Two-year postdoc position at University of Lorraine (France)

Tetrahedral mesh updating for subsurface modeling: line and finite surface insertion.

Topic description

Volume meshes are essential to represent and numerically simulate the properties and the physical behavior of materials in a variety of application fields. This two-year postdoctoral position addresses some specific meshing needs for the geoscience application area. Namely, the goal is to insert effectively finite lines and finite surfaces in an existing multi-material tetrahedral mesh.

Indeed, creating a valid mesh from geological interfaces is generally a demanding task because of the relative complexity of the geometrical configurations encountered in geosciences (PELLERIN ET AL., 2015). Also, uncertainty about the locations or even the existence of some geological interfaces generally exists at depth because of the lack of observations. Finally, the exploitation of geothermal resources or the injection of CO_2 in subsurface reservoirs often requires simulating fluid and heat transfers for several well placement scenarios, which rely on appropriate mesh design to correctly approximate the physical situations around wells. Incremental mesh editing has been shown to be a promising pathway to address these modeling challenges (DASHTI ET AL., 2023; LEGENTIL ET AL., 2023), but it has mainly focused on the insertion of closed interfaces and interfaces that terminate on domain boundaries.

The goal of this postdoc is to improve existing mesh updating methods in a robust and guaranteed way by incorporating in an existing tetrahedral mesh: (1) lines representing wells or boundaries of finite surfaces and (2) finite surfaces representing faults and fractures. A research challenge is to integrate a suitable simplification strategy in the process to make sure the edited mesh avoids small and poor-quality geometric features, which can notably slow down numerical simulations.

The code implementing the proposed methodology will be developed within the open-source platform Mmg (BALARAC ET AL., 2022). The proposed remeshing strategy will also be evaluated with the incremental integration of geological faults in implicit structural geological modelling , e.g., by using the LoopStructural toolkit (GROSE, AILLERES, LAURENT, CAUMON ET AL., 2021; GROSE, AILLERES, LAURENT & JESSELL, 2021). Finally, the impact of remeshing strategies on the performance of some Multiphysics simulation codes will be assessed, for instance to forecast the thermo-hydraulic behavior of geothermal fluids.

Candidate profile

The ideal candidate has a PhD in computational geometry, computer graphics, computational physics, applied mathematics or a related field. An experience in **computer programming is required**. A background or a proven interest in geoscience is appreciated but not mandatory. She/he has strong scientific writing and communication skills. English language is required; French is preferable, but not necessary.

Context

The postdoctoral researcher will be located at Université de Lorraine, GeoRessources Laboratory in the RING team[1], a pluridisciplinary group of 12-15 researchers and graduate students, and collaborate closely with Guillaume Caumon (Université de Lorraine) and Charles Dapogny (CNRS / Université de Grenoble Alpes) within

[1] https://www.ring-team.org

the Mmg[2] project. The successful candidate will join the network of researchers involved in the Digital Earth project[3] of the PEPR *Sous-sol, Bien Commun*.

The postdoctoral scholarship includes full salary and social benefits, and budget to attend national and international conferences. The host research team is driven by passion for developing computer-based methods and theories for geological modeling, serving the geoscience community to address scientific and natural resource managements challenges in the context of the energy transition. It has a strong industry partnership culture and values collaboration and scientific exchange.

Nancy is a UNESCO World Heritage city with a vibrant student life and a rich cultural agenda, only 90 minutes away from Paris, Luxembourg and Strasbourg.

How to apply

Application files must be sent to jobs@ring-team.org before July 15 and must include:

- A cover letter
- A CV, including list of publications and contact information for two or more referees
- The PhD thesis
- If available, the PhD review and defense reports.

References

Balarac G, Basile F, Bénard P, Bordeu F, Chapelier J-B, Cirrottola L, Caumon G, Dapogny C, Frey P, Froehly A, Ghigliotti G, Laraufie R, Lartigue G, Legentil C, Mercier R, Moureau V, Nardoni C, Pertant S & Zakari M. (2022). Tetrahedral remeshing in the context of large-scale numerical simulation and high performance computing. *MathematicS In Action 11*(1):129-164. https://doi.org/10.5802/msia.22

Dashti A, Gholami Korzani M, Geuzaine C, Egert R & Kohl T. (2023). Impact of structural uncertainty on tracer test design in faulted geothermal reservoirs. *Geothermics 107*:102607. https://doi.org/10.1016/j.geothermics.2022.102607

Grose L, Ailleres L, Laurent G, Caumon G, Jessell M & Armit R. (2021). Modelling of faults in LoopStructural 1.0. *Geoscientific Model Development 14*(10):6197-6213. https://doi.org/10.5194/gmd-14-6197-2021

Grose L, Ailleres L, Laurent G & Jessell M. (2021). LoopStructural 1.0: time-aware geological modelling. *Geoscientific Model Development 14*(6):3915-3937. https://doi.org/10.5194/gmd-14-3915-2021

Legentil C, Pellerin J, Raguenel M & Caumon G. (2023). Towards a workflow to evaluate geological layering uncertainty on CO_2 injection simulation. *Applied Computing and Geosciences*:100118. https://doi.org/10.1016/j.acags.2023.100118

Pellerin J, Caumon G, Julio C, Mejia-Herrera P & Botella A. (2015). Elements for measuring the complexity of 3D structural models: Connectivity and geometry. *Computers & Geosciences 76*:130-140. https://doi.org/10.1016/j.cageo.2015.01.002

[2] https://www.mmgtools.org/

[3] https://www.soussol-bien-commun.fr/fr/terre-numerique-une-plateforme-unique-pour-connaissance-du-sous-sol