Flow predictions using convolutional neural networks

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Simulations of fluid flow are generally very costly because too low grid resolutions may even lead to qualitatively incorrect solutions. In applications, however, one is often not interested in accurate approximations of the complete flow field but only in the qualitative behavior of the flow or in individual quantities (e.g., maximum velocity, pressure drop within a section of a pipe, or wall shear stresses at certain locations). In this talk, the use of Convolutional Neural Networks (CNNs) to predict fluid flow fields is investigated. Therefore, U-Net [1] type convolutional neural networks, which are successfully used for image recognition and segmentation tasks, are applied in this context. As a model problem, the flow around obstacles with varying shape and size within a channel is considered. Obstacles of certain type are used as training data, and the generalization of the models to other obstacle geometries and sizes is analyzed. Even though, the training of a neural network is expensive, its evaluation is quite cheap compared to fully resolved Computational Fluid Dynamics (CFD) simulations. This results in a multitude of application possibilities for neural networks in this context, especially in time critical settings.

References

[1] Ronneberger, Olaf, Philipp Fischer, and Thomas Brox. "U-Net: Convolutional Networks for Biomedical Image Segmentation." Medical Image Computing and Computer-Assisted Intervention – MICCAI 2015 (2015): 234-241. Crossref. Web.