Robust nonlinear set-point control with reinforcement learning

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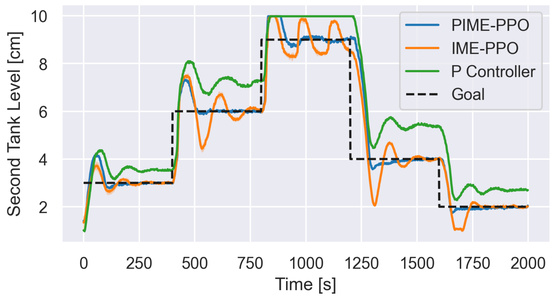
Introduction

Standard RL can often struggle even on seemingly simple set-point control problems. We propose three ideas to improve RL methods even for highly nonlinear set-point control problems:

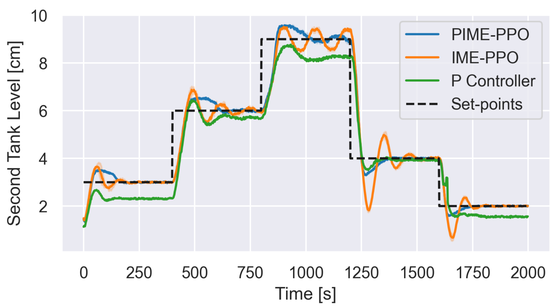
- Simple Prior Controller for Amplitude Exploration
- Use Integrated Errors
- Train on Model Ensembles

Train in Simulation and Transfer to Real-World Model

Directly apply on real-world tank:



Add unmodelled disturbances:



Conclusion

Integration of RL and control-theoretic method to obtain a robust set-point controller.

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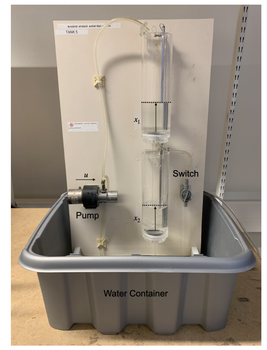
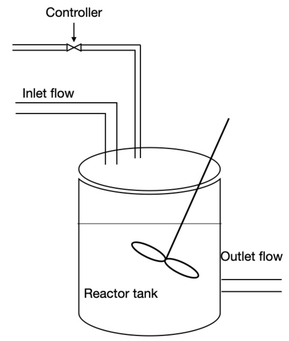
Standard RL **struggles** on *seemingly simple* set-point control problems.

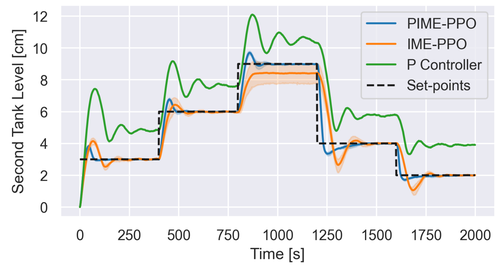
Integrator + Model Ensemble help to train a **robust** policy!

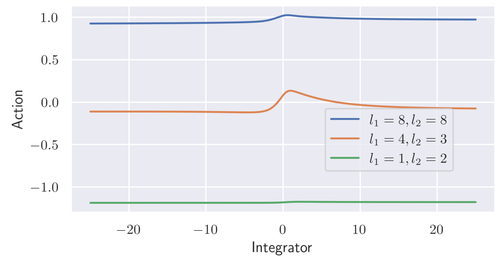
The cascaded water tank level control shows robustness against model errors. The highly nonlinear pH-control problem shows the enhancements when PID control falls short.





Without the integrator, there is no fixed policy that can handle changing parameters and unmodelled disturbances. **Without** Model Ensembles, the policy overfits to the simulated model.





Highly-Nonlinear pH Control Result