

PREDICTING COVID-19 CASE CONCENTRATION IN MASSACHUSETTS MUNICIPALITIES

IE 7280 Statistical Methods in Engineering

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Project 1

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Introduction

Goal:

- Find predictors of COVID-19 concentration in Massachusetts towns

Implications:

- Increase preventative measures in towns susceptible to disease spread
- Could be applicable to other states/countries

Data Collection

Dependent Variable

COVID-19 Cases per 1,000

- To the probability of being infected given residency in a town

Possible Predictors

- Population Density
- Number of nearby hospitals
- Median Household Income
- Accessibility by road/air/sea
- Locations
- Industry presence
- Number of grocery stores

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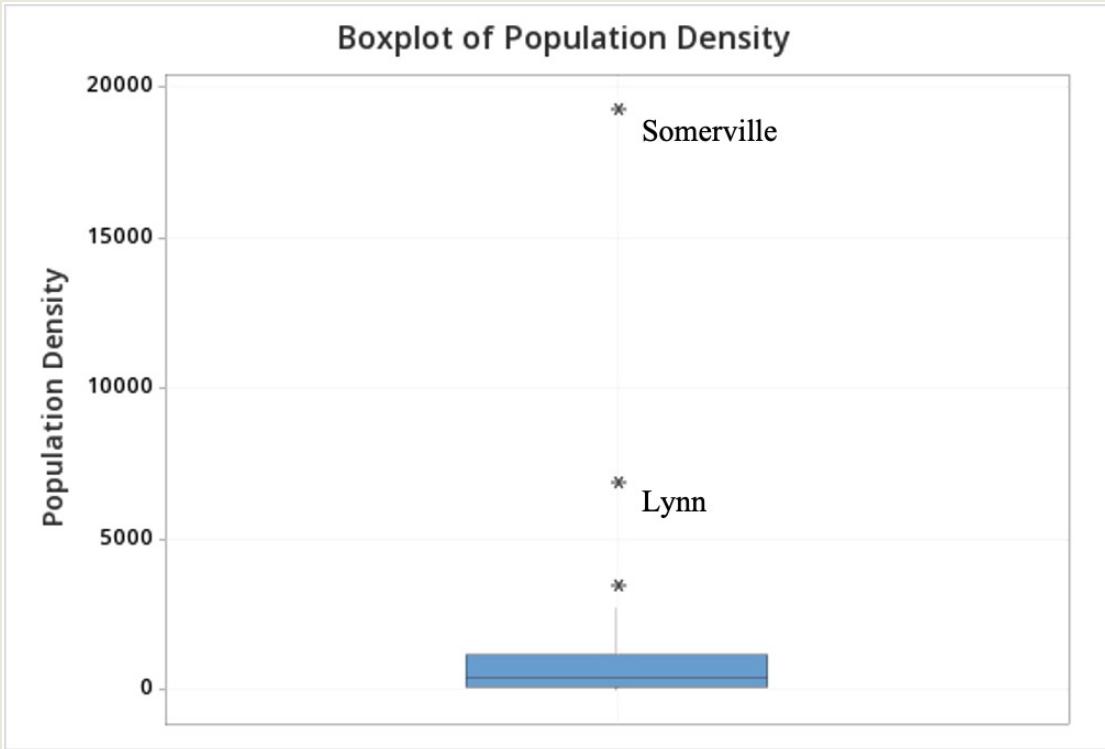
Data Collection

- Gathered data online of each Massachusetts municipality (*see references*):
 1. Total COVID-19 cases as of Feb 2, 2021
 2. Population (2019)
 3. Land Area (mi²)
 4. Median Household income
- Selected 50 random municipalities from 361 and calculated the following measurements:

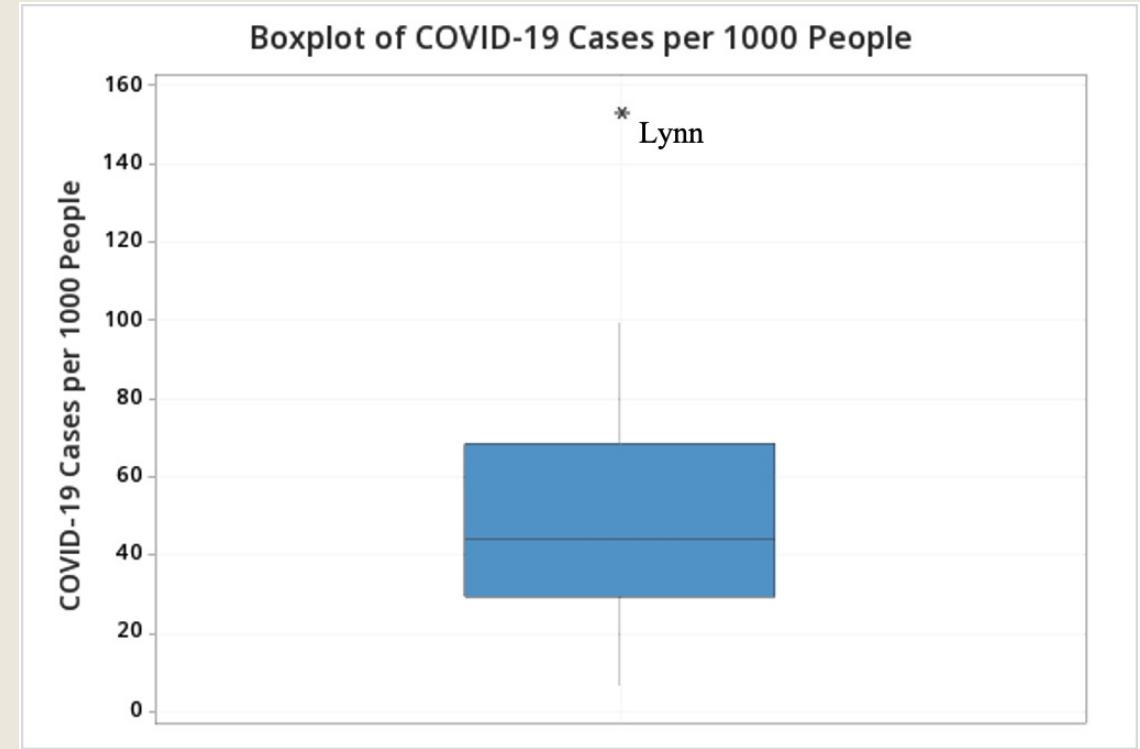
COVID-19 Cases per 1,000 People (Y)	Population Density (X₁)	Median Household Income (X₂)
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Removing Outliers

X_1



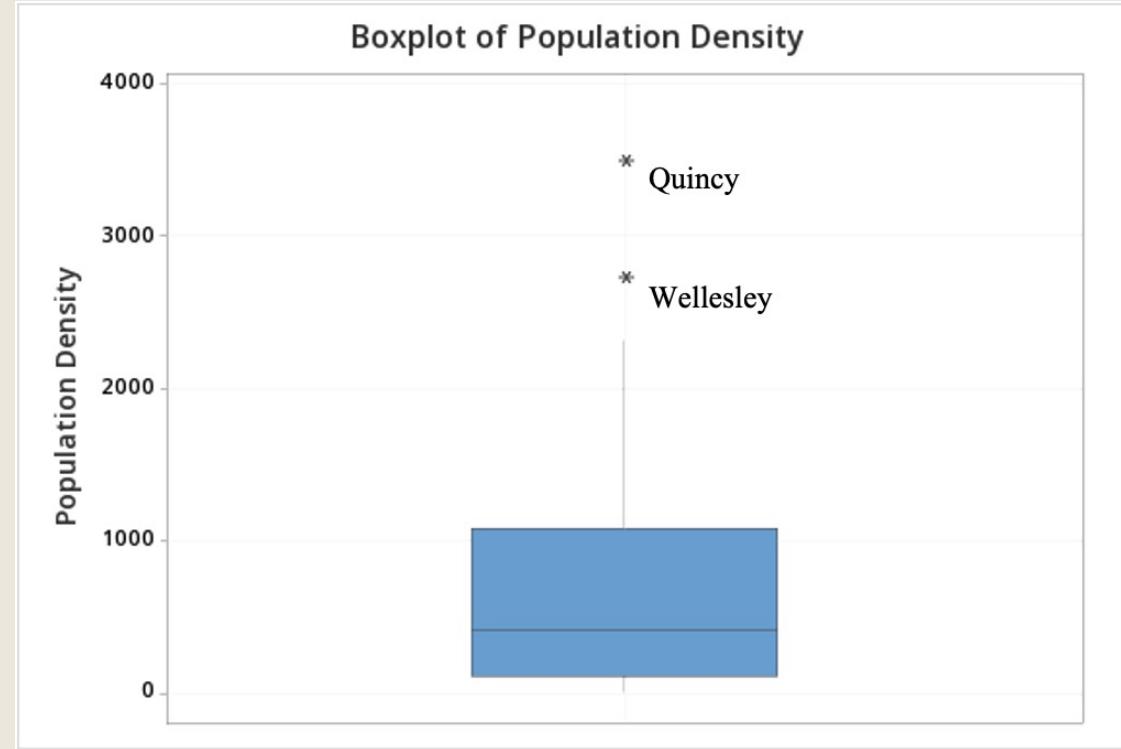
Y



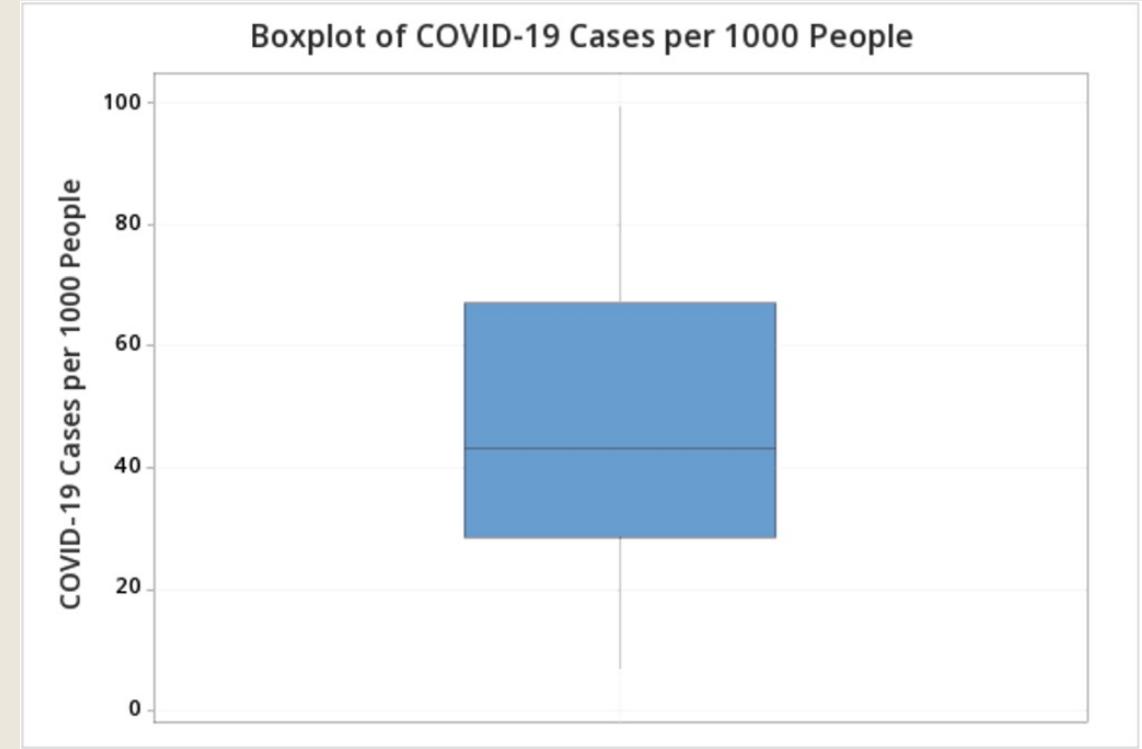
- Median household income (X_2) had no extreme outliers.

Removing Outliers

X_1

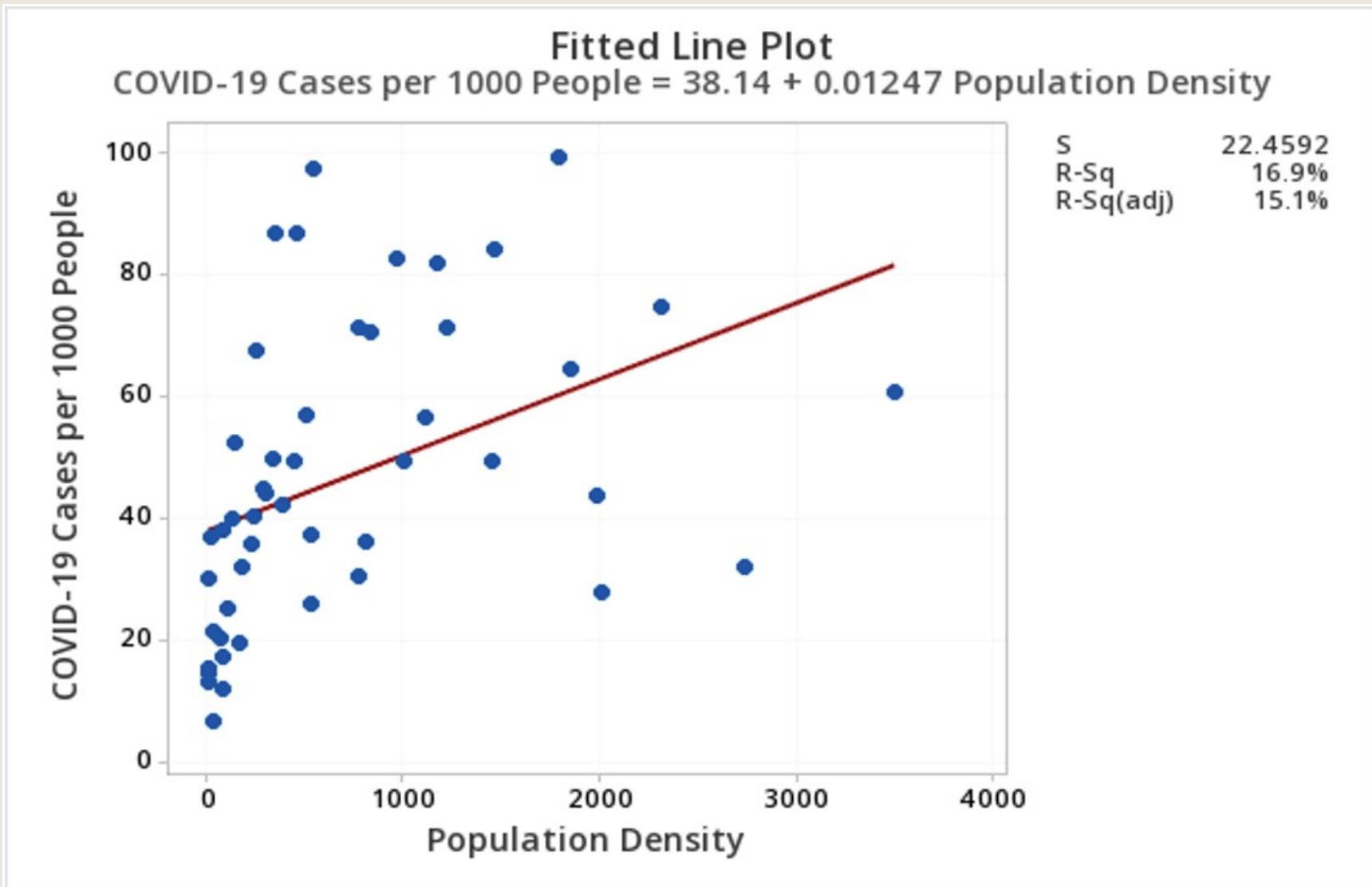


Y

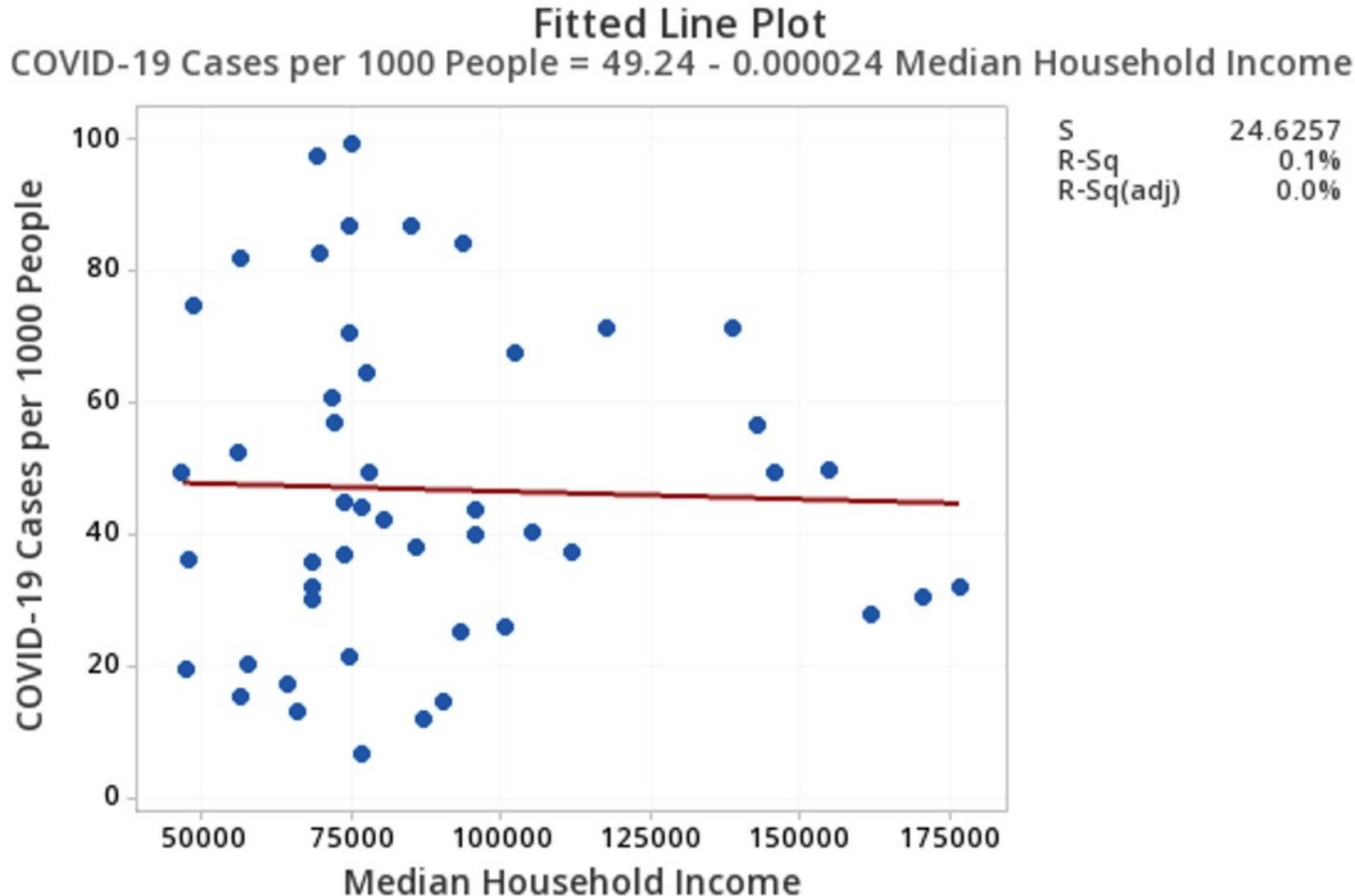


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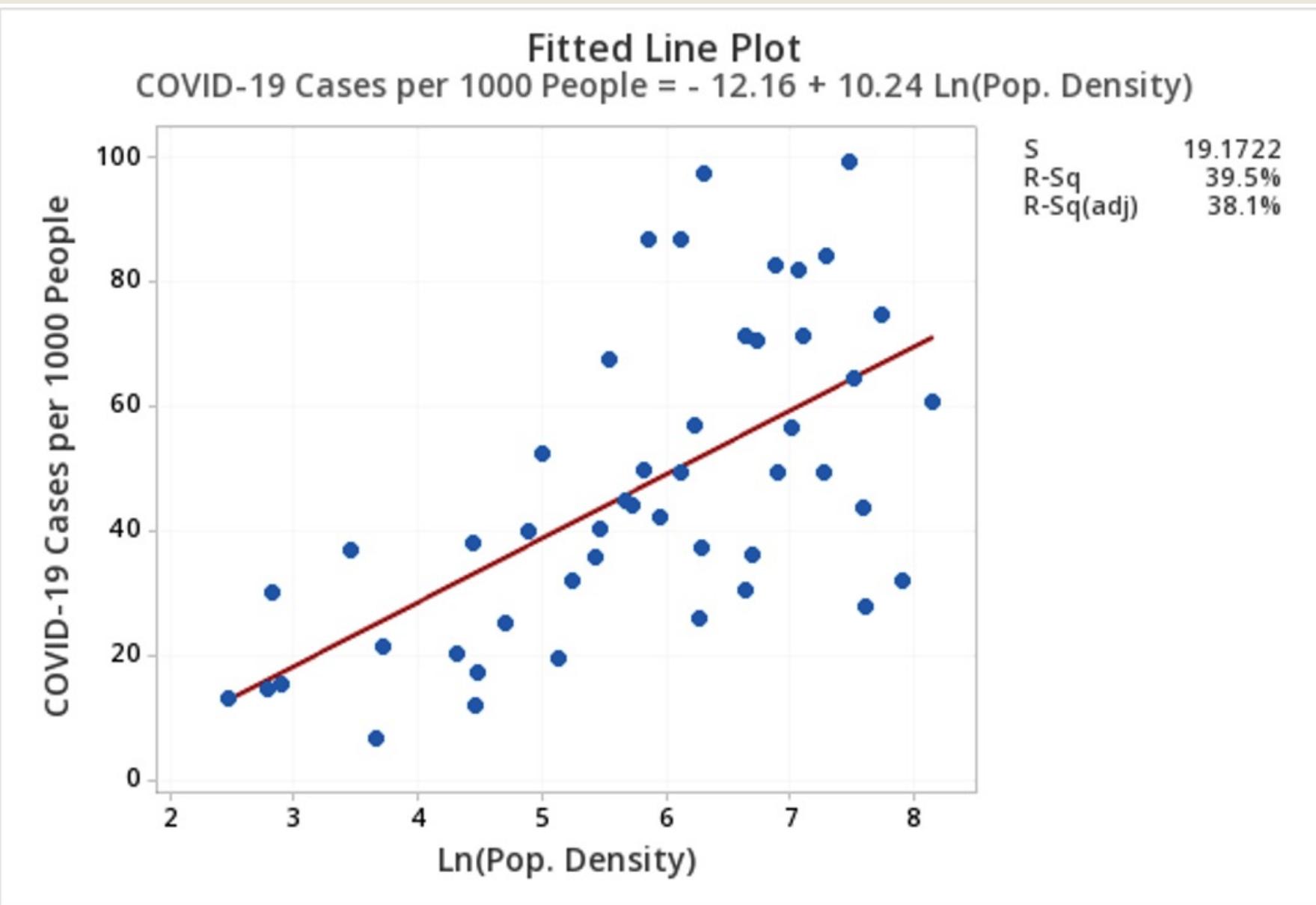
Simple Linear Regression



Simple Linear Regression



Log Transformation of Population Density



Correlation Coefficients Between Variables

	Y	X₁	X₂
Y	-	0.4112	-0.0325
X₁	0.4112	-	0.2819
X₂	-0.0325	0.2819	-

Multiple Linear Regression

Median household income (X_2) included
(MLR)

R^2	0.1930
Adjusted R^2	0.1572

Population density SLR

R^2	0.1691
Adjusted R^2	0.1510

	Intercept (b_0)	Slope (b_1, X_1)	Slope (b_2, X_2)
Coefficients	47.6358	0.0139	-0.0001
Standard Error	9.3038	0.0042	0.0001
t Stat	5.1203	3.2719	-1.1152
P-value	0.0000	0.0021	0.2541

	Intercept (b_0)	Slope (b_1, X_1)
Coefficients	38.1420	0.0125
Standard Error	4.3739	0.0041
t Stat	8.7204	3.0597
F Stat	-	9.3616
P-value	0.0000	0.0037

F	Significance F
5.3821	0.0080

Multiple Linear Regression with Log Transformation

Median household income (X_2) included
(MLR)

R^2	0.4592
Adjusted R^2	0.4352

ln(Population density) SLR

R^2	0.3945
Adjusted R^2	0.3813

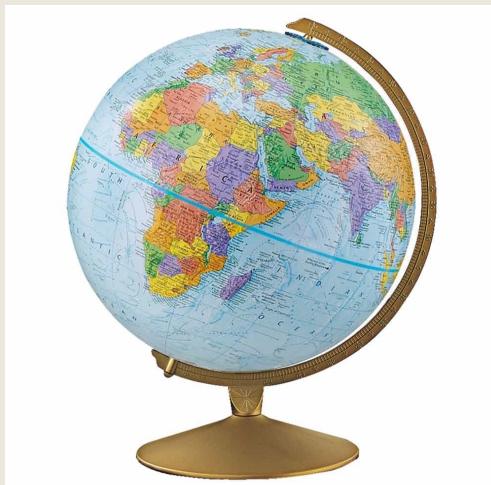
	Intercept (b_0)	Slope ($b_1, \ln(X_1)$)	Slope (b_2, X_2)
Coefficients	-3.0378	11.6957	-0.0002
Standard Error	11.3813	1.8942	~ 0.0000
t Stat	-0.2669	6.1745	-2.3204
P-value	0.7907	1.72×10^{-7}	0.0249

F	Significance F
19.1062	9.87×10^{-7}

	Intercept (b_0)	Slope (b_1, X_1)
Coefficients	-12.1626	10.2431
Standard Error	11.1777	1.8710
t Stat	-1.0881	5.4746
F Stat	-	29.9717
P-value	0.2822	1.76×10^{-6}

Conclusion and Future Directions

- Log transform of Population Density was the best predictor tested
 - COVID-19 case concentration is capped by population
- Our analysis may be applicable to other states/countries



- Future Directions:
 - Conduct similar analysis using different/additional predictors
 - Health care quality?
 - Conduct similar analysis on different state/countries to see if results hold

References

- [1] Galvin, William Galvin, Secretary of the Commonwealth of Massachusetts. (Feb. 2021). CIS: Massachusetts City and Town Incorporation and Settlement Dates <<https://www.sec.state.ma.us/cis/cisctlist/ctlstalph.htm>>
- [2] Massachusetts Department of Public Health COVID-10 Dashboard. (Feb. 4, 2021) Weekly COVID-19 Public Health Report. <<https://www.mass.gov/doc/weekly-covid-19-public-health-report - february-4-2021/download>>
- [3] Cubit Planning Inc. (2021). Massachusetts Cities by Population. Massachusetts Demographics by Cubit. <https://www.massachusetts-demographics.com/cities_by_population>
- [4] Reiss, J. & Rocheleau, M. (Dec. 11, 2018). Full list of Massachusetts median household incomes by town. The Boston Globe. <<https://www.bostonglobe.com/metro/2018/12/11/full-list - massachusetts-median-household-incomes-town/eZpgJkpB1uF2FVmpM4O8XO/story.html>>
- [5] Wikipedia (Dec. 31, 2020). List of municipalities in Massachusetts. Wikipedia. <https://en.wikipedia.org/wiki/List_of_municipalities_in_Massachusetts>