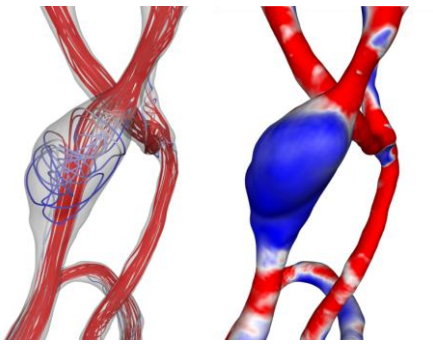
Master's thesis – DMD approximations for unsteady blood flow

Topic description

The method of *Dynamic Mode Decomposition* (DMD) is able to identify a surrogate model for a nonlinear system based on time series (*snapshots*). Typically, surrogate models are less complex than the original model equations so that they can be used to simulate the same phenomena but in less computation time (*speedup*) and with lower memory requirements (*compression*). The theory of DMD is more than 100 years old. In practice, DMD has experienced strong popularity within the last 10 years, mostly due to interesting and successful application examples in flow problems.



Screenshot of a numerical high-fidelity simulation of an aneurysm

In the context of numerical investigation of PDEs in general and flow problems in particular, the *snapshots* can be considered as approximate solutions at given time instances. Each of these approximate solutions are discrete functions which are defined on a spatial mesh. If the mesh is constant over all time instances, DMD is readily applicable. On the application side, we study the unsteady blood flow in vessels based on patient specific image data. Models for these phenomena can become arbitrarily complex if they are built to capture ever finer-grained effects in time and space. As a result, a numerical simulation has to deal with large data sets and demanding computation requirements.

In this master's thesis, we will investigate how DMD can mitigate the computational costs in unsteady three-dimensional blood flow simulations. Based on previous works, we will develop a formulation of DMD that respects external parameters like flow-rates and vessel geometry to improve the prediction performance.

Requirements and Contact

For this work, knowledge or particular interests in the following fields are of advantage:

- modelling of dynamical systems
- numerical simulation of flows

as well as programming expertise (most suitably in `Python` or `Matlab`)

In case of interest or request for further details, please contact

- M.Sc. Jana Korte (OvGU-FVST) – jana.korte@ovgu.de
- Jun.-Prof. Jan Heiland (OvGU-FMA and MPI) – jan.heiland@ovgu.de