Bike Rentals

Data Analysis

Current Catalysts:

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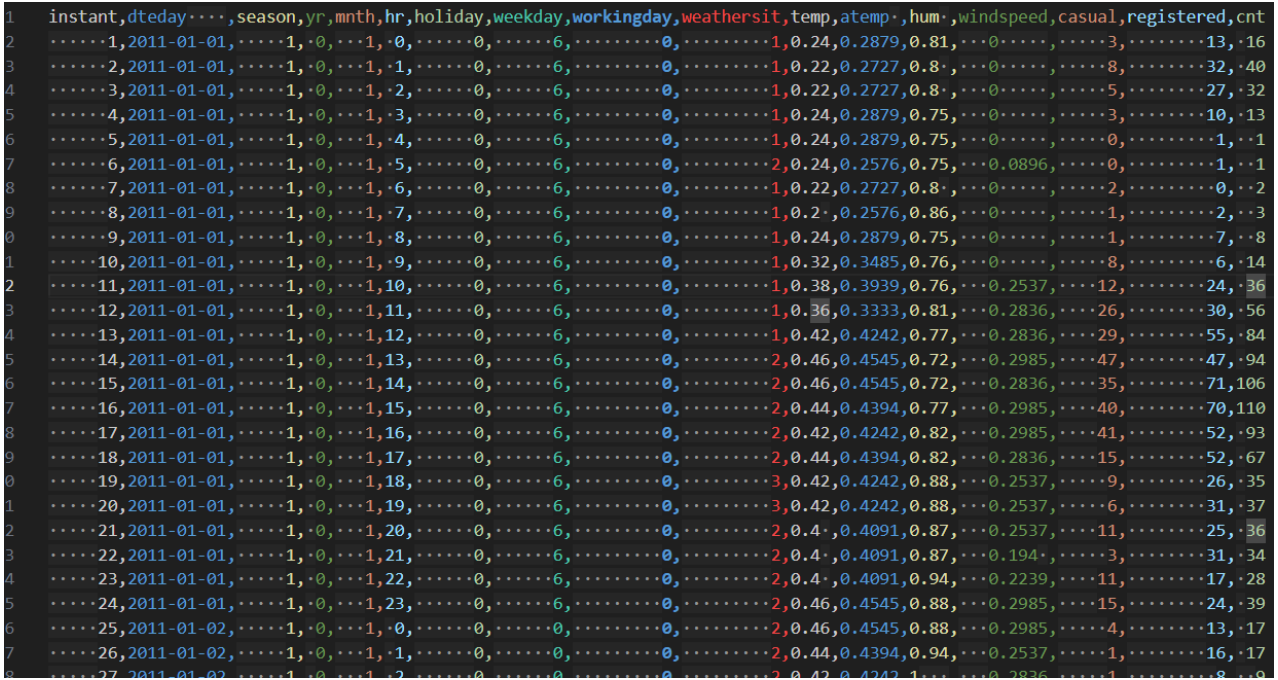
Data Set



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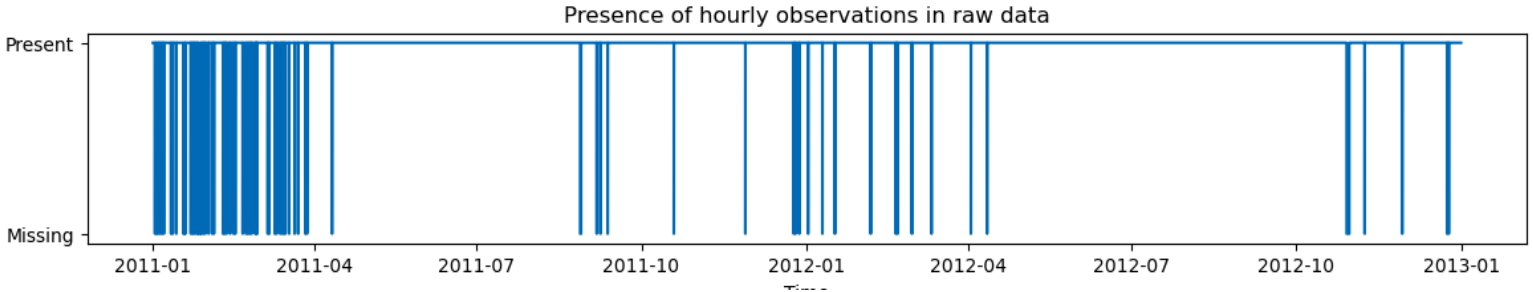
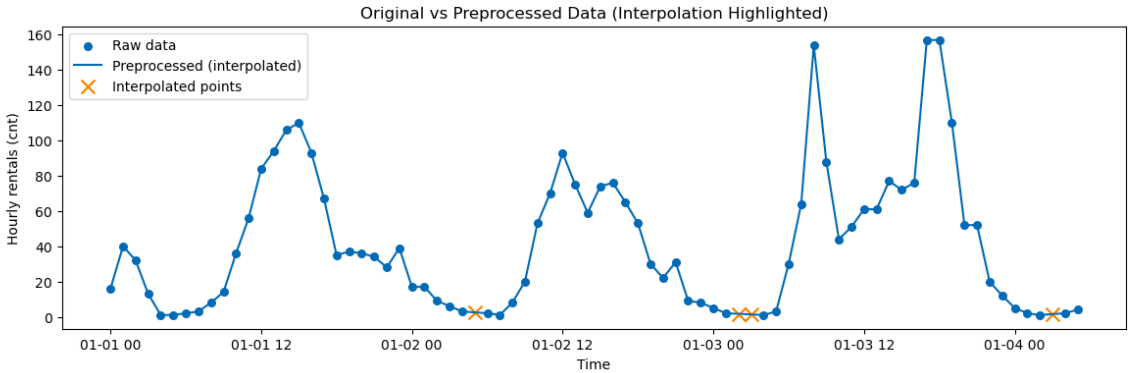
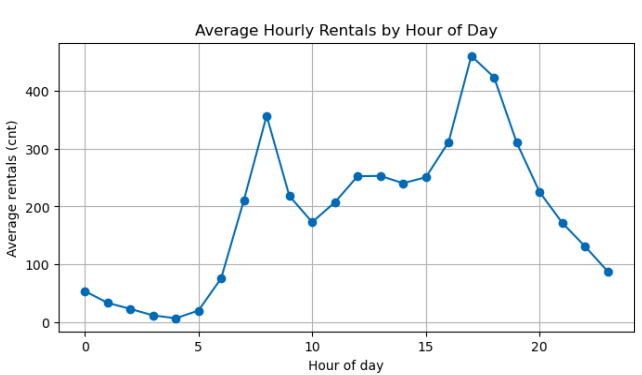
Missing Timestamps in Data and Interpolation

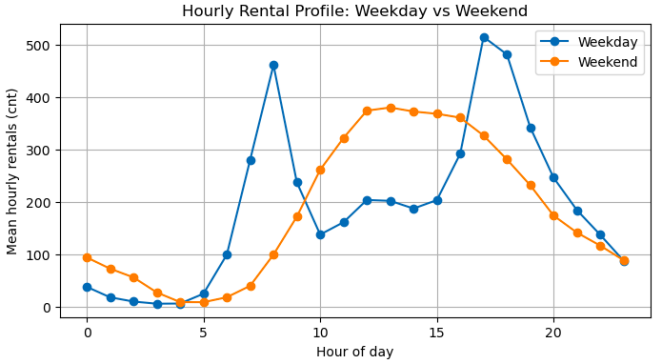


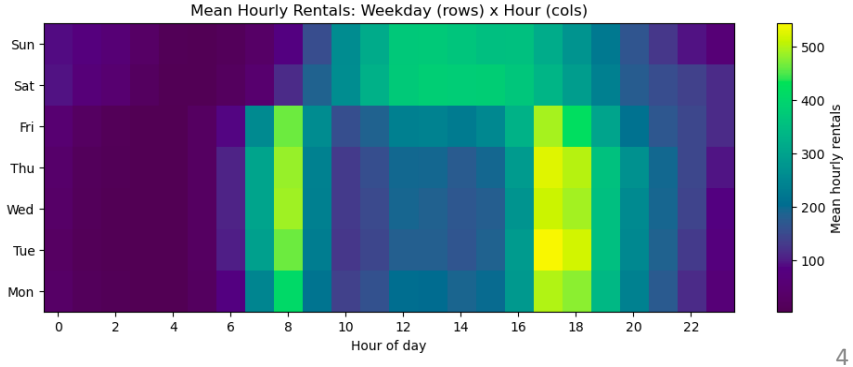


Mean Rentals of Bikes

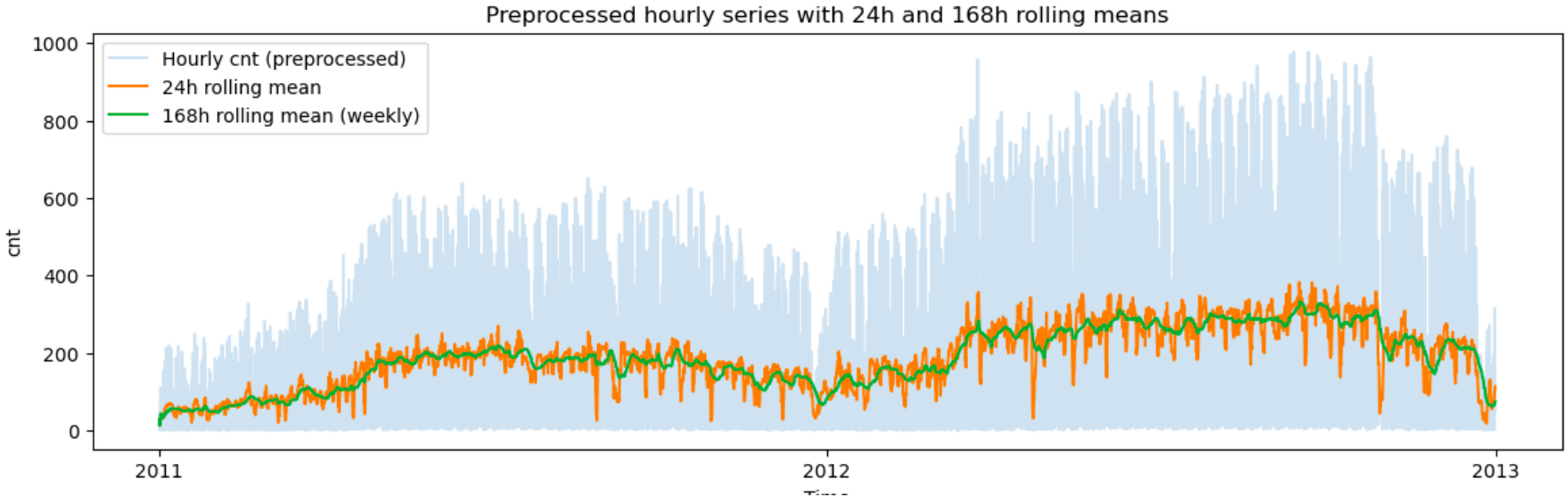
- Peak in rentals is observed during weekdays at
  - Morning hour around 0800.
  - During evening around 1800.
- Peak rentals is observed during weekend.
  - Between 1000 hrs and 1600 hrs.





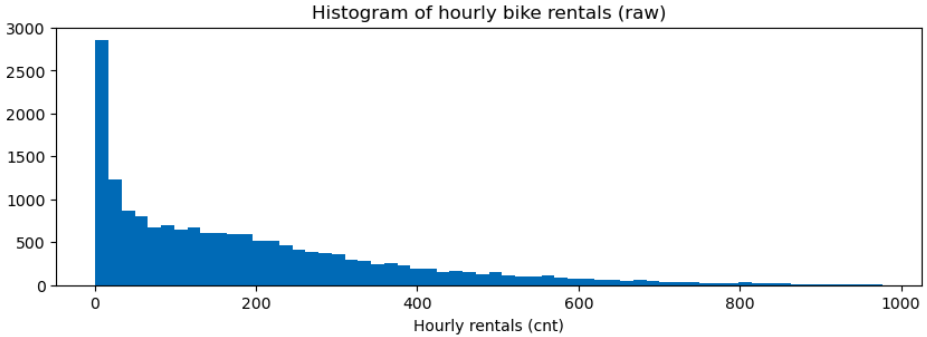


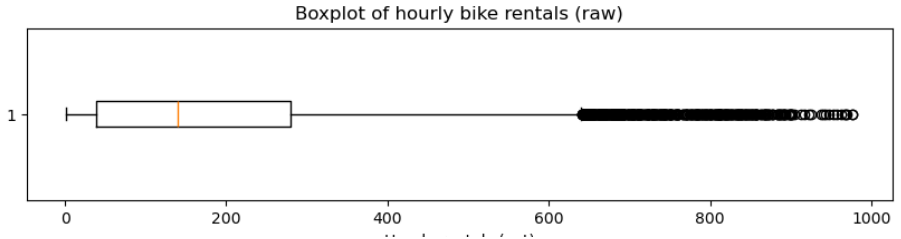
Preprocessing of data with 24h and 168h Rolling means



Histogram and Boxplot of Bike rentals.

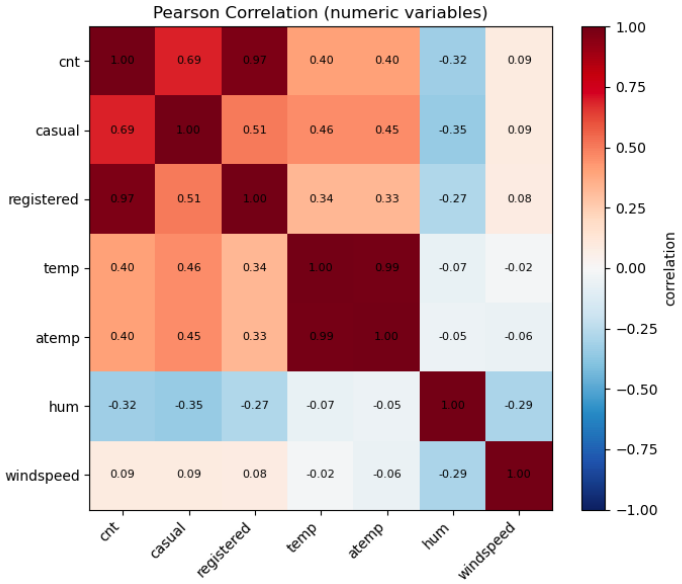
- Most of the data points are centered around at 0.
- Large number of rentals are observed very less time.
- Median of data is at around 140.
- A lot of Data points are above the maximum limit of outliers.
    - These data points are still covered in the data and are not filtered.
    - We are interested in the large numbers of rentals in particular hours.



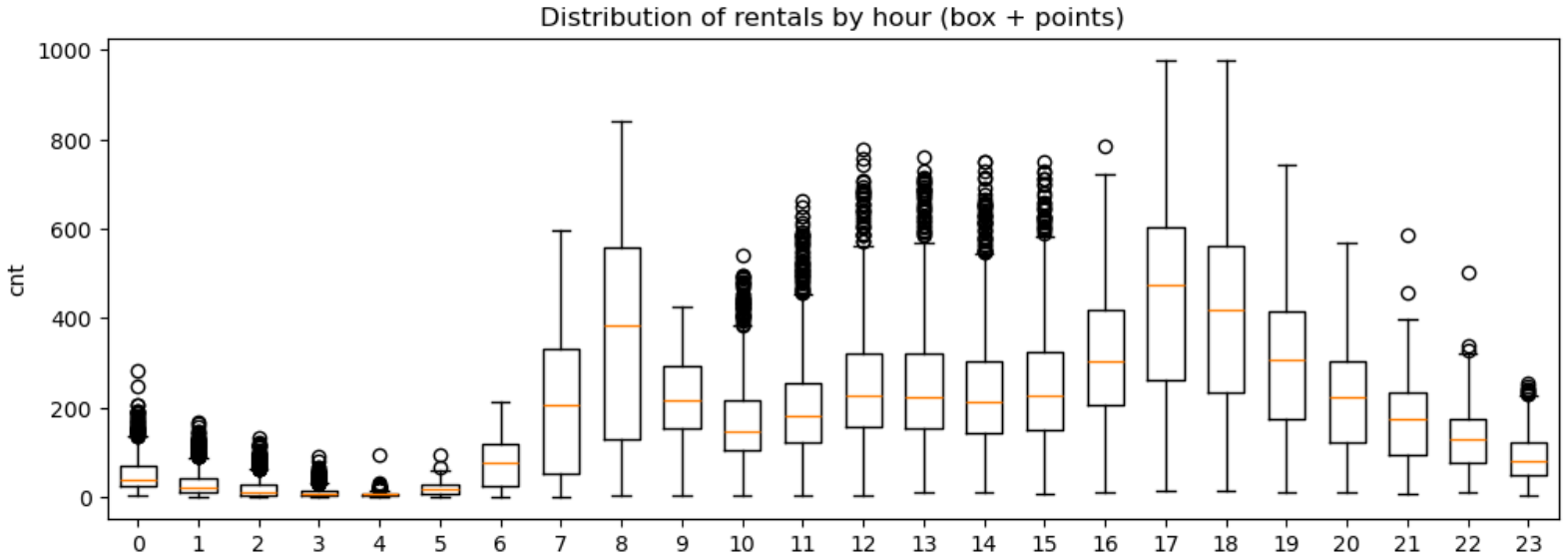


Pearson Correlation Matrix

- Pearson correlation matrix is used to observe the linear relationship between the number of hourly rentals and different parameters.
- Our only parameter of concern in temperature to analyze the data.
- We see that correlation appears to be 0.40 with the temperature which signifies a linear relationship between the hourly rentals and temperature.
    - If temperature increases (summers) the number of rentals are also increased.



Boxplot of rentals Per Day for Whole Data

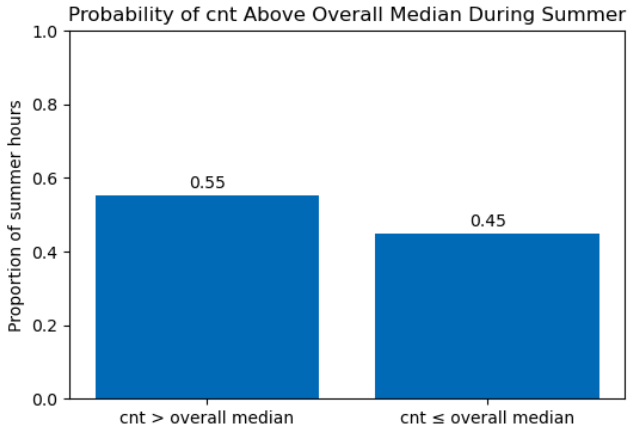


Probability of Rentals above overall median during Summers

- It is an Empirical probability
  - Because we are observing the real data and not the theoretical model.
  - Probability that rentals are above overall median given that it is summer.
  - Total number of hours in summer are 4409.
  - 2435 hrs the rentals are above overall median.
  - `P(cnt > overall median | summer) = 0.5523 (55.23%)`

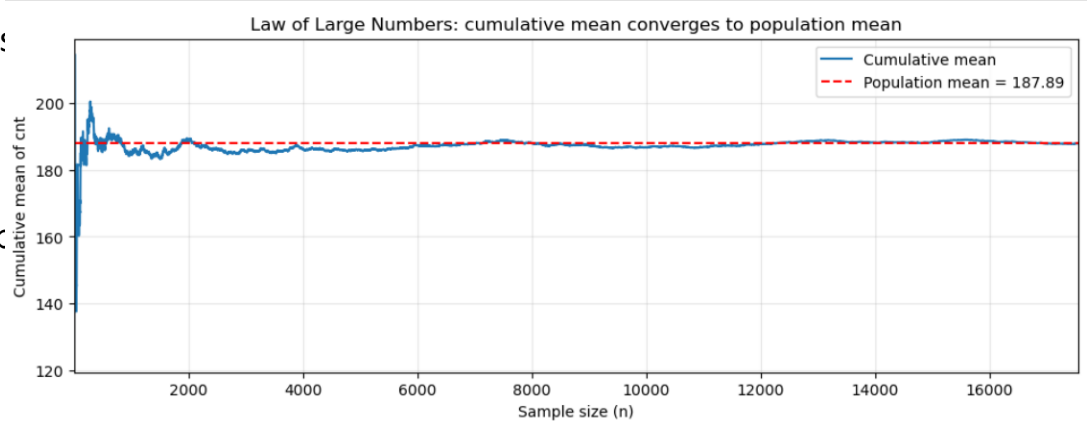
```
Overall median cnt = 140.0
Number of summer hours = 4409
Number of summer hours above overall median = 2435

Empirical probability:
P(cnt > overall median | summer) = 0.5523 (55.23%)
```



Law of Large Numbers

- As the number of observations increases, sample averages converge to the true population value.
- Cumulative probability of high-demand hours stabilizes as more hourly observations are included.
- Temporal dependence in hourly data slows convergence compared to independent samp but convergence is still observable.
- LLN justifies using long-term averages and empirical probabilities for stable demand estimation.



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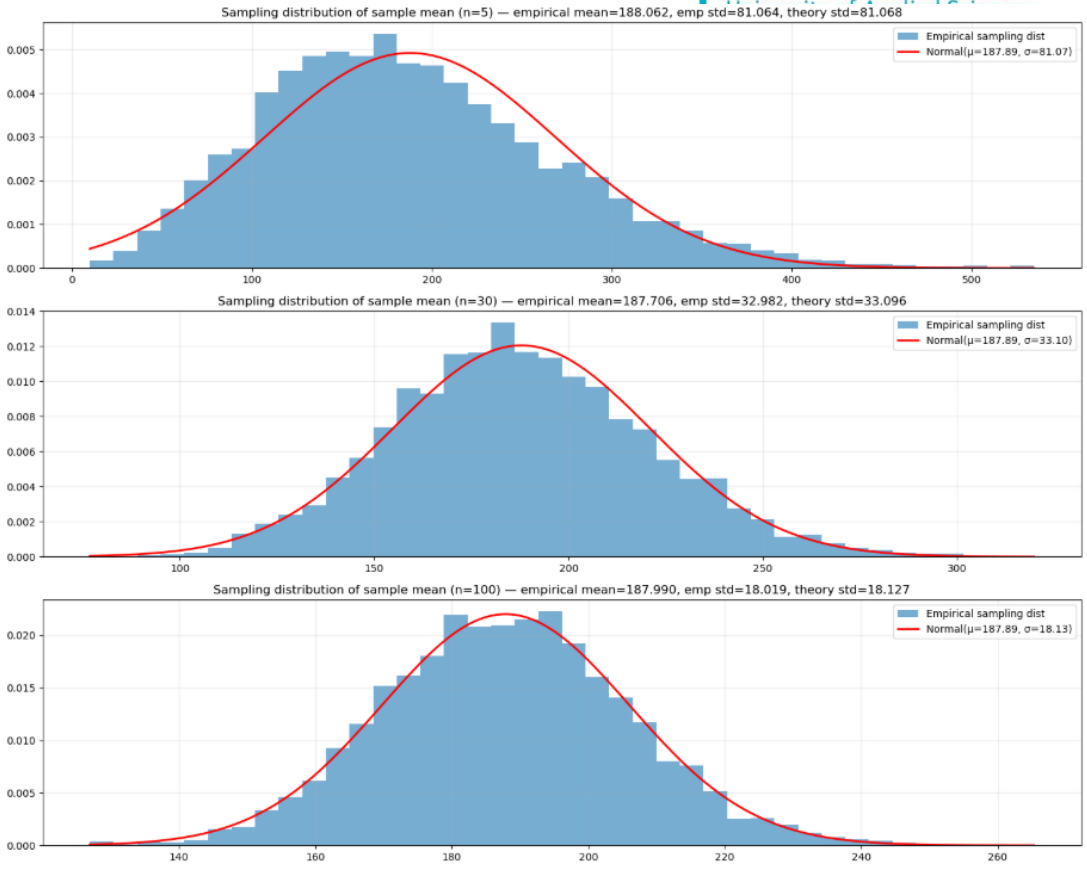
Central Limit Theorem

- The distribution of sample means approaches a normal distribution as sample size increases.
- sampling distributions of mean hourly rentals become more symmetric and concentrated with larger sample sizes.
- Larger samples reduce variability of the sample mean, improving stability and reliability of estimates.



Residual Analysis

- Residuals are centered around zero, indicating no strong systematic bias.
- Most prediction errors are small, showing that the model performs well for typical demand level
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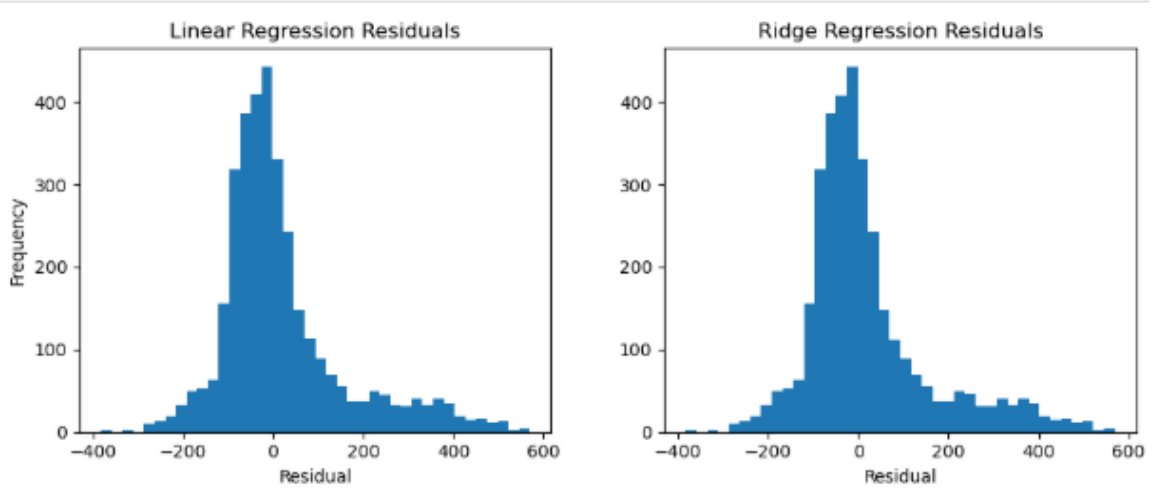
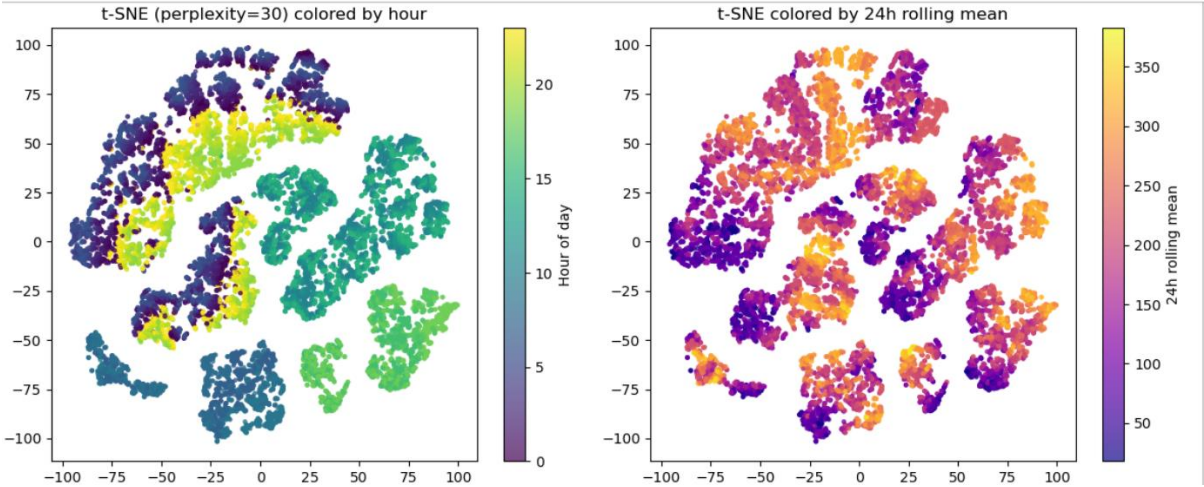


t-SNE

- The hour-of-day coloring transitions smoothly inside and across clusters, indicating that time of day is a major organizing factor.
- Each island groups hours with similar feature patterns.
- The rolling-mean coloring shows that clusters also separate by baseline demand intensity (low vs. high average usage)

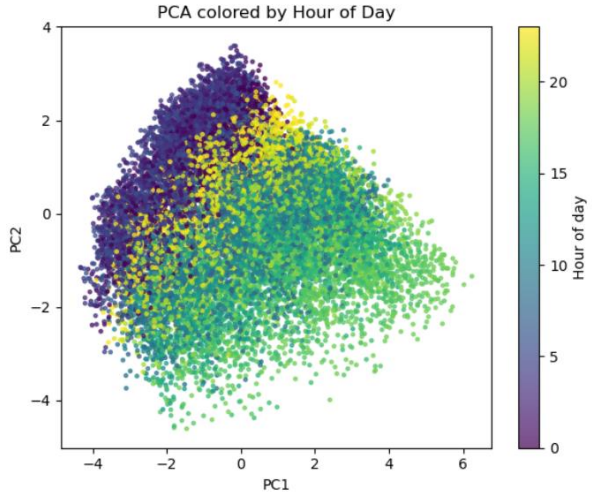


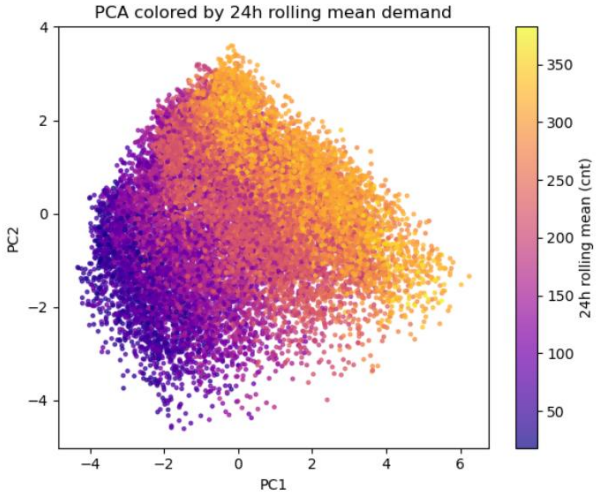
PC1 x PC2

PC plot shows the data projected onto the first two principal components, which capture the largest sources of variance in the dataset.

coloring by hour of day shows a smooth gradient, indicating that daily usage cycles are a major contributor to variance.

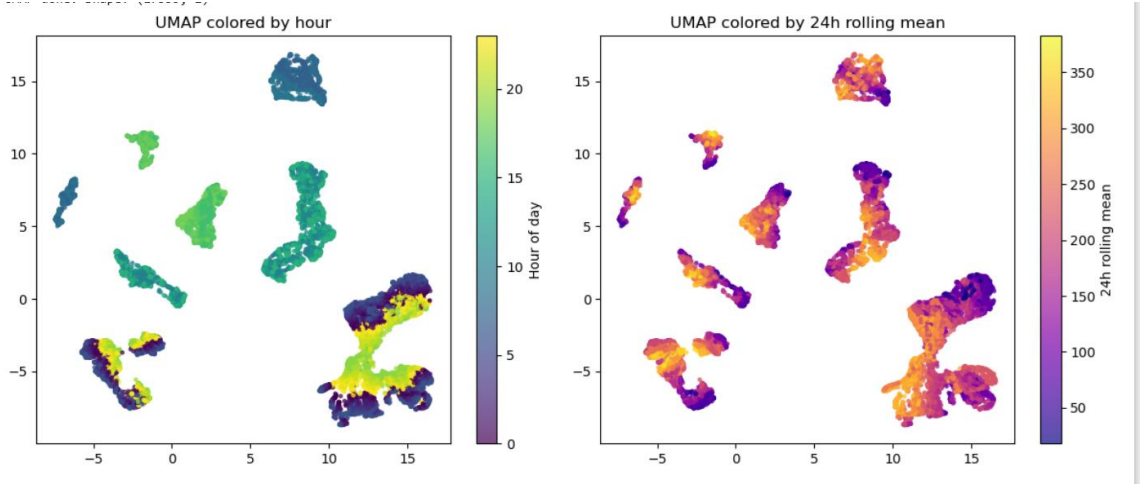
coloring by the 24-hour rolling mean demand shows an even clearer separation along PC1, suggesting that PC1 represents baseline demand intensity.





U-MAP

- UMAP produces clearer, more separated islands that preserve both local clusters and some global relationships
- UMAP produces distinct islands that correspond to groups of hours with similar features.
- Rolling-mean coloring clusters together regions of similar baseline demand — islands with warmer colors correspond to consistently higher-demand regimes



Q&A