

# Time Series Analysis of COVID-19: SARIMA vs. LSTM Neural Networks

By Ben Mauss

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# Overview

Data Description

Compare and  
Contrast the  
Performance of  
SARIMA Models to  
LSTM Neural  
Networks

COVID-19 Trends  
and Exogenous  
Factors Contributing  
to Spread

# The Data



# The Data

Data was collected from all over the internet including:

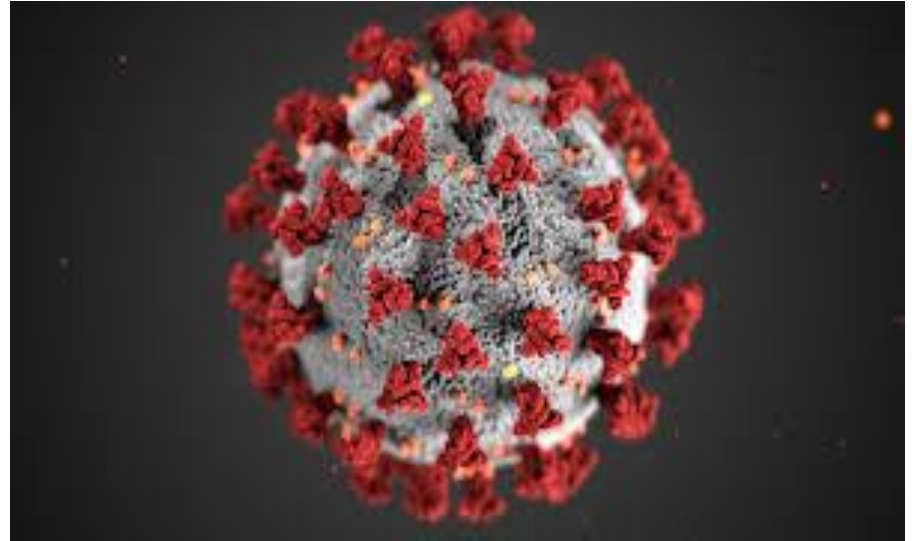
- Johns Hopkins University
- US Census
- Amazon Web Services
- Center for Disease Control

Data included details such as:

- State's Daily Reported Confirmed and Probable COVID-19 Cases (County Level)
- Locational Data
- Number of Hospitalized and in ICU
- Number of Deaths per Day/ Total
- Number of COVID-19 Tests Administered per Day
- 2019 County Population Estimates

# COVID-19

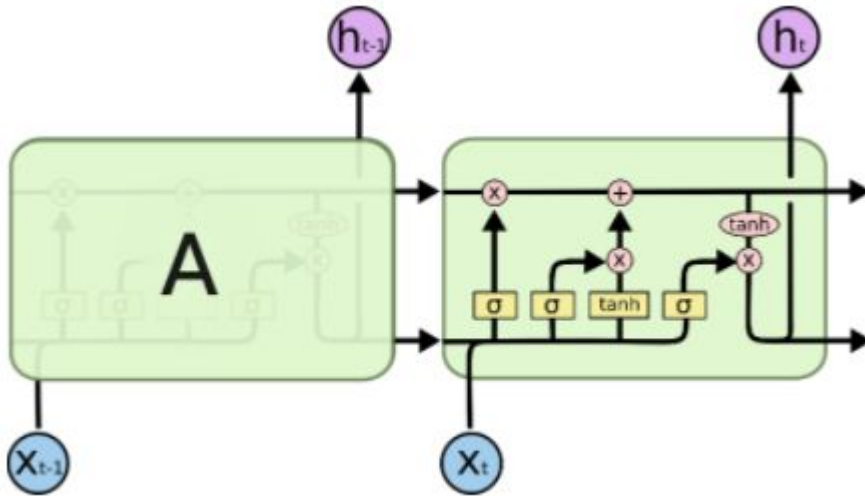
- Highly contagious respiratory infection
- Symptoms vary in severity by age and immune health; mostly flu-like
- “The primary and most important mode of transmission for COVID-19 is through close contact from person-to-person” -CDC.gov



# Long Short-Term Memory Neural Networks



# LSTM



## Quick Facts

- LSTMs are traditionally used in NLP (such as Text prediction) and Speech Recognition
- Recurrent Neural Network that uses the context of previous inputs to inform its predictions
- Can be applied to Time Series Analysis with frighteningly high accuracy.

# Top 5 States



# Top 5

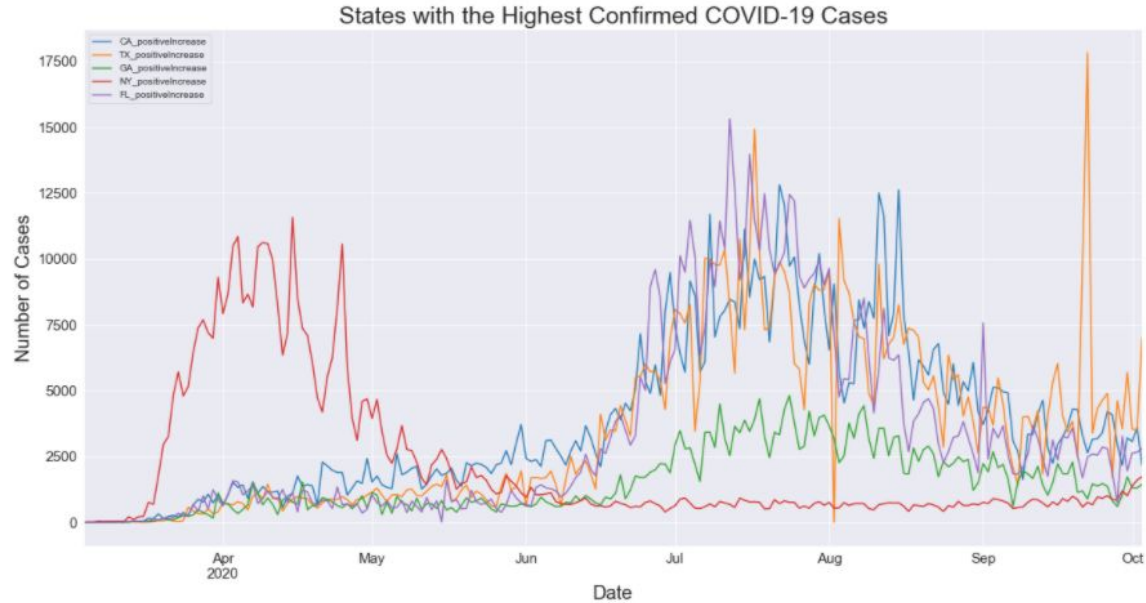
California

Florida

Georgia

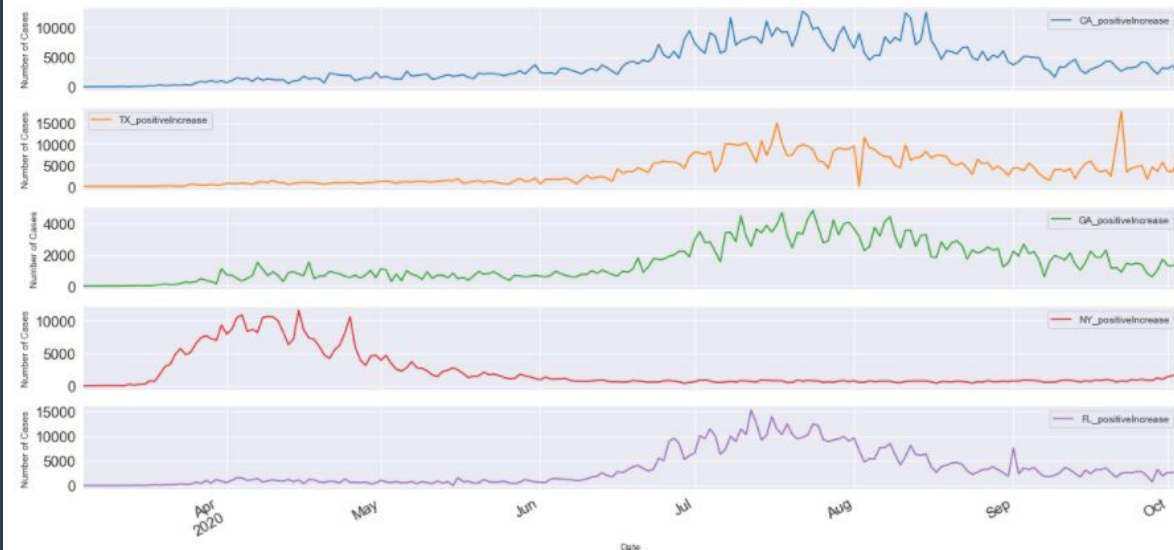
New York

Texas

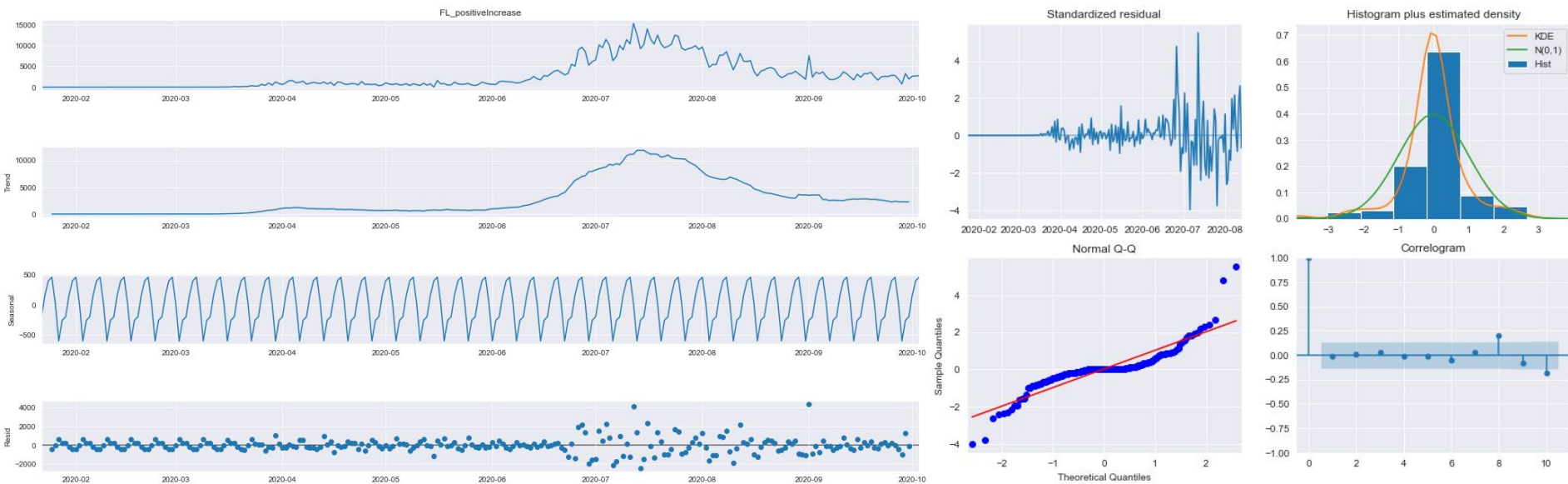


# Summer Trend

- NY has a rough start and stabilizes
- All others experience exponential increase in mid-to late-June and peak in mid-July
- 11 other states follow this summer trend:
- Alabama, Arizona, Idaho, Louisiana, Mississippi, Nevada, Ohio, South Carolina, Tennessee, Utah, Washington, Oregon, Missouri



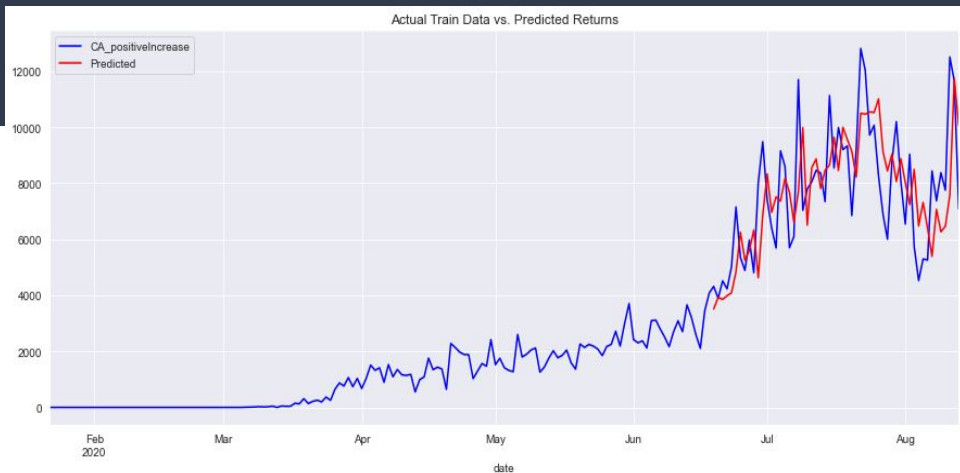
# Similarities



All 5 states share the same traits

California

# California SARIMA – Predictions

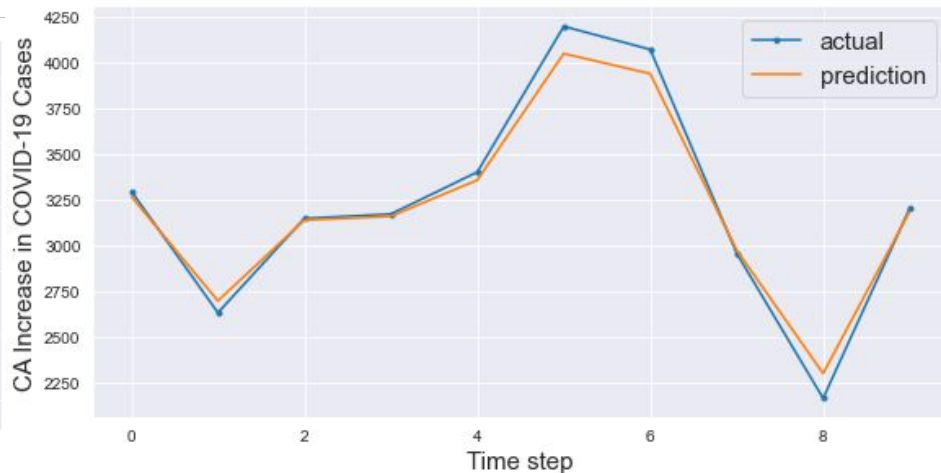
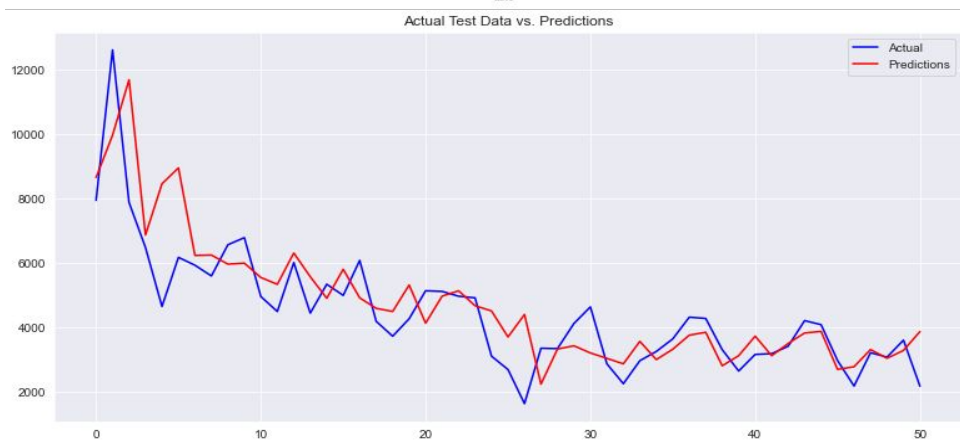


SARIMA Train RMSE: 1838.365

SARIMA Test RMSE: 1204.548

LSTM Train: 1252.697

LSTM Test: 630.178



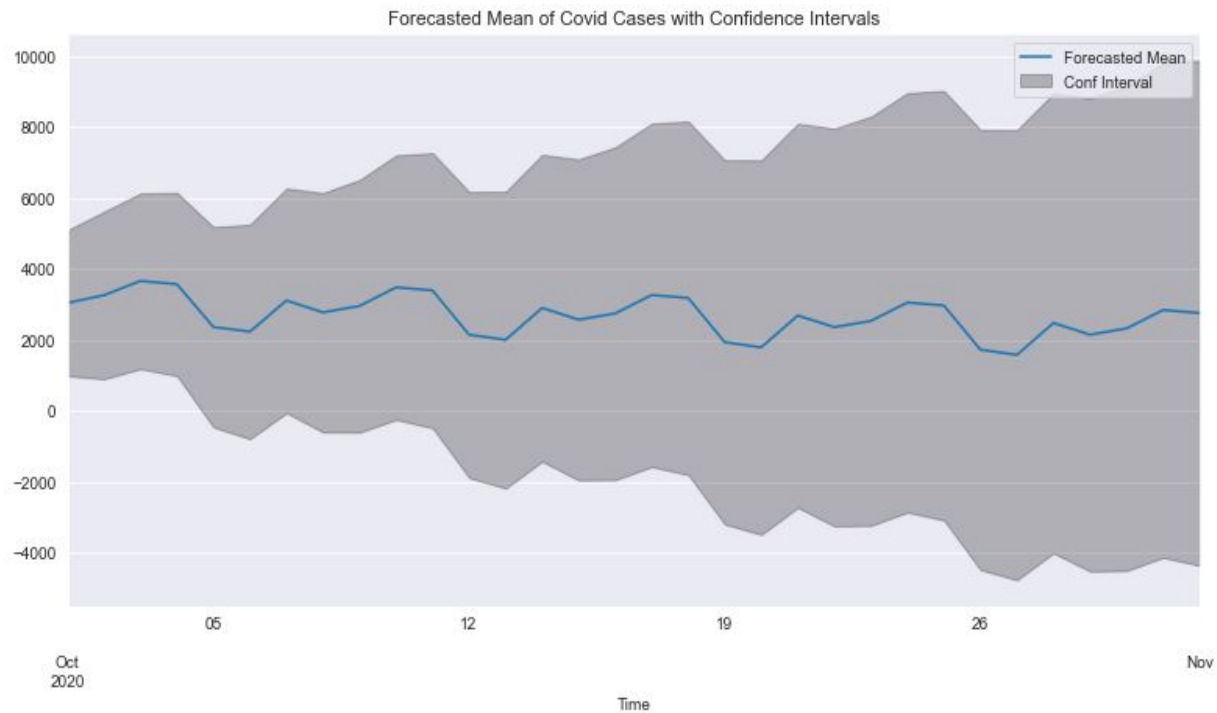
# California Forecast

According to The New York Times:

Oct 5, 2020 - 3,273 Reported Cases

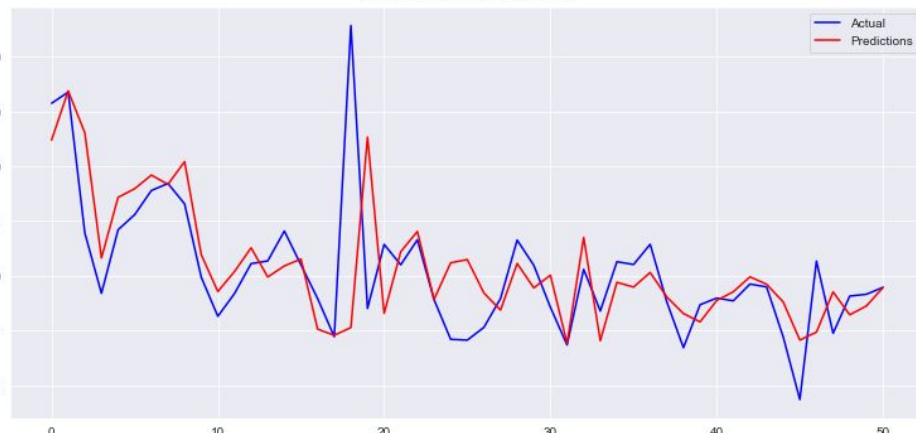
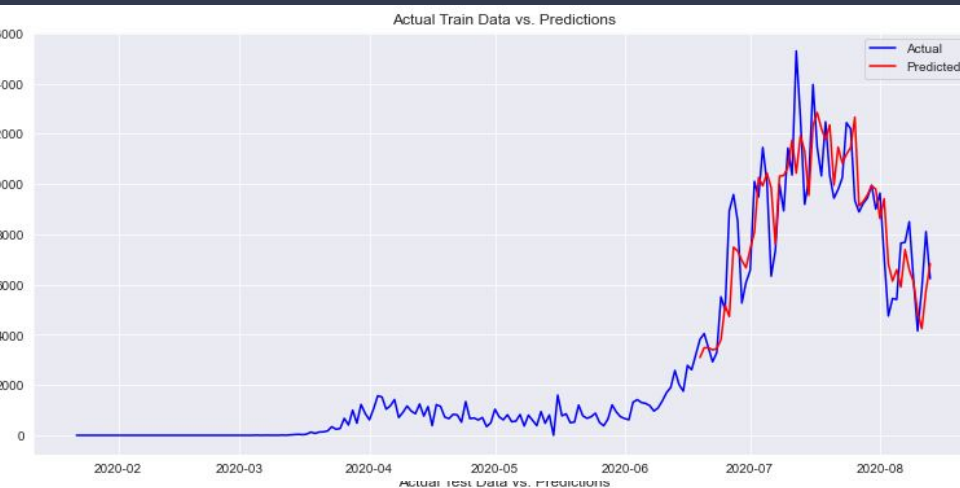
Oct 12, 2020 - 2,883 Reported Cases

Oct 18, 2020 - 2,089 Reported Cases



Florida

# Florida - Predictions

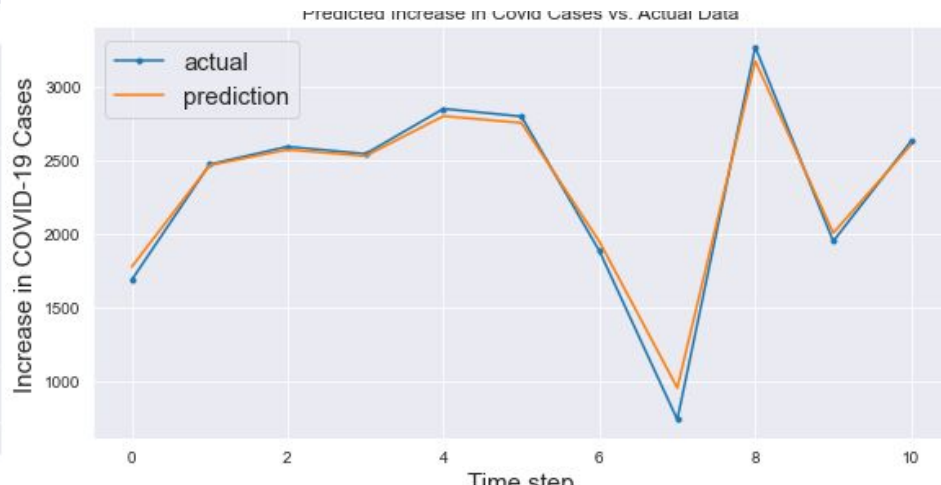


SARIMA Train RMSE: 1598.558

SARIMA Test RMSE: 1082.762

LSTM Train: 1160.042

LSTM Test: 945.861





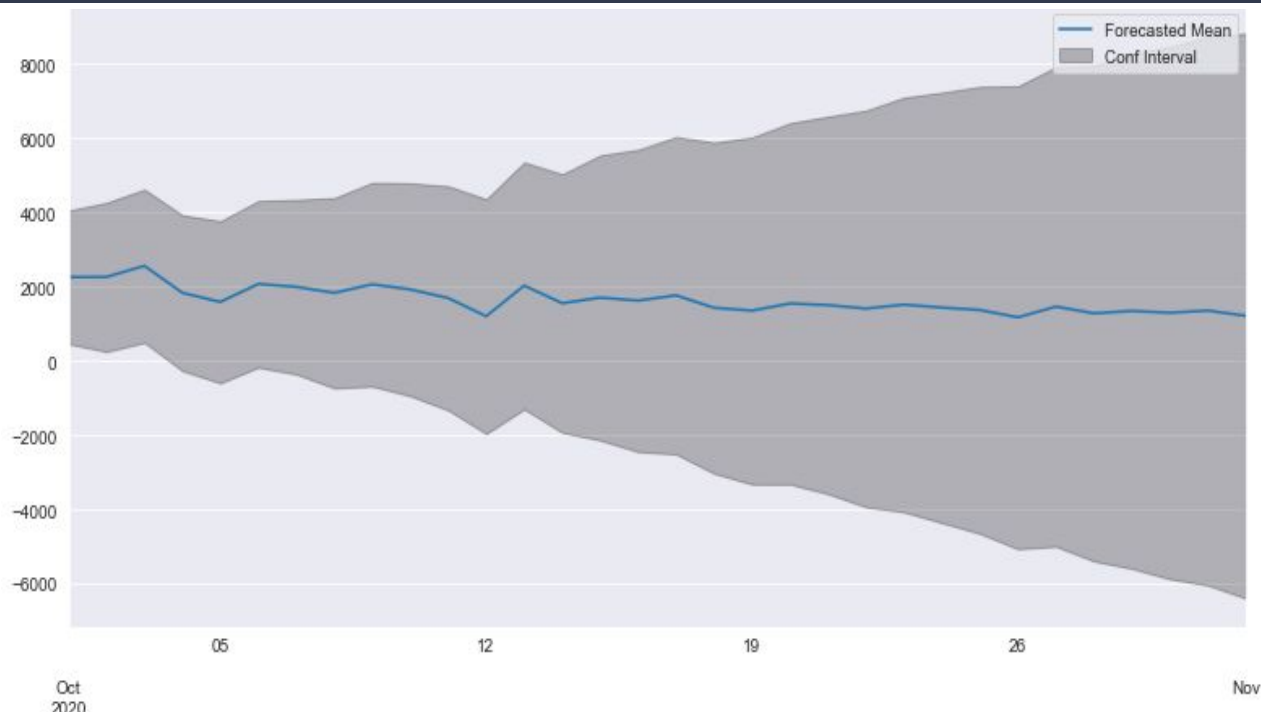
# Florida Forecast

According to The New York Times:

Oct 5 - 1,415 Reported Cases

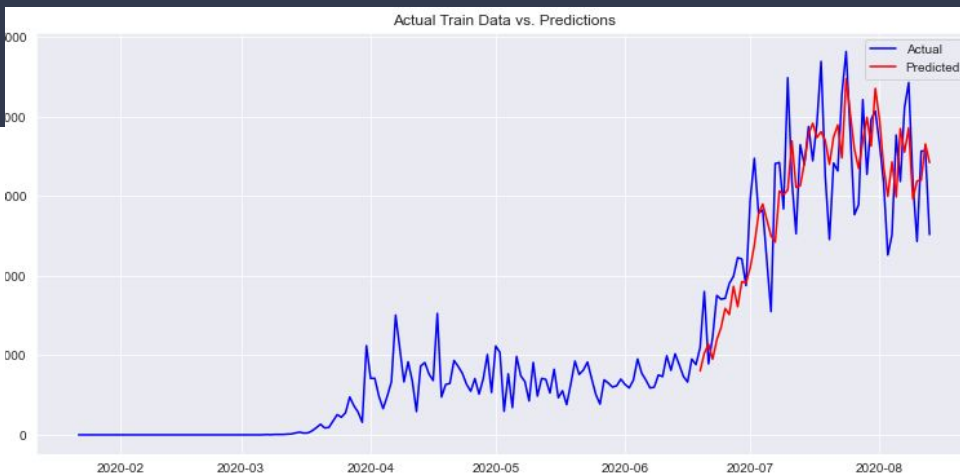
Oct 12 - 1,533 Reported Cases

Oct 18 - 2,539 Reported Cases



Georgia

# Georgia - Predictions

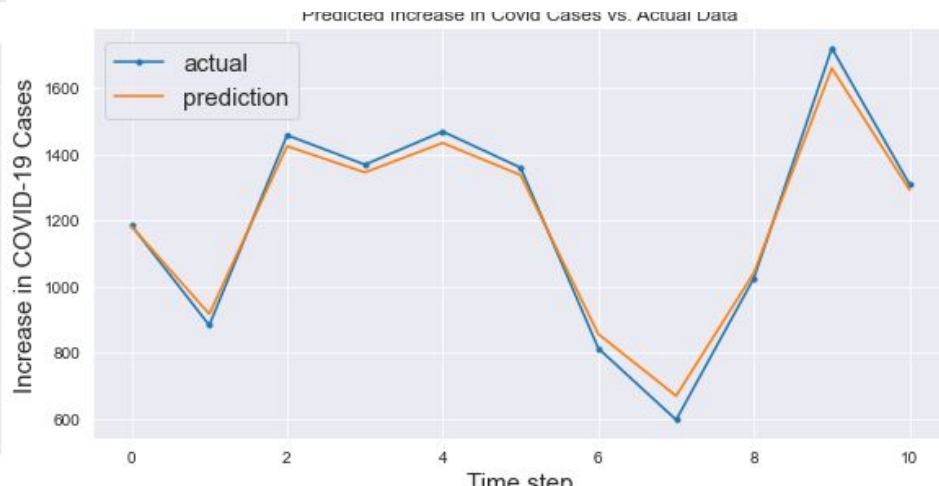


SARIMA Train RMSE: 582.002

SARIMA Test RMSE: 359.503

LSTM Train RMSE: 480.471

LSTM Test RMSE: 349.086



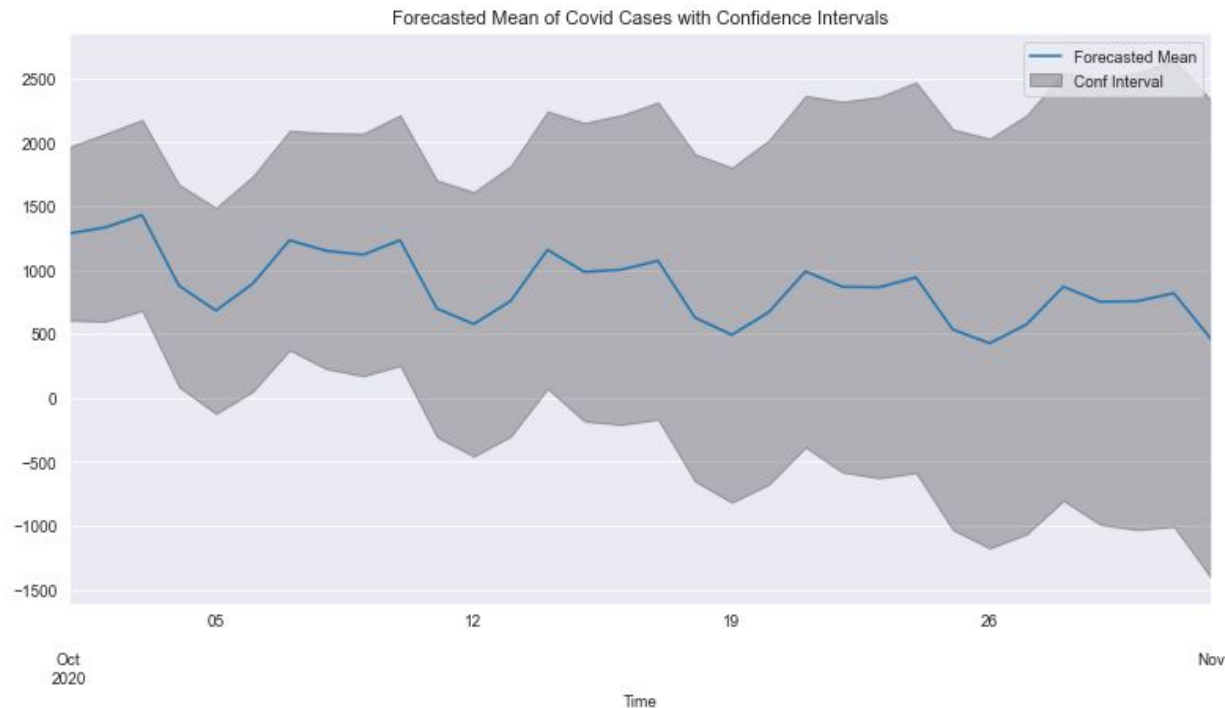
# Georgia Forecast

According to The New York Times:

Oct 5, 2020 - 741 Reported Cases

Oct 12, 2020 - 906 Reported Cases

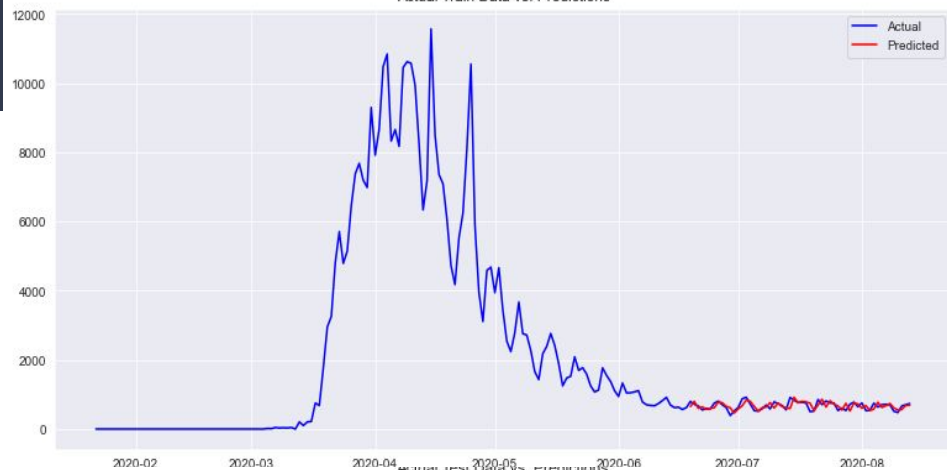
Oct 18, 2020 - 1,305 Reported Cases



New York

# New York – Predictions

Actual Train Data vs. Predictions



Actual test Data vs. Predictions



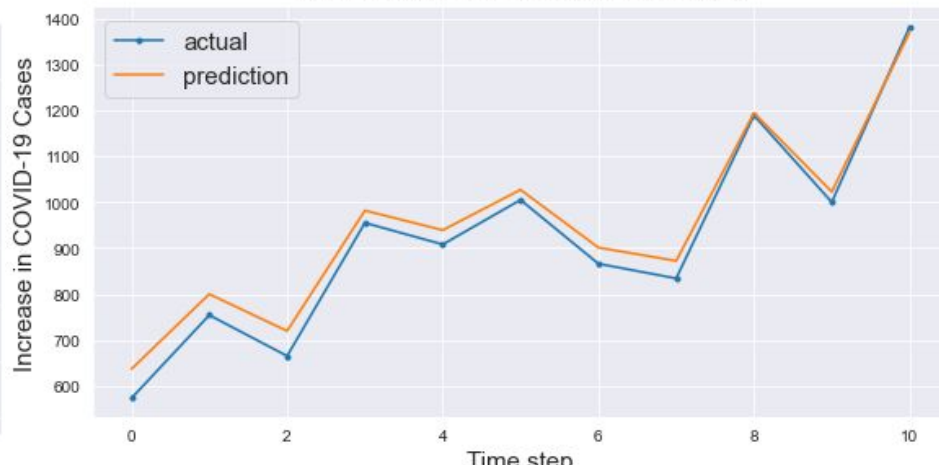
SARIMA Train RMSE: 116.436

SARIMA Test RMSE: 135.534

LSTM Train RMSE: 742.979

LSTM Test RMSE: 214.778

Predicted Increase in Covid Cases vs. Actual Data



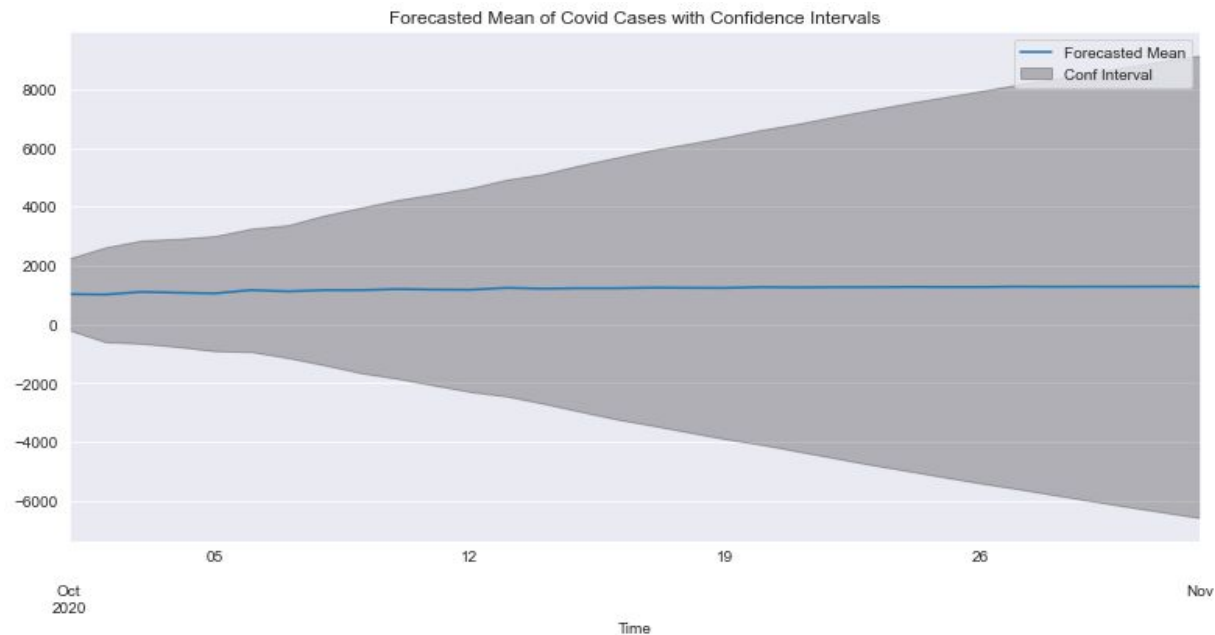
# Florida Forecast

According to The New York Times:

Oct 5, 2020 - 937 Reported Cases

Oct 12, 2020 - 1,032 Reported Cases

Oct 18, 2020 - 1,390 Reported Cases

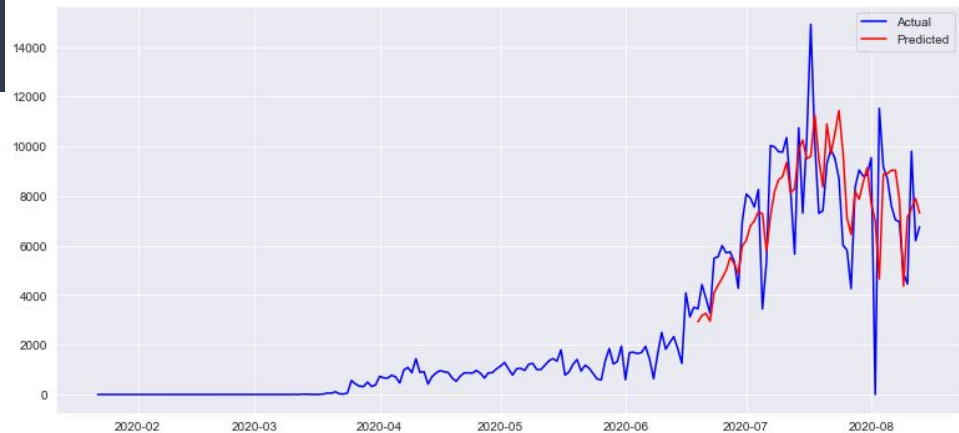


Texas



# Texas - Predictions

Actual Train Data vs. Predictions



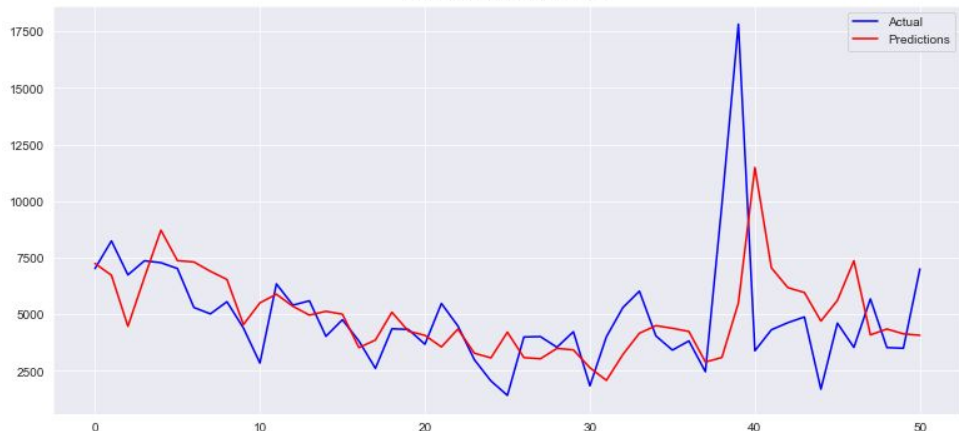
SARIMA Train RMSE: 2122.503

SARIMA Test RMSE: 2691.542

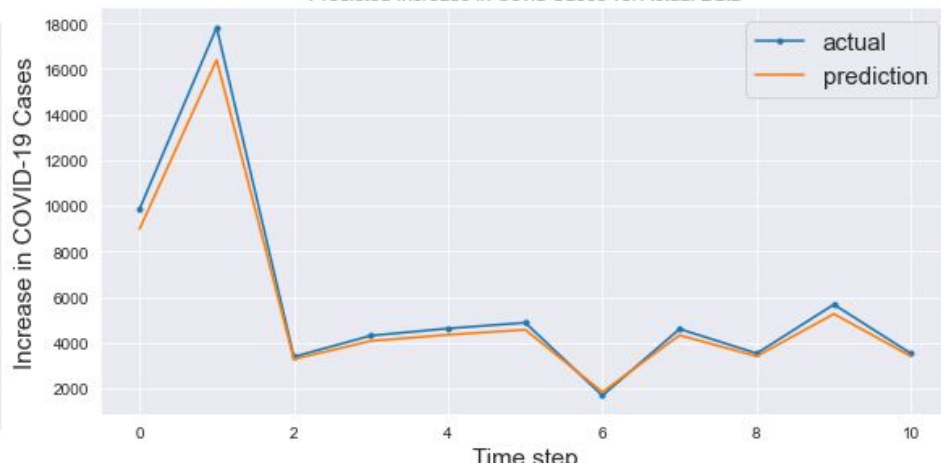
LSTM Train RMSE: 1512.816

LSTM Test RMSE: 5225.313

Actual test Data vs. Predictions



Predicted Increase in Covid Cases vs. Actual Data



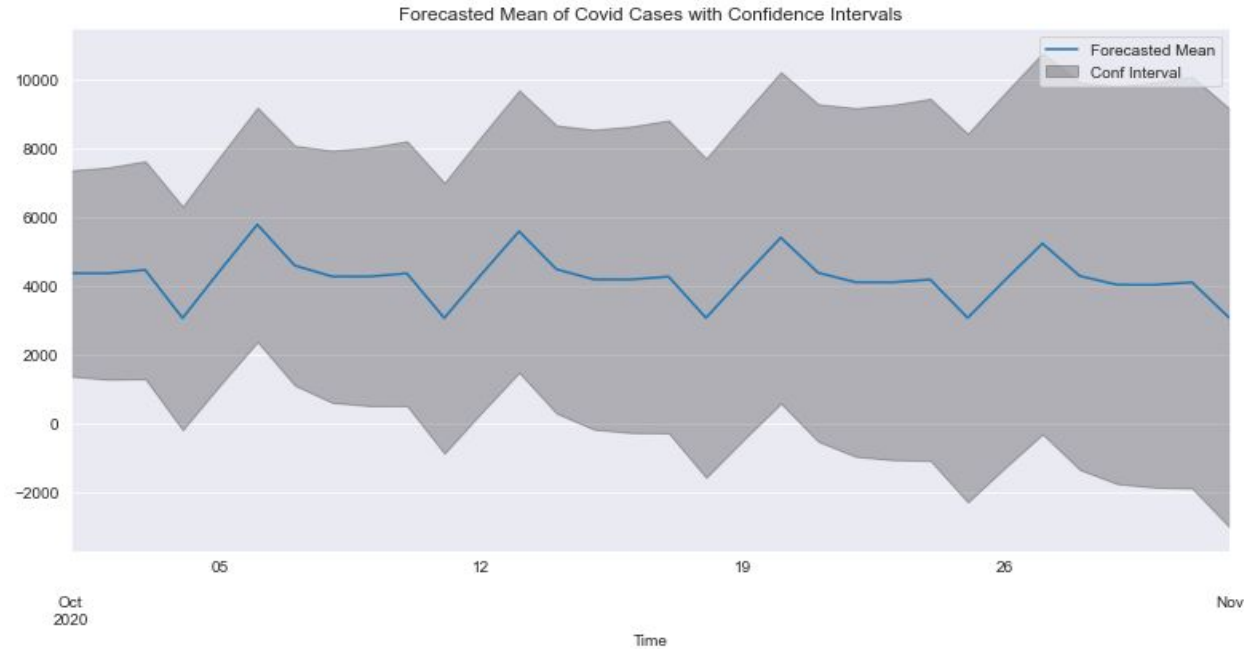
# Texas Forecast

According to The New York Times:

Oct 5, 2020 - 3,977 Reported Cases

Oct 12, 2020 - 4,047 Reported Cases

Oct 18, 2020 - 5,383 Reported Cases

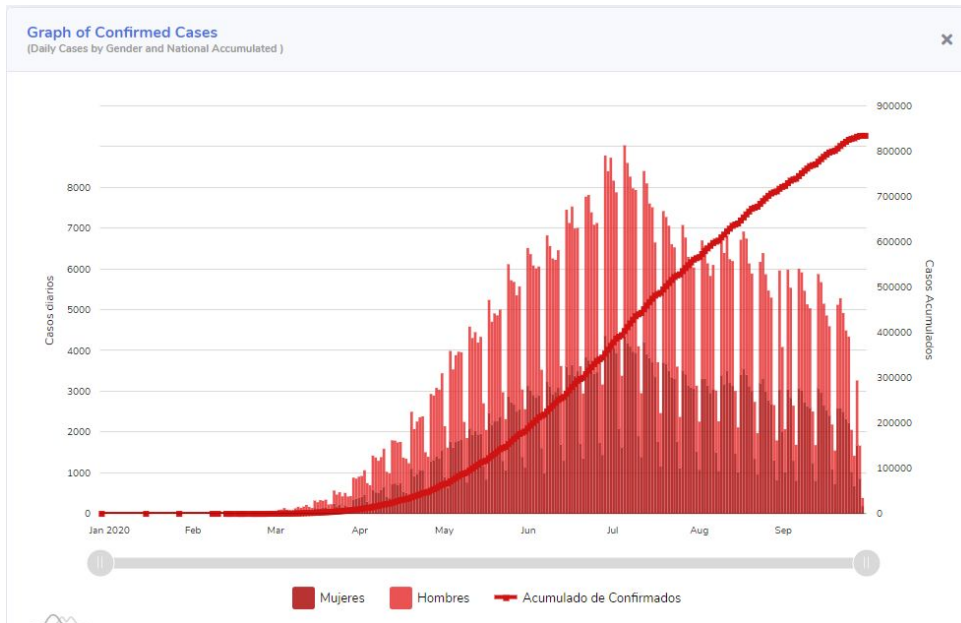
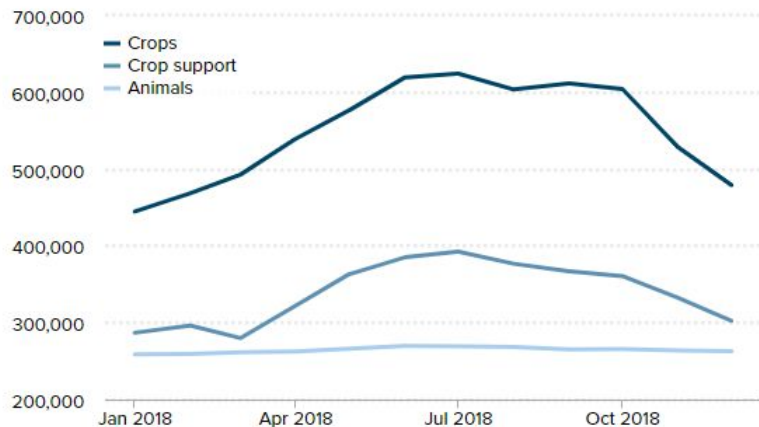


# Exogenous Factors

# Summer Farming and Seasonal Farmworkers

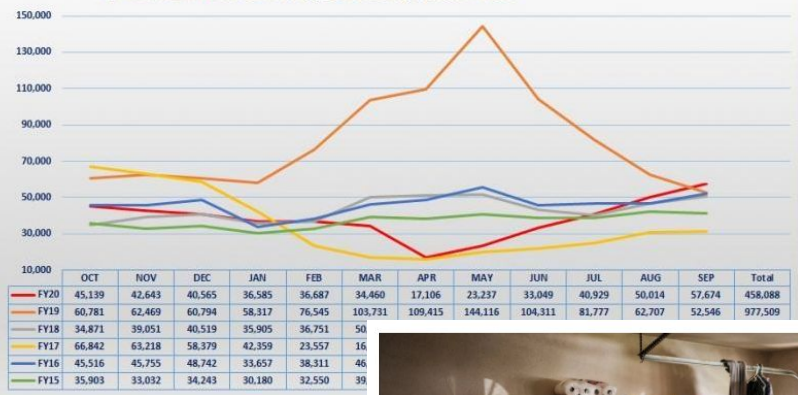
## Farmworker employment increases in spring and peaks in the summer

Unemployment-insurance-covered employment in crop, animal, and crop support agriculture, 2018



# Undocumented Farmworkers

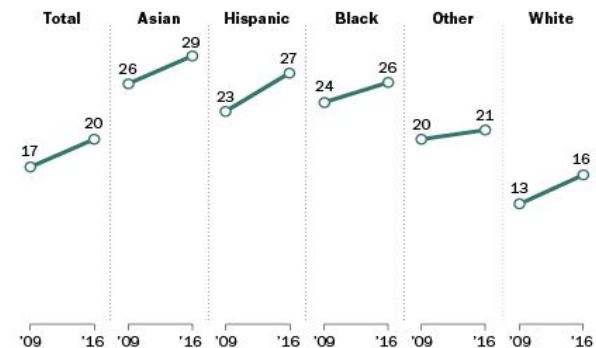
CBP Southwest Border Total Apprehensions / Inadmissibles



A garage converted to house farmworkers in Mendota, Calif. Max Whittaker for The New York Times

## Whites less likely than other racial and ethnic groups to live in multigenerational households

% of population in multigenerational households

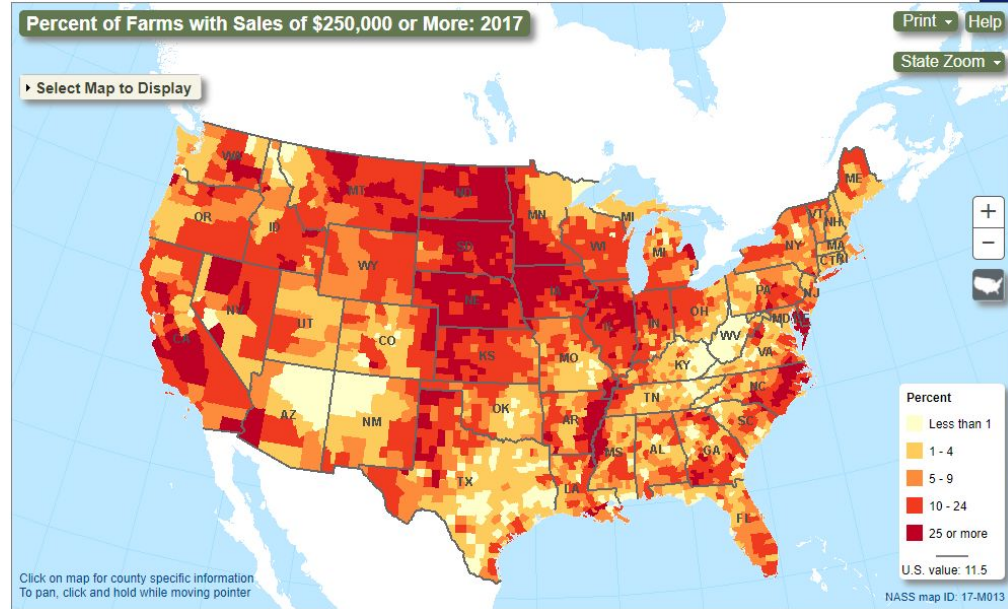
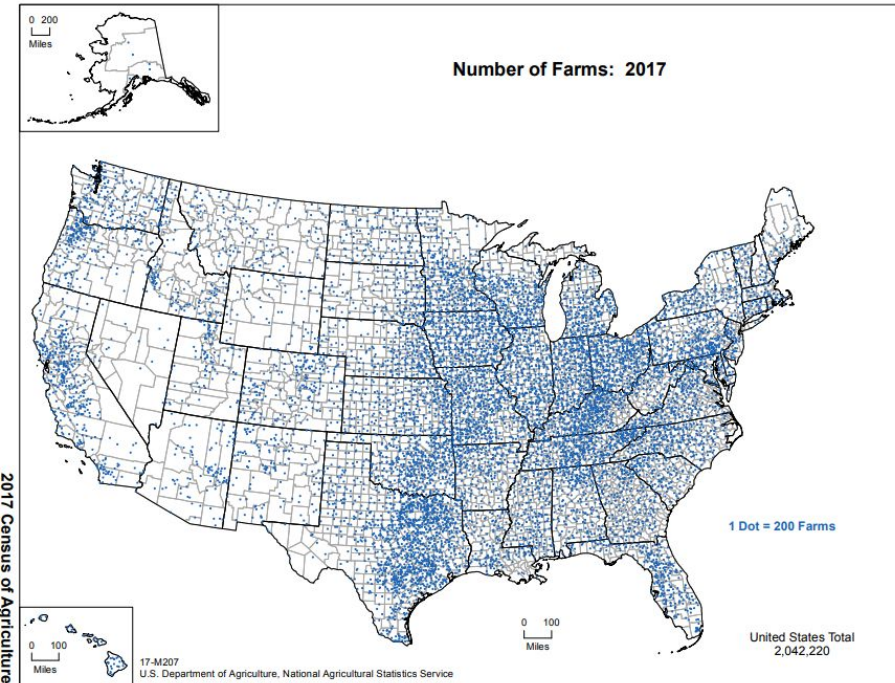


Note: Multigenerational households include at least two adult generations or grandparents and grandchildren younger than 25. Hispanics are of any race. Asians include Pacific Islanders. Whites, blacks and Asians are single-race only and include only non-Hispanics. "Other" includes non-Hispanics in remaining single-race groups or multiracial groups.

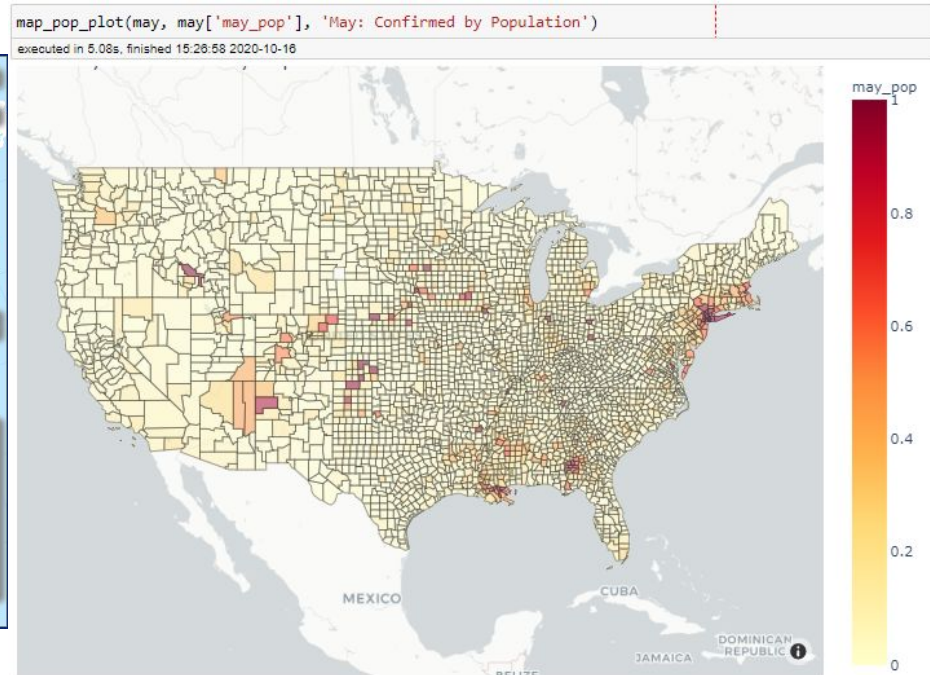
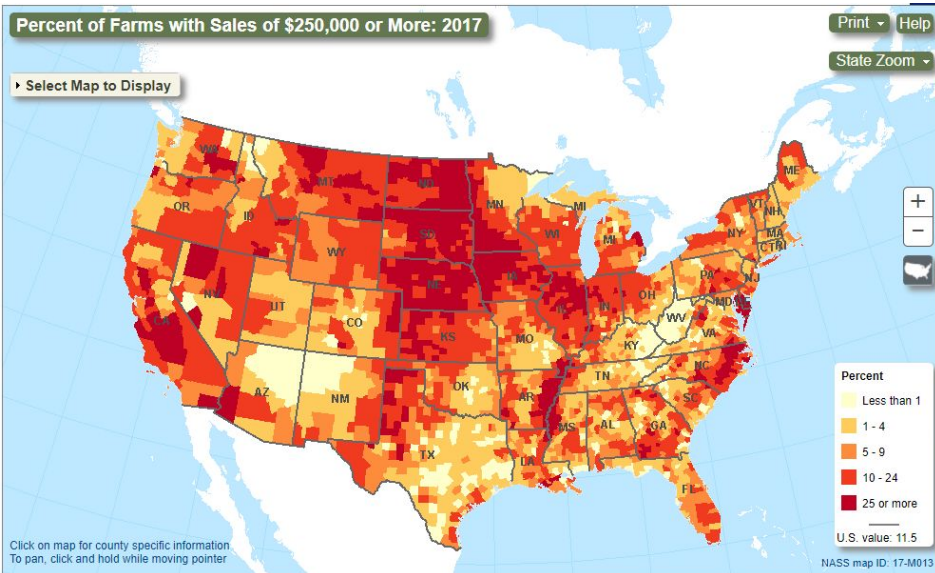
Source: Pew Research Center analysis of 2009 and 2016 American Community Surveys (IPUMS).

PEW RESEARCH CENTER

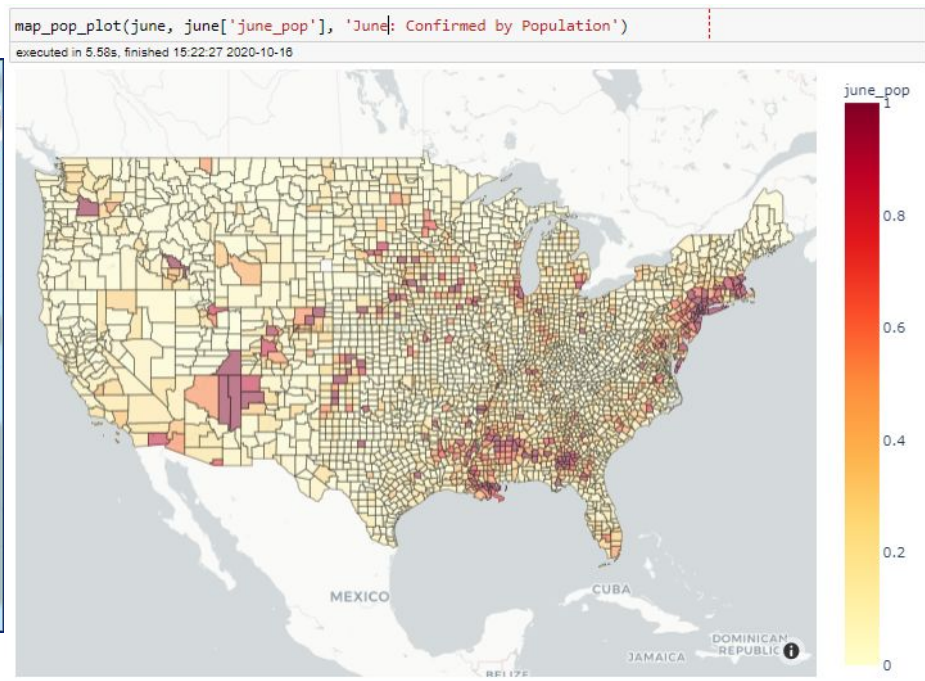
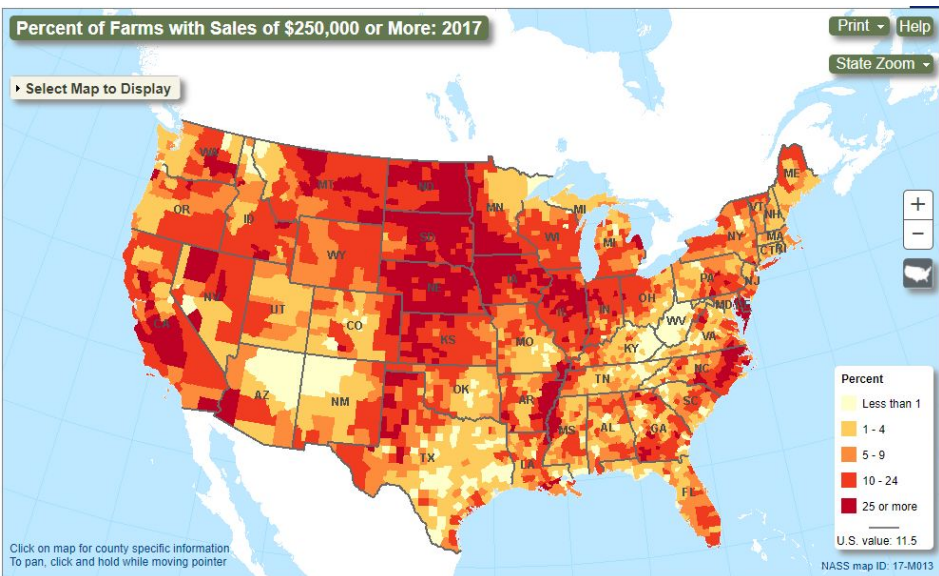
# Farm Locations





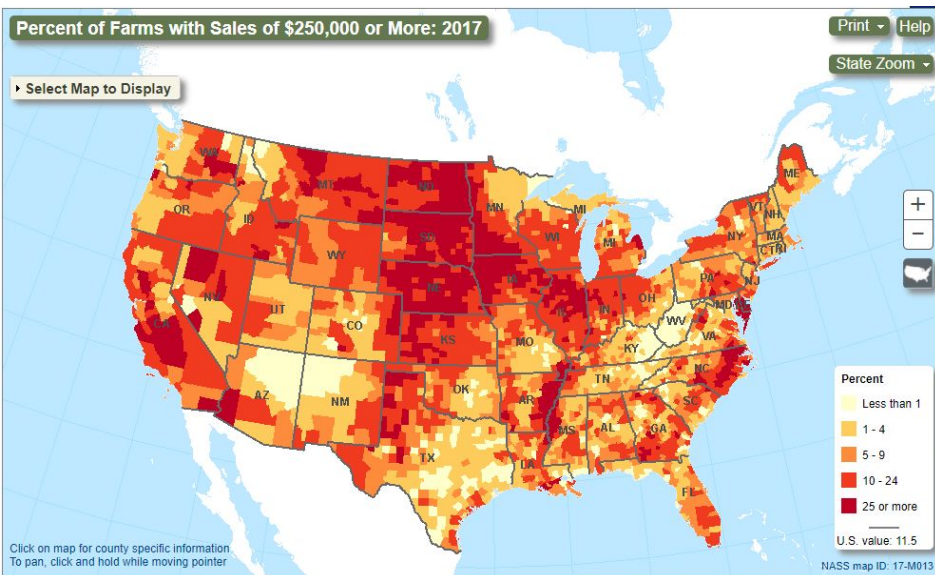


May



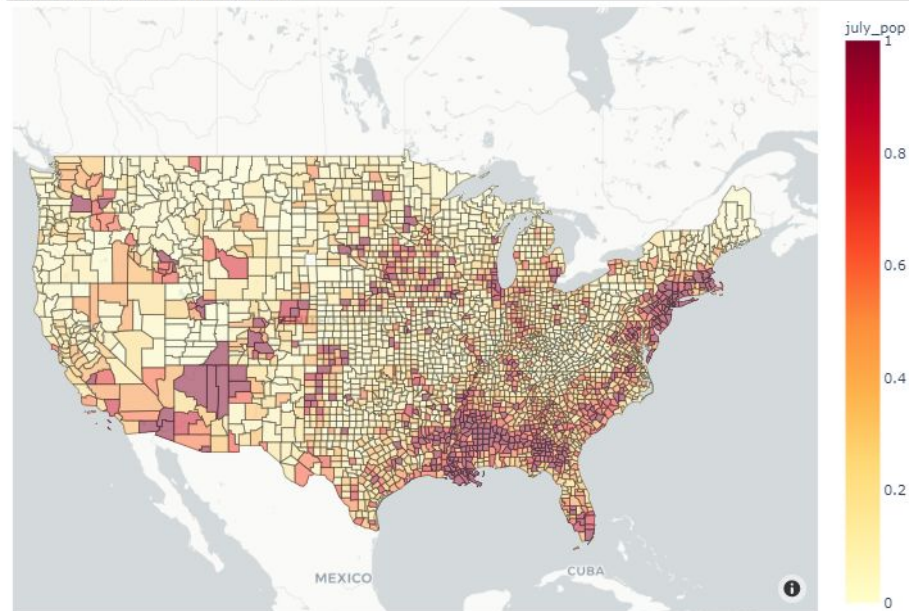
June



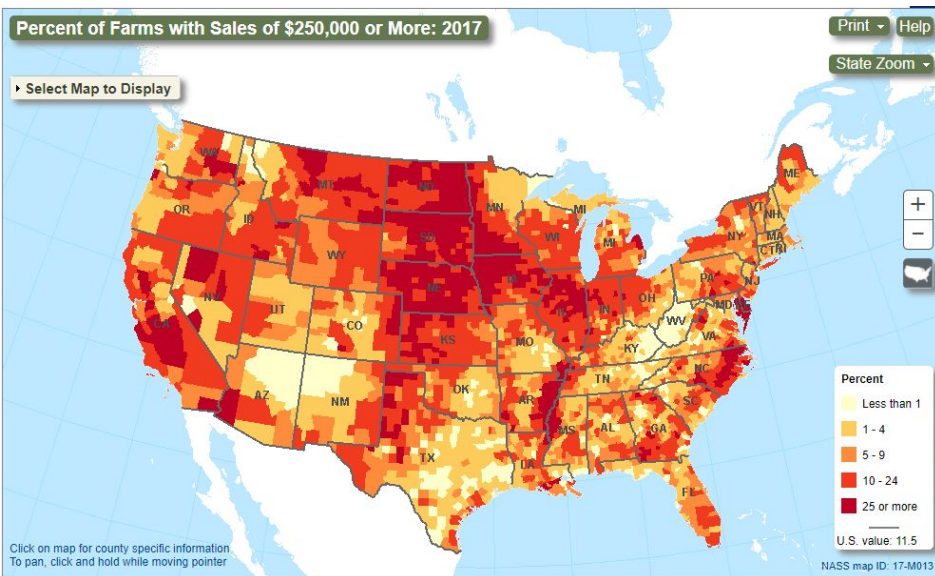


```
map_pop_plot(july, july['july_pop'], 'July: Confirmed by Population')
```

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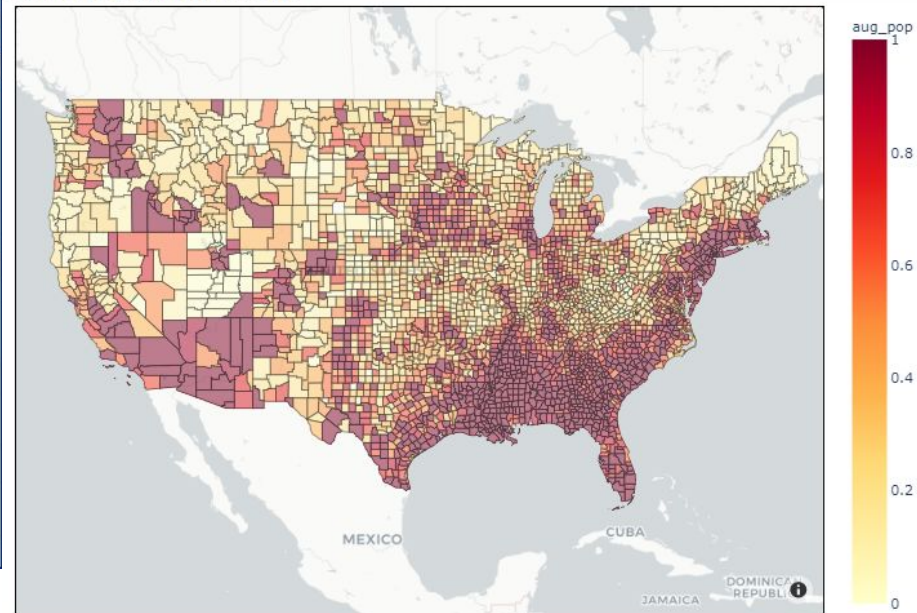


July



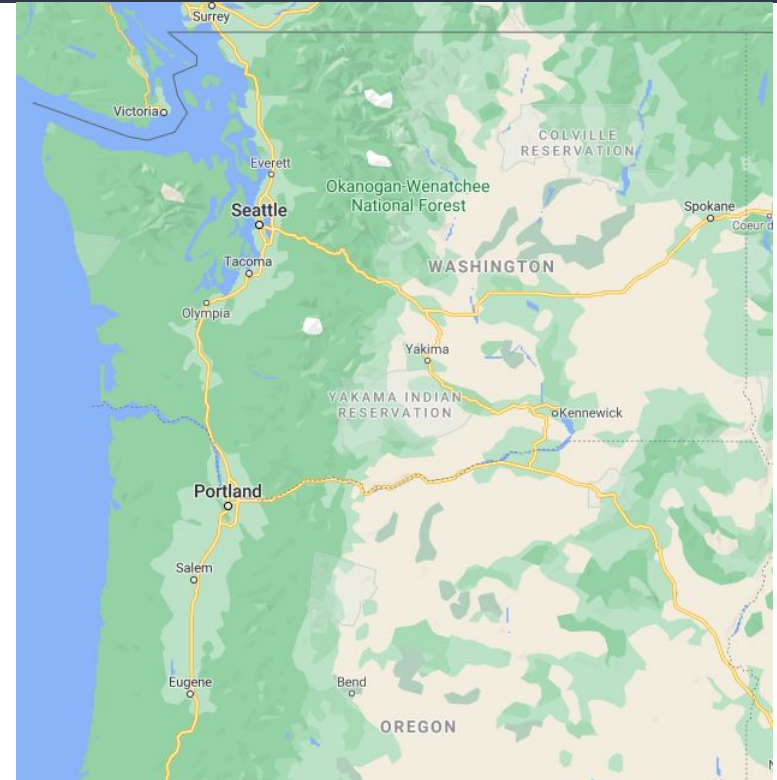
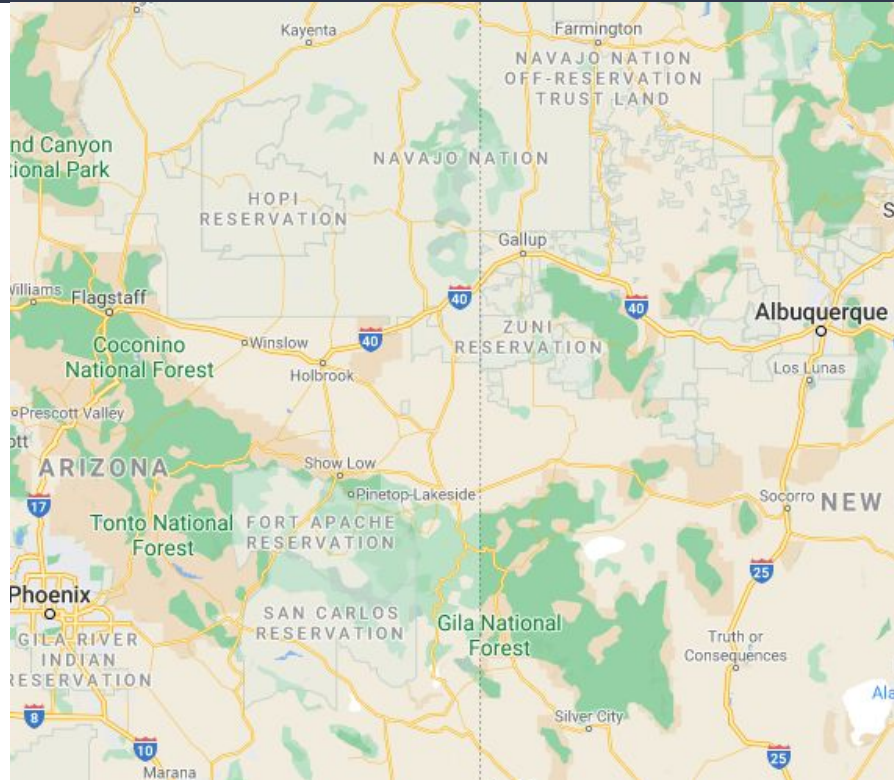
```
map_pop_plot(august, august['aug_pop'], 'August: Confirmed by Population')
```

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# August

# Native American Reservations





# Socioeconomic Disparity

Rate ratios compared to White, Non-Hispanic Persons	American Indian or Alaska Native, Non-Hispanic persons	Asian, Non-Hispanic persons	Black or African American, Non-Hispanic persons	Hispanic or Latino persons
Cases <sup>1</sup>	2.8x higher	1.1x higher	2.6x higher	2.8x higher
Hospitalization <sup>2</sup>	5.3x higher	1.3x higher	4.7x higher	4.6x higher
Death <sup>3</sup>	1.4x higher	No Increase	2.1x higher	1.1x higher

# Conclusions and Recommendations

- There is a correlation between Seasonal Farm work and the increase in confirmed cases over the summer season.
- Recommend:
  - Provisions taken to protect ALL Seasonal Farmworkers, regardless of citizenship
  - Work with Tribe Leaders and Contractors to employ Native residents in the construction of housing, providing plumbing and other amenities to improve living conditions
  - Contact your state representatives and tell them that the improvement of socioeconomic conditions for people of color should be a top priority.

# Future Work

- Redo study using latest Census data
- Investigate how broad the definition of “Probable Cases” is per state and how many of those cases actually turn positive.
- Study the occupations of people who have contracted COVID-19

# Sources

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# More Sources

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