Modeling COVID-19 Risk in Nursing Homes

December 15, 2020

Anzhi Mou, Zhaoyu Qiao, Harvir Singh Virk, Xiaoyu Zhu, Alexandra Allen

Faculty Advisor: Rema Padman   Client Advisor: Manuel Figallo

Agenda

- Team Introduction (5 min)
- Project Presentation (40 min)
  - COVID-19 Nursing Home Story
  - Project Objectives and Data Exploration
  - Modeling
  - Dashboard Deliverables
  - Conclusions
- Q&A (15 min)

Graduate Student Team

Anzhi Mou
amou@andrew.cmu.edu

Team Role: Data Manager & Quality Assurance Engineer

Qualifications:
- MS Information Systems Management
- The Home Depot senior data analyst, TeleTracking data engineer II

Graduate Student Team

Zhaoyu Qiao
qzhaoyu@andrew.cmu.edu

Team Role: Analytics Chief & Data Scientist

Qualifications:
- MS Healthcare Analytics and Information Technology
- Highmark Health data scientist intern on operation performance during Covid-19

Graduate Student Team

Harvir Singh Virk (DJ Virk)
hvirk@andrew.cmu.edu

Team Role: Healthcare Data Analyst / Documentation Manager

Qualifications:
- MS Healthcare Analytics and Information Technology
- UT San Antonio researcher, Worldwide Clinical Trials data manager and quality control specialist

Graduate Student Team

Xiaoyu Zhu (Volanda)
xzhu4@andrew.cmu.edu

Team Role: Language Processing
Engineer / Data Scientist

Qualifications:
- MS Information Systems
  Management
- IEEE machine learning
  engineer intern, eBay data
  scientist intern, eClicks
  software engineer

Graduate Student Team

Alexandra Allen
sydneya@andrew.cmu.edu

Team Role: Project Manager / Healthcare Policy Advisor

Qualifications:
- MS Public Policy & Management
- National Committee to Preserve Social Security & Medicare legislative advocacy & health policy intern, El Centro de la Raza public health benefits navigator

Faculty Advisor

Rema Padman
rpadman@andrew.cmu.edu

Trustees Professor of Management Science &
Healthcare Informatics at Heinz College

Client Advisor

Manuel Figallo
Manuel.Figallo@sas.com

Principal Systems Engineer at SAS Analytics
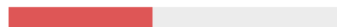Government Business Unit

The COVID-19 Nursing Home Story

More Than 100,000 U.S. Coronavirus Deaths Are Linked to Nursing Homes

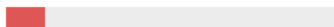By The New York Times   Updated December 4, 2020

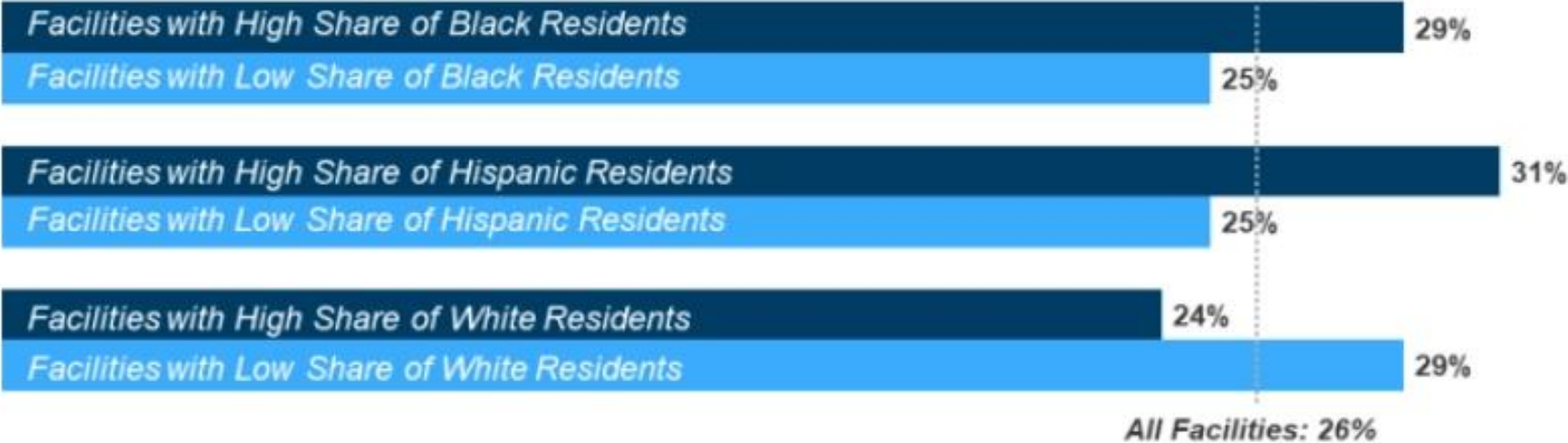## 38%
OF ALL U.S. DEATHS
106,000+

5%
OF ALL U.S. CASES
787,000+

Coronavirus Infection Outbreaks Were More Severe in Nursing Homes With A Relatively Large Share of Black or Hispanic Residents

Confirmed/Suspected Coronavirus Cases As A Share of Nursing Home Beds (as of October 11, 2020):

Facilities with High Share of Black Residents	29%
Facilities with Low Share of Black Residents	25%
Facilities with High Share of Hispanic Residents	31%
Facilities with Low Share of Hispanic Residents	25%
Facilities with High Share of White Residents	24%
Facilities with Low Share of White Residents	29%

All Facilities: 26%

Nursing Homes With Relatively High Shares of Black or Hispanic Residents Were More Likely To Have At Least One COVID-19 Death

Share of Nursing Homes With At Least One COVID-19 Death (as of October 11, 2020):

Facilities with High Share of Black Residents	63%
Facilities with Low Share of Black Residents	40%
Facilities with High Share of Hispanic Residents	55%
Facilities with Low Share of Hispanic Residents	44%
Facilities with High Share of White Residents	37%
Facilities with Low Share of White Residents	58%

All Facilities: 45%

"**Nobody gave a damn about the Black people dying at a higher clip**."

Eric Russell
Son of Resident
Villa at Windsor Park
Chicago, Illinois

Research Relevant: Vaccine Allocation

As COVID-19 vaccine distribution starts, Pa.'s lack of specifics complicates planning
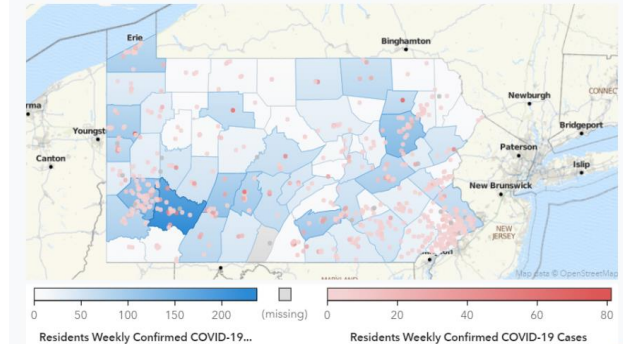
About the Project
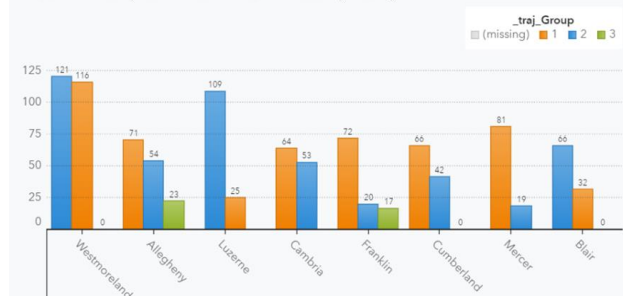
Project Objectives

1. **Targeting:** Use machine learning to identify nursing home at high risk of COVID-19 infection and mortality to target facilities with resources such as testing supplies/PPE.

2. **Investigation:** Summarize nursing home inspection report narratives for more efficient review by investigators.

3. **Intervention:** Operationalize potential equitable vaccine allocation strategy in interactive dashboard.

Data Pipeline

Data Pipeline (midterm)

COVID-19 Data limited to post June

Data Pipeline

Upload Weekly

Covid-19 Mortality Data 2020

Resident Demographic + Condition Data 2017

Provider Quality, Ratings, Staffing Data 2019

Inspection Report Data 2019

- Data Filtration
- Feature Engineering
- Aggregation by Facility

NYT Community Infection and Mortality Rates 2020

Community COVID-19 Social Vulnerability Index 2020

Tribal Facility + Native American Alaska Native

Improved Business Understanding

Modeling

12,571 unique facilities

Preseve no missing value dataset

Dashboard

15,387 unique facilities

Preserve all data even with missing value

COVID-19 Data limited to post June
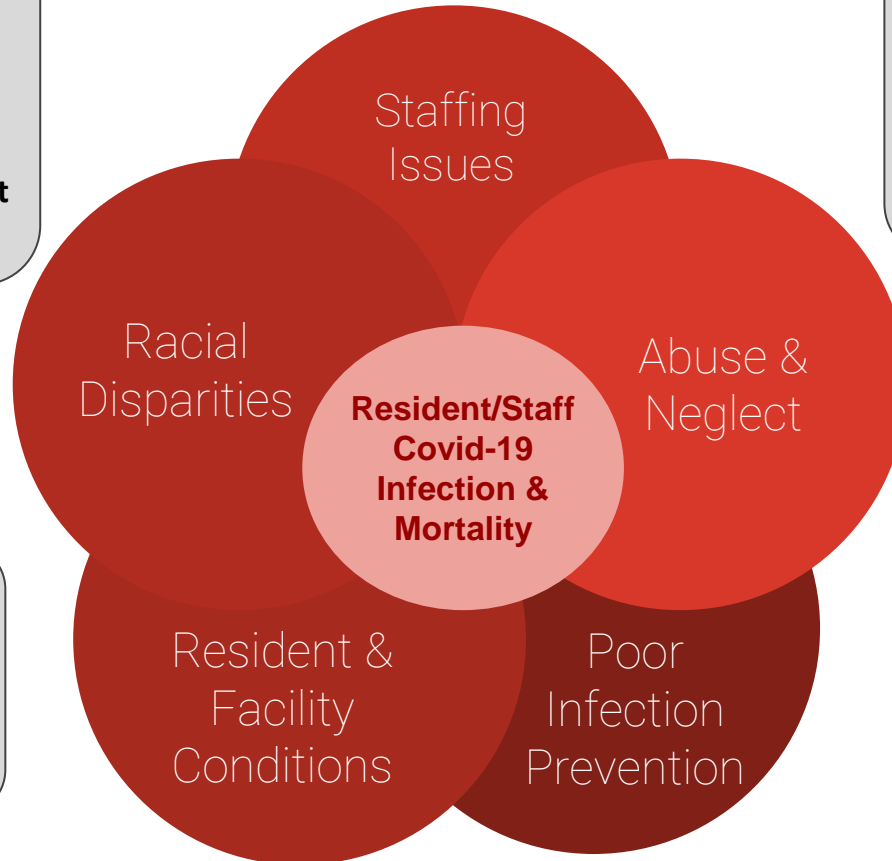
Exploring the Data

- Pandemic staffing shortage
- Nurse Hours per Resident per Day
- RN Staffing Rating
- Overall Staffing Rating

- Resident % White, % Black, % Hispanic
- Zip code/county
- Community COVID-19 Social Vulnerability Index
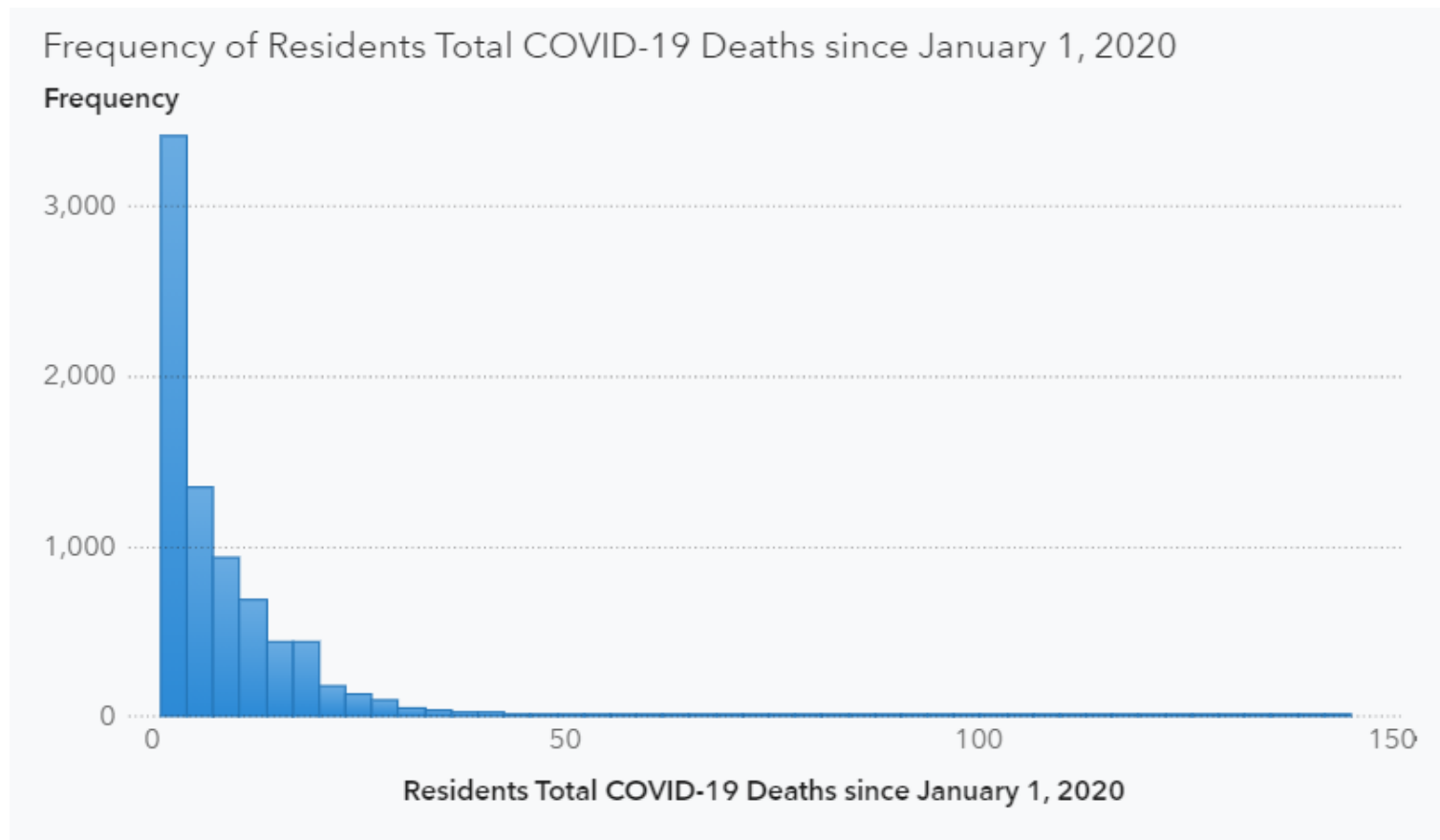- Tribal Facilities + Resident % Indian/Alaska Native

- Abuse flag
- # complaints
- Deficiency Tags & Scope-Severity
- Use of restraint

- Resident age
- Resident acuity
- Facility size (# beds)
- Nonprofit vs. for-profit

- Staff and resident COVID-19 testing
- PPE supply
- Total Weighted Health Survey Score
- Health Inspection Rating

Staffing Issues

Racial Disparities

Abuse & Neglect

Resident/Staff Covid-19 Infection & Mortality

Resident & Facility Conditions

Poor Infection Prevention

Nursing Home Mortality is Highly Skewed

Frequency of Residents Total COVID-19 Deaths since January 1, 2020

TRAJ Classification Shows Varied Past Infection Trends

Residents Weekly Confirmed COVID-19 Cases

Green
17% of facilities

Blue
12% of facilities

Red
71% of facilities
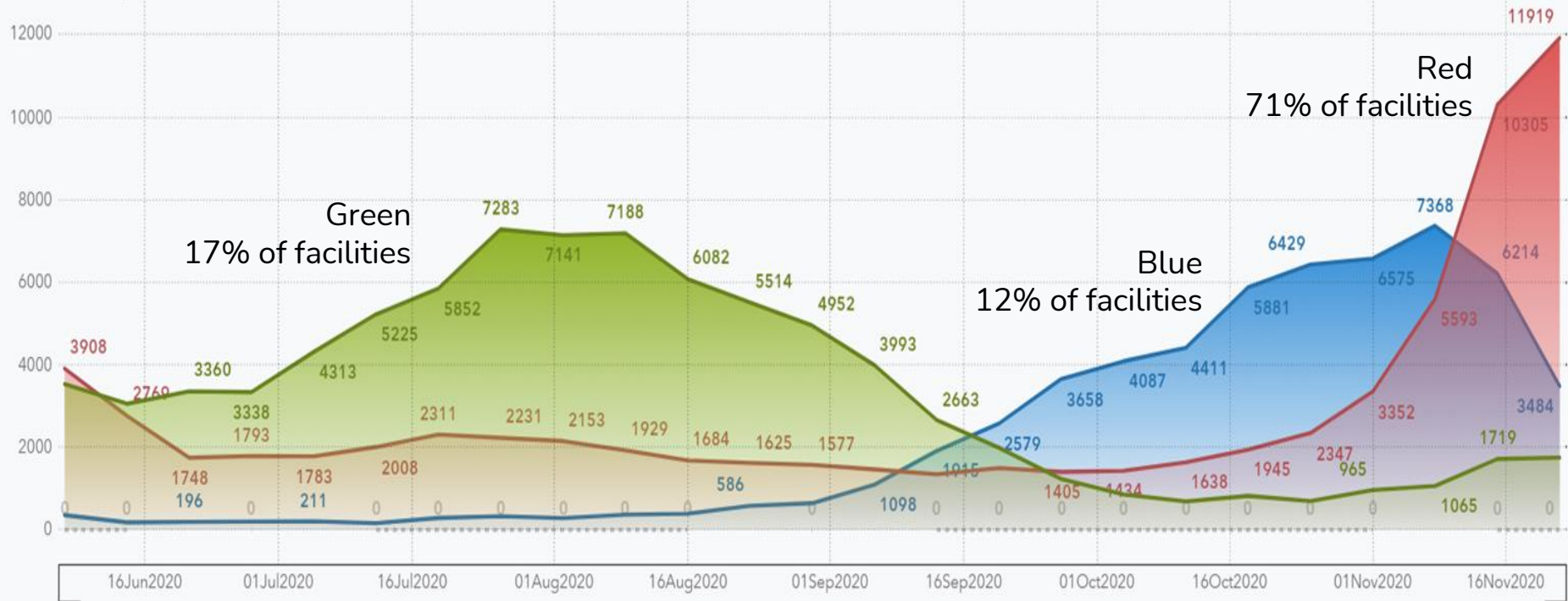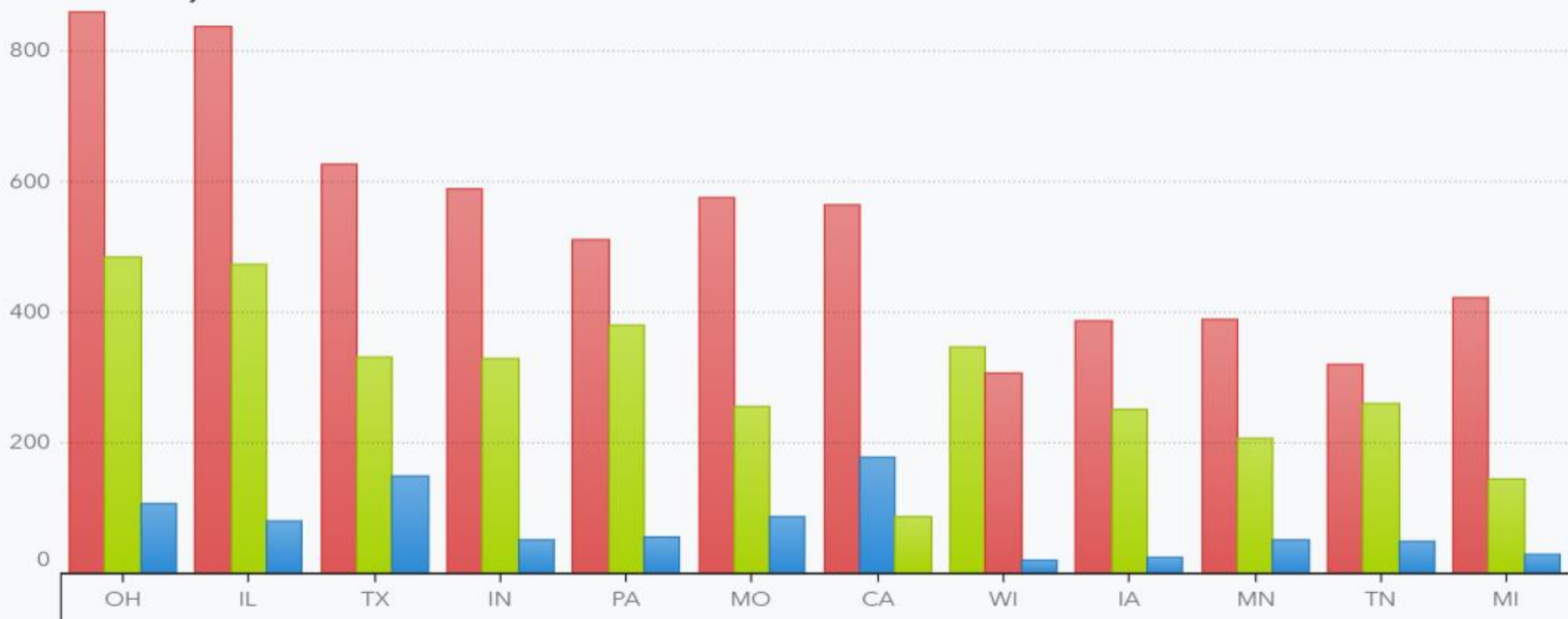
Sample of States Driving High Case Count in Fall Surge

Sample of States Ordered by Number of Cases from Facilities in Red Trajectory Group during week of November 15, 2020

Residents Weekly Confirmed COVID-19 Cases

Inspection Report Text Modeling

Text Processing

- Case normalization

- HTML Tag removal

- Special Symbol removal

- Punctuation removal

- Stopwords removal

- Frequent words removal

- Rare words removal
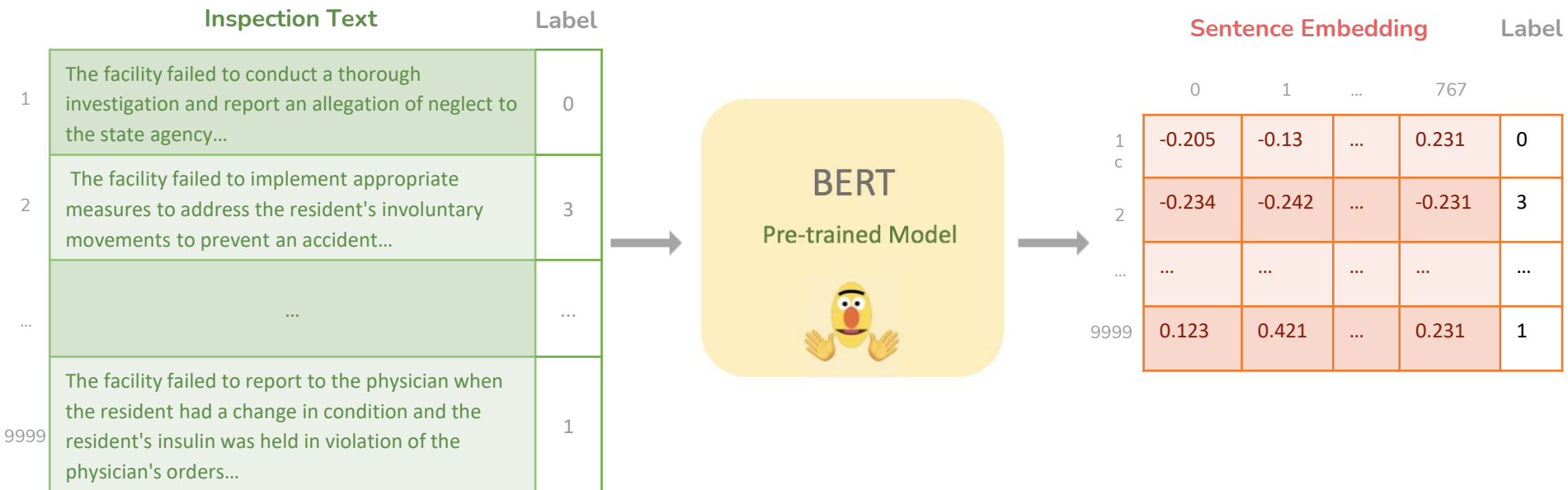
- Tokenization

- Stemming

- Lemmatization

NOTE- TERMS IN BRACKETS HAVE BEEN EDITED TO PROTECT CONFIDENTIALITY
Based on clinical record review, review of facility documentation and interviews for one sampled resident (Resident #347) who had reported a grievance regarding mistreatment, the facility failed to conduct a thorough investigation and/or report an allegation of neglect to the state agency. The finding include:
Resident #347's [DIAGNOSES REDACTED].
The Resident Care Plan (RCP) dated 1/13/17 identified the resident with lung disease. Interventions directed to obtain pulse oximetry every shift and when needed, notify physician if oxygen saturation is below 90%, to administer oxygen as ordered and/or directed to observe for worsening Shortness of Breath (SOB), and to notify the physician of any unrelieved or new SOB at rest.
The 14 day Minimum Data Set (MDS) assessment dated [DATE] identified Resident #347 as noted with intact cognition, required extensive assistance with Activities of Daily Living (ADL) and indicated the received oxygen therapy
the physician's orders [REDACTED].
 podiatry consultation report dated 2/7/17 at 3:17 P.M. identified Resident # 347 was sent from the facility to the podiatry appointment with an empty oxygen tank. The resident's oxygen saturation level was at 90% (Normal Value greater than 95%).
The nurse's note dated 2/7/17 at 9:07 P.M. identified Resident # 347 was alert and oriented, had no acute respiratory distress and no glycemic issues.
The Grievance/Concern Report received 2/8/17 identified on 2/7/17 Resident #347's portable oxygen tank was empty while the resident was at doctor's appointment. The Grievance/ Concern Report dated 2/8/17 further indicated the resident returned back to the facility after the appointment and her/his pulse oximetry was at 90%. The nurse directed the NA to bring the resident to her/his room and connect him/she to his/her concentrated oxygen tank.
The Reportable Event Form dated 2/16/17 identified Resident #347's family reported the resident went to a doctor's appointment without sufficient amount of oxygen which subsequently cause the resident to run out of oxygen. Additionally, the Reportable Event indicated that upon return to facility the resident asked for help with the oxygen but did not receive any assistance from the staff <BR/> review of clinical record and review of the facility investigation regarding the allegation of neglect lacked documentation to reflect the time the resident left the facility for the podiatry appointment, when the resident returned from the appointment and how many liters of oxygen Resident # 347 had in the oxygen. Facility documentation also failed to reflect the amount of oxygen the resident had in the tank prior to leaving the facility and/ or if the resident's portable oxygen tank had been checked prior to the appointment.
urther review of facility documentation records, Risk Management System (RMS) dated 2/13/17 reflected that the facility identified the family and Resident #347 concerns were identified as an alleged abuse and/or neglect.
A review of the facility investigation dated 2/13/17 identified the facility conducted their investigation 6 days after the family and /or the resident expressed a concern regarding an allegation of neglect.
Interview and review of facility documentation with Social Worker (SW #1) on 9/27/17 at 11:00 [NAME]M. identified on 2/13/17 she/he conducted a follow up interview with Resident # 347. H

' Based on clinical record review, review of facility documentation and interviews for one sampled resident (Resident 347) who had reported a grievance regarding mistreatment, the facility failed to conduct a thorough investigation and/or report an allegation of neglect to the state agency. The 14 day Minimum Data Set (MDS) assessment dated [DATE] identified Resident 347 was noted with intact cognition, required extensive assistance with Activities of Daily Living (ADL) and indicated the received oxygen therapy. The physician's orders [REDACTED].A podiatry consultation report dated 2/7/17 at 3:17 P.M. identified Resident 347 was sent from the facility to the podiatry appointment with an empty oxygen tank. The resident's oxygen saturation level was at 90% (Normal Value greater than 95%).The nurse's note dated 2/7/17 at 9:07 P.M. identified Resident 347 was alert and oriented, had no acute respiratory distress and no glycemic issues. A review of clinical record and review of the facility '

Natural Language Processing Model: BERT

	Inspection Text	Label
1	The facility failed to conduct a thorough investigation and report an allegation of neglect to the state agency...	0
2	The facility failed to implement appropriate measures to address the resident's involuntary movements to prevent an accident...	3
...	...	...
9999	The facility failed to report to the physician when the resident had a change in condition and the resident's insulin was held in violation of the physician's orders...	1

BERT

Pre-trained Model

Sentence Embedding

	0	1	...	767	Label
1 c	-0.205	-0.13	...	0.231	0
2	-0.234	-0.242	...	-0.231	3
...	...	...	...	...	...
9999	0.123	0.421	...	0.231	1

Accuracy: 72%

Word Embedding - TFIDF

Word	Report 1	Report 2	...	TF-IDF 1	TF-IDF 2	...
Facility	1	1	...	0.00	0.00	...
Failed	1	1	...	0.00	0.00	...
to	1	2	...	0.00	0.02	...
provide	1	1	...	0.00	0.00	...
adequate	1	0	...	0.54	0.00	...
supervision	3	0	...	0.68	0.00	...
and	2	2	...	0.00	0.00	...
efficient	4	1	...	0.67	0.12	...
intervention	2	0	...	0.57	0.00	...
...	...	...	...	...	...	...

$$tf_{t,d} = \frac{n_{t,d}}{Number\ of\ terms\ in\ the\ document}$$

$$idf_t = \log \frac{number\ of\ documents}{number\ of\ documents\ with\ term\ 't'}$$

$$(tf\_idf)_{t,d} = tf_{t,d} * idf_t$$

Example: TFIDF keyword extraction

"The findings include:
 Resident #2's [DIAGNOSES REDACTED].",
"The admission nurse's note dated 4/2/18 at 3:56 PM identified Resident #2 was alert oriented to person, place and time, was verbally appropriate and had a surgical wound ",
"The nurse's note dated 4/2/18 at 11:14 PM identified a dressing changed was performed to the left foot with measurements as follow: from the left thigh to knee there were twelve (12) staples and
"Review of the skin and/or wound notes from 4/6/18 through 8/29/18 identified that although Resident #2's surgical wound to left lower extremity was monitored weekly by the treatment nurse a Lice
"Interview with the treatment/wound nurse, LPN #2, on 7/3/19 at 11:15 AM identified that she was responsible to monitor resident's pressure ulcers and/or other wounds weekly.",
'LPN #2 stated she rounds weekly with the wound physician, and typically the wound physician does not monitor residents with surgical wounds.',
'Interview with the Director of Nursing (DON) on 7/3/19 at 1:55 PM identified that a licensed practical nurse (LPN) was responsible to monitor wounds on weekly bases and to conduct weekly wounds
'The DON stated if the wound was not classified as a pressure ulcer, the wound physician was available on an as needed bases and Resident #2 was not being monitored by the wound physician due to
'The DON identified she oversees the wound nurse.',

Keywords: surgical, staple, wound, nurse, knee, monitor, wind, physician, identify, weekly
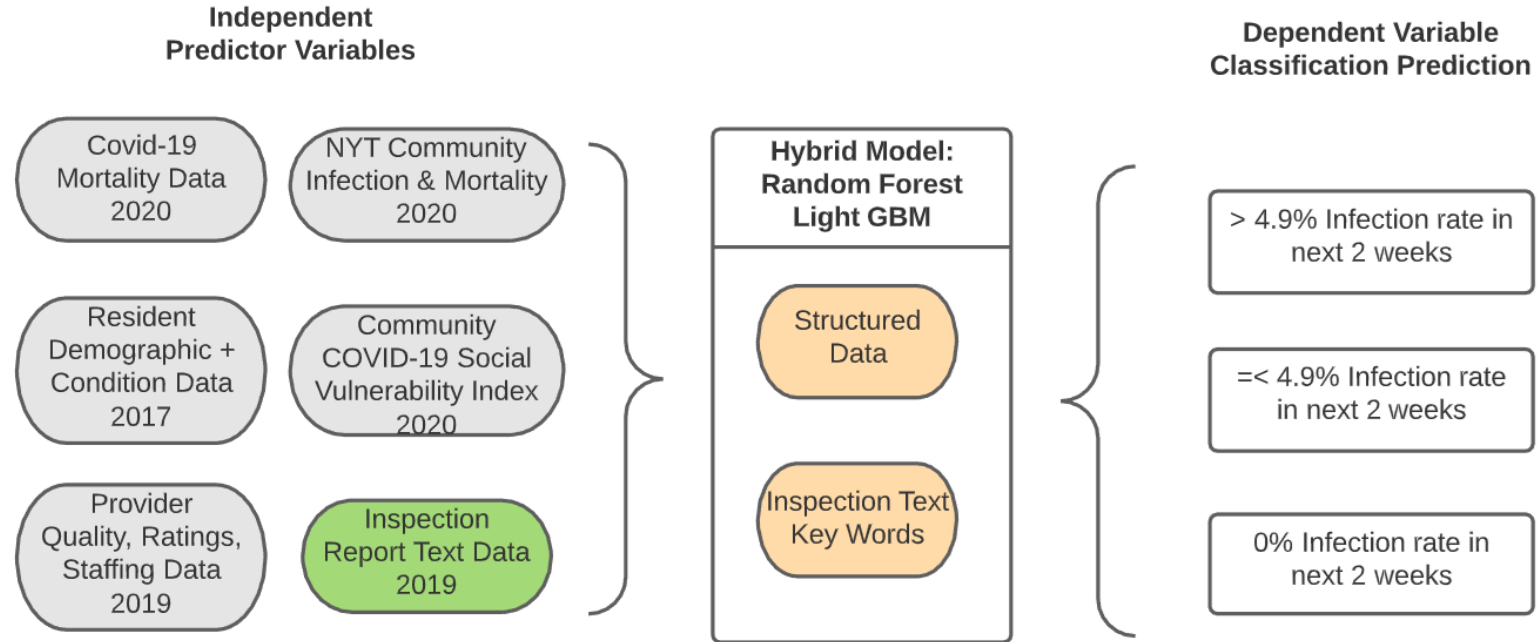
Target Dependent Variable:
Covid-19 Resident Infection Rate

$$\left[\frac{\text{Resident Covid Infections}}{\text{\# Occupied Beds}} \right] \times 100$$

What % of residents in this nursing home will be confirmed newly infected in the next two-week period?

# Hybrid Model Combined Structured Data with Inspection Report Text

Independent Predictor Variables

Dependent Variable Classification Prediction

Covid-19 Mortality Data 2020

NYT Community Infection & Mortality 2020

Resident Demographic + Condition Data 2017

Community COVID-19 Social Vulnerability Index 2020

Provider Quality, Ratings, Staffing Data 2019

Inspection Report Text Data 2019

Hybrid Model: Random Forest Light GBM

Structured Data

Inspection Text Key Words

> 4.9% Infection rate in next 2 weeks

=< 4.9% Infection rate in next 2 weeks

0% Infection rate in next 2 weeks

*4.9% is average infection rate for the general population.

Using every 4 weeks to predict the infection risk of coming 2 weeks.
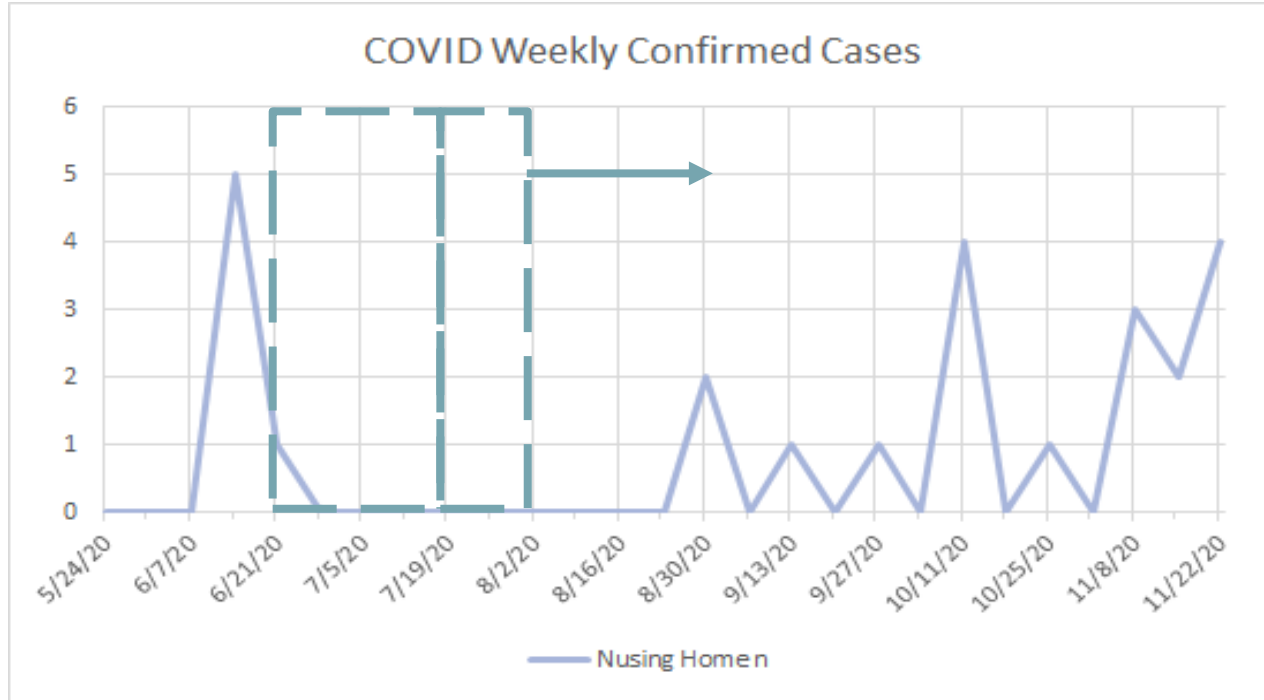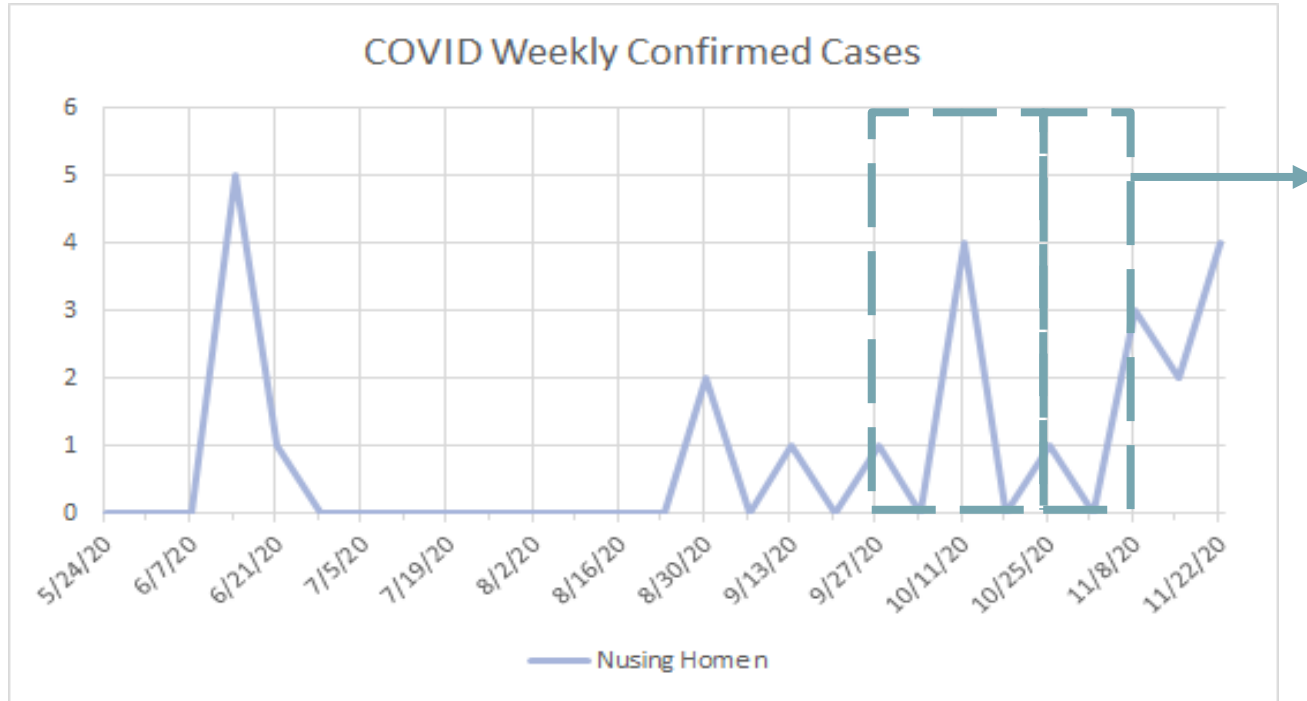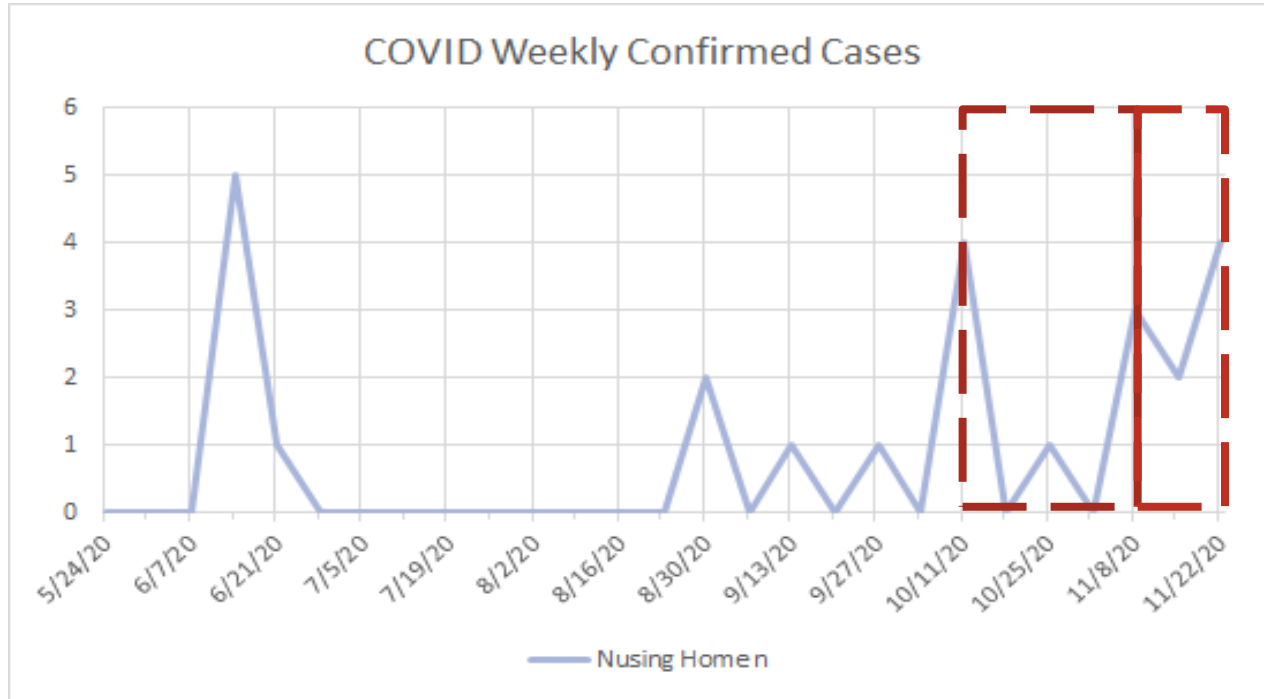
Using every 4 weeks to predict the infection risk of coming 2 weeks.
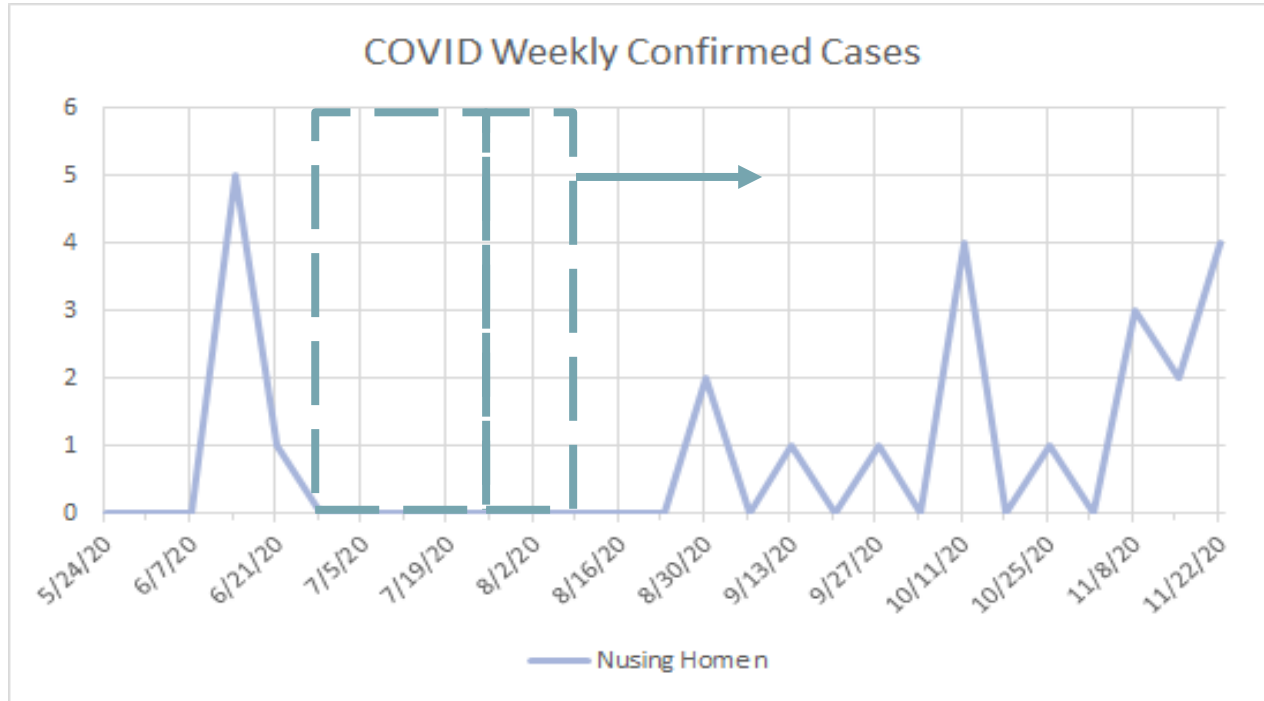
Using every 4 weeks to predict the infection risk of coming 2 weeks.
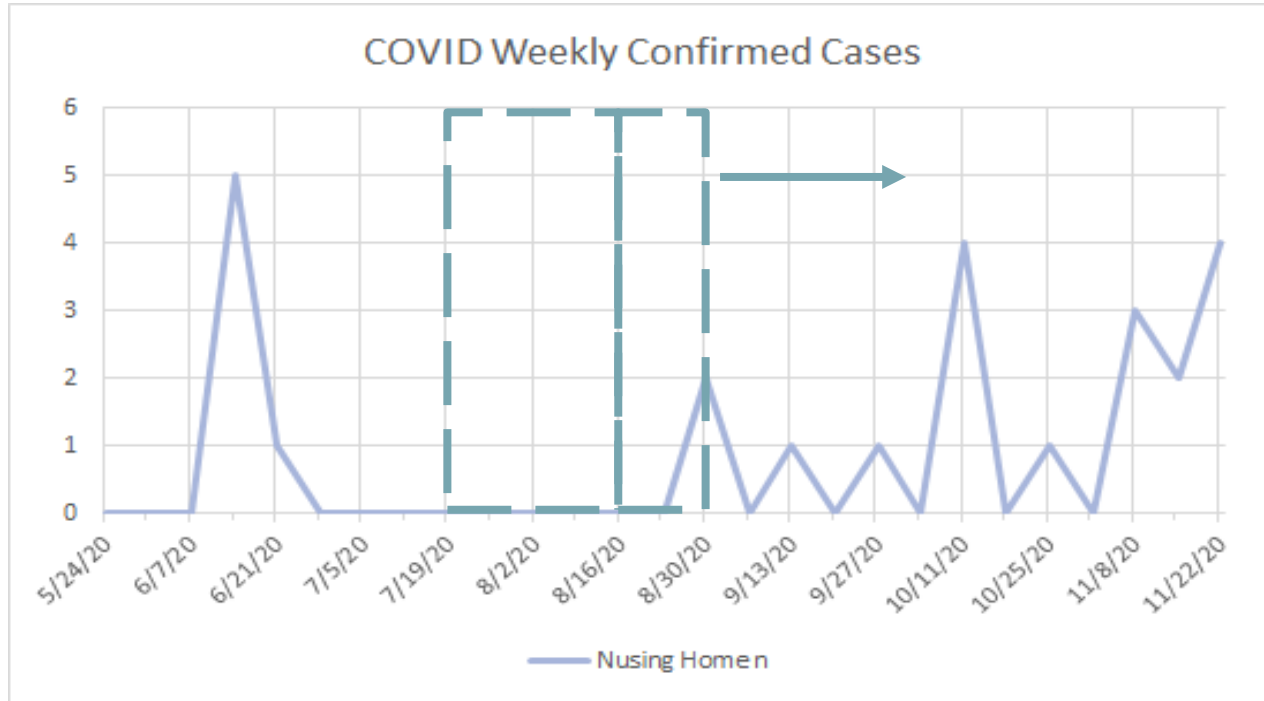
Using every 4 weeks to predict the infection risk of coming 2 weeks.

Using every 4 weeks to predict the infection risk of coming 2 weeks.

Sample of Important Features from Hybrid Classification Model

Feature Selection : From 159 features to 50 features

Community Factors

- Community infection/mortality
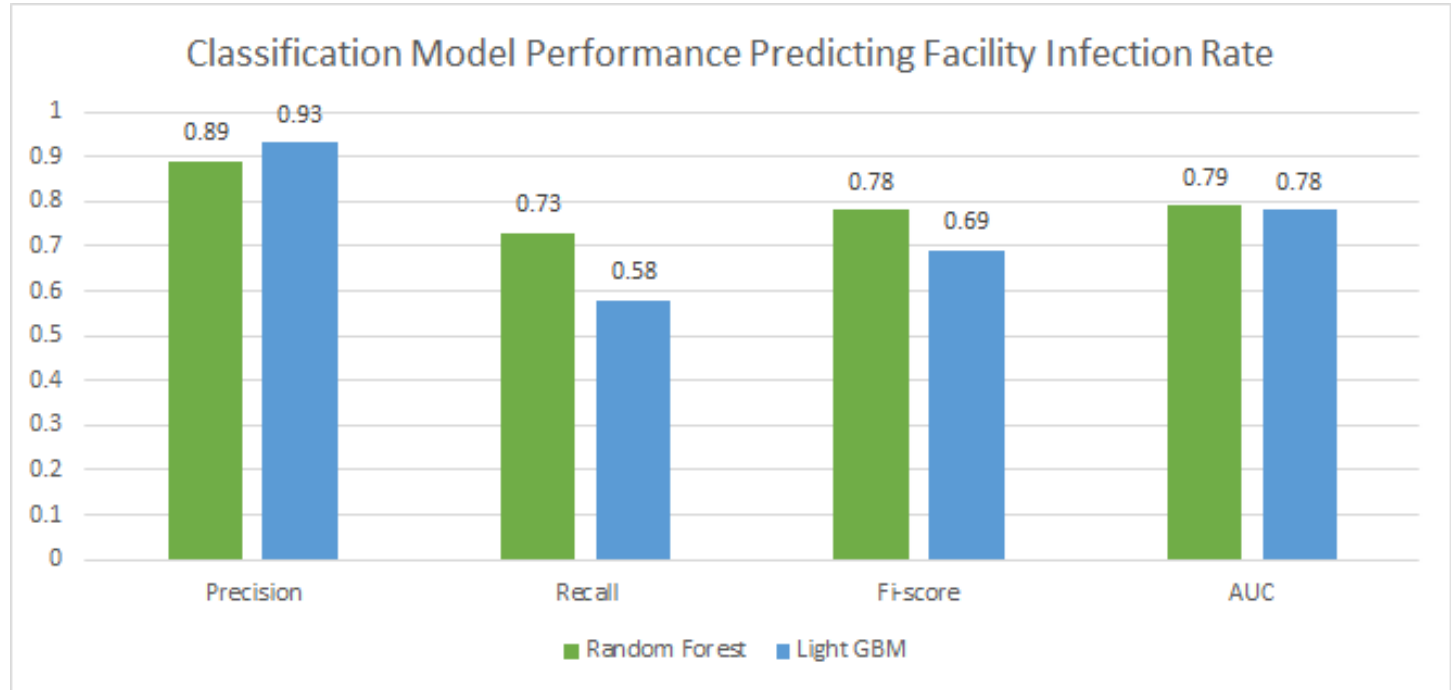- COVID-19 Social Vulnerability Score

Resident Health

- Resident Acuity
- % Residents with Hypertension
- Rehospitalization Rate

Resident Demographics

- Total Number of Residents in Facility
- % White/Black Residents
- Average Age
- % Female Residents

Hybrid Model Results

Classification Model Performance Predicting Facility Infection Rate

Selected Model Prediction Results

	Predicted		
Risk	**Low**	**Middle**	**High**
Low	√ 6752	2564	2332
Middle	! 0	√ 285	230
High	! 0	199	√ 208

Actual

	precision	recall	f1-score	support
Low	1.00	0.58	0.73	11648
Middle	0.09	0.55	0.16	515
High	0.08	0.51	0.13	407
accuracy			0.58	12570
macro avg	0.39	0.55	0.34	12570
weighted avg	0.93	0.58	0.69	12570

Low Misidentification of >0% Infection Groups

Modeling Limitations and Future Steps

Limitations:
- Imbalanced data
- Novel pandemic with limited historic data
- Not involving policy and human behavior
- Important features from modeling still merit further examination

Future Steps:
- Construct label classification involving both infection and mortality to present the comprehensive risk
- Consider both long term and short term historical data impact
- Add local level policy decisions data
- Validate important features using diverse methods
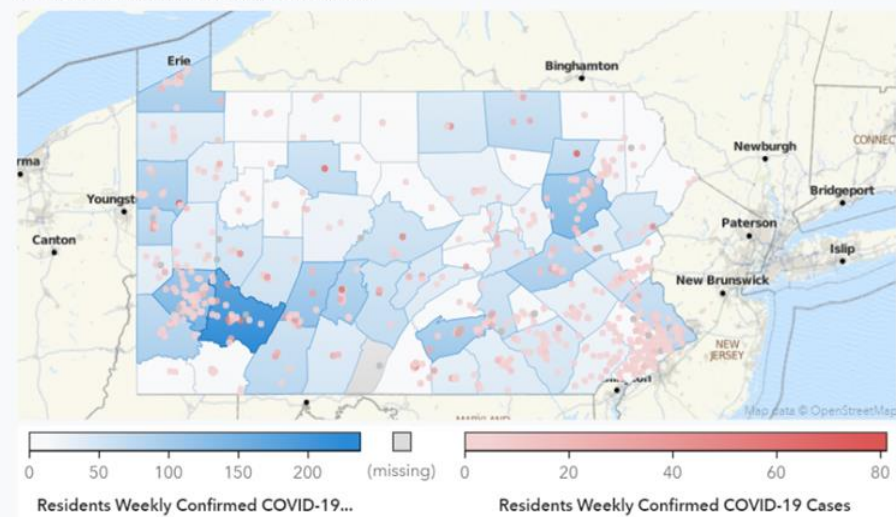
Client Deliverables: Interactive Dashboard

Project Objectives - SAS Viya Dashboard

1. **Targeting:** Use machine learning to identify nursing home at high risk of COVID-19 infection and mortality to target facilities with resources such as testing supplies and PPE.

1. **Investigation:** Summarize nursing home inspection report narratives for more efficient review by investigators.

1. **Intervention:** Operationalize potential equitable vaccine allocation strategy in interactive dashboard.
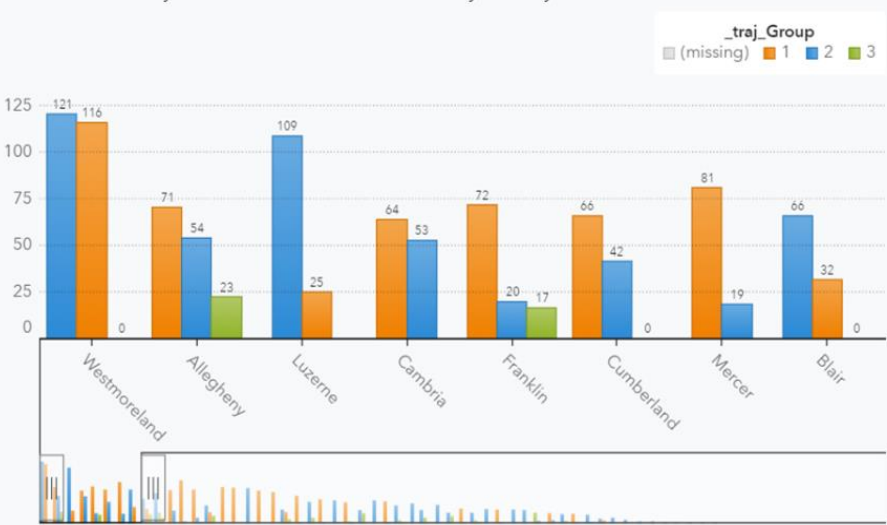
Targeting: Identify nursing homes with high infection rates and recommend resource supports such as testing supplies and PPE.

RESIDENT INFECTIONS:

Resident Confirmed COVID-19 Cases

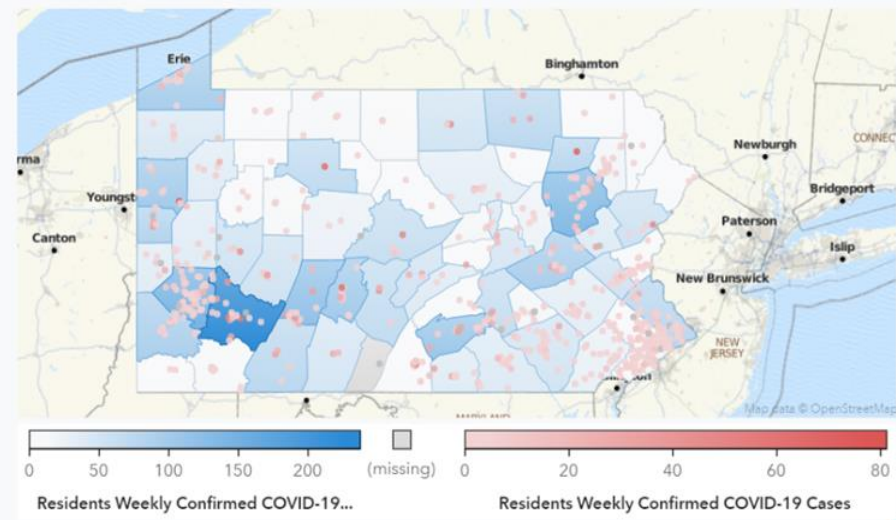Residents Weekly Confirmed COVID-19 Cases by County

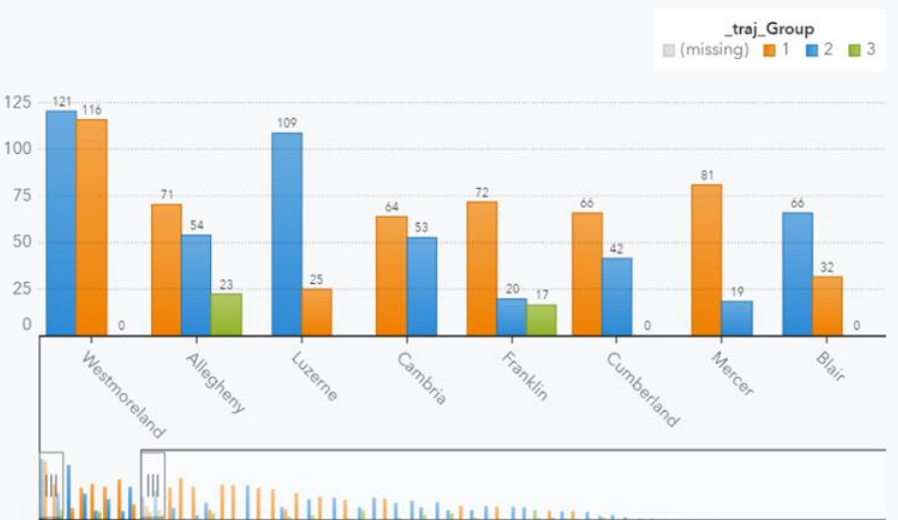| Provider Name	Provider County	Number of Residents in Facility (average)	Residents Weekly Confirmed COVID-19 Cases	Resident Cumulative Case Fatality Ratio since 6/21/2020 (COVID-19 Deaths per Confirmed Case + Admissions)	_traj_Group
QUALITY LIFE SERVICES - GROVE CITY	Mercer	79.8	81	12%	1
SOUTH HILLS REHABILITATION AND WELLNESS CENTER	Washington	94	81	7%	1
GARDENS AT TUNKHANNOCK, THE	Wyoming	85.3	71	.	1
ELK HAVEN NURSING HOME	Elk	86.8	64	6%	1
ALTOONA CENTER FOR NURSING CARE	Blair	92.3	62	.	2
TWIN LAKES REHABILITATION AND HEALTHCARE CENTER	Westmoreland	105	56	10%	1

Targeting: Identify nursing homes with high infection rates and recommend resource supports such as testing supplies and PPE.
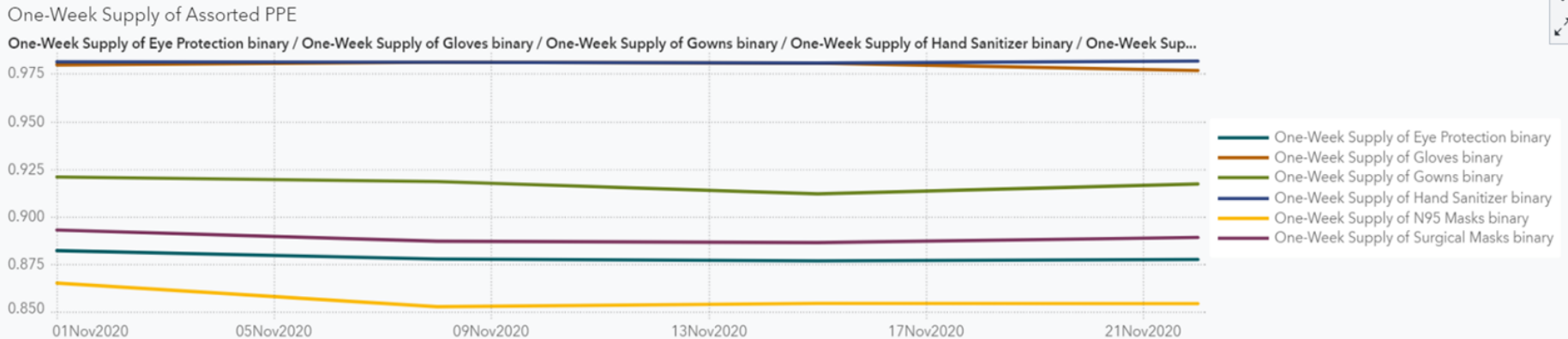

RESIDENT INFECTIONS:

Resident Confirmed COVID-19 Cases

Residents Weekly Confirmed COVID-19 Cases by County

Provider Name	Provider County	Number of Residents in Facility (average)	Residents Weekly Confirmed COVID-19 Cases	Resident Cumulative Case Fatality Ratio since 6/21/2020 (COVID-19 Deaths per Confirmed Case + Admissions)	_traj_Group
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ALTOONA CENTER FOR NURSING CARE	Blair	92.3	62	.	2
TWIN LAKES REHABILITATION AND HEALTHCARE CENTER	Westmoreland	105	56	10%	1

Targeting: Identify nursing homes with high infection rates and recommend resource supports such as testing supplies and PPE.

PPE SUPPLY: Contact the facilities with less than 100% record of 1-week supply of PPE items in the last 4-6 weeks. Provide them with the needed resources.

One-Week Supply of Assorted PPE

One-Week Supply of Eye Protection binary / One-Week Supply of Gloves binary / One-Week Supply of Gowns binary / One-Week Supply of Hand Sanitizer binary / One-Week Sup...

Provider County	Provider Name	One-Week Supply of Eye Protection binary	One-Week Supply of Gloves binary ▲	One-Week Supply of Gowns binary	One-Week Supply of Hand Sanitizer binary	One-Week Supply of N95 Masks binary	One-Week Supply of Surgical Masks binary	One-Week Supply of Ventilator Supplies binary
Erie	LECOM AT PRESQUE ISLE, INC	1	1	1	1	1	1	1
Lackawanna	ALLIED SERVICES SKILLED NURSING...	1	1	.67	.67	.67	1	1
Lancaster	CONESTOGA VIEW	1	1	1	1	1	1	1
Lehigh	GOOD SHEPHERD HOME RAKER CE...	1	1	1	1	1	1	1
Lycoming	MUNCY PLACE	1	1	1	1	0	1	1
Montgomery	ARISTACARE AT MEADOW SPRINGS	1	1	1	1	.75	1	1

Targeting: Identify nursing homes with high infection rates and recommend resource supports such as testing supplies and PPE.

TESTING CAPACITY: Contact facilities unable to test all staff 100% of the time in the last 4-6 weeks. Address their reasons for not testing and provide them necessary resources.

Able to Test or Obtain Resources to Test All Staff and/or Personnel Within Next 7 Days binary by Week

Able to Test or Obtain Resources to Test All Staff and/or Personnel Within Next 7 Days binary
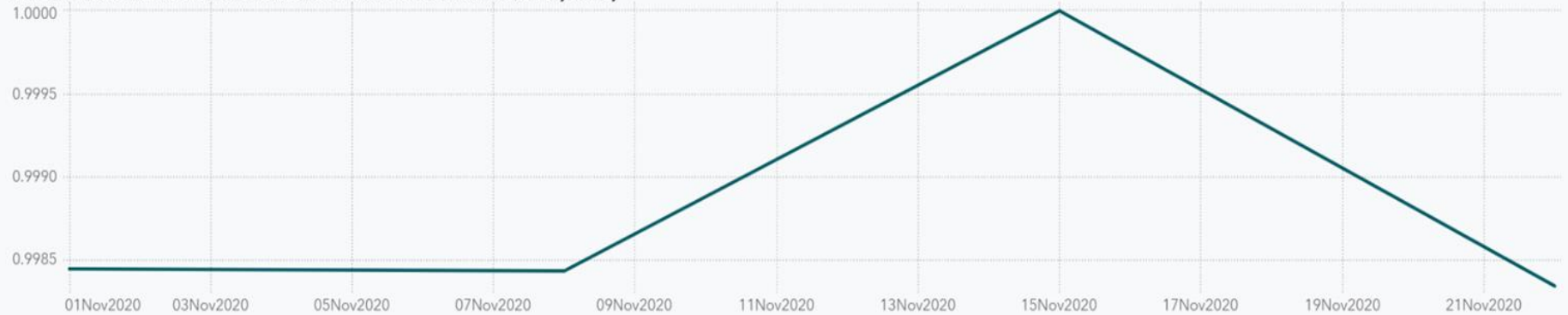
Provider Name	Provider County	Able to Test or Obtain Resources to ▲ Test All Staff and/o...	Reason for Not Testing Staff and/or Personnel - Lack of Access to Tra...	Reason for Not Testing Staff and/or Personnel - Lack of Access to Lab...	Reason for Not Testing Staff and/or Personnel - Lack of PPE for Perso...	Reason for Not Testing Staff and/or Personnel - Lack of Supplies binary	Reason for Not Testing Staff and/or Personnel - Other binary	Reason for Not Testing Staff and/or Personnel - Uncertainty About Re...
GINO J MERLI VETERANS CENTER	Lackawanna	0.00	0.00	0.00	0.00	1.00	0.00	0.00

Targeting: Identify nursing homes with high infection rates and recommend resource supports such as testing supplies and PPE.

DATA QUALITY ASSURANCE: Contact the facilities with less than 100% record of Passing Quality Assurance Check in the last 4-6 weeks and review submission protocols.

Passed Quality Assurance Check binary, Submitted Data binary by Week

Provider County	Provider Name	Submitted Data binary	Passed Quality Assurance Check binary ▲
Carbon	SUMMIT AT BLUE MOUNTAIN NURSING...	100%	0%,
Westmoreland	GREENSBURG CARE CENTER	25%	0%
Cumberland	CUMBERLAND CROSSINGS RETIREMEN...	100%	0%
Luzerne	GARDENS AT EAST MOUNTAIN, THE	100%	0%
Fulton	FULTON COUNTY MEDICAL CENTER	100%	0%
Luzerne	TIMBER RIDGE HEALTH CENTER	100%	0%
Crawford	EMBASSY OF PARK AVENUE	100%	25%
Centre	VILLAGE AT PENN STATE, THE	100%	25%
Butler	QUALITY LIFE SERVICES - CHICORA	100%	25%
Cumberland	BETHANY VILLAGE RETIREMENT CENTER	100%	25%
York	SPIRITRUST LUTHERAN THE VILLAGE A...	100%	25%
Centre	EMBASSY OF HEARTHSIDE	100%	25%
Allegheny	BRIDGEVILLE REHABILITATION & CARE...	100%	50%
Bucks	PHOEBE RICHLAND HCC	100%	50%

Investigation: Summarize nursing home inspection report narratives for more efficient review by investigators.
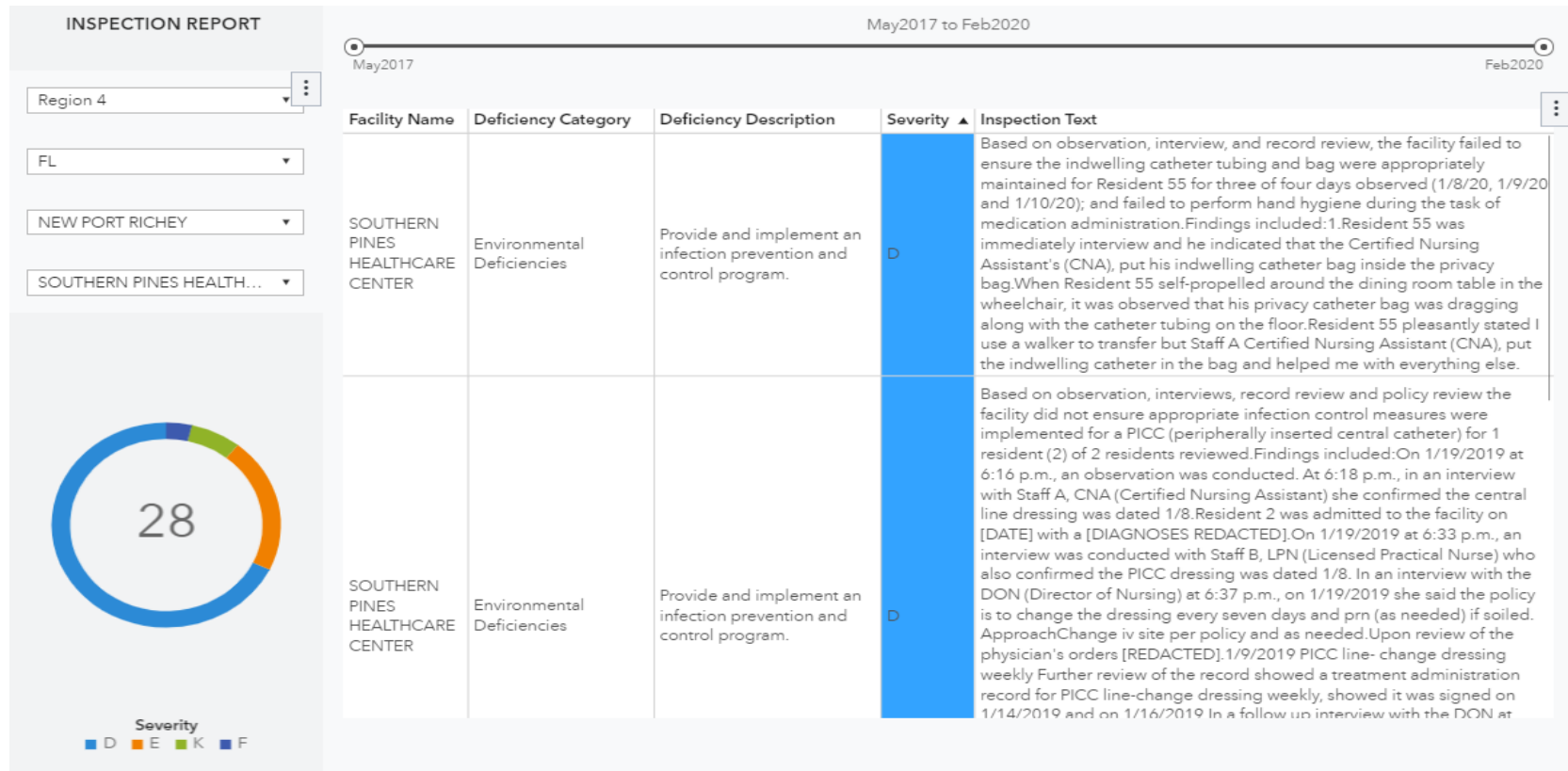
Investigation: Summarize nursing home inspection report narratives for more efficient review by investigators.

Facility Name	Deficiency Category	Deficiency Description	Severity ▲	Inspection Text
MADISON POINTE CARE CENTER	Environmental Deficiencies	Provide and implement an infection prevention and control program.	D	Based on observation, interview and record review the facility failed to follow infection control practices related to adequately cleaning blood glucose meters for two residents (7 and 99) of two residents observed for glucose monitoring. An observation on 2/11/20 at 4:55 p.m. revealed Staff A, Licensed Practical Nurse (LPN) removed the blood glucose meter from the top drawer of the medication cart and set it on the top of the cart. She opened the top drawer of the medication cart and placed the uncleaned blood glucose meter inside. An observation on 2/11/20 at 6:00 p.m. revealed Staff B, Registered Nurse (RN) had two blood glucose meters sitting on top of her medication cart in plastic cups.

Inspection report (cont.)
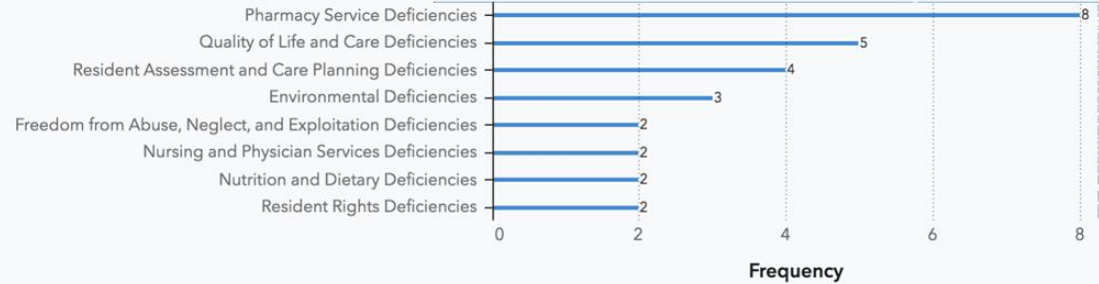
Intervention: Operationalize potential equitable vaccine allocation strategy in interactive dashboard.

Tribal Facilities & Non-Continental Facilities
Facilities in the CMS Tribal Nursing Home Collaborative for which COVID-19 data was reported; Select CMS facilities with >10% Native American/Alaska Native Residents for which COVID-19 data was reported. Facilities in HI, AK, PR, and GU.

Facilities Ranked by Number of Residents, Share of Black/Hispanic residents, Resident Acuity, and Community COVID-19 Social Vulnerability.
Primary rank facilities by Number of Residents highest to lowest with % Black/Hispanic residents as tie-breaker highest to lowest.
Among facilities missing % Black/Hispanic, Average Resident Acuity as tie-breaker highest to lowest.
Among facilities for which we lack any demographic or acuity data, ranked by Community COVID-19 Social Vulnerability Index highest to lowest.

Provider Name	Provider State (1)	Number of Residents in Facility (average)	2017 % Black or Hispanic Residents	2017 Average Acuity Index	County Social Vulnerability Index Score (0-1)
NORTHAMPTON COUNTY-GRACEDALE	PA	537	6%	11.382	0.059
CEDARBROOK SENIOR CARE AND REHABILITATION	PA	508	13%	11.944	0.31
FAIR ACRES GERIATRIC CENTER	PA	450	.	11.355	0.141
MASONIC VILLAGE AT ELIZABETHTOWN	PA	374	.	12.672	0.202
CONESTOGA VIEW	PA	348	14%	13.129	0.202
BRIGHTON REHABILITATION AND WELLNESS CENTER	PA	347	.	13.134	0.103
SPRING CREEK REHABILITATION AND NURSING CENTER	PA	343	30%	13.394	0.299
NESHAMINY MANOR HOME	PA	340	.	12.559	0.017
HORSHAM CENTER FOR JEWISH LIFE	PA	332	.	11.259	0.099
PLEASANT ACRES REHABILITATION AND NURSING CENTER	PA	311	.	11.786	0.047
WESTMORELAND MANOR	PA	306	.	12.64	0.291
BERKS HEIM NURSING & REHABILITATION	PA	304	.	12.691	0.176

Reflections and Insights

1. Improve modeling by capturing policy and human behavior.
2. Forecasting is difficult in a novel disease pandemic.
3. NLP can support efficient report review.
4. SAS Viya can visualize complex problems and identify actionable solutions.
5. Our custom data and analysis pipeline is agile.

Acknowledgements

Questions?