DecentraLearn: Robust Learning in Decentralized Environments using Best-Effort Aggregation

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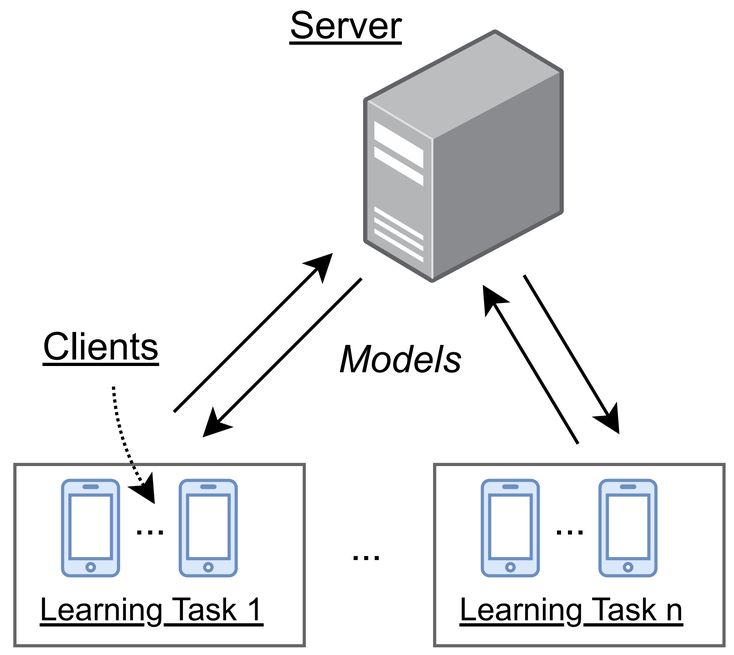
Motivation

Server in FL Setups [1]

1. **Selecting** clients for model training
2. **Aggregating** model updates
3. **Tracking** availability and capabilities of devices

Challenges using Server

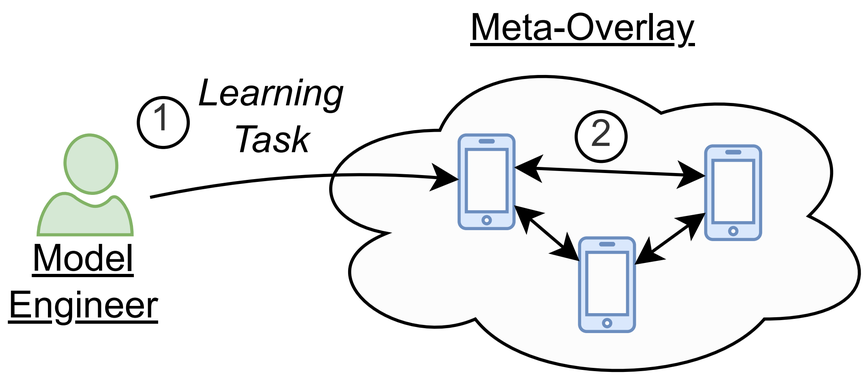
1. Single point of **failure**
2. Infrastructure and maintanance **costs**
3. Risk of **censorship**



RQ: How can we design a distributed learning setup without any critical dependency on a server?

Approach

Creating/Discovering Learning Tasks

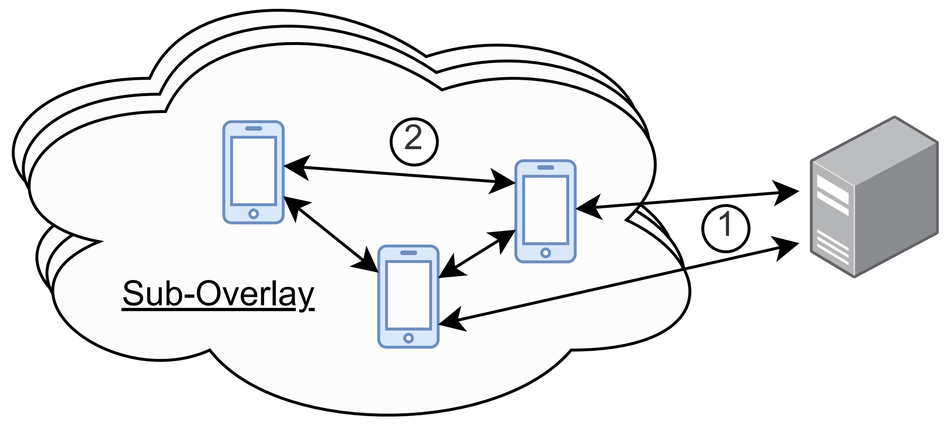


1. **Model Engineers** create learning tasks and publish in a decentralized meta-overlay
   - **Peer-reviewed** to prevent abuse
2. **End-users** join a decentralized meta-overlay to discover learning tasks
   - Peers gossip available learning tasks

Solving Learning Tasks

Federated Learning vs. Gossip Learning [2]

1. **Server available**
   - server-side aggregation (asynchronously)
2. **Server unavailable**
   - gossip aggregation
3. **Doubly weighted averaging**
   - server model vs. model age



A central server is optional in our design and not critical for progression of training!

Benefits

1. **Open infrastructure** for creating and solving learning tasks
2. **Autonomy** for end-users to work on the learning tasks they want
3. **No dependency** on central server
   - But a server can speed up the model training

Evaluation

Plan to evaluate using: FedScale

- Realistic models
- Real-world device traces from FedScale [3]

- What is the model convergence speed compared to FL?
- How energy-efficient is DecentraLearn?

[1] Bonawitz, Keith, et al. "Towards federated learning at scale: System design." *Proceedings of machine learning and systems* 1 (2019): 374-388.
[2] Hegedűs, István, Gábor Danner, and Márk Jelasity. "Gossip learning as a decentralized alternative to federated learning." DAIS, 2019.
[3] Lai, Fan, et al. "Fedscale: Benchmarking model and system performance of federated learning at scale." *International Conference on Machine Learning*. PMLR, 2022.