Resolution Independent Neural Operator (RINO)

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ABSTRACT

The Deep Operator Network (DeepONet) has introduced a promising approach for data-driven learning of operators between function spaces. However, its vanilla architecture suffers from resolution dependency, as the discretization of the input function is integrated into the architecture, requiring all input functions to be discretized at the same locations. To address this limitation, we propose the Resolution Independent Neural Operator (RINO) variant of DeepONet. This approach introduces a dictionary learning procedure to adaptively learn fully continuous, differentiable basis functions parameterized as implicit neural representations. The learned dictionary is then used to project an arbitrarily (but sufficiently richly) sampled realization of input functions (as a point cloud) onto the space spanned by its basis functions, obtaining a sparse representation of finite dimensions. This representation can subsequently be used in the vanilla DeepONet without any further architectural changes. We demonstrate the robustness and applicability of RINO in handling arbitrarily (but sufficiently richly) sampled input functions during both training and inference through several numerical examples.

REFERENCES

[1] Lu, Lu, et al. "Learning nonlinear operators via DeepONet based on the universal approximation theorem of operators." *Nature machine intelligence* 3.3 (2021): 218-229.