Assessing the accuracy of California county level COVID-19 hospitalization forecasts to inform public policy decision making

COVID Modeling Team
California Department of Public Health
CCLHO: Board of Directors Meeting
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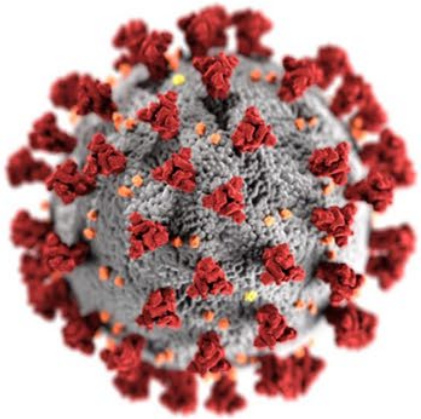
BACKGROUND

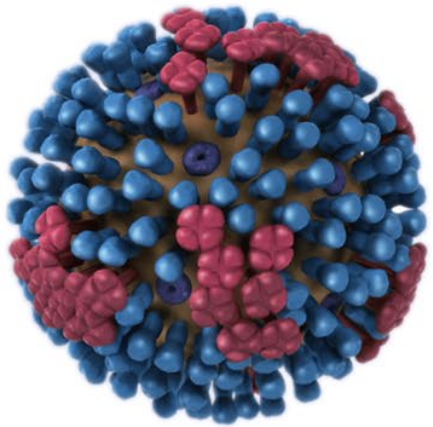
Modeling Communicable Diseases to Inform State and Local Response

COVID



How fast is COVID-19 spreading right now? What can we expect in the next 2-4 weeks?

Influenza



What can we expect for flu burden in the next 2-4 weeks?

Motivation

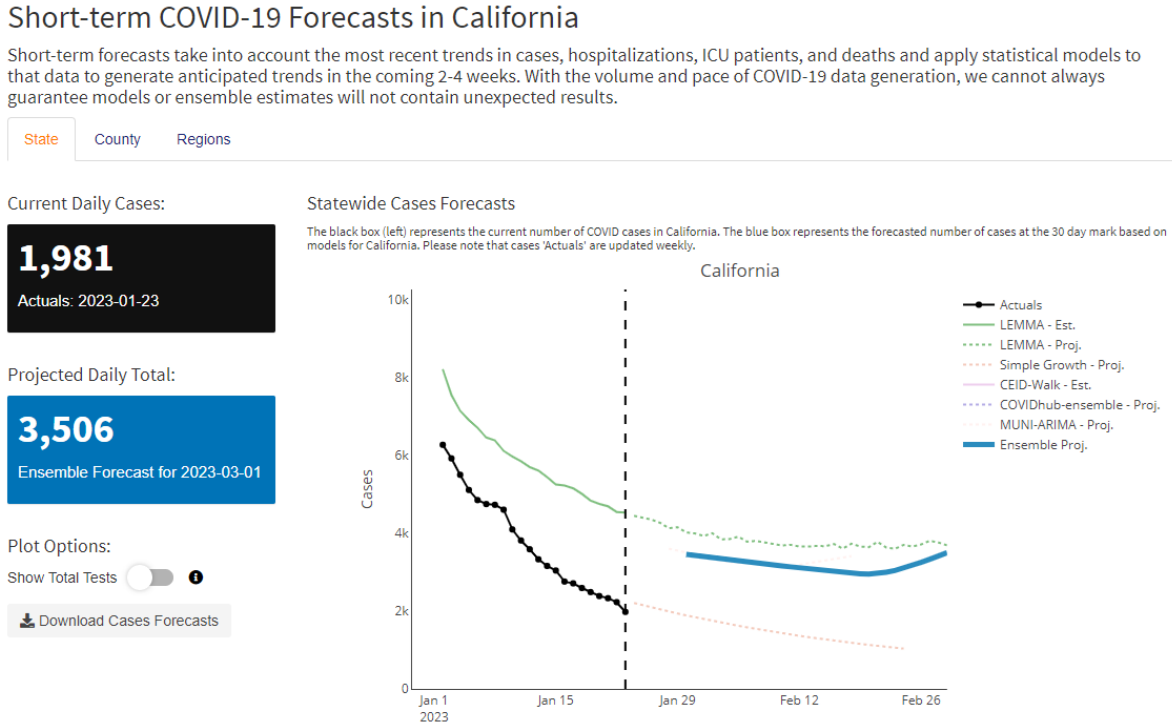
The COVID-19 pandemic has highlighted the role of infectious disease forecasting in informing public policy.

- But barriers remain:
  - Standardization of model outputs
  - Communicating model complexity and uncertainty
  - Model predictions for outcomes and scales needed by public health practitioners (e.g., county- vs. state-level forecasts)
  - Lack of validation: **Under which conditions were models reliable?**
    - How could they be improved in the future?

METHODS

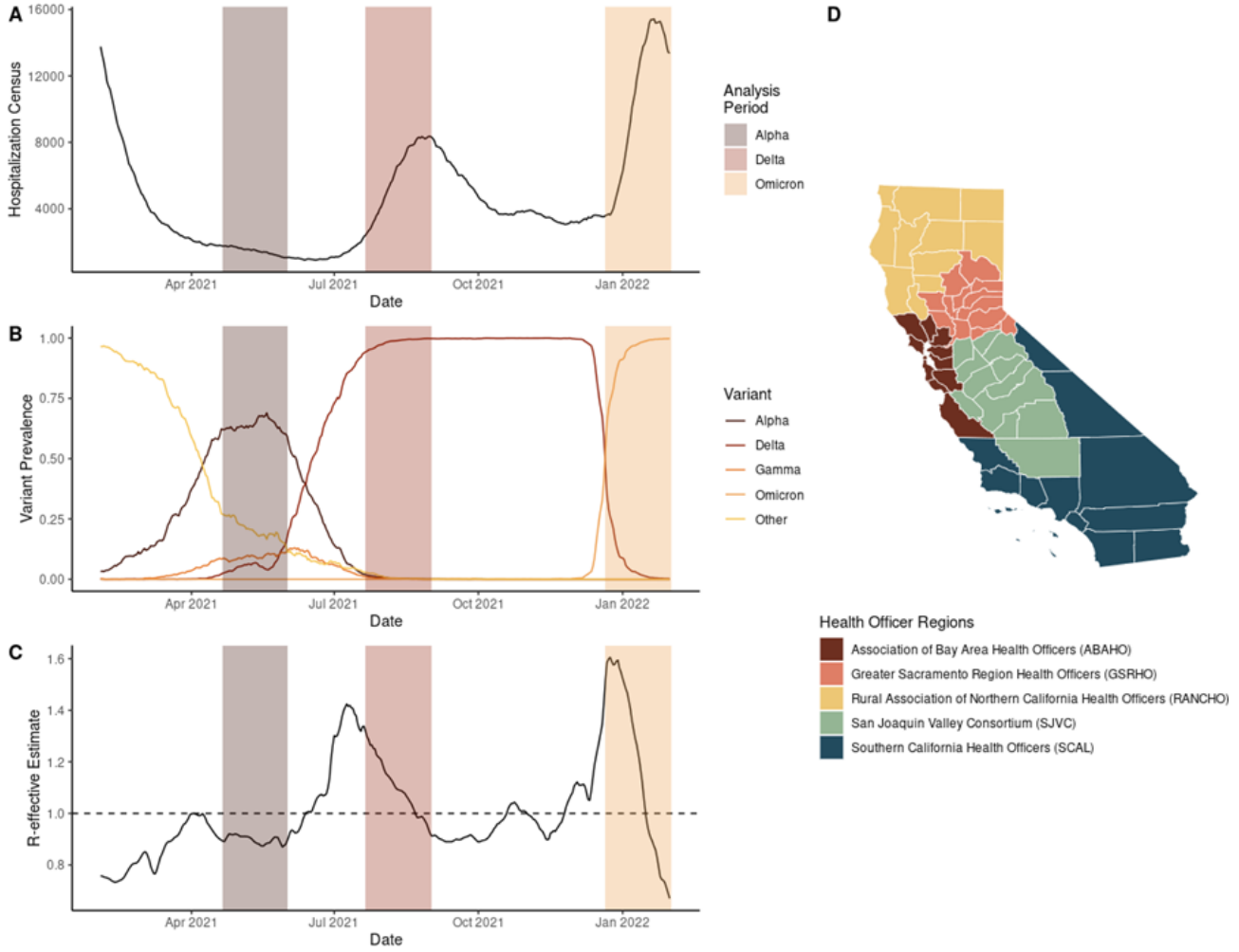
Data sources

- Forecasting predictions from archived CalCAT data: https://calcat.covid19.ca.gov/cacovidmodels/
  - Some national contributors, some only in CA
- Median (50th percentile) point estimates from forecasting models for hospital census from February 1, 2021 to February 1, 2022



Time frame and geographic scale

- Time periods of variant predominance:
  - Alpha
  - Delta
  - Omicron
- Geographic scale: CA counties and public health regions
- Evaluated different forecast horizons: 7, 14, 21 days

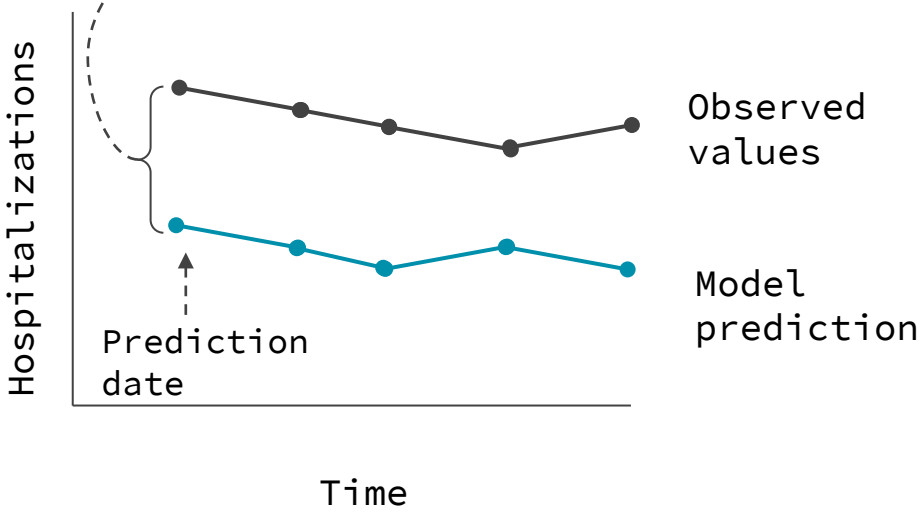


Models evaluated

Model	Forecast update frequency	Methods/Approach
Columbia	Weekly	County level metapopulation model
UCSF, COVID NearTerm	Daily	Bootstrap-based method based on an autoregressive model
UCB LEMMA	Daily	SEIR compartmental model with parameters fit using case series data of COVID-19 hospital and ICU census, hospital admissions, deaths, cases and seroprevalence
CDPH Simple Growth	Daily	Assumes new cases grow exponentially according to the rate given by the latest ensemble R-effective. Assumes a fixed severity and average length of stay to generate hospitalizations
CalCAT Ensemble	Daily	The ensemble forecast takes the median of all the forecasts available on a given date and fits a smoothed spline to the trend.
CA Baseline	Daily	Retroactive 7-day rolling average mean of past hospitalization values

Mean absolute error (MAE)

1. Absolute error$_t$= |predicted$_t$-observed$_t$|

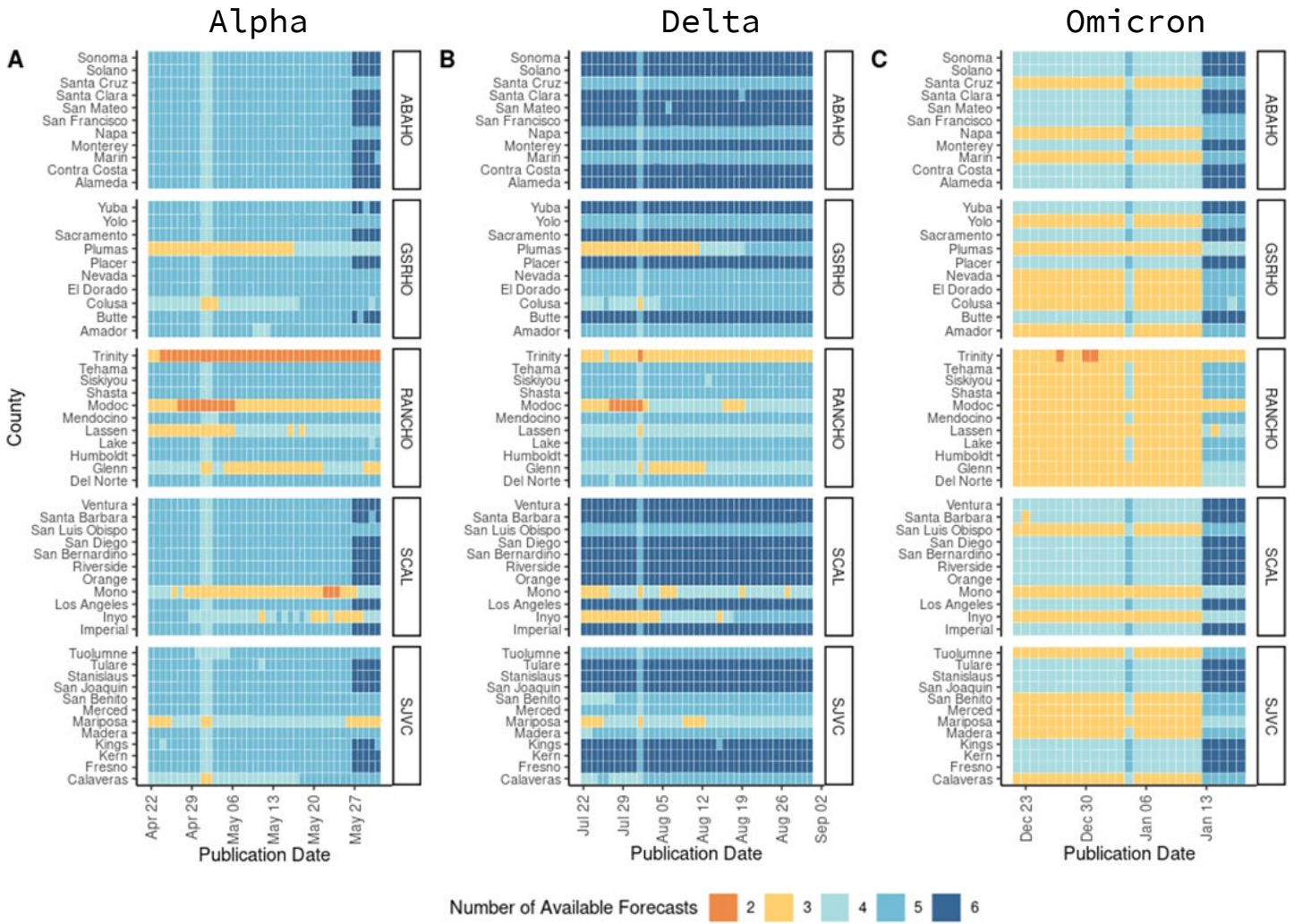


2. Mean absolute error (MAE) =

$$1/N \sum_{i=1}^{N} |y_i - \hat{y}_i|$$

3. MAE/(county or regional hospital capacity)*100

Number of forecast contributors varies by location and through time



How to control for frequency of participation? Pairwise tournament

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$$\theta_{m,m'} = median\left\{\frac{MAE(m;\ i,j,k)}{MAE(m';\ i,j,k)}\right\}$$

- Relative MAE
  - For each pair of models *m* and *m'*
  - With shared publication dates *i*, target end dates *j*, and locations *k*
  - May differ for each pair of models
  - $\theta_{m,m'}$>1 means that on average model *m* has greater error than model *m'*

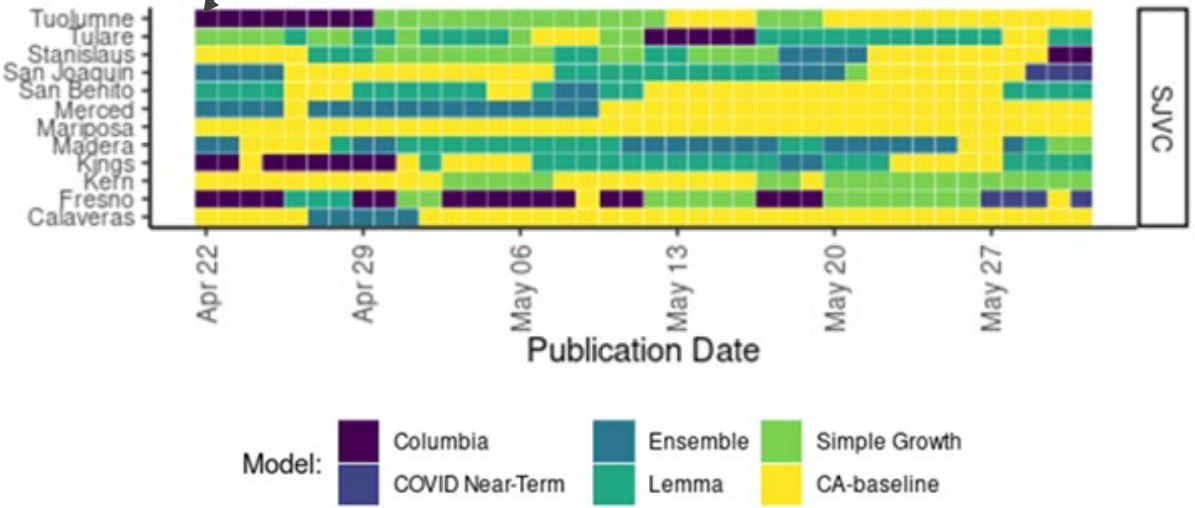
- Overall performance score
  - *M* is the total number of all models available for comparison

$$\theta_m = \left(\prod_{m'=1}^{M} \theta_{m,m'}\right)^{1/M}$$

RESULTS

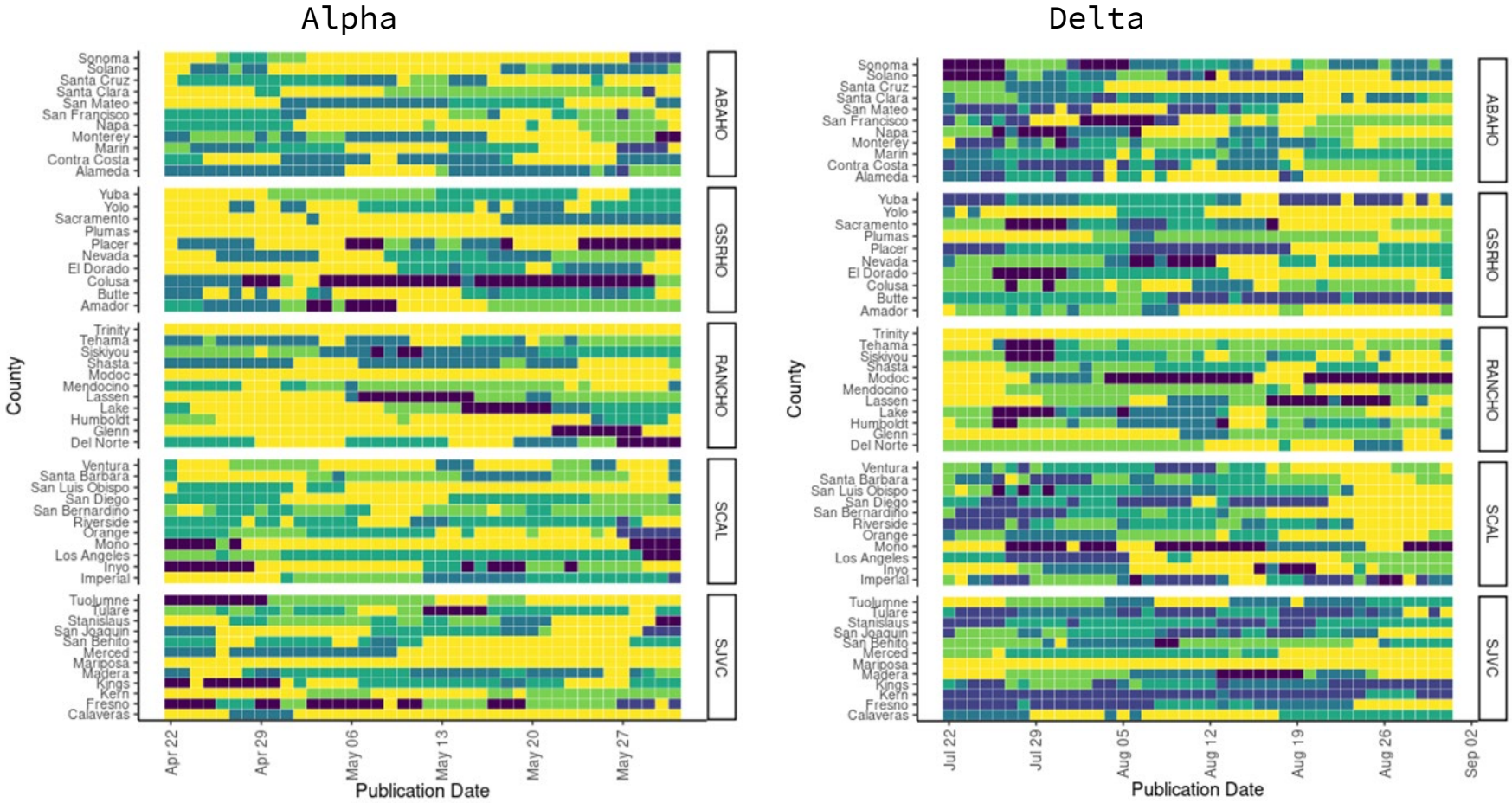
Each tile represents the "winning" model with the lowest 14-day MAE for a give forecast/publication date

County



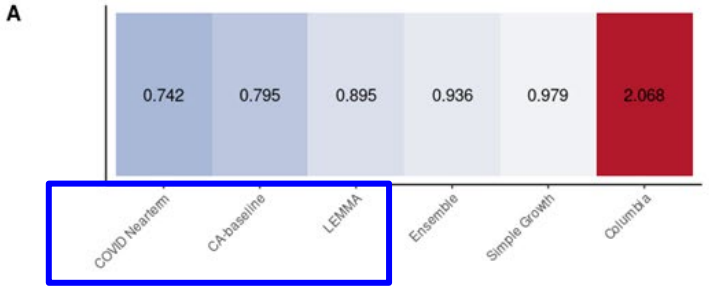
Region

Model performance varied through time, by county, and by region

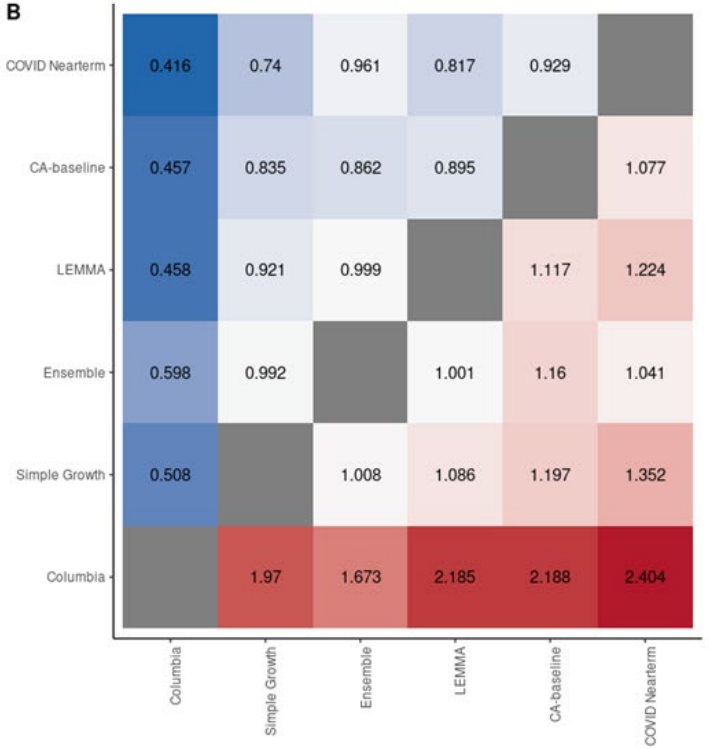


Model performance varied across locations and under different periods of variant predominance

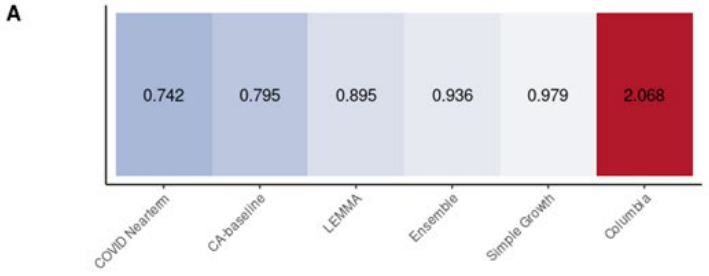
When controlling for participation, some models outperformed the ensemble.

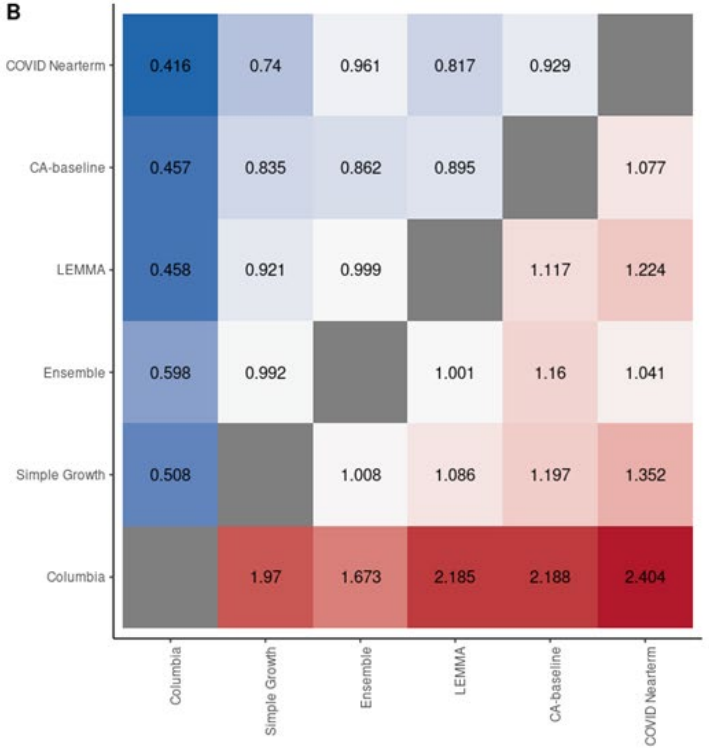


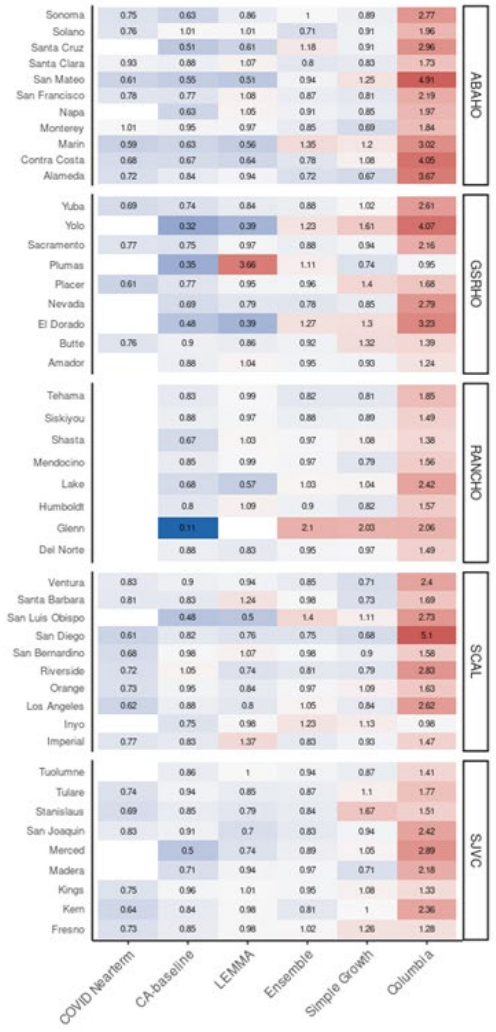
$$\theta_m = \left(\prod_{m\prime=1}^{M} \theta_{m,m\prime}\right)^{1/M}$$



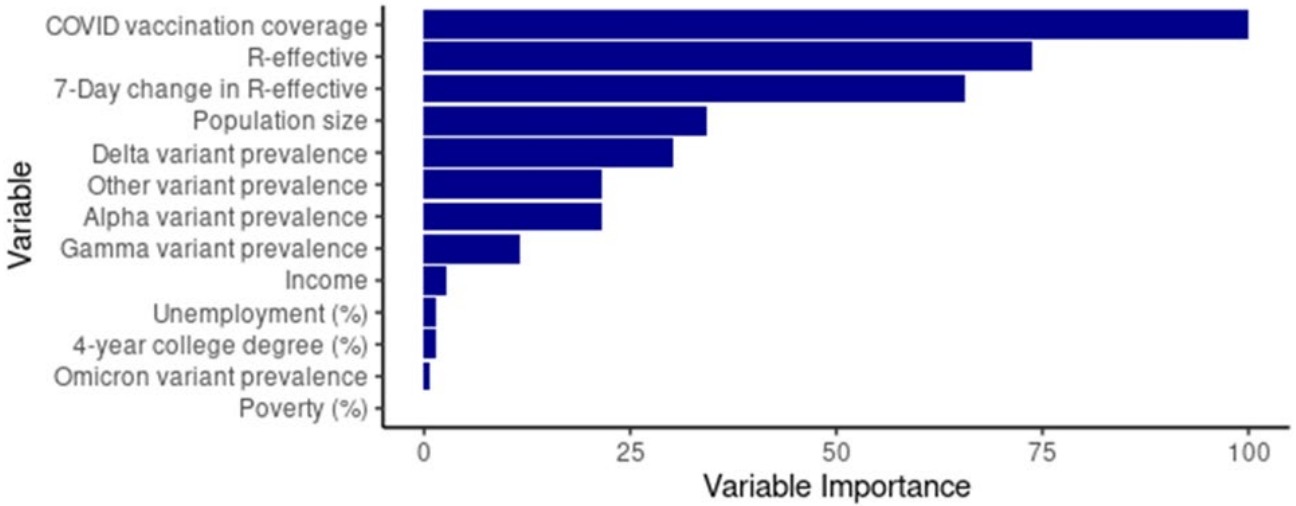
$$\theta_{m,m\prime} = median\left\{\frac{MAE(m;\ i,j,k)}{MAE(m\prime;\ i,j,k)}\right\}$$



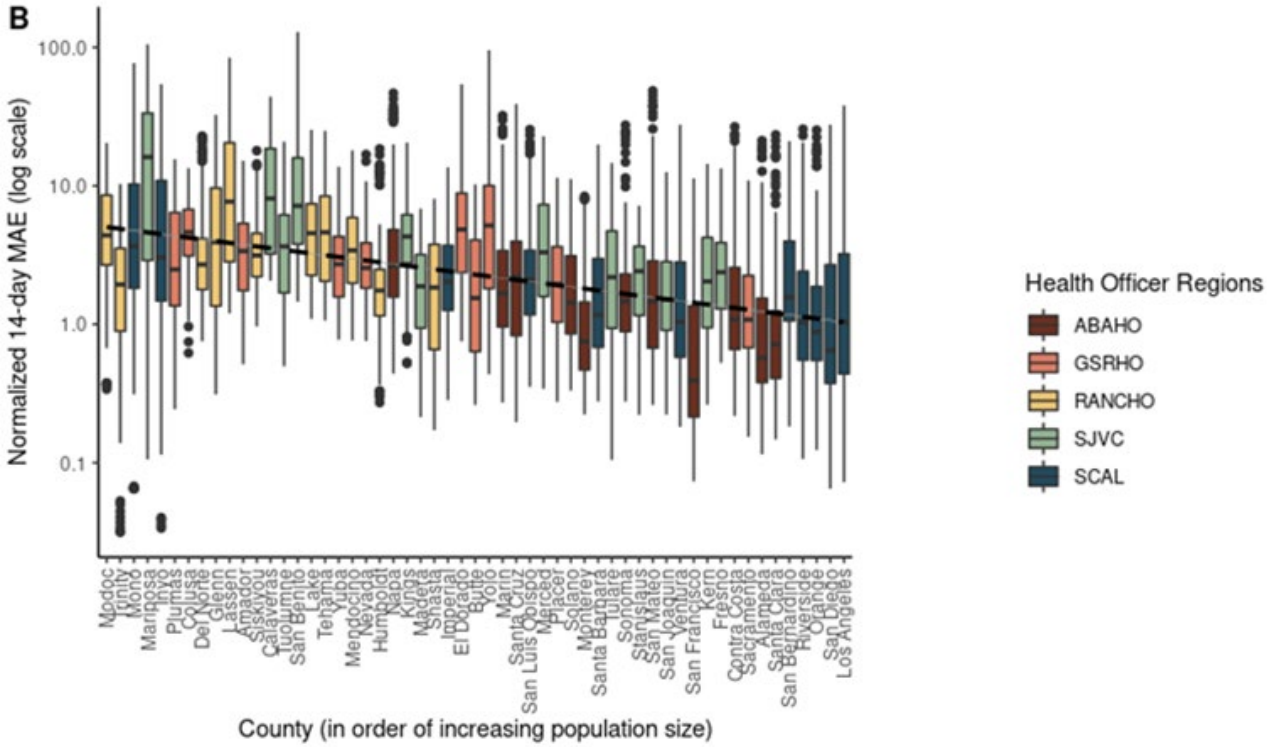




BUT pairwise model rankings varied substantially across counties.



Epidemiological traits, county population size, and variant traits best predicted forecast “winners”



Less populated counties have ensemble predictions with higher median MAE and more variable MAE

TAKEAWAYS & NEXT STEPS

Key Points

- Forecasting models performed variably across CA counties/regions and for different periods/variants of the COVID pandemic
  - Certain models consistently outperformed the ensemble when controlling for participation
  - Highlights the difficulty of making blanket recommendations for which models to use for individual counties
  - Ensemble model could be improved by incorporating geographic heterogeneity in model coverage and performance
- Counties and LHJs care about performance at their level, not at the state level
  - Lower forecast coverage in less populated counties weakens evidence-based decision making

QUESTIONS?

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L.A. White, R. McCorvie, D. Crow, S. Jain & T.M. León. Assessing the accuracy of California county level COVID-19 hospitalization forecasts to inform public policy decision making. *medRxiv* 2022.11.08.22282086; doi: https://doi.org/10.1101/2022.11.08.22282086