

パンデミック解析の周辺

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abstract

There are mainly three methodologies in analyzing the infectious disease spread: 1) the SIR model, 2) the multi-agent simulation (MAS) model, and 3) network-information-oriented model. Although the MAS seems to be useful because it can, under a variety of initial and boundary conditions, deal with detailed simulations for artificial social network models, we cannot use it with ease because the specific real world is too complex to express. On the contrary, the SIR is still attractive because of its simple scheme and adaptability to real cases. Comparing the simulation results using the two models, we have found that they are consistent with each other. Thus, we can combine these two methods, the MADE, for simulations to save the computing cost. This kind of simulation is a white-box simulation. We have first shown the pandemic simulations by scenario using the MADE which is the combination of the SIR model and the multi-agent simulation model. This kind of simulation is useful to grasp the structure of pandemics. Figure 1 shows the consistency between the SIR model and the MAS model.

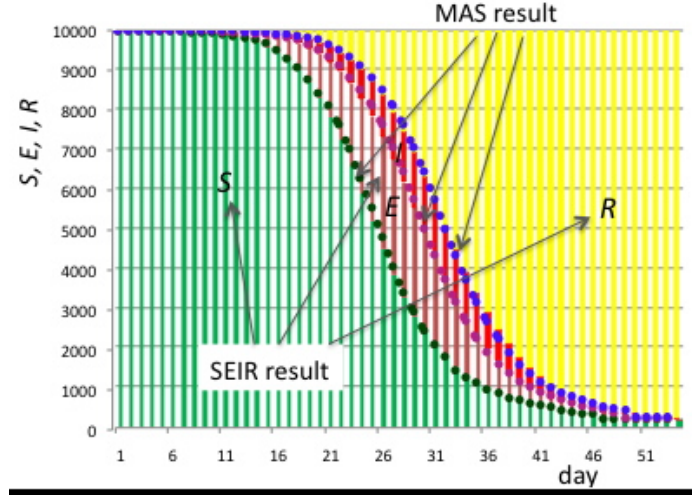


図 1: An example of the MAS result and the solution for S , E , I , and R .

In real pandemic cases, however, parameters are unknown in advance. To predict the pandemic size, preparing the parameters as accurately as possible using

the incomplete observed data becomes crucial. This is a sort of the gray-box or the assimilation type. We have introduced a gray-box type computation using the SIR model for real pandemic cases of the FMD in Miyazaki in 2010 and the SARS case in Hong Kong in 2003. Figure 2 shows the predicted cumulative numbers of cattle to be killed at the final stage; each dot corresponds to the truncated time T ; using data by time T , we first estimate the parameters in the SIR model by the combination of differential equation solving and the method of least squares, called the BBS (best backward solution method), then we predict the future state. We can see that the SIR predicts the possible pandemics even in the early stages. More than half of the cattle could be killed if no network disconnection nor vaccination were performed. The figure compares the results by the SIR model and the truncated model. The SIR model can predict the future risk for the pandemics in earlier stages; on the contrary, the truncated model has given too small values in predicting the future state. This tendency was seen in other real cases such as the A(H1N1) influenza case and the SARS case.

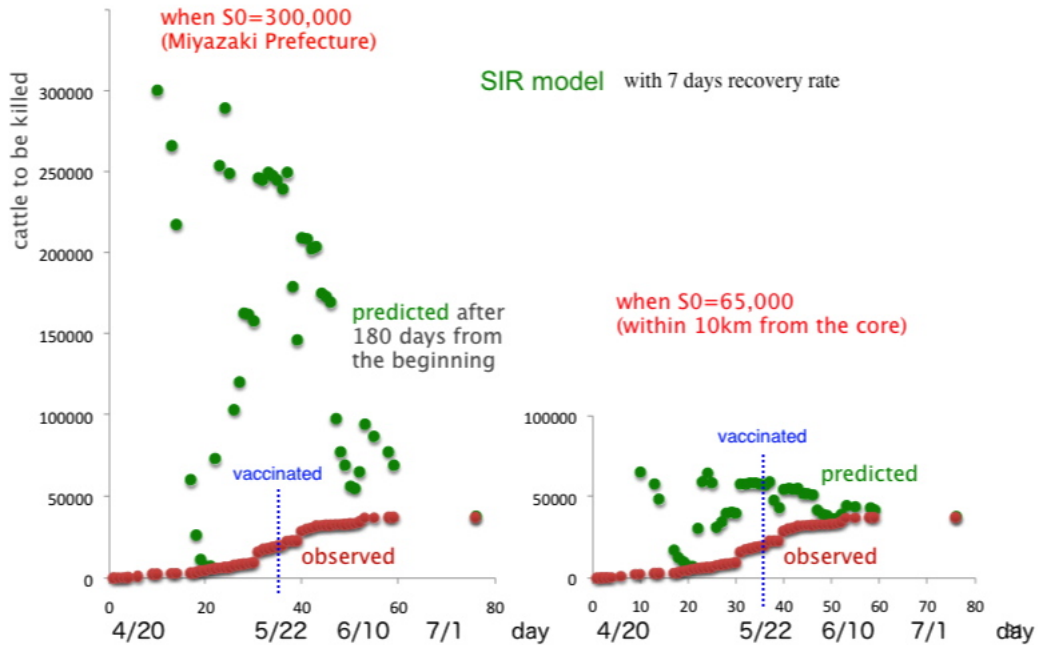


Figure 2: Final stage prediction of the FMD in Miyazaki in 2010 using the SIR model.