Chair for Computation in Engineering
Department of Geo, Civil and Environmental Engineering
Technical University of Munich

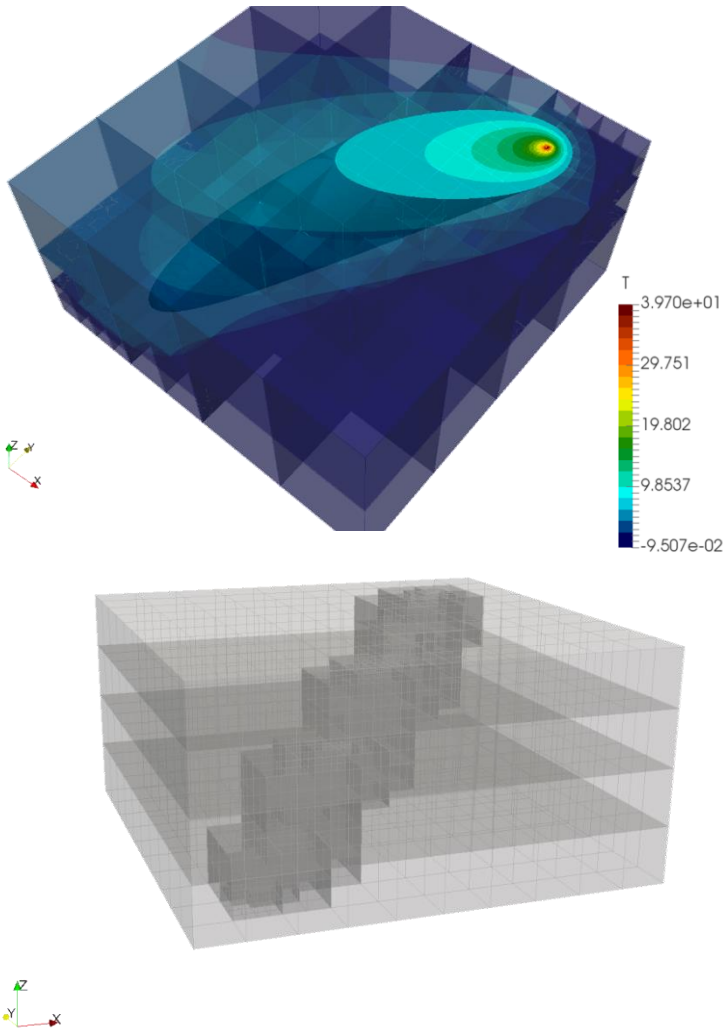
Modeling: ★★☆☆☆
Mathematics: ★★★★☆
Programming: ★★★★☆
Science: ★★★★☆

Software Lab:

Space-Time Finite Element Method

Setting

The space-time finite element method is an alternative approach for solving time-dependent problems. In contrast to the commonly used semi-discrete approach, space-time FEM discretizes both space *and* time using finite elements. The basis-functions are constructed by taking a tensor-product of the spatial-basis functions with a one-dimensional basis in time.
This approach has several potential advantages. Using high-order basis functions for time discretization, as well as for the spatial discretization delivers an approximation with higher accuracy. This approach makes it easier to handle evolving domains. Especially for large problems, taking large “time slabs” (discrete time intervals) allows the exploitation of high-performance computing resources. Additionally, using a non-uniform discretization of the space-time domain allows for local refinement in both space and time (subcycling approach), in contrast to the spatially uniform time-step size of the traditional semi-discrete approach.



Tasks

- Literature review / understanding the theory
- Formulating the discrete problem and implementing a transient 1D problem
  (so 2D: (x,t))
- Extension to higher dimensions
- Investigating stability for large “time slabs”
- Comparison to the traditional approach with finite difference schemes

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References

[1] Hughes, T.J.R. and Hulbert, G.M. (1988). Space-time finite-element methods for elastodynamics formulations and error estimates. *Computer Methods in Applied Mechanics and Engineering,* 66:339-363