FedPD: Personalized Federated Learning based on Partial Distillation

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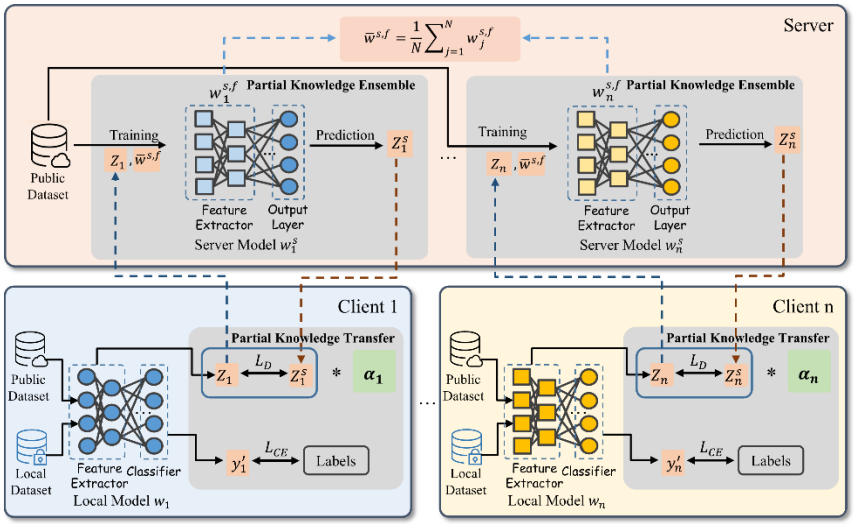
Problems & Ideas

- Problems of conventional federated distillation methods:
  - Existing federated distillation methods do not take into account the importance of different distillation knowledge to the client.
  - Significant biases may exist in client knowledge, potentially compromising the quality of linear aggregated global knowledge.
- Ideas: A personalized federated distillation method that selectively transfers and ensembles knowledge based on client relevance.



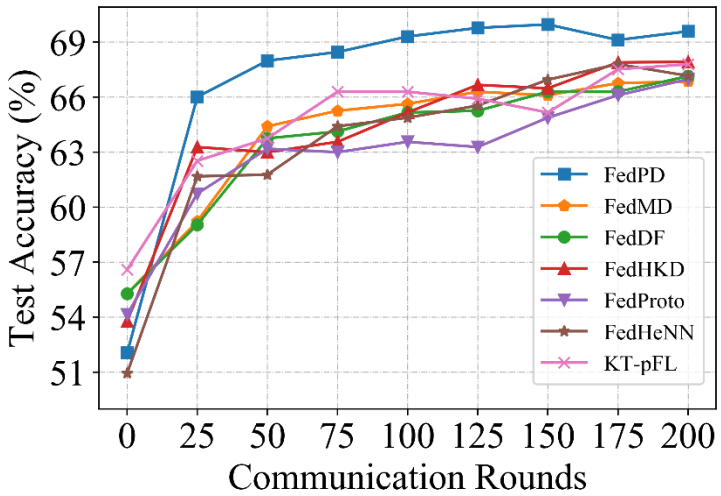
The framework of FedPD. In each round, the client n selects distillation knowledge based on partial distillation coefficient α_n. The server model is trained based on the client knowledge Z_n and the global basic model $\bar{\omega}^{s,f}$, and extracts the corresponding distillation knowledge Z_n^s for the client n.

Main Contributions

- Contributions:
  - A novel personalized federated learning method called FedPD, which leverages partial distillation to achieve selective knowledge transfer, thereby improving the performance of client models;
  - A PKT module, which uses the partial distillation coefficient to measure the importance of different distillation knowledge, enabling more effective distillation for clients;
  - A PKE module, which integrates distillation knowledge for each client to guide their training, thereby enhancing client model performance.

Methods	20 clients, β=0.1															
	CIFAR10				CIFAR100				EMNIST				FMNIST			
	ACC	PRE	REC	AUC	ACC	PRE	REC	AUC	ACC	PRE	REC	AUC	ACC	PRE	REC	AUC
FedMD[NIPS19] [25]	66.91	53.06	66.58	76.86	63.15	50.96	63.58	79.98	89.85	86.33	90.48	98.54	85.47	79.28	85.28	96.16
FedDF[NIPS20] [24]	67.15	55.79	60.00	74.91	63.61	51.70	58.23	77.01	90.67	89.23	88.43	98.47	82.07	80.50	80.20	94.83
KT-pFL[NIPS21] [28]	67.80	53.02	65.56	74.25	62.37	48.28	61.75	74.46	91.59	88.91	91.64	98.80	87.56	83.59	87.02	96.33
FedHeNN[ICML22] [26]	67.89	58.62	67.62	76.70	65.65	53.68	63.36	78.97	92.26	90.90	92.34	98.59	87.73	83.51	86.78	96.45
FedProto[AAAI22] [36]	66.97	56.83	66.75	75.47	63.61	51.01	61.48	76.34	87.45	80.59	85.97	96.51	83.56	75.77	83.28	93.53
FedHKD[ICLR23] [42]	67.15	58.01	67.58	76.16	64.85	51.41	63.95	78.92	93.01	91.32	92.75	98.69	87.82	86.00	88.13	96.57
FedPD(Our)	**69.94** (2.05↑)	**62.75** (4.13↑)	**69.72** (2.10↑)	**79.45** (2.59↑)	**68.14** (2.49↑)	**58.14** (4.46↑)	**69.06** (5.11↑)	**83.68** (3.78↑)	**94.21** (1.20↑)	**93.74** (2.42↑)	**94.15** (1.40↑)	**98.91** (0.11↑)	**89.98** (2.16↑)	**89.86** (3.86↑)	**90.32** (2.19↑)	**97.02** (0.45↑)

Methods	50 clients, β=0.1															
	CIFAR10				CIFAR100				EMNIST				FMNIST			
	ACC	PRE	REC	AUC	ACC	PRE	REC	AUC	ACC	PRE	REC	AUC	ACC	PRE	REC	AUC
FedMD[NIPS19] [25]	68.69	57.42	68.86	73.99	67.32	54.87	66.67	74.47	90.86	87.47	90.83	97.96	87.14	83.22	87.34	95.35
FedDF[NIPS20] [24]	52.78	57.31	52.30	78.62	51.84	54.93	51.38	77.44	90.54	90.68	90.61	97.70	79.54	86.10	77.25	95.43
KT-pFL[NIPS21] [28]	69.53	59.55	69.43	71.32	66.01	55.62	65.98	70.18	92.04	90.21	91.99	98.37	88.30	85.79	88.35	95.89
FedHeNN[ICML22] [26]	72.10	64.08	71.77	77.29	68.17	58.19	68.23	77.47	92.54	90.73	92.56	97.87	88.72	87.12	88.77	95.82
FedProto[AAAI22] [36]	71.81	63.68	71.95	76.48	68.18	59.44	68.71	77.24	87.16	89.94	91.93	97.04	88.76	88.01	88.42	95.90
FedHKD[ICLR23] [42]	71.69	63.79	71.85	77.03	68.74	59.49	69.11	77.18	93.10	91.41	93.11	97.97	89.34	88.26	89.56	96.15
FedPD(Our)	**74.46** (2.36↑)	**69.65** (5.57↑)	**74.52** (2.57↑)	**82.58** (3.96↑)	**74.18** (5.44↑)	**69.60** (10.11↑)	**73.06** (3.95↑)	**84.30** (6.83↑)	**94.20** (1.10↑)	**93.83** (2.42↑)	**94.45** (1.34↑)	**98.27** (0.30↑)	**90.53** (1.19↑)	**90.62** (2.36↑)	**90.70** (1.14↑)	**96.42** (0.27↑)



Left: Test accuracy (ACC), Precision (PRE), Recall (REC), and AUC-ROC (%) of FedPD and other baseline methods on CIFAR10, CIFAR100, EMNSIT, and FMNIST datasets and various heterogeneous settings with β=0.1. Right: Performance comparison of different methods on CIFAR10 dataset.