Guidance for the CDC COVID-19 ILI Forecasting Project
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Objective

The US CDC will host the COVID-19 influenza-like illness (ILI) Forecasting Project, open to all, with the goal of generating probabilistic forecasts of COVID-19 activity in the US during 2020. For each week between March 16th, 2020 through August 29, 2020, participants will be asked to provide national- and regional-level and/or state-level probabilistic forecasts for a set of specific targets related to the trajectory of ILI during the COVID-19 outbreak.

Eligibility

All are welcome to participate in this collaborative challenge, including individuals or teams that have not participated in previous CDC forecasting challenges. Teams do not need to provide forecasts for all locations or targets to participate in the project.

Overview

Information on outpatient visits to health care providers for influenza-like illness (ILI) is collected through the U.S. Outpatient Influenza-like Illness Surveillance Network (ILINet). For this system, ILI is defined as fever (temperature of 100°F [37.8°C] or greater) and a cough and/or a sore throat without a known cause other than influenza. Because testing for COVID-19 will not be possible at the time of presentation, possible COVID-19 ILI cases would be considered ILI for the purposes of ILINet. The ILINet data comprises data on outpatient doctors office visits at sentinel sites. The ILI % referred to below is the percent of these outpatient visits where the primary complaint is for ILI. During the COVID-19 outbreak in the US, it is anticipated that the ILINet system will serve as an important source of information about the trajectory of the outbreak and the degree to which symptomatic cases of COVID-19 are driving outpatient visits for care. More info on ILINet can be found here: https://www.cdc.gov/flu/weekly/overview.htm.

Regional and national level ILI are reported as population-weighted ILI (sometimes referred to as wILI), i.e. as weighted averages of state-level ILI values. Initially reported ILI and wILI values are revised and updated in subsequent releases of ILINet data. Detailed explorations of data revisions and the impact of revisions on forecast accuracy have been described in other work. Specific versions of ILINet data (i.e., the data as it was available from ILINet at a specific date) are available from the Delphi EpiData API.

Communication about this project will be disseminated via a Google Group.

Throughout this description, and in the templates, we use the standard definition of "epidemic weeks" (EW) or "MMWR weeks", as defined by the CDC and other public health agencies. There are standard software packages to convert from dates to epidemic weeks and vice versa. E.g. MMWRweek for R and pymmwr and epiweeks for python.

This template defines a set of targets relative to the time series of observed ILI % as reported by ILINet. The targets are described in greater detail below in the Target Details section. In brief, the targets are:

- 1- through 6-week ahead ILI percentages
- "Below baseline for 3 weeks"

  A binary target indicating whether or not ILI% will be below baseline levels between March 1 (2020-EW10) and August 29 (2020-EW35) and stay below for at least 3 consecutive weeks (National and HHS Regions only). Note that the consecutive weeks could extend beyond 2020-EW35.
- "First week below baseline"

  Conditional on offset occuring, the first week that ILI% is below baseline levels between March 1 (2020-EW10) and August 29 (2020-EW35) and stays below baseline for at least 3 consecutive weeks (to include the first week) (National and HHS Regions only).
- "Peak height"

  The highest ILI % observed within the range of 2020-EW10 and 2020-EW35. The peak is defined as the highest ILI value observed within these weeks for a given location. If a distinct peak occurs early in the specified weeks, project organizers may "reset" the time-frame to allow for teams to forecast a second peak.
- "Peak week"

  The week of the first ILI peak between 2020-EW10 and 2020-EW35. The peak is defined as the highest ILI value observed within the given time-range. If an early distinct peak occurs, project organizers may "reset" the time to allow for teams to forecast a second peak.

Forecasts may be provided for any of these locations: National level, HHS Regions, and US states and certain jurisdictions and territories. As many decisions are made on local scales, state-level forecasts may hold the most operational value.

Forecasts should be submitted on Mondays by 11:59pm ET, but the first forecast deadline will be extended until 11:59pm ET Thursday, March 19. Teams may start submitting forecasts at any time during the project time-period, although early participation is encouraged. We have provided a table showing the dates on which ILINet data will be released (typically Fridays), when forecasts will be due (typically Mondays, with a few exceptions for holidays), and, for each forecast date, which weeks the "week-ahead" targets should correspond to. For complete

instructions on submitting forecasts, please see the Template and formatting details section below.

Ground truth determination: The final observed target values for eventual forecast evaluation will be determined by the reported data in ILINet as of 5 weeks after the last week that may affect any of the targets. (This date specification is subject to change or revision.)

Target details

1- through 6-week-ahead ILI%

- Type of target: continuous
- Description: The reported %ILI for {1, 2, 3, 4, 5,6} week(s) after the most recently released ILINet data. Please see the dates table for exact information on which EW week each target should refer to.
- Units: percent, a real number in [0, 100]
- Bin boundaries: {0, 0.1, 0.2, 0.3, …., 24.9, 25.0, 100}, lower bound inclusive, upper bound not inclusive except for at 100.
- Notes: Unlike in the FluSight challenge, we will not round values. Therefore a reported ILI value of 3.46 would be determined to fall in the bin of [3.4, 3.5).

Below baseline for 3 weeks

- Type of target: binary
- Description: A binary target indicating the probability that ILI% decreases below location-specific baseline levels between 2020-EW10 (start date March 1) and 2020-EW35 (start date August 23) and stay below baseline for at least 3 consecutive weeks. (National and HHS Regions only)
- Units: probability

First week below baseline

- Type of target: date
- Description: Conditional on ILI dropping below baseline for more than 3 weeks, this target describes the first week that ILI% would be below baseline levels between 2020-EW10 and 2020-EW35 and stay below baseline for at least 3 consecutive weeks. If the ILI drops below baseline for the first time in late August, weeks in early September could count towards the 3 consecutive weeks. If a team predicts that there is zero probability of ILI going below baseline for three weeks, then this target can be omitted. This target applies to the National and HHS Region levels only, as ILI baselines are not defined for states.
- Units: week
- Categories/bins: Point predictions and categories for probabilistic distributions will be represented by an unambiguous notation for epidemic weeks (e.g., “2020-EW33”). The set of valid values for this target are therefore {“2020-EW10”, “2020-EW13”, …, “2020-EW34”, “2020-EW35”}. Probabilities associated with EWs should add to 1, they

are interpreted as probabilities of the first week below baseline, conditional on the ILI being below baseline for at least 3 consecutive weeks.

- Notes:
    - Unlike in the FluSight challenge, ILI% values will not be rounded before determining the first week below baseline. Therefore, if the baseline for a given region is 3.2 and a week has a reported ILI value of 3.16, this week would be determined as being "below baseline".
    - ILINet baseline values for the US and each HHS region are available at http://www.cdc.gov/flu/weekly/overview.htm. Baseline ILI% values for past seasons in a machine-readable format can be found at https://github.com/cdcepi/FluSight-forecasts/blob/master/wILI_Baseline.csv.

Peak week

- Type of target: date
- Description: This target captures information about the epidemic week (defined using MMWR week standards) in which the reported ILI % for a given location will achieve its highest value between the 2020-EW10 (start date March 1, 2020) and 2020-EW35 (start date August 23, 2020).
- Units: week
- Categories/bins: Point predictions and categories for probabilistic distributions will be represented by an unambiguous notation for epidemic weeks (e.g., "2020-EW33"). The set of valid values for this target are therefore {"2020-EW10", "2020-EW13", …, "2020-EW34", "2020-EW35"}.
- Notes: Unlike the FluSight challenge, we will not round values before determining the peak week. Therefore, if the two highest reported ILI values for a given location are 10.47 in EW 20 and 10.54 in EW42, this would result in the determination that EW42 is the peak week.

Peak ILI%

- Type of target: continuous
- Description: This target contains information about peak value of ILI% observed in a given location between the 2020-EW10 (start date March 1, 2020) and 2020-EW35 (start date August 23, 2020).
- Units: percent, a real number in [0, 100]
- Bin boundaries: {0, 0.1, 0.2, 0.3, …., 24.9, 25.0, 100}, lower bound inclusive, upper bound not inclusive except for at 100.
- Notes: Unlike the FluSight challenge, we will not round values. Therefore, if the highest reported ILI value for a given location is 13.46, the peak would be determined to fall in the bin of [13.4, 13.5).

Template and data formatting details

Teams and models

Teams interested in participating in the CDC COVID-19 ILI Forecasting Project can submit forecasts from multiple models. Teams are encouraged to provide forecasts for locations and targets for which they feel their models are well-suited. Prior to the first submission for a given model, the submitting team must provide a metadata file with structured information about the model. Each submitting team must choose a full name and an abbreviation for both their team and their model to uniquely identify their submissions.

The metadata file for each model must be named `metadata-[teamabbr]-[modelabbr].txt` and include the following information:

- team name
- team abbreviation for submission files (<20 characters preferred, not strictly enforced; alpha-numeric and underscores only, no spaces)
- model name
- model abbreviation (<20 characters preferred, not strictly enforced; alpha-numeric and underscores only, no spaces)
- model contributors, main point of contact(s) should have an email specified
- brief description of each data source
- whether or not the model itself is a type of ensemble model
- brief list of interventions included in model construction
- methodological description, including citations if appropriate.

An example metadata file is provided.

Forecast file format

In what follows, we refer to a "forecast" as a collection of quantitative predictions that are specific to a location and target specified above. One forecast can be submitted for a given model on or before the forecast "due date" specified in the dates table. A forecast consists of a single plain-text file, in a particular format, that encapsulates the set of predictions for all or a subset of locations and targets.

A forecast may be submitted using either the template for state forecasts or the template for national and regional forecasts, details of which are provided below. In general, a prediction for a specific location and target will be specified by point forecasts and a binned representation of a probability distribution. We will refer to these two representations as "point forecasts" and "bin forecasts".

Forecasts should provide probabilistic forecasts (i.e., 50% peak will occur on week 2; 30% chance on week 3, etc...) as well as point predictions for each target. The probabilities for each single probabilistic prediction should be non-negative and sum to 1. If the sum is greater than 0.9 and less than 1.1, the probabilities will be normalized to 1.0. If any probability is negative or the sum is outside of the 0.9-1.1 range, the forecast will be discarded.

Here is a data dictionary describing the columns in the forecast template:

- location: location code for the prediction
- target: target for the prediction
- type: the type of prediction, should be either “point” or “sample”
- bin: the lower bound of the “bin” of the empirical distribution
- value: the actual value of the sample or point prediction

All forecasts should be structured to match either the national/regional or state template. The column structure of the template should not be modified in any way. Rows for targets or locations that have not been forecasted should be left out. Peak height and week-ahead forecasts should be given in the provided 0.1 percentage intervals labeled “bin” on the submission sheet. For example, the row with bin=3.1 represents the probability that the ILI target will eventually be observed to be in the interval [3.1, 3.2). The probability assigned to the final bin labeled 25 includes the probability of ILINet values greater than or equal to 25.0%, or in the interval [25.0, 100].

Forecast file name
A forecast submission using ILINet data through epiweek 12 submitted by John Doe University (team abbreviation: JDU) for the Deep Learning Special Sauce model (model abbreviation: DLSpecialSauce) on March 30, 2020, should be named “2020-EW12-JDU-DLSpecialSauce.csv” where 2020-EW12 is the latest week of ILINet data used in the forecast.

Forecast file storage and submission
Submitted forecasts will be stored in a public GitHub repository: https://github.com/cdcepi/COVID-19-ILI-forecasting
We request that all metadata and forecast submissions for each team will be submitted via a GitHub pull request. We will provide instructions for submitting via pull request if this process is new for a team. As a backup, teams that are unable to submit via a pull request may email their submission files to: flucontest@cdc.gov.

In the COVID-19-ILI-forecasting repository, there are two main folders for storing forecasts:
- state-forecast-data
- nation-region-forecast-data

Each of these folders will contain subfolders for each model for which forecasts are being submitted. The subfolders will follow the naming convention of `[teamabbr]-[modelabbr]`. Subfolders will contain the metadata file for that model and all submitted forecasts for that model.

For example, for the JDU team and DLSpecialSauce model for state forecasts, the metadata file would have the path:
`state-forecast-data/JDU-DLSpecialSauce/metadata-JDU-DLSpecialSauce.txt`
And the forecast using ILINet data up through 2020-EW15 would have the path:
`state-forecast-data/JDU-DLSpecialSauce/2020-EW15-JDU-DLSpecialSauce.csv`

Forecast licensing
All forecast data will be publicly available on GitHub under a Creative Commons 4.0 license. At an appropriate time, the data repository will be archived in a permanent data repository, with a DOI, to facilitate future use and citation/referencing. A collaborative academic manuscript describing this forecasting project will be coordinated by a designated representative of CDC.

Data Sources
Historical national surveillance data may be used for training and model development, and are available at http://gis.cdc.gov/grasp/fluview/fluportaldashboard.html. These data are typically updated every Friday at noon Eastern Time. The cdcfluview package for R can be used to retrieve these data automatically. In addition, an archive of historical CDC regional baselines are available.

Teams are welcome to utilize additional data beyond ILINet - additional potential data sources include but are not limited to: Carnegie Mellon University's Delphi Group's Epidata API and Health Tweets. The Epidata API includes weekly surveillance data as they were first published and in their most up-to-date version following revisions to initially published data.

Contact Info
Additional questions may be addressed to flucontest@cdc.gov.
