

Noise is not error: detecting parametric heterogeneity between epidemiologic time series

E.O. Romero-Severson; R.M. Ribeiro; M. Castro Ponce

Abstract-

Mathematical models play a central role in epidemiology. For example, models unify heterogeneous data into a single framework, suggest experimental designs, and generate hypotheses. Traditional methods based on deterministic assumptions, such as ordinary differential equations (ODE), have been successful in those scenarios. However, noise caused by random variations rather than true differences is an intrinsic feature of the cellular/molecular/social world. Time series data from patients (in the case of clinical science) or number of infections (in the case of epidemics) can vary due to both intrinsic differences or incidental fluctuations. The use of traditional fitting methods for ODEs applied to noisy problems implies that deviation from some trend can only be due to error or parametric heterogeneity, that is noise can be wrongly classified as parametric heterogeneity. This leads to unstable predictions and potentially misguided policies or research programs. In this paper, we quantify the ability of ODEs under different hypotheses (fixed or random effects) to capture individual differences in the underlying data. We explore a simple (exactly solvable) example displaying an initial exponential growth by comparing state-of-the-art stochastic fitting and traditional least squares approximations. We also provide a potential approach for determining the limitations and risks of traditional fitting methodologies. Finally, we discuss the implications of our results for the interpretation of data from the 2014-2015 Ebola epidemic in Africa.

Index Terms- stochastic, deterministic, epidemiology, panel data, random effects, fixed effects

Due to copyright restriction we cannot distribute this content on the web. However, clicking on the next link, authors will be able to distribute to you the full version of the paper:

[Request full paper to the authors](#)

If your institution has an electronic subscription to Frontiers in Microbiology, you can download the paper from the journal website:

[Access to the Journal website](#)

Citation:

Romero-Severson, E.O.; Ribeiro, R.M.; Castro, M. "Noise is not error: detecting parametric heterogeneity between epidemiologic time series", Frontiers in

