A close-up photograph of a clear plastic pipette tip held diagonally, with a small amount of clear liquid at its tip. The background is a blurred image of a DNA gel electrophoresis pattern, showing horizontal bands of various colors (red, blue, yellow) against a white background.

Capstone Research Progress & Planning

Predictive Maintenance using
AI on Fleet Data
Presented by: Dang, Dale,
Sadman, Barsat

- Planning (Week 1-4)
 - Research (Week 4-6)
 - Data collection and preparation (Week 6-9)
 - Building and Testing the Model (Week 8-12)

Semester 2

- Refining the model
 - GUI and deployment
 - API integration and Backend
 - Frontend integration
 - Live data integration

Legend

- In Progress
 - Not completed

Solution & AI Model Research

Goals:

- Identify suitable Machine / Deep Learning models for time-series predictive maintenance.
- Evaluate models based on requirements

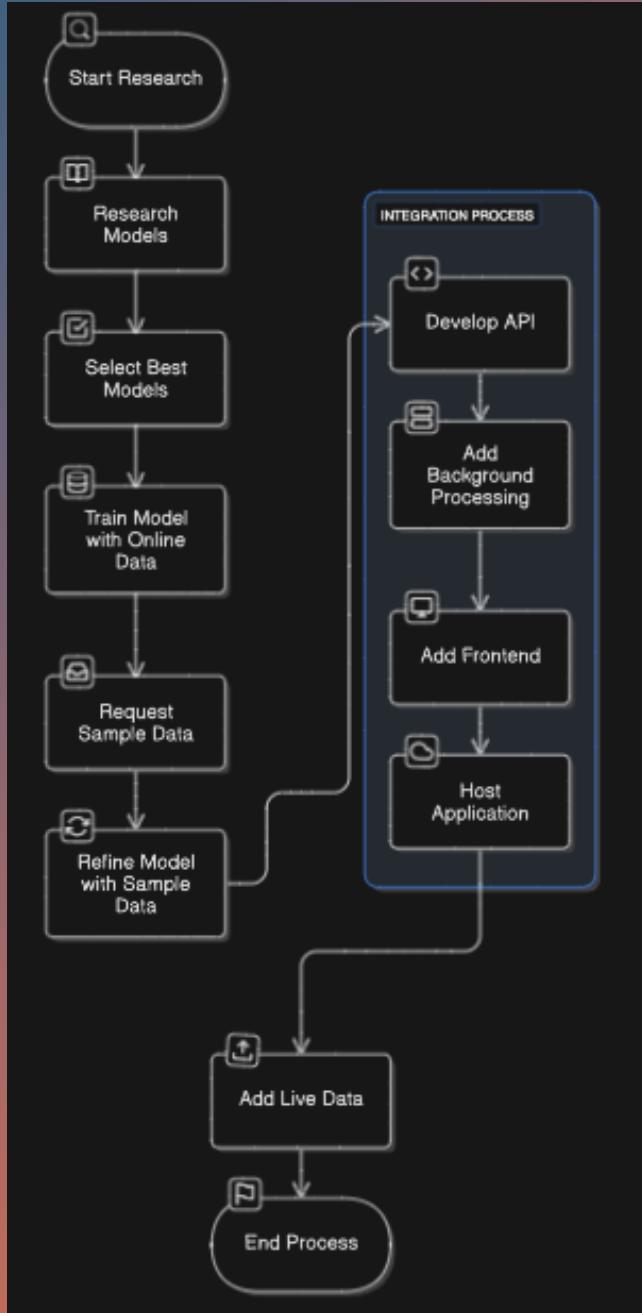
Explored Models:

- LSTM / GRU (deep learning, time-series)
- Random Forest, XGBoost
- Autoencoders for anomaly detection

Early Findings:

- Experiment with external datasets (from various sources and manufacturers) shows XGBoost the highest accuracy.
- Combing LSTM and an autoencoder will benefit from large datasets and complexity, but interpretability can be an issue

Architecture Research



Research Phase

- Investigate existing models and technologies
- Select the best-suited models for the task
- Model Training Phase
- Train initial models using online data
- Request real-world sample data
- Refine model accuracy using sample datasets

Integration Process

- Develop backend API
- Add background processing functionality
- Build and integrate frontend
- Host the application

Final Steps

- Integrate live data streams
- Complete and finalize the process

External Dataset Research

Why External Datasets?

- To train/test models while live data is being collected.
- Examine key features that has highest likelihood to vehicle degradation (strongest correlation)

Sources Researched:

- Kaggle OBD-II datasets [1][2]
- Hyundai Vehicle data [3]
- SCANIA Component X [4]
- UCI Machine Learning Repository [5]
- Ford Challenge Dataset (Sensor data) [6]

Status:

- 4 datasets experimented and conduct reflection on model selection + feature correlations.
- 2 potential datasets shortlisted.
- Need to ensure similarity to our sensor input format.

[1] C. Dulaj, "Vehicle Maintenance Data," *Kaggle*, 2020. Available: <https://www.kaggle.com/datasets/charindulaj/vehicle-maintenance-data>.

[2] P. Modi, "Automotive Vehicles Engine Health Dataset," *Kaggle*, 2021. Available: <https://www.kaggle.com/datasets/paavmodi/automotive-vehicles-engine-health-data>.

[3] Hyundai, "Hyundai Vehicle Telematics and Sensor Dataset," *Hyundai AutoEver Research*, Internal Dataset

[4] SCANIA, "Component Faults Dataset," *UCI Machine Learning Repository*, 2016. Available: <https://archive.ics.uci.edu/ml/datasets/Scania+Truck+Dataset>.

[5] UCIMachine Learning Repository, "Various Datasets," *University of California, Irvine*. Available: <https://archive.ics.uci.edu/ml/index.php>.

[6] Ford Research, "Ford Challenge Vehicle Sensor Data," *Ford Motor Company Research Challenge*. Available: <https://www.kaggle.com/competitions/ford-challenge/data>.

What Does Statistics Say?

Key Features Predicting Maintenance Need

1. Issue & Condition Logs (Top Overall Predictor)

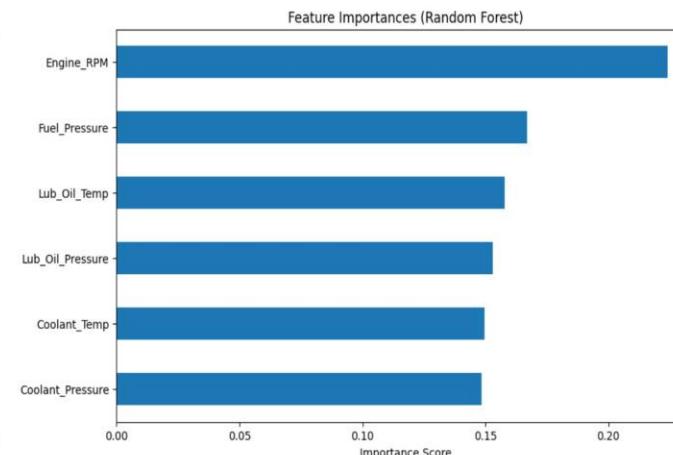
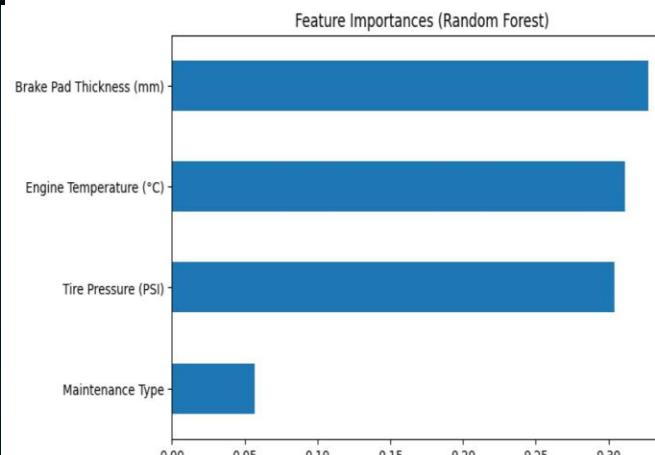
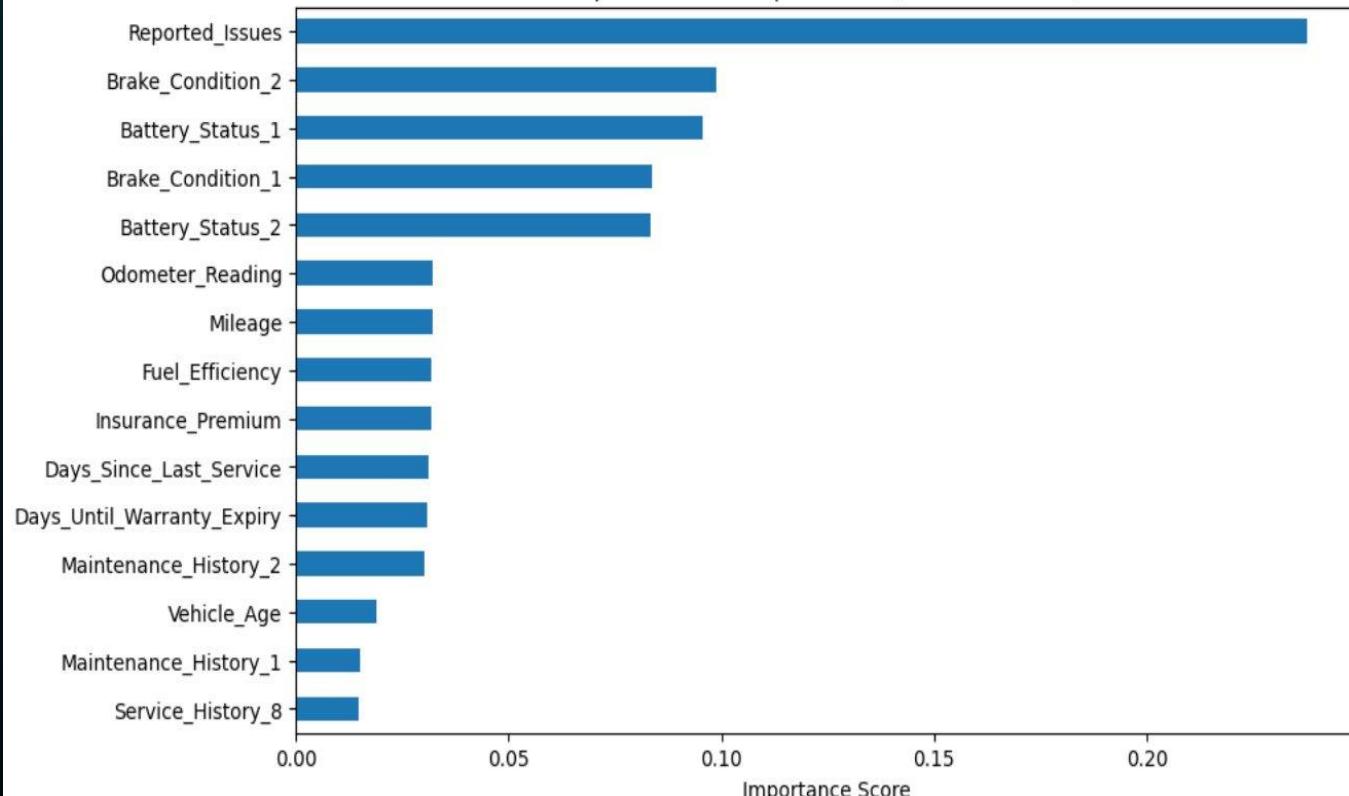
- **Reported_Issues:** Most influential feature (Importance ≈ 0.23)
- **Brake_Condition_1 & 2:** Importance ≈ 0.10
- **Battery_Status_1 & 2:** Importance ≈ 0.09

2. Sensor & Mechanical Metrics (Hyundai Dataset)

- **Engine RPM:** Highest importance at **0.23**
- **Fuel Pressure:** Importance ≈ 0.17
- **Lubricant Oil Temp/Pressure:** Importance ≈ 0.15
- **Coolant Temp/Pressure:** Also scored ≈ 0.15

3. Tire & Brake Sensor Data (Fleet Maintenance Dataset)

- **Brake Pad Thickness:** Highest scoring at **0.32**
- **Engine Temperature (°C):** Importance **0.31**
- **Tire Pressure (PSI):** Importance **0.30**



Constraints Investigation



DATA AVAILABILITY



ACCESS TO REAL TIME DATA

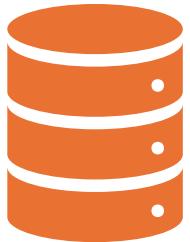


OTHER TRAITS NOT AVAILABLE
THROUGH OBD-II PORT
(TIRES, BRAKES ETC.)

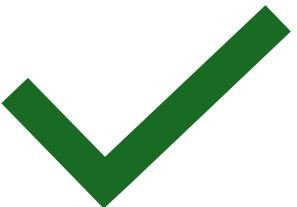


BUDGET

Next Steps



Finalize architecture
blueprint



Shortlist datasets and
begin pretraining



Prepare for physical data
collection (start Week 7)

Why Real- World Data Matter?



Improves Model Accuracy



Enhances Anomaly Detection



Ensures Operational Relevance



Enables Continuous Improvement



Supports Business Decisions



Reduces Maintenance Costs & Downtime

Budget Proposal

Item	Quantity	Unit Price (AUD)	Total Cost (AUD)	Source
ELM327 Bluetooth OBD-II Adapter	1	\$26.99	\$26.99	Amazon Australia
Google Colab Pro Subscription	3 month	\$45.00	\$45.00	Google Colab Pricing
Contingency Fund (10% of total)	-	-	\$7.20	-
Raspberry Pi 4 and hardware integration	1	108.65	108.65	Core Electronics
Micro-HDMI to Standard HDMI Cable (1m)	1	\$9.95	\$9.95	Core Electronics
Total Estimated Cost			\$79.19	

Budget Proposal

Hardware Components:

- **ELM327 Bluetooth OBD-II Adapter:** Essential for accessing vehicle diagnostics data. The selected model is cost-effective and compatible with our project requirements [1].
- **Optional Hardware: Raspberry Pi 4 Model B (4GB RAM) [2]** Official Raspberry Pi 4 Power Supply [3] Micro-HDMI to Standard HDMI Cable [4], Raspberry Pi 4 Official Case [5] if the existing system can handle data collection and processing

Software and Cloud Services:

- **Google Colab Pro Subscription:** Provides enhanced computational resources for model training and data analysis. The subscription is on a monthly basis, allowing flexibility in usage [6].

Contingency Fund:

- Allocated <10% of the total estimated cost to cover unforeseen expenses or price fluctuations.

Financial Planning Considerations

- **Remaining Budget:** After the initial expenditure of **\$79.19 AUD**, approximately **\$320.81 AUD** remains for the duration of the project.
- **Monthly Budget:** 7 x \$11 AUD per month.
- **Future Expenses:** Google Colab Pro subscription (plus pay-as-you-go), cloud services for hosting, database, additional computational resources beyond this period.

Item	Quantity	Unit Price (AUD)	Total Cost (AUD)	Source
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[1] Amazon Australia, "OBD2 ELM327 Bluetooth Scanner," Amazon AU, [Online]. Available: <https://www.amazon.com.au/elm327-bluetooth/s?k=elm327+bluetooth>. [Accessed: 05-Apr-2025].

[2] Core Electronics, "Raspberry Pi 4 Model B (4GB RAM)," Core Electronics, [Online]. Available: <https://core-electronics.com.au/raspberry-pi-4-model-b-4gb.html>. [Accessed: 05-Apr-2025].

[3] Core Electronics, "Raspberry Pi 4 Power Supply USB-C," Core Electronics, [Online]. Available: <https://core-electronics.com.au/raspberry-pi-4-power-supply-usb-c-5-1v-15-3w-white.html>. [Accessed: 05-Apr-2025].

[4] Core Electronics, "Micro HDMI to Standard HDMI (1m) Cable," Core Electronics, [Online]. Available: <https://core-electronics.com.au/micro-hdmi-to-standard-hdmi-1m-cable.html>. [Accessed: 05-Apr-2025].

[5] Core Electronics, "Raspberry Pi 4 Case - Red/White (Official)," Core Electronics, [Online]. Available: <https://core-electronics.com.au/raspberry-pi-4-case-red-white-official.html>. [Accessed: 05-Apr-2025].

[6] Google, "Colaboratory: Pro and Pro+," Google Colab, [Online]. Available: <https://colab.research.google.com/signup>. [Accessed: 05-Apr-2025].