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HPC-PREDICT – workflow for computer-augmented 4D-Flow-MRI of the ascending aorta

DS and high-performance computing

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Abstract

High-performance computing is an enabling technology to improve the predictive value of medical imaging modalities. Here, we present the computational workflow HPC-PREDICT which has been developed in a project funded by the Platform for Advanced Scientific Computing (<https://www.pasc-ch.org/>). It aims to enhance 4D-Flow-MRI imaging of the ascending aorta by producing computer-augmented images of the blood flow in the ascending aorta which may support the prognosis of adverse aortic events due to unphysiological blood flow.

HPC-PREDICT comprises several modules which address different limitations of clinical 4D-Flow-MRI: MRI data acquisition and reconstruction is significantly accelerated by a convolutional neural network (CNN), segmentation of the aortic arch is done automatically also by a CNN, temporal and spatial resolution of the MRI data is increased by a data assimilation process using a high-order forward model, and the resulting high-resolution flow fields are analyzed by an abnormality detection algorithm which has been trained with data from healthy probands. This workflow is implemented on the high-performance computing infrastructure at the Swiss Supercomputing Centre CSCS in Lugano and data transfer channels are established for the encrypted transfer of patient data by clinical users.