Machine Learning Based Enhanced Road Safety

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Project Impact

- Automate road safety and vehicle ticketing
- Cost Reduction/Human Resource Optimization
- Analyze Ticketing Pattern/Trends
- Behaviour Insights
- No automated tool available which considers driver's characteristics
- Data Driven Policy Making

Problem Statement

Drowsiness Detection:

- Currently, there's a noticeable absence of automated tools that factor in driver characteristics. This raises the question: How can we leverage machine learning algorithms to detect driver drowsiness in real-time, thereby preventing accidents caused by drowsy driving?

License Plate Recognition:

- Accountability is key to ensuring safety, especially concerning vehicles. Thus, our focus is on identifying number plates to hold individuals accountable. How can we develop and implement a machine learning model to accurately recognize and extract license plate numbers from images for the automated enforcement of traffic rules and regulations?

Ticketing Analysis:

- Understanding the significant factors contributing to parking infractions in Toronto is crucial. Moreover, analyzing these factors to uncover trends and patterns in parking ticket issuance can inform strategic deployment and optimization of human resources, reducing costs while enhancing performance.

Datasets

Parking Tickets: https://open.toronto.ca/dataset/parking-tickets/
Toronto Neighbourhoods: https://open.toronto.ca/dataset/neighbourhoods/
Driver Population Statistics: https://data.ontario.ca/en/dataset/driver-population-statistics
License Plate Recognition: Open Images Website
Drowsiness Detection: https://www.kaggle.com/datasets/dheerajperumandla/drowsiness-dataset

Methodology and Tools

GeoJson and Parking Tickets Dataset Integration: -
Tools and Libraries: Python, Pandas, NumPy, Shapely
Analysis Methods: Spatial analysis, merging datasets based on geographical coordinates.

Data Cleaning, Processing, Integration, Feature Engineering, and Visualization: -
Tools and Libraries: Python, Pandas, Matplotlib, Plotly
Analysis Methods: Exploratory data analysis, feature engineering, data visualization

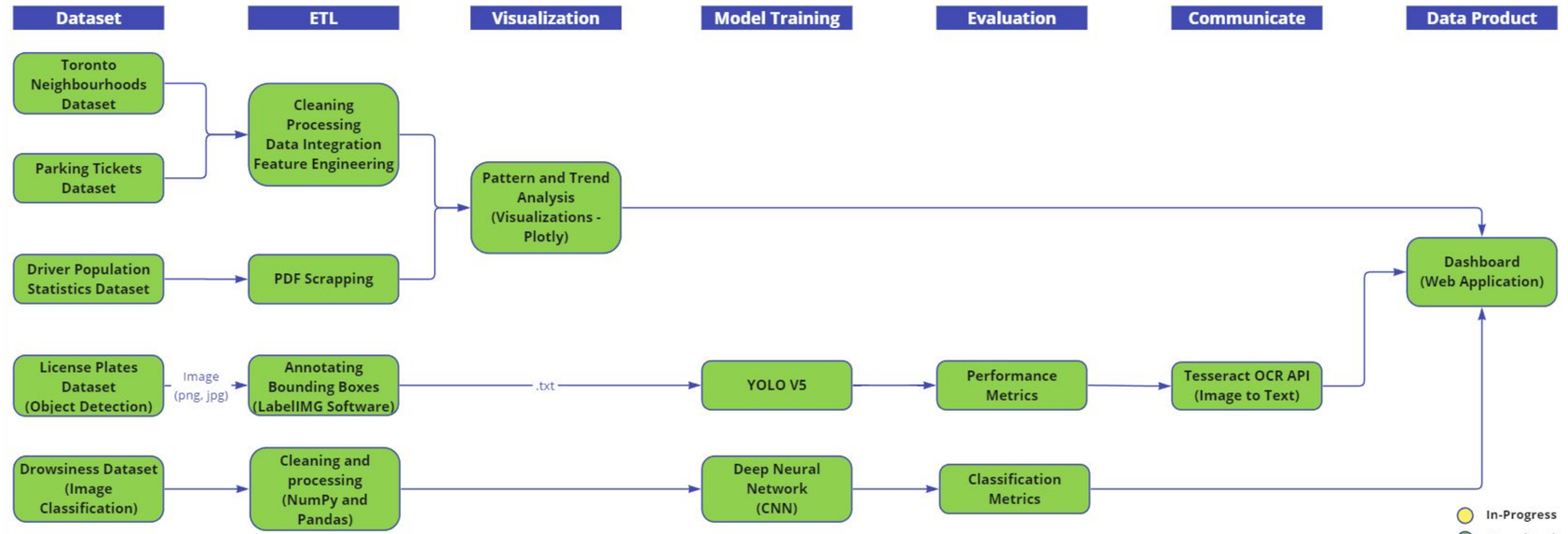
Driver Population Statistics Analysis: -
Tools and Libraries: Python, Pandas, Tabula, Matplotlib, Dataprep
Analysis Methods: Statistical analysis, demographic analysis

License Plate Recognition:
Tools and Libraries: Python, labelImg, CV2, Numpy, Pandas, Tensorflow, Pytesseract, Scikit-learn
Analysis Methods: Object detection (YOLO Model), deep learning

Driver Drowsiness Detection:
Tools and Libraries: Python, NumPy, Pandas, CV2, TensorFlow, Matplotlib, Scikit-learn
Analysis Methods: Image classification (CNN Model) Deep learning

Web Application Development:
Tools and Libraries: HTML, CSS, Bootstrap, JavaScript, Python Flask
Analysis Methods: Front-end and back-end development, user interface design

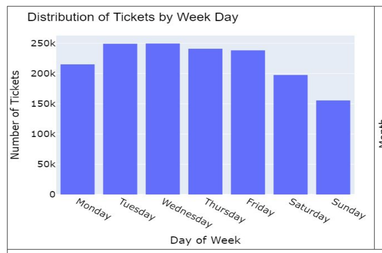
Pipeline

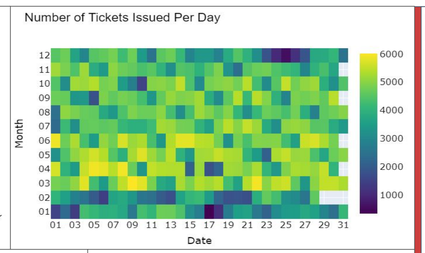


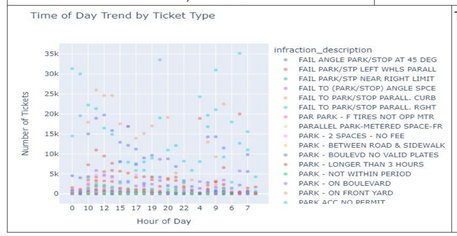
Results

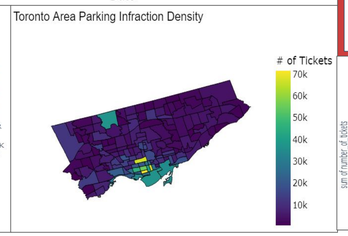
Ticketing Analysis

Efficiently pinpointing high-violation areas enables targeted resource allocation, promoting traffic safety and enhancing overall safety for drivers, passengers, and pedestrians.



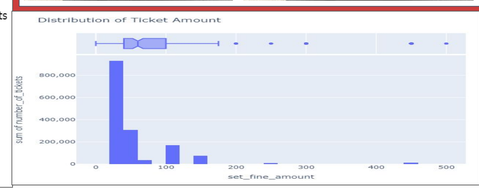






License Plate Recognition:

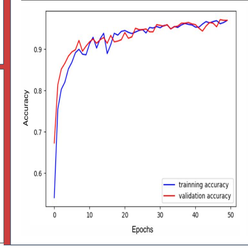
Using YOLOv5, precision is perfect (1), recall is high (0.958), and mean Average Precision (mAP) at IoU 0.5 is impressively high (0.993), yet the overall mAP score (0.734) suggests challenges with overlapping or closely packed objects.

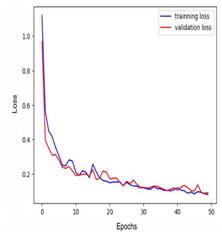


Driver Drowsiness Detection

The accuracy and loss graphs demonstrate strong convergence, indicating balanced generalization and absence of overfitting, with both training and validation metrics closely aligned throughout training.

	precision	recall	f1-score	support
yawn	0.94	0.71	0.81	63
no_yawn	0.81	0.96	0.88	74
Closed	0.97	0.99	0.98	215
Open	0.99	0.97	0.98	226
accuracy			0.95	578
macro avg	0.93	0.91	0.91	578
weighted avg	0.95	0.95	0.95	578





Project Learnings

- Data Gathering and Integration
- Data Cleaning
- Processing, and Visualization
- Project Management
- Model Development
- Web Application Development
- Problem-Solving and Troubleshooting
- Skills Acquisition and Transferability

Future Scope

- Incorporating pedestrian information to analyze interactions between drivers and pedestrians for comprehensive road safety assessment.
- Dataset: https://universe.roboflow.com/vincent-huard-axo4r/dataset_0610
- Integrating weather data to provide insights into road conditions affecting safety.
- Dataset: https://climatedata.ca/download/
- Integrate with emergency response services.
- Dataset: https://data.sfgov.org/dataset/EMSA-Emergency-Medical-Services-Response-Times-Dat/faug-73ss/data_preview

Data Product

- Youtube Link: https://youtu.be/wa_gxY8OSuE
- GitHUB Link: https://github.sfu.ca/mja125/ML-Based-Enhanced-Road-Safety