A simulation approach for an extended 2D Quarantine Model.

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Abstract

The measures performed in pandemic conditions produced by the coronavirus led to the estimation of predictive mathematical models that consider the influence of isolation in certain regions on the development of those infected. This model modifies the simplistic view of the Susceptible, Infected and Recovered (SIR) model, commonly used to describe the evolution of pandemics.

Articles published on the proposal of these models [1] summarise, from a theoretical point of view, the possibility of creating a method that considers the measures adopted by the majority of countries in Europe or Asia. The so-called "Quarantine Model" (QM) was introduced to deal with this subject. Mentioned model considers the existence of a subpopulation of latently infected that, due to their isolation, prevents the possibility of infection. In addition, QM introduces a certain non-symptoms incubation period, and, for that reason, it is said that, along this period, the population isolates itself and it is not susceptible to infection at any other time. The equation introduced by the aforementioned method, does not consider the spatial diffusion of the disease. However, a spatiotemporal diffusion model (in one dimension), that honours the quarantine model, is proposed in [1]. This one-dimension diffusion model is based on an equation which is analogous to a thermal diffusion one, which consists of a Parabolic Partial Differential Equation (PDE), that includes a series of parameters to be adjusted for a certain region of interest where they can be considered constant.

Present work extends the single dimension diffusion model to a surface one, introducing a set of free parameters, and performs a set of simulations in a real dataset. The data provided by the statistical agencies in certain regions of interest, such as the Province of Valencia, are used to fit the previous free parameters, stablishing boundary conditions. A set of real simulations, involving different methods of numerical resolution of the PDE, will be shown. In addition, we analyse the importance of the qualitative analysis of the behaviour of the model, recreating situations where factors, such as mobility tend to zero, comparing these ones with data obtained in areas with more restrictive measures.

References

[1] Volpert, V., Banerjee, M., Petrovskii, S. . On a quarantine model of coronavirus infection and data analysis. *Mathematical Modelling of Natural Phenomena*, 15, 24 (2020).

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