Dhiraj Santwani **EXPERIMENT NO: 1** D15C-47

Aim: Introduction to Data science and Data preparation using Pandas steps.

Theory:

Data preparation is a crucial step in data science, involving cleaning and transforming raw data into an analyzable format. Using Pandas, we can perform operations such as handling missing values, encoding categorical data, and scaling numerical features. Proper preprocessing ensures the dataset is reliable for analysis and modeling by addressing inconsistencies, missing data, and outliers.

Problem Statement:

The Vehicle Safety Recall dataset, provided by NHTSA, contains 15 columns detailing various aspects of recall events, such as manufacturers, affected components, and corrective actions. This analysis focuses on:

- **Manufacturer Trends**: Identifying manufacturers prone to frequent recalls or specific defects.
- **Impact Analysis**: Understanding recall types affecting the largest populations and assessing average completion rates.
- **Temporal Patterns**: Detecting trends in recalls over time and seasonal spikes.
- **Safety Implications**: Investigating critical safety advisories like "Do Not Drive" or "Park Outside" and their resolution rates.

By cleaning the dataset and applying data preprocessing steps, the goal is to enhance its quality and draw actionable insights for stakeholders.

Dataset Overview:

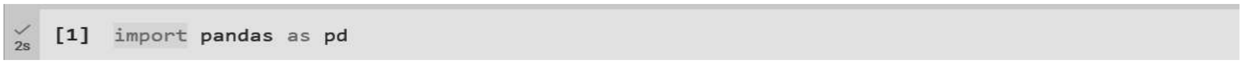
The dataset provides detailed information about vehicle safety recalls managed by the National Highway Traffic Safety Administration (NHTSA). It contains 15 columns, each capturing specific aspects of recall events. Below is a breakdown of the columns and their relevance:

1. **Report Received Date:** Date the recall was officially reported.
2. **NHTSA ID:** A unique identifier for each recall event.
3. **Recall Link:** A hyperlink to the recall details on the NHTSA website.
4. **Manufacturer:** Name of the vehicle or product manufacturer responsible for the recall.
5. **Subject:** Brief description of the recall issue.

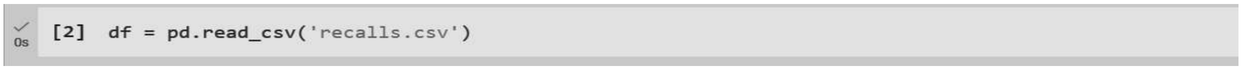
6. **Component:** The affected part of the vehicle/product (e.g., "POWER TRAIN").
7. **Mfr Campaign Number:** Manufacturer’s internal reference for the recall.
8. **Recall Type:** Type of product involved (e.g., vehicle, tire, or car seat).
9. **Potentially Affected:** Number of units potentially impacted by the recall.
10. **Recall Description:** Detailed explanation of the defect or issue.
11. **Consequence Summary:** Description of the risks or consequences associated with the defect.
12. **Corrective Action:** Steps taken to address the defect.
13. **Park Outside Advisory:** Indicates whether there's an advisory to park outside for safety.
14. **Do Not Drive Advisory:** Indicates whether there's an advisory not to drive the affected vehicle.
15. **Completion Rate %:** Percentage of affected vehicles repaired or addressed.

Steps:

1. **Loading The Dataset**

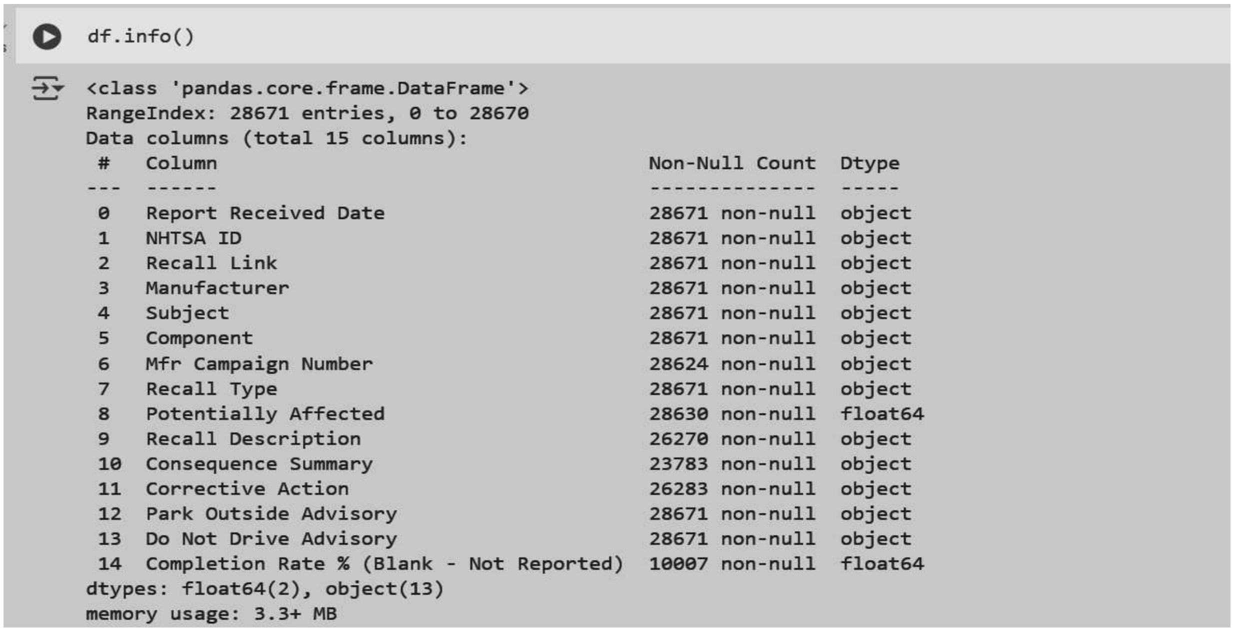


```
[1] import pandas as pd
```



```
[2] df = pd.read_csv('recalls.csv')
```

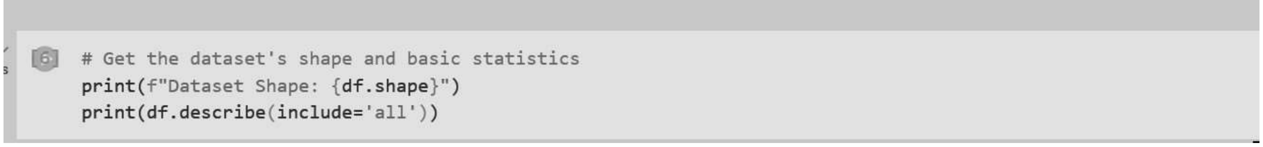
2. **Description of the dataset**
    a. **Information about dataset**



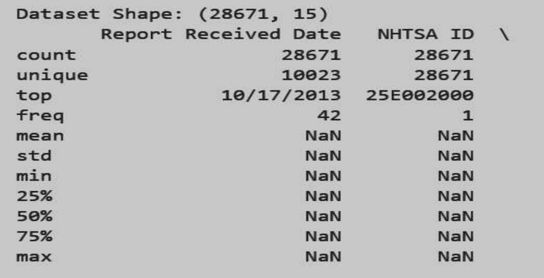
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 28671 entries, 0 to 28670
Data columns (total 15 columns):
 #   Column                                Non-Null Count  Dtype  
---  ------                                --------------  -----  
 0   Report Received Date                  28671 non-null  object 
 1   NHTSA ID                              28671 non-null  object 
 2   Recall Link                           28671 non-null  object 
 3   Manufacturer                          28671 non-null  object 
 4   Subject                               28671 non-null  object 
 5   Component                             28671 non-null  object 
 6   Mfr Campaign Number                   28624 non-null  object 
 7   Recall Type                           28671 non-null  object 
 8   Potentially Affected                  28630 non-null  float64
 9   Recall Description                    26270 non-null  object 
 10  Consequence Summary                   23783 non-null  object 
 11  Corrective Action                     26283 non-null  object 
 12  Park Outside Advisory                 28671 non-null  object 
 13  Do Not Drive Advisory                 28671 non-null  object 
 14  Completion Rate % (Blank - Not Reported)  10007 non-null  float64
dtypes: float64(2), object(13)
memory usage: 3.3+ MB
```

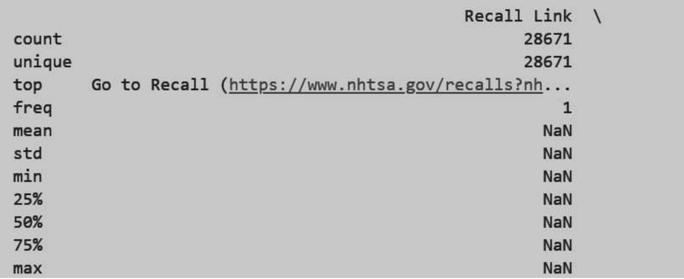
b. Description of Dataset



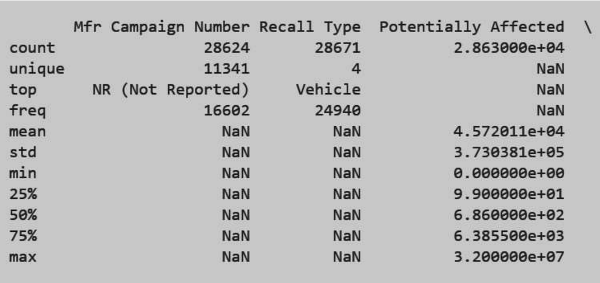
```
# Get the dataset's shape and basic statistics
print(f"Dataset Shape: {df.shape}")
print(df.describe(include='all'))
```



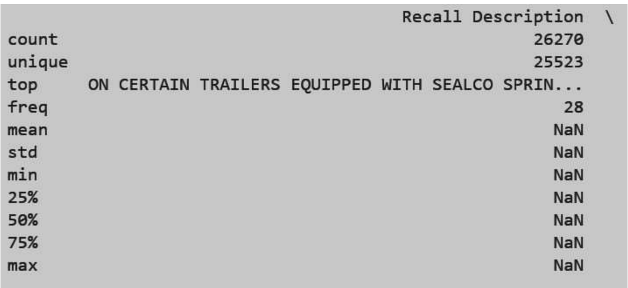
```
Dataset Shape: (28671, 15)
       Report Received Date   NHTSA ID  \
count                 28671      28671
unique                10023      28671
top              10/17/2013  25E002000
freq                     42          1
mean                    NaN        NaN
std                     NaN        NaN
min                     NaN        NaN
25%                     NaN        NaN
50%                     NaN        NaN
75%                     NaN        NaN
max                     NaN        NaN
```



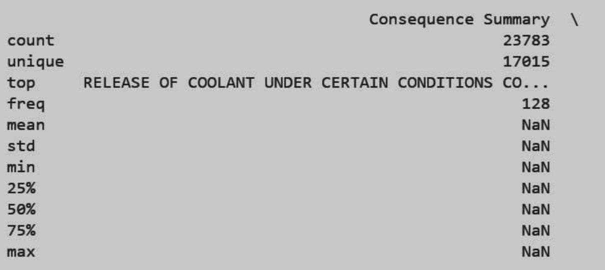
```
                                                Recall Link  \
count                                                 28671
unique                                                28671
top     Go to Recall (https://www.nhtsa.gov/recalls?nh...
freq                                                      1
mean                                                    NaN
std                                                     NaN
min                                                     NaN
25%                                                     NaN
50%                                                     NaN
75%                                                     NaN
max                                                     NaN
```



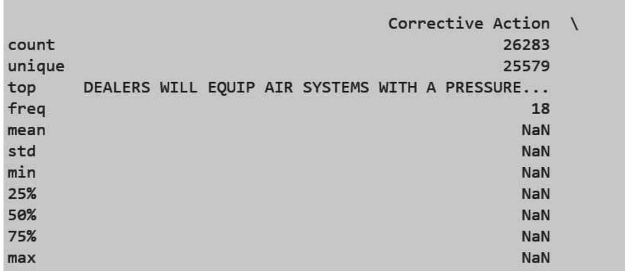
```
       Mfr Campaign Number Recall Type  Potentially Affected  \
count                28624       28671          2.863000e+04
unique               11341           4                   NaN
top      NR (Not Reported)     Vehicle                   NaN
freq                 16602       24940                   NaN
mean                   NaN         NaN          4.572011e+04
std                    NaN         NaN          3.730381e+05
min                    NaN         NaN          0.000000e+00
25%                    NaN         NaN          9.900000e+01
50%                    NaN         NaN          6.860000e+02
75%                    NaN         NaN          6.385500e+03
max                    NaN         NaN          3.200000e+07
```



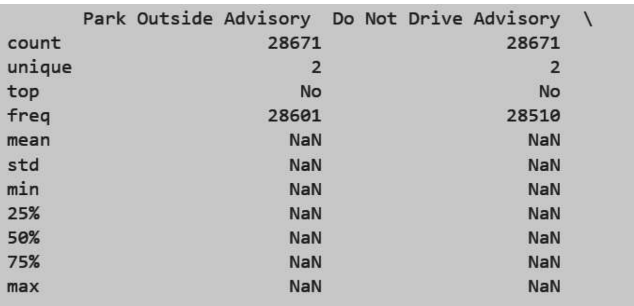
```
                                       Recall Description  \
count                                               26270
unique                                              25523
top     ON CERTAIN TRAILERS EQUIPPED WITH SEALCO SPRIN...
freq                                                   28
mean                                                  NaN
std                                                   NaN
min                                                   NaN
25%                                                   NaN
50%                                                   NaN
75%                                                   NaN
max                                                   NaN
```



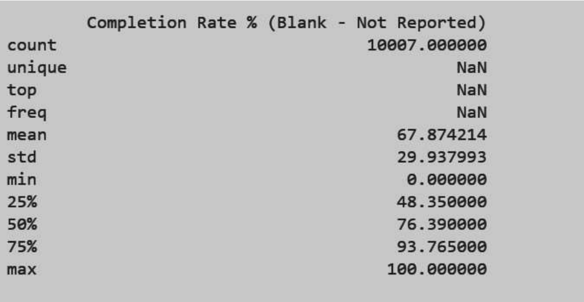
```
                                      Consequence Summary  \
count                                               23783
unique                                              17015
top     RELEASE OF COOLANT UNDER CERTAIN CONDITIONS CO...
freq                                                  128
mean                                                  NaN
std                                                   NaN
min                                                   NaN
25%                                                   NaN
50%                                                   NaN
75%                                                   NaN
max                                                   NaN
```



```
                                        Corrective Action  \
count                                               26283
unique                                              25579
top     DEALERS WILL EQUIP AIR SYSTEMS WITH A PRESSURE...
freq                                                   18
mean                                                  NaN
std                                                   NaN
min                                                   NaN
25%                                                   NaN
50%                                                   NaN
75%                                                   NaN
max                                                   NaN
```



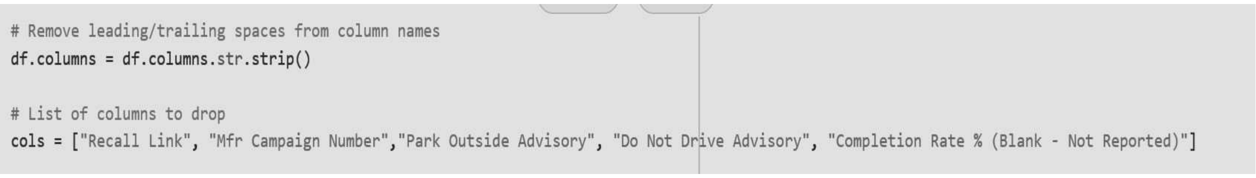
```
       Park Outside Advisory  Do Not Drive Advisory  \
count                  28671                  28671
unique                     2                      2
top                       No                     No
freq                   28601                  28510
mean                     NaN                    NaN
std                      NaN                    NaN
min                      NaN                    NaN
25%                      NaN                    NaN
50%                      NaN                    NaN
75%                      NaN                    NaN
max                      NaN                    NaN
```



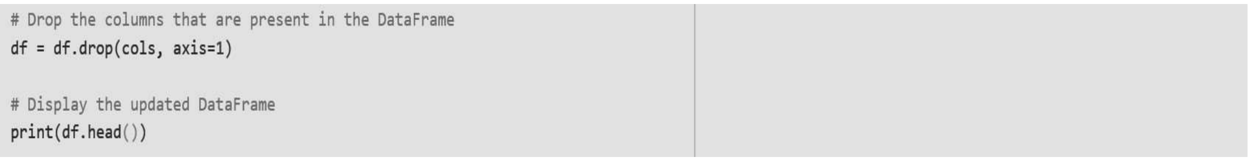
```
        Completion Rate % (Blank - Not Reported)
count                               10007.000000
unique                                       NaN
top                                          NaN
freq                                         NaN
mean                                   67.874214
std                                    29.937993
min                                     0.000000
25%                                    48.350000
50%                                    76.390000
75%                                    93.765000
max                                   100.000000
```

3. Drop columns that aren’t useful.

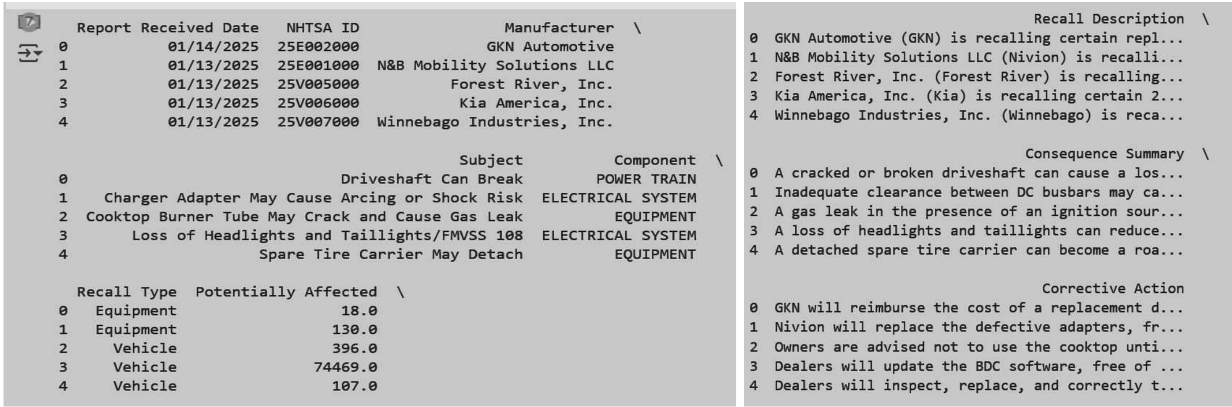
Columns that might not be necessary for analysis include Recall Link, Mfr Campaign Number, Park Outside Advisory,Completion rate(%).These columns do not provide much insight in the context of data analysis for recall trends or consequences. Therefore, you can drop them to simplify the dataset.



```
# Remove leading/trailing spaces from column names
df.columns = df.columns.str.strip()

# List of columns to drop
cols = ["Recall Link", "Mfr Campaign Number","Park Outside Advisory", "Do Not Drive Advisory", "Completion Rate % (Blank - Not Reported)"]
```

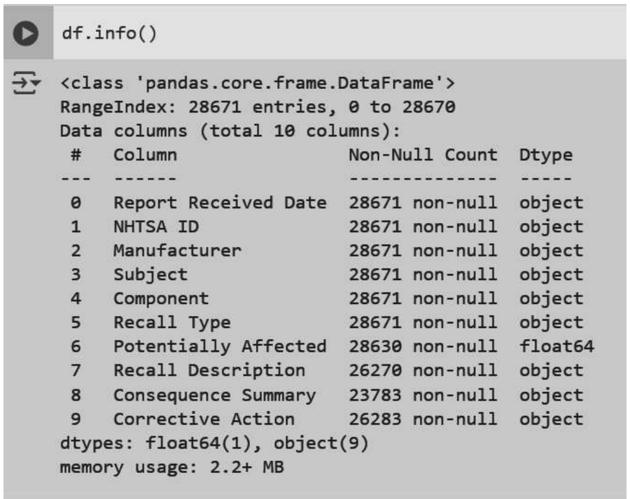


```
# Drop the columns that are present in the DataFrame
df = df.drop(cols, axis=1)

# Display the updated DataFrame
print(df.head())
```



```
  Report Received Date   NHTSA ID                Manufacturer  \
0           01/14/2025  25E002000               GKN Automotive
1           01/13/2025  25E001000  N&B Mobility Solutions LLC
2           01/13/2025  25V005000          Forest River, Inc.
3           01/13/2025  25V006000           Kia America, Inc.
4           01/13/2025  25V007000  Winnebago Industries, Inc.

                                  Subject          Component  \
0                        Driveshaft Can Break         POWER TRAIN
1   Charger Adapter May Cause Arcing or Shock Risk  ELECTRICAL SYSTEM
2  Cooktop Burner Tube May Crack and Cause Gas Leak          EQUIPMENT
3      Loss of Headlights and Taillights/FMVSS 108  ELECTRICAL SYSTEM
4                  Spare Tire Carrier May Detach          EQUIPMENT

  Recall Type  Potentially Affected  \
0   Equipment                  18.0
1   Equipment                 130.0
2     Vehicle                 396.0
3     Vehicle               74469.0
4     Vehicle                 107.0

                                 Recall Description  \
0  GKN Automotive (GKN) is recalling certain repl...
1  N&B Mobility Solutions LLC (Nivion) is recalli...
2  Forest River, Inc. (Forest River) is recalling...
3  Kia America, Inc. (Kia) is recalling certain 2...
4  Winnebago Industries, Inc. (Winnebago) is reca...

                                Consequence Summary  \
0  A cracked or broken driveshaft can cause a los...
1  Inadequate clearance between DC busbars may ca...
2  A gas leak in the presence of an ignition sour...
3  A loss of headlights and taillights can reduce...
4  A detached spare tire carrier can become a roa...

                                  Corrective Action
0  GKN will reimburse the cost of a replacement d...
1  Nivion will replace the defective adapters, fr...
2  Owners are advised not to use the cooktop unti...
3  Dealers will update the BDC software, free of ...
4  Dealers will inspect, replace, and correctly t...
```

Thus the columns now present in dataset are:

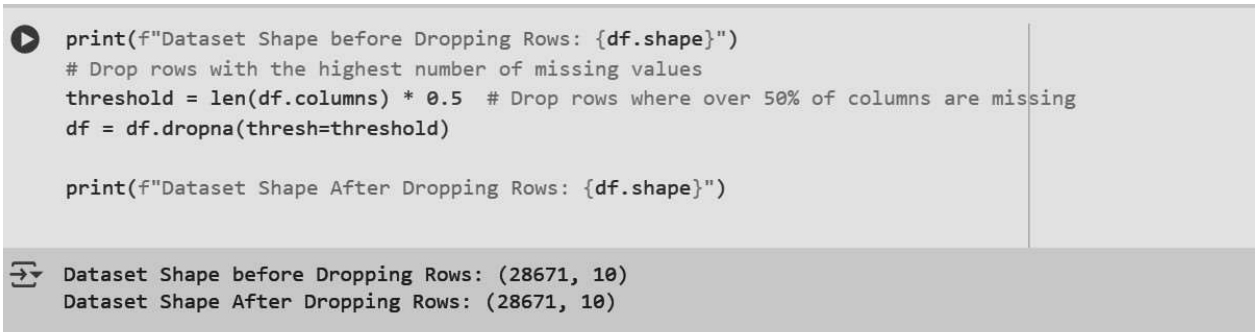


```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 28671 entries, 0 to 28670
Data columns (total 10 columns):
 #   Column                Non-Null Count  Dtype  
---  ------                --------------  -----  
 0   Report Received Date  28671 non-null  object 
 1   NHTSA ID              28671 non-null  object 
 2   Manufacturer          28671 non-null  object 
 3   Subject               28671 non-null  object 
 4   Component             28671 non-null  object 
 5   Recall Type           28671 non-null  object 
 6   Potentially Affected  28630 non-null  float64
 7   Recall Description    26270 non-null  object 
 8   Consequence Summary   23783 non-null  object 
 9   Corrective Action     26283 non-null  object 
dtypes: float64(1), object(9)
memory usage: 2.2+ MB
```

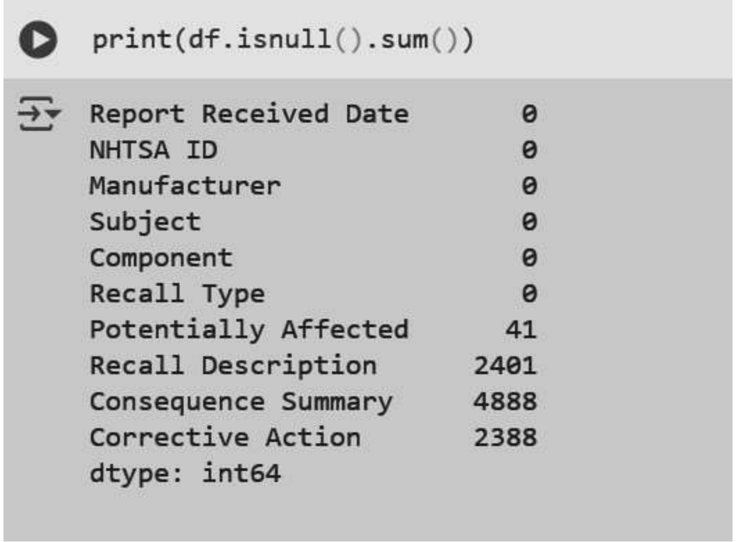
4. **Take care of missing data.**
    a. **Drop rows with maximum missing values.**

Here we drop the rows which have more than 50% missing values.these can be done by dropna() function with threshold parameter=0.5.



```
print(f"Dataset Shape before Dropping Rows: {df.shape}")
# Drop rows with the highest number of missing values
threshold = len(df.columns) * 0.5  # Drop rows where over 50% of columns are missing
df = df.dropna(thresh=threshold)

print(f"Dataset Shape After Dropping Rows: {df.shape}")
```

```
Dataset Shape before Dropping Rows: (28671, 10)
Dataset Shape After Dropping Rows: (28671, 10)
```

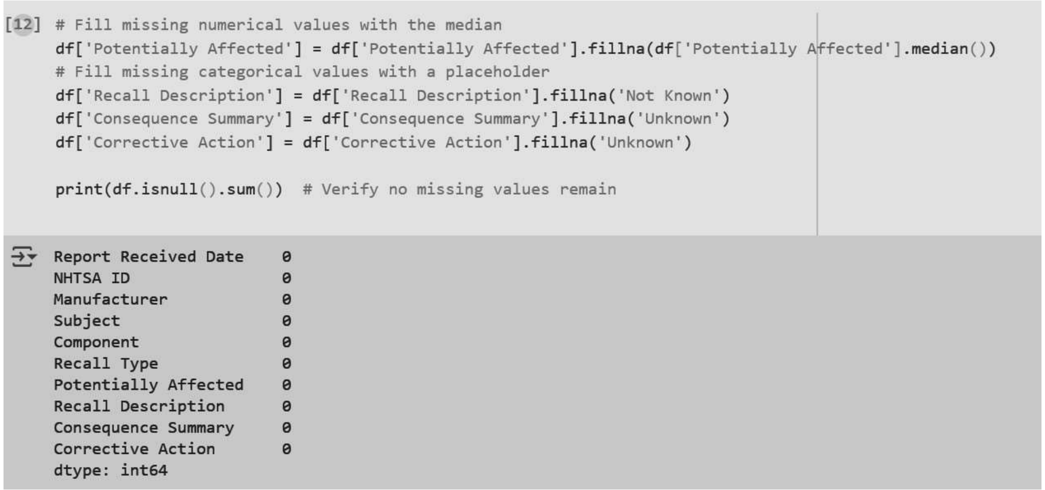


```
print(df.isnull().sum())
```

```
Report Received Date       0
NHTSA ID                   0
Manufacturer               0
Subject                    0
Component                  0
Recall Type                0
Potentially Affected      41
Recall Description      2401
Consequence Summary     4888
Corrective Action       2388
dtype: int64
```

b. Handle Missing Data

Here the above information says Potential Affected ,Recall Description ,Consequence Summary and corrective action contain some null values thus we need to handle missing data.For these columns, either fill in with a placeholder (e.g., "Unknown") or drop the rows if the missing data is significant.

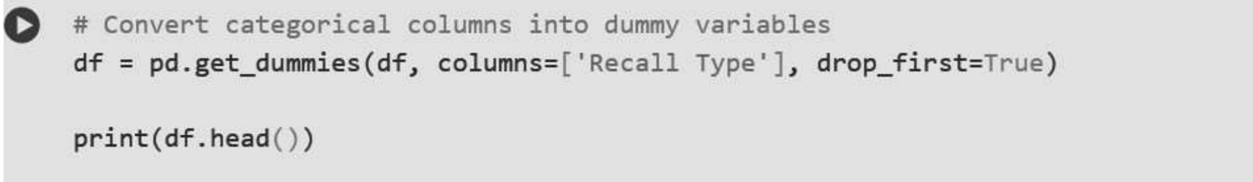


```
# Fill missing numerical values with the median
df['Potentially Affected'] = df['Potentially Affected'].fillna(df['Potentially Affected'].median())
# Fill missing categorical values with a placeholder
df['Recall Description'] = df['Recall Description'].fillna('Not Known')
df['Consequence Summary'] = df['Consequence Summary'].fillna('Unknown')
df['Corrective Action'] = df['Corrective Action'].fillna('Unknown')

print(df.isnull().sum())  # Verify no missing values remain
```

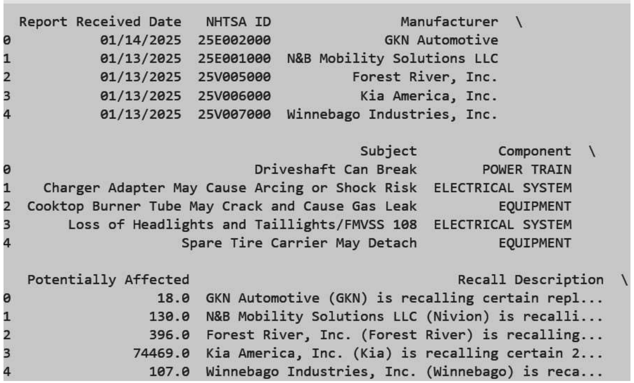
```
Report Received Date    0
NHTSA ID                0
Manufacturer            0
Subject                 0
Component               0
Recall Type             0
Potentially Affected    0
Recall Description      0
Consequence Summary     0
Corrective Action       0
dtype: int64
```

5. Create dummy variables

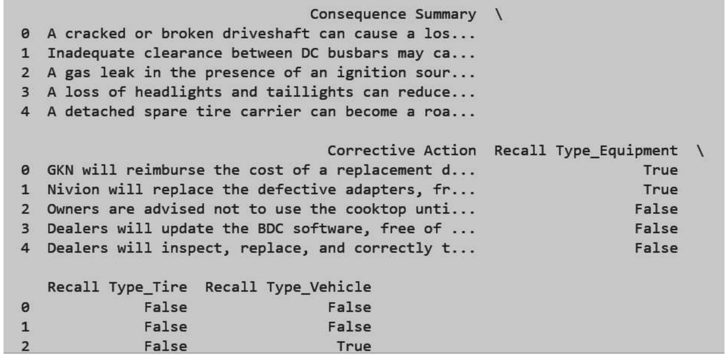
For columns containing categorical data (e.g., Recall Type), we can create dummy variables. This is helpful for machine learning models.



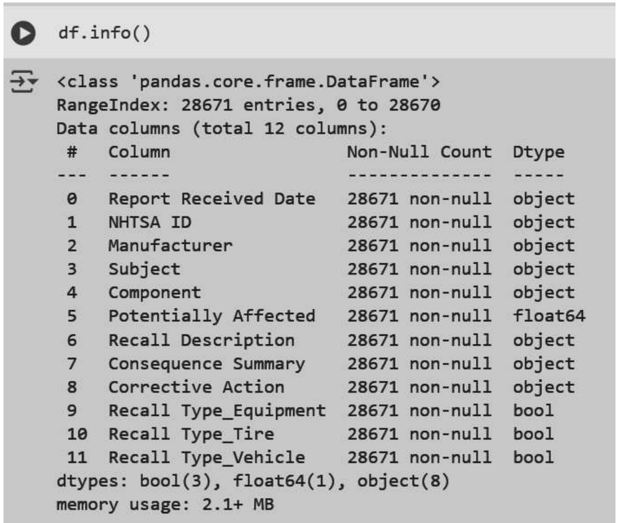
```
# Convert categorical columns into dummy variables
df = pd.get_dummies(df, columns=['Recall Type'], drop_first=True)

print(df.head())
```



```
  Report Received Date   NHTSA ID                   Manufacturer  \
0           01/14/2025  25E002000                 GKN Automotive
1           01/13/2025  25E001000  N&B Mobility Solutions LLC
2           01/13/2025  25V005000             Forest River, Inc.
3           01/13/2025  25V006000              Kia America, Inc.
4           01/13/2025  25V007000  Winnebago Industries, Inc.

                                     Subject          Component  \
0                        Driveshaft Can Break        POWER TRAIN
1   Charger Adapter May Cause Arcing or Shock Risk  ELECTRICAL SYSTEM
2  Cooktop Burner Tube May Crack and Cause Gas Leak          EQUIPMENT
3      Loss of Headlights and Taillights/FMVSS 108  ELECTRICAL SYSTEM
4                   Spare Tire Carrier May Detach          EQUIPMENT

   Potentially Affected                                Recall Description  \
0                  18.0  GKN Automotive (GKN) is recalling certain repl...
1                 130.0  N&B Mobility Solutions LLC (Nivion) is recalli...
2                 396.0  Forest River, Inc. (Forest River) is recalling...
3               74469.0  Kia America, Inc. (Kia) is recalling certain 2...
4                 107.0  Winnebago Industries, Inc. (Winnebago) is reca...
```



```
                               Consequence Summary  \
0  A cracked or broken driveshaft can cause a los...
1  Inadequate clearance between DC busbars may ca...
2  A gas leak in the presence of an ignition sour...
3  A loss of headlights and taillights can reduce...
4  A detached spare tire carrier can become a roa...

                                 Corrective Action  Recall Type_Equipment  \
0  GKN will reimburse the cost of a replacement d...                   True
1  Nivion will replace the defective adapters, fr...                   True
2  Owners are advised not to use the cooktop unti...                  False
3  Dealers will update the BDC software, free of ...                  False
4  Dealers will inspect, replace, and correctly t...                  False

   Recall Type_Tire  Recall Type_Vehicle
0             False                False
1             False                False
2             False                 True
```



```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 28671 entries, 0 to 28670
Data columns (total 12 columns):
 #   Column                 Non-Null Count  Dtype
---  ------                 --------------  -----
 0   Report Received Date   28671 non-null  object
 1   NHTSA ID               28671 non-null  object
 2   Manufacturer           28671 non-null  object
 3   Subject                28671 non-null  object
 4   Component              28671 non-null  object
 5   Potentially Affected   28671 non-null  float64
 6   Recall Description     28671 non-null  object
 7   Consequence Summary    28671 non-null  object
 8   Corrective Action      28671 non-null  object
 9   Recall Type_Equipment  28671 non-null  bool
 10  Recall Type_Tire       28671 non-null  bool
 11  Recall Type_Vehicle    28671 non-null  bool
dtypes: bool(3), float64(1), object(8)
memory usage: 2.1+ MB
```

6. Find out outliers (manually):

Outliers can be detected by looking at numerical columns like Potentially Affected. One method for identifying outliers is by visualizing the data using box plots or using statistical methods like the Z-score.

First Quartile (Q1):=QUARTILE(H2:H28719, 1)
Q1 = 99
Third Quartile (Q3):=QUARTILE(H2:H28719, 3)
Q3 = 6386
Interquartile Range (IQR):=Q3 - Q1

IQR = 6386 - 99 = 6287

Outlier Boundaries:

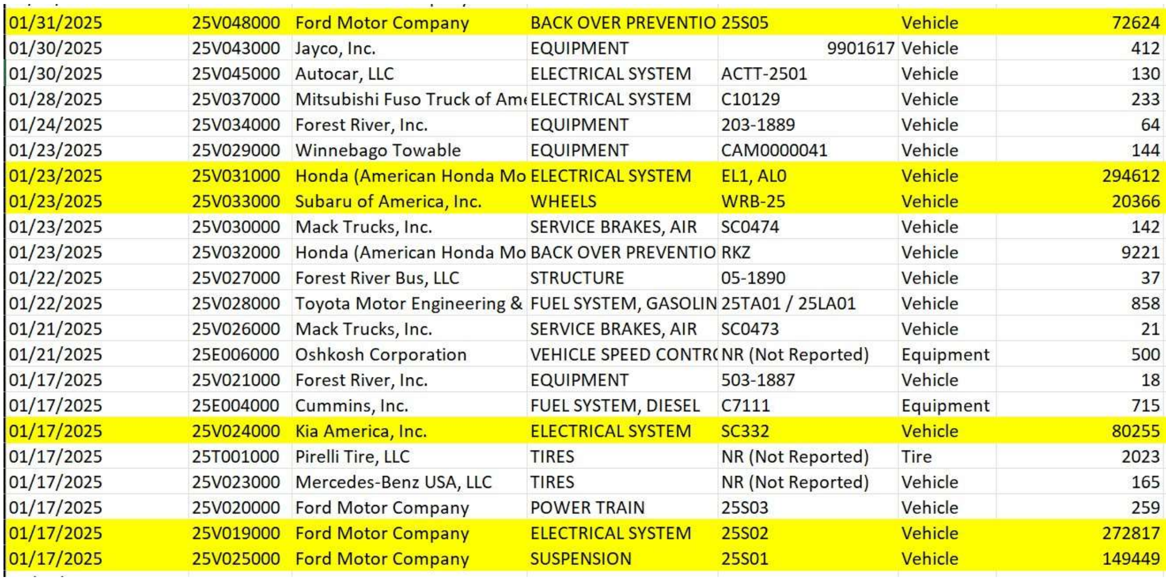
Lower Bound:=Q1 - 1.5 * IQR

Lower Bound = 99 - (1.5 * 6287) = -9331.5

Upper Bound: =Q3 + 1.5 * IQR

Upper Bound = 6386 + (1.5 * 6287) = 15816.5

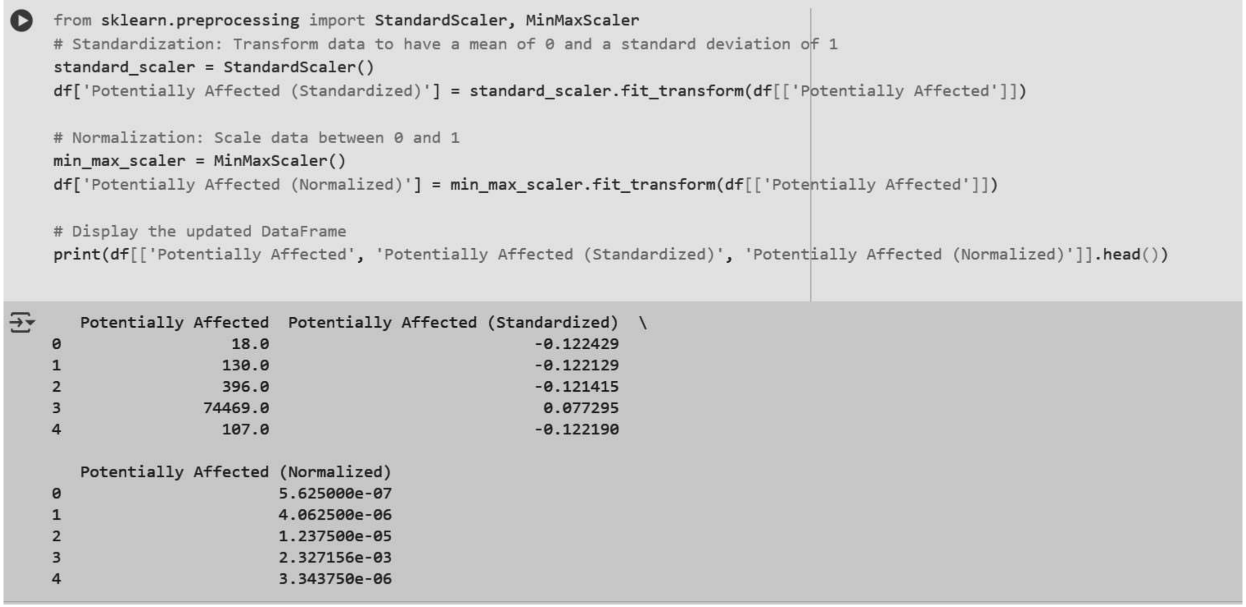
Identifying Outliers: Any value less than -9331.5 or greater than 15816.5 is considered an outlier.



01/31/2025	25V048000	Ford Motor Company	BACK OVER PREVENTIO	25S05	Vehicle	72624
01/30/2025	25V043000	Jayco, Inc.	EQUIPMENT	9901617	Vehicle	412
01/30/2025	25V045000	Autocar, LLC	ELECTRICAL SYSTEM	ACTT-2501	Vehicle	130
01/28/2025	25V037000	Mitsubishi Fuso Truck of Ame	ELECTRICAL SYSTEM	C10129	Vehicle	233
01/24/2025	25V034000	Forest River, Inc.	EQUIPMENT	203-1889	Vehicle	64
01/23/2025	25V029000	Winnebago Towable	EQUIPMENT	CAM0000041	Vehicle	144
01/23/2025	25V031000	Honda (American Honda Mo	ELECTRICAL SYSTEM	EL1, AL0	Vehicle	294612
01/23/2025	25V033000	Subaru of America, Inc.	WHEELS	WRB-25	Vehicle	20366
01/23/2025	25V030000	Mack Trucks, Inc.	SERVICE BRAKES, AIR	SC0474	Vehicle	142
01/23/2025	25V032000	Honda (American Honda Mo	BACK OVER PREVENTIO	RKZ	Vehicle	9221
01/22/2025	25V027000	Forest River Bus, LLC	STRUCTURE	05-1890	Vehicle	37
01/22/2025	25V028000	Toyota Motor Engineering &	FUEL SYSTEM, GASOLIN	25TA01 / 25LA01	Vehicle	858
01/21/2025	25V026000	Mack Trucks, Inc.	SERVICE BRAKES, AIR	SC0473	Vehicle	21
01/21/2025	25E006000	Oshkosh Corporation	VEHICLE SPEED CONTR(	NR (Not Reported)	Equipment	500
01/17/2025	25V021000	Forest River, Inc.	EQUIPMENT	503-1887	Vehicle	18
01/17/2025	25E004000	Cummins, Inc.	FUEL SYSTEM, DIESEL	C7111	Equipment	715
01/17/2025	25V024000	Kia America, Inc.	ELECTRICAL SYSTEM	SC332	Vehicle	80255
01/17/2025	25T001000	Pirelli Tire, LLC	TIRES	NR (Not Reported)	Tire	2023
01/17/2025	25V023000	Mercedes-Benz USA, LLC	TIRES	NR (Not Reported)	Vehicle	165
01/17/2025	25V020000	Ford Motor Company	POWER TRAIN	25S03	Vehicle	259
01/17/2025	25V019000	Ford Motor Company	ELECTRICAL SYSTEM	25S02	Vehicle	272817
01/17/2025	25V025000	Ford Motor Company	SUSPENSION	25S01	Vehicle	149449

7. standardization and normalization of column

Standardization and normalization are crucial when dealing with numerical data that varies in scale, especially for machine learning algorithms.



```
from sklearn.preprocessing import StandardScaler, MinMaxScaler
# Standardization: Transform data to have a mean of 0 and a standard deviation of 1
standard_scaler = StandardScaler()
df['Potentially Affected (Standardized)'] = standard_scaler.fit_transform(df[['Potentially Affected']])

# Normalization: Scale data between 0 and 1
min_max_scaler = MinMaxScaler()
df['Potentially Affected (Normalized)'] = min_max_scaler.fit_transform(df[['Potentially Affected']])

# Display the updated DataFrame
print(df[['Potentially Affected', 'Potentially Affected (Standardized)', 'Potentially Affected (Normalized)']].head())
```

```
   Potentially Affected  Potentially Affected (Standardized)  \
0                  18.0                            -0.122429
1                 130.0                            -0.122129
2                 396.0                            -0.121415
3               74469.0                             0.077295
4                 107.0                            -0.122190

   Potentially Affected (Normalized)
0                       5.625000e-07
1                       4.062500e-06
2                       1.237500e-05
3                       2.327156e-03
4                       3.343750e-06
```

Conclusion:

This experiment demonstrated effective data cleaning and preparation techniques. Issues such as missing values, irrelevant data, and outliers were addressed, and the dataset was scaled for uniformity. These steps are essential for ensuring high-quality data and reliable model outcomes.