Using Rwave to detect synchrony of influenza between U.S. states

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Keywords: Spatio-temporal, Wavelets, Time series, Rwave, Influenza

The continuous wavelet transform (CWT) is a powerful tool for analyzing non-stationary spatio-temporal data. Compared to the discrete wavelet transform (DWT), the CWT offers a well-defined relationship between scale and frequency, and a time-scale decomposition that is independent of translations and truncations of the original time series [1]. To our knowledge, **Rwave** is the only active R package that implements the CWT.

Influenza epidemics in temperate regions display marked yearly seasonality, with peak incidence occurring during the winter months. The spatio-temporal course of yearly epidemics has significant public health consequences, but is non-stationary and difficult to predict. Here, I use the **Rwave** package to investigate synchrony of influenza infections between U.S. states over 6 years. I use weekly estimates of influenza incidence published by Google [4, 5]. I compute the cross-wavelet spectrum between all states with complete records, excluding Hawaii (36 states total), and examine the distribution of phases at frequencies around 1 year. I use a Wilcox test to determine the significance of these phase differences, and estimate the difference in phase from zero using the `wilcox.test`'s pseudomedian estimate. I then examine latitude, longitude, and population of the comparison states as predictors of estimated phase difference using linear regression. Of these, latitude is the only significant predictor of phase difference.

Previous work has inferred synchrony of influenza primarily from timing of epidemic peak (e.g. [2] and [3]). The CWT, as used here, allows inspection of synchrony over the full period of record. As such, this method accounts for synchrony of epidemic onset and decay, as well as inter-epidemic dynamics, and allows a richer exploration of underlying disease dynamics.

References

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