China-UK Low Carbon College, Shanghai Jiao Tong University

PE6201:Advanced Heat Transfer　　　Project of Spring 2022

Due date: 06/15/2022, Wednesday

The application of machine learning techniques to heat transfer problems can be dated back to the 1990s. However, the efforts did not directly take into account the underlying physics of heat transfer problems. To tackle this problem, only until recently, the framework of physics-informed neural networks (PINNs) has been developed [1–3]. This approach was first proposed for solving both forward and inverse problems described by a combination of some data and of partial differential equations (PDEs), and subsequently it was applied to various fluid mechanics and heat transfer problems.

Try to learn the method and solve one 2-D heat transfer problem by yourself.

1. Elaborate the theory behind the physics-informed neural networks.
2. Clearly describe the heat transfer problem you want to solve with PINN, and write down the governing equation and its auxiliary conditions.
3. Solve the problem with an analytical method (if possible) or the conventional finite difference numerical method to obtain the results (which will be used to validate the PINN results).
4. Solve the problem with PINN and validate your results.

Write a computer-generated report where you describe the problem, state the assumptions, write the equations used in the analysis, and provide discussions of the results together with the main conclusions of your work. In addition, upload the code to Canvas together with your report.

References

[1] Raissi, Maziar, Paris Perdikaris, and George E. Karniadakis. ”Physics-informed neural networks: A deep learning framework for solving forward and inverse problems involving nonlinear partial differential equations.” Journal of Computational Physics 378 (2019): 686-707.

[2] Raissi, Maziar, Paris Perdikaris, and George Em Karniadakis. ”Physics Informed Deep Learning (Part I): Data-driven Solutions of Nonlinear Partial Differential Equations.” arXiv preprint arXiv:1711.10561 (2017).

[3] Raissi, Maziar, Paris Perdikaris, and George Em Karniadakis. ”Physics Informed Deep Learning (Part II): Data-driven Discovery of Nonlinear Partial Differential Equations.” arXiv preprint arXiv:1711.10566 (2017).