1. Research Activity

- **Geometric evolution equations.** Mean curvature flow. Barriers, fattening, minimizing movements, higher order approximations. Anisotropic and crystalline mean curvature flow. The total variation flow. Evolution of partitions. The book by G. Bellettini: Lecture Notes on Mean Curvature flow, Barriers and Singular Perturbations, *Scuola Normale Superiore, Pisa* 2013, pp. xviii-325 (see the list of publications), is an introduction to the evolution of a hypersurface by its mean curvature. The aim of the book is to give an introduction to mean curvature flow using, as much as possible, a parametrization free approach. Some relevant aspects of mean flow are described, such as the role of the signed distance function and the comparison principle, and their use in the theory of barriers. Some examples of singularities are discussed. In the last chapters, also making use of a formal asymptotic inner and outer expansion, the convergence of the parabolic Allen-Cahn’s equation to mean curvature flow for sufficiently short times is proven, together with an error estimate.


- **Backward-forward parabolic equations.** Gradient flows of nonconvex functionals in dimension one. The Perona-Malik equation. Weak solutions, fourth-order approximations, discretizations.


- **Image Segmentation.** Reconstruction of three-dimensional shapes from apparent contours; topological and variational problems in computer vision. Apparent contours and their invariants. The book by B. Bellettini, V. Beorchia, M. Paolini, F. Pasquarelli, Shape Reconstruction from Apparent Contours. Theory and Algorithms, *Computational Imaging and Vision*, Springer 2015 (see the list of publications), is concerned with the problem of reconstructing a (not necessarily connected) shape starting from information on its apparent contour. Starting from a variational model concerning the depth of the objects in a picture and the problem of hidden and illusory contours, we investigate one of the central problems of computer vision: the topological and algorithmic reconstruction of a smooth three dimensional scene starting from the visible part of an apparent contour. We focus our attention on the manipulation of apparent contours using a finite set of elementary moves, corresponding to diffeomorphic deformations of three dimensional scenes. The book is intended also as a user’s guide to the software code **appcontour**, written for the manipulation of apparent contours and their invariants.
- **Mathematical aspects of Statistical Mechanics.** Nonlocal functionals in phase transitions, nonlocal parabolic equations.

- **Miscellanea.** Regularization of the two-body problem, systems of PDEs, general relativity, invariants of surfaces embedded in three-dimensional space, encyclopaediae.