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ADVANCED NODE-WISE CLASSIFICATION FOR AUTOMATED IDENTIFICATION OF REGIONS IN LOCAL AND NONLOCAL MODELS COUPLING

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ABSTRACT

Recent advancements in mechanics have increasingly focused on integrating local and nonlocal models to address complex behaviors in material science. While local models, based on continuum mechanics, have limitations in capturing phenomena like cracks and fracture, nonlocal models offer more accurate predictions by considering the influence of surrounding material. These, however, entail significant computational costs. Various coupling approaches have been proposed to mitigate these limitations, including methods like the Variable Horizon Coupling Method (VHCM) and matching displacements or stresses in overlapping regions [1].

In this study, we introduce a novel machine learning-based approach for the automatic identification between local and nonlocal regions in a coupling process. The identification process takes into consideration various factors, including load functions, boundary conditions, and material geometry.

Our research has used the windowing approach, which proved to be a highly effective strategy for handling load functions with varying numbers of discontinuities and other conditions. This approach allow the examination of each individual data point from the load. In our dataset, different load conditions were included such as loads with or without discontinuities.

Using window-based techniques, the problem is formulated in a node-wise classification approach. By utilizing window configurations around each data point, we are effectively segmenting the load, enabling a focused and precise classification strategy at each point. This method allows for a more focused classification approach, providing a detailed insight into the load characteristics within specific windowed segments.

We are using Convolutional Neural Network (CNN) [2] as deep learning algorithm which takes in windows as the input and generates a label for the window central node. The resulting output comprises label assigned to the central node, indicating either **LM** if the node is located within the local region or **NLM** if it is located within the non-local region. The model demonstrated exceptional performance, with an accuracy of 0.98 and an F1-score of 0.97. These results highlight the potential of our approach in significantly enhancing coupling processes, leading to more accurate and computationally efficient designs in material science.

REFERENCES

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