

Climate Change Analysis

The Bayesian Approach

DS 6040 – Summer 2023

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SCHOOL of DATA SCIENCE

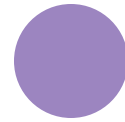
Data Set

- Yale Program on Climate Change Communication & George Mason University Center for Climate Change Communication
- Survey data from American adults (ages 18+) about their beliefs, attitudes, and policy opinions regarding global warming from 2008 through 2022.
- Includes demographic data from the U.S. Census:
 - gender
 - race and ethnicity
 - level of education
 - Ideology and political party affiliation
 - Etc..



Data Set

- Data is in categorical form and provided as a .SAV file.
- In addition, there is a Survey Methods pdf which functions as a codebook for the data.
- There are 30,136 observations and 54 features.



Problem Statement



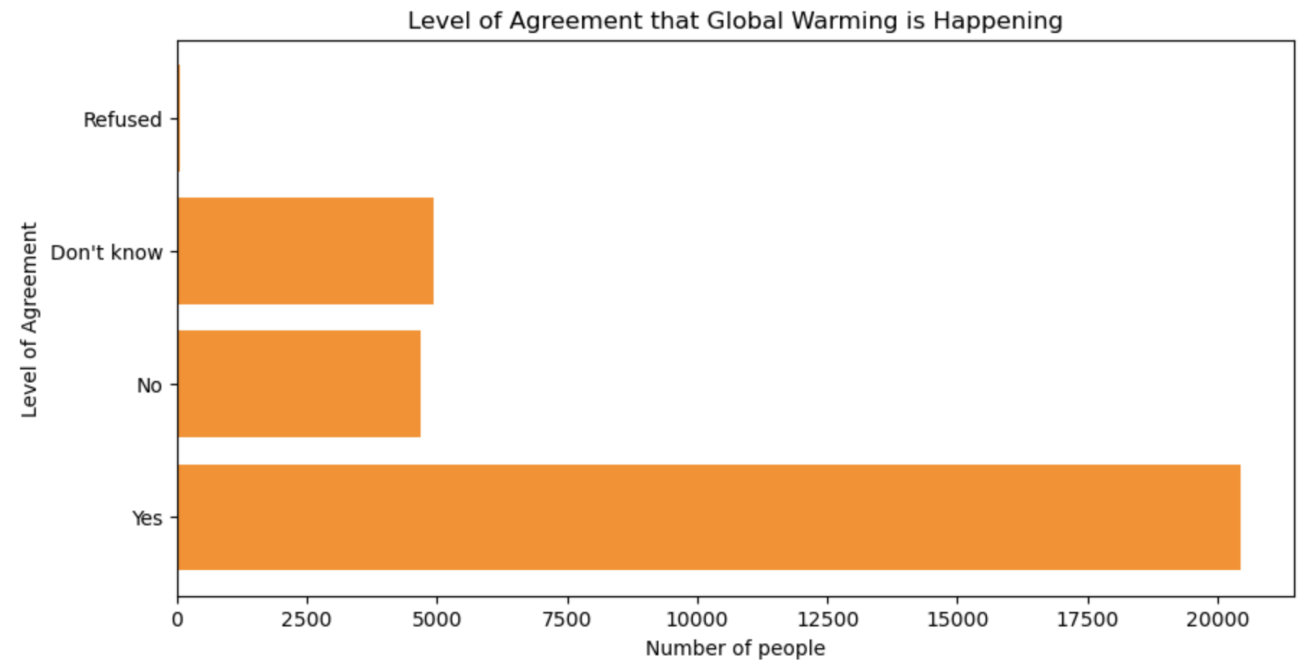
To what extent are beliefs in climate change shaped by demographic data?



Is climate change *happening*?

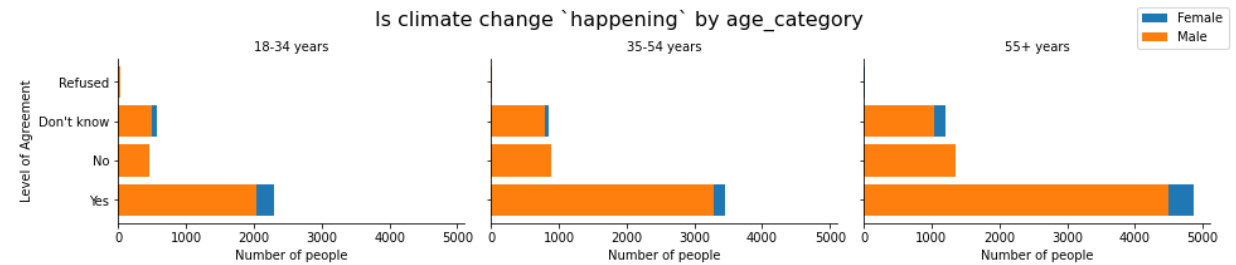
- We chose to use the survey question which examined a person's belief that climate change is *happening* as the response variable chosen for our models.
- Most people believe climate change IS happening

region4	count			marit_status	count
Midwest	7065			Divorced	2889
Northeast	5493			Living with partner	1628
South	10643			Married	15786
West	6935			Never married	4975
gender	count	income_category	count	percent	
Female	15235	Less than \$50,000	10953	36.345235	
Male	14901	\$50,000 to \$99,999	10107	33.537961	
		\$100,000 or more	9076	30.116804	
race	count	age_category	count	educ_category	count
Black, Non-Hispanic	2675	18-34 years	6259	Bachelor's degree or higher	10748
Hispanic	3104	35-54 years	9912	High school	8305
Other, Non-Hispanic	1987	55+ years	13965	Less than high school	2223
White, Non-Hispanic	22370			Some college	8860
ideology	count	party	count	percent	
Moderate, middle of the road	11994	Democrat	9903	32.861030	
Refused	591	Republican	8336	27.661269	
Somewhat conservative	6635	Independent	7737	25.673613	
Somewhat liberal	5375	No party/not interested in politics	2992	9.928325	
Very conservative	3317	Other; Please specify:	859	2.850411	
Very liberal	2224	Refused	309	1.025352	

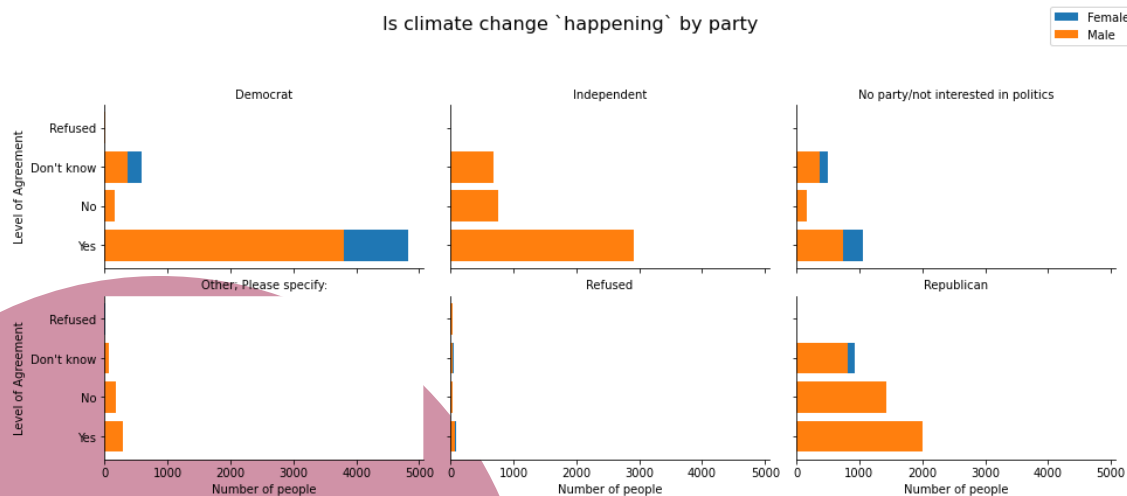


Is climate change *happening*?

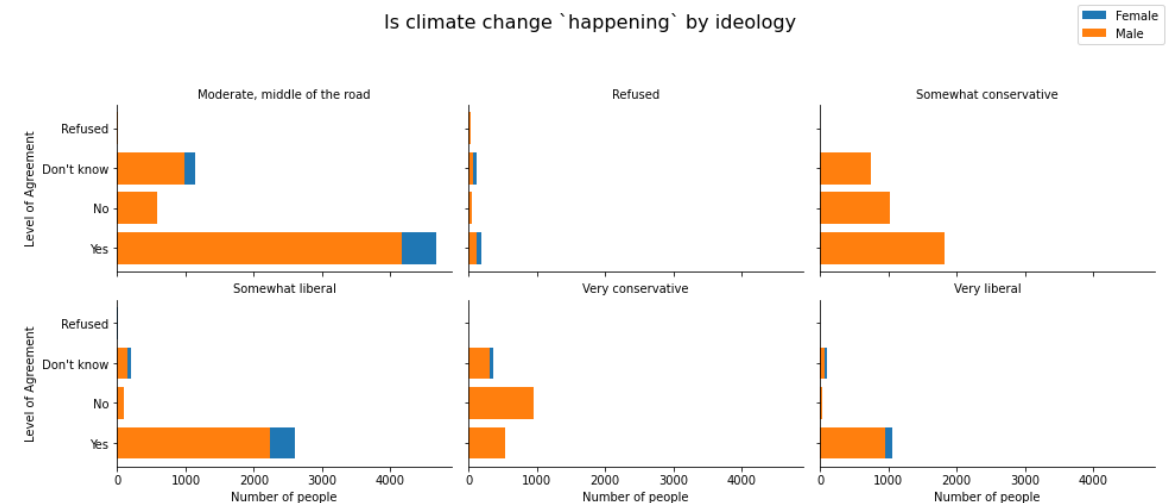
- Some interesting demographics (we utilize *ideology* in a later model)
- Same behavior as overall chart, most people believe climate change IS happening



Is climate change `happening` by party



Is climate change `happening` by ideology



Model Design

Developed 4 Bernoulli logistic regression models

Programming Language:



```
Python implementation: CPython
Python version       : 3.9.7
IPython version      : 8.11.0
```

Packages Involved:



```
seaborn      : 0.12.2
pandas       : 2.0.2
numpy        : 1.22.1
bambi        : 0.12.0
matplotlib   : 3.7.0
arviz        : 0.12.1
```

Model Design

- Based on the EDA, we trimmed down the predictor variables to those that we are most interested in: (10 out of 54)
 - *Gender*
 - *Age category*
 - *Education category*
 - *Income category*
 - *Race*
 - *Ideology*
 - *Party*
 - *Region*
 - *Religion*
 - *Marital status*
- Split the data 60/40 for training and testing

Model Description

$\mu = 0$

$\sigma = \dots$ (bambi)

$\sigma = 100$ (weak)

Model
1

Bambi default normal priors. ALL possible predictors

Model
2

Weakly informed normal priors. ALL possible predictors

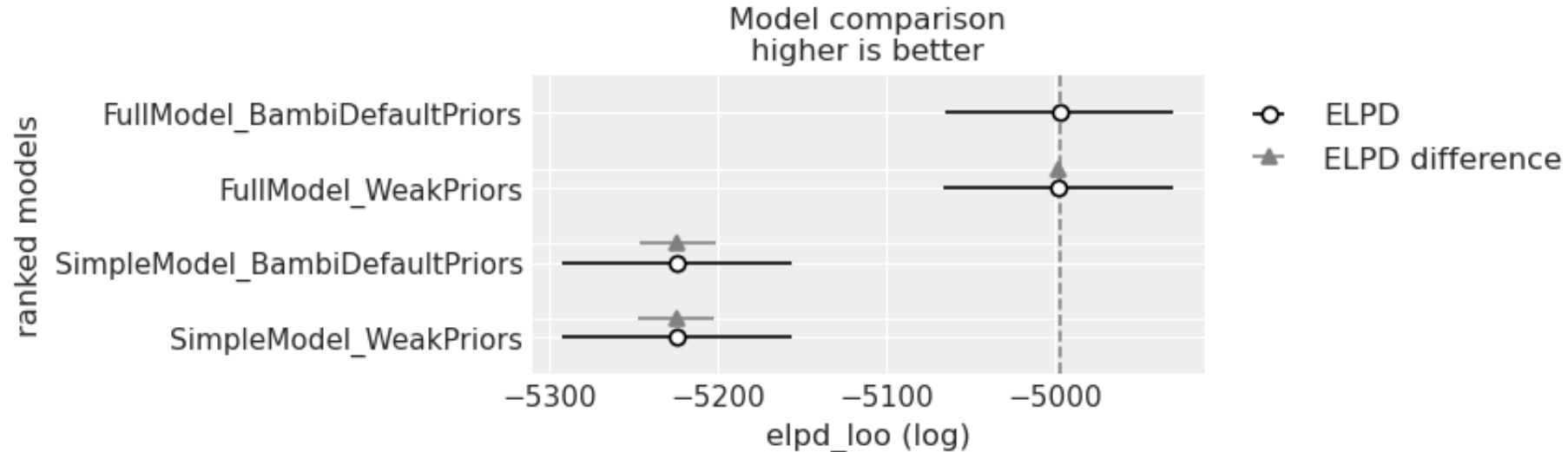
Model
3

Bambi default normal priors. Select predictors (education, ideology)

Model
4

Weakly informed normal priors. Select predictors (education, ideology)

Model Comparison & Selection

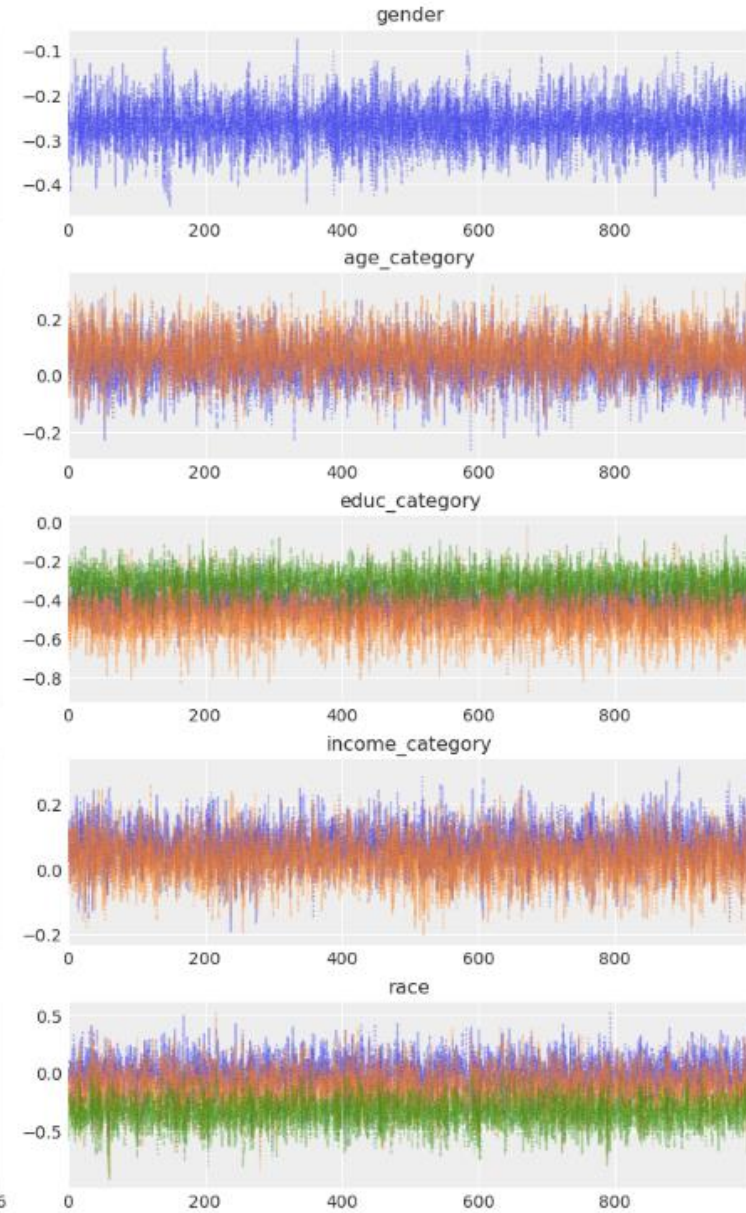
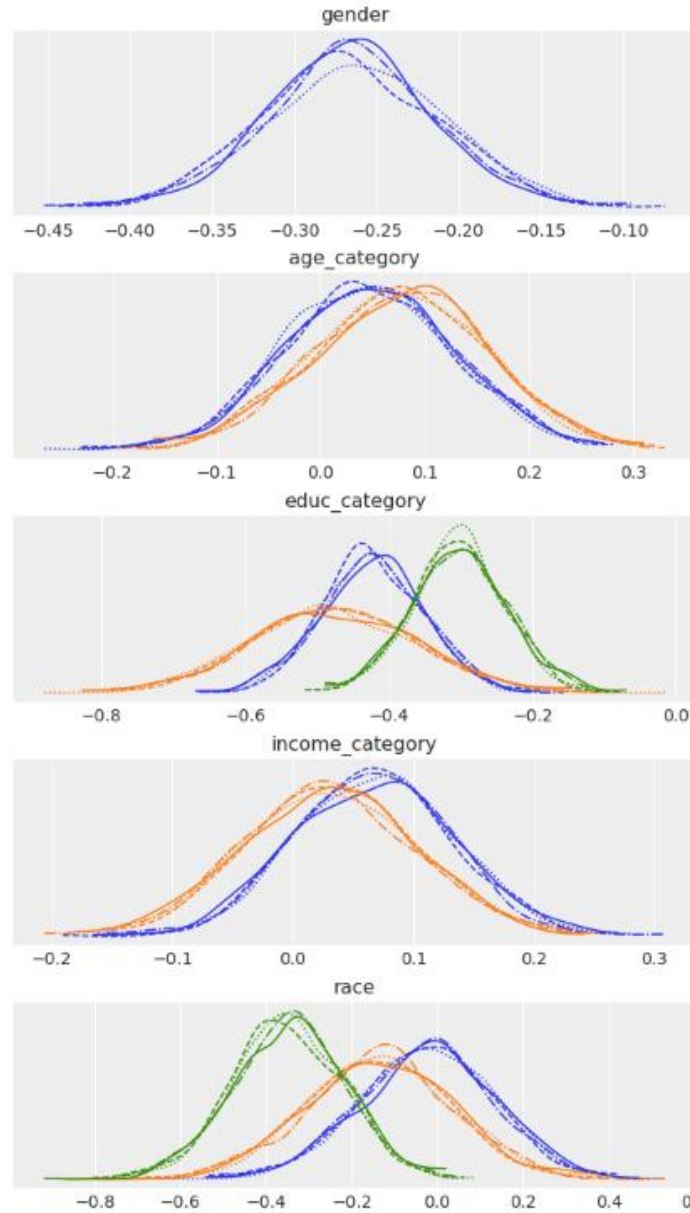


- Utilized Leave-One-Out Cross-Validation
- Compared model performance with ELPD (expected log predictive density).
- Models 1 and 2 with **all predictors** have a higher ELPD and **perform better** than the simpler model.
- Both model 1 & 2 have similar ELPD -- priors do not have impact on our analysis, when using Normal priors.
- **We will move forward with Model 1 (all predictors, default priors)**

Results

Some observations:

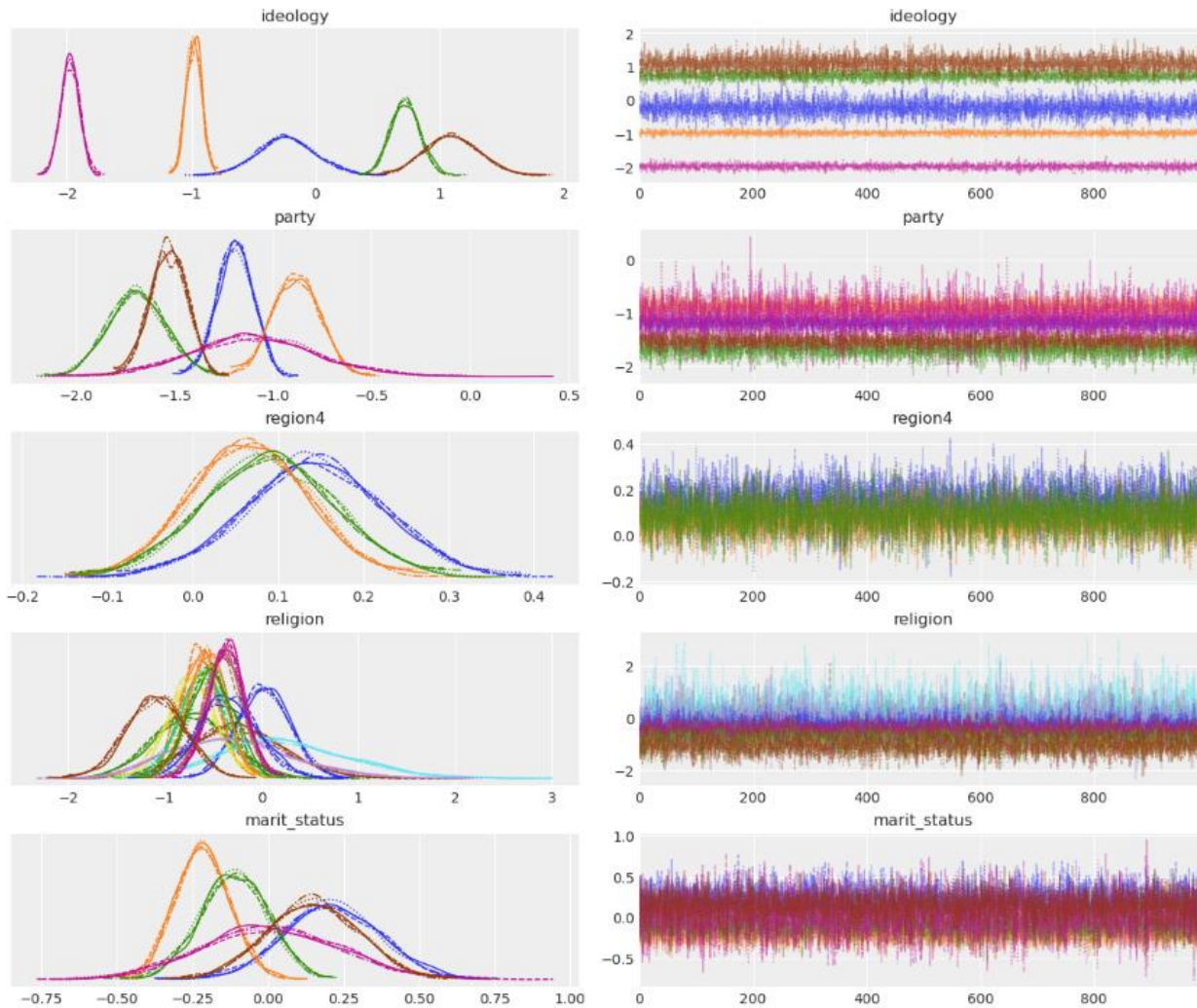
- For *Gender*
 - ~23% reduction in belief that global warming is happening for men compared to women.
- For *Education category*
 - Completing college increases the odds that a person believes global warming is happening.



Results

Some observations:

- For *Ideology*
 - Clear pattern in ideology and climate change.
 - The more liberal a person is, the more likely they believe global warming is happening relative to moderates
 - In contrast, conservatives were much less likely to believe global warming is happening. This follows the behavior we observed during the exploratory data analysis phase.
- For *religion*
 - With some variation, belief in some religion is generally associated with a decreased chance in believing global warming is happening, relative to agnostics.
- For *age*
 - Little effect on whether a person believes global warming is happening (HDI's overlap with zero).



Results



- Separation plot of the model's performance using test data.
- The vertical lines are represented as model predictions.
 - Light blue is class 0 (global warming is not happening)
 - Dark blue is class 1 (yes, it is happening).
- However, the position of the vertical lines represents the **truth**:
 - Further to the left, a person *does not believe global warming*
 - Further to the right, a person *does believe it is happening*.
- Based on the plot, we do see light blue vertical lines towards the left and **more** dark blue lines to the right.
- This model does a decent job at predicting whether a person believes global warming is happening or not.



Results and Conclusion

- Some predictors, such as education, ideology, and religion, have an impact to varying degrees on whether a person believes in climate change or not. There are also predictors that have little to no impact on determining if a person believes in climate change or not.
- Future studies could further explore the dataset by not only examining various modeling options but also investigating the extent to which interactions between predictors impact the overall model.
- This information could be utilized to inform policymakers and educators to tailor their approach for specific demographic groups by targeting the issues they are most concerned about.
- Knowing your audience can help persuade those who are not swayed by scientific facts and figures.

Thank you!

