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Joint Participant Selection and Learning Optimization for Federated Learning of Multiple Models in Edge Cloud

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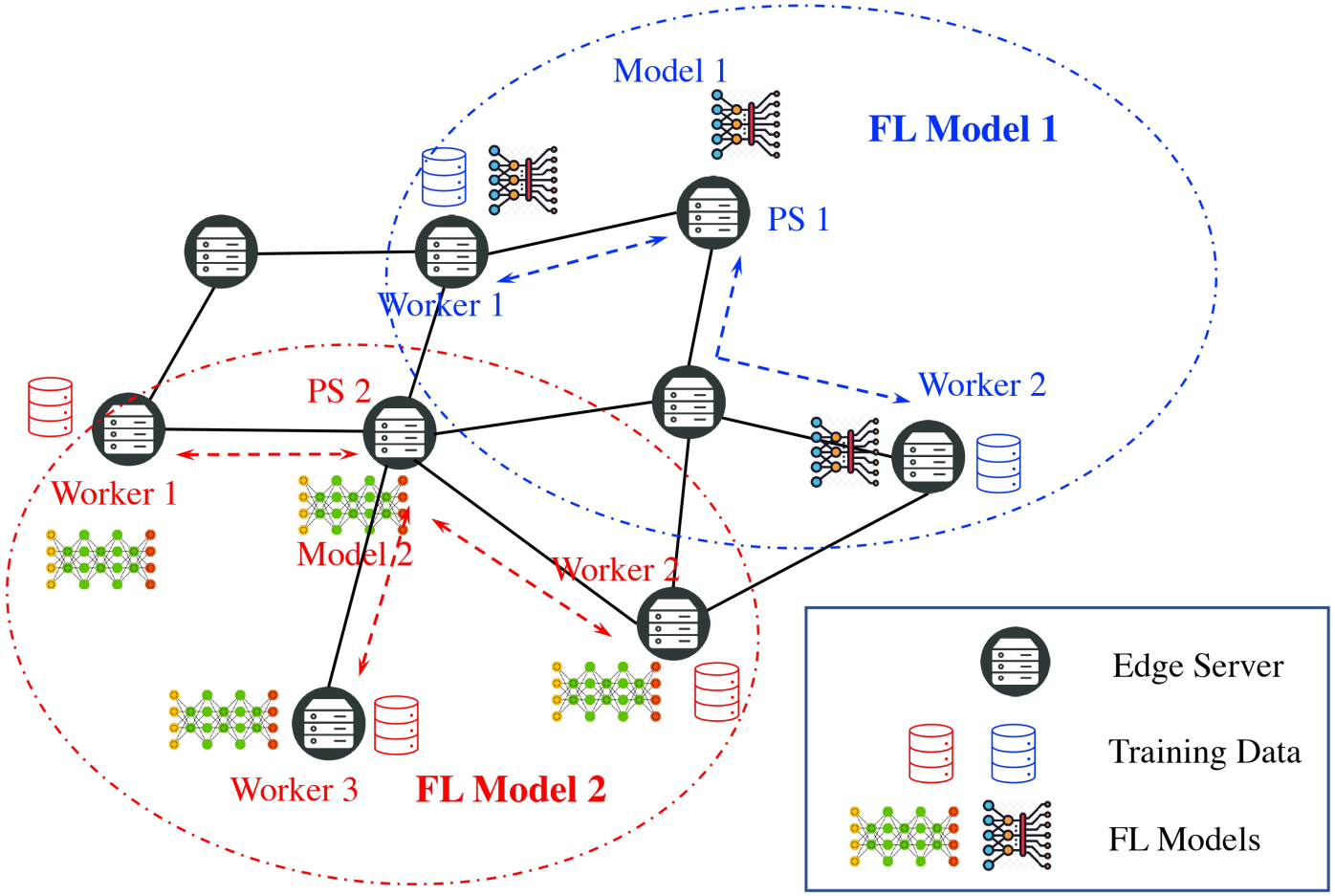
Research Objectives

- We mainly study the joint participant selection and learning optimization problem in multi-model federated learning on a shared edge cloud.
- Our goal is to find a parameter server (PS) and multiple FL workers for each FL model, and determine the local convergence rate of FL workers to minimize the total training cost of all FL models.
- By allowing different FL models to choose their own PS, the algorithm proposed in this paper can better handle the resource competition between models and provide appropriate load balancing for the edge cloud than the traditional FL solution (all models adopt a centralized PS).

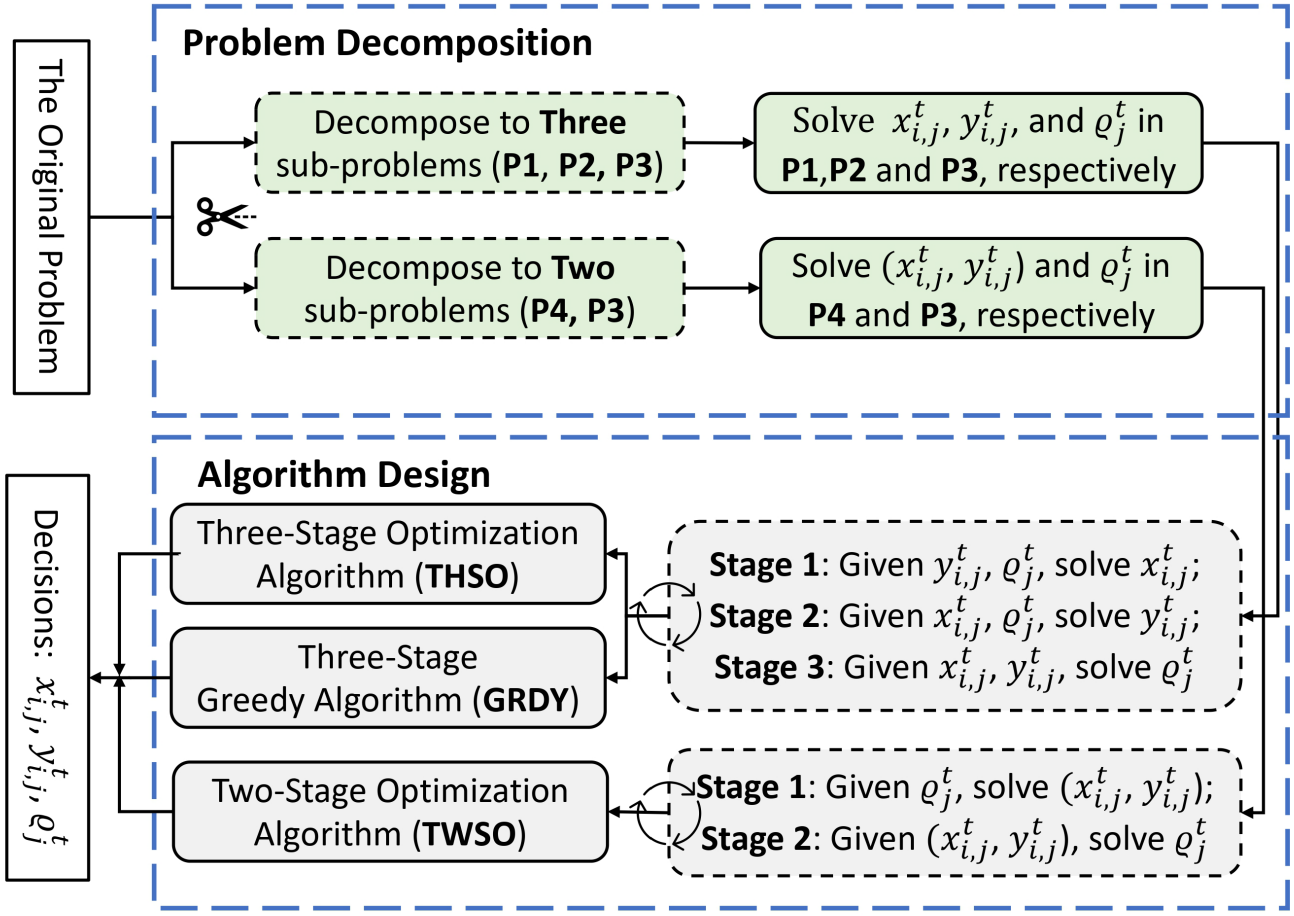
Example of multi-model FL over the edge



Research Method

- We first define the joint participant selection and learning optimization problem as a joint optimization problem whose nature is a typical mixed integer nonlinear programming (MINLP) problem.
- We decouple the original optimization problem into two or three sub-problems, and then propose three different iterative algorithms (i.e., three-stage optimization algorithm, three-stage greedy algorithm, and two-stage optimization algorithm).
- In addition, we further considered the impact of the prioritization order of all FL models on the total cost in resource-limited edge scenarios.

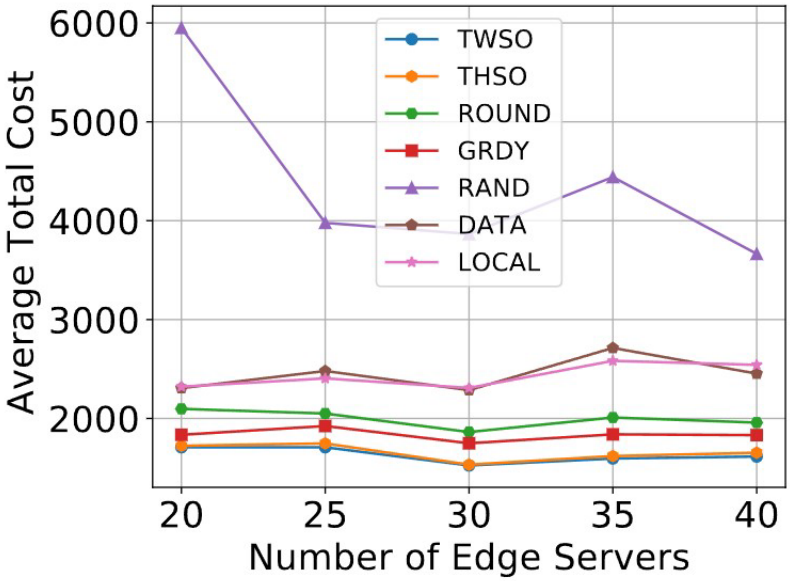
The proposed framework



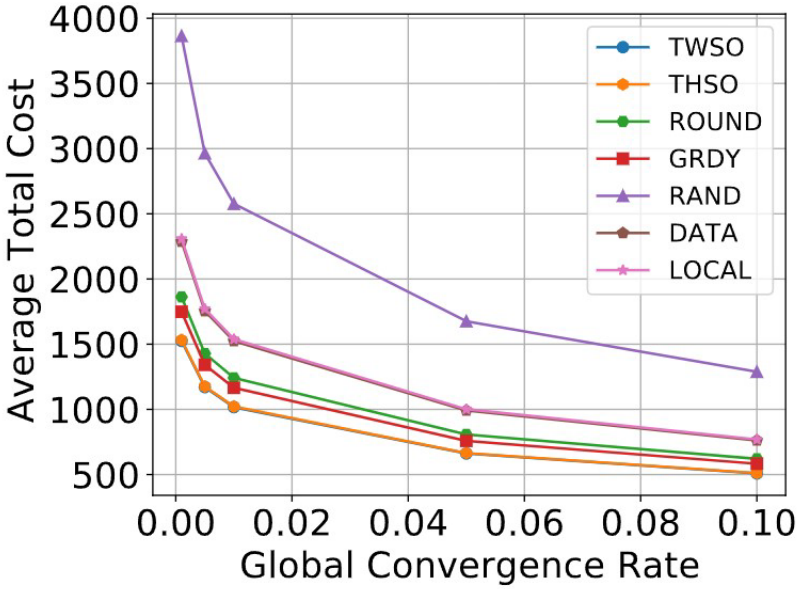
Research Results

- Compared with existing algorithms, our proposed algorithm can effectively reduce the training cost of all FL models regardless of the number of edge servers, FL models or FL workers.
- Furthermore, letting FL models with larger model sizes select participants first can further reduce the total training cost.
- The algorithm proposed in this paper is also applied in the real FL training process. The results show that with the increase of the number of FL workers, the participants selected by the algorithm in this paper can make the FL model obtain higher accuracy.

Research Results



(a) # of servers



(b) global convergence rate

Research Conclusions

- A joint participant selection and learning optimization problem for Multi-Model FL has been studied.
- Three different iterative algorithms have been presented to decompose the original problem into multi-stages so that each stage can be solved by an optimization solver or a greedy algorithm.
- Extensive simulations with real FL experiments show that our proposed algorithms outperform similar existing solutions.
- In the future, we plan to further investigate (1) reinforcement learning-based solutions for similar optimization problems in a more dynamic edge system, (2) new joint optimization problems where different FL models can choose different FL training topologies (such as DFL or HFL), and (3) similar joint optimization problems but in a more complex edge system with multiple edge operators.