

Trip Duration Prediction and CO₂ Optimization: A Data Science Approach to Urban Sustainability

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21/08/2025

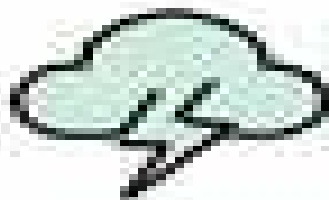
SUSTAINABLE DEVELOPMENT GOALS



1. Motivation & Problem



NYC taxis emit
450,000 tons CO₂
annually



Inefficient routes
result in 15–25x
more emissions
per mile



Green Rides
Initiative at 100%
zero-emission by
2030

UN Sustainable Development Goals

SDG Alignment



SDG 11: Sustainable Cities and Communities



SDG 13: Climate Action



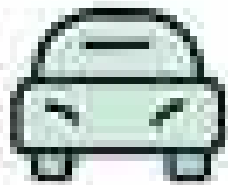
SDG 9: Industry, Innovation and Infrastructure



2. Research Questions

1. Can ML models accurately predict trip durations?
2. Which features best explain variability (time, weather, geography)?
3. How much CO₂ can optimized routing save?
4. Can we operationalize via a real-time dashboard?

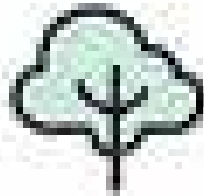
3. Data Sources



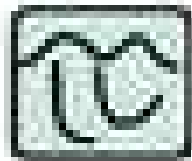
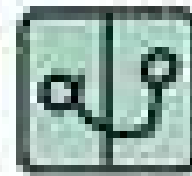
NYC Taxi Trip
Data



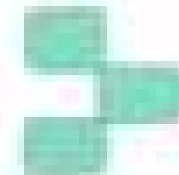
1.4M records



Weather &
Holidays



OSRM Routing
0.15 kg/km



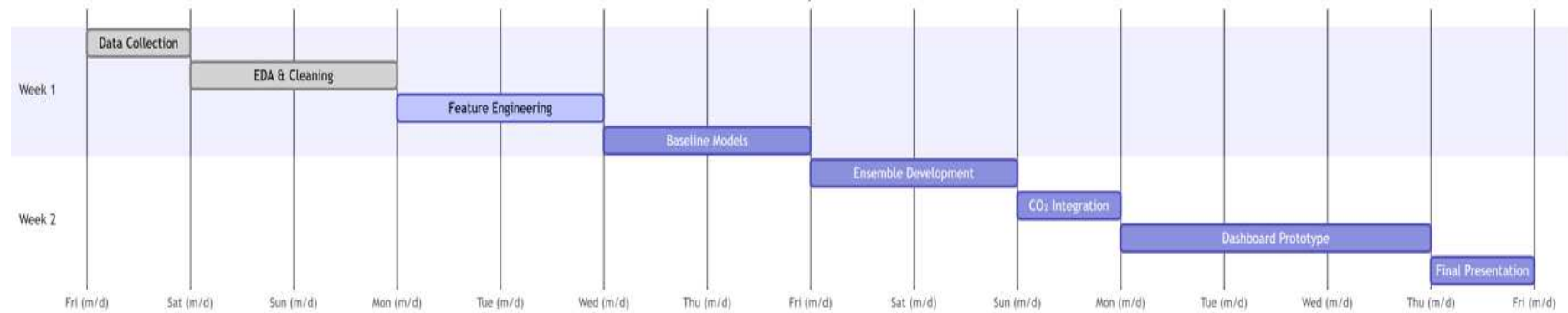
www.kaggle.com/c/nyc-taxi-trip-duration

www.ncdc.noaa.gov/cdo-web/datasets/GHCND/stations/USW00094728/detail

www.opm.gov/policy-data-oversight/pay-leave/federal-holidays

[Endpoint: router.project-osrm.org/route/v1/car/{coordinates}](https://router.project-osrm.org/route/v1/car/{coordinates})

2-Week Sprint Plan



4. Methodology

Feature Engineering



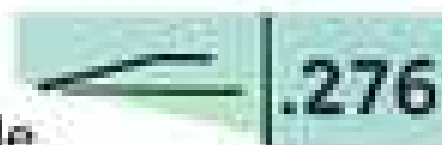
- time cycles
- distances (Haversine/Manhattan)
- weather
- clustering

CO₂ Framework



- 0.15 kg/km
- route reduction scenarios

Final RMSLE



stacked ensemble

Table 1. RMSLE values

Model	RMSLE
XGBoost	0.26267
LightGBM	0.29127
CatBoost	0.30160
Stacked Model	0.27662

Table 2. Kaggle Competition Scores

Model	Public score	Private score
Final model	0.39228	0.39228

Table3. CO₂ impact after reduction scenarios

Optimization Level	Route Reduction	CO ₂ Saved	Distance Saved	Business Impact
Conservative (3%)	3%	18,068 kg	150,570 km	Immediate implementation
Moderate (6%)	6%	36,137 kg	301,140 km	Recommended target
Advanced (10%)	10%	60,228 kg	501,900 km	Maximum potential

<https://github.com/kasriS/TripDurationCO2SustainabilityDashboard/tree/main>

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kasriS Create new4d97008 · now13 Commits

docs	Add files via upload	3 hours ago
models	Add files via upload	yesterday
results	Create new	now
src	Update RoutesCO2Scenarios.py	4 minutes ago
README.md	Update README.md	3 hours ago
requirements.txt	Add files via upload	yesterday

README

About

Trip Duration CO2 Sustainability Dashboard

Readme

Activity

0 stars

0 watching

0 forks

Releases

No releases published

Create a new release

Packages



Deploy

Dashboard Menu

Navigate

- ☒ Home
- ☐ EDA
- ☐ Prediction
- ☐ Routes & CO₂ Scenarios
- ☐ Model Info

Tip: Add Kaggle-trained artifacts into [/models](#).



SDG 11: Sustainable Cities and Communities



SDG 13: Climate Action



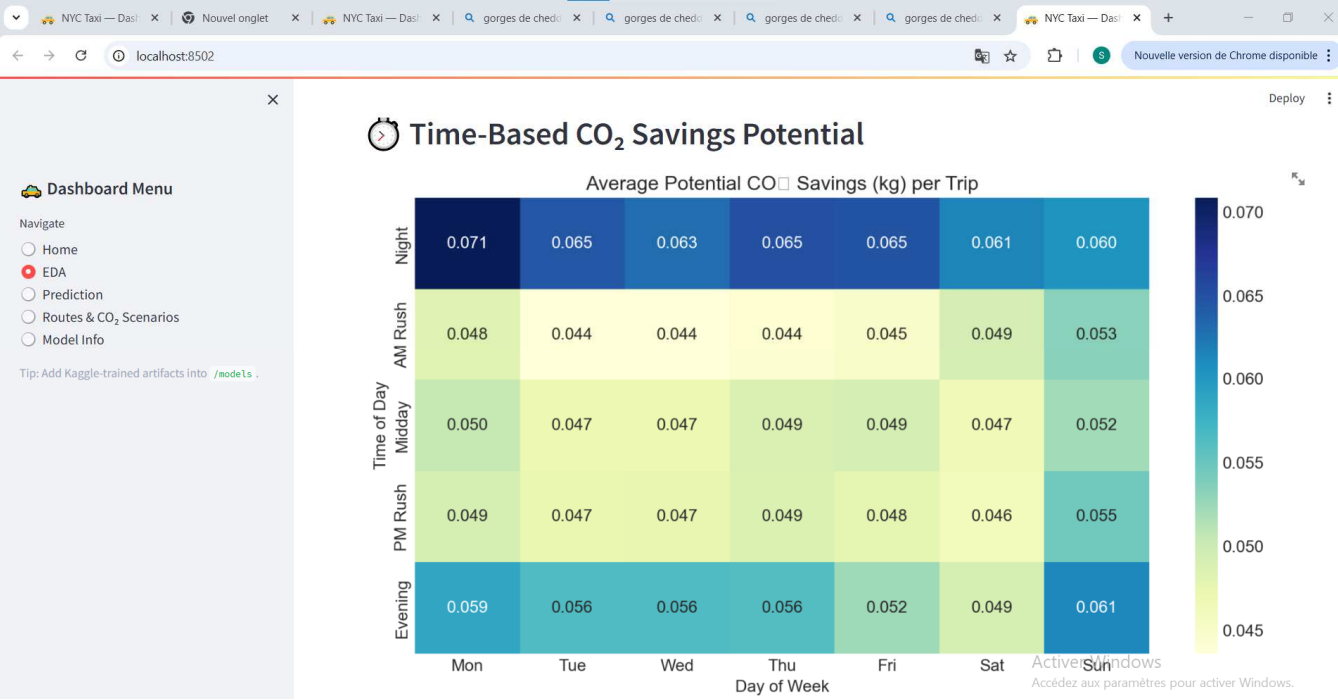
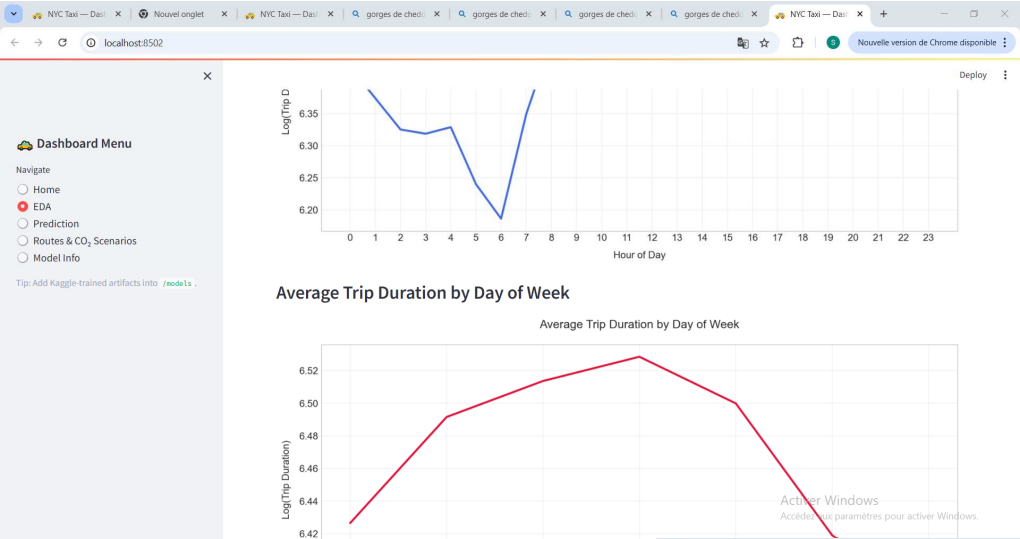
SDG 9: Industry, Innovation and Infrastructure



Interactive Dashboard Features

Quick Map Preview





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🚗 Dashboard Menu

Navigate

☐ Home

☐ EDA

☐ Prediction

☒ Routes & CO₂ Scenarios

☐ Model Info

Tip: Add Kaggle-trained artifacts into `/models`.

Deploy

⋮

Route Optimization Scenarios

Average Route Reduction (%)

3

0

20

Scenario Summary

Trips	Avg reduction	Total CO ₂ Saved	Total Distance Saved
1,458,644	3%	18,068.38 kg	150,569.86 km

Sample of Trips with Savings

	pickup_latitude	pickup_longitude	dropoff_latitude	dropoff_longitude	Original_km	Optimized_km	Distance_Saved_km	CO2_Saved_kg
0	40.7679	-73.9822	40.7656	-73.9646	1.4985	1.4536	0.045	0.0054
1	40.7386	-73.9804	40.7312	-73.9995	1.8055	1.7513	0.0542	0.0065
2	40.7639	-73.979	40.7101	-74.0053	6.3851	6.1935	0.1916	0.023
3	40.72	-74.01	40.7067	-74.0123	1.4855	1.4409	0.0446	0.0053
4	40.7932	-73.9731	40.7825	-73.9729	1.1886	1.1529	0.0357	0.0043
5	40.7422	-73.9829	40.7492	-73.9921	1.0989	1.066	0.033	0.004
6	40.7578	-73.969	40.7659	-73.9574	1.3263	1.2865	0.0398	0.0048
7	40.7078	-73.9603	40.7606	-73.9225	5.715	5.5435	0.1714	0.0206

Active Windows
Accédez aux paramètres pour activer Windows.

Deploy

Dashboard Menu

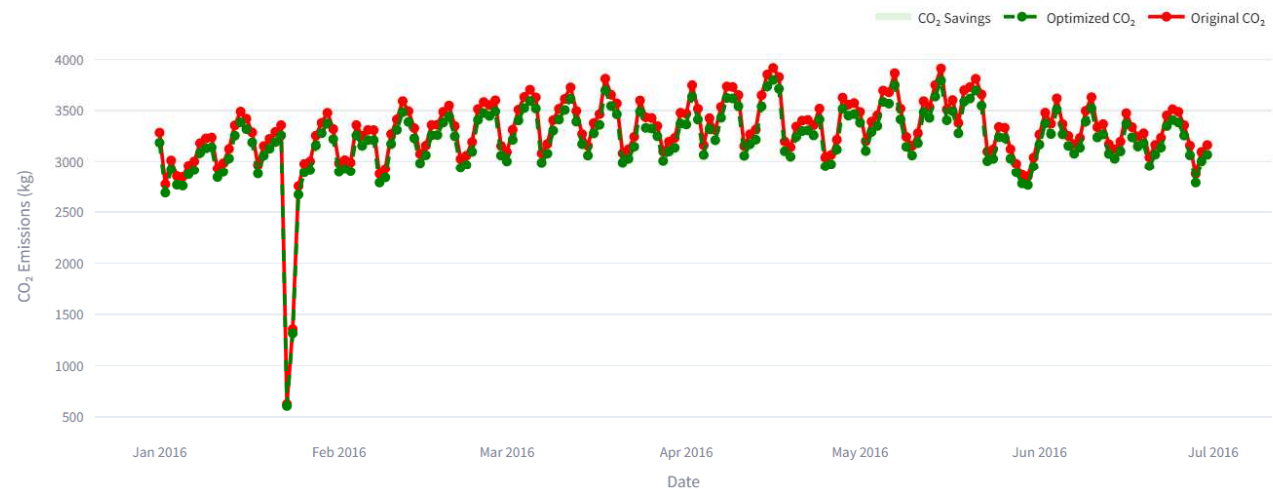
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Daily CO₂ Emissions: Before vs After Optimization

Daily CO₂ Emissions Reduction



Daily CO₂ Savings Trend

Active Windows

Accédez aux paramètres pour activer Windows.

7. Future Directions

- Integrate real-time traffic APIs
- Pilot test with taxi fleets
- Expansion to ride-sharing and last-mile delivery
- API integration for smart cities