Oblivious Federated Analytics for Mobile Devices

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As the volume of data generated from mobile devices surges, the need for efficient data analysis while preserving privacy is increasingly urgent. Federated analytics [2] enables distributed data analysis among edge devices without participants uploading their records to a trusted third party. It presents a compelling solution to this quandary. For example, Google's Now Playing feature on Pixel phones enables their servers to refine their song recommendation data by securely aggregating over the listening habits of individual users [4]. Here, a user's phone locally recognizes and records the songs they are hearing. It periodically encrypts these listening habits, and sends them to the a centralized server for analysis with that of other users. Although federated analytics offers efficient privacy-preserving data analysis, it inherently relies on centralized servers that learn the output of this analysis. This raises fundamental questions about trust: How can we ensure these servers do not misuse the aggregated data? Is it possible to create a system where users benefit from aggregated insights without the server ever 'seeing' this data? The Fundamental Law of Information Recovery [1] indicates that revealing these raw statistics leaves users vulnerable to reconstruction attacks. We posit that this personalization is possible with better security by pushing more of this computation into mobile devices.

Secure multi-party computation (MPC) is a crucial technology, enabling privacy-preserving method for aggregating data across devices without revealing the aggregated data to the server. To optimize this process for our system's specific needs, we have tailored the approach to effectively manage a continuous querying environment, distinguishing our work from existing models, e.g., SMPAI [3]. In our approach, devices conduct an initial phase of local partial aggregation of their data, lightening the computational load in MPC. The aggregation of partially processed data is then transformed into secret shares. This transformation involves splitting the aggregated data into pieces that are meaningless on their own but can be combined to reveal a specific piece of information. These shares are distributed among the participating devices, initiating the MPC process. Within this MPC framework, a series of cryptographic protocols are executed, allowing the devices to collaboratively compute the final aggregate without any single device having to reveal its own aggregated data to others. Once the final aggregation is complete, the result is converted back to all participating devices. Our methodology is expected to not only facilitate privacy-preserving analysis across multiple parties without revealing individual data but also to enhance querying efficiency in a continuous querying edge device environment.

By integrating MPC and local data aggregation within federated analytics for edge devices in a continuous querying environment, our approach contributes to introducing a federated analytics model that eliminates the need for server visibility into aggregated data. Our experimental evaluation will focus on measuring computational overhead, latency, and bandwidth usage during the secure aggregation process, anticipating significant enhancements in computational efficiency. This effort opens pathways for secure and efficient federated analytics across edge devices. Furthermore, by leveraging aggregated data to improve personal models without server knowledge, it promotes private device-level personalization.

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