ID5030- Machine learning for Engineering and science applications

Homework 8 – Physics Informed Neural Networks

Assignment Given on : Apr 18th , 2023

Due Date : Apr 28th, 2023 (Online submission)

Context : The purpose of this assignment is to

a) Understand how PINNs work for forward problems
b) Implement PINNs for some simple PDEs and ODEs

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Download the following two papers:

a) Lagaris et. al. (1997) https://arxiv.org/pdf/physics/9705023.pdf
b) Raissi et. al. (2017) https://arxiv.org/pdf/1711.10561.pdf

You may also access the github repository of the PINN approach from link (b) above to execute the tasks given below.

1. **PINN for an unsteady problem**
   The advection equation in 1D is given by
   $$u_t + a u_x = 0$$
   a) Modify the Burgers equation code obtained from Raissi et. al to solve this equation with the same initial conditions and boundary conditions as Example 2.1 in the paper. Use the same ANN hyperparameters as in the paper.
   b) Compare the solutions you have obtained above with the exact solution for this equation. (Search online for exact solutions if you do not know the exact solution from previous classes!).
2. **Effect of boundary conditions imposition** –
   Consider Problem 5 (Section 4.2.1) in the Lagaris et. al. paper.
   a) Replicate the results of this using the Lagaris approach for boundary conditions. Use a neural network with one hidden layer and 10 neurons as in the paper.
   b) Repeat the same case with the PINN approach for boundary conditions. What (if any) differences do you observe in your results?