Can Fair Federated Learning reduce the need for Personalisation?

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Flower

TL;DR

- Federated Learning (FL) does not perform **fairly** across clients
- Local models may have higher accuracy than federated ones
- **Fair** and/or **Personalised** Federated Learning address this
- Our contribution:
  - We show Fair FL (FFL) does **not** benefit personalisation
  - We propose using regularisers that **anticipate** personalisation
  - We show **Personalisation-aware** FL (PaFL) outperforms FFL

Fair FL and Personalisation

- FL trains models directly on client devices and then averages them
- The data distribution of clients in FL is **Non-IID**
- FL models perform worse on heterogeneous clients
- Some clients may have been able to train **better local models**
  - Thus receiving **no benefit** from participating in FL
- **Fair FL**
  - Focuses on clients with high losses during FL aggregation
  - Reduces the variance of the FL model accuracy over clients
- **Personalisation**:
  - Fine-tune the FL model locally
  - Use **KD**, **EWC**, or FreezeBase (**FB**) as regularisers

Personalisation-aware FL (PaFL)

- Fair FL tends to flatten the top of the performance distribution
  - Has difficulties handling clients with very good local models
- PaFl uses regularisers like KD, EWC, FB **during** FL training
  - Allows their weight to **vary across rounds**
  - Maintains the **average** and **peak** performance of the model
    - While allowing training on heterogeneous clients
  - Can pre-empt the personalisation loss used after training
  - Inspired by Quantisation-aware training

Experimental Setup

- Two datasets: **Reddit**, **FEMNIST**
- Train centralised models using:
  - Q-FedAvg or TERM
  - PaFL: FedAvg+EWC/KD after the halfway round of training
- Personalise with KD, EWC, FB, or None
- Eval **delta** between FL/personalised model and fully local models

Fair FL

Fair FL fails to reduce underperforming clients and harms accuracy.

Reddit
- Slight **decrease** in average accuracy

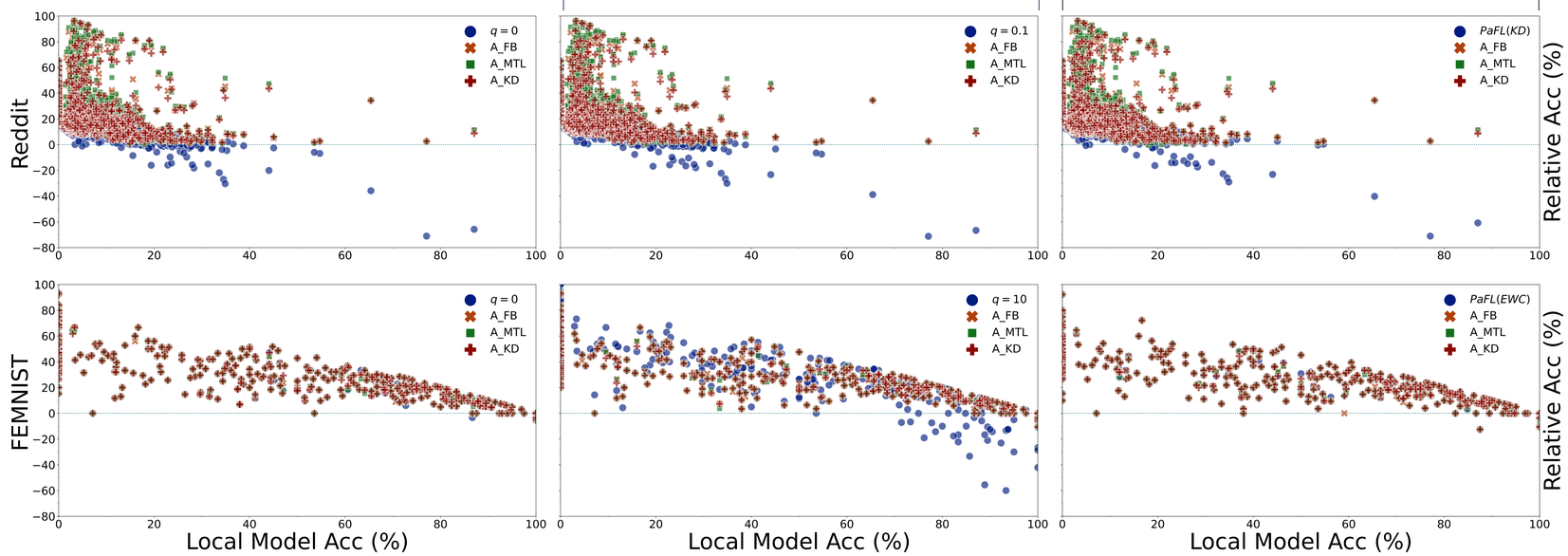
FEMNIST:
- **Doubles** underperforming clients
- Despite **improving** average accuracy

Personalisation-aware FL

PaFL either does not harm the number of underperforming clients or halves it.

Reddit
- **Halves** underperforming clients

FEMNIST:
- Achieves similar average accuracy
- Improves personalisation with EWC



Experimental Results

- **Fair FL** is capable of reducing the variance of the accuracy distribution over clients
  - This leads to decreased performance on certain clients which are capable of training a very high quality local model
  - Thus, it **hurts** the **relative accuracy** distribution by skewing it towards negative values
  - It shows **no benefits** to later personalisation
- **Personalisation-aware Federate Learning (PaFL)** provides an alternative which:
  - Allows training on heterogeneous clients while maintaining performance on the federated distribution
  - Leads to equivalent or **higher** accuracy on a centralised test-set representative of the federated distribution
  - May **reduce** the number of underperforming clients by up to **50%** and thus the need for personalisation