July 2022

TEXAS
The University of Texas at Austin

ARCHITECTURE AGNOSTIC FEDERATED LEARNING FOR NEURAL NETWORKS

International Conference of Machine Learning 2022

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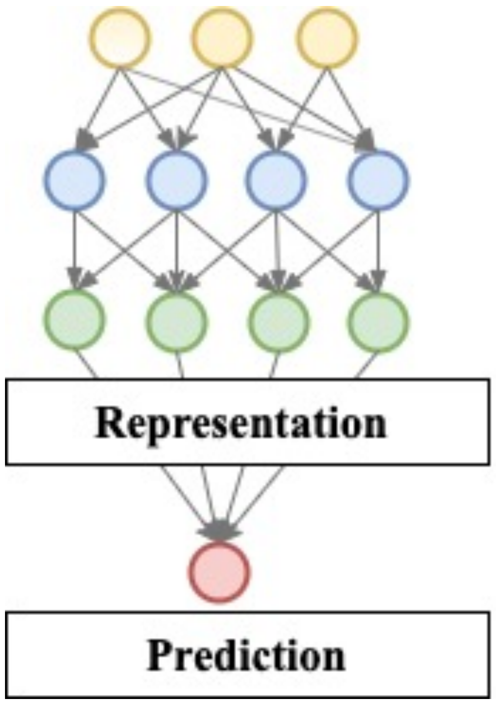
Outline

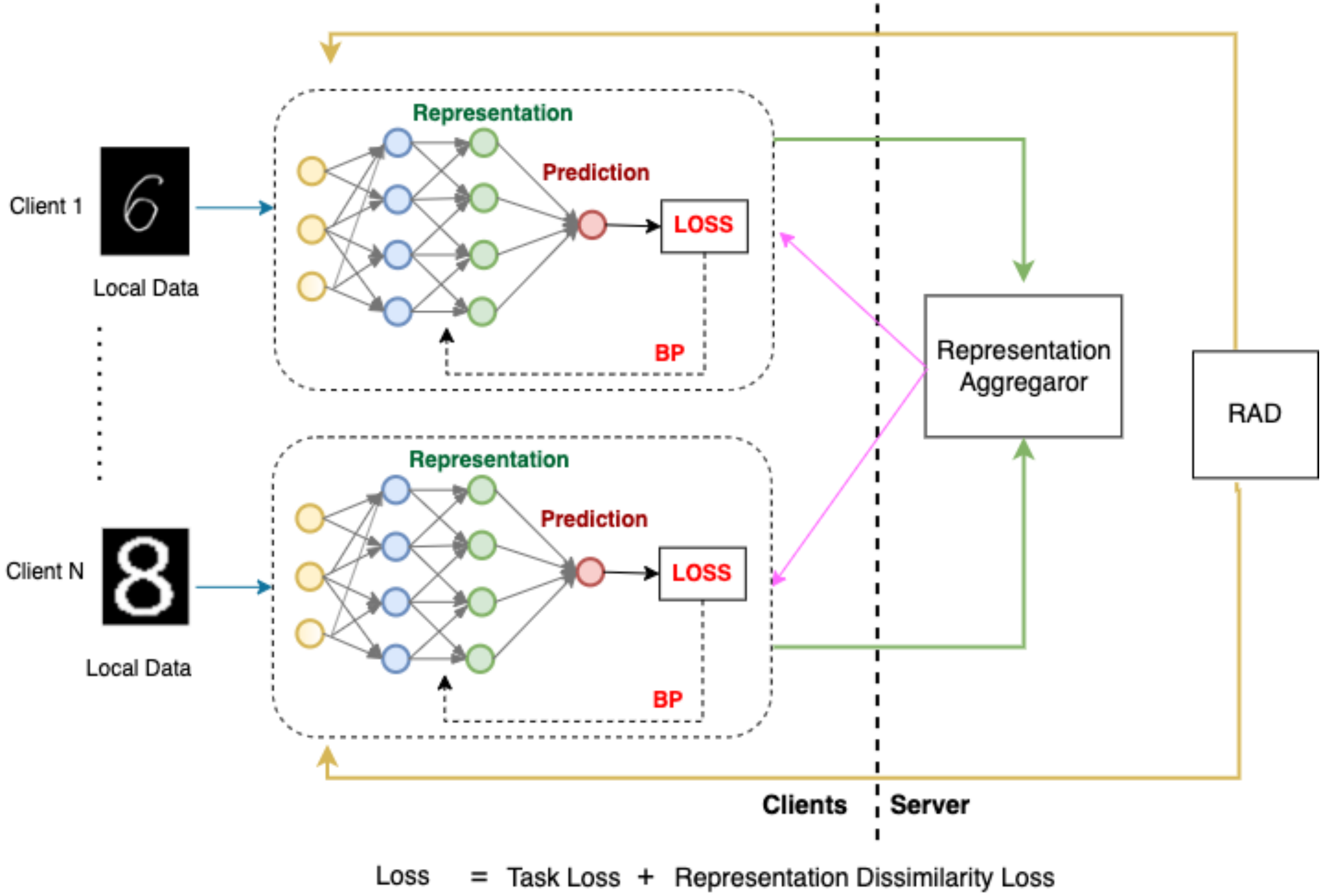
- Motivation
- Proposed Approach
- Experimental Results

Motivation

- Standard FL algorithms assume each client use the same architecture
  - But clients may differ in their compute resources and local data size/properties
  - May have pre-existing (uncoordinated) solutions
  - Identical architecture requirement is severe, even impractical
- Aggregation of client models to generate single global model is not straightforward due to facts like permutation invariance of neurons, non-linearities etc.
- We propose a systematic framework for architecture-agnostic federated learning called FedHeNN

Proposed Approach : FedHeNN





Proposed Approach : FedHeNN

- FedHeNN for Homogeneous Clients

$$\min_{\mathcal{W}_i} \mathcal{L}_i = \mathcal{F}(\mathcal{W}_i) + \eta\, \mathrm{d}(\Phi_i(\mathbf{X}; \mathcal{W}_i), \Phi_{\text{global}}(\mathbf{X}; \hat{\mathcal{W}}(t-1))).$$

- FedHeNN for Heterogeneous Clients

$$\min_{\mathcal{W}_i} \mathcal{L}_i = \mathcal{F}(\mathcal{W}_i) + \eta\, \mathrm{d}(\Phi_i(\mathbf{X}; \mathcal{W}_i), \bar{\Phi}(\mathbf{X}; (t-1))).$$

where $\bar{\Phi}(\mathbf{X}; (t-1)) = \sum_{j=1}^{N} w_j \Phi_j(\mathbf{X}; \mathcal{W}_j(t-1))$

Distance Function

- Use a kernel-based distance metric to allow comparison between NNs of different widths
- Specifically, we use CKA(centered kernel alignment) whose linear version is given by

$$\text{Linear CKA}(K_i, K_j) =$$

$$\text{Linear CKA}(A_i A_i^T, A_j A_j^T) = \frac{||A_j^T A_i||_F^2}{||A_i^T A_i||_F ||A_j^T A_j||_F}.$$

Experimental Results

DATA SET(SETTING)	FEDAVG	FEDPROX	FEDHENN GLOBAL
CIFAR-10(100 CLIENTS, 2 CLS/CLIENT)	44.29 ± 0.5	53.8 ± 2.3	$\mathbf{68.8 \pm 2.1}$
CIFAR-10(100 CLIENTS, 5 CLS/CLIENT)	58.14 ± 0.7	63.3 ± 2.0	$\mathbf{70.19 \pm 2.0}$
CIFAR-10(500 CLIENTS, 2 CLS/CLIENT)	42.7 ± 0.4	50.46 ± 1.4	$\mathbf{65.4 \pm 0.8}$
CIFAR-10(500 CLIENTS, 5 CLS/CLIENT)	56.8 ± 0.5	55.2 ± 1.2	$\mathbf{64.7 \pm 0.7}$
CIFAR-100(100 CLIENTS, 20 CLS/CLIENT)	28.6 ± 0.8	27.3 ± 1.1	$\mathbf{44.2 \pm 0.7}$
SENTIMENT140(100 CLIENTS, 2 CLS/CLIENT)	52.6 ± 0.4	52.7 ± 1.0	$\mathbf{52.7 \pm 0.01}$

Table 1: Average test accuracy of FedHeNN computed for the common global model as compared to the baselines with global models.

DATA SET(SETTING)	FEDREP	FEDHENN HOMO	FEDHENN HETERO
CIFAR-10(100 CLIENTS, 2 CLS/CLIENT)	85.7 ± 0.4	94.7 ± 1.1	88.9 ± 0.35
CIFAR-10(100 CLIENTS, 5 CLS/CLIENT)	72.4 ± 1.2	84.37 ± 1.5	73.01 ± 0.3
CIFAR-10(500 CLIENTS, 2 CLS/CLIENT)	78.9 ± 0.6	86.5 ± 0.9	82.02 ± 0.8
CIFAR-10(500 CLIENTS, 5 CLS/CLIENT)	58.14 ± 0.21	73.32 ± 1.23	61.74 ± 0.6
CIFAR-100(100 CLIENTS, 20 CLS/CLIENT)	38.85 ± 0.9	62.89 ± 0.8	43.36 ± 0.2
SENTIMENT140(100 CLIENTS, 2 CLS/CLIENT)	69.8 ± 0.4	72.6 ± 0.3	71.5 ± 0.5

Table 2: Average test accuracy of FedHeNN computed for the personalised models as compared to the baselines with personalised models.

Thank you!