FedAIMS: Personalized Federated Learning with Adaptive Intermediate Supervision

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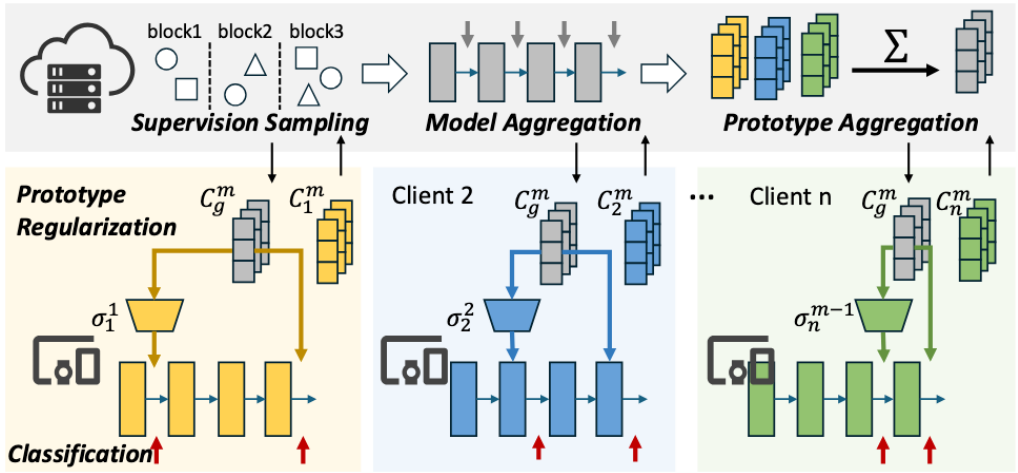
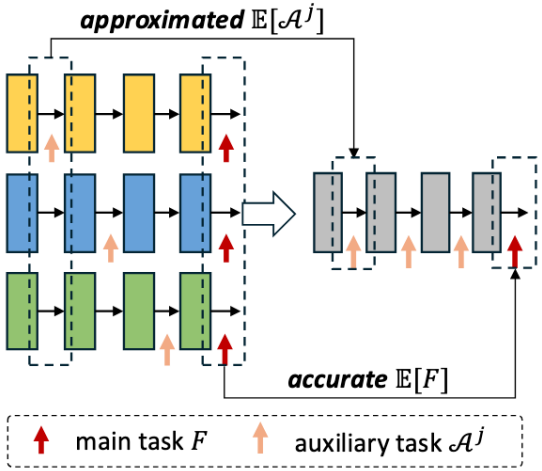
Problems & Ideas

- Personalized Federated Learning:
  - PFL enables clients to collaboratively train models tailored to their local data.
  - Existing solutions focus solely on optimizing the final output layer, overlooking hierarchical feature representations learned at intermediate layers
- Ideas:
  - FedAIMS enables lightweight yet effective intermediate supervision in PFL through federated prototype alignment and adaptive supervision sampling



FedAIMS overview



Reformulating intermediate supervision

Main Contributions

- Contributions:
  - The first work that integrates intermediate supervision into PFL.
  - A novel adaptive intermediate supervision framework for PFL, balancing supervision and efficiency through feature alignment and adaptive sampling.
  - Experiments on diverse datasets show that FedAIMS outperforms PFL baselines by up to 36.76% in accuracy.

Method	EMNIST		CIFAR-10		CIFAR-100		TinyImageNet	
	Dir(0.3)	Dir(0.1)	Dir(0.3)	Dir(0.1)	Dir(0.3)	Dir(0.1)	Dir(0.3)	Dir(0.1)
Local	$77.98_{\pm 7.76}$	$87.72_{\pm 8.08}$	$66.69_{\pm 13.15}$	$80.49_{\pm 16.30}$	$23.48_{\pm 5.25}$	$41.04_{\pm 10.39}$	$19.10_{\pm 13.40}$	$32.47_{\pm 15.75}$
FedAvg [2]	$79.40_{\pm 6.48}$	$79.51_{\pm 9.96}$	$26.26_{\pm 16.48}$	$14.00_{\pm 28.08}$	$31.54_{\pm 5.28}$	$20.19_{\pm 6.76}$	$19.64_{\pm 4.90}$	$11.01_{\pm 4.43}$
FedProx [21]	$81.64_{\pm 5.58}$	$79.31_{\pm 9.66}$	$62.47_{\pm 13.43}$	$56.85_{\pm 14.73}$	$30.26_{\pm 5.10}$	$22.62_{\pm 6.74}$	$19.79_{\pm 4.94}$	$12.74_{\pm 4.92}$
MOON [22]	$80.44_{\pm 6.43}$	$80.20_{\pm 10.43}$	$52.24_{\pm 12.60}$	$10.27_{\pm 22.64}$	$32.79_{\pm 5.58}$	$17.64_{\pm 6.63}$	$21.67_{\pm 5.59}$	$13.33_{\pm 6.23}$
FedPer [7]	$85.14_{\pm 4.50}$	$91.80_{\pm 3.89}$	$75.40_{\pm 14.50}$	$86.22_{\pm 10.80}$	$32.70_{\pm 5.29}$	$55.22_{\pm 9.23}$	$26.66_{\pm 12.07}$	$44.93_{\pm 13.66}$
FedRep [9]	$83.94_{\pm 5.23}$	$91.21_{\pm 4.28}$	$74.23_{\pm 11.37}$	$86.36_{\pm 10.86}$	$30.09_{\pm 5.85}$	$48.57_{\pm 9.45}$	$23.34_{\pm 12.62}$	$41.32_{\pm 14.08}$
LG-FedAvg [8]	$76.46_{\pm 8.19}$	$87.21_{\pm 5.49}$	$66.70_{\pm 12.82}$	$8.91_{\pm 23.33}$	$23.87_{\pm 5.88}$	$40.73_{\pm 10.38}$	$20.14_{\pm 13.18}$	$33.62_{\pm 15.43}$
Ditto [17]	$78.23_{\pm 5.22}$	$90.88_{\pm 7.63}$	$67.47_{\pm 13.08}$	$80.71_{\pm 15.80}$	$23.75_{\pm 5.37}$	$41.81_{\pm 10.24}$	$19.81_{\pm 13.32}$	$33.66_{\pm 15.53}$
FedBABU [11]	$80.78_{\pm 4.83}$	$90.79_{\pm 4.31}$	$73.27_{\pm 11.65}$	$87.12_{\pm 10.53}$	$29.38_{\pm 8.12}$	$49.93_{\pm 14.42}$	$27.54_{\pm 14.08}$	$20.00_{\pm 23.89}$
FedRoD [10]	$76.34_{\pm 5.53}$	$88.63_{\pm 4.72}$	$76.87_{\pm 10.27}$	$87.81_{\pm 10.05}$	$35.95_{\pm 6.48}$	$53.73_{\pm 8.44}$	$28.65_{\pm 12.55}$	$42.82_{\pm 13.64}$
FedALA [18]	$81.95_{\pm 4.69}$	$83.63_{\pm 10.62}$	$60.16_{\pm 14.89}$	$66.19_{\pm 17.45}$	$32.79_{\pm 5.49}$	$21.50_{\pm 6.19}$	$19.37_{\pm 4.20}$	$14.78_{\pm 11.92}$
FedAIMS	$\mathbf{88.85}_{\pm 3.54}$	$\mathbf{93.33}_{\pm 3.46}$	$\mathbf{81.79}_{\pm 8.04}$	$\mathbf{89.45}_{\pm 8.72}$	$\mathbf{48.52}_{\pm 6.01}$	$\mathbf{58.26}_{\pm 8.86}$	$\mathbf{33.17}_{\pm 11.71}$	$\mathbf{46.43}_{\pm 13.65}$