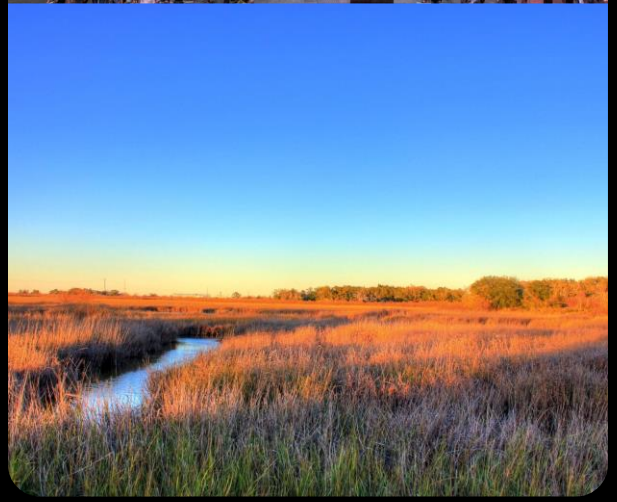

EPPS 6356

Climate Change and Crime

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Umme Kulsum

Order of Presenting

01 Introduction: Umme Kulsum

02 Literature Review: Umme Kulsum

03 Methodology : Umme and Changho

04 Data: Americo Gamarra

05 Analysis: Changho Lee

06 Conclusion: Brennan Stout

Introduction

Some researchers have found correlations or likelihood in violent crime with high ambient temperatures (Trujillo & Howley 2021; Hsiang et al, 2013)

Robert Agnew (2011) suggested that changing climate will facilitate social conflict and will help increase crime opportunities. According to him, climate change will be one of the major driving forces in the upcoming years

Objective

- Explore the relationship between climate change and crime rate.
- Compare the relationship between climate change and crime for different climatic conditions.

02

Literature Review

i. Crime Forecast Due to Climate Change

Ranson (2014) forecasted that between 2010-2099, there will be an additional of 22, 000 murders and 1.2 million aggravated assaults because of climate change. Mares et al, (2019) suggests that for 1°C increase in the temperature, on an average the number of crimes will increase by 100,000 annually.

ii. Seasonality in Crime

Monthly temperature anomalies for warmer months are linked to higher number of homicides. In case of other crimes e.g., rape, the relationship is stronger with colder months.

iii. Climate Change – Temperature – Crime Hypothesis (CC-T-C)

Lynch et al, (2020) used the term in their article which refers to the concept that temperature and level of crime will increase which has been stressed by the green criminologists.

iv. Geographical Scope

The scale of the studies also varies. Some researchers looked into this at a larger scale and others at a local scale.

03

Methodology

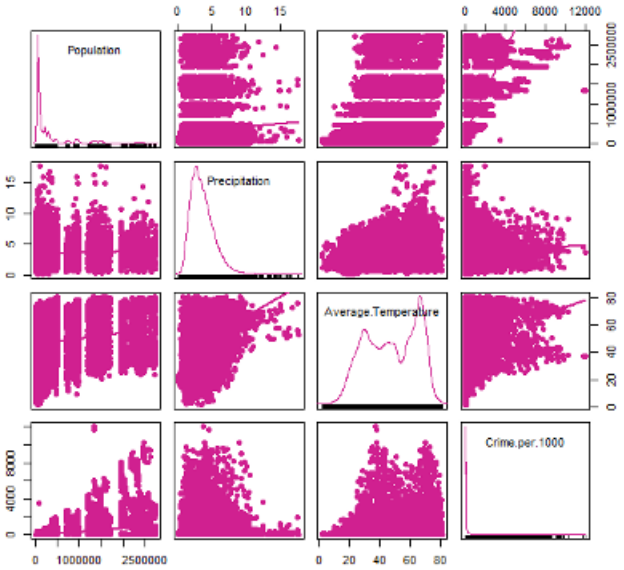
i. Exploratory Data Analysis

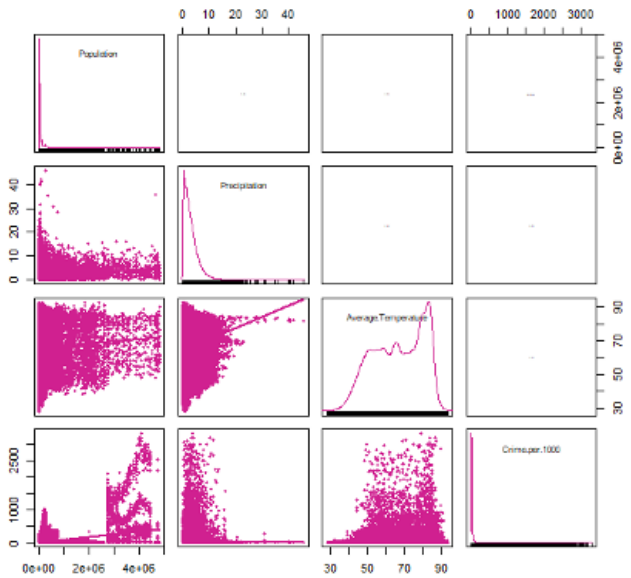
- Aggregating data to check for relationships provide conflicting results
- Creating charts to explore the data visually is time consuming as the data contains 468 months and each month has multiple entries for each crime type

i. Exploratory Data Analysis

Decade	Average Temperature	Average Crime per 1000	Average Population	State
1980	46.29	122.05	288447	New York
1990	47.06	67.68	297794	New York
2000	47.30	69.23	308805	New York
2010	48.00	63.92	321834	New York
2020	49.04	30.35	319370	New York
1980	64.47	5.75	65299	Texas
1990	65.25	5.56	73896	Texas
2000	65.69	5.84	89551	Texas
2010	66.21	4.10	106705	Texas
2020	66.85	2.25	117450	Texas

i. Exploratory Data Analysis





ii. Bayesian modeling approach using INLA

- **Enhanced Predictive Modeling**

Leverages spatial and temporal autocorrelation to estimate missing data, improve predictions, and provide robust decision-making under uncertainty.

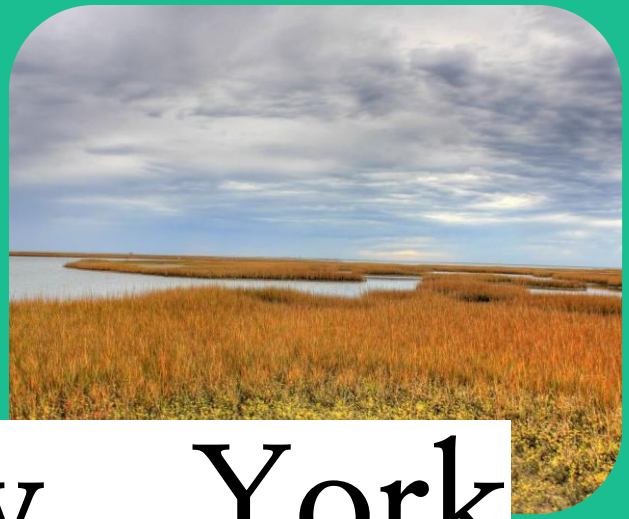
- **Explicit Uncertainty Modeling**

Bayesian approaches like INLA deliver credible intervals for predictions and insights into result reliability, ensuring transparency in uncertainty quantification.

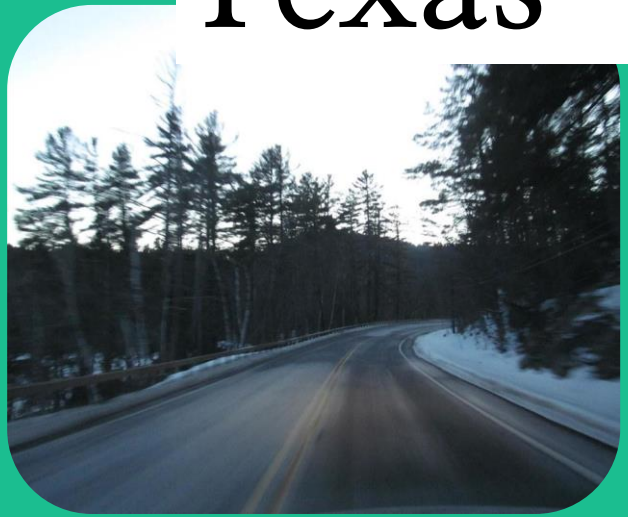
- **Versatile Applications Across Fields**

Applicable to disease mapping, environmental monitoring, and social science research; INLA also manages high-dimensional data with latent variables, accommodating complex spatio-temporal challenges.





Texas vs. New York



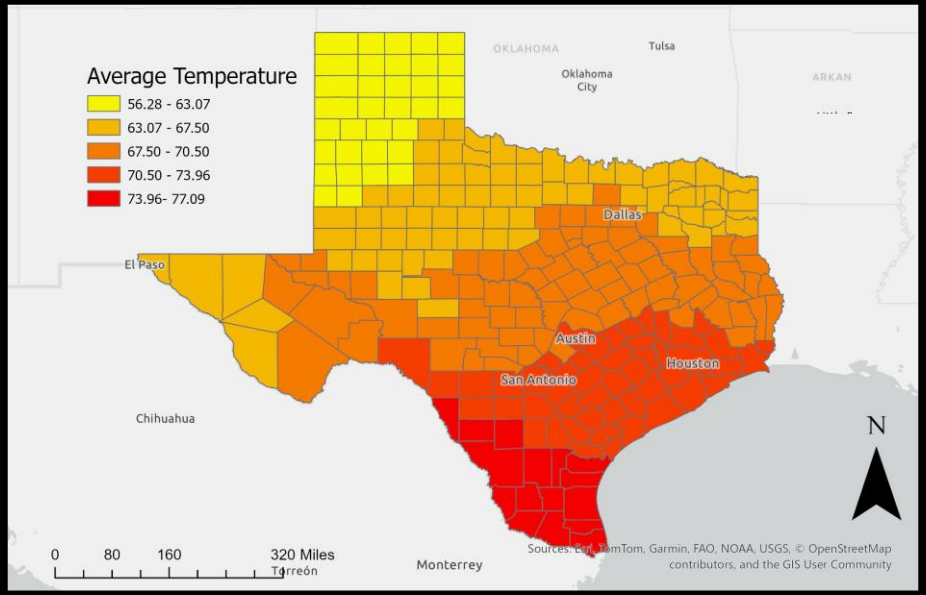

Texas

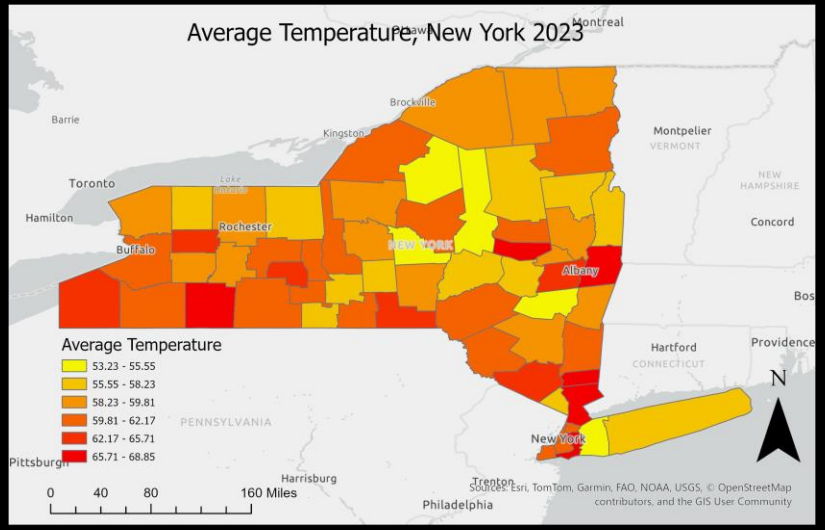
- Texas is the second largest in the United States of America by population and land area.
- Texas has been divided into 10 climate zones according to the National Climatic Data Center

New York

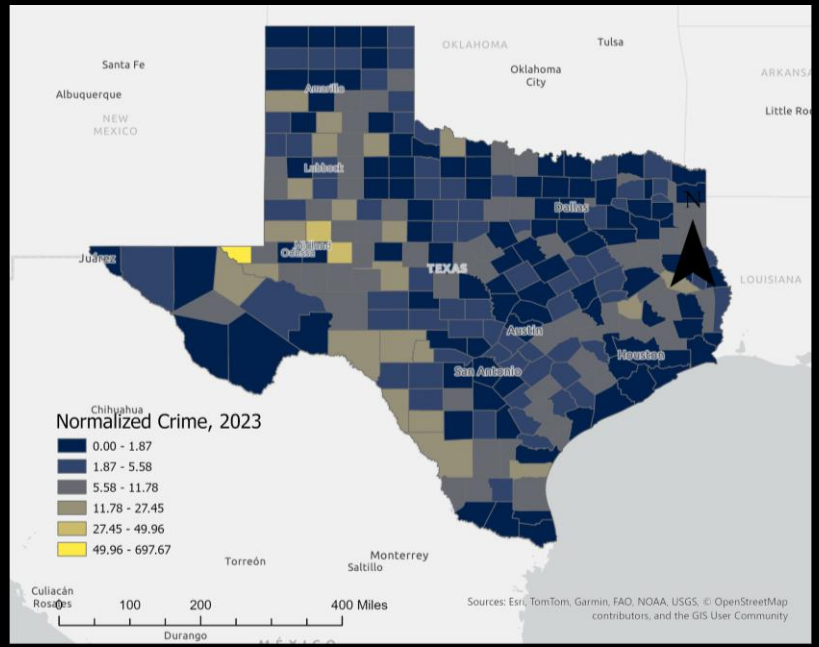
- New York was its leading state till 1960 in almost all the indices (e.g., population, economic and cultural) (Brittanica, Accessed: Dec 2024).

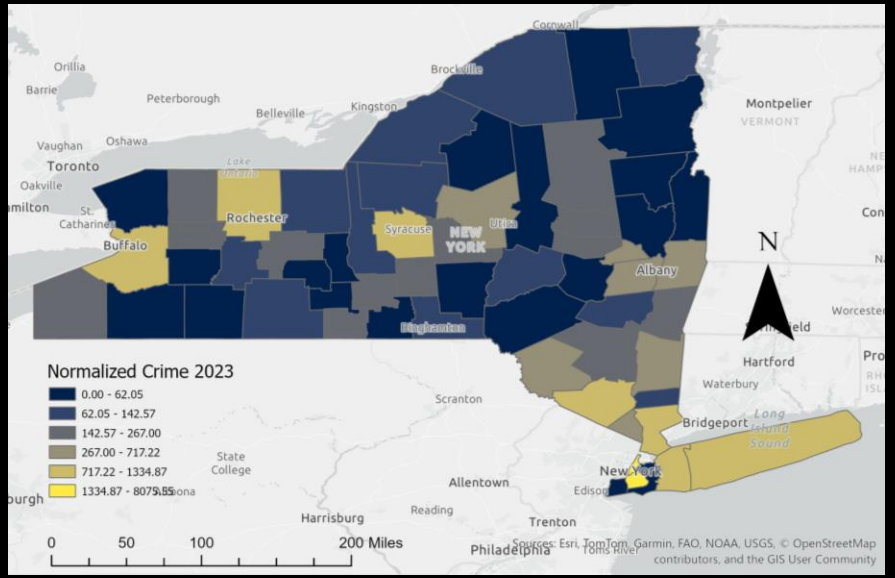
Methodology : Temperature





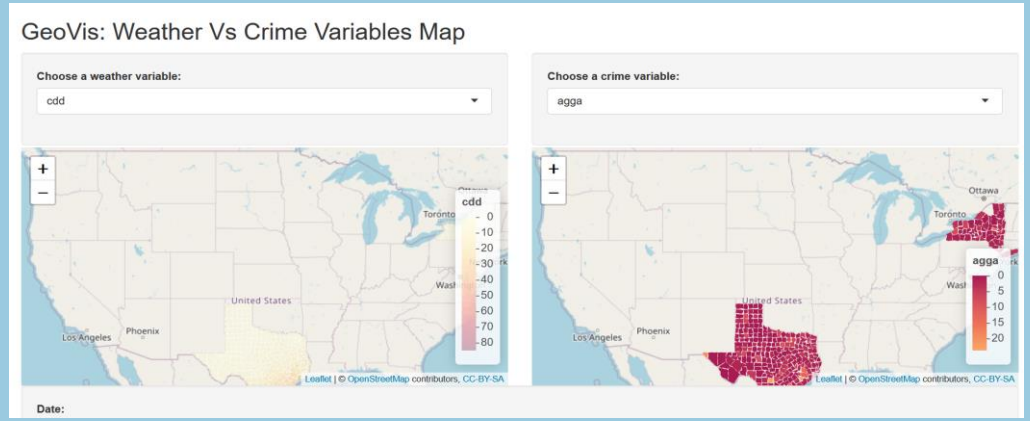
Methodology : Crime





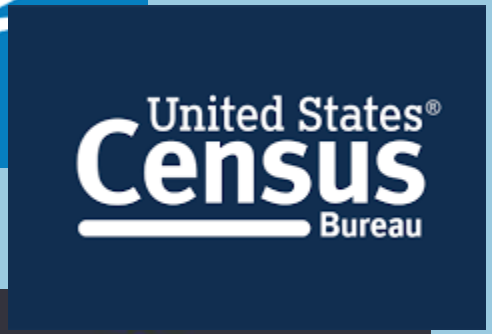
Data

Shiny Visualization



Source

- Crime data for the Texas and New York 1985 – 2023
  - Crimes against person
  - Using the FBI UCR API
  - County or lower area
- Climate data for the Texas and New York 1985 – 2023
  - Temperature
  - Humidity
  - Precipitation
  - County or lower geographical unit area
- Socio-economic data for the Texas and New York 1985 – 2023
  - Unemployment rate
  - Annual population



Variables

Crime:

- Crime type
  - Aggravated Assault
  - Robbery
  - Rape
  - Arson
  - Homicide
  - Burglary
  - Larceny
  - Motor Vehicle Theft
- Date
  - Monthly
- Locations
  - Texas and New York

Climate:

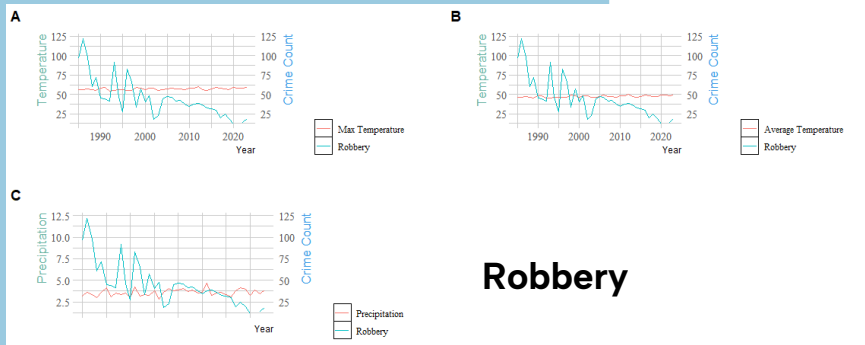
- Atmosphere
  - Temperature
    - Average Temperature
    - Maximum Temperature
    - Minimum Temperature
  - Humidity
  - Precipitation
- Date
  - Monthly
- Population
  - Annual

Crimes Against Person (Violent Crime

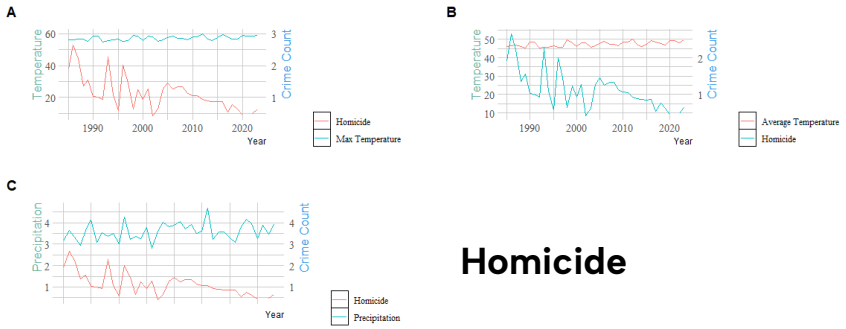
Data

Crime

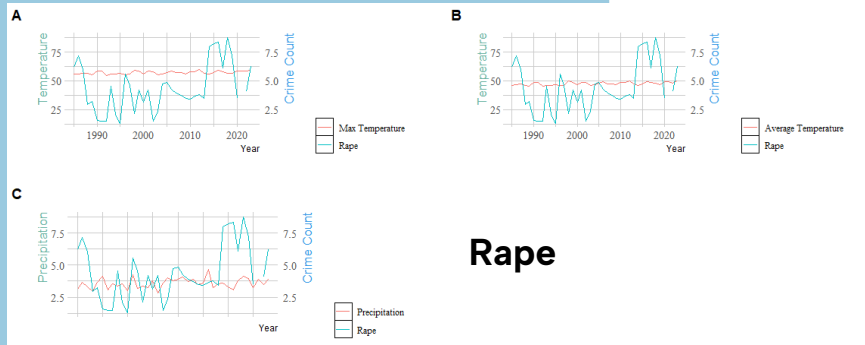
Relation between climate and violent crime annually between the years 1985 and 2023 for New York



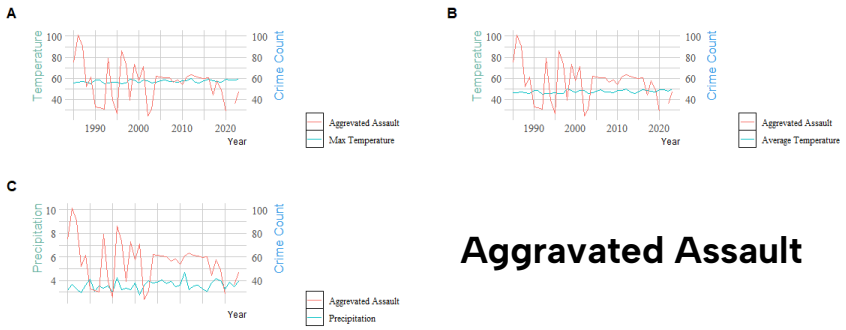
Robbery



Homicide



Rape

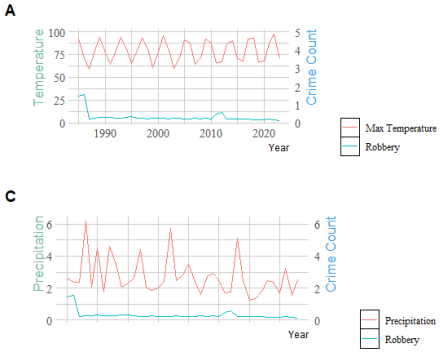


Aggravated Assault

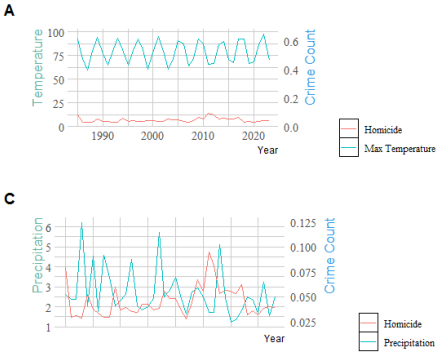
Data

Crime

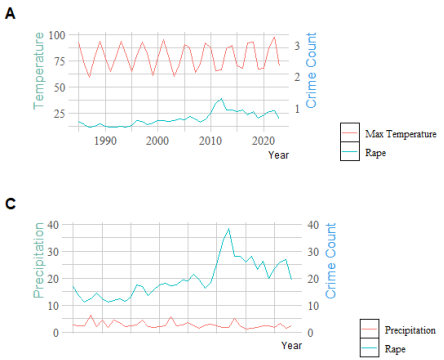
Relation between climate and violent crime annually between the years 1985 and 2023 for Texas



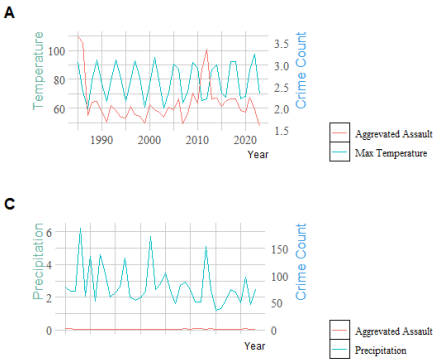
Robbery



Homicide



Rape



Aggravated Assault

05

Analysis

Model Construction

Dependent variable :

Crime rate
(unit: events / 1,000 persons)

Independent variable :

Mean temperature
(unit: F^o)

Unemployment rate
(unit: %)

Population density
(unit: %)

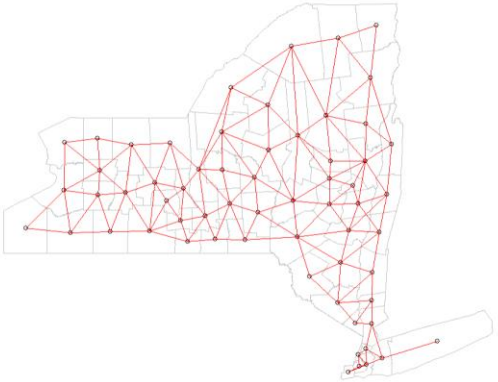
Spatial component :

Adjacent matrix
(method: queen)

Temporal component :

Autoregressive
(order: 1 for TX and 2 for NY)

	GEOID	NAME	period	avgTemp	crimeRate	period2	ID.area	ID.area.period	unemp	popden	SHAPE
1	36001	Albany	1985-01-01	18.6	2.415742	5479	1	1	NA	NA	MULTIPOLYGON (((-73.96379 4...
2	36001	Albany	1985-02-01	25.5	3.002423	5510	1	2	NA	NA	MULTIPOLYGON (((-73.96379 4...
3	36001	Albany	1985-03-01	35.3	3.292312	5538	1	3	NA	NA	MULTIPOLYGON (((-73.96379 4...
4	36001	Albany	1985-04-01	47.5	3.623614	5569	1	4	NA	NA	MULTIPOLYGON (((-73.96379 4...
5	36001	Albany	1985-05-01	58.8	3.489022	5599	1	5	NA	NA	MULTIPOLYGON (((-73.96379 4...
6	36001	Albany	1985-06-01	61.2	3.513180	5630	1	6	NA	NA	MULTIPOLYGON (((-73.96379 4...
7	36001	Albany	1985-07-01	69.6	3.761656	5660	1	7	NA	13.682614	MULTIPOLYGON (((-73.96379 4...
8	36001	Albany	1985-08-01	67.2	4.027388	5691	1	8	NA	NA	MULTIPOLYGON (((-73.96379 4...
9	36001	Albany	1985-09-01	62.1	3.420001	5722	1	9	NA	NA	MULTIPOLYGON (((-73.96379 4...
10	36001	Albany	1985-10-01	49.6	0.200162	5752	1	10	NA	NA	MULTIPOLYGON (((-73.96379 4...
11	36001	Albany	1985-11-01	39.9	0.207064	5783	1	11	NA	NA	MULTIPOLYGON (((-73.96379 4...
12	36001	Albany	1985-12-01	23.4	0.196710	5813	1	12	NA	NA	MULTIPOLYGON (((-73.96379 4...
13	36001	Albany	1986-01-01	22.3	2.852136	5844	1	13	NA	NA	MULTIPOLYGON (((-73.96379 4...
14	36001	Albany	1986-02-01	22.4	2.790282	5875	1	14	NA	NA	MULTIPOLYGON (((-73.96379 4...
15	36001	Albany	1986-03-01	36.0	3.233566	5903	1	15	NA	NA	MULTIPOLYGON (((-73.96379 4...
16	36001	Albany	1986-04-01	48.9	3.336655	5934	1	16	NA	NA	MULTIPOLYGON (((-73.96379 4...
17	36001	Albany	1986-05-01	59.6	3.133913	5964	1	17	NA	NA	MULTIPOLYGON (((-73.96379 4...



Model Result (TX)

Model for crime rate (events / 1,000 ppl) log-transformed (crime rate + 0.0001)	Model 1: Null	Model 2: Climate	Model3: Climate + Economic	Model 4: Climate + Economic + Demographic
Intercept	-3.226 (0.582)	-3.721 (0.507)	-3.833 (0.676)	-3.700 (0.325)
Average Temperature		0.007 (0.001)	0.007 (0.001)	0.007 (0.001)
Unemployment rate(%)			0.028 (0.004)	0.028 (0.004)
Population Density(ppl/sq.km)				-0.003 (0.001)
Residuals	0.139 (0.001)	0.139 (0.001)	0.139 (0.001)	0.139 (0.001)
Spatial random effect (neighbor:queen)	0.053 (0.006)	0.055 (0.005)	0.056 (0.005)	0.057 (0.006)
Temporal random effect, ar(1)	1.785 (0.660)	2.253 (0.347)	1.844 (0.694)	4.826 (0.768)
Temporal autocorrelation, ar(1)	0.994 (0.003)	0.996 (0.001)	0.997 (0.001)	0.986 (0.004)
Marginal log-likelihood	-286865	-286826	-286817	-286836
RMSE	14.506	14.512	14.502	14.496

Model Result (NY)

Model for crime rate (events / 1,000 ppl) log-transformed (crime rate + 0.0001)	Model 1: Null	Model 2: Climate	Model3: Climate + Economic	Model 4: Climate + Economic + Demographic
Intercept	-0.745 (0.238)	-1.113 (0.312)	-1.164 (0.321)	-1.170 (0.321)
Average Temperature		0.008 (0.004)	0.008 (0.004)	0.008 (0.004)
Unemployment rate(%)			0.007 (0.011)	0.009 (0.011)
Population Density(ppl/sq.km)				0.000 (0.000)
Residuals	0.305 (0.003)	0.305 (0.003)	0.305 (0.003)	0.305 (0.003)
Spatial random effect (neighbor:queen)	0.533 (0.104)	0.538 (0.106)	0.532 (0.099)	0.536 (0.105)
Temporal random effect, ar(1)	0.406 (0.061)	0.400 (0.059)	0.399 (0.059)	0.398 (0.061)
Temporal autocorrelation, ar(1)	0.825 (0.027)	0.824 (0.026)	0.825 (0.026)	0.825 (0.027)
Marginal log-likelihood	-59261	-59268	-59276	-59280
RMSE	6.023	6.021	6.021	6.016

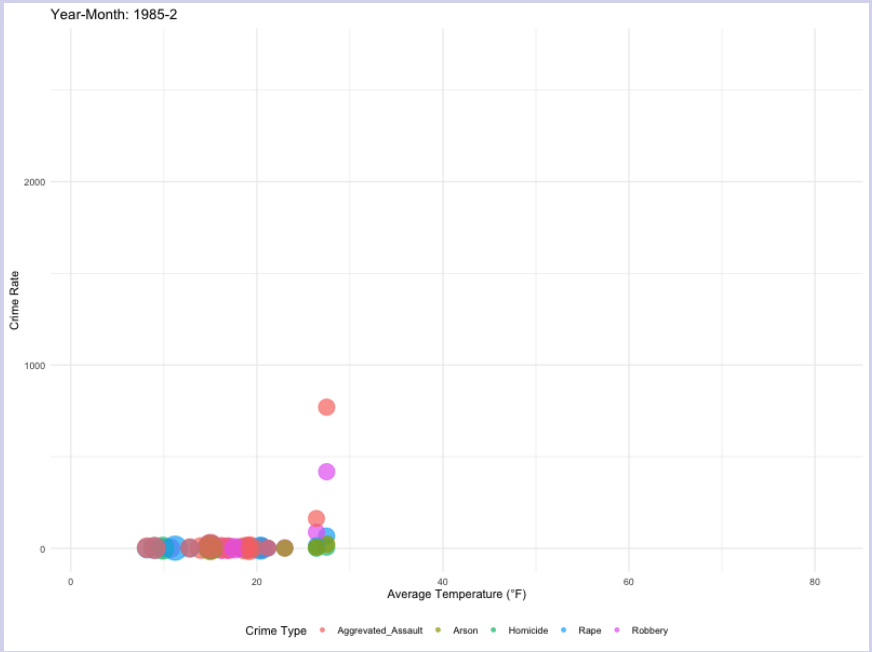
Model Result (TX vs NY)

		Texas	New York
	Model for crime rate (events / 1,000 ppl) log-transformed (crime rate + 0.0001)	Model 4: Climate + Economic + Demographic	Model 4: Climate + Economic + Demographic
	Intercept	-3.700 (0.325)	-1.170 (0.321)
Climate	Average Temperature	0.007 (0.001)	0.008 (0.004)
Socio Econ	Unemployment rate(%)	0.028 (0.004)	0.009 (0.011)
Socio Econ	Population Density(ppl/sq.km)	-0.003 (0.001)	0.000 (0.000)
	Residuals	0.139 (0.001)	0.305 (0.003)
	Spatial random effect (neighbor:queen)	0.057 (0.006)	0.536 (0.105)
	Temporal random effect, ar(1)	4.826 (0.768)	0.398 (0.061)
	Temporal autocorrelation, ar(1)	0.986 (0.004)	0.825 (0.027)
	Marginal log-likelihood	-286836	-59280
	RMSE	14.496	6.016

Slight positive relationship between temperature and total crime rate, when normalized for population. Texas is more clear in this measure (lower SD, 0.001) than New York (0.004).

05

Conclusions



Conclusions

Questions?

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