Problems with Current DHS COVID-19 Flagging Methods

Steve Goldstein, Marlin Lee, Abe Megahed, Kyllan Wunder
University of Wisconsin Data Science Institute - August, 2022

This analysis shows three issues in the Department of Health Services (DHS) wastewater and case flagging methods: (1) Missing long-term trends, (2) Flagging false positives based on noise, (3) Day-of-the-week effect.

Flagging methods

The DHS has created multiple flagging methods to warn of COVID-19 spikes in Wisconsin communities to better inform decision-making policy. We analysed the wastewater and case flagging methods.

Wastewater method

The wastewater method uses a two-step system to identify potential warning signs in the data. The core method uses a five-measurement rolling regression to calculate an estimated percent change over time. Then if it is estimated to be over 100% increase, it is logged as a CDC flag. Then if the measurement is in the 80th percentile of the last 90 days, it is logged as a flag.

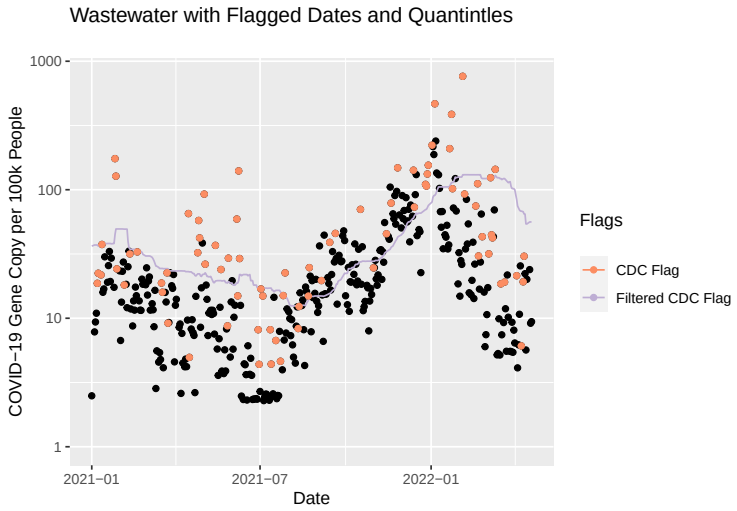

Figure 1: The red points are CDC flags using the wastewater method, and there is little to no correlation between an increase in gene copies in the wastewater and the CDC flags.

Case method

The case flagging method uses a 7-day rolling regression to create flags. If the regressed slope is over 5, it is a case flag. Because the slopes are roughly continuous, case flags often cluster. Using the slope switch flag, we can log only the first case flag in a cluster. This method is very good at detecting an increase in the slope, but if cases increase at a steady rate with a slope of less than five, it will go undetected.

Missing long-term trends

Both flagging methods rely on short-term information to detect long-term changes in the data. This inherently means a lack of confidence in the flags because there is no difference between normal fluctuation and the start of a spike in the short term.

A single case flag is suspect, but 5 case flags in a row are much more likely to represent a genuine rise in COVID-19 in the population. This confidence is not being represented in the system, hurting effectiveness.

The wastewater flagging does a better job overall than the case method due to The 90-day rolling 80th percentile filter. However, the CDC method is terrible at detecting long-term trends meaning that the filter only masks the underlying issue.

The plot to the right shows when the signal slope is decreasing more flags appear then when the slope is increasing.

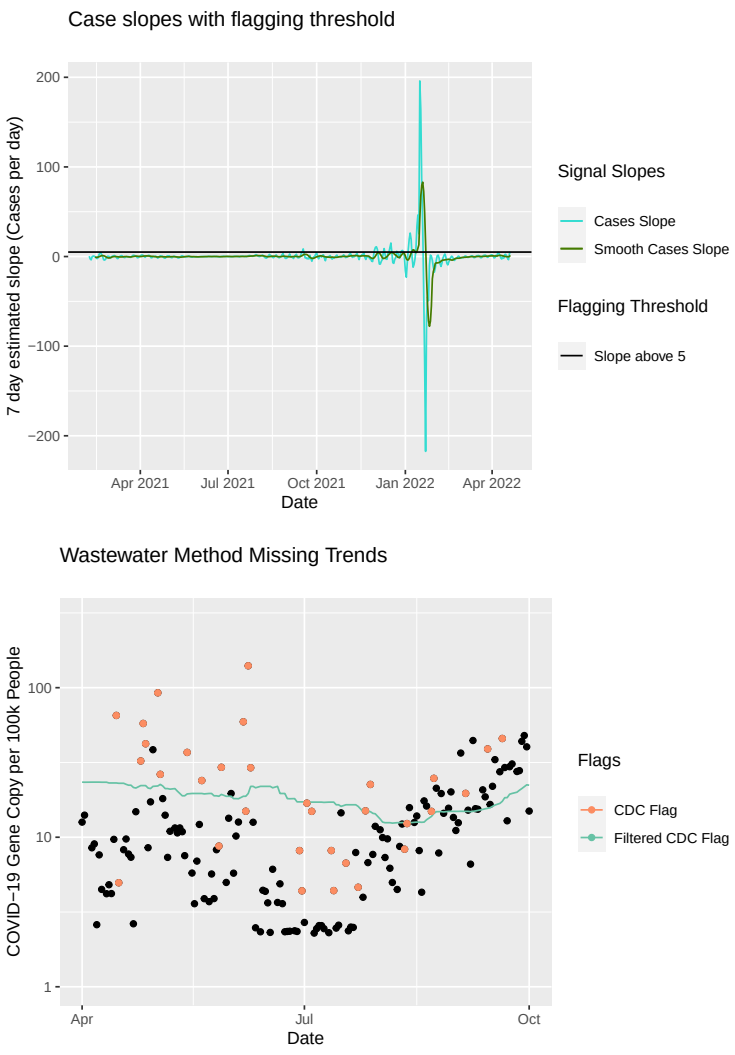

Figure 3: Zoomed-in Figure 1

Flagging false positives based on noise

COVID-19 data can be exceptionally noisy; effective flagging methods should combat this. The CDC flagging method does not account for noise leading to many points that could be considered noise or outliers being flagged because they are in the 80th percentile and increase the slope dramatically. The quantile filter helps filter some of the more notable false positives. Still, if the measurement is unusually high, it can pass the filter even if the rest of the measurements fall well below the line.

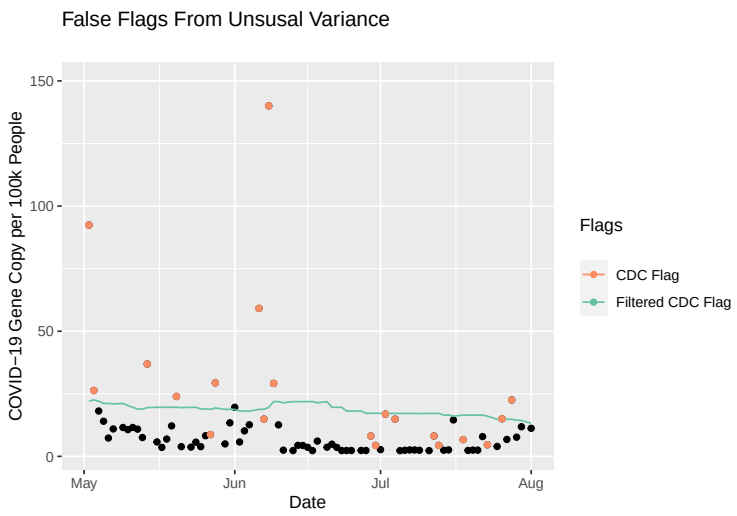

Figure 4: Zoomed-in Figure 1 showing false flags based on noise

Day-of-the-week effect

Case data is known to have a day-of-the-week effect; regardless of trends, some days have more reported cases than others. It is not immediately evident that this would affect the output of the 7-day regression, but the plot on the right clearly shows that this effect causes Friday's estimated slope to be larger. On September 17th, this effect, combined with an unusual high measurement, was labeled as a flag. A 7-day smoothing before regression or a regression window larger than seven days can remove this effect.

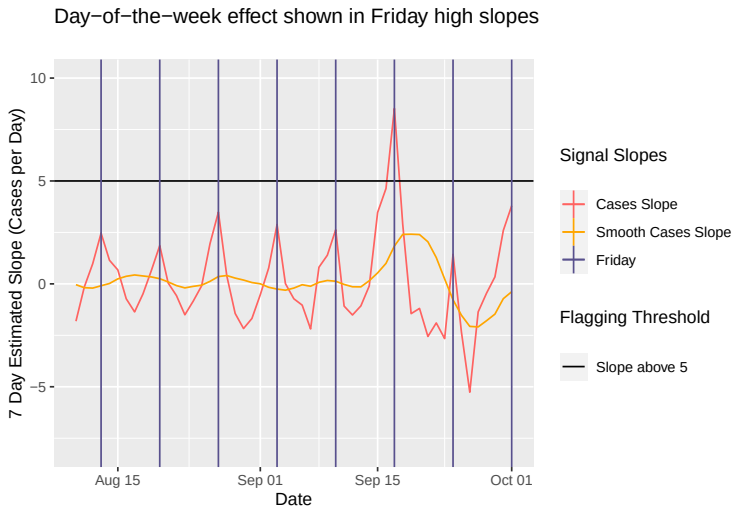

Figure 5: This plot is a zoomed-in version of the plot in the Case Method section with green lines added to highlight Friday

Conclusion

The problems described in the analysis hinder any usability these flags have in there current state. Each problem can be solved with some degree of modification. This is seen in the day of the week effect where using a 7 day mean removes the effect entirely. Looking for solutions is still an ongoing process.