Master-Seminar: Fictitious Domain and Immersed Boundary methods

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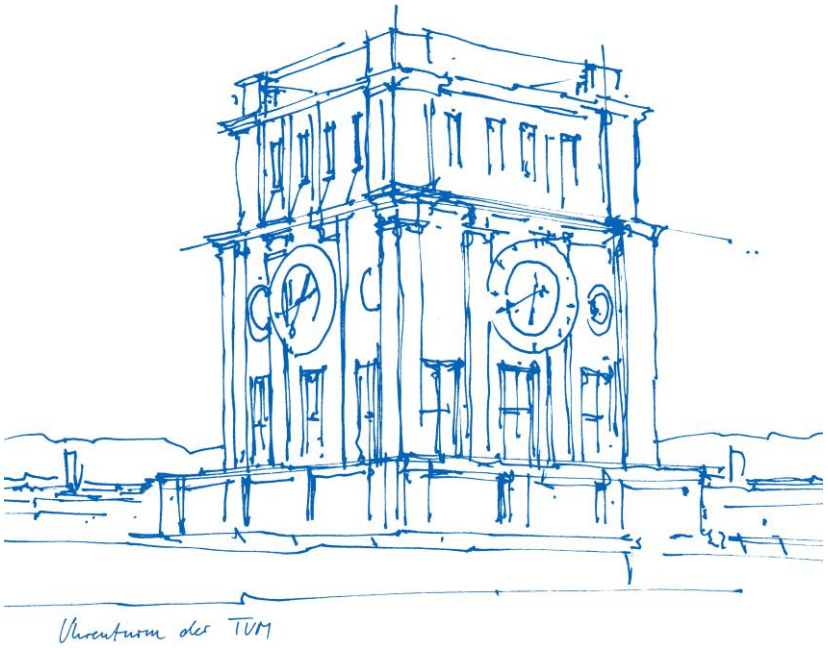
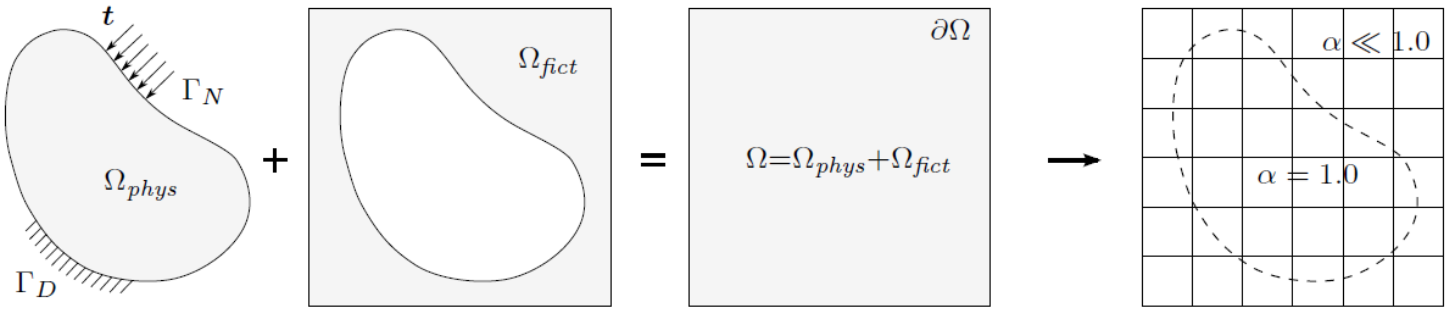


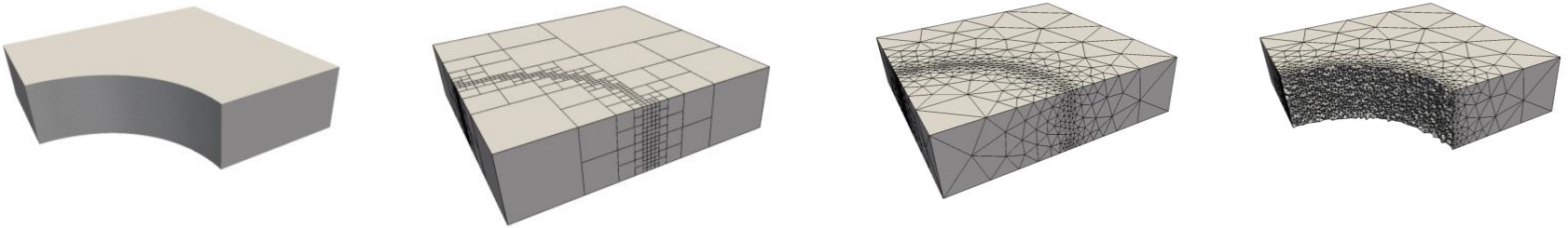
Fictitious Domain and Immersed Boundary methods

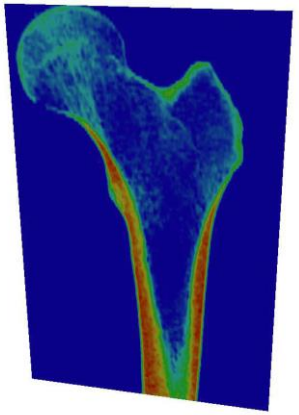
- Finite Cell Method
  - Immersed domain finite element method
  - Higher-order non-boundary-fitted meshes
  - Weak enforcement of Dirichlet boundary conditions
  - Adaptive quadrature based on recursive subdivision



Non-Boundary Conforming Meshes

- “Exaxt” and diffuse geometry descriptions

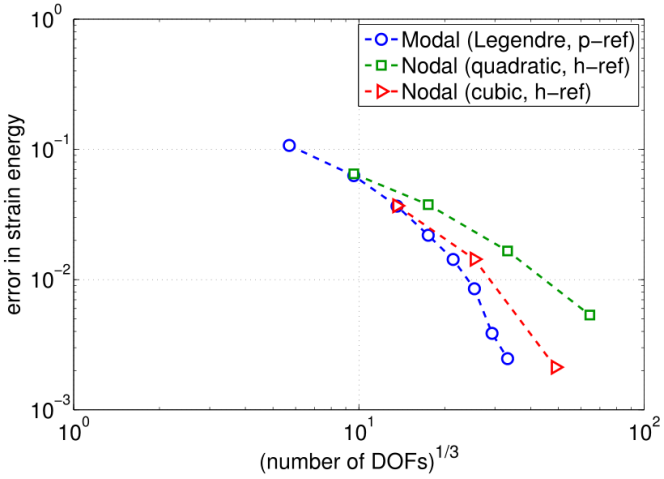


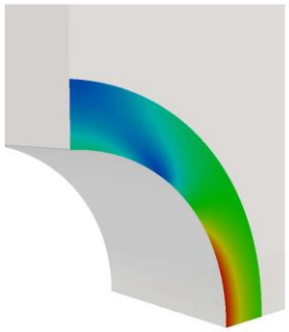


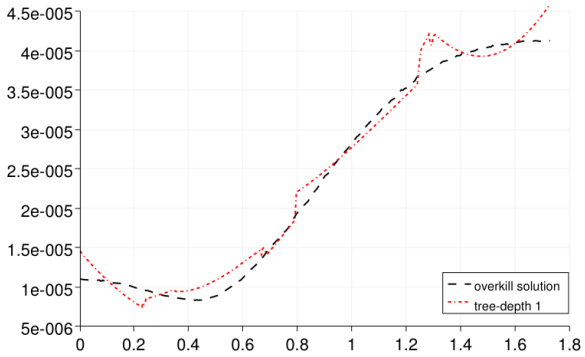
M. Ruess, D. Tal, N. Trabelsi, Z. Yosibash, and E. Rank. The finite cell method for bone simulations: Verification and validation. Biomechanics and Modeling in Mechanobiology, 11(3):425–437, 2012.

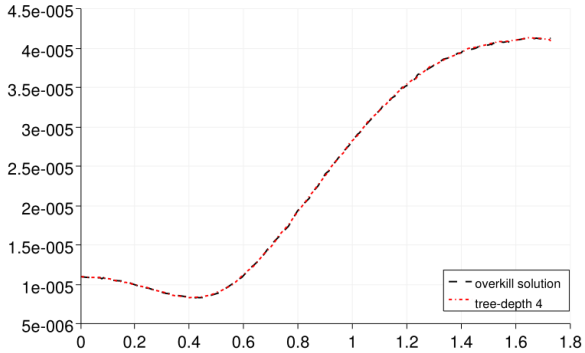
Benchmarks

- Performance of the method
  - Achieves optimal rates of convergences
  - Here: Thick plate benchmark
- Sensitivity to accurate geometry representation
  - Must be highly exact
  - Limits convergence severely



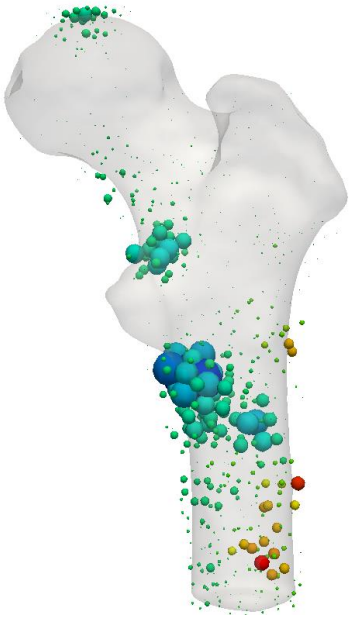






Simulation

- Solution of Partial Differential Equations
  - Elliptic problems
  - Computational fluid dynamics CFD
  - Linear elasticity and phase-field models



Organization

- Seminar
  - Individual topics
  - Theory (lecture-style) vs. small programming project + (less) theory
  - Paper
  - Presentation
- Registration
  - Now: Mandatory registration
  - Topic: email with your preferences + your background
- Presentation
  - In the middle of the semester
  - 30 minutes (short) or 60 min (lecture)
  - Peer reviewing (2 per paper)
  - Paper must be written in Latex, template will be provided
  - Participation at all presentations is mandatory

Topics

- Topics
  - The Finite Cell Method (FCM)
  - The Tetrahedral Finite Cell Method (TetFCM)
  - Immersed Boundary methods for (linear) elasticity
  - Immersed Boundary methods for CFD
  - Generation of adaptive tetrahedral meshes
  - Parallel linear and direct solvers
  - Parallel system assembly strategies
  - Parallelization on GPUS
  - Parallelization on Xeon Phi

Topics – Even More

- More topics
  - Adaptive integration based on space-trees
  - Volume integration for exact NURBS surface boundaries
  - Volume integration for triangulated surface boundaries
  - Dirichlet boundary conditions: Nitsche's method
  - Dirichlet boundary condition : Penalty method
  - Boundary conditions for CT and voxel-based simulations
  - Volume Visualization of Fictitious Domain Simulation Results

- Interested?
  - Send your favorite topic to varduhn@tum.de

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