# B_S

July 5, 2023

[ ]:
```
"""        - instant: record index
        - dteday : date
        - season : season (1:springer, 2:summer, 3:fall, 4:winter)
        - yr : year (0: 2011, 1:2012)
        - mnth : month ( 1 to 12)
        - hr : hour (0 to 23)
        - holiday : weather day is holiday or not (extracted from http://dchr.
 ↪dc.gov/page/holiday-schedule)
        - weekday : day of the week
        - workingday : if day is neither weekend nor holiday is 1, otherwise is␣
 ↪0.
        + weathersit :
                - 1: Clear, Few clouds, Partly cloudy, Partly cloudy
                - 2: Mist + Cloudy, Mist + Broken clouds, Mist + Few clouds,␣
 ↪Mist
                - 3: Light Snow, Light Rain + Thunderstorm + Scattered clouds,␣
 ↪Light Rain + Scattered clouds
                - 4: Heavy Rain + Ice Pallets + Thunderstorm + Mist, Snow + Fog
        - temp : Normalized temperature in Celsius. The values are divided to␣
 ↪41 (max)
        - atemp: Normalized feeling temperature in Celsius. The values are␣
 ↪divided to 50 (max)
        - hum: Normalized humidity. The values are divided to 100 (max)
        - windspeed: Normalized wind speed. The values are divided to 67 (max)
        - casual: count of casual users
        - registered: count of registered users
        - cnt: count of total rental bikes including both casual and registered
"""
```

[ ]:
```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import numpy as np
%matplotlib inline
```

[ ]:
```
hourly_data = pd.read_csv("/content/drive/MyDrive/DA_Projects/Bike_shareING/
 ↪hour.csv")
```

[ ]:
```
hourly_data
```

[ ]:
```
       instant      dteday  season  yr  mnth  hr  holiday  weekday  \
0            1  2011-01-01       1   0     1   0        0        6
1            2  2011-01-01       1   0     1   1        0        6
2            3  2011-01-01       1   0     1   2        0        6
3            4  2011-01-01       1   0     1   3        0        6
4            5  2011-01-01       1   0     1   4        0        6
…          …          …     …   ..    …   ..       …        …
17374    17375  2012-12-31       1   1    12  19        0        1
17375    17376  2012-12-31       1   1    12  20        0        1
17376    17377  2012-12-31       1   1    12  21        0        1
17377    17378  2012-12-31       1   1    12  22        0        1
17378    17379  2012-12-31       1   1    12  23        0        1

       workingday  weathersit  temp   atemp   hum  windspeed  casual  \
0               0           1  0.24  0.2879  0.81     0.0000       3
1               0           1  0.22  0.2727  0.80     0.0000       8
2               0           1  0.22  0.2727  0.80     0.0000       5
3               0           1  0.24  0.2879  0.75     0.0000       3
4               0           1  0.24  0.2879  0.75     0.0000       0
…             …           …    …     …       …        …        …
17374           1           2  0.26  0.2576  0.60     0.1642      11
17375           1           2  0.26  0.2576  0.60     0.1642       8
17376           1           1  0.26  0.2576  0.60     0.1642       7
17377           1           1  0.26  0.2727  0.56     0.1343      13
17378           1           1  0.26  0.2727  0.65     0.1343      12

       registered  cnt
0              13   16
1              32   40
2              27   32
3              10   13
4               1    1
…             …  …
17374        108  119
17375         81   89
17376         83   90
17377         48   61
17378         37   49

[17379 rows x 17 columns]
```

[ ]:
```
print(f"Shape of data: {hourly_data.shape}")
print(f"Number of missing values in the data:{hourly_data.isnull().sum().
 ↪sum()}")
```

```
Shape of data: (17379, 17)
Number of missing values in the data:0
```

[ ]:
```
hourly_data.describe().T
```

[ ]:

| | count | mean | std | min | 25% | 50% | \ |
|---|---|---|---|---|---|---|---|
| instant | 17379.0 | 8690.000000 | 5017.029500 | 1.00 | 4345.5000 | 8690.0000 | |
| season | 17379.0 | 2.501640 | 1.106918 | 1.00 | 2.0000 | 3.0000 | |
| yr | 17379.0 | 0.502561 | 0.500008 | 0.00 | 0.0000 | 1.0000 | |
| mnth | 17379.0 | 6.537775 | 3.438776 | 1.00 | 4.0000 | 7.0000 | |
| hr | 17379.0 | 11.546752 | 6.914405 | 0.00 | 6.0000 | 12.0000 | |
| holiday | 17379.0 | 0.028770 | 0.167165 | 0.00 | 0.0000 | 0.0000 | |
| weekday | 17379.0 | 3.003683 | 2.005771 | 0.00 | 1.0000 | 3.0000 | |
| workingday | 17379.0 | 0.682721 | 0.465431 | 0.00 | 0.0000 | 1.0000 | |
| weathersit | 17379.0 | 1.425283 | 0.639357 | 1.00 | 1.0000 | 1.0000 | |
| temp | 17379.0 | 0.496987 | 0.192556 | 0.02 | 0.3400 | 0.5000 | |
| atemp | 17379.0 | 0.475775 | 0.171850 | 0.00 | 0.3333 | 0.4848 | |
| hum | 17379.0 | 0.627229 | 0.192930 | 0.00 | 0.4800 | 0.6300 | |
| windspeed | 17379.0 | 0.190098 | 0.122340 | 0.00 | 0.1045 | 0.1940 | |
| casual | 17379.0 | 35.676218 | 49.305030 | 0.00 | 4.0000 | 17.0000 | |
| registered | 17379.0 | 153.786869 | 151.357286 | 0.00 | 34.0000 | 115.0000 | |
| cnt | 17379.0 | 189.463088 | 181.387599 | 1.00 | 40.0000 | 142.0000 | |

| | 75% | max |
|---|---|---|
| instant | 13034.5000 | 17379.0000 |
| season | 3.0000 | 4.0000 |
| yr | 1.0000 | 1.0000 |
| mnth | 10.0000 | 12.0000 |
| hr | 18.0000 | 23.0000 |
| holiday | 0.0000 | 1.0000 |
| weekday | 5.0000 | 6.0000 |
| workingday | 1.0000 | 1.0000 |
| weathersit | 2.0000 | 4.0000 |
| temp | 0.6600 | 1.0000 |
| atemp | 0.6212 | 1.0000 |
| hum | 0.7800 | 1.0000 |
| windspeed | 0.2537 | 0.8507 |
| casual | 48.0000 | 367.0000 |
| registered | 220.0000 | 886.0000 |
| cnt | 281.0000 | 977.0000 |

[ ]:
```
preprocessed_data = hourly_data.copy()
```

[ ]:
```
#map Seasons
seasons_mapping = {1: 'winter', 2: 'spring',3: 'summer', 4: 'fall'}
preprocessed_data['season'] = preprocessed_data['season'].apply(lambda x:␣
 ↪seasons_mapping[x])
```

```
#map Years
yr_mapping = {0: 2011, 1: 2012}
preprocessed_data['yr'] = preprocessed_data['yr'].apply(lambda x: yr_mapping[x])
#map Weeks
weekday_mapping = {0: 'Sunday', 1: 'Monday', 2: 'Tuesday',3: 'Wednesday', 4:␣
 ↪'Thursday', 5: 'Friday',6: 'Saturday'}
preprocessed_data['weekday'] = preprocessed_data['weekday'].apply(lambda x:␣
 ↪weekday_mapping[x])
#map Weather
weather_mapping = {1: 'clear', 2: 'cloudy',3: 'light_rain_snow', 4:␣
 ↪'heavy_rain_snow'}
preprocessed_data['weathersit'] = preprocessed_data['weathersit'].apply(lambda␣
 ↪x:weather_mapping[x])
#rescale hum and windspead
preprocessed_data['hum'] = preprocessed_data['hum']*100
preprocessed_data['windspeed'] = preprocessed_data['windspeed']*67
```

[ ]:
```
preprocessed_data
```

[ ]:

| | instant | dteday | season | yr | mnth | hr | holiday | weekday | \ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2011-01-01 | winter | 2011 | 1 | 0 | 0 | Saturday | |
| 1 | 2 | 2011-01-01 | winter | 2011 | 1 | 1 | 0 | Saturday | |
| 2 | 3 | 2011-01-01 | winter | 2011 | 1 | 2 | 0 | Saturday | |
| 3 | 4 | 2011-01-01 | winter | 2011 | 1 | 3 | 0 | Saturday | |
| 4 | 5 | 2011-01-01 | winter | 2011 | 1 | 4 | 0 | Saturday | |
| … | … | … | … | … | … | .. | … | … | |
| 17374 | 17375 | 2012-12-31 | winter | 2012 | 12 | 19 | 0 | Monday | |
| 17375 | 17376 | 2012-12-31 | winter | 2012 | 12 | 20 | 0 | Monday | |
| 17376 | 17377 | 2012-12-31 | winter | 2012 | 12 | 21 | 0 | Monday | |
| 17377 | 17378 | 2012-12-31 | winter | 2012 | 12 | 22 | 0 | Monday | |
| 17378 | 17379 | 2012-12-31 | winter | 2012 | 12 | 23 | 0 | Monday | |

| | workingday | weathersit | temp | atemp | hum | windspeed | casual | \ |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | clear | 0.24 | 0.2879 | 81.0 | 0.0000 | 3 | |
| 1 | 0 | clear | 0.22 | 0.2727 | 80.0 | 0.0000 | 8 | |
| 2 | 0 | clear | 0.22 | 0.2727 | 80.0 | 0.0000 | 5 | |
| 3 | 0 | clear | 0.24 | 0.2879 | 75.0 | 0.0000 | 3 | |
| 4 | 0 | clear | 0.24 | 0.2879 | 75.0 | 0.0000 | 0 | |
| … | … | … | … | … | … | … | … | |
| 17374 | 1 | cloudy | 0.26 | 0.2576 | 60.0 | 11.0014 | 11 | |
| 17375 | 1 | cloudy | 0.26 | 0.2576 | 60.0 | 11.0014 | 8 | |
| 17376 | 1 | clear | 0.26 | 0.2576 | 60.0 | 11.0014 | 7 | |
| 17377 | 1 | clear | 0.26 | 0.2727 | 56.0 | 8.9981 | 13 | |
| 17378 | 1 | clear | 0.26 | 0.2727 | 65.0 | 8.9981 | 12 | |

| | registered | cnt |
|---|---|---|
| 0 | 13 | 16 |

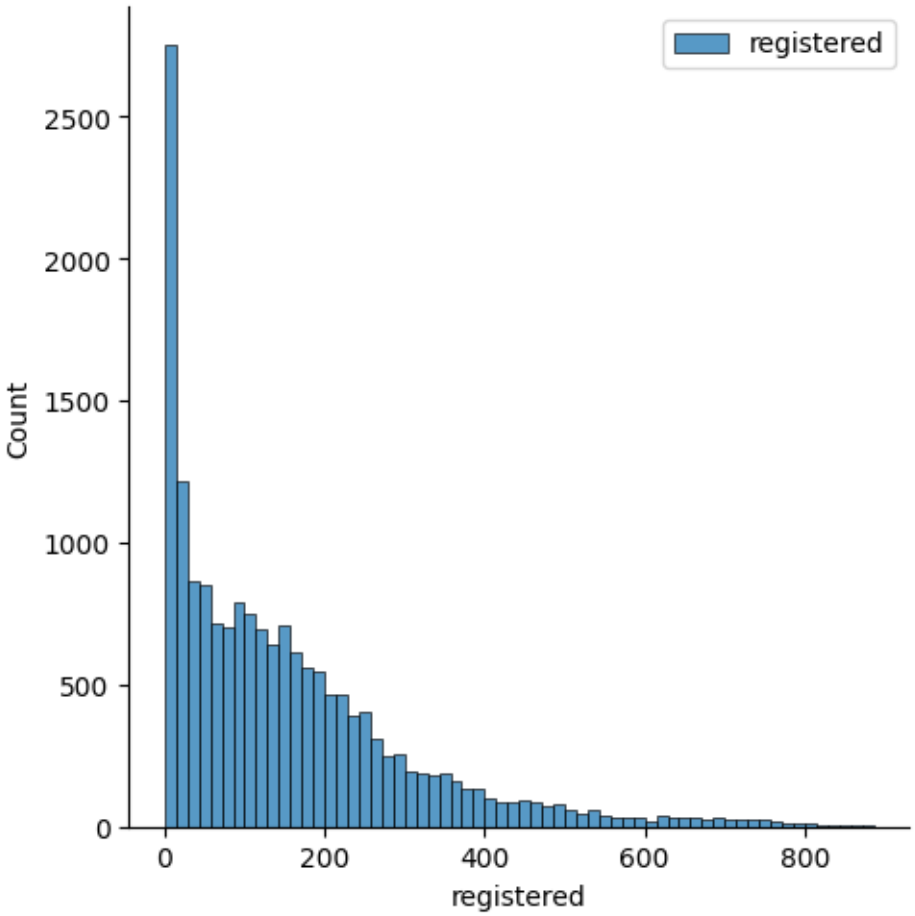
```
1                32   40
2                27   32
3                10   13
4                 1    1
…              …   …
17374          108  119
17375           81   89
17376           83   90
17377           48   61
17378           37   49

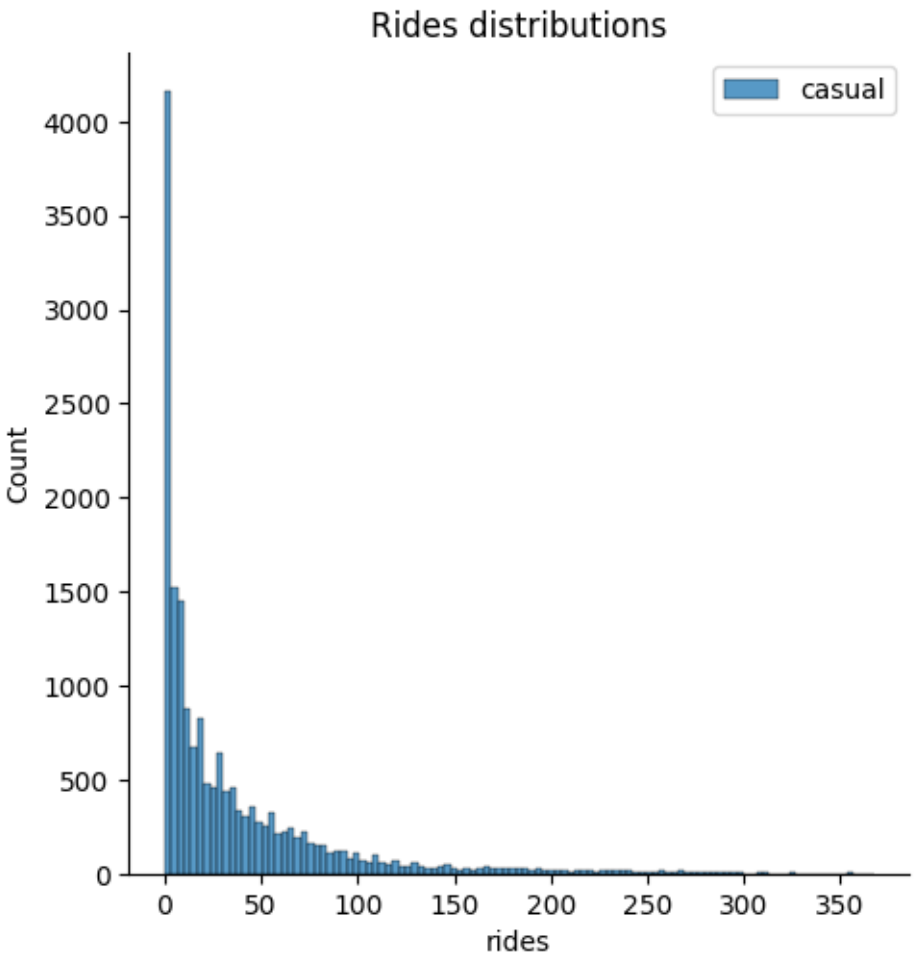
[17379 rows x 17 columns]
```

# 1 Ploting and Tests

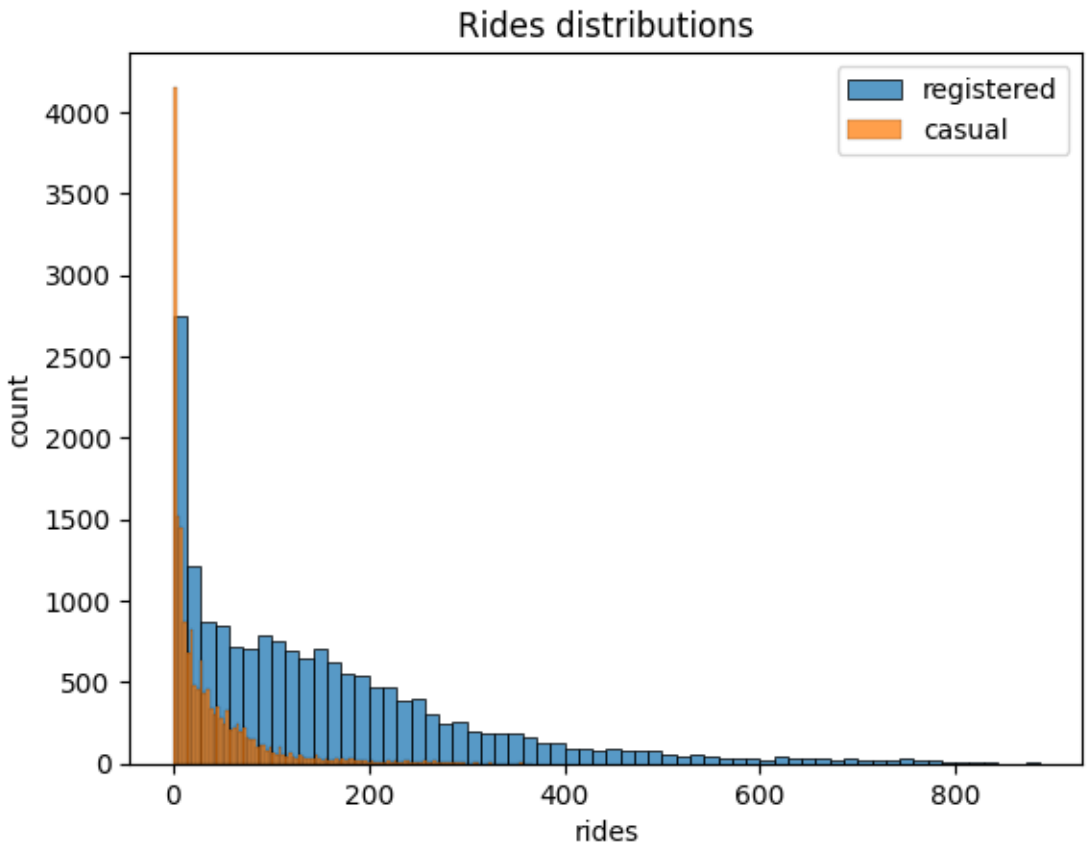
[ ]:
```
sns.displot(preprocessed_data['registered'], label='registered')
plt.legend()
sns.displot(preprocessed_data['casual'], label='casual')
plt.legend()
plt.xlabel('rides')
plt.title("Rides distributions")
```

[ ]:
```
Text(0.5, 1.0, 'Rides distributions')
```


registered
2500
2000
1500
1000
500
0
Count
0
200
400
600
800
registered

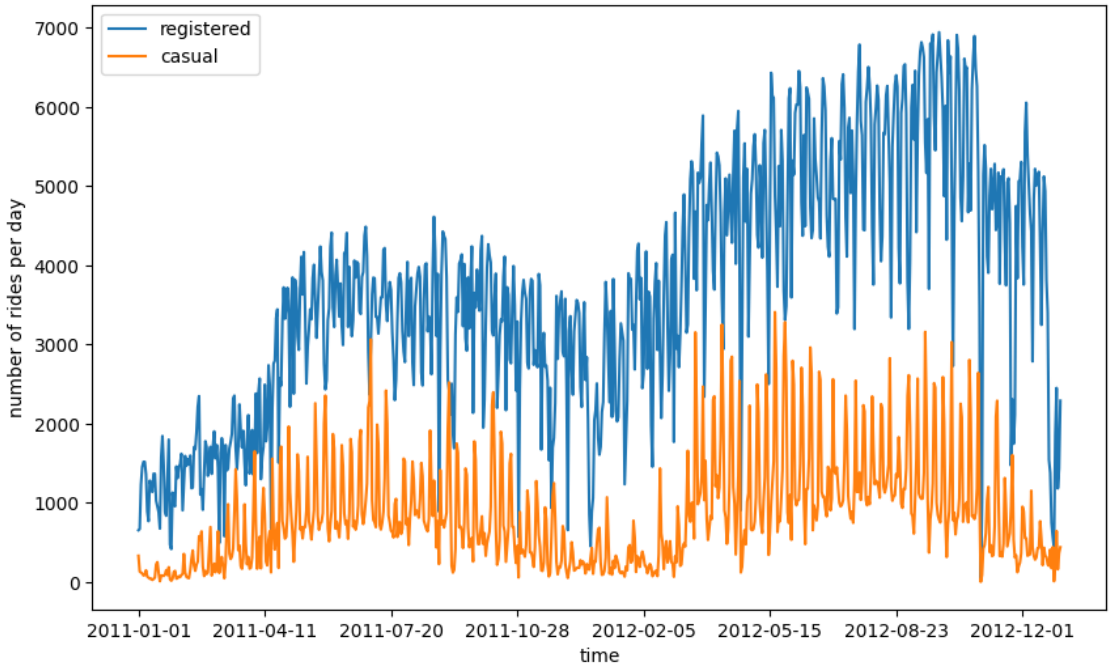



[ ]:
```
fig, ax = plt.subplots()
sns.histplot(preprocessed_data['registered'], ax=ax,label='registered')
sns.histplot(preprocessed_data['casual'],ax=ax, label='casual')
plt.legend()
ax.set_xlabel('rides')
ax.set_ylabel('count')
ax.set_title("Rides distributions")
plt.show()
```




[ ]:
```
"""
from the plot we can see that reg riders perform more rides than casual ones␣
 ↪and that was expected
"""
```

[ ]:
```
plot_data = preprocessed_data[['registered', 'casual', 'dteday']]
ax = plot_data.groupby('dteday').sum().plot(figsize=(10,6))
ax.set_xlabel("time");
ax.set_ylabel("number of rides per day")
plt.show()
```



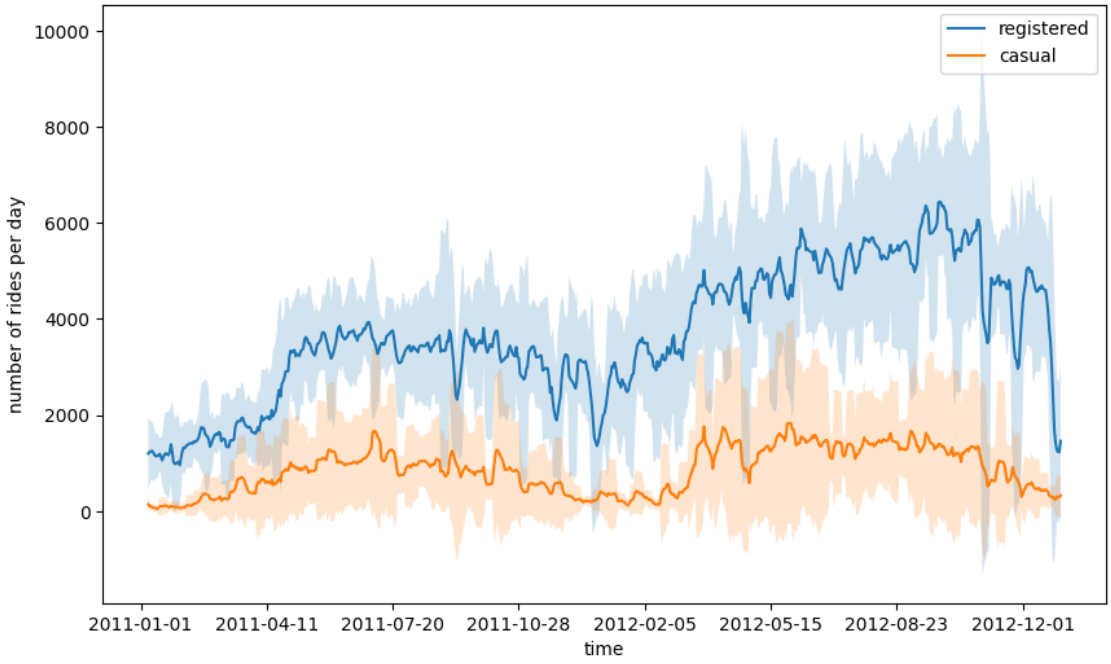

[ ]:
```
"""
-here are the sum of ref and casual rides for each day
-and for all days reg rides are more than casual ones
-during winter no. of rides become less than in other seasons
"""
```

[ ]:
```
plot_data = preprocessed_data[['registered', 'casual', 'dteday']]
plot_data = plot_data.groupby('dteday').sum()

window = 7
rolling_means = plot_data.rolling(window).mean()
rolling_deviations = plot_data.rolling(window).std()

ax = rolling_means.plot(figsize=(10,6))
ax.fill_between(rolling_means.index, rolling_means['registered'] +␣
 ↪2*rolling_deviations['registered'], rolling_means['registered'] -␣
 ↪2*rolling_deviations['registered'],alpha = 0.2)
ax.fill_between(rolling_means.index, rolling_means['casual'] +␣
 ↪2*rolling_deviations['casual'],rolling_means['casual'] -␣
 ↪2*rolling_deviations['casual'],alpha = 0.2)
ax.set_xlabel("time");
ax.set_ylabel("number of rides per day")
```

[ ]:
```
Text(0, 0.5, 'number of rides per day')
```

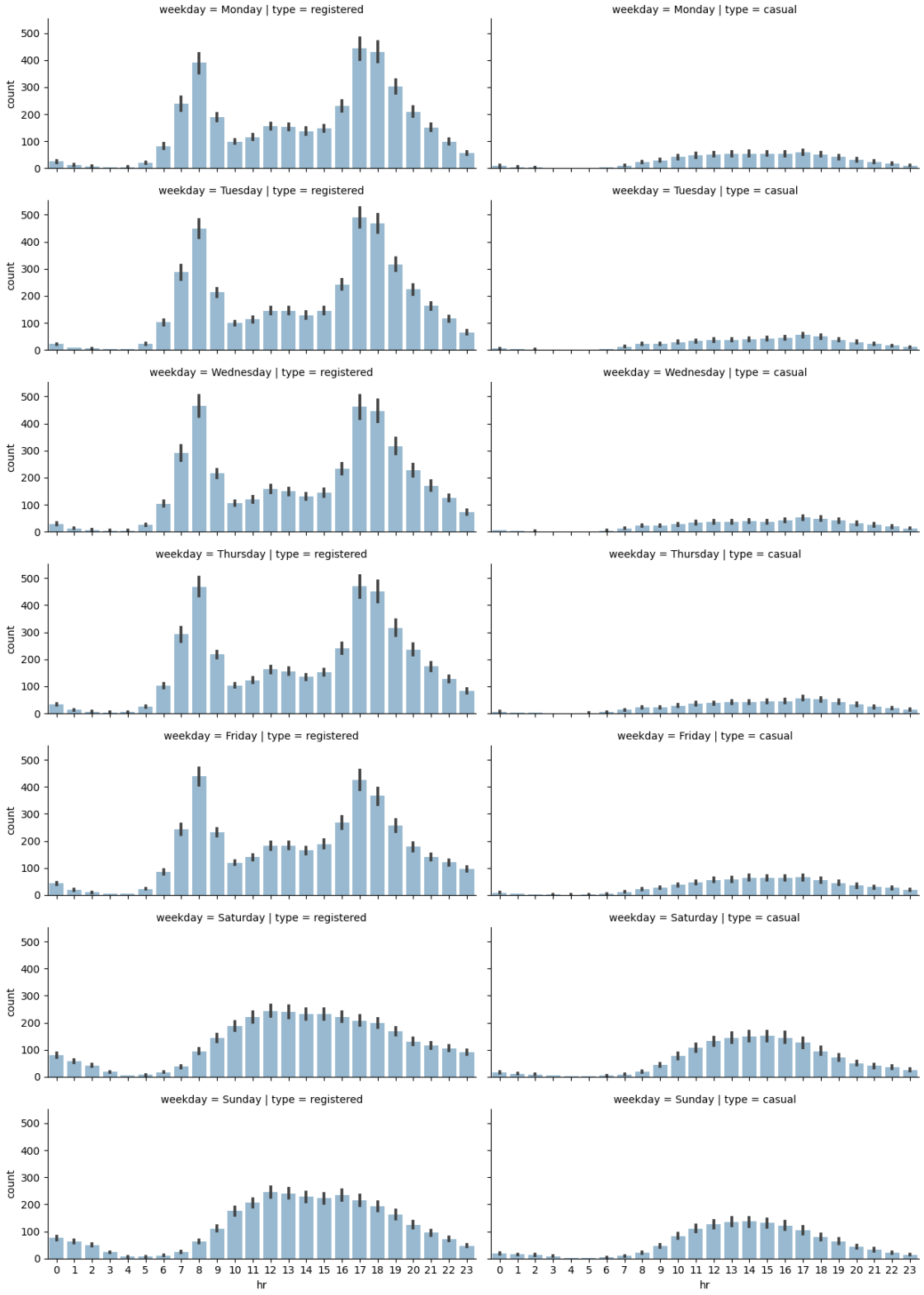



[ ]:
```
"""

"""
```

[ ]:
```
plot_data = preprocessed_data[['hr', 'weekday', 'registered', 'casual']]
plot_data = plot_data.melt(id_vars=['hr', 'weekday'],var_name='type',␣
 ↪value_name='count')
grid = sns.FacetGrid(plot_data, row='weekday', col='type', height=2.5, aspect=2.
 ↪5, row_order=['Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday',␣
 ↪'Saturday', 'Sunday'])
grid.map(sns.barplot, 'hr', 'count', alpha=0.5)
plt.show()
```

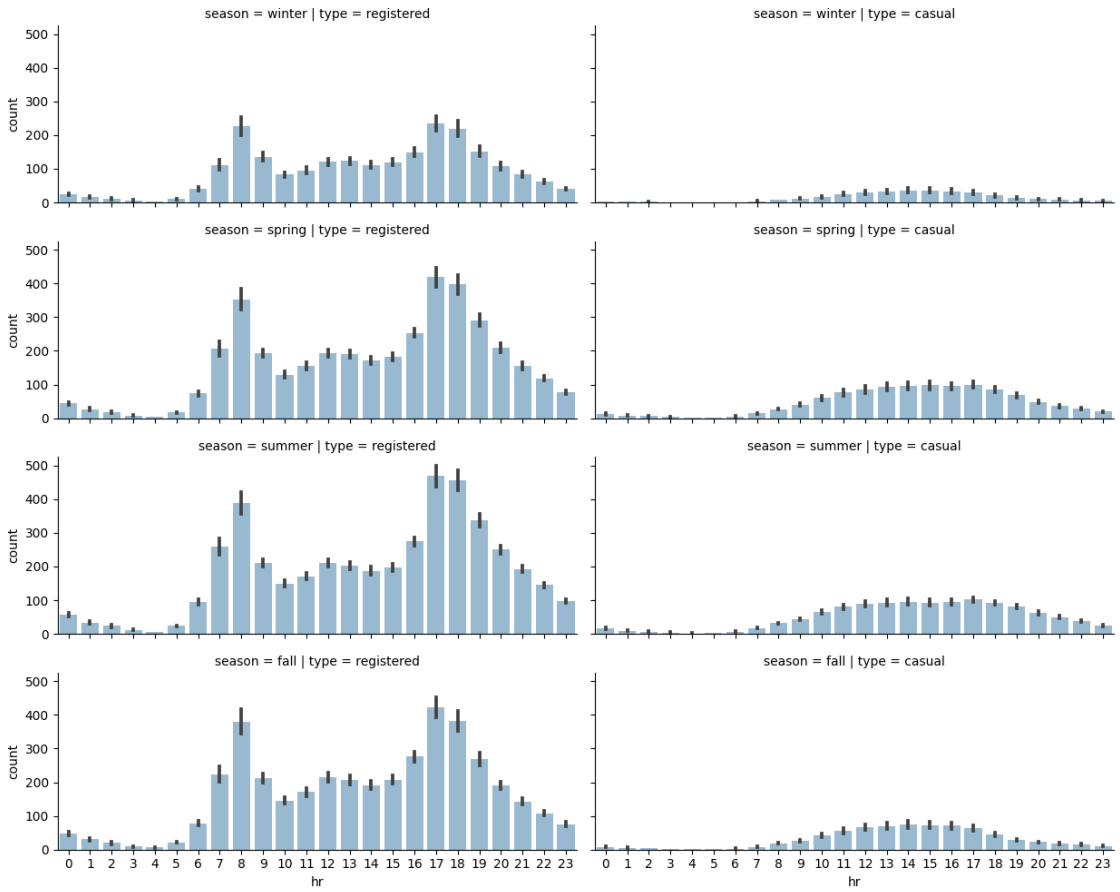
```
/usr/local/lib/python3.10/dist-packages/seaborn/axisgrid.py:712: UserWarning:
Using the barplot function without specifying `order` is likely to produce an
incorrect plot.
  warnings.warn(warning)
```


weekday = Monday | type = registered
weekday = Monday | type = casual
weekday = Tuesday | type = registered
weekday = Tuesday | type = casual
weekday = Wednesday | type = registered
weekday = Wednesday | type = casual
weekday = Thursday | type = registered
weekday = Thursday | type = casual
weekday = Friday | type = registered
weekday = Friday | type = casual
weekday = Saturday | type = registered
weekday = Saturday | type = casual
weekday = Sunday | type = registered
weekday = Sunday | type = casual
count
hr

[ ]:
```
"""
-from this we get which day have more rides and which houre in the day has has␣
 ↪more rides and thies type
-most of reg rides at early hours and most of cas rides at the end of the day
- special case in weekends most of the rides become in later hours and in␣
 ↪weekend more cas rides counted
"""
```

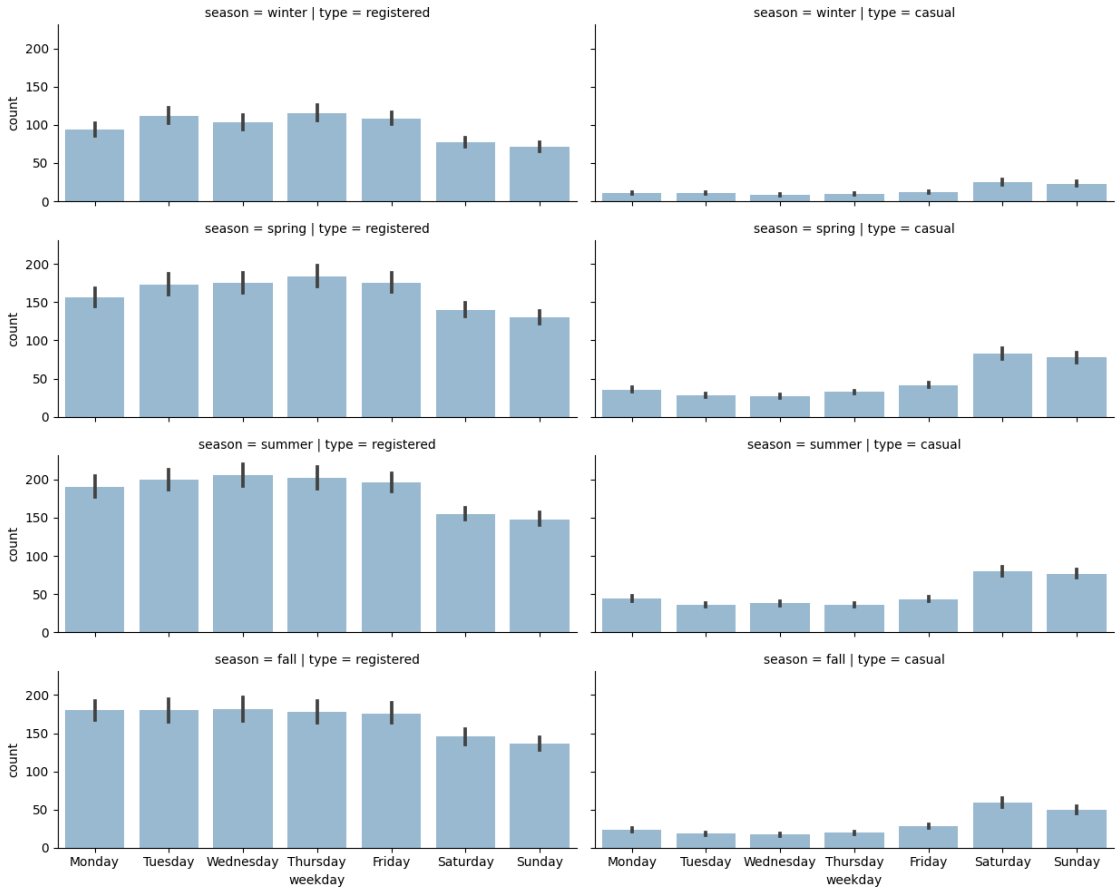
[ ]:
```
plot_data = preprocessed_data[['hr', 'season','registered', 'casual']]
plot_data = plot_data.melt(id_vars=['hr', 'season'], var_name='type',␣
 ↪value_name='count')
grid = sns.FacetGrid(plot_data, row='season',   col='type', height=2.5,␣
 ↪aspect=2.5,row_order=['winter', 'spring','summer', 'fall'])
grid.map(sns.barplot, 'hr', 'count', alpha=0.5)
plt.show()
```

```
/usr/local/lib/python3.10/dist-packages/seaborn/axisgrid.py:712: UserWarning:
Using the barplot function without specifying `order` is likely to produce an
incorrect plot.
  warnings.warn(warning)
```



[ ]:
```
"""
as expected and showed in the plots above winter is the most season has min␣
 ↪rides
"""
```

[ ]:
```
plot_data = preprocessed_data[['weekday', 'season','registered', 'casual']]
plot_data = plot_data.melt(id_vars=['weekday', 'season'],var_name='type',␣
 ↪value_name='count')
grid = sns.FacetGrid(plot_data, row='season', col='type', height=2.5, aspect=2.
 ↪5,  row_order=['winter', 'spring','summer', 'fall'])
grid.map(sns.barplot, 'weekday', 'count', alpha=0.5, order=['Monday',␣
 ↪'Tuesday', 'Wednesday', 'Thursday','Friday', 'Saturday', 'Sunday'])
plt.show()
from scipy.stats import ttest_ind
test_res = ttest_ind(weekend_data, workingdays_data)
print(f"Statistic value: {test_res[0]:.03f}, \
p-value: {test_res[1]:.03f}")
```



[ ]:
```
"""
as at showd most for the cas rises in weekends and for reg rides it dist equaly␣
 ↪but become slightly less in weekends
"""
```

[ ]:
```
population_mean = preprocessed_data.registered.mean()
sample = preprocessed_data[(preprocessed_data.season == "summer") &␣
 ↪(preprocessed_data.yr == 2011)].registered
```

[ ]:
```
from scipy.stats import ttest_1samp
test_result = ttest_1samp(sample, population_mean)
print(f"Test statistic: {test_result[0]},p-value: {test_result[1]}")
```

```
Test statistic: -3.4919691483786197,p-value: 0.0004887645279519505
```

[ ]:
```
import random
random.seed(111)
sample_unbiased = preprocessed_data.registered.sample(frac=0.05)
test_result_unbiased = ttest_1samp(sample_unbiased, population_mean)
print(f"Unbiased test statistic: {test_result_unbiased[0]:.03f}, p-value:␣
 ↪{test_result_unbiased[1]:.03f}")
```

```
Unbiased test statistic: -2.557, p-value: 0.011
```

[ ]:
```
"""
by taking random sample each time istead of the biased sample from 2011 it make␣
 ↪better results on p-value as it was accepted some the times
"""
```

[ ]:
```
weekend_days = ['Saturday', 'Sunday']
weekend_mask = preprocessed_data.weekday.isin(weekend_days)
workingdays_mask = ~preprocessed_data.weekday.isin(weekend_days)
weekend_data = preprocessed_data.registered[weekend_mask]
workingdays_data = preprocessed_data.registered[workingdays_mask]
```

[ ]:
```
from scipy.stats import ttest_ind
test_res = ttest_ind(weekend_data, workingdays_data)
print(f"Statistic value: {test_res[0]:.03f}, p-value: {test_res[1]:.03f}")
```

```
Statistic value: -16.004, p-value: 0.000
```

[ ]:
```
"""
as intial con it differ from workday and weekend as it showed in test
"""
```

[ ]:
```
sns.distplot(weekend_data, label='weekend days')
sns.distplot(workingdays_data, label='working days')
```

```
plt.legend()
plt.xlabel('rides')
plt.ylabel('frequency')
plt.title("Registered rides distributions")
plt.show()
```

```
<ipython-input-20-1357c19e72cc>:1: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

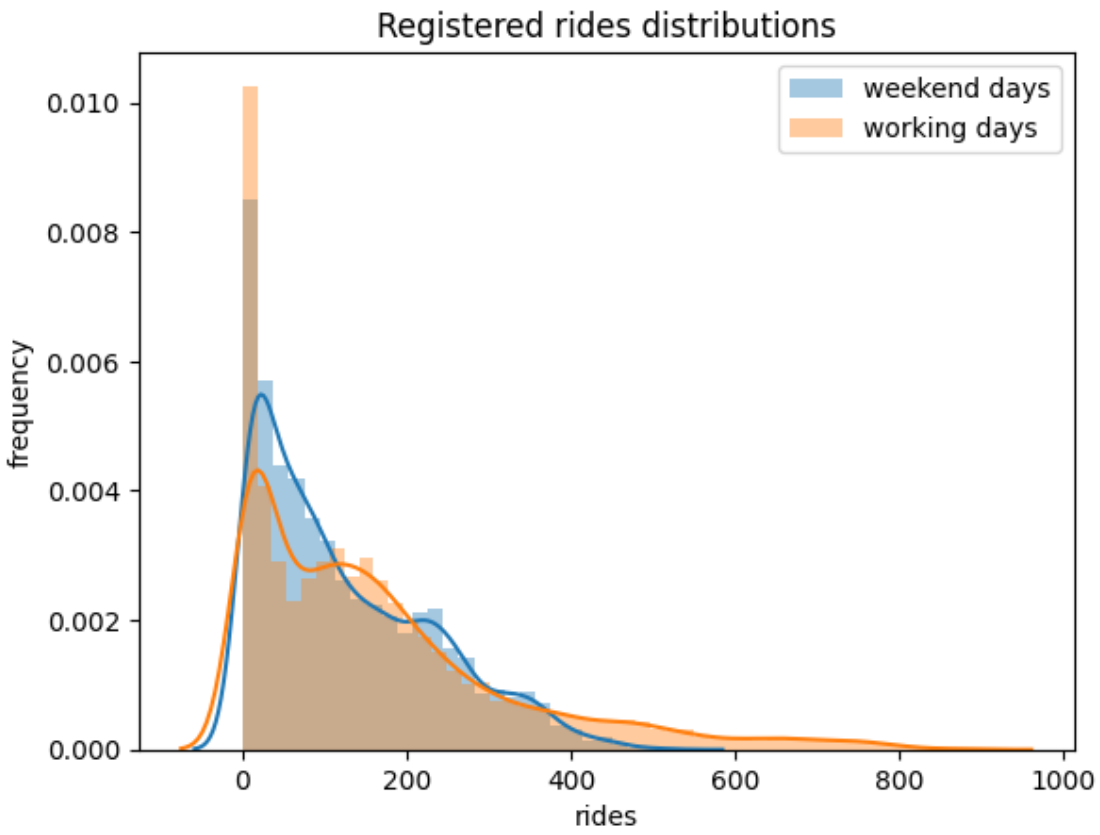
  sns.distplot(weekend_data, label='weekend days')
<ipython-input-20-1357c19e72cc>:2: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(workingdays_data, label='working days')
```




[ ]:
```
weekend_data = preprocessed_data.casual[weekend_mask]
workingdays_data = preprocessed_data.casual[workingdays_mask]
test_res = ttest_ind(weekend_data, workingdays_data)
print(f"Statistic value: {test_res[0]:.03f}, p-value: {test_res[1]:.03f}")
```

```
Statistic value: 41.077, p-value: 0.000
```

[ ]:
```
sns.distplot(weekend_data, label='weekend days')
sns.distplot(workingdays_data, label='working days')
plt.legend()
plt.xlabel('rides')
plt.ylabel('frequency')
plt.title("Casual rides distributions")
plt.show()
```

```
<ipython-input-22-b191d7dc4b25>:1: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).
```

```
For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

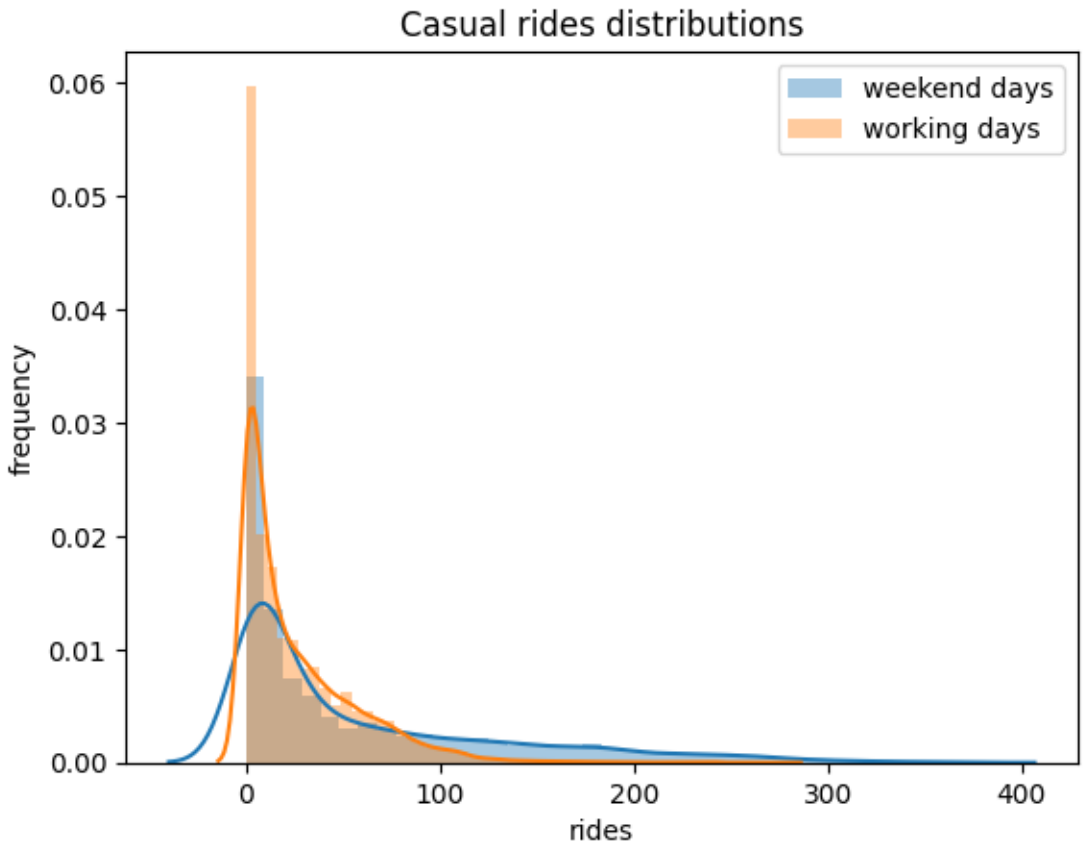
  sns.distplot(weekend_data, label='weekend days')
<ipython-input-22-b191d7dc4b25>:2: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(workingdays_data, label='working days')
```



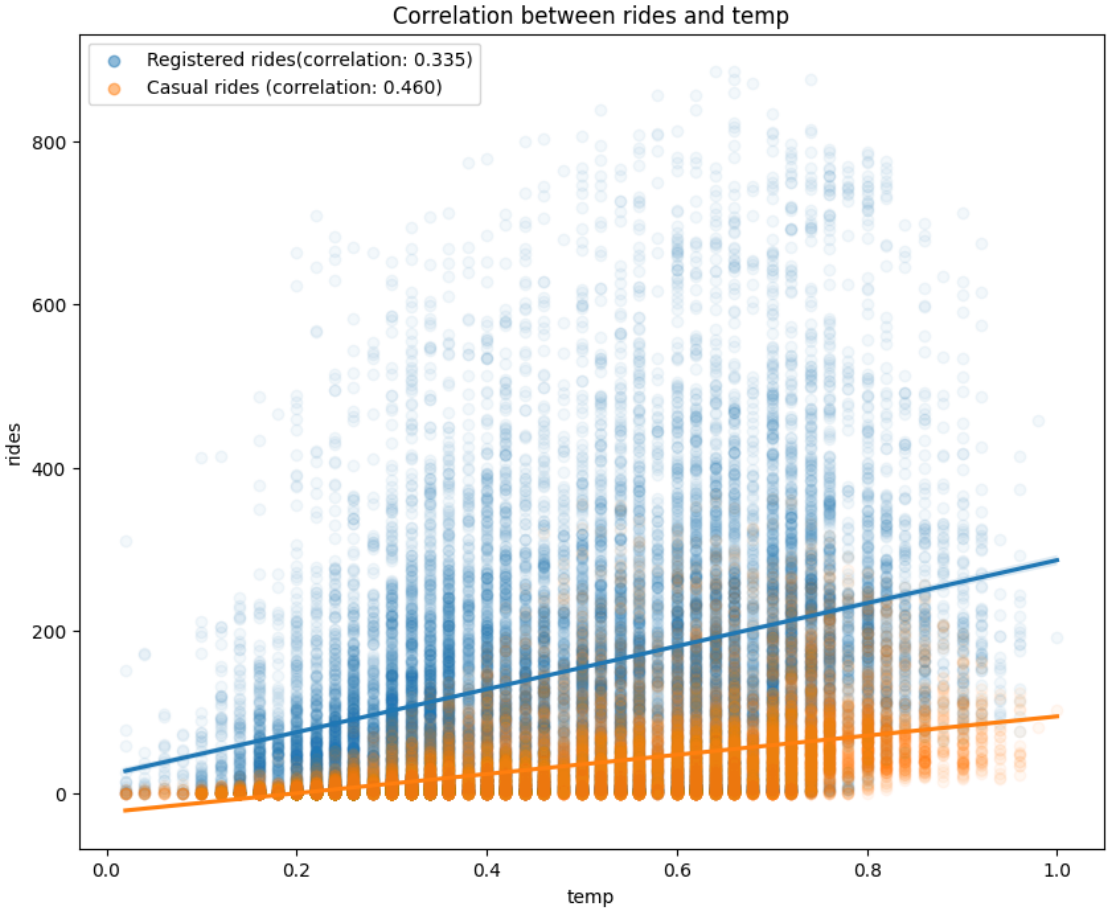
## 2 Wheather Analysis

[ ]:
```
def plot_correlations(data, col):
  corr_r = np.corrcoef(data[col], data["registered"])[0,1]
  ax = sns.regplot(x=col, y="registered", data=data, scatter_kws={"alpha":0.
 ↪05}, label=f"Registered rides(correlation: {corr_r:.3f})")
  corr_c = np.corrcoef(data[col], data["casual"])[0,1]
  ax = sns.regplot(x=col, y='casual', data=data, scatter_kws={"alpha":0.05},␣
 ↪label=f"Casual rides (correlation: {corr_c:.3f})")
  legend = ax.legend()
  for lh in legend.legendHandles:
      lh.set_alpha(0.5)
      ax.set_ylabel("rides")
      ax.set_title(f"Correlation between rides and {col}")
  return ax
```

[ ]:
```
plt.figure(figsize=(10,8))
ax = plot_correlations(preprocessed_data, 'temp')
plt.show()
```

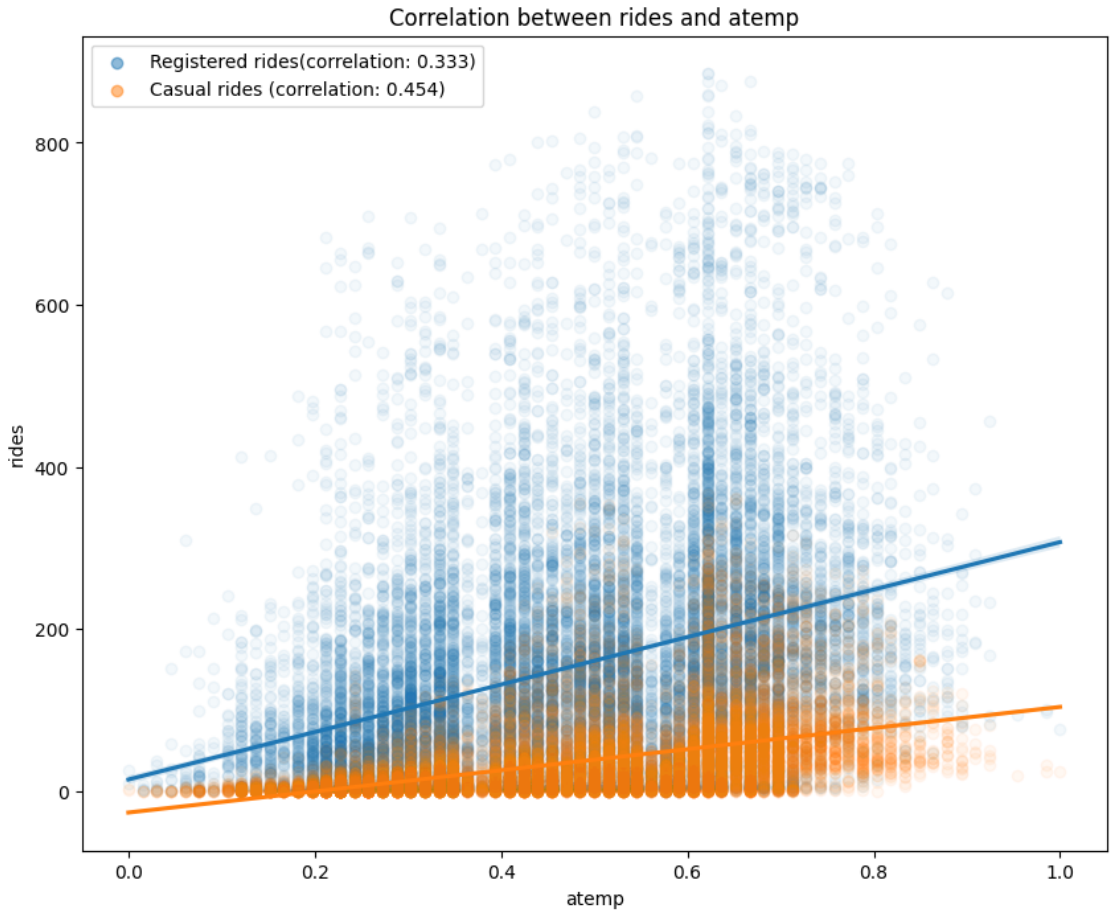
```
<ipython-input-9-ea75f609b519>:7: MatplotlibDeprecationWarning: The
legendHandles attribute was deprecated in Matplotlib 3.7 and will be removed two
minor releases later. Use legend_handles instead.
  for lh in legend.legendHandles:
```

[ ]:
```
<function matplotlib.pyplot.show(close=None, block=None)>
```



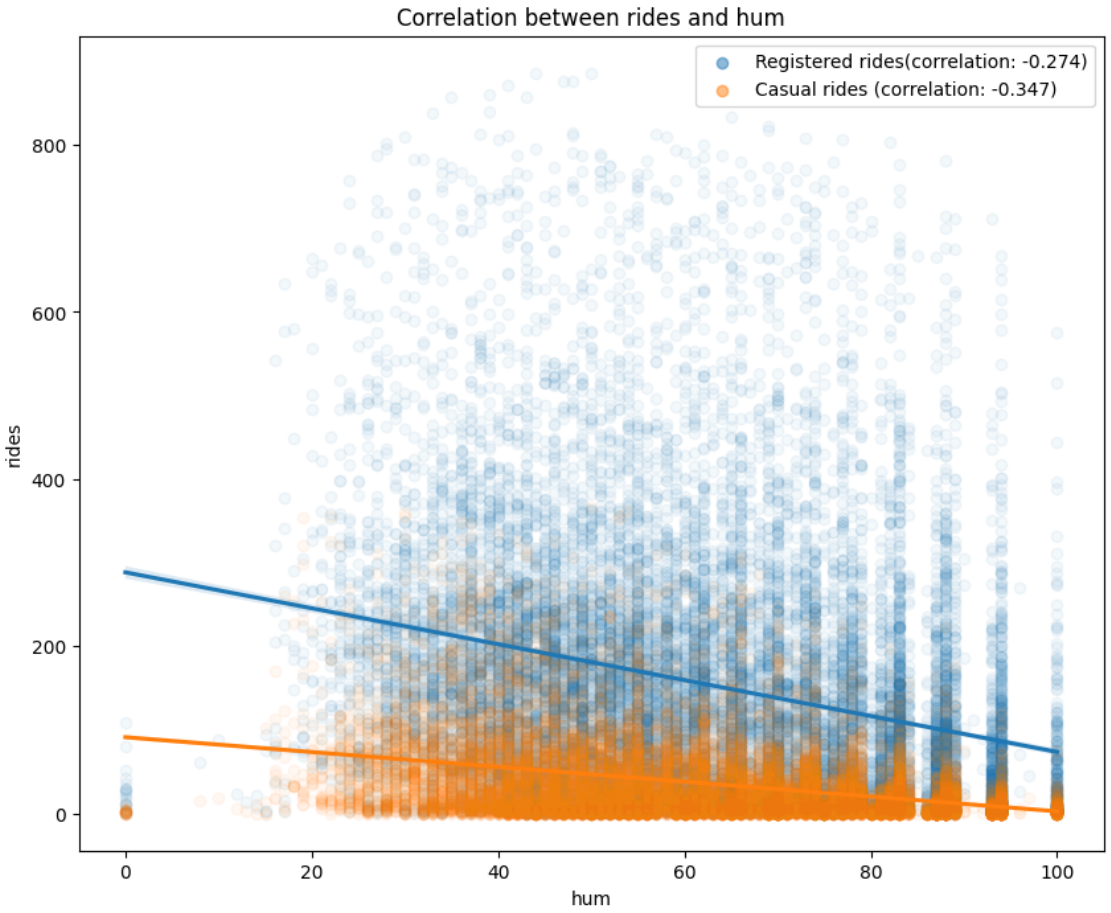

[ ]:
```
plt.figure(figsize=(10,8))
ax = plot_correlations(preprocessed_data, 'atemp')
plt.show()
```

```
<ipython-input-9-ea75f609b519>:7: MatplotlibDeprecationWarning: The
legendHandles attribute was deprecated in Matplotlib 3.7 and will be removed two
minor releases later. Use legend_handles instead.
  for lh in legend.legendHandles:
```



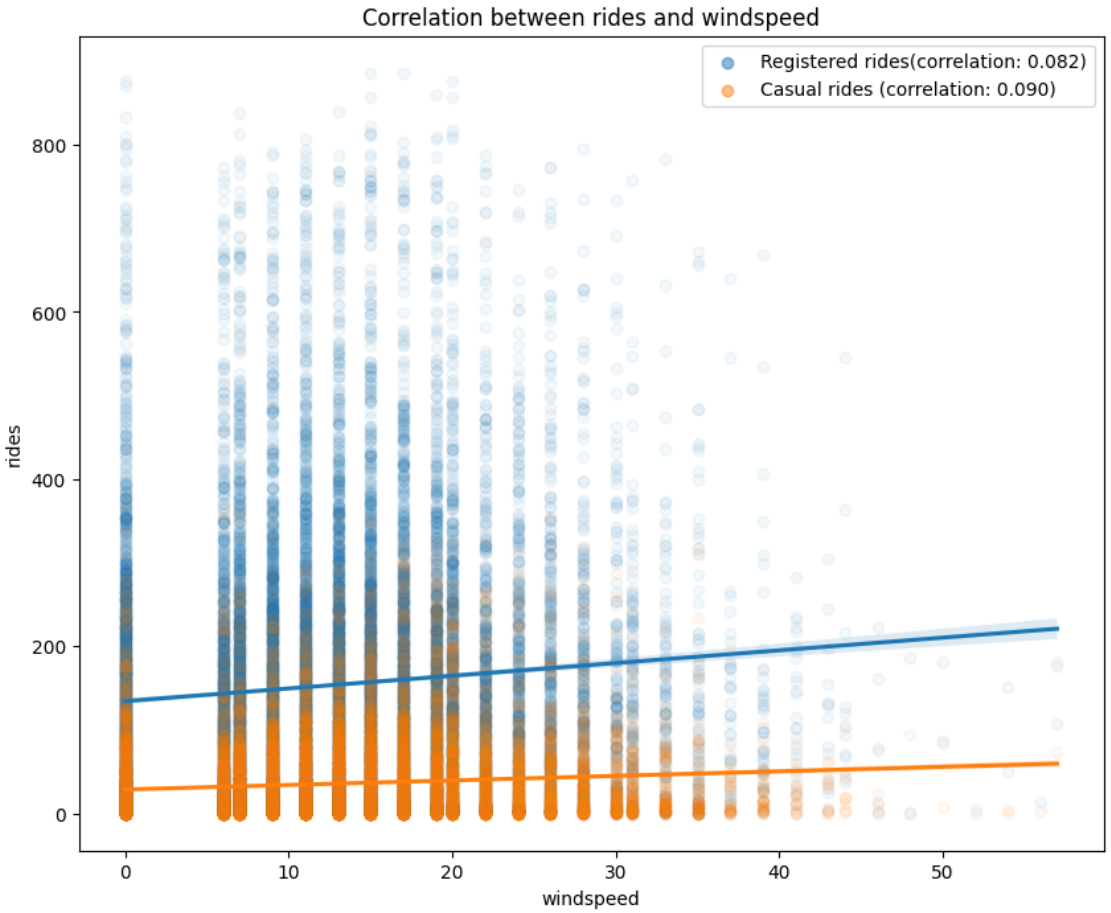

[ ]:
```
plt.figure(figsize=(10,8))
ax = plot_correlations(preprocessed_data, 'hum')
plt.show()
```

```
<ipython-input-9-ea75f609b519>:7: MatplotlibDeprecationWarning: The
legendHandles attribute was deprecated in Matplotlib 3.7 and will be removed two
minor releases later. Use legend_handles instead.
  for lh in legend.legendHandles:
```




[ ]:
```
plt.figure(figsize=(10,8))
ax = plot_correlations(preprocessed_data, 'windspeed')
plt.show()
```

```
<ipython-input-9-ea75f609b519>:7: MatplotlibDeprecationWarning: The
legendHandles attribute was deprecated in Matplotlib 3.7 and will be removed two
minor releases later. Use legend_handles instead.
  for lh in legend.legendHandles:
```




[ ]:
```
"""
first 2 plots have pos affect on the no. of the rides
third one has neg one
and for the last one its affect its not that big like the first 3 ones
"""
```

[ ]:
```
from scipy.stats import pearsonr, spearmanr
```

[ ]:
```
def compute_correlations(data, col):
    pearson_reg = pearsonr(data[col], data["registered"])[0]
    pearson_cas = pearsonr(data[col], data["casual"])[0]
    spearman_reg = spearmanr(data[col], data["registered"])[0]
    spearman_cas = spearmanr(data[col], data["casual"])[0]
    return pd.Series({"Pearson (registered)": pearson_reg,"Spearman␣
 ↪(registered)": spearman_reg,"Pearson (casual)": pearson_cas,"Spearman␣
 ↪(casual)": spearman_cas})
```

[ ]:
```
cols = ["temp", "atemp", "hum", "windspeed"]
corr_data = pd.DataFrame(index=["Pearson (registered)", "Spearman␣
 ↪(registered)","Pearson (casual)", "Spearman (casual)"])
for col in cols:
    corr_data[col]=compute_correlations(preprocessed_data, col)
corr_data.T
```

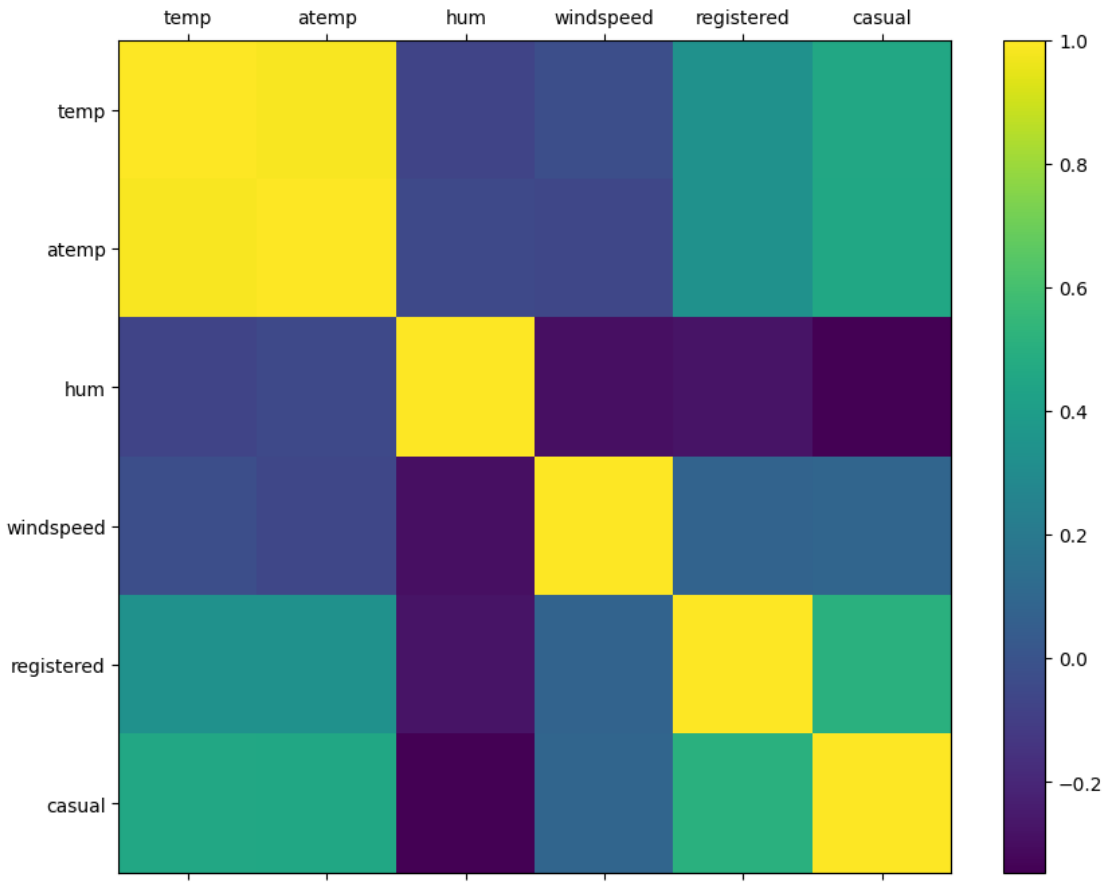
[ ]:

| | Pearson (registered) | Spearman (registered) | Pearson (casual) | \ |
|---|---|---|---|---|
| temp | 0.335361 | 0.373196 | 0.459616 | |
| atemp | 0.332559 | 0.373014 | 0.454080 | |
| hum | -0.273933 | -0.338480 | -0.347028 | |
| windspeed | 0.082321 | 0.122936 | 0.090287 | |

| | Spearman (casual) |
|---|---|
| temp | 0.570989 |
| atemp | 0.570419 |
| hum | -0.388213 |
| windspeed | 0.122920 |

[ ]:
```
"""
here to make sure that the assumtion of that the relation between each of the 2␣
 ↪variables are linear
,so spearman rank corr to determent that and test that assumtion
"""
```

[ ]:
```
cols = ["temp", "atemp", "hum", "windspeed", "registered", "casual"]
plot_data = preprocessed_data[cols]
corr = plot_data.corr()
fig = plt.figure(figsize=(10,8))
plt.matshow(corr, fignum=fig.number)
plt.xticks(range(len(plot_data.columns)), plot_data.columns)
plt.yticks(range(len(plot_data.columns)), plot_data.columns)
plt.colorbar()
plt.ylim([5.5, -0.5])
plt.show()
```



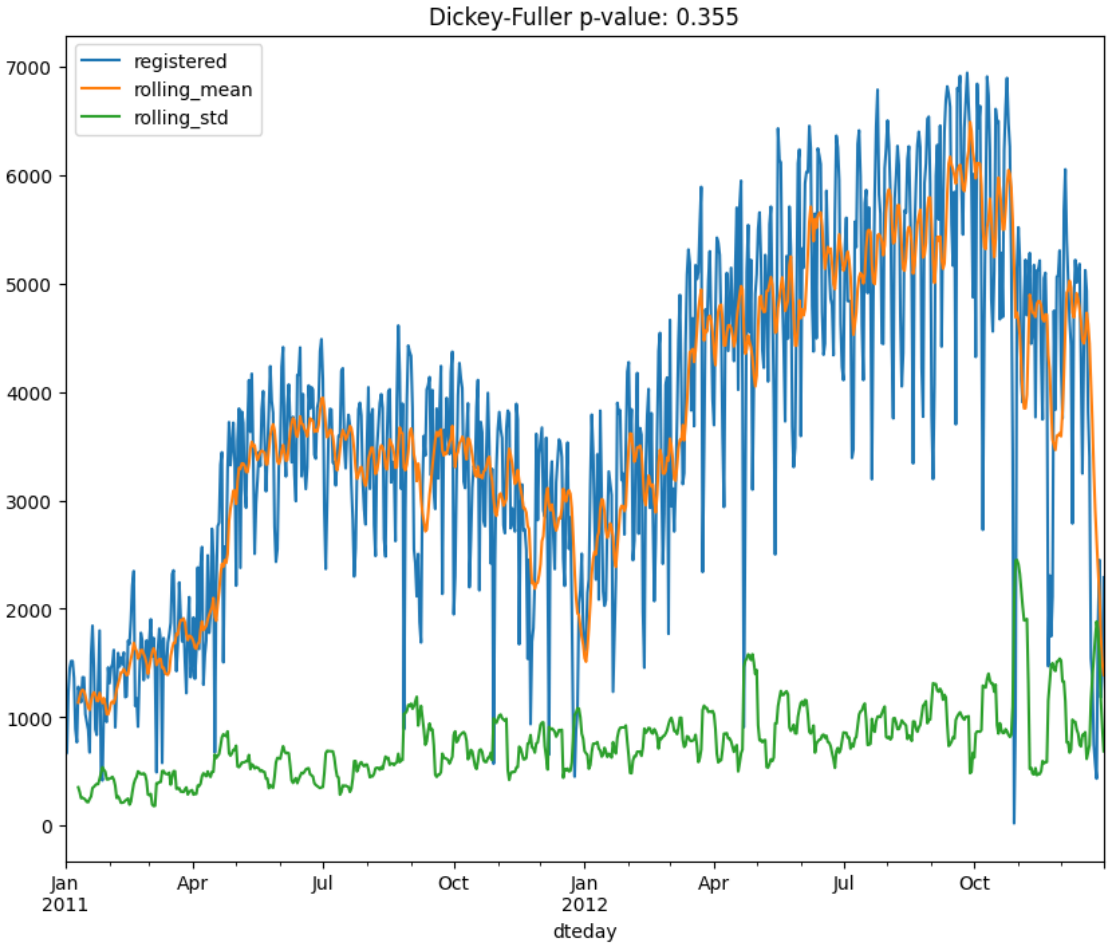

## 3 Time Series Analysis

[ ]:
```
from statsmodels.tsa.stattools import adfuller
def test_stationarity(ts, window=10, **kwargs):
  # create dataframe for plotting
  plot_data = pd.DataFrame(ts)
  plot_data['rolling_mean'] = ts.rolling(window).mean()
  plot_data['rolling_std'] = ts.rolling(window).std()
  # compute p-value of Dickey-Fuller test
  p_val = adfuller(ts)[1]
  ax = plot_data.plot(**kwargs)
  ax.set_title(f"Dickey-Fuller p-value: {p_val:.3f}")
```

[ ]:
```
daily_rides = preprocessed_data[["dteday", "registered", "casual"]]
daily_rides = daily_rides.groupby("dteday").sum()
# convert index to DateTime object
daily_rides.index = pd.to_datetime(daily_rides.index)
```

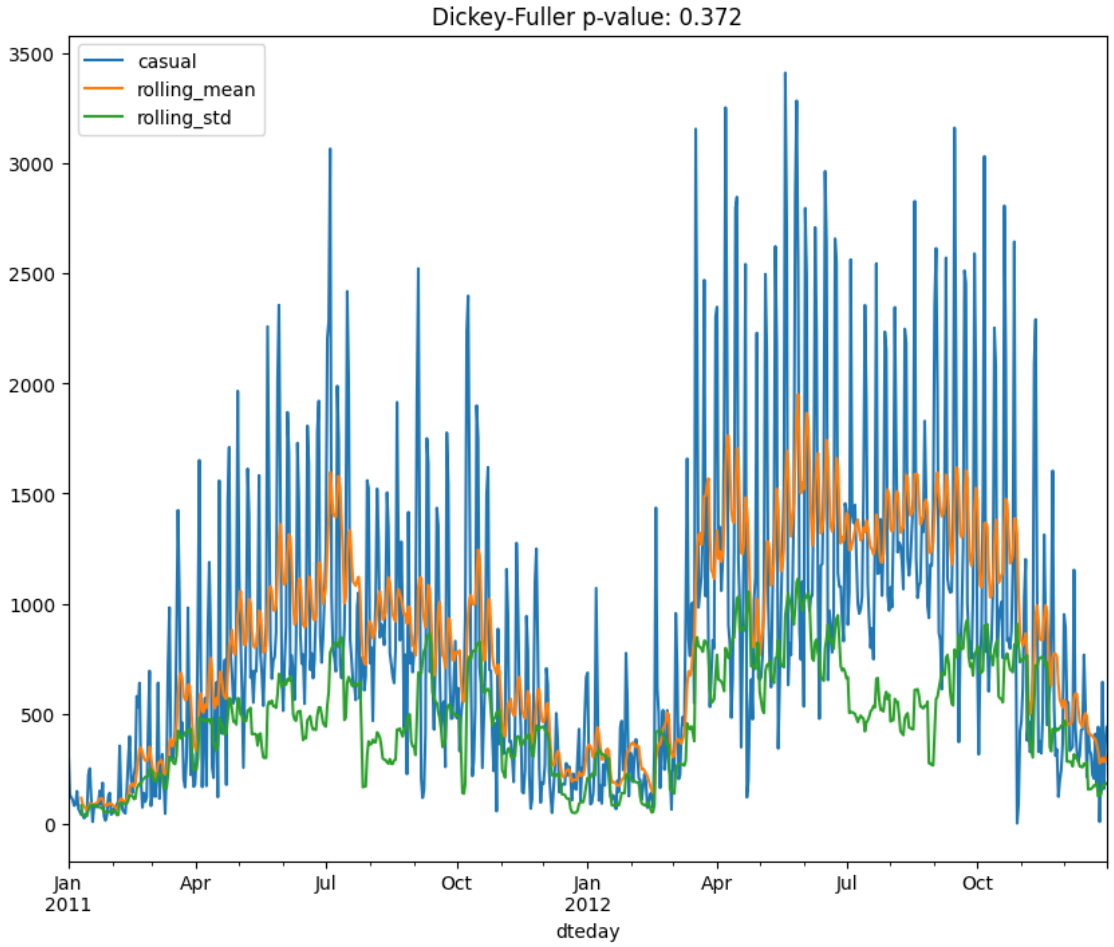
[ ]:
```
plt.figure()
test_stationarity(daily_rides.registered, figsize=(10, 8))
plt.show()
```

```
<Figure size 640x480 with 0 Axes>
```




[ ]:
```
plt.figure()
test_stationarity(daily_rides.casual, figsize=(10, 8))
plt.show()
```

```
<Figure size 640x480 with 0 Axes>
```



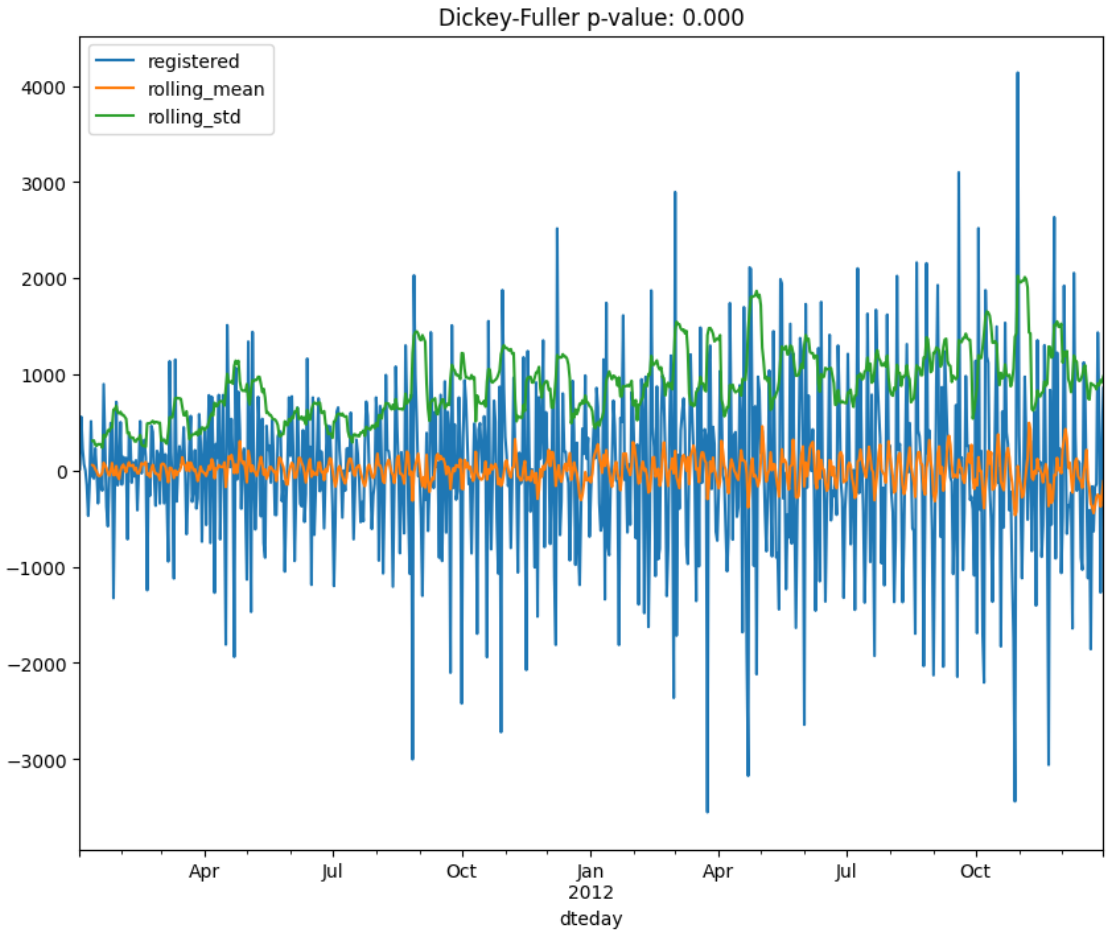

[ ]:

[ ]:
```
registered = daily_rides["registered"]
registered_ma = registered.rolling(10).mean()
registered_ma_diff = registered - registered_ma
registered_ma_diff.dropna(inplace=True)
casual = daily_rides["casual"]
casual_ma = casual.rolling(10).mean()
casual_ma_diff = casual - casual_ma
casual_ma_diff.dropna(inplace=True)
```

[ ]:
```
"""
here we make data stationary by subtract the rolling mean from each window
the other approch is to  subract the last value
"""
```

[ ]:
```
registered = daily_rides["registered"]
registered_diff = registered - registered.shift()
registered_diff.dropna(inplace=True)
casual = daily_rides["casual"]
casual_diff = casual - casual.shift()
casual_diff.dropna(inplace=True)
plt.figure()
test_stationarity(registered_diff, figsize=(10, 8))
plt.show
```

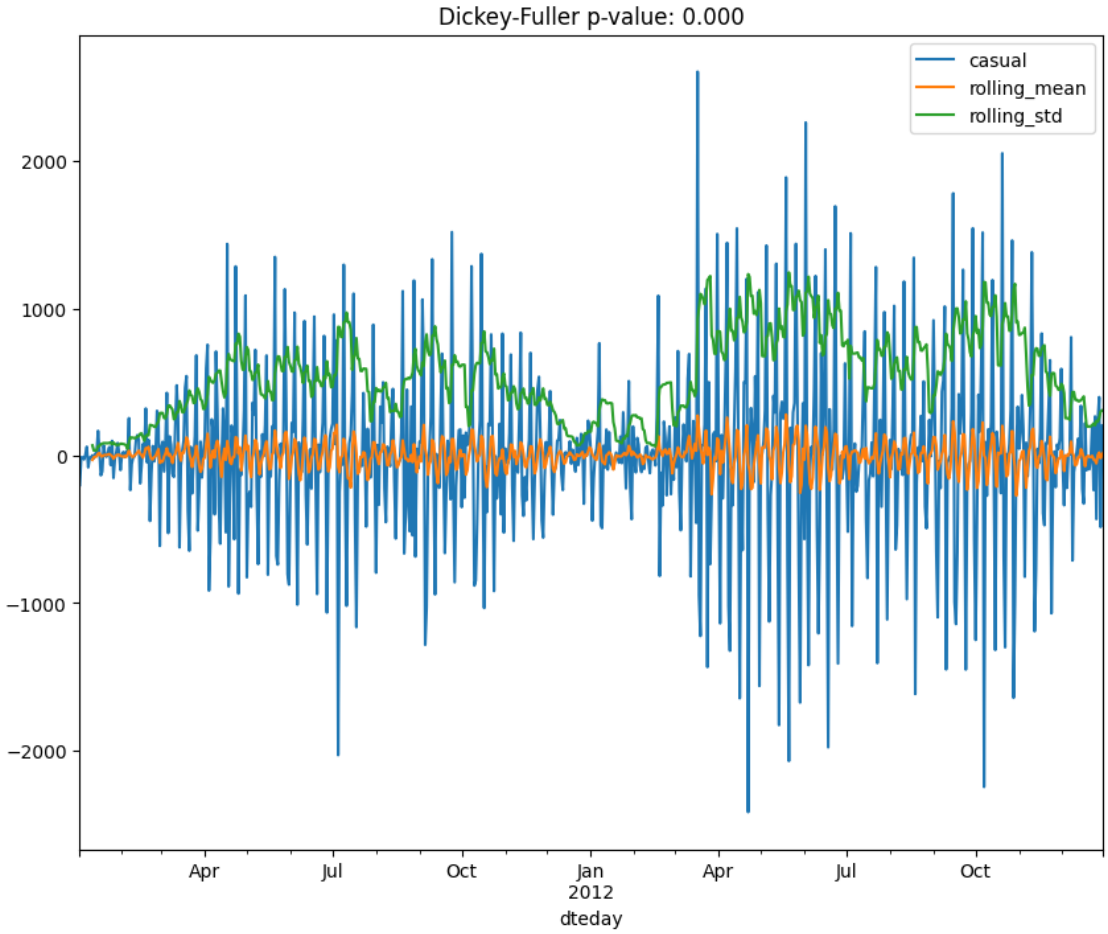
```
<Figure size 640x480 with 0 Axes>
```




[ ]:
```
<function matplotlib.pyplot.show(close=None, block=None)>
```

[ ]:
```
plt.figure()
test_stationarity(casual_diff, figsize=(10, 8))
plt.show()
```

```
<Figure size 640x480 with 0 Axes>
```

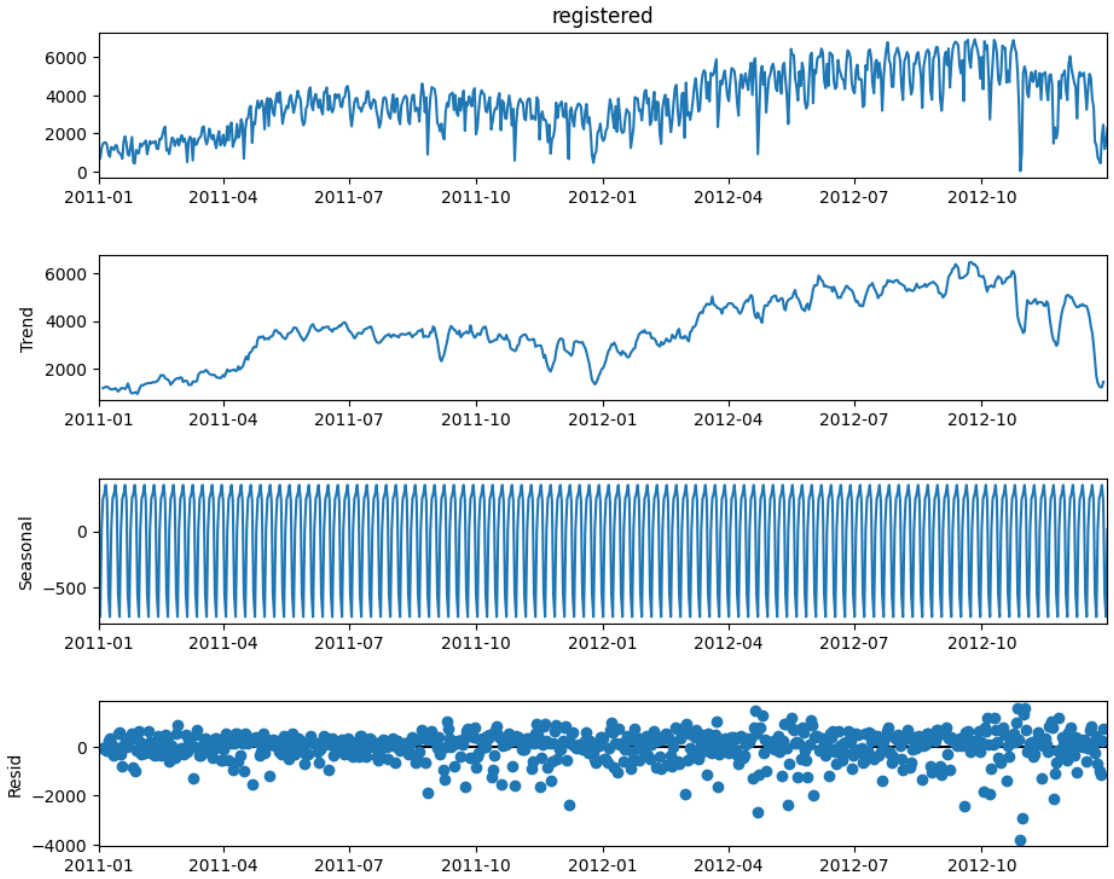



[ ]:
```
"""
as it showed it made the data stationary and the p-value is less than 0.05 so␣
 ↪we can reject the {Ho} which means data is stationay and we
accepted {Ha}

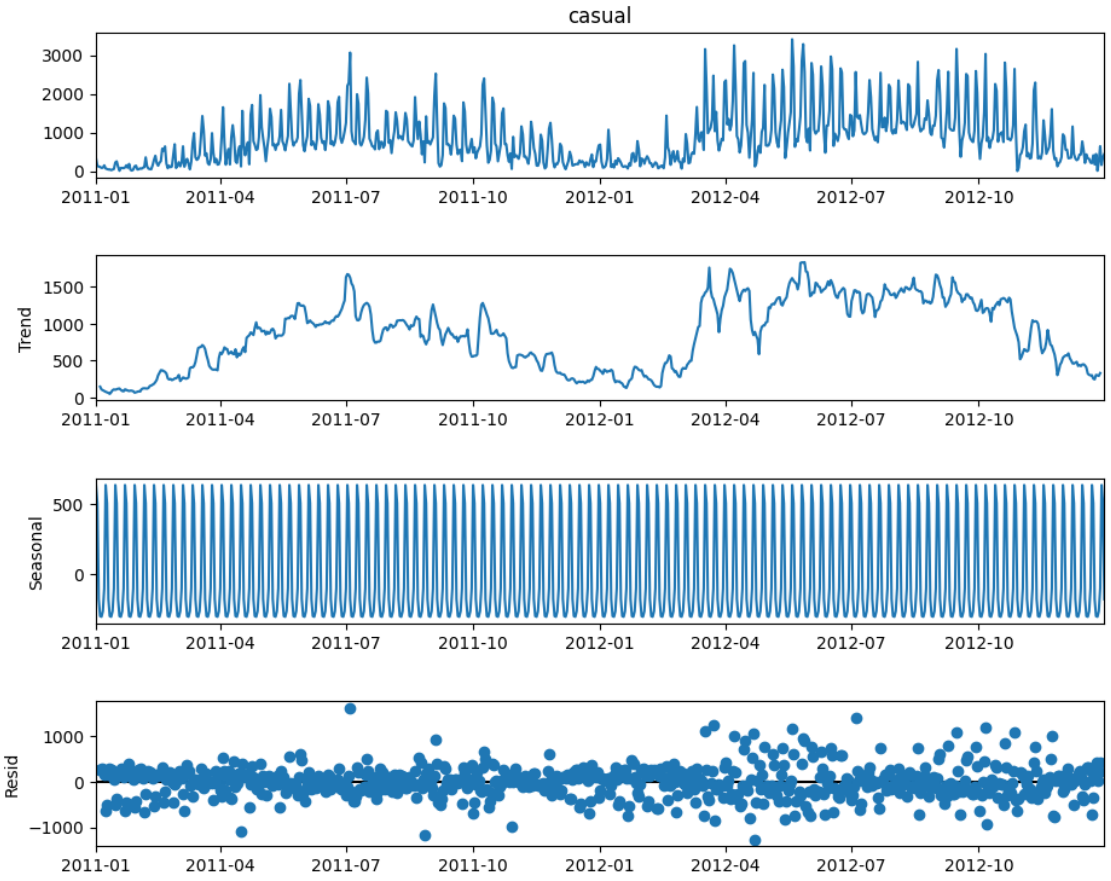

with stationary data we made sure that our assumtions of that during winter␣
 ↪ther are less casual rides than reg rides
"""
```

[ ]:
```
from statsmodels.tsa.seasonal import seasonal_decompose
registered_decomposition = seasonal_decompose(daily_rides["registered"])
casual_decomposition = seasonal_decompose(daily_rides["casual"])
```

[ ]:
```
registered_plot = registered_decomposition.plot()
registered_plot.set_size_inches(10, 8)
```

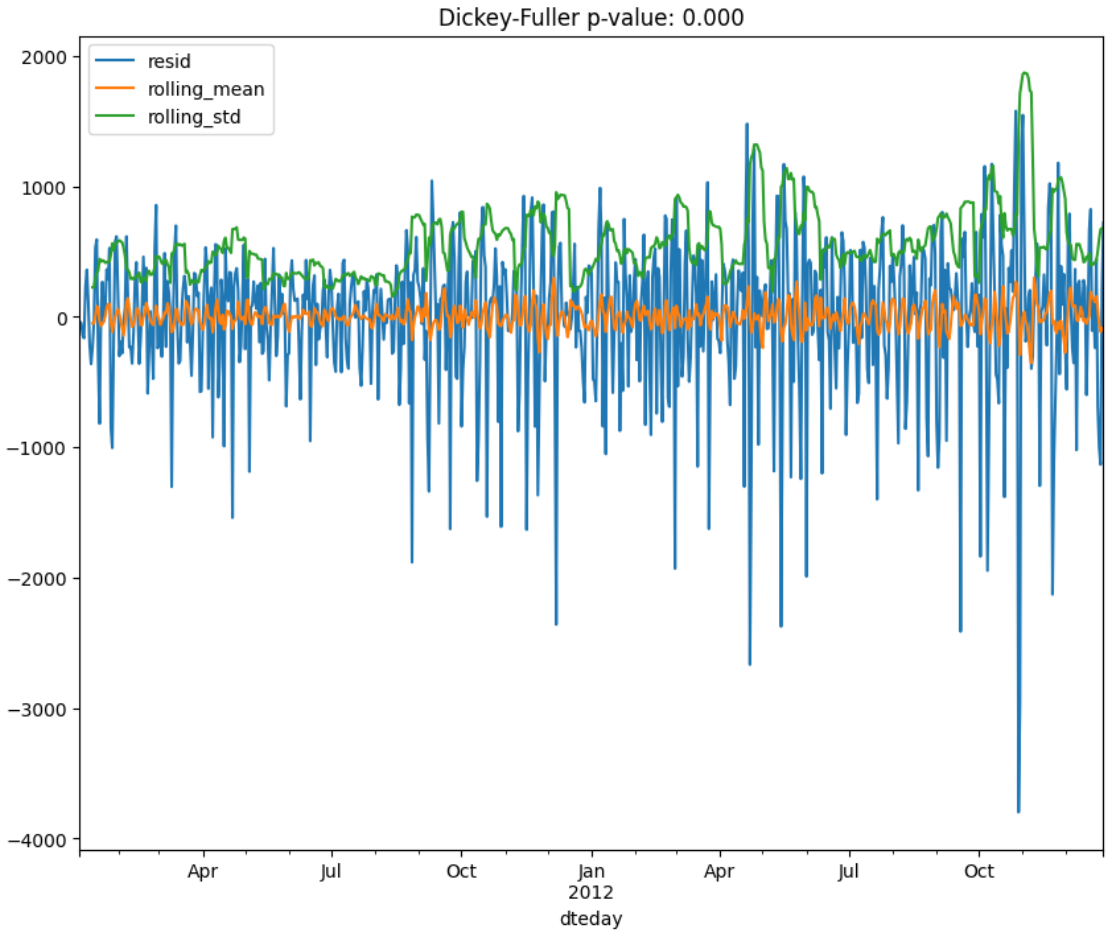



[ ]:
```
casual_plot = casual_decomposition.plot()
casual_plot.set_size_inches(10, 8)
```



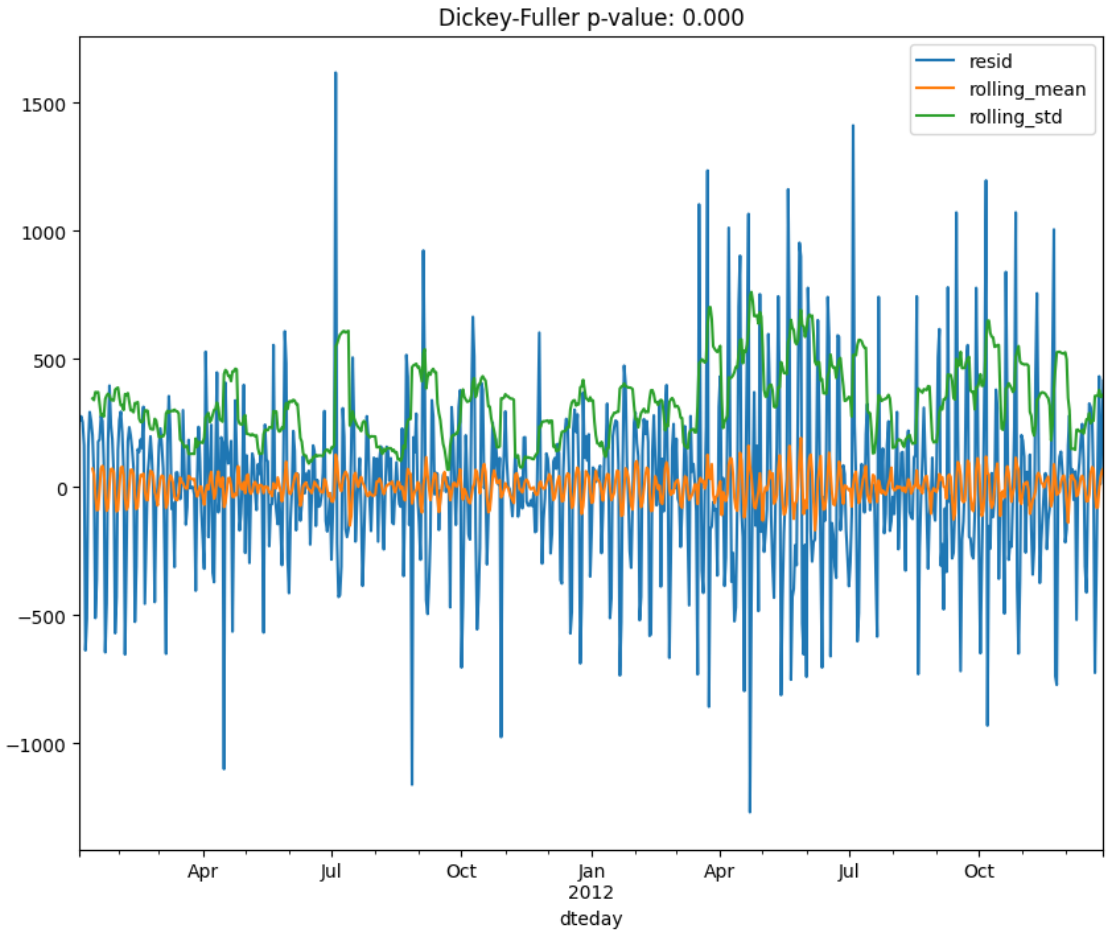

[ ]:
```
plt.figure()
test_stationarity(registered_decomposition.resid.dropna(), figsize=(10, 8))
```

```
<Figure size 640x480 with 0 Axes>
```




[ ]:
```
plt.figure()
test_stationarity(casual_decomposition.resid.dropna(), figsize=(10, 8))
```

```
<Figure size 640x480 with 0 Axes>
```




# 4 ARIMA Models

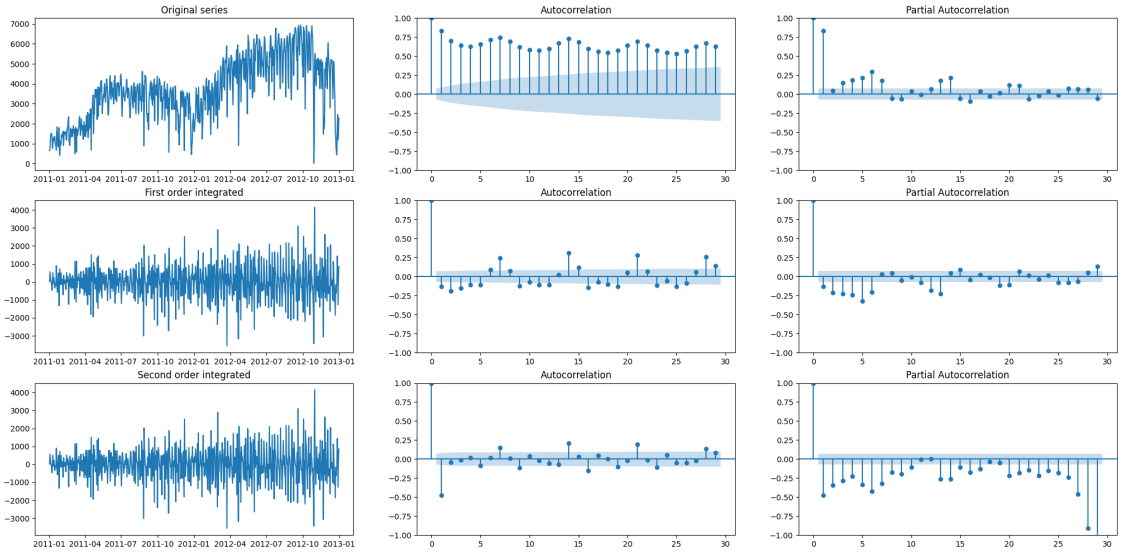
[ ]:
```
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf
```

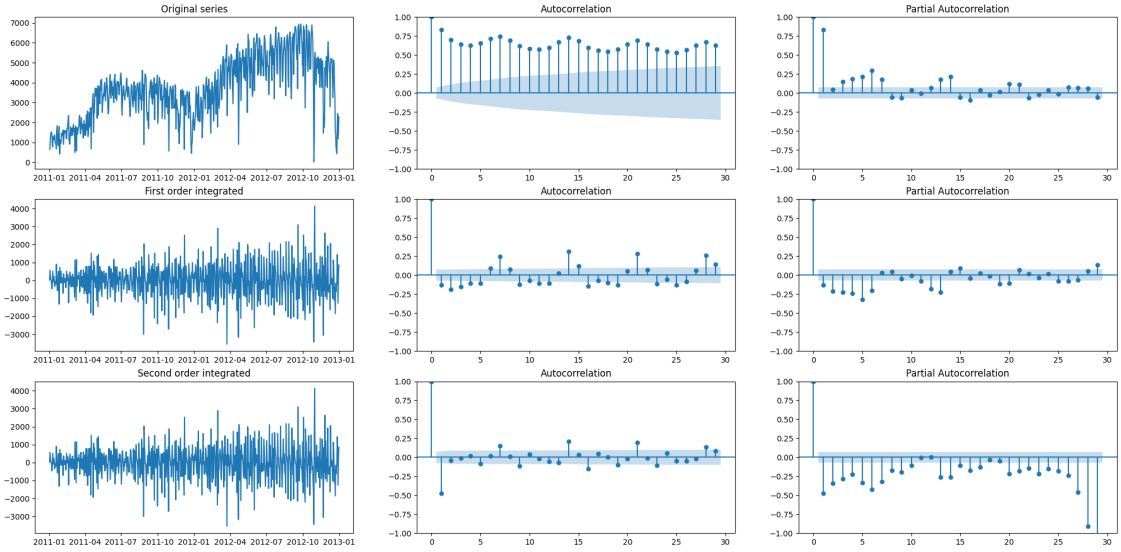
[ ]:
```
fig, axes = plt.subplots(3, 3, figsize=(25, 12))
# plot original series
original = daily_rides["registered"]
axes[0,0].plot(original)
axes[0,0].set_title("Original series")
plot_acf(original, ax=axes[0,1])
plot_pacf(original, ax=axes[0,2])
# plot first order integrated series
first_order_int = original.diff().dropna()
axes[1,0].plot(first_order_int)
axes[1,0].set_title("First order integrated")
plot_acf(first_order_int, ax=axes[1,1])
plot_pacf(first_order_int, ax=axes[1,2])
```

```
# plot first order integrated series
second_order_int = first_order_int.diff().dropna()
axes[2,0].plot(first_order_int)
axes[2,0].set_title("Second order integrated")
plot_acf(second_order_int, ax=axes[2,1])
plot_pacf(second_order_int, ax=axes[2,2])
```

```
/usr/local/lib/python3.10/dist-packages/statsmodels/graphics/tsaplots.py:348:
FutureWarning: The default method 'yw' can produce PACF values outside of the
[-1,1] interval. After 0.13, the default will change tounadjusted Yule-Walker
('ywm'). You can use this method now by setting method='ywm'.
  warnings.warn(
```

[ ]:



[ ]:
```
!pip install pmdarima
```

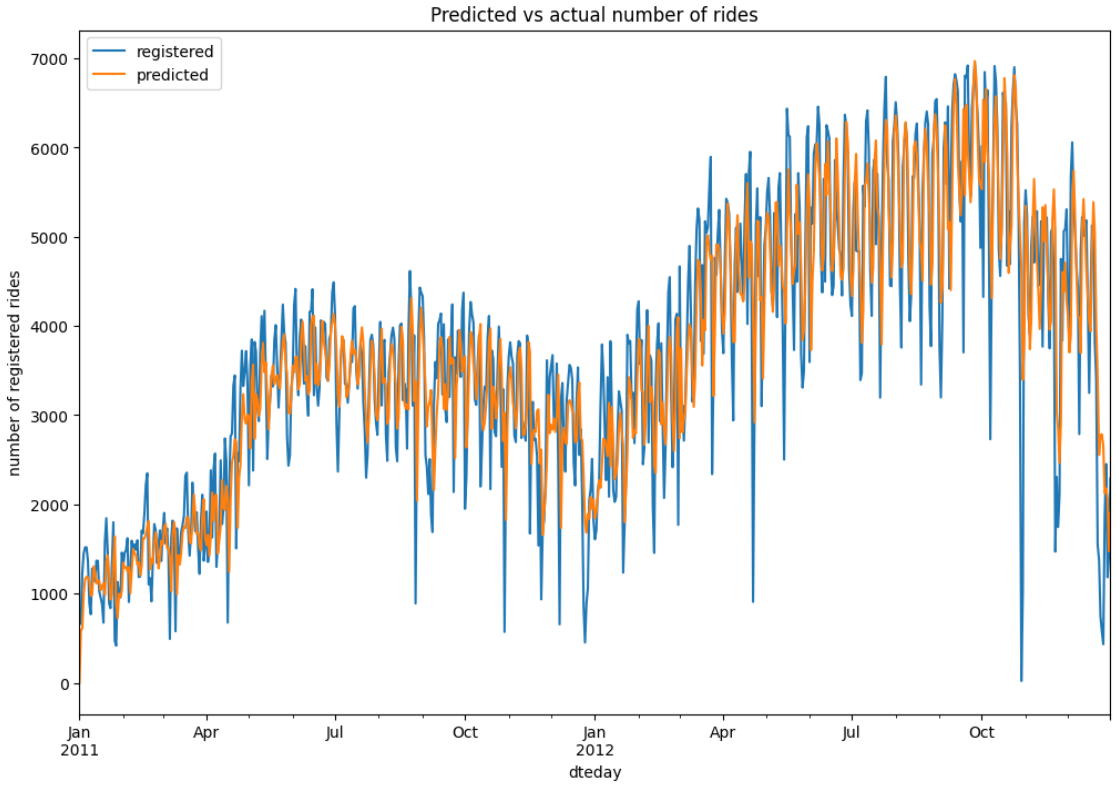
```
Collecting pmdarima
  Downloading pmdarima-2.0.3-cp310-cp310-
manylinux_2_17_x86_64.manylinux2014_x86_64.manylinux_2_28_x86_64.whl (1.8 MB)
                           1.8/1.8 MB
26.9 MB/s eta 0:00:00
Requirement already satisfied: joblib>=0.11 in
/usr/local/lib/python3.10/dist-packages (from pmdarima) (1.2.0)
Requirement already satisfied: Cython!=0.29.18,!=0.29.31,>=0.29 in
/usr/local/lib/python3.10/dist-packages (from pmdarima) (0.29.35)
Requirement already satisfied: numpy>=1.21.2 in /usr/local/lib/python3.10/dist-
packages (from pmdarima) (1.22.4)
Requirement already satisfied: pandas>=0.19 in /usr/local/lib/python3.10/dist-
packages (from pmdarima) (1.5.3)
Requirement already satisfied: scikit-learn>=0.22 in
/usr/local/lib/python3.10/dist-packages (from pmdarima) (1.2.2)
Requirement already satisfied: scipy>=1.3.2 in /usr/local/lib/python3.10/dist-
packages (from pmdarima) (1.10.1)
Requirement already satisfied: statsmodels>=0.13.2 in
/usr/local/lib/python3.10/dist-packages (from pmdarima) (0.13.5)
Requirement already satisfied: urllib3 in /usr/local/lib/python3.10/dist-
packages (from pmdarima) (1.26.16)
Requirement already satisfied: setuptools!=50.0.0,>=38.6.0 in
/usr/local/lib/python3.10/dist-packages (from pmdarima) (67.7.2)
Requirement already satisfied: python-dateutil>=2.8.1 in
/usr/local/lib/python3.10/dist-packages (from pandas>=0.19->pmdarima) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.10/dist-
packages (from pandas>=0.19->pmdarima) (2022.7.1)
Requirement already satisfied: threadpoolctl>=2.0.0 in
/usr/local/lib/python3.10/dist-packages (from scikit-learn>=0.22->pmdarima)
(3.1.0)
Requirement already satisfied: patsy>=0.5.2 in /usr/local/lib/python3.10/dist-
packages (from statsmodels>=0.13.2->pmdarima) (0.5.3)
Requirement already satisfied: packaging>=21.3 in
/usr/local/lib/python3.10/dist-packages (from statsmodels>=0.13.2->pmdarima)
(23.1)
Requirement already satisfied: six in /usr/local/lib/python3.10/dist-packages
(from patsy>=0.5.2->statsmodels>=0.13.2->pmdarima) (1.16.0)
Installing collected packages: pmdarima
Successfully installed pmdarima-2.0.3
```

[ ]:
```
from pmdarima import auto_arima
model = auto_arima(registered, start_p=1, start_q=1, max_p=3, max_q=3,␣
 ↪information_criterion="aic")
print(model.summary())
```

```
                               SARIMAX Results
==========================================================================================
Dep. Variable:                           y   No. Observations:                  731
Model:                 SARIMAX(3, 1, 3)   Log Likelihood               -5854.522
Date:                  Mon, 03 Jul 2023   AIC                          11723.045
Time:                          21:07:28   BIC                          11755.196
Sample:                    01-01-2011   HQIC                         11735.449
                         - 12-31-2012
Covariance Type:                   opg
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1          1.6068      0.050     32.293      0.000       1.509       1.704
ar.L2         -1.4465      0.062    -23.275      0.000      -1.568      -1.325
ar.L3          0.3601      0.049      7.356      0.000       0.264       0.456
ma.L1         -2.1137      0.034    -62.350      0.000      -2.180      -2.047
ma.L2          2.0590      0.047     43.929      0.000       1.967       2.151
ma.L3         -0.8601      0.032    -27.029      0.000      -0.922      -0.798
sigma2      6.239e+05   2.42e+04     25.791      0.000    5.77e+05    6.71e+05
==============================================================================
===
Ljung-Box (L1) (Q):                   0.37   Jarque-Bera (JB):
753.41
Prob(Q):                              0.55   Prob(JB):
0.00
Heteroskedasticity (H):               3.35   Skew:
-1.32
Prob(H) (two-sided):                  0.00   Kurtosis:
7.22
==============================================================================
===

Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-
step).
```

[ ]:
```
plot_data = pd.DataFrame(registered)
plot_data['predicted'] = model.predict_in_sample()
plot_data.plot(figsize=(12, 8))
plt.ylabel("number of registered rides")
plt.title("Predicted vs actual number of rides")
plt.show()
```




[ ]:

[ ]:

[ ]:
```
!sudo apt-get install texlive-xetex texlive-fonts-recommended␣
↪texlive-plain-generic
```

```
Reading package lists… Done
Building dependency tree
Reading state information… Done
The following additional packages will be installed:
  dvisvgm fonts-droid-fallback fonts-lato fonts-lmodern fonts-noto-mono
  fonts-texgyre fonts-urw-base35 javascript-common libapache-pom-java
  libcommons-logging-java libcommons-parent-java libfontbox-java libfontenc1
  libgs9 libgs9-common libharfbuzz-icu0 libidn11 libijs-0.35 libjbig2dec0
  libjs-jquery libkpathsea6 libpdfbox-java libptexenc1 libruby2.7 libsynctex2
  libteckit0 libtexlua53 libtexluajit2 libwoff1 libzzip-0-13 lmodern
  poppler-data preview-latex-style rake ruby ruby-minitest ruby-net-telnet
  ruby-power-assert ruby-test-unit ruby-xmlrpc ruby2.7 rubygems-integration
  t1utils teckit tex-common tex-gyre texlive-base texlive-binaries
  texlive-latex-base texlive-latex-extra texlive-latex-recommended
  texlive-pictures tipa xfonts-encodings xfonts-utils
```

```
Suggested packages:
  fonts-noto fonts-freefont-otf | fonts-freefont-ttf apache2 | lighttpd
  | httpd libavalon-framework-java libcommons-logging-java-doc
  libexcalibur-logkit-java liblog4j1.2-java poppler-utils ghostscript
  fonts-japanese-mincho | fonts-ipafont-mincho fonts-japanese-gothic
  | fonts-ipafont-gothic fonts-arphic-ukai fonts-arphic-uming fonts-nanum ri
  ruby-dev bundler debhelper gv | postscript-viewer perl-tk xpdf | pdf-viewer
  xzdec texlive-fonts-recommended-doc texlive-latex-base-doc python3-pygments
  icc-profiles libfile-which-perl libspreadsheet-parseexcel-perl
  texlive-latex-extra-doc texlive-latex-recommended-doc texlive-luatex
  texlive-pstricks dot2tex prerex ruby-tcltk | libtcltk-ruby
  texlive-pictures-doc vprerex default-jre-headless
The following NEW packages will be installed:
  dvisvgm fonts-droid-fallback fonts-lato fonts-lmodern fonts-noto-mono
  fonts-texgyre fonts-urw-base35 javascript-common libapache-pom-java
  libcommons-logging-java libcommons-parent-java libfontbox-java libfontenc1
  libgs9 libgs9-common libharfbuzz-icu0 libidn11 libijs-0.35 libjbig2dec0
  libjs-jquery libkpathsea6 libpdfbox-java libptexenc1 libruby2.7 libsynctex2
  libteckit0 libtexlua53 libtexluajit2 libwoff1 libzzip-0-13 lmodern
  poppler-data preview-latex-style rake ruby ruby-minitest ruby-net-telnet
  ruby-power-assert ruby-test-unit ruby-xmlrpc ruby2.7 rubygems-integration
  t1utils teckit tex-common tex-gyre texlive-base texlive-binaries
  texlive-fonts-recommended texlive-latex-base texlive-latex-extra
  texlive-latex-recommended texlive-pictures texlive-plain-generic
  texlive-xetex tipa xfonts-encodings xfonts-utils
0 upgraded, 58 newly installed, 0 to remove and 15 not upgraded.
Need to get 169 MB of archives.
After this operation, 537 MB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu focal/main amd64 fonts-droid-fallback all
1:6.0.1r16-1.1 [1,805 kB]
Get:2 http://archive.ubuntu.com/ubuntu focal/main amd64 fonts-lato all 2.0-2
[2,698 kB]
Get:3 http://archive.ubuntu.com/ubuntu focal/main amd64 poppler-data all 0.4.9-2
[1,475 kB]
Get:4 http://archive.ubuntu.com/ubuntu focal/universe amd64 tex-common all 6.13
[32.7 kB]
Get:5 http://archive.ubuntu.com/ubuntu focal/main amd64 fonts-urw-base35 all
20170801.1-3 [6,333 kB]
Get:6 http://archive.ubuntu.com/ubuntu focal-updates/main amd64 libgs9-common
all 9.50~dfsg-5ubuntu4.7 [681 kB]
Get:7 http://archive.ubuntu.com/ubuntu focal/main amd64 libidn11 amd64
1.33-2.2ubuntu2 [46.2 kB]
Get:8 http://archive.ubuntu.com/ubuntu focal/main amd64 libijs-0.35 amd64
0.35-15 [15.7 kB]
Get:9 http://archive.ubuntu.com/ubuntu focal/main amd64 libjbig2dec0 amd64
0.18-1ubuntu1 [60.0 kB]
Get:10 http://archive.ubuntu.com/ubuntu focal-updates/main amd64 libgs9 amd64
9.50~dfsg-5ubuntu4.7 [2,173 kB]
```

```
Get:11 http://archive.ubuntu.com/ubuntu focal-updates/main amd64 libkpathsea6
amd64 2019.20190605.51237-3ubuntu0.1 [57.0 kB]
Get:12 http://archive.ubuntu.com/ubuntu focal/main amd64 libwoff1 amd64
1.0.2-1build2 [42.0 kB]
Get:13 http://archive.ubuntu.com/ubuntu focal/universe amd64 dvisvgm amd64
2.8.1-1build1 [1,048 kB]
Get:14 http://archive.ubuntu.com/ubuntu focal/universe amd64 fonts-lmodern all
2.004.5-6 [4,532 kB]
Get:15 http://archive.ubuntu.com/ubuntu focal-updates/main amd64 fonts-noto-mono
all 20200323-1build1~ubuntu20.04.1 [80.6 kB]
Get:16 http://archive.ubuntu.com/ubuntu focal/universe amd64 fonts-texgyre all
20180621-3 [10.2 MB]
Get:17 http://archive.ubuntu.com/ubuntu focal/main amd64 javascript-common all
11 [6,066 B]
Get:18 http://archive.ubuntu.com/ubuntu focal/universe amd64 libapache-pom-java
all 18-1 [4,720 B]
Get:19 http://archive.ubuntu.com/ubuntu focal/universe amd64 libcommons-parent-
java all 43-1 [10.8 kB]
Get:20 http://archive.ubuntu.com/ubuntu focal/universe amd64 libcommons-logging-
java all 1.2-2 [60.3 kB]
Get:21 http://archive.ubuntu.com/ubuntu focal/main amd64 libfontenc1 amd64
1:1.1.4-0ubuntu1 [14.0 kB]
Get:22 http://archive.ubuntu.com/ubuntu focal-updates/main amd64 libharfbuzz-
icu0 amd64 2.6.4-1ubuntu4.2 [5,580 B]
Get:23 http://archive.ubuntu.com/ubuntu focal/main amd64 libjs-jquery all
3.3.1~dfsg-3 [329 kB]
Get:24 http://archive.ubuntu.com/ubuntu focal-updates/main amd64 libptexenc1
amd64 2019.20190605.51237-3ubuntu0.1 [35.5 kB]
Get:25 http://archive.ubuntu.com/ubuntu focal/main amd64 rubygems-integration
all 1.16 [5,092 B]
Get:26 http://archive.ubuntu.com/ubuntu focal-updates/main amd64 ruby2.7 amd64
2.7.0-5ubuntu1.11 [95.6 kB]
Get:27 http://archive.ubuntu.com/ubuntu focal/main amd64 ruby amd64 1:2.7+1
[5,412 B]
Get:28 http://archive.ubuntu.com/ubuntu focal/main amd64 rake all 13.0.1-4 [61.6
kB]
Get:29 http://archive.ubuntu.com/ubuntu focal/main amd64 ruby-minitest all
5.13.0-1 [40.9 kB]
Get:30 http://archive.ubuntu.com/ubuntu focal/main amd64 ruby-net-telnet all
0.1.1-2 [12.6 kB]
Get:31 http://archive.ubuntu.com/ubuntu focal/main amd64 ruby-power-assert all
1.1.7-1 [11.4 kB]
Get:32 http://archive.ubuntu.com/ubuntu focal/main amd64 ruby-test-unit all
3.3.5-1 [73.2 kB]
Get:33 http://archive.ubuntu.com/ubuntu focal/main amd64 ruby-xmlrpc all 0.3.0-2
[23.8 kB]
Get:34 http://archive.ubuntu.com/ubuntu focal-updates/main amd64 libruby2.7
amd64 2.7.0-5ubuntu1.11 [3,533 kB]
```

```
Get:35 http://archive.ubuntu.com/ubuntu focal-updates/main amd64 libsynctex2
amd64 2019.20190605.51237-3ubuntu0.1 [55.0 kB]
Get:36 http://archive.ubuntu.com/ubuntu focal/universe amd64 libteckit0 amd64
2.5.8+ds2-5ubuntu2 [320 kB]
Get:37 http://archive.ubuntu.com/ubuntu focal-updates/main amd64 libtexlua53
amd64 2019.20190605.51237-3ubuntu0.1 [105 kB]
Get:38 http://archive.ubuntu.com/ubuntu focal-updates/main amd64 libtexluajit2
amd64 2019.20190605.51237-3ubuntu0.1 [235 kB]
Get:39 http://archive.ubuntu.com/ubuntu focal/universe amd64 libzzip-0-13 amd64
0.13.62-3.2ubuntu1 [26.2 kB]
Get:40 http://archive.ubuntu.com/ubuntu focal/main amd64 xfonts-encodings all
1:1.0.5-0ubuntu1 [573 kB]
Get:41 http://archive.ubuntu.com/ubuntu focal/main amd64 xfonts-utils amd64
1:7.7+6 [91.5 kB]
Get:42 http://archive.ubuntu.com/ubuntu focal/universe amd64 lmodern all
2.004.5-6 [9,474 kB]
Get:43 http://archive.ubuntu.com/ubuntu focal/universe amd64 preview-latex-style
all 11.91-2ubuntu2 [184 kB]
Get:44 http://archive.ubuntu.com/ubuntu focal/main amd64 t1utils amd64 1.41-3
[56.1 kB]
Get:45 http://archive.ubuntu.com/ubuntu focal/universe amd64 teckit amd64
2.5.8+ds2-5ubuntu2 [687 kB]
Get:46 http://archive.ubuntu.com/ubuntu focal/universe amd64 tex-gyre all
20180621-3 [6,209 kB]
Get:47 http://archive.ubuntu.com/ubuntu focal-updates/universe amd64 texlive-
binaries amd64 2019.20190605.51237-3ubuntu0.1 [8,041 kB]
Get:48 http://archive.ubuntu.com/ubuntu focal/universe amd64 texlive-base all
2019.20200218-1 [20.8 MB]
Get:49 http://archive.ubuntu.com/ubuntu focal/universe amd64 texlive-fonts-
recommended all 2019.20200218-1 [4,972 kB]
Get:50 http://archive.ubuntu.com/ubuntu focal/universe amd64 texlive-latex-base
all 2019.20200218-1 [990 kB]
Get:51 http://archive.ubuntu.com/ubuntu focal/universe amd64 libfontbox-java all
1:1.8.16-2 [207 kB]
Get:52 http://archive.ubuntu.com/ubuntu focal/universe amd64 libpdfbox-java all
1:1.8.16-2 [5,199 kB]
Get:53 http://archive.ubuntu.com/ubuntu focal/universe amd64 texlive-latex-
recommended all 2019.20200218-1 [15.7 MB]
Get:54 http://archive.ubuntu.com/ubuntu focal/universe amd64 texlive-pictures
all 2019.20200218-1 [4,492 kB]
Get:55 http://archive.ubuntu.com/ubuntu focal/universe amd64 texlive-latex-extra
all 2019.202000218-1 [12.5 MB]
Get:56 http://archive.ubuntu.com/ubuntu focal/universe amd64 texlive-plain-
generic all 2019.202000218-1 [24.6 MB]
Get:57 http://archive.ubuntu.com/ubuntu focal/universe amd64 tipa all 2:1.3-20
[2,978 kB]
Get:58 http://archive.ubuntu.com/ubuntu focal/universe amd64 texlive-xetex all
2019.20200218-1 [14.6 MB]
```

```
Fetched 169 MB in 16s (10.4 MB/s)
debconf: unable to initialize frontend: Dialog
debconf: (No usable dialog-like program is installed, so the dialog based
frontend cannot be used. at /usr/share/perl5/Debconf/FrontEnd/Dialog.pm line 76,
<> line 58.)
debconf: falling back to frontend: Readline
debconf: unable to initialize frontend: Readline
debconf: (This frontend requires a controlling tty.)
debconf: falling back to frontend: Teletype
dpkg-preconfigure: unable to re-open stdin:
Selecting previously unselected package fonts-droid-fallback.
(Reading database … 123069 files and directories currently installed.)
Preparing to unpack …/00-fonts-droid-fallback_1%3a6.0.1r16-1.1_all.deb …
Unpacking fonts-droid-fallback (1:6.0.1r16-1.1) …
Selecting previously unselected package fonts-lato.
Preparing to unpack …/01-fonts-lato_2.0-2_all.deb …
Unpacking fonts-lato (2.0-2) …
Selecting previously unselected package poppler-data.
Preparing to unpack …/02-poppler-data_0.4.9-2_all.deb …
Unpacking poppler-data (0.4.9-2) …
Selecting previously unselected package tex-common.
Preparing to unpack …/03-tex-common_6.13_all.deb …
Unpacking tex-common (6.13) …
Selecting previously unselected package fonts-urw-base35.
Preparing to unpack …/04-fonts-urw-base35_20170801.1-3_all.deb …
Unpacking fonts-urw-base35 (20170801.1-3) …
Selecting previously unselected package libgs9-common.
Preparing to unpack …/05-libgs9-common_9.50~dfsg-5ubuntu4.7_all.deb …
Unpacking libgs9-common (9.50~dfsg-5ubuntu4.7) …
Selecting previously unselected package libidn11:amd64.
Preparing to unpack …/06-libidn11_1.33-2.2ubuntu2_amd64.deb …
Unpacking libidn11:amd64 (1.33-2.2ubuntu2) …
Selecting previously unselected package libijs-0.35:amd64.
Preparing to unpack …/07-libijs-0.35_0.35-15_amd64.deb …
Unpacking libijs-0.35:amd64 (0.35-15) …
Selecting previously unselected package libjbig2dec0:amd64.
Preparing to unpack …/08-libjbig2dec0_0.18-1ubuntu1_amd64.deb …
Unpacking libjbig2dec0:amd64 (0.18-1ubuntu1) …
Selecting previously unselected package libgs9:amd64.
Preparing to unpack …/09-libgs9_9.50~dfsg-5ubuntu4.7_amd64.deb …
Unpacking libgs9:amd64 (9.50~dfsg-5ubuntu4.7) …
Selecting previously unselected package libkpathsea6:amd64.
Preparing to unpack …/10-libkpathsea6_2019.20190605.51237-3ubuntu0.1_amd64.deb
…
Unpacking libkpathsea6:amd64 (2019.20190605.51237-3ubuntu0.1) …
Selecting previously unselected package libwoff1:amd64.
Preparing to unpack …/11-libwoff1_1.0.2-1build2_amd64.deb …
Unpacking libwoff1:amd64 (1.0.2-1build2) …
```

```
Selecting previously unselected package dvisvgm.
Preparing to unpack …/12-dvisvgm_2.8.1-1build1_amd64.deb …
Unpacking dvisvgm (2.8.1-1build1) …
Selecting previously unselected package fonts-lmodern.
Preparing to unpack …/13-fonts-lmodern_2.004.5-6_all.deb …
Unpacking fonts-lmodern (2.004.5-6) …
Selecting previously unselected package fonts-noto-mono.
Preparing to unpack …/14-fonts-noto-
mono_20200323-1build1~ubuntu20.04.1_all.deb …
Unpacking fonts-noto-mono (20200323-1build1~ubuntu20.04.1) …
Selecting previously unselected package fonts-texgyre.
Preparing to unpack …/15-fonts-texgyre_20180621-3_all.deb …
Unpacking fonts-texgyre (20180621-3) …
Selecting previously unselected package javascript-common.
Preparing to unpack …/16-javascript-common_11_all.deb …
Unpacking javascript-common (11) …
Selecting previously unselected package libapache-pom-java.
Preparing to unpack …/17-libapache-pom-java_18-1_all.deb …
Unpacking libapache-pom-java (18-1) …
Selecting previously unselected package libcommons-parent-java.
Preparing to unpack …/18-libcommons-parent-java_43-1_all.deb …
Unpacking libcommons-parent-java (43-1) …
Selecting previously unselected package libcommons-logging-java.
Preparing to unpack …/19-libcommons-logging-java_1.2-2_all.deb …
Unpacking libcommons-logging-java (1.2-2) …
Selecting previously unselected package libfontenc1:amd64.
Preparing to unpack …/20-libfontenc1_1%3a1.1.4-0ubuntu1_amd64.deb …
Unpacking libfontenc1:amd64 (1:1.1.4-0ubuntu1) …
Selecting previously unselected package libharfbuzz-icu0:amd64.
Preparing to unpack …/21-libharfbuzz-icu0_2.6.4-1ubuntu4.2_amd64.deb …
Unpacking libharfbuzz-icu0:amd64 (2.6.4-1ubuntu4.2) …
Selecting previously unselected package libjs-jquery.
Preparing to unpack …/22-libjs-jquery_3.3.1~dfsg-3_all.deb …
Unpacking libjs-jquery (3.3.1~dfsg-3) …
Selecting previously unselected package libptexenc1:amd64.
Preparing to unpack …/23-libptexenc1_2019.20190605.51237-3ubuntu0.1_amd64.deb
…
Unpacking libptexenc1:amd64 (2019.20190605.51237-3ubuntu0.1) …
Selecting previously unselected package rubygems-integration.
Preparing to unpack …/24-rubygems-integration_1.16_all.deb …
Unpacking rubygems-integration (1.16) …
Selecting previously unselected package ruby2.7.
Preparing to unpack …/25-ruby2.7_2.7.0-5ubuntu1.11_amd64.deb …
Unpacking ruby2.7 (2.7.0-5ubuntu1.11) …
Selecting previously unselected package ruby.
Preparing to unpack …/26-ruby_1%3a2.7+1_amd64.deb …
Unpacking ruby (1:2.7+1) …
Selecting previously unselected package rake.
```

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Preparing to unpack …/27-rake_13.0.1-4_all.deb …
Unpacking rake (13.0.1-4) …
Selecting previously unselected package ruby-minitest.
Preparing to unpack …/28-ruby-minitest_5.13.0-1_all.deb …
Unpacking ruby-minitest (5.13.0-1) …
Selecting previously unselected package ruby-net-telnet.
Preparing to unpack …/29-ruby-net-telnet_0.1.1-2_all.deb …
Unpacking ruby-net-telnet (0.1.1-2) …
Selecting previously unselected package ruby-power-assert.
Preparing to unpack …/30-ruby-power-assert_1.1.7-1_all.deb …
Unpacking ruby-power-assert (1.1.7-1) …
Selecting previously unselected package ruby-test-unit.
Preparing to unpack …/31-ruby-test-unit_3.3.5-1_all.deb …
Unpacking ruby-test-unit (3.3.5-1) …
Selecting previously unselected package ruby-xmlrpc.
Preparing to unpack …/32-ruby-xmlrpc_0.3.0-2_all.deb …
Unpacking ruby-xmlrpc (0.3.0-2) …
Selecting previously unselected package libruby2.7:amd64.
Preparing to unpack …/33-libruby2.7_2.7.0-5ubuntu1.11_amd64.deb …
Unpacking libruby2.7:amd64 (2.7.0-5ubuntu1.11) …
Selecting previously unselected package libsynctex2:amd64.
Preparing to unpack …/34-libsynctex2_2019.20190605.51237-3ubuntu0.1_amd64.deb
…
Unpacking libsynctex2:amd64 (2019.20190605.51237-3ubuntu0.1) …
Selecting previously unselected package libteckit0:amd64.
Preparing to unpack …/35-libteckit0_2.5.8+ds2-5ubuntu2_amd64.deb …
Unpacking libteckit0:amd64 (2.5.8+ds2-5ubuntu2) …
Selecting previously unselected package libtexlua53:amd64.
Preparing to unpack …/36-libtexlua53_2019.20190605.51237-3ubuntu0.1_amd64.deb
…
Unpacking libtexlua53:amd64 (2019.20190605.51237-3ubuntu0.1) …
Selecting previously unselected package libtexluajit2:amd64.
Preparing to unpack
…/37-libtexluajit2_2019.20190605.51237-3ubuntu0.1_amd64.deb …
Unpacking libtexluajit2:amd64 (2019.20190605.51237-3ubuntu0.1) …
Selecting previously unselected package libzzip-0-13:amd64.
Preparing to unpack …/38-libzzip-0-13_0.13.62-3.2ubuntu1_amd64.deb …
Unpacking libzzip-0-13:amd64 (0.13.62-3.2ubuntu1) …
Selecting previously unselected package xfonts-encodings.
Preparing to unpack …/39-xfonts-encodings_1%3a1.0.5-0ubuntu1_all.deb …
Unpacking xfonts-encodings (1:1.0.5-0ubuntu1) …
Selecting previously unselected package xfonts-utils.
Preparing to unpack …/40-xfonts-utils_1%3a7.7+6_amd64.deb …
Unpacking xfonts-utils (1:7.7+6) …
Selecting previously unselected package lmodern.
Preparing to unpack …/41-lmodern_2.004.5-6_all.deb …
Unpacking lmodern (2.004.5-6) …
Selecting previously unselected package preview-latex-style.
```

```
Preparing to unpack …/42-preview-latex-style_11.91-2ubuntu2_all.deb …
Unpacking preview-latex-style (11.91-2ubuntu2) …
Selecting previously unselected package t1utils.
Preparing to unpack …/43-t1utils_1.41-3_amd64.deb …
Unpacking t1utils (1.41-3) …
Selecting previously unselected package teckit.
Preparing to unpack …/44-teckit_2.5.8+ds2-5ubuntu2_amd64.deb …
Unpacking teckit (2.5.8+ds2-5ubuntu2) …
Selecting previously unselected package tex-gyre.
Preparing to unpack …/45-tex-gyre_20180621-3_all.deb …
Unpacking tex-gyre (20180621-3) …
Selecting previously unselected package texlive-binaries.
Preparing to unpack …/46-texlive-
binaries_2019.20190605.51237-3ubuntu0.1_amd64.deb …
Unpacking texlive-binaries (2019.20190605.51237-3ubuntu0.1) …
Selecting previously unselected package texlive-base.
Preparing to unpack …/47-texlive-base_2019.20200218-1_all.deb …
Unpacking texlive-base (2019.20200218-1) …
Selecting previously unselected package texlive-fonts-recommended.
Preparing to unpack …/48-texlive-fonts-recommended_2019.20200218-1_all.deb …
Unpacking texlive-fonts-recommended (2019.20200218-1) …
Selecting previously unselected package texlive-latex-base.
Preparing to unpack …/49-texlive-latex-base_2019.20200218-1_all.deb …
Unpacking texlive-latex-base (2019.20200218-1) …
Selecting previously unselected package libfontbox-java.
Preparing to unpack …/50-libfontbox-java_1%3a1.8.16-2_all.deb …
Unpacking libfontbox-java (1:1.8.16-2) …
Selecting previously unselected package libpdfbox-java.
Preparing to unpack …/51-libpdfbox-java_1%3a1.8.16-2_all.deb …
Unpacking libpdfbox-java (1:1.8.16-2) …
Selecting previously unselected package texlive-latex-recommended.
Preparing to unpack …/52-texlive-latex-recommended_2019.20200218-1_all.deb …
Unpacking texlive-latex-recommended (2019.20200218-1) …
Selecting previously unselected package texlive-pictures.
Preparing to unpack …/53-texlive-pictures_2019.20200218-1_all.deb …
Unpacking texlive-pictures (2019.20200218-1) …
Selecting previously unselected package texlive-latex-extra.
Preparing to unpack …/54-texlive-latex-extra_2019.202000218-1_all.deb …
Unpacking texlive-latex-extra (2019.202000218-1) …
Selecting previously unselected package texlive-plain-generic.
Preparing to unpack …/55-texlive-plain-generic_2019.202000218-1_all.deb …
Unpacking texlive-plain-generic (2019.202000218-1) …
```

[ ]:
```
!jupyter nbconvert --to pdf /content/drive/MyDrive/DA_Projects/Bike_shareING/
↪B_S.ipynb
```