Covidcast: Forecasting Aids for Delphi

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Covidcast: Forecasting Aids for Delphi

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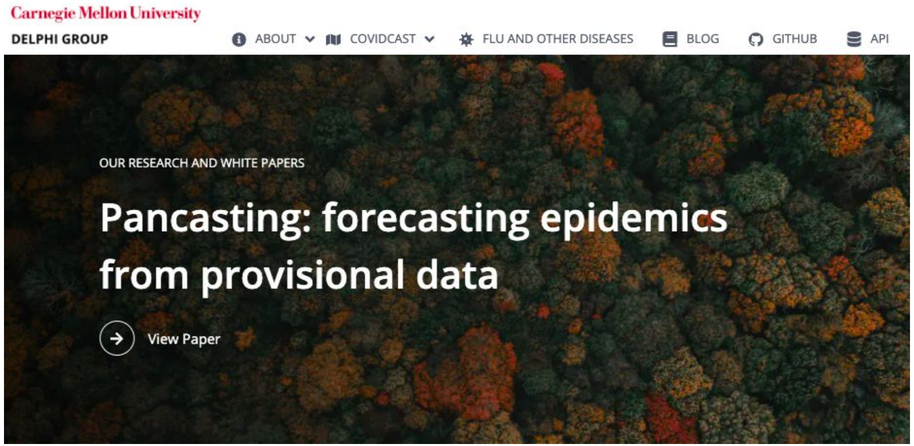
Delphi Research Group

The Delphi Research Group at Carnegie Mellon University and is **one of the two influenza forecasters in the United States**

- The group's goal is to develop the theory and practice of **epidemiological forecasting**

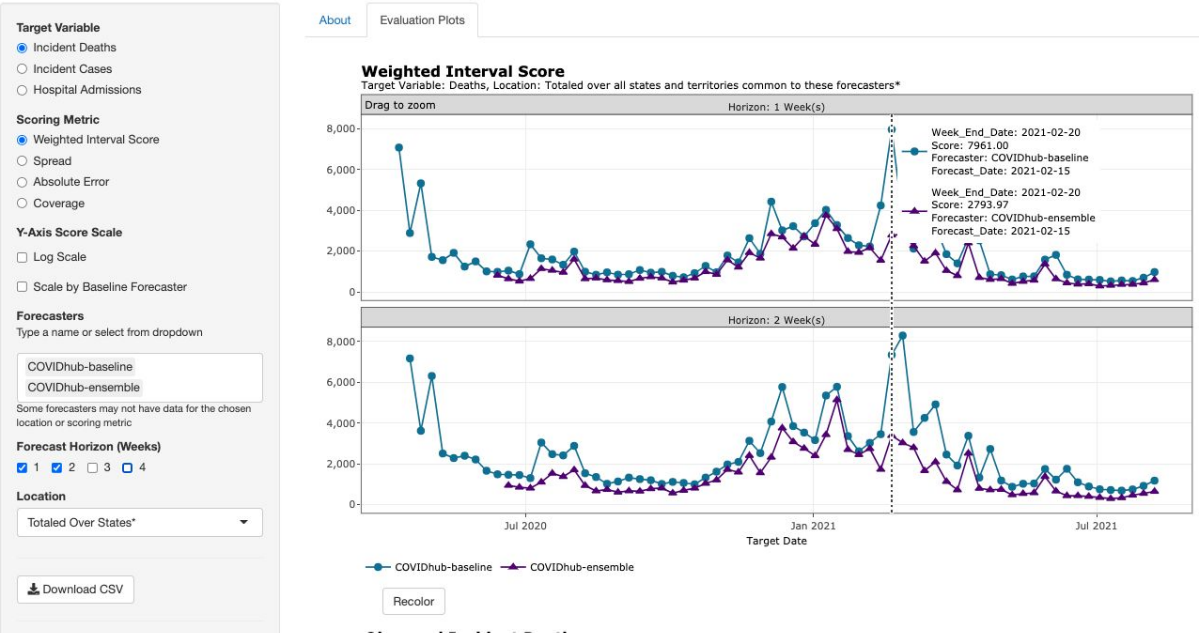
- Prior to COVID-19, the group also worked on forecasting for influenza, dengue, and norovirus



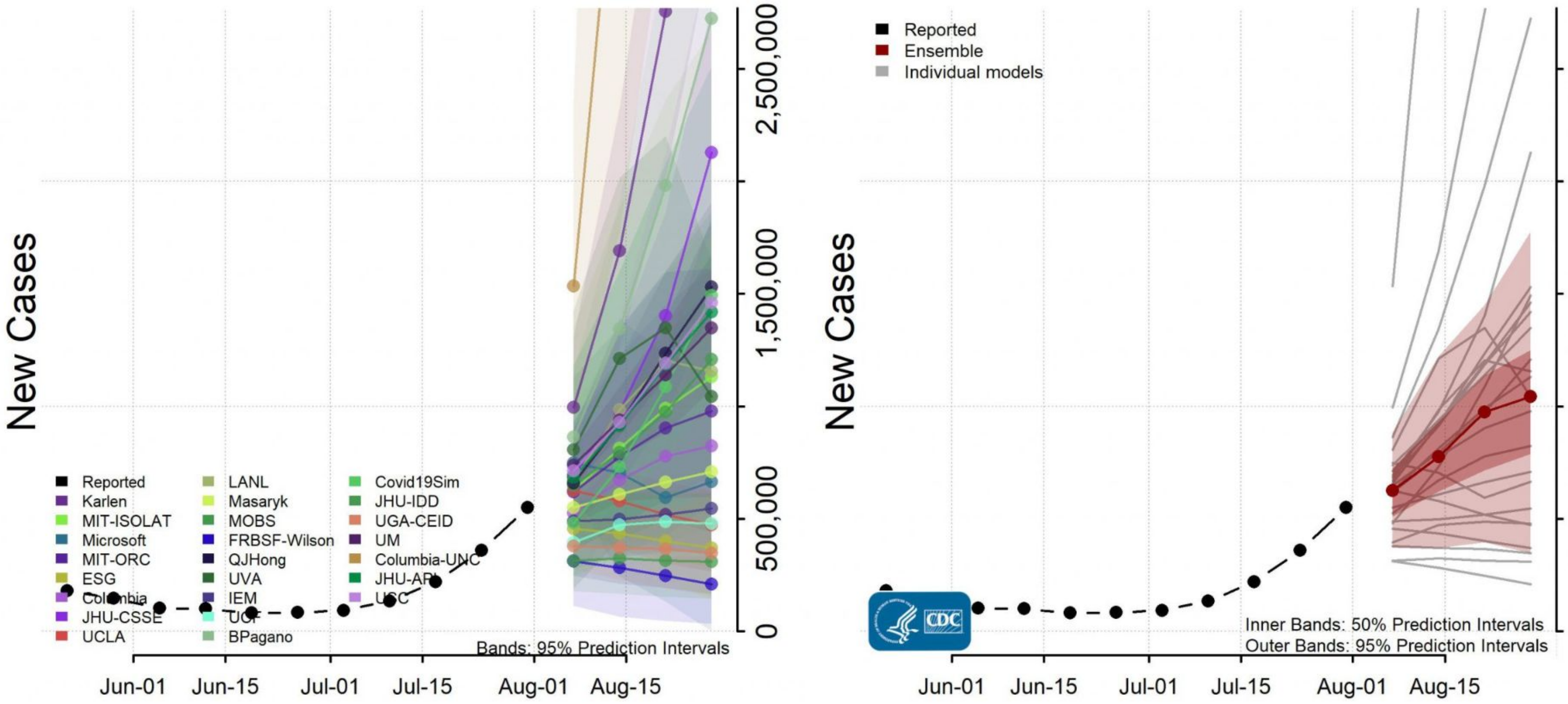
Delphi Covidcast

Since March 2020, the Delphi research group has maintained **the largest public repository of real-time indicators of COVID-19 activity**, through a public API.

Every Monday, the Delphi Covidcast generates forecasts of cumulative COVID-19 cases and deaths in the U.S. These predictions are reviewed by the team and sent to the CDC COVID-19 Forecast Hub



National Forecast

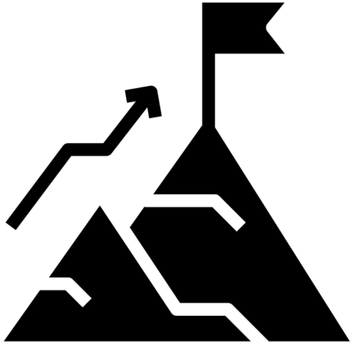


What DELPHI would like to know

- How does our (Delphi's Covidcast) forecaster do compared to others?
- Assess new forecasters before they are deployed
- Are there periods of time that we do much worse or better?
- Are there areas of improvement we need to focus on?

Our project involves the creation of a report that answers these questions

Goals & Deliverables



Our Goal

- Develop tools for comparing and evaluating COVID forecasters

Our Deliverables

- An interactive parameterized report that evaluates and compares the performance of several COVID-19 forecasters for cases, deaths, and hospitalizations
  - Along with the report, the user can download the underlying report-specific data
- The user can automatically generate a report according to their chosen parameters
  - The number of *epi-weeks ahead* that the forecasts are made
  - The specific *forecasters* to compare to
  - Whether to use a *colorblind-safe* palette for generating the plots
- A GitHub repository with fully documented code and vignettes

Outcomes of Interest & Data Sources

- **Covid-19 cases**
  Number of daily confirmed cases reported by state and local health authorities

- **Covid 19- deaths**
  Official figures of death due to COVID-19 as confirmed by health authorities

- **Covid-19 hospitalizations**
  Daily Covid-19 related hospital admissions, estimated from health authorities' aggregated statistics and patient data

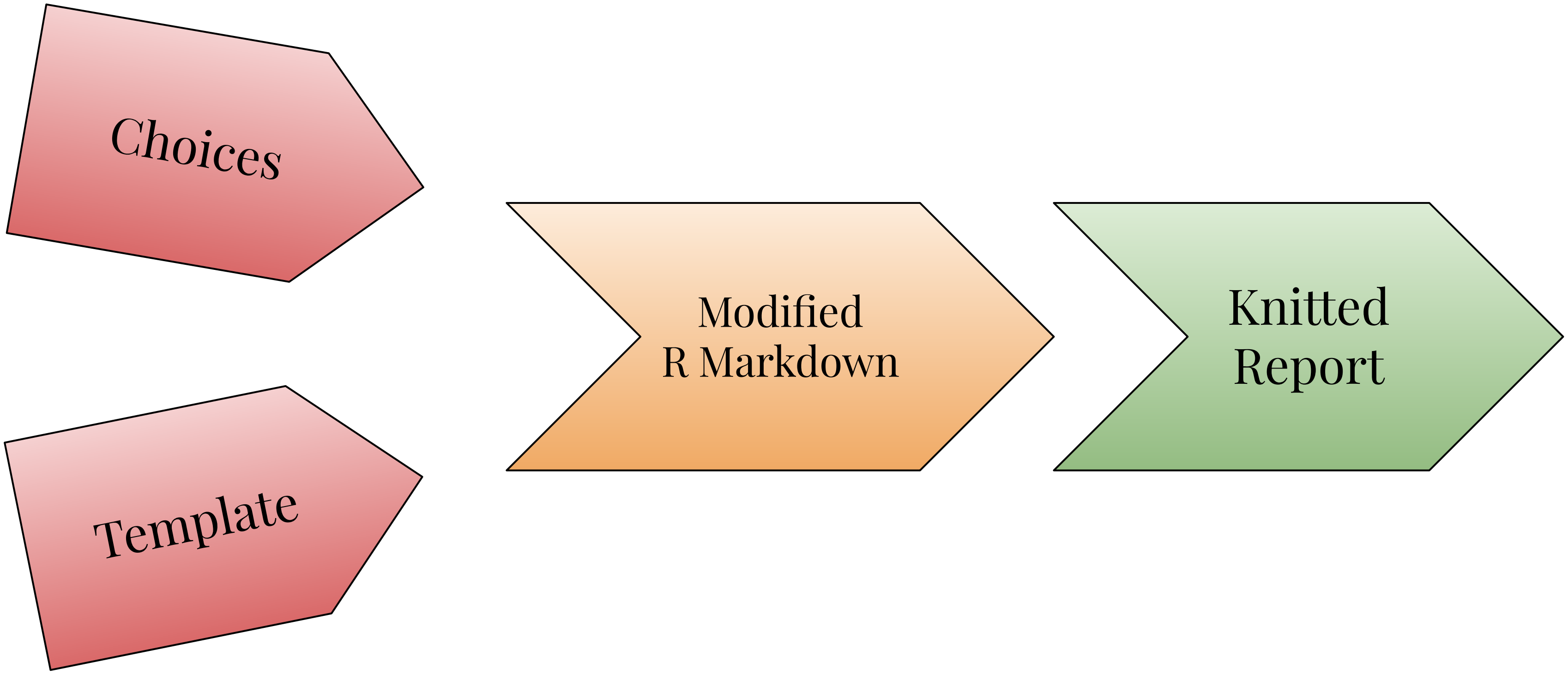
Metrics to Evaluate Forecasting Performance

- **Weighted Interval Score (WIS)**
  A proper score that combines a set of prediction interval scores. A smaller WIS indicates better performance
- **Coverage**
  An estimate of the probability that a forecaster's 80% interval correctly includes the actual value
- **Absolute Error**
  The difference between the actual value and the point forecast

Limitations of the Current Report

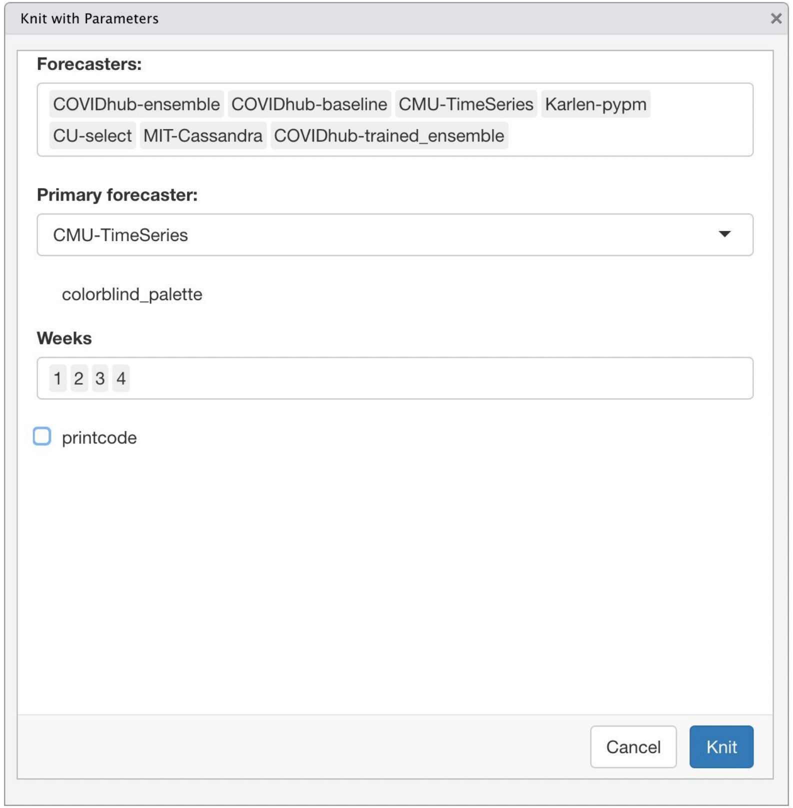
- Too specific
- API based:
  - Slow in knitting in R studio
  - Unable to run reports in case of API problems
- Unable to personalize
- Visually unappealing (many plots, colors of the graphs)

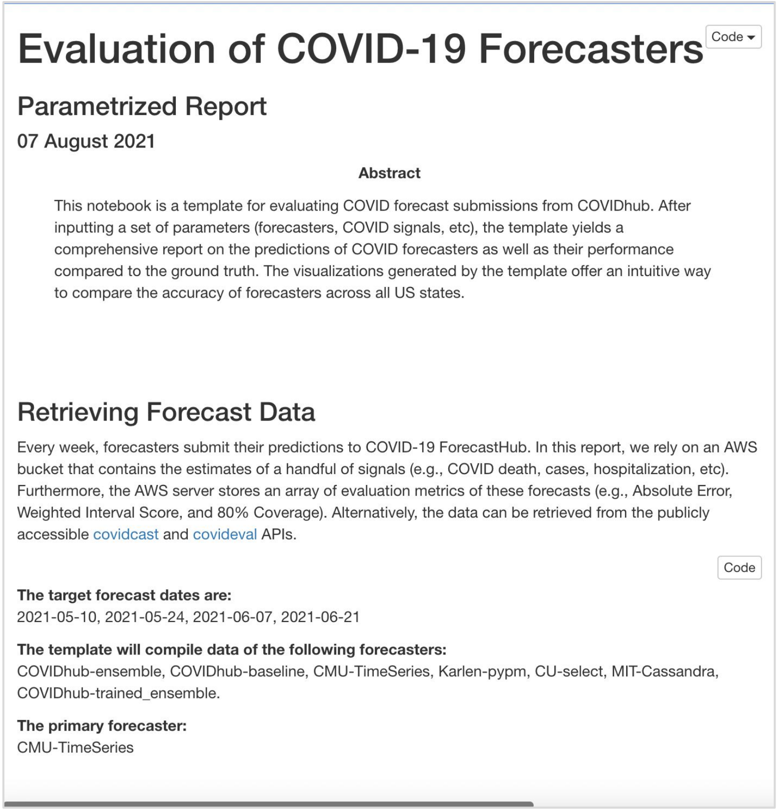
Project Architect: Generalizable Report



Functionality

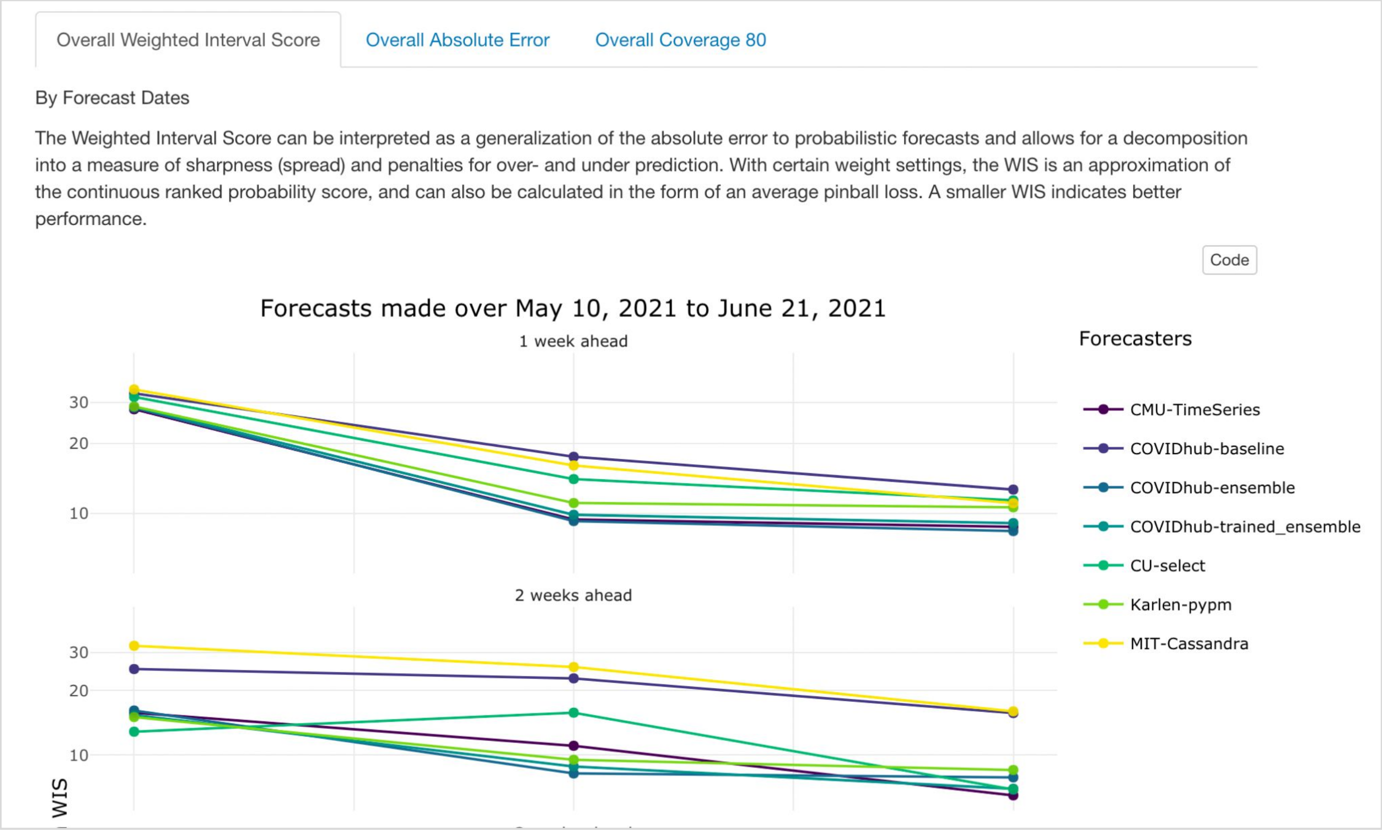
Step 1 : Generate (*cases*, *hospitalizations*, or *deaths*) report with chosen parameters





Functionality

Step 2: Explore interactive graphs in tabs



Functionality

Step 3 (optional): Download underlying data

To promote the flexibility to replicate the report, the data used in this report can be easily downloaded as a CSV file. By doing so, the user can generate customized plots or even include their own forecaster.

Code

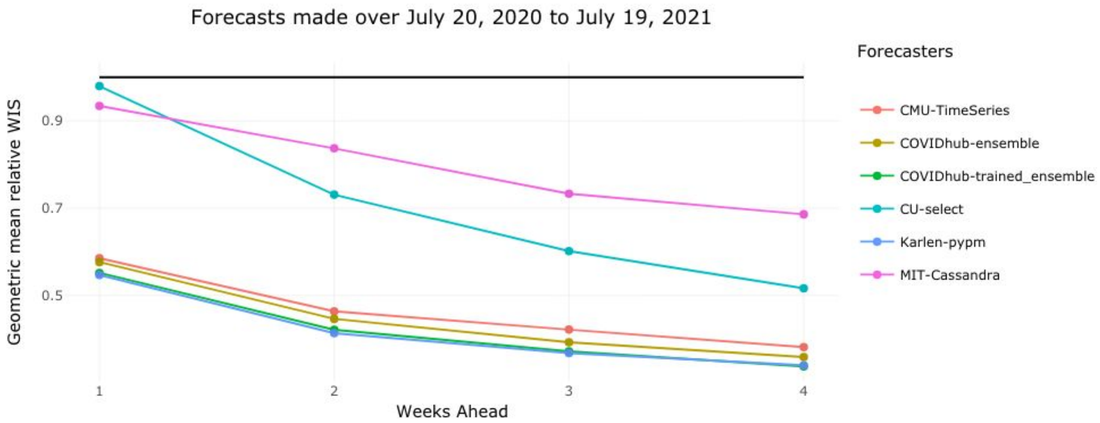
Download Predictions Evaluation

Code

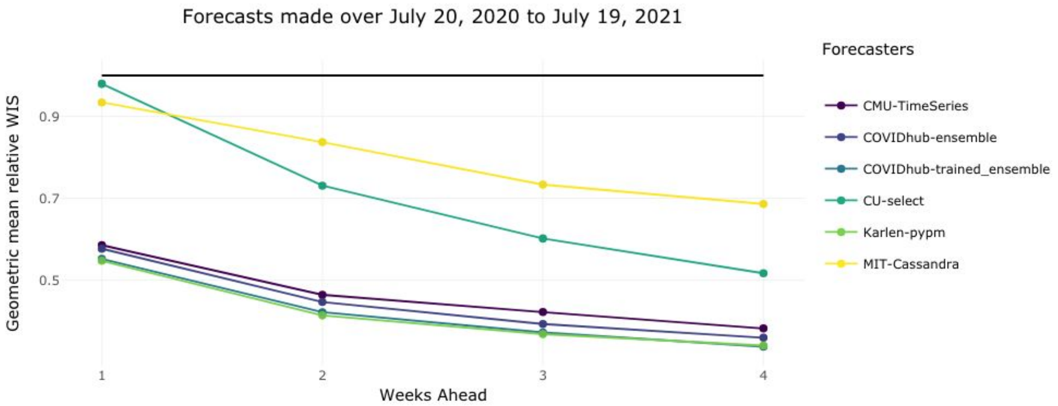
Download Raw Predictions

Colorblind-Safe Mode

Before:



After:



Identifying Discrepancies and Performances

Maps

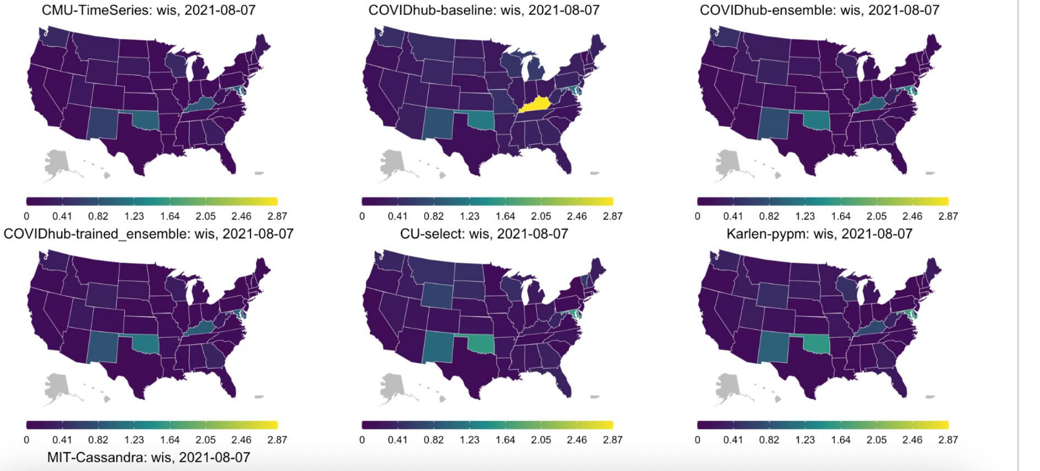
To contextualize the forecast evaluations, the following tabs illustrates the performance of COVID forecasts across all US states over forecast dates and weeks ahead. Note that the results are scaled by population.

Code

Mean Weighted Interval Score | Mean Absolute Error | Mean Coverage 80

The Weighted Interval Score can be interpreted as a generalization of the absolute error to probabilistic forecasts and allows for a decomposition into a measure of sharpness (spread) and penalties for over- and under prediction. With certain weight settings, the WIS is an approximation of the continuous ranked probability score, and can also be calculated in the form of an average pinball loss. A smaller WIS indicates better performance.

Code



A look inside...

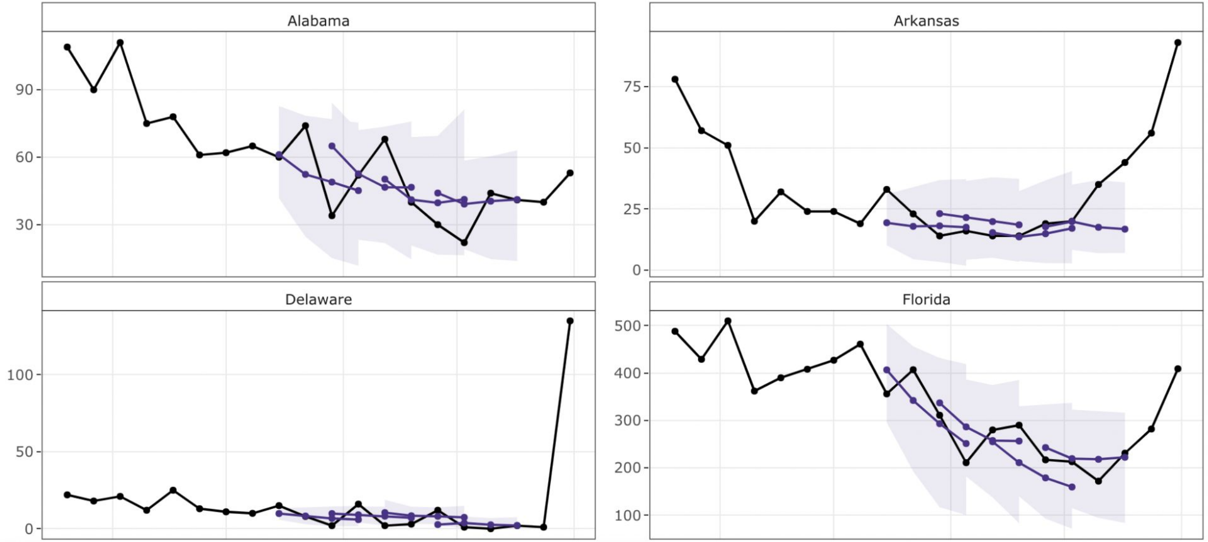
Trajectory plots

The following plots show the predictions of the **CMU-TimeSeries** forecaster along with the confidence interval for each of the US states. The forecasts project 1, 2, 3, 4 weeks ahead.

Code

South West Northeast North Central

Code



Limitations of the Original Report

1. Too specific
2. API based:
    a. Slow in knitting in R studio
    b. Unable to run reports in case of API problems
3. Unable to personalize
4. Visually unappealing (many plots, colors of the graphs)

Solutions

1. Use parameters and helper functions that can change the markdown parameters
2. Allow download of preformatted data from AWS bucket and prediction data frame (avoid API call)
3. Add better interactivity to plots
4. Organize the plots into tabs for easier navigation

Project Artifacts

- Templated markdown files
- Auxiliary R scripts for manipulating markdowns and generating reports
- Example reports
- A GitHub repository with fully documented code and vignettes

Future Directions

- Shiny app that generates the report with the click of a button
- County-specific forecaster performance
- Docker solution for batch generation of reports

Thank you to our mentors and the DELPHI team !

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DELPHI

Stanford | Data Science

Carnegie Mellon University
DELPHI GROUP