Physics Informed Neural Networks

Synopsis for the 02456 Deep Learning Project

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November 3, 2025

Motivation & background

Most neural networks (NN) are used to find data driven solutions of any form. But the computational power of neural networks can also be used to solve equations, which can be effective on areas with little to no data available. By giving the neural network physical constraints on it's loss function, it is able to solve partial differential equations (PDEs), allowing it to make physically possible predictions [1].

This has been done on a number of areas already including solving the Navier-Strokes equation in fluid dynamic complex scenarios [2], solving 2D linear elasticity problems [3] and making accelerating hydrodynamic simulations of urban drainage systems [4] to name a few. This is known as Physics Informed Neural Networks (PINNs).

Milestones

The project is a steppingstone for the group to get to know PINNs and use one to solve a PDE in the form of the wave equation. Our goals are:

- Build a PINN.
- Solve a simple PDE (wave equation on a square domain).
- Solve the wave equation on a spherical domain.
- If time allows, also explore neural operators and their potential for solving PDEs.

References

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