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FREE BOUNDARY PROBLEMS AND NONLOCAL PARTIAL DIFFERENTIAL EQUATIONS

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Abstract

Free boundary problems are those where one has to simultaneously find the solution as well as a priori unknown (free) interfaces or boundaries. They are often described by PDEs involving local effects and can also be derived by nonlocal equations in presence of long range interactions. Examples of free boundary problems are given by overdetermined boundary value problems. Moreover, prototypes of operators driving nonlocal problems arise for instance in long-jump diffusion processes and the usual in the literature is the so-called *fractional Laplacian*. Free boundary problems find applications in modeling of infectious diseases and population dynamics, in fluid mechanics and capillarity theory, in electrostatics and the theory of torsion. Nonlocal phenomena translated by free boundary problems also appear in mathematical finance and phase transition problems, in ecological models within a shifting climate environment and in biological scenarios. In phase coexistence models, free boundary problems share a strong connection with the analysis of (nonlocal) minimal interfaces.

In this talk, we start by introducing the audience to the local and nonlocal worlds by concrete examples from real life. Next we present some methods of solving local/nonlocal free boundary problems while illustrating them with our recent results. We also discuss some perspectives and underline the impact of our research.

Key words: Free boundary problems, local PDEs, nonlocal PDEs, fractional Laplacian, minimal interfaces.