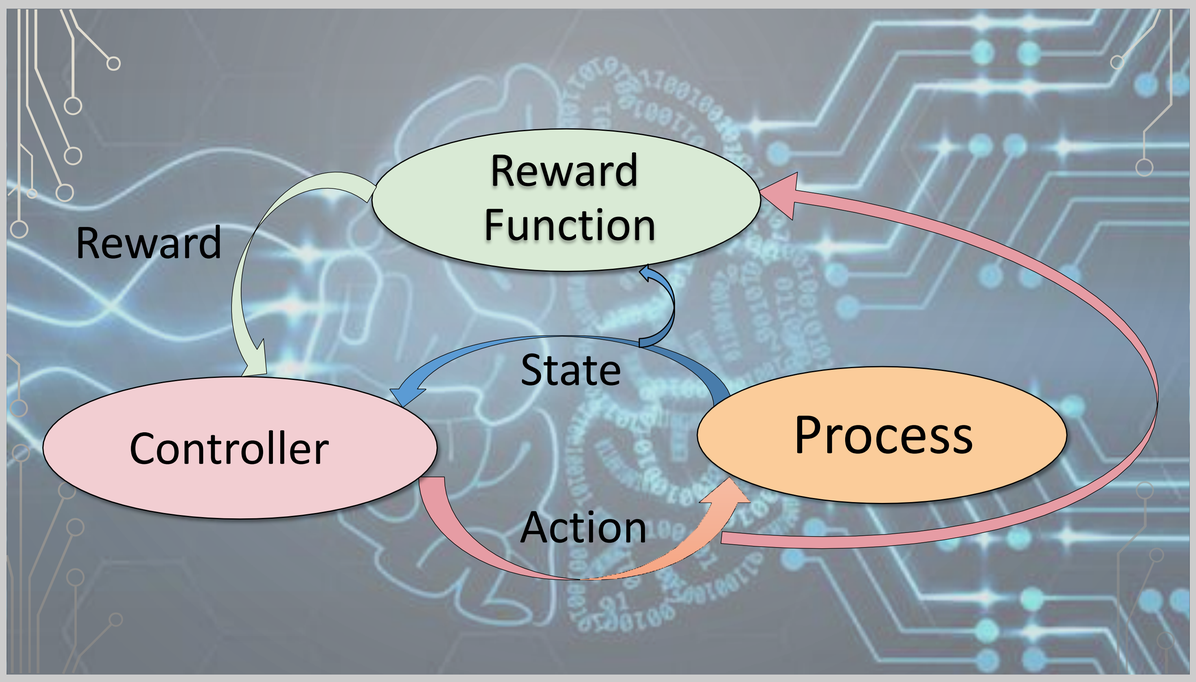
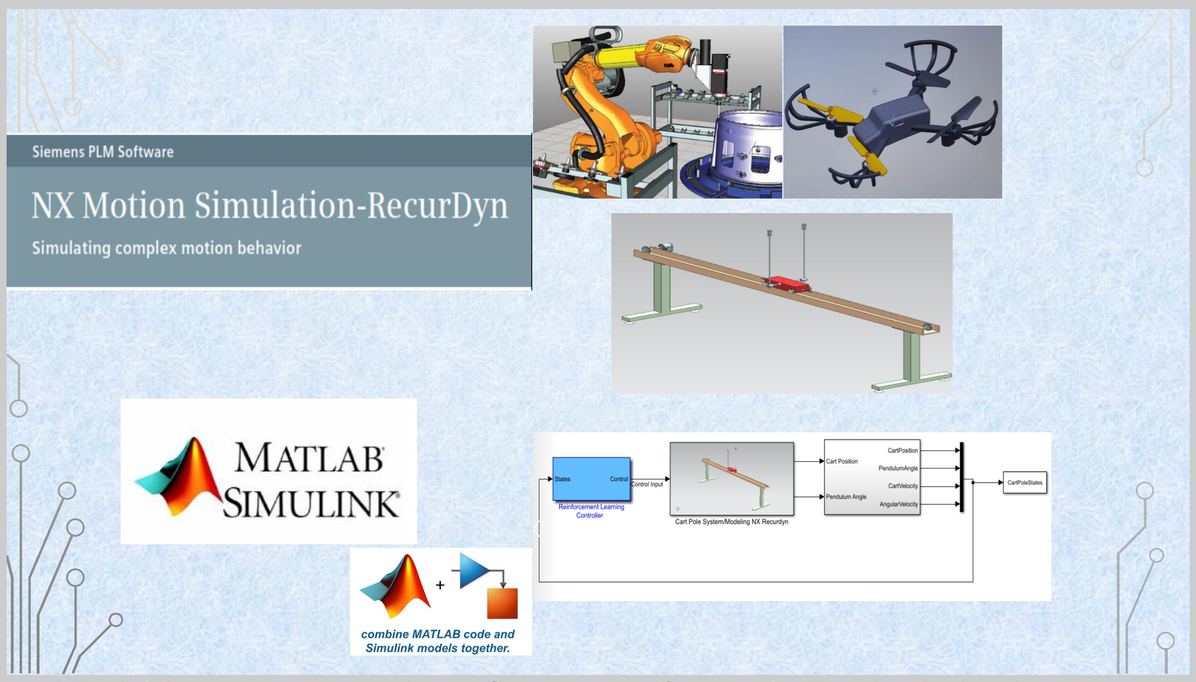


Figure 1: RL elements and the flow of interaction.

Methods and Tools



- Model is a representation of a system for analyzing its behavior.
- Simulation is the transition from a mathematical or computer model to a description of the system behavior.

Reinforcement Learning algorithms was implemented using MATLAB/Simulink software in order to learn optimal controllers in our system(cart-pole). The learning controller is integrated into a motion simulations through co-simulation with MATLAB/Simulink and NX Motion Control Simulation.

Conclusions an Future Work

- RL controllers learn policies that map observations(samples) to control actions in order to regulate the system.
- Modeling and Simulation are very useful in RL because they avoid to make real experiments that could be dangerous or expensive.
- Future work will involve extending the ideas to more complex systems and improve the algorithms for faster learning.

References

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[3] F. L. Lewis, D. Vrabie, and K. G. Vamvoudakis, "Reinforcement learning and feedback control: Using natural decision methods to design optimal adaptive controllers," *Control Systems, IEEE*, vol. 32, no. 6, pp. 76–105, 2012.

Learning

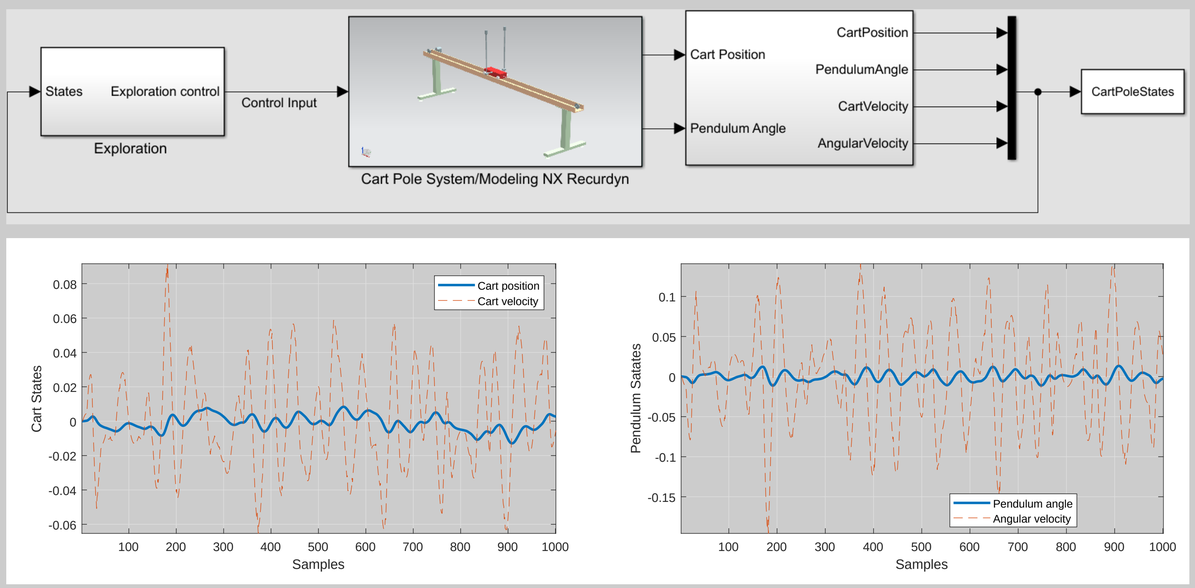

Figure 2: In order to get samples(DataSet) an exploration control is used on the cart pole system.

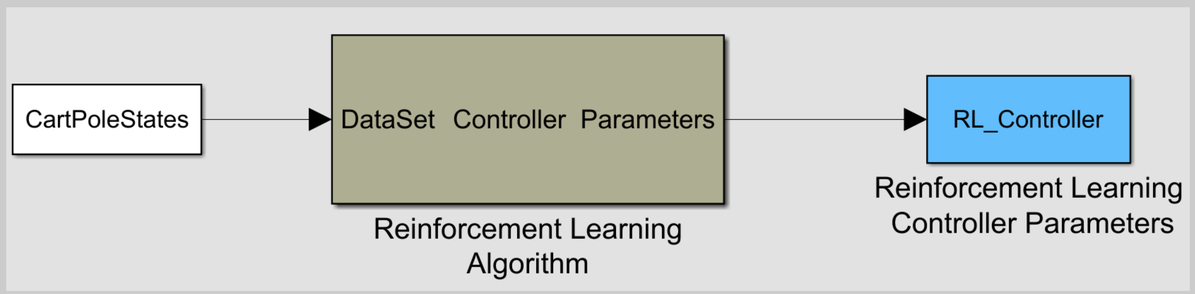

Figure 3: Reinforcement Learning Algorithm (Q-Learning[3])

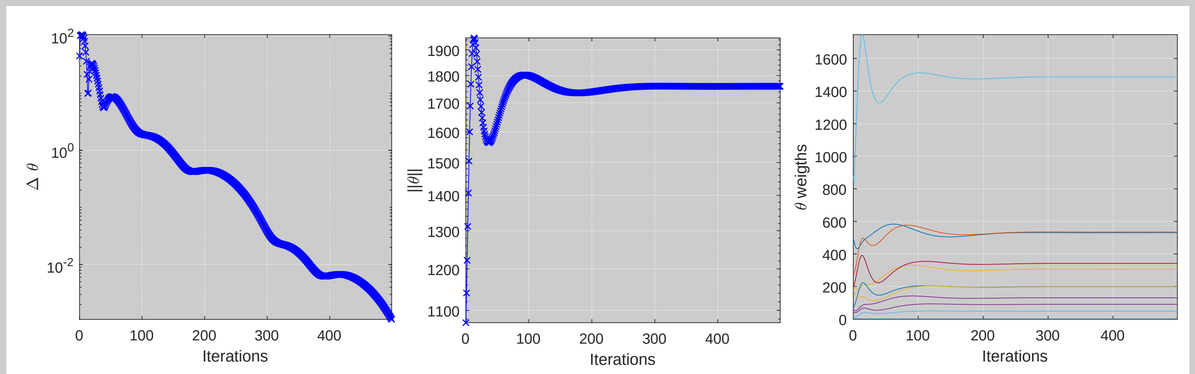

Figure 4: Convergence of the RL algorithm

Results

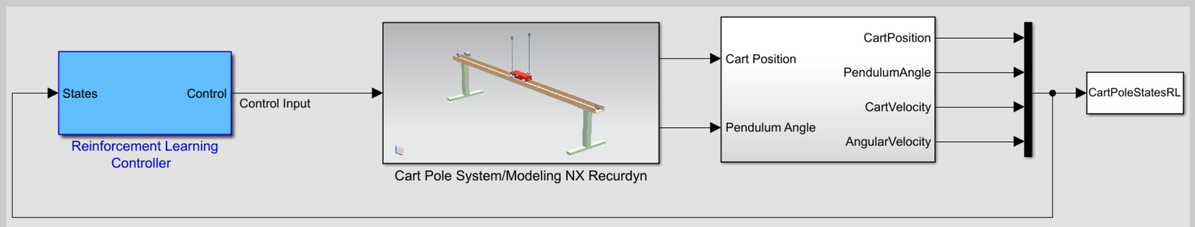

Figure 5: Balancing the cart-pole system using a RL controller

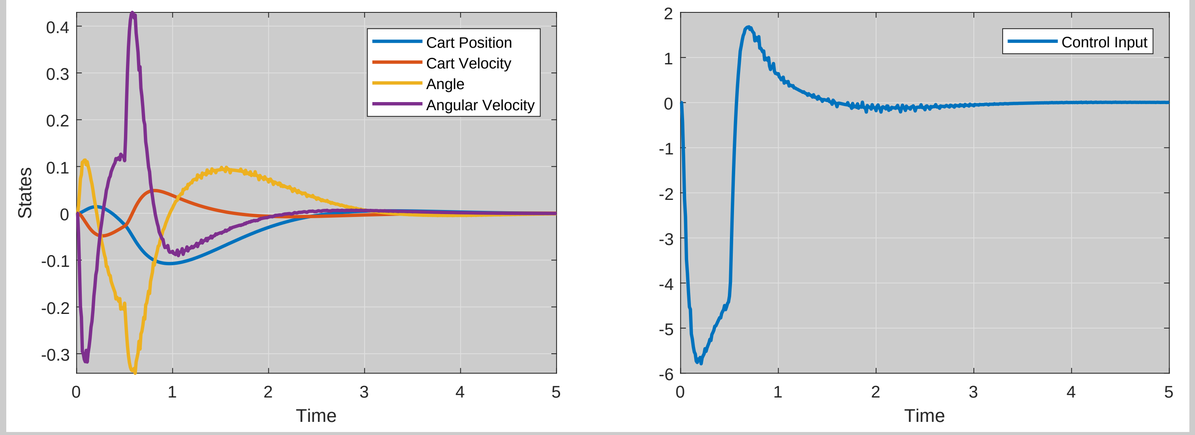

Figure 6: States evolution and control signal when the system is disturbed.

Acknowledgment

The authors are grateful to the financial support of Spanish Ministry of Economy and European Union, grant DPI2016-81002-R (AEI/FEDER, UE) and PhD. grant SENESCYT from the Government of Ecuador.