

Autonomous Vehicles

& the pursuit of
automobile
disruption

Preliminary discovery report



Autonomous vehicles are expected to disrupt transportation technology and urban design decisions

Untapped market opportunity

\$300-400B

Projected revenue creation by 2035

1 in 3
are expected to have some kind of advanced driver assistance system (ADAS) by 2035

\$200B

Cumulative investment in AV R&D by 2022

Pursued by leading players



cruise



apollo



ZOOX



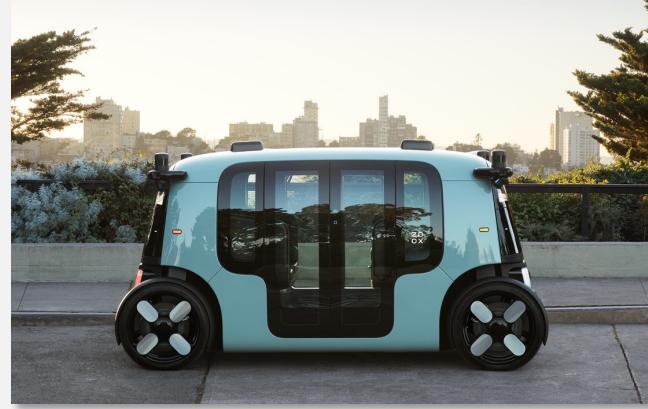
LUMINAR
RIVIAN

Transforming our urban lives and mobility

- Shift towards Mobility as a Service (MaaS)
- Redesigned **traffic systems and infrastructure**
- Optimized road management for **safety** and **eco-friendliness**
- End-user **convenience** and **time savings**
- Smart cities** integration
- Logistics** impact with **first and last mile delivery efficiencies**

Streets around the world are already filling up with more and more AVs

Cities with licenses for trials or operations



ZOOX



cruise



apollo



Our study builds on existing user AV sentiment while adding three key dimensions

Previous research informed policy design choices

Analysis of Public Perception of Autonomous Vehicles Based on Unlabelled Data from Twitter

Achal Shankar Gupta & Shilpi Sharma

Conference paper | First Online: 08 November 2022

356 Accesses | 1 Citations

Part of the [Lecture Notes in Networks and Systems](#) book series (LNNS, volume 520)

→ Sentiment found to be neutral on average



Transportation Research Part C: Emerging Technologies
Volume 131, October 2021, 103356



How are sentiments on autonomous vehicles influenced? An analysis using Twitter feeds

Yue Ding,^a Rostyslav Korolov,^b William (Al) Wallace,^c Xiaokun (Cara) Wang,^d

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<https://doi.org/10.1016/j.trc.2021.103356>

Get rights and content

→ Highlighted the impact of news on sentiment shifts

Source: Gupta and Sharma (2022), Ding, Korolov, Wallace, and Wang (2021)

But ours is focused on commercialization



Analyzing sentiment analysis across **time**



Uncovering and mapping key discussion **topics**



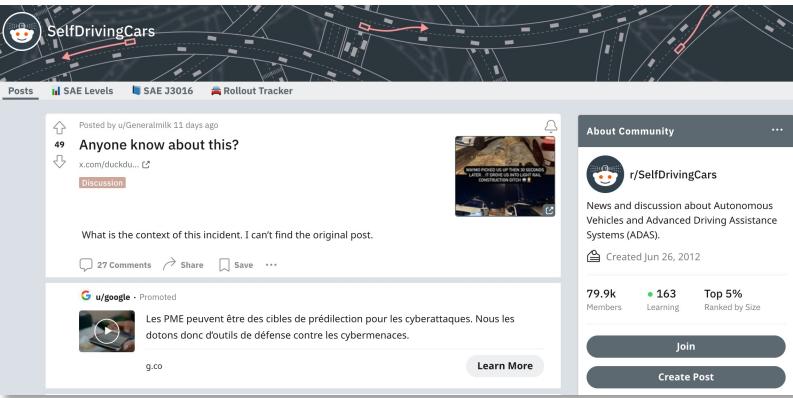
Understanding **sentiment-topic sensitivity**

Predicting news impact on future user sentiment to shift commercial strategies

We scraped over 23k Reddit user comments across the four most active subreddit channels

Data collection and processing

4
Subreddit channels



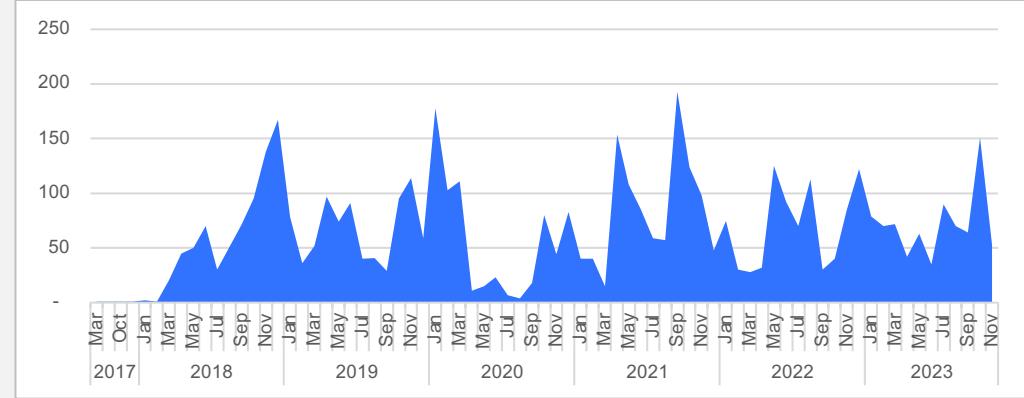
3
Processing steps

- Removing blank comment text cells
- Removing duplicate entries
- Correcting Excel column datatypes

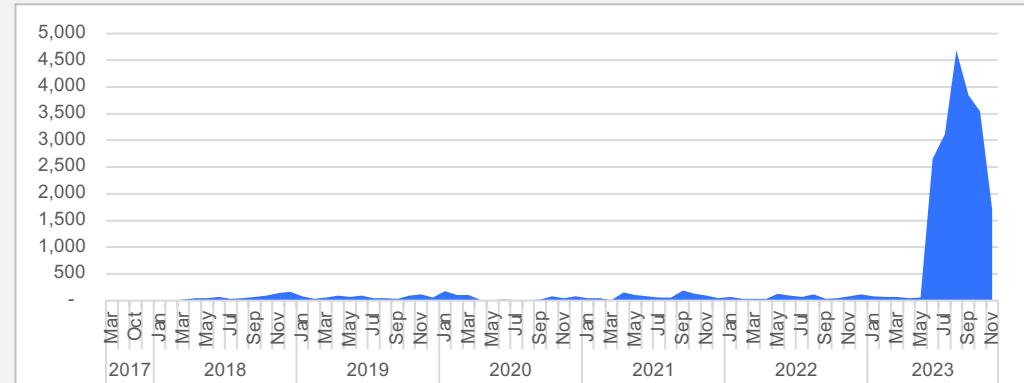
23,965 2017 – 2023
Comments Timestamp

Dataset visualization

Comment counts



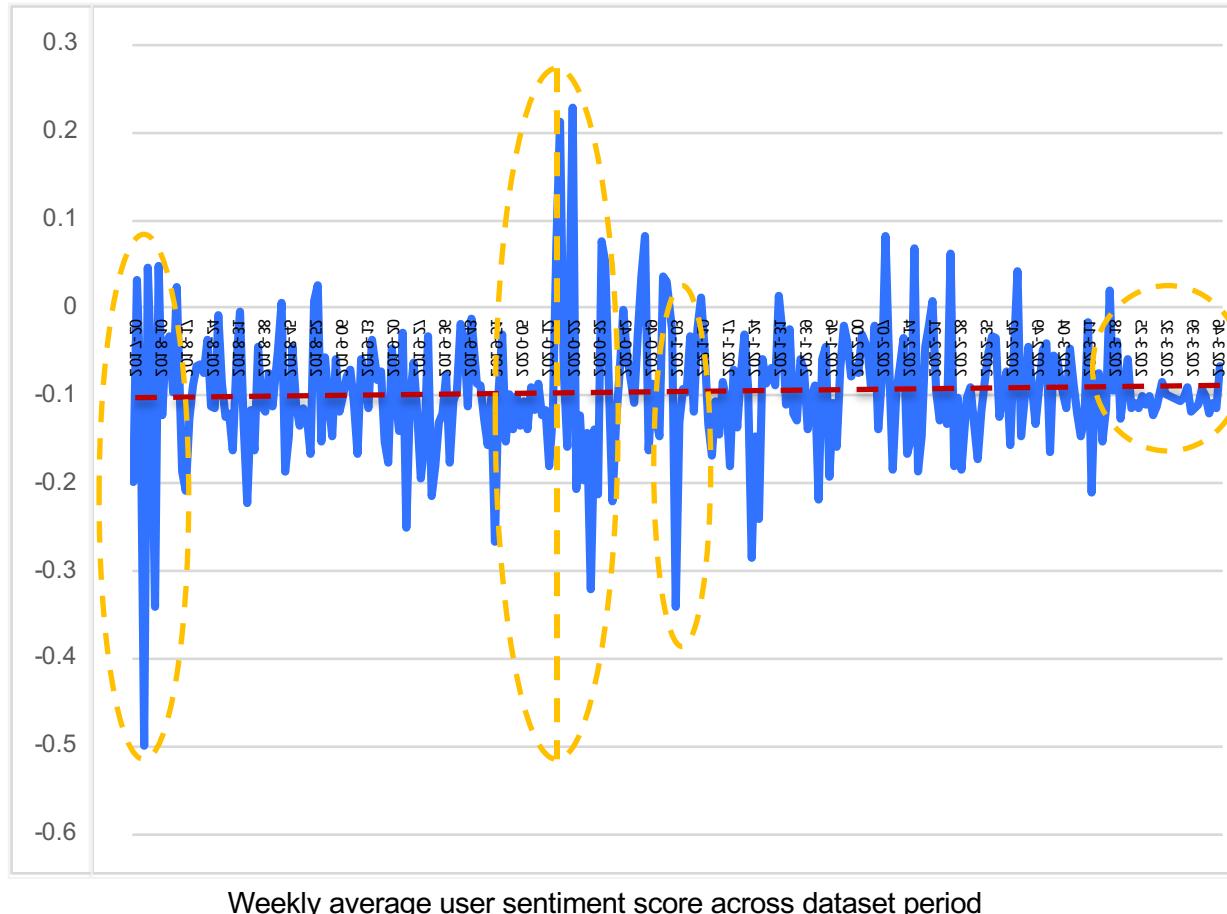
Monthly distribution across subreddit channels, without r/SelfDrivingCars



Monthly distribution across subreddit channels, with r/SelfDrivingCars

While sentiment was noisy, we identified periods for deep dives

We ran a weekly sentiment analysis using TextAnalyzer



Key insights

- Average sentiment has barely changed between 2017 and now (0.00005 slope)
- Sentiment stability in the last 6 months due to concentration of data points
- High sentiment shifts around specific periods in time opening for further investigation
 - December 2018
 - January 2020
 - March 2020
 - January 2021

BUSINESS

Former Google Engineer Charged With Trade-Secret Theft Reaches Deal With U.S.

AUTOS

General Motors to spend \$20 billion through 2025 on new electric, autonomous vehicles

TRANSPO / RIDE-SHARING / UBER

Uber has resumed testing its self-driving cars in San Francisco

CARS | RUMBLE SEAT

Sleeping in Self-Driving Cars? It's No Pipe Dream.

When you absolutely, positively have to get there overnight,

GENERAL MOTORS

GM unveils 11 future EVs, new batteries and its plan to beat Tesla

Media & Telecom

U.S. agency proposes revising auto safety rules to speed self-driving cars

By David

March 17

BUSINESS | **AUTOS INDUSTRY**

GM Aims to Convince Wall Street Skeptics Its Future Is Electric

New Rules Could Finally Clear the Way for Self-Driving Cars

For the first time, the National Highway Traffic Safety Administration

◆ WSJ NEWS EXCLUSIVE

TECH

Waymo Raises \$2.25 Billion After Courting Outside Investors for First Time

Waymo raises \$2.25 billion to scale up autonomous vehicles operations

We conducted topic modelling to understand better what users were talking about

We tried different combinations and used ChatGPT for labelling...

Process

4

trials

25

Top words per topic

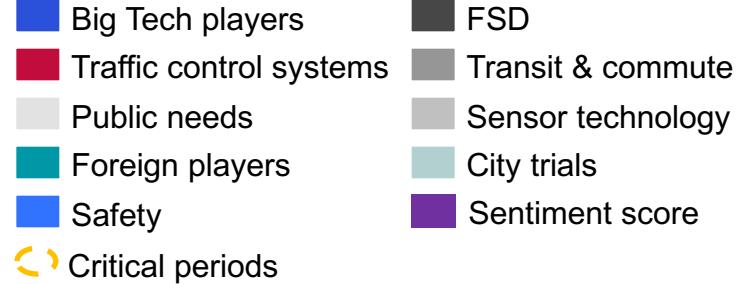


ChatGPT

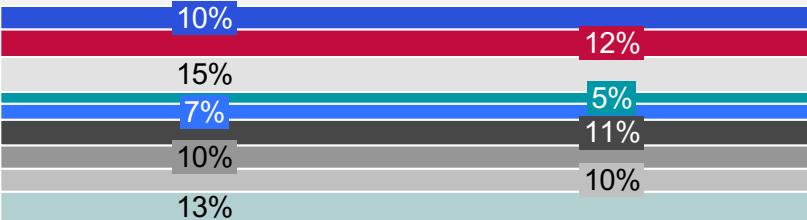
“Give me a title for the theme
and topic of these words”

Output

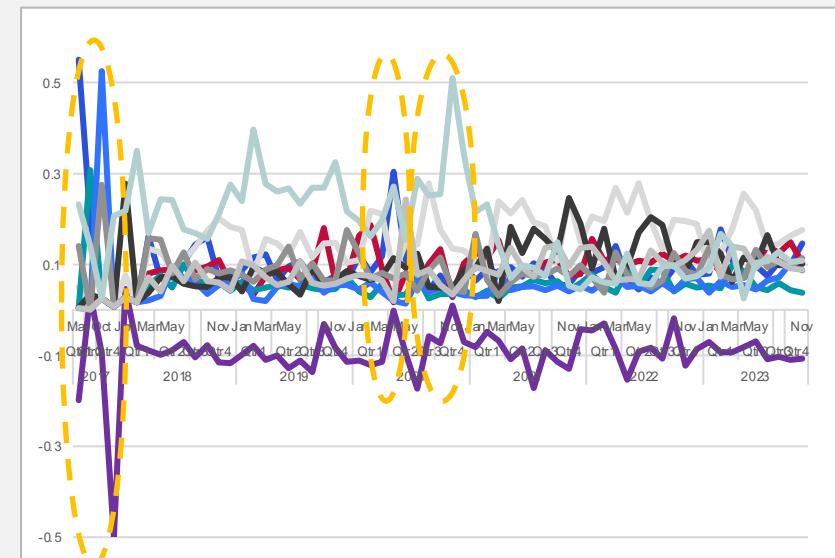
comment_text	comment_date	comment_author	Big Tech players	Advanced Dr	Public needs	
Going to have	2020-03-19		0.00147059	0.00147059	0.001470588	
Some guests	2020-12-07		0.0015873	0.0015873	0.001587302	
What do you	2023-07-28		0.00217391	0.00217391	0.002173913	
[deleted]	2019-12-28		0.01341463	0.00121951	0.001219512	
What part by	2023-08-21		0.00285714	0.00285714	0.002857143	
Hard to say t	2023-06-15		0.0030303	0.0030303	0.003030303	
I'll add: Wavr	2023-08-08		0.003125	0.003125	0.003125	
Yo						
If	Foreign players	Safety	FSD	Transit and commute	Sensor technology	City trials
Th	0.001470588	0.00147059	0.001470588	0.001470588	0.001470588	0.98676471
Pu	0.001587302	0.0015873	0.001587302	0.001587302	0.001587302	0.98571429
> I	0.002173913	0.00217391	0.002173913	0.002173913	0.002173913	0.98043478
Ho	0.001219512	0.00121951	0.001219512	0.001219512	0.001219512	0.97682927
It	0.002857143	0.00285714	0.002857143	0.002857143	0.002857143	0.97428571
Yo	0.003030303	0.0030303	0.003030303	0.003030303	0.003030303	0.97272727
	0.003125	0.003125	0.003125	0.003125	0.003125	0.971875
	0.003448276	0.00344828	0.003448276	0.003448276	0.003448276	0.96996552
	0.003571429	0.00357143	0.003571429	0.003571429	0.003571429	0.96785714
	0.003703704	0.0037037	0.003703704	0.003703704	0.003703704	0.96666667
	0.003703704	0.0037037	0.003703704	0.003703704	0.003703704	0.96666667
	0.003703704	0.0037037	0.003703704	0.003703704	0.003703704	0.96666667
	0.003703704	0.0037037	0.003703704	0.003703704	0.003703704	0.96666667
	0.003703704	0.0037037	0.003703704	0.003703704	0.003703704	0.96666667
	0.003846154	0.00384615	0.003846154	0.003846154	0.003846154	0.96538462



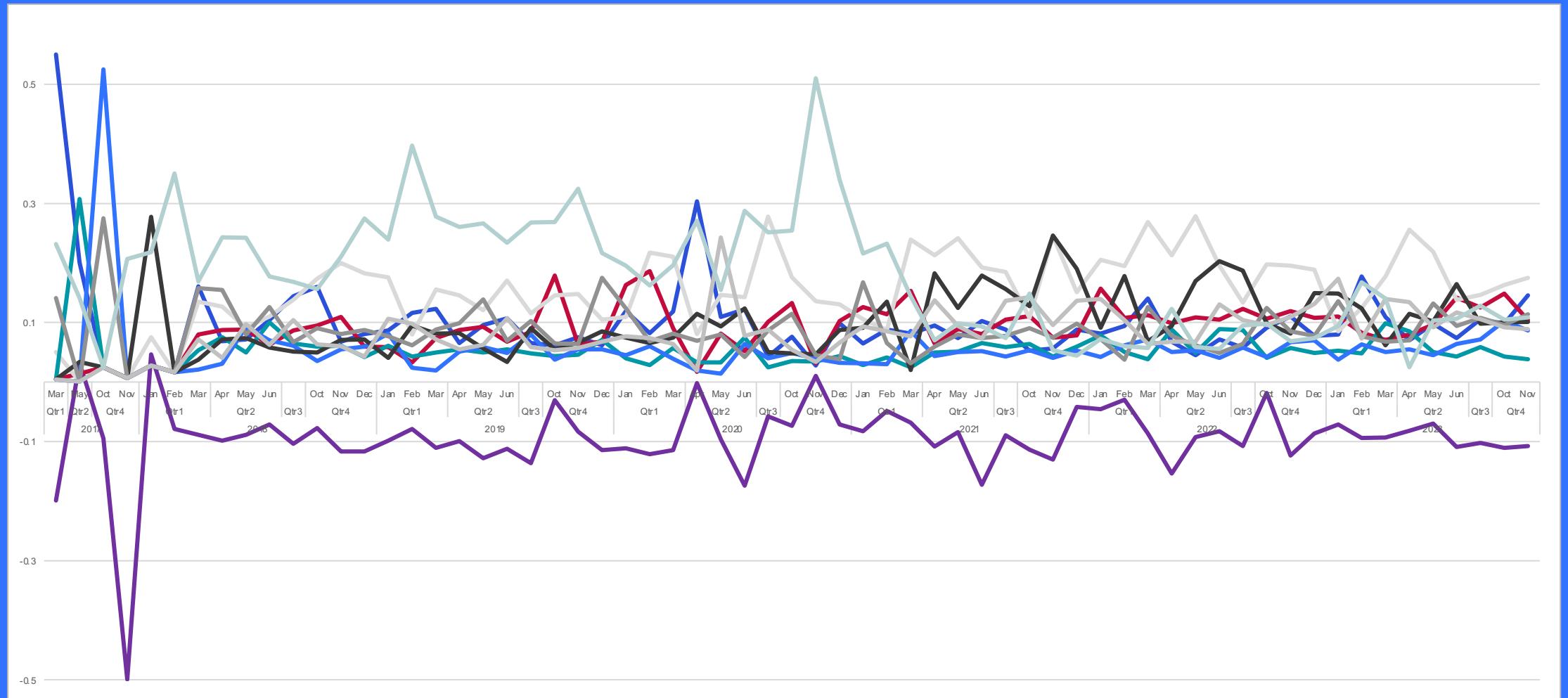
...uncovering 9 key topics



Topic distribution



Monthly average sentiment score variation with topic distribution



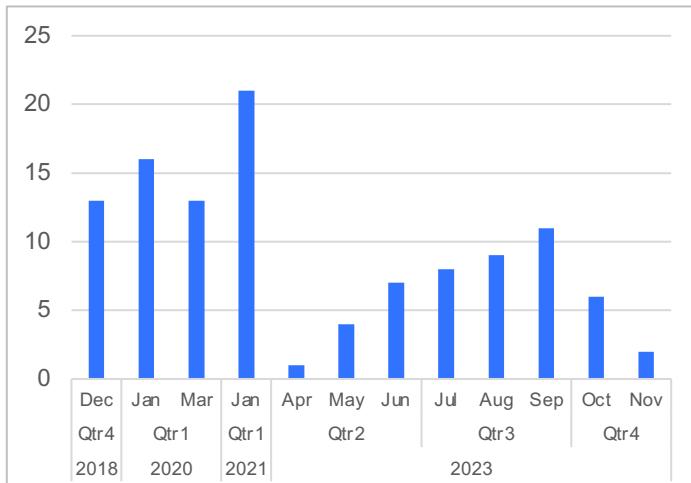
Our similarity analysis gave us inputs for our final model

Extracting news data

- 2 sources of news



- We scraped 111 articles with WebScraper



Monthly distribution of scraped news articles

Establishing a baseline

Output

Big Tech players	Assistance and Traffic	Public needs	Foreign players	Safety
0.319469791	0.362410891	0.299289318	0.359520473	0.213964671
0.342509355	0.437833123	0.35238307	0.44373978	0.230263076
0.287585267	0.368995327	0.297865024	0.371690935	0.197550893
0.324507444	0.363849983	0.326805959	0.389209091	0.220320787
0.288481746	0.368056276	0.292756131	0.389046836	0.206008671
0.341818076	0.405120653	0.329396085	0.426657832	0.229415924
0.316707579	0.386809227	0.306802094	0.39535301	0.217694523
0.33	FSD	transit and communi	sensor technolog	City trials
0.30	0.281762531	0.300195804	0.383898604	0.269329766
0.293607539	0.379361573	0.449933456	0.308852601	
0.249160414	0.316707325	0.38976204	0.279319251	
0.285940405	0.35622345	0.450250956	0.301973984	
0.251499942	0.332920888	0.380416816	0.25677999	
0.299541359	0.373138876	0.446805399	0.310436691	
0.278246131	0.336088469	0.402432136	0.29369465	
0.268630991	0.364915233	0.414350565	0.284121819	
0.261969426	0.325602652	0.397169029	0.275190226	

Top 10 comments per topic

Key insights

- The topic of *Sensor Technology* and *Foreign Players* have the highest average similarity to our articles
- News articles tend to emphasize more on technical aspects of AVs
- Surprisingly, *Safety* is the least mentioned topic across overall data

Thus, we ran a ridge regression to prevent overfitting

Connecting topics in the news to online user sentiment

- For each article, we sought to **find the online sentiment just after publication**
 - Isolated comments posted in the days *right after* the article publication
 - Found the minimum number of days such that there were **at least 10 comments**, then took the average of the sentiment

Model Results

Topic	Coefficient
Big Tech players	-0.000536
Advanced Driver Assistance and Traffic Control Systems	-0.001929
Public needs	-0.000757
Foreign players	-0.000810
Safety	0.001065
FSD	0.000862
Transit and commute	-0.000264
Sensor technology	0.000682
City trials	0.001687

Key insights

- City trials** has the most positive impact to average sentiment
 - Online enthusiasts may be receptive to these accomplishments
- Traffic control** is correlated with a **decrease** in sentiment
 - Topic focuses on challenges of integrating with road infrastructure
 - Includes high-risk areas such as intersections

While our model may have low predictive power...

We tested our model with new comments/articles...

The New York Times

Cruise's C.E.O. Quits as the Driverless Carmaker Aims to Rebuild Trust

Kyle Vogt, a founder of Cruise, resigned from the company on Sunday, weeks after it suspended all of its self-driving operations.

Since November 20th, 2023



From all 4 channels

...but came out short of the actual sentiment score!



Predicted
-0.000389



Actual
-0.10831849

Limitations

- Small Reddit and news sample due to limited computational resources
- We did not explore more advanced prediction models (e.g., RNN)
- We focused solely on topics/time as predictive variables

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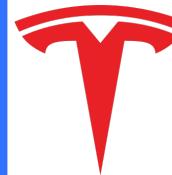


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Our study has uncovered key commercial implications

Strategy



Monitor and learn from Tesla's FSD: they are receiving superior user buy-in and winning the race

Implementation

- Pinpoint and replicate select design choices
- Compete on their value chain (i.e., hire employees, contact suppliers)



Establish a direct communication channel with users: don't let the media spoil the narrative and set back adoption

- Create a Consumer Relations function
- Share the product roadmap and progress transparently with users



Online users are more sensitive to what directly affects them: they need to see and feel the product

- Integrate their feedback in product design
- Present solutions to the grand public through public car shows or gifted testing emphasizing **safety**
- Expand trials to more cities