Levitation Learn:

Magnetic Levitation & Control Via Machine Learning

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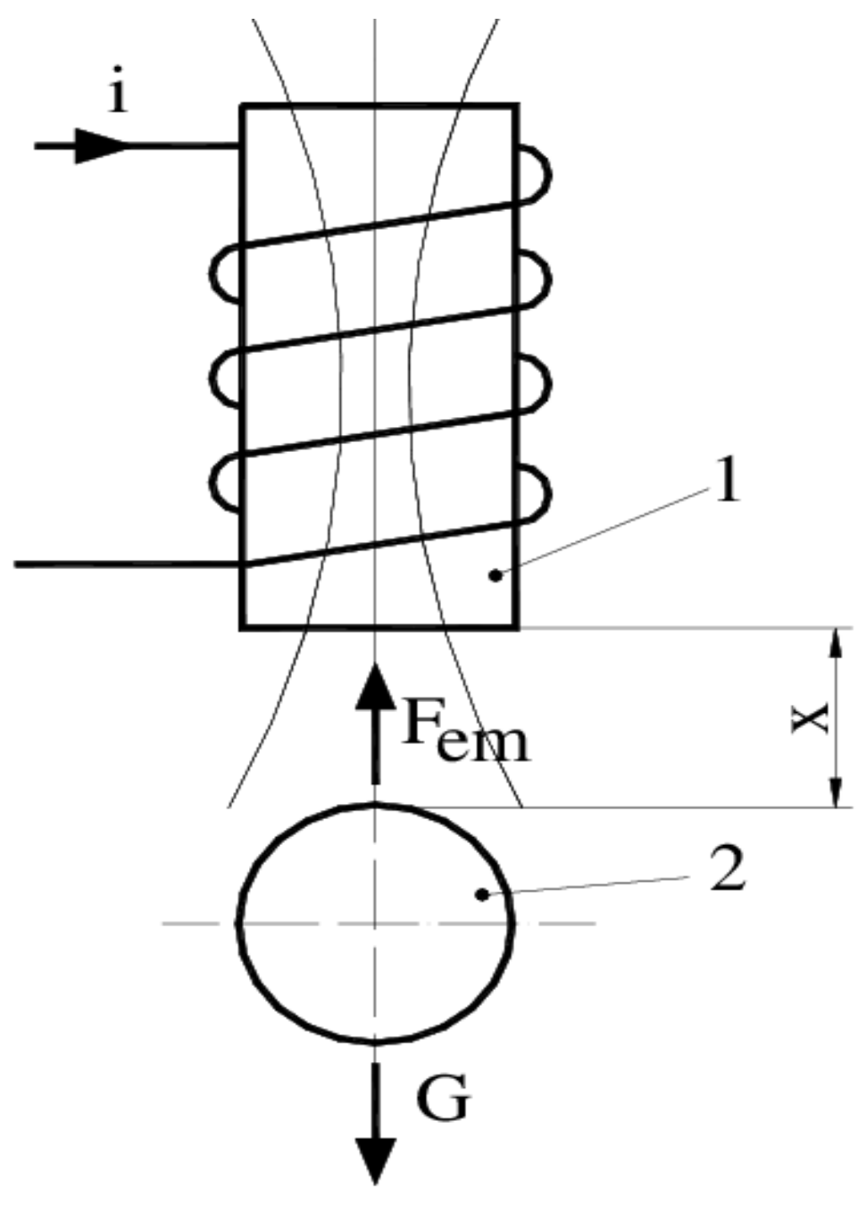
Introduction

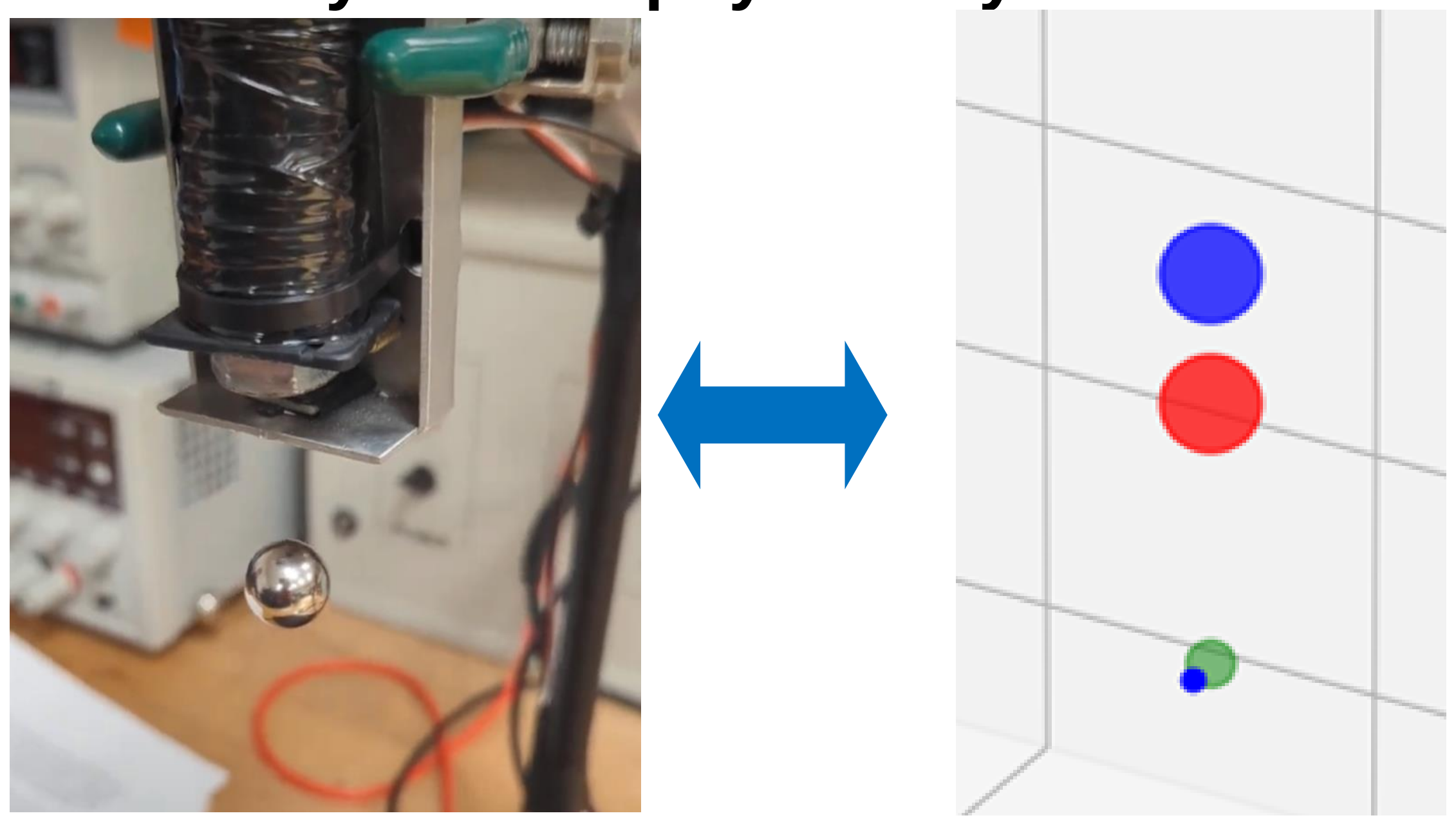
The task of levitating a magnet is conceptually simple with varying implementation difficulty. For simple systems, manual calculations of equilibrium suffice. As they grow more complex, we rely on control methods

After a certain point, however, the system becomes too complex and uncertain to reasonably model with traditional control, thus requiring a more sophisticated model such as a Neural Network

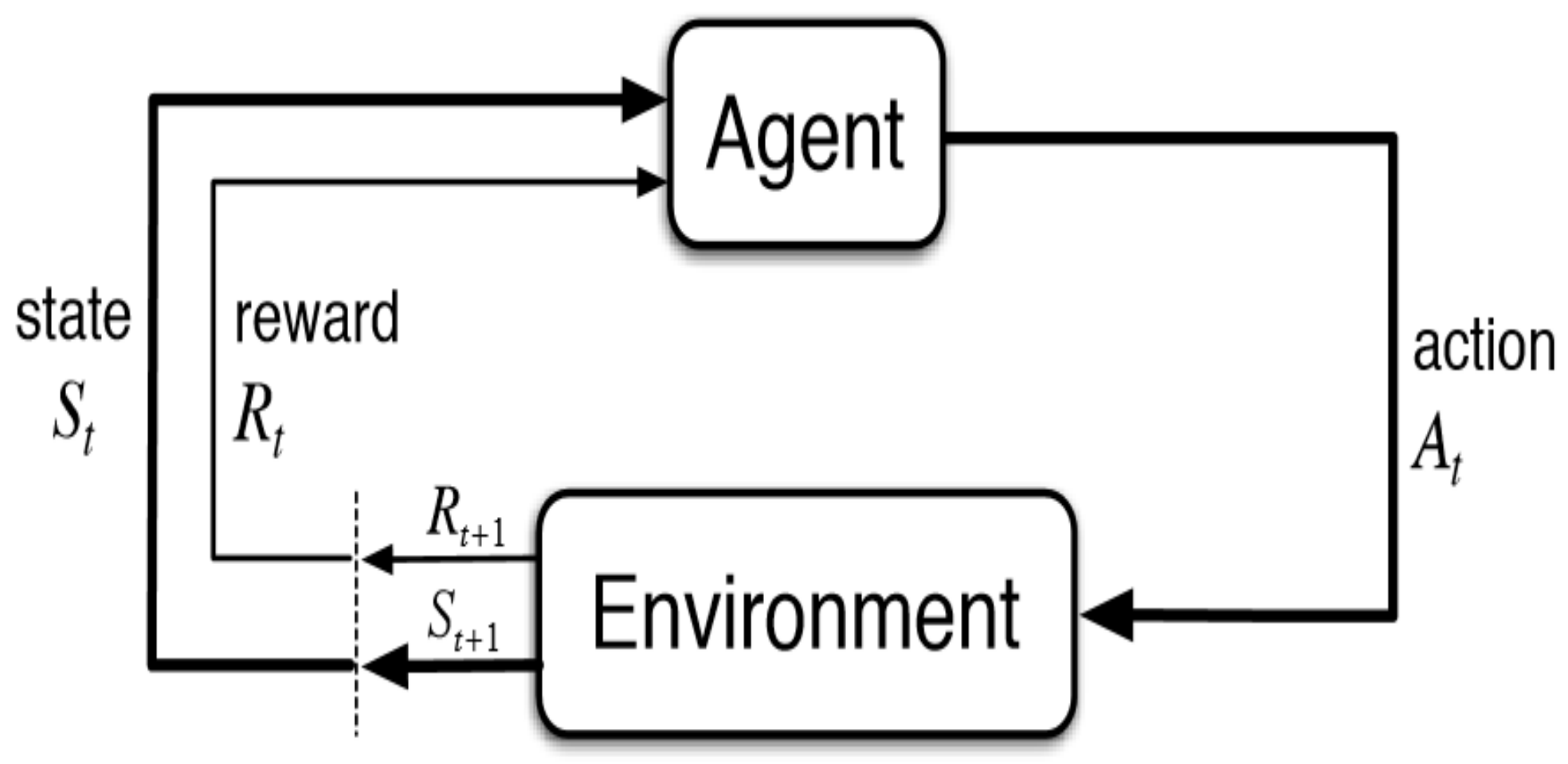


Objectives

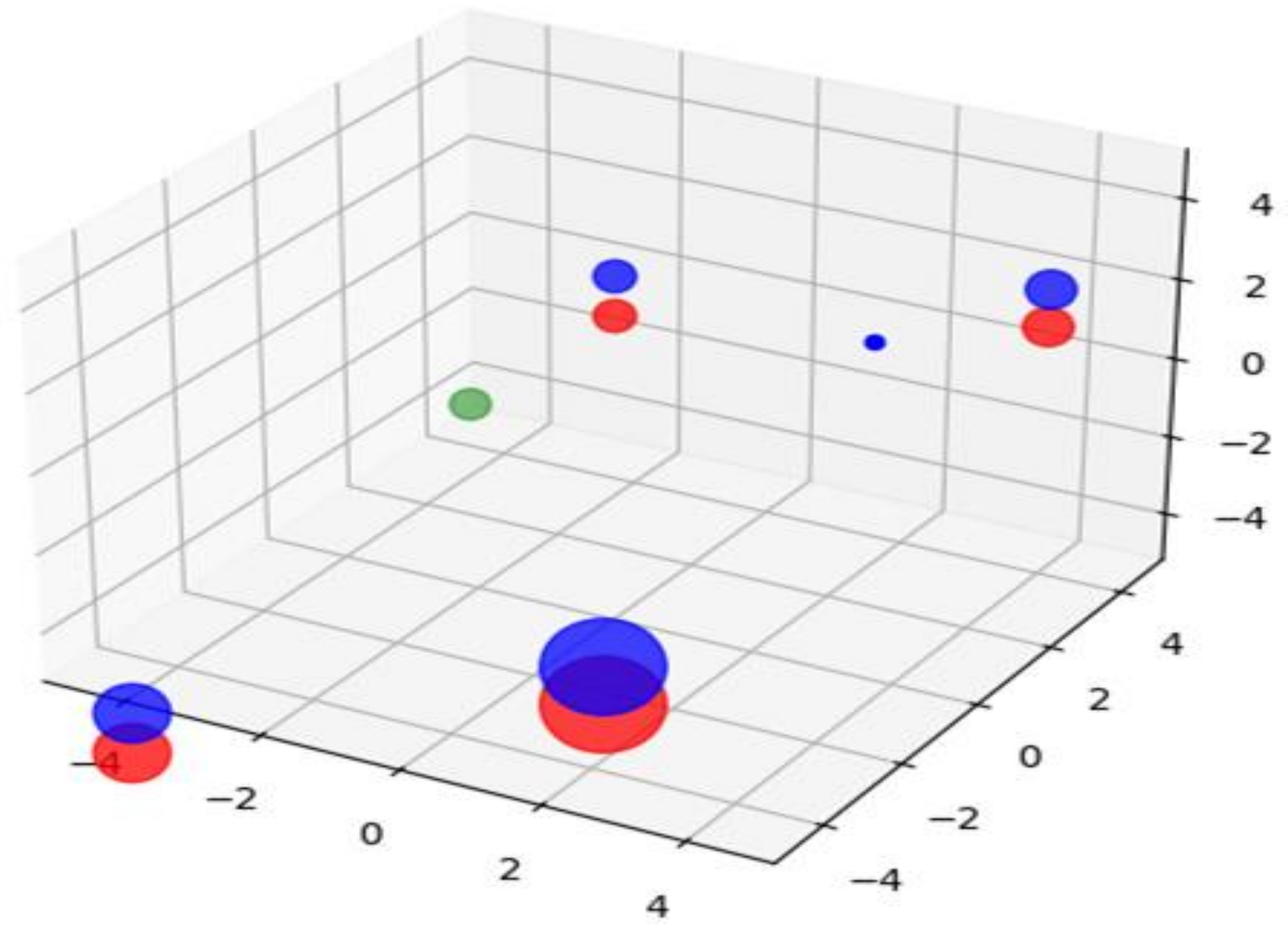
Develop simulation environment that accurately models physical system behavior



Develop control method for magnetic levitation that uses Reinforcement Learning instead of traditional approaches

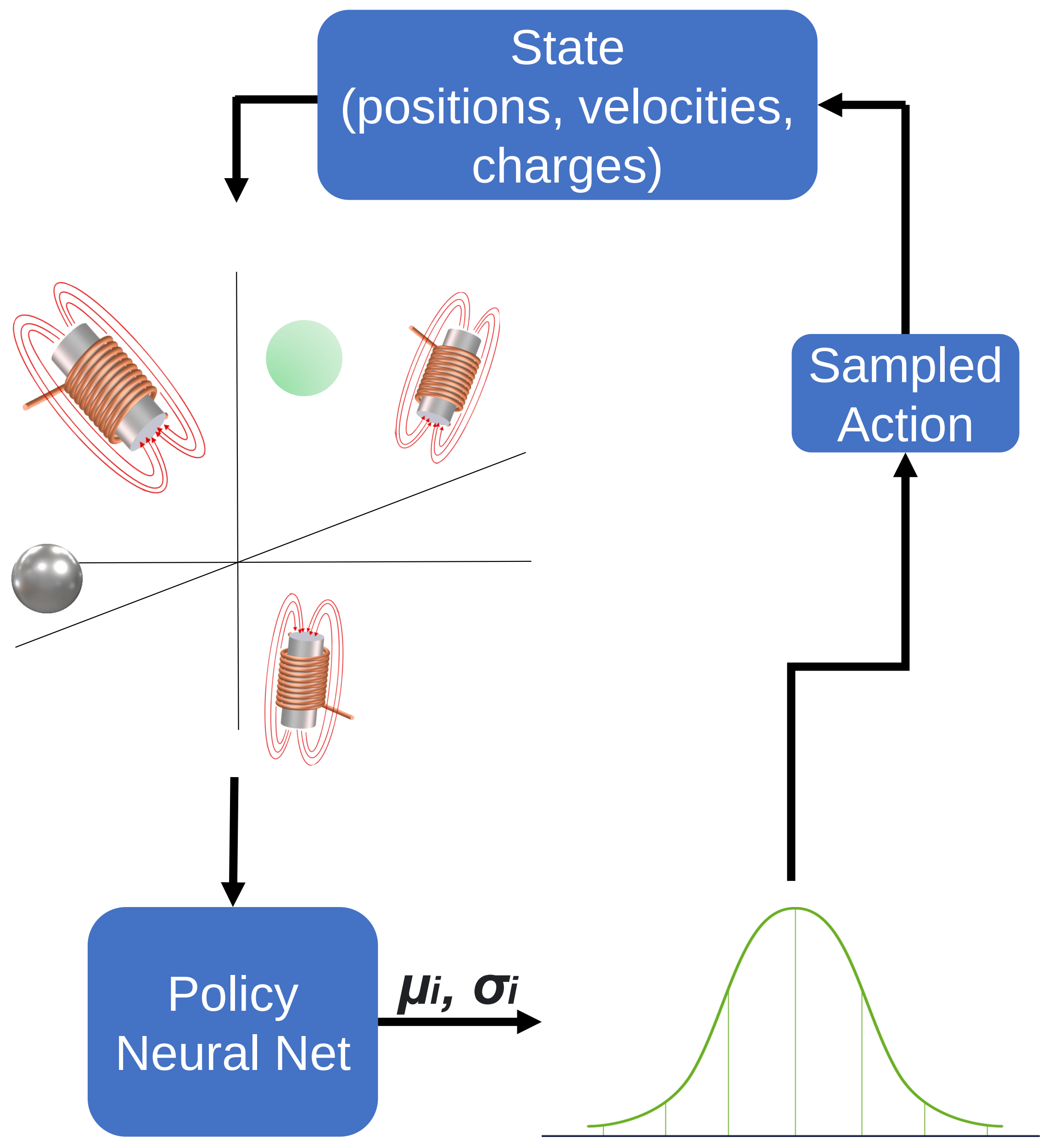


Develop RL policy that learns & manipulates systems of varying configurations



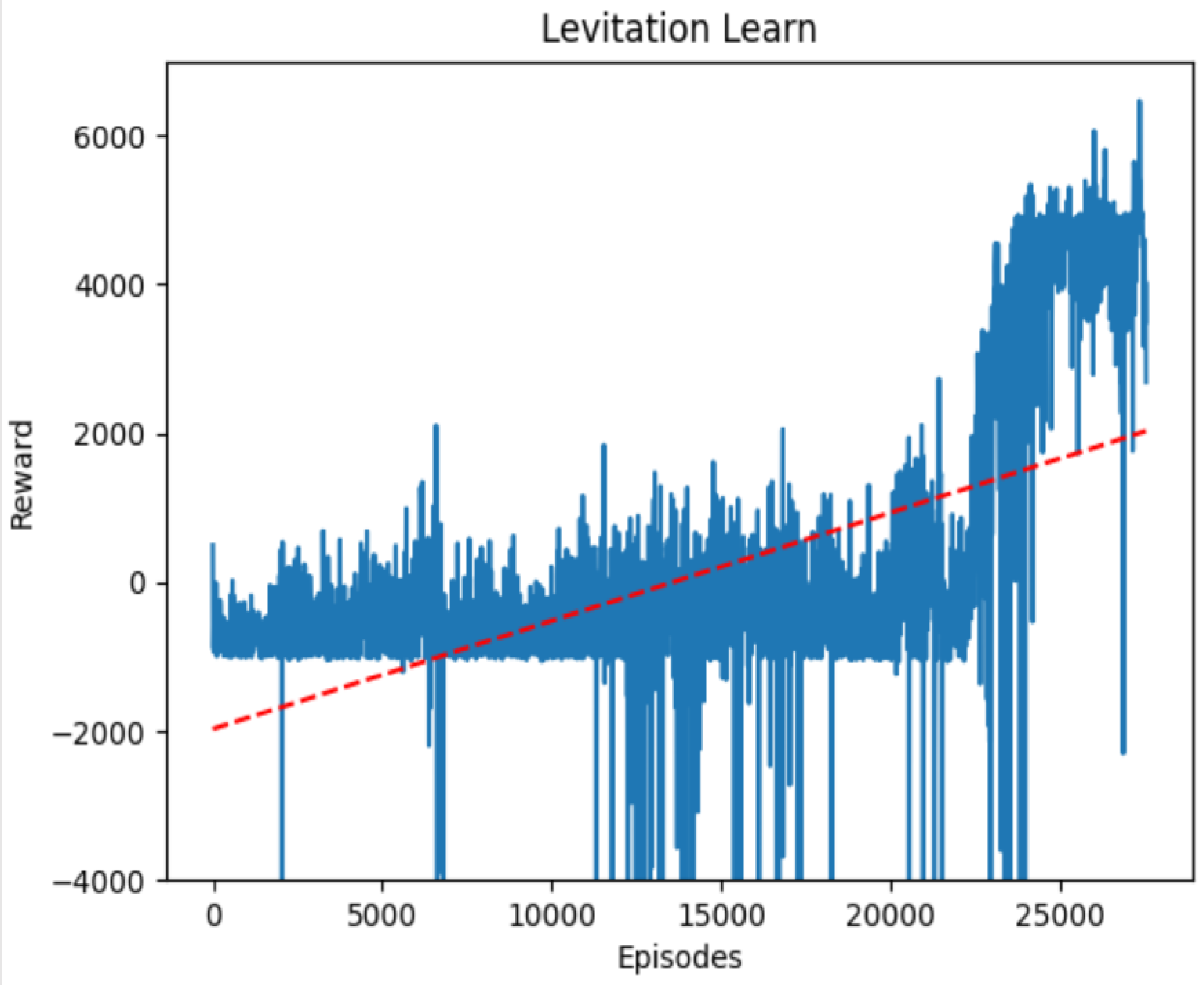
Methods & Initial Results

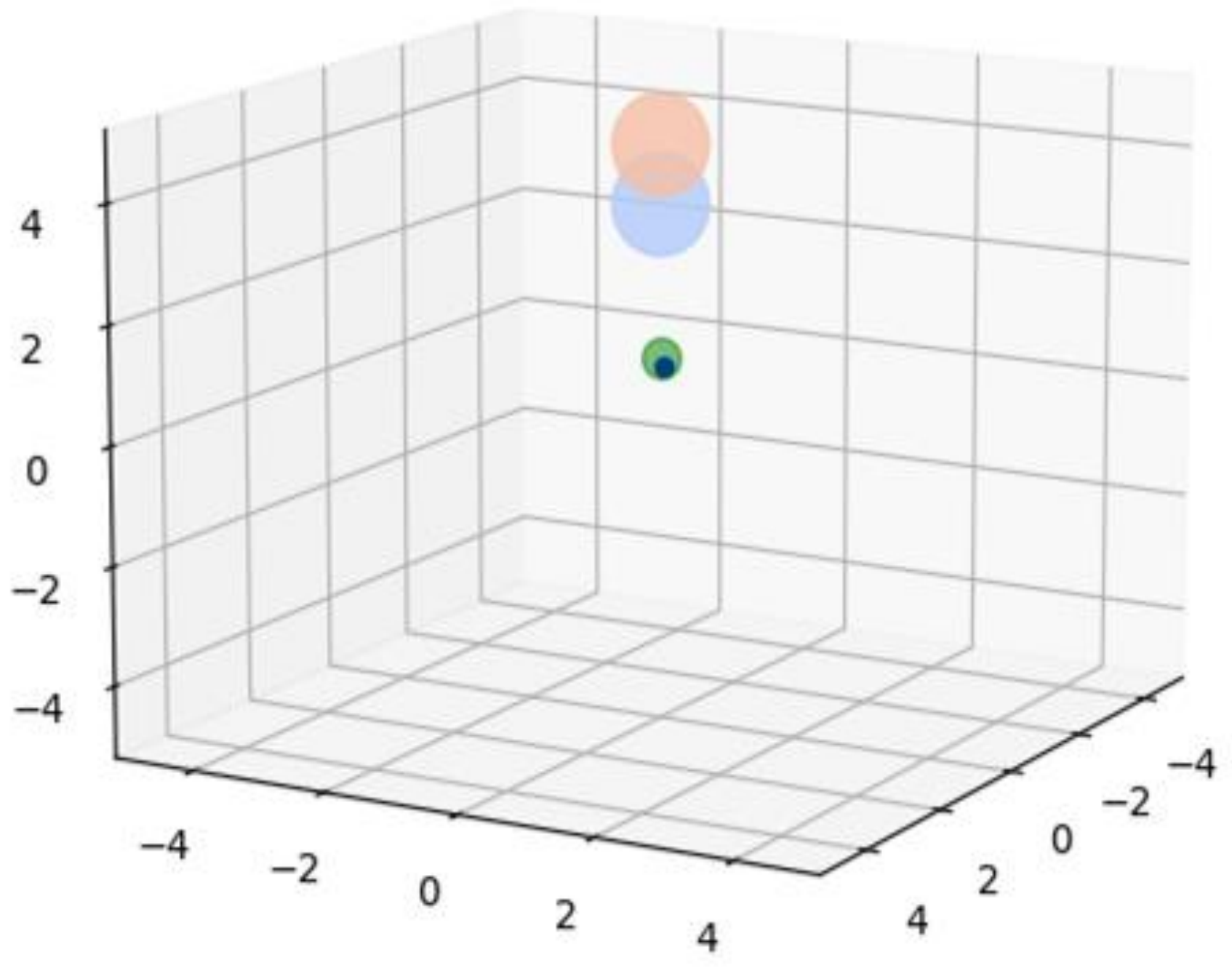
Various RL approaches were considered for application to this problem with **policy-gradient** being the final choice due to its ability to work with **a continuous action space**



N distributions for charge magnitude corresponding to N magnets in the system

The **REINFORCE algorithm** has shown the ability to **converge** on any 1D system **given an arbitrary starting system configuration.** A snapshot of this learning process is shown below





Electromagnet Strength – Vibrance of Pole Colors

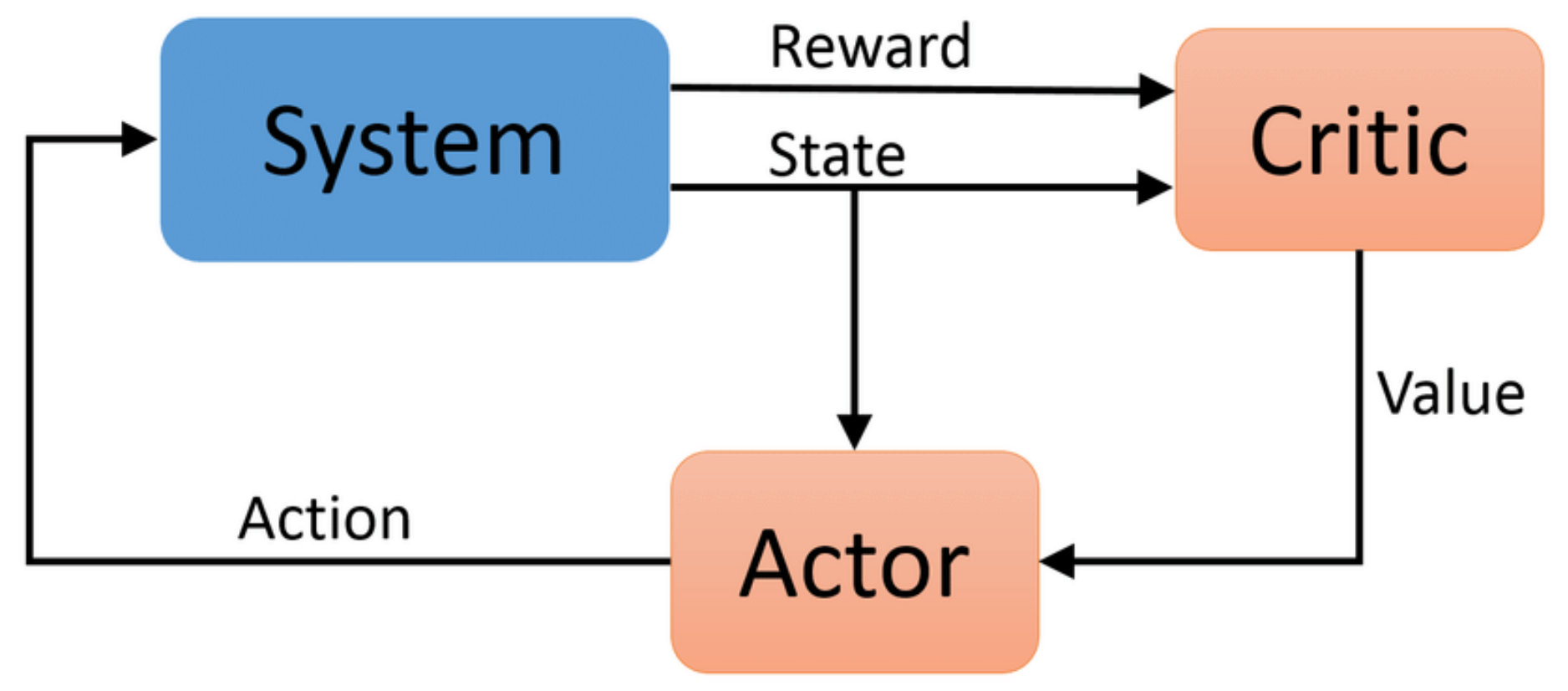
Conclusions

- RL is unstable, but versatile when applied to systems where adapting to environment is critical

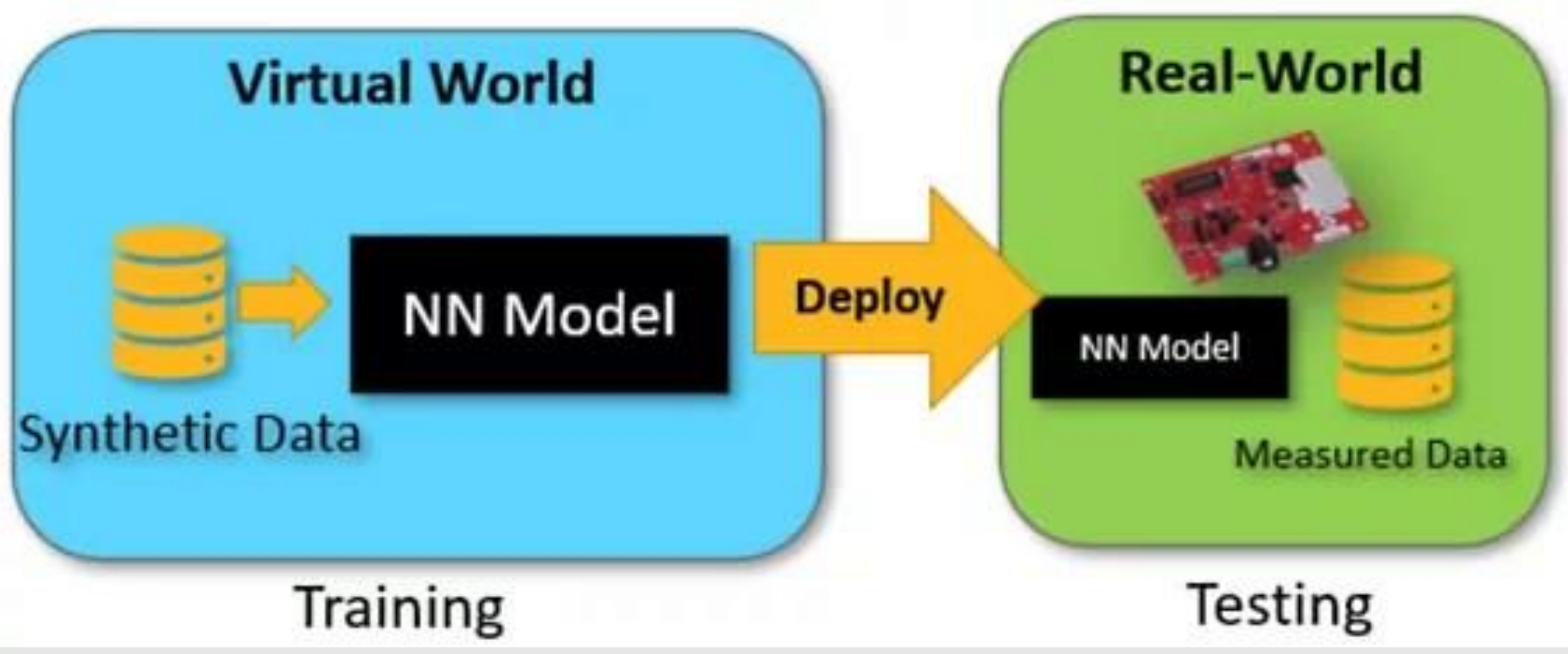
- Convergence to a solution is brittle, and reaching it requires a tradeoff between complex architectures or intricate fine tuning. Reward is especially important

Future Work

- Generalize environment to work in N-dimensions
- Parallelize training so GPU can be used more efficiently
- Change to Soft Actor Critic to increase convergence performance



- Deploy Levitation Learn in physical system



References

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