Sobolev Spaces on Metric Measure Spaces: An Approach Based on Upper Gradients (New Mathematical Monographs)

Juha Heinonen, Pekka Koskela, Nageswari Shanmugalingam, Jeremy T. Tyson

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Analysis on metric spaces emerged in the 1990s as an independent research field providing a unified treatment of first-order analysis in diverse and potentially nonsmooth settings. Based on the fundamental concept of upper gradient, the notion of a Sobolev function was formulated in the setting of metric measure spaces supporting a Poincaré inequality. This coherent treatment from first principles is an ideal introduction to the subject for graduate students and a useful reference for experts. It presents the foundations of the theory of such first-order Sobolev spaces, then explores geometric implications of the critical Poincaré inequality, and indicates numerous examples of spaces satisfying this axiom. A distinguishing feature of the book is its focus on vector-valued Sobolev spaces. The final chapters include proofs of several landmark theorems, including Cheeger's stability theorem for Poincaré inequalities under Gromov-Hausdorff convergence, and the Keith-Zhong self-improvement theorem for Poincaré inequalities.

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