KNUST **RANKS NO.1 GLOBALLY** FOR THE PROVISION OF QUALITY EDUCATION **(SDG 4)** By: THE WORLD UNIVERSITY RANKINGS

Anomaly Detection in 5G Networks using Federated Learning

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OUTLINE

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2. TRADITIONAL MACHINE LEARNING RESULT
3. FEDERATED LEARNING RESULTS
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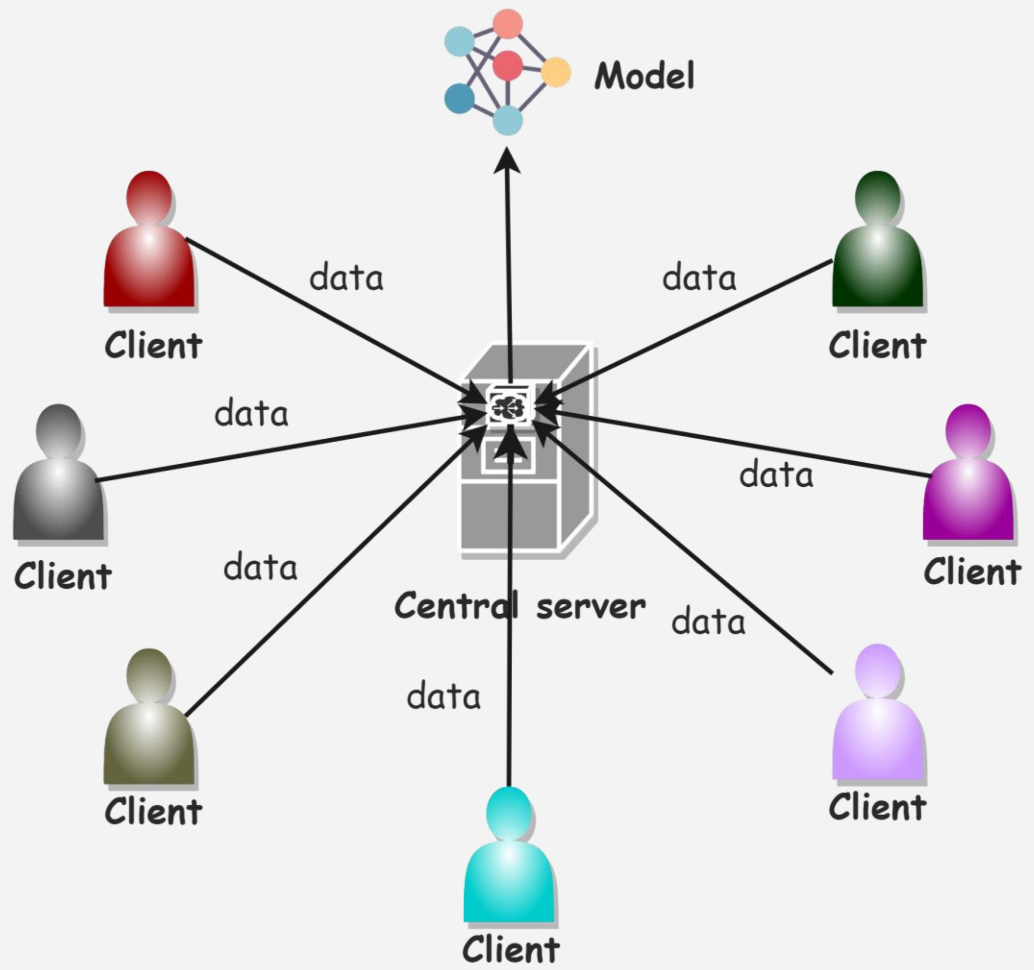
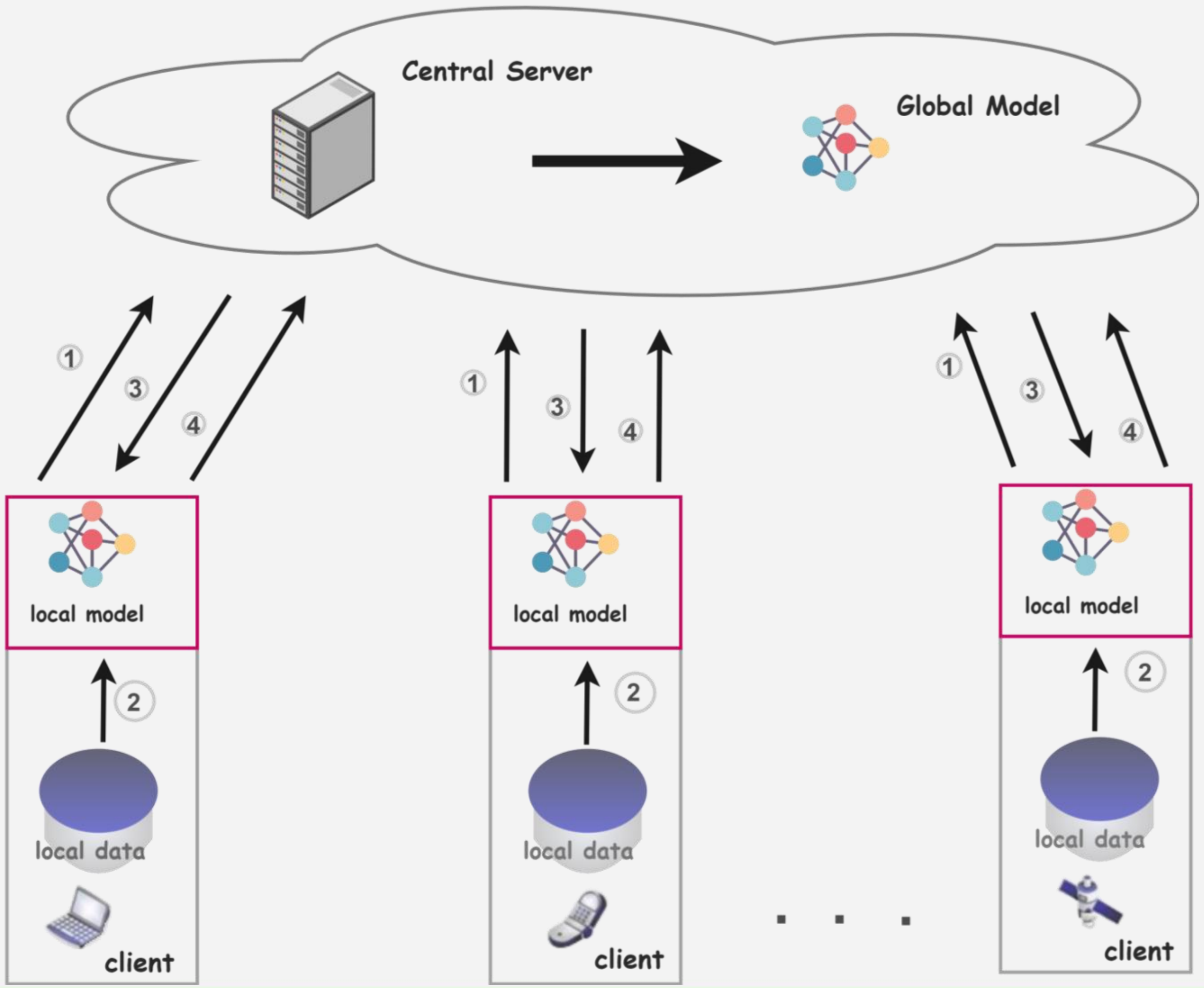
INTRODUCTION



TRADITIONAL MACHINE LEARNING

FEDERATED LEARNING



SPECIFIC OBJECTIVE ONE(1)

Evaluate the performance of the model developed by a classical deep neural network

Perform hyperparameter tuning to improve the performance of the model.

DATASET DESCRIPTION

- CIC-IOT 2023 dataset.
- Size of dataset: 1177098 x 34
- Number of features: 33 features + 1 label

ANOMALIES: ATTACKS

FLOODING

WEB-BASED

SPOOFING

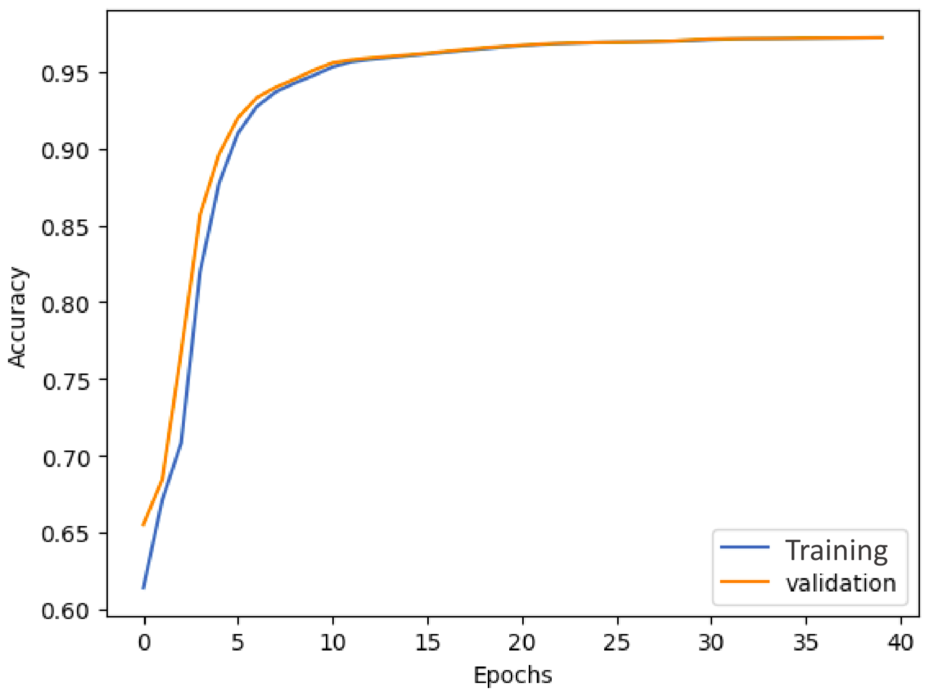
MODEL SUMMARY

Tensor
Flow

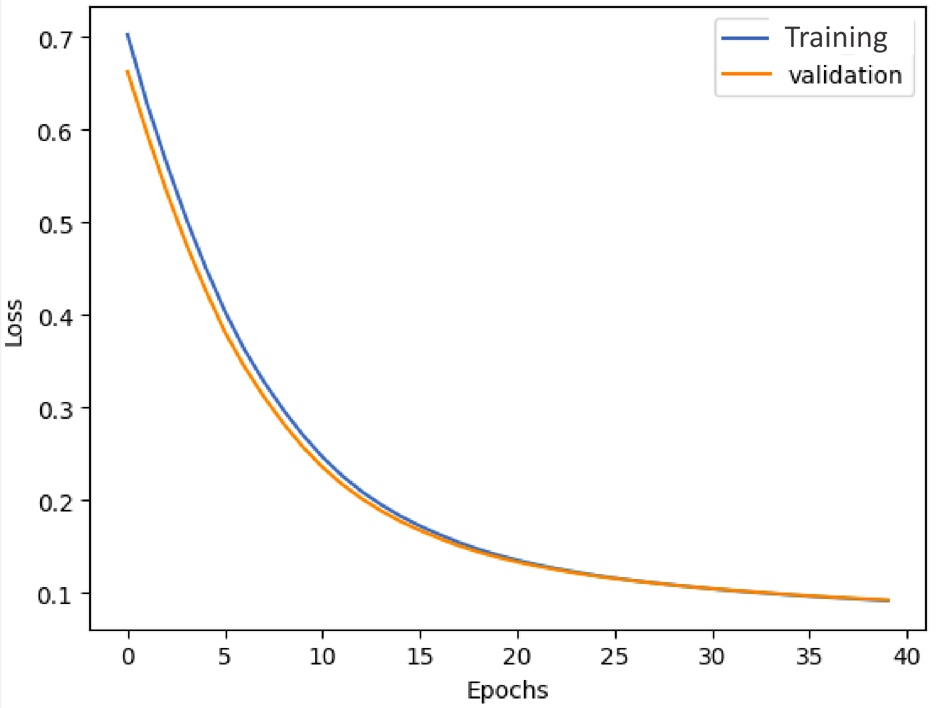
Layer (type)	Output Shape	Param #
dense_6 (Dense)	(None, 4)	136
activation_6 (Activation)	(None, 4)	0
dense_7 (Dense)	(None, 4)	20
activation_7 (Activation)	(None, 4)	0
dense_8 (Dense)	(None, 1)	5
activation_8 (Activation)	(None, 1)	0

Model summary

TRADITIONAL MACHINE LEARNING RESULTS



Training and validation accuracy curves



Training and validation loss curves

TRADITIONAL MACHINE LEARNING RESULTS CONT'D

```
Confusion Matrixs
[[99893  2706]
 [ 3375 70591]]


Evaluation metrics
              precision    recall  f1-score   support

           0    0.96732   0.97363   0.97046    102599
           1    0.96308   0.95437   0.95871     73966

    accuracy                        0.96556    176565
   macro avg    0.96520   0.96400   0.96458    176565
weighted avg    0.96554   0.96556   0.96554    176565
```

Model's performance on unseen data

Evaluation metrics	Values in %
Precision score	96.52
Recall	96.40
F1 score	96.46
Accuracy	96.56

Summary of the results

SPECIFIC OBJECTIVE TWO(2)

Co

Evaluate the performance of the model developed by federated learning.

technique.

Perform hyperparameter tuning to improve the performance of the model.

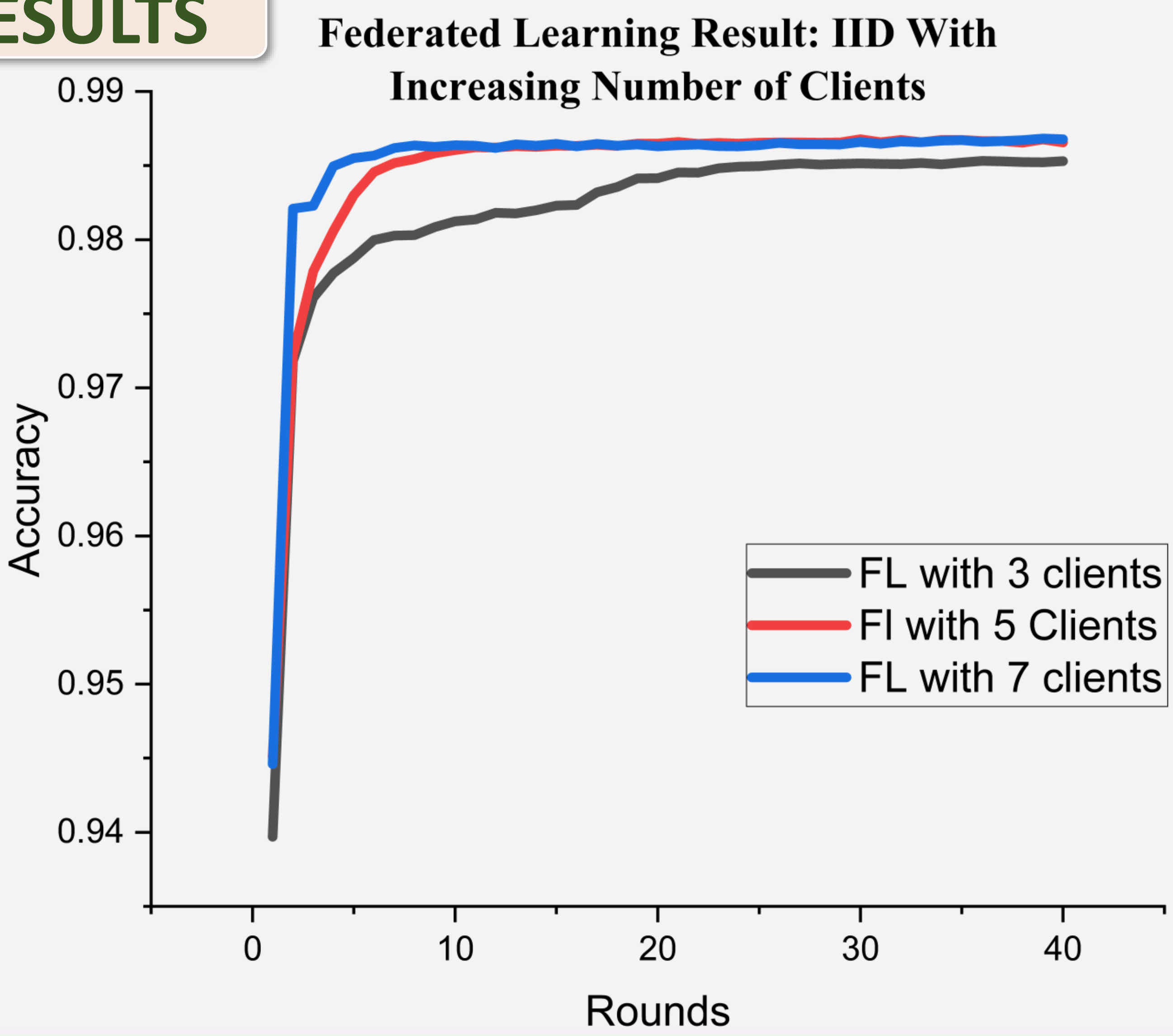
FEDERATED LEARNING RESULTS

framework

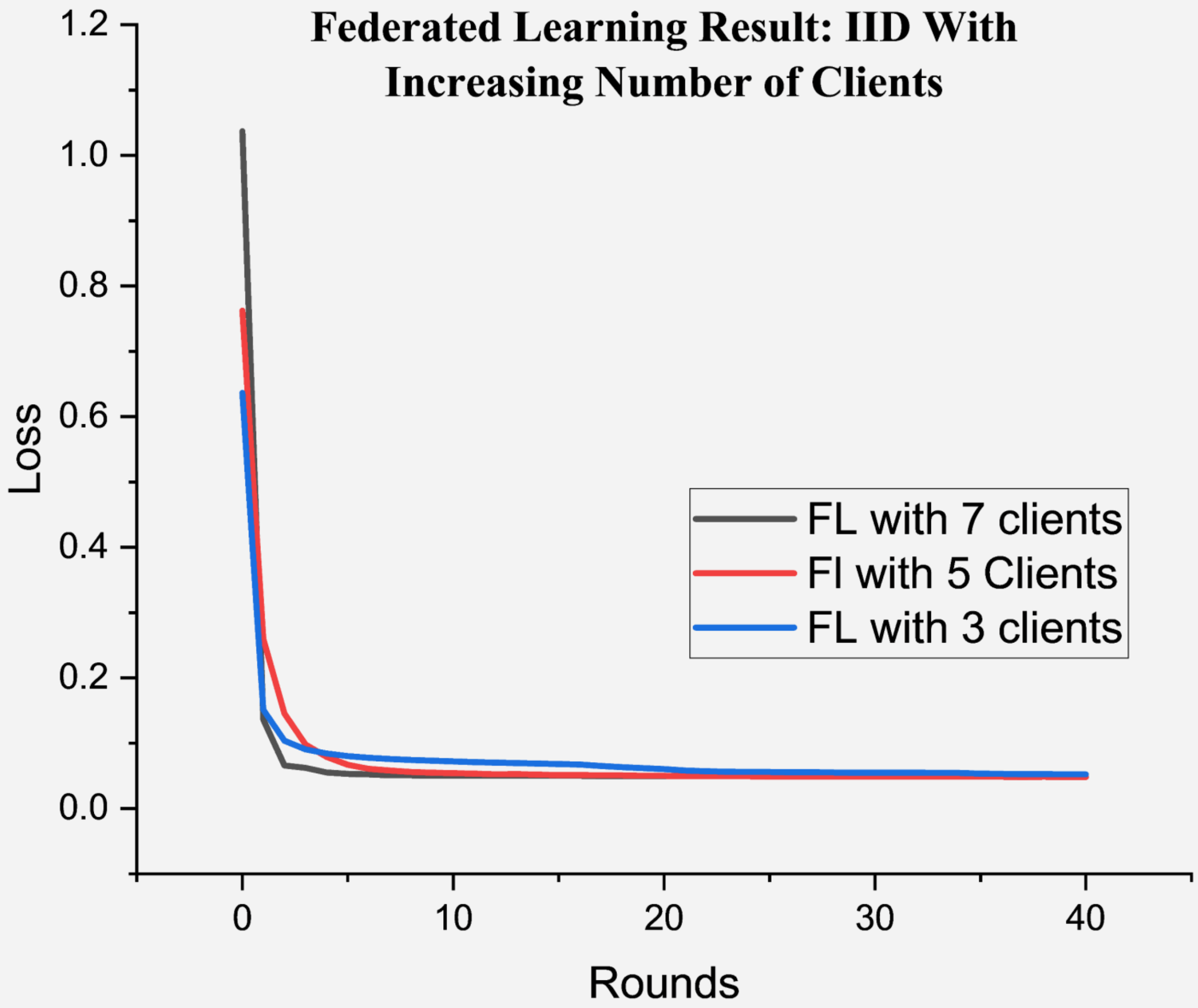
- ➢ Flower

scenarios

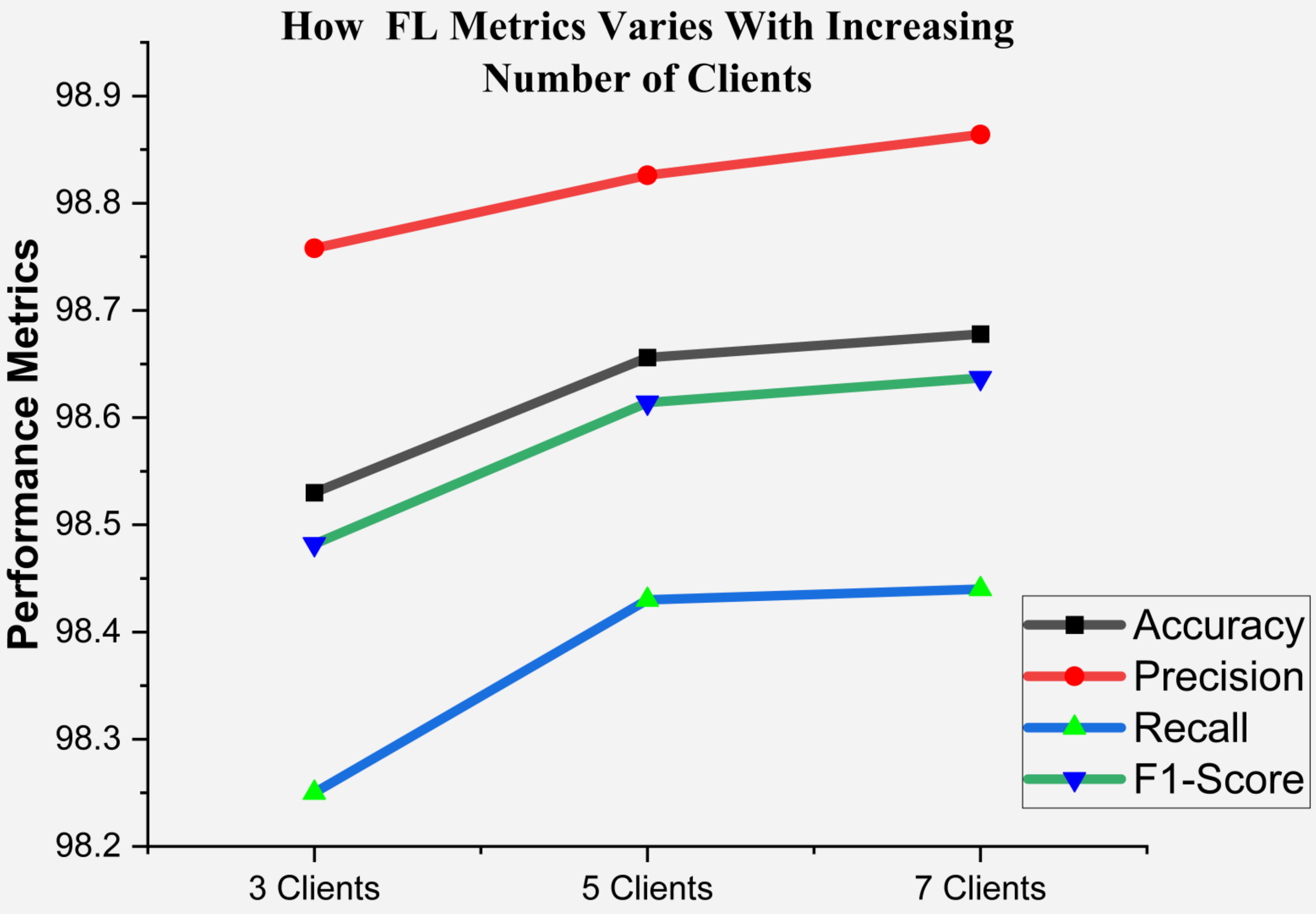
- ➢ Impact of increased clients
- ➢ Accuracy Trend as the number of rounds is varied



FEDERATED LEARNING RESULTS



FEDERATED LEARNING RESULTS



ANALYSIS

We observed an upward trend in model performance as the number of clients increased.

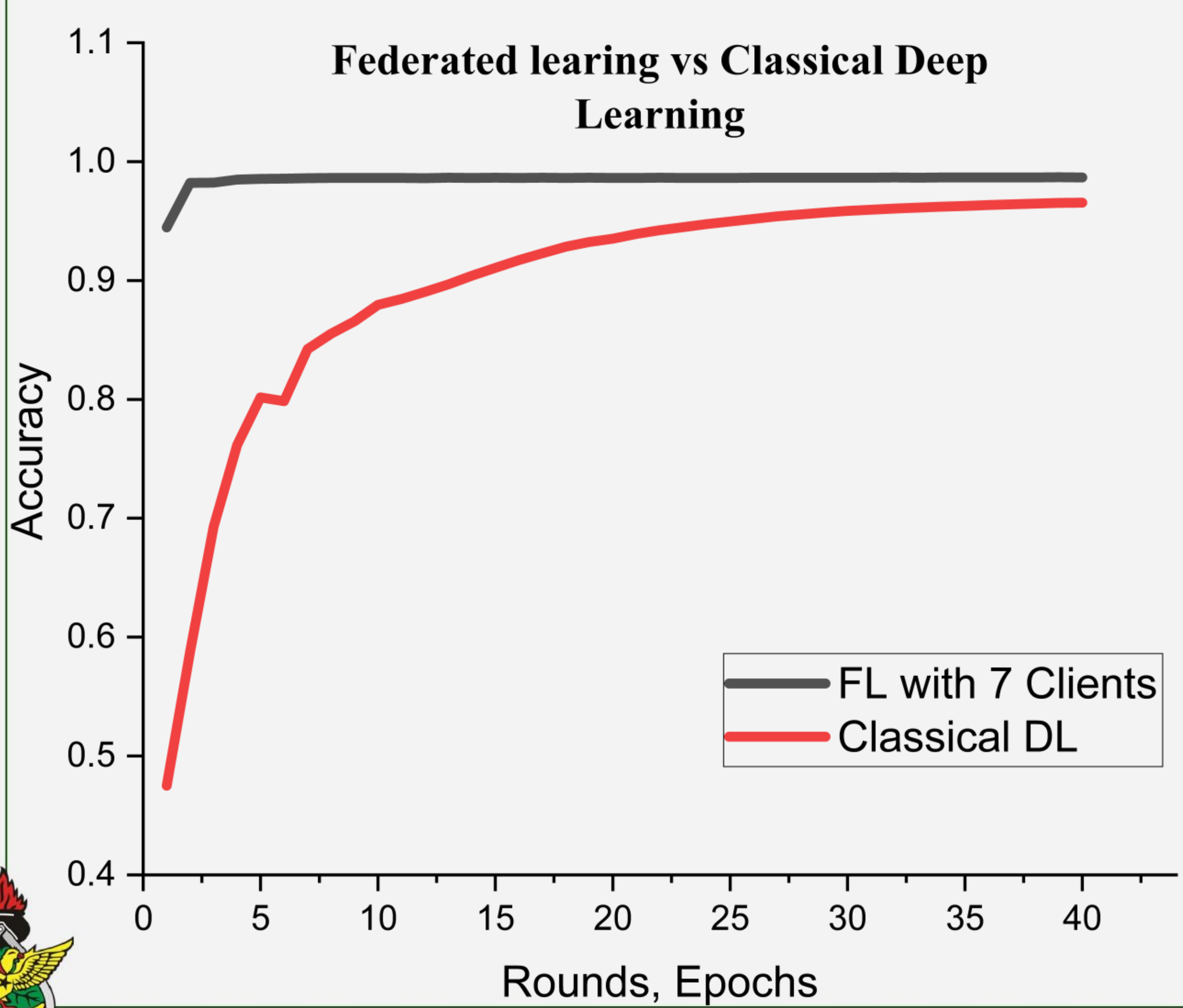
Suggests that the model might benefit even further if scaled to an even larger number of devices.

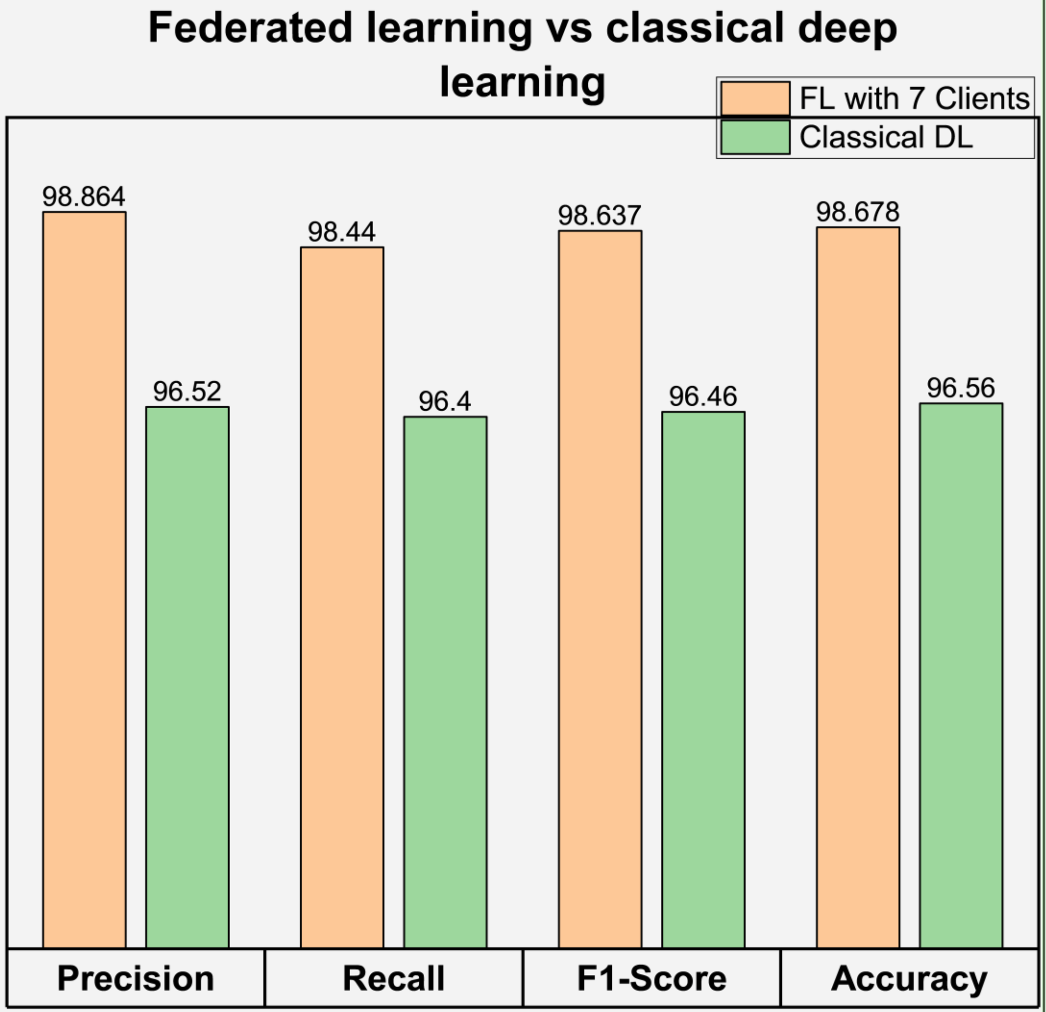
The model converges in 20 rounds regardless of client count, indicating no increase in communication cost as the client base expands.

SPECIFIC OBJECTIVE THREE(3)

Comparative analysis of Classical Deep Learning and Federated learning techniques

COMPARATIVE ANALYSIS





ANALYSIS

- In terms of the KPIs, the FL model performs better than the classical
- We were able to move the model to the data rather than the data to the model.
- Continual learning is made possible with federated learning than in classical deep learning

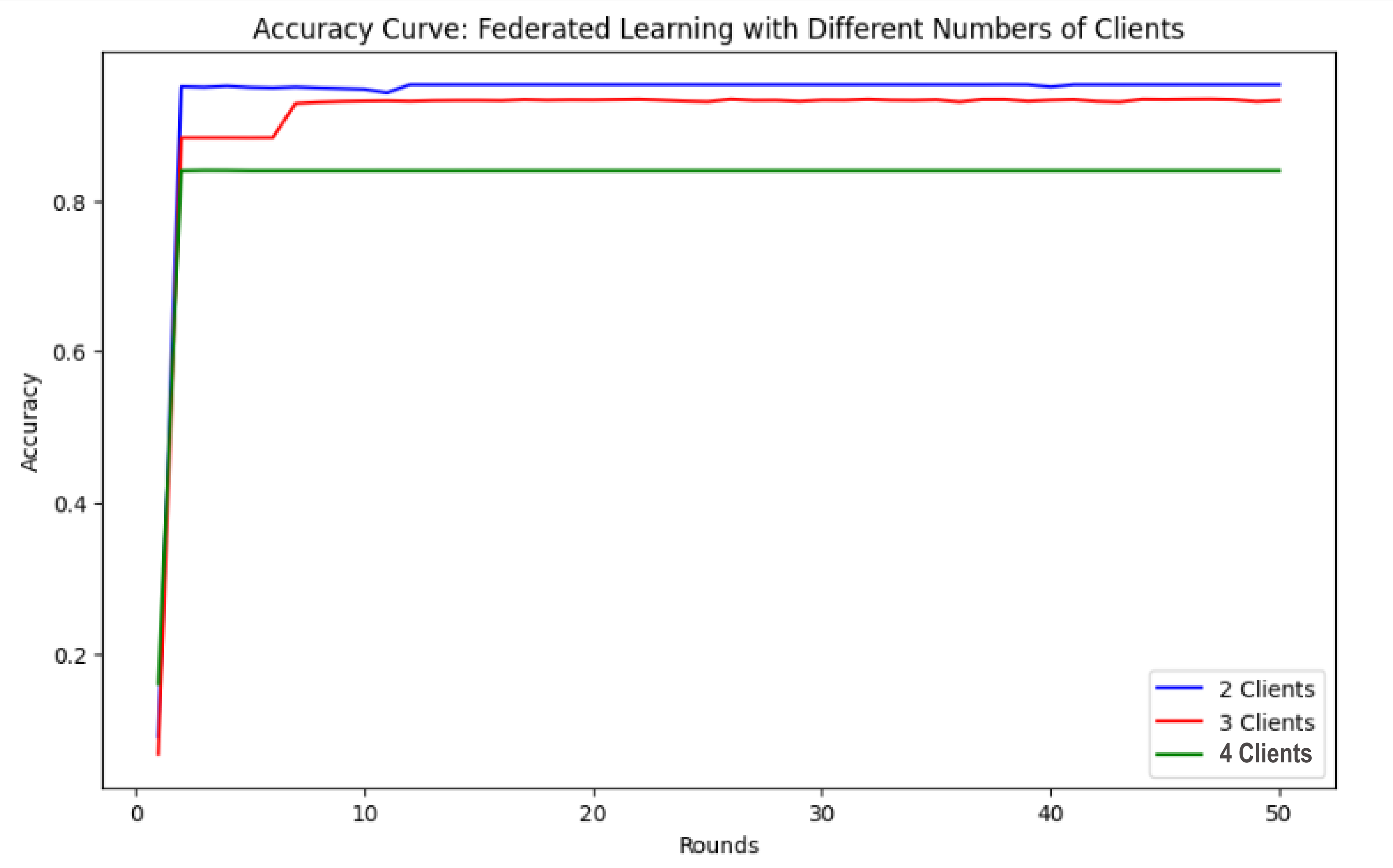
FEDERATED LEARNING RESULTS: NON-IID

PARTITIONING STRATEGIES FOR NON-IID

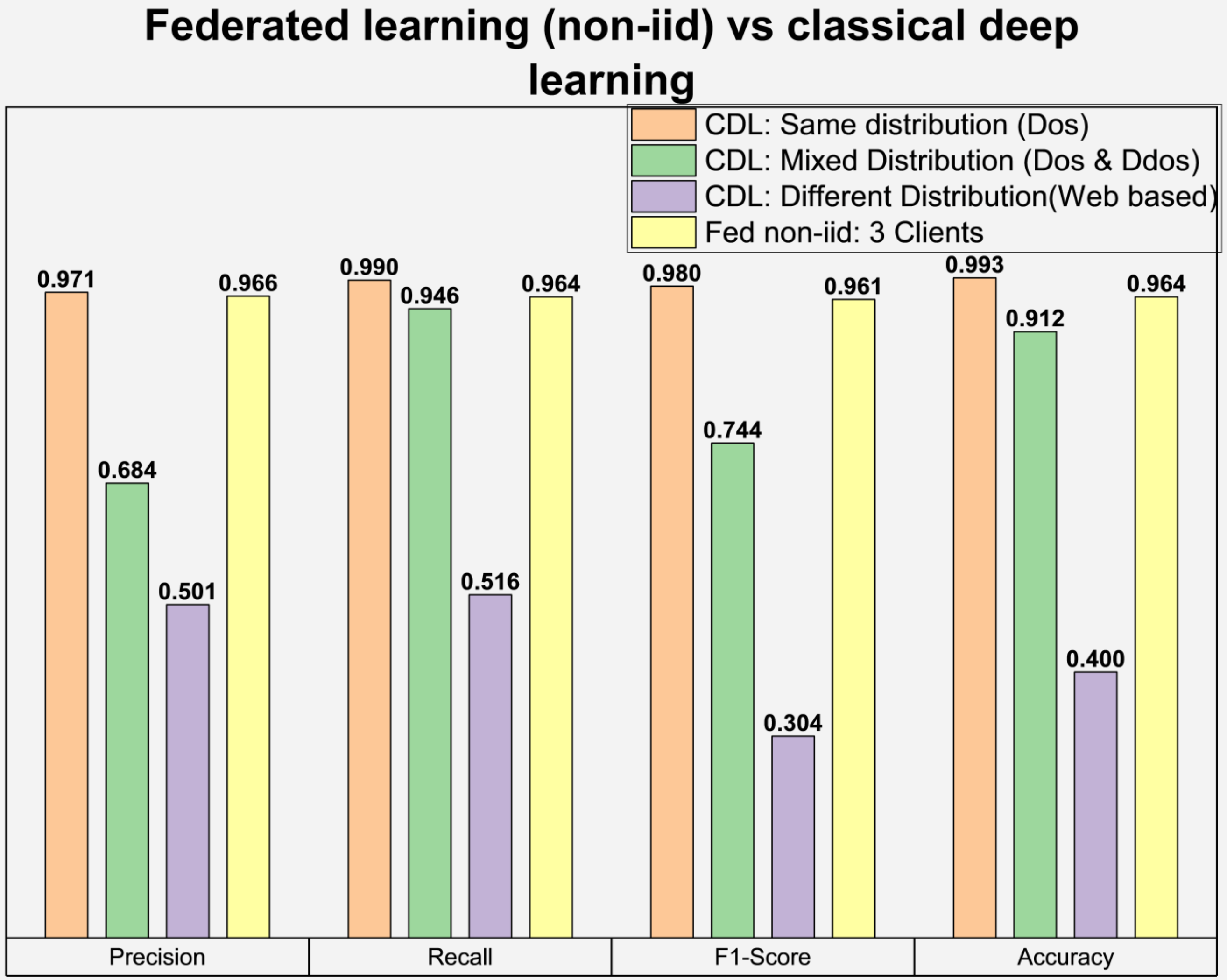
- Label Distribution Skew
- Feature Distribution Skew
- Quantity Distribution Skew

Number of Clients	Main Attacks	Total number of Samples	Label Ratio 0:1
CLIENT 1	DDos	519,478	2:8
CLIENT 2	Web Based	34,306	9:1
CLIENT 3	Spoofing	25,921	6:4
CLIENT 4	Dos	234,299	5:2

FEDERATED LEARNING RESULTS: NON-IID



FEDERATED LEARNING RESULTS: NON-IID CONT'D



CONCLUSION

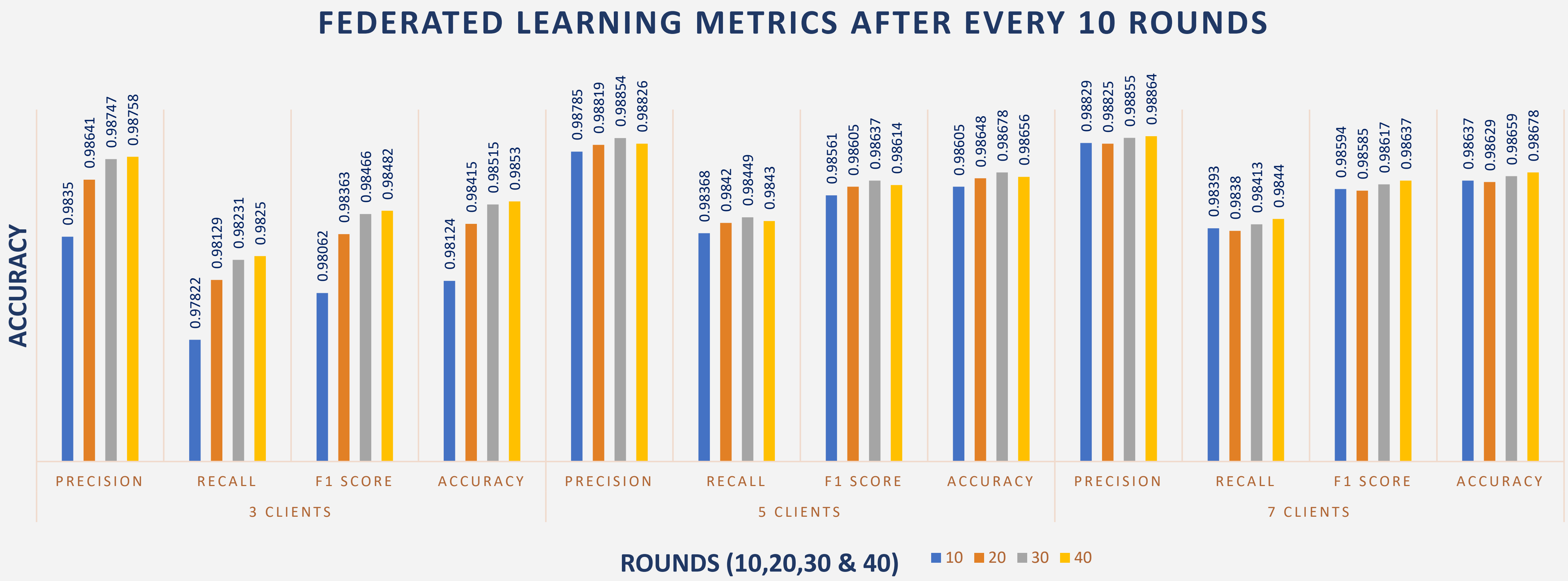
We can detect network anomalies 96.56% of the time if traditional machine learning is used.

However, we can detect network anomalies 98.68% of the time and still preserve privacy if federated learning is used in an IID context.

We can detect anomalies of the same distribution 99.3% of the time, but the system's effectiveness at detecting anomalies of mixed distribution decreases to 91.2% and drops to a 40% detection rate at detecting anomalies of different distributions.

However, federated learning, irrespective of the different distributions and heterogeneity, achieves a 96.4% detection rate.

REFERENCE



Summary of the results

THANK YOU

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