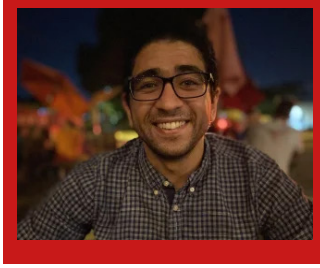
Supervisor	**Michael Abdelmalik**
2nd supervisor	**Victorita Dolean (M&CS)**
Company	**N/A**
Internal / External	**Internal**
Starting date	**Any time**
Exp./Num./Design	**Numerical**

Available for ME

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Project number: 2024 Q4-01



Neural Operators for Preconditioning Iterative Solvers

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Keywords: *Machine Learning, Neural Networks, Partial Differential Equations, Preconditioners*

INTRODUCTION

While partial differential equations (PDEs) play a fundamental role in the way we mathematically describe physical phenomena, the resolution of such equations is restricted by our capability of computing discrete solutions to the linearized system of equations. When the number of such equations becomes large, direct matrix inversion methods become prohibitively expensive, and the use of iterative methods becomes necessary. A key factor for effective use of iterative solvers is the availability of a *precondtioner* which approximates the action of the inverse.

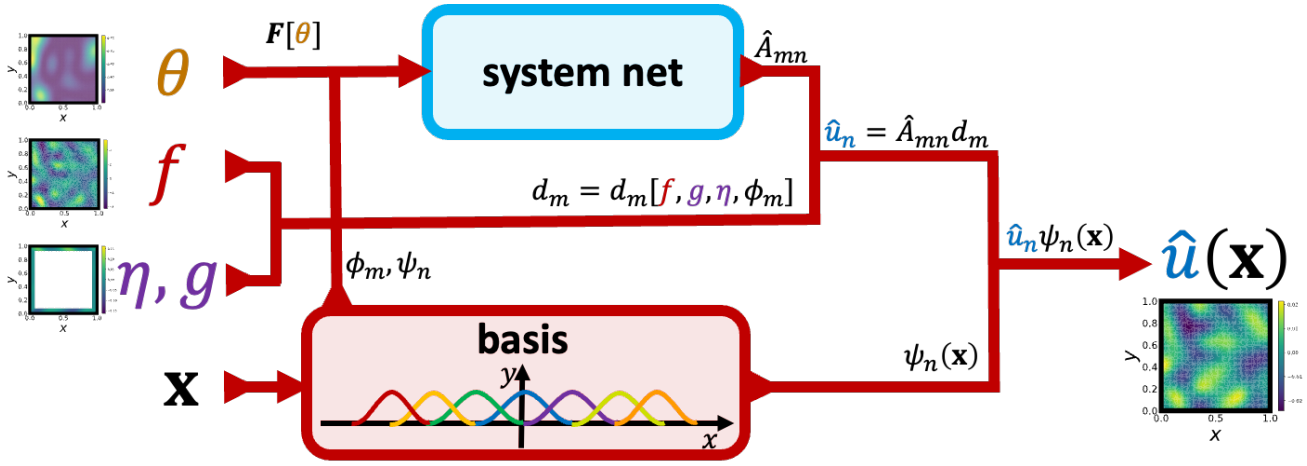
TASKS

- Formulate suitable objective/loss function(s)
- Generate training and validation datasets,
- Construct tailored Neural Operator architectures,
- Train and validate network
- Use neural operator to accelerate iterative solvers

STUDENT PROFILE

We are looking for a MSc student who is interested in:

- machine learning and neural networks,
- mathematical modelling of physical phenomena,
- practical algorithms for mathematical models,
- programming (e.g., Python) and improving coding skills.



Neural Operator for Parametric PDEs

OBJECTIVE

The aim of this MSc project is to explore architectures for neural operators that can approximate the solution operator to a PDE. Moreover, we aim to use such an (approximate) solution operator to i) construct a reduced-order/surrogate model which can provide generalized, accurate and fast solutions; ii) to construct precondtioners to accelerate iterative solvers.

REFERENCES

[1] Neural Green's Operators for Parametric Partial Differential Equations (2024) . arXiv preprint arXiv:2406.01857.

[2] Variationally mimetic operator networks (2024). Computer Methods in Applied Mechanics and Engineering.