TWO-LEVEL DOMAIN DECOMPOSITION ALGORITHMS FOR PHYSICS-INFORMED NEURAL NETWORKS

Hee Jun Yang\textsuperscript{1} and Hyea Hyun Kim\textsuperscript{2}

1) Department of Mathematics, College of Science, Kyung Hee University, 26 Kyungheedae-ro, Dongdaemun-gu, Seoul, 02447, Republic of Korea
2) Department of Applied Mathematics, College of Applied Science, Kyung Hee University, 1732 Deogyeong-daero, Giheung-gu, Yongin-si, Gyeonggi-do, 17104, Republic of Korea

Corresponding Author: Hyea Hyun Kim, hhkim@khu.ac.kr

ABSTRACT

Domain decomposition algorithms are proposed when training neural networks as a solution of partial differential equations (PDEs). The neural network consists of smaller independent networks, that are trained as solutions of partial differential equations in smaller subdomains. Each neural network is a physics-informed learning problem with two terms, the domain term and the boundary term, that make the desired solution satisfy the PDEs and corresponding boundary conditions [1]. The solution of the whole domain can then be obtained by solving the smaller problems iteratively and exchanging the subproblem information across the interface at each iteration step. The use of smaller independent networks speeds up parameter training but slows down the convergence of iteration. A coarse neural network with a smaller parameter set is included to speed up the convergence. The coarse neural network is then trained as a solution of PDEs in the whole domain using a coarse data set. Using a coarse data set, the coarse neural network is then trained as a solution of PDEs in the whole domain or trained to reduce a global residual loss. The coarse solution then can be used to accelerate the convergence in the iterative scheme. Convergence analysis for the proposed algorithms using a projection operator are included [2]. Numerical results are included to show the performance of the proposed method.

REFERENCES