2025年清华大学工物系、核研院与安全学院联合博士生学术论坛

1D Time-varying Temperature Prediction Based on PINN

Yong Liu, Jun Sun

Institute of nuclear and new energy technology, Tsinghua University, Beijing, 100084

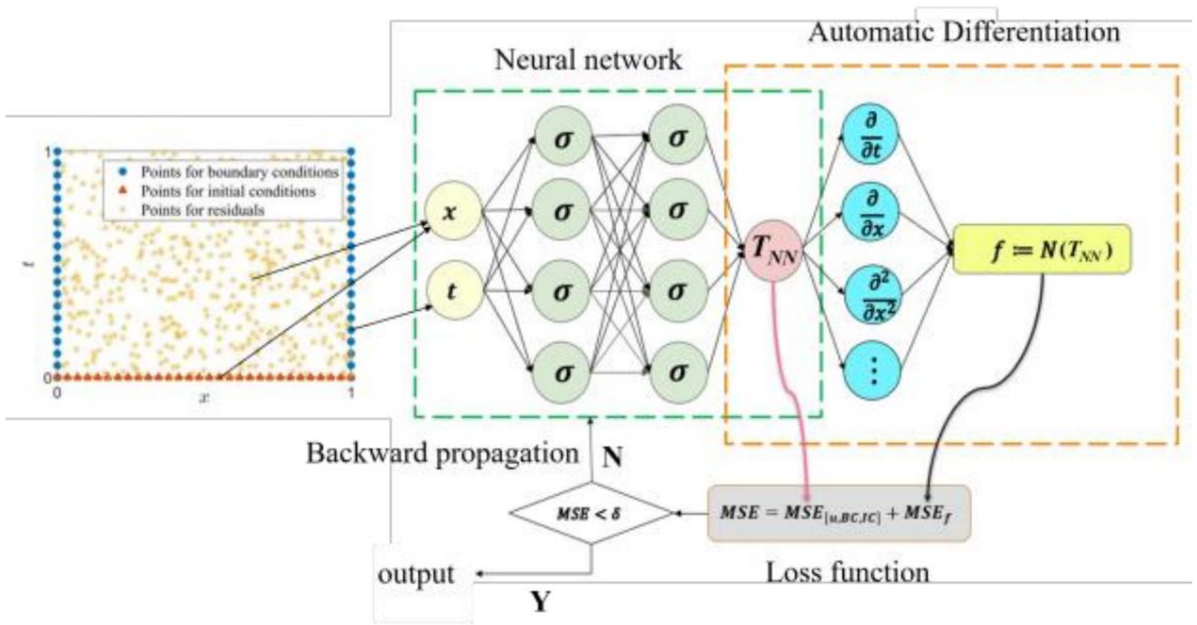
Motivation and Measures

When predicting the temperature distribution in HTGR, simplify the pebble bed as a porous medium and treat the fuel spheres as uniform spheres with internal heat sources.

With simplification: unable to accurately predict local temperature variations

Without simplification: out of the capability of computer and time-consuming

Drawbacks: unable to **predict the real-time temperature distribution**



Schematic Diagram of PINN model structure

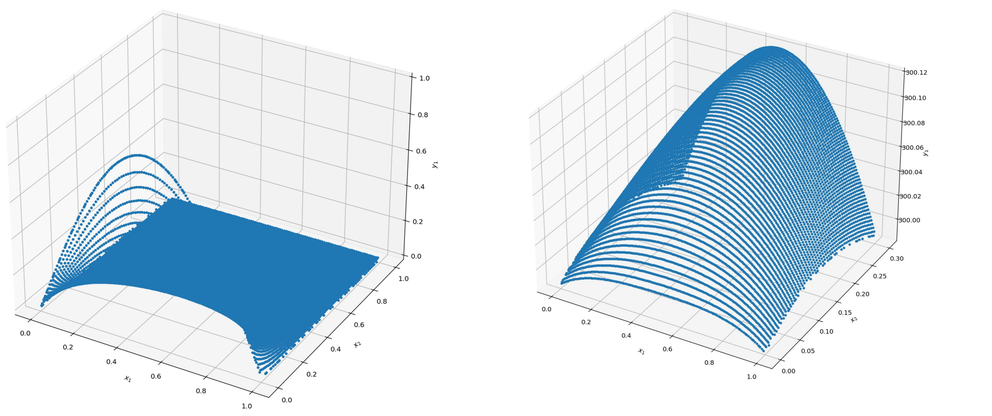
Physics-informed neural networks (PINN): specialized category of ANN that seamlessly integrate physics principles into their learning algorithms.

Differences from ANN: less depend on data, fit physical laws better

Next step: rebuild the whole temperature distribution of the core by PINN, even when only sparsely dispersed sensor measurements are available.

Results

1D:



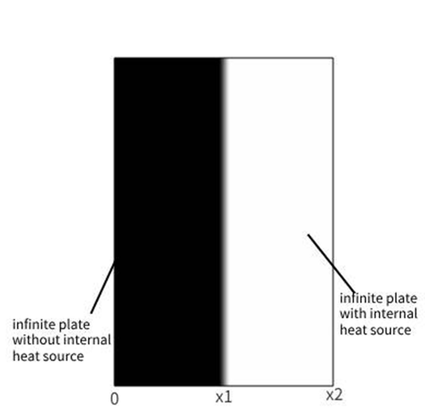
without internal heat sources

The initial condition: sin

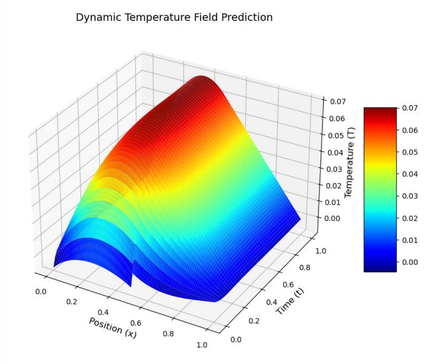
Boundary condition: both constant at both ends.

with uniform internal heat sources

0



the arrangement of two infinite large plates



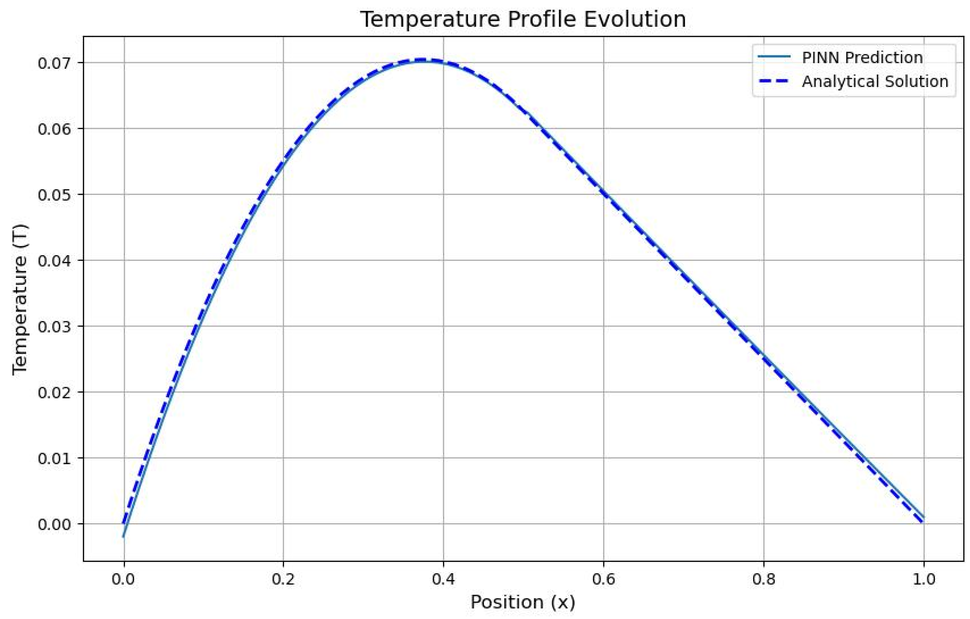
The initial condition: constant 0

Boundary condition: 0 at both ends.

Conclusion and Discussion

Traditional numerical methods: mesh generation

PINN: random sampling points within the solution domain.



This study **demonstrates** the potential of Physics-Informed Neural Networks as a powerful tool for solving the time-varying heat conduction equations.

2D:

Further investigation is needed to explore more complex scenarios:

- varying internal heat sources
- multi-dimensional heat transfer
- reactor geometry

清華大學 工程物理系
Department of Engineering Physics, Tsinghua University

清華大學 安全科学学院
School of Safety Science, Tsinghua University

清華大學 核能与新能源技术研究院
Institute of Nuclear and New Energy Technology
Tsinghua University