Visualization Explanation

Main Visualization: Infection Rate and Derivative of Infection Rate

The first visualization shows the change points that capture the difference in the derivative function in the time series data for changes in daily infection rate along with the timelines of masking mandate policies in Milwaukee County, Wisconsin State, USA. The purpose of this plot is to visually represent the mask policy's impact on the virus infection rate in the county. The X-axis represents the date when the data was collected, and the Y-axis represents the infection rate on that date. The infection rate is calculated using the below formula, where k = 100.

$$\frac{\text{\# of Infections}}{\text{Population at Risk}} \quad \textbf{X constant (k) = Rate of Infection}$$

The population at Risk is the susceptible population from SIR analysis – The population susceptible to infection. Considering a **recovery period of 14 days**, we calculated the recovered population and subtracted it from the cumulative cases to get the infected population. These values are then used to obtain the susceptible population, i.e., the population at Risk.

Population at Risk = Total Population - Infected - Recovered - Deaths

After calculating the infection rate, we leveraged the ruptures package, which leverages the Pelt Search method to identify and plot the change points (brown dotted lines) in the data, indicating slope changes over the infection rate. The red dashed lines show the start and end of the masking mandate in Milwaukee. The ideal way of reading the graph is first to understand the virus progression using change points at various periods and how it has brought the necessity of masking policy. Next, by looking at the post-facto lens for impact analysis, the reader must observe the masking policy dates and infer how the policy changes impact the infection rate - Change points in the data after a few time intervals post-mandate. At the 4th change point in the plot, we can observe how the masking mandate lowered the infection rate. This change shows evidence of the impact of the masking policy. From the 8th change point to the 9th, there is no considerable difference in infection rates. Hence, removing the masking policy can be attributed to the stability observed. However, at the final change point (10th), the COVID infection rate peaked. Overall, the graph gives a holistic picture of the impact of the masking policy on the infection rate using pivotal change points.

Similar to the first visual, the second visual also talks the same story but with a more detailed metric – Derivative of the infection rate on the Y-axis. We can observe that after the 4th change point post the masking mandate started, the derivate is closer to 0, indicating the change in infection rate over time is not frequent. The same pattern can be observed after removing the mandate but oscillates more at the end. Corroborating to the story the first visual tells, the derivative values superimposed with the change points also indicate that the daily change of infection rate is smoothened (closer to 0) after imposing the masking policy and the impact stayed for almost two months. The survey data collected shows a positive sentiment for mask culture, with almost 50% mentioning that they wear a mask always and only 5% saying they never wear a mask. Though it gives us the sentiment about the mask policy, we can't generalize this data for Milwaukee county as the mask mandate started on August 1st, 2020, and continued till April 1st, 2021.

Overall, it is evident from the above analysis why the enforcing and removing masking policy took place. It indicates the impact of masking on the infection rate by showing how it decelerated after the mandate was enforced and accelerated after the mandate was removed. However, a few exceptions are observed where we see peak infection rates even after the masking policy is in place. This can be attributed to the high impact of other aspects like vaccinations, recovery rates, hospitalizations

Supporting Visualizations:

Incidence Rate or Positive Per capita Plot: The plot contains the positive cases per capita rate and its progression regarding masking policy changes. From the graph, we can observe that the spread category is uncontrolled before the mask mandate is enforced (red band), indicating the necessity for a mask mandate. After the mask mandate was implemented, we noticed that the phase shifted into a controlled band (orange) and stayed for 60-time intervals (2 months). The same trend can be observed before the masking mandate end. However, the impact of removing the mandate can be seen in the subsequent 30-time intervals (1 month). This shows a clear impact of masking on Milwaukee's positive cases per capita.

Growth Factor Plot: The graph contains the growth factor and its progression regarding masking policy changes. The plot clearly shows how the GF values had died down after the mask mandate started, and the impact lasted for almost two months before it spiked again during the next wave of COVID. High growth factor values were again observed after the mask mandate was relaxed in April 2021.

Transmission Rate Plot: The third graph contains the virus transmission rate and its progression with respect to masking policy changes. In the plot, we can observe that the transmission rate decreased after the masking mandate started. This also indicates how the spread of the virus has gone down after people followed the mandate. However, the transmission rate peaked immediately after the mandate was removed but came down after a month. This can be because of the vaccination phase that started and the implementation of second doses to the mass population.