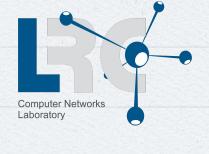


# DISSERTATION PROPOSAL: DECENTRALIZED LEARNING FOR VEHICULAR TRAFFIC RE-ROUTING SYSTEM



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• BELO HORIZONTE - AUGUST 18TH - 2021•



# MOTIVATION

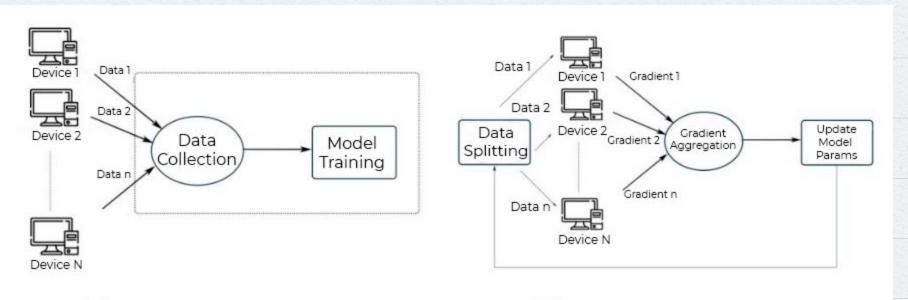
- Big data issue A lot of data to store, which leads to long processing time
- Split data to speed up
- **X** Explore more efficient training methods
- **X** Explore multiple machines to optimize the learning
- Decentralize the training



## DECENTRALIZED LEARNING

- On-Device Machine Learning without Data Extraction
- Unleash Innovation from Periphery
- X Connect Idle Processing Power of Billions Devices
- Mass Participation in Machine Learning Training

# DECENTRALIZED LEARNING



(a) Centralized Model

(b) Decentralized Model



# FEDERATED LEARNING MOTIVATION

Decentralized, Distributed, and Parallel Learning

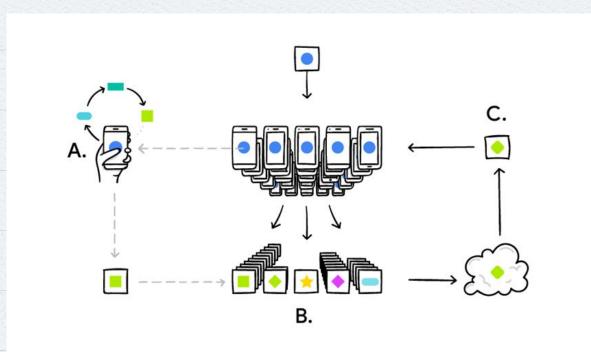
X Random Sampling

Preserve privacy and data

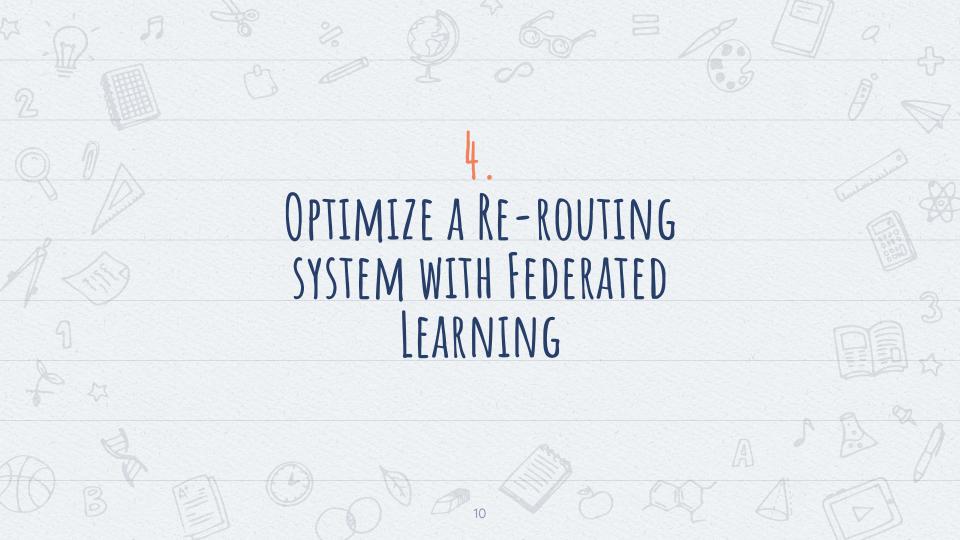
Reduce data storage and training

**X** Communication efficiency

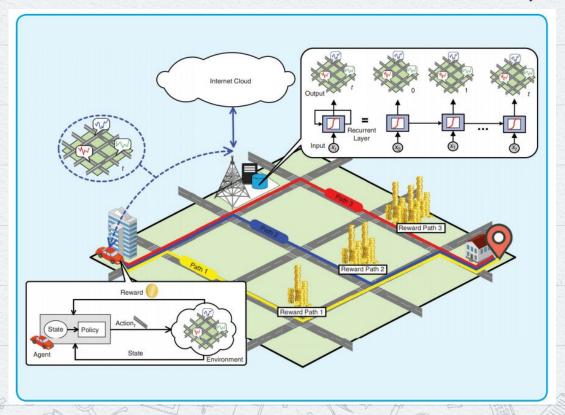
# FEDERATED LEARNING MOTIVATION



Source: Google Al Blog



# VEHICULAR TRAFFIC RE-ROUTING SYSTEM



Source: A. M. de Souza et. al.

# VEHICULAR TRAFFIC RE-ROUTING SYSTEM

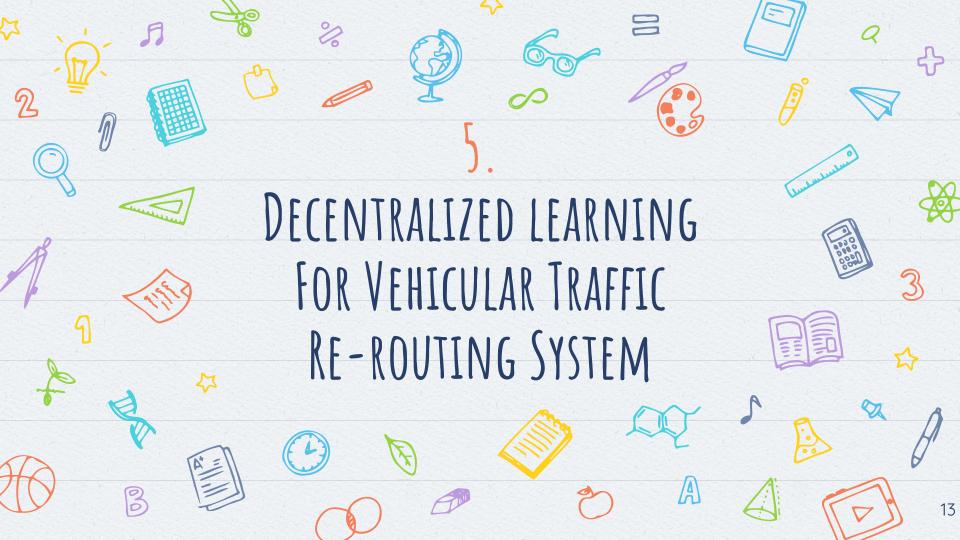
Collect Traffic Data

Train a Recurrent Neural Network

Provide the trained model

Choose a path with specific policy

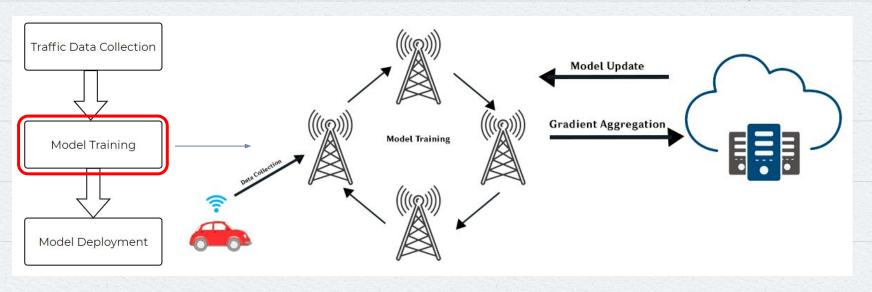
\* Reward the model



# DECENTRALIZED LEARNING FOR VEHICULAR TRAFFIC RE-ROUTING SYSTEM

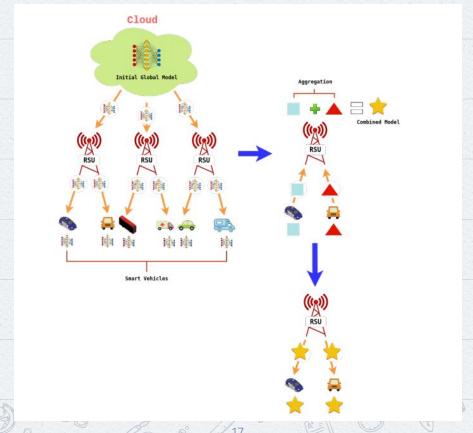
- Train model with Federated Learning
  - X RSU responsible for the training
  - X Download the most updated model
  - X Train and generate its gradients
  - X Send its gradients to a cloud/ Master RSU
  - X Aggregate gradients and update current Model
  - X Provide most recent model

# DECENTRALIZED LEARNING FOR VEHICULAR TRAFFIC RE-ROUTING SYSTEM

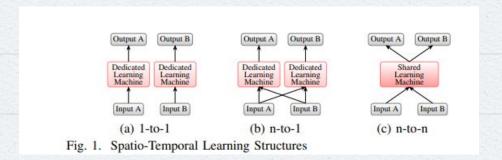


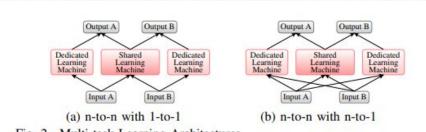


# Towards Federated Learning in Edge Computing for Real-Time Traffic Estimation in Smart Cities



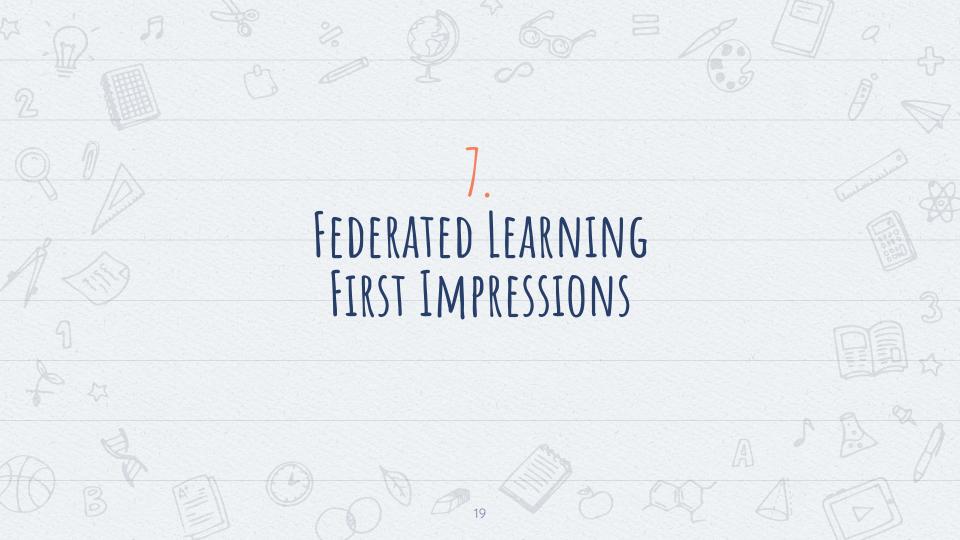
#### **Spatio-Temporal Wireless Traffic Prediction with Recurrent Neural Network**





Multi-task Learning Architectures

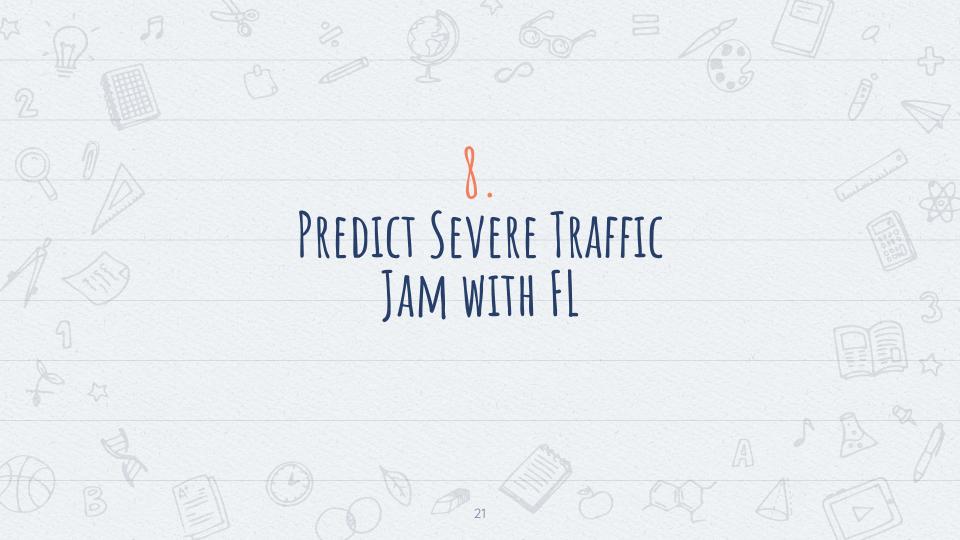
et. Source: Chen Qiu,



#### **Federated Learning First Impressions**

- Train/Test using MNIST dataset
  - X 3 Dense Layers (200 Neurons)
  - X 10 Clients 1 epoch each
  - X 100 communication rounds
  - X FedAvg aggregation

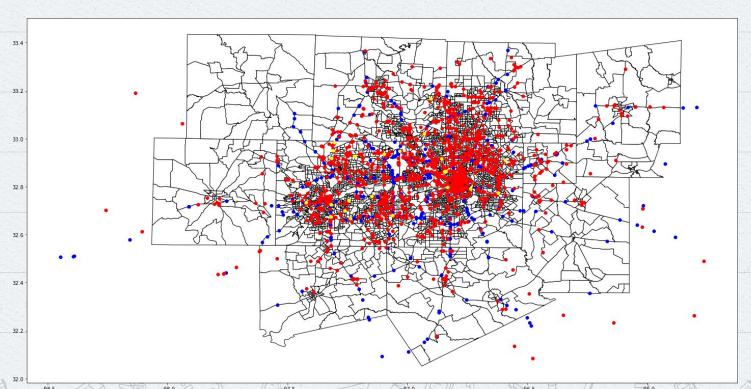
Accuracy	Precision	Recall	F1-Score
0.9723	0.9723	0.9723	0.9722



#### Predict Severe Traffic Jam with FL

- Waze data (Frisco TX)
  - **X** Traffic events
  - Whether lead or not to severe Traffic Jam
  - X 1722 entries accumulated over 30m
  - 32 different events, such as accident, flooding, animal struck, object on the roadway, etc
  - X 80% to training set, 20% to test (60% validation)

#### **Predict Severe Traffic Jam with FL**



#### Legend:

Traffic Jam
Accidents
Stopped car

#### Predict Severe Traffic Jam with FL

Federated Learning Configuration10 communication rounds

X 5 clients - 50 epochs eachX 947, 346, 251, 121, 53

X FedAvg aggregation



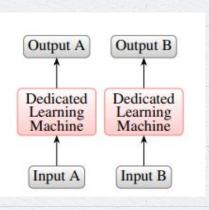
#### Sequential Model

Accuracy	Precision	Recall	F1-Score
0.7681	0.7681	0.7681	0.7680



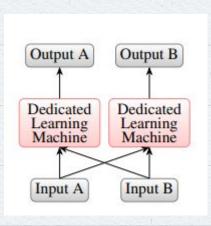
#### X Chen Qiu 1-to-1

М	odel	Set	Accuracy	Precision	Recall	F1-Score
11	ouci	size	Accuracy	1100131011	RCCall	11 30010
	1	947	0.7632	0.7120	0.7632	0.7006
	2	346	0.6667	0.8333	0.6667	0.6667
	3	251	0.8571	0.8791	0.8571	0.8274
	4	125	0.9091	1.0000	0.9091	0.9524
	5	53	0.8000	0.8500	0.8000	0.7810



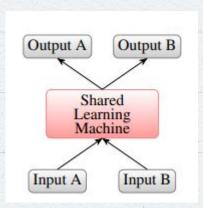
#### X Chen Qiu N-to-1

Model	Set size	Accuracy	Precision	Recall	F1-Score	
1	947	0.7632	0.7120	0.7632	0.7006	
2	346	1.0000	1.0000	1.0000	1.0000	Contract District
3	251	0.8571	0.8791	0.8571	0.8274	
4	125	0.7273	1.0000	0.7273	0.8421	
5	53	0.8000	0.8667	0.8000	0.8000	ALL ALL DESCRIPTION OF THE PERSON OF THE PER



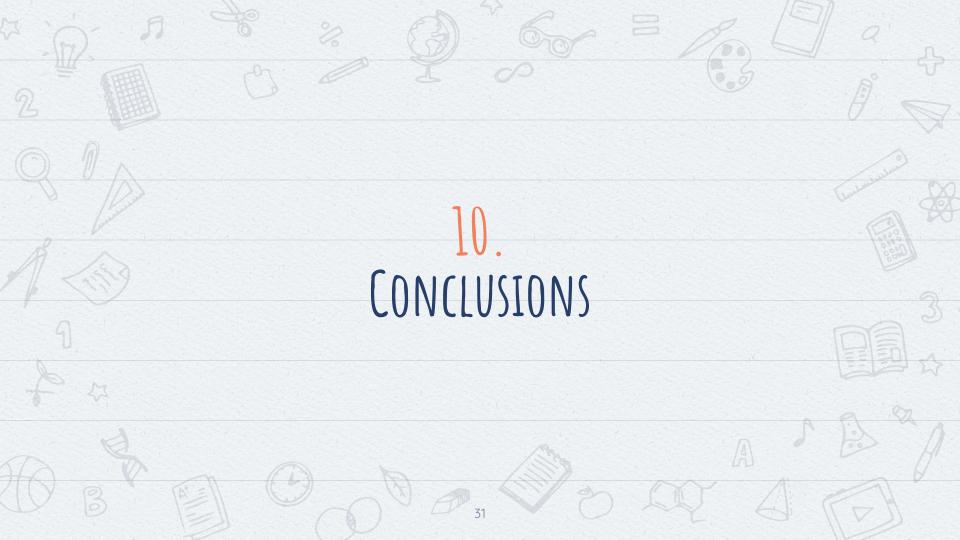
#### X Chen Qiu N-to-N

Model	Recall	l F1-Score			
HOUET	Set size	Accuracy	Precision	NCCall	11 30016
1	947	0.7632	0.7544	0.7632	0.7582
2	346	1.0000	1.0000	1.0000	1.0000
3	251	0.9286	0.9345	0.9286	0.9230
4	125	0.7273	1.0000	0.7273	0.8421
5	53	0.8000	0.8667	0.8000	0.8000



#### Federated Learning

Model	Set size	Accuracy	Precision	Recall	F1-Score
1	947	0.7566	0.7570	0.7566	0.7555
2	346	0.7647	0.7647	0.7647	0.7647
3	251	0.7925	0.7936	0.7925	0.7928
4	125	0.6000	0.6208	0.6000	0.6067
5	53	0.5455	0.5390	0.5455	0.5377
Global	1722	0.7608	0.7642	0.7608	0.7606



#### Conclusions

- Decentralized Learning fitted the application
- No greater results were obtained, but kept the same
- Federated Learning showed to be the best model among the presented decentralized methods
- Federated Learning has the potential to scale



#### **Future Directions**

- Explore a larger dataset
- Created Model must adapt to current scenario conditions
- X Analyze limitations in models created by Chen Qiu
- Consider user privacy while training: which existent algorithm best suits the application

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