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Robust level set methods for moving interfaces

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We present recent results relevant for an application of level set methods to track moving interfaces and free boundaries. We cover the most important tasks typically required in level set methods like an advection of level set function, a preservation of signed distance property, and an extrapolation of missing data in the normal direction to the interface.

Typically a movement of the interface is driven by some additional processes that require a coupled modelling on evolving domains. The level set methods result in implicitly defined computational domains when some interface conditions must be approximated without an explicit reconstruction of the interface. For that purpose the immersed interface methods are developed for convenient unfitted grids. The methods are well covered for elliptic and parabolic problems, but not so much for a hyperbolic type of problems. The reason is so called cut cell problem due to a CFL time step restriction for numerical schemes with an explicit in time discretization that are typical for hyperbolic problems. We are interested in semi-implicit methods that are unconditionally stable with respect to the choice of time steps and that have no CFL restriction for cut cells.

A brief illustration of the level set tools will be given for a flow in porous media with an evolving part of a boundary (a moving groundwater table).

References

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flow with moving boundary. Adv. Water. Resour. 47:56-66, 2012.

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Primary author: FROLKOVIC, Peter (Slovak University of Technology)

Presenter: FROLKOVIC, Peter (Slovak University of Technology)

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