**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.

Paragraph 1: Public health importance and statistics  
Begin by framing the health issue as a significant global or national concern. Provide recent statistics on prevalence, incidence, or  
mortality to emphasize its magnitude. Highlight temporal trends (e.g., rising or declining cases) and, if possible, project future  
burdens to establish urgency.  
Paragraph 2: Risk factors, disparities, geographic or demographic heterogeneity  
Briefly explain the main biological, behavioral, or environmental risk factors associated with the disease. Discuss how the burden is  
unevenly distributed across age, sex, socioeconomic status, or regions. Emphasize disparities, such as higher incidence in specific  
sub-populations or limited healthcare access in resource-constrained settings.  
Paragraph 3: Existing initiatives/goals, progress made, remaining gaps  
Introduce major public health initiatives, programs, or global goals designed to reduce the disease burden (e.g., WHO Sustainable  
Development Goals, national initiatives). Summarize progress made so far and point out any measurable successes. Then  
underline the remaining challenges—such as inequities, stalled progress, or emerging threats—that justify further study.  
Paragraph 4: Importance of forecasting and limitations of past studies  
Explain why forecasting is critical for guiding public health policy, resource allocation, and prevention strategies. Acknowledge past  
forecasting or modeling efforts and describe their limitations, such as short time horizons, lack of subgroup analysis, or insufficient  
consideration of social determinants. This sets up the rationale for why improved or more comprehensive approaches are needed.  
Paragraph 5: Study objectives and contribution  
End the introduction by clearly stating the study’s objectives. For example, indicate the intent to forecast future disease burden by  
age group, region, or risk category and to evaluate progress toward specific global or national targets. Emphasize how the study  
fills gaps in the literature and provides actionable insights for policymakers and public health practitioners.  
12-18 references cited in the introduction