

Final Project Presentation

Group 1
April 6, 2023

Meet our Team



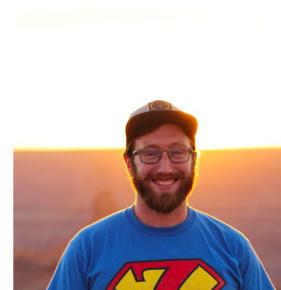
Iris Belensky



Milos Popov



Olga
Mironova



Patrick
Gilchrist



Anastassia
Tatarskaja



I alone cannot change the world, but
I can cast a stone across the waters
to create many ripples.

— *Mother Teresa* —

AZ QUOTES

Question to the audience

Using the chat feature, identify major public health crisis in the United States?



Let's ask Chat GPT

A

major public health crisis in the US

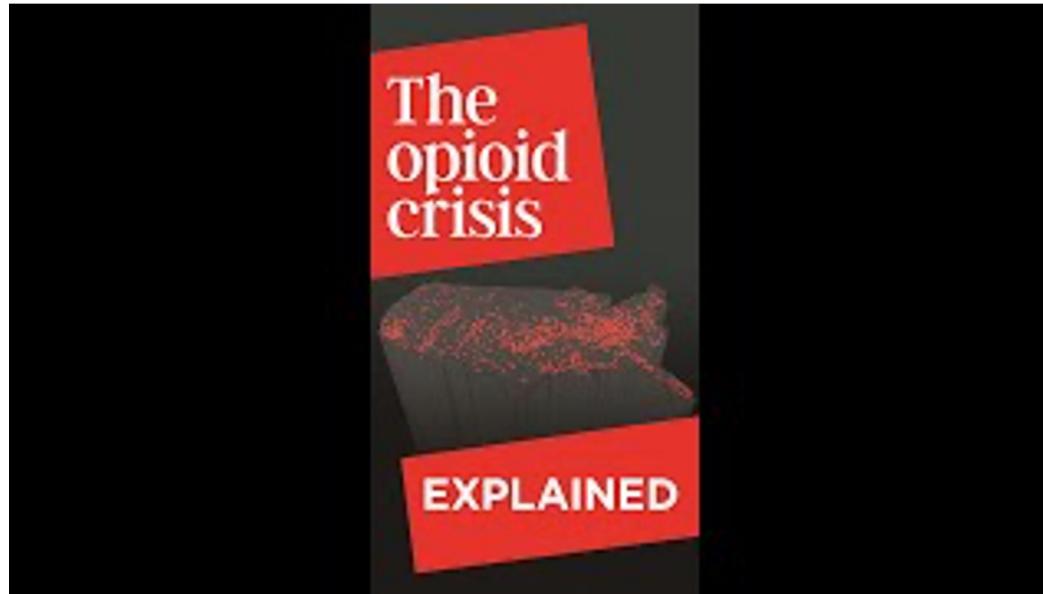


The United States has faced several major public health crises in recent years, including:

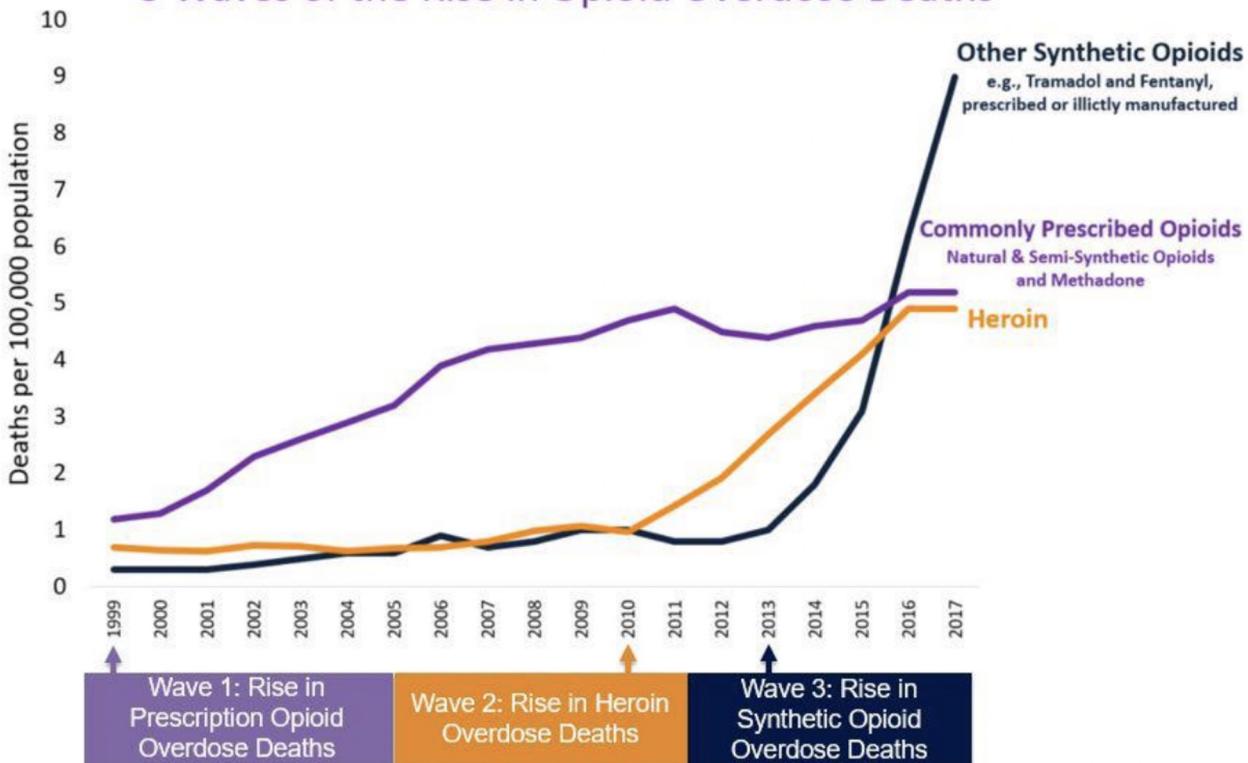


1. COVID-19 pandemic: This ongoing pandemic, caused by the SARS-CoV-2 virus, has had a significant impact on public health, causing widespread illness and death, overwhelming healthcare systems, and disrupting daily life for millions of people.
2. Opioid epidemic: This crisis is characterized by the widespread misuse and abuse of prescription opioids and illicit drugs, leading to a sharp increase in overdose deaths and related health problems.

Why is it Important?



3 Waves of the Rise in Opioid Overdose Deaths



Source: Centers for Disease Control and Prevention, National Vital Statistics System

THE OPIOID EPIDEMIC BY THE NUMBERS



130+

People died every day from opioid-related drug overdoses³
(estimated)



11.4 m

People misused prescription opioids¹



47,600

People died from overdosing on opioids²



2.1 million

People had an opioid use disorder¹



886,000

People used heroin¹



81,000

People used heroin for the first time¹



2 million

People misused prescription opioids for the first time¹



15,482

Deaths attributed to overdosing on heroin²



28,466

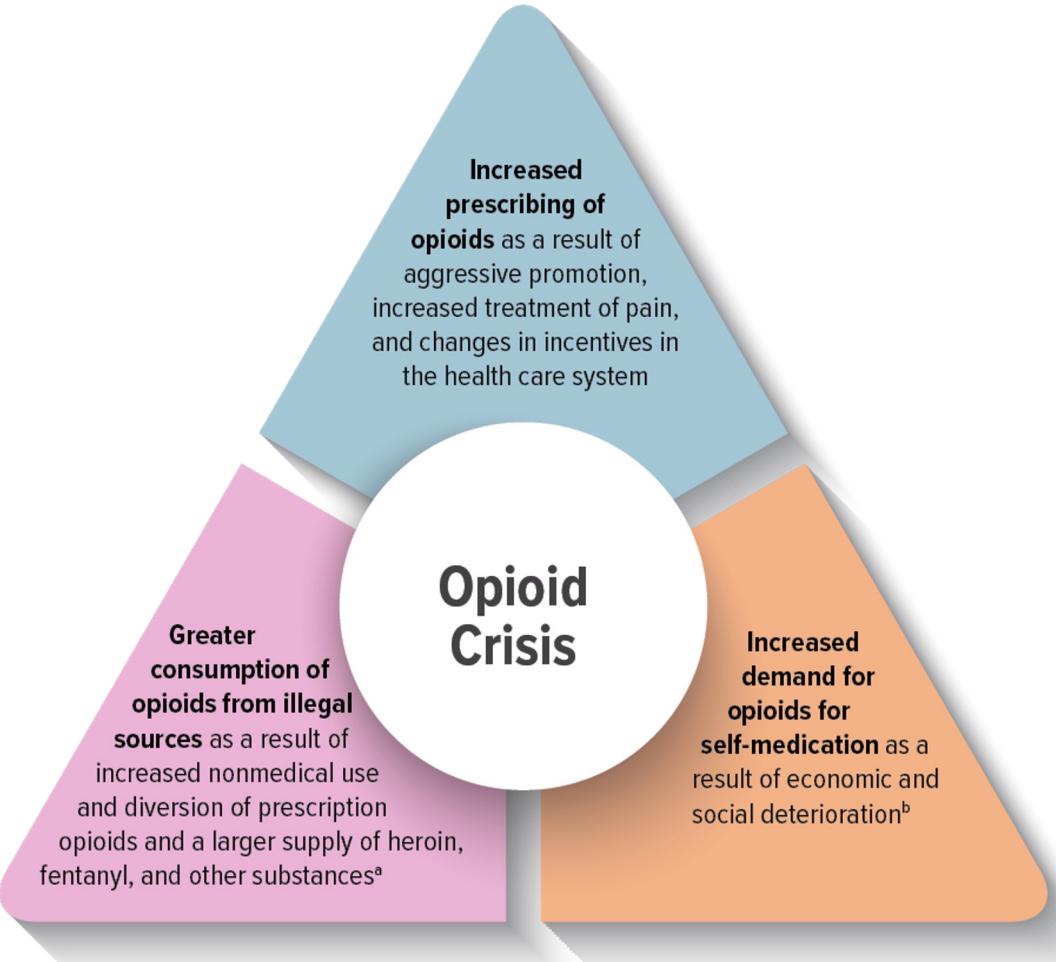
Deaths attributed to overdosing on synthetic opioids other than methadone²

SOURCES

1. 2017 National Survey on Drug Use and Health, Mortality in the United States, 2016

2. NCHS Data Brief No. 293, December 2017

3. NCHS, National Vital Statistics System. Estimates for 2017 and 2018 are based on provisional data.



Opioid Crisis

Increased prescribing of **opioids** as a result of aggressive promotion, increased treatment of pain, and changes in incentives in the health care system

Greater consumption of **opioids from illegal sources** as a result of increased nonmedical use and diversion of prescription opioids and a larger supply of heroin, fentanyl, and other substances^a

Increased demand for **opioids for self-medication** as a result of economic and social deterioration^b

Research Questions

Our project aims to answer the following questions:

- Can we predict the **rate of opioid overdose deaths** by county based on basic socio-economic variables AND the **dispensing rate** of prescription opioids for that county?
- Which factors contribute the **most** to our prediction for the rate of opioid deaths?

Searching for Data Sets

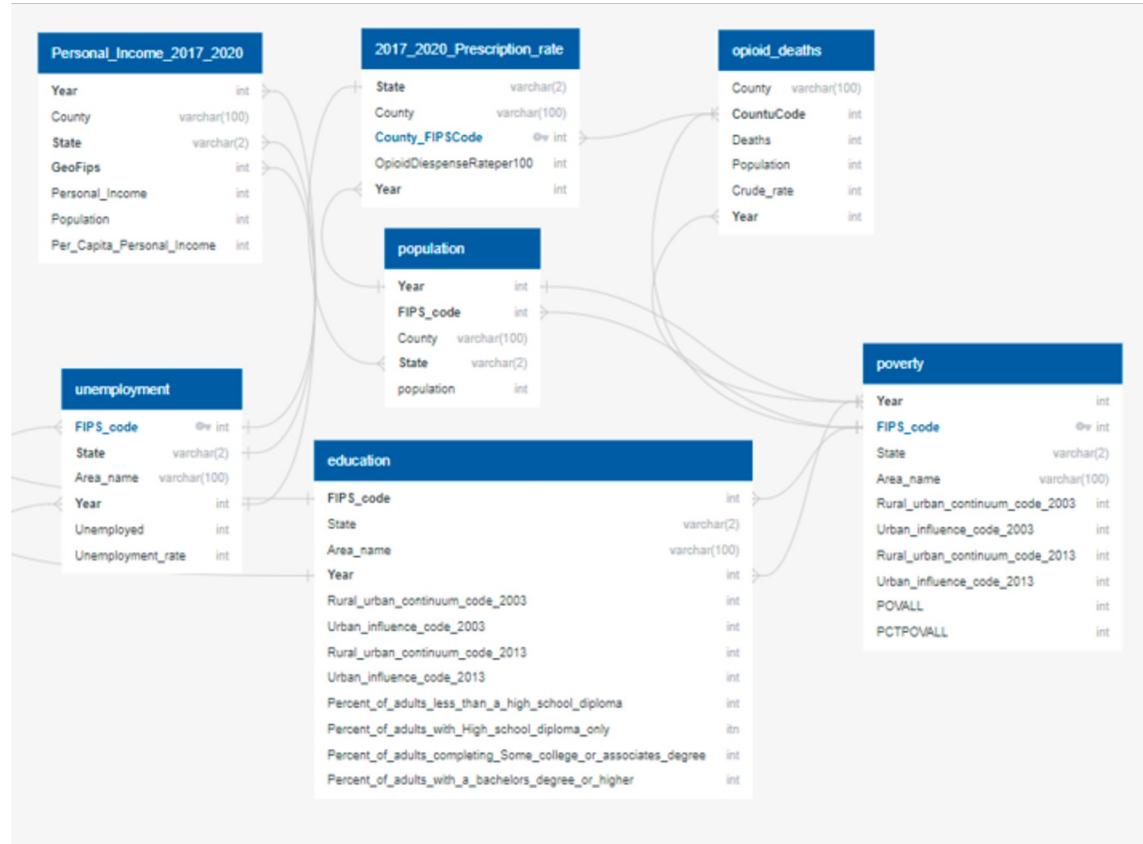
Independent Variables:

- Opioid Prescription Dispense Rate
- Personal Income & Personal Income per Capita
- Education
- Poverty Rate
- Unemployment Rate
- Population

Dependent Variables:

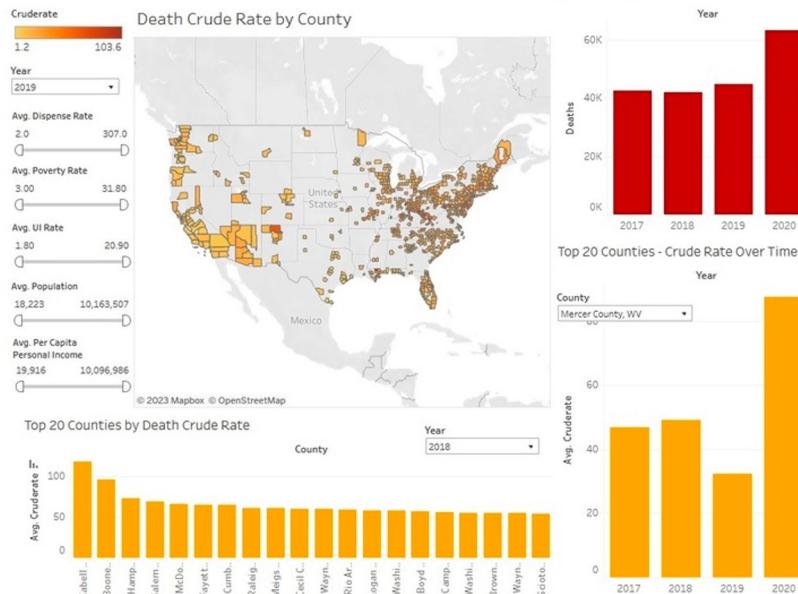
- Total Deaths
- Crude Rate

Database Creation

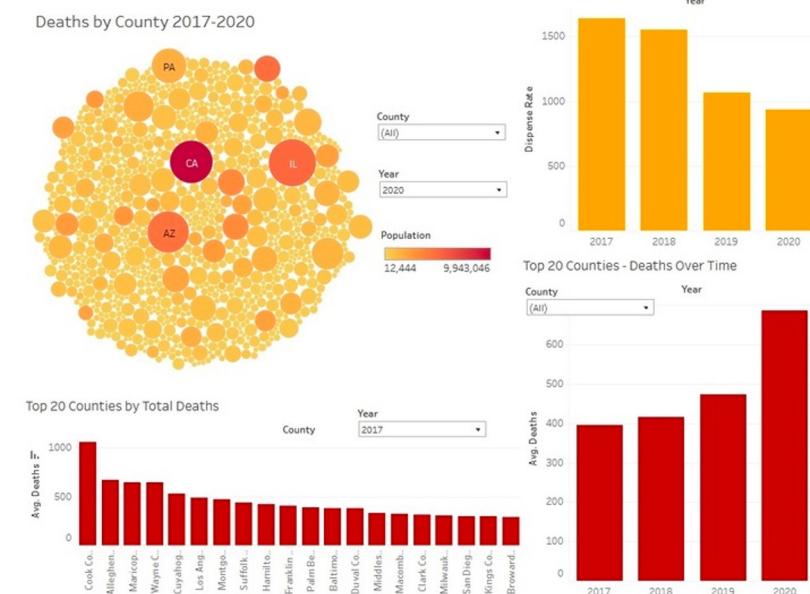


Tableau

The U.S. Opioid Crisis 2017-2020



The U.S. Opioid Crisis 2017-2020 (cont.)



Link to Tableau Public:

https://public.tableau.com/app/profile/iris.bel8090/viz/Final_Project_Workbook/CrudeRate_vs_Unemployment

Random Forest

Confusion Matrix

| | Predicted 0 | Predicted 1 |
|----------|-------------|-------------|
| Actual 0 | 528 | 38 |
| Actual 1 | 102 | 96 |

Accuracy Score : 0.8167539267015707

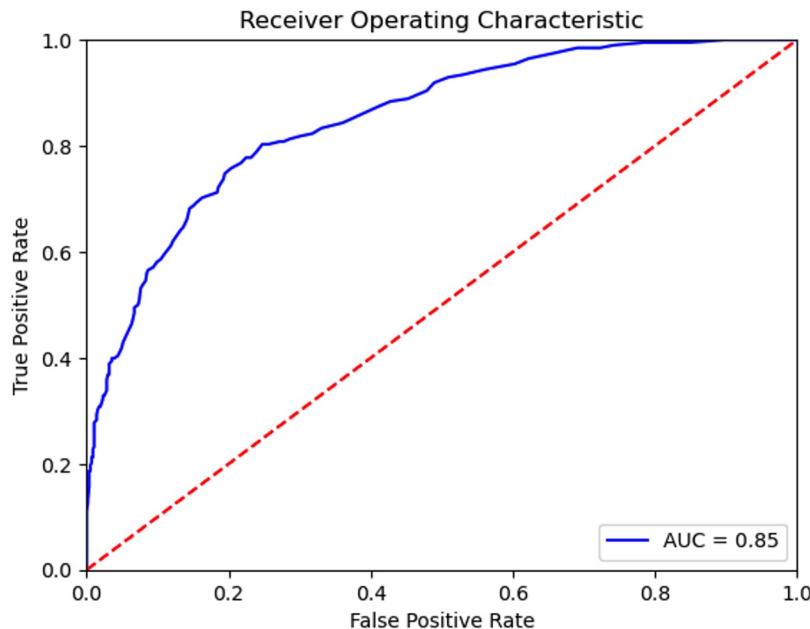
Classification Report

| | precision | recall | f1-score | support |
|--------------|-----------|--------|----------|---------|
| 0 | 0.84 | 0.93 | 0.88 | 566 |
| 1 | 0.72 | 0.48 | 0.58 | 198 |
| accuracy | | | 0.82 | 764 |
| macro avg | 0.78 | 0.71 | 0.73 | 764 |
| weighted avg | 0.81 | 0.82 | 0.80 | 764 |

Importance of the included features

| Features | Importance |
|--------------------------|------------|
| population | 0.170988 |
| DispenseRate | 0.073677 |
| PersonallIncome | 0.079453 |
| PerCapitaPersonallIncome | 0.149795 |
| LessThanHS | 0.087364 |
| HSDiplomaOnly | 0.097239 |
| SomeCollege | 0.087017 |
| BachelorOrHigher | 0.084779 |
| PovertyPop | 0.085069 |
| UnemployedRate | 0.084620 |

The Receiver Operating Characteristic Curve and the AUC score



Random Forest/SMOTEEN Process

Confusion Matrix

| | Predicted 0 | Predicted 1 |
|----------|-------------|-------------|
| Actual 0 | 436 | 130 |
| Actual 1 | 56 | 142 |

Accuracy Score : 0.756544502617801

Classification Report

| | precision | recall | f1-score | support |
|--------------|-----------|--------|----------|---------|
| 0 | 0.89 | 0.77 | 0.82 | 566 |
| 1 | 0.52 | 0.72 | 0.60 | 198 |
| accuracy | | | 0.76 | 764 |
| macro avg | 0.70 | 0.74 | 0.71 | 764 |
| weighted avg | 0.79 | 0.76 | 0.77 | 764 |

Logistic Regression Model

Confusion Matrix

| | Predicted 0 | Predicted 1 |
|----------|-------------|-------------|
| Actual 0 | 568 | 5 |
| Actual 1 | 188 | 3 |

Accuracy Score: 0.7473821989528796

Classification Report

| | precision | recall | f1-score | support |
|--------------|-----------|--------|----------|---------|
| 0 | 0.75 | 0.99 | 0.85 | 573 |
| 1 | 0.38 | 0.02 | 0.03 | 191 |
| accuracy | | | 0.75 | 764 |
| macro avg | 0.56 | 0.50 | 0.44 | 764 |
| weighted avg | 0.66 | 0.75 | 0.65 | 764 |

SVM

Confusion Matrix

| | Predicted 0 | Predicted 1 |
|----------|-------------|-------------|
| Actual 0 | 573 | 0 |
| Actual 1 | 191 | 0 |

Accuracy Score: 0.75

Classification Report

| | precision | recall | f1-score | support |
|--------------|-----------|--------|----------|---------|
| 0 | 0.75 | 1.00 | 0.86 | 573 |
| 1 | 0.00 | 0.00 | 0.00 | 191 |
| accuracy | | | 0.75 | 764 |
| macro avg | 0.38 | 0.50 | 0.43 | 764 |
| weighted avg | 0.56 | 0.75 | 0.64 | 764 |

Decision Tree Classifier

Confusion Matrix

| | Predicted 0 | Predicted 1 |
|----------|-------------|-------------|
| Actual 0 | 469 | 100 |
| Actual 1 | 79 | 116 |

Accuracy Score : 0.7657068062827225

Classification Report

| | precision | recall | f1-score | support |
|--------------|-----------|--------|----------|---------|
| 0 | 0.86 | 0.82 | 0.84 | 569 |
| 1 | 0.54 | 0.59 | 0.56 | 195 |
| accuracy | | | 0.77 | 764 |
| macro avg | 0.70 | 0.71 | 0.70 | 764 |
| weighted avg | 0.77 | 0.77 | 0.77 | 764 |

Machine Learning Models for Predicting Opioid Overdose Deaths

MLPRegressor Model for Predicting Opioid Overdose Deaths without Suppressed Values

MLPRegressor R-squared score: 0.682
MLPRegressor Mean Squared Error: 4169.988
MLPRegressor Root Mean Squared Error: 64.575

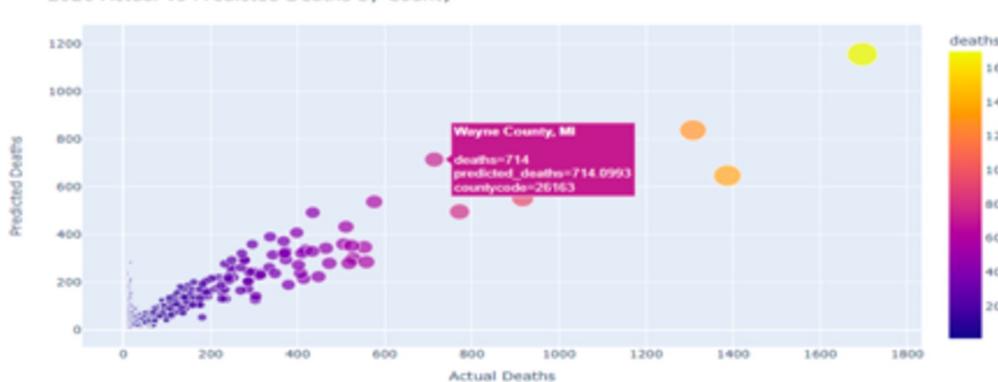
Opioid Overdose Prediction using MLPRegressor with Imputed Values

MLPRegressor R-squared score: -0.593
MLPRegressor Mean Squared Error: 16012.284
MLPRegressor Root Mean Squared Error: 126.540

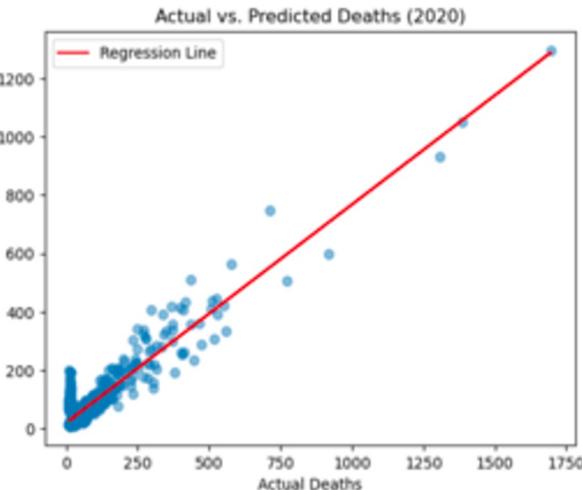
Opioid Overdose Prediction using Deep Neural Networks (No Suppressed Values)

Deep Neural Network R-squared score: 0.846
Deep Neural Network Mean Squared Error: 2484.396
Deep Neural Network Root Mean Squared Error: 49.844

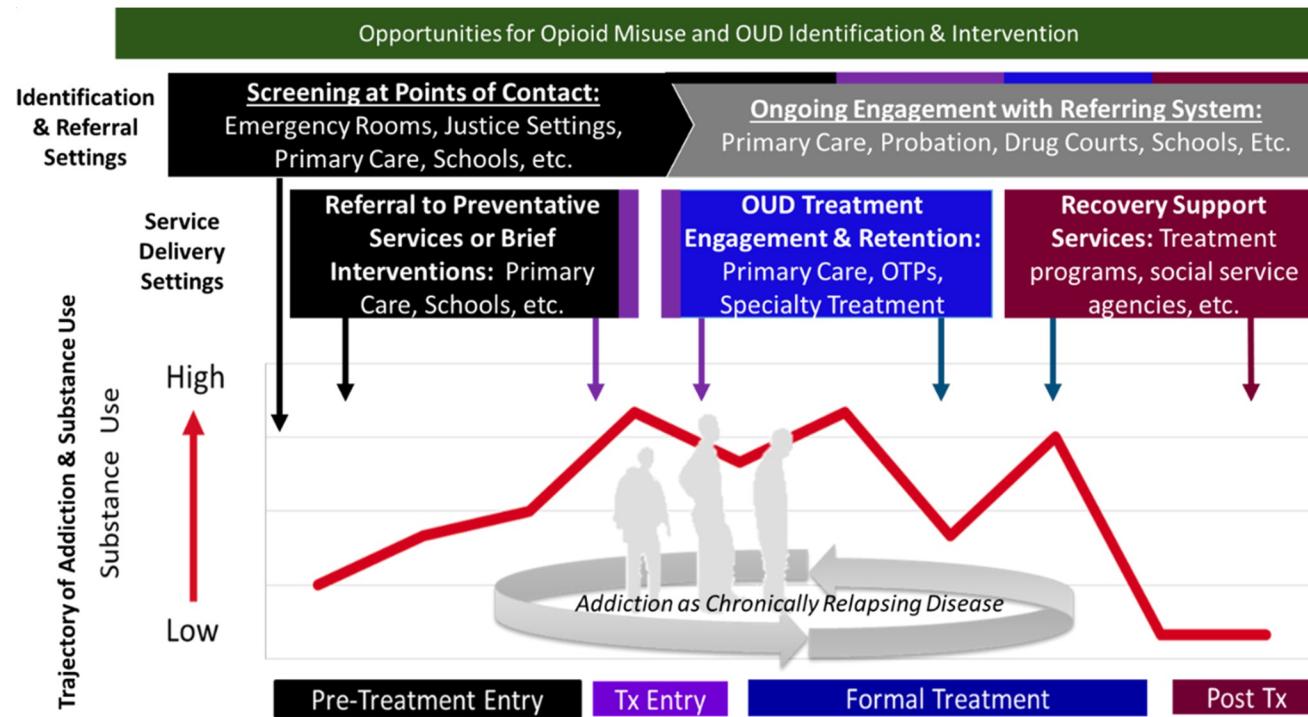
2020 Actual vs Predicted Deaths by County



Actual vs. Predicted Deaths (2020)



Conclusions

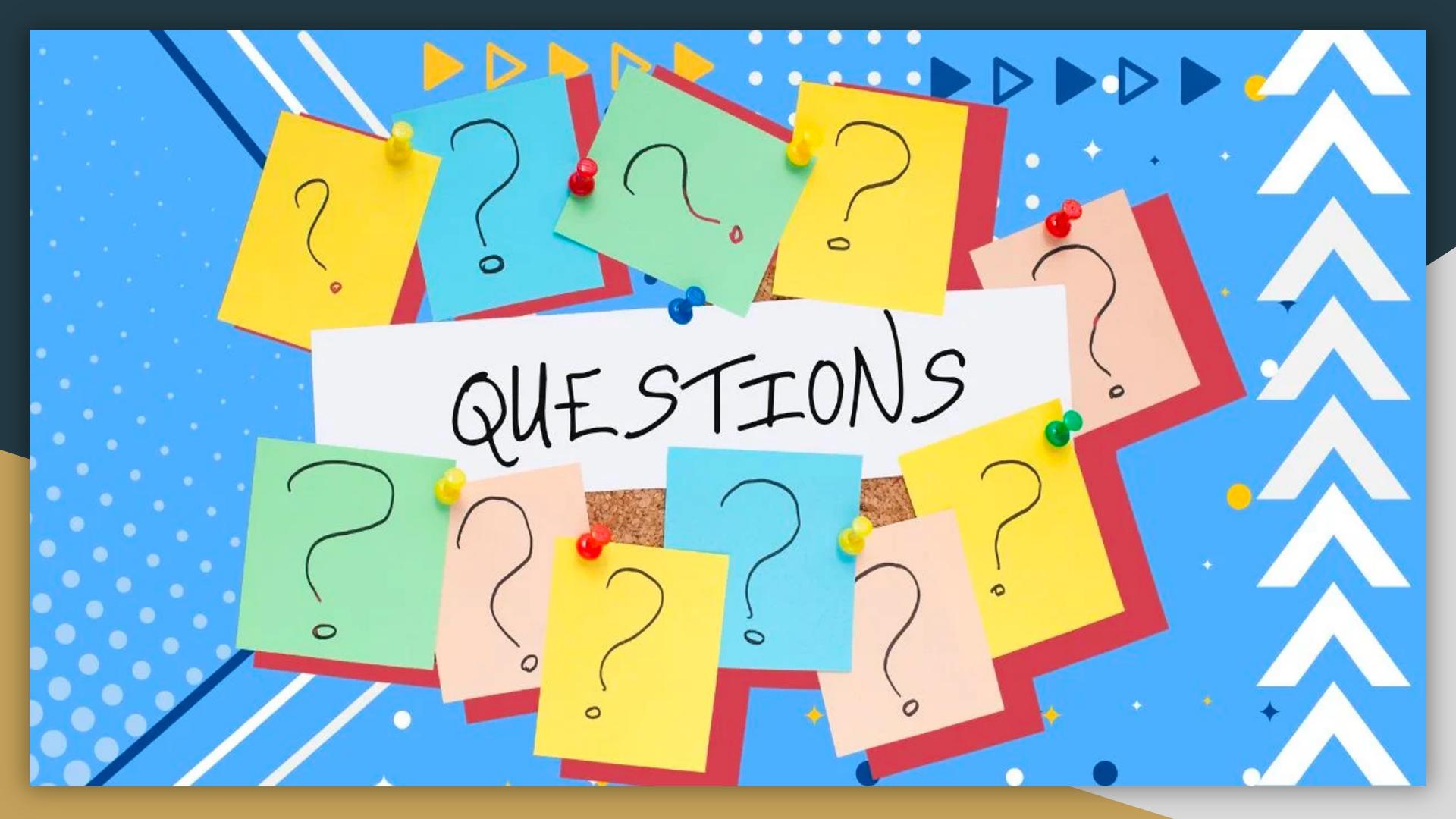


Future Recommendations

- ❖ Finding data sets that are more cohesive(rate vs. population totals)
- ❖ Finding additional data sets to increase the features(i. e. mortgage rates, access to rehab centers)
- ❖ Finding data sets that include demographic information
- ❖ Face to face time
- ❖ Presentation limitations

Link to the Interactive Website: <https://milospopov007.github.io/Opioid-Overdose-Death-Prediction---University-of-Denver/>





QUESTIONS

Presentation Requirements

- The selected topic and the reasoning for that selection (2 points)
- A description of the data (3 points)
- The questions that the team originally planned to answer with the project (2 points)
- A description of the data exploration phase of the project (5 points)
- A description of the analysis phase of the project (5 points)
- The technologies, languages, tools, and algorithms that the team used throughout the project (3 points)

Data Ethics and Compliance Disclosure

- Used the data exclusively for health statistical reporting and analysis in the context of our project.
- Ensured that any sub-national geographic data presented or published does not include death counts of 9 or fewer, or death rates based on counts of nine or fewer.
- Made no attempts to discover the identity of any person or establishment included in the data.
- Committed to reporting any inadvertent discoveries of personal or establishment identities to the NCHS Confidentiality Officer, and refraining from disclosing or using such information.

Data Sources

- Death by Opioid Type: Detailed mortality data provided by the CDC WONDER database.
- Education: Educational attainment data for adults age 25 and older in US counties, provided by the USDA.
- Unemployment: Unemployment and median household income data for US counties, also provided by the USDA .
- Income: Personal income data by county and metropolitan area, including government social benefits, provided by the Bureau of Economic Analysis.
- Dispensing Rate: US county opioid dispensing rates based on prescriber location, provided by the CDC.

The Opioid Crisis by the Numbers

- **700,000** Americans died from a drug overdose between **1999 and 2017**, and **400,000** of these deaths involved a prescribed or illicit opioid.
- Nearly **48,000 died in 2017** from an overdose involving an opioid.
- Each day, more than **130 Americans** die from an opioid related overdose.
- Opioid overdose deaths today are **six times** higher than in 1999.
- The US consumes **about 80%** of all the world's opioids.
- **38%** of U.S. adults (92 million) use prescription opioids.
- **11.4 million Americans** misuse opioid prescriptions, and **2.1 million** are addicted to opioids.
- The annual economic burden of prescription opioid misuse in the United States is **\$78.5 billion**

Exploring Root Causes



Question to the audience

Using the chat feature: in the past year do you think the problem of people being addicted to opioids in your community has gotten better, worse, or remained about the same?

- Better
- Worse
- About the Same

A

Ways to prevent an opioid epidemic



Preventing an opioid epidemic requires a multifaceted approach, including strategies aimed at reducing the supply of opioids, addressing the root causes of addiction, and promoting alternative pain management options. Here are some ways to prevent an opioid epidemic:

Like Dislike

1. Improve prescription drug monitoring: Better monitoring of prescription drug use can help identify potential cases of abuse or diversion and prevent unnecessary or inappropriate prescriptions.
2. Increase access to addiction treatment: People struggling with opioid addiction need access to effective treatment, including medication-assisted treatment (MAT) and behavioral therapy.
3. Expand access to non-opioid pain management options: Healthcare providers should consider non-opioid pain management options, such as physical therapy or alternative therapies, for patients with chronic pain.
4. Increase public awareness and education: Educating the public about the risks of opioid use and the signs of addiction can help prevent misuse and overdose.
5. Enforce laws and regulations: Strict enforcement of laws and regulations around the prescribing, dispensing, and distribution of opioids can help prevent diversion and misuse.
6. Promote responsible prescribing: Healthcare providers should use caution when prescribing opioids, including screening patients for risk factors and prescribing the lowest effective dose for the shortest duration possible.
7. Support research and innovation: More research is needed to understand the causes and consequences of the opioid epidemic and develop innovative approaches to prevention and treatment.

Conclusions

The opioid counter drug medication that is commonly used to treat opioid overdoses is called naloxone. The availability and accessibility of naloxone may vary by state, as state laws and regulations may differ regarding its distribution and administration. Some states may require a prescription from a healthcare provider to obtain naloxone, while others may allow it to be obtained without a prescription from a pharmacy or community-based organization. Additionally, some states may provide naloxone through statewide distribution programs, while others may not have such programs in place.

AWS Database

my_aws_postgres_rds

General Connection SSL SSH Tunnel Advanced

| | |
|--------------------------|---|
| Host name/address | mypostgresdb.czsg8gzo4zg1.us-east-2.rds.amazonaws.com |
| Port | 5432 |
| Maintenance database | postgres |
| Username | root |
| Kerberos authentication? | <input type="checkbox"/> |
| Role | |
| Service | |

? ? X Close Reset Save

Tableau

