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Interreg Vlaanderen-Nederland

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Art-IE

Federated Learning in Edge Devices

Strengthening Data Privacy and Security

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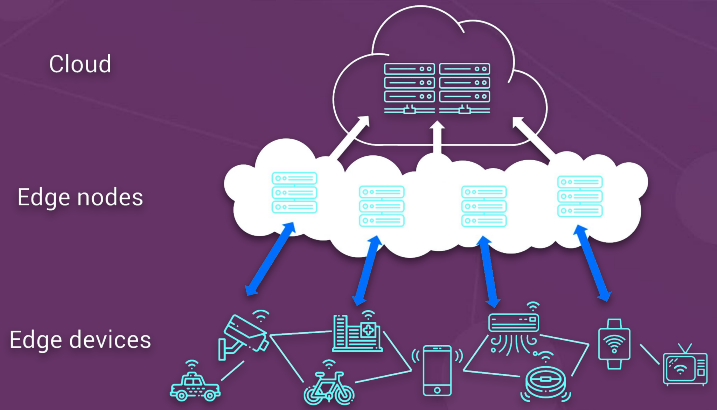
WHAT ARE EDGE DEVICES

Edge devices are network-connected devices that collect, process, and transmit data close to its source, reducing reliance on centralized systems.



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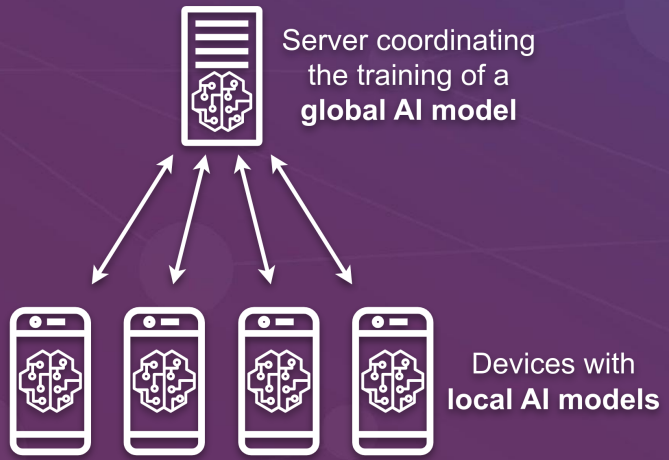
WHAT IS FML

Federated Machine Learning (FML) is a decentralized approach to training models across multiple devices or servers.



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BENEFITS OF FML

Federated Machine Learning enhances data privacy, reduces data transfer bandwidth usage, and enables collaboration across decentralized devices.

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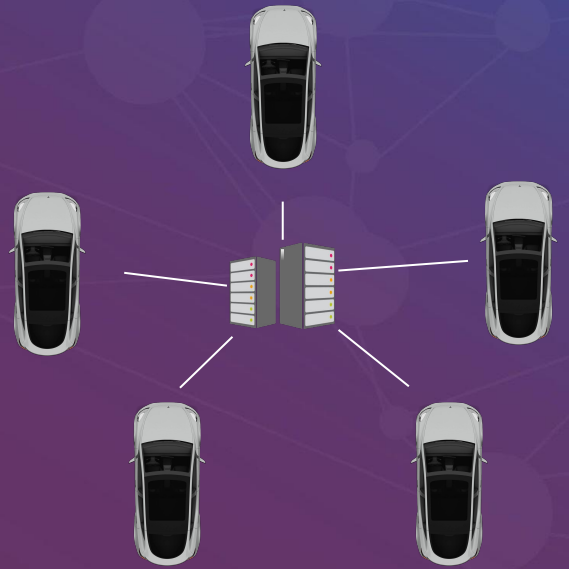
RESEARCH DOMAN

Autonomous vehicles: Enables real-time model improvement by leveraging diverse, distributed driving data from multiple vehicles



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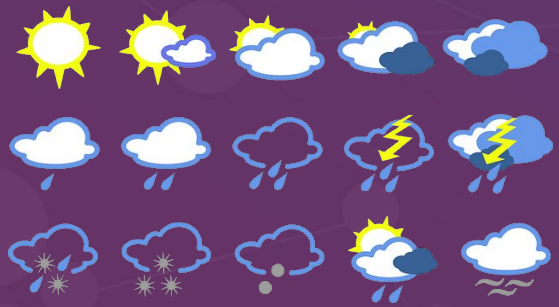
WHAT CONSTRAINTS DOES FML HAVE

Resource Constraints: FML adoption requires edge devices with sufficient computational power.

Data Diversity and Distribution: Non-IID data in vehicle settings, caused by factors like weather and traffic patterns, quantity of data available.

Security Vulnerabilities: Adversarial threats, such as data poisoning, degrade global model performance.



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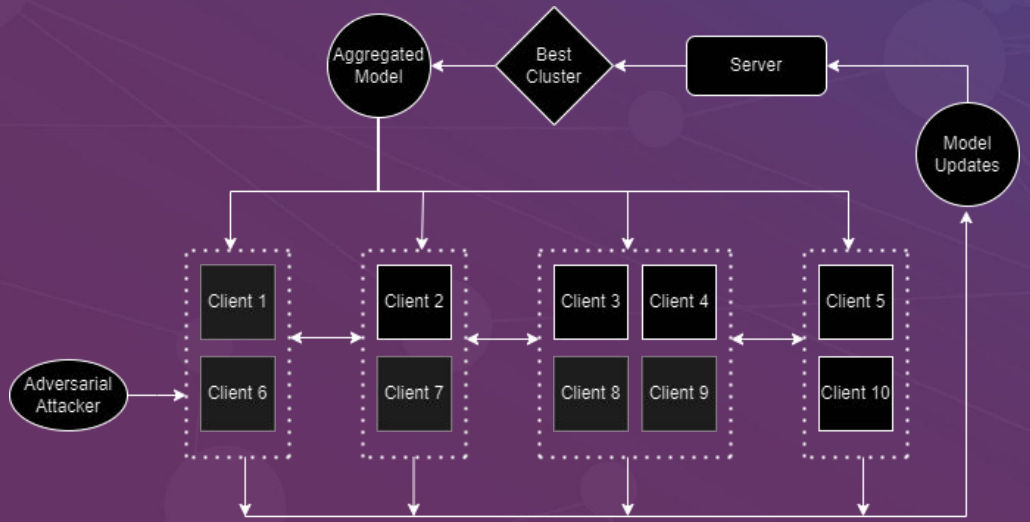
WHAT TECHNIQUE WILL WE USE IN FML

Accuracy-based clustering in FML groups clients with similar models to optimize training efficiency and improve overall model



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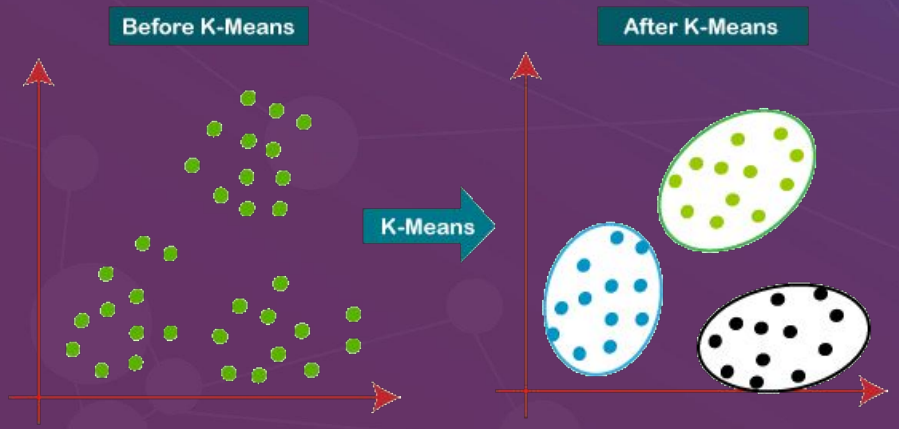
WHAT IS CLUSTERING

- Accuracy Scores
- KMeans



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USED TECHNOLOGY

Flower Framework: Chosen for its flexibility, support for TensorFlow and PyTorch, and ability to simplify FML experimentation in complex systems.

MobileNetv3 Model: Lightweight and efficient for edge devices, optimized for real-time classification with minimal computational overhead.

Self-driving cars: A database from **Kaggle** from which 8,000 images sizing 480x300 pixels, with 5 labels, were used.

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SCENARIOS

- Baseline Experiments Without Poisoning
- Effect of Number of Poisoned Clients (NPC) with Fixed DPP (100%)
- Effect of Data Poisoning Percentage (DPP) with Fixed NPC (5)
- Effect of Number of Poisoned Clients (NPC) with Fixed DPP (100%) in Non-IID Data
- 24 Tests Conducted

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RESULTS

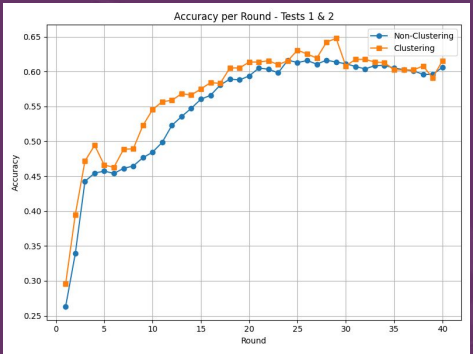
Numerical

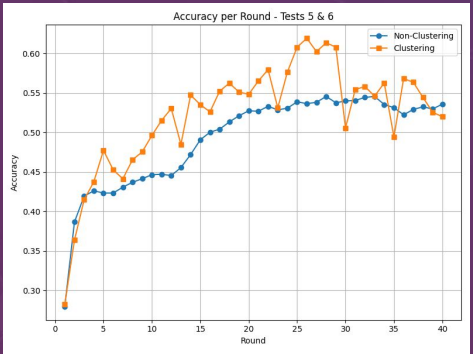
Model Type	Accuracy	F1 Score	Log Loss
Base	0.6163	0.6064	1.1506
Clustering	0.7273	0.7175	0.9756

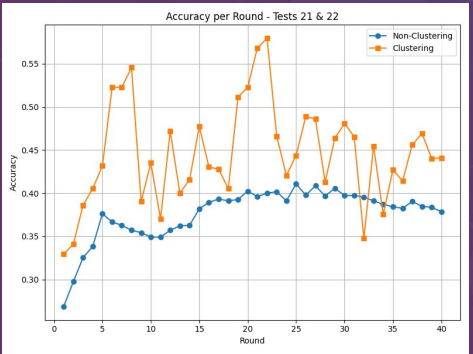
Difference:

Average:17.88%

Best: 18.01%







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CONCLUSIONS

- **Dynamic Clustering Efficiency:** Successfully mitigates data poisoning by grouping clients based on performance, maintaining system robustness.
- **MobileNetv3 Effectiveness:** Possibly demonstrated suitability for complex environments with its lightweight and resource-efficient design.
- **Operational Feasibility:** The approach operates well within the computational limits of modern automotive CPUs and GPUs, proving its practicality.

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RECOMMENDATIONS

- **Refine Clustering Techniques:** Enhance adaptability by dynamically adjusting the number of clusters based on participating clients.
- **Improve Model Selection:** Optimize the selection process to ensure only the most reliable updates are incorporated into the global model.
- **Expand Applications:** Test the methodology in diverse real-world scenarios to improve scalability and robustness across edge environments.

THANKS!

Do you have any questions?

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