User-Empowered Federated Learning in Automotive

Marcello Maugeri, Mirko I. P. Morana, Sergio Esposito, Giampaolo Bella
University of Catania

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Privacy on Cars

What does your car track, and how does this impact your privacy?

Big Brother is in the Backseat

It's Official: Cars Are the Worst Product Category We Have Ever Reviewed for Privacy

By **Jen Caltrider, Misha Rykov** and **Zoë MacDonald** | Sept. 6, 2023

"Most (92%) give drivers little to no control over their personal data"

https://foundation.mozilla.org/en/privacynotincluded/categories/cars/

PETs to the Rescue!

Choosing the Right PET

Anonimity

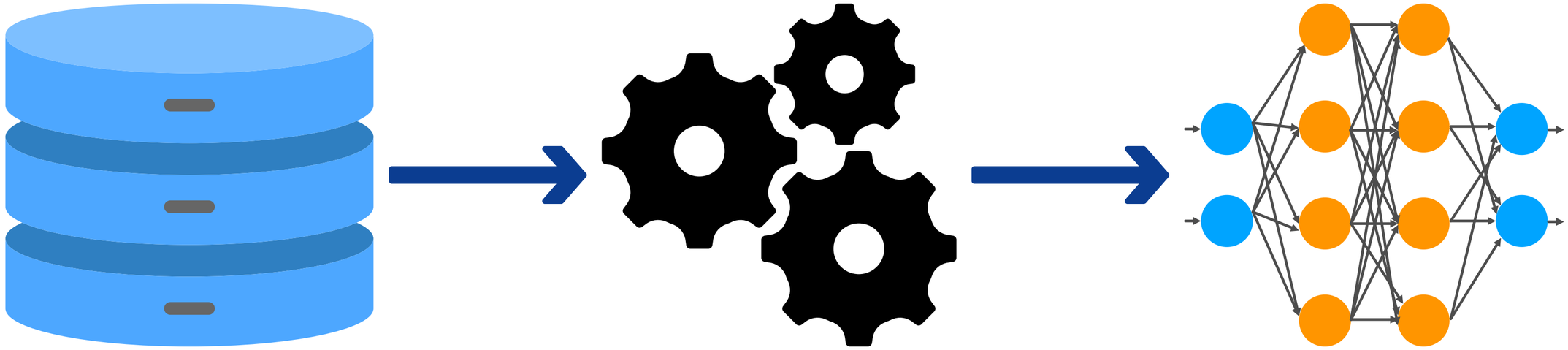
- Differential Privacy
- Key Anonymity
- Synthetic Data

Confidentiality

- Zero Knowledge Proof
- Secure Multi-Party Computation
- Homomorphic Encryption
- Trusted Execution Environment
- **Federated Learning**

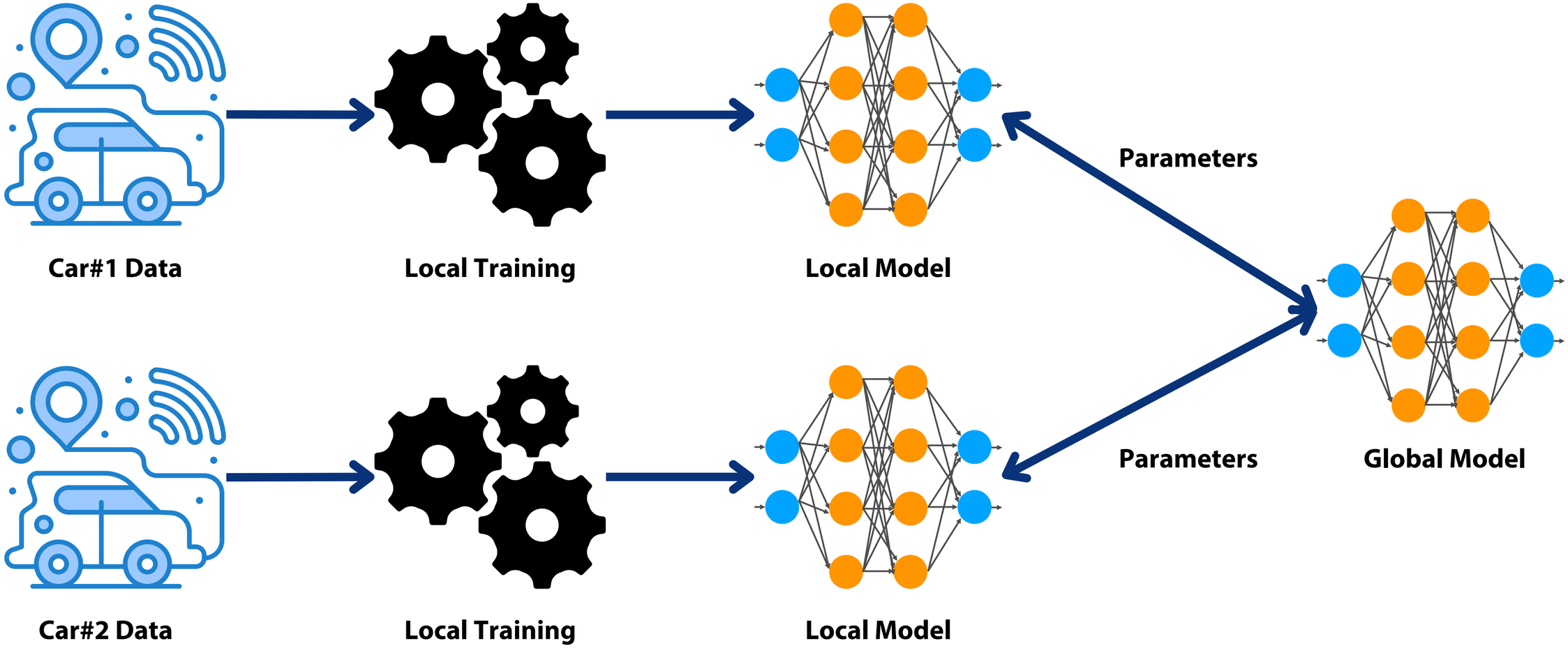
Exploring privacy-enhancing technologies in the automotive value chain, 10.1109/BigData52589.2021.9671528

Conventional Machine Learning



Aggregated Dataset **Training Step** **Model**

Federated Learning



What if the user does not want to participate in training?

The Google Assistant case

“With your explicit consent, audio samples are collected and stored on Google’s servers.” [1]

“You can choose whether you want Google to save voice and audio activity [...]. Other machine learning processes, not controlled by this setting, may be used to improve audio recognition technologies with federated learning or ephemeral learning.” [2]

[1] https://support.google.com/assistant/answer/11140942
[2] https://support.google.com/websearch/answer/6030020

User Empowerment: Informed and Explicit Consent

Our contribution: Android Automotive App Template

Open Source Template

Follows Google's UX requirements

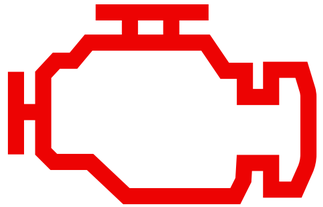
User Empowered

Built upon Flower

https://developers.google.com/cars/design/create-apps/ux-requirements/overview

Use Case: Engine Fault Classification

Houston, We Have a Problem!



Possible Reasons

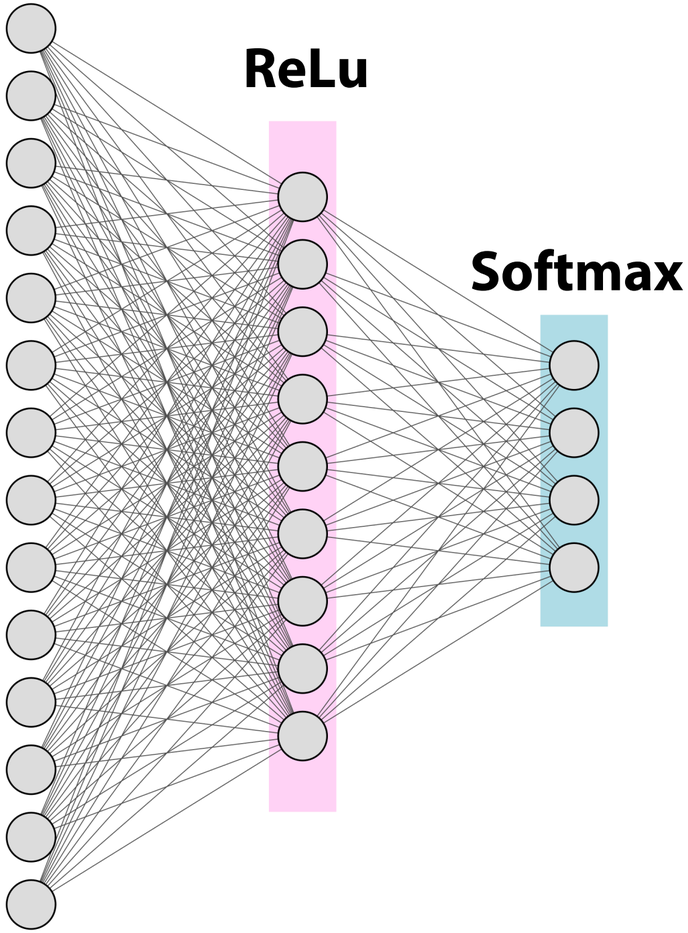
- **Rich Mixture**: Excess fuel in the air-fuel mixture
- **Low Mixture**: Insufficient fuel in the air-fuel mixture
- **Low Voltage**: Insufficient voltage in the electrical system

Features

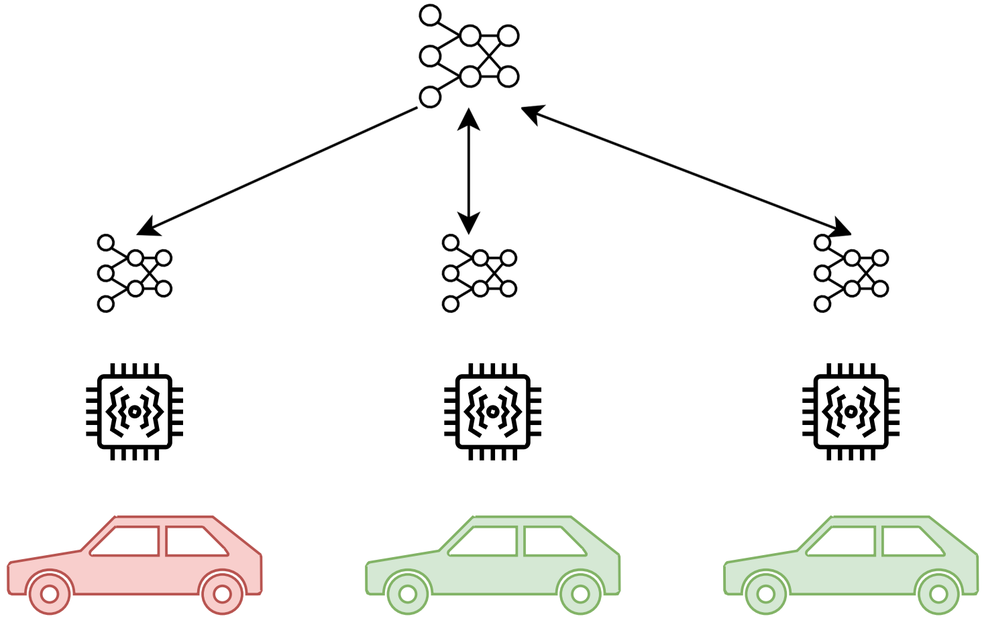
- Engine Speed (RPM)
- Consumption per Hour (l/h)
- Consumption per 100km (l/100km)
- Speed (km/h)
- Power (kW)
- Manifold Absolute Pressure (kPa)
- Force (N)
- Lambda (ER)
- Air-Fuel Ratio (AFR)
- Throttle Position Sensor (%)
- Carbon monoxide (%)
- Hydrocarbons (ppm)
- Carbon dioxide (%)
- Oxygen (%)

EngineFaultDB: A Novel Dataset for Automotive Engine Fault Classification and Baseline Results

Evaluation Setting



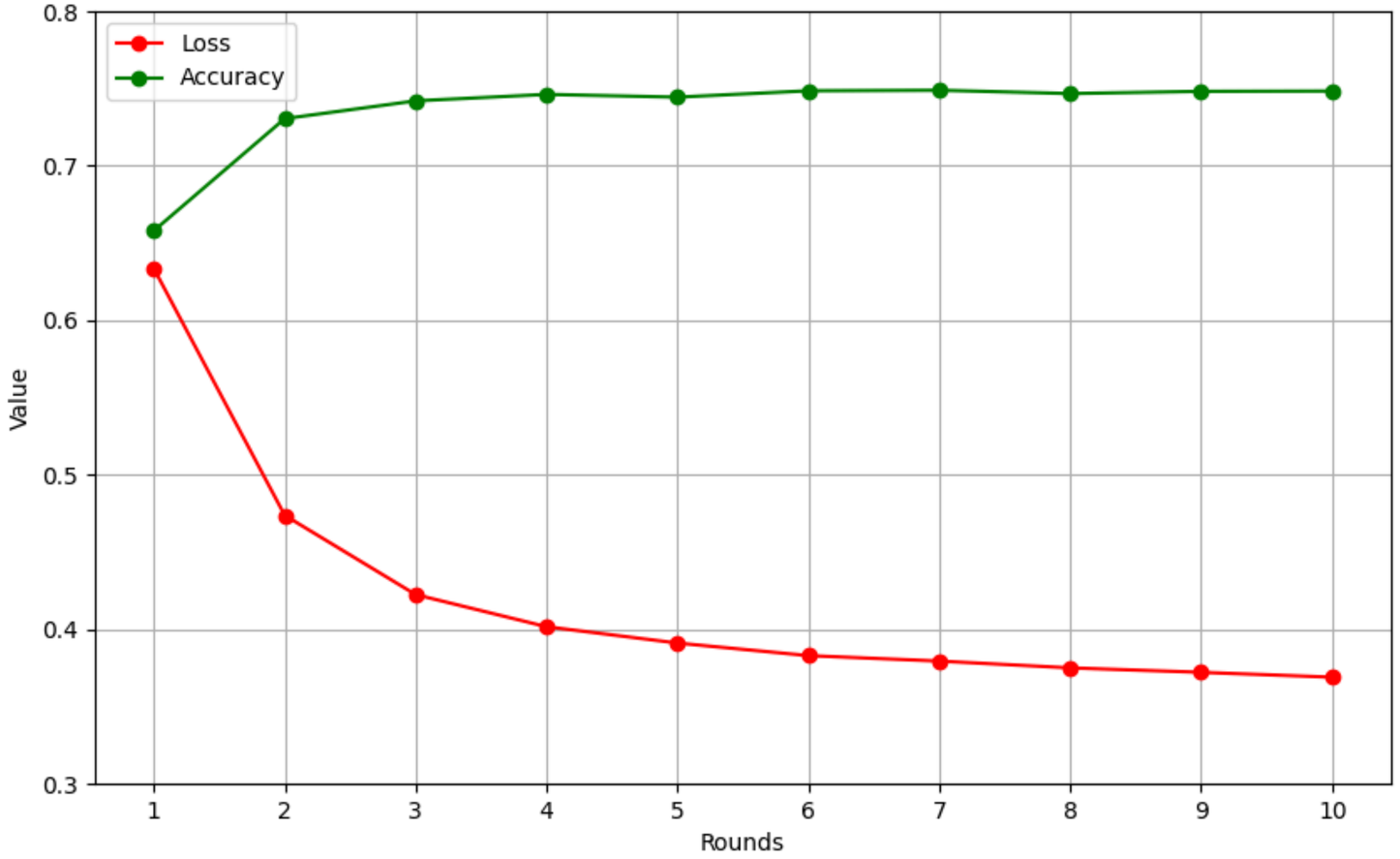
A classification approach using multi-layered neural networks



Dataset distribution: 40% each consenting client + 20% for evaluation

Evaluation

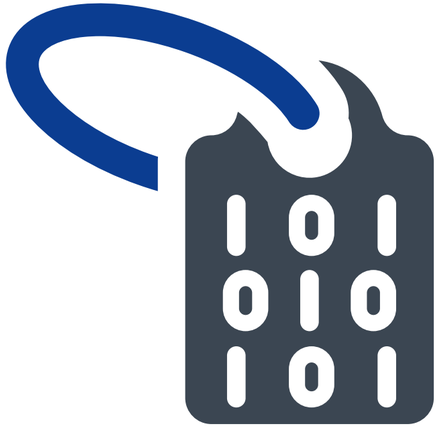
Clients	2
Loss Function	Sparse Categorical Cross Entropy
Local Epochs	10
Rounds	10
Batch Size	16



Limitations and Future Works

External Instrumentation Required

Feature Reduction



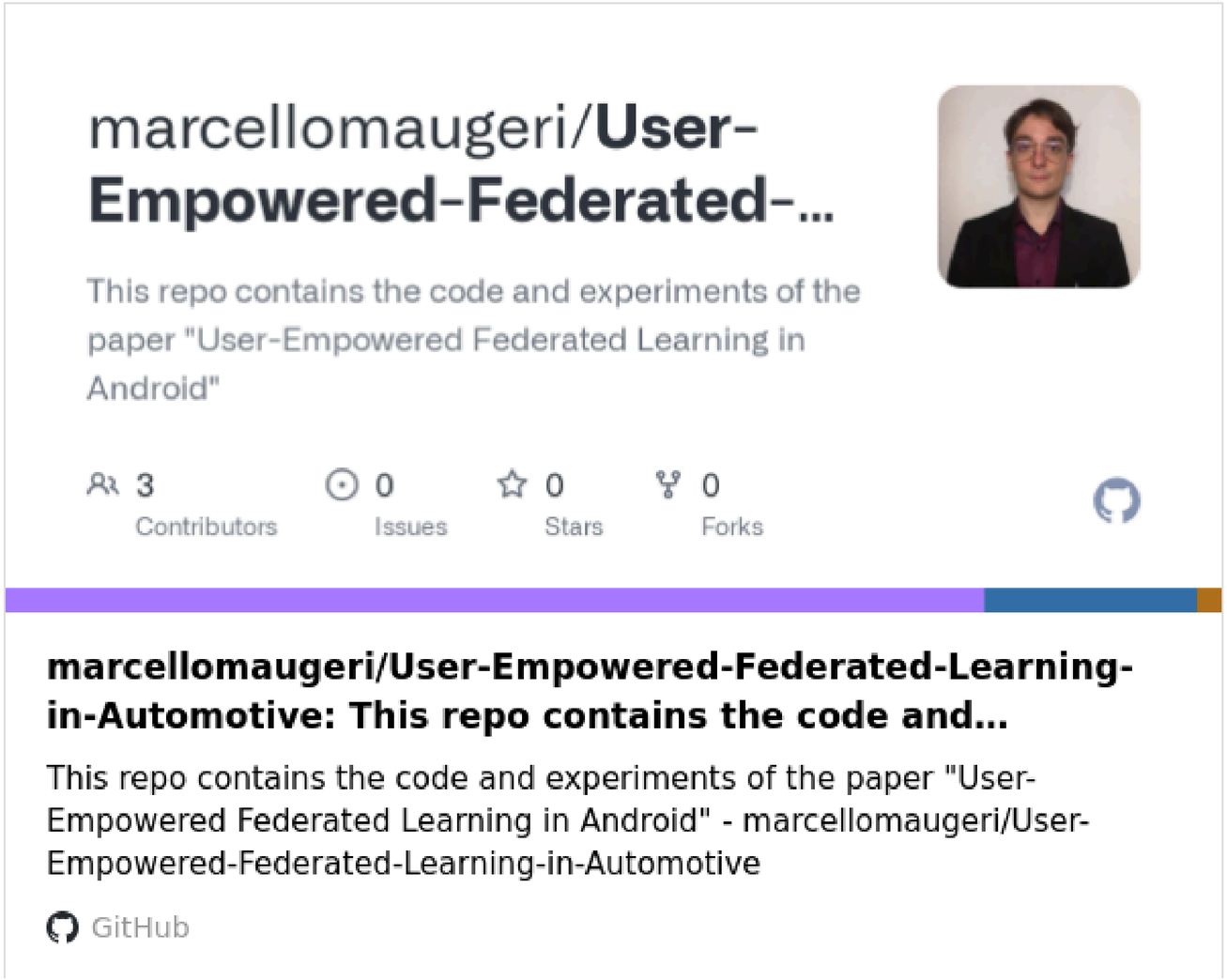
Labelled Data Only

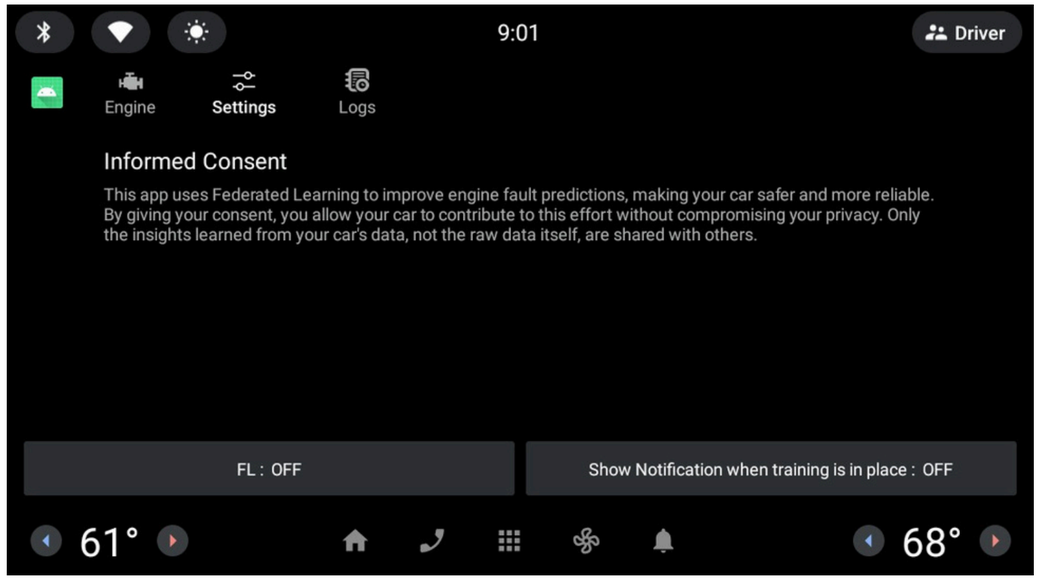
Self-Supervised Learning

Dataset built on one engine

Feature Augmentation

Conclusions





Acknowledgments

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https://pecs-project.dmi.unict.it

Thank you for the attention

</> marcellomaugeri.github.io

 linkedin.com/in/marcello-maugeri/