Machine Learning Models for Automated Performance Optimization of Software Systems and Services

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Abstract: *The rapid growth of modern software systems and services has resulted in increasingly complex performance management challenges. Traditional rule-based approaches to performance optimization often fail to adapt to dynamic workloads, heterogeneous infrastructures, and unpredictable user demands. To address these limitations, machine learning (ML) has emerged as a powerful enabler of automated performance optimization by leveraging data-driven insights and predictive intelligence. This study explores the application of various ML models—including regression algorithms, reinforcement learning, neural networks, and ensemble methods—for analyzing performance metrics, detecting anomalies, predicting system bottlenecks, and autonomously tuning configurations. By continuously learning from historical and real-time data, ML-driven optimization frameworks can achieve significant improvements in resource utilization, response time, throughput, and overall system reliability. The proposed framework highlights the integration of ML models into performance monitoring pipelines to enable proactive and adaptive decision-making, thereby reducing human intervention and operational costs. The findings underscore the potential of ML-based automation in building self-optimizing software ecosystems that align with the principles of scalability, resilience, and intelligent service management.*

Keywords: Machine Learning, Performance Optimization, Software Systems, Automated Tuning, Predictive Analytics