

A close-up, low-angle shot of the front sections of several bicycles. The frames are silver, and the front wheels have black tires with prominent white lettering and orange reflectors. Each bicycle has a simple wire basket attached to the handlebars. The background is blurred, showing more of the same bicycles extending into the distance.

# Urban Bike-Sharing Forecasting and Optimization Worldwide

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22 Jul 2024

# Outline

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- Executive Summary
- Introduction
- Methodology
- Results
- Conclusion
- Appendix

# Executive Summary

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## Introduction

- This project aims to predict the hourly rented bike count using weather and date information for Seoul, South Korea, and to build an interactive dashboard for visualizing weather forecast data and predicted hourly bike-sharing demand across five cities: Seoul, South Korea; New York, USA; Paris, France; Suzhou, China; and London, UK.

## Objectives

- Predict hourly bike rental demand based on weather conditions and date information for Seoul.
- Develop an interactive dashboard to visualize forecasted weather data and bike-sharing demand in multiple cities.

# Executive Summary

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## Methodology

- The methodology of this project encompasses a comprehensive approach, combining data collection, data wrangling, exploratory data analysis (EDA), the development of predictive models, and the creation of an interactive dashboard.

## Recommendations/Implications

- City planners and bike-sharing companies can use the model from this project to optimize bike distribution and improve service availability in Seoul.
- The interactive dashboard can be used for real-time decision-making and strategic planning for renting bikes for the five cities: Seoul, South Korea; New York, USA; Paris, France; Suzhou, China; and London, UK.

# Introduction

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As a Data Scientist at an AI-powered weather data analytics company, I have undertaken a project to analyze the impact of weather on bike-sharing demand in urban areas. This project is divided into two main parts:

## Part – 1 (Weather Impact Analysis on Bike-Sharing Demand in Seoul)

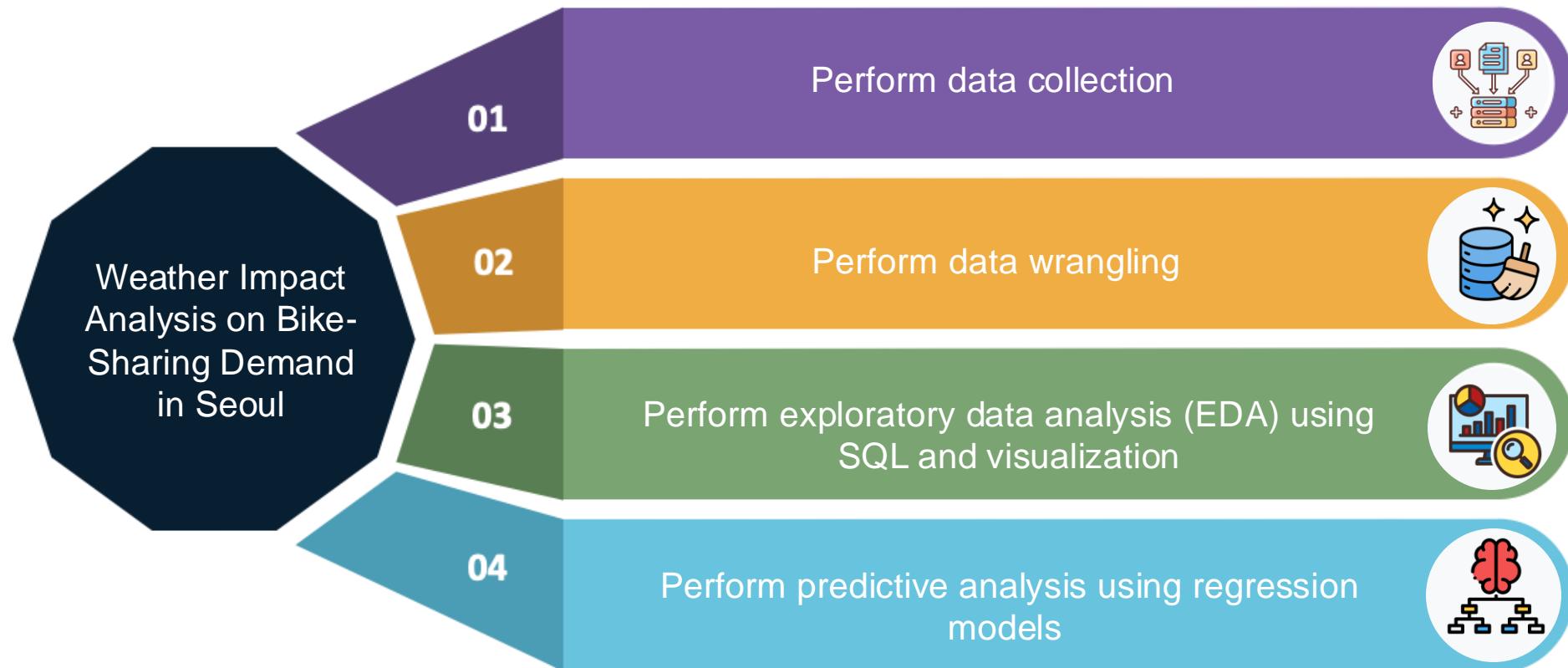
- Data Collection and Processing: Gathered and processed weather and bike-sharing demand data from various sources.
- Exploratory Data Analysis (EDA): Conducted EDA to uncover patterns and relationships in the data.
- Predictive Modeling: Developed predictive models to forecast bike-sharing demand in Seoul based on weather conditions.

## Part – 2 (Interactive Dashboard for Global Cities:)

- Utilization of Pre-Trained Model: Employed a pre-trained model to predict rental bike counts for five cities: Seoul, South Korea; New York, USA; Paris, France; Suzhou, China; and London, UK.
- Data Extraction: Extracted weather data from the Open Weather API.
- Integration of Results: Combined the predictive results with existing weather data.
- Dashboard Development: Created a live dashboard displaying:
  - Temperature trends for the next five days at 3-hour intervals.
  - Predicted bike counts for the next five days.
  - Predicted bike counts versus humidity for the next five days.

# Methodology

# Content of Part-1 Methodology



# Data Collection

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In the part-1 of this project, data are collected from three sources:

1. Global bike sharing systems data on public web pages
2. Cities Weather forecast data via OpenWeather APIs
3. Aggregated tabular data from cloud storage

# Collecting Global bike sharing systems data

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- Global bike sharing data contains a list of bicycle-sharing systems, both docked and dockless, around the world.
- It is collected from a Wikipedia page by extracting a required table and save it as data frame.



# Collecting Global Weather Forecast Data

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- Global Weather Forecast data contains predicted weather condition of specified cities for coming 5 days.
- It is collected from Open Weather API Map website by using an API key.



# Collecting Seoul bike sharing and world cities data

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- World cities data contains information such as name, latitude, and longitude, about major cities around the world.
- Seoul bike sharing data contains how many bicycles were rented at when.
- Both of them are collected by downloading directly from IBM Cloud Storage.



# GitHub URL for Data Collection

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- GitHub URL for Data Collection with OpenWeatherMap and IBM Cloud Storage:

<https://github.com/thetkhanlin25/Data-Science-R-Capstone-Project/tree/1655a305c9e3d5a312578a1915062f60bfdccb7c/Data%20Collection/From%20OpenWeather%20API%20and%20IBM%20Cloud%20Storage>

- GitHub URL for Data Collection with Web Scraping:

<https://github.com/thetkhanlin25/Data-Science-R-Capstone-Project/tree/1655a305c9e3d5a312578a1915062f60bfdccb7c/Data%20Collection/Web%20Scraping>

# Data wrangling

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- The data wrangling process includes handling missing data, normalizing categorical variables using the One-Hot-Encoding method, standardizing continuous values, and formatting data types and column names.
- These steps were performed using the "dplyr" package from the "tidyverse" and regular expressions in R.



# GitHub URL for Data Wrangling

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- GitHub URL for Data Wrangling with dplyr:

<https://github.com/thetkhinelin25/Data-Science-R-Capstone-Project/tree/1655a305c9e3d5a312578a1915062f60bfdccb7c/Data%20Wrangling/With%20dplyr>

- GitHub URL for Data Wrangling with Regular Expression:

<https://github.com/thetkhinelin25/Data-Science-R-Capstone-Project/tree/1655a305c9e3d5a312578a1915062f60bfdccb7c/Data%20Wrangling/With%20Regular%20Expressions>

# EDA with SQL

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Task	Performed Query
1.	Display number of records in Seoul Bike Sharing Dataset
2.	Display number of total hours, which has non-zero rented bike count
3.	Display forecasted weather condition for Seoul over next 3 hours
4.	List the seasons, which are included in Seoul Bike Sharing Dataset
5.	Display the first and last dates in Seoul Bike Sharing Dataset
6.	Display the date and hour, which had the most bike rentals
7.	Display the average hourly temperature and the average number of bike rentals per hour over each season

# EDA with SQL

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8.	Display average hourly bike count during each season by including minimum, maximum, and standard deviation of the hourly bike count for each season
9.	Display the average of TEMPERATURE, HUMIDITY, WIND_SPEED, VISIBILITY, DEW_POINT_TEMPERATURE, SOLAR_RADIATION, RAINFALL, and SNOWFALL per season
10.	Display total number of bikes available in Seoul by including CITY, COUNTRY, LAT, LNG, POPULATION
11.	List all cities with total bike counts between 15000 and 20000 by including city, country names, coordinates (LAT, LNG), population, and number of bicycles for each city

# EDA with data visualization

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No	Chart Type	Applied Columns	Purpose
1.	Scatter plot	X = DATE Y = RENTED_BIKE_COUNT	To explore how many bikes are rented on which date
2.	Scatter plot	X = DATE Y = RENTED_BIKE_COUNT COLOR = HOUR	To explore how many bikes are rented on each date, with the points colored based on their starting rental hour.
3.	Histogram	X = RENTED_BIKE_COUNT	To explore the distribution of Rented_Bike_COUNT column
4.	Scatter plot	X = TEMPERATURE Y = RENTED_BIKE_COUNT	To explore the correlation between temperature and the number of rented bikes in each season

# EDA with data visualization

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5.	Box plot	X = HOUR Y = RENTED_BIKE_COUNT	To explore the distribution of the number of rented bikes by hour in each season
6.	Box plot	X = DAILY_TOTAL_RAINFALL, DAILY_TOTAL_SNOWFALL Y = Total Values	To explore the distribution of daily total rainfall and snowfall

# GitHub URL for EDA

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- GitHub URL for EDA with SQL:

<https://github.com/thetkhinelin25/Data-Science-R-Capstone-Project/tree/1655a305c9e3d5a312578a1915062f60bfdccb7c/Exploratory%20Data%20Analysis/With%20SQL>

- GitHub URL for EDA with Data Visualization:

<https://github.com/thetkhinelin25/Data-Science-R-Capstone-Project/tree/1655a305c9e3d5a312578a1915062f60bfdccb7c/Exploratory%20Data%20Analysis/With%20Data%20Visualization>

# Predictive analysis (Regression)

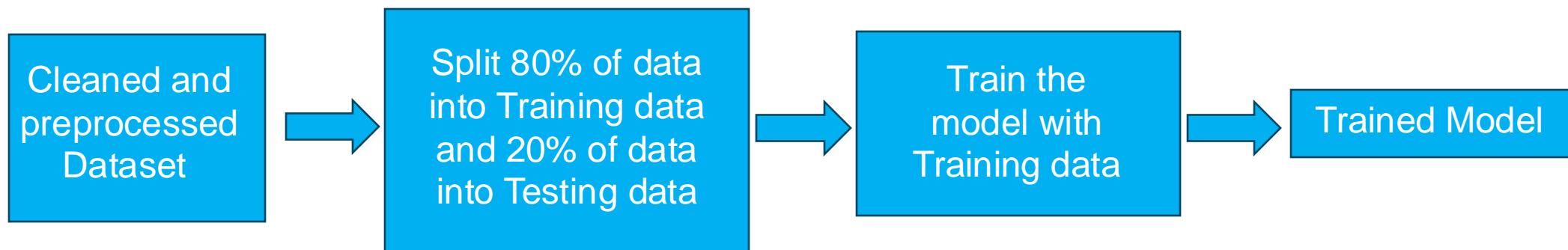
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- Before selecting the model for predicting rented bike count in Seoul, five different model with different algorithm were developed and evaluated by using the data that had been collected.
- Those algorithm are Polynomial Linear Regression, Polynomial Linear Regression with interaction terms, Ridge Regularization with grid search, Lasso Regularization with grid search, and Elastic Net Regularization with grid search.
- Once all the above models were trained with trained data, they were tested with test data and evaluate them by using Root Mean Square Error (RMSE), and R-Squared methods.
- Then the model, which gave the lowest Root Mean Square Error (RMSE) and highest R-Squared value, was selected as the best model. (In this project, Polynomial Linear Regression with interaction is the best model)
- The following slide will show how each model was developed with a flow chart.

# Predictive analysis (Regression)

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Flow Chart of Developing a Regression model



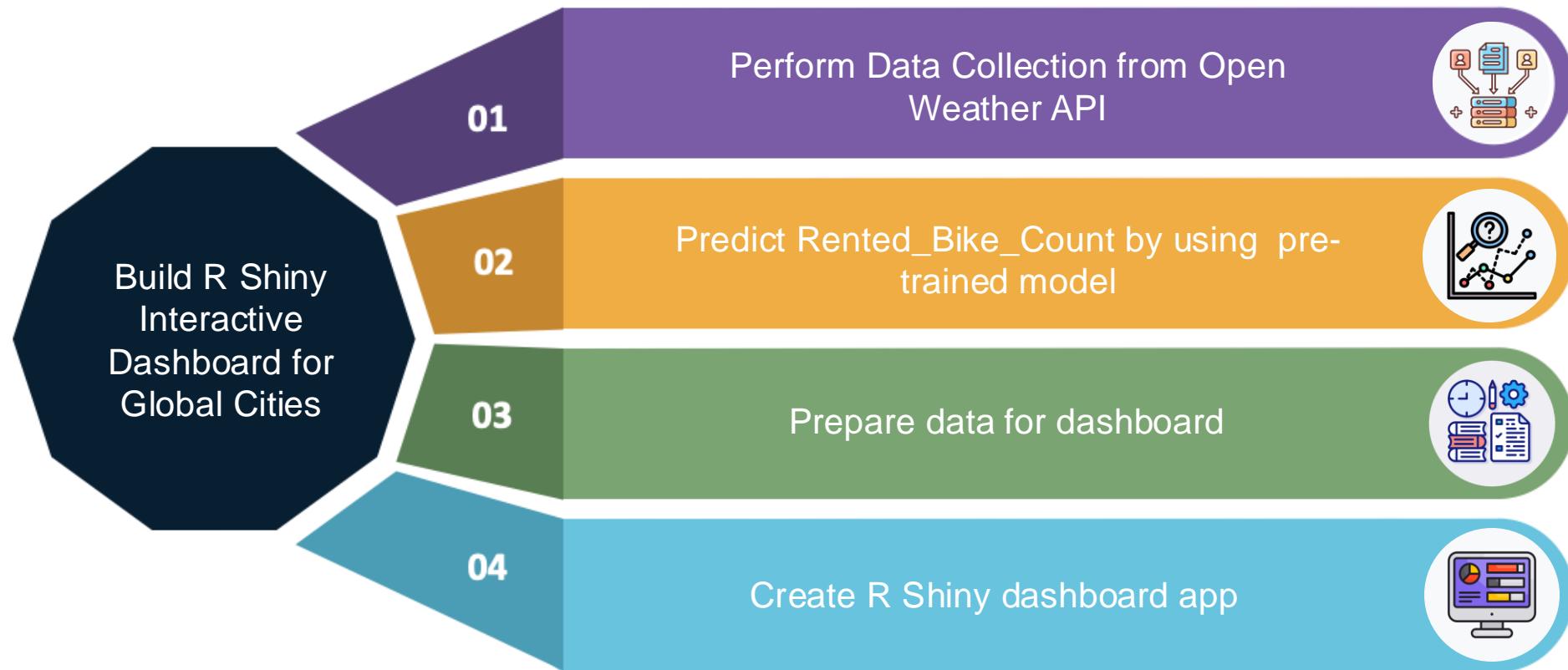
# GitHub URL for Predictive analysis

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- GitHub URL for predictive analysis:

<https://github.com/thetkhanlin25/Data-Science-R-Capstone-Project/tree/1655a305c9e3d5a312578a1915062f60bfdccb7c/Predictive%20Analysis>

# Content of Part-2 Methodology



# Data Collection

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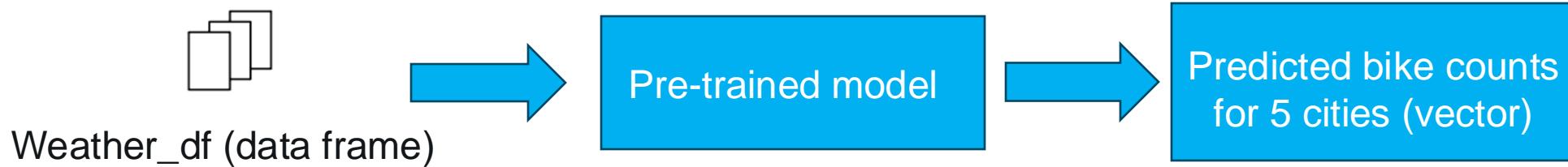
- In the part-2 of this project, data are collected from Open Weather Map website by using API key.
- The data contains the weather condition of 5 different cities: Seoul, South Korea; New York, USA; Paris, France; Suzhou, China; and London, UK.
- The collected data were saved in data frame to use as an input data of pre-trained model.



# Predict Rented\_Bike\_Count

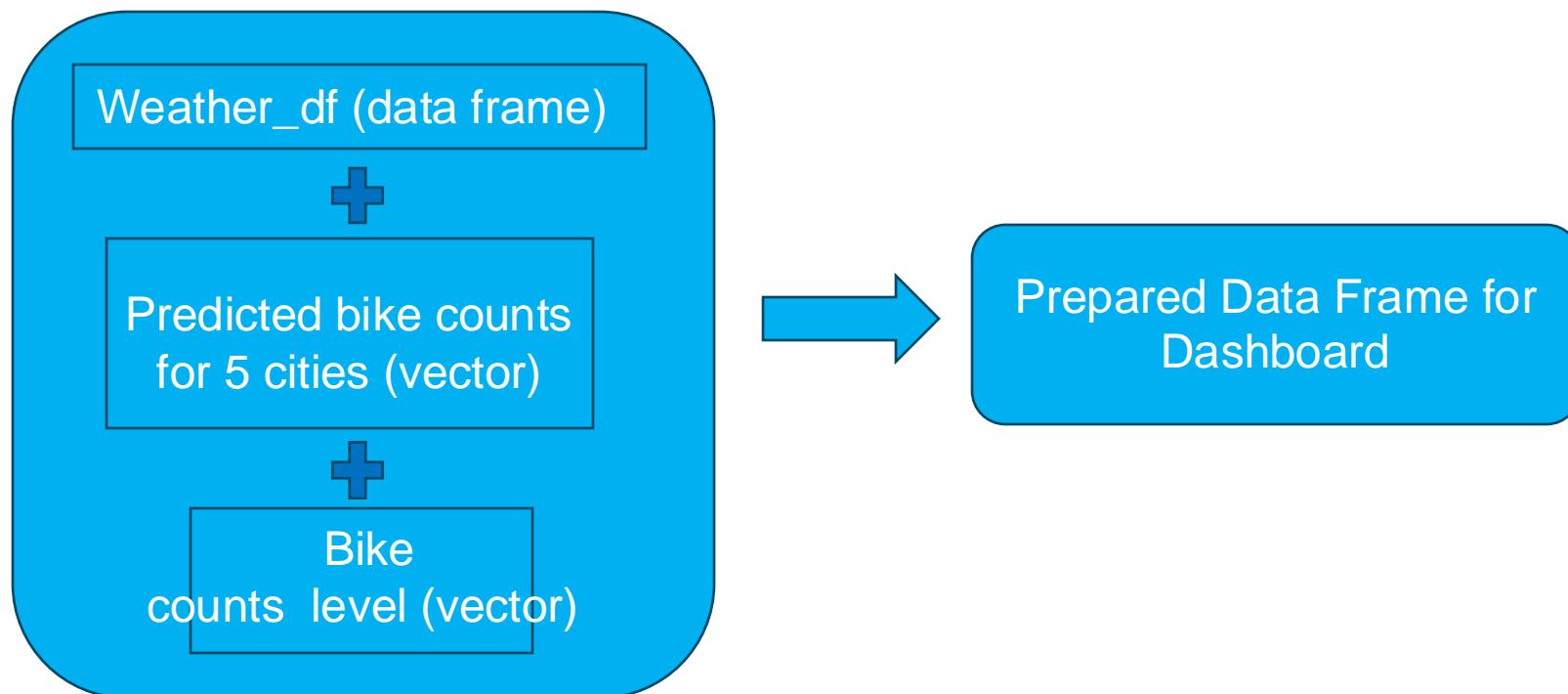
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- To predict the number of rented bikes for the five cities, Seoul, South Korea; New York, USA; Paris, France; Suzhou, China; and London, UK, the pre-trained model's coefficients were used.
- The numbers were predicted by giving the weather\_df data frame as an input to the pre-trained model.



# Prepare Data For Dashboard

- In the data preparation for creating dashboard, the required features' columns from the weather data collected from Open Weather Map, the predicted bike count, and the level of predicted bike count, which was created based on the number of predicted bikes, were merged together into a single data frame.



# Build a R Shiny dashboard

## Plots used in dashboard

No.	Plot name	Plot type	Purpose
1.	City_bike_map	Map	To observe maximum bike prediction for next 5 days across five different cities
2.	Temp_line	Line graph	To observe temperature trend in next 5 days of each city
3.	Bike_line	Line graph with interaction	To observe the trend of predicted number of bike for coming 5 days.
4.	Humidity_pred_chart	Scatter plot	To observe how humidity effect on predicted bike count in coming 5 days.

## Interaction used in dashboard

No.	Interaction name	Interaction type	Purpose
1.	City_dropdown	Dropdown menu	To select specific city for drilling down about that city

# GitHub URL for Dashboarding

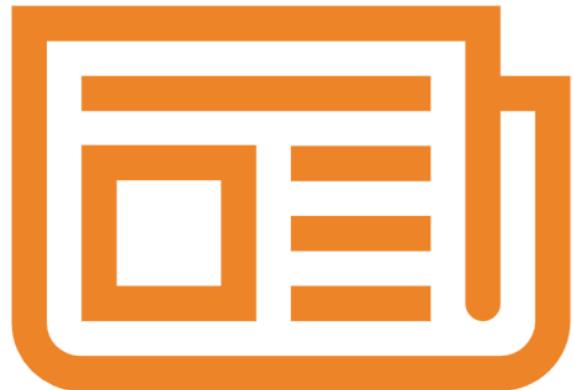
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- GitHub URL for dashboarding:

<https://github.com/thetkhinelin25/Data-Science-R-Capstone-Project/tree/1655a305c9e3d5a312578a1915062f60bfdccb7c/Building%20a%20R%20Shiny%20Dashboard%20App>

# Results

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- Exploratory data analysis results
- Predictive analysis results
- A dashboard demo in screenshots

# EDA with SQL

# Busiest bike rental times

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SQL Query and Result:

```
> dbGetQuery(con,
+             "SELECT DATE, HOUR, RENTEDBIKECOUNT
+              FROM SEOULBIKE_SHARING
+             WHERE RENTEDBIKECOUNT = (SELECT MAX(RENTEDBIKECOUNT) FROM SEOULBIKE_SHARING)")
DATE HOUR RENTEDBIKECOUNT
1 19/06/2018    18          3556
```

Explanation:

The data analysis reveals that the highest number of bike rentals in Seoul occurred on the 19th of June, 2018, at 18:00 (6 PM). This indicates a peak in bike-sharing activity during the early evening, which is typically a busy time as people commute home from work.

# Hourly popularity and temperature by seasons

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SQL Query and Result:

```
> dbGetQuery(con,
+             "SELECT SEASONS, HOUR, AVG(TEMPERATURE) AS AVG_TEMP, AVG(RENTED_BIKE_COUNT) AS AVG BIKE COUNT
+              FROM SEOULBIKE_SHARING
+             GROUP BY SEASONS, HOUR
+            ORDER BY AVG BIKE COUNT DESC
+           LIMIT(3)")
SEASONS HOUR AVG TEMP AVG BIKE COUNT
1 Summer 18 29.38791 2135.141
2 Autumn 18 16.03185 1983.333
3 Summer 19 28.27378 1889.250
```

Explanation:

The table shows the average number of bike rentals and average temperature for each hour across different seasons. The data is sorted by the average bike count in descending order. The query result shows that the highest average bike count is observed during the summer season at 18:00 (6 PM), with an average bike count of 2135.141 and an average temperature of 29.39°C. This indicates peak bike rental activity in the early evening during summer.

# Rental Seasonality

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SQL Query and Result:

```
> dbGetQuery(con,
+             "SELECT SEASONS, HOUR, MIN(RENTED_BIKE_COUNT) AS MIN_BIKE_RENT,
+             MAX(RENTED_BIKE_COUNT) AS MAX_BIKE_RENT, AVG(RENTED_BIKE_COUNT) AS AVG_BIKE_COUNT,
+             SQRT(AVG(RENTED_BIKE_COUNT)*RENTED_BIKE_COUNT) - AVG(RENTED_BIKE_COUNT)*AVG(RENTED_BIKE_COUNT) ) AS STDDEV_BIKE_COUNT
+             FROM SEOUL_BIKE_SHARING
+             GROUP BY SEASONS, HOUR
+             ORDER BY AVG_BIKE_COUNT
+             LIMIT(3)")
```

	SEASONS	HOUR	MIN_BIKE_RENT	MAX_BIKE_RENT	AVG_BIKE_COUNT	STDDEV_BIKE_COUNT
1	Winter	4	20	120	50.47778	19.05561
2	Winter	5	13	100	51.22222	18.98759
3	Winter	3	21	230	77.81111	37.68256

Explanation:

The table shows the minimum, maximum, and average number of bike rentals, as well as the standard deviation of bike rentals, for each hour across different seasons. The data is sorted by the average bike count in descending order. The highest average bike count is observed during the summer season at 18:00 (6 PM), with an average bike count of 2135.141, a minimum rental count of 17, and a maximum rental count of 3556. The standard deviation of bike rentals at this time is 884.0829.

# Weather Seasonality

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SQL Query and Result:

```
> dbGetQuery(con,
+             "SELECT SEASONS, AVG(TEMPERATURE), AVG(HUMIDITY), AVG(WIND_SPEED),
+             AVG(VISIBILITY), AVG(DEW_POINT_TEMPERATURE), AVG(SOLAR_RADIATION),
+             AVG(RAINFALL), AVG(SNOWFALL)
+             FROM SEOUL_BIKE_SHARING
+             GROUP BY SEASONS")
```

	SEASONS	AVG(TEMPERATURE)	AVG(HUMIDITY)	AVG(WIND_SPEED)	AVG(VISIBILITY)	AVG(DEW_POINT_TEMPERATURE)	AVG(SOLAR_RADIATION)	AVG(RAINFALL)	AVG(SNOWFALL)
1	Autumn	13.821580	59.04491	1.492101	1558.174	5.150594	0.5227827	0.11765617	0.06350026
2	Spring	13.021685	58.75833	1.857778	1240.912	4.091389	0.6803009	0.18694444	0.00000000
3	Summer	26.587711	64.98143	1.609420	1501.745	18.750136	0.7612545	0.25348732	0.00000000
4	Winter	-2.540463	49.74491	1.922685	1445.987	-12.416667	0.2981806	0.03282407	0.24750000

Explanation:

The table provides the average values of various weather parameters for each season. Overall, the summer season experiences the highest temperatures, humidity, dew point temperature, solar radiation, and rainfall, whereas the winter season sees the lowest temperatures, highest snowfall, and notable wind speeds. Autumn has the highest visibility among all seasons.

# Bike-sharing info in Seoul

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SQL Query and Result:

```
> dbGetQuery(con,
+             "SELECT SUM(BSS.BICYCLES) AS TOTAL_NUM_BICYCLES_SEOUL, WC.CITY, WC.COUNTRY, WC.LAT, WC.LNG, WC.POPULATION
+              FROM WORLD_CITIES WC, BIKE_SHARING_SYSTEMS BSS
+             WHERE WC.CITY = BSS.CITY AND UPPER(BSS.CITY) = 'SEOUL'")
TOTAL_NUM_BICYCLES_SEOUL CITY      COUNTRY      LAT LNG POPULATION
1                      20000 Seoul Korea, South 37.5833 127    21794000
```

Explanation:

The table provides information about the total number of bicycles in Seoul's bike-sharing system, along with some geographical and demographic details of the city.

# Cities similar to Seoul

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SQL Query and Result:

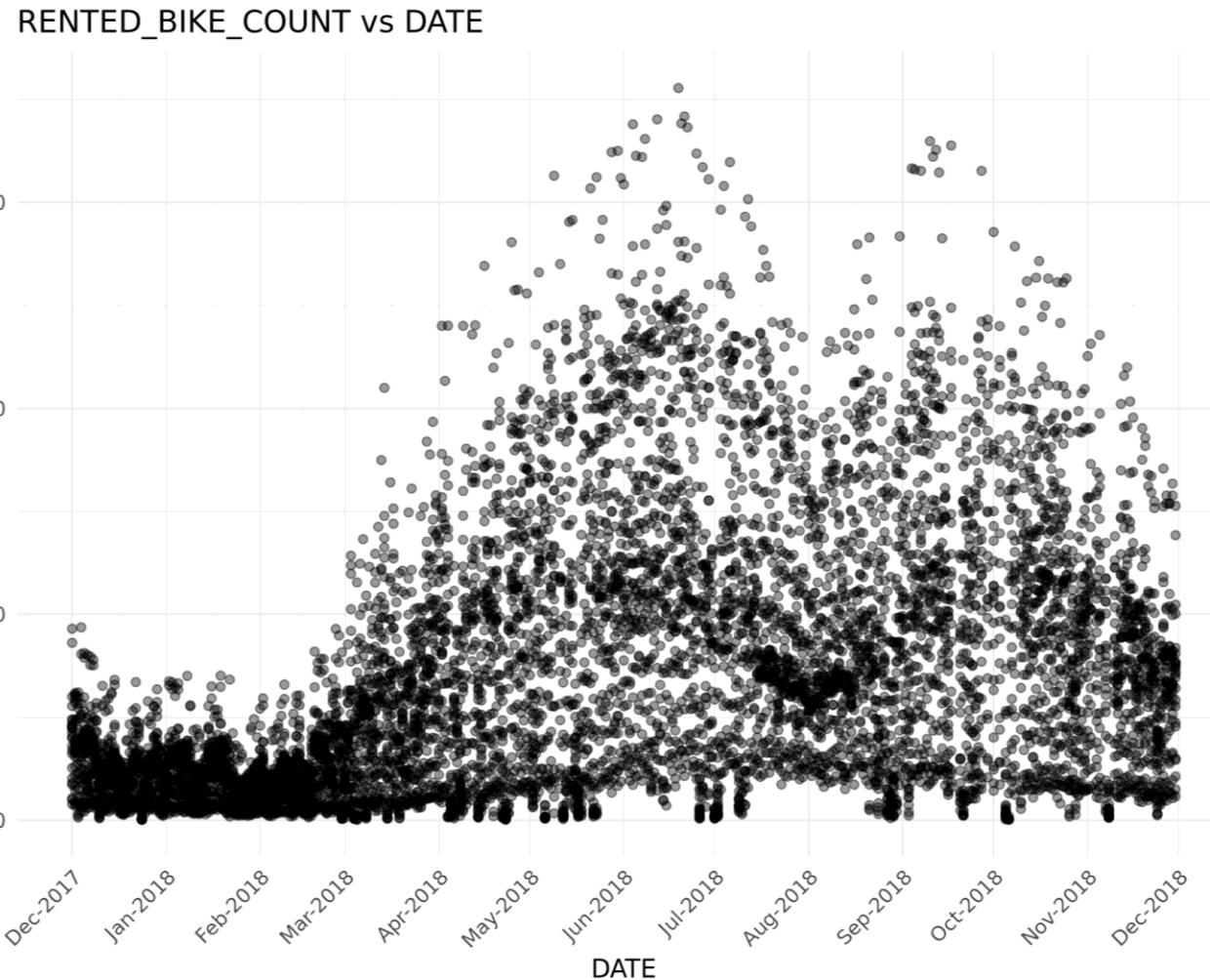
```
> dbGetQuery(con,
+             "SELECT WC.CITY, WC.COUNTRY, WC.LAT, WC.LNG, WC.POPULATION, SUM(BSS.BICYCLES) AS TOTAL_BICYCLES
+              FROM WORLD_CITIES WC, BIKE_SHARING_SYSTEMS BSS
+             WHERE WC.CITY = BSS.CITY
+           GROUP BY WC.CITY
+          HAVING TOTAL_BICYCLES BETWEEN 15000 AND 20000")
      CITY      COUNTRY     LAT      LNG POPULATION TOTAL_BICYCLES
1  Beijing        China 39.9050 116.3914   19433000       16000
2  Ningbo        China 29.8750 121.5492   7639000       15000
3  Seoul  Korea, South 37.5833 127.0000   21794000       20000
4  Shanghai       China 31.1667 121.4667   22120000       19165
5  Weifang        China 36.7167 119.1000   9373000       20000
6  Zhuzhou       China 27.8407 113.1469   3855609       20000
```

The query lists cities that have a total number of bicycles in their bike-sharing systems between 15,000 and 20,000. The above query result reflect the scale and distribution of bike-sharing systems in major East Asian cities, highlighting the prevalence and importance of such systems in urban transportation planning.

# EDA with Visualization

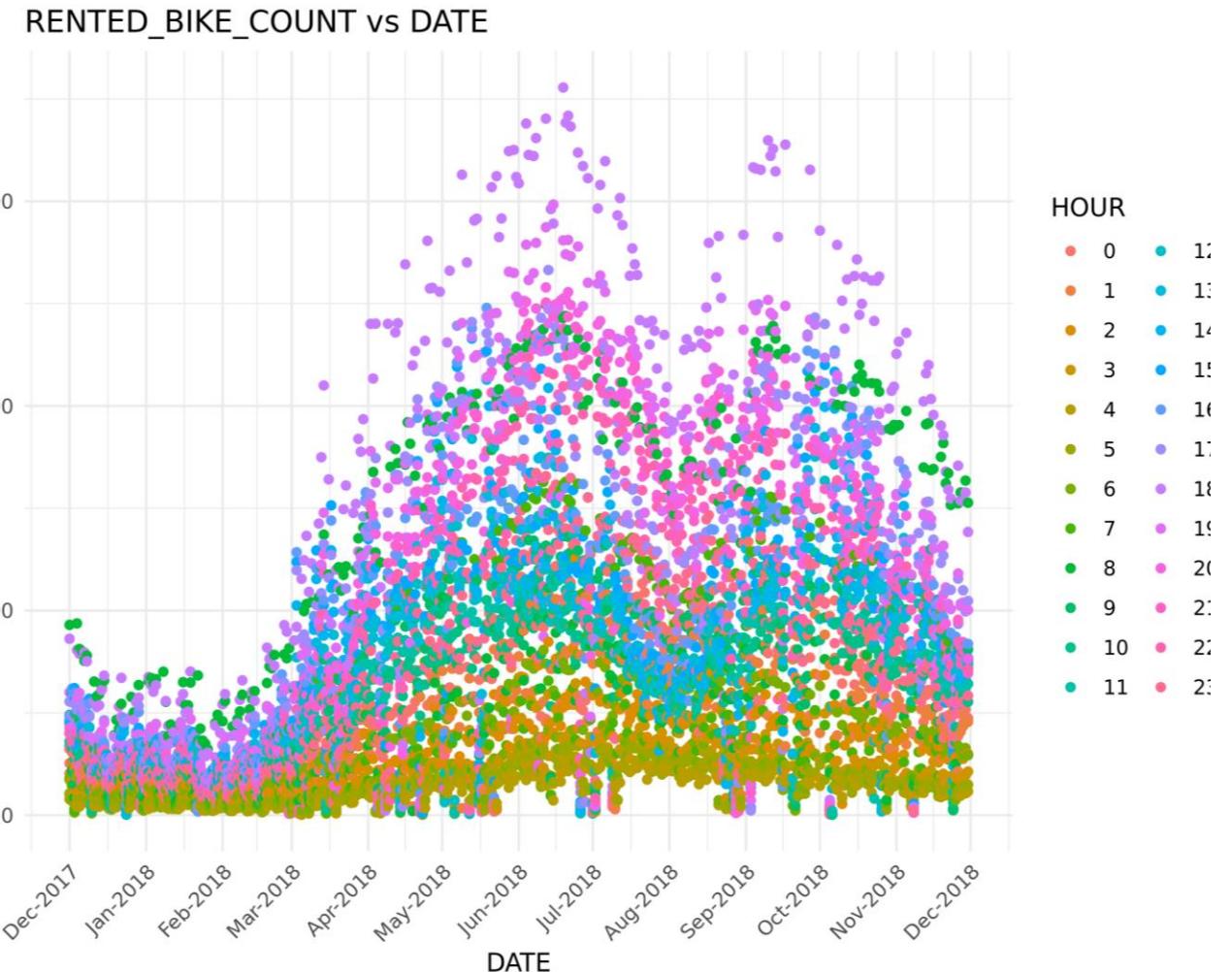
# Bike rental vs. Date

- Upon examining the scatter plot of rented bike counts, it is evident that the majority of observations cluster densely below 500 bikes on the RENTED BIKE COUNT axis. This suggests that most days experience a rental demand of fewer than 500 bikes
- Besides, it also shows that the number of rented bike went up to over 3000 in the months between May and August, and September and October.



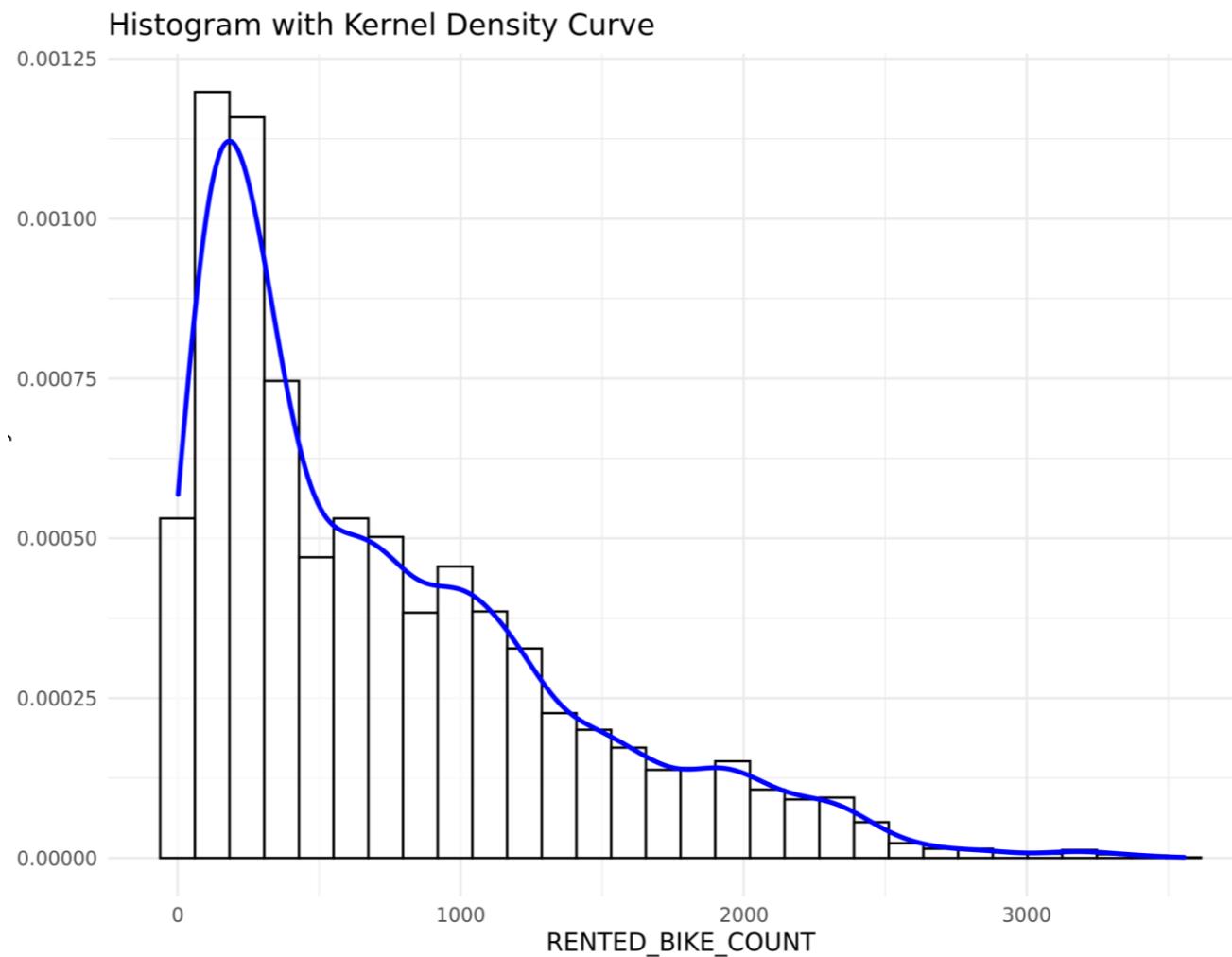
# Bike rental vs. Datetime

- Once the HOUR is used as a color, it is clear that the highest bike counts, exceeding 3000, occurred at 18:00 (6 PM).
- The lowest rented bike counts were observed during the hours between 3:00 and 5:00. However, the rented bike count between that times are below 500.



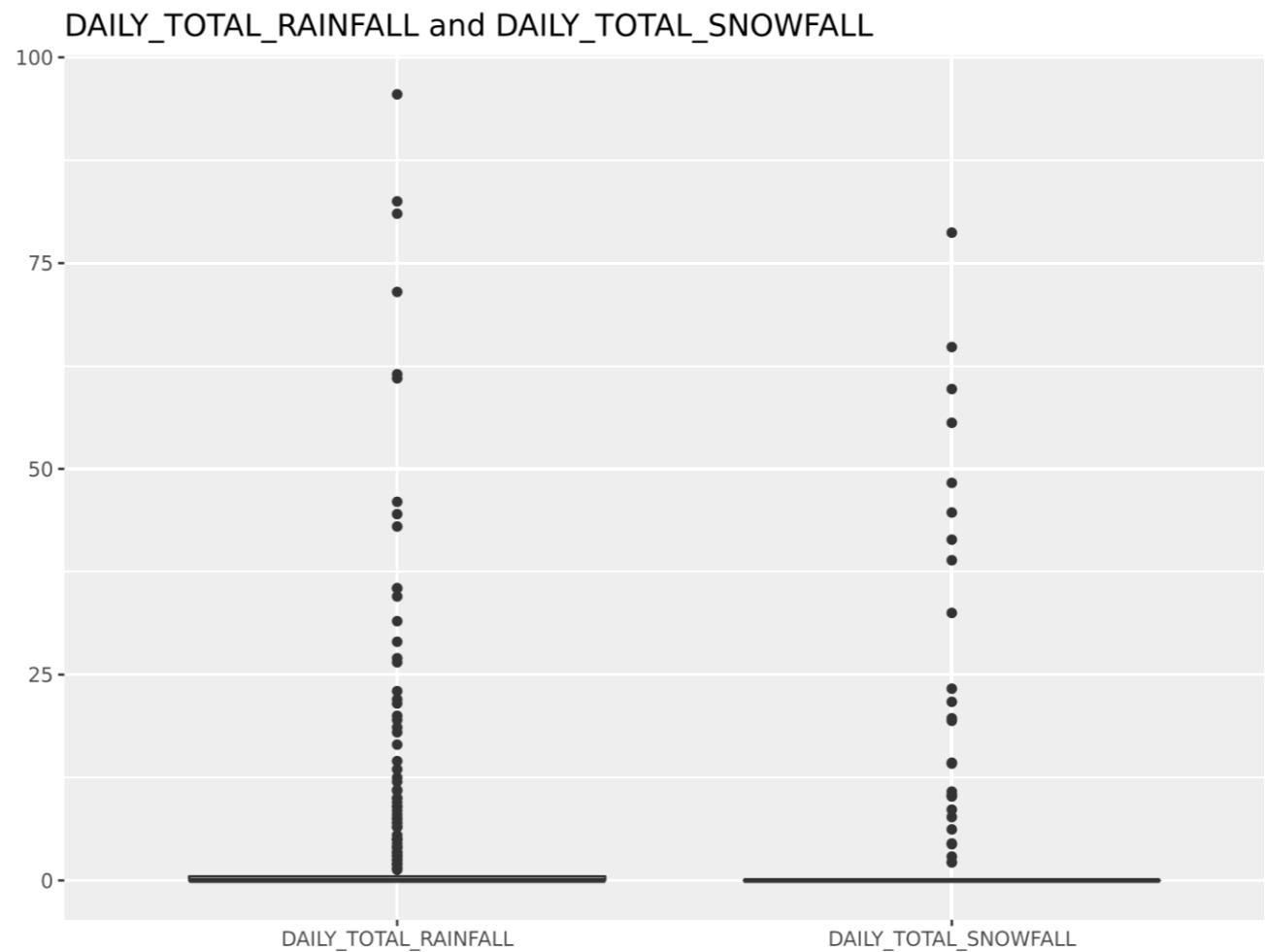
# Bike rental histogram

- Based on the histogram, we observe that bike rentals typically involve relatively low numbers most of the time. The 'mode', which represents the most frequent number of bikes rented, appears to be around 250.
- Additionally, there are noticeable peaks ('bumps') in the histogram around 700, 900, 1900, and 3200 bikes rented. These peaks suggest that there may be distinct subgroups within the data where other modes or frequent rental amounts occur.
- Besides, judging from the tail of the distribution, there are occasional instances where significantly more bikes are rented out than what is typically observed



# Daily total rainfall and snowfall

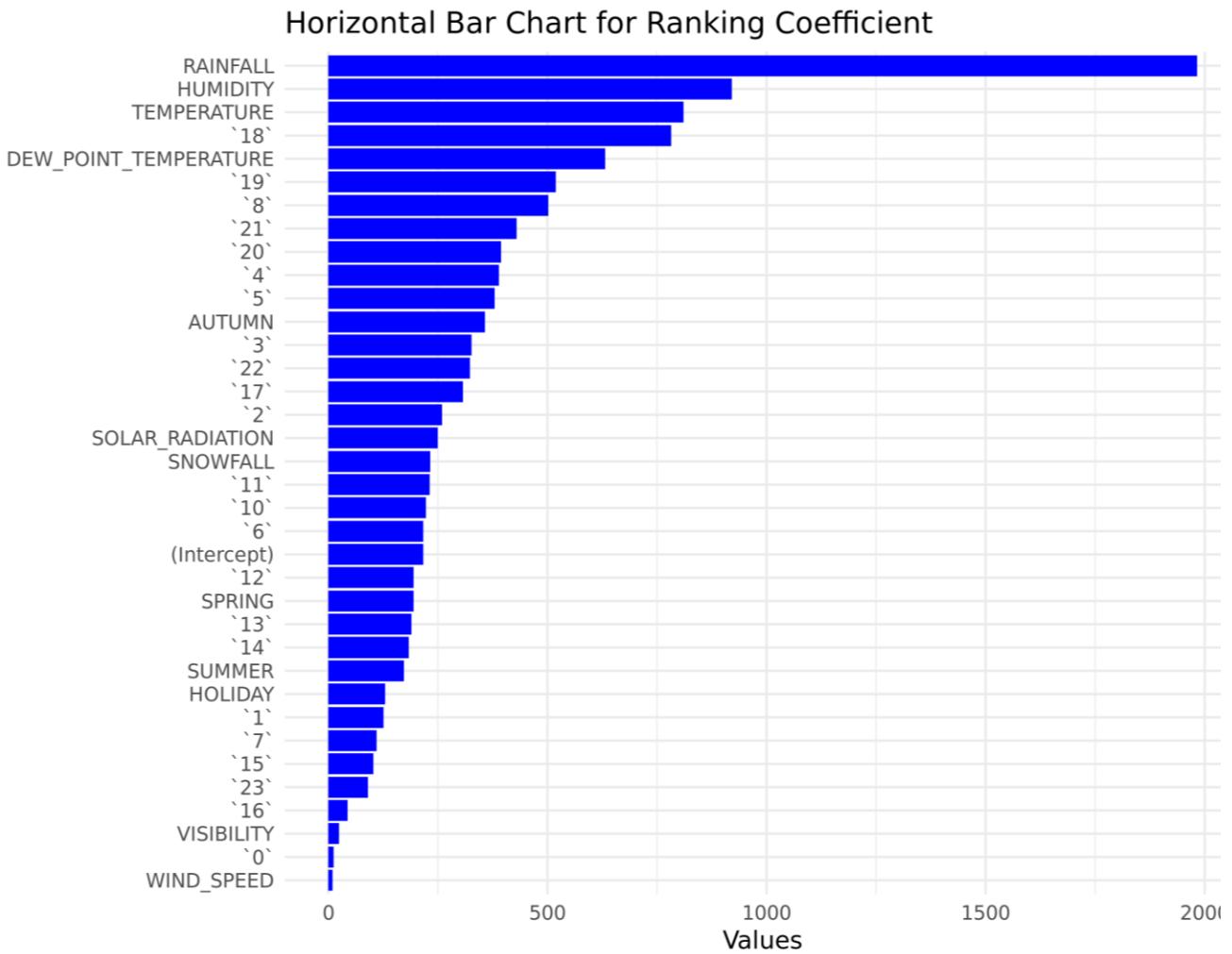
- Based on the box plots, we can clearly see that the interquartile range (IQR) for daily total rainfall is between 0 and 1, while the IQR for daily total snowfall is exactly at 0. This observation is derived from the total data points for both metrics, which amount to 353.
- For daily total rainfall, 100 data points are greater than 0, representing approximately 28% of the total. When ordered in ascending order, only about 3% of these points fall within the IQR of the box plot. In contrast, for daily total snowfall, only 27 data points are greater than 0, representing just 7% of the total. Consequently, the IQR of the box plot for daily total snowfall remains at 0.



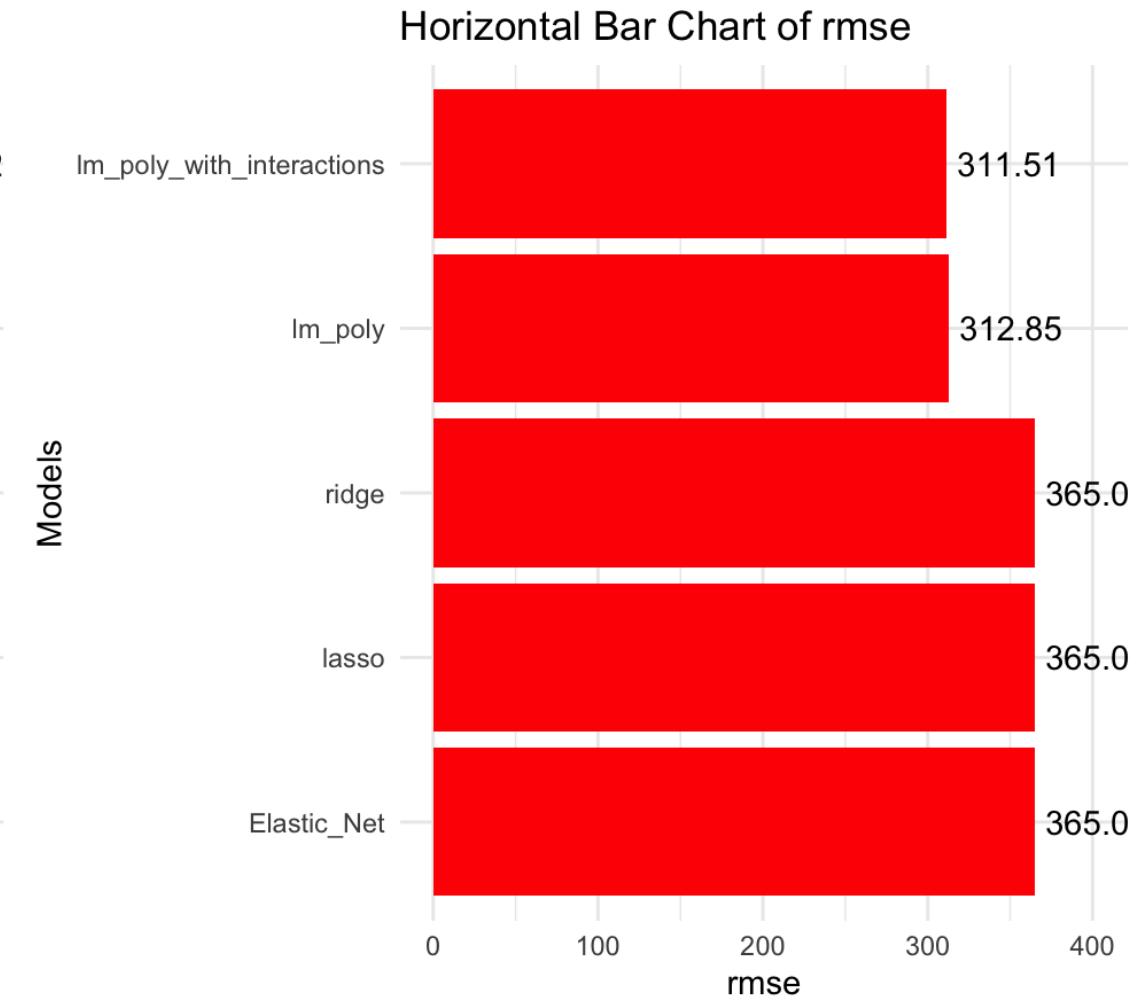
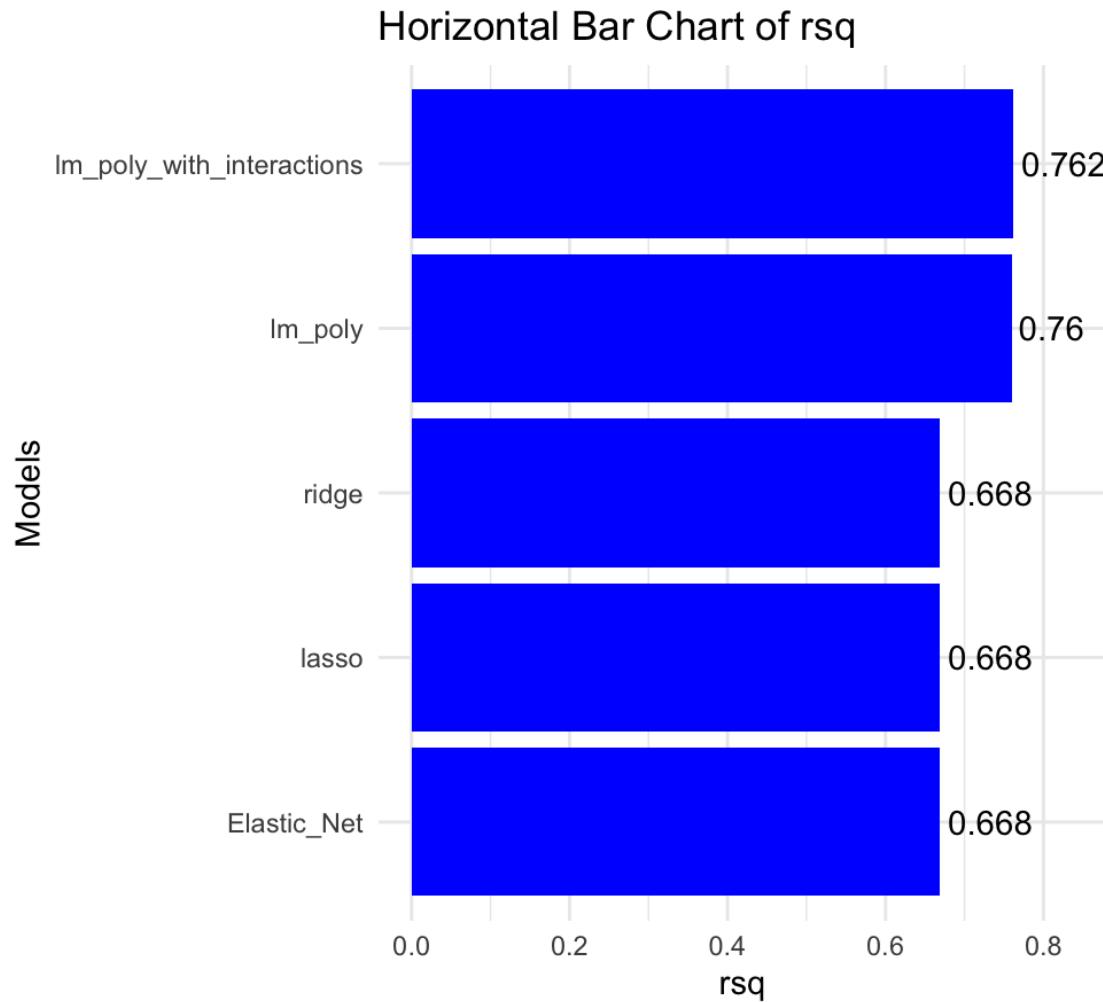
# Predictive analysis

# Ranked coefficients

- In our exploration of the factors influencing bike-sharing demand, we discovered that some features have a strong relationship with the number of bikes rented, while others have little to no impact.
- For example, **rainfall**, which has the highest coefficient, indicates that even a slight increase in rainfall leads to a noticeable drop in bike rentals. This makes sense, as people are generally less inclined to use bikes in wet weather, preferring more comfortable and dry modes of transportation. On the other hand, **wind speed**, which has the lowest coefficient, does not have a significant effect on bike-sharing demand. This suggests that moderate changes in wind speed do not deter people from renting bikes as much as other factors like rainfall do.



# Model evaluation



# Find the best performing model

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- For part 1 of this project, the selected model is a Polynomial Linear Regression with interaction terms of degree 6. This model was chosen as the best performing model because it produced the lowest RMSE value and the highest R-squared value among the five models tested.

The model formula

```
RENTED_BIKE_COUNT ~ poly(RAINFALL, 6)*poly(HUMIDITY, 6) + WIND_SPEED +
  VISIBILITY + DEW_POINT_TEMPERATURE + SOLAR_RADIATION + SNOWFALL +
  `0` + `1` + `10` + `11` + `12` + `13` + `14` + `15` + `16` + `17` + `18` + `19` + `2` +
  `20` + `21` + `22` + `23` + `3` + `4` + `5` + `6` + `7` + `8` + `9` +
  AUTUMN*poly(TEMPERATURE, 6) + SPRING*poly(TEMPERATURE, 6) + SUMMER*poly(TEMPERATURE, 6) +
  WINTER*poly(TEMPERATURE, 6) + HOLIDAY + NO_HOLIDAY
```

# Find the best performing model

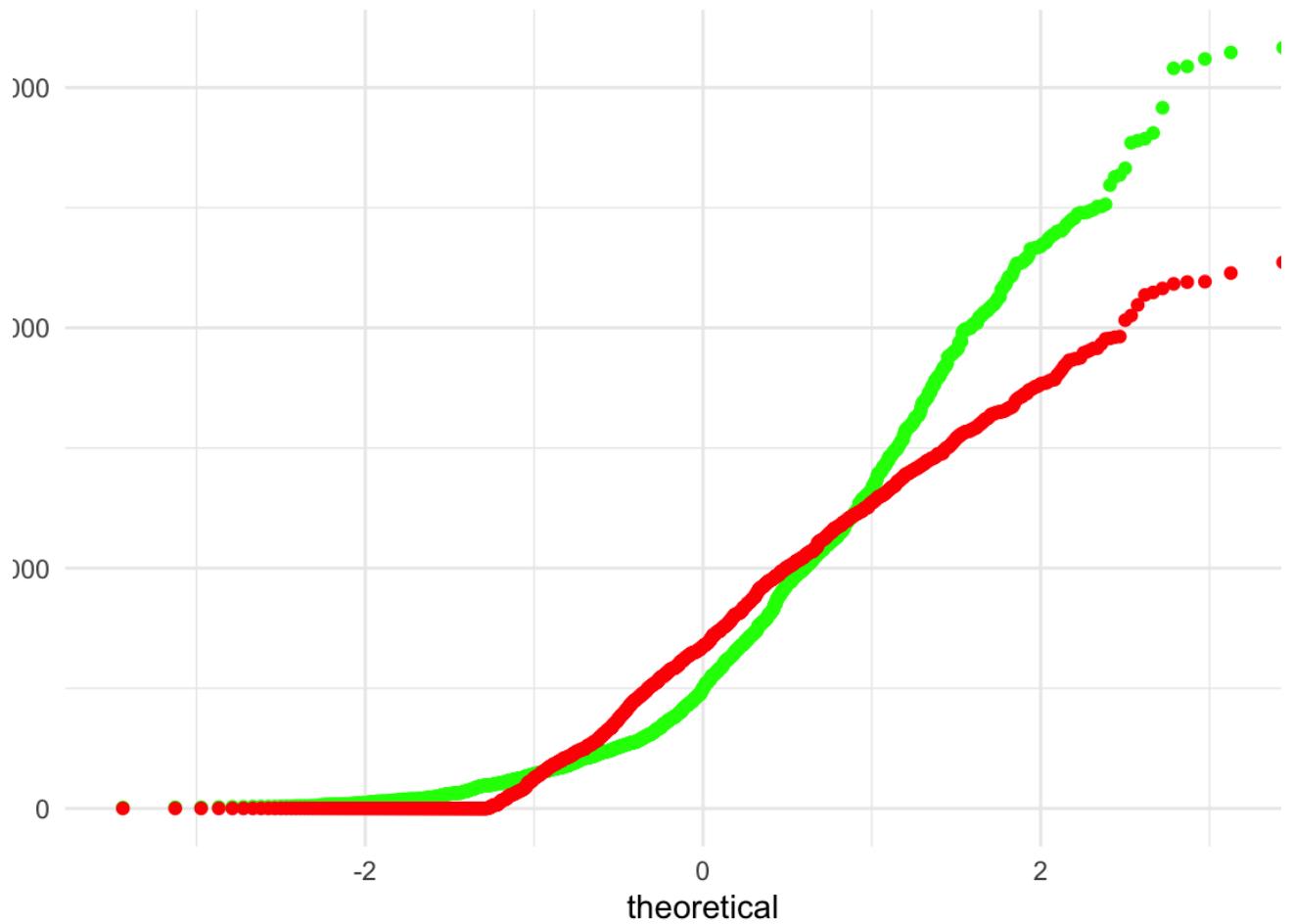
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The model's coefficients

1	(Intercept)	1.66e11	7.23e10	2.30	2.14e- 2	42	'9`	NA	NA	NA	NA	83	poly(RAINFALL, 6)5:poly(HUMIDITY, 6)5	-2.17e14	9.13e13	-2.38	1.75e- 2
2	poly(RAINFALL, 6)1	3.60e14	1.56e14	2.31	2.12e- 2	43	AUTUMN	1.11e 4	2.45e 4	0.454	6.50e- 1	84	poly(RAINFALL, 6)6:poly(HUMIDITY, 6)5	-2.02e13	8.43e12	-2.39	1.67e- 2
3	poly(RAINFALL, 6)2	5.27e14	2.28e14	2.31	2.08e- 2	44	poly(TEMPERATURE, 6)1	-1.16e 6	2.80e 6	-0.414	6.79e- 1	85	poly(RAINFALL, 6)1:poly(HUMIDITY, 6)6	2.55e14	1.09e14	2.35	1.90e- 2
4	poly(RAINFALL, 6)3	3.43e14	1.48e14	2.32	2.04e- 2	45	poly(TEMPERATURE, 6)2	-1.24e 6	2.64e 6	-0.471	6.38e- 1	86	poly(RAINFALL, 6)2:poly(HUMIDITY, 6)6	3.72e14	1.58e14	2.35	1.87e- 2
5	poly(RAINFALL, 6)4	1.16e14	4.98e13	2.33	1.97e- 2	46	poly(TEMPERATURE, 6)3	-9.38e 5	1.87e 6	-0.502	6.15e- 1	87	poly(RAINFALL, 6)3:poly(HUMIDITY, 6)6	2.41e14	1.02e14	2.36	1.83e- 2
6	poly(RAINFALL, 6)5	2.70e13	1.15e13	2.35	1.90e- 2	47	poly(TEMPERATURE, 6)4	-4.80e 5	8.90e 5	-0.539	5.90e- 1	88	poly(RAINFALL, 6)4:poly(HUMIDITY, 6)6	8.13e13	3.43e13	2.37	1.76e- 2
7	poly(RAINFALL, 6)6	2.52e12	1.07e12	2.36	1.83e- 2	48	poly(TEMPERATURE, 6)5	-1.66e 5	2.84e 5	-0.583	5.60e- 1	89	poly(RAINFALL, 6)5:poly(HUMIDITY, 6)6	1.88e13	7.86e12	2.39	1.69e- 2
8	poly(HUMIDITY, 6)1	-1.99e13	8.65e12	-2.30	2.12e- 2	49	poly(TEMPERATURE, 6)6	-2.82e 4	4.54e 4	-0.620	5.35e- 1	90	poly(RAINFALL, 6)6:poly(HUMIDITY, 6)6	1.75e12	7.25e11	2.41	1.61e- 2
9	poly(HUMIDITY, 6)2	2.03e13	8.79e12	2.31	2.10e- 2	50	SPRING	1.09e 4	2.45e 4	0.447	6.55e- 1	91	AUTUMN:poly(TEMPERATURE, 6)1	1.23e 6	2.80e 6	0.439	6.61e- 1
10	poly(HUMIDITY, 6)3	-1.48e13	6.41e12	-2.32	2.06e- 2	51	SUMMER	7.55e 4	8.70e 4	0.867	3.86e- 1	92	AUTUMN:poly(TEMPERATURE, 6)2	1.25e 6	2.64e 6	0.476	6.34e- 1
11	poly(HUMIDITY, 6)4	6.42e12	2.77e12	2.32	2.03e- 2	52	WINTER	NA	NA	NA	NA	93	AUTUMN:poly(TEMPERATURE, 6)3	8.99e 5	1.87e 6	0.481	6.30e- 1
12	poly(HUMIDITY, 6)5	-1.36e12	5.82e11	-2.33	1.98e- 2	53	HOLIDAY	-9.34e 1	1.99e 1	-4.69	2.74e- 6	94	AUTUMN:poly(TEMPERATURE, 6)4	4.74e 5	8.91e 5	0.532	5.95e- 1
13	poly(HUMIDITY, 6)6	1.18e11	5.03e10	2.34	1.93e- 2	54	NO_HOLIDAY	NA	NA	NA	NA	95	AUTUMN:poly(TEMPERATURE, 6)5	1.55e 5	2.85e 5	0.543	5.87e- 1
14	WIND_SPEED	1.02e 1	3.48e 1	0.293	7.69e- 1	55	poly(RAINFALL, 6)1:poly(HUMIDITY, 6)1	-4.31e16	1.87e16	-2.31	2.10e- 2	96	AUTUMN:poly(TEMPERATURE, 6)6	2.08e 4	4.78e 4	0.436	6.63e- 1
15	VISIBILITY	-4.83e 1	1.85e 1	-2.61	9.09e- 3	56	poly(RAINFALL, 6)2:poly(HUMIDITY, 6)1	-6.32e16	2.73e16	-2.31	2.07e- 2	97	poly(TEMPERATURE, 6)1:SPRING	1.26e 6	2.80e 6	0.449	6.53e- 1
16	DEW_POINT_TEMPERATURE	-4.87e 3	4.08e 2	-11.9	1.76e- 32	57	poly(RAINFALL, 6)3:poly(HUMIDITY, 6)1	-4.10e16	1.77e16	-2.32	2.02e- 2	98	poly(TEMPERATURE, 6)2:SPRING	1.25e 6	2.64e 6	0.474	6.35e- 1
17	SOLAR_RADIATION	1.32e 2	3.70e 1	3.58	3.52e- 4	58	poly(RAINFALL, 6)4:poly(HUMIDITY, 6)1	-1.39e16	5.95e15	-2.34	1.96e- 2	99	poly(TEMPERATURE, 6)3:SPRING	9.18e 5	1.87e 6	0.492	6.23e- 1
18	SNOWFALL	1.67e 2	9.19e 1	1.82	6.88e- 2	59	poly(RAINFALL, 6)5:poly(HUMIDITY, 6)1	-3.22e15	1.37e15	-2.35	1.88e- 2	100	poly(TEMPERATURE, 6)4:SPRING	4.88e 5	8.90e 5	0.548	5.84e- 1
19	'0`	-5.60e 1	2.92e 1	-1.92	5.50e- 2	60	poly(RAINFALL, 6)6:poly(HUMIDITY, 6)1	-3.02e14	1.28e14	-2.36	1.82e- 2	101	poly(TEMPERATURE, 6)5:SPRING	1.59e 5	2.85e 5	0.559	5.76e- 1
20	'1`	-1.71e 2	2.89e 1	-5.93	3.21e- 9	61	poly(RAINFALL, 6)1:poly(HUMIDITY, 6)2	4.39e16	1.90e16	2.31	2.07e- 2	102	poly(TEMPERATURE, 6)6:SPRING	3.51e 4	4.68e 4	0.750	4.53e- 1
21	'10`	-2.07e 2	2.79e 2	-7.41	1.43e- 13	62	poly(RAINFALL, 6)2:poly(HUMIDITY, 6)2	6.43e16	2.77e16	2.32	2.04e- 2	103	poly(TEMPERATURE, 6)1:SUMMER	-7.86e 6	1.20e 7	-0.657	5.11e- 1
22	'11`	-1.84e 2	2.90e 1	-6.34	2.51e- 10	63	poly(RAINFALL, 6)3:poly(HUMIDITY, 6)2	4.17e16	1.79e16	2.33	2.00e- 2	104	poly(TEMPERATURE, 6)2:SUMMER	1.06e 7	1.19e 7	0.888	3.75e- 1
23	'12`	-1.01e 2	2.95e 1	-3.43	6.01e- 4	64	poly(RAINFALL, 6)4:poly(HUMIDITY, 6)2	1.41e16	6.03e15	2.34	1.93e- 2	105	poly(TEMPERATURE, 6)3:SUMMER	-5.66e 6	8.23e 6	-0.688	4.92e- 1
24	'13`	-8.56e 1	3.02e 1	-2.83	4.66e- 3	65	poly(RAINFALL, 6)5:poly(HUMIDITY, 6)2	3.27e15	1.39e15	2.35	1.86e- 2	106	poly(TEMPERATURE, 6)4:SUMMER	3.56e 6	3.77e 6	0.945	3.45e- 1
25	'14`	-6.37e 1	2.96e 1	-2.15	3.14e- 2	66	poly(RAINFALL, 6)6:poly(HUMIDITY, 6)2	3.06e14	1.29e14	2.37	1.79e- 2	107	poly(TEMPERATURE, 6)5:SUMMER	-7.25e 5	1.08e 6	-0.672	5.02e- 1
26	'15`	6.35e 0	2.97e 0	0.214	8.31e- 1	67	poly(RAINFALL, 6)1:poly(HUMIDITY, 6)3	-3.21e16	1.38e16	-2.32	2.04e- 2	108	poly(TEMPERATURE, 6)6:SUMMER	1.54e 5	1.51e 5	1.02	3.09e- 1
27	'16`	1.25e 2	2.92e 1	4.28	1.86e- 5	68	poly(RAINFALL, 6)2:poly(HUMIDITY, 6)3	-4.70e16	2.02e16	-2.33	2.01e- 2	109	poly(TEMPERATURE, 6)1:WINTER	NA	NA	NA	NA
28	'17`	3.91e 2	2.92e 1	13.4	2.50e- 40	69	poly(RAINFALL, 6)3:poly(HUMIDITY, 6)3	-3.05e16	1.31e16	-2.33	1.96e- 2	110	poly(TEMPERATURE, 6)2:WINTER	NA	NA	NA	NA
29	'18`	8.28e 2	2.93e 1	28.3	1.80e- 166	70	poly(RAINFALL, 6)4:poly(HUMIDITY, 6)3	-1.03e16	4.39e15	-2.35	1.90e- 2	111	poly(TEMPERATURE, 6)3:WINTER	NA	NA	NA	NA
30	'19`	5.37e 2	2.92e 1	18.4	6.92e- 74	71	poly(RAINFALL, 6)5:poly(HUMIDITY, 6)3	-2.39e15	1.01e15	-2.36	1.83e- 2	112	poly(TEMPERATURE, 6)4:WINTER	NA	NA	NA	NA
31	'2`	-2.79e 2	2.89e 1	-9.66	6.08e- 22	72	poly(RAINFALL, 6)6:poly(HUMIDITY, 6)3	-2.23e14	9.38e13	-2.37	1.76e- 2	113	poly(TEMPERATURE, 6)5:WINTER	NA	NA	NA	NA
32	'20`	4.26e 2	2.92e 1	14.6	2.15e- 47	73	poly(RAINFALL, 6)1:poly(HUMIDITY, 6)4	1.39e16	5.97e15	2.33	2.00e- 2	114	poly(TEMPERATURE, 6)6:WINTER	NA	NA	NA	NA
33	'21`	4.19e 2	2.92e 1	14.3	5.63e- 46	74	poly(RAINFALL, 6)2:poly(HUMIDITY, 6)4	2.03e16	8.72e15	2.33	1.97e- 2	115	poly(TEMPERATURE, 6)7:WINTER	NA	NA	NA	NA
34	'22`	3.05e 2	2.91e 1	10.5	1.74e- 25	75	poly(RAINFALL, 6)3:poly(HUMIDITY, 6)4	1.32e16	5.63e15	2.34	1.93e- 2	116	poly(TEMPERATURE, 6)8:WINTER	NA	NA	NA	NA
35	'23`	5.69e 1	2.90e 1	1.97	4.93e- 2	76	poly(RAINFALL, 6)4:poly(HUMIDITY, 6)4	4.45e15	1.89e15	2.35	1.86e- 2	117	poly(TEMPERATURE, 6)9:WINTER	NA	NA	NA	NA
36	'3`	-3.32e 2	2.92e 1	-11.4	1.30e- 29	77	poly(RAINFALL, 6)5:poly(HUMIDITY, 6)4	1.03e15	4.35e14	2.37	1.79e- 2	118	poly(TEMPERATURE, 6)10:WINTER	NA	NA	NA	NA
37	'4`	-4.17e 2	2.91e 1	-14.3	6.05e- 46	78	poly(RAINFALL, 6)6:poly(HUMIDITY, 6)4	9.59e13	4.03e13	2.38	1.72e- 2	119	poly(TEMPERATURE, 6)11:WINTER	NA	NA	NA	NA
38	'5`	-3.84e 2	2.87e 1	-13.4	2.59e- 40	79	poly(RAINFALL, 6)1:poly(HUMIDITY, 6)5	-2.93e15	1.26e15	-2.33	1.96e- 2	120	poly(TEMPERATURE, 6)12:WINTER	NA	NA	NA	NA
39	'6`	-2.22e 2	2.88e 1	-7.71	1.39e- 14	80	poly(RAINFALL, 6)2:poly(HUMIDITY, 6)5	-4.29e15	1.83e15	-2.34	1.93e- 2	121	poly(TEMPERATURE, 6)13:WINTER	NA	NA	NA	NA
40	'7`	8.19e 1	2.87e 1	2.86	4.28e- 3	81	poly(RAINFALL, 6)3:poly(HUMIDITY, 6)5	-2.78e15	1.18e15	-2.35	1.88e- 2	122	poly(TEMPERATURE, 6)14:WINTER	NA	NA	NA	NA
41	'8`	4.25e 2	2.80e 1	15.2	3.86e- 51	82	poly(RAINFALL, 6)4:poly(HUMIDITY, 6)5	-9.38e14	3.97e14	-2.36	1.82e- 2	123	poly(TEMPERATURE, 6)15:WINTER	NA	NA	NA	NA

# Q-Q plot of the best model

QQ Plot of the best model

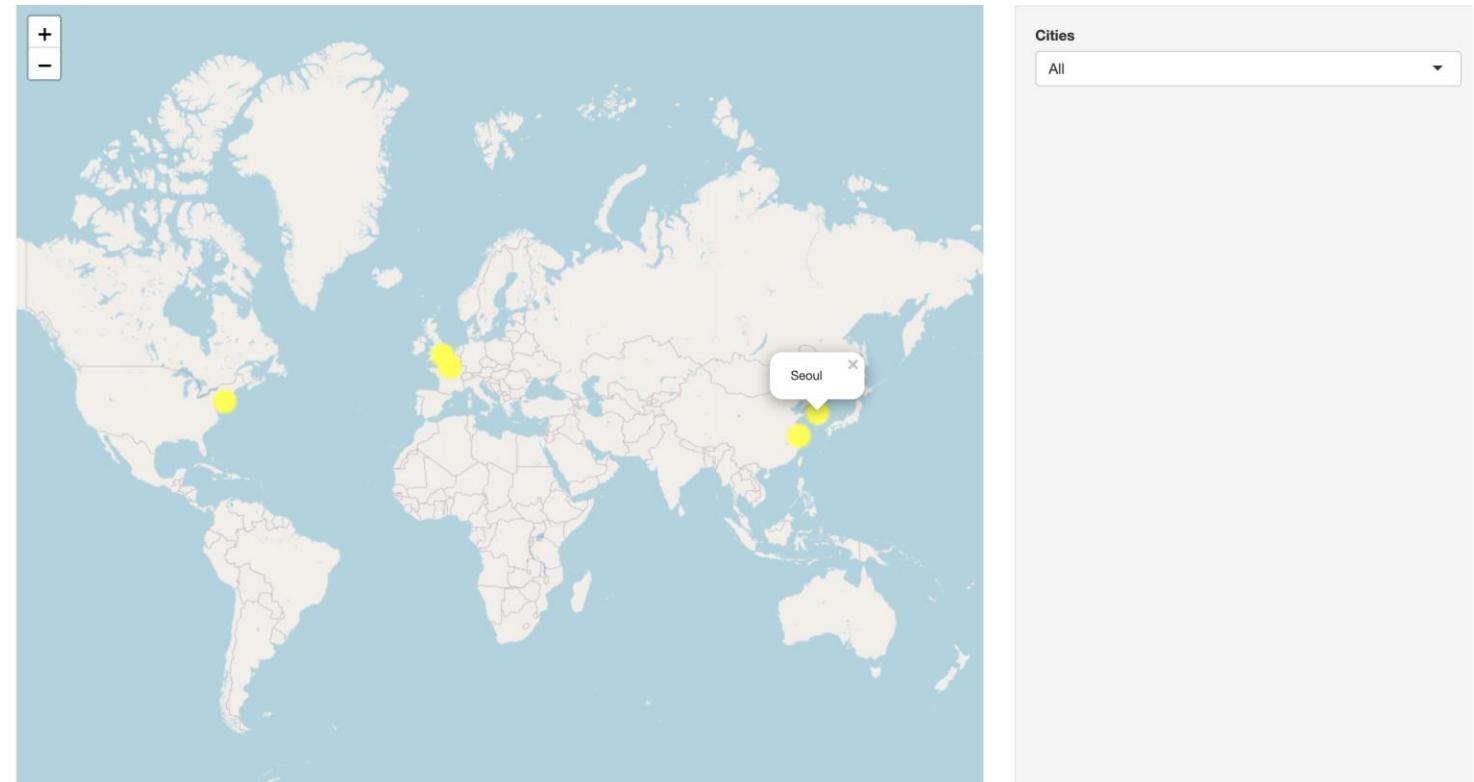


# Dashboarding

# Max Bike Rental Distribution Across Five Cities

The map highlights five cities using circles, with each circle's size and color representing the number of max rented bikes. Larger circles indicate higher rental counts. The color scheme is as follows:

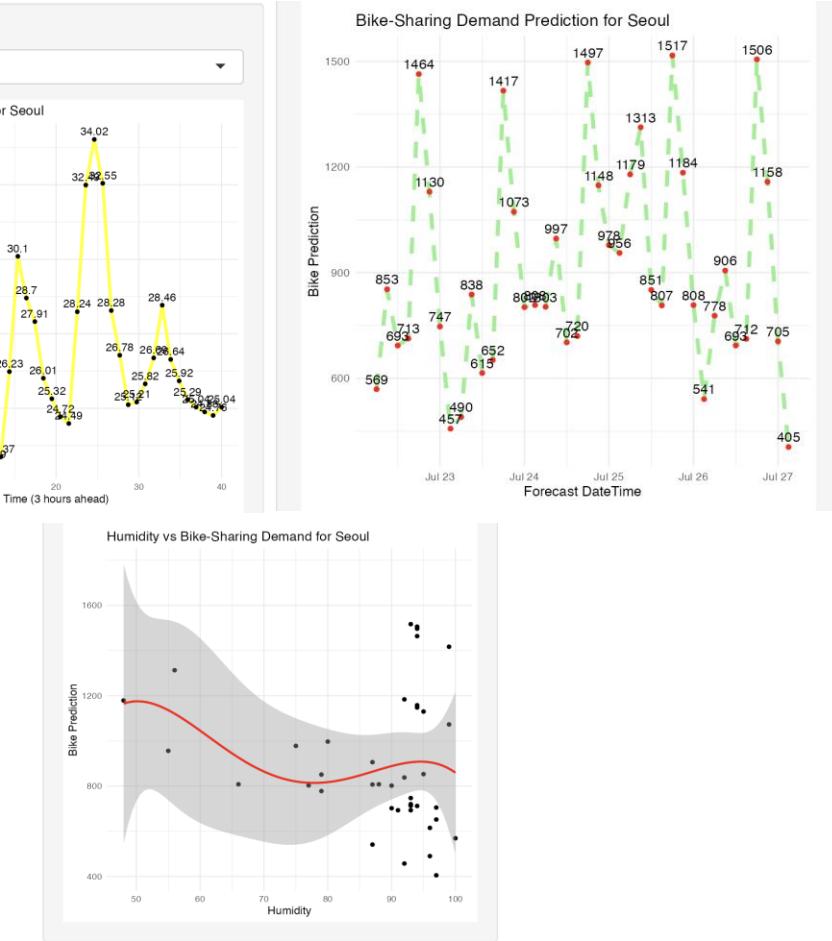
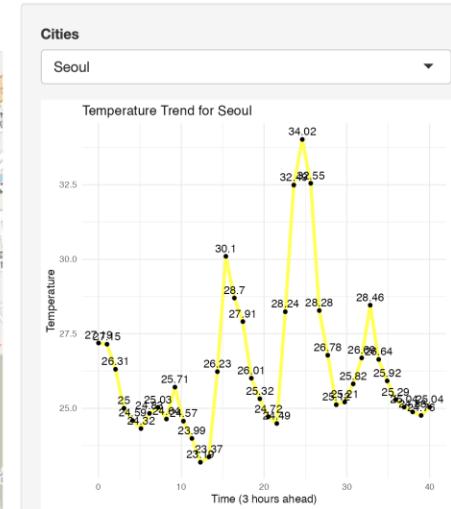
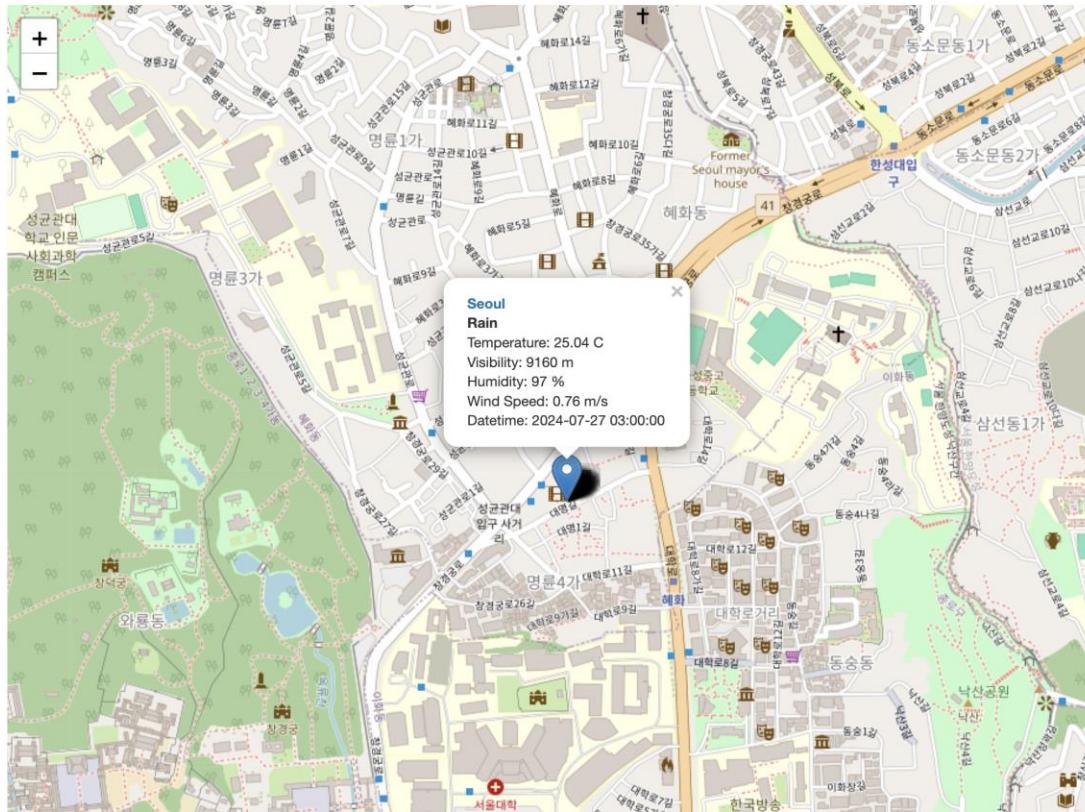
- **Green:** Represents a small rental count (0 to 1000 bikes).
- **Yellow:** Indicates a medium rental count (1000 to 3000 bikes).
- **Red:** Signifies a high rental count (over 3000 bikes).



The above map depicts all five cities indicated by yellow circles, meaning the bike rental count in all cities falls within the range of 1000 to 3000.

# Seoul Bike Rental Trends & Forecasts

Bike-sharing demand prediction app



# Seoul Bike Rental Trends & Forecasts

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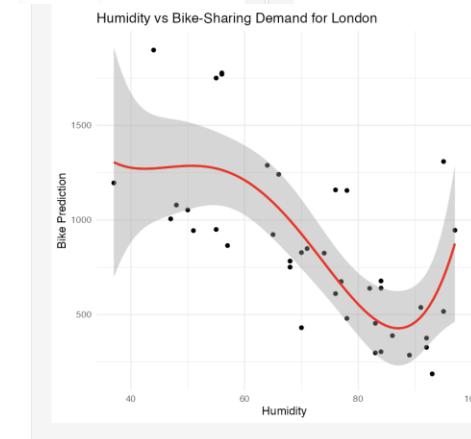
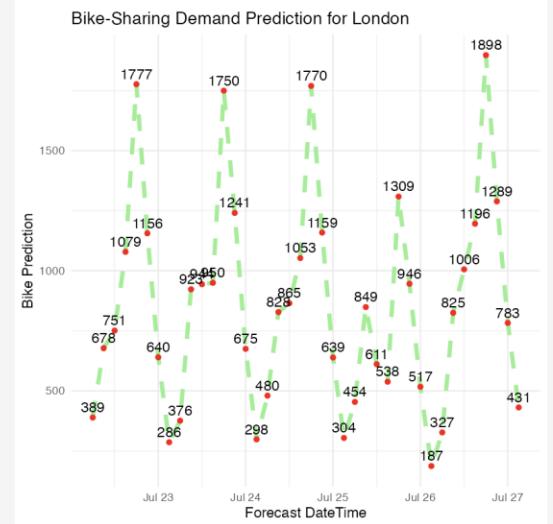
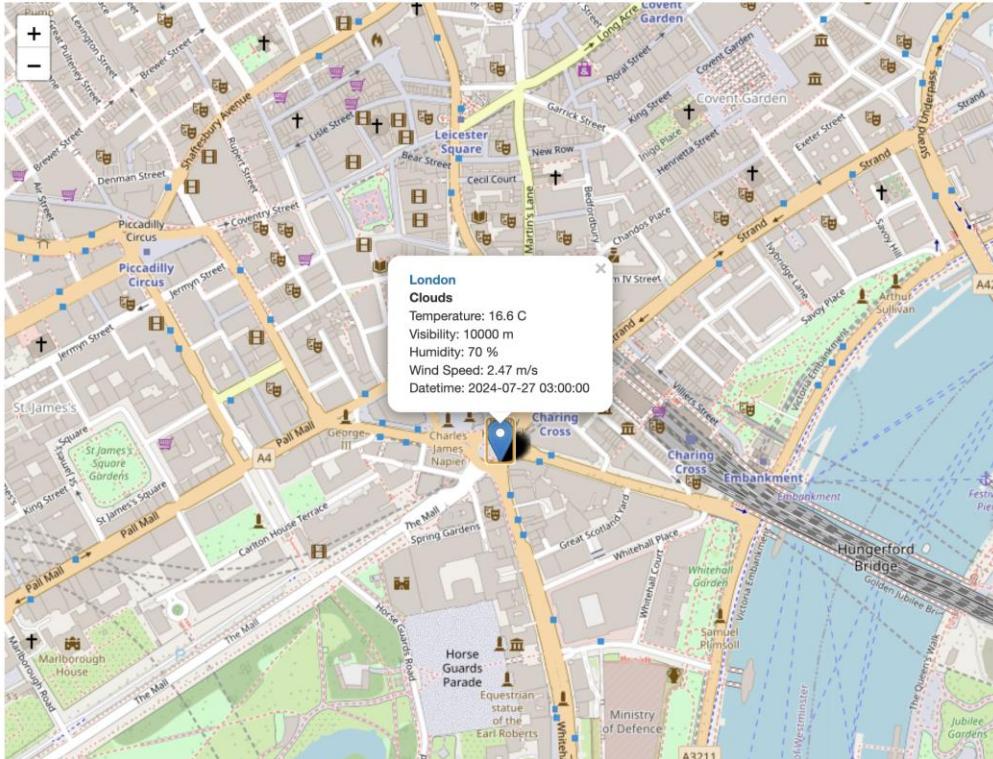
This dashboard provides key insights into bike rental trends in Seoul, including current distribution, future predictions, and weather correlations.

## Key Elements:

- **Max Bike Rental Distribution:** Visualizes the spatial distribution of bike rentals across Seoul. Clicking on a location reveals the predicted weather and temperature conditions for the last hour of the last day.
- **5-Day Temperature Trend:** A line graph displaying the predicted temperature trend for the next 5 days. Data points indicate daily temperature forecasts ranging from a peak of 34.02°C to a low of 23.19°C
- **5-Day Bike Count Prediction:** A line graph forecasting bike rental counts for the next 5 days. Data points represent daily rental predictions with a maximum of 1517 and a minimum of 405.
- **Humidity vs. Bike Count Correlation:** A scatter plot with a trend line showing the relationship between humidity levels and bike rental counts for the next 5 days. The data suggests minimal correlation, with points showing no clear trend.

# London Bike Rental Trends & Forecasts

Bike-sharing demand prediction app



# London Bike Rental Trends & Forecasts

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This dashboard provides key insights into bike rental trends in London, including current distribution, future predictions, and weather correlations.

## Key Elements:

- Max Bike Rental Distribution: Visualizes the spatial distribution of bike rentals across London. Clicking on a location reveals the predicted weather and temperature conditions for the last hour of the last day.
- 5-Day Temperature Trend: A line graph displaying the predicted temperature trend for the next 5 days. Data points indicate daily temperature forecasts ranging from a peak of 25.34°C to a low of 14.7°C
- 5-Day Bike Count Prediction: A line graph forecasting bike rental counts for the next 5 days. Data points represent daily rental predictions with a maximum of 1898 and a minimum of 187.
- Humidity vs. Bike Count Correlation: A scatter plot with a trend line showing the relationship between humidity levels and bike rental counts for the next 5 days. The data suggests a small negative correlation between them.

# CONCLUSION



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This project aimed to analyze the impact of weather on bike-sharing demand in urban areas, focusing on Seoul and extending the analysis to a global scale.

## Part 1: Weather Impact Analysis on Bike-Sharing Demand in Seoul

- **Data Collection and Processing:** Successfully gathered and processed weather and bike-sharing demand data.
- **Exploratory Data Analysis (EDA):** Uncovered significant patterns and relationships in the data.
- **Predictive Modeling:** Developed robust models to forecast bike-sharing demand in Seoul based on weather conditions.

## Part 2: Interactive Dashboard for Global Cities

- **Utilization of Pre-Trained Model:** Applied a pre-trained model to predict rental bike counts for Seoul, New York, Paris, Suzhou, and London.
- **Data Extraction:** Extracted weather data using the Open Weather API.
- **Integration of Results:** Combined predictive results with current weather data.
- **Dashboard Development:** Created an interactive dashboard showcasing temperature trends, bike count predictions, and bike counts versus humidity for the next five days.

# CONCLUSION



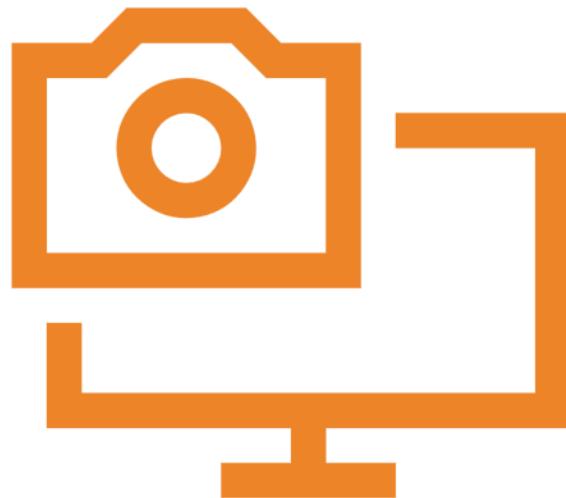
## Applications

- **For City Planners and Bike-Sharing Companies in Seoul:** The predictive model can optimize bike distribution and enhance service availability.
- **For Real-Time Decision-Making and Strategic Planning:** The interactive dashboard aids in making informed decisions and planning for bike rentals in Seoul, New York, Paris, Suzhou, and London.

By utilizing the outcomes of this project, we can improve bike-sharing services in Seoul and other global cities by adapting to weather variations.

# APPENDIX

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GitHub Link for the whole project:

<https://github.com/thetkhinelin25/Data-Science-R-Capstone-Project.git>

# Thank You!

