

Lecture Notes in Networks and Systems 1531

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Basar Oztaysi · Sezi Cevik Onar ·
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Irem Otay *Editors*

Intelligent and Fuzzy Systems

Artificial Intelligence in Human-Centric,
Resilient and Sustainable Industries,
Proceedings of the INFUS 2025
Conference, Volume 4

 Springer



Intelligent Monte Carlo Method for Solving Multidimensional Fredholm Integral Equations

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Abstract. Fredholm integral equations play a crucial role in various scientific and engineering applications, yet their multidimensional forms present significant computational challenges. This paper introduces an intelligent Monte Carlo (IMC) approach for efficiently solving multidimensional Fredholm integral equations. By employing an unbiased stochastic method based on the walk-on-equation (WOE) algorithm for linear systems, the proposed technique enhances computational accuracy while significantly reducing simulation costs. The effectiveness of the approach is validated through benchmark problems, demonstrating its capability to handle high-dimensional integrations with improved convergence rates. Unlike traditional Monte Carlo methods, the IMC technique optimizes sampling efficiency, ensuring a balance between computational feasibility and solution precision. Results indicate that the proposed method provides a scalable and robust solution for solving complex integral equations, making it highly applicable in applied mathematics,