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PeaceMaker: A Mediator for Organizations with Conflicting Interests in Cross-Silo Federated Learning

Dissertation

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Abstract

Cross-Silo Federated Learning (FL) promotes collaboration between organizations for Machine Learning (ML) tasks whilst ensuring data privacy. However organizations are competitive and self-interested in nature, thus can be hesitant to collaborate. Organizations with high-quality data may be reluctant to collaborate with low-quality data organizations since their benefits is minimal and it's also possible that one or more organizations may unethically opt-out of using their high-quality data. The difference in the contribution level of organizations causes conflicting interests, which is a severe concern since organizations could exit the system, resulting in low client engagement and lowering the overall efficacy of the cross-silo FL system.

To address this gap, the author proposes a novel flow that integrates incentive design to the existing cross-silo FL flow to enhance client engagement. The main focus of this design is to reward high-quality data owners for their contributions which provides them an incentive to remain in the system. The incentive scheme entails collecting a charge for each training round, evaluating client contributions using a test-based evaluation technique or the Shapley Value approach, and distributing appropriate rewards using the proposed linear arithmetic equation to compute each client's compensation. Furthermore, the author was inspired to create a library for computing Shapley Value in FL after discovering the lack of one. Finally, a FL system is developed to demonstrate the proposed flow.

After briefly testing the system using the specified experimental configuration, it is clear that it correctly determines the organization's contribution measure and distributes a payout based on it. High-quality data owners are compensated higher than low-quality data owners for their contribution. The system, which is based on the proposed flow, was exhibited to professionals, who all agreed that the results obtained justify that it addresses the problem.

Keywords: Federated Learning, Cross-Silo Federated Learning, Shapley Value, Incentive Design

Subject Descriptors

- Computing methodologies → Machine learning → Machine learning approaches
- Security and privacy