Optimizing AI-Powered Mobile Applications with Serverless Cloud Computing : A Performance, Cost, and Sustainability Analysis in Flutter

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Abstract: *The integration of Artificial Intelligence (AI) into mobile applications has transformed user experience and functionality, while serverless cloud computing has emerged as a promising paradigm offering scalable and cost-effective backend solutions. This study examines the integration of AI into Flutter applications using serverless architectures, with a comprehensive analysis of performance, cost, and environmental sustainability—including CO_2 emissions. By benchmarking various AI workloads across platforms such as AWS Lambda, Google Cloud Functions, and Firebase Cloud Functions, we evaluate key metrics including cold start latency, scalability, computational efficiency, and cost structures, alongside the energy consumption and corresponding carbon footprint of serverless deployments. The findings indicate that while serverless architectures are highly effective for lightweight AI tasks and intermittent workloads, challenges such as cold start delays and increased energy usage may impact their viability for real-time, compute-intensive applications. Furthermore, our environmental impact analysis reveals that optimizing serverless execution can contribute to reduced CO_2 emissions, aligning mobile app development with broader green innovation objectives. This research provides actionable insights and best practices for developers, promoting sustainable, high-performance AI-powered mobile applications.*

Keywords: Flutter, Artificial Intelligence, Serverless Cloud Computing, Performance Analysis, Cost Efficiency, Sustainability, CO_2 Emissions