Title: Graph-based machine learning approaches for model order reduction
Speaker: Federico Pichi (SISSA)

Abstract: The development of efficient reduced order models (ROMs) from a deep learning perspective enables users to overcome the limitations of traditional approaches [1, 2].
One drawback of the techniques based on convolutional autoencoders is the lack of geometrical information when dealing with complex domains defined on unstructured meshes.
The present work proposes a framework for nonlinear model order reduction based on Graph Convolutional Autoencoders (GCA) to exploit emergent patterns in different physical problems, including those showing bifurcating behavior, high-dimensional parameter space, slow Kolmogorov-decay, and varying domains [3].
Our methodology extracts the latent space's evolution while introducing geometric priors, possibly alleviating the learning process through up- and down-sampling operations.
Among the advantages, we highlight the high generalizability in the low-data regime and the great speedup.
Moreover, we will present a novel graph feedforward network (GFN), extending the GCA approach to exploit multifidelity data, leveraging graph-adaptive weights, enabling large savings, and providing computable error bounds for the predictions [4].
This way, we overcome the limitations of the up- and down-sampling procedures by building a resolution-invariant GFN-ROM strategy capable of training and testing on different mesh sizes, resulting in a more lightweight and flexible architecture.

References

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