Using "mean field" models to predict the dynamics of epidemic spread

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In 2020-2021, the Covid-19 pandemic became one of the key issues in healthcare, the economy and people's daily lives. To predict the spread of morbidity during the pandemic, more than a hundred different mathematical models have been developed, and the search for the most effective of them is still ongoing, since SARS-Cov-2 has a number of significant features that make modeling difficult. For example, the dynamic of the coronavirus disease varies depending on the region under consideration and is extremely unstable due to the emergence of new strains or the introduction of antiviral measures. Coronavirus also has a number of symptomatic differences from other viruses, often has a mild form and can be asymptomatic, and a recovered person does not receive strong immunity and can become re-infected.

The work is devoted to the transfer of well-known "mean field" economic models [1] to forecasting the spread of epidemics, in particular the coronavirus epidemic. The idea of using the models is due to the fact that traditional epidemiological ones, such as SIR-type compartmental models [2], do not take into account population heterogeneity, and therefore cannot be used for long-term forecasts. Another well-known approach to solving such a problem, the so-called agent-based models [3], allows taking into account non-epidemiological factors, but leads to computationally complex systems. In turn, the structural simplicity of "mean field" models and the ability to take into account the average mass behavior of agents make such models attractive for use in the field of epidemiology.

We present two "mean field" mathematical approaches for solving the problem of forecasting the development of an epidemic. The difference between the approaches under consideration lies in the choice of whether the isolation strategy chosen by the players is common for the entire population or different for each epidemiological group. It is shown that models that are similar in structure lead to different modeling results. An example of forecasting the spread of COVID-19 using both approaches based on the observed epidemiological situation in Novosibirsk in 2020 is given.

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References

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