Recurrent Kalman Graph Network Simulators

Description

Accurate simulation of physical systems lies at the core of numerical engineering. Yet, classical simulators are often highly specialized to a very narrow domain and require large amounts of compute to produce satisfying results. In recent years, Graph Network Simulators (GNS) [3] have risen to popularity as a fast, differentiable and general-purpose alternative to such classical simulators. Use cases include the fluid flow prediction as well as the simulation of both rigid and deformable objects. Some examples can be seen in Figure 1.

Figure 1: Visualizations of a Graph Network Simulator simulating a flag in the wind (left) and a metal plate being deformed by a rigid object (right).

While these simulators produce trajectories that look realistic, they often suffer from problems such as error accumulation and drift over time. This problem arises because GNSs are Graph Neural Networks [2] that are trained to iteratively predict the dynamics of a physical system in a supervised fashion, and thus depend on their previous output for each prediction step. In this work, we want to alleviate these issues by integrating sensory information such as point cloud data into the system. To this end, we want to employ Recurrent Kalman Networks (RKNs) [1], which account for additional sensory information at an arbitrary time resolution while maintaining a principled estimate of simulation uncertainty throughout inference. The resulting architecture can use additional observations as a reference, correcting wrong simulated behavior and gathering additional knowledge about the simulation during inference.

Tasks

- Literature Review: Get familiar with Graph Network Simulators, Recurrent Kalman Networks, and the theory behind the two.
- Algorithm Design: Combine the general principles of the RKN with a GNS architecture to allow for a principled integration of sensory information into learned simulators.
- Evaluation: Evaluate your algorithm on different simulations and compare it to existing approaches.

References

