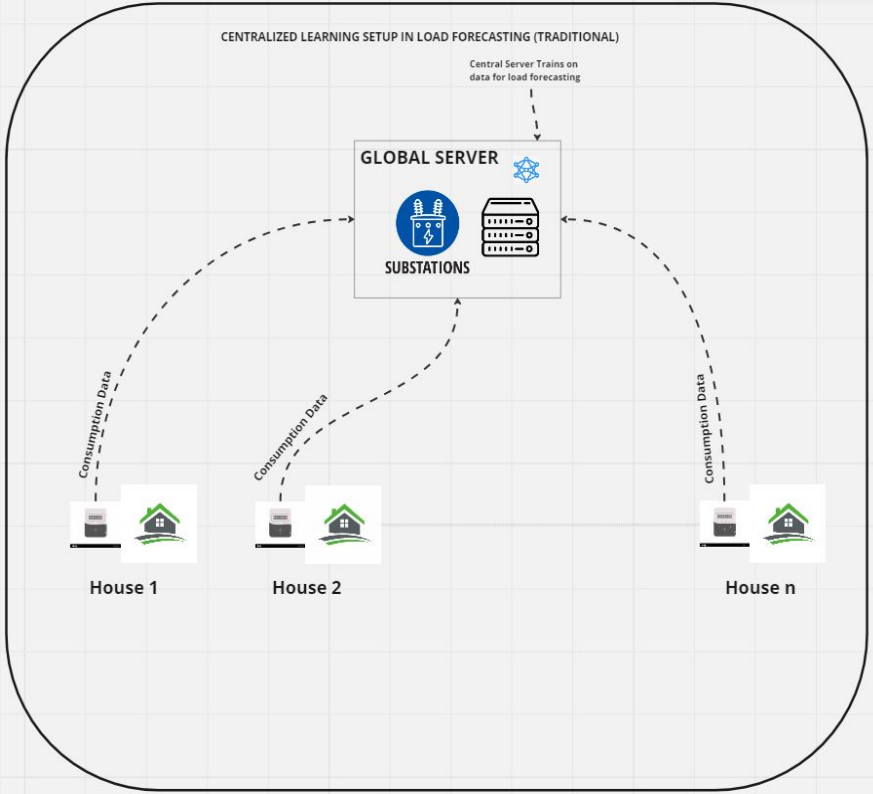
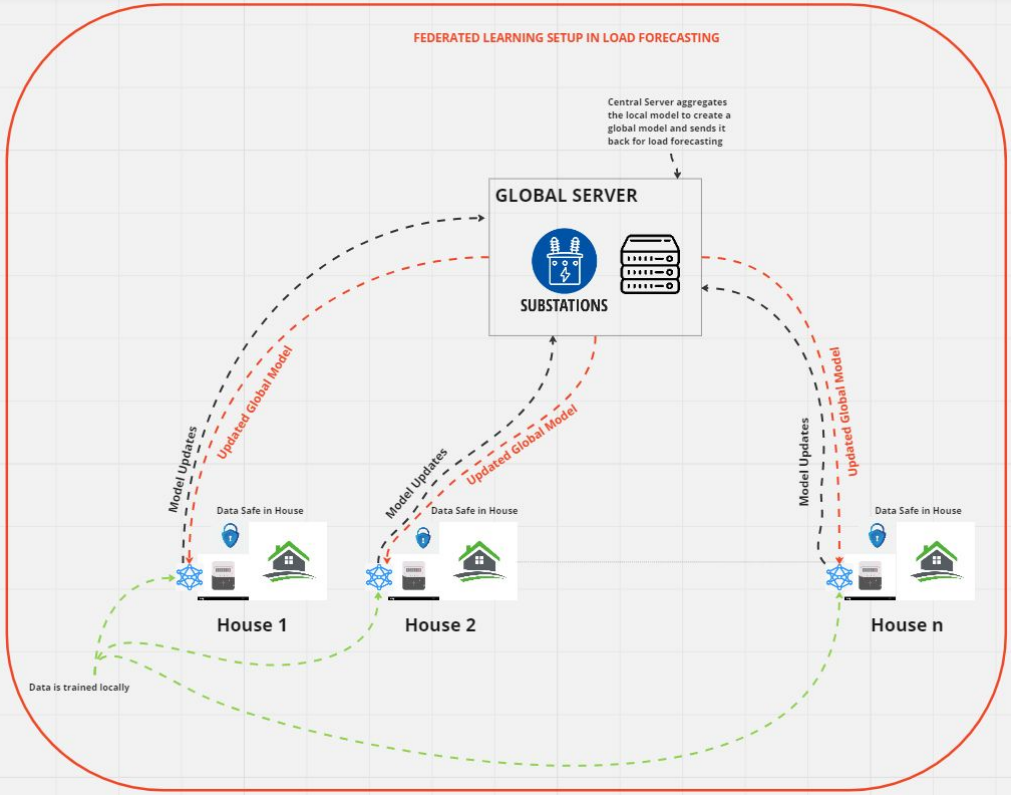
M.sc Thesis - A Federated learning approach towards smart meter dataset using small sequential neural networks

Difference in Approach



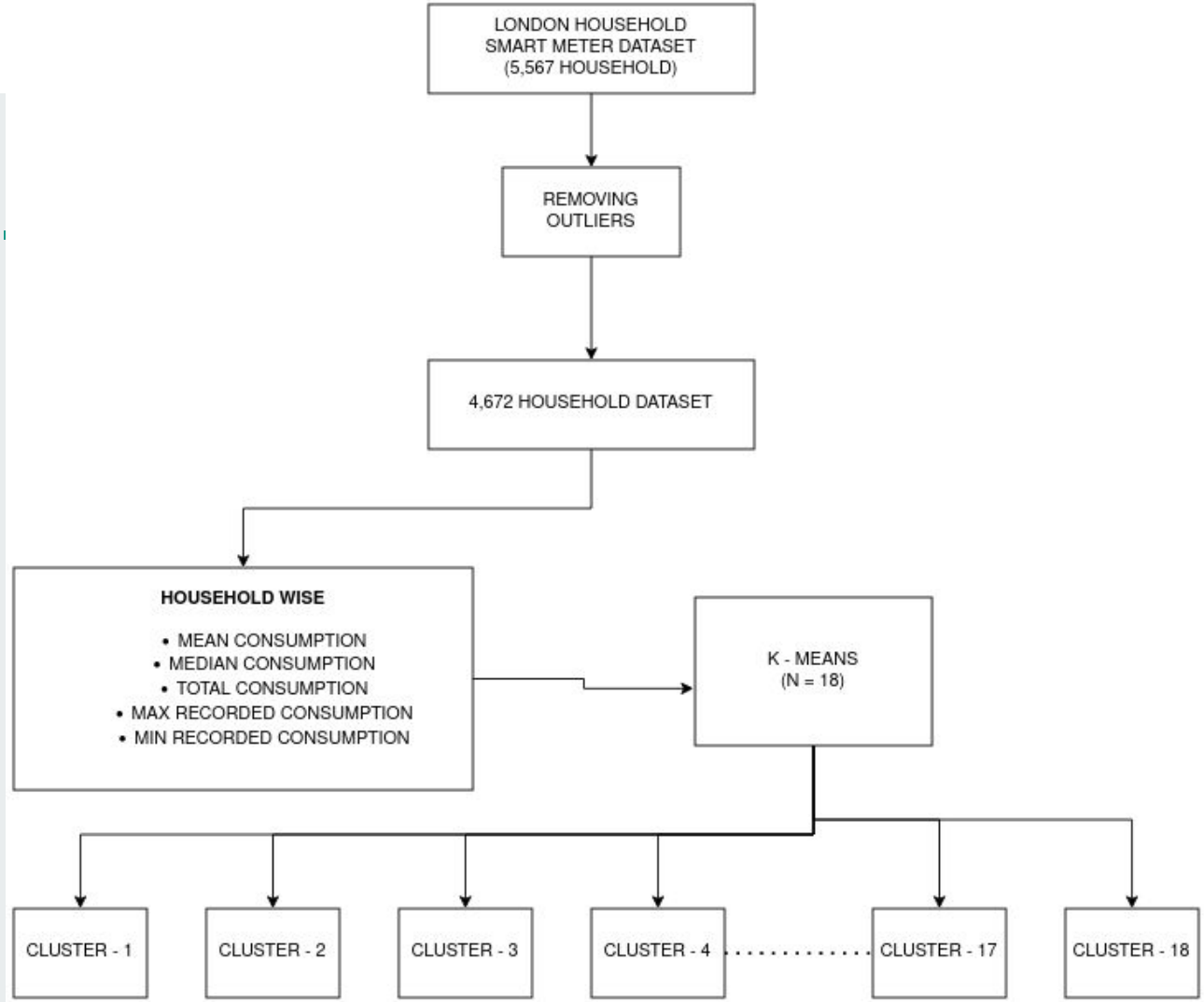


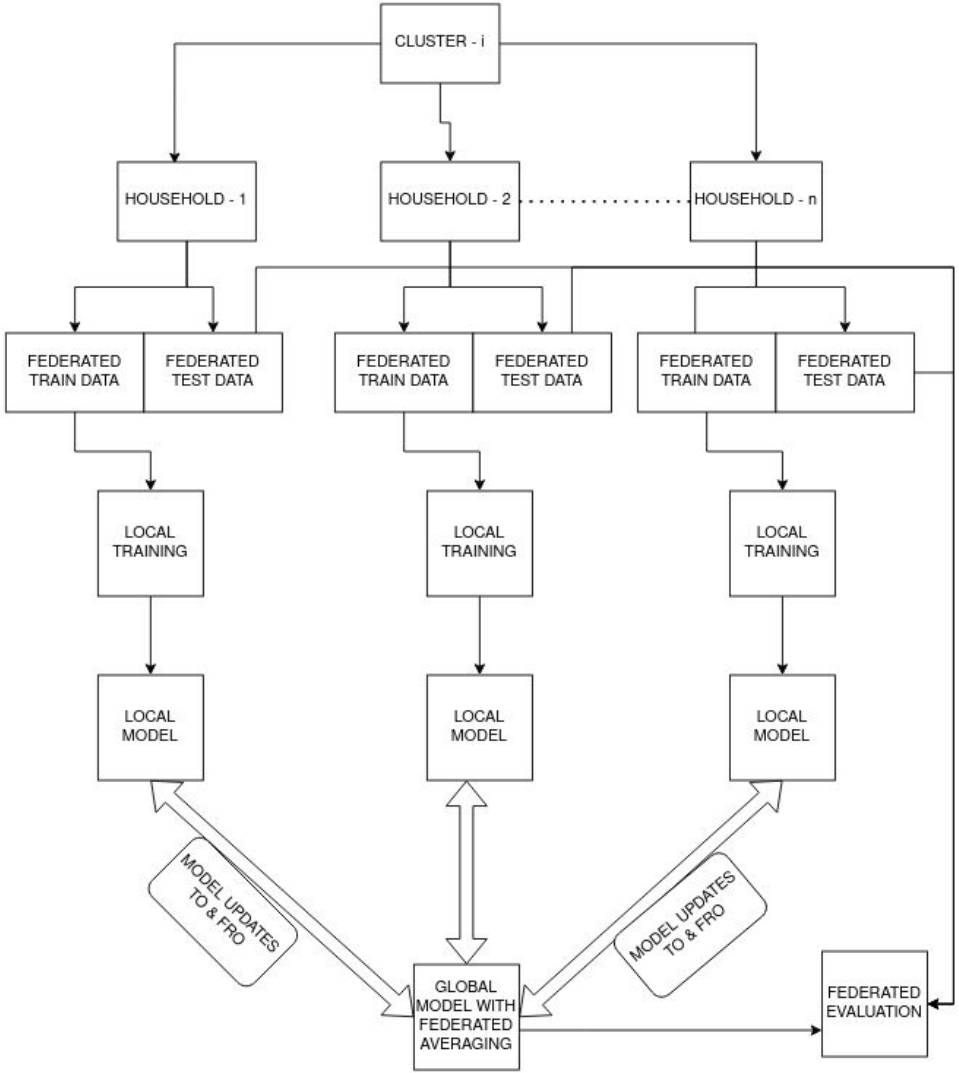
Aim & Objectives

- Application of Federated learning on smart energy meter dataset.
- Tackling data heterogeneity with data clustering prior to application of federated learning.
- Simulate real world non - i.i.d scenario. [Keep minimum client participation ratio and use an algorithm that randomly selects clients every federated computation round.]

Aim & Objectives

- Use small sequential models instead of SOTA complex models, considering edge IOT devices computational capabilities.
- Using metrics RMSE & MAPE, evaluate daily, weekly, monthly and yearly load forecast performance with aim to achieve almost similar performance showing computation vs utility trade off.


LONDON HOUSEHOLD
SMART METER DATASET
(5,567 HOUSEHOLD)
REMOVING
OUTLIERS
4,672 HOUSEHOLD DATASET
HOUSEHOLD WISE
• MEAN CONSUMPTION
• MEDIAN CONSUMPTION
• TOTAL CONSUMPTION
• MAX RECORDED CONSUMPTION
• MIN RECORDED CONSUMPTION
K - MEANS
(N = 18)
CLUSTER - 1
CLUSTER - 2
CLUSTER - 3
CLUSTER - 4
CLUSTER - 17
CLUSTER - 18


CLUSTER - i
HOUSEHOLD - 1
HOUSEHOLD - 2
HOUSEHOLD - n
FEDERATED TRAIN DATA
FEDERATED TEST DATA
FEDERATED TRAIN DATA
FEDERATED TEST DATA
FEDERATED TRAIN DATA
FEDERATED TEST DATA
LOCAL TRAINING
LOCAL TRAINING
LOCAL TRAINING
LOCAL MODEL
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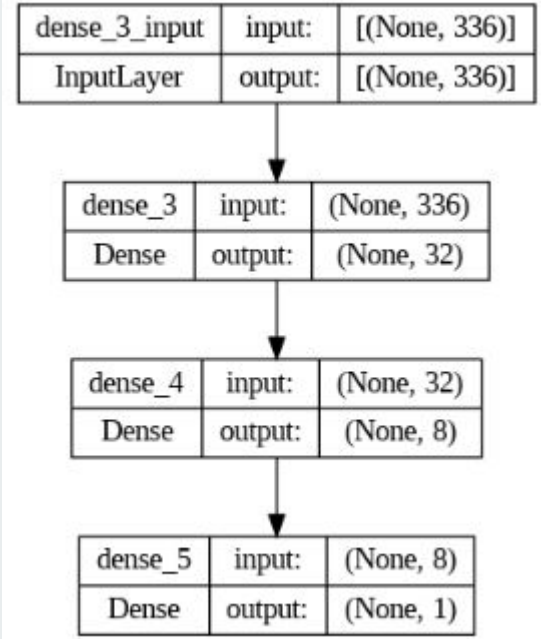
LOCAL MODEL
MODEL UPDATES TO & FRO
MODEL UPDATES TO & FRO
GLOBAL MODEL WITH FEDERATED AVERAGING
FEDERATED EVALUATION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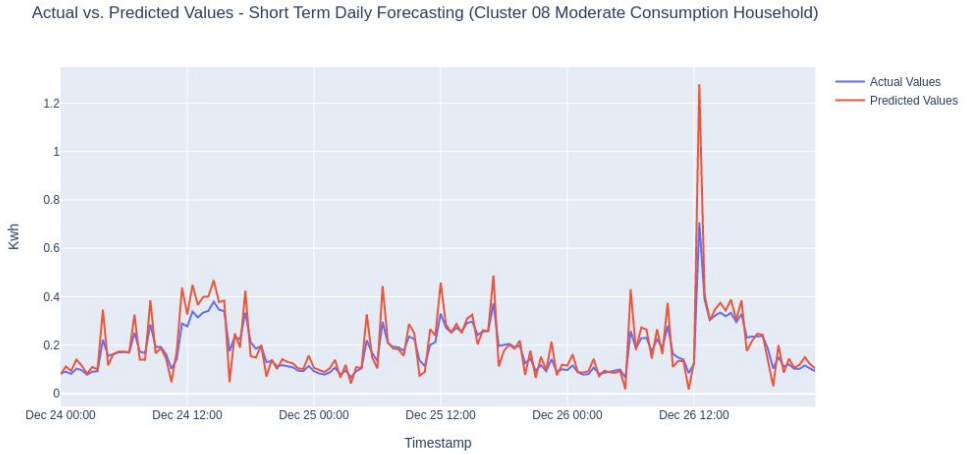
InputLayer | output: | [(None, 336)]
dense_3 | input: | (None, 336)
Dense | output: | (None, 32)
dense_4 | input: | (None, 32)
Dense | output: | (None, 8)
dense_5 | input: | (None, 8)
Dense | output: | (None, 1)

M.sc Thesis - Results (Cluster - 08)

Table 5.2 Monthly Load Forecasting RMSE - Comparison between different Households - Cluster 08

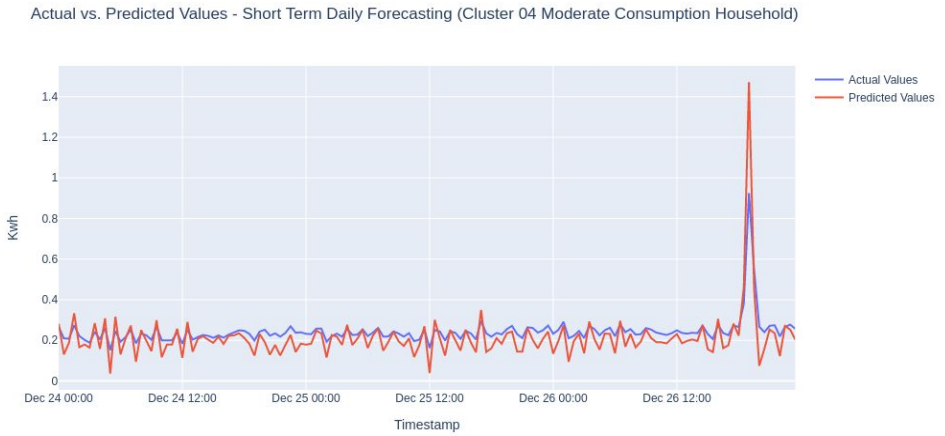
Month	Client Type (RMSE)			
	Moderate (All)	Moderate (Non-i.i.d)	High (Non-i.i.d)	Low (Non-i.i.d)
January	0.0636	0.1465	0.2507	0.0778
February	0.0633	0.1213	0.2581	0.0665
March	0.0623	0.2346	0.2875	0.0760
April	0.0544	0.1320	0.1531	0.0797
May	0.0570	0.1612	0.0866	0.0740
June	0.0621	0.1316	0.0583	0.0752
July	0.0638	0.1329	0.1690	0.7425
August	0.0662	0.1345	0.2217	0.7119
September	0.0528	0.0866	0.1417	0.0730
October	0.0611	0.1222	0.1896	0.0695
November	0.0539	0.1383	0.2505	0.0684
December	0.0650	0.1357	0.2484	0.0787



M.sc Thesis - Results (Cluster - 04)

Table 5.3 Monthly Load Forecasting RMSE - Comparison between different Households - Cluster 04

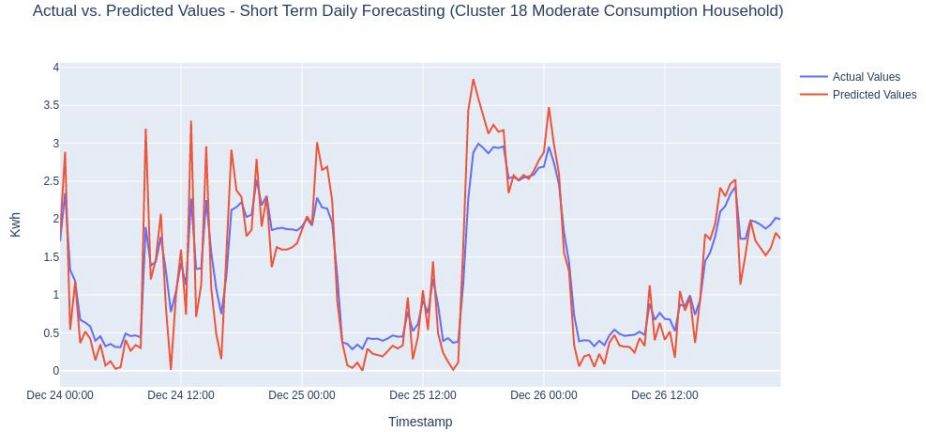
Month	Client Type (RMSE)			
	Moderate (All)	High (All)	Low (All)	Moderate (Non-i.i.d)
January	0.1839	0.2073	0.1364	0.1512
February	0.1894	0.2114	0.1496	0.1403
March	0.1762	0.2123	0.1779	0.2300
April	0.1766	0.1771	0.1530	0.1860
May	0.1802	0.1902	0.1430	0.1450
June	0.1606	0.1563	0.1366	0.1004
July	0.1430	0.1758	0.1090	0.1311
August	0.1772	0.1920	0.1344	0.1217
September	0.1705	0.2027	0.1300	0.1515
October	0.1574	0.1978	0.1483	0.1426
November	0.1771	0.2036	0.1481	0.1768
December	0.2034	0.2165	0.1695	0.1342



M.sc Thesis - Results (Cluster - 18)

Table 5.4 Monthly Load Forecasting RMSE - Comparison between different Households - Cluster 18

Month	Client Type (RMSE)			
	Moderate (All)	High (All)	Moderate (Non-i.i.d)	High (Non-i.i.d)
January	0.3454	0.4012	0.3843	0.7139
February	0.3638	0.2843	0.3833	0.7333
March	0.3311	0.3604	0.5887	0.2769
April	0.3400	0.2998	0.4700	0.2600
May	0.3612	0.2950	0.4467	0.2040
June	0.5078	0.2677	0.3242	0.1981
July	0.5822	0.3106	0.2715	0.2008
August	0.4927	0.2700	0.2477	0.1933
September	0.4034	0.2700	0.3371	0.5429
October	0.3970	0.2626	0.3404	0.6637
November	0.3827	0.2880	0.4619	0.7876
December	0.3551	0.3193	0.4515	0.7373



M.sc Thesis - Results (Average)

Table 5.5 Analysing Performance for Different Clusters and Scenarios

Clusters	Aggregation	Normal Scenario			Worst Case Scenario		
		MAE	RMSE	MAPE	MAE	RMSE	MAPE
8	Average - Monthly	0.0377	0.0604	23.26%	0.1449	0.1929	46.75%
4	Average - Monthly	0.0854	0.1509	26.68%	0.1153	0.1953	31.58%
18	Average - Monthly	0.2052	0.3024	16.09%	0.4203	0.4593	27.06%

Table 5.6 RMSE Results in Federated and Centralized Setup for Different Clusters

Cluster	Setup	Mean RMSE	Max RMSE	Min RMSE	Std. Dev. RMSE
08	Federated	0.0605	0.0662	0.0528	0.0045
08	Centralized	0.0663	0.0868	0.0557	0.0082
04	Federated	0.1509	0.2300	0.1004	0.0322
04	Centralized	0.1952	0.2152	0.1570	0.0161
18	Federated	0.3024	0.4012	0.2626	0.0398
18	Centralized	0.2772	0.3306	0.2505	0.0219

Results Comparison

Same Dataset : London Household

Table 5.7 Comparison of RMSE between Our Proposed Model and M. Savi Model

Month	Our Proposed Model (RMSE)	M. Savi Model (RMSE)
January	0.2053	0.1463
February	0.1626	0.153
March	0.2176	0.1535
April	0.1800	0.1345
May	0.1657	0.1304
June	0.1434	0.1259
July	0.1685	0.1057
August	0.1526	0.1106
September	0.1581	0.1302
October	0.1554	0.1335
November	0.1729	0.1471
December	0.1728	0.1328

Small DNN : 5500 parameter, Total Houses = 42

LSTM Model : 9000 parameter, Total Houses = 80
Results of Which Cluster ?, MAPE ?

Different Dataset : But MAPE there to compare

Table 5.8 Comparison of Participation Ratio, Number of Rounds, and Average MAPE

Model	Participation Ratio	No of Rounds	Avg MAPE
Taik's Model	36%	5	34.14%
Our Proposed Model	10.50%	20	22.01%

THANK YOU