Leveraging Information Visualization Techniques and Driving Statistics for Influencing User Behaviour

Hazem, Rifat, Tushar, Yasaman
April 29th, 2019

Introduction/ Motivation

Introduction and Motivation

- Future of ground transportation
- Powerful computational resources (i.e. deep learning)
- Goal: safe transportation
- Challenge: safety
- Current state: Drivers are still responsible for safe operation

Introduction and Motivation (cont.)

- Drivers are not playing their parts
- Companies deny responsibility
- AV research focus more on the machine and less on the human
- Ultimately, the goal is to improve human safety in AVs. We want to look at this problem from a different standpoint, by looking to improve human performance rather than vehicle performance.
- Our goal: help drivers train themselves to improve their driving behavior by giving them a means to contextually understand their driving performance.

Literature Review

Related Work

Safety of Autonomous Vehicle, Ergonomics, and HCI

- Contextual awareness, safety, perception, warning systems, and communication tools and techniques
- Positive cues in intelligent user interfaces increase learners' inductive capability (Hoc et al.)
- Measuring drivers' situational awareness in real time - both on-board and in simulated environments (Sirkin et al.)
- People's perception of safety in terms of design elements of warning systems (Li et al.)
- Pedestrians most clearly understood the information communicated via textual eHMI over other mediums (i.e., Knightrider, smiley, front brake) (de Clercq)

Related Work

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Limitations in terms of generalizability, design choices, and users' responsiveness.

Related Work (cont.)

Persuasion and Visualization

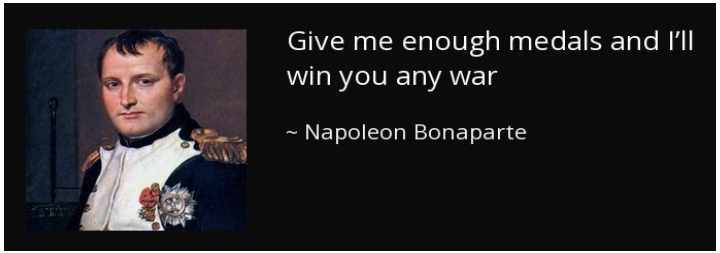
- How persuasion influence human behavior
- People change their behavior when they see evidence, especially statistical evidence and when they are already persuaded in some ways (Pandey et al.)
- Motivational, instructional, and supportive intervention techniques for workplaces for effective behavior changes (Yun et al.)

Related Work (cont.)

Gamification

- Applied to other contexts such as motivation, engagement, education, steering users' behavior (Jent and Janneck)

- Badging: one of the main behavior-modification mechanisms (Hamari et al.)
    - Positive effect on user behavior (Anderson et al., Bornfeld and Rafaeli, Hamari)



Proposed System

Requirements

The system must:

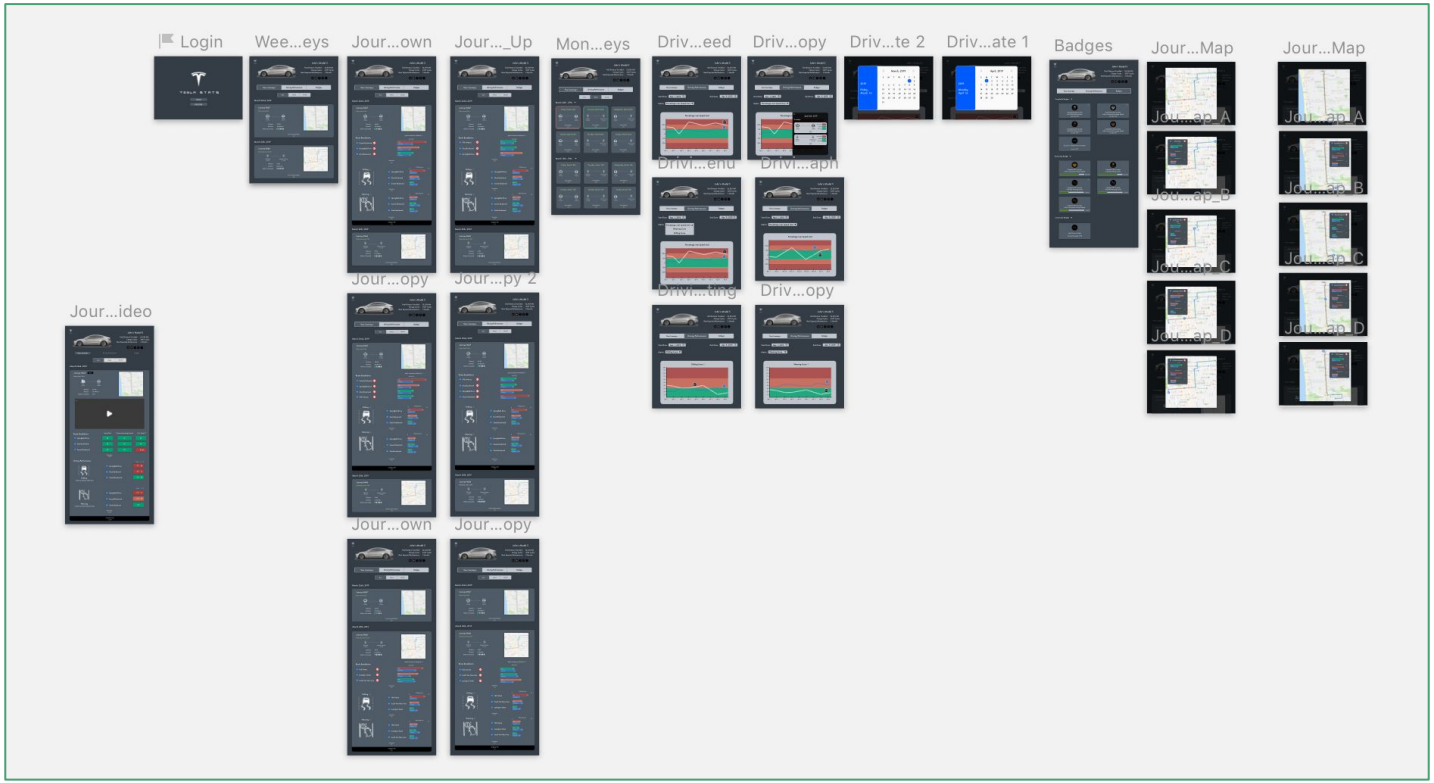
1. Visualize individual journey information
2. Visualize aggregate journey statistics
3. Enable users to infer relative driving performance
4. Motivate users to drive more safely

Datasets Used

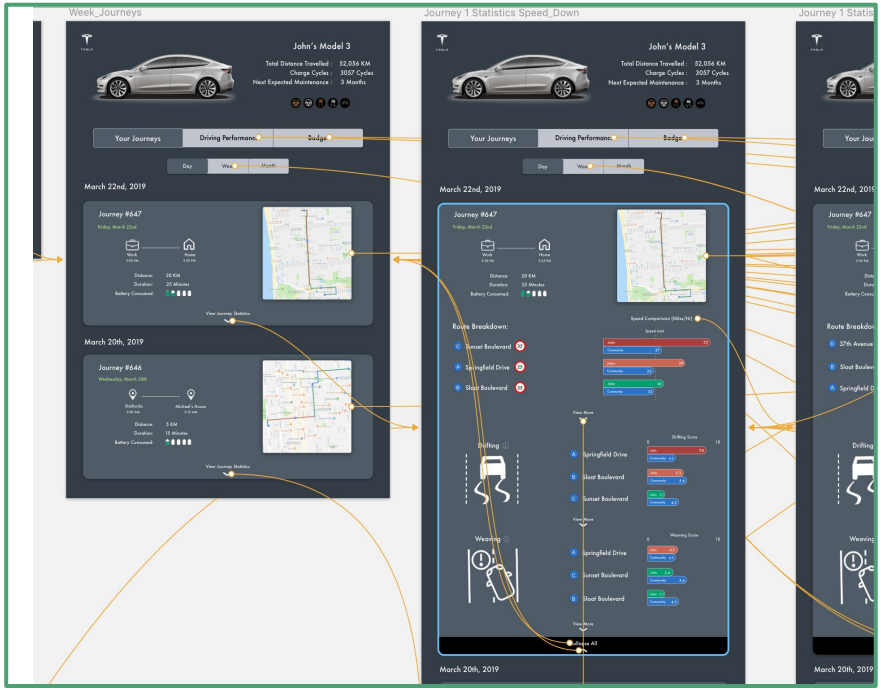
1. San Francisco Speed Limit Dataset
    a. Coordinates on streets and associated speed limits and average speeds

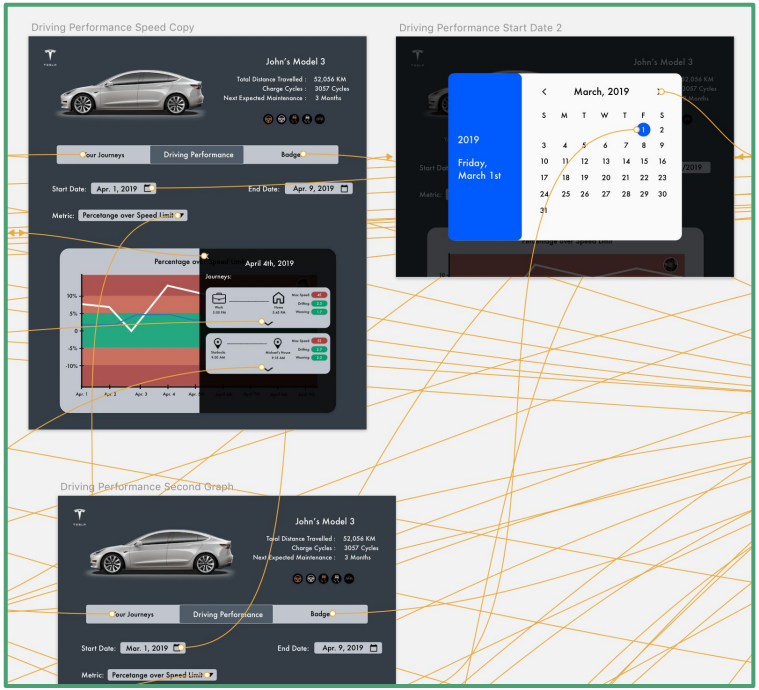
2. UAH Driving Dataset
    a. Raw information from accelerometer and GPS
    b. Processed information scores for weaving, drifting, acceleration, breaking, turning, and overspeeding
    c. Identification of normal, drowsy, and aggressive behavior

Design Overview



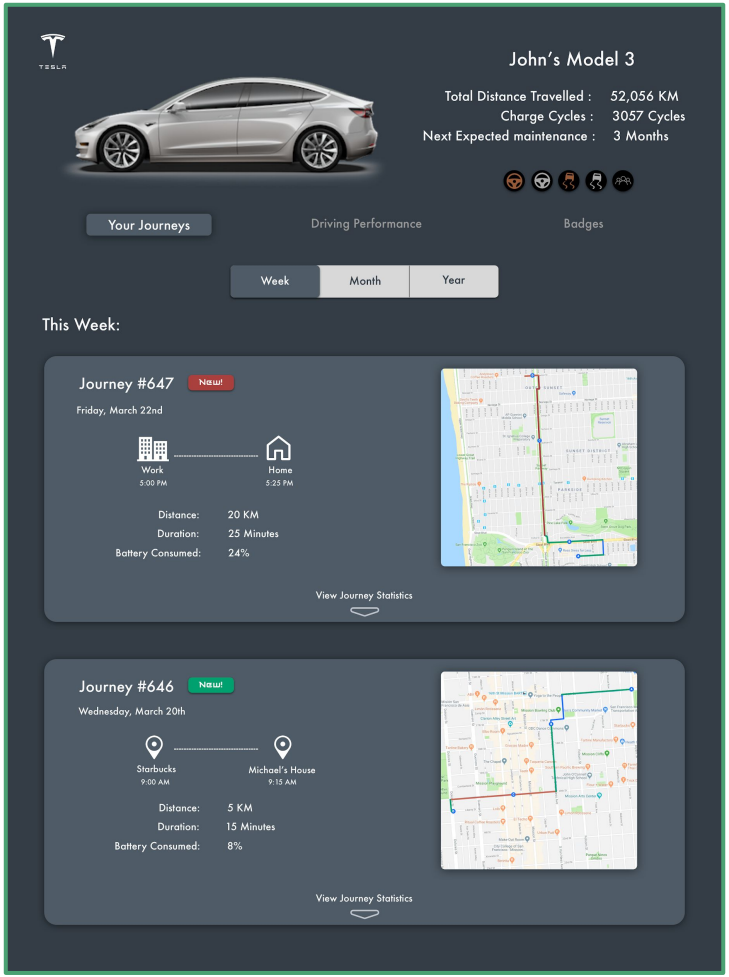
Interaction Prototyping

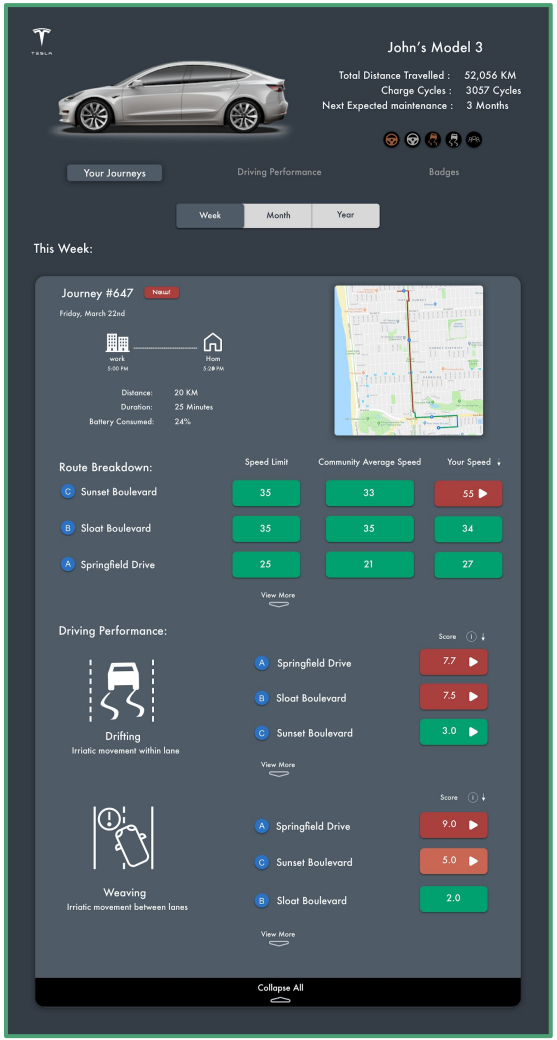


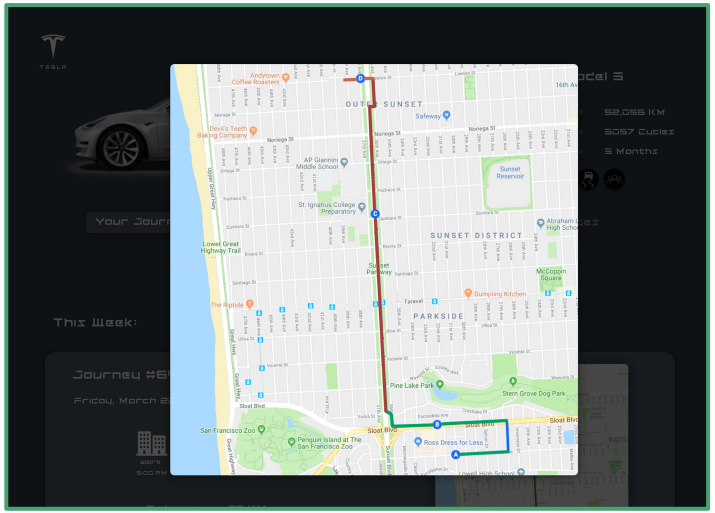


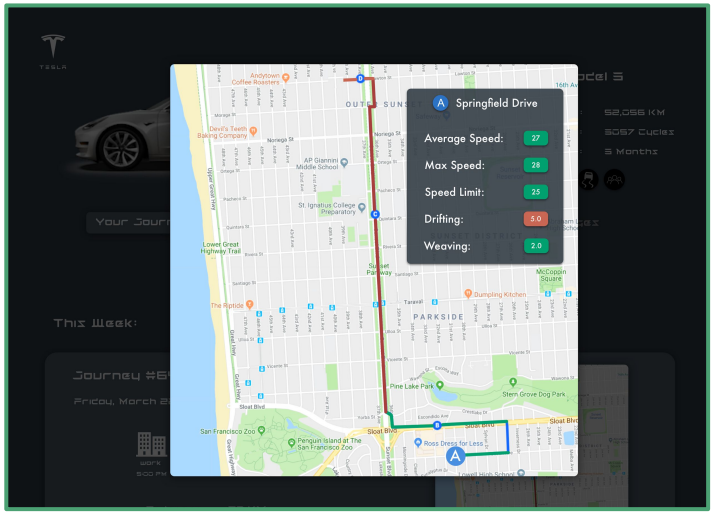
Design

1. **Visualize individual journey information**
2. Visualize aggregate journey statistics
3. Enable users to infer relative driving performance
4. Motivate users to drive more safely




John's Model 3
Total Distance Travelled : 52,056 KM
Charge Cycles : 3057 Cycles
Next Expected maintenance : 3 Months
Your Journeys
Driving Performance
Badges
Week
Month
Year
This Week:
Journey #647
Newt
Friday, March 22nd
work
5:00 PM
Hom
5:28 PM
Distance: 20 KM
Duration: 25 Minutes
Battery Consumed: 24%
Route Breakdown:
Speed Limit
Community Average Speed
Your Speed
C Sunset Boulevard 35 33 55
B Sloat Boulevard 35 35 34
A Springfield Drive 25 21 27
View More
Driving Performance:
Drifting
Irriatic movement within lane
Score
A Springfield Drive 7.7
B Sloat Boulevard 7.5
C Sunset Boulevard 3.0
View More
Weaving
Irriatic movement between lanes
Score
A Springfield Drive 9.0
C Sunset Boulevard 5.0
B Sloat Boulevard 2.0
View More
Collapse All


SUNSET
SUNSET DISTRICT
PARKSIDE
Andytown Coffee Roasters
Safeway
AP Giannini Middle School
St. Ignatius College Preparatory
Sunset Reservoir
Dumpling Kitchen
Pine Lake Park
Stern Grove Dog Park
San Francisco Zoo
Penguin Island at The San Francisco Zoo
Ross Dress for Less
Sloat Blvd
Lowell High School


A Springfield Drive
Average Speed: 27
Max Speed: 28
Speed Limit: 25
Drifting: 5.0
Weaving: 2.0
SUNSET DISTRICT
PARKSIDE
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Safeway
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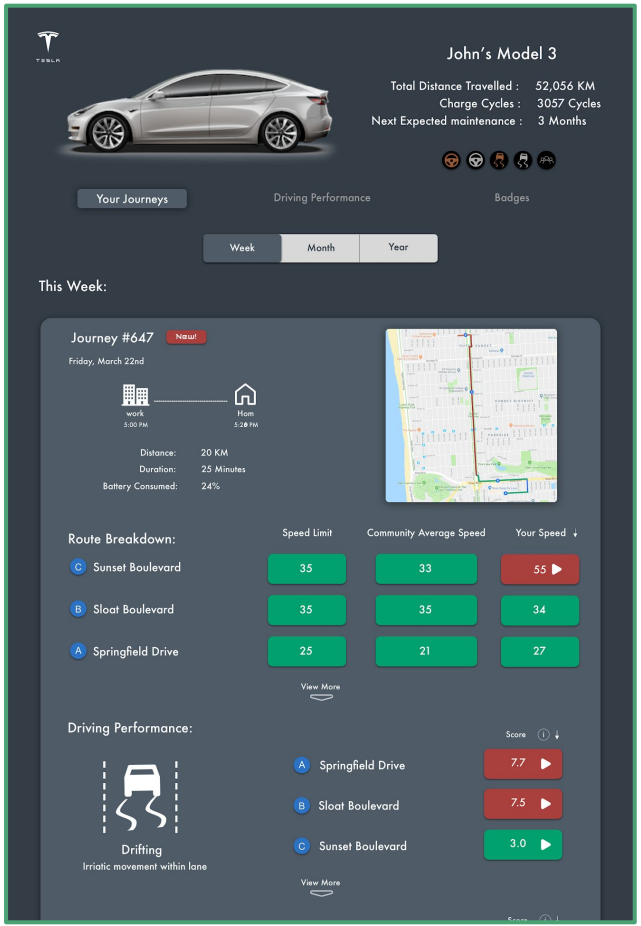
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Driving Performance
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Week
Month
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This Week:
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New!
Friday, March 22nd
work
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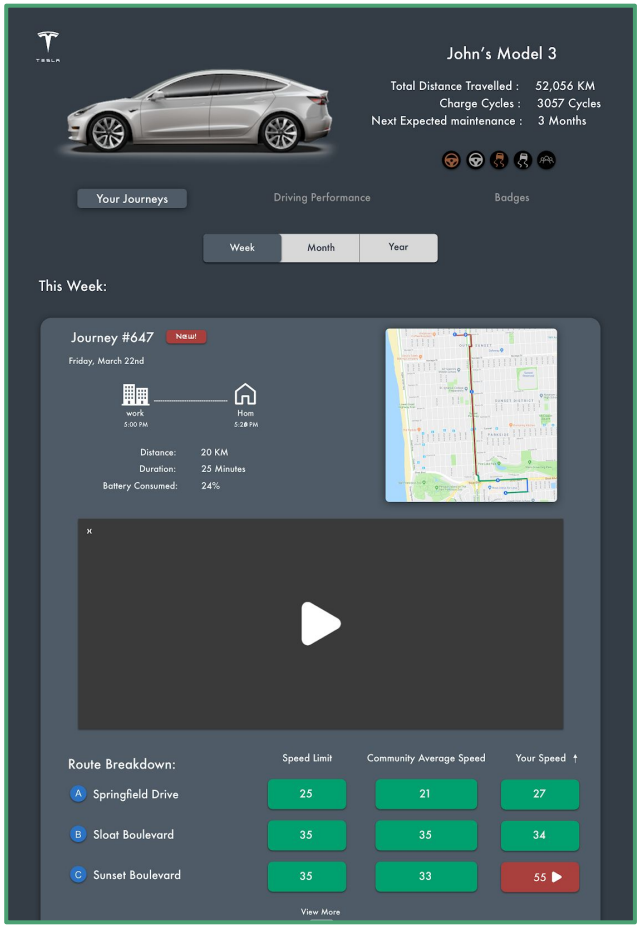
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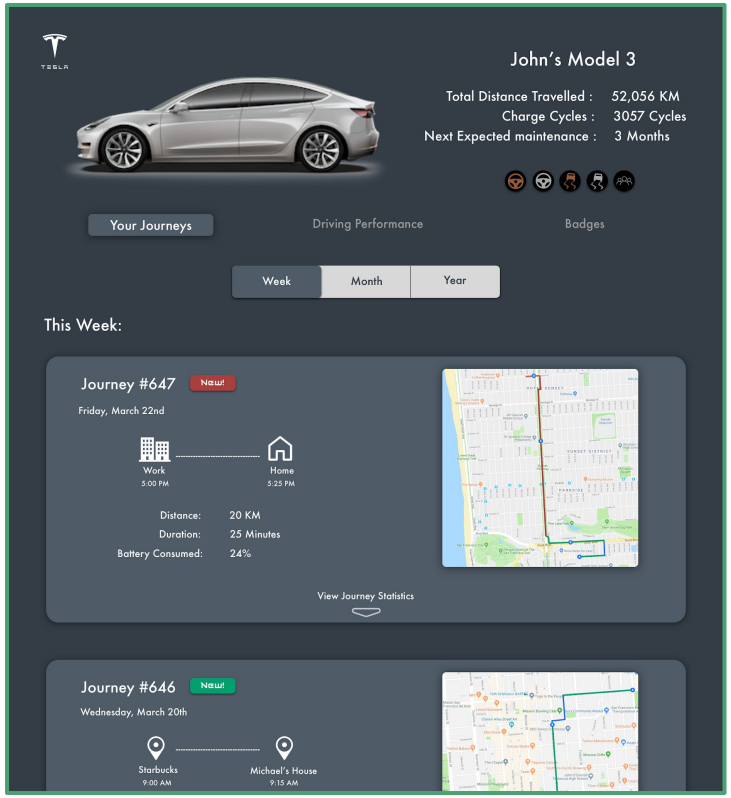
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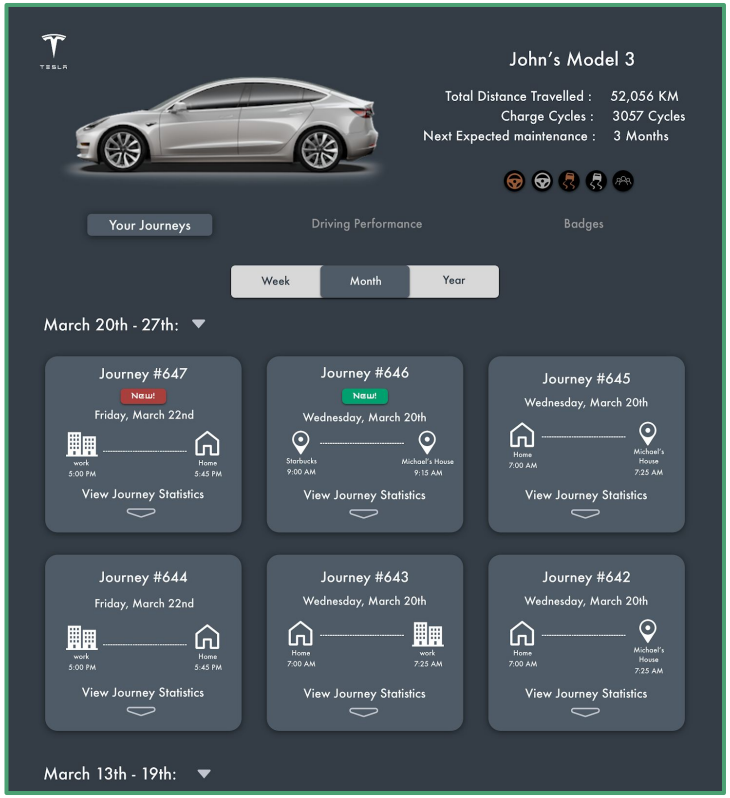
Your Journeys
Driving Performance
Badges
Week
Month
Year
This Week:
Journey #647
New!
Friday, March 22nd
Work
5:00 PM
Home
5:25 PM
Distance: 20 KM
Duration: 25 Minutes
Battery Consumed: 24%
View Journey Statistics
Journey #646
New!
Wednesday, March 20th
Starbucks
9:00 AM
Michael's House
9:15 AM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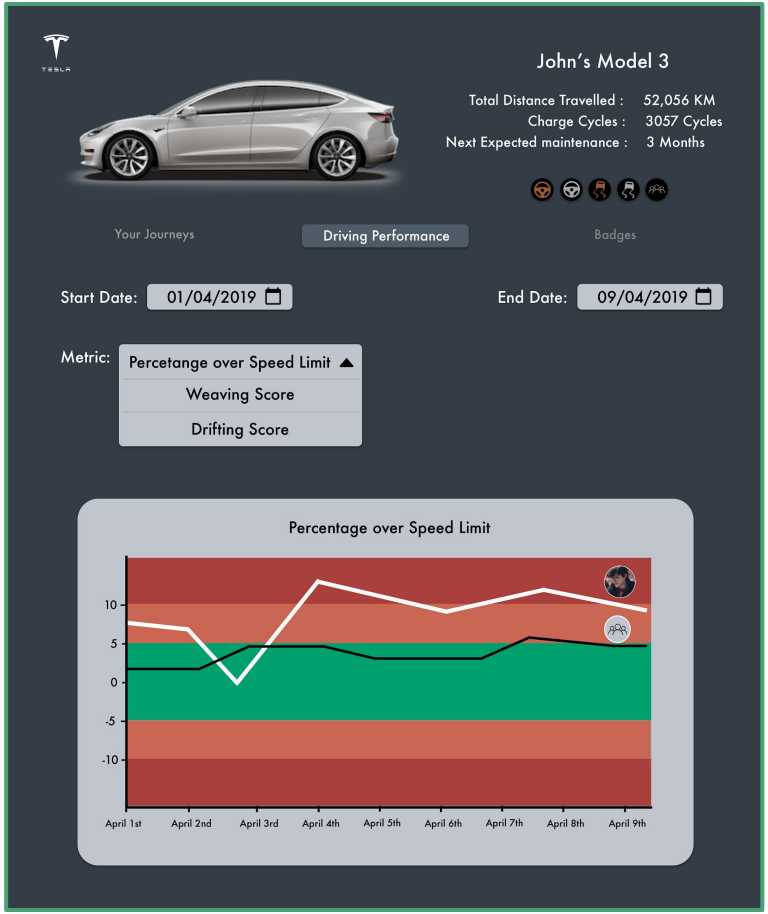
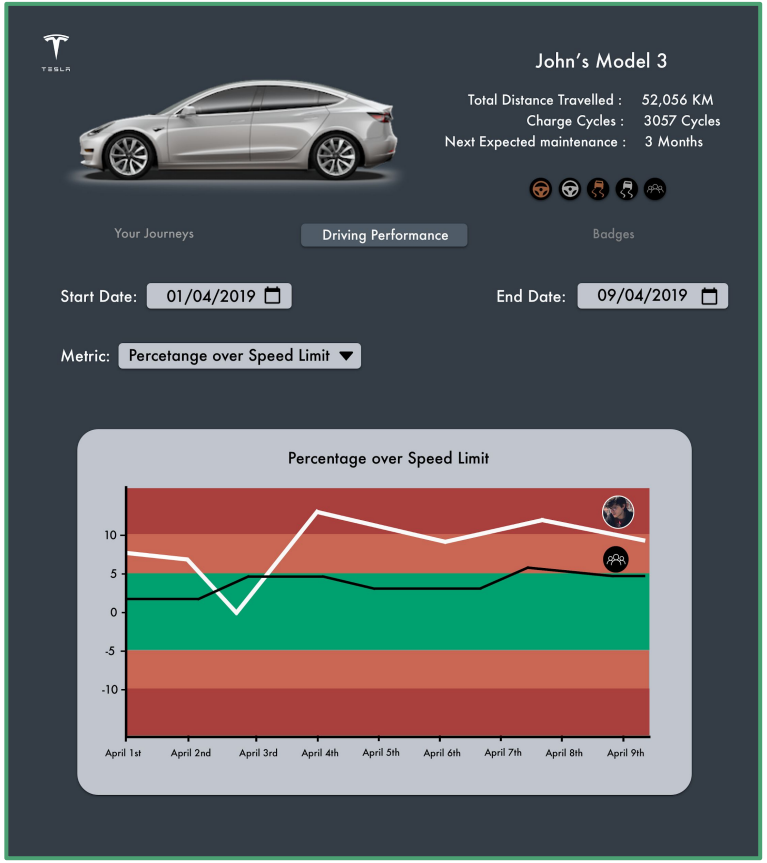
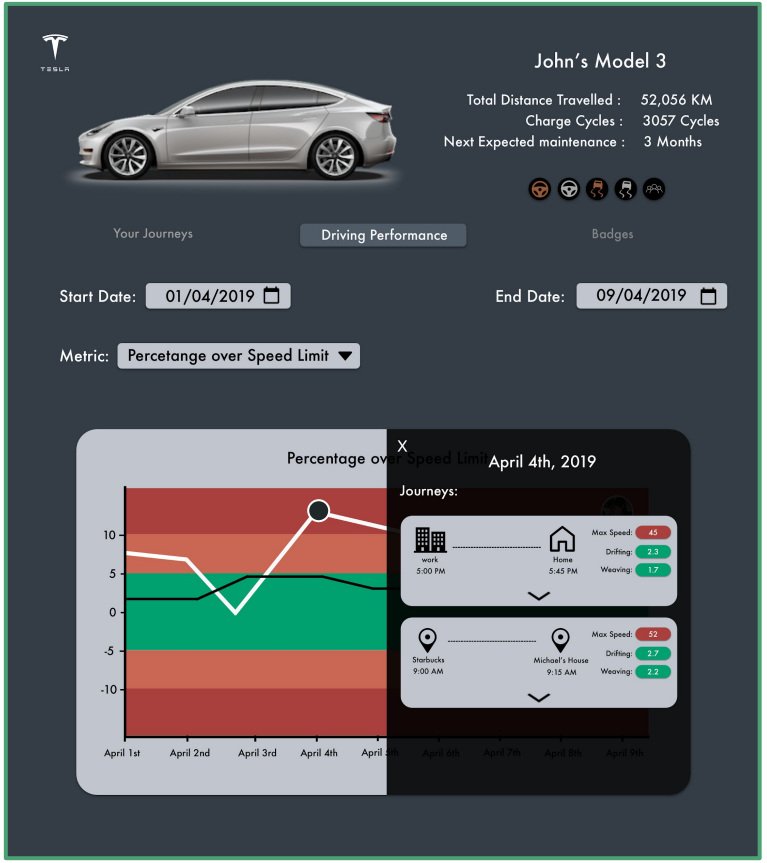
Next Expected maintenance : 3 Months
Your Journeys
Driving Performance
Badges
Week
Month
Year
March 20th - 27th:
Journey #647
New!
Friday, March 22nd
work
5:00 PM
Home
5:45 PM
View Journey Statistics
Journey #646
New!
Wednesday, March 20th
Starbucks
9:00 AM
Michael's House
9:15 AM
View Journey Statistics
Journey #645
Wednesday, March 20th
Home
7:00 AM
Michael's House
7:25 AM
View Journey Statistics
Journey #644
Friday, March 22nd
work
5:00 PM
Home
5:45 PM
View Journey Statistics
Journey #643
Wednesday, March 20th
Home
7:00 AM
work
7:25 AM
View Journey Statistics
Journey #642
Wednesday, March 20th
Home
7:00 AM
Michael's House
7:25 AM
View Journey Statistics
March 13th - 19th:

Design

1. Visualize individual journey information
2. **Visualize aggregate journey statistics**
3. **Enable users to infer relative driving performance**
4. Motivate users to drive more safely




John's Model 3
Total Distance Travelled : 52,056 KM
Charge Cycles : 3057 Cycles
Next Expected maintenance : 3 Months
Your Journeys
Driving Performance
Badges
Start Date: 01/04/2019
End Date: 09/04/2019
Metric: Percetange over Speed Limit
Percentage over Speed Limit
10
5
0
-5
-10
April 1st
April 2nd
April 3rd
April 4th
April 5th
April 6th
April 7th
April 8th
April 9th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Next Expected maintenance : 3 Months
Your Journeys
Driving Performance
Badges
Start Date: 01/04/2019
End Date: 09/04/2019
Metric: Percetange over Speed Limit
X
April 4th, 2019
Journeys:
work
5:00 PM
Home
5:45 PM
Max Speed: 45
Drifting: 2.3
Weaving: 1.7
Starbucks
9:00 AM
Michael's House
9:15 AM
Max Speed: 52
Drifting: 2.7
Weaving: 2.2
10
5
0
-5
-10
April 1st
April 2nd
April 3rd
April 4th

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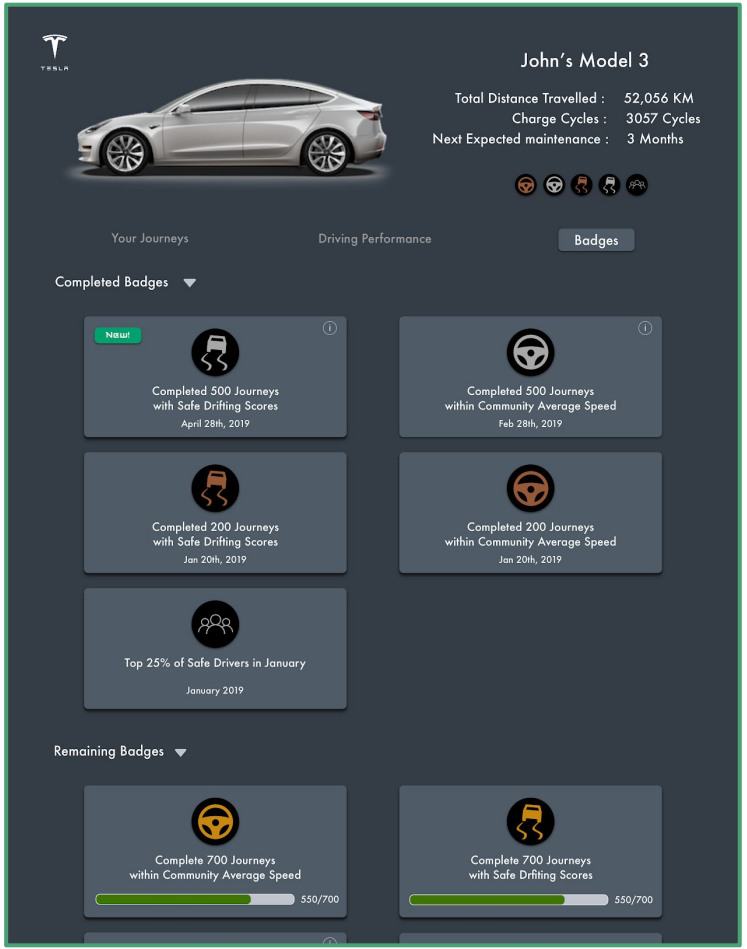

Personal Badges

Community Badges

Usability Testing

Moderated UX Testing

1. Participants
    a. 10 participants (7 Male, 3 Female)
    b. Age: 24 - 33; Demographic: Canadian, Chinese, Brazilian, Iranian, and others
    c. Everyone with significant driving experience (2 - 15 years)
2. Methods
    a. Heuristic Evaluation: measure of ease for navigation and finding information
    b. Qualitative Questionnaire: most visible information and ways of improvement
3. Feedback
    a. Impact on safe driving
    b. Chances of using the system

Key Findings

1. Graphical Representation
2. Design Element Visibility
3. Icons and Tags
4. Consistency

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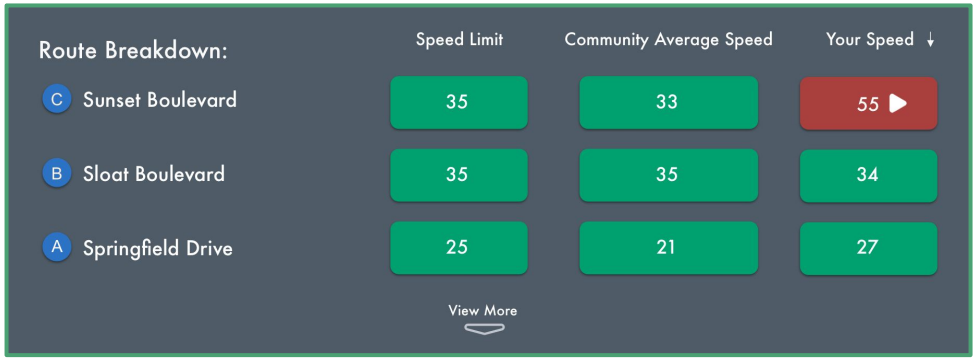
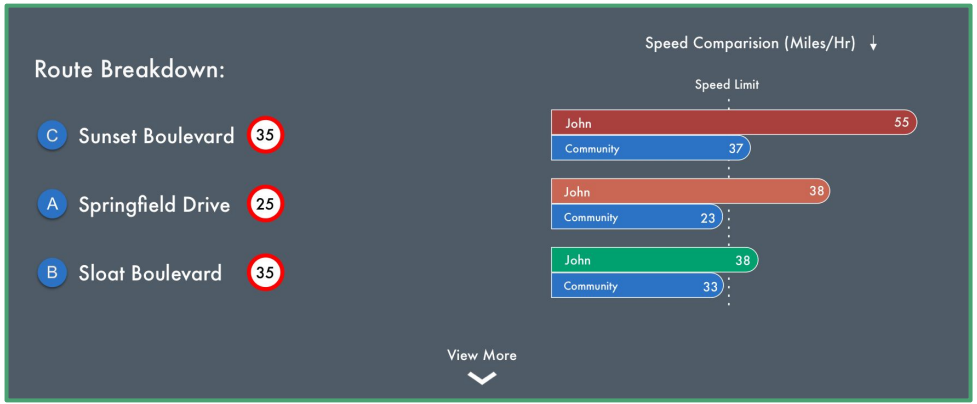


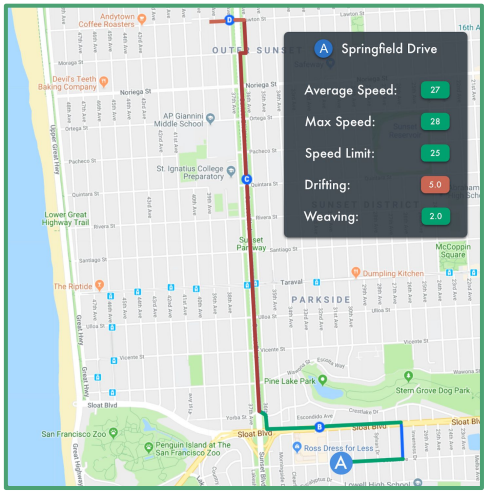


Key Findings

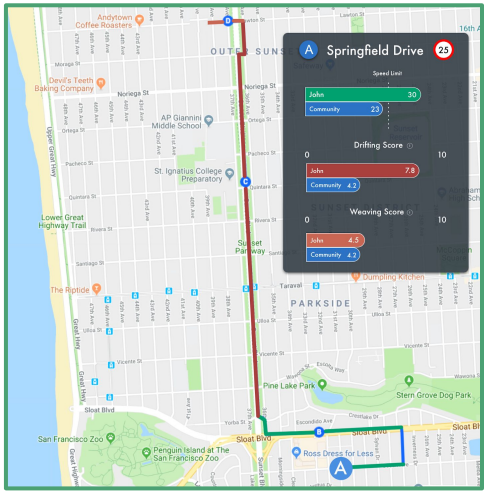
1. **Graphical Representation**

“Speed limits can be displayed as a graph; [currently there are] too much information (which can be somewhat misleading) and too many numbers.”

Battery Consumed: 24%

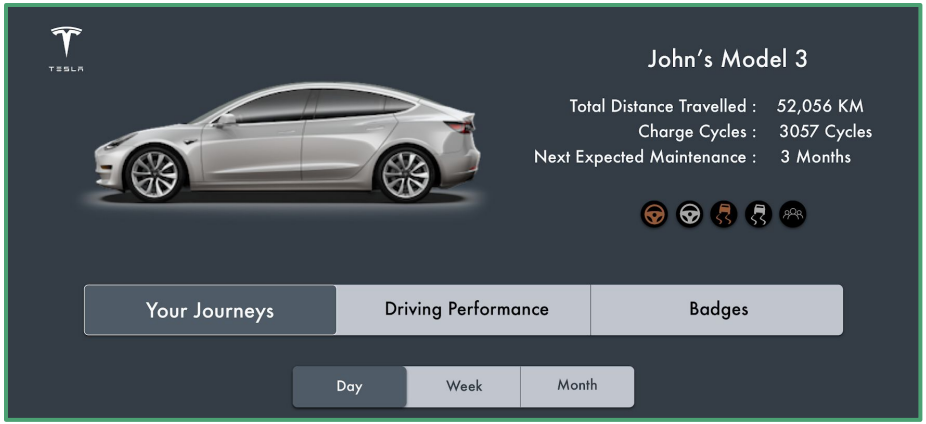


Battery Consumed:



Key Findings

1. Graphical Representation
2. **Design Element Visibility**
3. Icons and Tags
4. Consistency



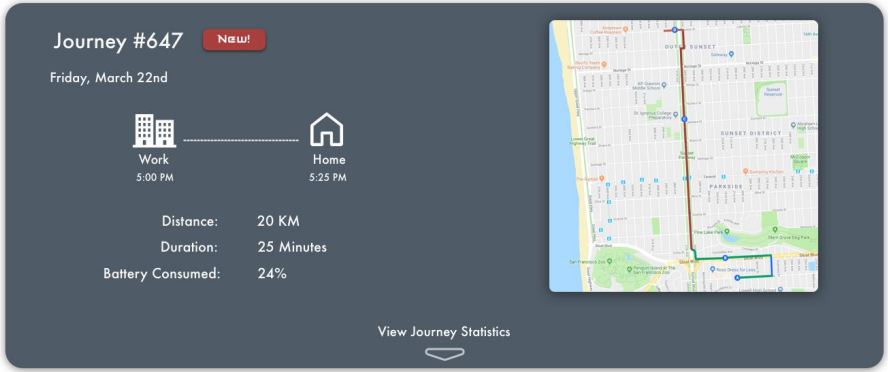
Key Findings

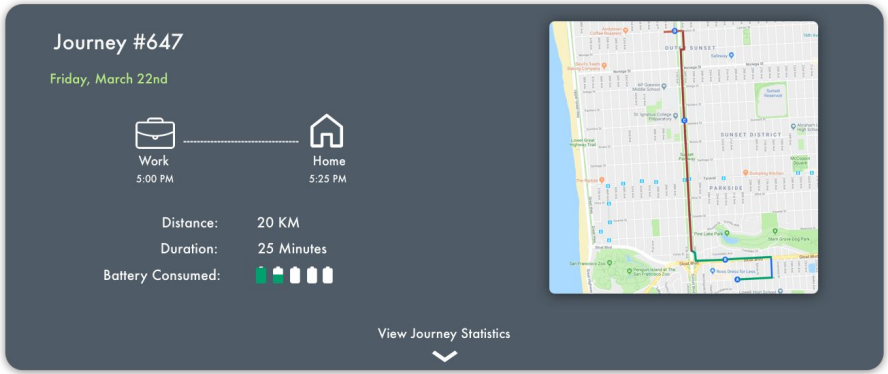
2. Design Element Visibility

“It is hard to figure out that the arrow is a clickable element, it actually looks more like a part of the design.”

Key Findings

1. Graphical Representation
2. Design Element Visibility
3. **Icons and Tags**
4. Consistency



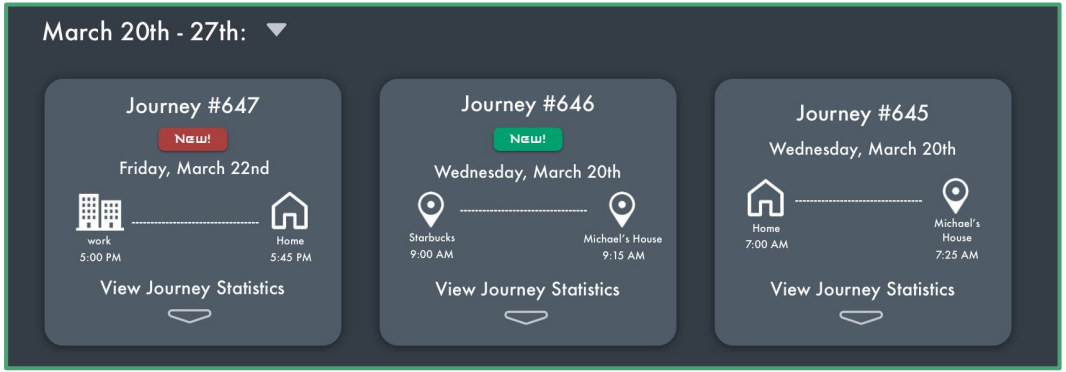


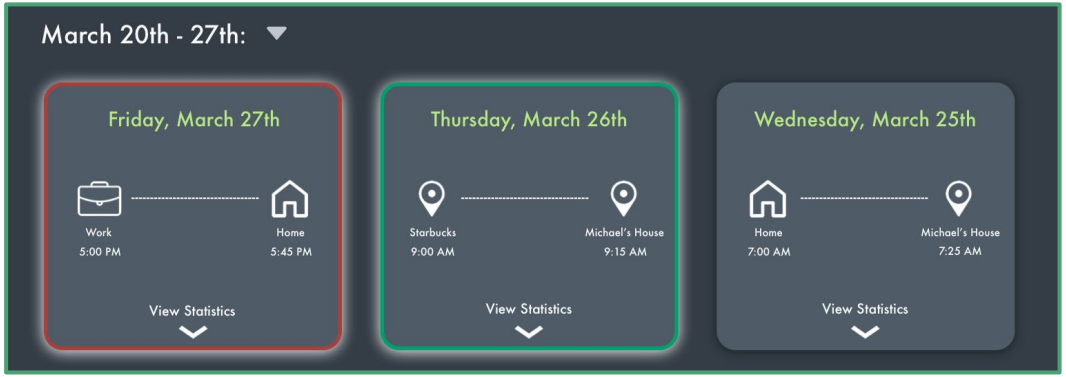
Key Findings

3. Icons and Tags

“The color of the tags are not meaningful enough. Maybe trying to give two types of information through one tag is not a good idea.”

“The ‘new’ is confusing; instead, circle the entire thing.”





Key Findings

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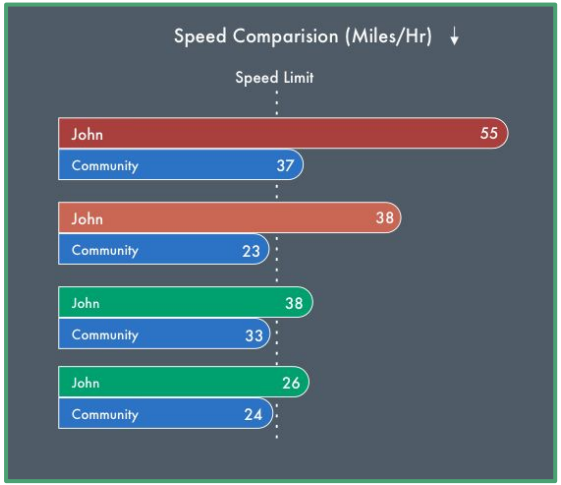
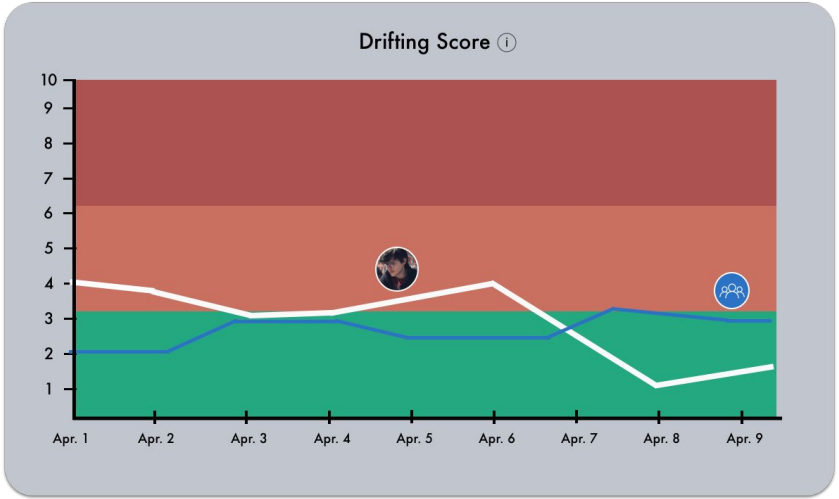
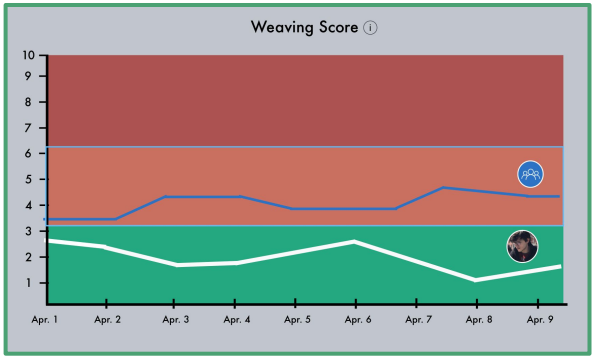




Key Findings

4. Consistency

“Maybe put up a question mark with the weaving and drifting. If I’m in any page and I am confused, I can look up the definition instantly.”



Demo

Frameworks

Flask

web development,
one drop at a time

SQLAlchemy

SQLite

Chart.js

Discussion

Discussion

Data Collection Method	Independent vs Integrated
Institutional Interventions	Driver License Renewal?
Privacy and Security	Privacy Critical Information

Limitations

Usability Testing	Longitudinal Study
Data set restrictions	Mock Data

Future Work

Multi Platform System	Merging data collection and visualization
Additional Metrics (Level 2)	Safe distance ahead of vehicle, Turning without using the indicator
Predicting Driver Behaviour (Level 3)	Comparison between predicted and actual behaviour

Thank you for your attention