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Metaheuristic Algorithms in Wireless Sensor Networks

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Wireless Sensor Networks (WSNs) are fundamental to many of today's intelligent and connected systems, supporting applications in the Internet of Things (IoT), environmental monitoring, healthcare, smart agriculture, industrial automation, defence, disaster management, and cyber-physical infrastructure. Yet their effectiveness is often limited by constrained energy, computational resources and bandwidth, dynamic network topologies, scalability, security, and quality-of-service requirements. Addressing these competing demands creates complex optimization problems, many of which are NP-hard.

This book provides a systematic and comprehensive treatment of metaheuristic algorithms for solving key optimization problems in Wireless Sensor Networks. Beginning with the foundations of WSN architecture, classification, energy models, deployment strategies, challenges, and emerging research trends, it establishes the technical background needed to understand optimization within resource-constrained sensor networks.

The book then introduces essential optimization concepts, including objective functions and constraints, computational complexity, single- and multi-objective optimization, fitness-function modeling, performance metrics, and trade-off analysis. Building on these foundations, it examines a broad range of metaheuristic approaches, including Genetic Algorithms, Particle Swarm Optimization, Differential Evolution, Ant Colony Optimization, Artificial Bee Colony Optimization, Simulated Annealing, Teaching-Learning-Based Optimization, Grey Wolf Optimization, and Chicken Swarm Optimization.

Each technique is presented through its mathematical foundations and algorithmic procedure before being applied specifically to WSN challenges. Numerical examples, implementation considerations, advantages and limitations, and future research directions help connect optimization theory with practical network design and performance.

Combining WSN fundamentals, optimization theory, and computational intelligence within a single resource, this book provides readers with the tools to select, adapt, evaluate, and apply metaheuristic methods to complex sensor-network problems. It is designed for postgraduate students, doctoral researchers, academics, and professionals working in WSNs, IoT, computational intelligence, and network optimization.

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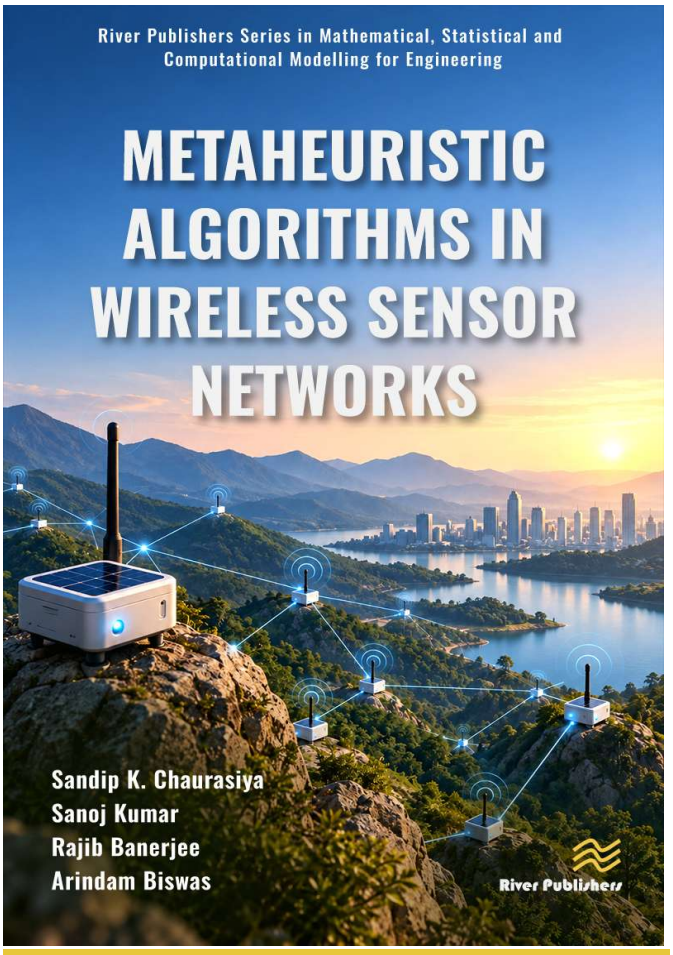

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KEYWORDS:
Wireless Sensor Networks; WSN optimization; Metaheuristic algorithms; Computational intelligence; Swarm intelligence; Internet of Things; Energy efficiency; Network lifetime; Cluster-head selection; Routing optimization; Coverage optimization; Connectivity; Load balancing; Data aggregation; Sensor deployment; Sink placement; Localization; Fitness function; Multi-objective optimization; Genetic Algorithm; Particle Swarm Optimization; Differential Evolution; Ant Colony Optimization; Artificial Bee Colony Optimization; Simulated Annealing; Teaching-Learning-Based Optimization; Grey Wolf Optimization; Chicken Swarm Optimization; Energ ing; IoT-based WSNs; Smart s rce-constrained networks; NP-har Benchmarking; Reproducibility; A zation; Hybrid metaheuristics.

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