Model Fitting in Malaria Epidemics: Applying High-Frequency Empirical Data for SEI-SI Model

***Mitsuhiro Odaka*[1].**

(1) SOKENDAI (The Graduate University for Advanced Studies), 2-1-2 Hitotsubashi, Chiyoda-ku, Tokyo 101-8430, Japan, odaka@nii.ac.jp.

Model fitting, namely setting parameter based on the comparison of theoretical model data with empirical data, is a critical procedure for avoiding unsound prediction. As for model fitting in malaria epidemics, while annual or monthly data have been widely utilized, daily or weekly data have not. This is mainly due to a poor access to such high-frequency open microdata about malaria prevalence or incidence. Therefore, the model according to high-frequency data would enable one to forecast short-term malaria epidemics. Here, this research aims to fit the model to high-frequency data. The data is curated from weekly malaria reports published by public health ministry of Uganda, which contains weekly total of newly reported malaria cases. On the other hand, the SEI-SI model is built, where one mosquito compartment is linked to 50 human compartments at different transmission rates (β) and recovery rates (γ) on bipartite graph. In order to fit trend component of this model to that of observed data, Evolutionary Programming (EP) is implemented. In particular, (β, γ) vectors' ensembles with small residual sum of squares of logarithmic difference are selected and their offspring (the arithmetic mean of parent and normalized random number) are generated online. Based upon 80/20 rule [1], the results from different proposition of (β, γ) are compared; the set of random variables following to power-law distribution, Weibull distribution and uniform distribution.

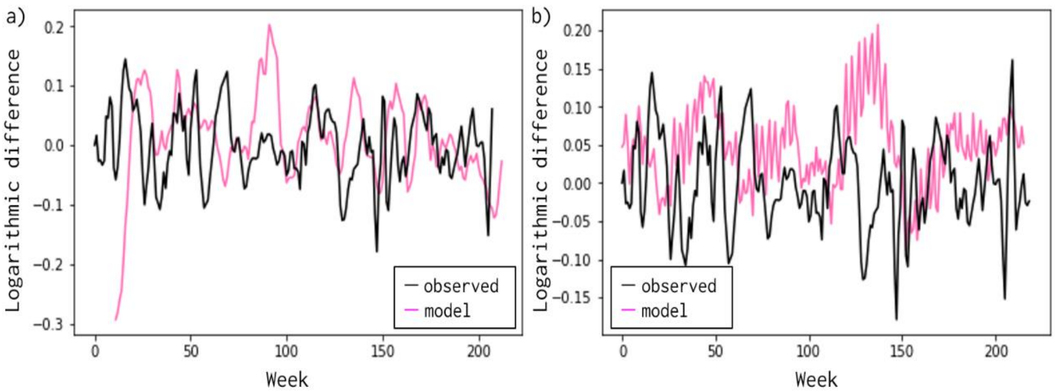

Figure 1: The model fitting with parameters vectors following to different distributions; a) power-law distribution, b) Wiener process

As a result, trafficking of model data starts from three months (Figure 1a). The convergence of parameter vectors to 0.8 to 1.0 is observed, whereby resembling random numbers, which implies that the randomness ensures fluctuation as well as geometric Brownian motion of stock price. Followed by this, other simulation are investigated with setting parameter the sum of drift and Wiener process (Figure 1b). Although the results are robust, the fitness of them are not good. There remains the necessity of model modification with other stochastic processes.

References

[1] M. E. J. Woolhouse., et al. (1997) Heterogeneities in the transmission of infectious agents: Implications for the design of control programs. PNAS January, 1997 94 (1) 338-342.