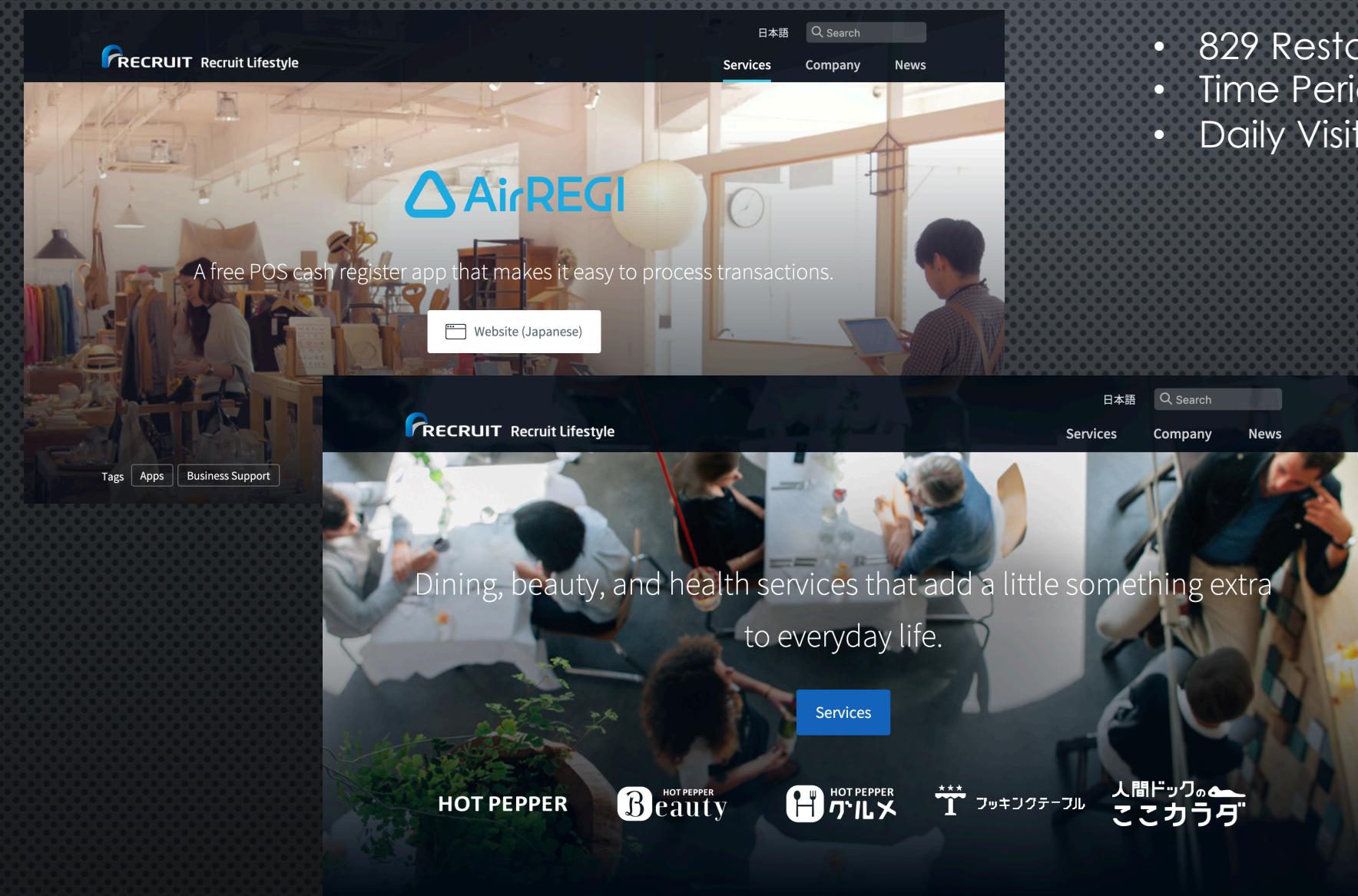


„ „AirReg Website, Restaurant Visitor Forecasting”



BE PREPARED! VISITORS ARE COMING :)

# DATA AVAILABLE THROUGH AirREGI WEBSITE



- 829 Restaurants across Japan
- Time Period 1.5 years
- Daily Visitors Records

Available Data:

Main:  
air\_store\_id  
visit\_datetime  
visitors

Related:  
reserve\_datetime  
reserve\_visitors  
air\_genre\_name  
air\_area\_name  
latitude  
longitude

# APPROACH

## Time Series (univariate)

Auto\_arima(p,d,q)(P,D,Q,m)

p- autoregressive term

d- degree differencing

q- moving average order

P- seasonal autoregressive term

D- seasonal degree differencing

Q- seasonal moving average order

m- “mystery component”

Evaluation: AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion) values are estimators to compare models.

## Prophet (Facebook freeware)

Fully automated .

Built-in cross validation function.

Robust to outliers, missing data, sharp change.

Still has tunable parameters.

## Regression (multivariate)

### Engineer Features:

Deconstructed Date, Weekday,

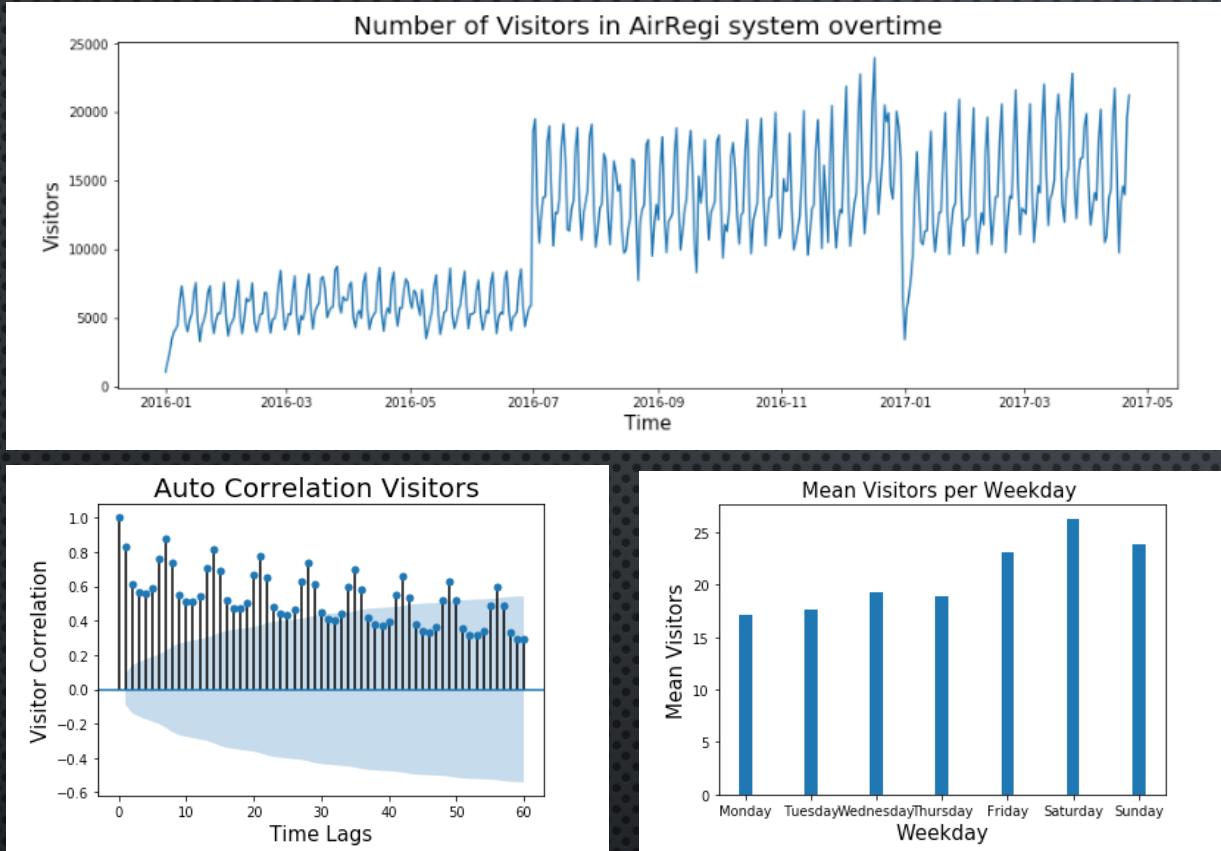
Area name, Geo Location, Food Genre,

Statistical Summaries

### Fit, Transform, Evaluate:



# EXPLORING DATA TIME CORRELATION

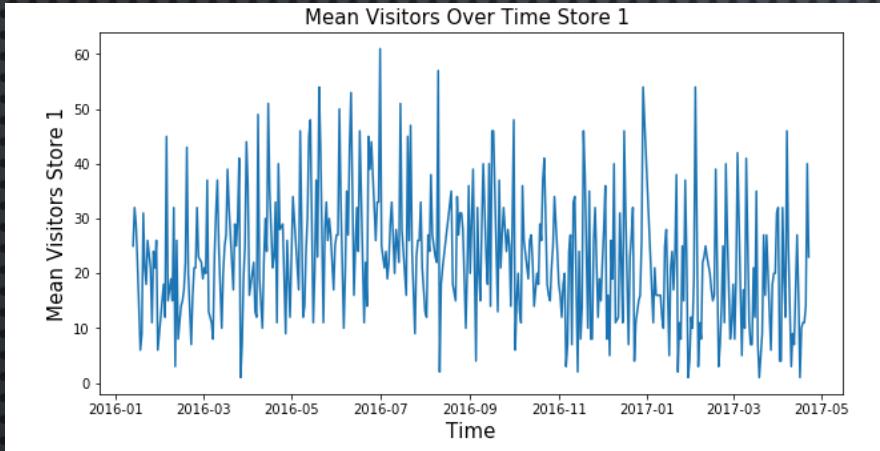


- Restaurants were added to the system June 2016
- Strong weekly trends for all restaurants
- Baseline prediction score was established  
Baseline 1:  
Mean visitors per weekday across for each restaurant

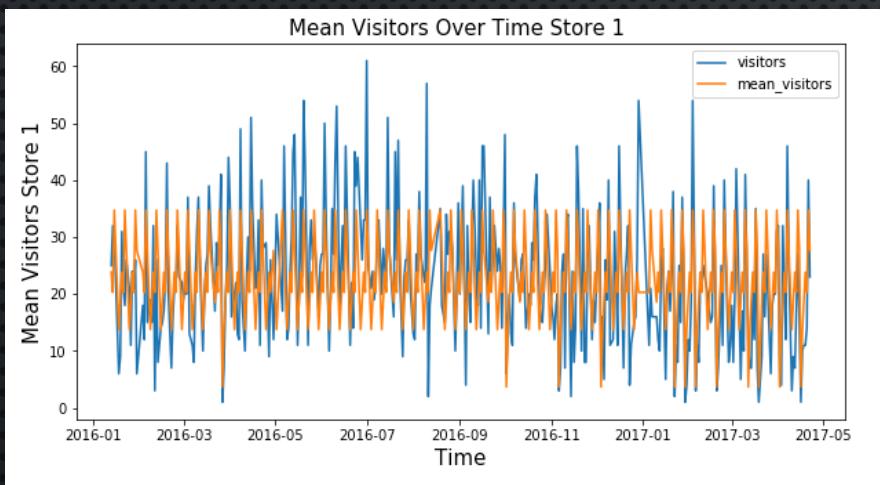
How about individual restaurant trends ?

	RMSE	R^2
Baseline 1	16.43	0.04

# WHEN WEEKLY MEANS ARE NOT ENOUGH

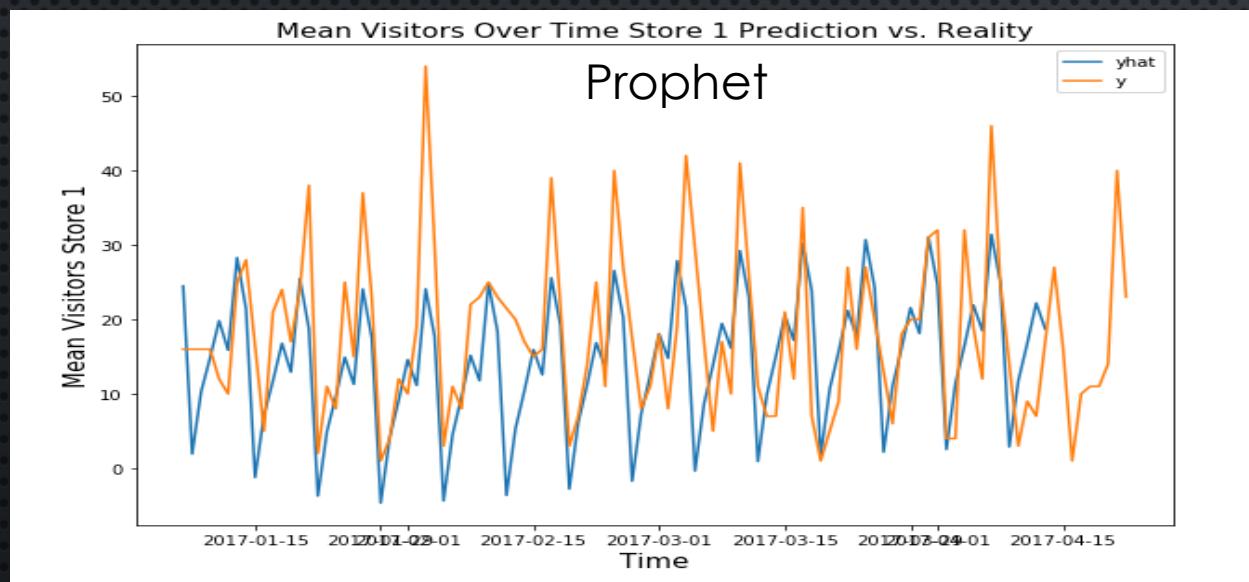
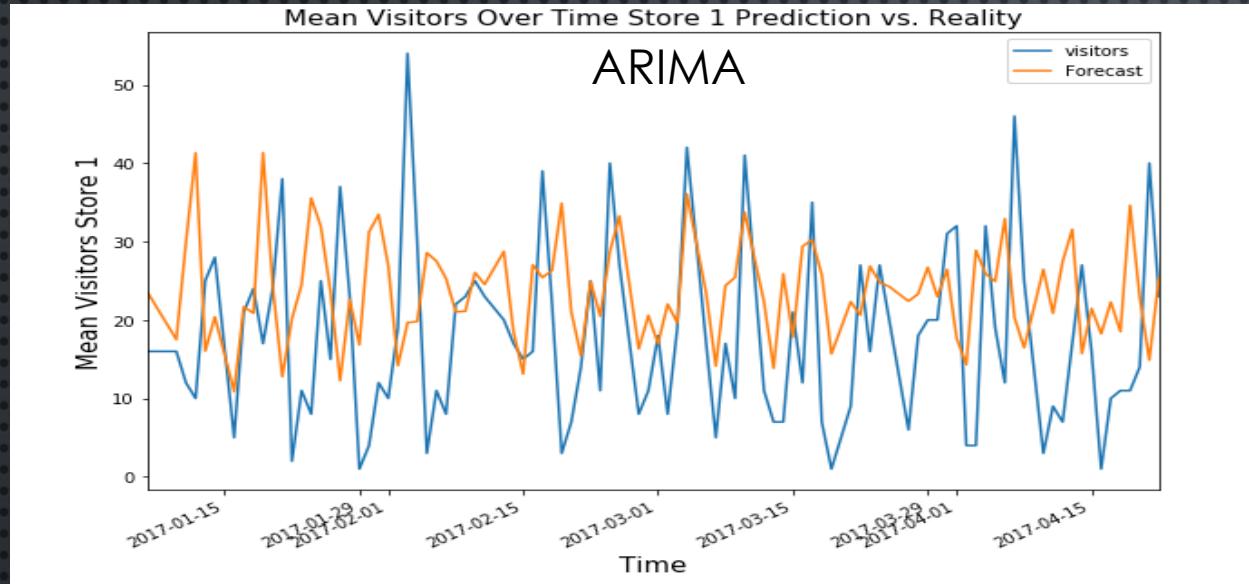


- Mean number of visitors per weekday per each restaurant individually does not accurately predict future visitors



	RMSE	R <sup>2</sup>
Baseline 1	16.43	0.04
Baseline 2	11.09	0.56

# DOES PAST VISITORS PREDICT THE FUTURE ?



PARTIALLY Yes/No

	RMSE	R^2
Baseline 1	16.43	0.04
Baseline 2	11.09	0.56
autoARIMA	14.14	-0.59
Prophet	14.97	-0.79

# Exploring number of visitors in relation to restaurant specific factors.



Geo-Spatial coordinates

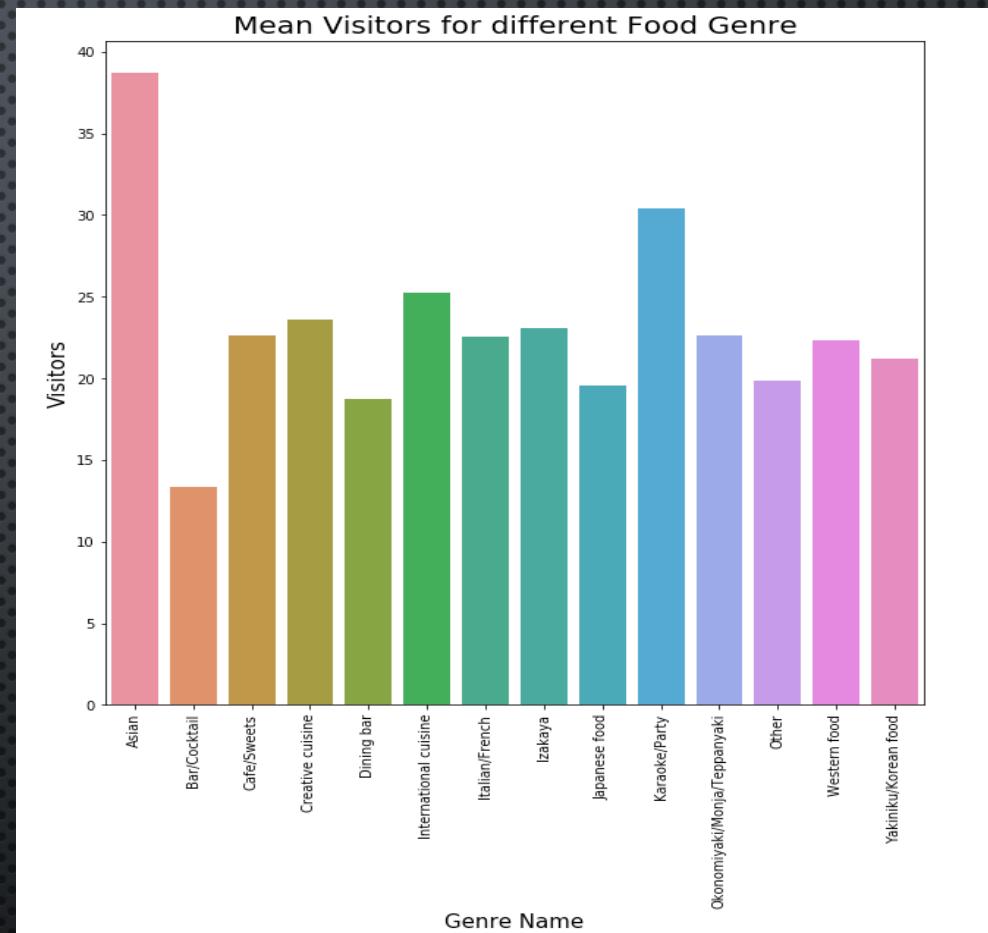
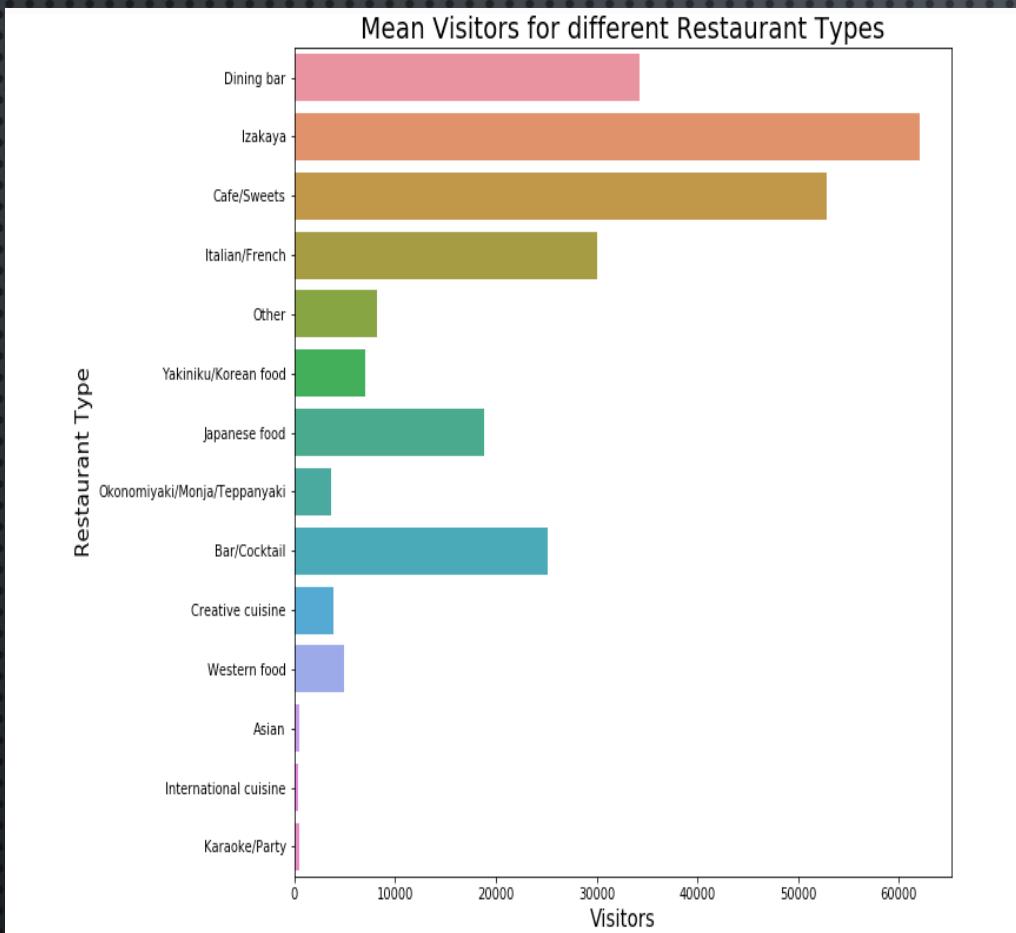
e.g.

Location relative to competition

Location relative to busy areas

Etc.

# VISITOR NUMBERS IN RELATION TO RESTAURANT SPECIFIC FACTORS.



# FEATURE ENGINEERING FOR REGRESSION ANALYSIS

How to turn our limited data into additional features:

Date: 05-17-2019 --> 5, 136, 2019, Friday

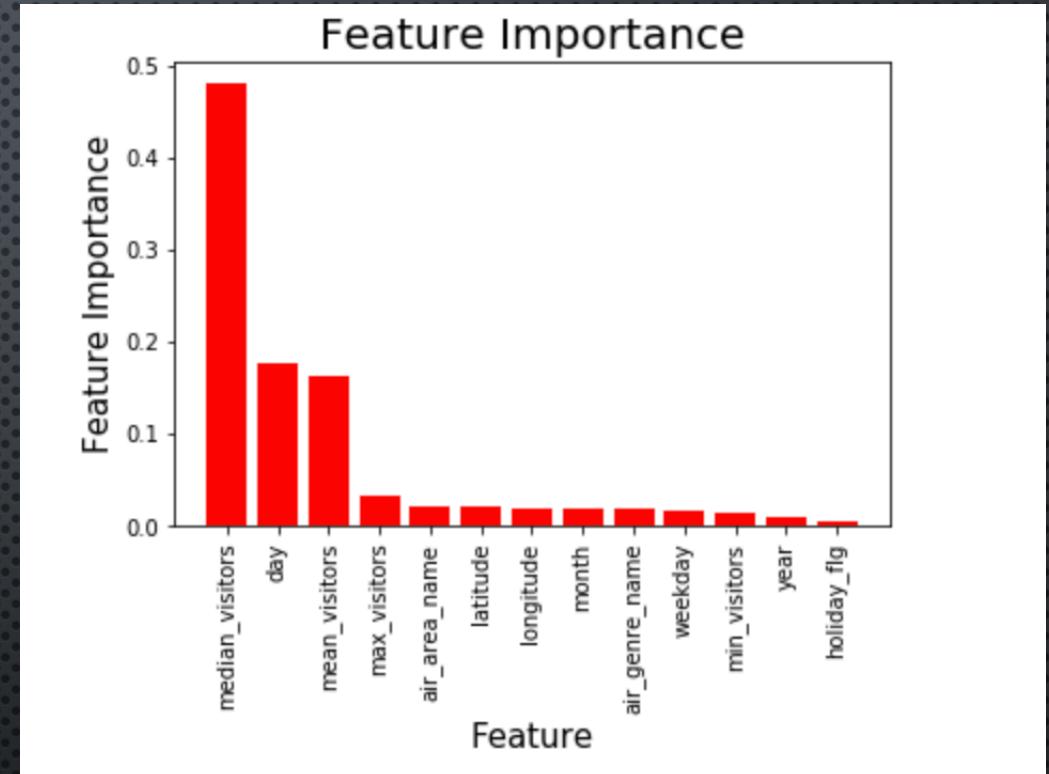
Latitude, Longitude: 35.65, 139.75

Visitors: 25 → min: 7 , mean: 23.8, median: 25, max: 57

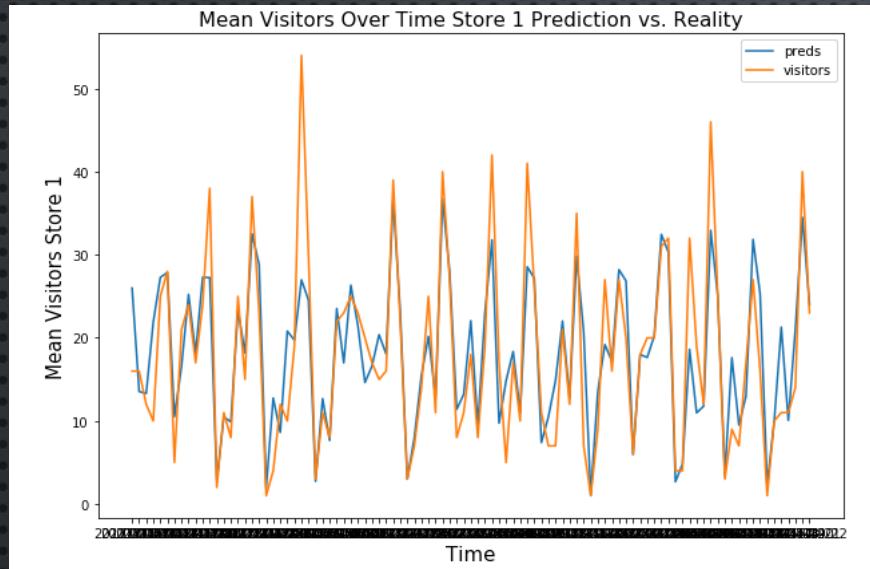
Genre\_name: Dining bar

Area\_name: Tokyo-to-Minato-ku-Shibakoen

Holiday: Yes



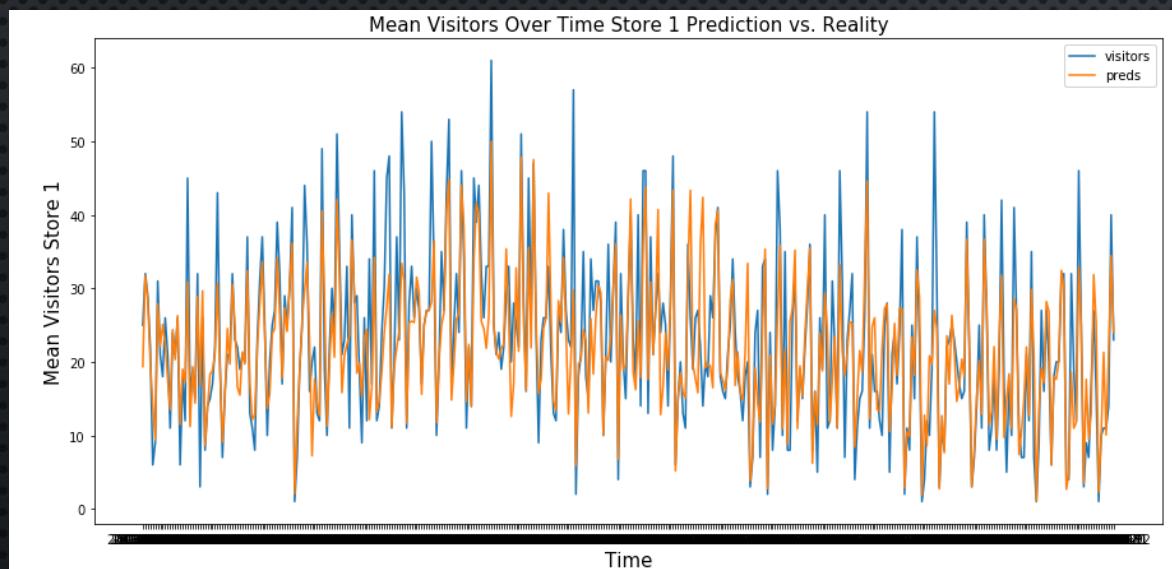
# DO CIRCUMSTANCES AND THE PAST VISITORS PREDICT THE FUTURE ?



Regression analysis with multiple engineered features  
More accurately predict future visitors

Features added:

- latitude and longitude
- cuisine genre, type of restaurant
- week-day specific visitors minimum, maximum, mean median for each specific restaurant
- year, month, weekday and day of the year



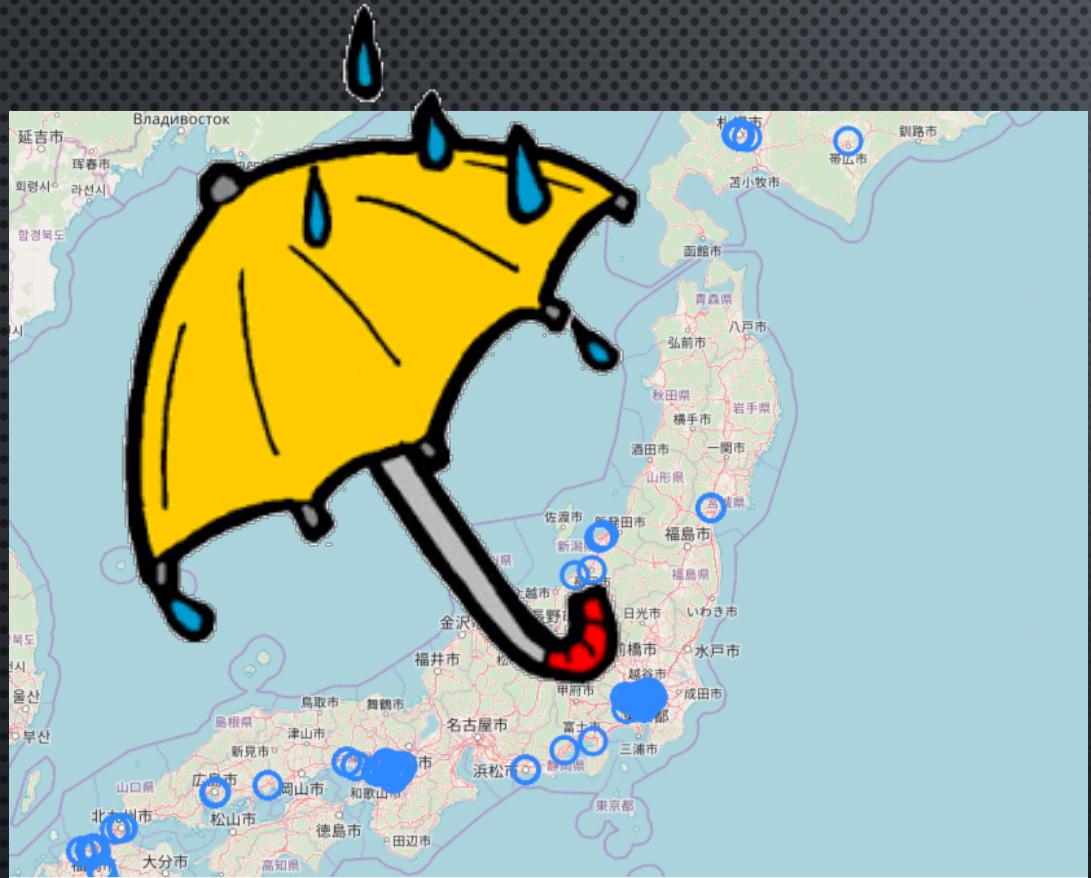
YES !

	RMSE	R <sup>2</sup>
Baseline 1	16.43	0.04
Baseline 2	11.09	0.56
autoARIMA	14.14	-0.59
Prophet	14.97	-0.79
<b>RandomForest</b>	<b>0.356</b>	<b>0.8</b>

## CONCLUSIONS

- Accurate visitor forecasting was achieved for 829 different restaurants in this study with application of multivariate regression modeling.
- Prediction of daily visitors at different restaurants in Japan depends on many parameters, including date, location, cuisine genre, restaurant type.
- Data is easily accessible through combination of data mining and datasets collected through AirRegi/Restaurant board website. Features could be added to website
- Results may be used to significantly relieve the pressure of planning daily operations in tough restaurant business.

# FUTURE DIRECTIONS



Techniques to explore:

- Multivariate Time Series analysis.
- Neural Networks.
- Bayesian analysis
- Survival Analysis
- Etc.

More features could be explored:

- Geo-spatial data to determine spatial proximity of each restaurant from busiest areas and competition.
- Weather in different areas of the country.
- Demand for certain types of areas
- How busy are different areas
- Etc.

Proposed additions to the app:

- Weather tracking,
- New/retired restaurants in the area
- Restaurant review tracking
- Restaurant inventory tracking to advise on ingredient purchasing and staff requirements.