

# FairRAG: A Privacy-Preserving Framework for Fair Financial Decision-Making

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## Abstract-

Customer churn prediction has become crucial for businesses, yet it poses significant challenges regarding privacy preservation and prediction accuracy. In this paper, we address two fundamental questions: (1) How can customer churn be effectively predicted while ensuring robust privacy protection of sensitive data? (2) How can large language models enhance churn prediction accuracy while maintaining data privacy? To address these questions, we propose FairRAG, a robust architecture that combines differential privacy, retrieval-augmented generation, and LLMs. Our approach leverages OPT-125M as the core language model along with a sentence transformer for semantic similarity matching while incorporating differential privacy mechanisms to generate synthetic training data. We evaluate FairRAG on two diverse datasets: Bank Churn and Telco Churn. The results demonstrate significant improvements over both traditional machine learning approaches and standalone LLMs, achieving accuracy improvements of up to 11% on the Bank Churn dataset and 12% on the Telco Churn dataset. These improvements were maintained when using differentially private synthetic data, thus indicating robust privacy and accuracy trade-offs.

**Index Terms-** algorithmic fairness; privacy-preserving machine learning; differential privacy; retrieval-augmented generation

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