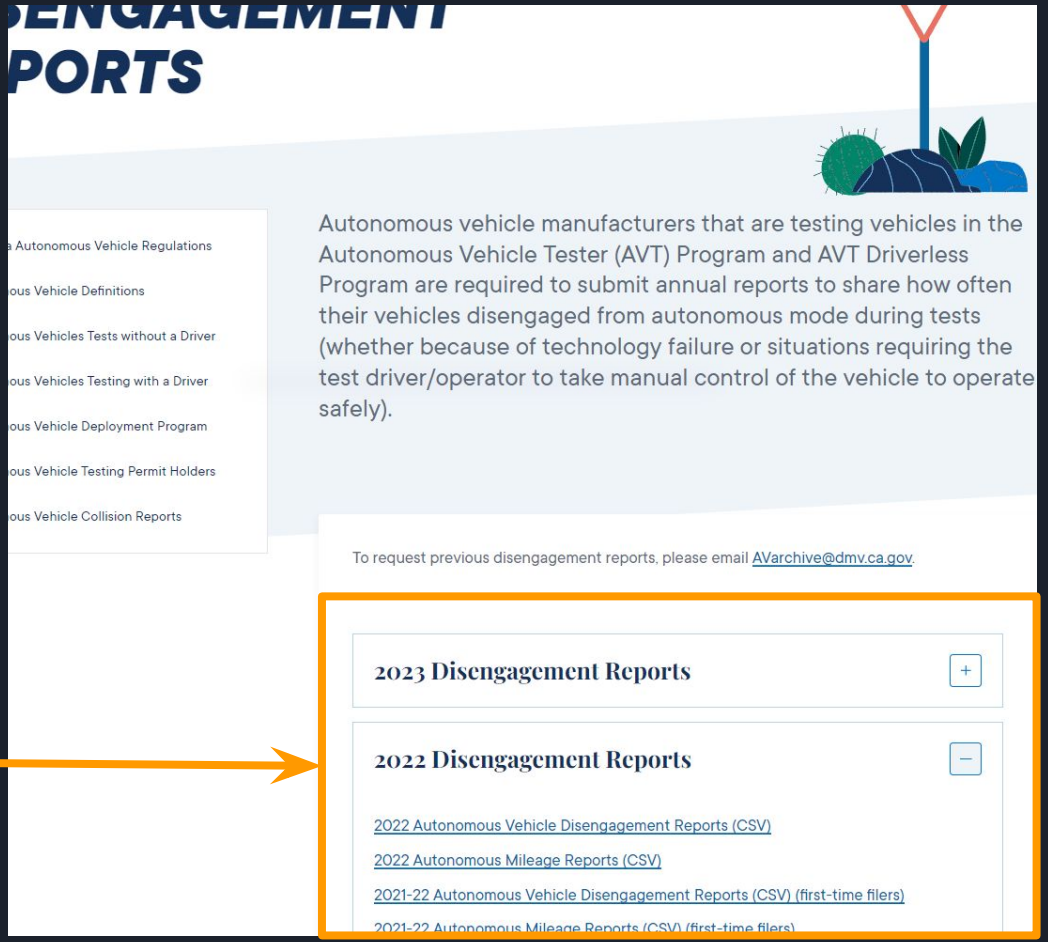
Data Sources

Mileage Reports

Disengagement Reports

- Vehicle in autonomy
- Comes out
- Regardless of driver

CSVs per year



Data Process

```
Locations: 15 - ['Express Way', 'Freeway', 'Freeway ', 'HIGHWAY', 'HIghway', 'Hig
Operators: 51 - ['AIMOTIVE INC.', 'APOLLO AUTONOMOUS DRIVING USA LLC', 'APPLE INC

Cleaned locations: 8 - ['EXPRESS WAY', 'FREEWAY', 'HIGHWAY', 'INTERSTATE', 'PARKI
Cleaned operators: 38 - ['AIMOTIVE', 'APOLLO', 'APOLLO AUTONOMOUS DRIVING USA', '

Original number of operators:  50
Actual number of unique operators:  32
'AIMOTIVE'
'APOLLO'
'APPLE'
'ARGO AI'
'AURORA OPERATIONS'
'AUTOX'
'BOSCH'
'CRUISE'
```

```python
# What are "Unnamed" colums? Probably useless "reserved"
# This and below are from kyle, and deal with the initial mileage_df
unnamed_cols = ['Unnamed: 17', 'Unnamed: 18', 'Unnamed: 19', 'Unnamed: 20', 'Unnamed: 21']
for check in unnamed_cols:
    non_null_count = mileage_df[check].notna().sum()
    print(f'Number of non values in {check}: {non_null_count}')

# Empty. Drop 'em
mileage_df = mileage_df.drop(columns=unnamed_cols)
mileage_df.columns
```

✓ 0.0s

```
Number of non values in Unnamed: 17: 0
Number of non values in Unnamed: 18: 0
Number of non values in Unnamed: 19: 0
Number of non values in Unnamed: 20: 0
Number of non values in Unnamed: 21: 0
```

Data Sources

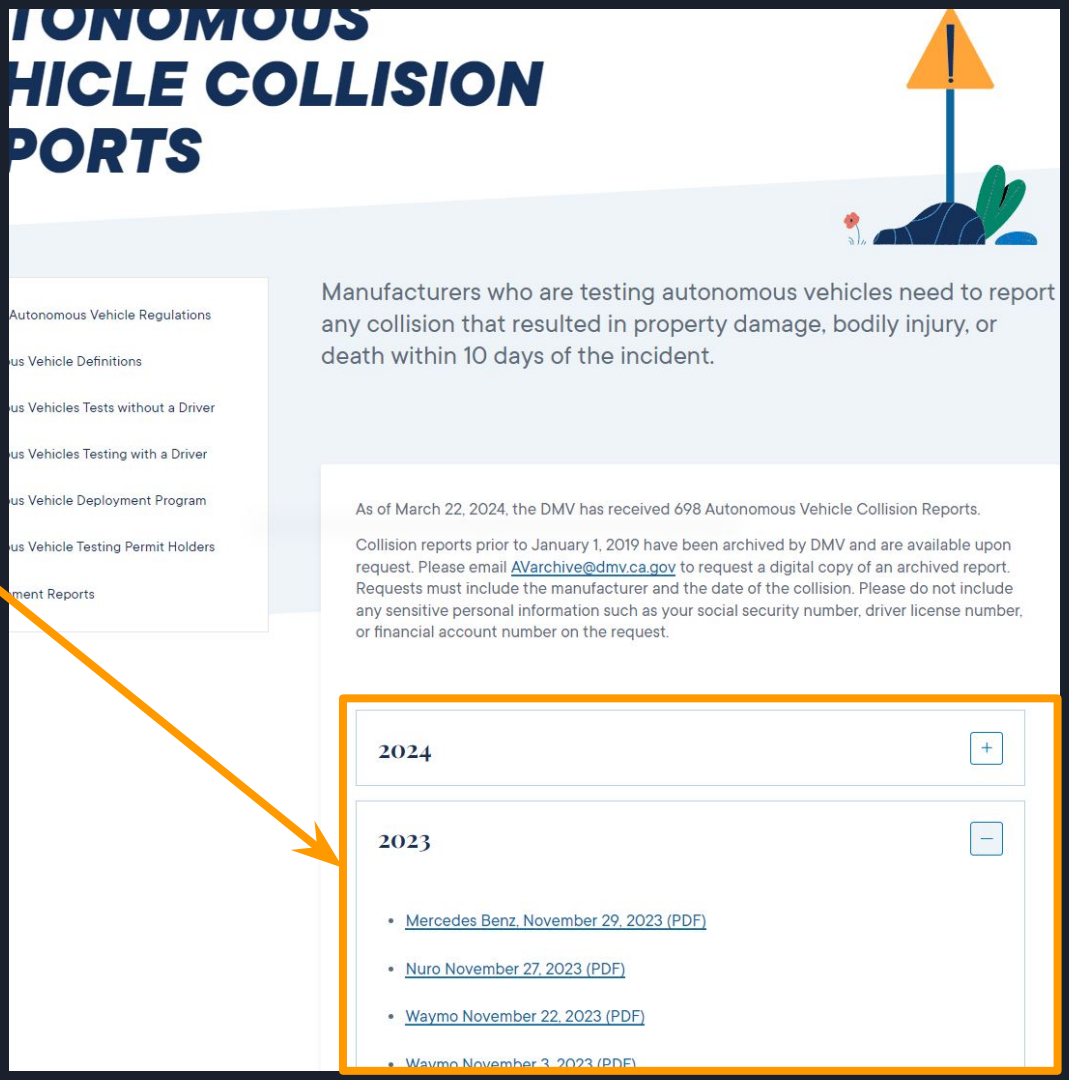
Collision reports

Individual PDFs per incident

Access problem:

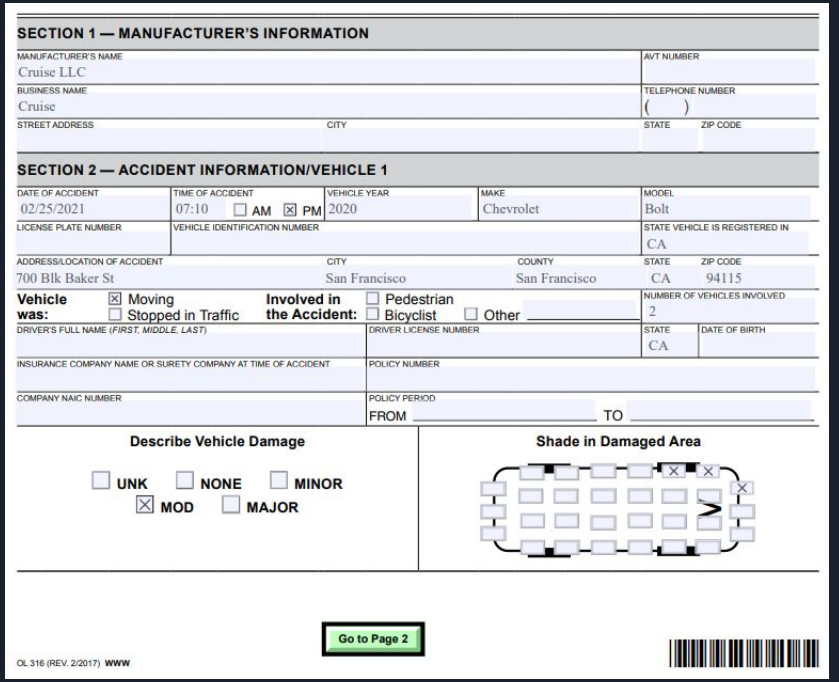
- No API
- Parse failed (href)
- Clicker failed (JS)

Manual download



PDF Mining

1. Download PDFs
2. Zip for memory (568 files);



SECTION 1 — MANUFACTURER'S INFORMATION

MANUFACTURER'S NAME: Cruise LLC
AVT NUMBER:
BUSINESS NAME: Cruise
TELEPHONE NUMBER: ( )
STREET ADDRESS:
CITY:
STATE:
ZIP CODE:

SECTION 2 — ACCIDENT INFORMATION/VEHICLE 1

DATE OF ACCIDENT	TIME OF ACCIDENT	VEHICLE YEAR	MAKE	MODEL
02/25/2021	07:10 ☐ AM ☒ PM	2020	Chevrolet	Bolt

LICENSE PLATE NUMBER	VEHICLE IDENTIFICATION NUMBER	STATE VEHICLE IS REGISTERED IN
		CA

ADDRESS/LOCATION OF ACCIDENT	CITY	COUNTY	STATE	ZIP CODE
700 Blk Baker St	San Francisco	San Francisco	CA	94115

Vehicle was: ☒ Moving ☐ Stopped in Traffic
Involved in the Accident: ☐ Pedestrian ☐ Bicyclist ☐ Other
NUMBER OF VEHICLES INVOLVED: 2

DRIVER'S FULL NAME (FIRST, MIDDLE, LAST)	DRIVER LICENSE NUMBER	STATE	DATE OF BIRTH
		CA	

INSURANCE COMPANY NAME OR SURETY COMPANY AT TIME OF ACCIDENT	POLICY NUMBER

COMPANY NAIC NUMBER	POLICY PERIOD
	FROM _____ TO _____

Describe Vehicle Damage

☐ UNK ☐ NONE ☐ MINOR
☒ MOD ☐ MAJOR

Shade in Damaged Area

Go to Page 2

OL 316 (REV. 2/2017) WWW

Scraping User-Entered data from PDF

```python
# This function read the filed name, alternate field name, and field values
def parse_field_helper(form_data, field, prefix=None):
    """ appends any PDF AcroForm field/value pairs in `field` to provided `form_data` list

        if `field` has child fields, those will be parsed recursively.
    """
    resolved_field = field.resolve()
    field_name = '.'.join(filter(lambda x: x, [prefix, resolve_and_decode(resolved_field.get("T"))]))
    if "Kids" in resolved_field:
        for kid_field in resolved_field["Kids"]:
            parse_field_helper(form_data, kid_field, prefix=field_name)
    if "T" in resolved_field or "TU" in resolved_field:
        # "T" is a field-name, but it's sometimes absent.
        # "TU" is the "alternate field name" and is often more human-readable
        # your PDF may have one, the other, or both.
        alternate_field_name = resolve_and_decode(resolved_field.get("TU")) if resolved_field.get("TU") else None
        field_value = resolve_and_decode(resolved_field["V"]) if 'V' in resolved_field else None

        # Remove non-printable characters and trailing spaces - This affects every Cruise file.
        field_name = ''.join(char for char in field_name if char.isprintable()).strip()
        alternate_field_name = ''.join(char for char in alternate_field_name if char.isprintable()).strip() if alternate_field_name else None
        field_value = ''.join(char for char in field_value if char.isprintable()).strip() if field_value else None

        form_data.append([field_name, alternate_field_name, field_value])
```

Returns a list of tuples, e.g:
[[field_name_1, alt_name_1, value_1], … [field_name_n, alt_name_n, value_n]]

Filter for what is interesting

```python
# Define filtering criteria
def find_important_tuples(tuple, search_condition):
    # Check if the first element of the tuple is in the search condition list
    return tuple[0] in search_condition
```

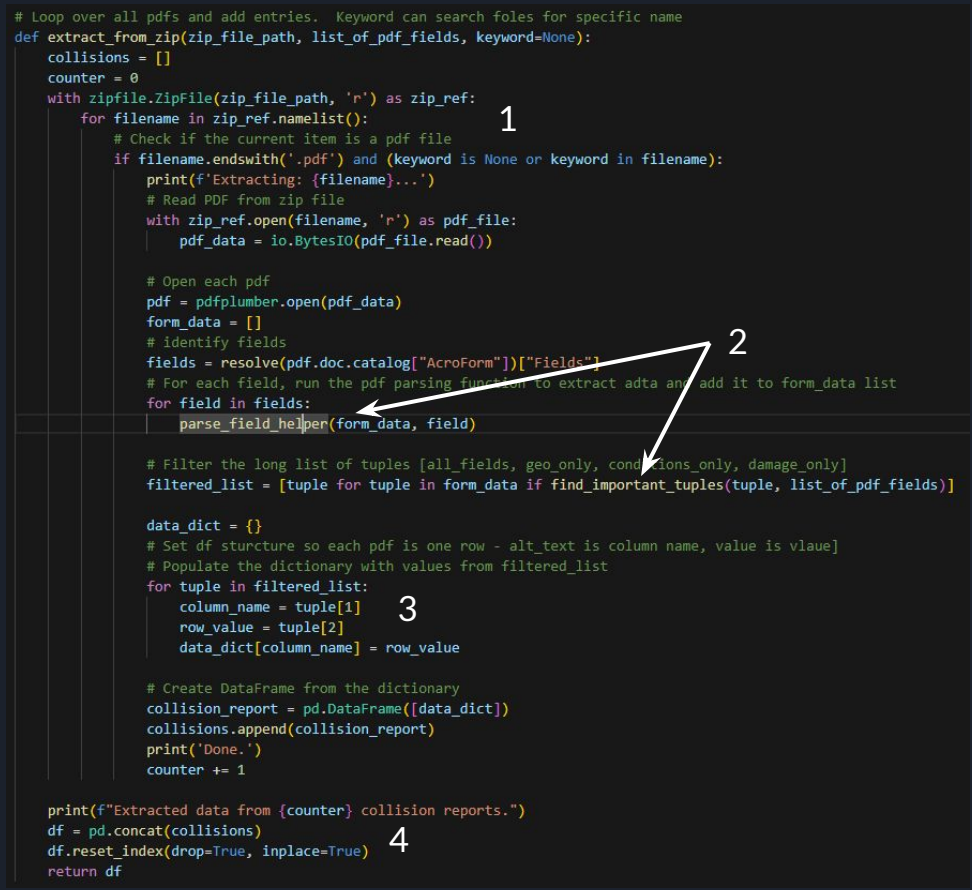
Manually checked whole list for fields we wanted (~½)

Created list to filter and some sub-lists

```python
all_fields = ['MANufACTuRERS NAME','BuSINESS NAME',
              'DATE Of ACCIDENT','Time of Accident','AM','PM',
              'VEhICLE YEAR','MAkE','MODEL',
              'section 2  accident infoRmation.0','section 2  accident infoRmation.1.0','section 2  accident infoRmation
              'Moving', 'Stopped in Traffic', 'Pedestrian', 'Bicyclist', 'undefined', 'Other',
              'NuMBER Of VEhICLES INVOLVED',
              'Unknown','None','minor','Moderate','major',
              'Left Rear 1','Rear Bumper','Right Rear 1','Left Rear 2','Left Rear 3','Right Rear 2','Right Rear 3',
              'Left Rear Passenger 1','Left Rear Passenger 2','Right Rear Passenger 1','Right Rear Passenger 2',
              'Left Rear Passenger 3','Left Rear Passenger 4','Right Rear Passenger 3','Right Rear Passenger 4',
              'Front Driver Side 1','Front Driver Side 2','Front Passenger Side 1','Front Passenger Side 2',
              'Front Driver Side 3','Front Driver Side 4','Front Passenger Side 3','Front Passenger Side 4',
              'Left Front Corner 1','Left Front Corner 2','Right Front Corner 1', 'Right Front Corner 2',
              'Left Front Corner 3','Front Bumper','Right Front Corner 3',
              'Moving_2', 'Stopped in Traffic_2','Pedestrian_2','Bicyclist_2','undefined_2','Other_2',
              'ADDRESS_2.1.0.1','Autonomous Mode','Conventional Mode',
              'WEATHER A 1','WEATHER A 2','WEATHER B 1','WEATHER B 2','WEATHER C 1','WEATHER C 2',
              'WEATHER D 1','WEATHER D 2','WEATHER E 1','WEATHER E 2','WEATHER F 1','WEATHER F 2','WEATHER G 1','WEATHER
              'LIGHTING A 1','LIGHTING A 2','LIGHTING B 1','LIGHTING B 2','LIGHTING C 1','LIGHTING C 2',
              'LIGHTING D 1','LIGHTING D 2','LIGHTING E 1','LIGHTING E 2',
              'ROADWAY A 1','ROADWAY A 2','ROADWAY B 1','ROADWAY B 2','ROADWAY C 1', 'ROADWAY C 2','ROADWAY D 1','ROADWA
              'ROAD CONDITIONS A 1','ROAD CONDITIONS A 2','ROAD CONDITIONS B 1','ROAD CONDITIONS B 2', 'ROAD CONDITIONS
              'ROAD CONDITIONS D 1','ROAD CONDITIONS D 2','ROAD CONDITIONS E 1', 'ROAD CONDITIONS E 2', 'ROAD CONDITIONS
              'ROAD CONDITIONS G 1', 'ROAD CONDITIONS G 2', 'ROAD CONDITIONS H 1', 'ROAD CONDITIONS H 2',
              'MOVEMENT A 1','MOVEMENT A 2','MOVEMENT  B 1', 'MOVEMENT  B 2','MOVEMENT C 1','MOVEMENT C 2', 'MOVEMENT  D
              'MOVEMENT  E 1','MOVEMENT  E 2', 'MOVEMENT  F 1', 'MOVEMENT  F 2', 'MOVEMENT  G 1','MOVEMENT  G 2', 'MOVEM
              'MOVEMENT  I 1', 'MOVEMENT  I 2', 'MOVEMENT J 1', 'MOVEMENT J 2', 'MOVEMENT  K 1', 'MOVEMENT  K 2', 'MOVEM
              'MOVEMENT  M 1', 'MOVEMENT  M 2','MOVEMENT  N 1', 'MOVEMENT  N 2', 'MOVEMENT  O 1', 'MOVEMENT  O 2',
              'MOVEMENT  P 1', 'MOVEMENT  P 2', 'MOVEMENT  Q 1', 'MOVEMENT  Q 2', 'MOVEMENT  R 1', 'MOVEMENT  R 2',
              'TYPE A 1', 'TYPE A 2', 'TYPE B 1', 'TYPE B 2','TYPE C 1','TYPE C 2','TYPE D 1','TYPE D 2','TYPE E 1','TYP
              'OTHER A YES','OTHER A NO','OTHER B','OTHER C','OTHER D','OTHER E','OTHER F','OTHER G',
              'OTHER H YES','OTHER H NO','OTHER I','OTHER J','OTHER K','OTHER L']
```

PDF Megafunction

1. Loop through all files in location (zip)
2. Call the scrape and filter functions
3. Make each pdf into one row
4. Concatenate




```python
# Loop over all pdfs and add entries.  Keyword can search foles for specific name
def extract_from_zip(zip_file_path, list_of_pdf_fields, keyword=None):
    collisions = []
    counter = 0
    with zipfile.ZipFile(zip_file_path, 'r') as zip_ref:
        for filename in zip_ref.namelist():
            # Check if the current item is a pdf file
            if filename.endswith('.pdf') and (keyword is None or keyword in filename):
                print(f'Extracting: {filename}...')
                # Read PDF from zip file
                with zip_ref.open(filename, 'r') as pdf_file:
                    pdf_data = io.BytesIO(pdf_file.read())

                # Open each pdf
                pdf = pdfplumber.open(pdf_data)
                form_data = []
                # identify fields
                fields = resolve(pdf.doc.catalog["AcroForm"])["Fields"]
                # For each field, run the pdf parsing function to extract adta and add it to form_data list
                for field in fields:
                    parse_field_helper(form_data, field)

                # Filter the long list of tuples [all_fields, geo_only, conditions_only, damage_only]
                filtered_list = [tuple for tuple in form_data if find_important_tuples(tuple, list_of_pdf_fields)]

                data_dict = {}
                # Set df sturcture so each pdf is one row - alt_text is column name, value is vlaue]
                # Populate the dictionary with values from filtered_list
                for tuple in filtered_list:
                    column_name = tuple[1]
                    row_value = tuple[2]
                    data_dict[column_name] = row_value

                # Create DataFrame from the dictionary
                collision_report = pd.DataFrame([data_dict])
                collisions.append(collision_report)
                print('Done.')
                counter += 1

    print(f"Extracted data from {counter} collision reports.")
    df = pd.concat(collisions)
    df.reset_index(drop=True, inplace=True)
    return df
```

Result!

Additional challenges:

CRUISE!! - non-printable characters
EVERY field

Checkboxes:

- X = “”, “Yes”
  - Change to 1
- Blank = None, NaN, “Off”
  - Change to 0

Timestamps - 12hr/24hr

```
path_to_zip = "data/collisions/Collision_PDFs.zip"
# read in all the data once.
all_collisions_df = extract_from_zip(path_to_zip, all_fields)
all_collisions_df.head()
```

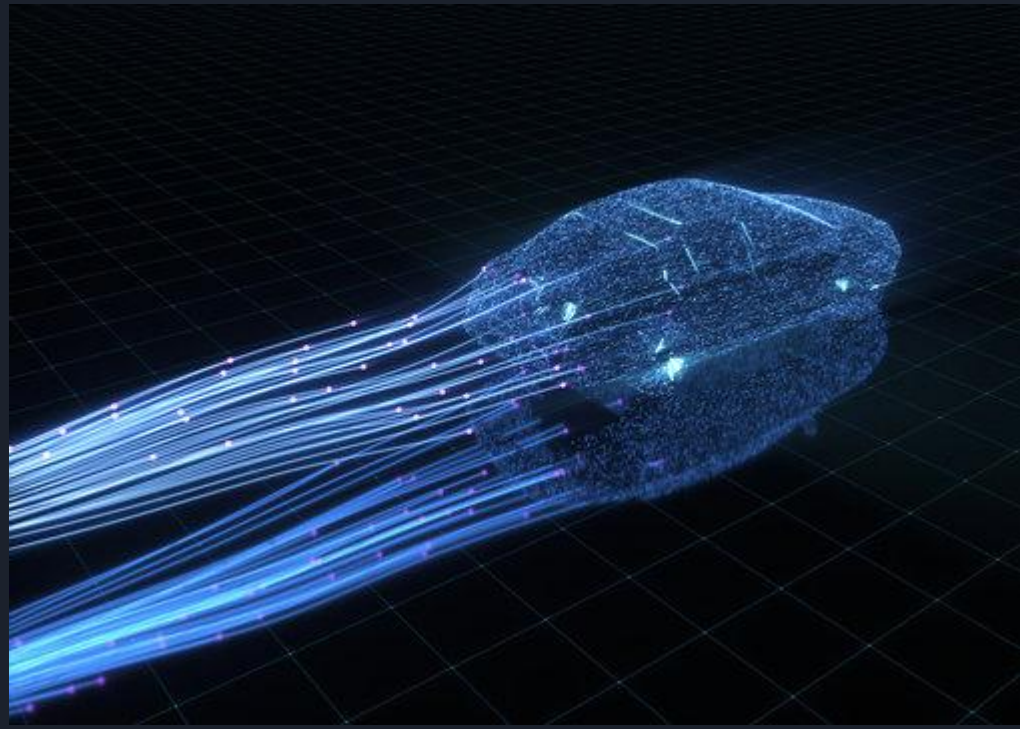
[6] ✓ 4m 16.6s

```
Extracting: Aimotive_091619.pdf...
Done.
Extracting: Apollo-OL316-062923-Redacted.pdf...
Done.
Extracting: Apollo-OL316-090623-Redacted.pdf...
Done.
Extracting: Apollo-OL316-101623-Redacted.pdf...
Done.
Extracting: Apple_012624.pdf...
Done.
Extracting: Apple_022123.pdf...
Done.
Extracting: apple_081921.pdf...
Done.
Extracting: apple_082321.pdf...
Done.
Extracting: Apple_091919.pdf...
Done.
Extracting: Apple_101022.pdf...
Done.
Extracting: Apple_120621.pdf...
Done.
Extracting: Apple_122022.pdf...
Done.
Extracting: Apple_OL316_061422_Redacted.pdf...
...
Done.
Extracting: Zoox-OL316-101223-Redacted.pdf...
Done.
Extracted data from 568 collision reports.
```

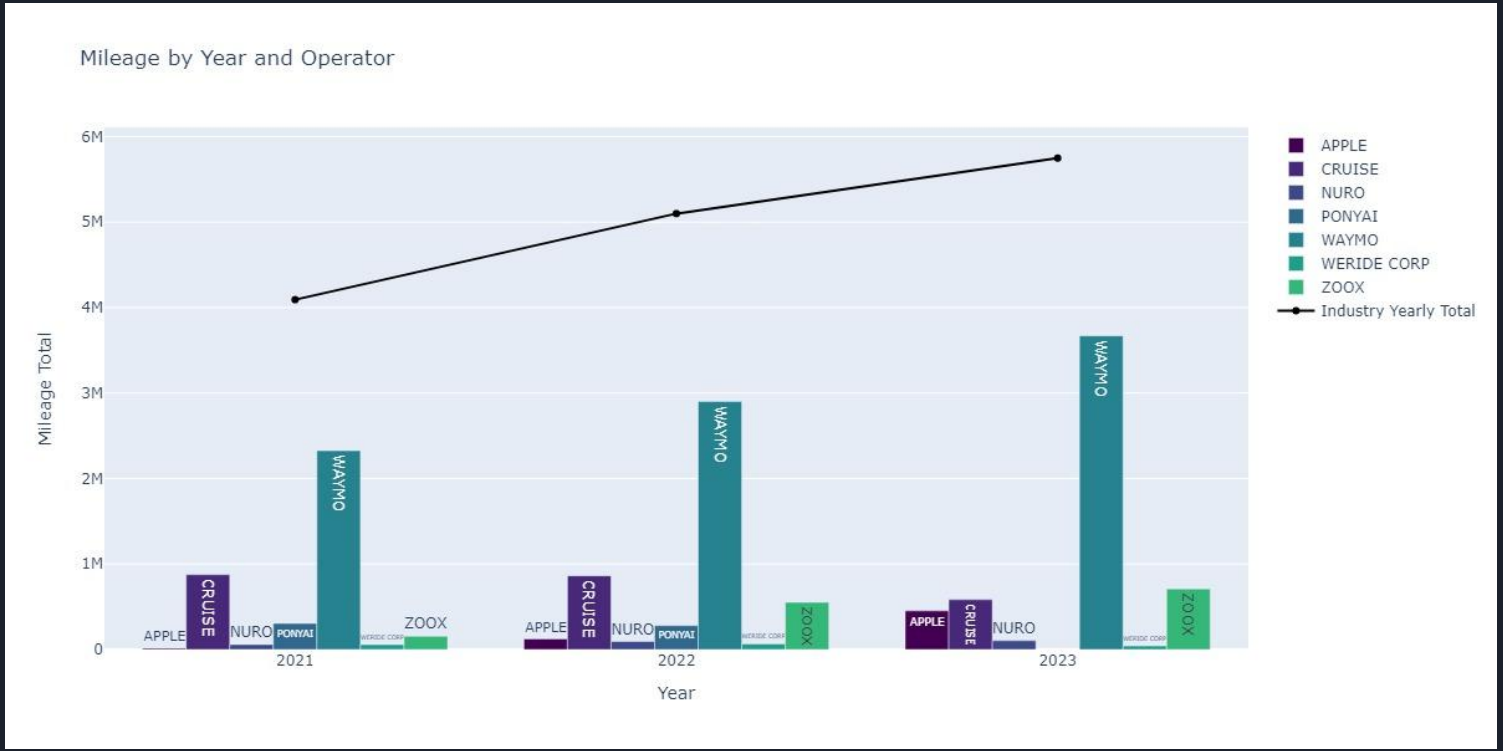
Self-Driving Trends in California

Maybe total mileage instead of annual

How many US-20 trips (3300m)



Comparisons twixt companies



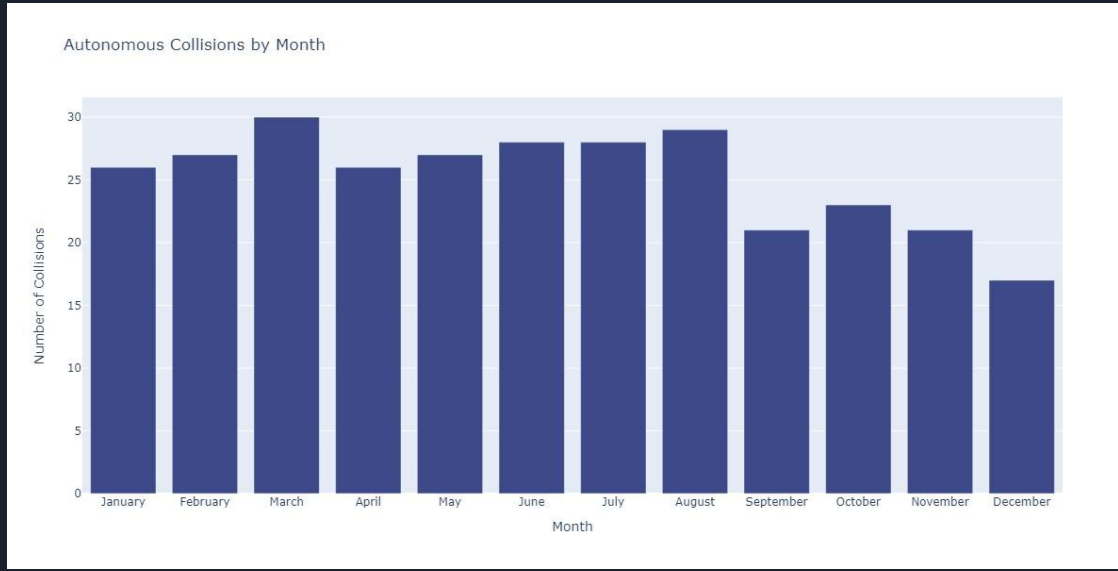
Things break d

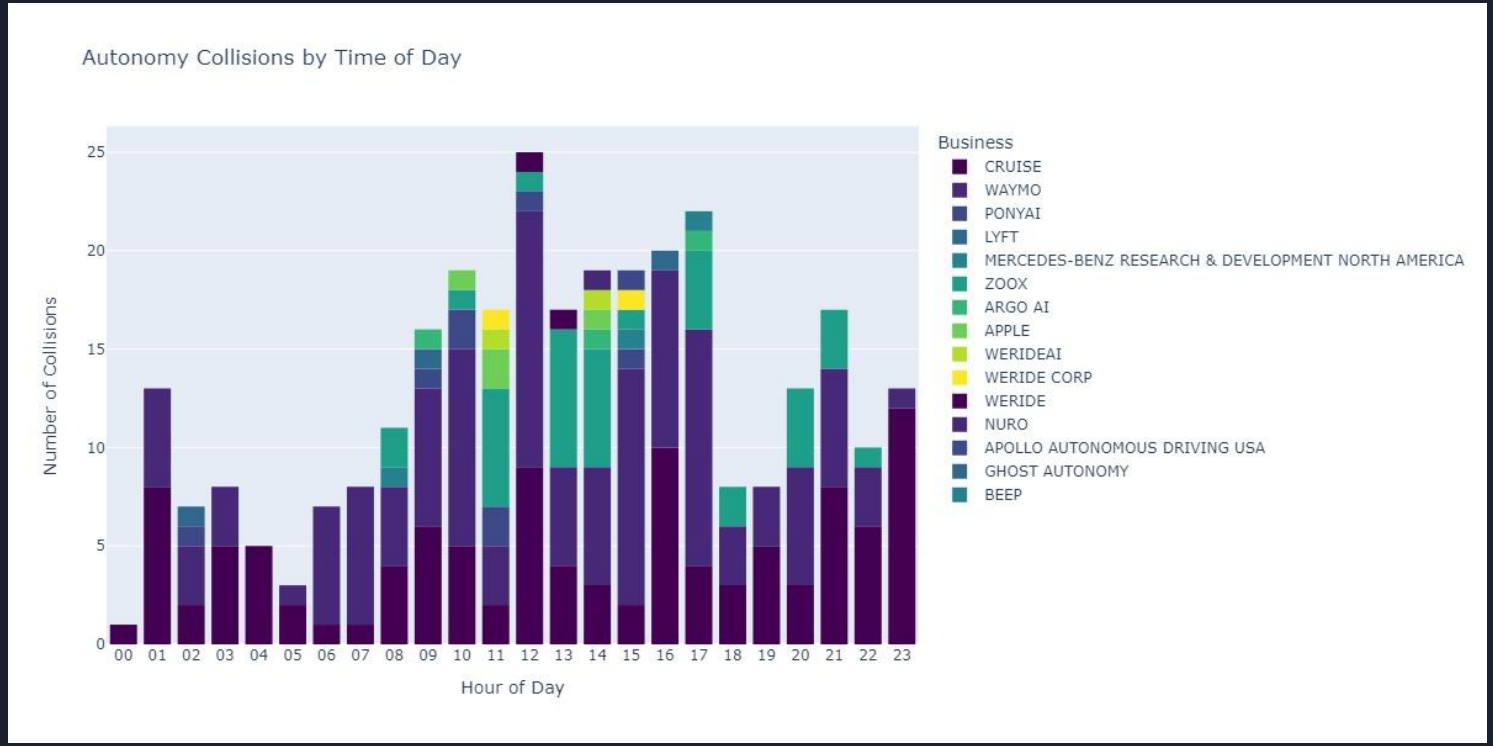
What happened?

What were they doing when ba

Autonomous collisions:
~25/ month, ~300/year

2023 autonomous mileage:
5.75M mi



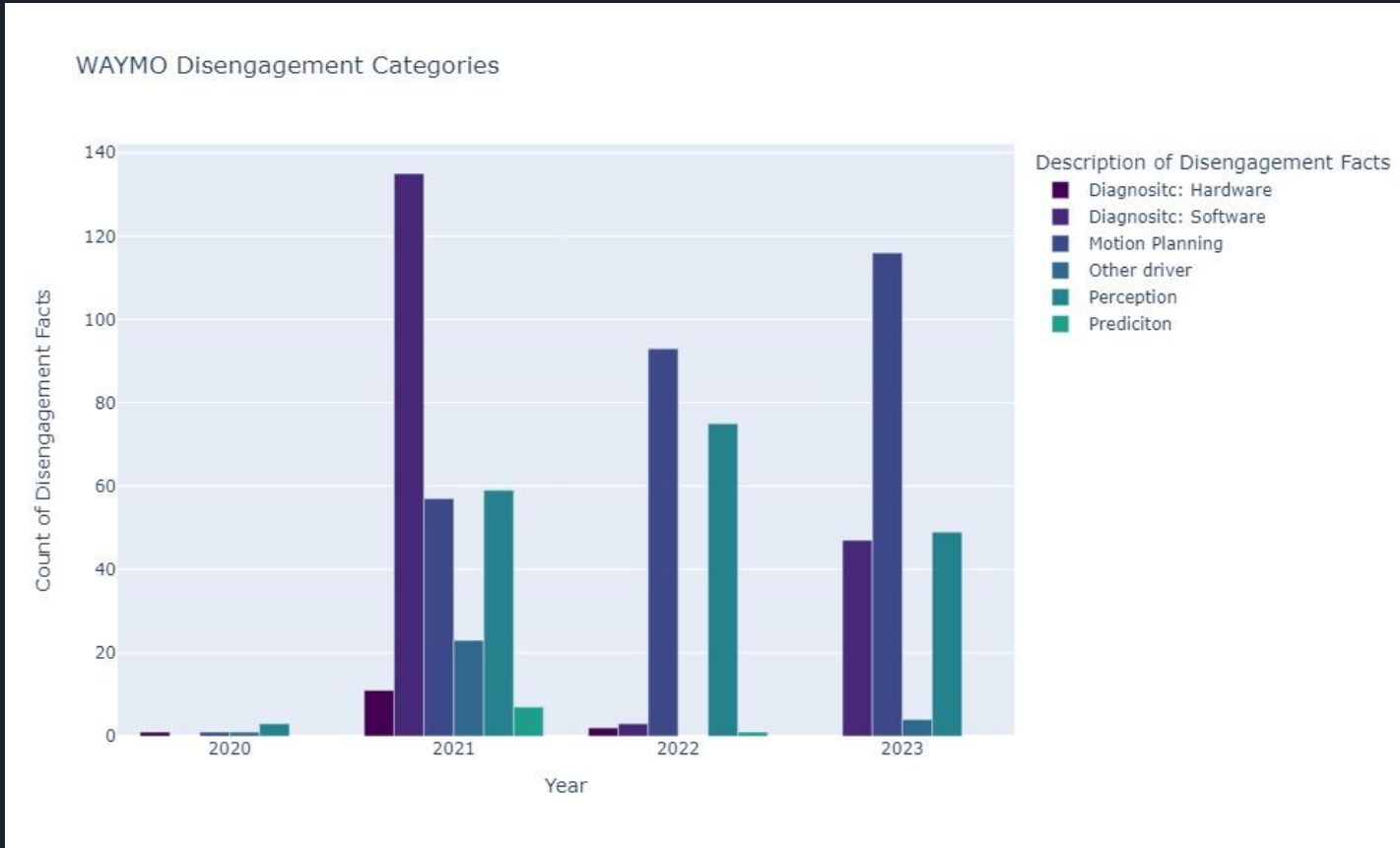

Autonomy Collisions by Time of Day
Number of Collisions
0
5
10
15
20
25
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Hour of Day
Business
CRUISE
WAYMO
PONYAI
LYFT
MERCEDES-BENZ RESEARCH & DEVELOPMENT NORTH AMERICA
ZOOX
ARGO AI
APPLE
WERIDEAI
WERIDE CORP
WERIDE
NURO
APOLLO AUTONOMOUS DRIVING USA
GHOST AUTONOMY
BEEP

Collision heatmap

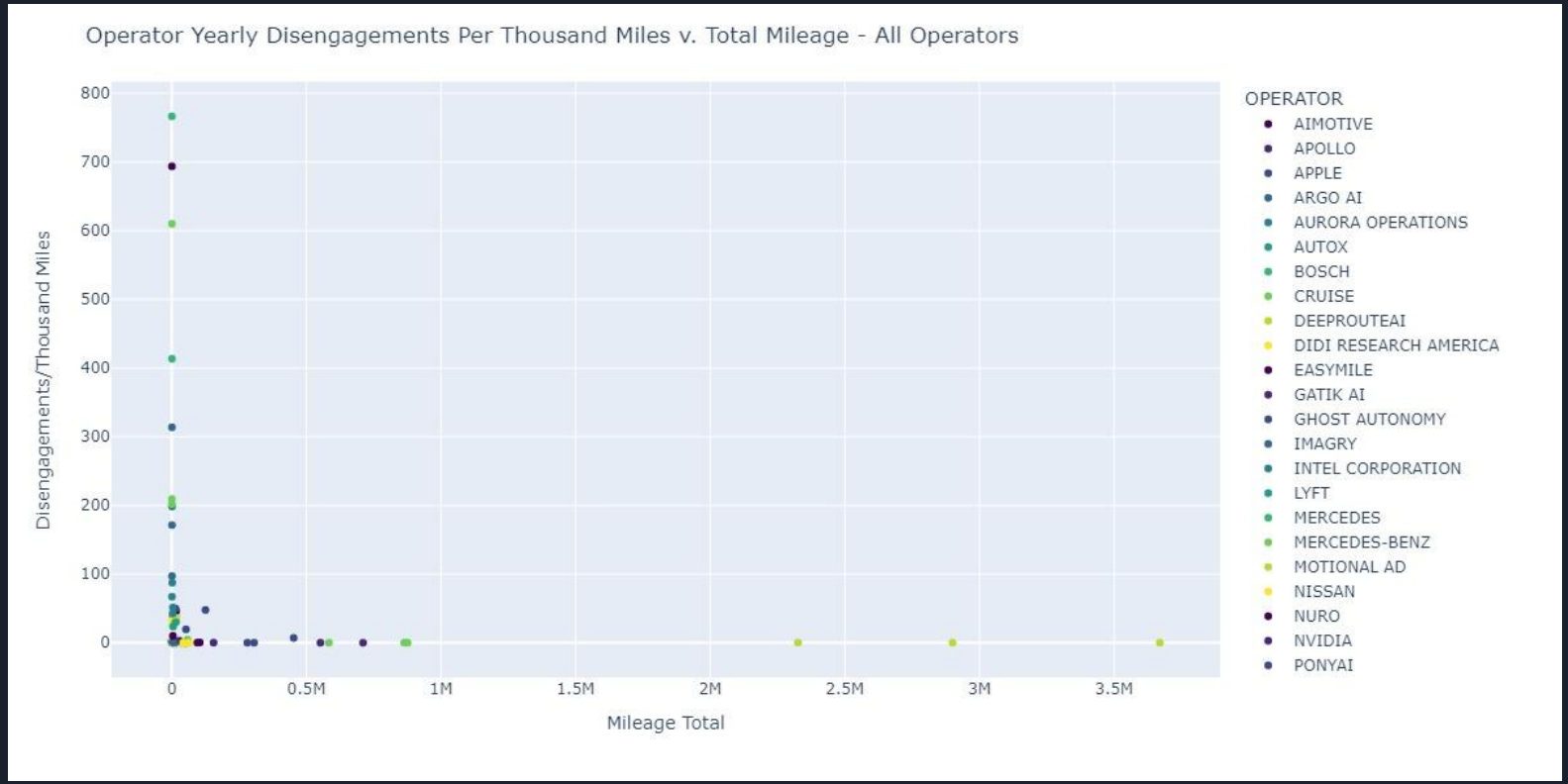
Waymo Gets there

NHTSA - 2021 crashes per 100M miles: 195

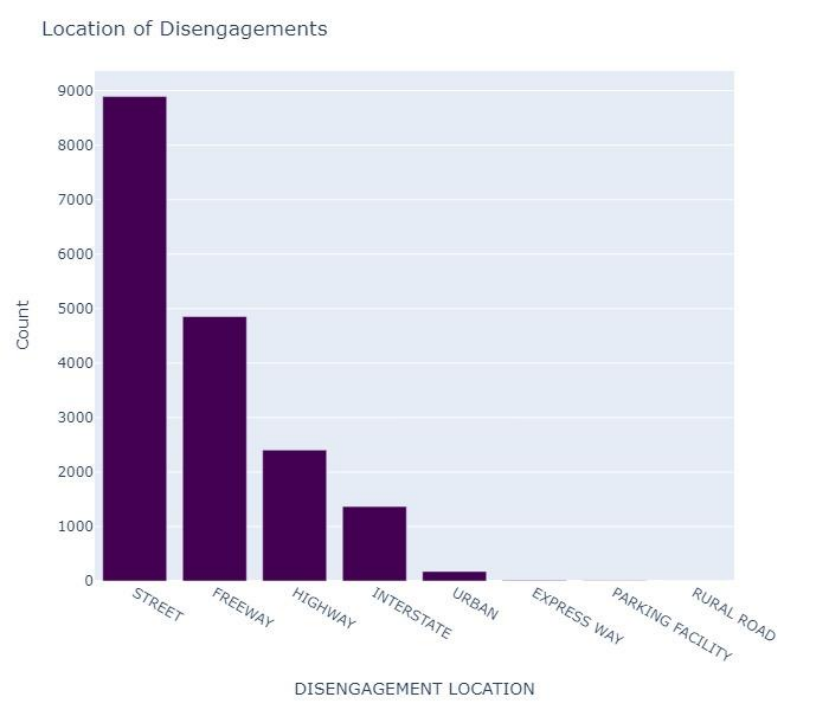
Waymo - disengagement rates

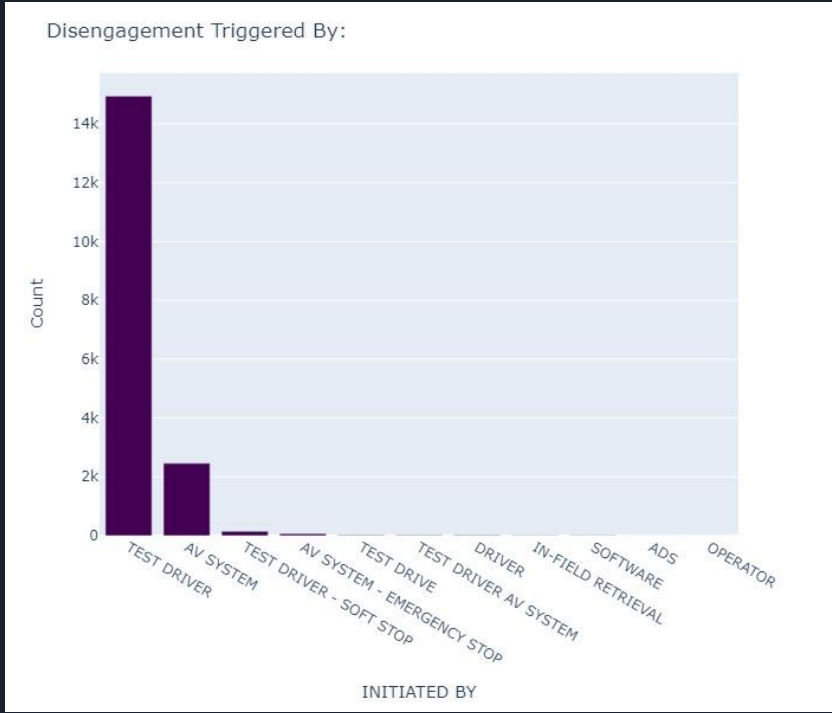


Disengagement Rates vs Miles Logged



Disengagement Insights





Disengagement Insights

Waymo - collision rates

- Compare to NHTSA avg for urban

California

- VINs - CA not checking
  - Dupes
  - Errant (not 17 digits)
- Outliers:
  - Cruise lack of disengagement reports
- Allowed Waymo to get there
- Other states which allow are not publishing this data

Zippy & Pokey

Focus on granularity of data

Conclusions

Things we could do

Waymo - vs all

General break down

Directions we could go in

Other states

Other environments (non-urban)