

Time to extinction of age-dependent branching processes: application to outbreaks of infectious disease

Miguel González¹, Rodrigo Martínez¹ and Maroussia Slavtchova-Bojkova²

¹ Department of Mathematics. University of Extremadura. SPAIN

² Department of Probability, Operational Research and Statistics. Faculty of Mathematics and Informatics. Sofia University. BULGARIA

When an infectious disease is strongly detrimental for the population where it is spreading, such that it becomes an epidemic, then a vaccination policy should be applied to protect the susceptible individuals and control its spread. Since immunizing the whole population is impossible in most of cases (because there exists a real impossibility or it is very expensive), only a proportion of susceptible individuals can be immunized by vaccination. How to determine this proportion is an important problem which depends on multiple factors. A significant factor for public authorities to assess the vaccination efficiency, is the time that the infectious disease should be allowed to survive after vaccination. The aim of this study is to provide an approach to this problem modelling epidemic spread and controlling its time to extinction by means of stochastic models, namely branching processes. We are using a Sevast'yanov's branching process (see [1]) to describe the outbreaks of an infectious disease with incubation period. We study the properties of the time to extinction of an infection, depending on the proportion of the immunized individuals into the population. From these results, we suggest a vaccination policy based on the mean of the infection survival time. Finally, we provide a simulation-based method to determine the optimal vaccination level and as an illustration we analyze the data from [2] outbreaks of H5N1 avian influenza virus spreading in South Vietnam at the end of 2006.

References

- [1] Haccou P, Jagers P, Vatutin V (2005) Branching processes: variation, growth and extinction of populations, Cambridge University Press
- [2] OIE, (2007) "Report reference 1828/TY-DT", World Organization for Animal Health, <http://www.oie.int>