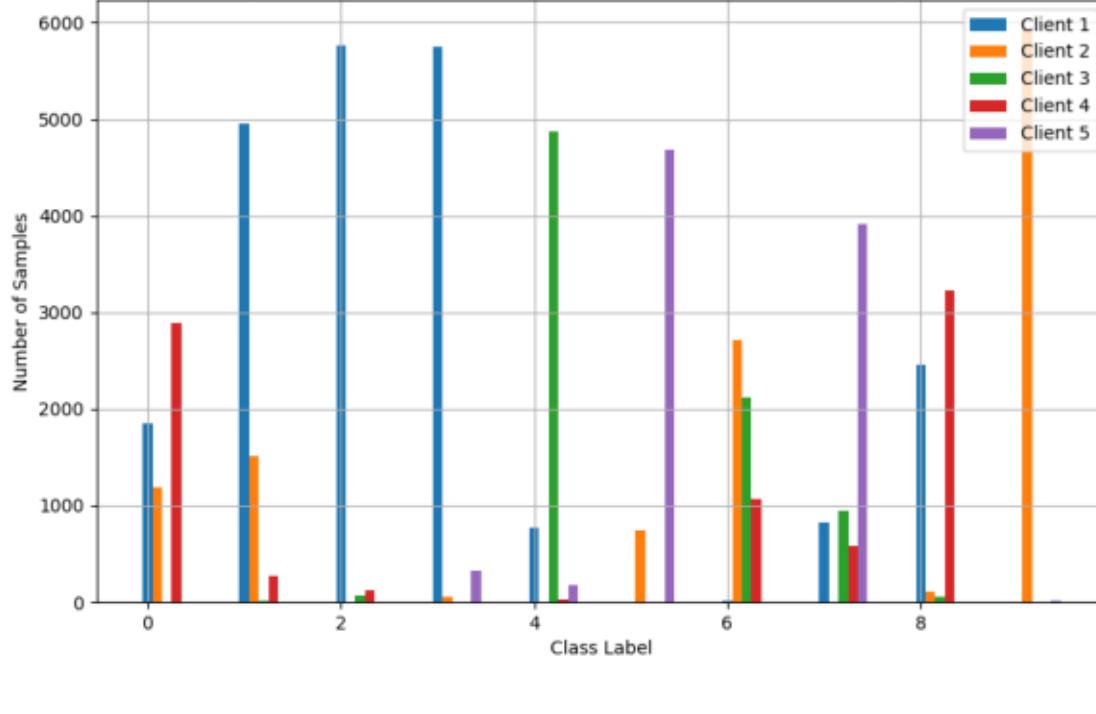


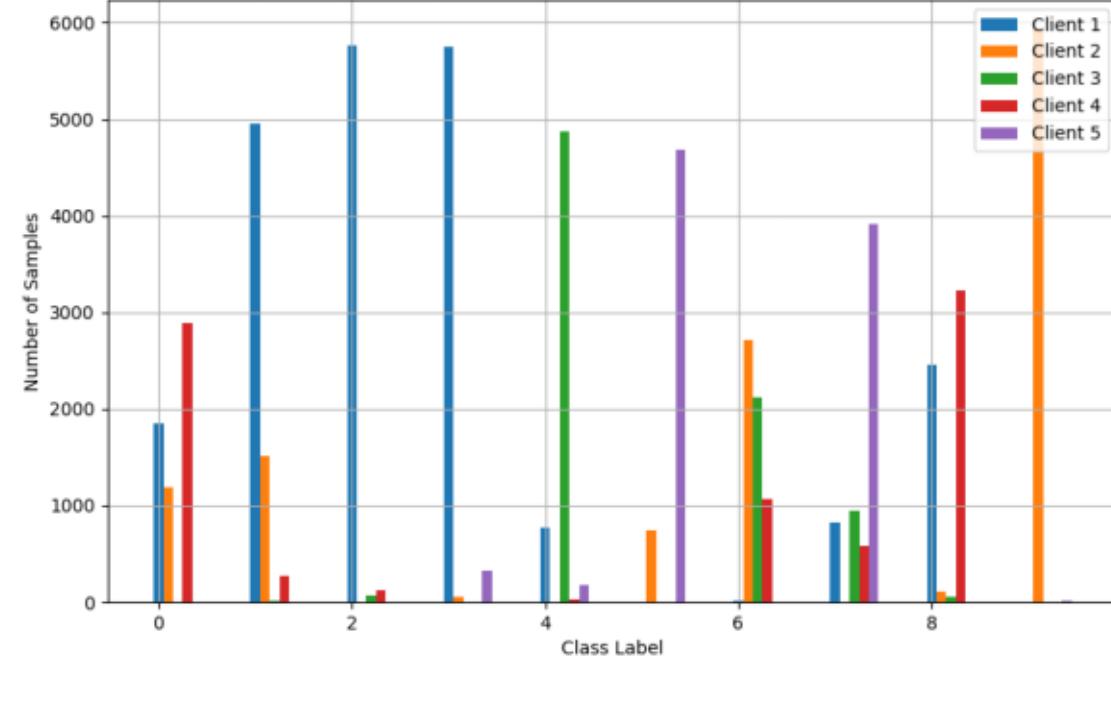
## Experiment 1 (Dirichlet alpha=0.1, 5 clients, 50 epoch)

In this experiment, we used 5 clients with Dirichlet partition ( $\alpha=0.1$ ).  
 The Accuracy of FedGM reached [91.26, 86.91, 91.57, 93.79, 91.91] for each client.  
 The Accuracy of FedAvg reached [93.76, 87.05, 92.92, 88.42, 90.88] for each client.

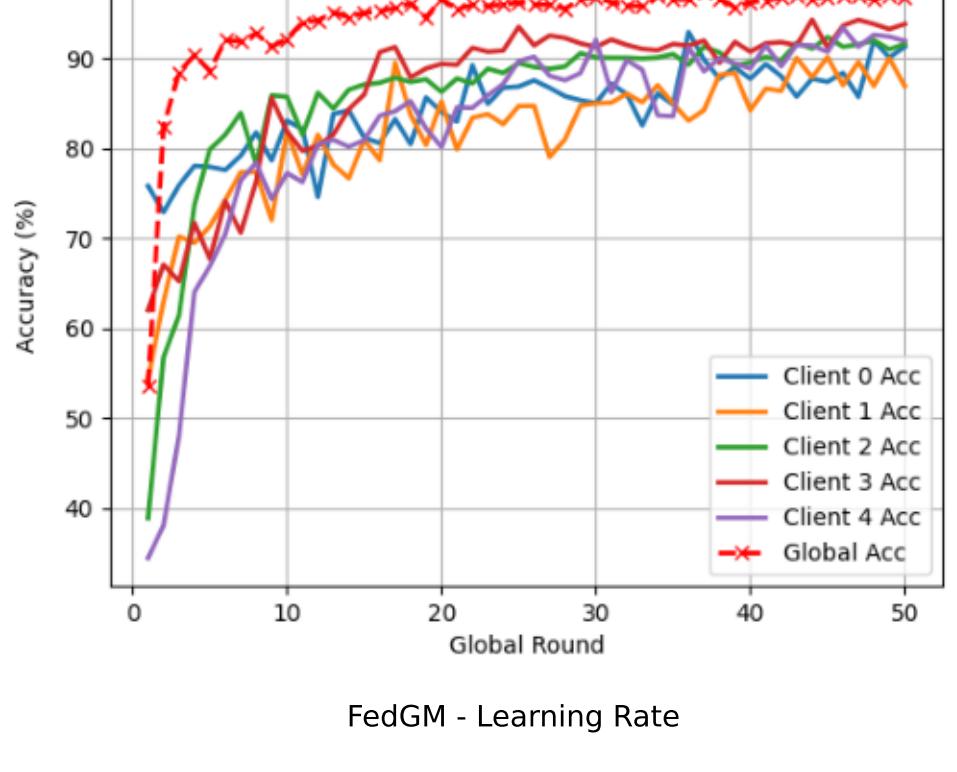
FedGM - Data Distribution



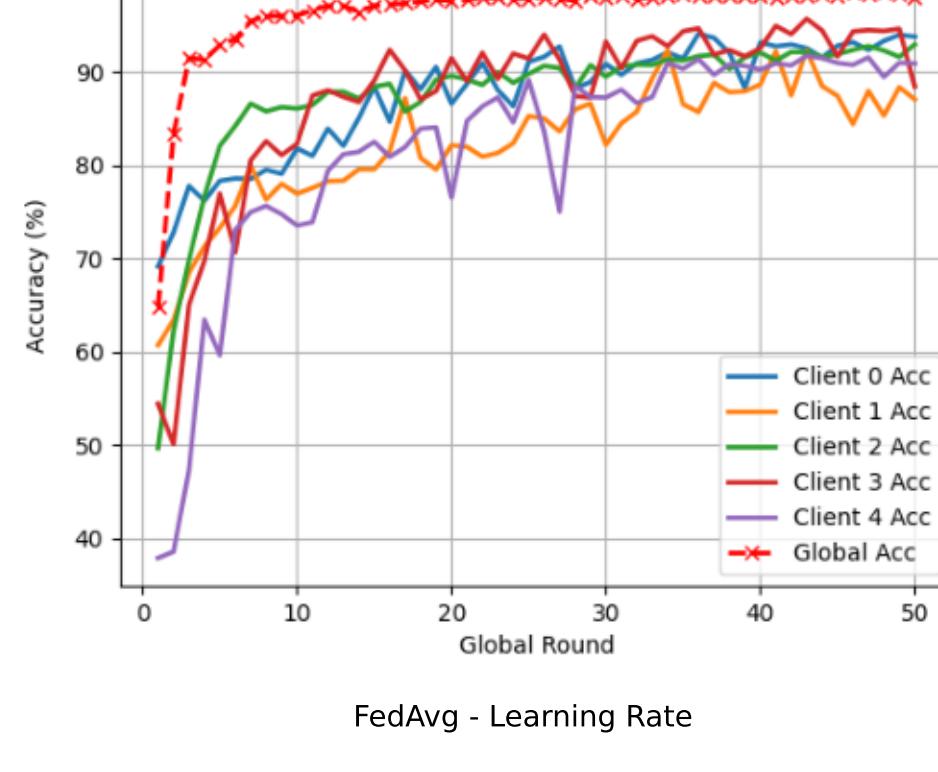
FedAvg - Data Distribution



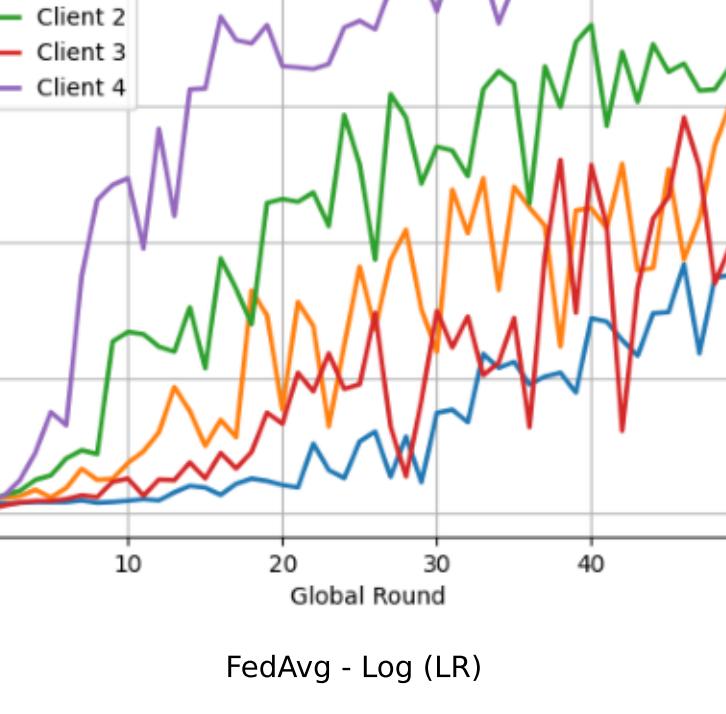
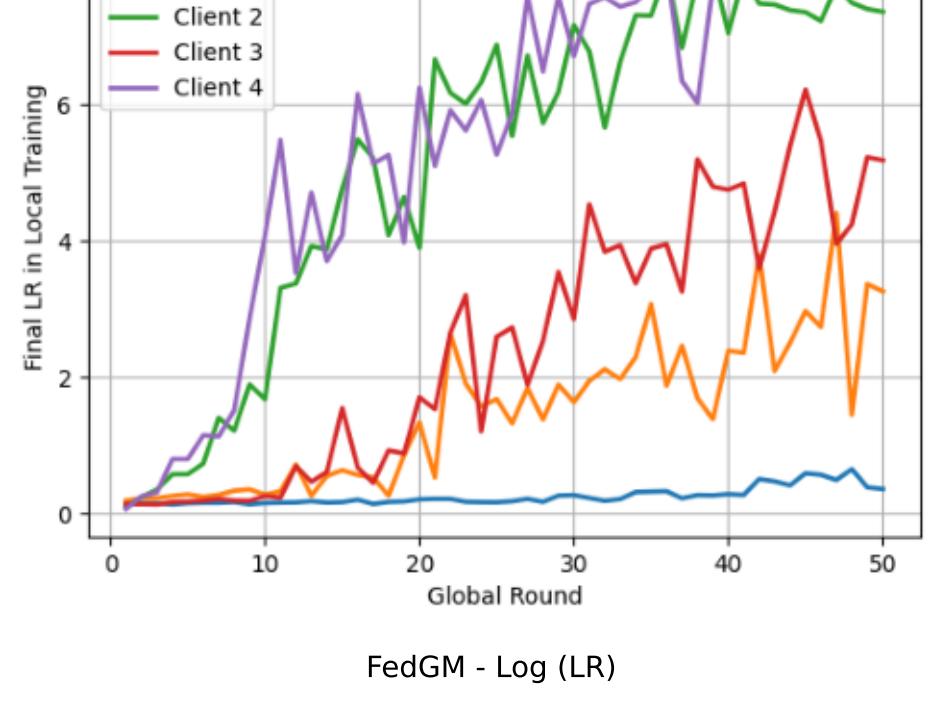
FedGM - Accuracy



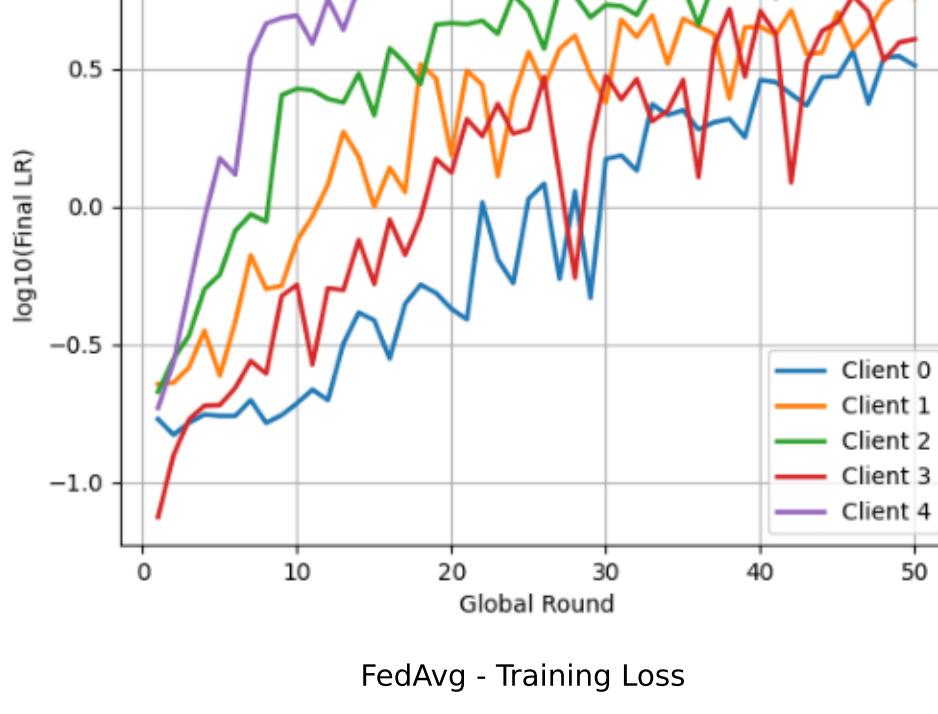
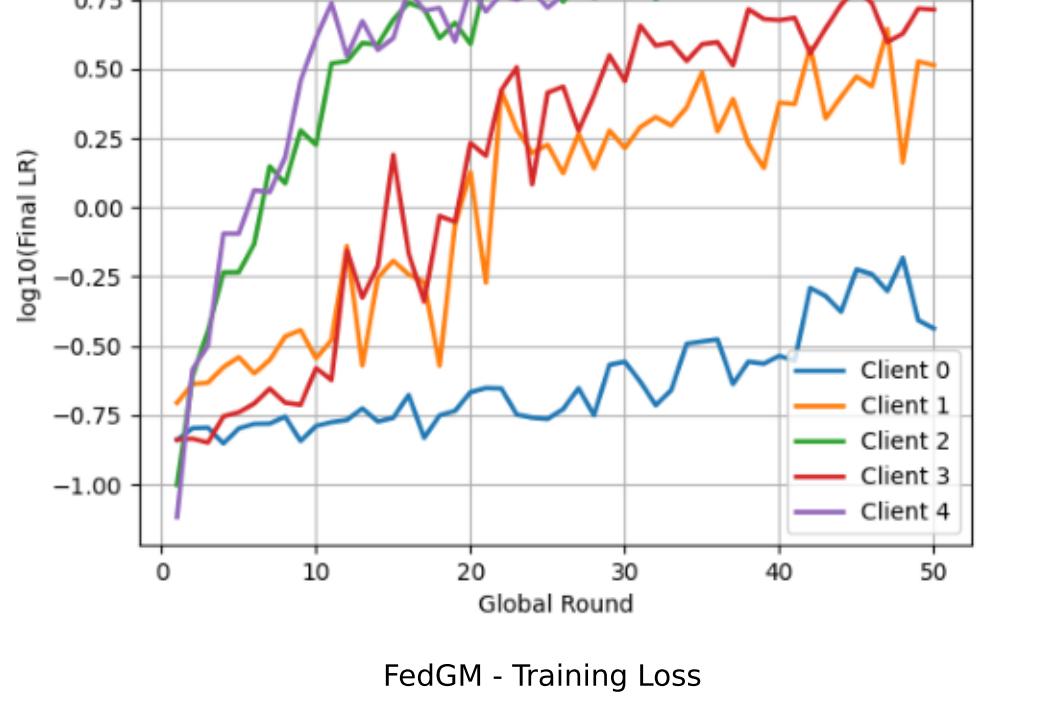
FedAvg - Accuracy



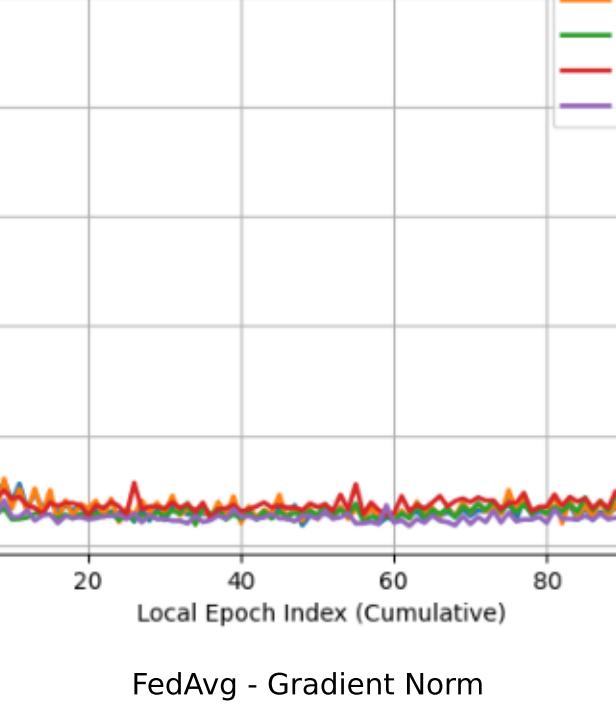
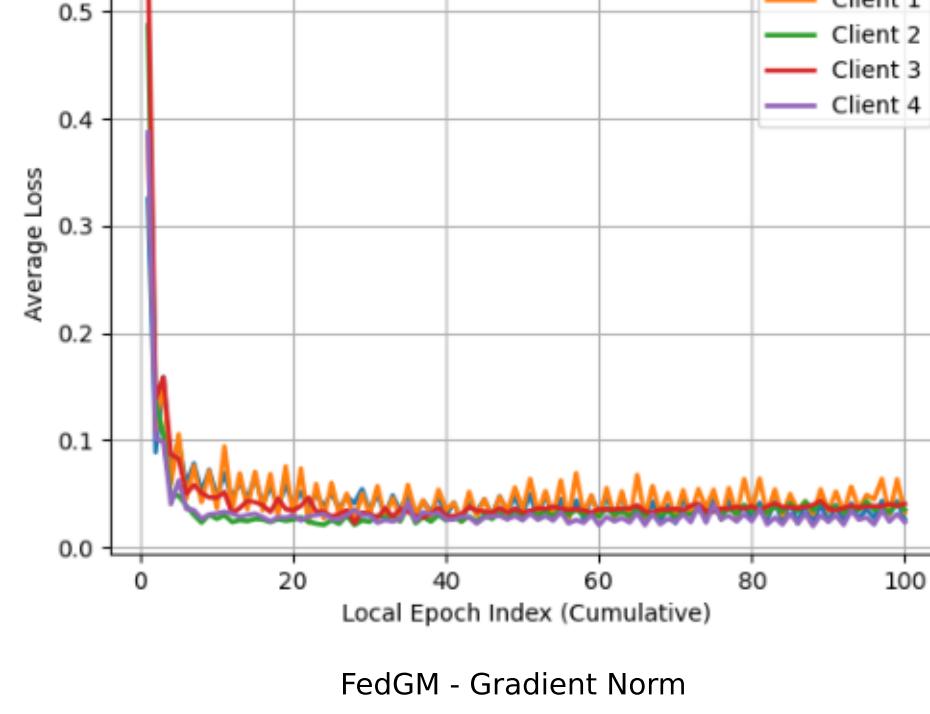
FedGM - Learning Rate



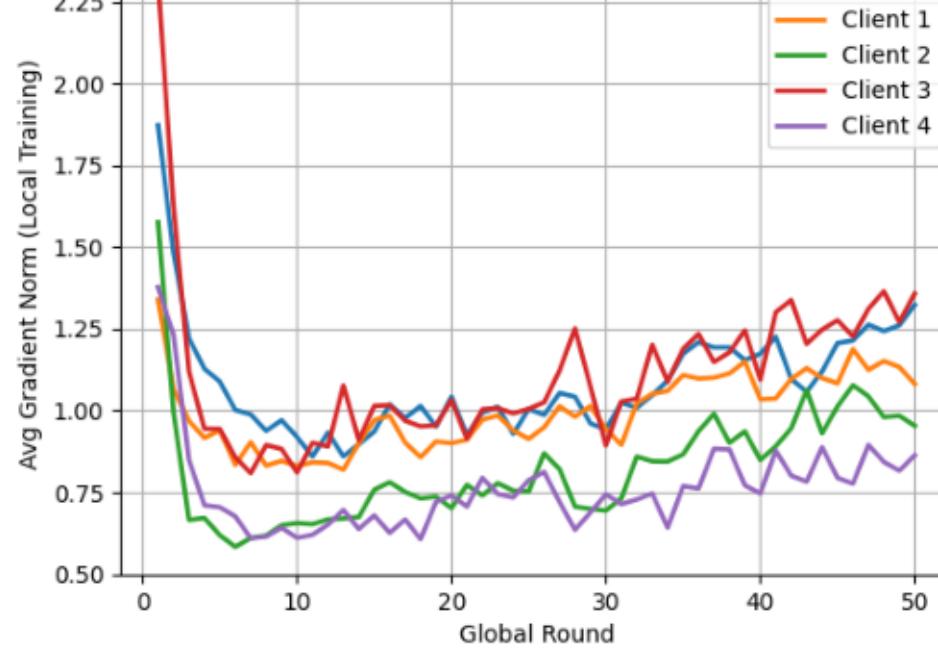
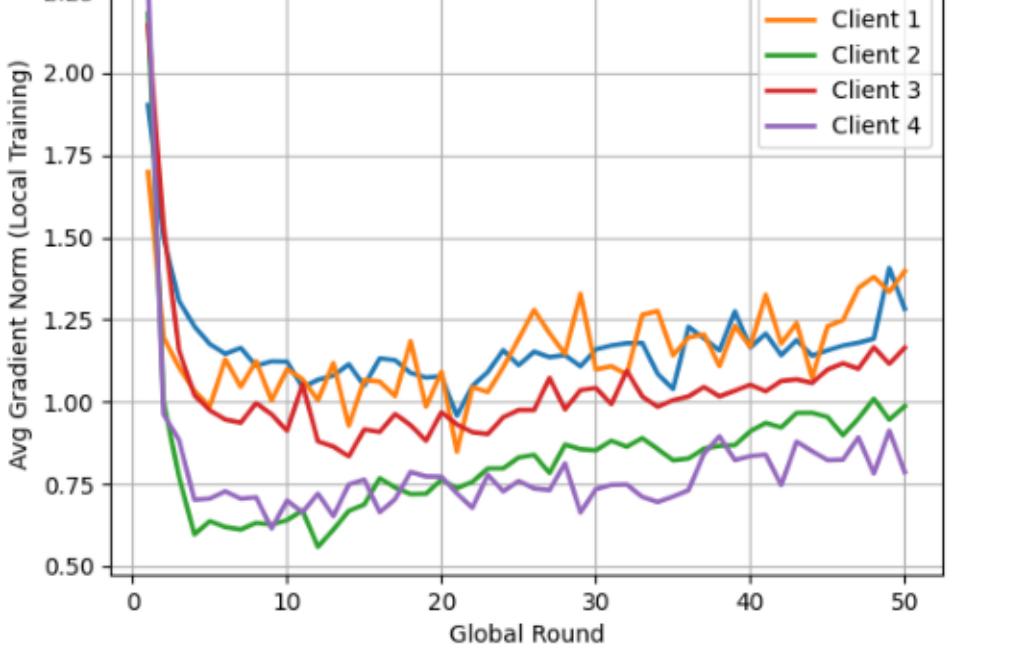
FedGM - Log (LR)



FedGM - Training Loss



FedGM - Gradient Norm



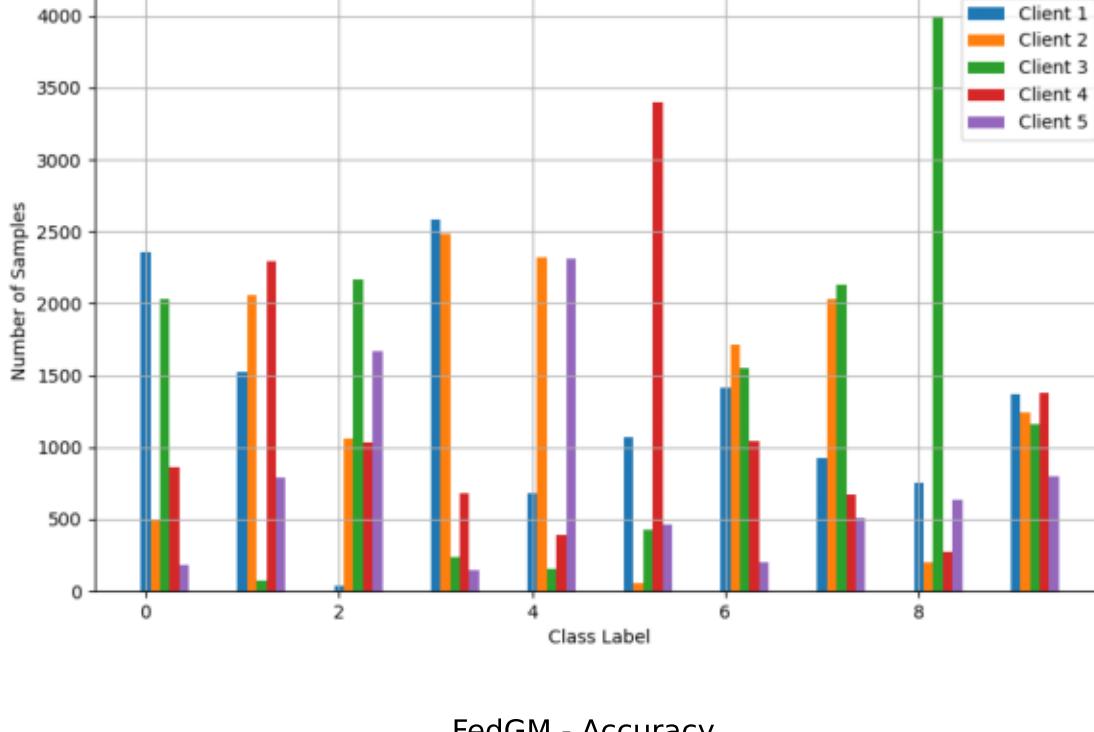
## Experiment 2 (Mild nonIID alpha=1, 5 clients, 50 epoch)

In this experiment, data is mild non IID across 5 clients.

The Accuracy of FedGM reached [98.91, 98.81, 98.83, 98.91, 98.99] for each client.

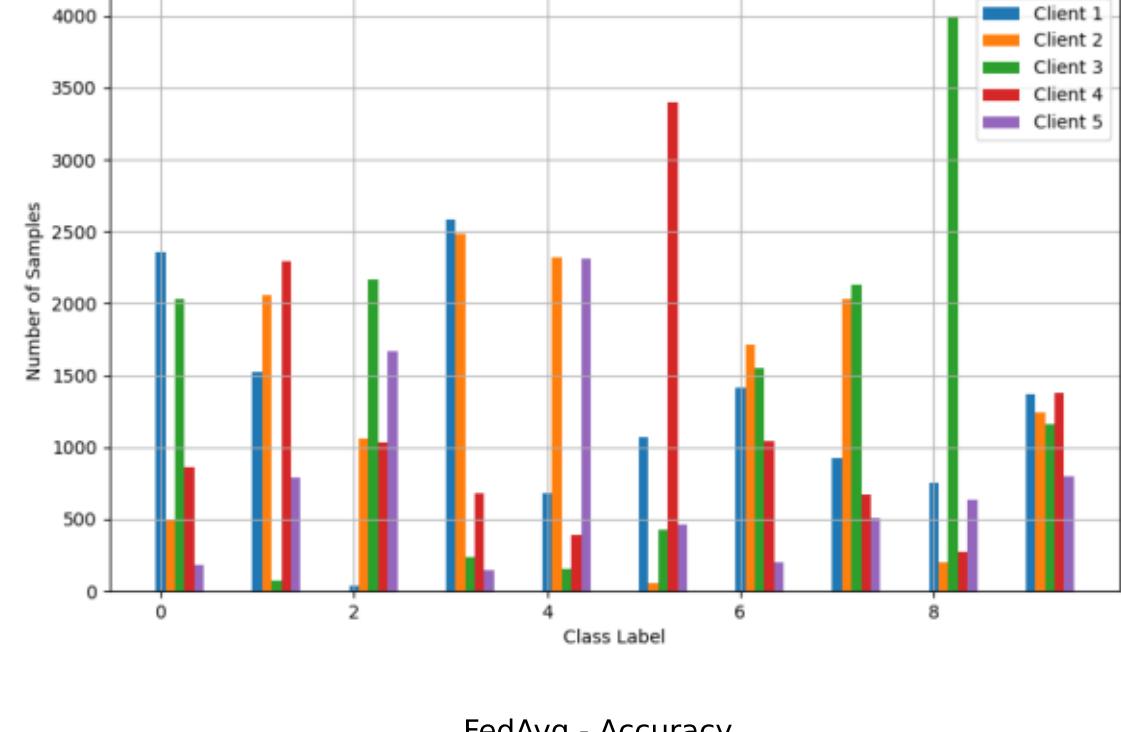
The Accuracy of FedAvg reached [98.99, 99.02, 98.70, 98.91, 98.93] for each client.

FedGM - Data Distribution

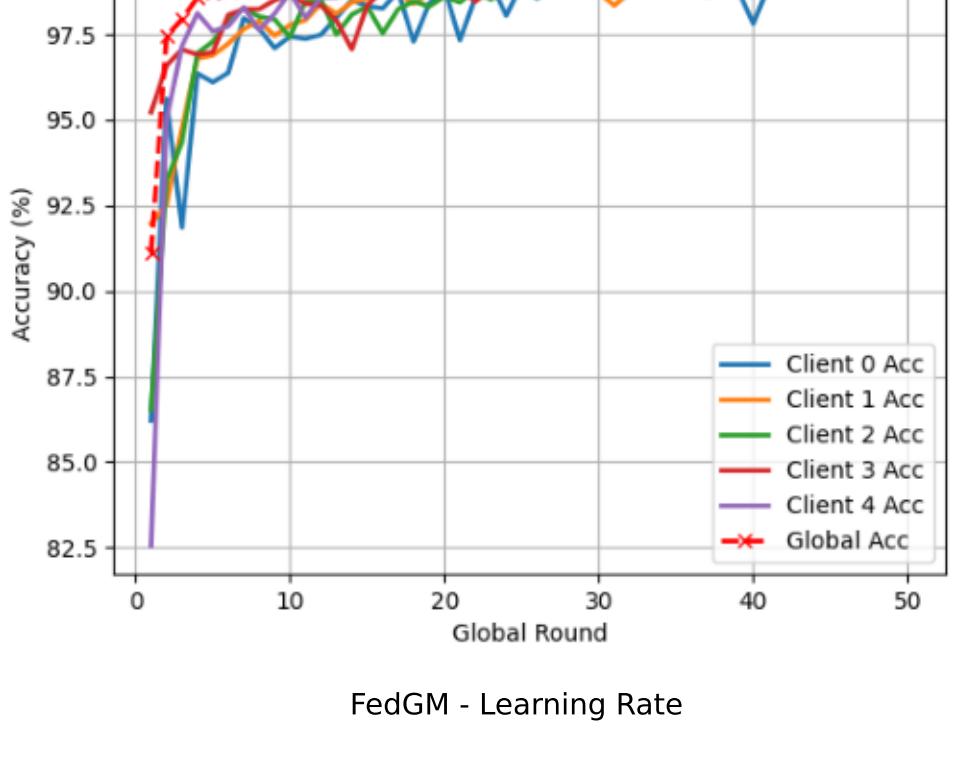


FedGM - Accuracy

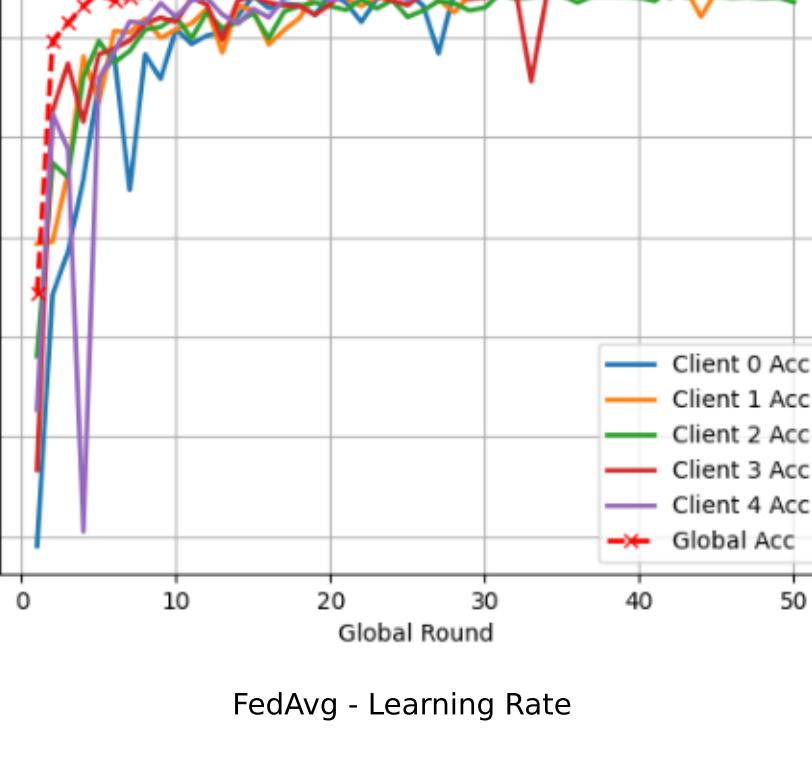
FedAvg - Data Distribution



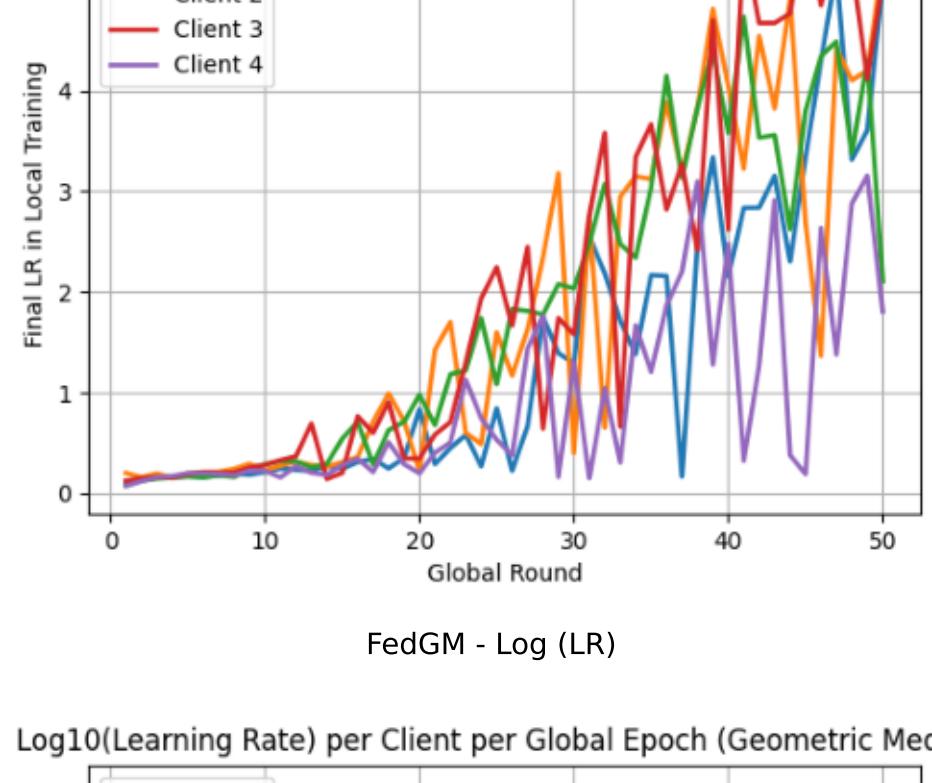
FedAvg - Accuracy



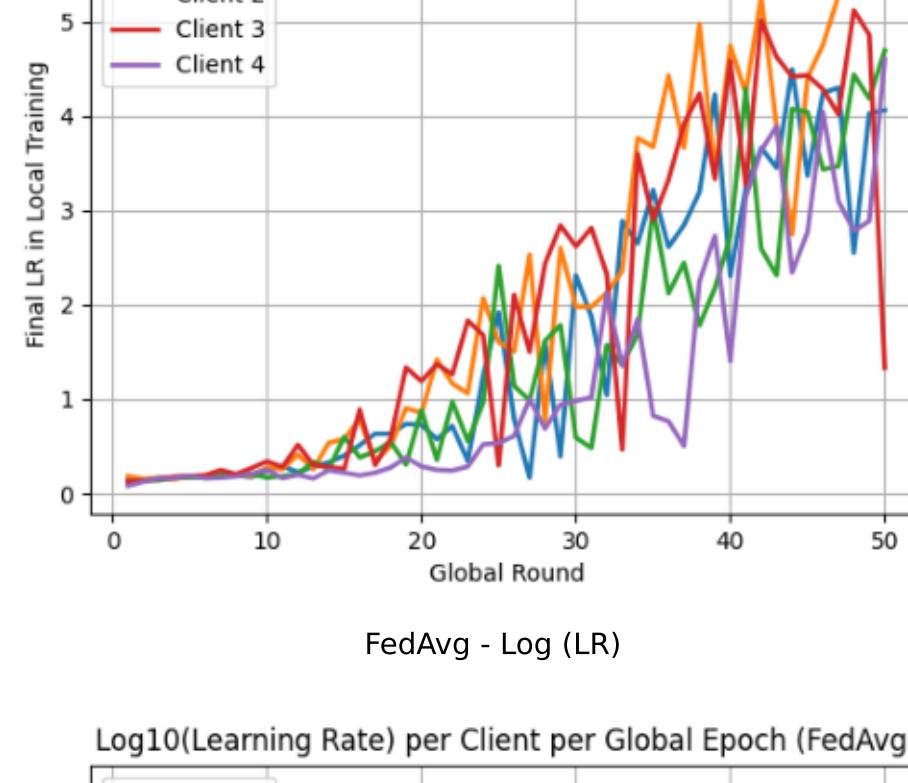
FedGM - Learning Rate



FedAvg - Learning Rate



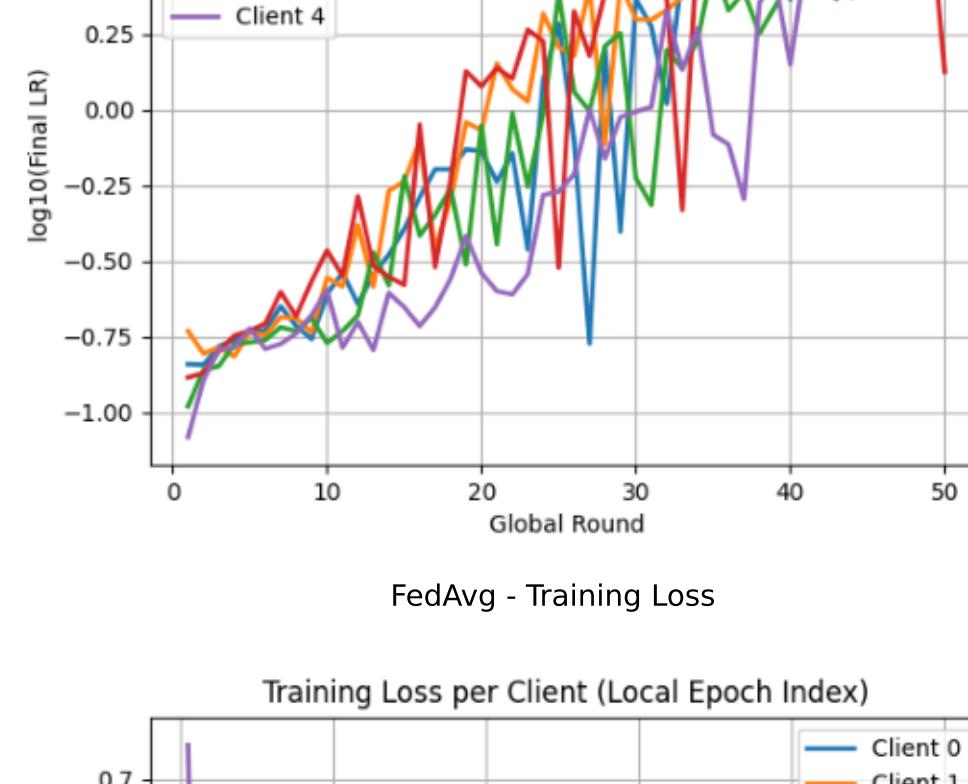
FedGM - Log (LR)



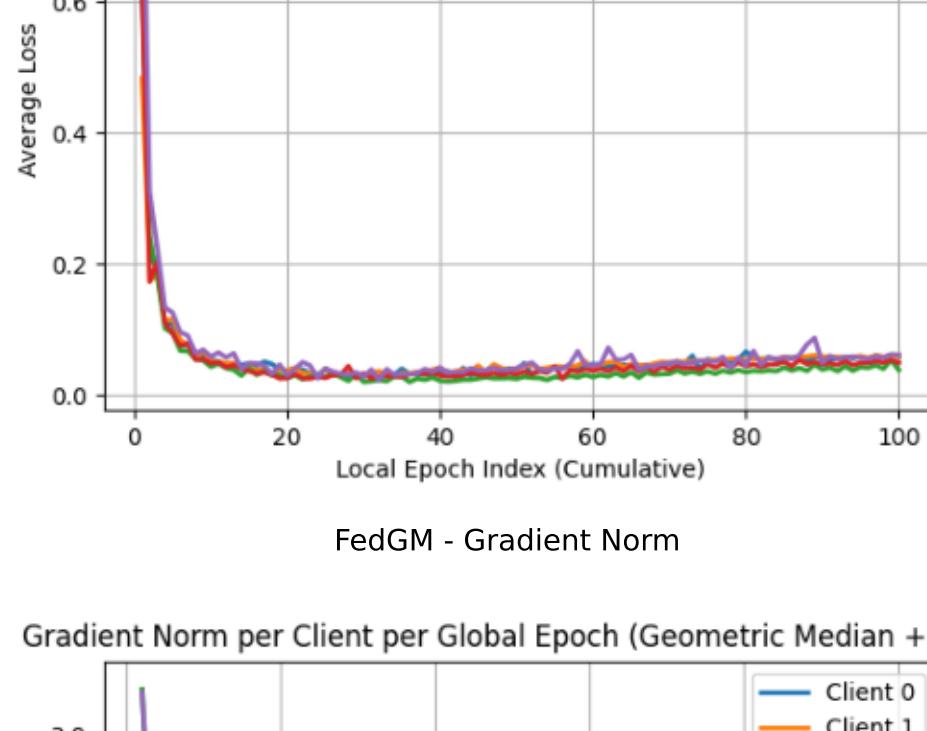
FedAvg - Log (LR)



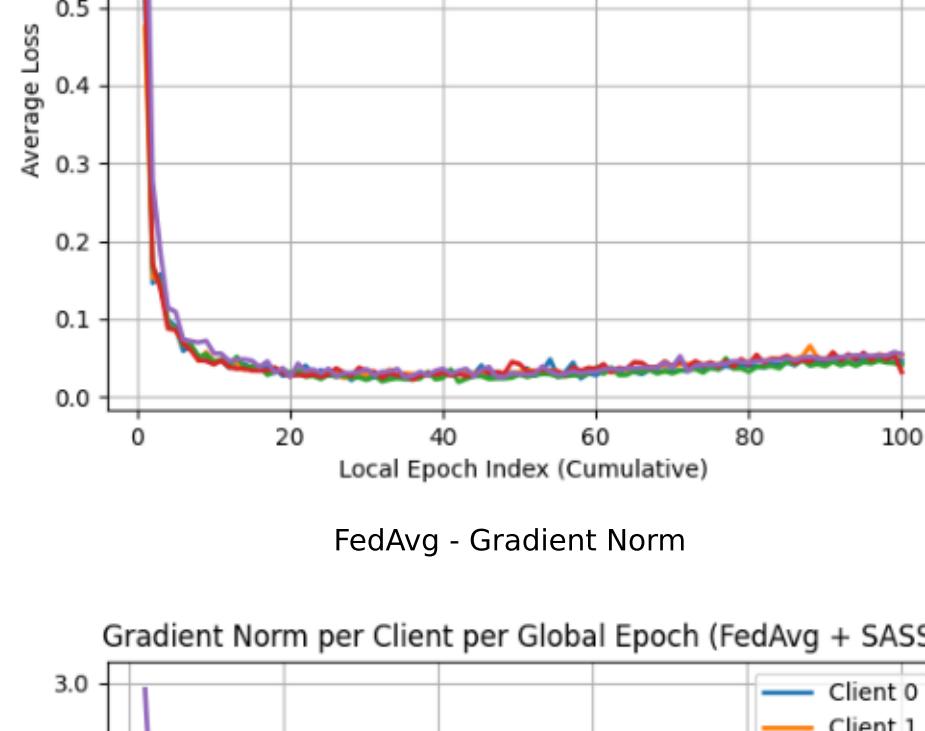
FedGM - Training Loss



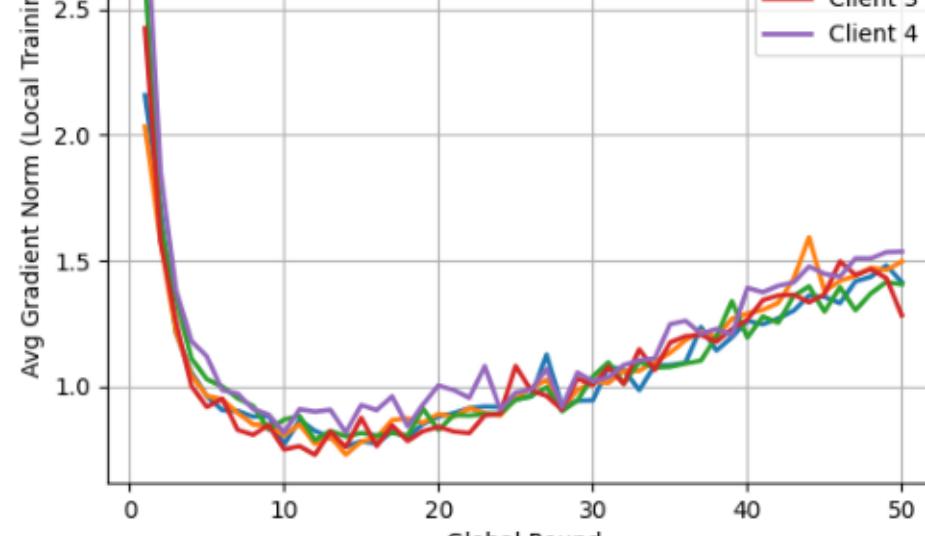
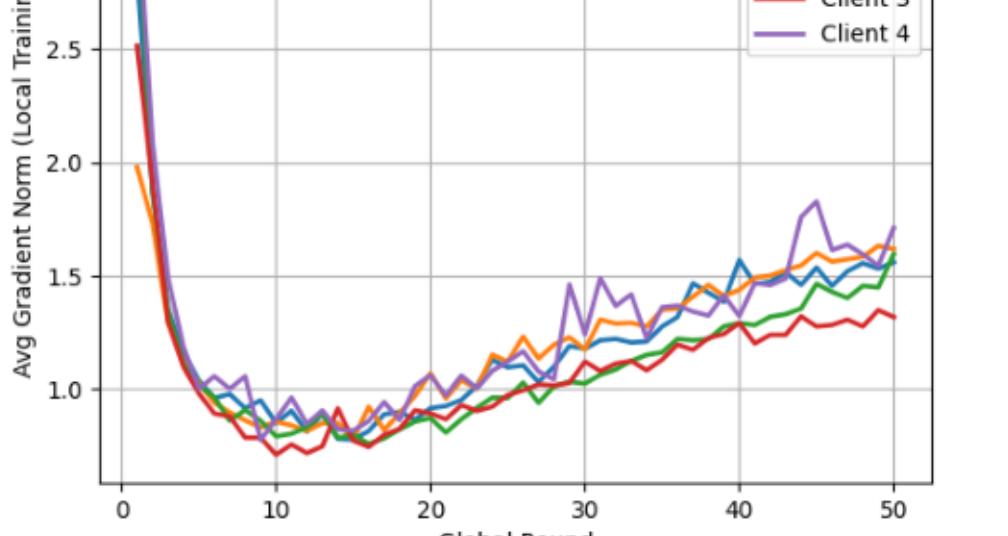
FedAvg - Training Loss



FedGM - Gradient Norm



FedAvg - Gradient Norm



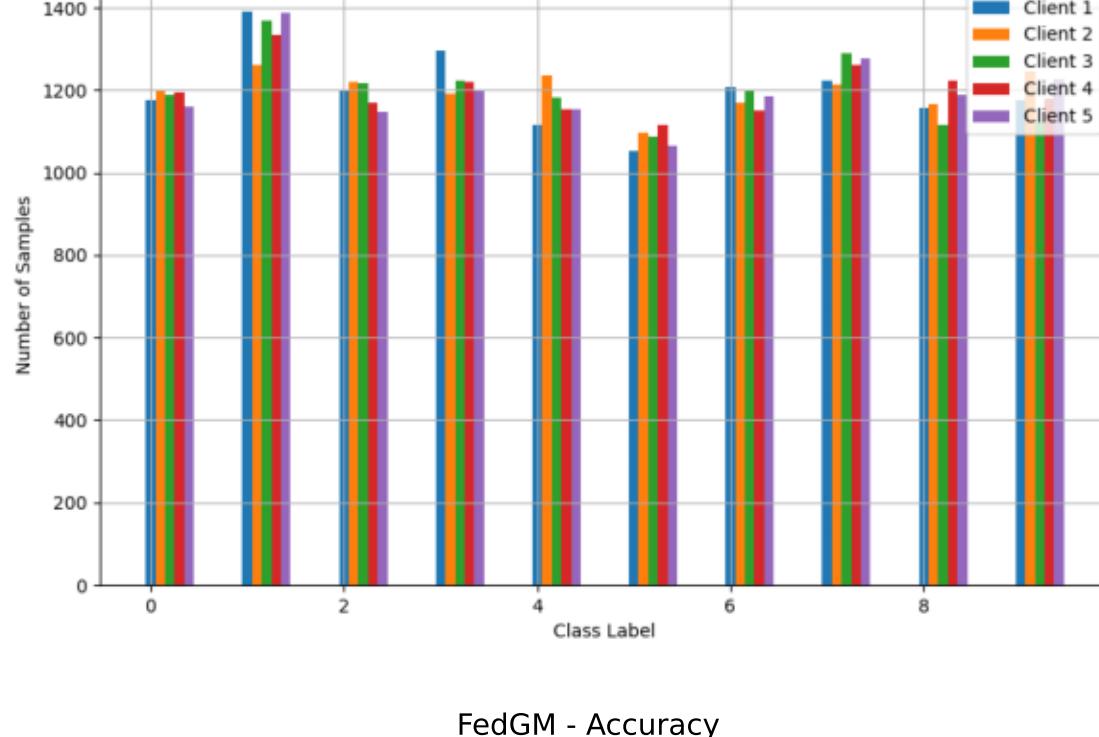
### Experiment 3 (IID alpha=1, 5 clients, 50 epoch)

In this experiment, data is IID across 5 clients.

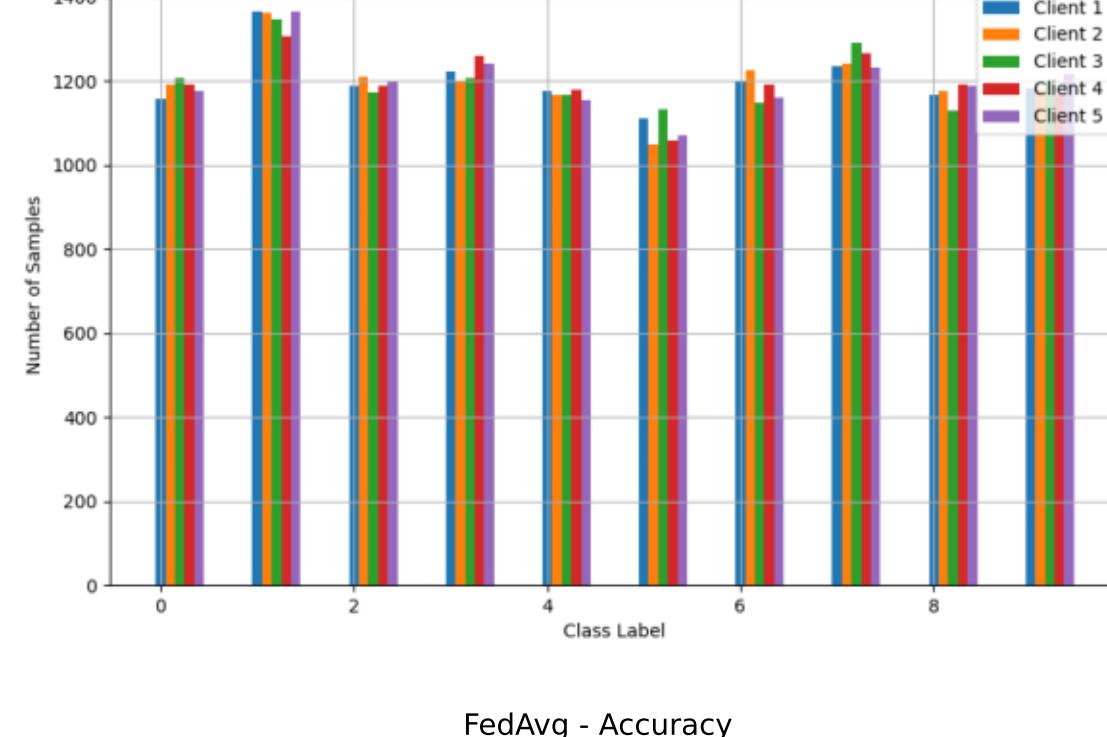
The Accuracy of FedGM reached [99.02, 99.07, 99.01, 99.08, 99.12] for each client.

The Accuracy of FedAvg reached [99.22, 99.19, 99.24, 99.25, 99.17] for each client.

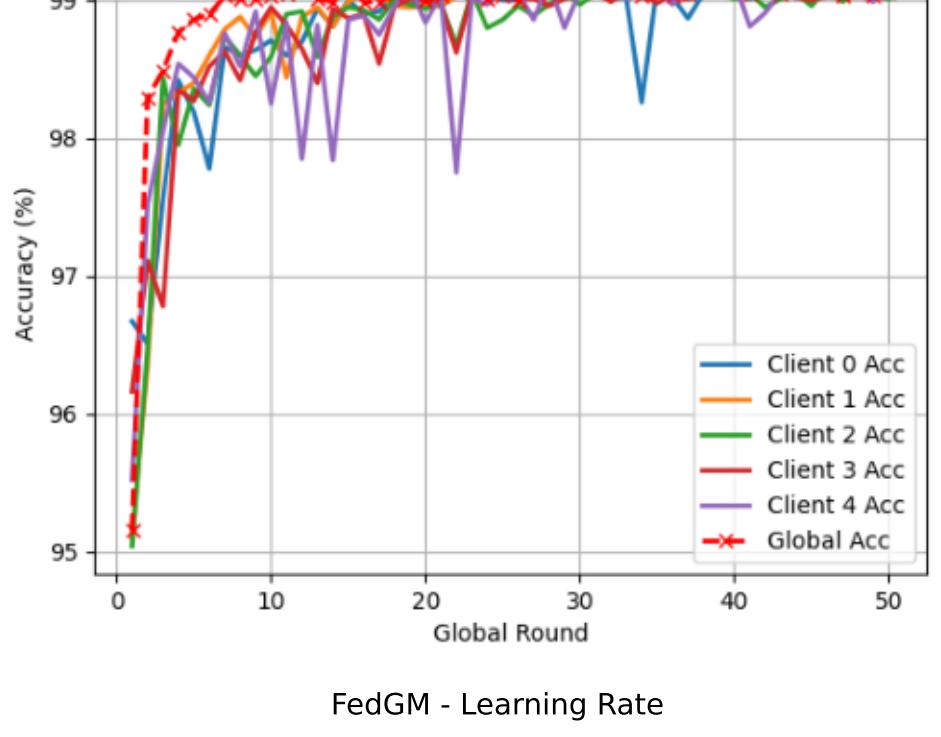
FedGM - Data Distribution



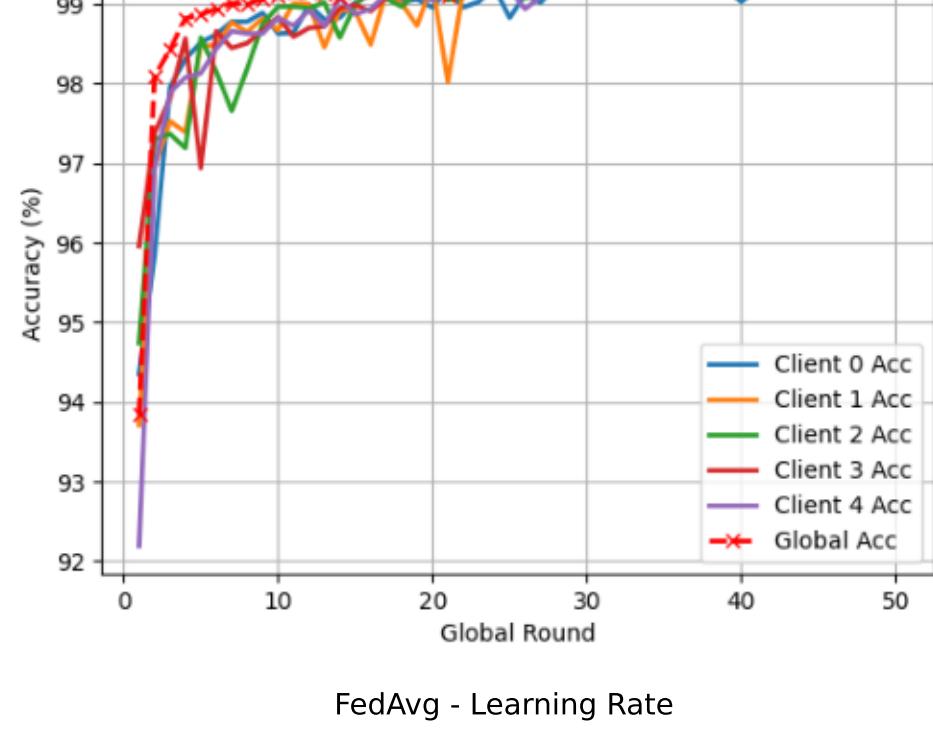
FedAvg - Data Distribution



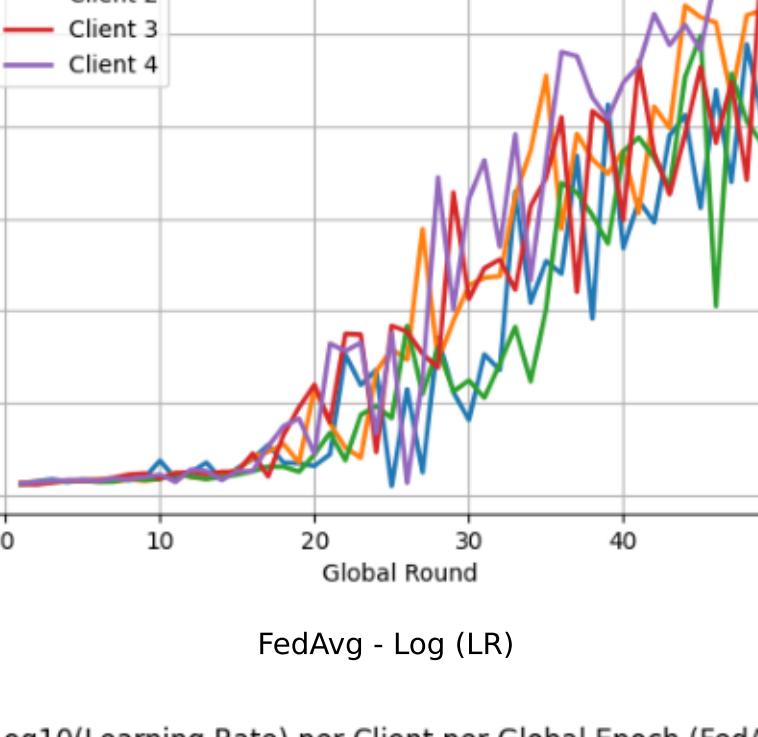
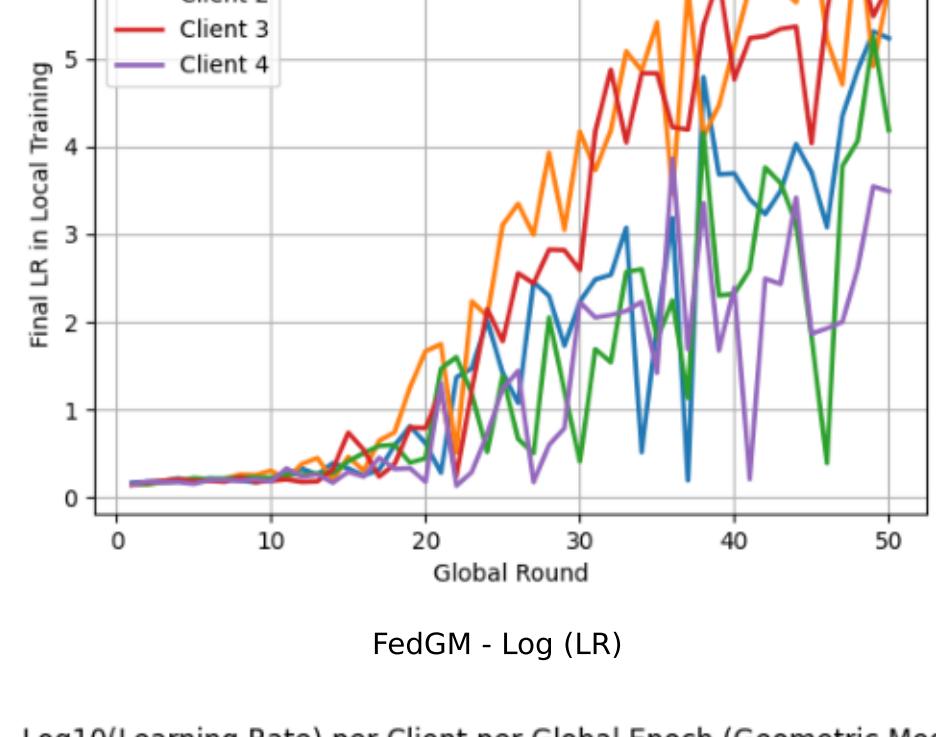
FedGM - Accuracy



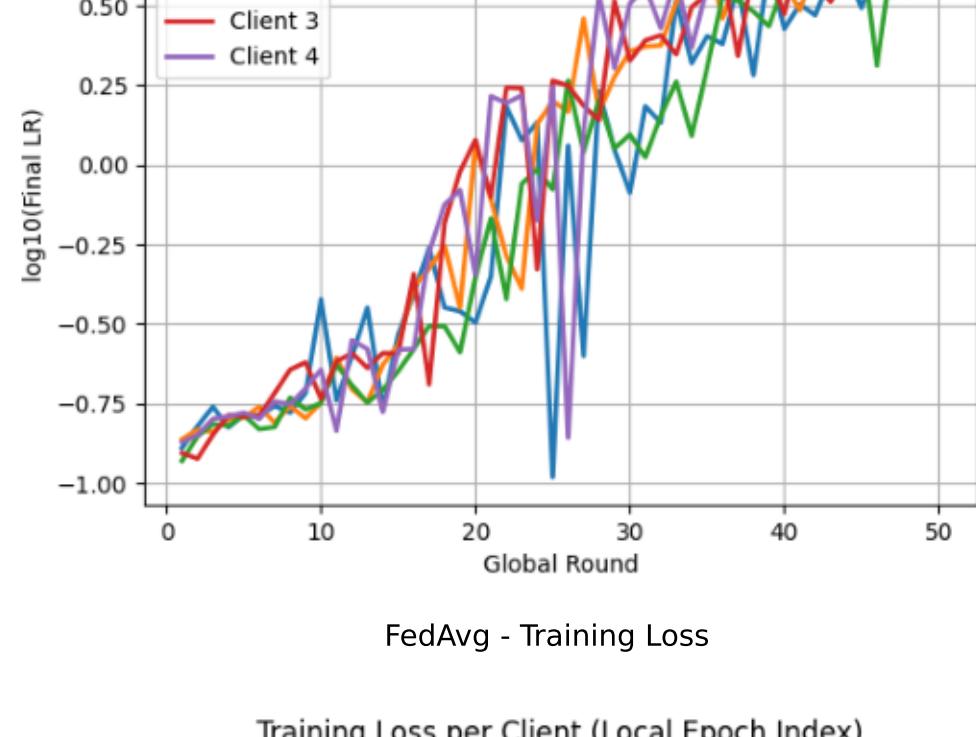
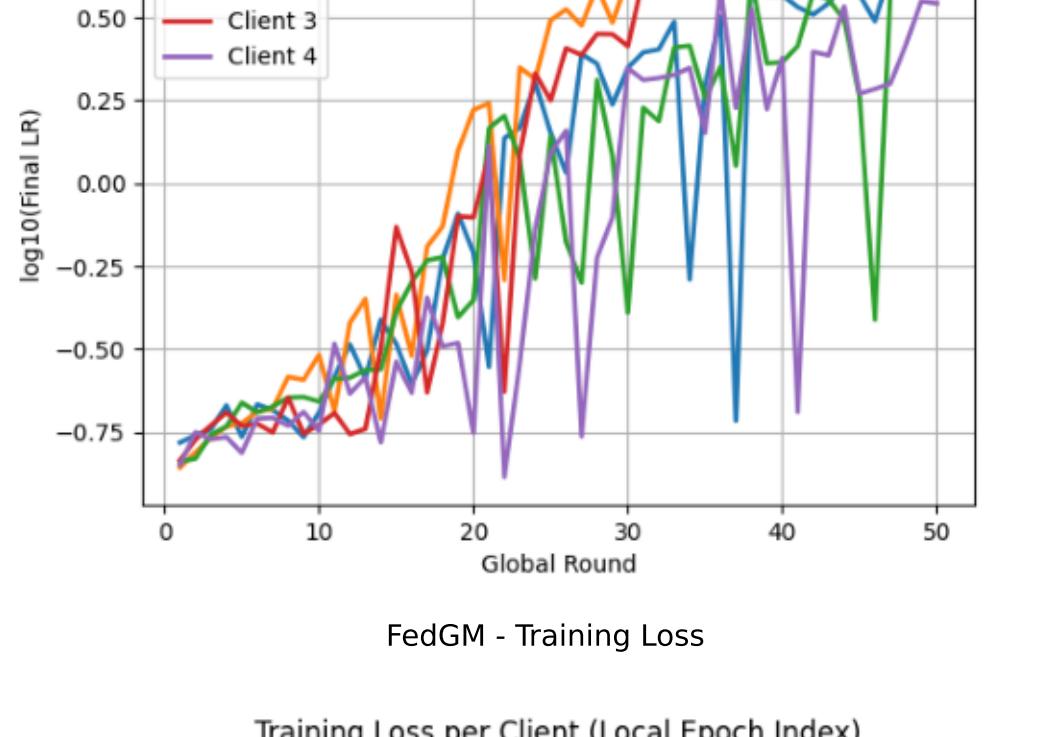
FedAvg - Accuracy



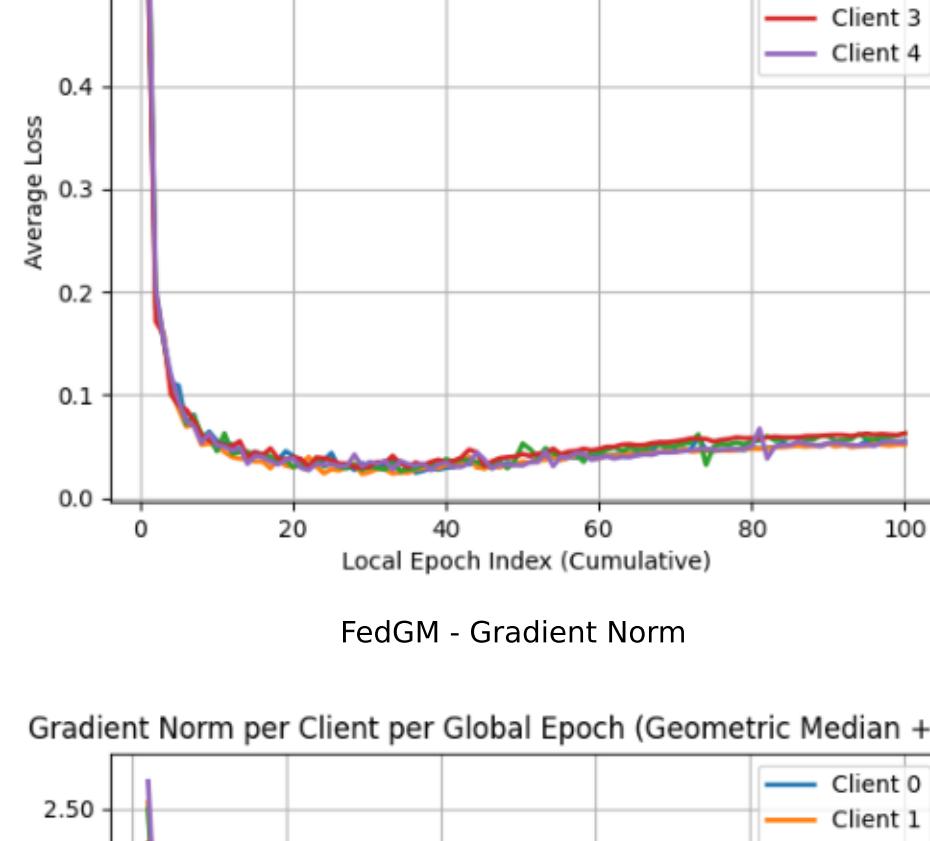
FedGM - Learning Rate



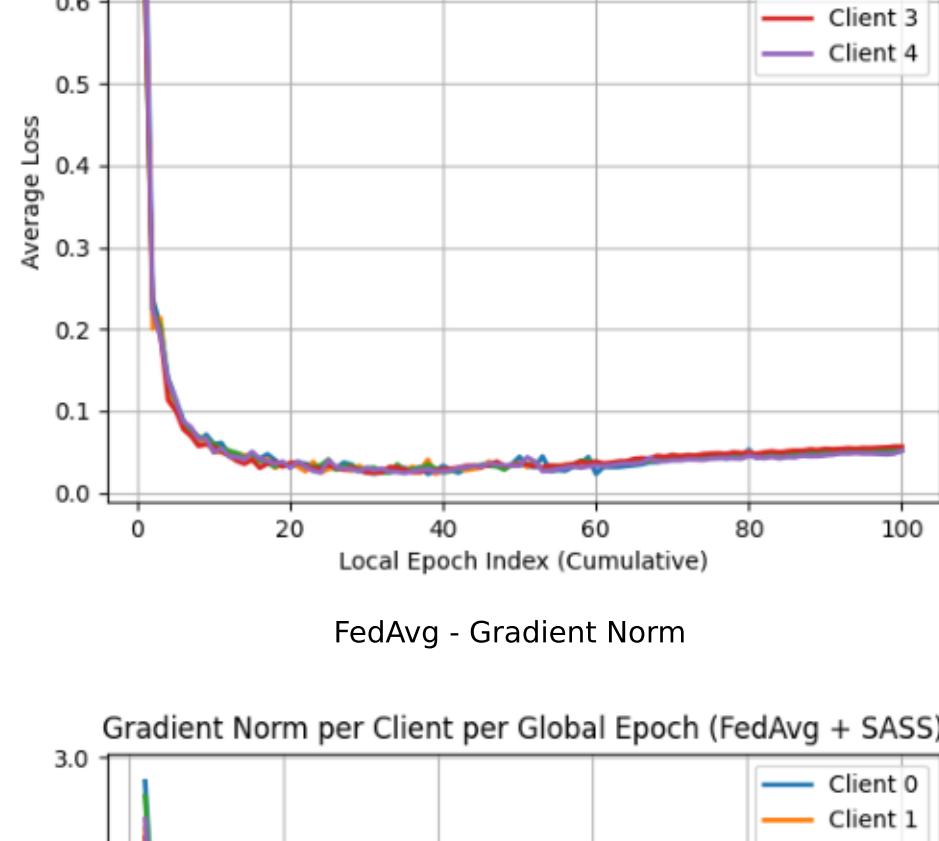
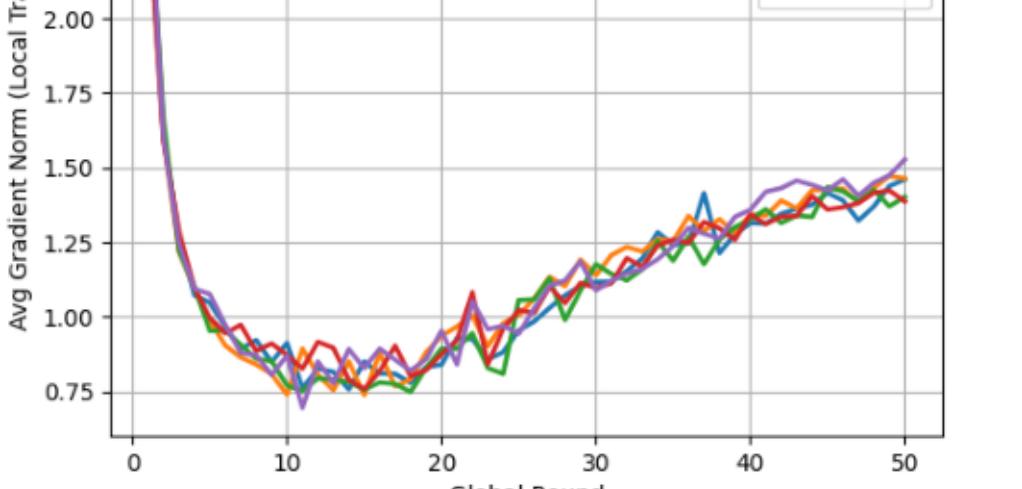
FedGM - Log (LR)



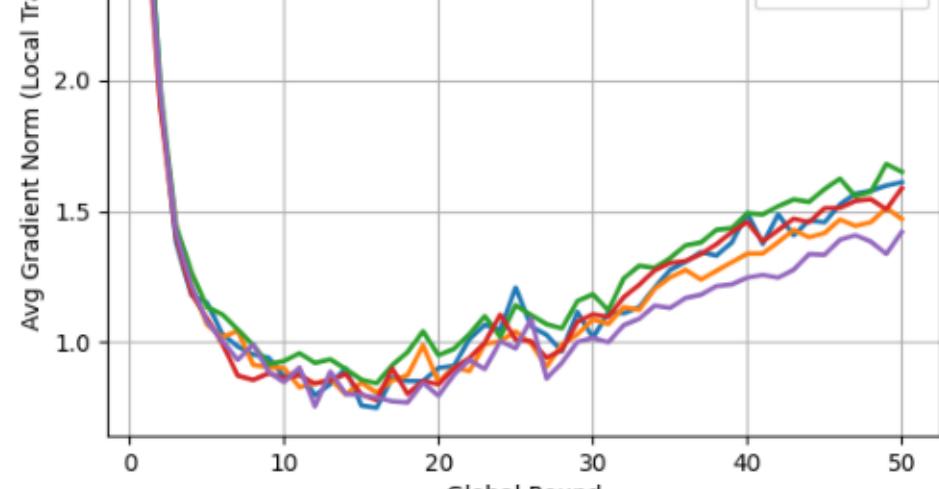
FedGM - Training Loss



FedGM - Gradient Norm



FedAvg - Gradient Norm



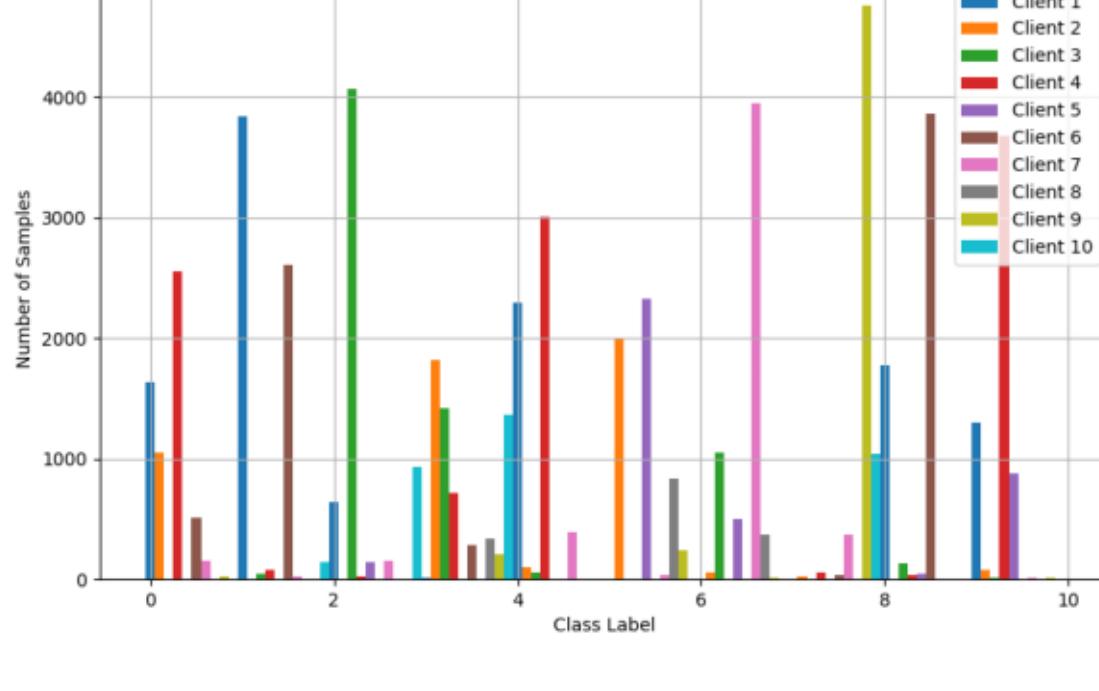
## Experiment 4 (Extreme nonIID alpha=0.1, 10 clients, 50 epoch)

In this experiment, data is extreme non IID across 10 clients.

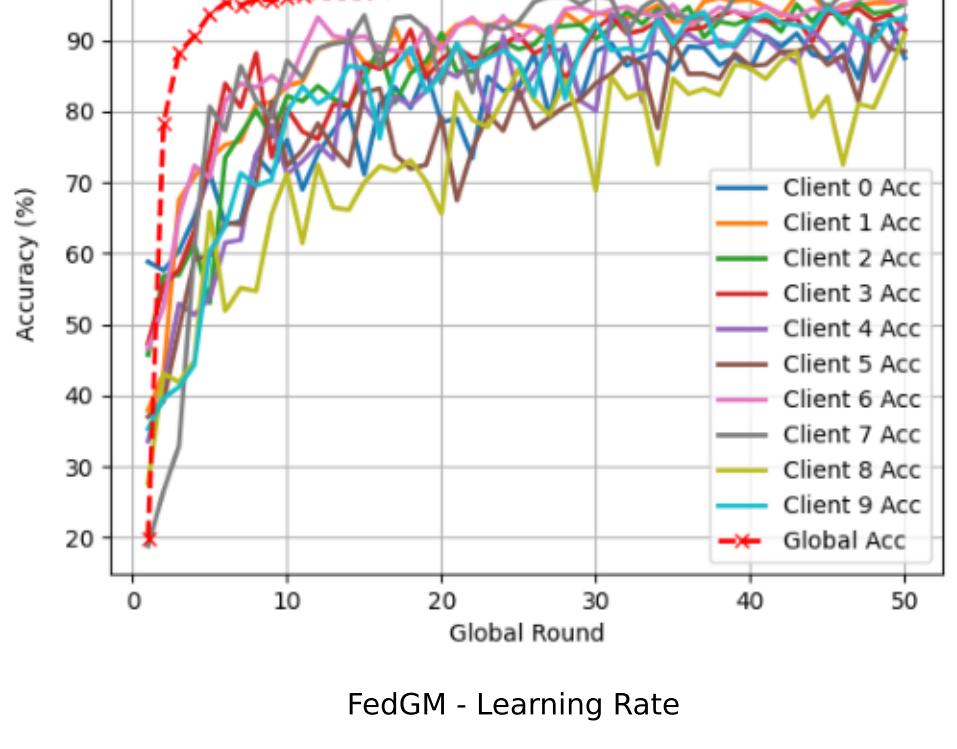
The Accuracy of FedGM reached [87.54, 95.99, 95.14, 91.45, 93.41, 88.45, 95.29, 97.55, 90.87, 93.10] for each client.

The Accuracy of FedAvg reached [91.89, 95.84, 92.66, 94.90, 95.62, 85.69, 96.12, 95.69, 83.98, 96.90] for each client.

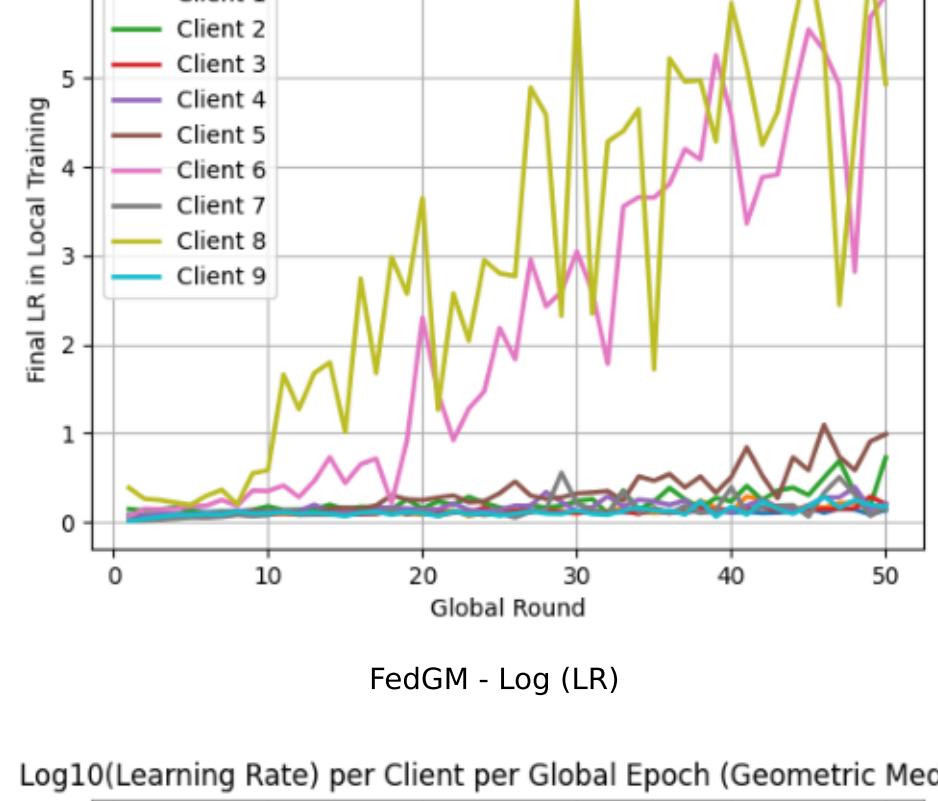
FedGM - Data Distribution



FedGM - Accuracy



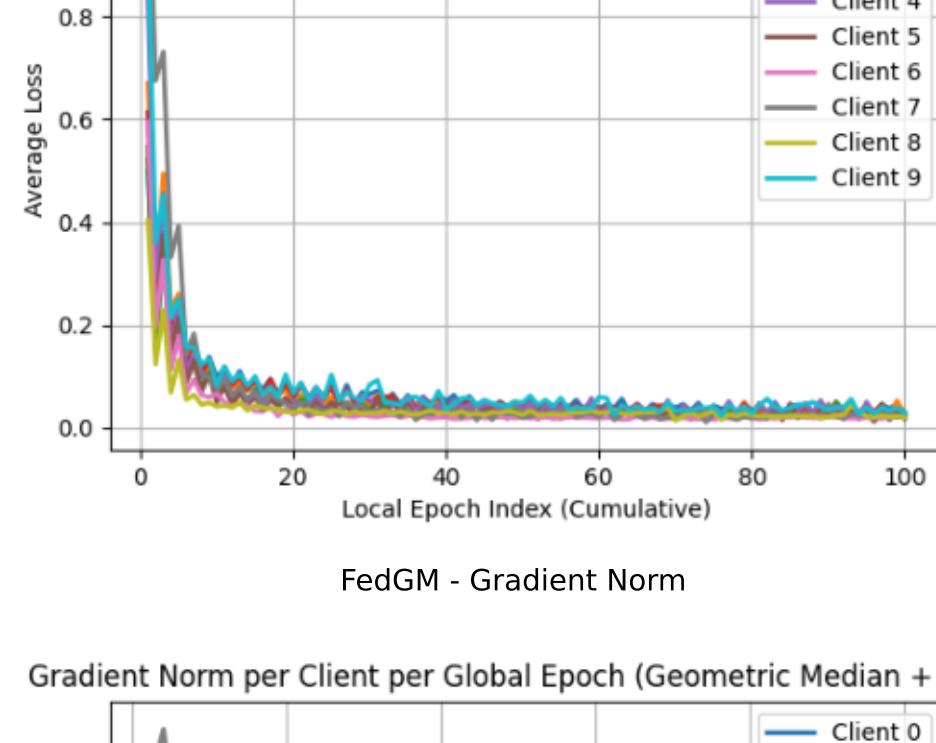
FedGM - Learning Rate



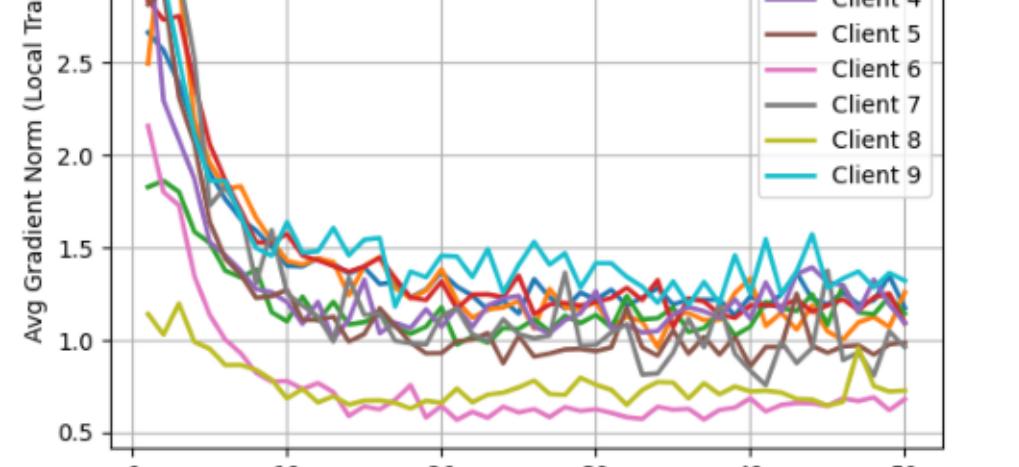
FedGM - Log (LR)



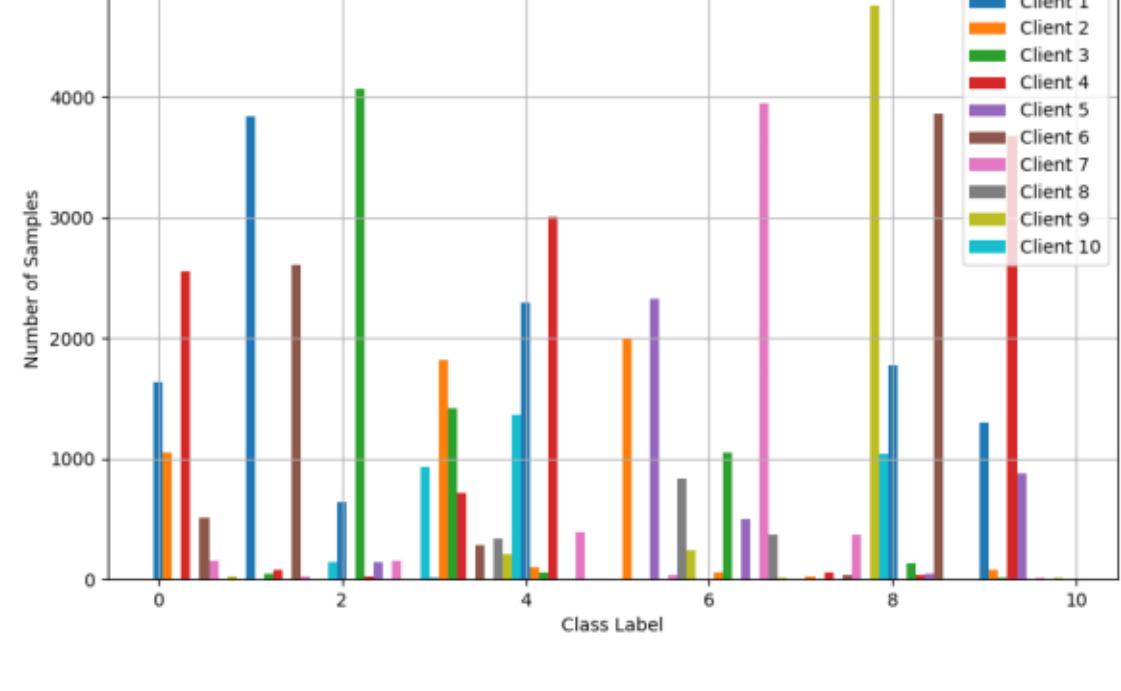
FedGM - Training Loss



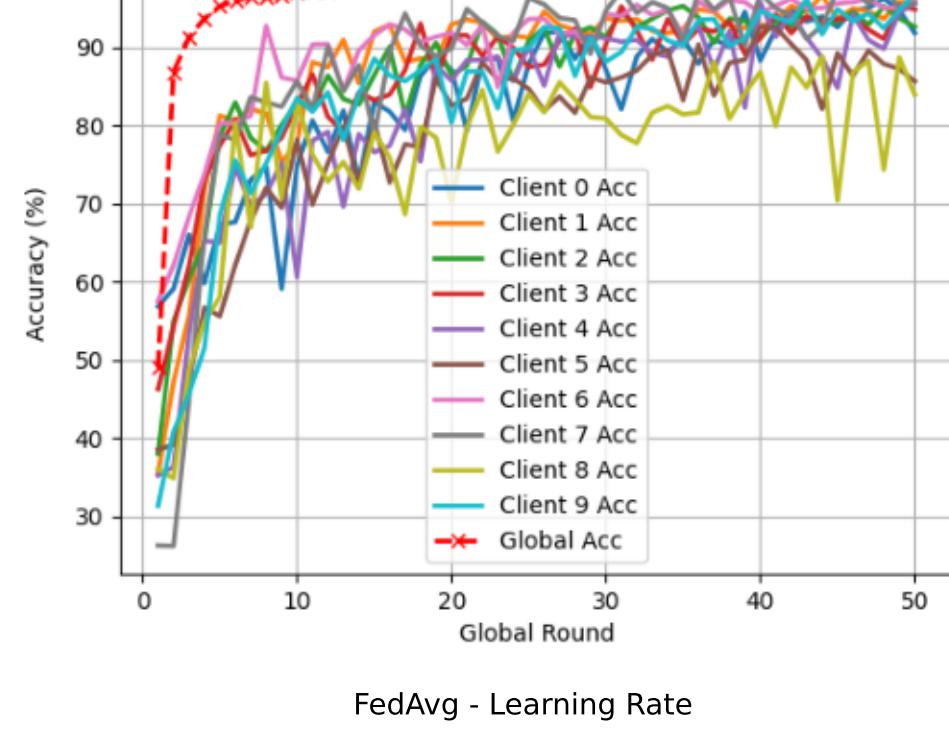
FedGM - Gradient Norm



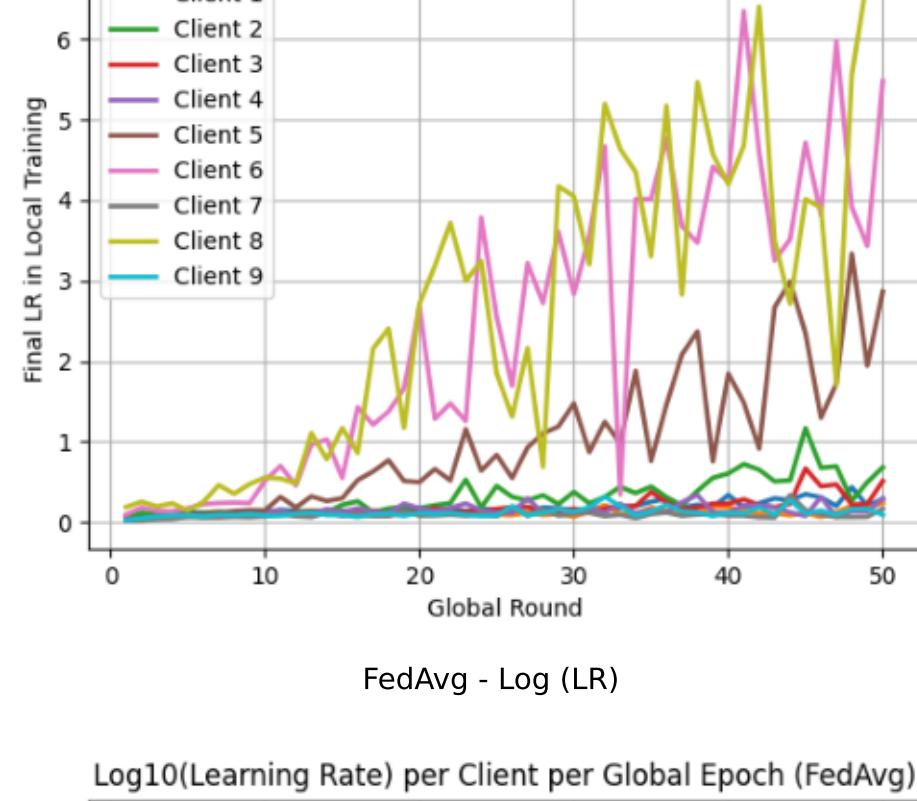
FedAvg - Data Distribution



FedAvg - Accuracy



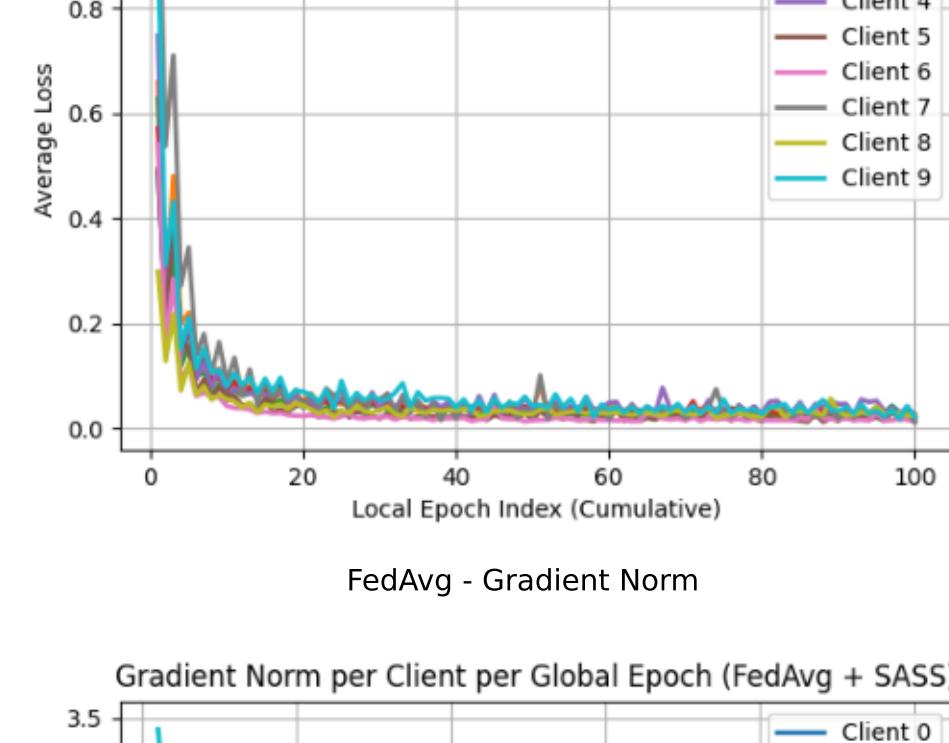
FedAvg - Learning Rate



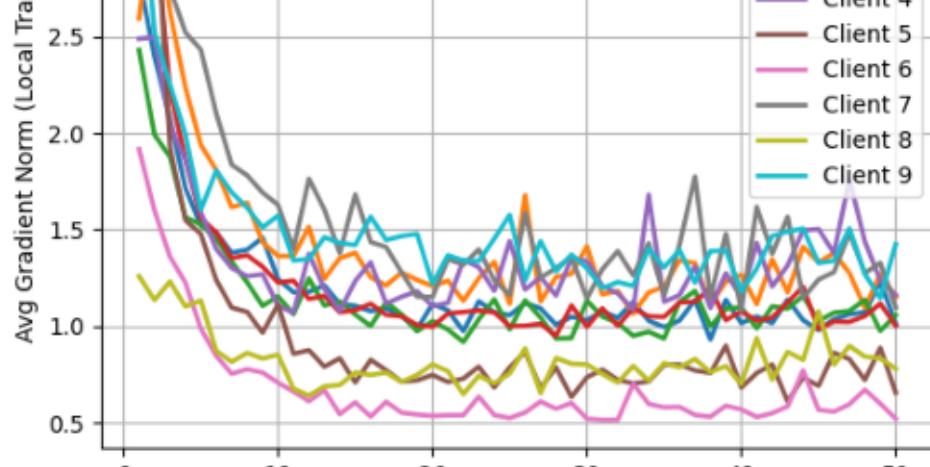
FedAvg - Log (LR)



FedAvg - Training Loss



FedAvg - Gradient Norm



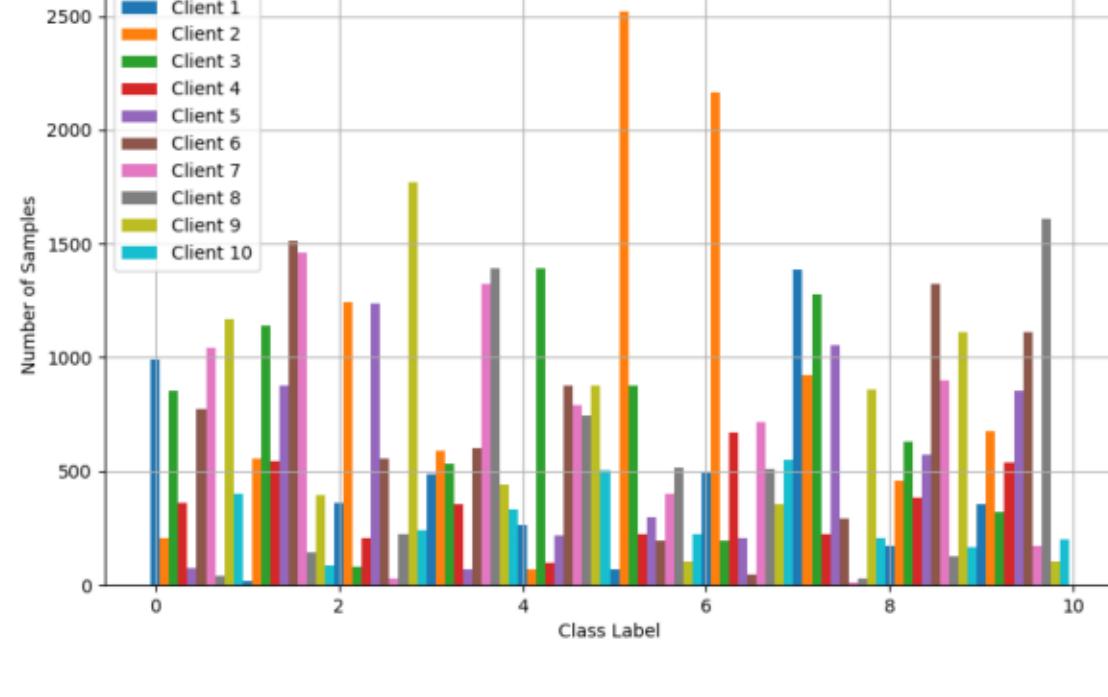
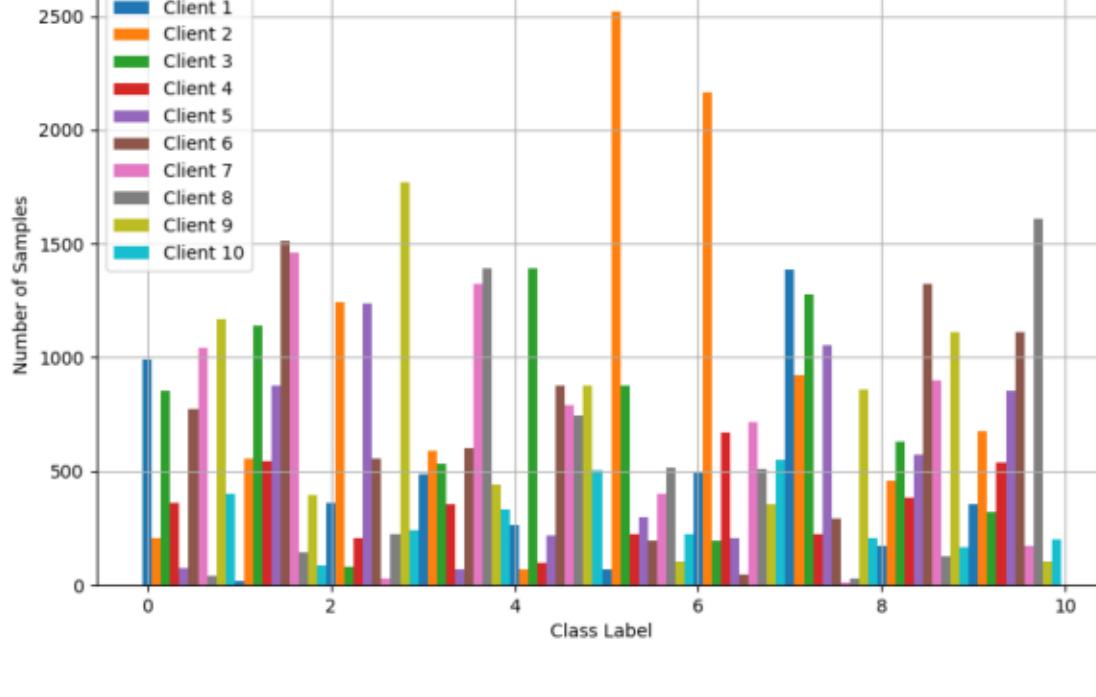
## Experiment 5 (Mild nonIID alpha=1, 10 clients, 50 epoch)

In this experiment, data is mild non IID across 10 clients.

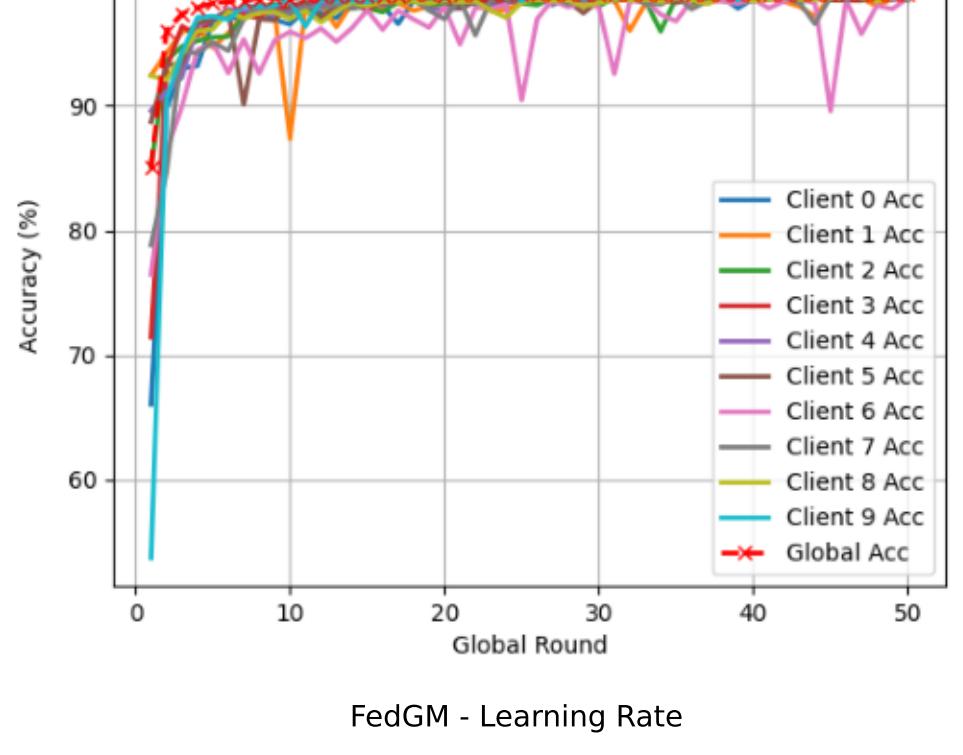
The Accuracy of FedGM:[98.83, 98.56, 98.86, 98.93, 98.78, 98.66, 98.62, 98.44, 98.67, 98.95 ]

The Accuracy of FedAvg:[98.76, 98.85, 98.71, 98.84, 98.98, 98.89, 98.66, 98.03, 98.90, 99.01 ]

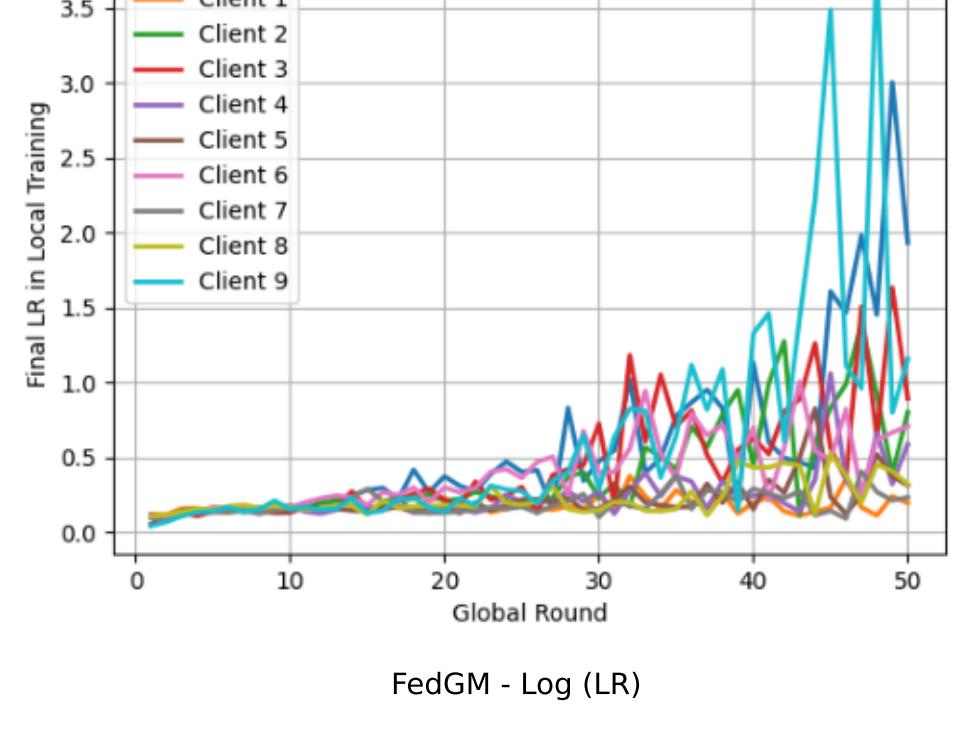
FedGM - Data Distribution



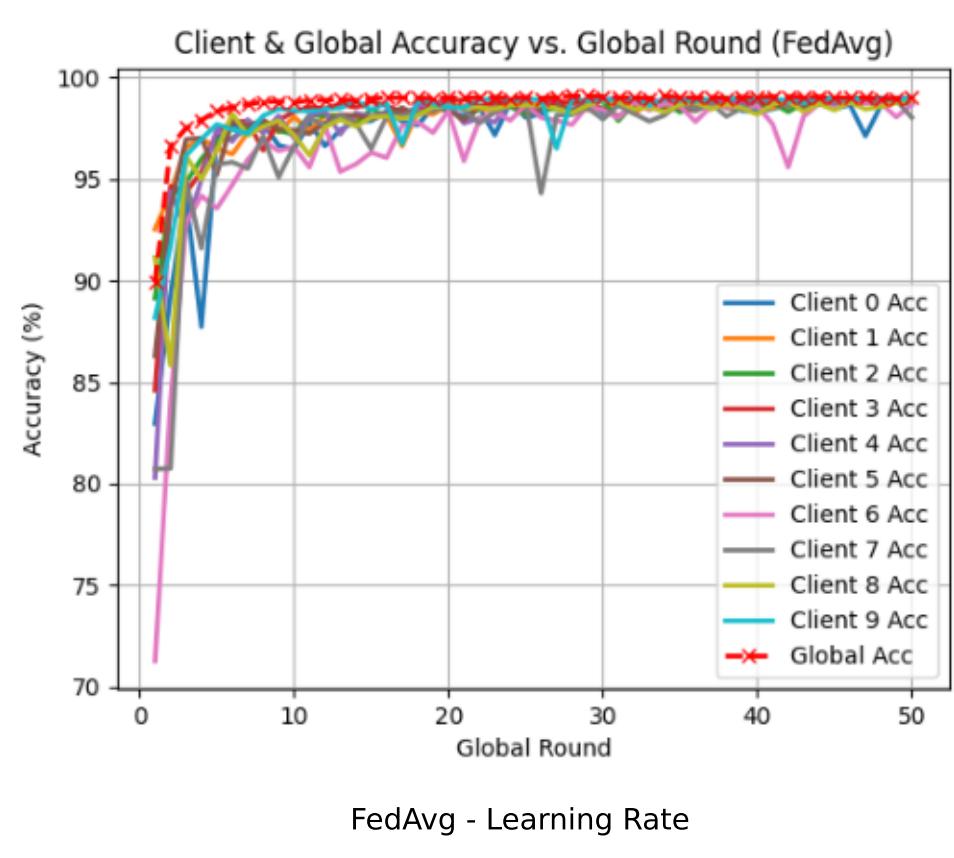
FedGM - Accuracy



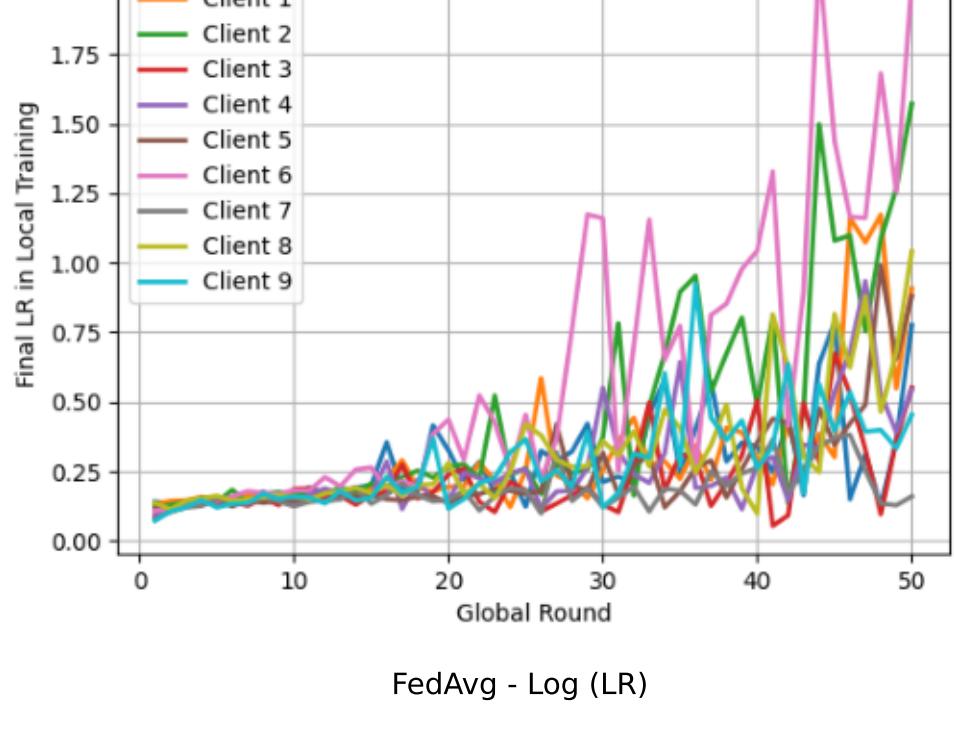
FedGM - Learning Rate



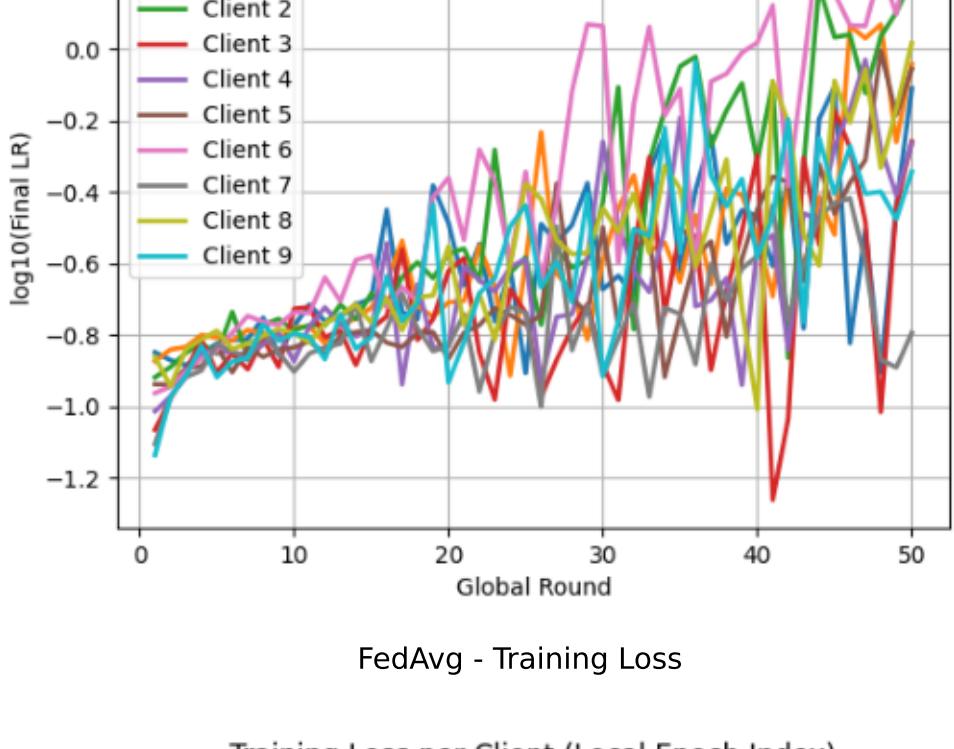
FedGM - Log (LR)



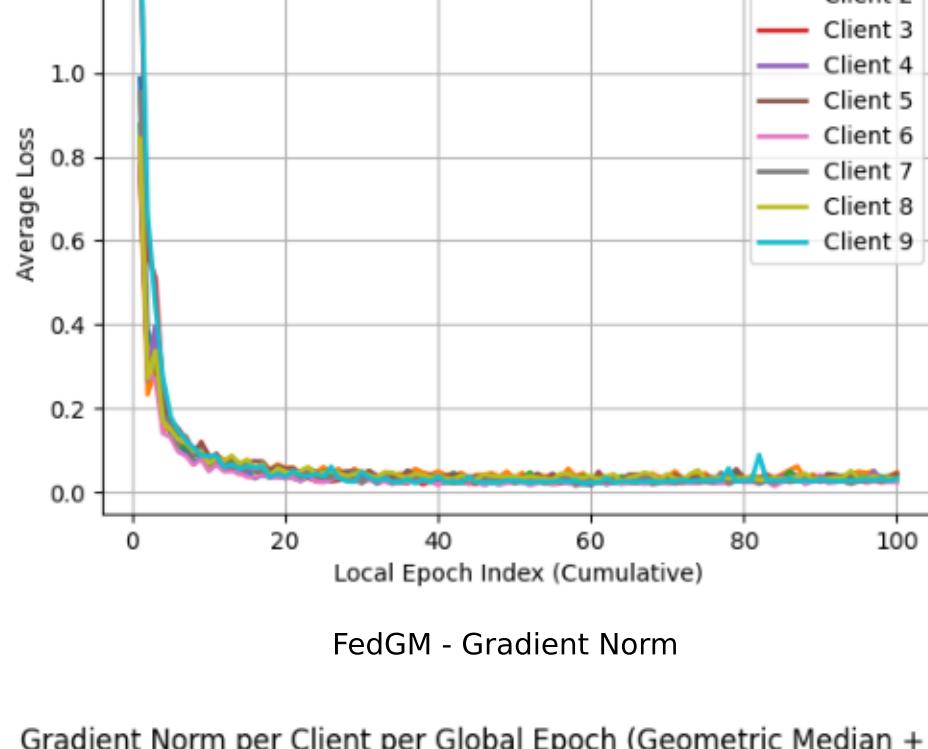
FedAvg - Learning Rate



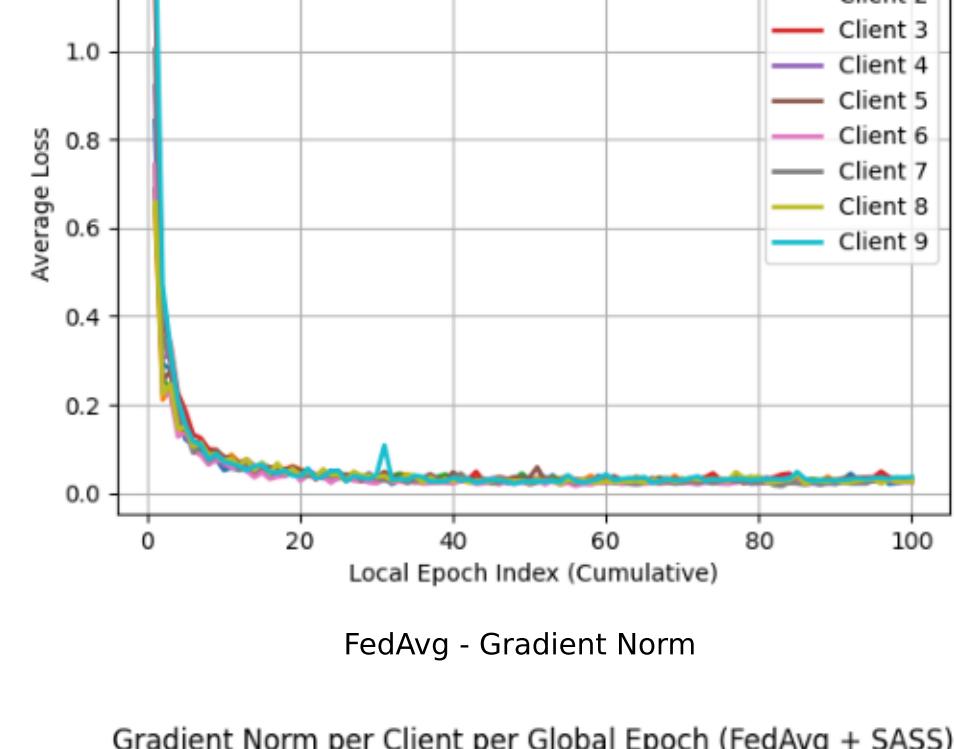
FedAvg - Log (LR)



FedGM - Training Loss

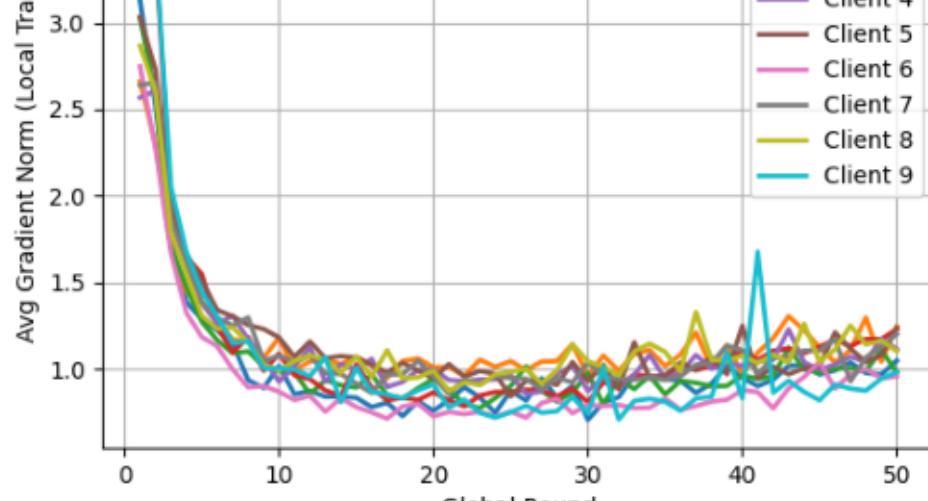


FedGM - Gradient Norm

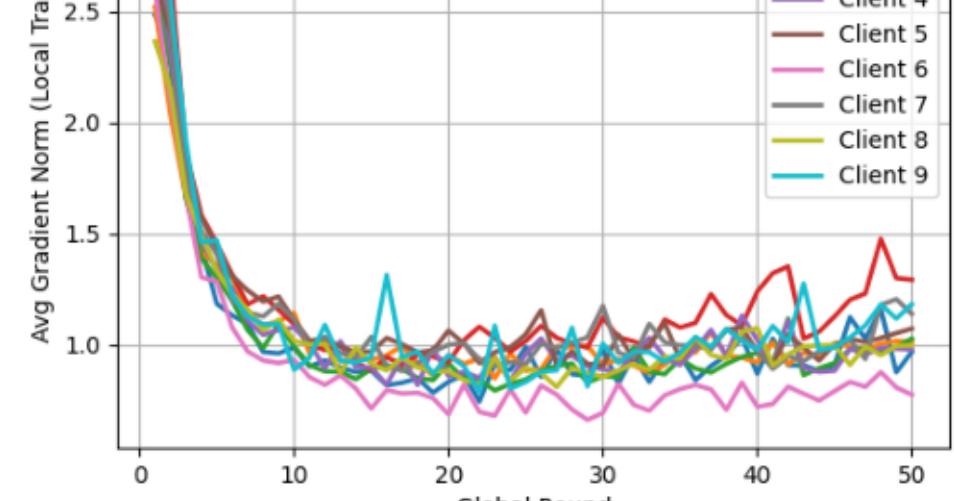


FedAvg - Gradient Norm

Gradient Norm per Client per Global Epoch (Geometric Median + SASS)



Gradient Norm per Client per Global Epoch (FedAvg + SASS)



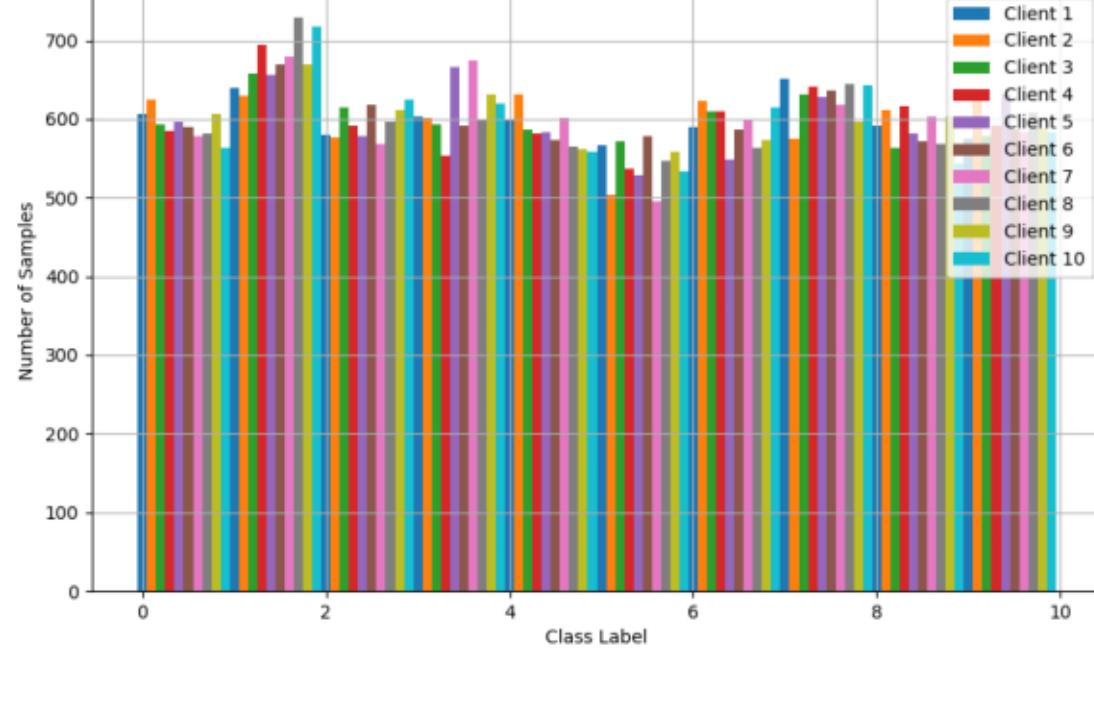
## Experiment 6 (IID, 10 clients, 50 epoch)

In this experiment, data is IID across 10 clients.

We see how FedGM compares to FedAvg in a more balanced setting. The Accuracy of FedGM: [99.01, 98.86, 98.86, 98.92, 98.90, 98.97, 98.90, 98.92, 98.92, 98.92]

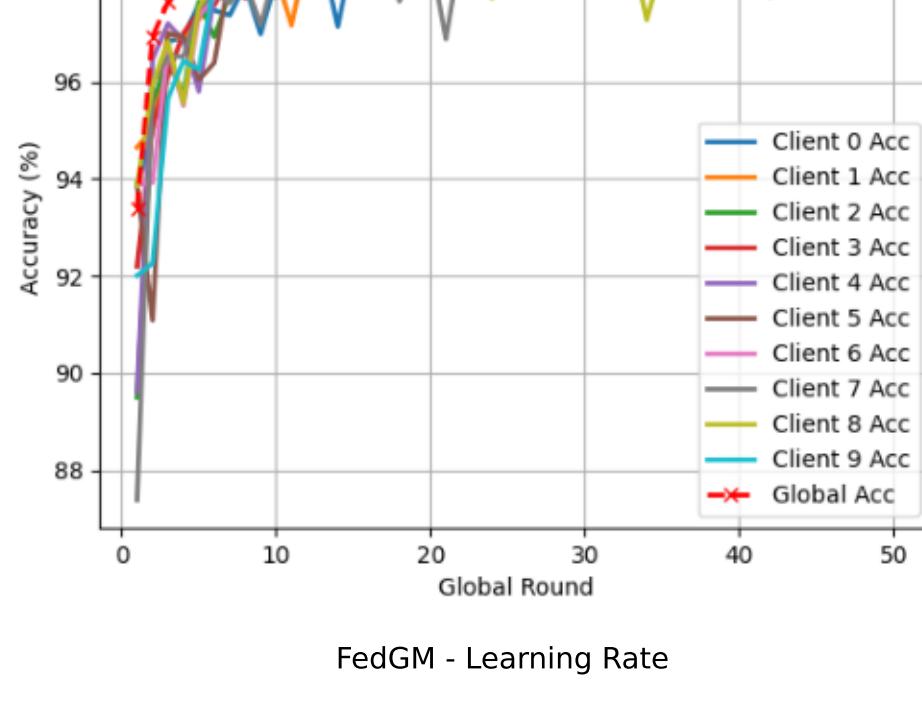
The Accuracy of FedAvg: [99.01, 98.92, 98.92, 99.07, 99.04, 99.05, 98.73, 99.00, 99.00, 99.00]

FedGM - Data Distribution



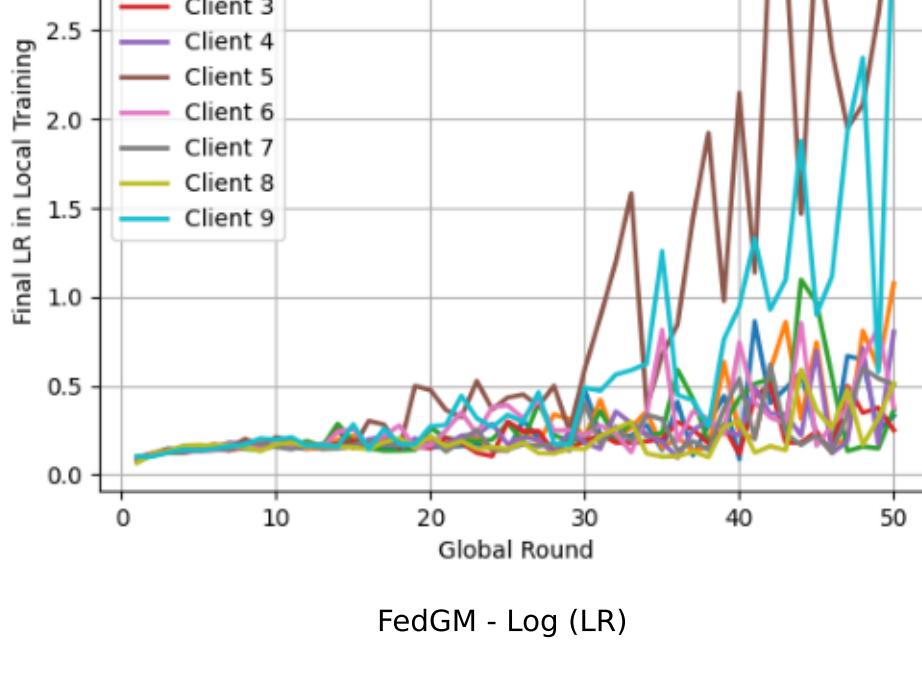
FedGM - Accuracy

Client & Global Accuracy vs. Global Round (Geometric Median)



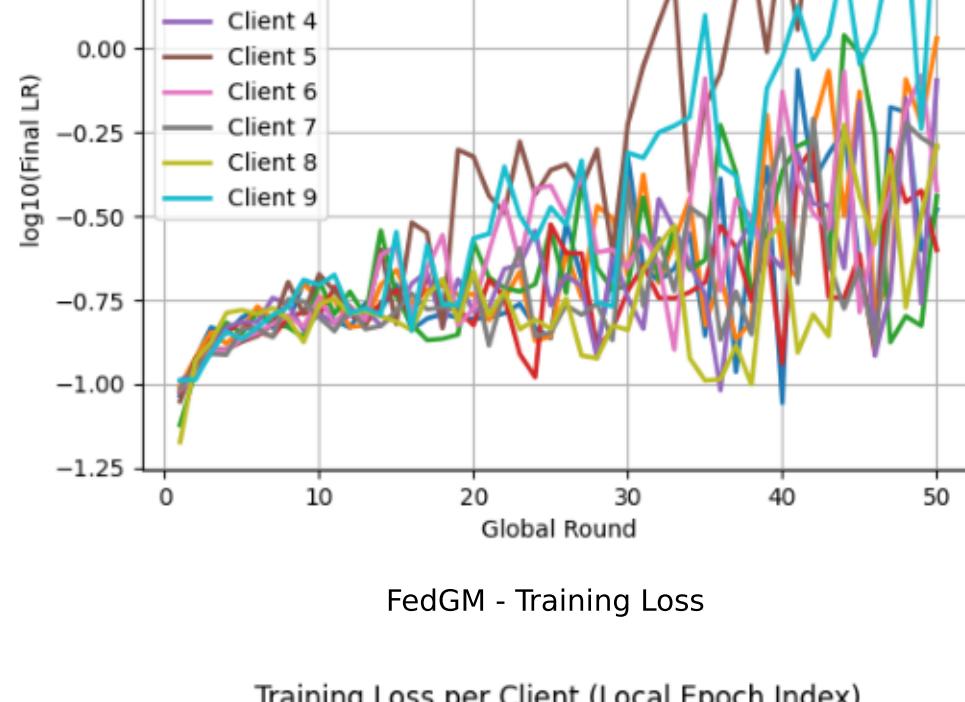
FedGM - Learning Rate

Learning Rate per Client per Global Epoch (Geometric Median)



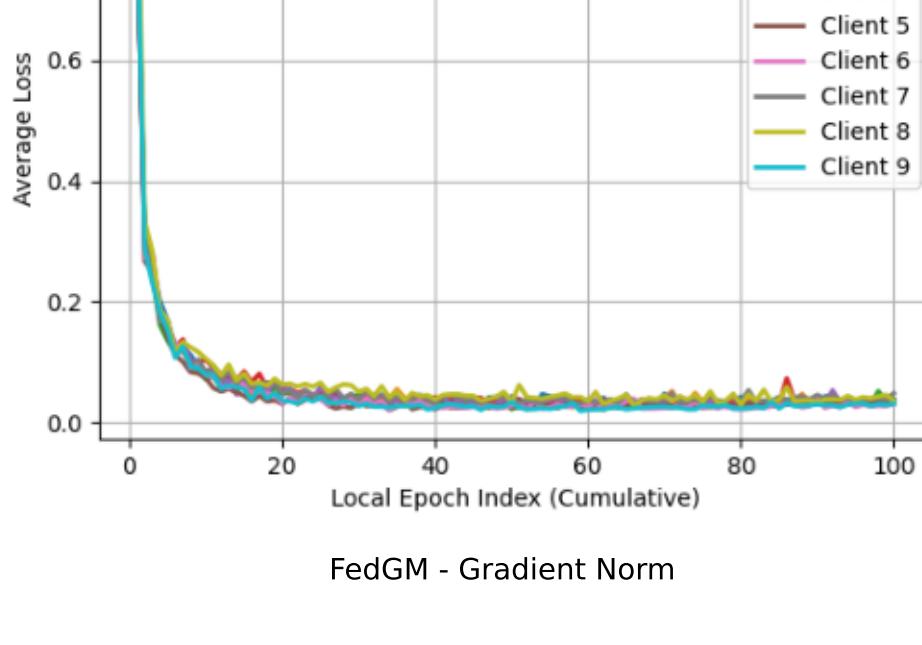
FedGM - Log (LR)

Log10(Learning Rate) per Client per Global Epoch (Geometric Median)



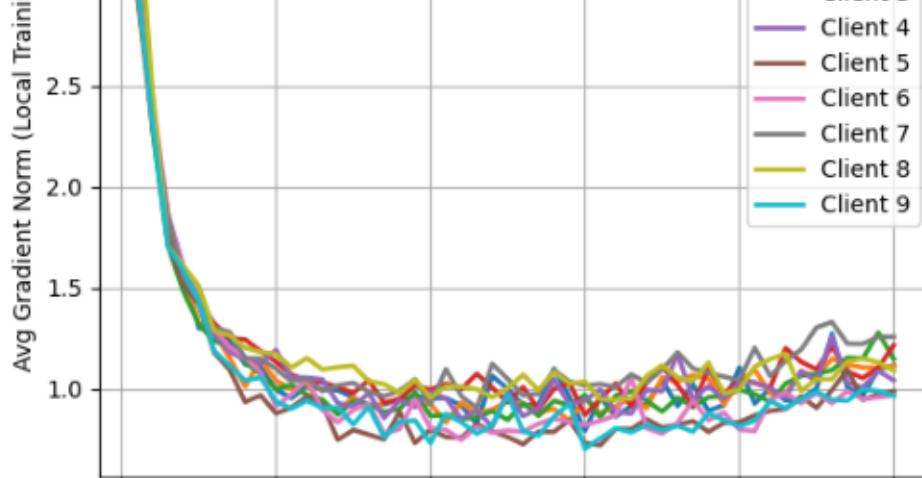
FedGM - Training Loss

Training Loss per Client (Local Epoch Index)

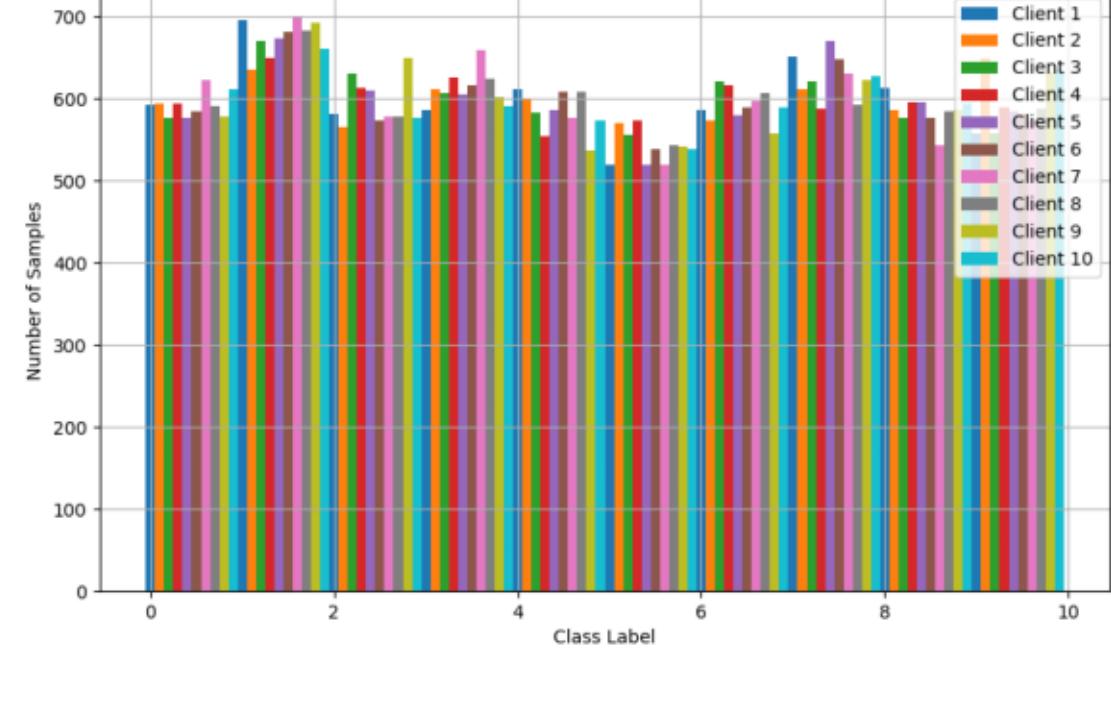


FedGM - Gradient Norm

Gradient Norm per Client per Global Epoch (Geometric Median + SASS)

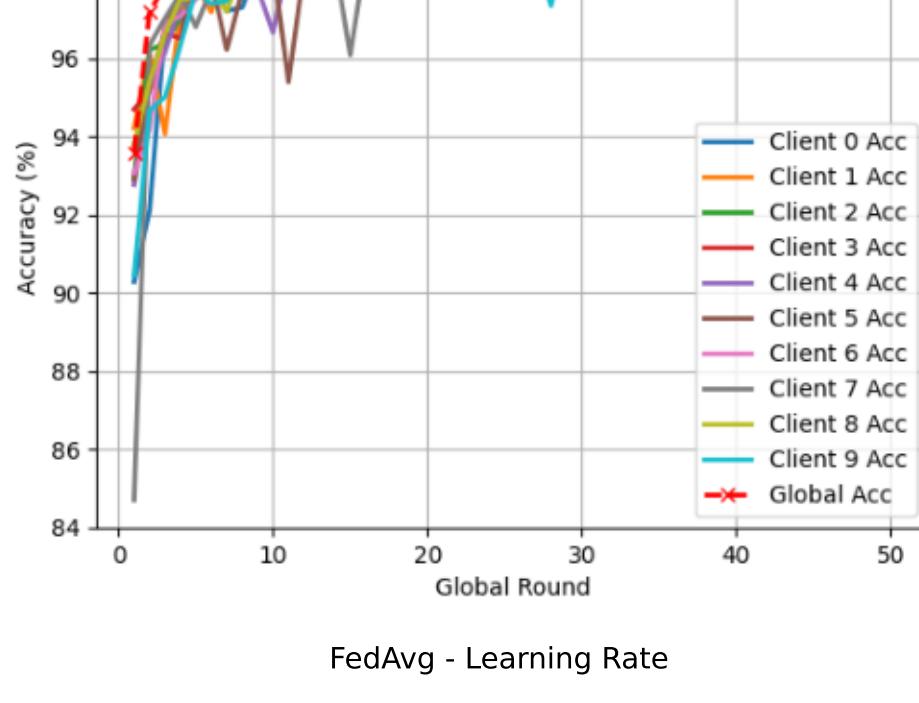


FedAvg - Data Distribution



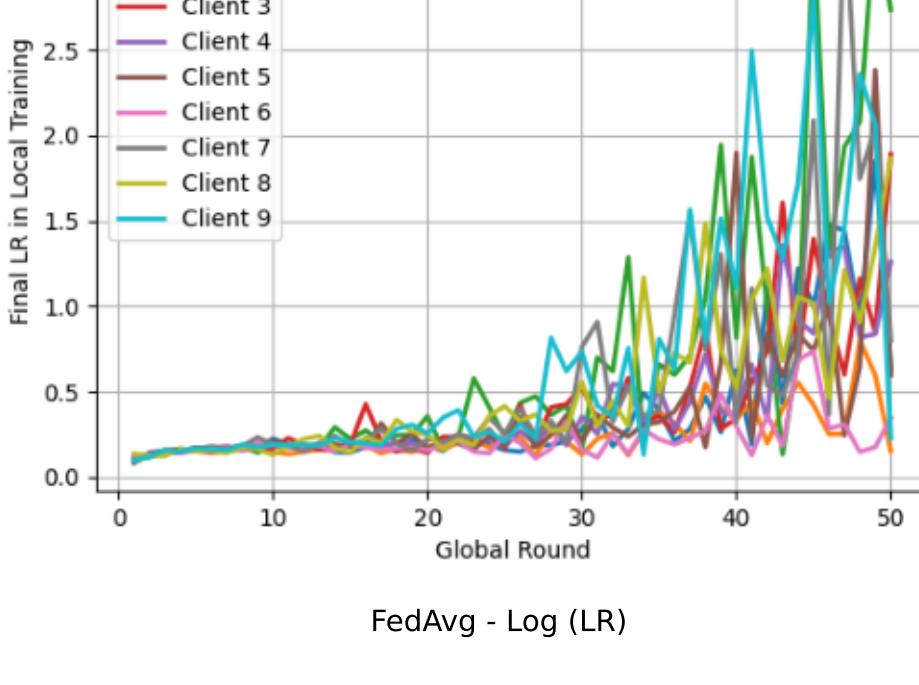
FedAvg - Accuracy

Client & Global Accuracy vs. Global Round (FedAvg)



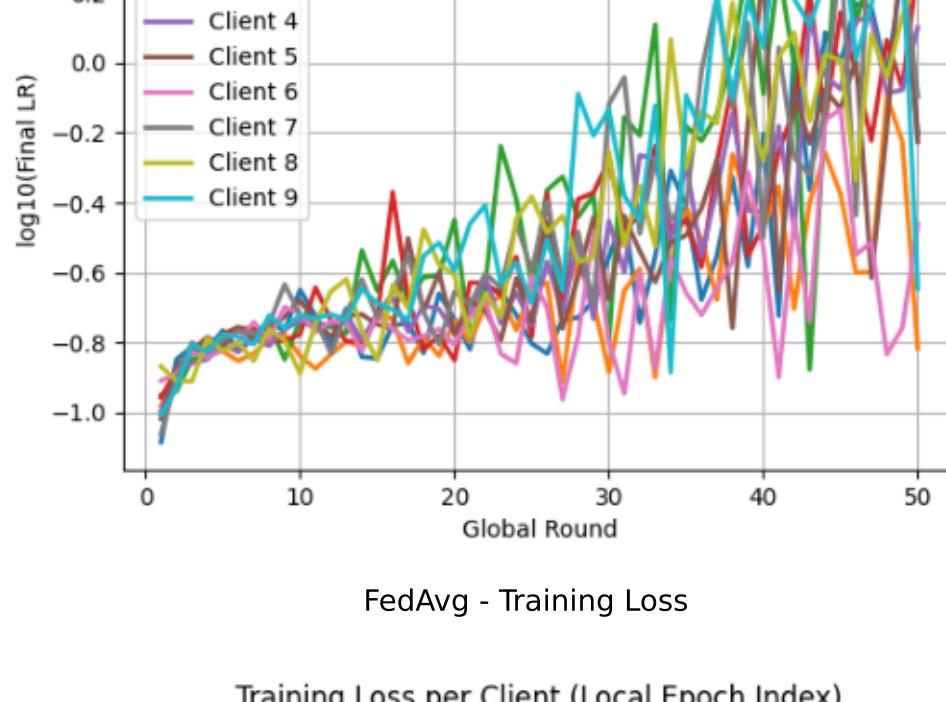
FedAvg - Learning Rate

Learning Rate per Client per Global Epoch (FedAvg)



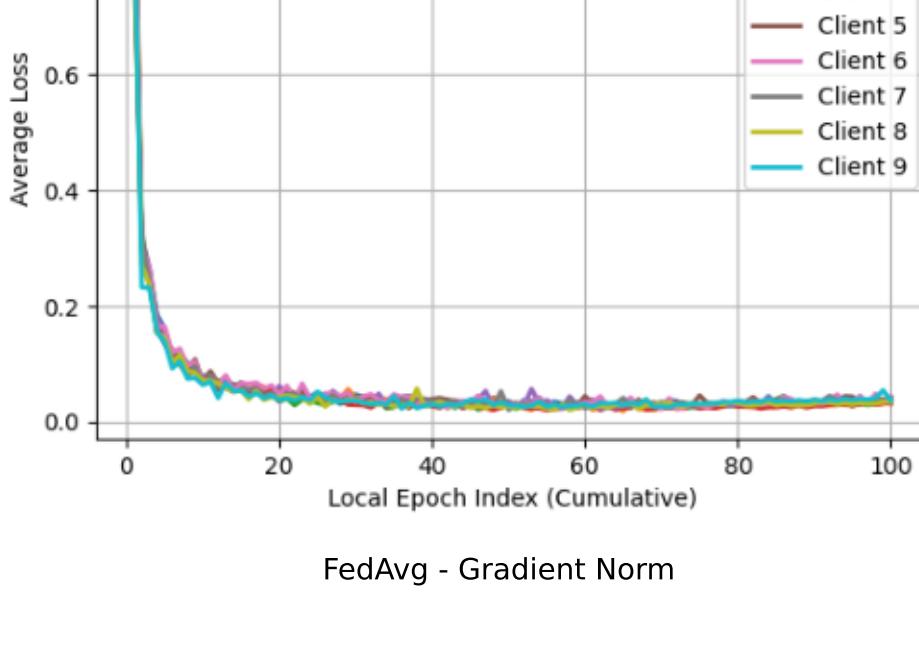
FedAvg - Log (LR)

Log10(Learning Rate) per Client per Global Epoch (FedAvg)



FedAvg - Training Loss

Training Loss per Client (Local Epoch Index)



FedAvg - Gradient Norm

Gradient Norm per Client per Global Epoch (FedAvg + SASS)

