A Bayesian methodology for on-line detecting the onset of influenza epidemics

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The early detection of outbreaks of diseases is one of the most challenging objectives of epidemiological surveillance systems. In this work, a Markov switching model is introduced to determine the epidemic and non-epidemic periods from influenza surveillance data: the process of differenced incidence rates is modelled either with a first-order autoregressive process or with a Gaussian white noise process depending on whether the system is in an epidemic or a non-epidemic phase. The transition between phases of the disease is modelled as a Markovian process. Bayesian inference is carried out on the former model to detect influenza epidemics at the very moment of their onset. Moreover, the proposal provides the probability of being in an epidemic state at any given moment. This modelling can be very helpful to identify which are the epidemic weeks during various seasons. Nevertheless, its main usefulness comes from the fact that it can be used on-line at every week in order to detect the very precise moments in which the epidemic phases starts.
After checking (in terms of DIC) that all the components of the model are a real contribution to it, a study of its on-line performance has been done. In particular, a comparison of its behaviour with other alternatives has been made using influenza illness data obtained from the Sanitary Sentinel Network of the Comunitat Valenciana (Spain). The selected metric for measuring the performance has been AUWROC1, the area under a ROC curve weighted by the mean time saved (see Cowling et al. [1] and Kleinmann and Abrams [2] for more details). Results indicate good performance of the method.

References

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[2] K. P. Kleinman and A. M. Abrams (2006) "Assessing surveillance using sensitivity, specificity and timeliness", Statistical Methods in Medical Research, vol. 15, pp. 445464, 2006.