Studying local and global loss landscapes in Federated Learning

Group 18:
Finn Vaughankraska
Chenglong Li
Sung Pok Yau

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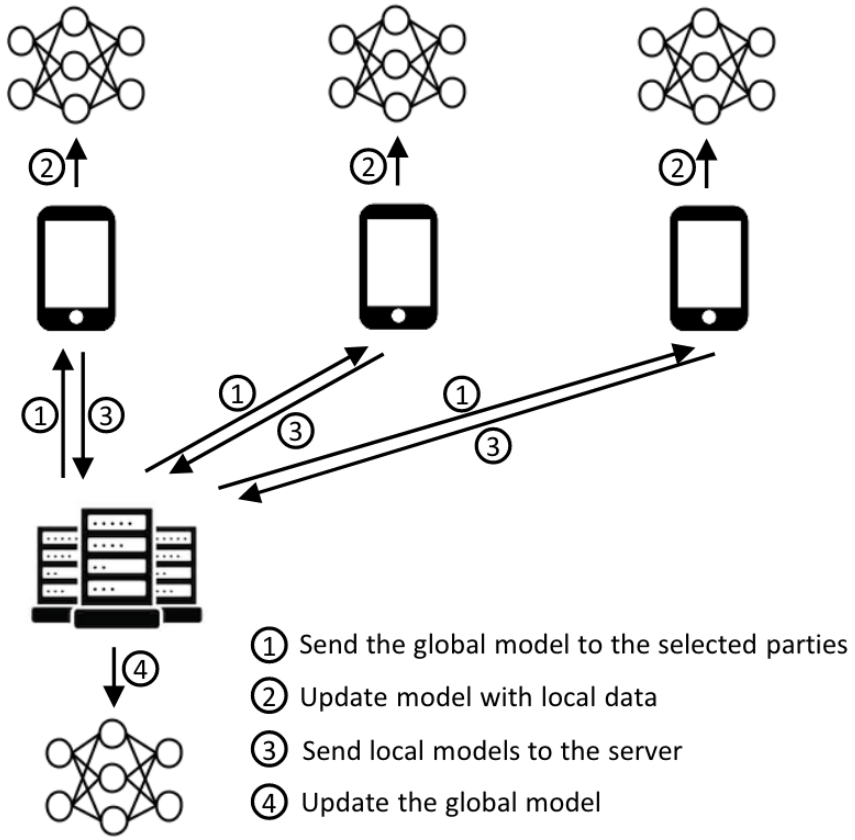
Introduction

Federated learning (FL) is a decentralized approach to machine learning. It tackles the issues of centralized machine learning by allowing models to train on distributed data sources.



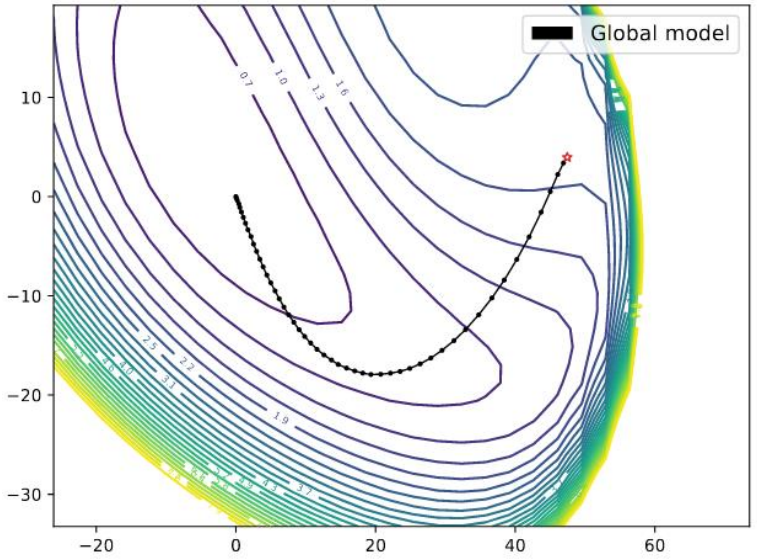
Underlying Architecture

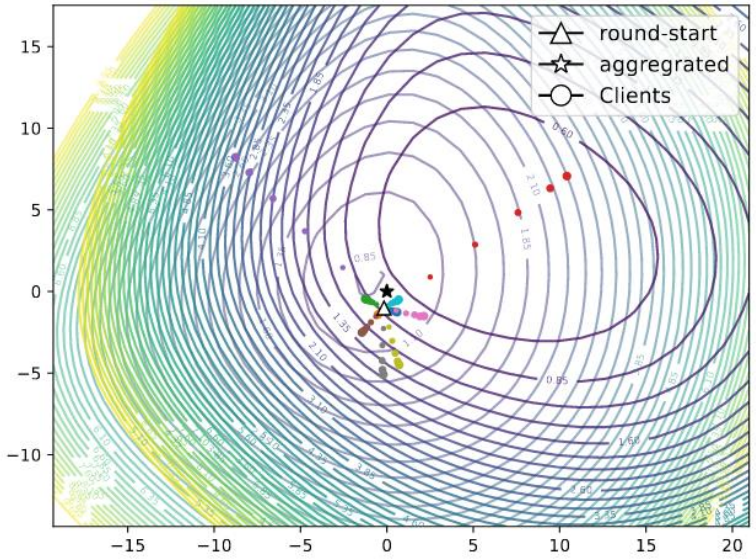
- Central Server
- Parties(Clients)
- Communication Framework
- Aggregation Algorithm
  - Parameter-based
  - Output-based

1 Scaleout: https://docs.scaleoutsystems.com/en/stable/introduction.html
2 A Survey on Federated Learning Systems: Vision, Hype and Reality for Data Privacy and Protection

Introduction

Loss landscape analysis is an effective approach for studying the learning dynamics and generalization properties of neural networks in high-dimensional spaces.





1 Visualizing the Loss Landscape of Neural Nets
2 Understanding Federated Learning through Loss Landscape Visualizations: A Pilot Study

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Introduction

Our Tasks:

1 Study local and global loss landscapes in federated learning.

2 Compare local loss landscapes and global loss landscapes in federated learning.

3 Understand a local client's contribution to the overall loss landscape.

4 Provide insights to optimize federated learning systems.

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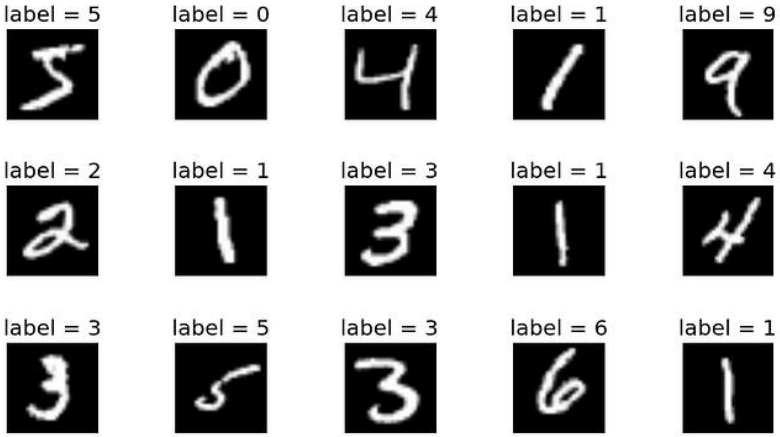
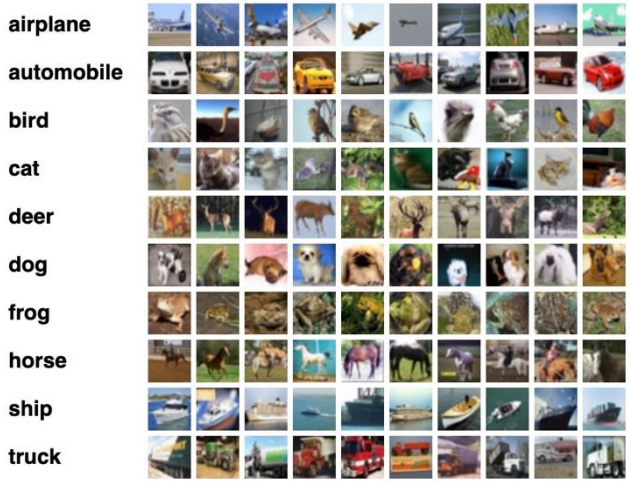
Experiments

Datasets



The **MNIST** dataset contains **70,000** images, each with dimensions of **28x28** pixels, resulting in **784** features per image. Each feature represents the intensity of a pixel, ranging from **0 to 255**.



The **CIFAR-100** dataset is a subset of the Tiny Images dataset, containing **60,000 32x32** color images across 100 classes grouped into 20 superclasses. Each class has 600 images, with 500 for training and 100 for testing. Images have both a "fine" label (class) and a "coarse" label (superclass).

1 The MNIST Database of Handwritten Digit Images for Machine Learning Research [Best of the Web]
2 Learning Multiple Layers of Features from Tiny Images

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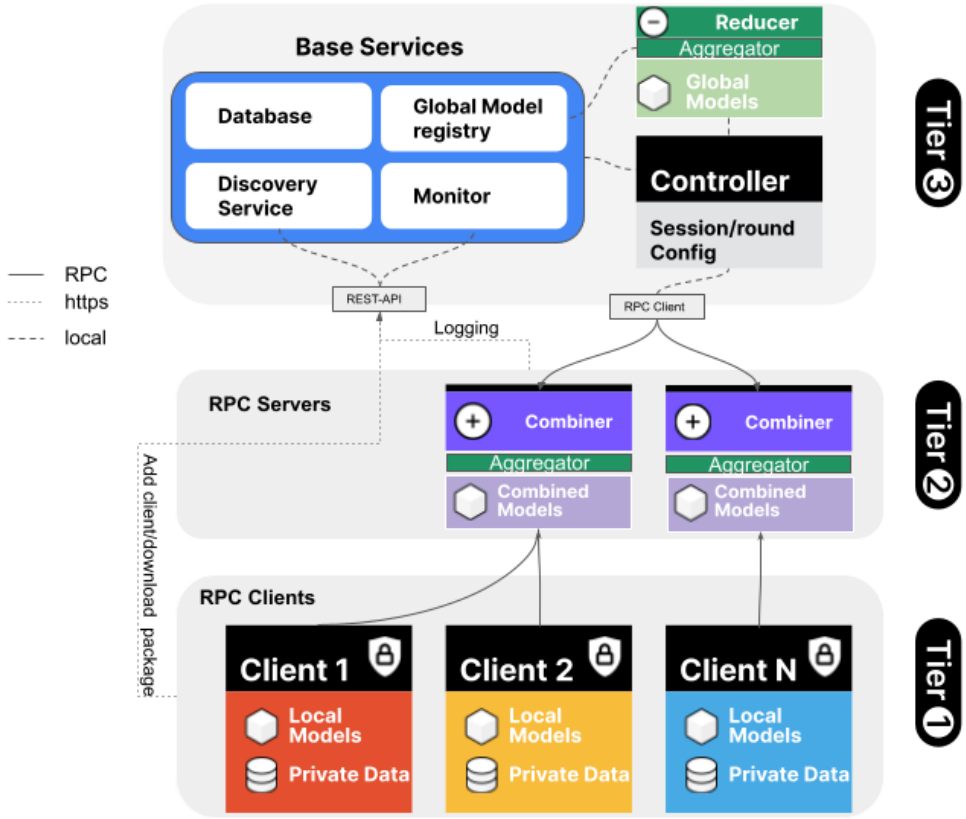
Experiments

Experiment FEDn Architecture



1 Scaleout: https://docs.scaleoutsystems.com/en/stable/architecture.html

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Experiments

Experiment Settings

Clients	Samples	Distribution	Experiments
2	Balanced	IID	.
3			.
4	Imbalanced	Non-IID	.
5			.
			.
			.

Clients + Samples + Distribution = Experiments

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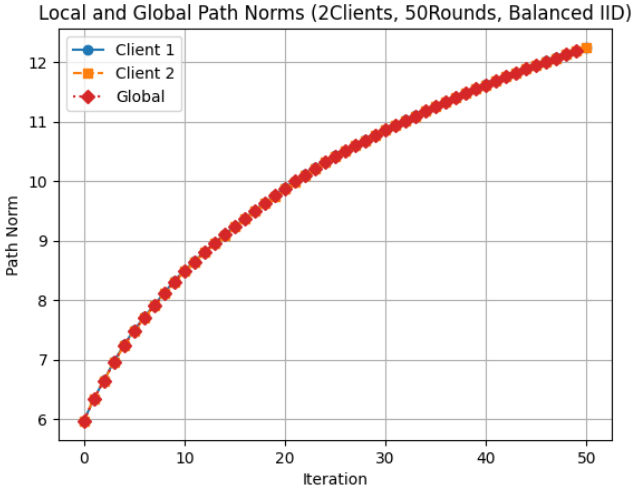
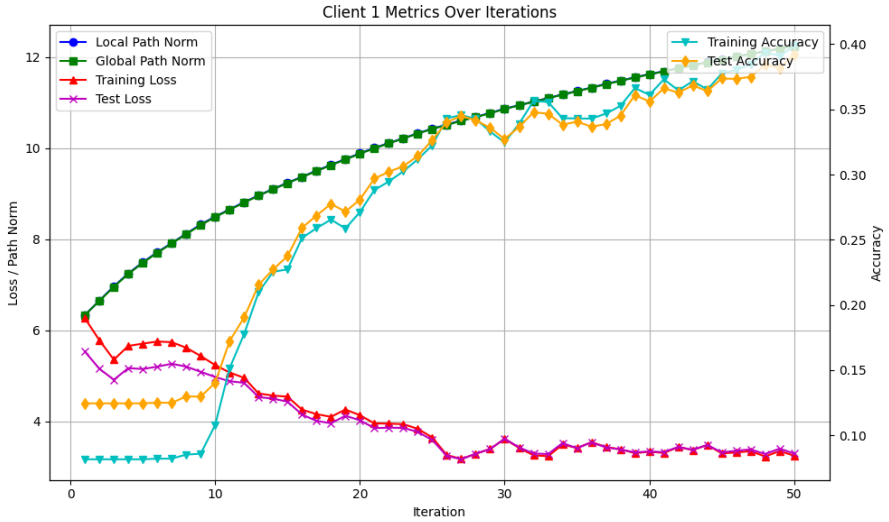
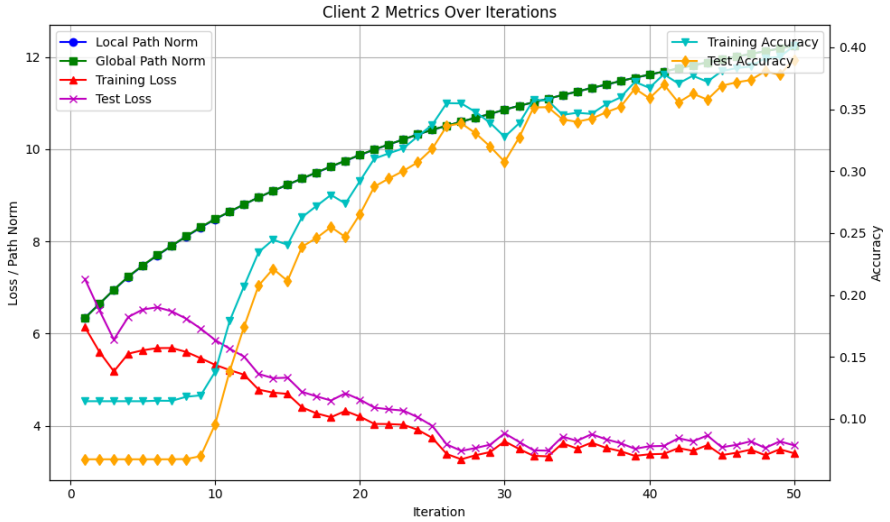
Experiments

2 Clients + Balanced + IID







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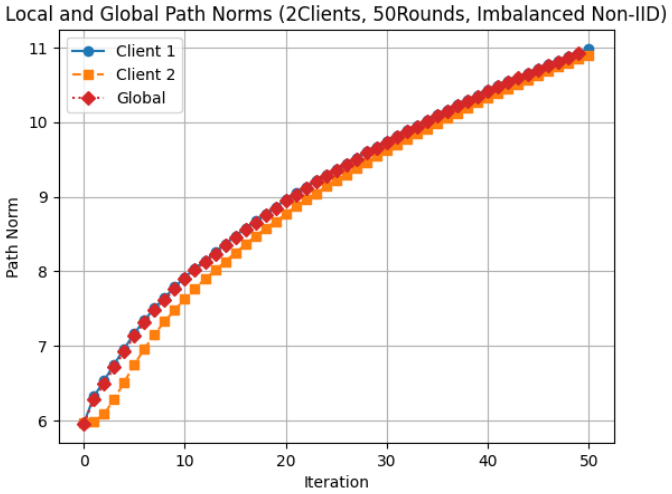
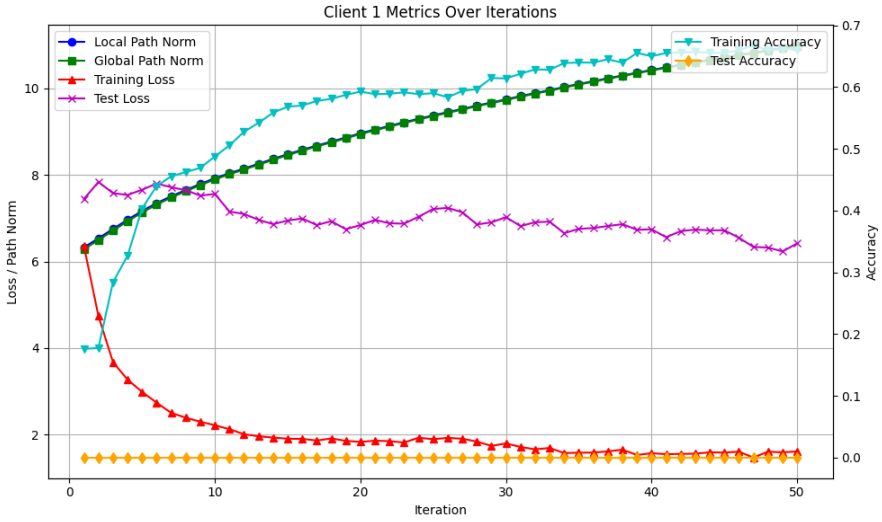
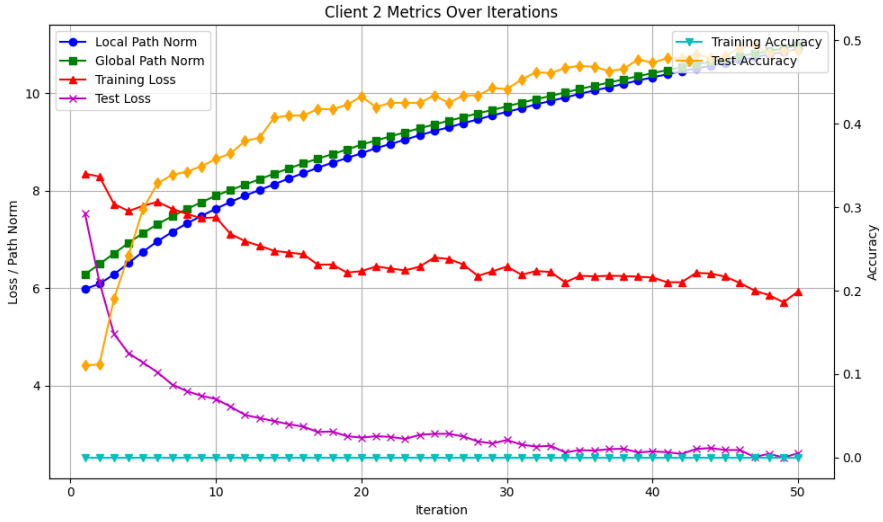
Experiments

2 Clients + Imbalanced + Non-IID







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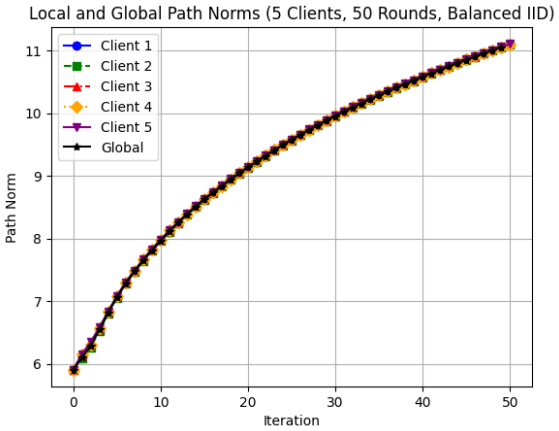
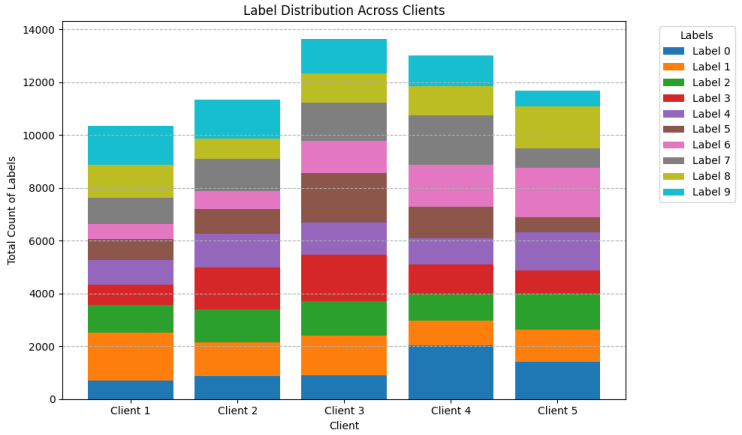
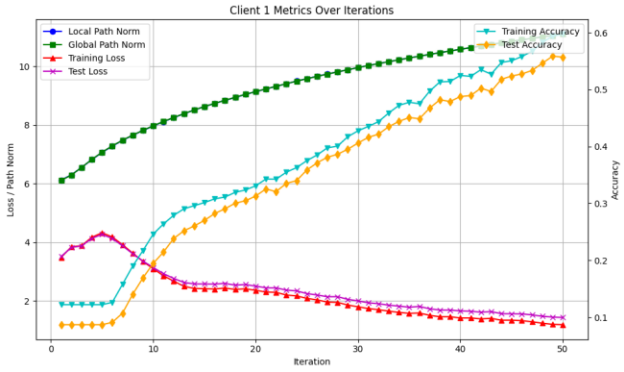
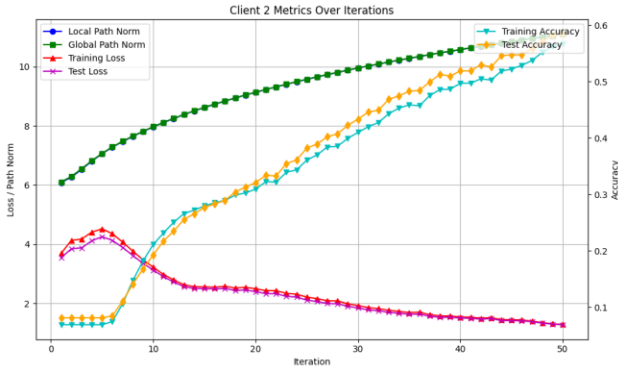
Experiments

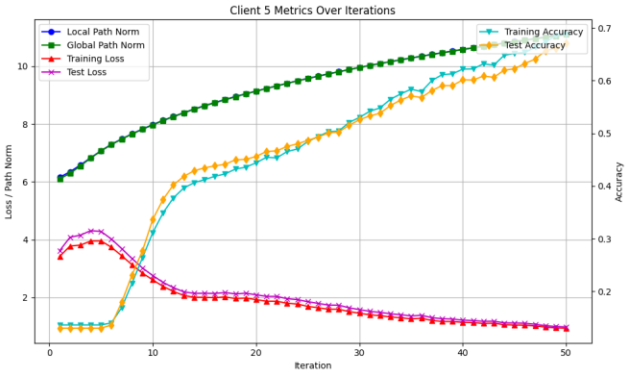
5 Clients + Balanced + IID











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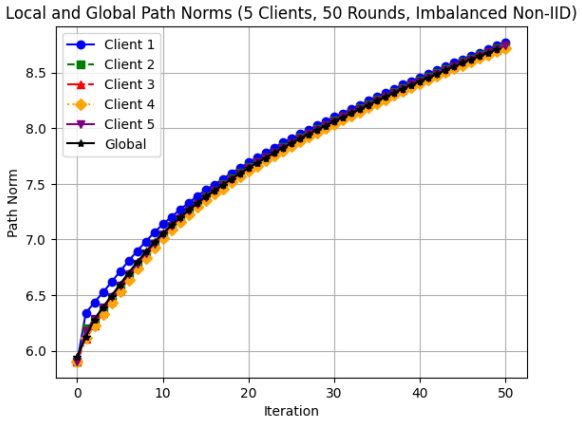
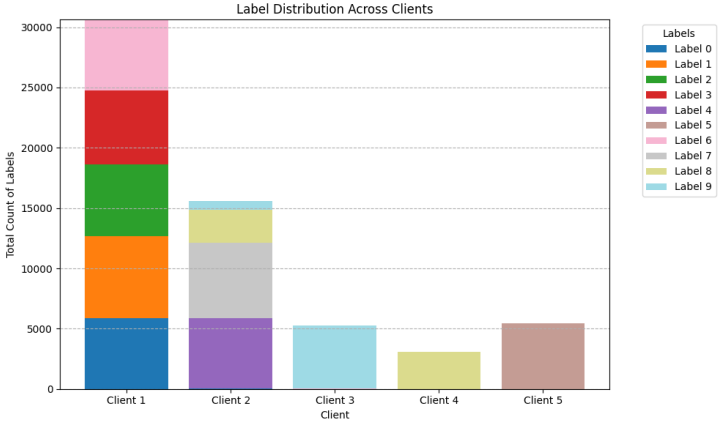
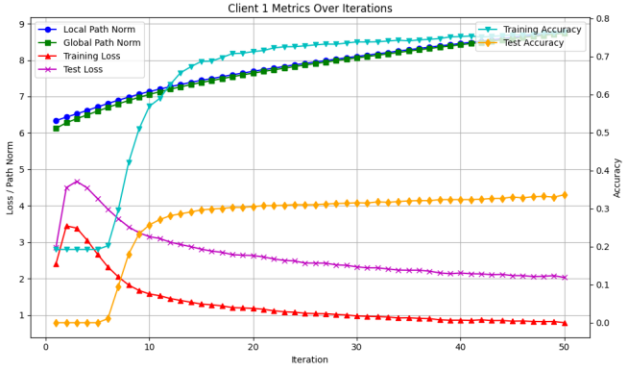
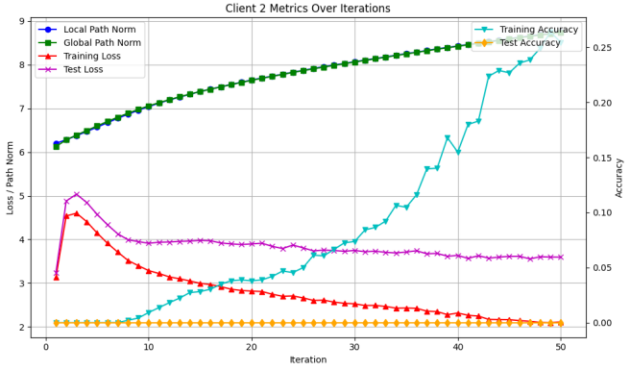
Experiments

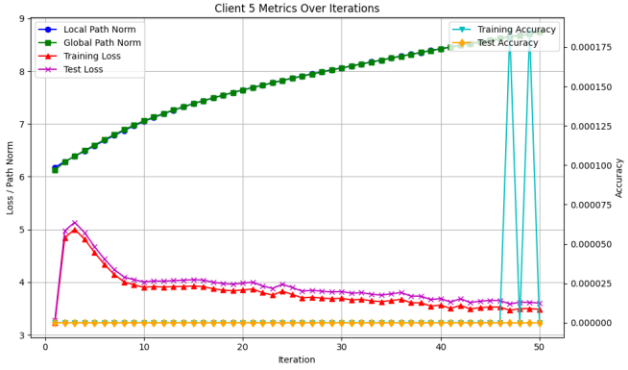
5 Clients + Imbalanced + Non-IID











Experiments

Experiment Results Analysis

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Future Wok

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Conclusion

Thanks

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