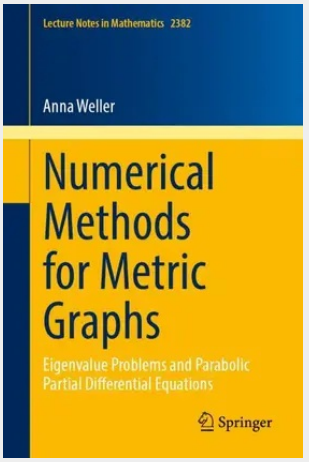
Weller

Numerical Methods for Metric Graphs

Eigenvalue Problems and Parabolic Partial Differential Equations



This book discusses the fundamentals of the numerics of parabolic partial differential equations posed on network structures interpreted as metric spaces. These so-called metric graphs frequently occur in the context of quantum graphs, where they are studied together with a differential operator and coupling conditions at the vertices. The two central methods covered here are a Galerkin discretization with linear finite elements and a spectral Galerkin discretization with basis functions obtained from an eigenvalue problem on the metric graph. The solution of the latter eigenvalue problems, i.e., the computation of quantum graph spectra, is therefore an important aspect of the method, and is treated in depth. Further, a real-world application of metric graphs to the modeling of the human connectome (brain network) is included as a major motivation for the investigated problems. Aimed at researchers and graduate students with a practical interest in diffusion-type and eigenvalue problems on metric graphs, the book is largely self-contained; it provides the relevant background on metric (and quantum) graphs as well as the discussed numerical methods. Numerous detailed numerical examples are given, supplemented by the publicly available Julia package MeGraPDE.jl.

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