# Evaluating Magnetic Field using Deep Learning

20th International IGTE Symposium on Computational Methods in Electromagnetics and Multiphysics

**Mohammad Mushfiqur Rahman, Arbaaz Khan, David Lowther and Dennis Giannacopoulos**

Computational Electromagnetics Lab, McGill University, Montreal, Canada

## ABSTRACT

The industry standard for simulating electromagnetic problems is using either the Finite Difference (FD) or the Finite Element (FE) methods. Optimization of the design process using such methods requires significant computational resources and time. Due to the recent advancements, the use of Deep Learning (DL) has become computationally much more efficient and cheaper. In this paper, we attempt to solve for the magnetic flux density (B) in electromagnetic systems using **Recurrent Neural Networks (RNN)** and **Physics-Informed Recurrent Neural Networks (PI-RNN)**. The solutions are compared with the ground truth, computed using FE, and the results show promising accuracy for our deep learning models while reducing the computation time and resources required.

## METHODOLOGY

**Models** proposed in our work:

1. Recurrent Neural Network (RNN)
2. Physics-Informed Recurrent Neural Network (PI-RNN)

**Problems** used to test our models:

I. DC current carrying wire with linear magnetic material around it

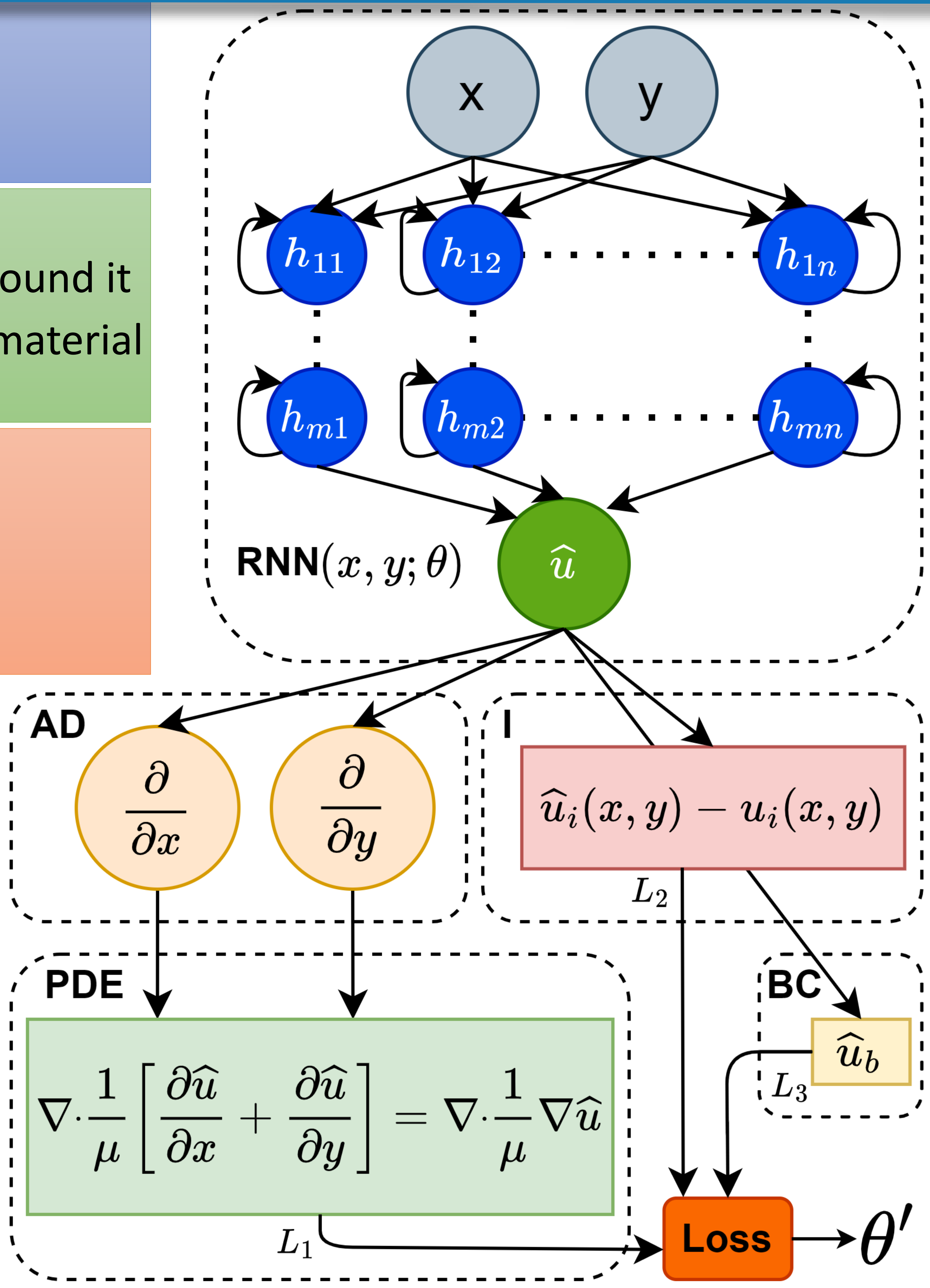
II. DC current carrying wire with non-linear magnetic material around it

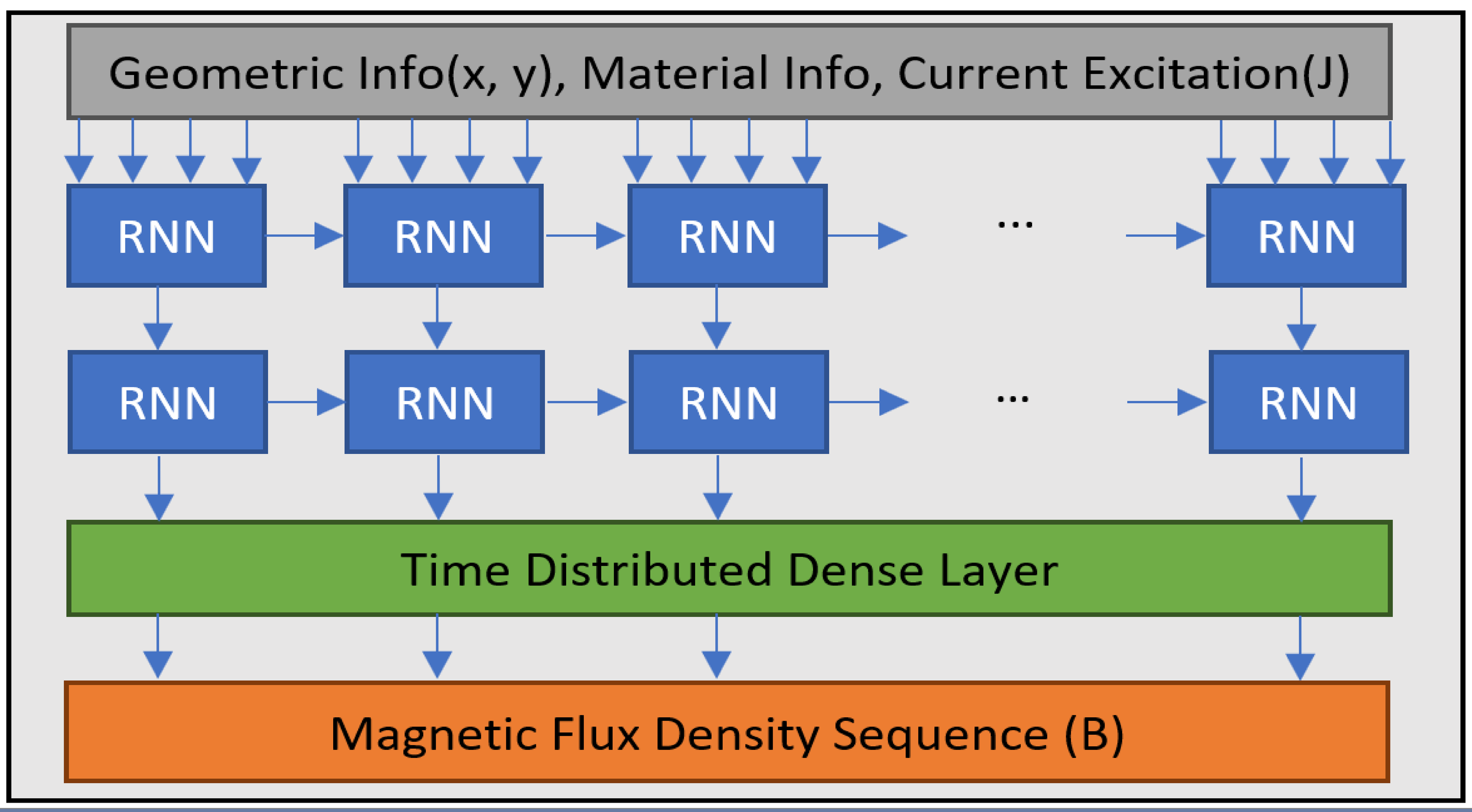
**Goals** for our paper:

a. Measure the magnetic field distribution around the wires

b. Train RNN using supervised learning

c. Train PI-RNN using hybrid learning




## RESULTS

- **RNN** was tuned for optimal hyperparameters using grid search
- **PI-RNN** was tuned using Async Successive Halving Algorithm (ASHA) scheduler

- On the top right, the two plots show results for a linear magnetic material around the wire using RNN.
- **RNN performs with an error rate of around 3% when compared to the ground truth**

- On the bottom right, the two plots show results for a non-linear magnetic material using PI-RNN.
- **PI-RNN performs with a mean error rate of around 3.5% when compared to the ground truth**

Once trained, the computation cost of solving unseen problems will be low