# Federated Learning

## Literature Review

December 14, 2023
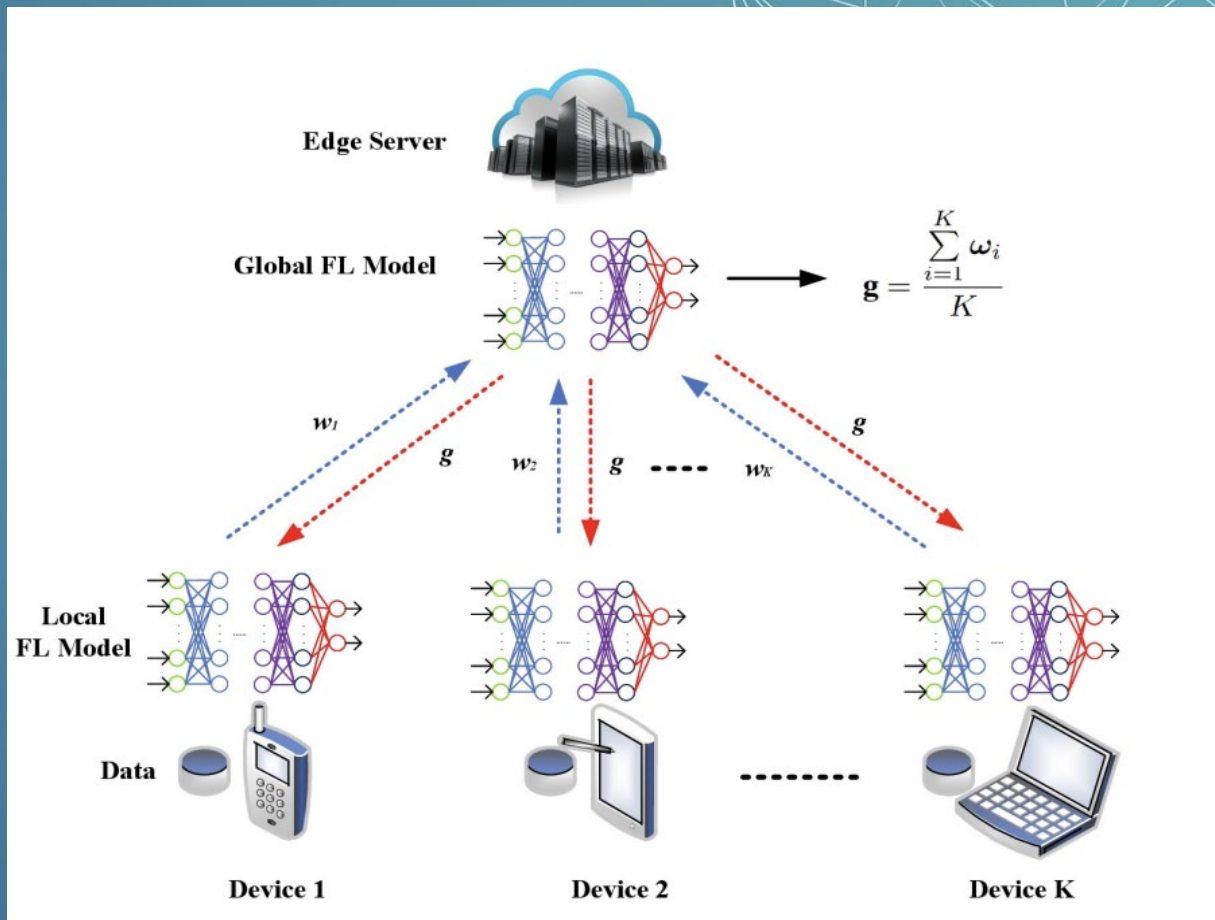
# Why FL?

## Differences from DML
Federated Learning is used when the devices involved has different datasets with diverse samples and feature space

## In our case
Useful to keep carrier topology and failures data private and share common key parameters

# How works

# Federated Learning common use cases

**IoT**      Little devices just apply the global model and send back the key values.

**Finance**      Needs to keep transactions data private but need to contribute to the global model for fraud detention.

**Mobile Network**      Provide personalized services without sending personal data to a central server.

# Main Features of FL

**Preserving data Privacy**

Local dataset on local devices without sharing crucial information.

**Centralized global server**

Communicate with edge servers receiving key parameters and updating the model.

**Data Diversity**

Aggregation of different dataset and for developing a unique model distribution.

**Difficulties with different data distributions**

Lack of uniformity in the input space makes challenging to train a model that generalizes.

Federated
Averaging

Gradient
Descent

Bayesian
Learning

FL
Tools

Clustering

Game Theory

Fairness

# Task 6

## Problem

Use FL to maintain quality of services in the network-cloud ecosystem based on cooperation among different entities

## Goal

-improve monitoring/telemetry
-ensure privacy
-accommodate new services and minimize future risks

# Objective and Mechanism

## Local Model Aggregation

Selection of optimal devices to upload the local models and minimize transmission error

Understanding the submodels of different entities and aggregate them globally (e.g., by PNE)

## Communication Efficiency and Energy consumption

Optimize transmission rate, avoid congestions, improve communication design

Optimize communication efficiency and energy consumption of the ecosystem

## Resource Allocation

Spectrum resource allocation and device selection

Investigate models for task 1 and 2 by adding FL tools.
Thus, each entity can apply global model

## Mechanism Design

Understand how to design the business mechanism with a certain outcome expectation

Find the right model for perfect cooperation and reach optimal solution for all entities

## Asynchronous FL

Each training round of the synchronous training is limited by the slowest device

Understanding the bottleneck in network-cloud ecosystem and make the training asynchronous

## Homomorphic Encryption

Computing sum of values without having any party reveal its values

Allow the ecosystem to ensure security of their data adding encrypted secret keys

## Game Theory

Design mathematical cooperative model for Service Pricing

Establish price and values of services and maximizing profits

## How to apply in task 6?

# References

**[1]**
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**[3]**
R. Zeng, et al., "Incentive Mechanisms in Federated Learning and A Game-Theoretical Approach" IEEE Network, vol. 36, no. 6, pp. 229-235, Dec. 2022