

PINN's to solve Differential Equations

Description:

Physics Informed Neural Networks (PINNs) to solve Differential Equations.

Pytorch library à JAX to build PINN's à Matlab for data generation à ODE's ,PDE's with Matlab.

Capstone project - Using PINN's to solve the Non-Linear Schrodinger Equation.

Timeline

Week 1 (29th aug - 5th sep)

▮ Familiarising ourselves with PINNs

& So, [What is a Physics Informed Neural Network?](#)

& [Original Paper](#): Physics-informed neural networks: A deep learning framework for solving forward and inverse problems involving nonlinear partial differential equations

& [Matthieu Barreau - Physics-Informed Learning: Using Neural Networks to Solve Differential Equations](#)

Week 2 (15th sep - 22nd sep)

▮ What are Neural Networks?

& [The Essential Main Ideas of Neural Networks](#)

& [Gradient Descent](#)

& [Backpropagation 1](#) & [Backpropagation 2](#)

Submission 1 (Graded)

Details	Deadline	Marks	How to submit
A quiz to test your understanding of Neural Networks.	September 22, 2024	5	Link will be sent

Week 3 (23rd sep - 30th sep)

- Learning Matlab for Data Generation←

Note: You can find the data to a couple differential equations [hereee](#), but if you wish to generate your own data, you can either use python if the analytical solution already exists or solve for it numerically using **Matlab**.

- & Learning Matlab (*if needed*)

- & [MATLAB Onramp](#)

- & [Solving Ordinary Differential Equations with MATLAB](#)

- & [Solving Nonlinear Equations with MATLAB](#)

Week 4 & 5 (1st oct - 16th oct)

- & Implementing NNs using PyTorch (or TensorFlow)

- & [The StatQuest Introduction to PyTorch](#)

- & [Deep Learning With PyTorch - Full Course](#)

- & [Github repo of pinns-torch library](#)

- Understanding optimizers (A few readings)

- & [Gentle Introduction to the Adam Optimization Algorithm for Deep Learning](#)

- & [A Gentle Introduction to the BFGS Optimization Algorithm](#)

Submission 2 (Graded)

Details	Deadline	Marks	How to submit
Implement a normal Neural Network to solve the differential equation and submit the .ipynb notebook with the results.	October 9, 2024	25	Forms link will be sent

Submission 3 (Graded)

Details	Deadline	Marks	How to submit
Now, implement a Physics informed Neural Network to solve the differential equation and submit the .ipynb notebook with the results.	October 16, 2024	40	Forms link will be sent

Week 6 (17th oct - 24th oct)

This is not compulsory, you can explore JAX if you wish to or skip directly to the capstone project depending on time commitments.

& Implementing the same NN using JAX

& Why JAX?

& [COMPARING PINNS ACROSS FRAMEWORKS: JAX, TENSORFLOW, AND PYTORCH](#)

& [Just In Time \(JIT\) Compilers - Computerphile](#)

& Learning JAX

& [Introduction to Google JAX for Physics Informed Neural Networks \(PINNs\)](#)

& [Github repo of pinns-jax library](#)

Submission 4 (Ungraded)

This submission is purely for the participant to further their knowledge and skills.

Details	Deadline	Marks	How to submit
Implement the PINN using JAX	October 24, 2024	0	Forms link will be sent

Week 7&8 (25th oct - 9th nov)

This is not compulsory, this is a more advanced problem which will extend your learning but you can also choose to **submit a report** of the equation/(s) previously solved.

Capstone Project!

Solve the NLSE using PINNs and present your work in a report to complete this project.

You can [FIND THE DATA FOR THE PROJECT here](#).

& Understanding the Non-Linear Schrodinger Equation (NLSE)

& [Nonlinear Schrödinger equation, Wikipedia](#)

& [The Nonlinear Schrödinger Equation, LibreTexts](#)

& [Are there any nonlinear Schrödinger equations?, StackExchange](#)

Submission 5 (Graded)

Details	Deadline	Marks	How to submit
Submit a report (Google Docs) of your project either solving the Differential Equation of your choice or the capstone project if you choose to partake in that. Marks will be the same regardless of the problem chosen.	November 9, 2024	30	Forms link will be sent