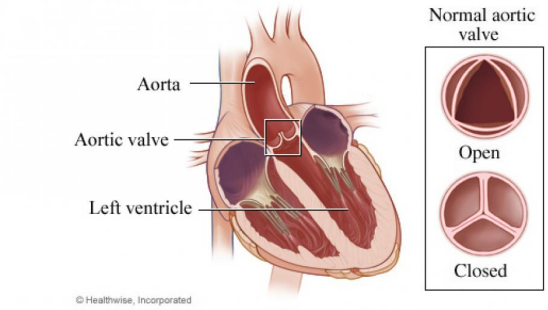
Lehrstuhl für Computergestützte Analyse Technischer Systeme | RWTH AACHEN UNIVERSITY

# Master/Bachelor/Project/Seminar Thesis

for Students of CES, Mechanical Engineering, Computer Science and similar

## 4D Meshes for Space-Time Simulations of Heart Valves




Based on a real biomedical application, we develop a comprehensive simulation of a human left ventricle for patients with a left ventricular assist device (LVAD).
The simulation of heart valves is a sub-topic in this application. Heart valve simulations of varying complexity are an ongoing research field. At CATS, we are developing a space-time finite element simulation of the blood flow over a heart valve. The idea behind space-time finite elements is the discretization of space and time with finite elements, as opposed to the common approach of using finite elements in space and finite differences in time. We are aiming at using an analytical description of the surface of a heart valve in 3 spatial dimensions plus time. For the simulation we need to represent this geometry as a four dimensional mesh. The task of this project will be applying known strategies to create a four dimensional mesh with topology changes in the spatial dimensions and developing new methods to improve meshing.
The mesh has to be usable in our in-house FEM solver, and the project can, but does not have to, include a first simple showcase of the mesh in a 4D simulation.

Your tasks are:

- Gaining insight into and implementing known strategies for 4D meshing,
- testing said strategies on a simplified 3D (2D in space + time) geometry,
- applying the tested strategies on a full 4D geometry,
- documenting and streamlining the workflow to create 4D meshes,
- running simulations on the 4D mesh.

**We offer:**
An interesting, self-contained research topic in a very relevant field of public health. The proposed meshing strategy could lead to a completely new, cutting edge method for space-time fluid simulations and might be incorporated in a peer-reviewed publication.

**Prerequisites:**
You are a highly motivated student with a strong interest in solving meaningful problems. We encourage independent working and thinking. You are able to present your work concisely and do not refrain from asking for help when it is needed. We do not require former knowledge about the biomedical problem. A background in Python will be beneficial. If your interests lie in programming, the tasks can be very interesting and challenging for you. We are happy to tailor the tasks at hand to the scope of your desired thesis (Seminar, Project, Bachelor, Master).

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