World Academy of Science, Engineering and Technology
International Journal of Computer and Systems Engineering
Vol:17, No:05, 2023

Surviral: An Agent-Based Simulation Framework for Sars-Cov-2 Outcome Prediction

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Abstract : History and the current outbreak of Covid-19 have shown the deadly potential of infectious diseases. However, infectious diseases also have a serious impact on areas other than health and healthcare, such as the economy or social life. These areas are strongly codependent. Therefore, disease control measures, such as social distancing, quarantines, curfews, or lockdowns, have to be adopted in a very considerate manner. Infectious disease modeling can support policy and decision-makers with adequate information regarding the dynamics of the pandemic and therefore assist in planning and enforcing appropriate measures that will prevent the healthcare system from collapsing. In this work, an agent-based simulation package named “survival” for simulating infectious diseases is presented. A special focus is put on SARS-Cov-2. The presented simulation package was used in Austria to model the SARS-Cov-2 outbreak from the beginning of 2020. Agent-based modeling is a relatively recent modeling approach. Since our world is getting more and more complex, the complexity of the underlying systems is also increasing. The development of tools and frameworks and increasing computational power advance the application of agent-based models. For parametrizing the presented model, different data sources, such as known infections, wastewater virus load, blood donor antibodies, circulating virus variants and the used capacity for hospitalization, as well as the availability of medical materials like ventilators, were integrated with a database system and used. The simulation result of the model was used for predicting the dynamics and the possible outcomes and was used by the health authorities to decide on the measures to be taken in order to control the pandemic situation. The survival package was implemented in the programming language Java and the analytics were performed with R Studio. During the first run in March 2020, the simulation showed that without measures other than individual personal behavior and appropriate medication, the death toll would have been about 27 million people worldwide within the first year. The model predicted the hospitalization rates (standard and intensive care) for Tyrol and South Tyrol with an accuracy of about 1.5% average error. They were calculated to provide 10-days forecasts. The state government and the hospitals were provided with the 10-days models to support their decision-making. This ensured that standard care was maintained for as long as possible without restrictions. Furthermore, various measures were estimated and thereafter enforced. Among other things, communities were quarantined based on the calculations while, in accordance with the calculations, the curfews for the entire population were reduced. With this framework, which is used in the national crisis team of the Austrian province of Tyrol, a very accurate model could be created on the federal state level as well as on the district and municipal level, which was able to provide decision-makers with a solid information basis. This framework can be transferred to various infectious diseases and thus can be used as a basis for future monitoring.

Keywords : modelling, simulation, agent-based, SARS-Cov-2, COVID-19
Conference Title : ICMS 2023 : International Conference on Modelling and Simulation
Conference Location : Barcelona, Spain
Conference Dates : May 22-23, 2023