Hotel Rooms and Revenue Forecaster

Author: Artem Lukinov

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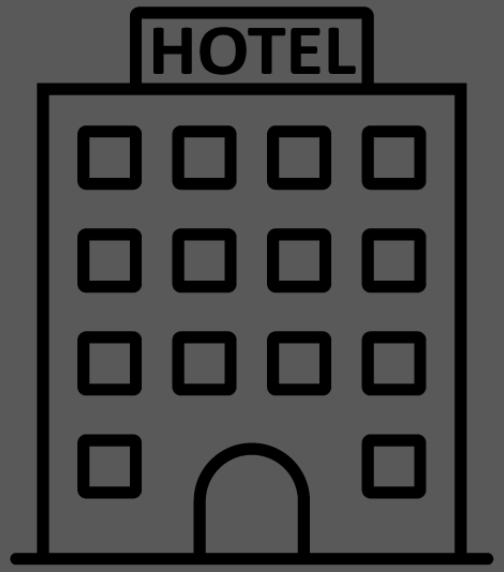
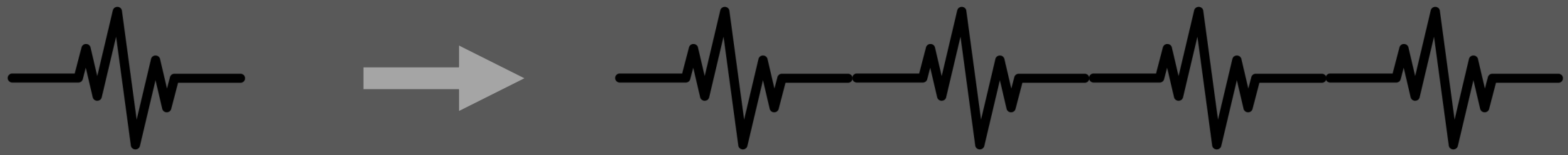


Room Nights Sold forecast: used for scheduling labor and controlling variable expenses to optimize business's bottom line daily

Revenue forecast: used for renovation schedules, large investments in operations, expansions.

Forecast Process

Story as old as time: "The mean king and the manual labor"



60%

Accuracy

How Can We Help?

What can be done to optimize this process?

Machine Learning!

Reliance on data
Better analysis of historical data
Hidden insights
Computational power

We want to

Determine whether it is possible to improve the accuracy of the baseline forecast

Use Machine Learning to forecast future data based on historical data

Stretch: wrap our model into software

Data Source

Anonymous hotel

Mutual benefit

Popular format

Large sample

Easy cleaning

Domain knowledge

*Multiple levels

Covid

Covid data

hospitalitynet™

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Home > News > External Article > Press Release

INDUSTRY UPDATE

EXTERNAL ARTICLE

24 December 2020

5 Predictions For 2021

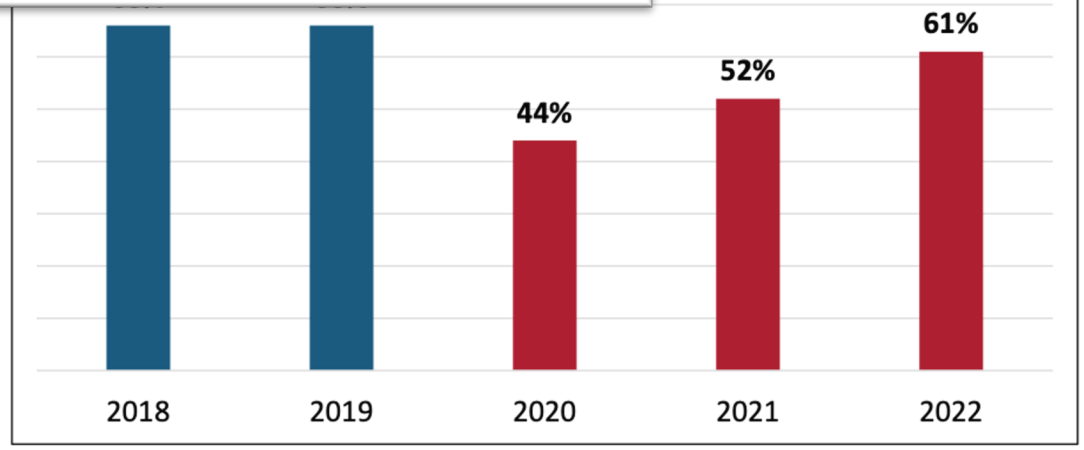
From the rebound of key hotel performance metrics to the potential return of group demand and international travel, the U.S. hotel industry could take its first steps on a

HOTEL MANAGEMENT

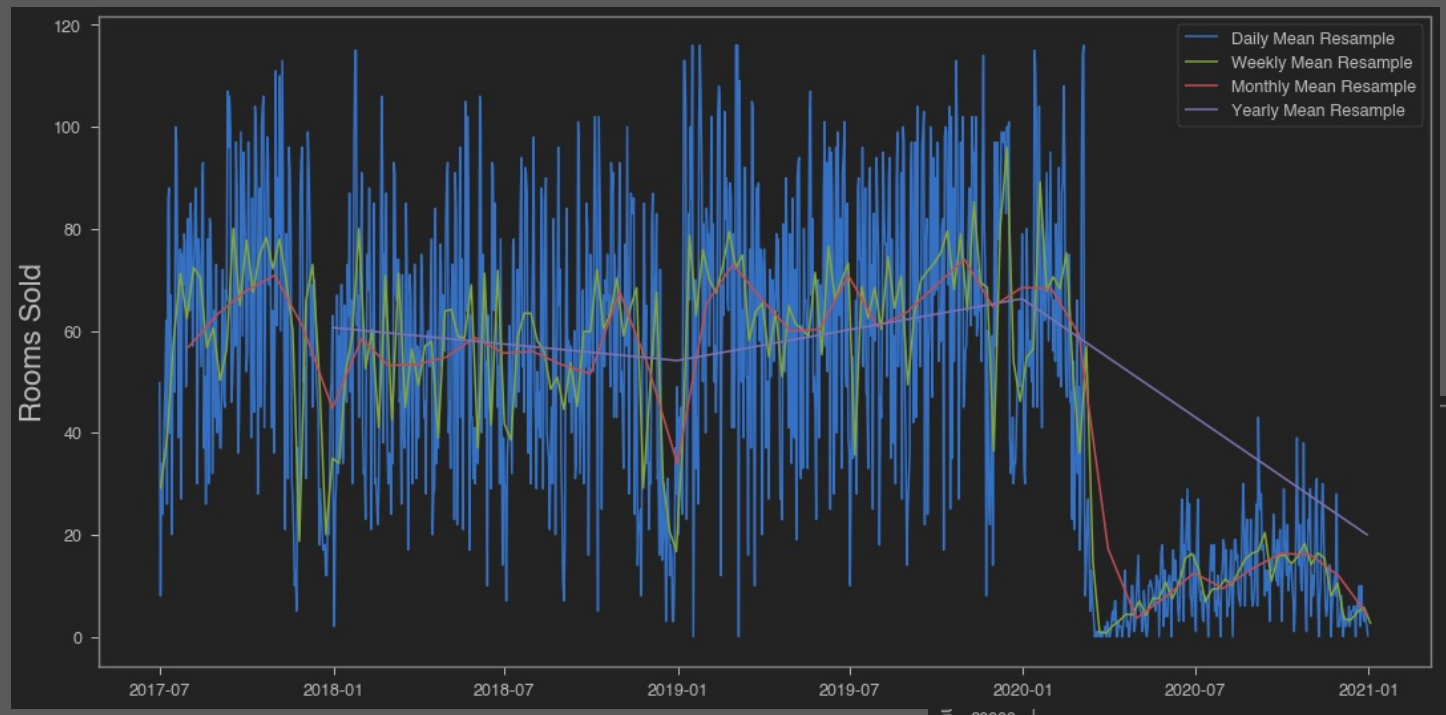
OWN OPERATE TECH DESIGN PROCURE HOTEL ROI

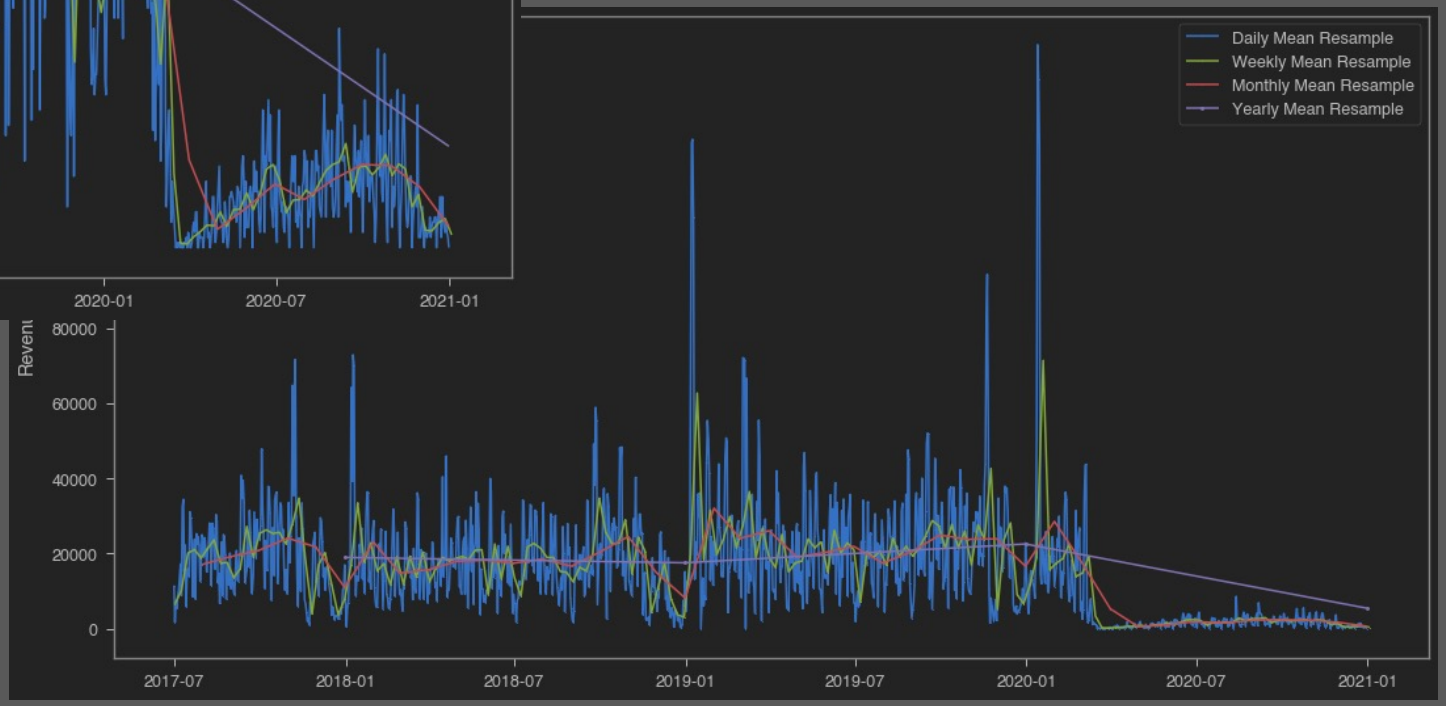
Operate

PwC report predicts rebound in H2 2021



First Look


Daily Mean Resample
Weekly Mean Resample
Monthly Mean Resample
Yearly Mean Resample
Rooms Sold
120
100
80
60
40
20
0
2017-07
2018-01
2018-07
2019-01
2019-07
2020-01
2020-07
2021-01


Daily Mean Resample
Weekly Mean Resample
Monthly Mean Resample
Yearly Mean Resample
Revenue
80000
60000
40000
20000
0
2017-07
2018-01
2018-07
2019-01
2019-07
2020-01
2020-07
2021-01

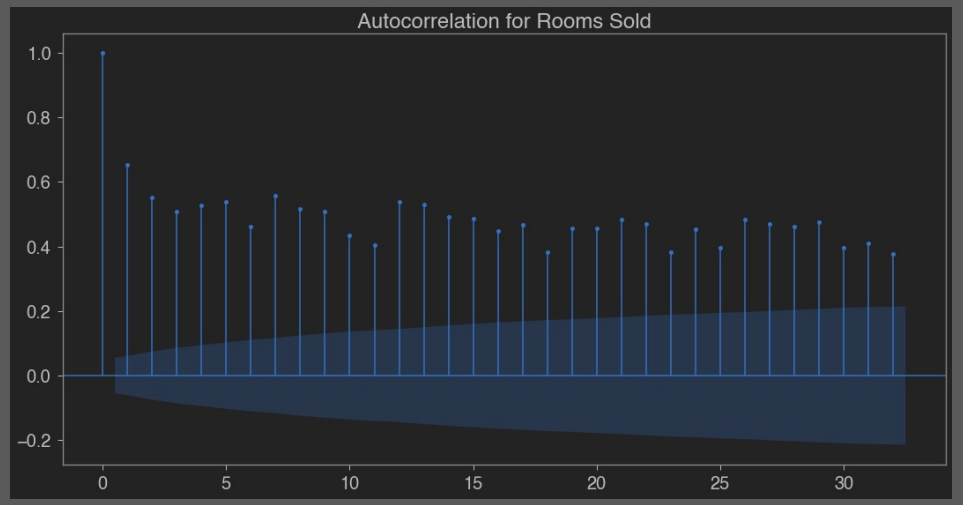
Stationarity Check

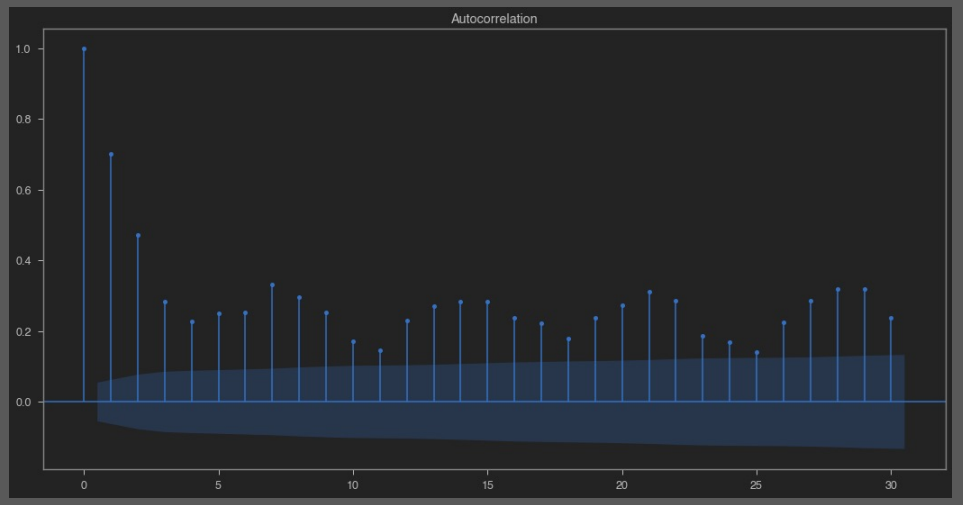
Augmented Dickey-Fuller Test

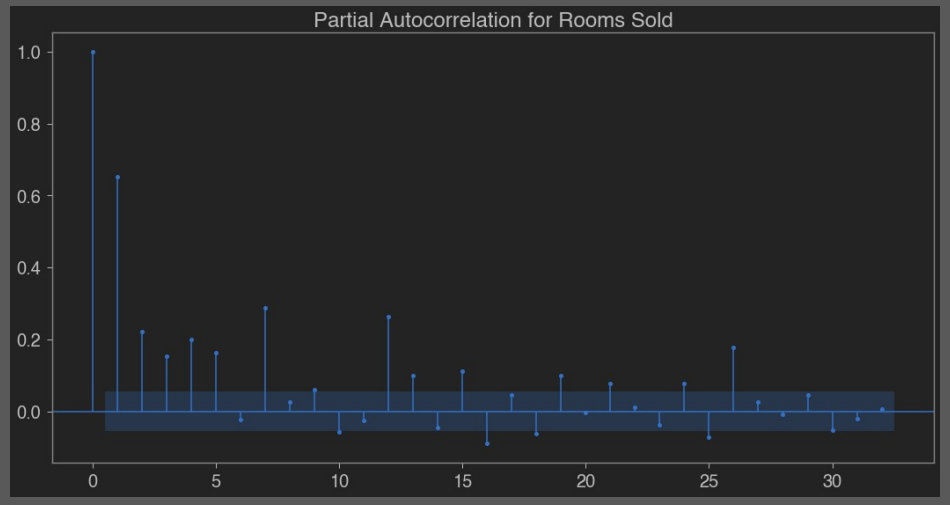
Metric	T-stat	Critical value at 1%	P-Value
Rooms	(-6.826844063432655)	(-3.4310597571975685)	1.9419934100737604e-09
Revenue	(-9.727564233908703)	(-3.431059834240982 4)	9.187072356670721e-17

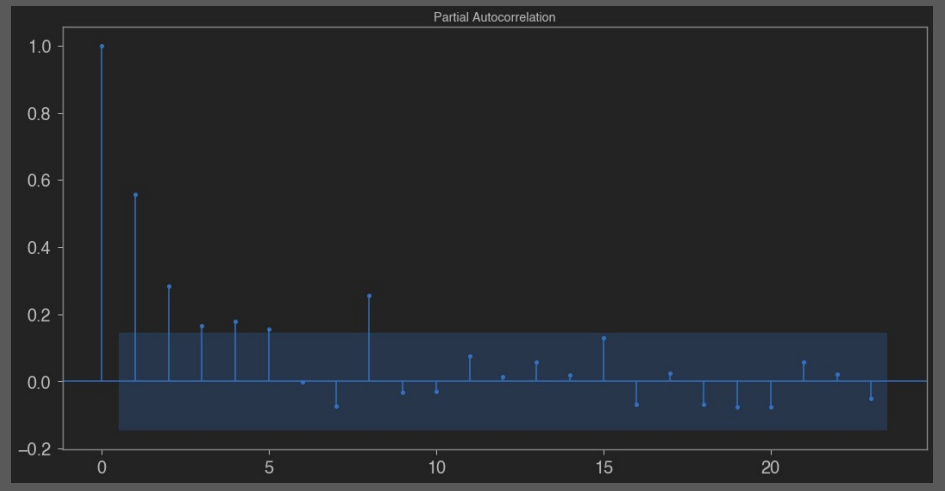
Stationarity Check

Rooms









Revenue

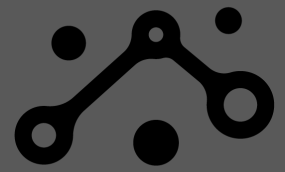
Model choice

Time Series:

- ARIMA
- SARIMA

RNN:

- LSTM
- GRU



Additional:

- Prophet
- NeuralProphet

Prophet and NeuralProphet

Logistic regressions

Seasonality

Special events

Linear and non-linear regressions

AR-Net
An Autoregressive Neural Network

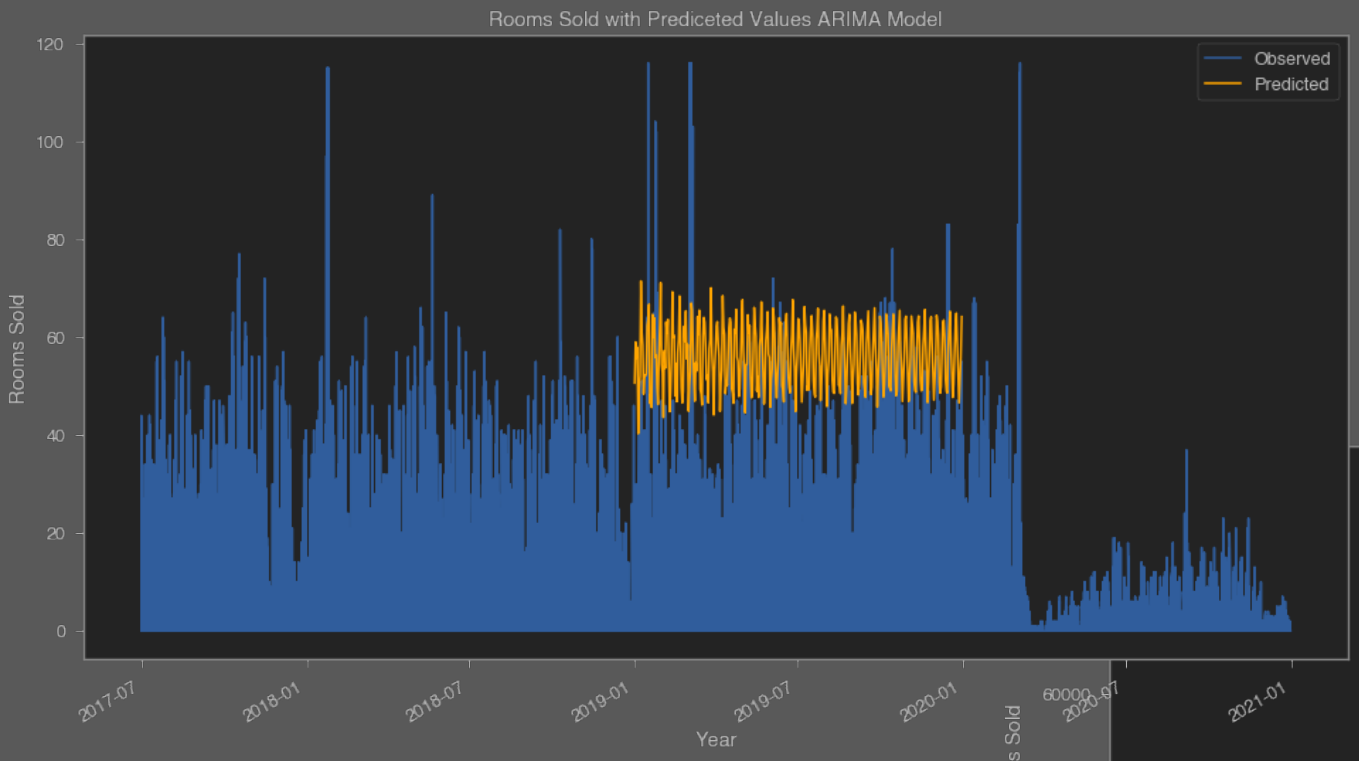
Time Series Models

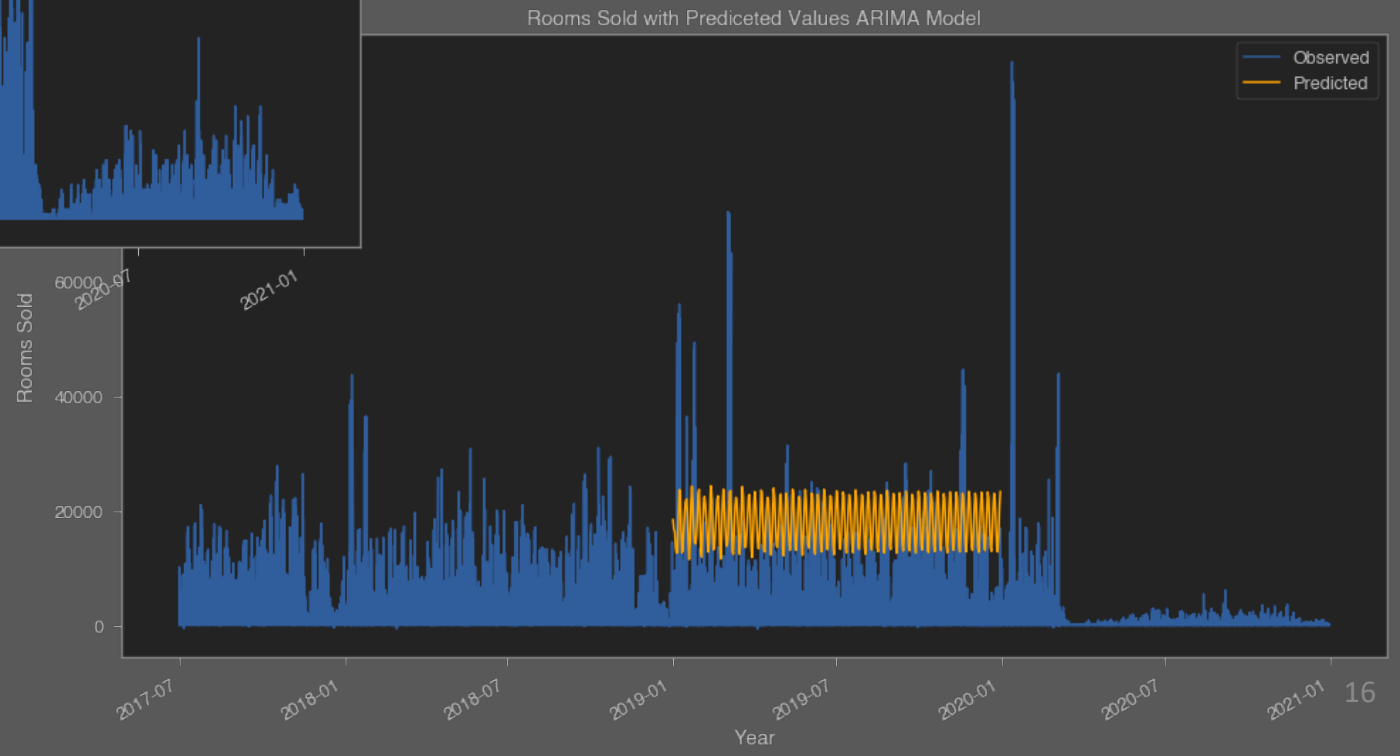
Model	AIC	RMSE	Improvement over Baseline
ARIMA (Baseline)	4995.92	27.83	-
ARIMA Grid Search	**4888.26**	***27.11***	***3%***
SARIMA	5039.08	48.36	-74%

Revenue

Model	AIC	RMSE	Improvement over Baseline
ARIMA (Baseline)	11615.94	17412.2	-
ARIMA Grid Search	***11523.83***	***16481.31***	***5%***
SARIMA	11690.08	24786.68	-42%

Best Time Series Model





Recurring Neural Networks

Why LTSM and GRU? Memory!

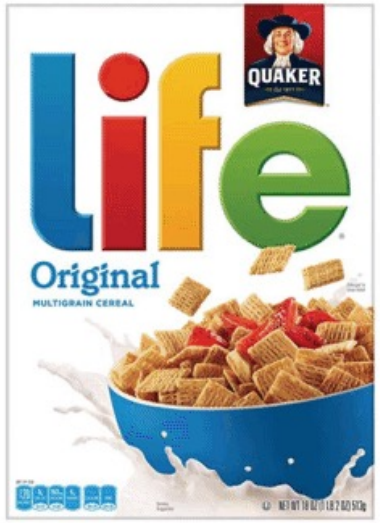
Customers Review 2,491

Thanos

September 2018

Verified Purchase

Amazing! This box of cereal gave me a perfectly balanced breakfast, as all things should be. I only ate half of it but will definitely be buying again!



A Box of Cereal

$3.99

Recurring Neural Networks

LSTM

Rooms

neurons in a hidden layer	epochs trained	RMSE	improvement over baseline
8	100	30.26	-
32	***100***	***29.98***	***1%***
64	50	38.56	-27%

Revenue

neurons in a hidden layer	epochs trained	RMSE	improvement over baseline
8	***100***	***18918.36***	***-***
32	100	20001.84	-6%
64	50	21398.04	-13%

GRU

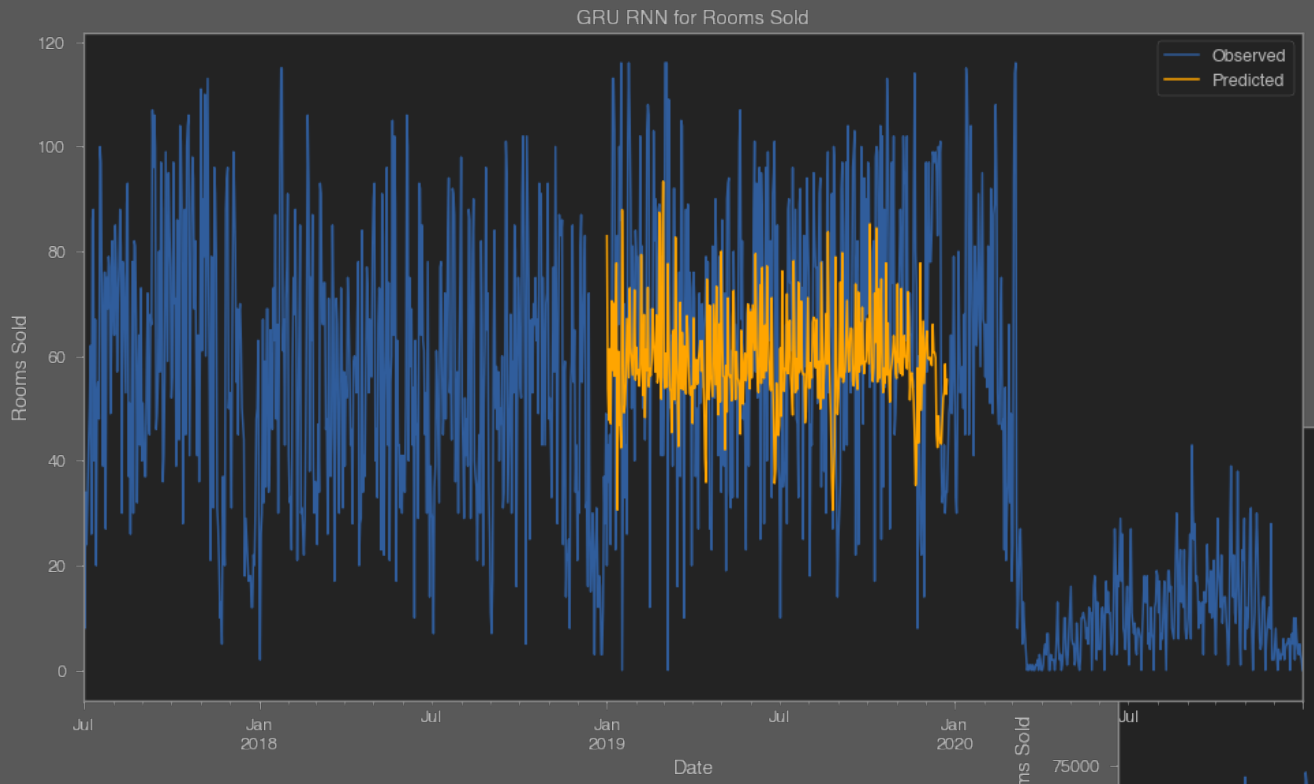
Rooms

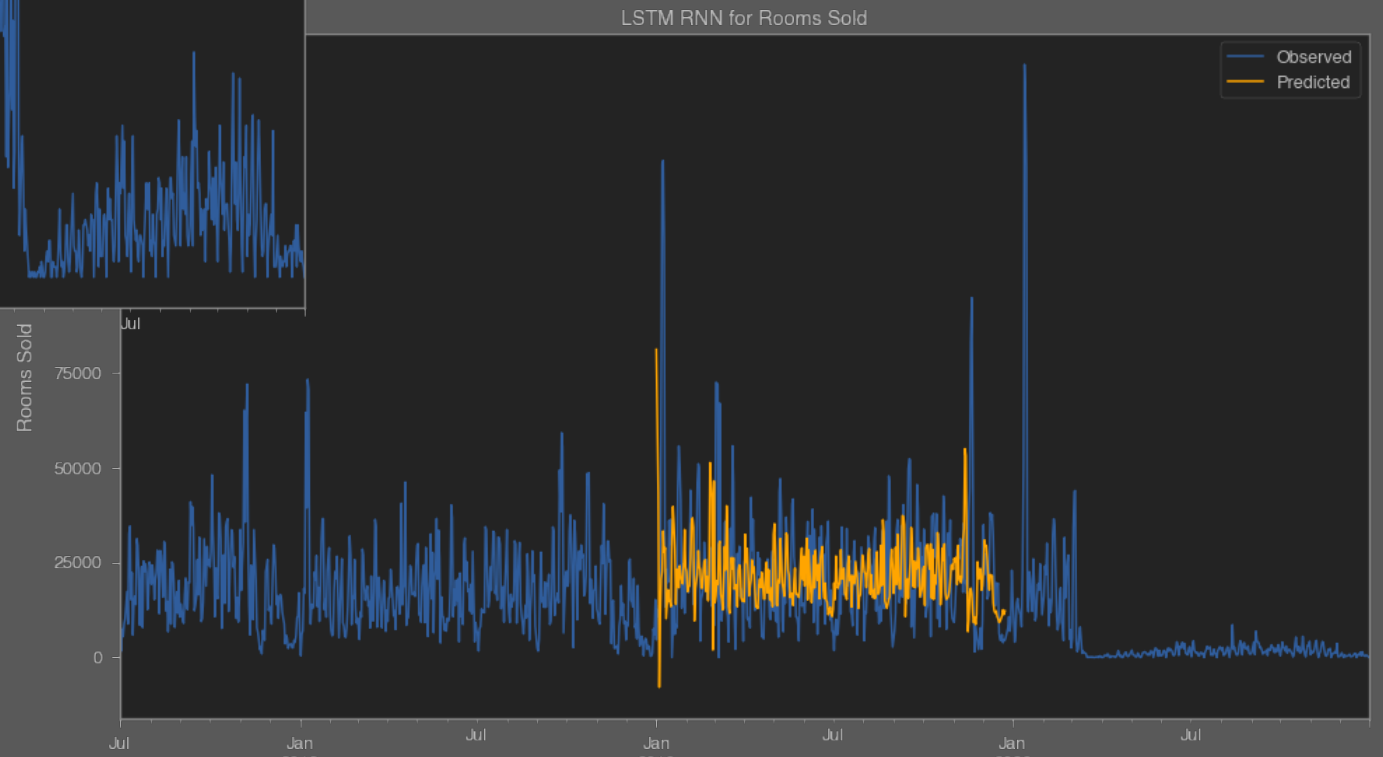
neurons in a hidden layer	epochs trained	RMSE	improvement over baseline
8	***100***	***29.87***	***-***
32	100	31.82	-7%
64	50	30.27	-1%

Revenue

neurons in a hidden layer	epochs trained	RMSE	improvement over baseline
8	***100***	***19246.39***	***-***
32	100	22128.54	-7%
64	50	20892.71	-1%

Best RNNs


GRU RNN for Rooms Sold
Observed
Predicted
Rooms Sold
120
100
80
60
40
20
0
Jul
Jan
2018
Jul
Jan
2019
Jul
Jan
2020
Date


LSTM RNN for Rooms Sold
Observed
Predicted
Rooms Sold
75000
50000
25000
0
Jul
Jan
Jul
Jan
Jul
Jan
Jul

Prophet vs. NeuralProphet vs. the rest

Rooms

Model	RMSE	Improvement over base
Prophet (baseline)	24.43	-
Prophet Grid Search	25.61	-5%
NeuralProphet	***22.59***	***8%***

Revenue

Model	RMSE	Improvement over base
Prophet (baseline)	41479.04	-
Prophet Grid Search	11015.68	73%
NeuralProphet	***9554.99***	***77%***

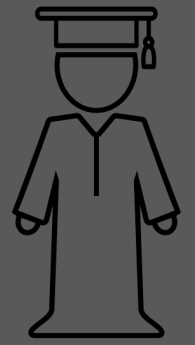
Rooms

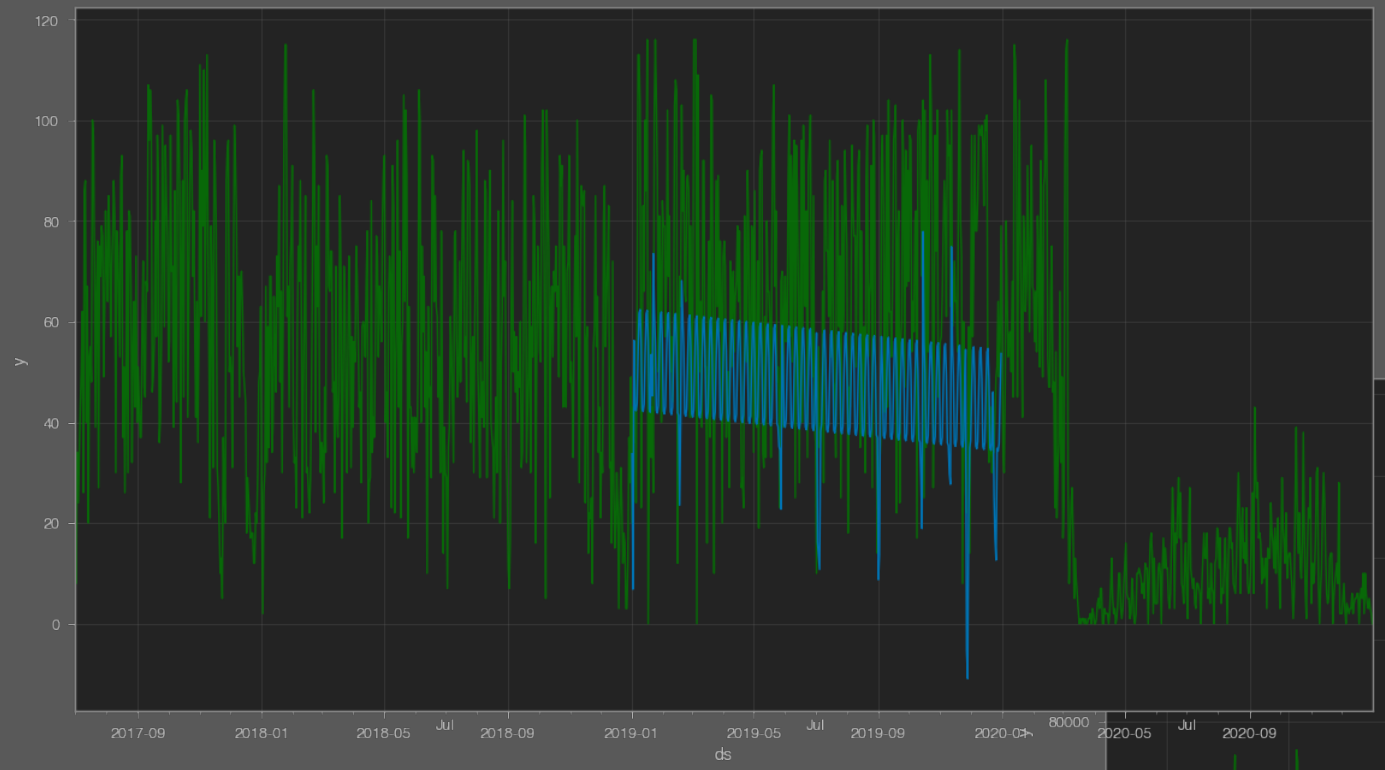
Rank	Model	RMSE
1	NeuralProphet	22.59
2	Prophet (baseline)	24.43
3	ARIMA Grid Search	27.11

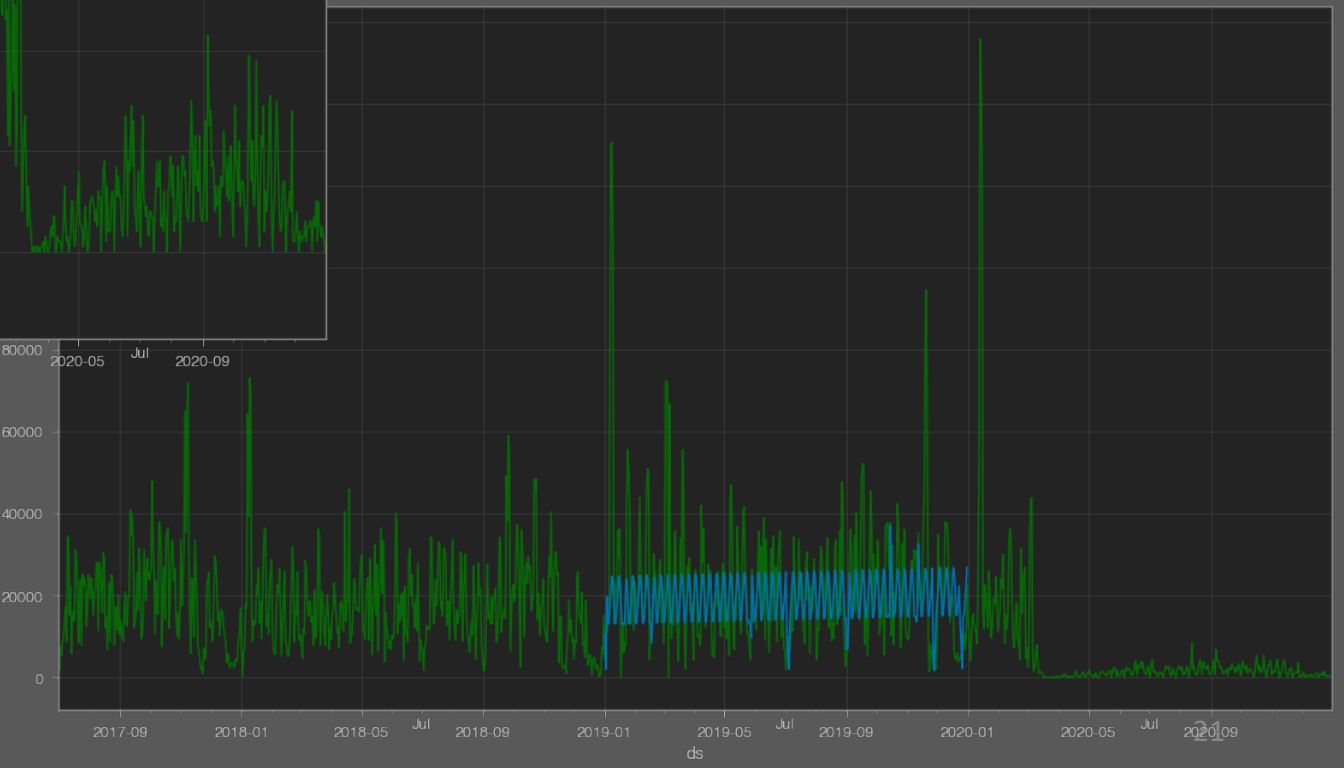
Revenue

Rank	Model	RMSE
1	NeuralProphet	9554.99
2	Prophet Grid Search	11015.68
3	ARIMA Grid Search	16481

NeuralProphet







Key Takeaways

NeuralProphet was the best performer

RNNs have potential

Machine Learning can help in yet another industry

Exploration leads to efficiency

How can we use this?

Explore NeuralProphet and others

Include all market segments

Use as core algorithm for a product

Thank you

Q&A