# AI MODEL TO PREDICT COVID TEST RESULTS.

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# Abstract

COVID-19 was declared a global pandemic by the WHO[1] on 11th March 2020. During this global pandemic, we faced a long wait for an appointment for Covid testing. The test results were even further delayed. Had there been a better system, we could have been prepared more and acted timely! The spread of Covid was also dependent on various factors like the living conditions, ethnicity, age, and health pre-conditions. This project was built using AI models for an early prediction of the test results. I used the CDC[2] public information available to build the logical regression to predict the Covid test results of individuals. Using these predictions, the potential red zones could be marked out to allow authorities to bring in extra care to the area to control the pandemic outbreak. This model can be extended to serve any such pandemic situations, if such a need arises.

# Introduction

This research paper addresses the question of how early predictions of Covid results can be made for individual patients thereby helping them to be cautious. Previous test results published by CDC were used for this purpose. Using this model, we use the health and living factors of previous test cases and predict the results based on such factors. The purpose of this research is to extend this AI model to analyze and predict the results during any such pandemic. This would help the authorities to prepare, based on demographics, that could be vulnerable for such a pandemic.

We as humans quickly became aware of people who have been affected by this Covid pandemic. However, the lack of testing to prevent the spread was a major problem. We had to wait days to get an appointment and then wait for up to two weeks to get the test results. Before we knew that we were affected, the infection was spread from us to everyone we interact with.
Schools were shut down and many people were forced to work and learn from home. As a result, people no longer had face to face interaction, with some losing vital motivation. Since we could not get the results in time, the only solution was to lock down towns and avoid personal interactions. Analyzing the data published by CDC, I tried to draw lines between various factors that seemed vulnerable for Covid infection. Ethnicity, age, and health pre-conditions like the body mass index factor,

[1] WHO – World Health Organization.
[2] CDC – Center of Disease Control.

glucose reading, blood Pressure were analyzed to see how the Covid infections were reported on earlier results.
Many of our towns have segregated demographics. Some of them have elderly segregations, while some others have segregations by ethnicity. A new patient trying to get to a Covid test could be undergoing the pre-test screening using my model. Based on the factors described, my model was able to predict the test result, which is not assured to be accurate. However, such a prediction based on the previous data of similar cases was helpful to give sufficient warnings to take extra care. This model could be a life saver for many such cases.
How do we help the authorities to bring sufficient care in time? I tried to mark the red zones based on the pre-screen results. Based on these readings, authorities would be able to be prepared for hospitalizations and give better awareness for such towns.

# Background

The COVID-19 virus has been responsible for over 2.5 million deaths across the world. This virus has severely affected the economy and the public health status of the people in various countries. In the past, these viruses had triggered many outbreaks, such as the Extreme Acute Respiratory Syndrome Coronavirus (SARS-CoV) in China and the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) in the Middle Eastern countries. The COVID-19 virus was initially identified in China in December 2019, after which it spread across all the countries in the world when people started getting in contact with the infected people and then traveled to different regions. It severely affects the lungs and other organs of the respiratory system in the body.

It is noted that the coronavirus significantly affects the health of people and even causes death, either directly or through exacerbating pre-existing health problems. As a large proportion of people have been affected by the COVID-19 pandemic throughout the world, and there is no cure available for the disease, it becomes important that we develop early predictions to prevent the spread of infection.

Many researchers, including data scientists, have been working intensely to design prediction models that highlight the probable activities of this virus. Most of them focus on predicting the Covid cases by States and territories based on daily incidence reported. The main contribution of this paper is that it proposes a prediction model which can present individuals' awareness by early prediction of potential positive COVID-19 cases. The model drills down to segregated

demographics based on these potential cases, thereby warning authorities of potential spikes in such towns.

# Dataset

For our project, the dataset that we used to perform the analysis was downloaded from the CDC website. Various data cubes on Covid testing were published in the CDC website https://data.cdc.gov. We used them to prepare the dataset for machine learning and testing. This data set was hosted in a MySQL relational database and was served to the Python program used to build the logical regression model. A summary of the data used is as follows.

```
##  SUMMARY OF THE DATA:

### PersonID - ID Number of the patient/Individual.
### Age - Age (years)
### Ethnicity - Social/cultural/national group
### Ethnicity_group - Group sorted alphabetically and numbered

                # Ethnicity             Ethnicity_Group
                # African American                    1
                # Asian                               2
                # Hispanic                            3
                # Latino                              4
                # Native American/Alaskan Native      5
                # Other                               6
                # Pacific Islander                    7
                # white                               8

### Fever - Temperature recorded in degrees Fahrenheit
### Asthma - Breathing issue recorded - Positive or negative
### Asthma_group - Breathing issue recorded - Positive = 1 or negative = 0
### BloodPressure - Diastolic blood pressure (mm Hg)
### HeartRate  - Beats per minute
### Glucose - Plasma glucose concentration
### BMI - Body mass index (\frac{weight}{height^2}height2weight in kg/m)

### Outcome(COVID Test Result - Class variable (0 - healthy or 1 - diabetic)
```

To better visualize the data set, given below is a snapshot of the data analysis.

*AI Model to Predict Covid test results using Logistic Regression/Binary Classification.*

Data Analysis.

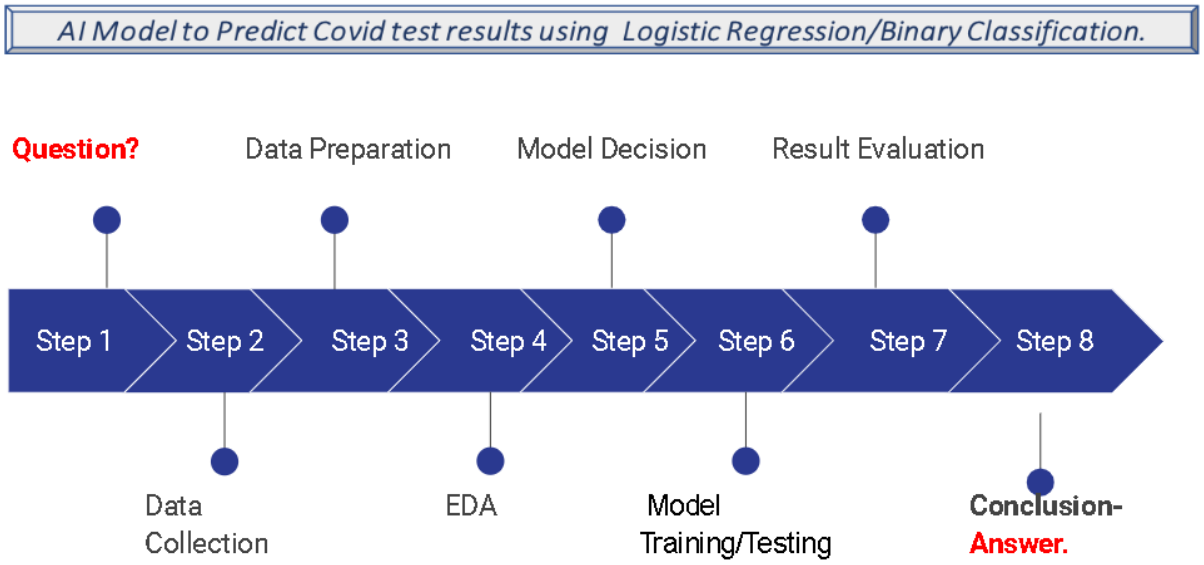
covid_analysis

| | PersonID | Age-years | Fever-temperature | Ethnicity | Ethnicity_Grp | Asthma | Asthma_Grp | BloodPressure-mm_hg | HeartRate-beatspermin | Glucose-SugarLevel | BMI-BodyMassIndex | COVID-TestResult |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1340386 | 21 | 96.0 | African American | 1 | negative | 0 | 48 | 97 | 77 | 47.150986 | 0 |
| 1 | 1807582 | 21 | 96.0 | African American | 1 | negative | 0 | 81 | 97 | 77 | 21.246453 | 0 |
| 2 | 1680684 | 21 | 96.0 | African American | 1 | negative | 0 | 49 | 97 | 77 | 41.289096 | 0 |
| 3 | 1560929 | 21 | 96.0 | African American | 1 | negative | 0 | 87 | 97 | 77 | 44.686495 | 0 |
| 4 | 1138937 | 21 | 96.0 | African American | 1 | negative | 0 | 82 | 97 | 77 | 21.999207 | 0 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 13995 | 1187803 | 59 | 100.2 | Asian | 2 | positive | 1 | 53 | 98 | 109 | 33.186520 | 1 |
| 13996 | 1843979 | 59 | 100.4 | Asian | 2 | positive | 1 | 61 | 98 | 111 | 33.854893 | 1 |
| 13997 | 1201886 | 59 | 100.2 | Asian | 2 | positive | 1 | 95 | 98 | 112 | 27.430496 | 1 |
| 13998 | 1228510 | 59 | 100.4 | Asian | 2 | positive | 1 | 50 | 98 | 115 | 34.692154 | 1 |
| 13999 | 1416388 | 59 | 100.4 | Asian | 2 | positive | 1 | 62 | 98 | 118 | 34.504598 | 1 |

I split the dataset as the training and testing datasets. Seventy percent of the data set was used to build the training set and the remaining thirty percent was used as a testing dataset.

# Methodology/Models

To solve the research problem, we had to analyze the dataset to extract what is required for our model. There was a steady inflow of data on the CDC website and hence we got sufficient data to build our training and testing datasets. The below diagram explains the steps of the methodology used for solving the problem.




Analysis of the data was performed in various angles by grouping them by various parameters. For example, I tried to plot the age – ethnicity combination to see the Covid results.

```
covid_analysis.groupby(['Ethnicity', 'Age-years']).count()
```

Glucose level by ethnicity was a key check to analyze the data.

```
covid_analysis.hist(column='Glucose-SugarLevel', by='Ethnicity')
```

After performing the initial analysis, I moved on to preparing the data sets for training and testing. scikit-learn package was used to prepare the train_test_split function.Using this package we can get a statistically random split of TRAINING and TEST data.

At this stage, I split the data into 70% for TRAINING and held back 30% for TESTING.

The next step was to decide the model to be used for training. I used a logistic regression model on the training set x_train, y_train. I used solver liblinear, a library used for large Linear Classification. This Uses a coordinate descent algorithm. Coordinate descent is based on minimizing a multivariate function by solving

univariate optimization problems in a loop. In other words, it moves toward the minimum in one direction at a time.

```
model = LogisticRegression(C=1/reg, solver="liblinear").fit(x_train, y_train)
```

I also checked the accuracy of the predictions - what PERCENTAGE of the labels did the model predict correctly? Mathematically it represents the ratio of the sum of true positives and true negatives out of all the predictions.

```
Accuracy:  0.9921428571428571
```

The accuracy reported is good enough to proceed. But What are the other ways that we can check if this model is good enough to use? I used the Classification report that is used to measure the quality of predictions from a classification algorithm. How many predictions are True and how many are False? Precision is the ability of a classifier not to label an instance positive that is negative. Recall is the ability of a classifier to find all positive instances. The F1 score is a weighted mean of precision and recall such that the best score is 1.0 and the worst is 0.0.

```
Overall Precision: 0.9936373276776246
```

The Model was checked and was found good to proceed for further analysis and results.

# Results

When creating results to analyze to address my original research question of— "How would we use the earlier results to predict the result on Covid testing? Can we plot the red zones based on results of different demographics"?

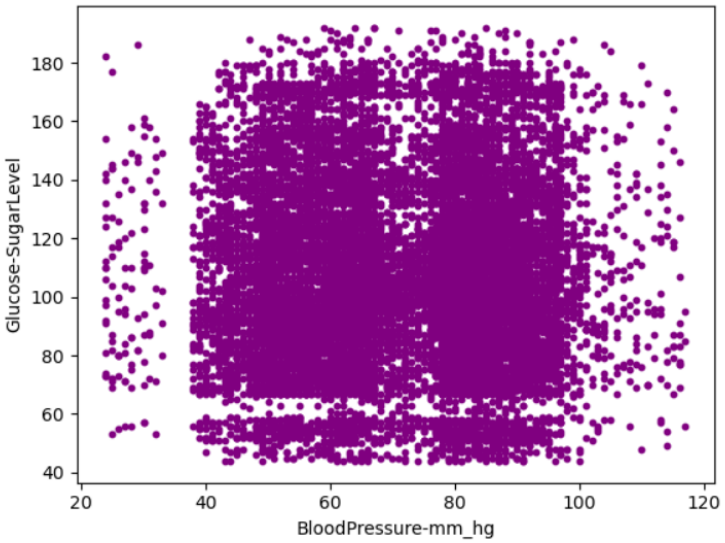
I created charts and visualizations to analyze the dataset. Different combinations of factors and test scores were plotted against each other. The first comparison that was conducted examined the potential correlation between the ethnicity against the positive cases reported.

In the next step I included Glucose level reading as a parameter to the above analysis. I also created a scatter plot by choosing glucose level (x) against blood pressure reading (y).

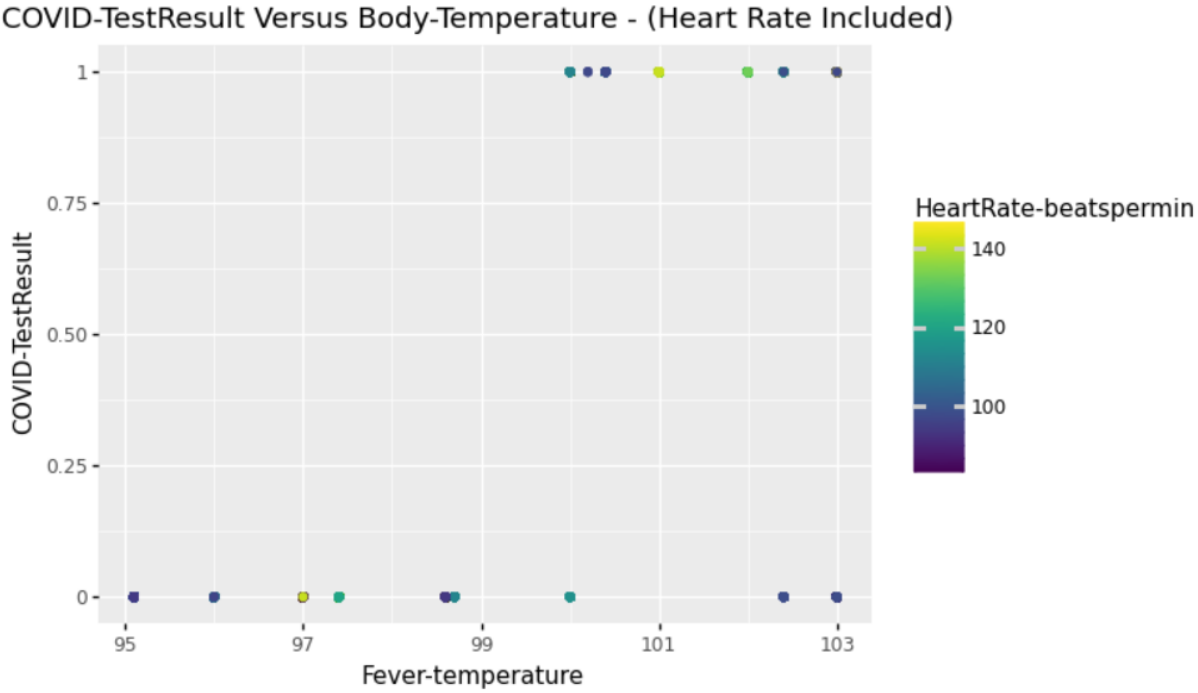
```
In [36]: # Create scatter plot for min_height and min_weight

         covid_analysis.plot.scatter(x='BloodPressure-mm_hg', y='Glucose-SugarLevel', s = 10, c='purple')
```

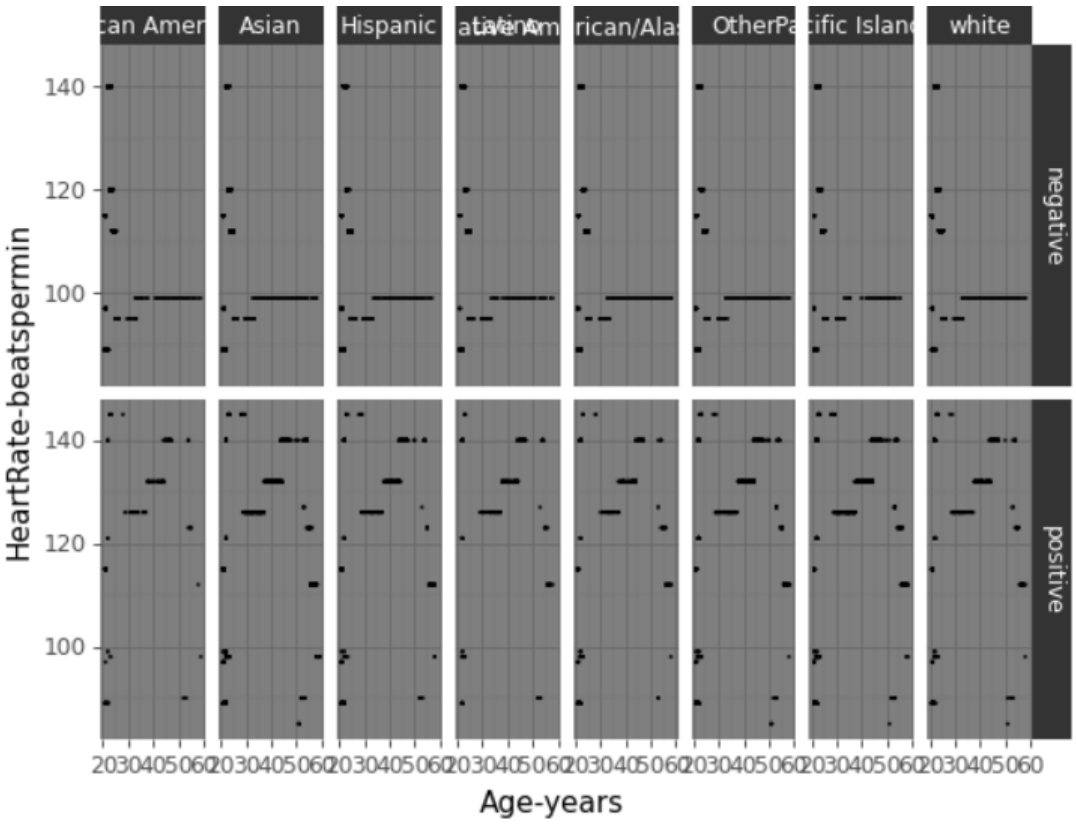
```
Out[36]: <Axes: xlabel='BloodPressure-mm_hg', ylabel='Glucose-SugarLevel'>
```




I also combined certain key factors to perform further data Investigation - Individuals with Fever and covid results including the heart rate reading to the plot.



Similar Plots were prepared bringing in ethnicity, heartbeat readings, age in years to compare the Covid results.




## Patient Sample Data Testing

```
Enter the New sample data that you want to check:
[30.0, 96.0, 1.0, 1.0, 60.0, 97.0, 79.0, 45.33189957]

Predicted class is 0

Predicted - Covid Testing Result = 0 = Negative


Enter the New sample data that you want to check:
[40.0, 101.0, 3.0, 1.0, 69.0, 132.0, 136.0, 40.81699943]

Predicted class is 1

Predicted - Covid Testing Result = 1 = Positive
```

# Conclusion

This research named AI Model to Predict COVID Test Results was conducted to check if an early prediction of test results during a pandemic outbreak is possible. I used the published data on the CDC website on Covid test results which do not use any personal information. However, various factors like ethnicity, age, body temperature, height, weight, heartbeat reading, oxygen level, glucose reading, blood pressure were given along with the Covid test result. I used these test results with some alterations as the data set for my model. Binary classification on Logical Regression was used to build the model using Python as Programming Language. Python scripts for Exploratory data analysis EDA-marginal and GGPLOT for EDA-pairs were used. Data was visualized using the Plotnine python package, which provides a grammar of graphics.

I would like to take this research to a further level. The goal is to extend this research to prepare a ready to use model for the local authorities to support pre-screening while an individual is doing a test during a pandemic. Along with the prediction of results for the patient to be cautious until the actual test results arrive, I wish that the new model would mark spots to keep track of the potential positive cases in a town. This would help the authorities be notified of a possible outbreak and be prepared to handle such an emergency.

# Acknowledgments

My first step into AI, Machine Learning and Data Science began with a summer course taught by MIT Alumni. I'm happy that I took this course right after my freshman year, which gave me inspiration to think and explore deep into this area of computer science.

I would like to thank all the instructors who gave me a big picture of what I can expect with data analysis. I thank CDC (data.cdc.gov) for providing the dataset (open data repositories) that was used for my research.This quality data gave accurate predictions.

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I also thank my parents for supporting me for academic success. Love you Mom and Appa!

# References

**Textbook:**

1. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani. An Introduction to Statistical Learning: with Applications in R. New York: Springer, 2013.
2. Thinkstats: Probability and Statistics for Programmers
3. Python Data Science Handbook

**Open Data Repositories: Dataset**
Data Access - Public-Use Data Files, Documentation (cdc.gov)
https://data.cdc.gov/browse?tags=covid-19

**Introduction to Statistical Learning:**
An Introduction to Statistical Learning (statlearning.com).
https://www.statlearning.com.

**Scikit Learn** – Machine Learning in Python. https://scikit-learn.org/

**Wikipedia Covid - Link :** https://en.wikipedia.org/wiki/COVID-19.