Estimating the infection fatality ratio and the spatio-temporal dynamics of COVID-19 by mechanistic-statistical approaches

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Mechanistic-statistical epimiological models typically combine a parcimonious differential equation model describing the unobserved epidemiological dynamics, a probabilistic model describing the data acquisition process and a statistical inference method. In the first part of my talk, I will present how these approaches allowed us to estimate key quantities such as the infection fatality ratio (IFR) at an early stage of the COVID-19 epidemic in France. These first results are based on mean-field SIR epidemiological models. In the second part of my talk, I will focus on the following question: "Is the spatial pattern of COVID-19 incidence in France between March and June 2020 a consequence of an environmental heterogeneity, e.g., in the climatic conditions, or simply reflects the specific locations of the introduction points initiating a spatial diffusion?". To answer this question, we compared four models, either spatially-explicit or not. We found that the best one is spatially-explicit but has spatially constant parameters and a non-local spatial diffusion term reflecting inter-county transmission. This shows that in France, once the epidemic was established, the effect of global processes overwhelmed the effect of local factors.