

Report on the outcomes of a Short-Term Scientific Mission¹

Action number: **18232**

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Details of the STSM

Optimal control of a stochastic SVIR model with logistic growth and saturated incidence function

Start and end date: 09/03/2024 to 21/03/2024

Description of the work carried out during the STSM

We introduced a stochastic SVIR (susceptible $S(t)$, vaccinated $V(t)$, infected $I(t)$ and recovered $R(t)$) epidemic system with saturation incidence rates and logistic growth. It is assumed that the virus is spreading when a susceptible person comes into contact with an infected person who is vaccinated or not. For the introduced model, we described optimal vaccination strategy that would maximize the vaccinated population and minimize both the infected, and at the same time minimize the costs of applying the vaccination strategy.

First we analyzed constant vaccination rates in order to better understand influence of the vaccination on the spread of the diseases via introduced stochastic model. We illustrated with numerical simulations spread of the diseases via stochastic model for different rates of vaccination (0%, 10%, 50%, 100%). We concluded that this simulations are usefulness to indicated influence of preventative measure(s) and defining stochastic optimal control problems.

For the optimal vaccination strategy, we distinguish two cases: unconstrained and constrained stochastic optimal control problems. For the unconstrained optimal control problem goal is to determine the strategy which minimizes the (defined, most suitable) performance functional. We analyzed Pontryagin's maximum principle for obtaining the optimal solution of unconstrained optimal control problem. For the constrained stochastic optimal control problem we defined two types of budget constraints and analyzed their solutions with generalized Lagrange multiplier methods.

¹ This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the GH for payment of the Grant.

Description of the STSM main achievements and planned follow-up activities

In the collaboration with colleague from Osijek, we achieved to define the model with all complexities which we intended to introduce and prove several results (advantages of stochastic model and stochastic optimal control problem over deterministic model and constant vaccination, unconstrained stochastic optimal control, constrained stochastic optimal control). Our next goal is to derive and compare different results for constrained and unconstrained stochastic optimal control problems for different performance functions and different budget constraints.

Final goal is to collect the results in a manuscript, submitted into the journal and present it at future events. As the topic is in the scope of the action, this will contribute to the outcomes and deliveries of the action through STSM.

We intend to continue this collaboration with between our sections, not only on this project but also in future projects within epidemical models.