

Smart Cities CO₂ Emission Reduction Through Machine Learning-Based Optimization and Metaheuristics

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Abstract:

As urbanization accelerates, the reduction of CO₂ emissions in smart cities has become a critical objective for achieving environmental sustainability. This study introduces a hybrid optimization framework that integrates machine learning techniques with metaheuristic algorithms to enhance CO₂ emission reduction strategies. Real-time data from IoT-enabled urban infrastructures—including traffic patterns, energy consumption, and industrial outputs—are analyzed using machine learning models such as Random Forests and Gradient Boosting to forecast emission levels. To identify optimal mitigation strategies, metaheuristics such as Genetic Algorithms (GA), Particle Swarm Optimization (PSO), and Ant Colony Optimization (ACO) are employed. These strategies guide the adaptive control of energy usage, transportation systems, and urban planning policies. The proposed framework demonstrates significant improvements in reducing emissions while maintaining operational efficiency, providing a scalable and intelligent solution for sustainable urban development.

Keywords:

CO₂ reduction, smart cities, machine learning, metaheuristics, sustainability, urban optimization.

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