Project: Computational techniques for two-phase flow.

Immiscible fluids are important in many situations, and there is a strong interest in developing accurate and efficient simulation techniques.

Water and air are two common fluids that do not mix (immiscible)

The standard mathematical model is the incompressible Navier-Stokes equation for pressure and velocity coupled to an interface, advected by the velocity. If surface tension effects are taken into account, the velocity and pressure are influenced by the shape of the interface through terms in the Navier-Stokes equation, which include the curvature and the normal vector of the interface. In a mathematical model the position of the interface needs to be represented, and a common way is to let a contour line of a function represent the interface. This function is called the level-set function. The dynamics of the interface can then be described by an advection equation for the level-set function. Approaches of this type are called level-set methods.

This project consists of investigating a particular level-set method; the conservative level-set approach in J.-L.GUERMOND, M. QUEZADA de LUNA, T. THOMPSON, *A conservative anti-diffusion technique for the level set method*, J. Comput. Appl. Math., 321 (2017) 448–468. In this paper a fluid interface (for example between oil and water) is represented by the zero contour of a level set function. The task is to investigate how accurate one can compute the normal and the curvature of the interface in a setting when the interface is advected by a known velocity field. Possible extensions include computations involving the incompressible Navier-Stokes equations.

The method under study ís a finite element method, and very useful would be some experience of using a FEM programming environment such as Fenics or deal2. The FEM course (1TD056 Applied finite element methods) would be a good starting point.

Contact: Gunilla.Kreiss@it.uu.se, Murtazo.Nazarov@it.uu.se