**Epidemic Structure and Predictive Accuracy of Influenza A and B: Insights from Sub-Epidemic Modeling**

**Project Description**

This project aims to characterize and compare the epidemic dynamics of influenza A and influenza B by decomposing their respective incidence time series into overlapping sub-epidemic components, and by assessing forecasting performance across different modeling approaches. Seasonal influenza epidemics often consist of multiple overlapping waves caused by distinct viral subtypes or lineages. These sub-epidemic waves can differ in onset, peak timing, and duration, and may vary substantially between influenza A and B.

We will analyze multi-year influenza surveillance data—stratified by type (A vs. B)—to (1) decompose observed epidemic curves into sub-epidemic components, (2) compare the temporal and magnitude characteristics of these components between types, and (3) evaluate short- and medium-term forecasting performance using both simple epidemic growth models and ensemble sub-epidemic models. By systematically comparing model performance for influenza A and B, this work will provide quantitative insights into differences in epidemic structure, the value of sub-epidemic decomposition for predictive accuracy, and practical guidance for seasonal influenza forecasting.

**Scope**

**1. Data Sources**

* Weekly or daily influenza incidence data, stratified by type (A and B), obtained from national influenza surveillance systems.
* Multi-year coverage to capture variability in epidemic timing and subtype dominance.

**2. Modeling Approaches**

* **Simple models:** Single epidemic growth curves (e.g., Richards model, logistic growth, or standard SEIR) fitted to entire seasonal curves without decomposition.
* **Sub-epidemic models:**
  + *Phenomenological*: n-sub-epidemic growth models (logistic or generalized logistic components).
  + *Mechanistic*: SEIR-based sub-epidemic model capturing overlapping transmission waves.
* **Ensemble sub-epidemic models:** Weighted and unweighted ensembles of top-performing sub-epidemic fits.

**3. Analytical Objectives**

1. **Decomposition analysis**: Identify the number, timing, and magnitude of sub-epidemics for influenza A and B; compare distributions of onset dates, peak times, and durations.
2. **Forecast evaluation**: Generate real-time forecasts at different points in the season using both simple and sub-epidemic models; compare point and probabilistic forecast accuracy.
3. **Performance metrics**: Evaluate models using mean absolute error (MAE), mean squared error (MSE), weighted interval score (WIS), and coverage of 95% prediction intervals.

**4. Comparisons**

* + Number of sub-epidemics per season.
  + Relative magnitude and contribution of each component.
  + Predictive accuracy and calibration across models.
* Simple vs. sub-epidemic models:
  + Differences in fit quality and forecast skill.