

Bảng kết quả (%) của mô hình huấn luyện tập trung và phân tán (FedAvg, dữ liệu IID) trên MNIST và CIFAR-10

		$acc_{micro}$	$acc_{macro}$	$P_{macro}$	$R_{macro}$	$F1_{macro}$
MNIST	Centralized	<b>97.07</b>	-	<b>97.04</b>	<b>97.03</b>	<b>97.04</b>
	FedAvg (IID)	90.36	90.34±2.24	90.37±2.29	90.25±2.22	90.12±2.29
CIFAR-10	Centralized	<b>61.91</b>	-	<b>61.7</b>	<b>62.01</b>	<b>61.72</b>
	FedAvg (IID)	53.83	53.83±3.14	53.46±3.19	53.85±3.26	53±3.21

Bảng kết quả (%) trên người dùng cục bộ của tập dữ liệu MNIST

	$acc_{micro}$	$acc_{macro}$	$P_{macro}$	$R_{macro}$	$F1_{macro}$
FedAvg	85.03	82.14±14.76	82.03±13.88	81.54±14.33	79.43±16.83
FedPer	77.29	75.48±14.84	76.07±14.99	74.01±15.13	72.32±15.99
FedAvgMeta	84.84	81.56±16.68	80.71±17.02	81.18±16.16	78.31±19.8
FedPerMeta	75.91	74.11±16.2	75.68±15.94	72.93±15.58	71.22±16.77
FedMeta(MAML)	92.99	91.14±5.99	90.56±6.24	90.98±5.9	90.16±6.28
FedMeta(Meta-SGD)	98.02	96.35±4.62	96.49±4.1	95.64±5.94	95.80±5.51
<b>FedMeta-Per(MAML)</b>	<b>99.37</b>	<b>99.12±1.29</b>	<b>99.11±1.3</b>	<b>98.82±1.99</b>	<b>98.94±1.6</b>
<b>FedMeta-Per(Meta-SGD)</b>	98.92	98.15±3.32	98.42±1.95	98.42±1.96	98.20±2.94

Bảng kết quả (%) trên người dùng mới của tập dữ liệu MNIST

	$acc_{micro}$	$acc_{macro}$	$P_{macro}$	$R_{macro}$	$F1_{macro}$
FedAvg	83.92	81.69±19.71	79.57±20.18	80.46±17.84	77.66±22.54
FedPer	78.3	76.19±18.79	75.91±17.52	74.73±17.32	72.72±19.3
FedAvgMeta	84.34	82.37±17.42	81.38±16.25	80.91±15.62	78.78±19.31
FedPerMeta	77.47	75.56±20.33	75.09±19.52	74.92±18.85	72.60±21.37
FedMeta(MAML)	92.96	91.88±5.88	90.14±7.97	90.74±5.95	90.02±7.34
FedMeta(Meta-SGD)	96.39	93.53±8.39	93.73±10.26	88.65±14.06	89.31±14.56
<b>FedMeta-Per(MAML)</b>	93.6	93.57±5.58	93.64±5.56	90.98±6.98	91.83±6.43
<b>FedMeta-Per(Meta-SGD)</b>	<b>96.62</b>	<b>95.88±3.58</b>	<b>95.73±4.11</b>	<b>94.34±5.05</b>	<b>94.85±4.61</b>

Bảng kết quả (%) trên người dùng cục bộ của tập dữ liệu CIFAR-10

	$acc_{micro}$	$acc_{macro}$	$P_{macro}$	$R_{macro}$	$F1_{macro}$
FedAvg	19.02	19.29±25.11	15.57±23.7	20.65±25.55	16.85±23.92
FedPer	13.22	12.99±19.39	18.34±28.59	14.14±20.83	10.52±14.91
FedAvgMeta	40.3	38.47±31.52	32.84±32.06	39.33±30.35	33.81±30.61
FedPerMeta	18.57	17.48±22.55	20.02±27.4	18.43±23.47	14.54±18.67
FedMeta(MAML)	69.02	68.76±14.86	67.42±21.16	66.56±13.48	61.14±20
FedMeta(Meta-SGD)	78.63	78.73±11.59	74.65±21.12	75.25±14.09	72.87±18.31
<b>FedMeta-Per(MAML)</b>	<b>86.6</b>	<b>86.52±6.31</b>	<b>86.43±5.88</b>	<b>85.47±6.87</b>	<b>85.33±6.77</b>
<b>FedMeta-Per(Meta-SGD)</b>	85.61	85.68±7.22	86.26±6.35	85.36±6.83	85.08±7.32

Bảng kết quả (%) trên người dùng mới của tập dữ liệu CIFAR-10

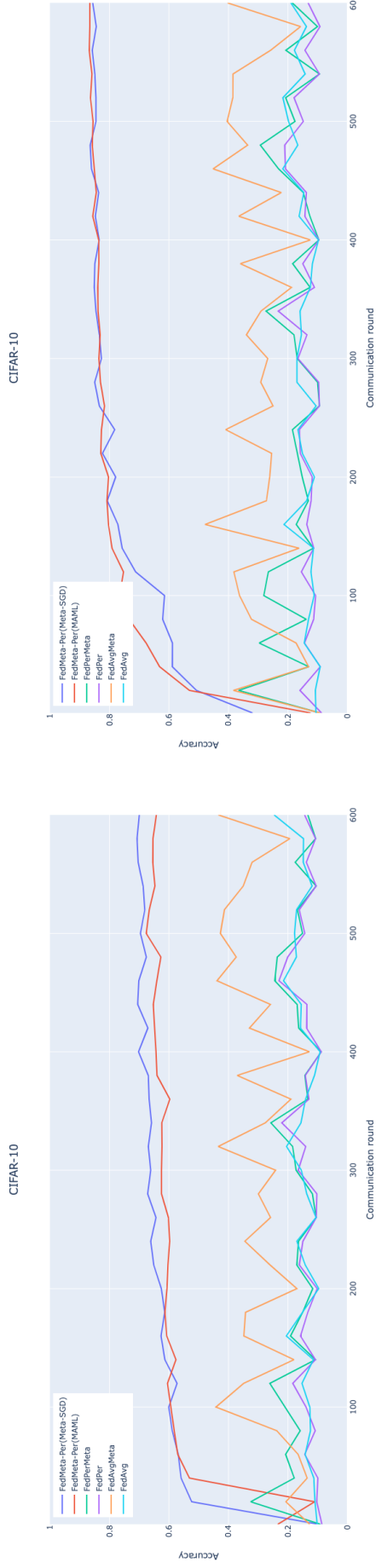
	$acc_{micro}$	$acc_{macro}$	$P_{macro}$	$R_{macro}$	$F1_{macro}$
FedAvg	24.63	24.83±22.57	18.36±20.15	24.44±21.95	20.52±20.45
FedPer	14.4	14.52±20.15	12.59±20.65	14.23±19.58	10.66±13.79
FedAvgMeta	43.39	43.54±18	33.45±21.44	42.87±16.98	35.14±17.22
FedPerMeta	13.33	13.57±19.62	11.99±19.52	13.53±19.08	10.05±13.17
FedMeta(MAML)	61.69	61.64±12.49	52.66±26.06	59.94±12.35	50.76±19.2
FedMeta(Meta-SGD)	68.36	67.89±15.11	<b>70.3±22.37</b>	66.86±15.02	60.24±21.52
<b>FedMeta-Per(MAML)</b>	64.22	63.70±12.29	57.06±24.99	61.63±12.66	53.68±19.06
<b>FedMeta-Per(Meta-SGD)</b>	<b>69.97</b>	<b>69.13±14.63</b>	66.53±24.91	<b>67.82±15.34</b>	<b>62.42±20.94</b>

Bảng 1: Bảng kết quả (%) trên tập dữ liệu CIFAR-10

		$acc_{micro}$	$acc_{macro}$	$P_{macro}$	$R_{macro}$	$F1_{macro}$
local client	FedAvg	19.02	19.29±25.11	15.57±23.7	20.65±25.55	16.85±23.92
	FedPer	13.22	12.99±19.39	18.34±28.59	14.14±20.83	10.52±14.91
	FedAvgMeta	40.3	38.47±31.52	32.84±32.06	39.33±30.35	33.81±30.61
	FedPerMeta	18.57	17.48±22.55	20.02±27.4	18.43±23.47	14.54±18.67
	FedMeta(MAML)	69.02	68.76±14.86	67.42±21.16	66.56±13.48	61.14±20
	FedMeta(Meta-SGD)	78.63	78.73±11.59	74.65±21.12	75.25±14.09	72.87±18.31
	<b>FedMeta-Per(MAML)</b>	<b>86.6</b>	<b>86.52±6.31</b>	<b>86.43±5.88</b>	<b>85.47±6.87</b>	<b>85.33±6.77</b>
	<b>FedMeta-Per(Meta-SGD)</b>	85.61	85.68±7.22	86.26±6.35	85.36±6.83	85.08±7.32
new client	FedAvg	24.63	24.83±22.57	18.36±20.15	24.44±21.95	20.52±20.45
	FedPer	14.4	14.52±20.15	12.59±20.65	14.23±19.58	10.66±13.79
	FedAvgMeta	43.39	43.54±18	33.45±21.44	42.87±16.98	35.14±17.22
	FedPerMeta	13.33	13.57±19.62	11.99±19.52	13.53±19.08	10.05±13.17
	FedMeta(MAML)	61.69	61.64±12.49	52.66±26.06	59.94±12.35	50.76±19.2
	FedMeta(Meta-SGD)	68.36	67.89±15.11	<b>70.3±22.37</b>	66.86±15.02	60.24±21.52
	<b>FedMeta-Per(MAML)</b>	64.22	63.70±12.29	57.06±24.99	61.63±12.66	53.68±19.06
	<b>FedMeta-Per(Meta-SGD)</b>	<b>69.97</b>	<b>69.13±14.63</b>	66.53±24.91	<b>67.82±15.34</b>	<b>62.42±20.94</b>

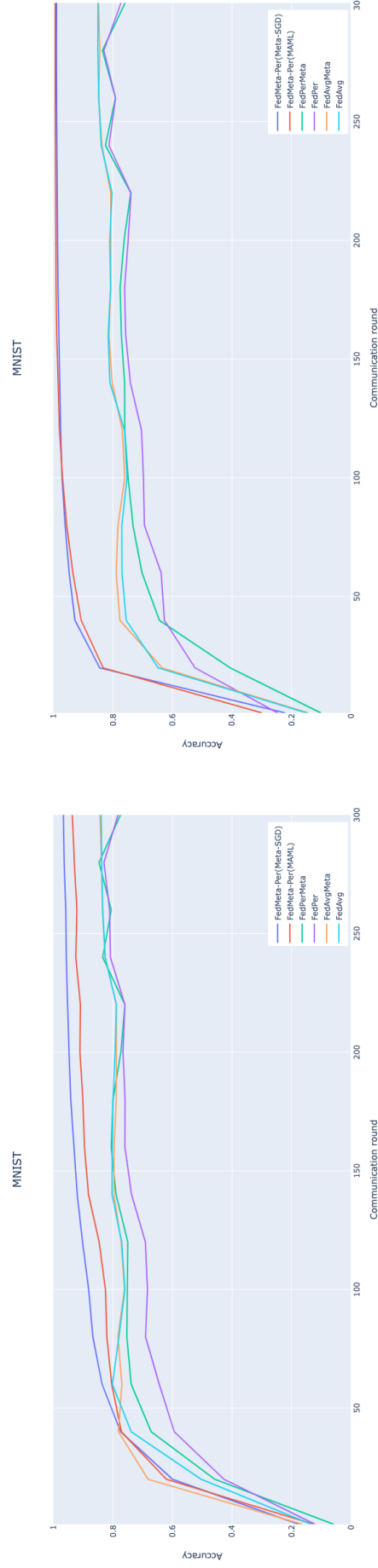
Bảng 2: Bảng kết quả (%) trên tập dữ liệu MNIST

		$acc_{micro}$	$acc_{macro}$	$P_{macro}$	$R_{macro}$	$F1_{macro}$
local client	FedAvg	85.03	82.14±14.76	82.03±13.88	81.54±14.33	79.43±16.83
	FedPer	77.29	75.48±14.84	76.07±14.99	74.01±15.13	72.32±15.99
	FedAvgMeta	84.84	81.56±16.68	80.71±17.02	81.18±16.16	78.31±19.8
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	FedMeta(MAML)	92.99	91.14±5.99	90.56±6.24	90.98±5.9	90.16±6.28
	FedMeta(Meta-SGD)	98.02	96.35±4.62	96.49±4.1	95.64±5.94	95.80±5.51
	<b>FedMeta-Per(MAML)</b>	<b>99.37</b>	<b>99.12±1.29</b>	<b>99.11±1.3</b>	<b>98.82±1.99</b>	<b>98.94±1.6</b>
	<b>FedMeta-Per(Meta-SGD)</b>	98.92	98.15±3.32	98.42±1.95	98.42±1.96	98.20±2.94
new client	FedAvg	83.92	81.69±19.71	79.57±20.18	80.46±17.84	77.66±22.54
	FedPer	78.3	76.19±18.79	75.91±17.52	74.73±17.32	72.72±19.3
	FedAvgMeta	84.34	82.37±17.42	81.38±16.25	80.91±15.62	78.78±19.31
	FedPerMeta	77.47	75.56±20.33	75.09±19.52	74.92±18.85	72.60±21.37
	FedMeta(MAML)	92.96	91.88±5.88	90.14±7.97	90.74±5.95	90.02±7.34
	FedMeta(Meta-SGD)	96.39	93.53±8.39	93.73±10.26	88.65±14.06	89.31±14.56
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	<b>FedMeta-Per(Meta-SGD)</b>	<b>96.62</b>	<b>95.88±3.58</b>	<b>95.73±4.11</b>	<b>94.34±5.05</b>	<b>94.85±4.61</b>



(a) CIFAR-10, new clients

(b) CIFAR-10, local clients



(c) MNIST, new clients

(d) MNIST, local clients

FedMeta-Per vs. (FedAvg, FedAvgMeta, FedPer, FedPerMeta)

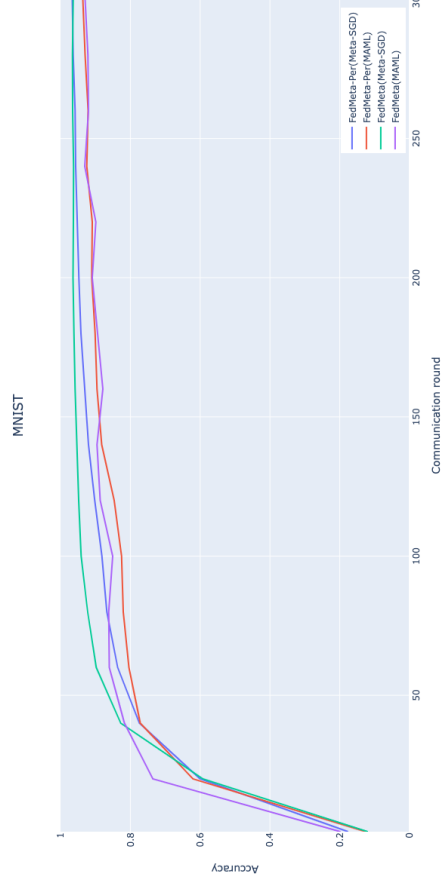


(a) CIFAR-10, new clients

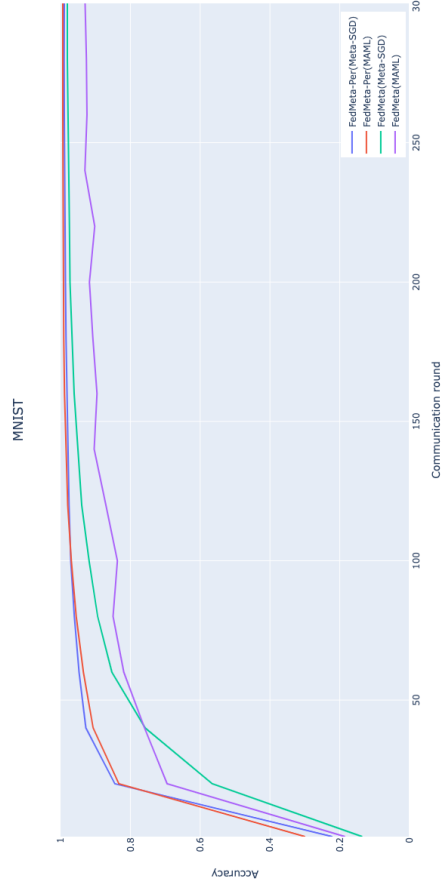


(b) CIFAR-10, local clients

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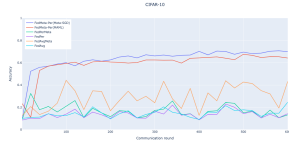


(c) MNIST, new clients

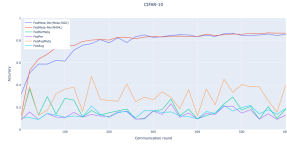


(d) MNIST, local clients

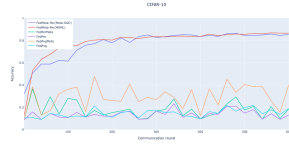
FedMeta-Per vs. FedMeta



(a) CIFAR-10, new clients



(b) CIFAR-10, local clients



(c) CIFAR-10, local clients



(d) CIFAR-10, local clients