# Efficient-Edge Computing Federated Learning for Industrial Internet-of-Things

Vidya Valsalan ,M.Tech CSE-IS

Admission Number :19MT0434

Department Of Computer Science & Engineering

# Introduction

- Internet Of Things is a platform where physical object “things” are connected to the internet ,So they can interact ,collabarate and exchange data with each other.
- From any time,any place connectivity to anyone,we will now have connectivity for anything.

# Introduction

- Huge Amount of smart devices connected together in IoT, we are able to get access to massive user data.
- Cloud Computing is a model for enabling convenient ,on-demand network access to a shared pool of configurable computing resources.
- Ubiquitous ,dynamic and on-demand access.
- More efficient resource utilization,usage based costing.

# Intodaction

- Billions of phones & IoT devices constantly generating data.Data enables better products and smarter model.
- Train task-specified machine learning models and utimately provide high-quality smart services and products.
- Collect scattered user data to a central cloud for modeling and then transfer the trained model to user devices for task inferences is not an efficient way.
- User-sensitive data are required to upload to the remote cloud, it may impose great privacy leakage risk

# Literature Survey

| Title | Cloud Machine Learning Model Selection for IIoT and Smart City services. |
|---|---|
| Author | Basheer Qolomany, Ihab Mohammed |
| Problem Defnition | cloud service providers collect big data from resource-constrained devices for building Trust based Cloud ML-based prediction models that are then sent back to be run locally on the intermittently-connected resource-constrained devices |
| Methodology | ML models from which a subset needs to be selected and deployed on IoT devices for T time slots. |
| Limitations | Centralization of data |

# Literature Survey

| Title | Personalized Federated Learning for Intelligent IoT Applications |
| --- | --- |
| Author | Qiong Wu,Kaiwen He,Xu Chen |
| Problem Defnition | personalized federated learning framework in a cloud-edge architecture for intelligent IoT applications. To cope with the heterogeneity issues in IoT environments. |
| Methodology | Federated Stochastic gradient descent(SGD) send the gradient to server. |
| Limitations | More communication and more number of rounds. |

# Motivation

- Much of the data is born decentralized. Data may be too sensitive or large in size so it is preferable not to log it to the data center purely for the purpose of model training.
- Data transmission and model transfer will result high communication cost.
- Machine Learning on decentralized data. Enable edge devices to do state of the art machine learning without centralizing data and with privacy by default.
- Train Model from device directly,no need to send privacy information to server.

# Existing Approach

- Approach 1:Performing Federated Learning for all clients with all n data samples(Gradient Descent).
- More computational power and need to transfer more parameter it leads to more communication cost.
- Approach 2:Performing Federated Learning for a randomly selected client that has $n_k$ training data samples.
- A single step of gradient decent is done per round
- More communication round it leads more communication cost.

# Proposed Approach

- Performing Federated Learning for fraction of clients with batch B data samples(Mini Batch Gradient Descent).
- Learning rate: η , total number of samples: n , total number of clients: k , Number of samples on a client k: $n_k$.
- In a round t:
- The central server broadcasts current model $w_t$ to each client; each client k computes gradient: $g_k$ ,on its local data.
- Approach: Each client k computes it's weight
- $w_{t+1}^{k} \leftarrow w_t$ - η $g_k$
- Central Server Perform the aggregation :
- $w_{t+1} \leftarrow \sum_{k=1}^{K} \frac{n_k}{n} w_{t+1}^{k}$

# Proposed Approach

Algorithm Server Execute:

Initialize the global model $w_0$ by averaging each local

for each round t=1,2,... do

m $\leftarrow$ max(C.K,1)

$S_t$ $\leftarrow$ set of clients that send the model

for each client k $\in S_t$ in parllel do

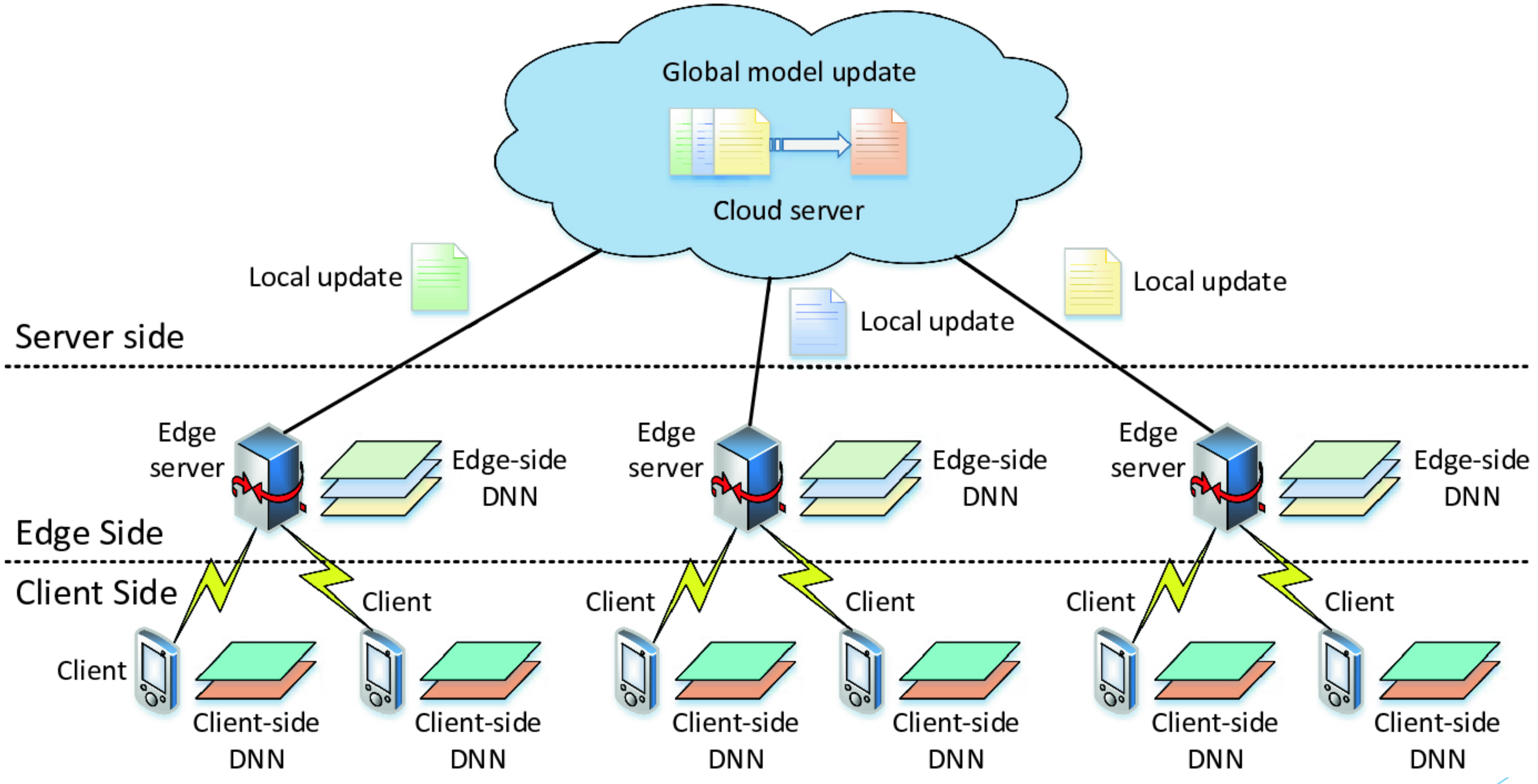
$w_{t+1}^{k} \leftarrow$ ClientUpdate(k,$w_t$)

$w_{t+1} \leftarrow \sum_{k=1}^{K} \frac{n_k}{n} w_{t+1}^{k}$

# Proposed Approach

- Algorithm:Client Execute
- Input:Global update of last round $T^t$ .
- 1.Initialize the global model $M_0$ by averaging each local model.
- 2.for each iteration do
- 3. for each user $u_i \in U$ do
- 4. $u_i$ train it local model on its data $D_i$
- 5. $u_i$ calculates its updated weight $W_i$ .
- 6. If current updated weight varies more than the threshold value.update its local model for gloabal aggregation.Otherwise $u_i$ continues its local training
- 7. end for
- 8.end for

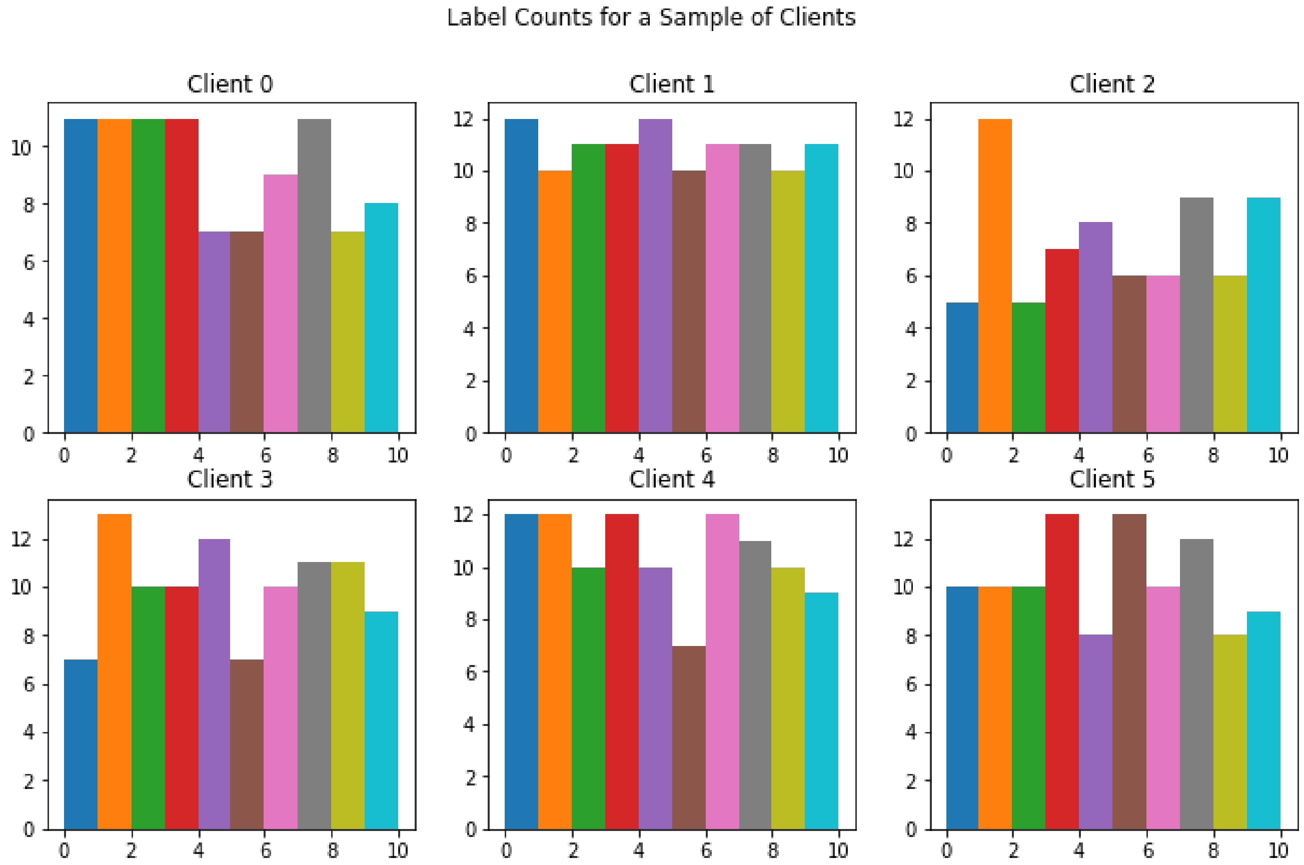
# System Model



# Implementation and Results

- Used MNIST digit recognition dataset contains 70000 handwritten grayscale digits images ranging from 0 to 9.
- Mainly 4 components:
- 1) A server-to-client broadcast step *(broadcast_fn())*
- 2) A local client update step *(client_update())*
- 3) A client-to-server upload step
- 4) A server update step. *(server_update())*

# Implementation and Results



# Implementation and Results

| Number Of Communication Round | FedSGD | FedAvg with Batch Size=10 | FedAvg with Batch Size=10 |
|---|---|---|---|
| 50 | 0.754 | 0.803 | 0.786 |
| 100 | 0.762 | 0.836 | 0.810 |
| 200 | 0.798 | 0.869 | 0.838 |

# Conclusion

- Federated Learning can be a promising solution that enables on-device machine learning without the need to migrate the private end-user data to a central cloud.
- Fed Avg Model trains high-quality model using relative few rounds of communication.
- It provide cloud edge architecture for intelligent IoT application with more data privacy.

THANK YOU