A Joint Learning and Communications Framework for Federated Learning over Wireless Networks

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January 11, 2021

List of notations

Notation	Description	Notation	Description
U	Number of users	$l_i^{\mathrm{U}}(\boldsymbol{r}_i, P_i)$	Uplink transmission delay
$\boldsymbol{X}_i$	Data collected by user i	$\boldsymbol{x}_{ik}$	FL input vector implemented by user i
y_{ik}	Output of $\boldsymbol{x}_{ik}$	$P_{\max}$	Maximum transmit power of each user
P_B	Transmit power of BS	$c_i^{\mathrm{U}}(\boldsymbol{r}_i, P_i)$	Uplink data rate of user i
P_i	Transmit power of user i	K_i	Number of samples collected by user i
R	Number of RBs	B^{D}	Total downlink bandwidth of each BS
$\boldsymbol{g}$	Global FL model	c_i^{D}	Downlink data rate of user i
$\mathcal{U}$	Set of users	l_i^{D}	Downlink transmission delay
$\boldsymbol{a} \in \mathbb{R}^{1\times U}$	User selection vector	$Z(\boldsymbol{g})$	Data size of global FL model
λ	Learning rate	$q_i(\boldsymbol{r}_i, P_i)$	Packet error rate of user i
$\boldsymbol{R} \in \mathbb{R}^{R\times U}$	RB allocation vector of all users	$Z(\boldsymbol{w}_i)$	Data size of local FL model
γ_{T}	Delay requirement	$f(\boldsymbol{g}(\boldsymbol{a}, \boldsymbol{R}), \boldsymbol{x}_{ik}, y_{ik})$	Loss function of FL
$\boldsymbol{w}_i$	Local FL model of user i	$e_i(\boldsymbol{r}_i, P_i)$	Energy consumption of user i
γ_{E}	Energy consumption requirement	$\boldsymbol{r}_i \in \mathbb{R}^{R\times 1}$	RB allocation vector of user i
K	Total number of training data samples	B^{U}	Bandwidth of each RB

Figure 1: List of notations.

Test for citations

- The first citation.[1]
- The second citation. [2]
- Recite the first citation. [1]

Reference

[1] Y. LeCun, Y. Bengio, and G. Hinton, "Deep learning," *Nature*, vol. 521, pp. 436–444, May 2015.

[2] H. Li, K. Ota, and M. Dong, "Learning IoT in edge: Deep learning for the Internet of Things with edge computing," *IEEE Netw.*, vol. 32, no. 1, pp. 96–101, Feb. 2018.