2020 DoD COVID-19 and ILI Forecasting Collaboration Guidelines

27 March 2020

# Introduction

The DoD is hosting a COVID-19 and Influenza-like Illness (ILI) forecasting collaboration, in concurrence with the CDC COVID-19 ILI Forecasting project, in order to provide probabilistic forecasts of the COVID-19 and ILI disease activity in the DoD population in select continental United States (CONUS) military treatment facilities (MTFs) and outside continental United States (OCONUS) locations. The collaboration will utilize ICD coded medical encounters for ILI and COVID-19, reportable medical events for COVID-19 and laboratory results for Influenza and COVID-19 provided by the Armed Forces Health Surveillance Division (AFHSD). Each week, starting March 30th, 2020, participants will provide CONUS MTF and OCONUS country-level probabilistic forecasts for specific targets related to the burden and trajectory of COVID-19 and ILI during the COVID-19 outbreak.

# Eligibility

All are welcome to participate in this challenge. Participants must complete a Defense Health Agency (DHA) Data Sharing Agreement (DSA) to receive historical data and a Memorandum of Agreement (MOA) to receive weekly datasets. All datasets will be de-identified. Participants do not need to provide forecasts for all locations or targets to participate.

# Overview

COVID-19 disease, caused by the novel 2019 coronavirus, SARS-CoV-2, was declared a pandemic by the WHO on March 11, 2020, with known global spread since January 2020. To provide insight on the burden and trajectory of COVID-19 outbreaks in DoD-relevant locations in the US and globally, AFHSD will undertake a collaborative comparison of COVID-19 and ILI medical encounter forecasts. For each week, participants will provide forecasts for 26 CONUS MTFs and 6 OCONUS countries using DoD service member and beneficiary data. The short-term targets are the percent of outpatient, MTF encounters experiencing COVID-19 or ILI one week, two weeks, three weeks, four weeks, five weeks and six weeks ahead from the week of most recently provided data. The long-term targets are offset week, peak week and peak intensity. Forecast results will be compared to the observed weekly COVID-19 and ILI percent based on data from the Defense Medical Surveillance System (DMSS).

# Forecasting Period

The forecast period will begin on Monday, March 30th, 2020 and is currently set to end on August 29, 2020. The end of the forecasting period may be altered based on the characteristics of the outbreak. Missed or late submissions will not preclude participation and participants will not be formally scored, however we ask that participants aim to be as timely as possible in their submissions to increase the utility of the results. AFHSD reserves the right to internally compare the submitted forecasts to observed values from DMSS, but forecast evaluation results will not preclude participation in the collaboration.

Forecasts should be submitted on Mondays by 11:59pm ET, but the first forecasting deadline may be extended so that teams can adjust to the novelty of the datasets and targets. Teams may start submitting forecasts at any time during the collaboration, but early participation is highly encouraged. DMSS data is usually shared with participants on Wednesdays, pending any system delays.

The final observed weekly COVID-19 and ILI target values for internal forecast evaluation will be determined by the reported DMSS data as of 6 weeks after the last week that may affect any of the targets (this date is subject to change).

# Forecasting Targets

## Short-term:

* 1 through 6-week ahead COVID-19 + ILI percentages: Level of combined COVID-19 outpatient MTF encounters and ILI encounters over total medical outpatient MTF encounters for the projected week, multiplied by 100 (combined COVID-19+ILI %).
  + Target details:
    - Type of target: continuous
    - Description: The reported COVID-19+ILI% for {1, 2, 3, 4, 5,6} week(s) after the most recently released DMSS data. Please see the dates table for exact information on which EW week each target should refer.
    - 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 COVID-19+ILI% value of 3.46 would be determined to fall in the bin of [3.4, 3.5).

## Long-term:

* 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.
  + Target details:
    - 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: Conditional on offset occurring, 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).
  + Target details:
    - 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.
    - 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 Flu challenge, COVID-19+ILI% values will not be rounded before determining the first week below baseline. Therefore, if the baseline for a given location is 3.2 and a week has a reported ILI value of 3.16, this week would be determined as being “below baseline”.
      * AFHSD will provide baseline values for each location to participants
* Peak height/Peak COVID-19+ILI Percent

The highest COVID-19+ILI% observed within the range of 2020-EW10 and 2020-EW35. The peak is defined as the highest COVID-19+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.

* + Target details:
    - Type of target: continuous
    - Description: This target contains information about the peak value of observed COVID-19+ILI% 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 Flu 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).
* Peak week

The week of the first COVID-19+ILI% peak between 2020-EW10 and 2020-EW35. The peak is defined as the highest COVID-19+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.

* + Target details:
* Type of target: date
* Description: This target captures information about the epidemic week (defined using MMWR week standards) in which the reported COVID-19+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 Flu challenge, we will not round values before determining the peak week. Therefore, if the two highest reported COVID-19+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.

# Forecasting Locations

Forecasts may be provided for any of the following 26 CONUS MTF and 6 OCONUS country locations:

**CONUS**: 28th MED GRP-ELLSWORTH AFB, 341st MED GRP-MALMSTROM, 55th MED GRP-OFFUTT, 56TH MED GRP-LUKE AFB, 60TH MED GRP-TRAVIS AFB, 75th MED GRP-HILL AFB, 88th MED GRP-WRIGHT-PATTERSON AFB, 96TH MED GRP-EGLIN AFB, 99TH MED GRP-NELLIS AFB, BLANCHFIELD ACH- FT CAMPBELL, BLISS AHC-FT HUACHUCA, BROOKE AMC-FT SAM HOUSTON, DARNALL AMC-FT HOOD, EVANS ACH-FT CARSON, FT BELVOIR-NCR, GUTHRIE AHC-FT DRUM, JAMES A LOVELL FHCC, KELLER ACH-WEST POINT, LEONARD WOOD ACH-FT LEONARD WOOD, MADIGAN AMC-JB LEWIS-MCCHORD, MARTIN ACH-FT BENNING, MUNSON AHC-FT LEAVENWORTH, NH BEAUFORT, NH JACKSONVILLE, NMC PORTSMOUTH, NMC SAN DIEGO-NAV HOSP PENDLETON, REYNOLDS AHC-FT SILL ,REYNOLDS AHC-FT SILL, WOMACK AMC-FT BRAGG

**OCONUS**: Germany, Italy, Japan, Korea, Spain, United Kingdom

Locations are mapped to the data by MTF DMISID, grouped by location name. A MTF-DMISID list CSV file is provided for participants. See ‘COVID Collaboration MTF DMISID List.csv’ for the list of DMISIDs grouped by MTF and country location name.

# DMSS Datasets and COVID-19+ILI% Definition

All participants will sign a data sharing agreement (DSA) in order to receive de-identified historical encounter data, respiratory pathogen laboratory data, aggregated historical encounter data, and a memorandum of agreement (MOA) to receive the same de-identified data elements weekly during the forecasting period. Once the DSA and MOA are in place, AFHSD will notify participants by email to download the DoD data from DoD SAFE (<https://safe.apps.mil/>), where it will be available for seven days and then automatically deleted**.** Teams already participating in the DoD Influenza Forecasting Challenge do not need to re-submit DSA or MOA, rather, only slight adjustments to the original MOA need to be reviewed and approved.

AFHSD will provide a total of 4 datasets with DMSS data for the COVID-19 and ILI Forecasting collaboration (see provided data dictionary for more dataset details):

* ILI medical encounters: line-list of all inpatient and outpatient medical encounters with an ILI-relevant ICD-10 code (for a list of ICD-10 codes, see appendix).
* COVID-19 medical encounters: line-list of all inpatient, outpatient and reportable medical event encounters with a COVID-19 relevant ICD-10 code (for a list of ICD-10 codes, see appendix).
* Total encounters: aggregated counts of total encounters by location, week, encounter type, cohort (service member or beneficiary), age group, source of care (outsourced or MTF), sex and service.
* Laboratory tests for respiratory pathogens: Individual influenza tests and results, and, on a rolling basis, as they become available in DMSS, individual tests and results for other respiratory pathogens (COVID-19, seasonal coronaviruses, adenovirus, rhinovirus, enterovirus, parainfluenza, human metapneumovirus, respiratory syncytial virus, bocavirus, *Chlamydia pneumoniae*, *Mycoplasma pneumoniae*).

AFHSD defines COVID-19+ILI% as the total number of weekly COVID-19 coded outpatient MTF medical encounters plus the total number of weekly ILI outpatient MTF encounters (Note: encounters should only be counted once if they qualify as both a COVID-19 and ILI outpatient MTF encounter) divided by the weekly number of total outpatient MTF encounters and multiplied by 100, for a given location. Individual COVID-19 and ILI encounters will be provided in separate files.

Additionally, an observed values, or ‘truth’ file with calculated COVID-19, ILI and COVID-19+ILI % file will be provided to participants each week. The truth file will be used by AFHSD to evaluate accuracy of forecast submissions for each target.

# Template and Data Formatting

## Teams and Models

Teams interested in participating in the DoD COVID-19 and ILI Forecasting Collaboration 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.

## 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 provided dates table. A forecast consists of a single plain-text file, in a particular format, which encapsulates the set of predictions for all or a subset of locations and targets.

Forecast submission template details 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 name 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 the forecast submission 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 COVID-19+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 observed COVID-19+ILI% values greater than or equal to 25.0%, or in the interval [25.0, 100].

## Forecast file name

A forecast submission using DMSS 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 DMSS data used in the forecast.

## Forecast file storage and submission

Submitted forecasts will be stored in a private GitHub repository: <https://github.com/DoD-FluChallenge/DoD-COVID-19-and-ILI-Forecasting-Collaboration>.

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: [dha.ncr.health-surv.mbx.dodflucontest@mail.mil](mailto:dha.ncr.health-surv.mbx.dodflucontest@mail.mil).

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 privately available the github site. 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 AFHSD.

# Data Sources

Historical DMSS surveillance data may be used for training and model development, and were provided for the DoD Influenza Forecasting Challenge. Teams are welcome and encouraged to utilize additional data beyond the provided DMSS data.

# Contact Info

Additional questions may be addressed to [dha.ncr.health-surv.mbx.dodflucontest@mail.mil](mailto:dha.ncr.health-surv.mbx.dodflucontest@mail.mil).

# Appendix

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| ICD-10 CODE for Influenza-like Illness | DESCRIPTION |
| *B97.89* | other viral agents as the cause of diseases classified elsewhere |
| *H66.9* | Otitis media, unspecified |
| *H66.90* | Otitis media, unspecified, unspecified ear |
| *H66.91* | Otitis media, unspecified, right ear |
| *H66.92* | Otitis media, unspecified, left ear |
| *H66.93* | Otitis media, unspecified, bilateral |
| *J00* | Acute nasopharyngitis [common cold] |
| *J01.9* | Acute sinusitis, unspecified |
| *J01.90* | Acute sinusitis, unspecified |
| *J06.9* | Acute upper respiratory infection, unspecified |
| *J09* | Influenza due to certain identified influenza viruses |
| *J09.X* | Influenza due to identified novel influenza A virus |
| *J09.X1* | Influenza due to identified novel influenza A virus with pneumonia |
| *J09.X2* | Influenza due to identified novel influenza A virus with other respiratory manifestations |
| *J09.X3* | influenza due to identified novel influenza A virus with gastrointestinal manifestations |
| *J09.X9* | Influenza due to identified novel influenza A virus with other manifestations |
| *J10* | Influenza due to other identified influenza virus |
| *J10.0* | Influenza due to other identified influenza virus with pneumonia |
| *J10.00* | Influenza due to other identified influenza virus with unspecified type of pneumonia |
| *J10.01* | Influenza due to other identified influenza virus with the same other identified influenza virus pneumonia |
| *J10.08* | Influenza due to other identified influenza virus with other specified pneumonia |
| *J10.1* | Influenza due to other identified influenza virus with other respiratory manifestations |
| *J10.2* | influenza due to other identified influenza virus with gastrointestinal manifestations |
| *J10.8* | Influenza due to other identified influenza virus with other manifestations |
| *J10.81* | Influenza due to other identified influenza virus with other manifestations with encephalopathy |
| *J10.82* | Influenza due to other identified influenza virus with other manifestations with myocarditis |
| *J10.83* | Influenza due to other identified influenza virus with otitis media |
| *J10.89* | Influenza due to other identified influenza virus with other manifestations |
| *J11* | Influenza due to unidentified influenza virus |
| *J11.0* | Influenza due to unidentified influenza virus with pneumonia |
| *J11.00* | Influenza due to unidentified influenza virus with unspecified type of pneumonia |
| *J11.08* | Influenza due to unidentified influenza virus with specified pneumonia |
| *J11.1* | Influenza due to unidentified influenza virus with other respiratory manifestations |
| *J11.2* | Influenza due to unidentified influenza virus with gastrointestinal manifestations |
| *J11.8* | Influenza due to unidentified influenza virus with other manifestations |
| *J11.81* | Influenza due to unidentified influenza virus with encephalopathy |
| *J11.82* | Influenza due to unidentified influenza virus with myocarditis |
| *J11.83* | Influenza due to unidentified influenza virus with otitis media |
| *J11.89* | Influenza due to unidentified influenza virus with other manifestations |
| *J12.89* | Other viral pneumonia |
| *J12.9* | Viral pneumonia, unspecified |
| *J18* | Pneumonia, unspecified organism |
| *J18.1* | Lobar pneumonia, unspecified organism |
| *J18.8* | Other pneumonia, unspecified organism |
| *J18.9* | Pneumonia, unspecified organism |
| *J20.9* | Acute bronchitis, unspecified |
| *J22* | Unspecified acute lower respiratory infection |
| *J40* | Bronchitis, not specified as acute or chronic |
| *R05* | Cough |
| *R50.9* | Fever, unspecified |

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| --- | --- |
| ICD-10 Code for COVID-19 | Description |
| *B97.29* | Other coronavirus |
| *B97.29 + J12.89* | Other viral pneumonia + Other coronavirus |
| *B97.29 + J20.8* | Acute Bronchitis due to other unspecified organisms + Other coronavirus |
| *B97.29 + J40* | Bronchitis not specified as acute or chronic + Other coronavirus |
| *B97.29 + J22* | Unspecified acute lower respiratory infection + Other coronavirus |
| *B97.29 + J98.8* | Other specified respiratory disorders + Other coronavirus |
| *B97.29 + J80* | Acute Respiratory Distress syndrome (ARDs) + Other coronavirus |
| *U07.1* | 2019 Novel coronavirus (COVID-19) |
| *Z03.818* | Possible exposure to COVID-19 |
| *Z20.828* | Actual exposure to someone confirmed to have COVID-19 |
| *B34.2* | Coronavirus infection, unspecified |
| *J12.81* | Pneumonia due to SARS-associated coronavirus |
| *079.82* | SARS-associated coronavirus |
| *480.3* | Pneumonia due to SARS-associated coronavirus |
| *V01.82* | Exposure to SARS-associated coronavirus |