Identification of parameters for Epidemiological models :
Observers

Gauthier Sallet

Institut Élie Cartan de Lorraine, UMR CNRS 7502

Université de Lorraine

Gauthier.Sallet@univ-lorraine.fr

In epidemiology mathematical models are very often used to describe the dynamic evolution of the diseases. Deterministic Ordinary differential Equations(ODEs) are one of the major modeling tools. Unfortunately some parameters of the system are unknown and moreover not all the states of the system are not observed. For example consider the intra-host model of Malaria introduced in the seminal paper of Anderson, May and Gupta [1]

$$
\begin{cases}
\dot{x} & = \Lambda - \mu_x\,x - \beta\,x\,m, \\
\dot{y} & = \beta\,x\,m - \mu_y\,y, \\
\dot{m} & = r\,\mu_y\,y - \mu_m\,m - \beta\,x\,m.
\end{cases}
$$

The variable x represents the concentration of erythrocytes, y represents the concentration of infected red blood cells and m is the concentration of free merozoites, the parasites of malaria. In case of malaria, only the concentration y of infected erythrocytes are measured [2]. For this system the parameters Λ, μ_x, μ_y, μ_m and r are known or at least widely accepted. However the infection rate β is unknown. Then the problem, when y is measured, is to reconstruct the states x, m and identify the parameter β.

In this talk we will introduce the concepts of observability, identifiability and observers. Roughly an observer is a dynamical system whose output converges to an estimation of the states and the parameters of the system.

We will give examples of construction of observers for intra-host model of malaria, Schistosomiasis Models, Ross model of Malaria.

References

[1] Anderson, R M and May, R M and Gupta, S, *Non-linear phenomena in host-parasite interactions.*, Parasitology **1989** 59-79.

[2] Gravenor, M B and van Hensbroek, M B and Kwiatkowski, D, *Estimating sequestered parasite population dynamics in cerebral malaria.*, PNAS, **1998** 7620-4.