Calculus Of Variations Pdes And Modeling Progress In Nonlinear Differential
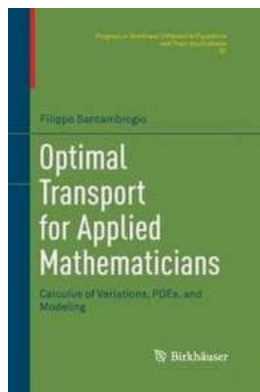
Calculus of Variations, PDEs, and Modeling Progress in Nonlinear Differential Equations

Calculus of Variations is a branch of mathematics that deals with finding optimal solutions to functionals. It has been widely used to address problems in physics, engineering, economics, and other fields. In this article, we will explore the application of calculus of variations in solving Partial Differential Equations (PDEs) and the impact it has on modeling progress in nonlinear differential equations.

Understanding Calculus of Variations

Calculus of Variations focuses on finding functions that optimize certain quantities. Instead of optimizing a single function, as in ordinary calculus, it aims to optimize a functional, which is a mapping from a set of functions to real numbers. The functional usually represents a physical or mathematical quantity that needs to be minimized or maximized.

Optimal Transport for Applied Mathematicians: Calculus of Variations, PDEs, and Modeling (Progress in Nonlinear Differential Equations and Their Applications Book 87)

by Filippo Santambrogio (1st ed. 2015 Edition, Kindle Edition)

★★★★☆ 4.3 out of 5

Language	: English
File size	: 7794 KB
Print length	: 380 pages
Screen Reader	: Supported

By using various techniques, including the Euler-Lagrange equation, the calculus of variations allows us to find these optimal functions. The Euler-Lagrange equation is a necessary condition for a function to be an extremum of a functional. By solving this equation, we can obtain the solutions that minimize or maximize the functional.

Application in Partial Differential Equations

Partial Differential Equations are equations that involve partial derivatives of unknown functions. They are used to describe various phenomena in physics, such as heat conduction, fluid flow, and electromagnetism. The calculus of variations has proven to be a powerful tool in dealing with PDEs.

By treating the unknown function in the PDE as the solution to a functional optimization problem, we can use calculus of variations techniques to derive the necessary conditions for the unknown function to satisfy the PDE. These conditions not only help us find the solutions to the PDE but also provide valuable insights into the underlying physical or mathematical problem.

Modeling Progress in Nonlinear Differential Equations

Nonlinear differential equations are equations that involve nonlinear derivatives or nonlinear functions of the unknown function. These equations often arise in real-world applications where complex interactions or nonlinear behavior occur.
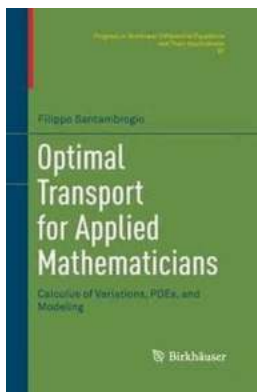
The use of calculus of variations in modeling progress in nonlinear differential equations has led to significant advancements. It allows us to analyze and understand the behavior of complex systems more accurately. By formulating the

problem as a functional optimization, we can study the existence, uniqueness, and stability of solutions.

Furthermore, the calculus of variations provides powerful mathematical techniques to analyze and solve nonlinear differential equations. It allows us to derive necessary conditions, such as the Euler-Lagrange equation, that guide us in finding solutions to these equations.

The calculus of variations has been instrumental in solving optimization problems in various fields. When applied to PDEs and modeling progress in nonlinear differential equations, it enhances our understanding of complex systems and provides valuable insights into their behavior.

By formulating the problems as functional optimizations, we can derive necessary conditions and find solutions that minimize or maximize the functionals. These solutions help us gain deeper insights into the underlying phenomena and facilitate further advancements in various scientific and engineering disciplines.

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This monograph presents a rigorous mathematical to optimal transport as a variational problem, its use in modeling various phenomena, and its connections with partial differential equations. Its main goal is to provide the reader with the techniques necessary to understand the current research in optimal transport and the tools which are most useful for its applications. Full proofs are used to illustrate mathematical concepts and each chapter includes a section that discusses applications of optimal transport to various areas, such as economics, finance, potential games, image processing and fluid dynamics. Several topics are covered that have never been previously in books on this subject, such as the Knothe transport, the properties of functionals on measures, the Dacorogna-Moser flow, the formulation through minimal flows with prescribed divergence formulation, the case of the supremal cost, and the most classical numerical methods. Graduate students and researchers in both pure and applied mathematics interested in the problems and applications of optimal transport will find this to be an invaluable resource.

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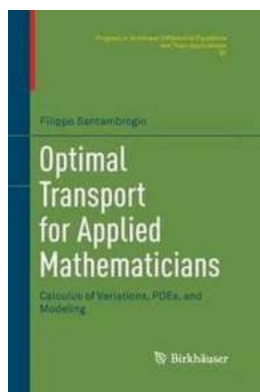

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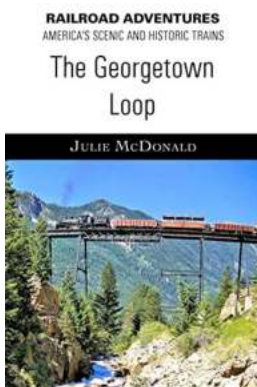
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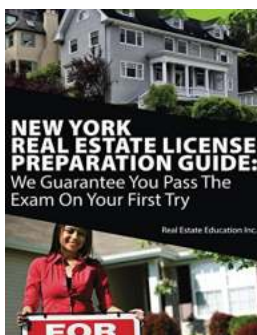
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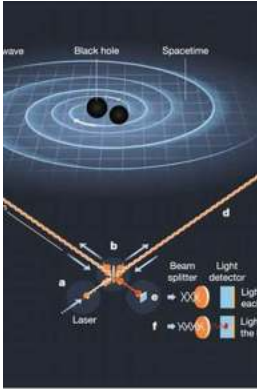
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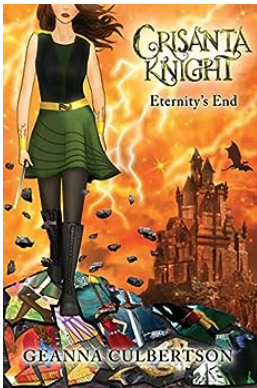
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