DiffSim

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DiffSim - Idea

- Autodiff frameworks work great for machine learning: we compute gradients for parameters conveniently
- Why stop at computing parameter gradients? Why not autodiff arbitrary code?
- Big part of modern engineering/research are based on computer models/simulations

- Let's autodiff entire computer models/simulations!
- Question: What could we do with that?

What's happened so far

- Simulation of explicit high-dim simulation vs low-dim latent simulation [Rotating Gaussian distribution]
- Parts of latent simulation is done by neural network ODE
- Chaotic system with external force field [Double Pendulum]
- Three Body Problem of rotating planets [N-Body Problem]

What's to discuss

Energy Conservation

- Continuously adding an external force field massivily increases the energy of the system in the long run, aka erratic evolution
- I have to pay very close attention to how I design the noise force fields

- Obvious solution: time varying, but I realized that too late as an explicit solution to this problem
- Wanted to work on time dependent DiffEqs anyway

What's to discuss

N-dimensional Hamiltonian benchmark

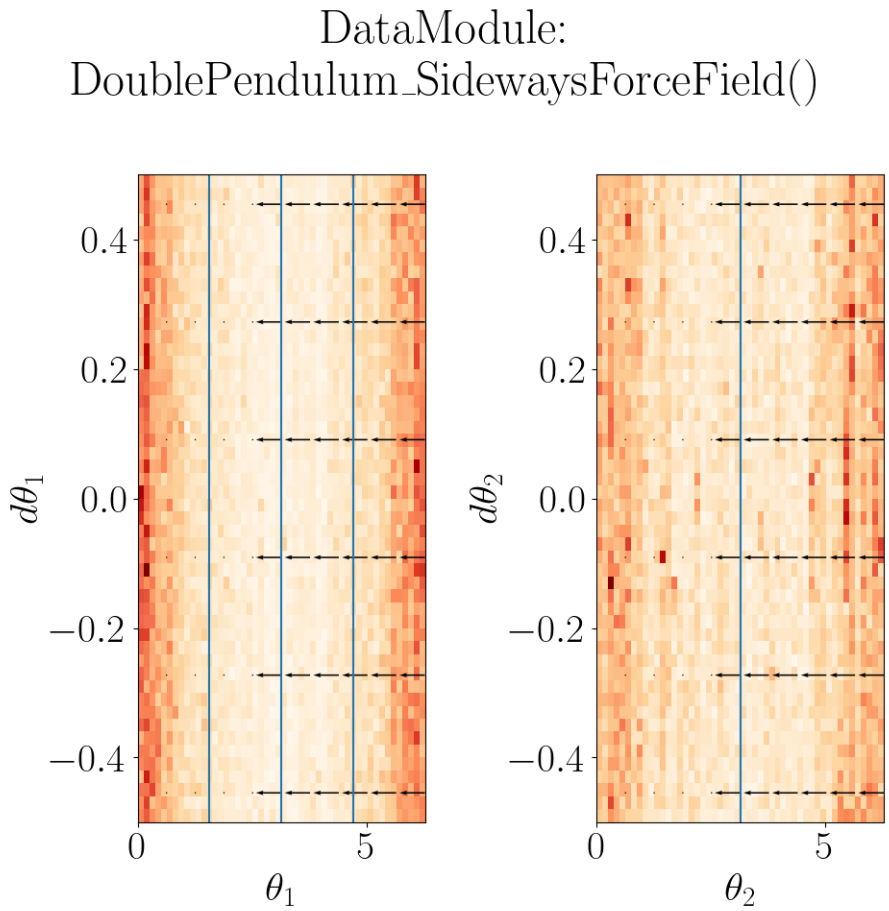
- Current benchmarks are unintuitive to debug
- More explicit state space debugging instead of human readable image space

- Implement very high Hamiltonian system via GMM in 10-20 dimensions
- Visualize 2D trajectories from that high dimensional space

What's to discuss

Visualization of Learnable Force Field

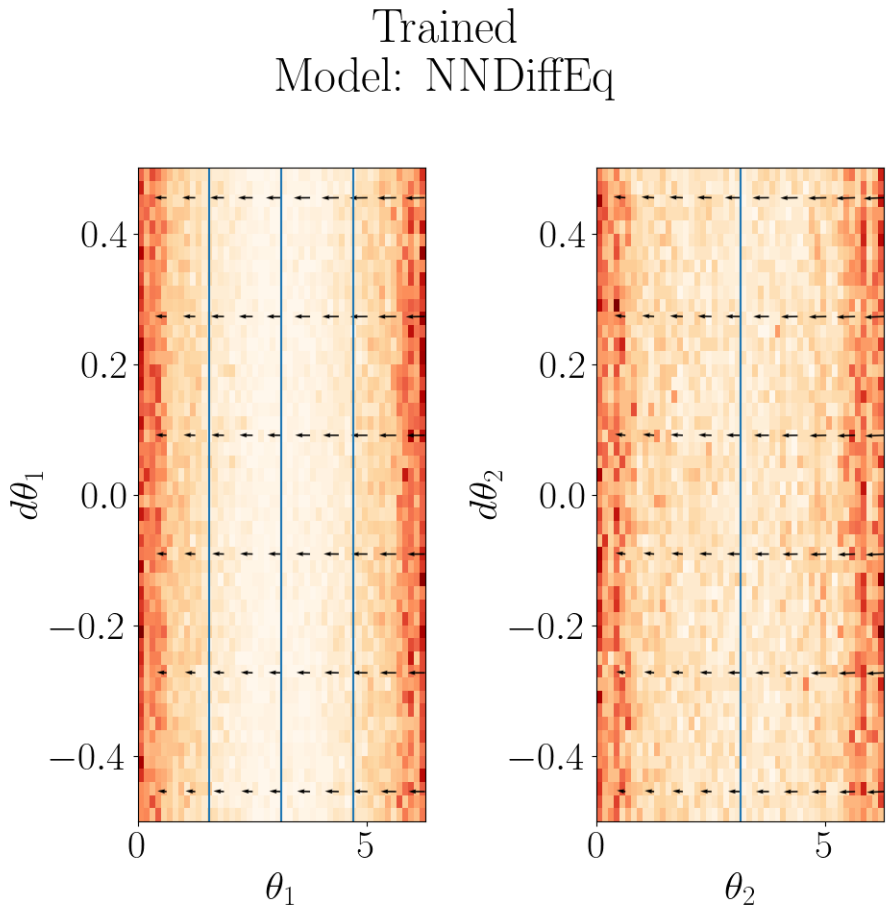
- Lyapunov instability is annoying, since visualizations diverge long term ... but ...



What's to discuss

Visualization of Learnable Force Field

- ... but Force Fields are explicitely learnable, color grading is training data distribution, but maybe only learns constant offset?



Next Step

- Implement time dependent/varying DiffEqs
- Devise energy stable noise force field development
- Hopefully use Nd Hamiltonian as well behaved benchmark to test out time dependent noise force fields
- With time dependent force fields, adding and subtracting energy is possible
- Implement N-dimensional Hamiltonian system to analyse sub trajectories