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Reduced-order modeling for the wave equation using Green's functions and neural networks

Several deep learning methods have been developed in recent years for the solution of PDE-based problems with the objective of producing techniques that are more flexible and possibly faster than classical discretization approaches. Deep operator networks (DeepONet), for example, aim at solving partial differential equations by learning the inverse of the differential operator for a wide class of input parameters. However, the approach turns out to be expensive for the wave equation at high frequency regimes as the identification of the network parameters may converge slowly. In this talk, we propose an approach based on the representation of the exact solution in terms of the Green's function. The resulting neural network architecture will be referred to as Green operator networks (GreenONets). The novel architecture yields a faster learning and a better generalization error when compared to the classical DeepONet architecture. Performance of the GreenONets and DeepONets will be compared on several numerical examples dealing with wave propagation in homogeneous and heterogeneous media.