Early online behavior during pandemics: why it matters for now-casting

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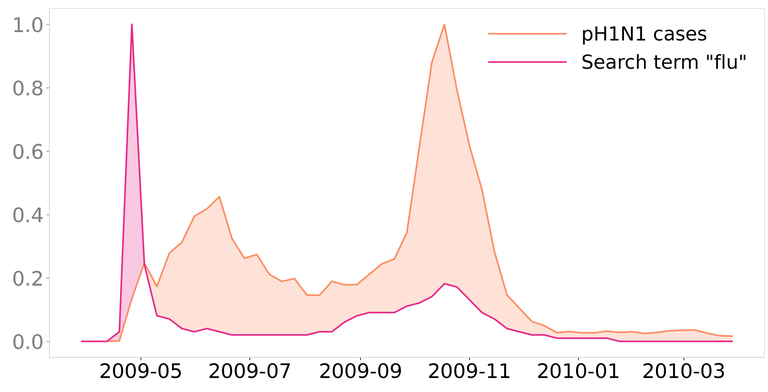
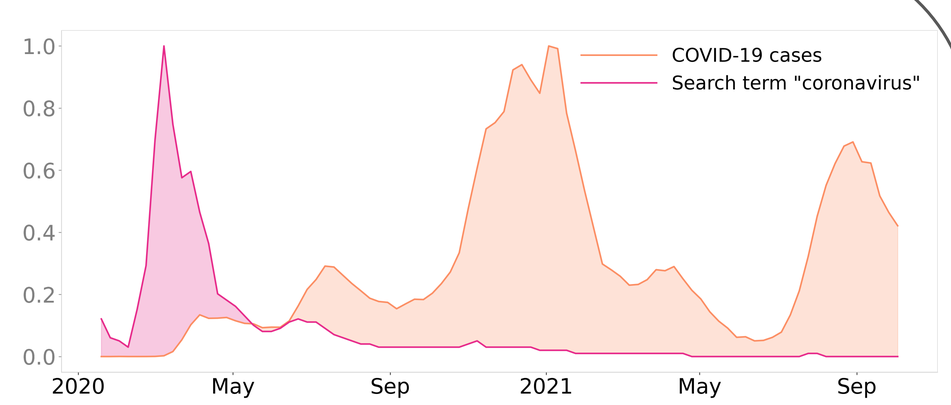
Online behavior has been used as a tool for close to real-time study of different health-related behaviors, including identifying disease outbreaks. However, its validity in predicting infections, has been questioned by many, particularly during extraordinary events, such as pandemics. Here we hypothesized that (1) **the earlier period of the pandemics could be used to disentangle between searches driven by media attention from searches driven by actual disease**. The rationale is that by having periods in which media attention and cases are decoupled, it should be possible to identify which search-terms are more sensitive to media hype. This assumes that (2) **models can be improved not necessarily by blindly increasing the size of the training dataset, but by integrating prior information**.

2009 H1N1 Pandemic

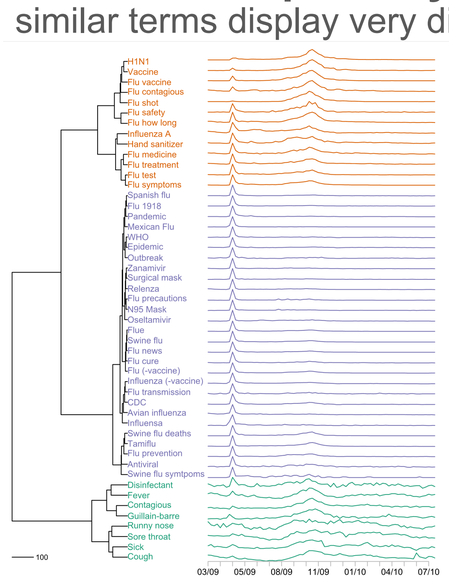


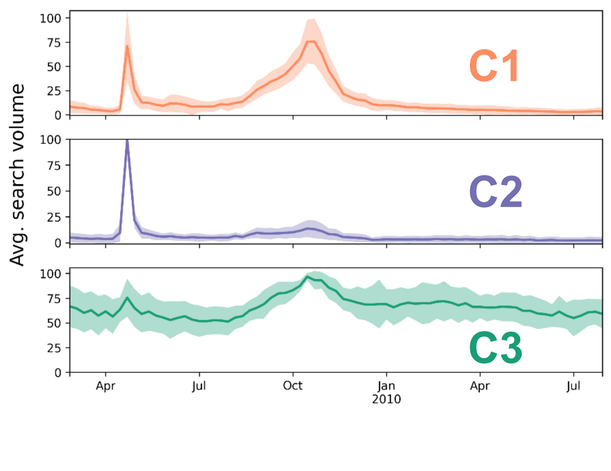
COVID-19 Pandemic



Different temporal dynamics

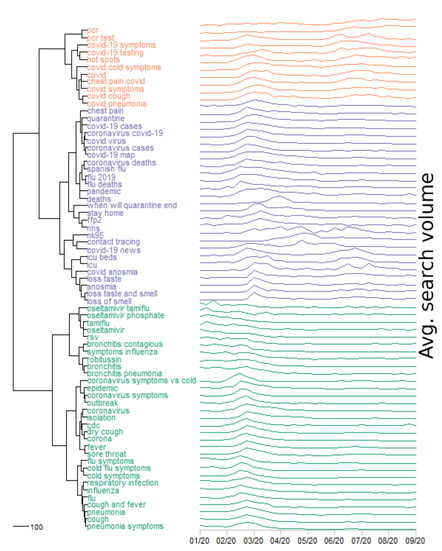
similar terms display very different temporal dynamics

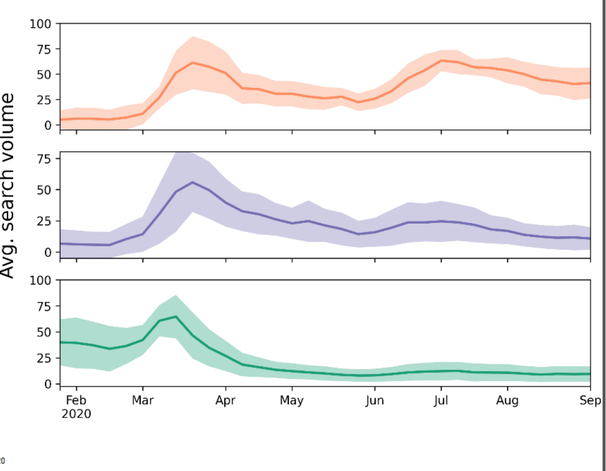




Hierarchical clustering:
3 main clusters identified

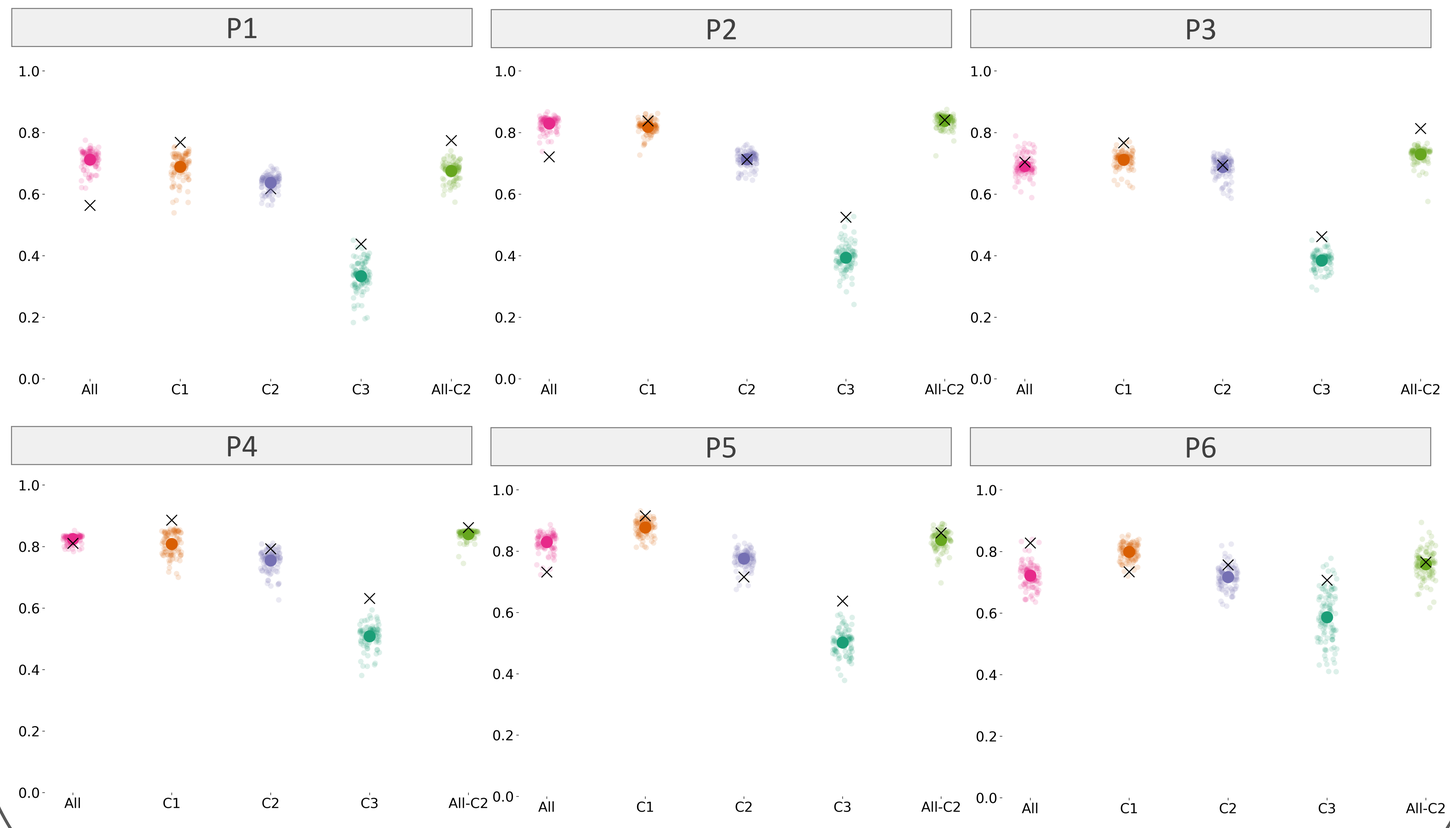
Different temporal dynamics





Models: Random Forest - RF (●) and Linear Regression - LR (x)

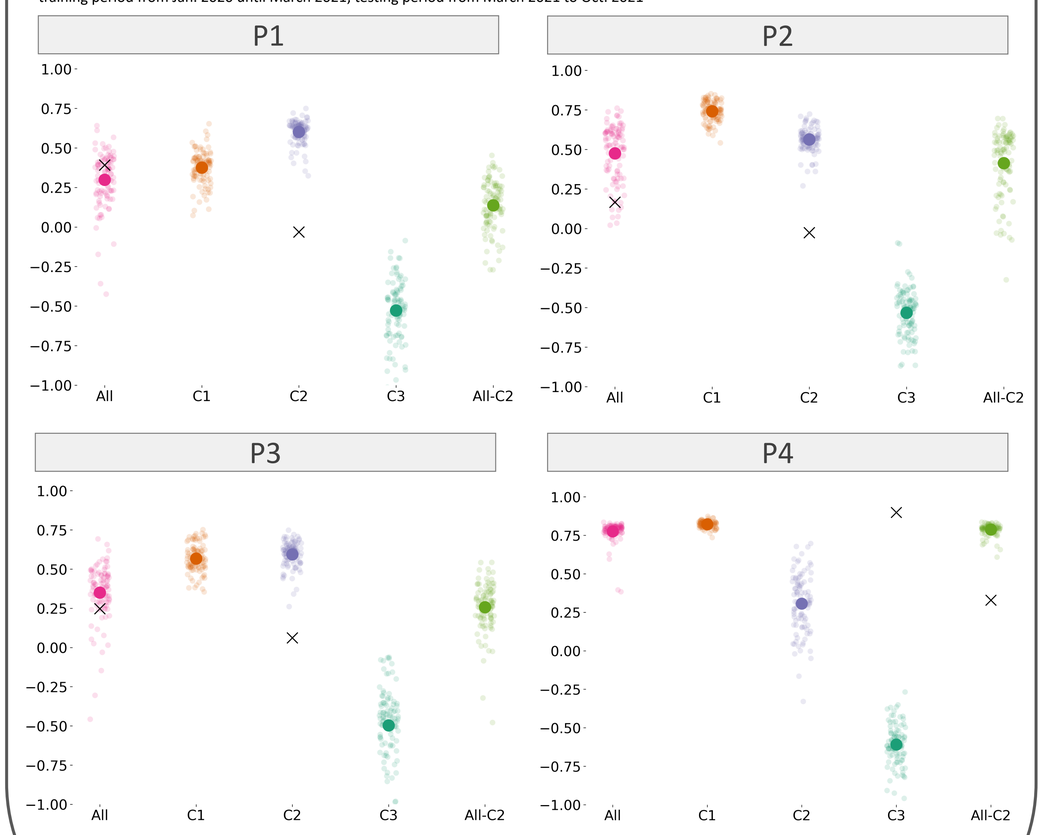
P1 - training period from 2010 to 2013; testing from 2013 to 2019; **P2 -** training period from 2010 to 2014; testing from 2014 to 2019; **P3 -** training period from 2010 to 2015; testing from 2015 to 2019; **P4** - training period from 2010 to 2016; testing from 2016 to 2019; **P5** - training period from 2010 to 2017; testing from 2017 to 2019; **P6** - training period from 2010 to 2018; testing from 2018 to 2019.



C1 consistently better over different time periods (P) than using all terms (**All**)

Models: RF(●) and LR (x)

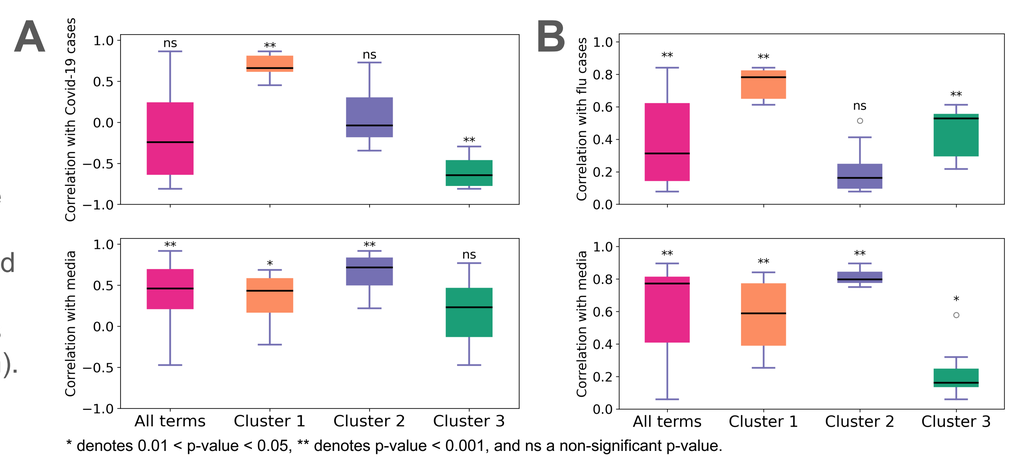
P1 - training period from Jan. 2020 to Sep. 2020; testing period from Sep 2020 to October 2021; **P2 -** training period from Jan. 2020 to Sep. 2020; testing period from Sep. 2020 to March 2021; **P3 -** training period from Jan. 2020 to Sep. 2020; testing period from Sep. 2020 to June 2021; **P4** - training period from Jan. 2020 until March 2021; testing period from March 2021 to Oct. 2021



C1 consistently better over different time periods (P) than using all terms (**All**)

Correlation with cases *vs* media

Pearson correlation between the cluster centroids and:
(**A**) H1N1 infection cases (top) and media mentions (bottom),
(**B**) SARS-CoV-2 infection cases (top) and media mentions (bottom).



* denotes 0.01 < p-value < 0.05, ** denotes p-value < 0.001, and ns a non-significant p-value.

Take home message:

We can learn from pandemics to improve now-casting of future infection waves and including more data is not necessarily better.

References

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