Sprint 3

Capstone Project
Alternative Fuel Stations and Electric Vehicles Study

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BrainStation Data Science Bootcamp
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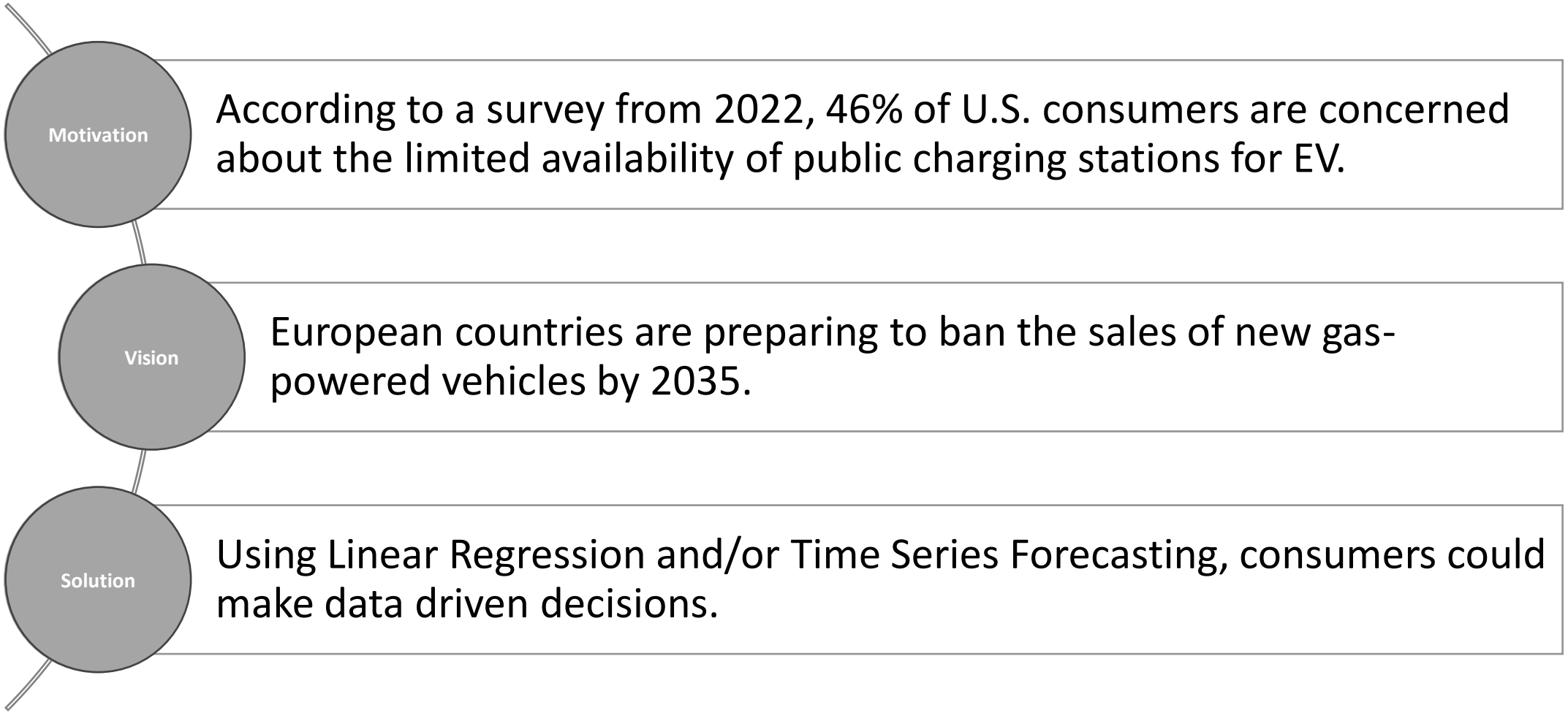
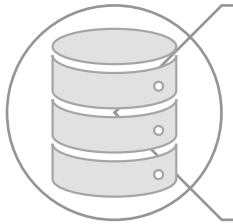
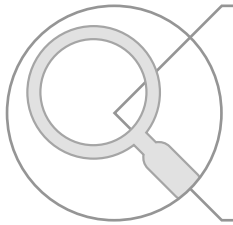
Project Overview



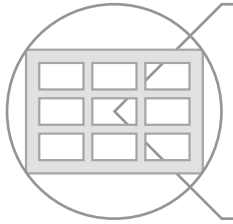
Dataset Overview



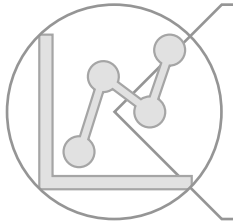
www.data.gov



Published by the National Renewable Energy Laboratory on July 31st, 2021.



Original dataframe shape (56800, 65)



Modeling dataframe shape (316, 1)

```
1  df_original.shape
```

```
(56800, 65)
```

```
2  df_TM.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 47086 entries, 159 to 56793
Data columns (total 2 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   Open Date  45791 non-null  datetime64[ns]
 1   State      47086 non-null  object
dtypes: datetime64[ns](1), object(1)
memory usage: 1.1+ MB
```

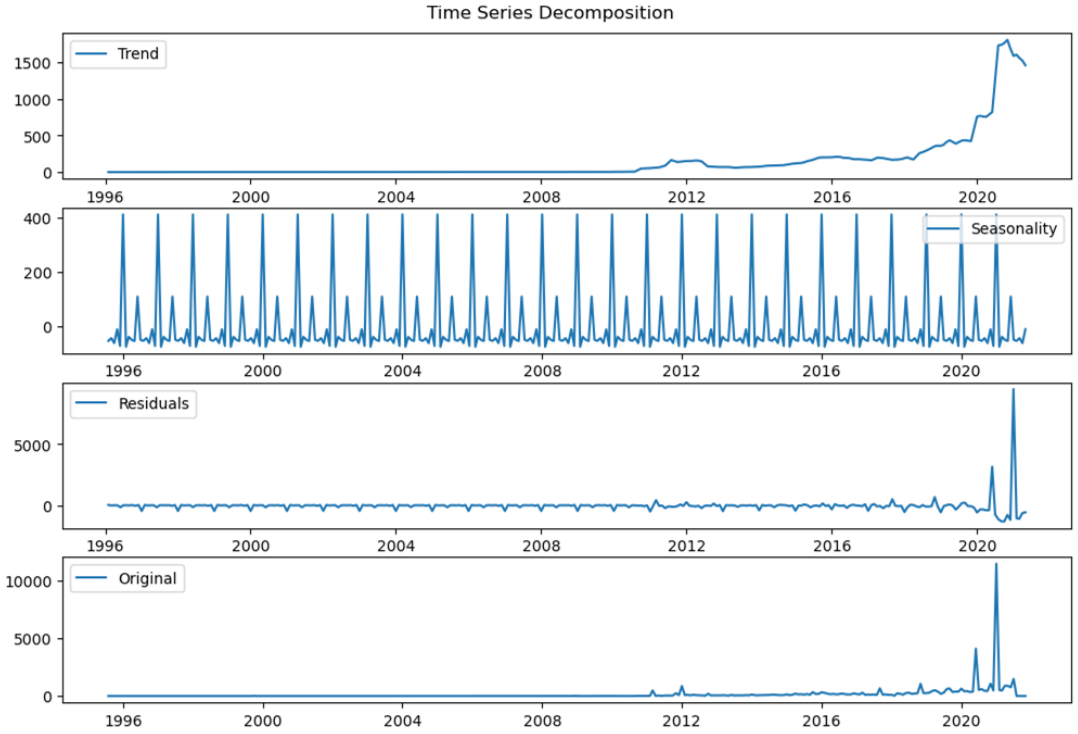
```
2  df_TM_dummies.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 45791 entries, 1999-10-15 to 2021-07-29
Data columns (total 53 columns):
 #   Column              Non-Null Count  Dtype
---  ------              --------------  -----
 0   State_AK            45791 non-null  uint8
 1   State_AL            45791 non-null  uint8
 2   State_AR            45791 non-null  uint8
```

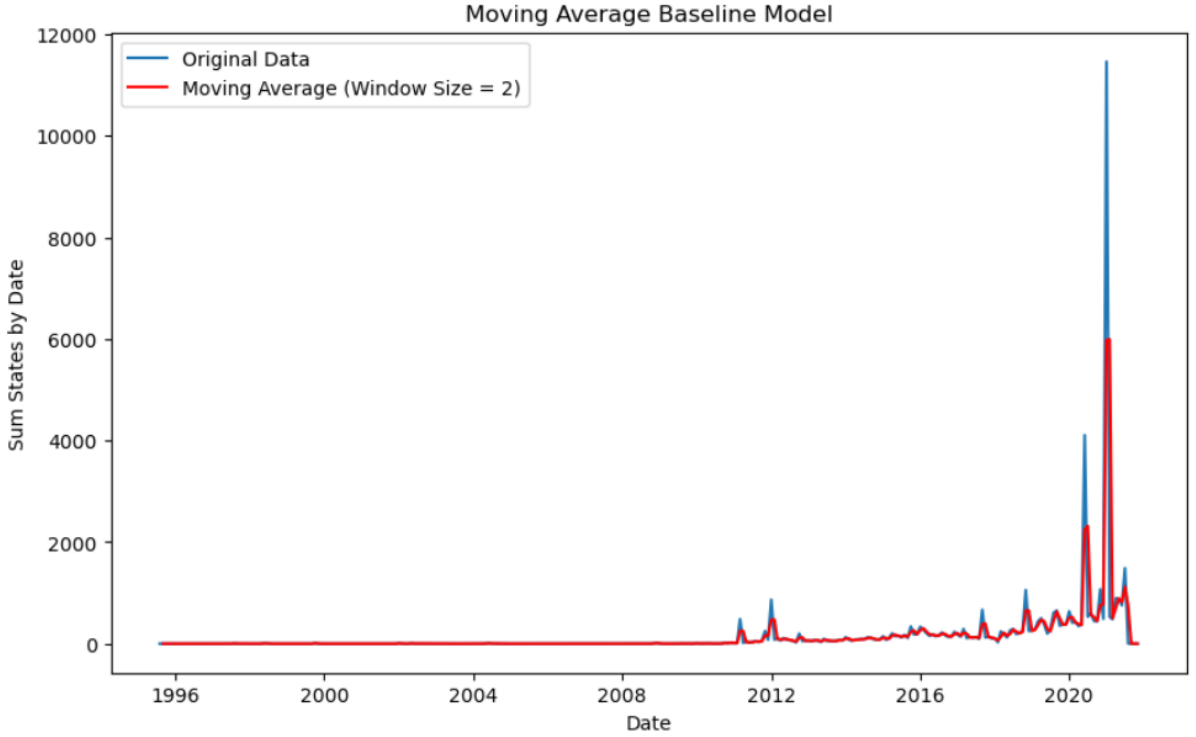
```
2  df_TM_monthly.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 316 entries, 1995-08-01 to 2021-11-01
Freq: MS
Data columns (total 1 columns):
 #   Column             Non-Null Count  Dtype
---  ------             --------------  -----
 0   Sum States by Date  316 non-null    int64
dtypes: int64(1)
memory usage: 4.9 KB
```

Important EDA Findings & Baseline Model



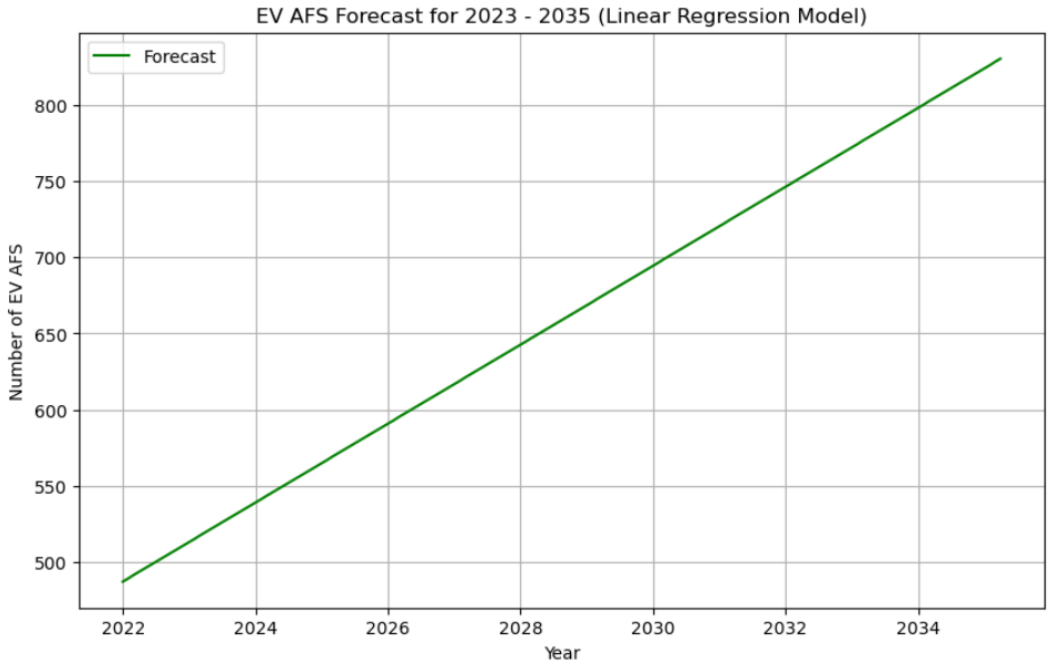
- Trend is positive.
- Seasonality is highest during January and June.
- Residual shows slight seasonality, notable variance at the end.
- Data is non-stationary, its statistical properties, such as mean and variance, change over time.



- Rolling Moving Average with a 2-month window was used for the Baseline.
  - Mean % Error = -132.92%
    - Underestimates the original data
    - 2-month window size provides finer granularity and sensitivity variations in the data.

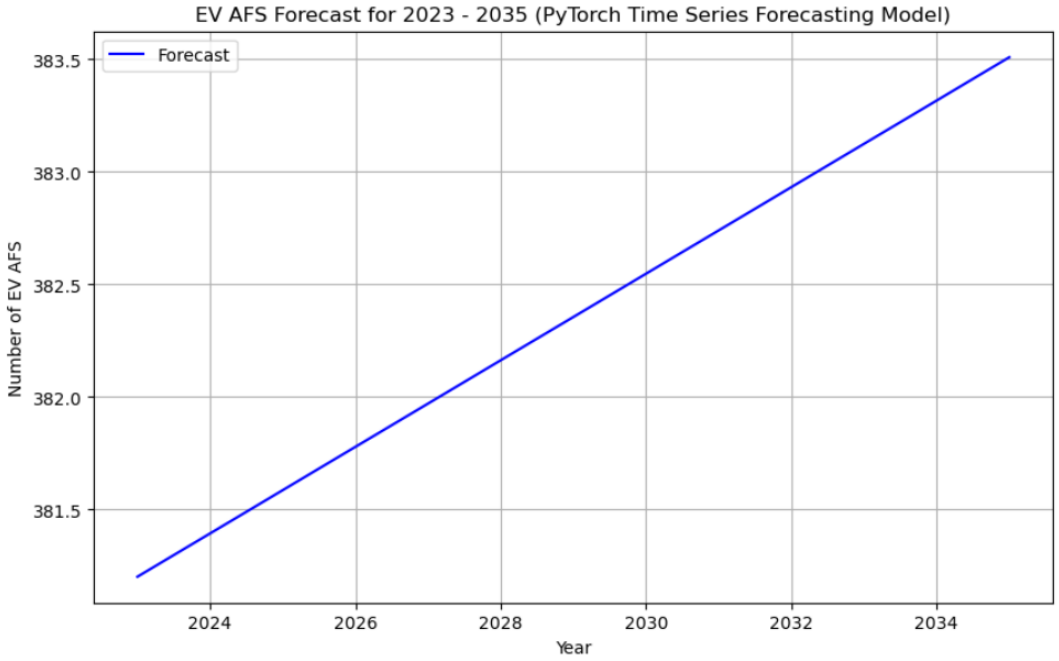
Modeling

Linear Regression Model



- R^2 = 7.8%
  - Correlation between Sum States by Date Variability and Time Index is low.
- From this chart we can visualize the future trend, 2023 through 2035, is a positive trend, with a ***(m = 25).***

PyTorch Time Series Forecasting



- The Mean Squared Error (MSE) on the testing data was approximately 213125136, significant discrepancy.
- From this chart we can visualize the trend of the number of predicted AFS over the years 2023 through 2035. It is a positive with a ***(m = 0.1).***

Additional Findings

	Vehicles by 2022	Vehicles by 2035	% Change	Number of Stations	Vehicles per Station (2022)	Fill-up/Charge Up Time
Gas Powered Vehicles	270 million (approximately)	250 million (rough estimate)	-11.11%	150,000	1,800 vehicles per 1 gas station	5 min (6 gas powered vehicles for every 1 EV)
Electric Vehicles	2.5 million (approximately)	40 million (rough estimate)	+1,500%	57,200	43 vehicles per 1 EV station	30 min (1 EV for every 6 gas powered vehicle)

- Consider:
  - For each EV charged, there are 6 gas powered vehicles fueled
  - EV market in the US expected to grow 1,500% by the year 2035
  - Although the current ratio of EV per EV Station is better than the gas powered vehicle infrastructure (even with the turnaround factored in), to maintain a healthy ratio, the growth of EV stations would have to grow by at least 130% to keep a 300 EV per 1 EV station ratio.

Conclusion

Findings	• Charging stations infrastructure must have a yearly rate of change of ~6.5% to keep a healthy vehicles to charging stations infrastructure ratio.
Model	• Linear regression slope = 25 • Pytorch Time Series Forecast slope = 0.1
Conclusion	• EV Consumers would face charging stations infrastructure challenges.
Considerations	• Keep in mind my dataset has reliability opportunities. • low R^2, high p-value, not a proper MSE.