Optimization of vaccination strategies based on mathematical models of epidemics

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Abstract

During the COVID-19 pandemic, it is important to promote the skills needed for analysing the disease course, including determining the relevance of vaccinations, especially among people who are unfamiliar with computer programming. During the lecture, the basic epidemiological model (SIR) and its modifications will be discussed, which enable the analysis of the importance of vaccination and the emergence of renewed waves of disease growth. Next, a literature model, extended SEIRD, which includes a more detailed division of the population into susceptible, latent, symptomatic and asymptomatic infected, recovered, and dead in eight age groups will be presented. Based on the SEIRD model, selected vaccination strategies will be discussed based on the vaccination rate (number of vaccinations/day), the effectiveness of vaccination, the moment of starting the vaccination campaign, and the order and percentage of vaccination in each age group. Selection of the optimal vaccination strategy should be based on the number of deaths by age group, the maximum number of people infected, and the duration of the pandemic. Students with no experience in independent programming can make use of the software that we have prepared and made available online here and here.

About the presenter

Prof. Krystian Kubica is a physicist and biochemist. He received the Ph.D. degree in natural sciences from the Agricultural University in Wrocław, in 1992, and the D.Sc. degree in biological sciences, specialization in biophysics from the University of Łódź, in 2004. His research interests include:

- Modelling of physiological processes (cholesterol homeostasis, gallbladder motility, gallstone formation, blood flow, homeothermia, spongy bone remodelling, pharma-cokinetics).
- Biophysics of biological membranes; studies on the properties of model lipid membranes (phase transitions, membrane fusion, electroporation).

• Theoretical studies of the interaction of biologically active molecules with biological membranes.

He is the author and co-author of several dozen papers in journals in the field of biophysics and biomedical engineering, and a co-author of several patents.