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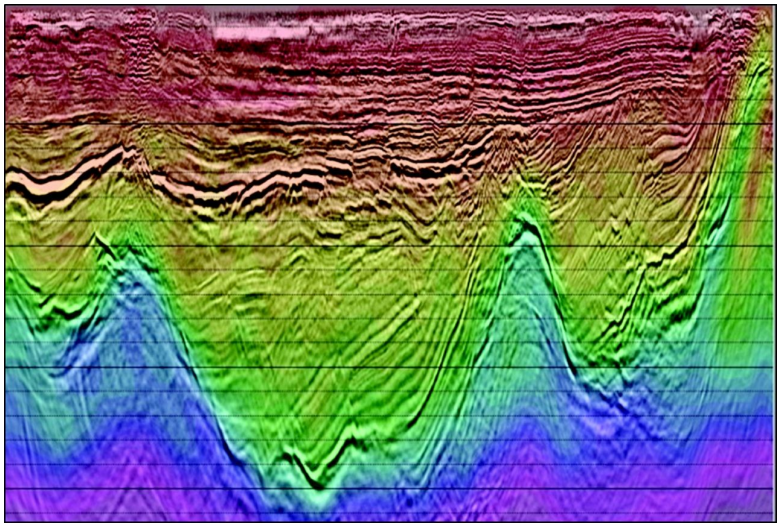
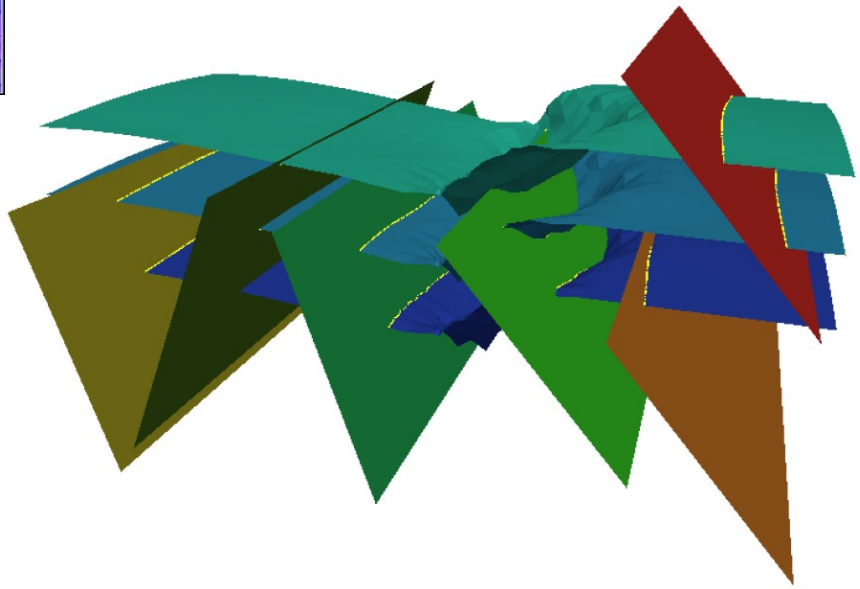
Thesis proposals on

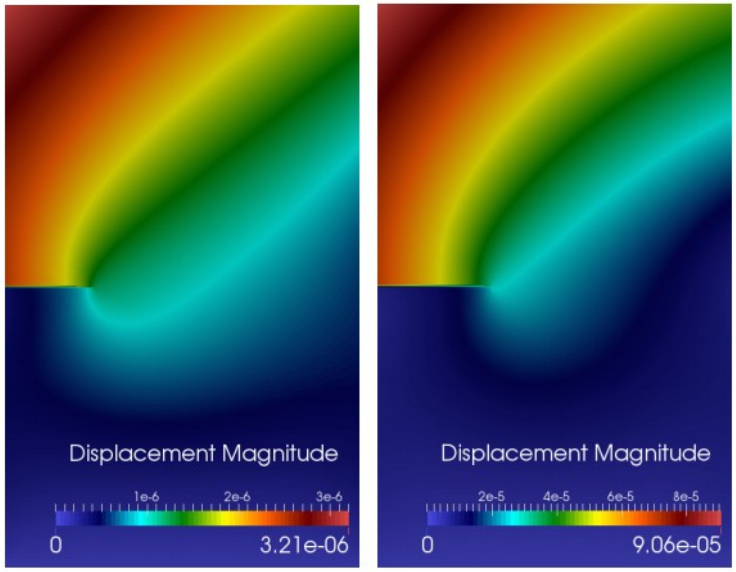
Unfitted FEM for fractures and inclusions in porous media

Motivation



Complex geometries

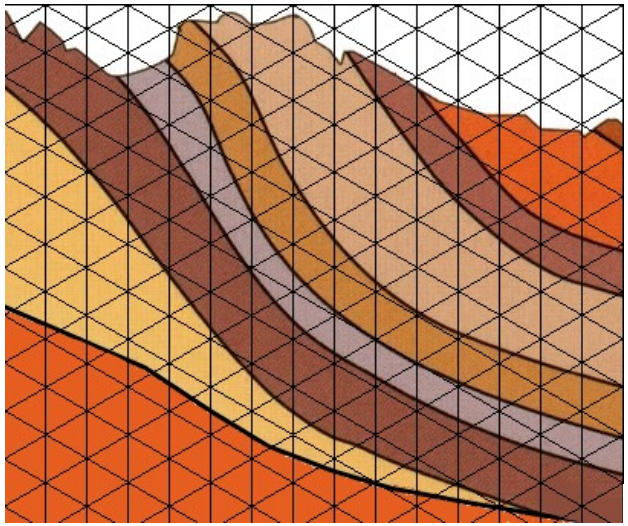




$t = 0$ $t = 2\ s$

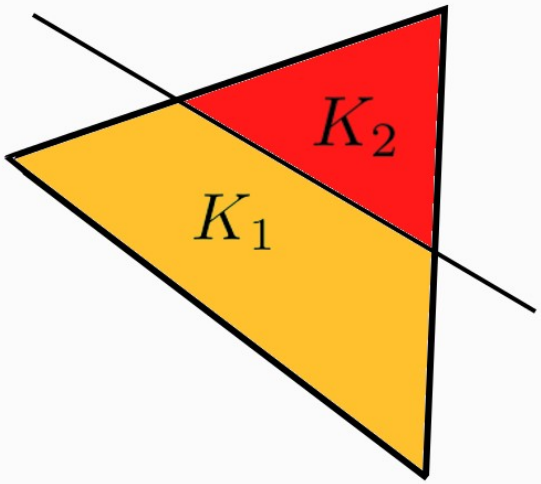
Uncertainty and moving interfaces

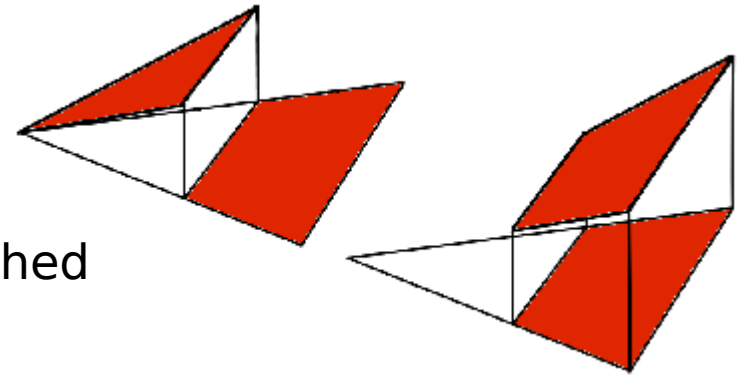
XFEM, GFEM, cutFEM...



Heterogeneities/interfaces are not honored by the grid

Some grid elements have discontinuous coefficients or solutions inside





In these elements the standard FEM space is enriched with more DOFS/ ad hoc basis functions

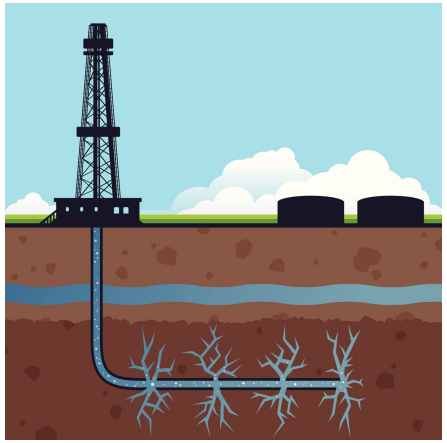
Crack propagation

Un metodo innovativo per la propagazione di fratture, Correlatore B. Giovanardi

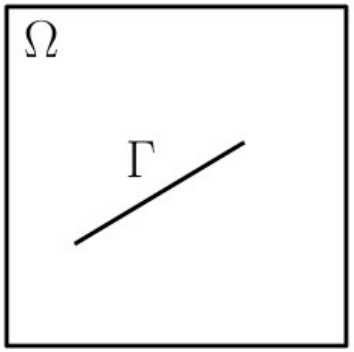
Motivation:

Failure due to
mechanical loading

Hydraulic fracturing



Governing equations:

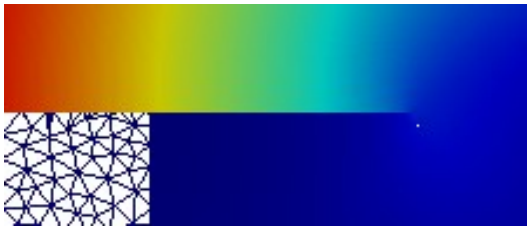


$$\begin{cases} \nabla \cdot \boldsymbol{\sigma} = \mathbf{0} & \text{in } \Omega \\ \boldsymbol{\sigma}\mathbf{n} = \mathbf{0} & \text{on } \Gamma \\ + \text{B.C.} & \text{on } \partial\Omega \setminus \Gamma \end{cases},$$

A hybrid method

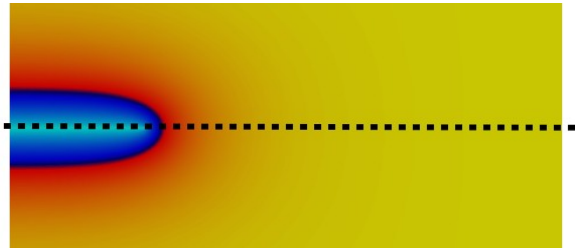
XFEM vs variational

XFEM methods allow the discontinuity of the displacement

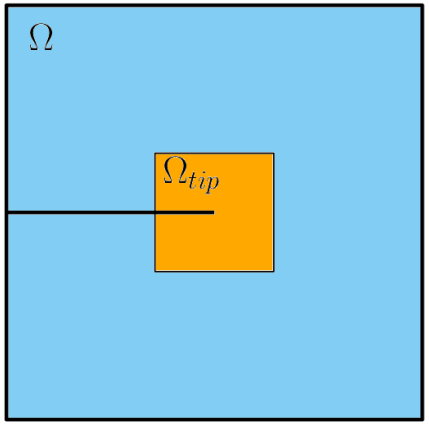


Needs extra criteria for crack propagation

A variable *c* varies continuously from the undamaged state, c = *1*, to the cracked state, *c = 0*.



Crack propagation is “natural” (based on energy)



Solve **everywhere** using XFEM

Find BC for the local problem

Compute propagation with an energy based method (and a **fine mesh**) only where needed

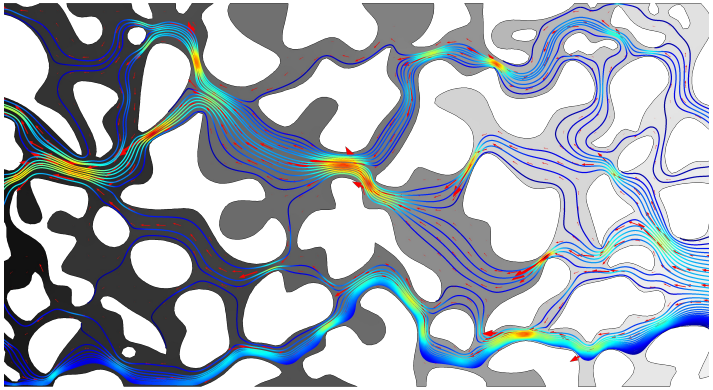
Un metodo innovativo per la propagazione di fratture, Correlatore B. Giovanardi

Stokes flow around a moving obstacle

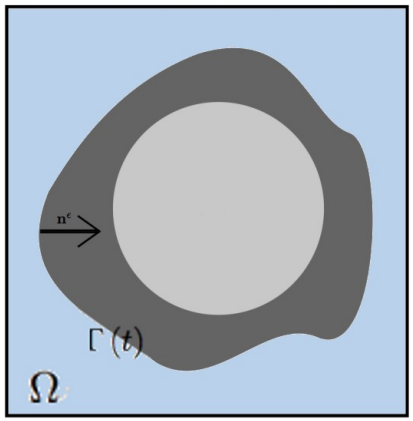
XFEM for unsteady Stokes' problem with moving interfaces, Correlatore P. Zunino

Motivation:

Pore scale flow in time dependent porous media (bio and geo applications)



Governing equations:



$$
\begin{aligned}
-\nabla \cdot (\mu \nabla \mathbf{u}) + \nabla p &= \mathbf{f} \quad \text{in } \Omega \\
\nabla \cdot \mathbf{u} &= 0 \quad \text{in } \Omega
\end{aligned}
$$

+BC

+ conditions on Γ(t)

Open issues

Model:

1) From an imposed geometry/motion of the interface to a fully coupled dynamic simulation

2) implicit representation of the interface by level set equations

Analysis:

1) time stepping vs space time FEM

2) Stability/stabilization of FEM spaces

Implementation:

Efficient implementation with variable DOF number

XFEM for unsteady Stokes' problem with moving interfaces, Correlatore P. Zunino