Robust vs recurrent patterns of influenza spread in France

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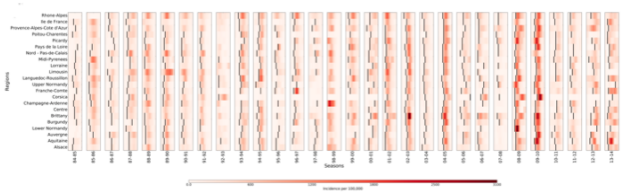
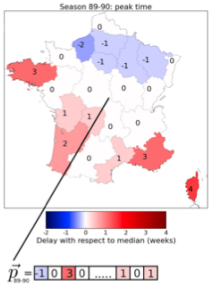
Introduction

Influenza activity shows a complex spatio-temporal pattern with a strong seasonal dynamic whose complete understanding is still missing .
Most of the literature about influenza epidemics have focused on properties as general as possible, trying to identify the features of a typical influenza season.
The aim of the present work is somehow different, since we want to classify influenza seasons according to their diffusion pattern, identifying groups of seasons that share a similar pattern. In this sense, while previous works have studied a typical (robust) diffusion pattern representative of all available seasons, here we want to study together only seasons displaying a similar (recurrent) diffusion pattern.

Data and Methods

We study 30 seasons of ILI weekly time series with a regional scale resolution



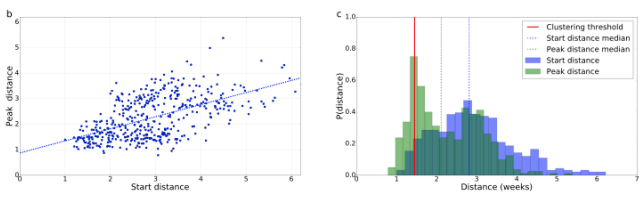


- We associate to each season two vectors
  - Regional epidemic start time
  - Regional epidemic peak time
- We compute distances between seasons s and t as distance between vectors

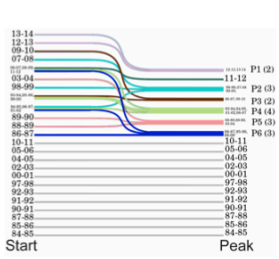
$$D^{\vec{}}_{s,t} = \sqrt{\frac{\sum_{l=1}^{N^{\text{regions}*}_{s,t}} (v_l^s - v_l^t)^2}{N^{\text{regions}*}_{s,t}}}$$

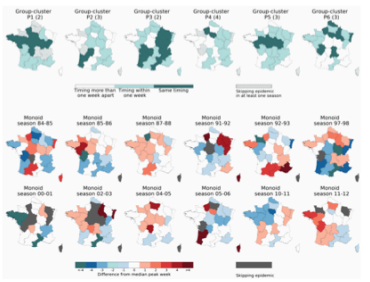
- We cluster seasons over start/peak distance

Results

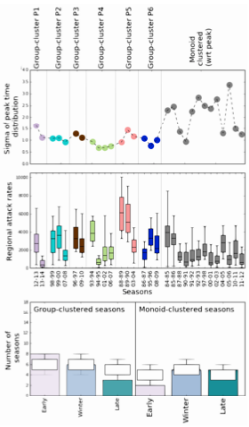


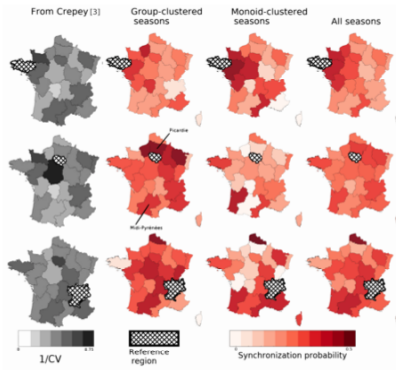
- Start distance and peak distance are correlated ($R = 0.56$, $p < 0.00001$)
- Peak distance is smaller than start distance in $\sim 75\%$ of comparisons
- Peak distance distribution has a peak for smaller values





- Clustering is stronger at peak than at the start
- Peak monoids are also Onset monoids
- Seasons clustering rearrange as epidemics unfold in the country
- Peak clusters identify regions with the same behaviour during several seasons
- Peak monoids display heterogeneous behavior





- Some clusters present higher synchronicity (not all of them)
- Some clusters present higher attack rates (not all of them)
- No difference in absolute timing for clusters and monoids
- Clusters and monoids present a different relation with mobility
- Clusters present correlation of synchronization and mobility
- This correlation remains also when considering all seasons together

Summary

In the present work we have characterized the spread of influenza at the regional level of France in terms of the classification of geographical distribution pattern of start and peak time.

- Defining a distance based on similarity between patterns, we have clustered seasons with respect to start and peak time
- Season clustered together share a recurrent pattern
- Clustering is stronger at peak than at start
- Seasons clustered at peak present a relevant correlation between synchornization and commuters mobility
- First sistematic classification of influenza seasons in terms of diffusion pattern

Acknowledgments

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