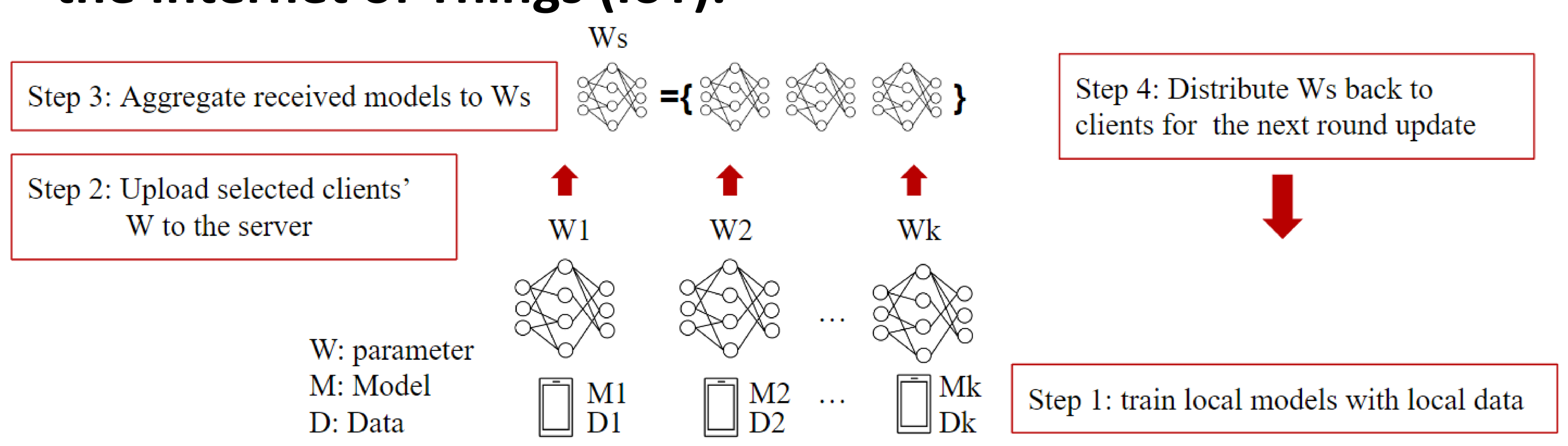
# Knowledge-Enhanced Semi-Supervised Federated Learning for Aggregating Heterogeneous Lightweight Clients in IoT

Jiaqi Wang[1], Shenglai Zeng[2], Zewei Long[3], Yaqing Wang[4], Houping Xiao[5], Fenglong Ma[1]
[1]The Pennsylvania State University, [2]University of Electronic Science and Technology of China,
[3]University of Illinois Urbana-Champaign, [4]Purdue University, [5]Georgia State University

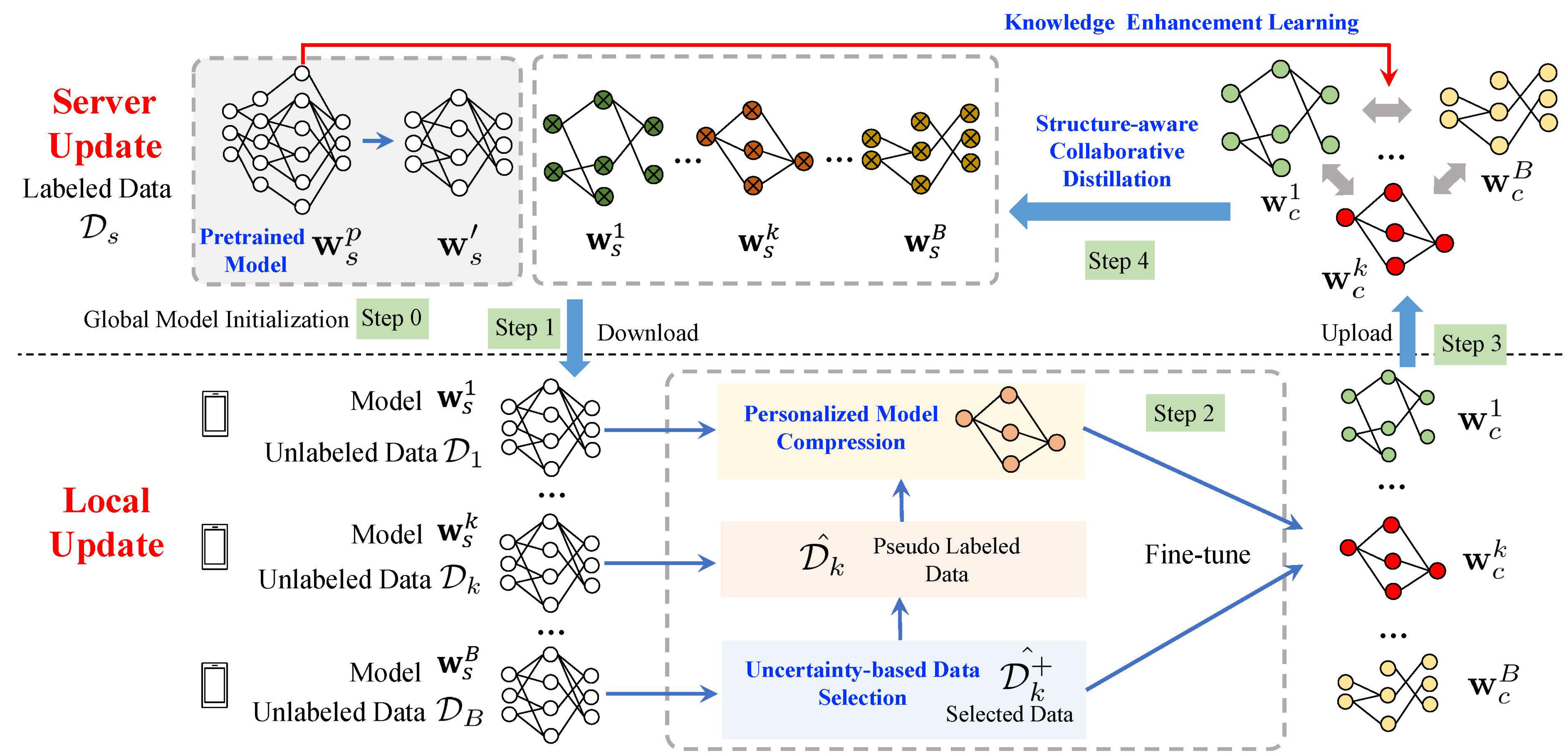
## Background and Motivation

- **Federated learning (FL) enables multiple clients to train models collaboratively without sharing local data, which has achieved promising results in different areas, including the Internet of Things (IoT).**




- **Motivation**
  - In the real world scenario, it is impractical to assume that local data is fully labelled, since users usually do not take any incentives or have the expertise to annotate the generated data.
  - A general global model may not be sufficient to characterize the uniqueness of each IoT user since IoT devices may store heterogeneous data. Thus, model customization has become a rigid need for IoT applications.
  - Existing methods are not developed for IoT applications and do not take into account the constraints of IoT devices such as limited computational resources and constrained network bandwidth.
- **Contribution**
  - To the best of our knowledge, we are the first work to **distill lightweight models** to warm up and further **customize compressed local models** with **different structures** using network pruning techniques in FL.
  - We propose a **new aggregation approach** with the combination of network **structure-aware collaborative distillation** and **large-model knowledge enhancement learning.**

## The Proposed Work: pFedKnow




## Experiments

Table 1: Image classification performance comparing with semi-supervised federated learning baselines.

| Dataset | SVHN | | CIFAR-10 | |
|---|---|---|---|---|
| Setting | IID | non-IID | IID | non-IID |
| FedMatch [8] | 78.34% | 74.76% | 64.70% | 61.12% |
| SSFL [39] | 76.06% | 70.29% | 64.45% | 60.33% |
| FedMix [38] | 78.45% | 71.76% | 63.68% | 61.79% |
| FedSEAL [1] | 72.64% | 69.02% | 62.39% | 60.07% |
| SemiFL [4] | 84.65% | 82.15% | 70.79% | 68.66% |
| pFedKnow | **85.31%** | **84.79%** | **71.05%** | **69.81%** |

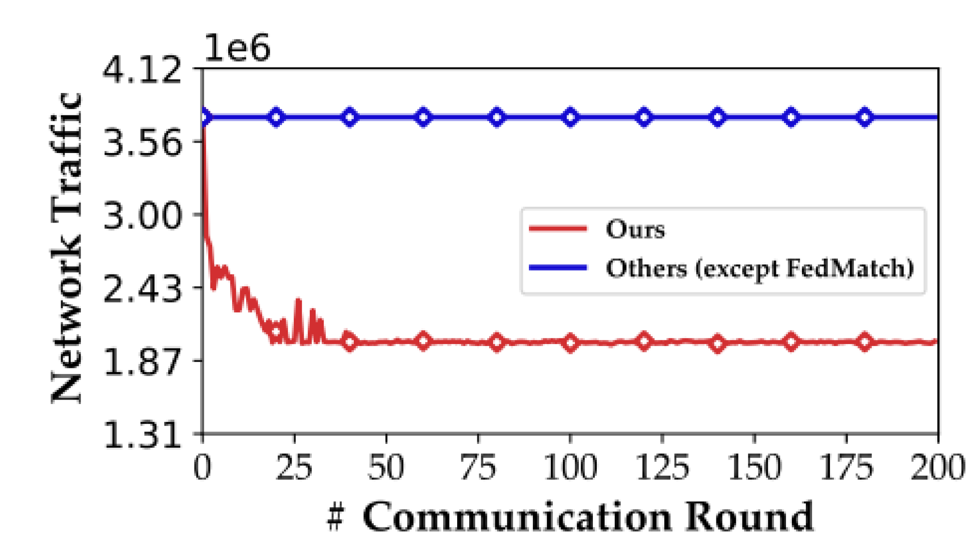



Figure 1: Communication cost analysis on CIFAR-10.

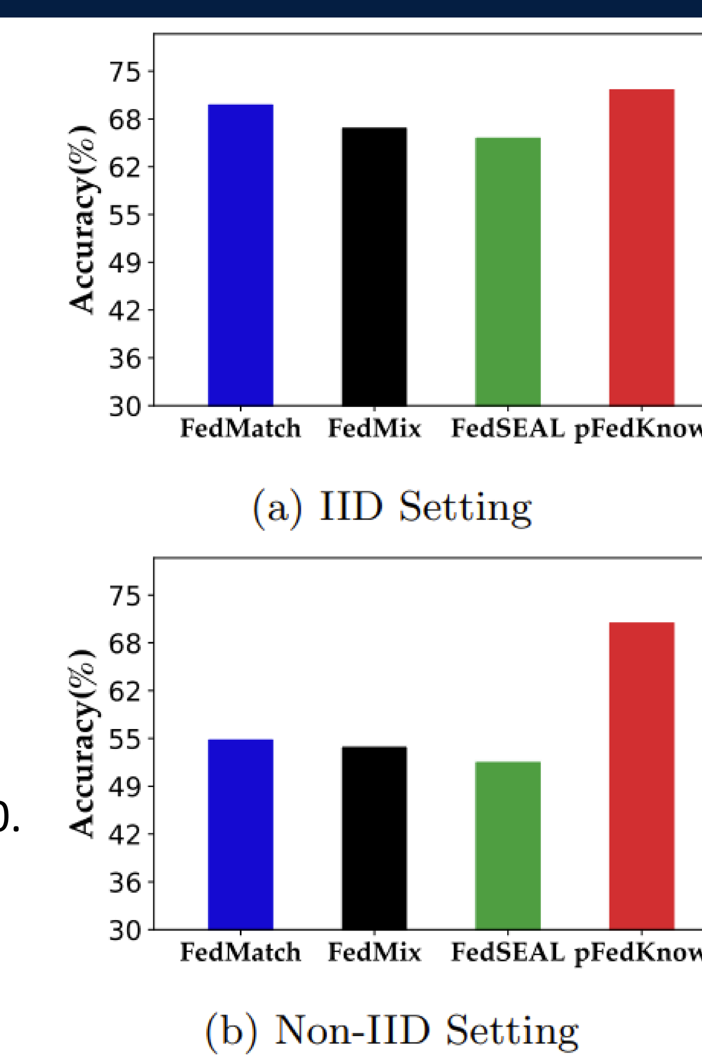



Figure 2: Performance comparison on AG.

Acknowledgement: registration and travel support for this presentation was provided by the Society for Industrial and Applied Mathematics.