Book Reviews

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Level Set Methods and Fast Marching Methods

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The book gives an overview of the author's work on theory and numerics of propagating interfaces, which began in his dissertation. Propagating interfaces are everywhere around us, and they include ocean waves, burning flames, crystal growth and many more. Less obvious examples are handwritten characters, iso–intensity contours in images. Such abundance of possible applications makes this book a useful reading for mathematicians, applied scientists, practicing engineers, computer graphics artists, and anyone interested in the evolution of boundaries.

The book is about two computational techniques: Fast Marching Methods and Level Set Methods, which are the result of author's effort to design a general framework for modeling the evolution of boundaries. Fast Marching Methods result from boundary value problem for the evolving interfaces, while Level Set Methods result from an associated initial value problem. Both techniques are based on Eulerian initial value partial differential equations, as opposed to traditional techniques that use Lagrangian geometric perspective. Several advantages result from this view of propagating interfaces: ability to construct robust numerical schemes, computational adaptivity, easy and natural curvature calculation, topology changes, etc.

The book can be divided in two parts. The first part presents the mathematical theory of evolving boundaries and partial differential equations of motion, theoretical analysis of propagating interfaces, description of traditional methods for interface tracking, and basic schemes for initial and boundary value problems. Efficient schemes for interface motion computing and algorithm's adaptivity are also explained.

The second part focuses on application of both techniques on variety of problems. The second edition gives eight areas of possible applications and examples of applications that the author has participated in, with the intent to indicate the range of problems that may be framed in the perspective. The areas are: geometry (curve/surface shrinkage and self–similar surfaces), grid generation, computer vision (shape detection and recognition), interface methods for combustion, solidification, fluid mechanics and electro migration; computational geometry and computer–aided design, optimality and first arrivals, etching and deposition in microchip fabrication.

The information provided by the book should be viewed as a framework for transforming new interface problems into partial differential equations framework. The book has 378 pages divided into 22 chapters, and it is easy to read, unlike some other books written by mathematicians.

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