FlexiFed: Adaptive Resource-Based Client Topology Selection and Similarity-Based Aggregation in Decentralized Federated Learning

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Introduction

In decentralized federated learning (DFL), optimizing system performance amid heterogeneous client resources and non-IID data remains challenging. Traditional methods like FedAvg and FedProx face limitations due to their simplistic handling of these issues. Recent approaches such as FedHP, CoCo, and YOGA attempt to address these challenges using coordinators to manage client interactions; however, these coordinators can become bottlenecks due to their reliance on maintaining robust connections across all clients.

FlexiFed algorithm, a two-stage method that dynamically adapts client topology and parameter aggregation without the need for a coordinator. Experimental results demonstrate that FlexiFed significantly outperforms traditional methods like FedAvg and FedProx in heterogeneous environments, offering a more scalable and efficient solution without the coordination overhead.

Contributions

- FlexiFed is an innovative framework designed to tackle the heterogeneous challenges DFL. This framework empowers each client to autonomously manage its resources and dynamically adjust the network topology based on resource availability, optimizing performance.
- By evaluating and normalizing client resources, FlexiFed guarantees an optimal and fair distribution of connections among clients. This improves collaboration and ensures a balanced workload across the network.
- FlexiFed employs a similarity-based aggregation mechanism that weights model updates according to the similarity of local models. This approach enhances overall model accuracy and maintains stability across different communication rounds.
- FlexiFed strengthens the robustness and scalability of DFL, making it ideally suited for dynamic and heterogeneous scenarios. It efficiently adapts to changing network conditions, improving model performance and ensuring consistent results.

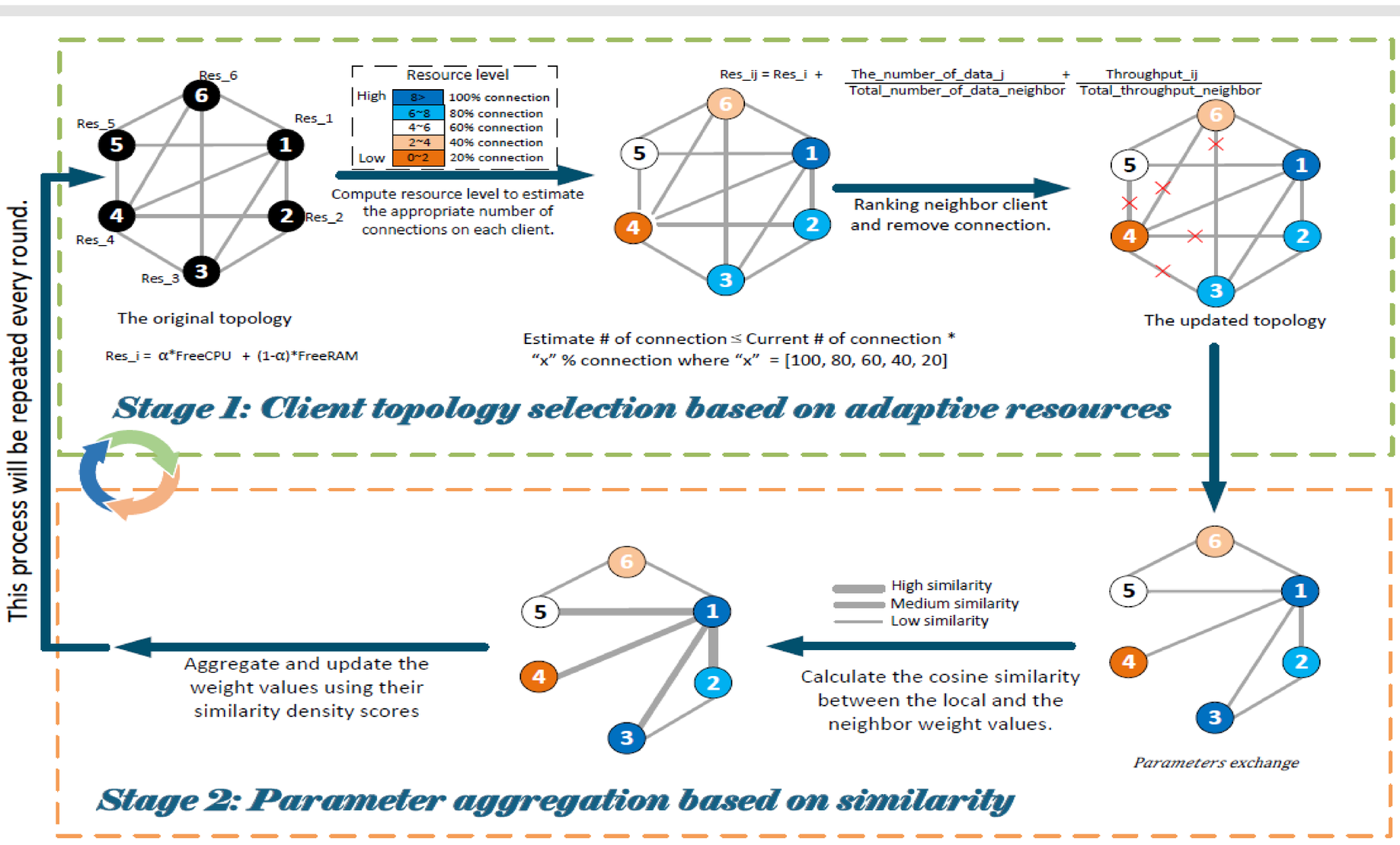

Figure 1. Architecture of FlexiFed

RESULTS

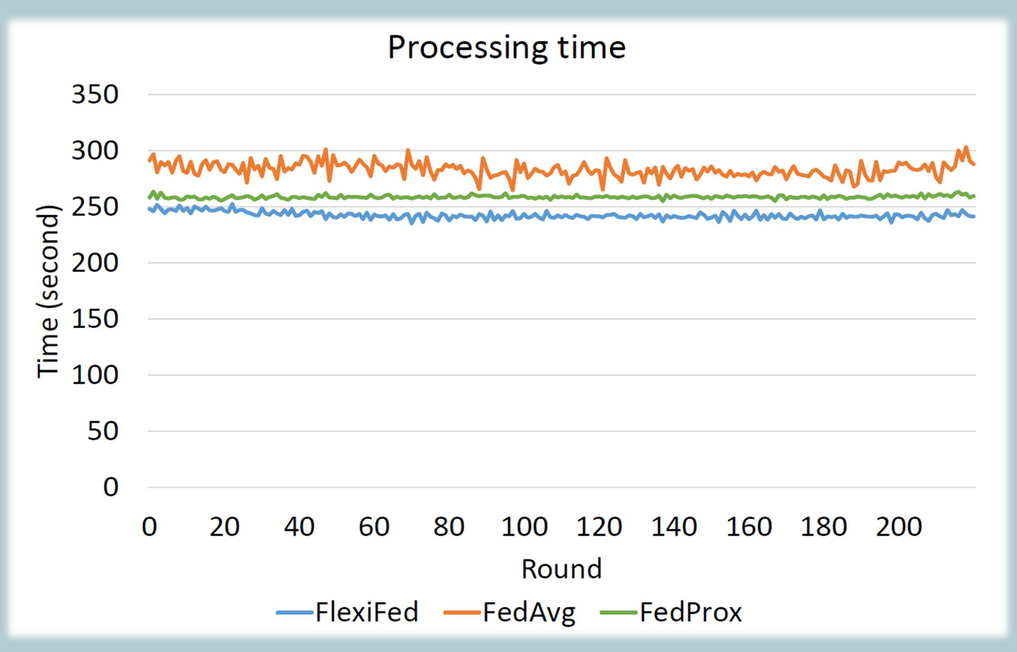

Figure 2. Processing time

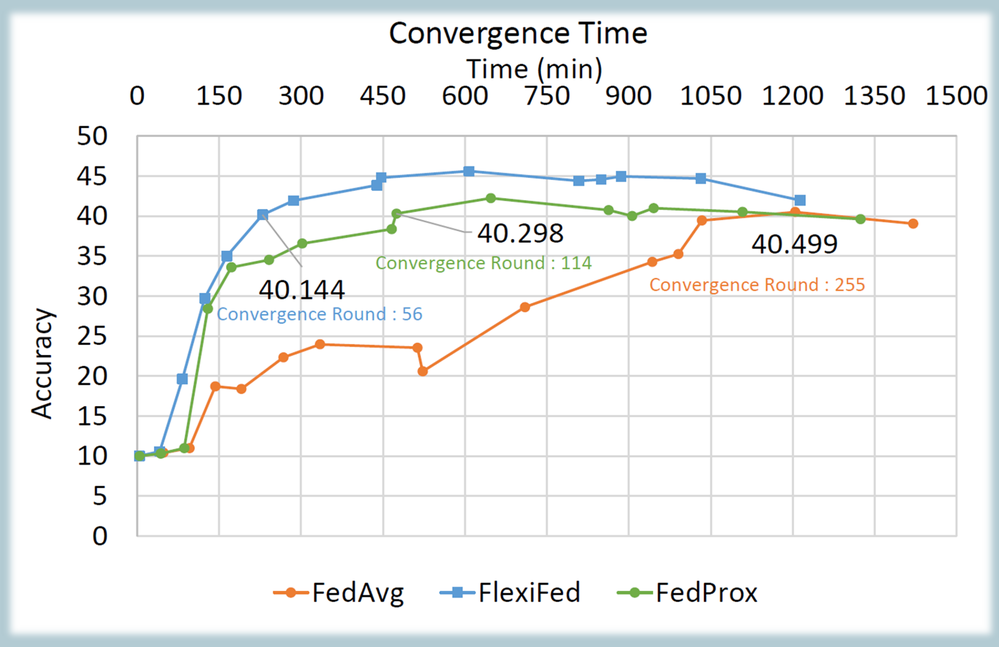

Figure 3. Convergence time

CONCLUSION

- FlexiFed provides an innovative solution to the challenges of DFL by dynamically adjusting client topologies and refining parameter aggregation based on resource availability and model similarity.
- Our experimental results show that FlexiFed reduces the communication cost while enhancing convergence time, and accuracy of the learning process in heterogeneous environments, offering significant improvements over traditional DFL approaches.
- The introduction of adaptive resource-based topology selection and similarity-based aggregation makes FlexiFed a robust framework for diverse and real-world applications, paving the way for more effective and efficient distributed learning systems.
- Future research will focus on further refining adaptive parameters and scaling the algorithm for larger and more complex networks.

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