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IDENTIFIABILITY AND OBSERVABILITY OF SOME EPIDEMIOLOGICAL SYSTEMS: SIR VS. SIRS

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ABSTRACT

Compartmental models based on ODEs are widely used for the study of infectious diseases. A typical methodology when applying these models to a real epidemic is (1) setting a model based on the known features of the disease, (2) looking for parameters available in the literature and collecting real data series, and (3) calibrating the remaining unknown parameters and initial conditions using these data. However, before performing (3), one can wonder if these unknowns are uniquely determined by the known data. This is addressed by studying the observability and identifiability properties of the system. In the first part of the talk, we present some theoretical results about these properties in general nonlinear ODE systems [1]. Then, we illustrate these results by applying them to the case of an SIRS model along with the observation of a portion of infectious individuals [2]]. Furthermore, when performing (1), it may not be clear which model suits better when there is little information available; for example, if the population will lose their acquired immunity after some time. Regarding this problem, we also study an SIR model with the same observation and compare both cases. This comparison yields a novel methodology for model discrimination, allowing us to determine whether these observed data come from an SIR or an SIRS model when the observations are available for a short period of time.

REFERENCES

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[2] A.B. Kubik, A. Rapaport, B. Ivorra, and Á.M. Ramos,*Identifiability and Observability Analysis for Epidemiological Models: Insights on the SIRS Model*, (2025), Preprint arXiv:2506.11583.