Predicting US Diabetes Prevalence

Can changes in demographics predict changes in diabetes prevalence?

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Springboard School of Data Capstone Presentation

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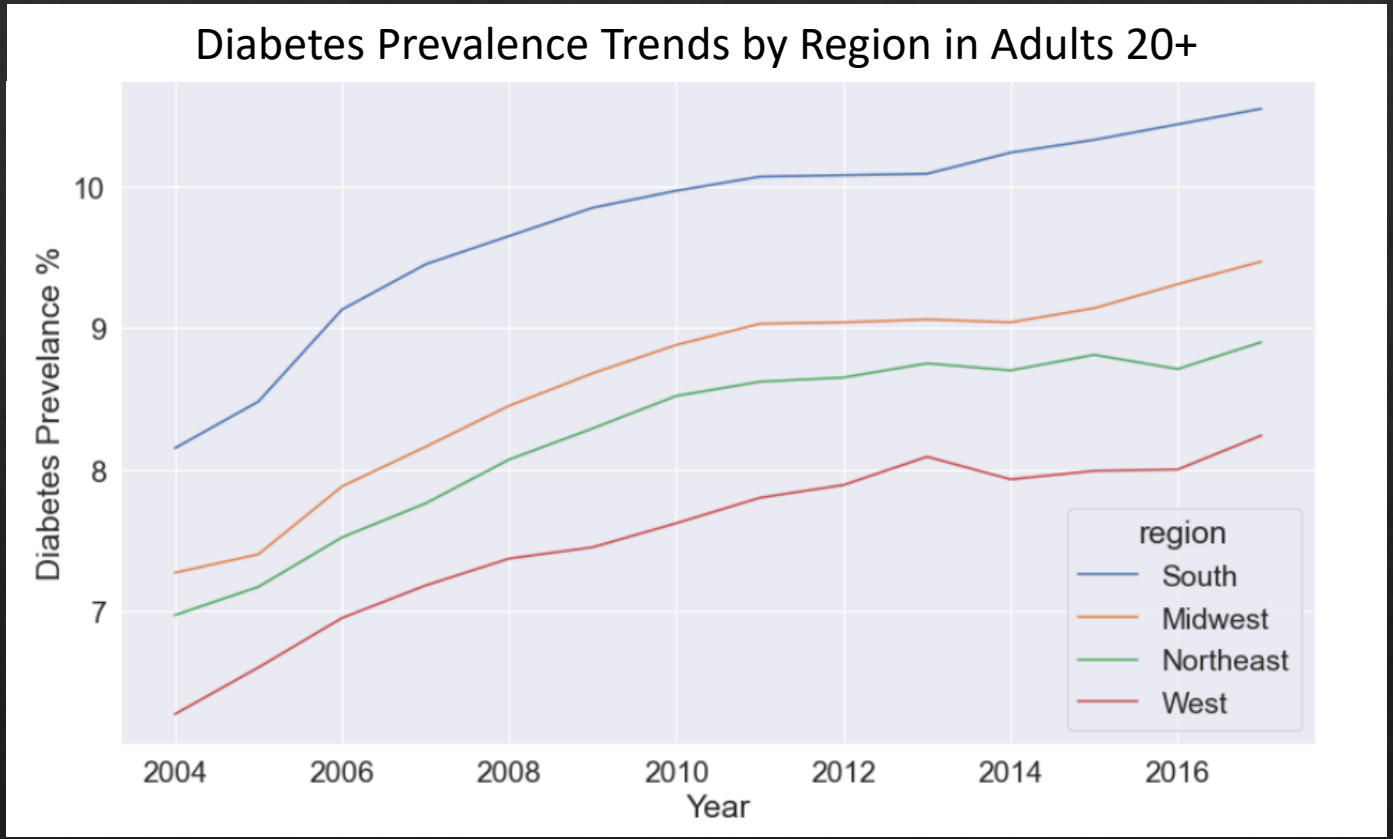
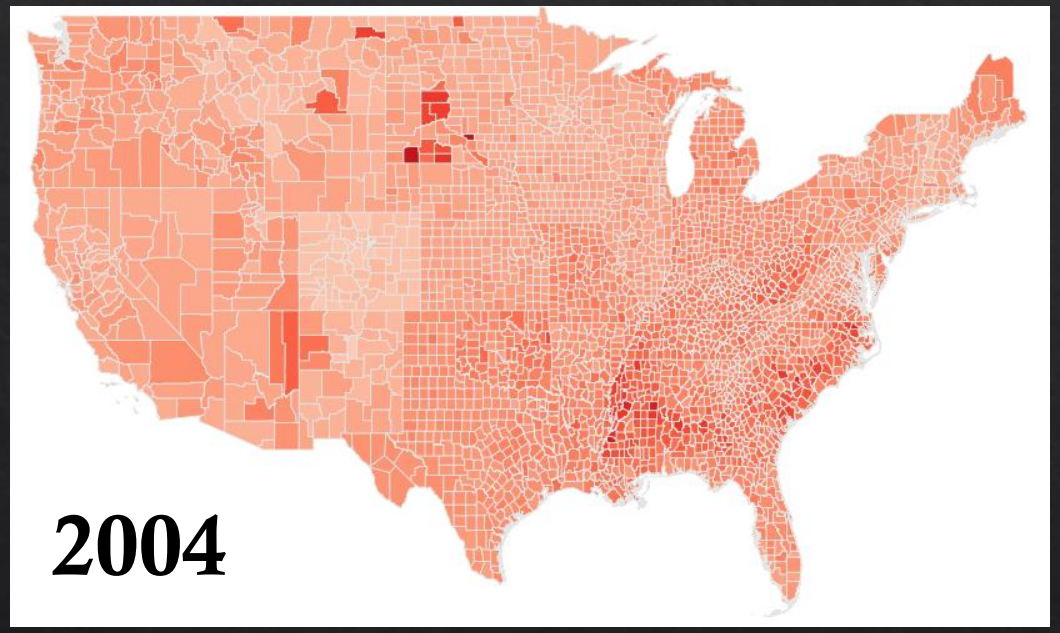
Diabetes in America

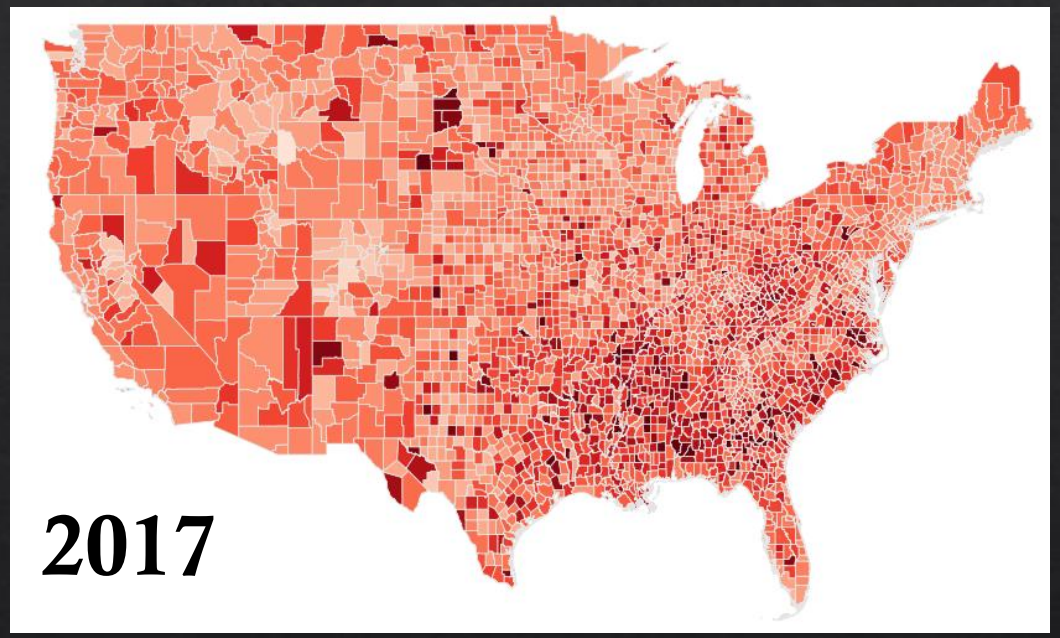
- In 2017, about 1 in 7 healthcare dollars spent on Diabetes and its complications [1]
- From 2000 to 2018, Diagnosed Diabetes rate in American adults has increased more than 50% [2]

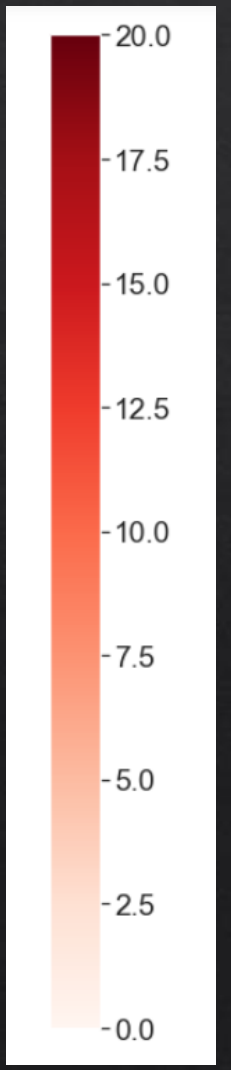


[1]: American Diabetes Association
[2]: Centers for Disease Control

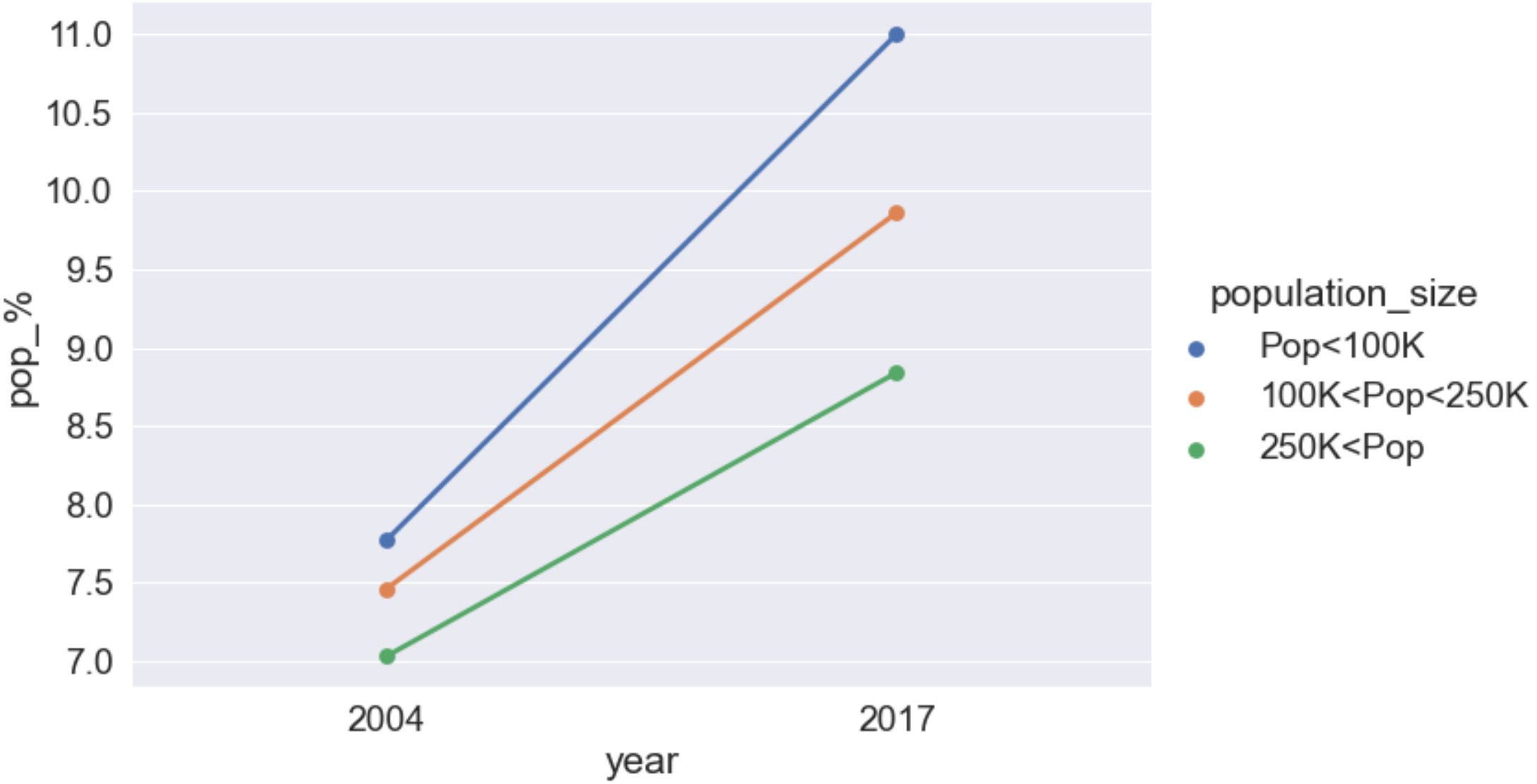
Diabetes Trends – County Level







Change in Diabetes%, Large vs. Small Counties



Factors that Affect Type II Diabetes

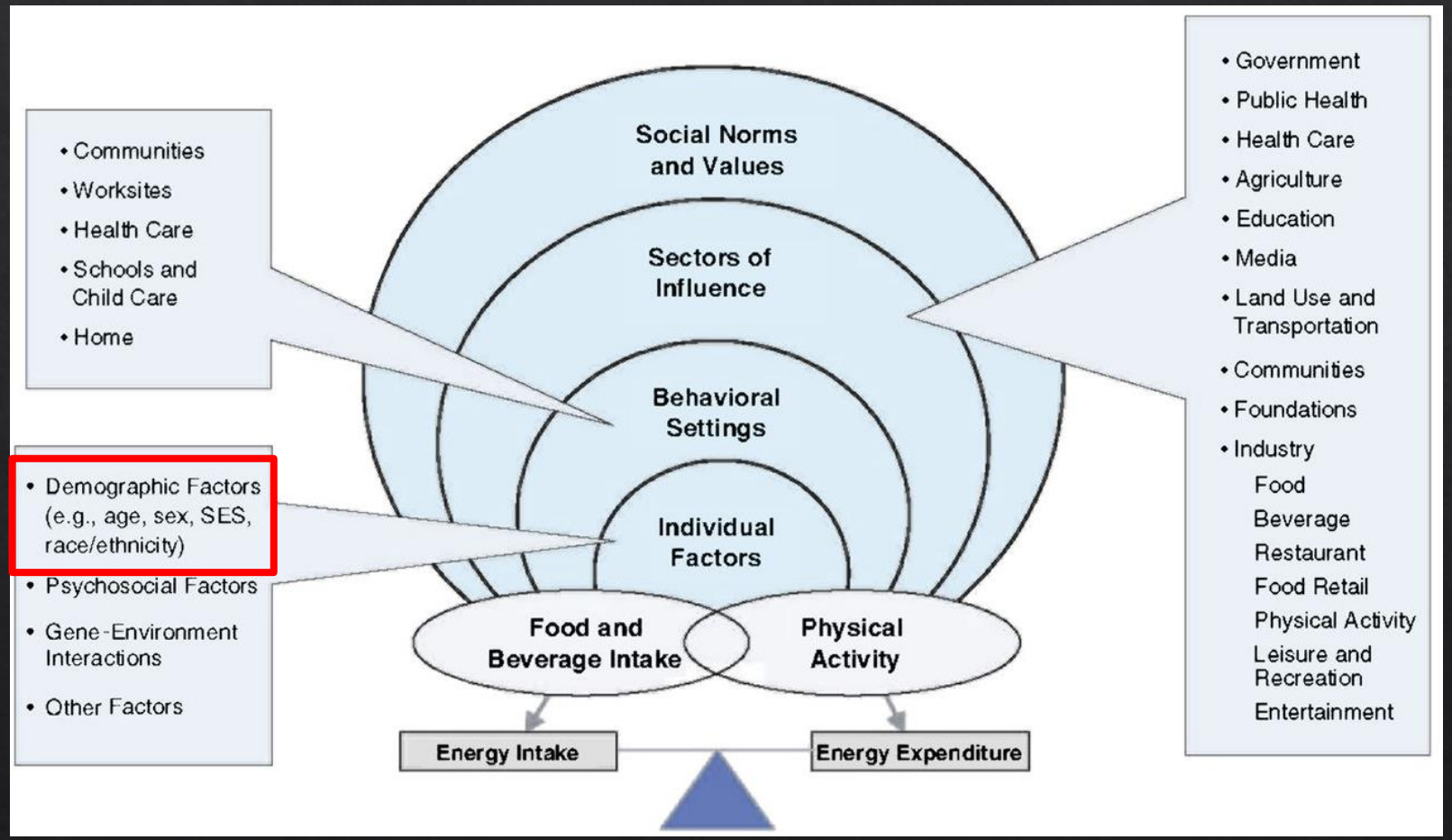


Image taken from:

[4] Hill, James P. et al. 'Scientific Statement: Socioecological Determinants of Prediabetes and Type 2 Diabetes.' Diabetes Care 2013 Aug; 36(8): 2430-2439. DOI: 10.2337/dc13-1161. Accessed 29 July 2021.

Problem Identification

Context

County level Diabetes prevalence data not yet available for 2018 and beyond

Solution Space

Use changes in demographic data to predict county level diabetes prevalence

Success Criteria

For each county, a smaller prediction error than using previous year's value as a prediction

Data Sources

-US Census: America Community Survey
-Centers for Disease Control (CDC)

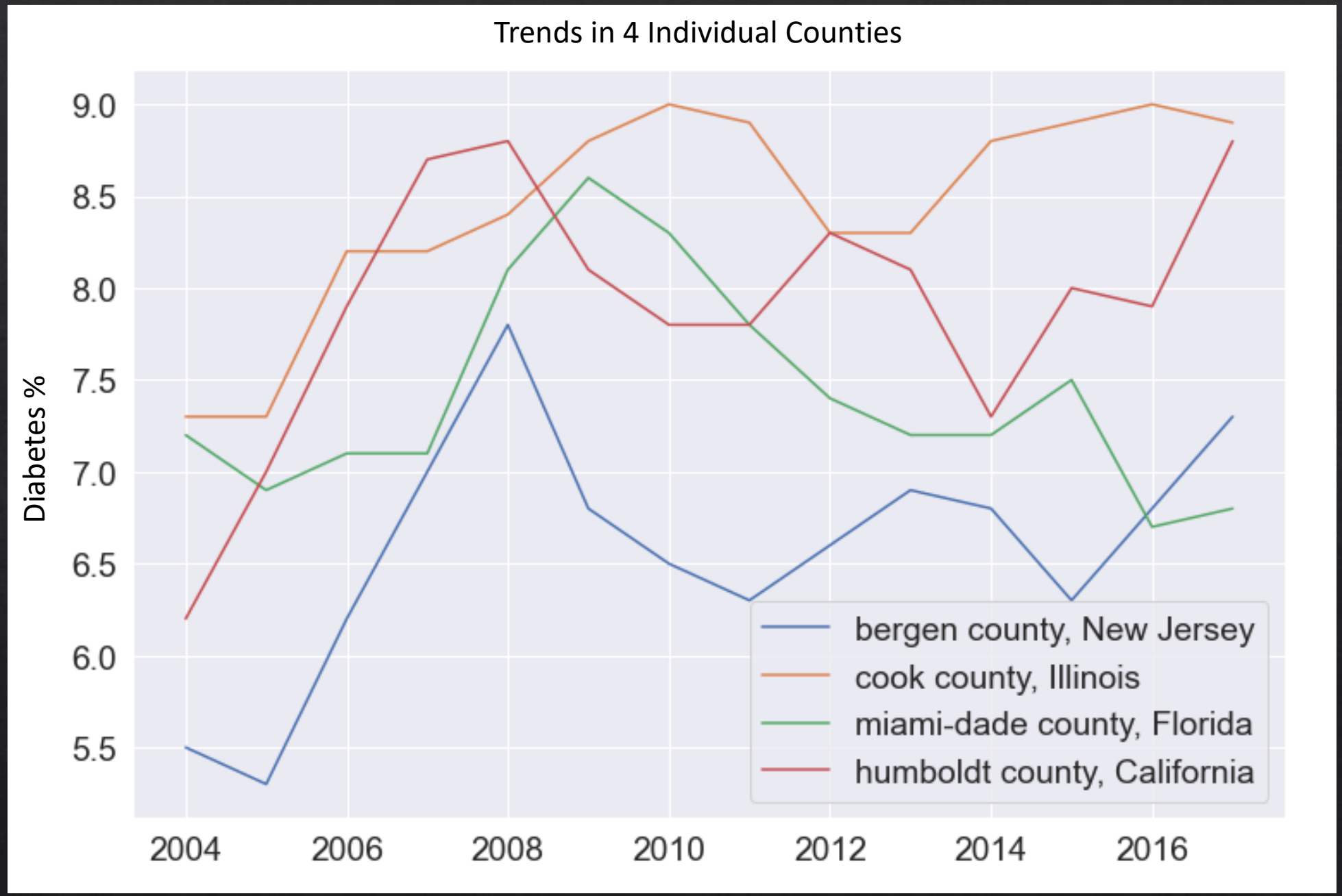
Problem Statement:

Can changes in demographic data be used to predict county-level prevalence of diabetes among adults in the United States in 2018?

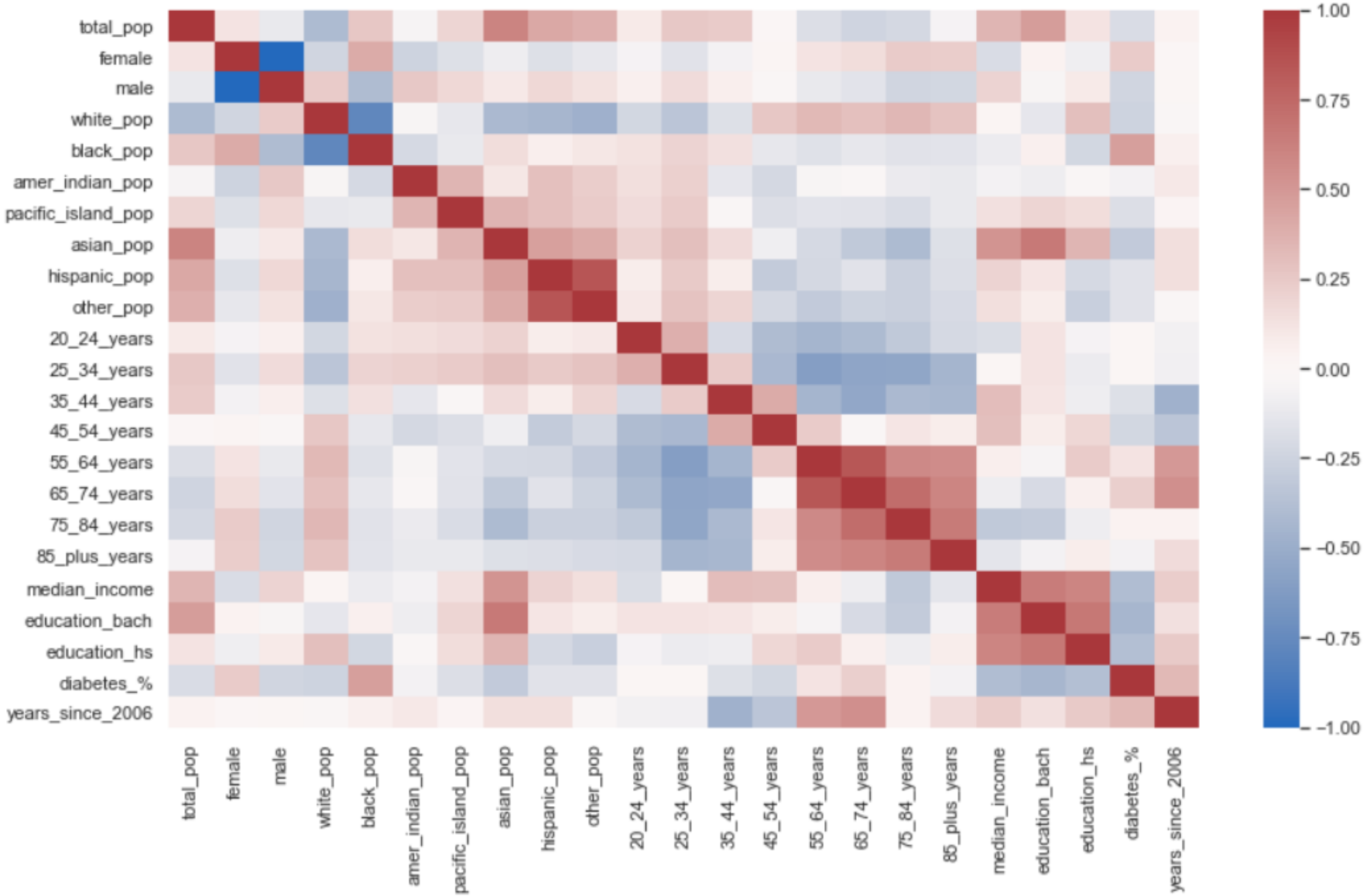
Data Details

Feature Category	Detail	Type	Source	Availability
Diabetes	% Prevalence 20+ years	Target	CDC*	-2004-2017 -All Counties
Population	# 20+ years	Explanatory	Census**	-2006-2019 -Counties w/ population >65,000
Sex	# Total	Explanatory	Census	
Race	# Total (x6)	Explanatory	Census	
Age	# in 10 year bins	Explanatory	Census	
Education I	% Highschool or >	Explanatory	Census	
Education II	% Bachelor's or >	Explanatory	Census	
Income	$ Median household income	Explanatory	Census	

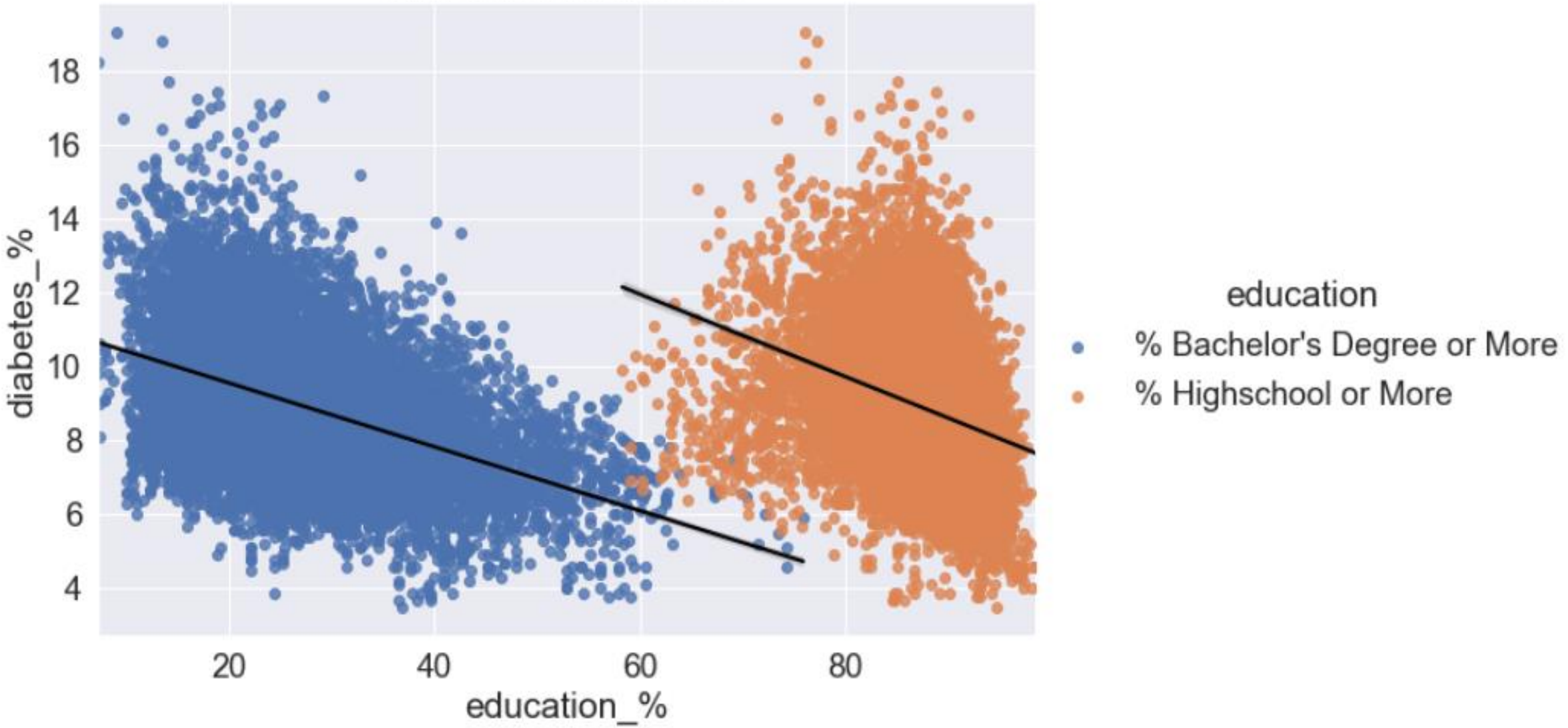
* United States Diabetes Surveillance System: https://gis.cdc.gov/grasp/diabetes/diabetesatlas.html#
**American Community Survey API: https://www.census.gov/programs-surveys/acs/data.html


Trends in 4 Individual Counties
Diabetes %
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
2004
2006
2008
2010
2012
2014
2016
bergen county, New Jersey
cook county, Illinois
miami-dade county, Florida
humboldt county, California

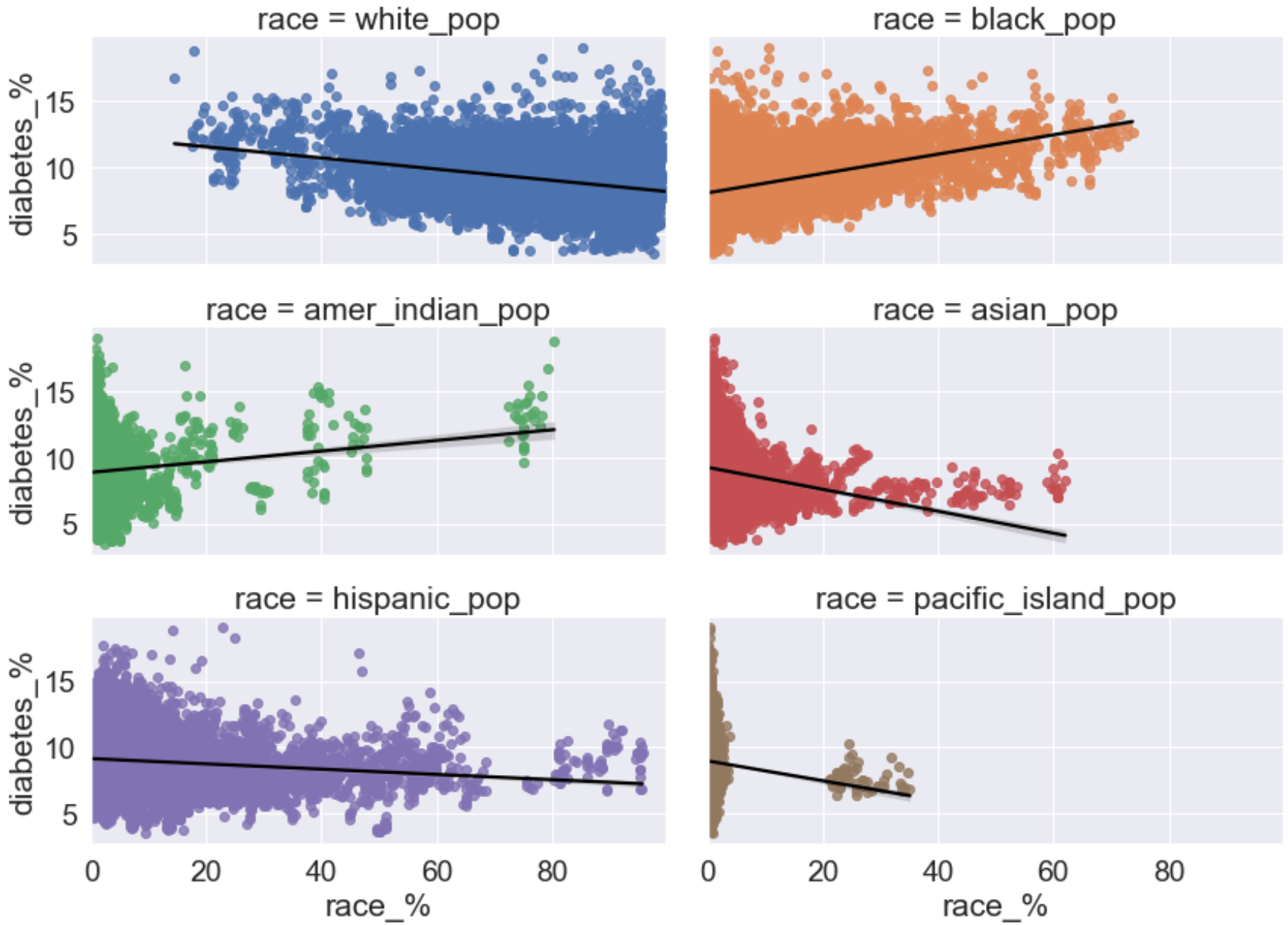
Spearman's Correlation: Relative % Features



Education vs. Diabetes



Race vs. Diabetes



2018 Prevalence by Race [3]	
White	7.5%
Black	11.7%
Amer. Indian	14.7%
Asian	9.2%
Hispanic	12.5%

[3]: American Diabetes Association

Modeling

Considerations

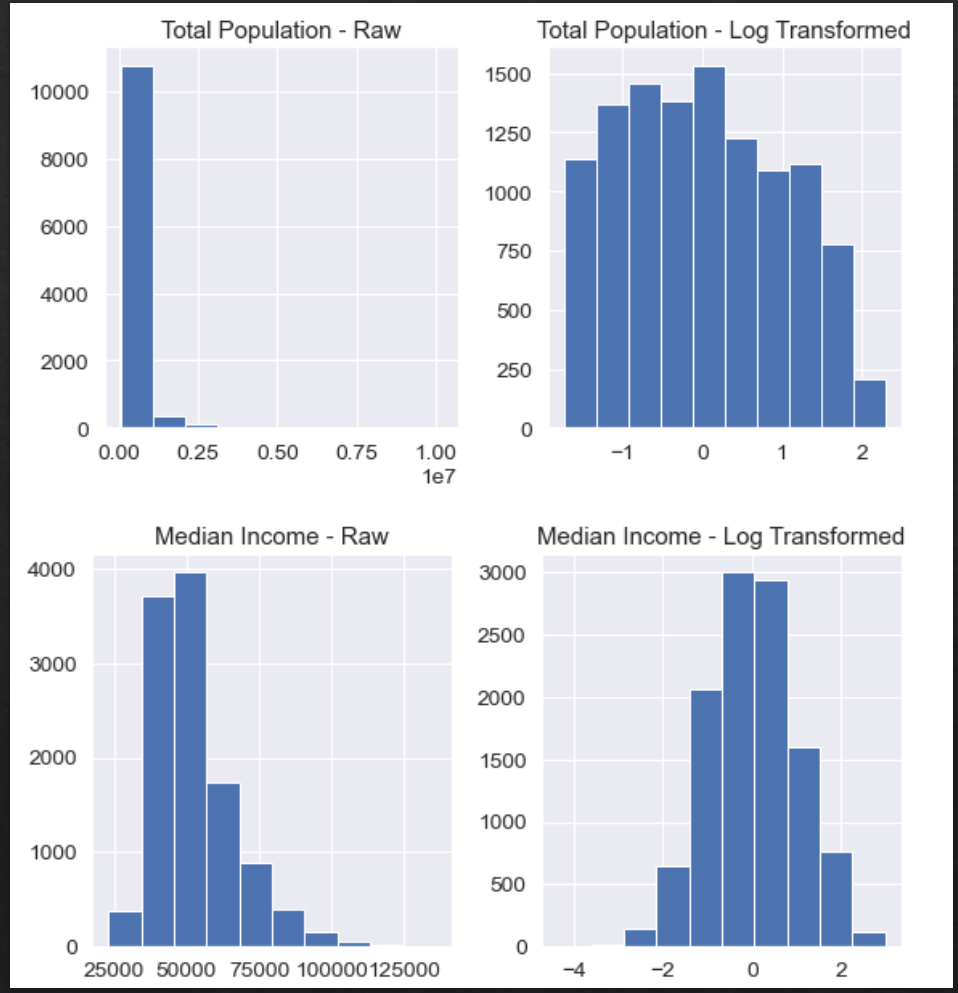
- Capture County-Level Trends
- Out of Sample Predictions
- Understand Features

Choices

- Linear Regression
- Feedforward Neural Net
- Multivariable LSTM Network

General Preprocessing Steps

- Drop counties with population <65K for >3 years
  - Back & forward fill remaining values
- Years-> ‘years_since_2006’
- Dummy-encode region
- Log transform
- Min & max scaling



Accounting for Time

- Linear regression & feedforward net:
  - Added diabetes % from 1, 2 & 3 years ago
- LSTM network:
  - Experimented with different sequence lengths
- Test/Train Split:
  - Testing Data: Up to 2016
  - Training Data: 2017

Years Since 2006	Diabetes %	Diabetes % (t-1)	Diabetes % (t-2)	Diabetes % (t-3)
1	8.1	7.8	7.2	7.2
2	8.6	8.1	7.8	7.2
3	9.9	8.6	8.1	7.8
4	10.2	9.9	8.6	8.1
5	9.8	10.2	9.9	8.6

Sample Data, Baldwin County Alabama

LSTM n=4 Structure : Training Features

Diabetes %	Demographic Data Col 1	…	Demographic Data Col 24
(t-1)	t	…	t
(t-2)	(t-1)	…	(t-1)
(t-3)	(t-2)	…	(t-2)
(t-4)	(t-3)	…	(t-3)

8 Sequences Per County

807 Counties

X_train Shape: (6456, 4, 25)

Model Comparison

Predicting 2016's Value
Error: 0.876

Linear Regression
Error: 0.804

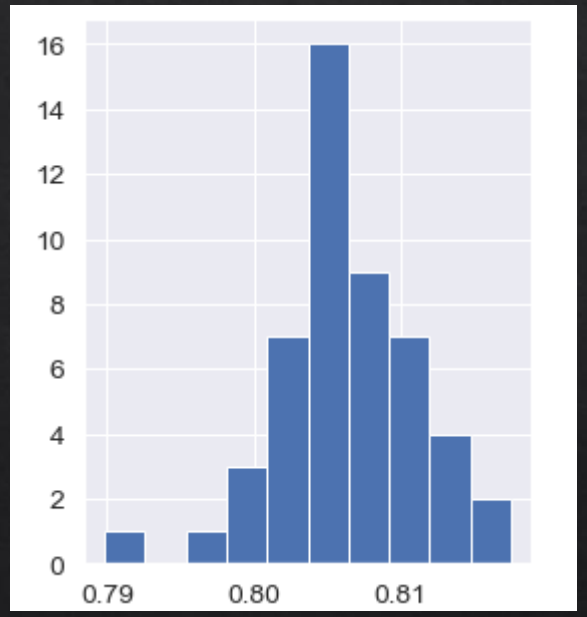
Feedforward Neural Net
Mean Error: 0.806

LSTM Network (n=4)
Mean Error: 0.786

Error = Mean Absolute Error (MAE)

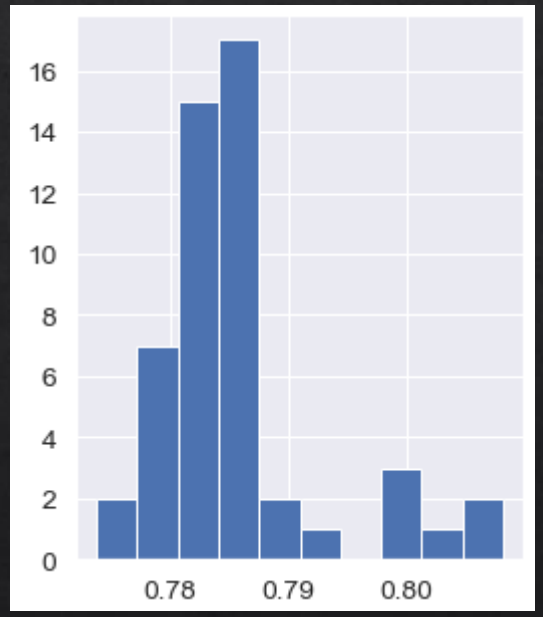
Error ‘Bootstrapping’: 50 Iterations

Feedforward Neural Net



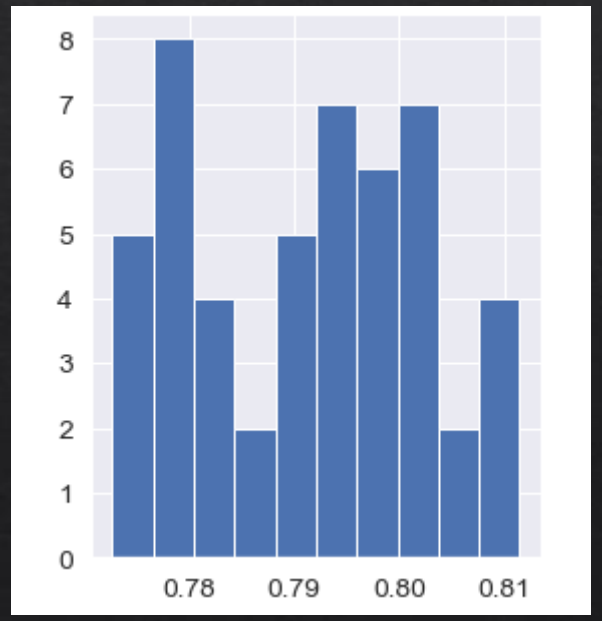
Mean: 0.806
Standard Dev: 0.00486

LSTM Network n=4



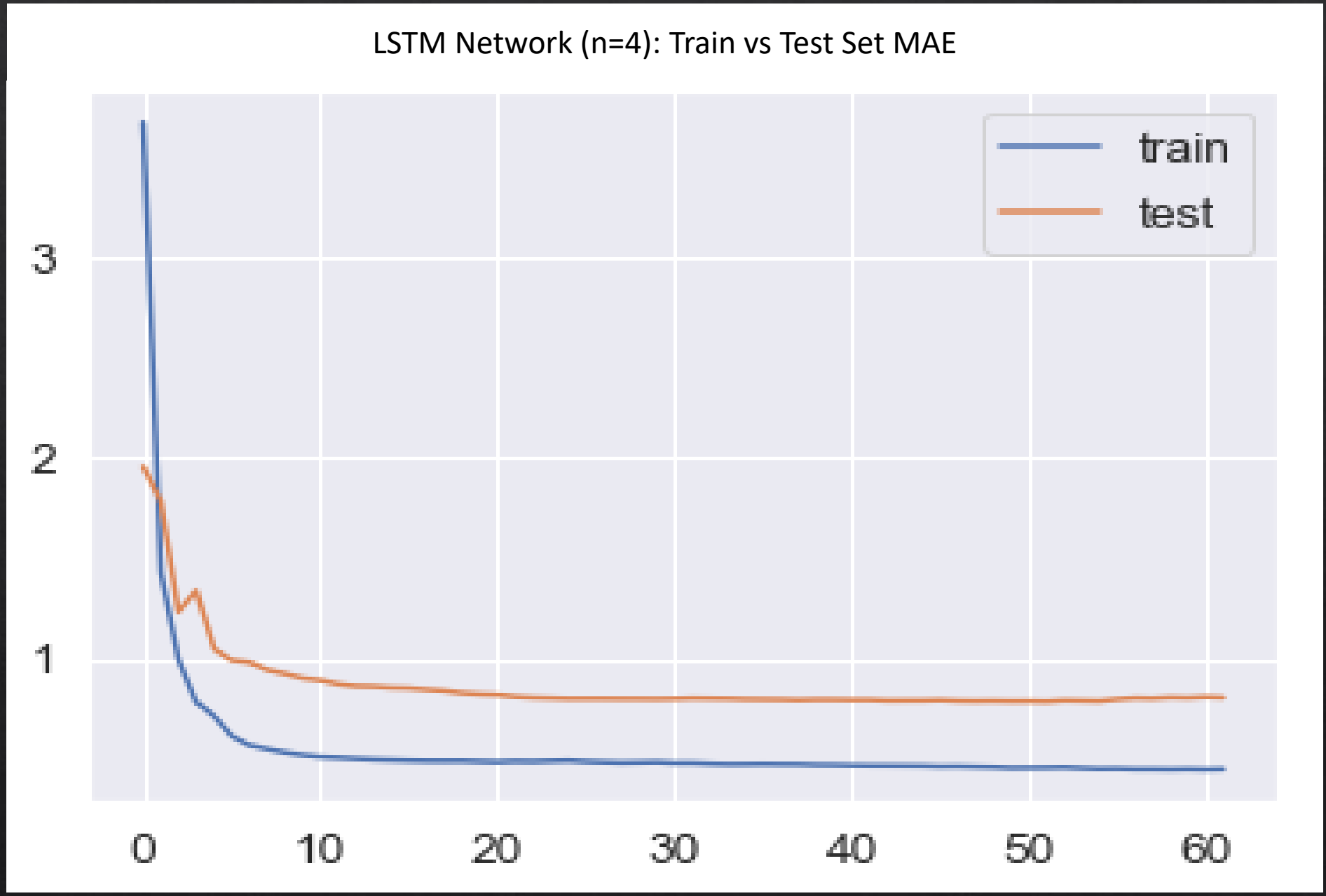
Mean: 0.786
Standard Dev: 0.00709

LSTM Network n=5

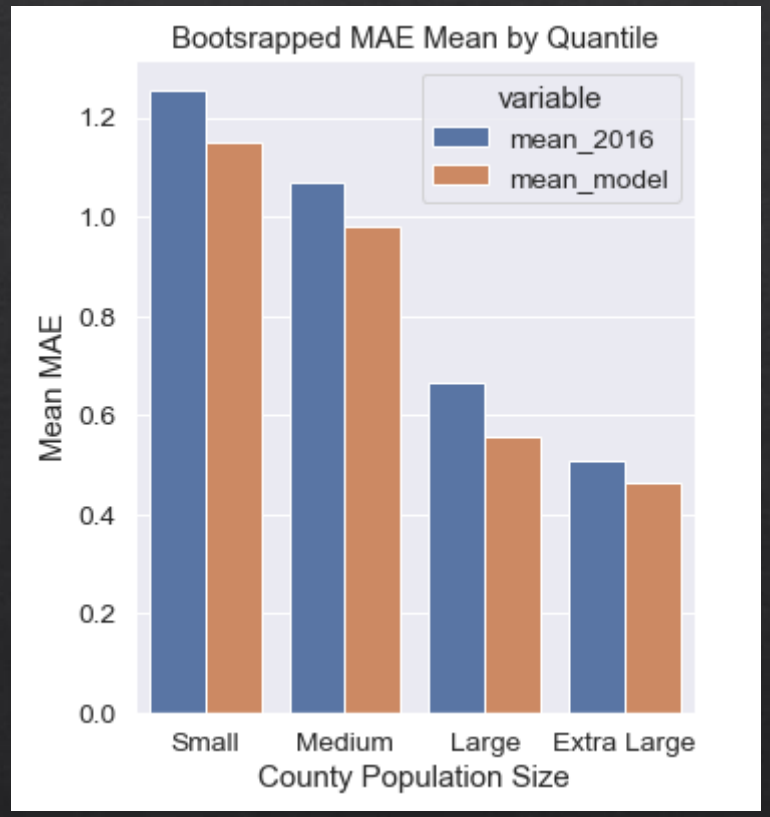


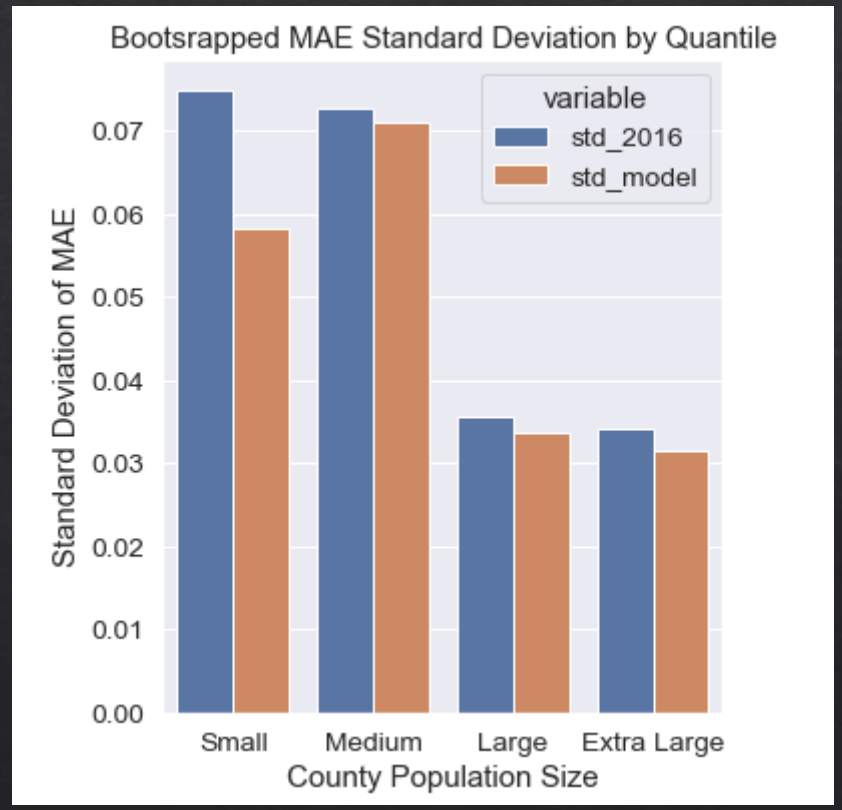
Mean: 0.791
Standard Dev: 0.0113

LSTM Network (n=4): Train vs Test Set MAE



Error by Population Quantile for Final Model





Final model vs. 2016 predictions by population quantile

Feature Importance

Linear Regression

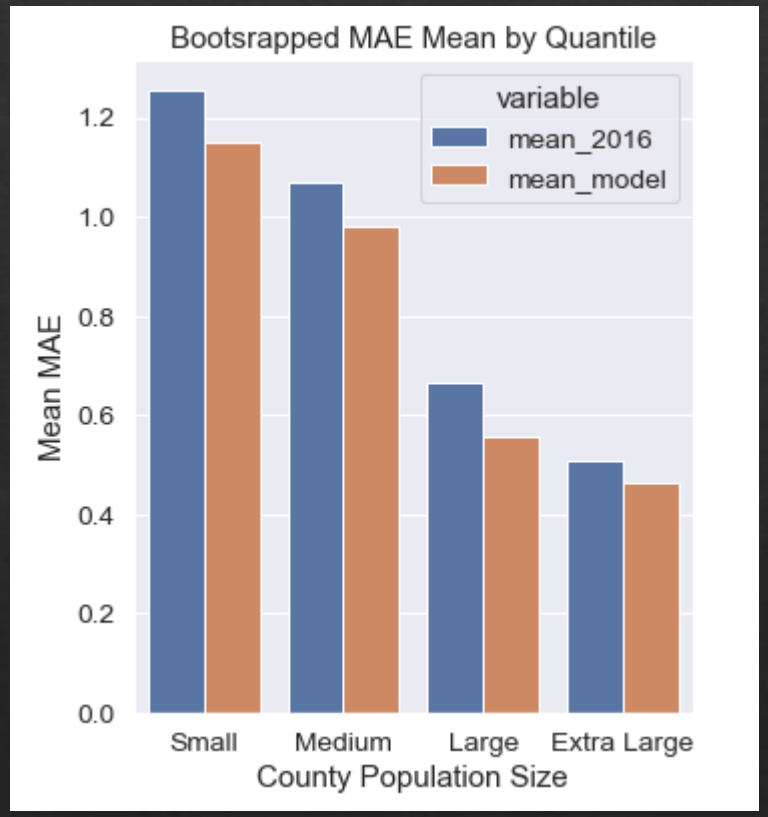
	p	coef	2.5%	97.5%
diabetes_1_year_past	0	14.0418	13.645	14.439
const	0	5.1329	4.029	6.237
diabetes_3_years_past	0	-1.4072	-1.728	-1.087
education_bach	0	-1.2907	-1.502	-1.079
hispanic_pop	0	-0.8132	-1.026	-0.601
median_income	0	-0.6391	-0.873	-0.405
years_since_2006	0	0.478	0.353	0.603
region_West	0	-0.184	-0.244	-0.124
region_South	0	0.0861	0.039	0.133
asian_pop	0.002	1.1804	0.438	1.923
amer_indian_pop	0.004	1.3698	0.446	2.294
85_plus_years	0.005	-0.3147	-0.533	-0.097
black_pop	0.006	1.2269	0.354	2.1
education_hs	0.008	-0.3059	-0.532	-0.079
25_34_years	0.009	-0.3573	-0.625	-0.09
35_44_years	0.016	0.3837	0.07	0.697
45_54_years	0.017	-0.3565	-0.65	-0.063
pacific_island_pop	0.021	-0.4929	-0.911	-0.075
20_24_years	0.028	-0.3611	-0.684	-0.039
other_pop	0.038	0.5574	0.031	1.084
white_pop	0.122	0.7927	-0.213	1.799
55_64_years	0.153	-0.1924	-0.456	0.071
region_Northeast	0.218	0.0309	-0.018	0.08
65_74_years	0.267	-0.346	-0.957	0.265
female	0.547	0.0817	-0.184	0.348
75_84_years	0.584	-0.1126	-0.516	0.291
total_pop	0.639	-0.0198	-0.102	0.063

Conclusions

Is the model useful?

Marginally, yes.

Overall, race & socioeconomic status more indicative than age in predicting diabetes.



References

- [1] “The Cost of Diabetes.” American Diabetes Association. Accessed June 19, 2021. https://www.diabetes.org/resources/statistics/cost-diabetes.
- [2] “U.S. Diabetes Surveillance System.” United Stats Diabetes Surveillance System, Centers for Disease Control and Prevention. . Accessed June 19, 2021. https://gis.cdc.gov/grasp/diabetes/DiabetesAtlas.html.
- [3] “Statistics about Diabetes.” American Diabetes Association. Accessed July 27, 2021. https://www.diabetes.org/resources/statistics/statistics-about-diabetes.
- [4] Hill, James P. et al. ‘Scientific Statement: Socioecological Determinants of Prediabetes and Type 2 Diabetes.’ Diabetes Care 2013 Aug; 36(8): 2430-2439. DOI: 10.2337/dc13-1161. Accessed 29 July 2021.

Project GitHub Repository:

https://github.com/Aisling-C/Springboard/tree/main/CapstoneProject2/DiabetesPrevalence