Crowd Sourcing Fuel Data for Sustainable Routing Algorithms

GENERAL MOTORS

MIT MANAGEMENT SLOAN SCHOOL

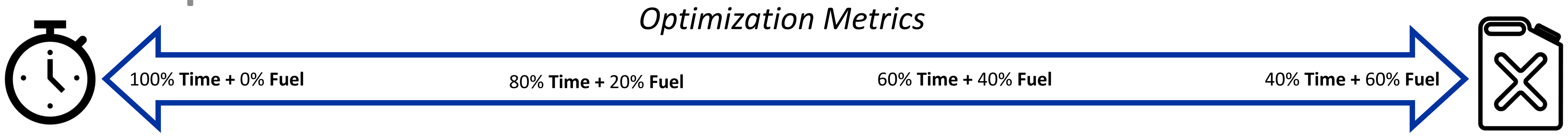
Objective

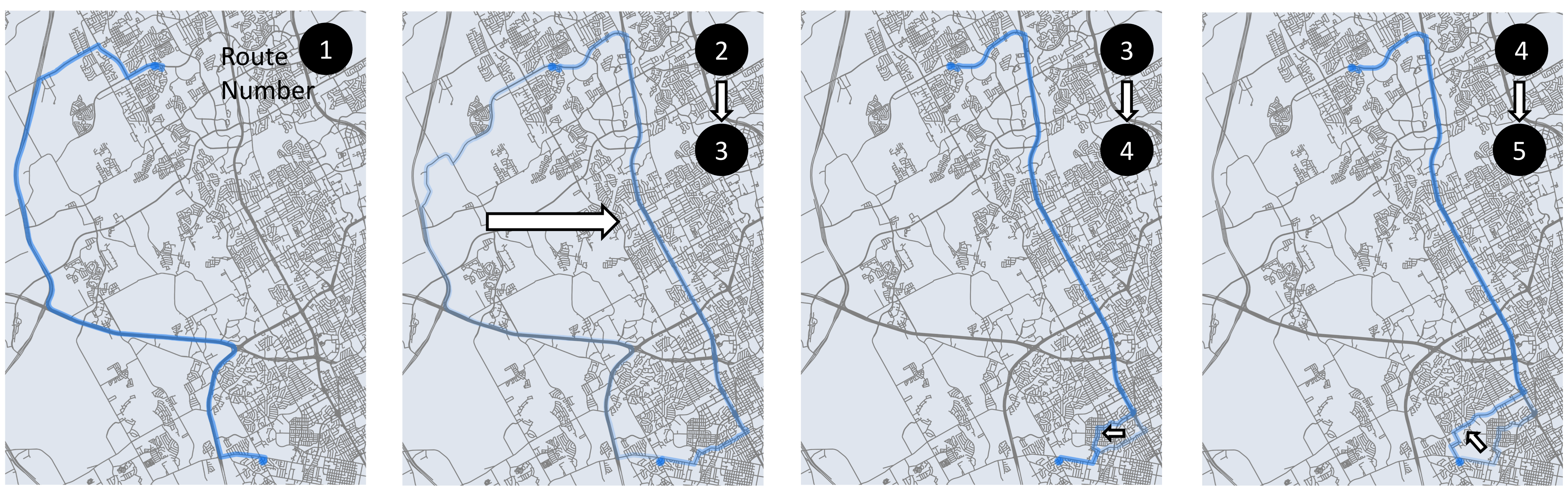
Advance General Motors Zero Emissions Initiative by decreasing emissions of the current and future fleet of internal combustion engine vehicles through a fuel conscious routing algorithm

Example

Our method changes which route is suggested based on a user's preference between decreasing fuel usage or trip time.

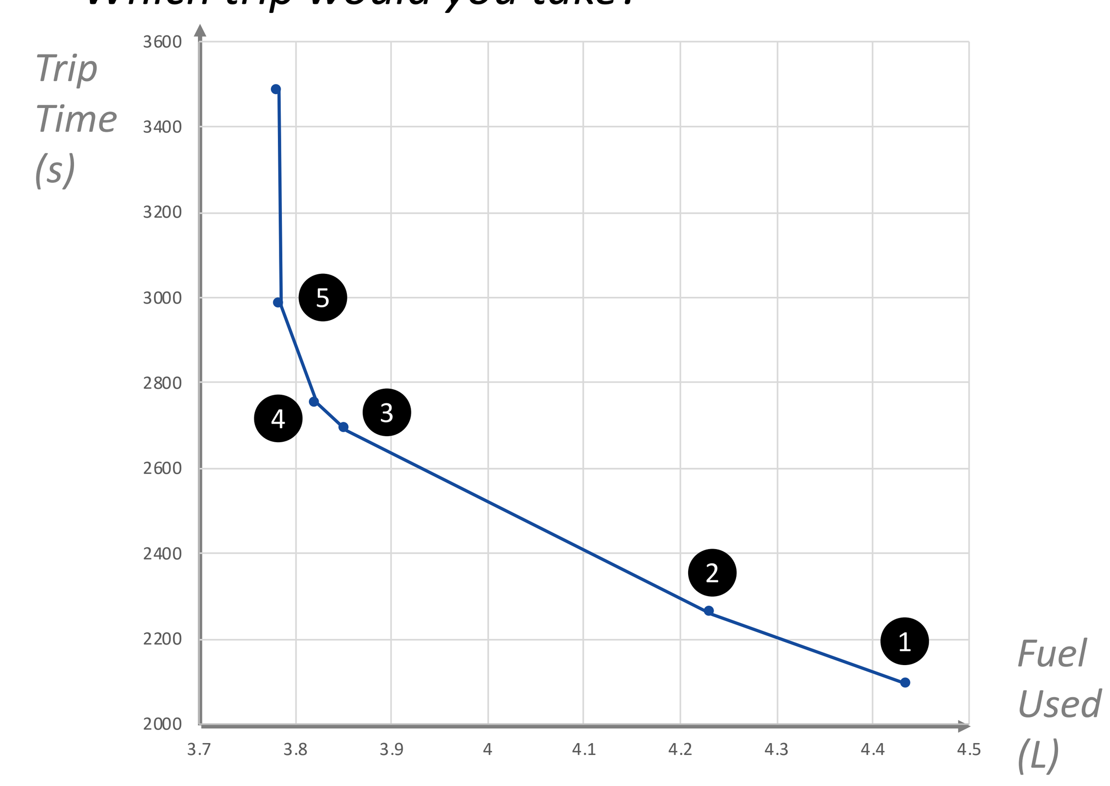
Optimization Metrics





We can visualize the tradeoffs of our preference for Time or Fuel. Below is the Trip Time and Fuel Used for each of the trips shown on the left. This *Multi-Objective Curve* helps understand the tradeoffs in a human-readable way.

Which trip would you take?



Methods

Data Wrangling

General Motors has the largest connected car datasets in the world. We analyzed this data using distributed computing tools such as Hadoop, Spark, and SQL.

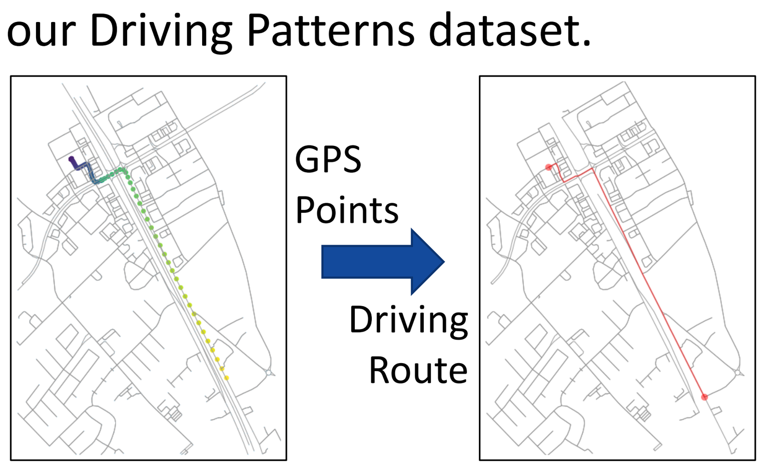
Data from 200,000 cars in Austin, TX

Over 17 million trips In Jan and Feb of 2020

Over 5.9 billion GPS data points

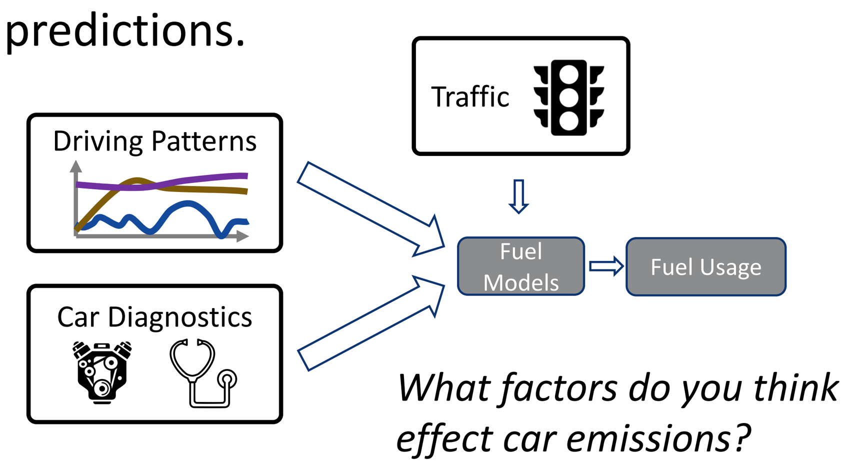
Map Matching

General Motors' data gives GPS locations of vehicles. We developed a method for determining which road a vehicle was on at any time. This creates our Driving Patterns dataset.



Fuel Predictions

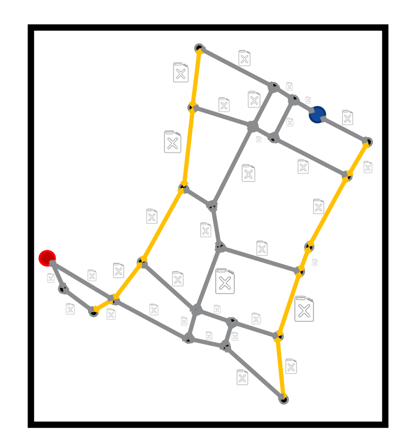
Predicting fuel usage of highways and roads is a critical step for fuel routing. We combine a multitude of information sources for high quality predictions.



What factors do you think effect car emissions?

Route Optimizations

Optimizing routes requires knowing each road's fuel cost. These costs change based on traffic, car type, and car diagnostics. A new graph can be built per vehicle to personalize predictions



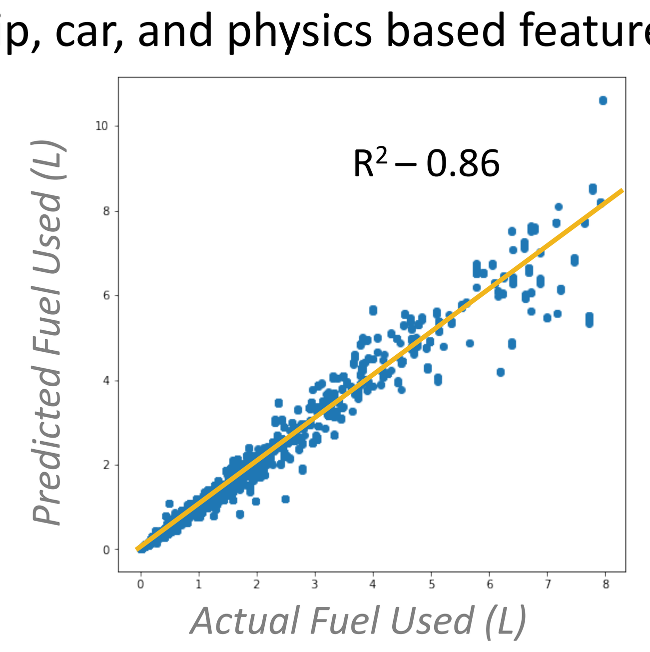
Most fuel efficient path from

Means finding the contiguous path that has smallest fuel usage. *Can you find the best path?*

Results

Fuel Predictions

Highly accurate and interpretable fuel predictions using trip, car, and physics based features



Route Optimization

- Highly promising results
- In preliminary backtesting, 25% of trips show at least a 5% decrease in fuel consumption
- A/B testing needed to accurately determine fuel improvements
- Flexible Routing Prototype can be expanded to other cities with available data
- Modular format for incorporating improvements to fuel prediction and Extensions

Extensions

Intersection Costs

Accounting for the amount of fuel used when driving or waiting at an intersection would improve our optimization performance.

Turning left is often more costly than turning right or driving through the intersection.

System Feedback

With significant adoption of this routing algorithm, the model may overwhelm "fuel-efficient" roads and cause congestion.

An algorithm aware of how its recommendations change a road's fuel efficiency would allow for dynamic routing that prevents over utilized roads

Impact

Informing Policymakers

- Predicting emissions effects of legislation
- A/B testing emissions interventions

Direct-to-Driver efficiency incentives

- Interpretable, accurate "efficiency" score
- Personalized recommendations for saving fuel

Informing Businesses

- Routing for delivery vehicles
- Transportation Cap and Trade predictions for fuel suppliers and derivatives markets

If you'd like to learn more, we'd love your vote to present at the MIT Virtual Analytics Capstone Showcase

Acknowledgements

We could not have accomplished this project if it wasn't for our amazing group of stakeholders. We would like to thank MIT & MIT Sloan, The MBAn Team, and the General Motors Chief Data and Analytics Office.

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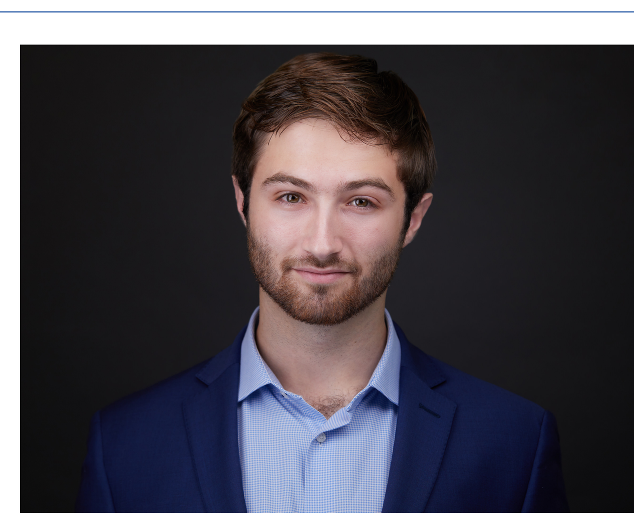

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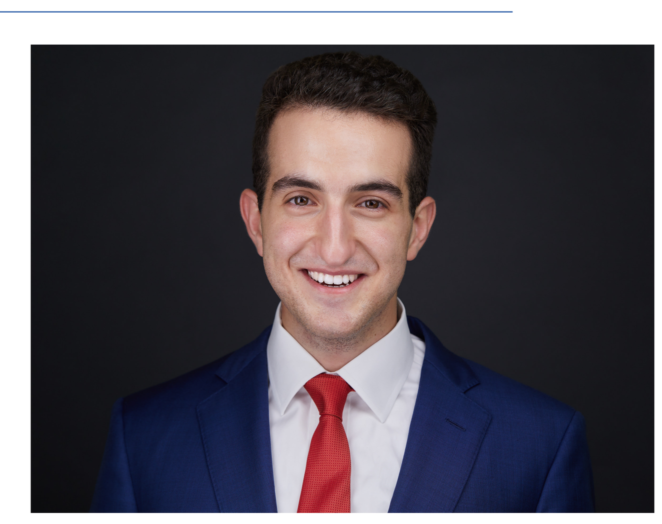

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