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Dynamics and Optimal Control in Epidemic Models

Shangbing Ai

Summer 2021 Research and Creative for Undergraduate Students (RCEU) Proposal

Dynamics and Optimal Control in Epidemic Models

Faculty Mentor:

Shangbing Ai, Professor
Department of Mathematical Sciences

Project Summary:

Since the outbreak of Covid-19 epidemic, many mathematical models have been proposed to study the epidemic. These studies have provided very useful information such as the computation of basic reproduction numbers R_0, prediction of the numbers of new infected cases, etc. Most of the models are compartmental models of ordinary differential equations (ODEs), based on the classical SEIR (Susceptible-Exposed-Infectious-Removed) models. In this project, we propose to remove the exposed compartment and study the dynamics of revised models, which are SIR models of **delay** differential equations with time delay depending on the latent period. We shall compare our study with those obtained from the ODE models.

Our second question is to study the optimal number of facilities (hospital beds, temporary hotels, etc.) needed for Covid-19 patients. We shall model this problem into an optimal control problem by introducing the control function into the above mathematical models. The objective is minimizing the cost in preparation of the facilities, etc. The mathematical questions to face are: (i) Establish existence and/or uniqueness of an optimal solution. (ii) Derive necessary and/or sufficient optimality conditions. (iii) Construct algorithms of the numerical approximation to the optimal solution

The solutions from this project are expected to provide insights in understanding the epidemic.

Student Prerequisites:

The perspective student should have good background in calculus, differential equations. The student should have high motivation for the proposed research projects.

Student Duties:

The student will be working about 40 hours per week during 10 weeks in summer 2020. Under the supervision of faculty mentor, the student is expected to learn additional necessary materials supporting this research, review scientific papers in the literature to understand the status of the

proposed problems, initiate and develop the methodology to tackle the problems, write algorithms and perform numerical simulations.

Mentor Supervision and Interaction:

The faculty mentor will be introducing the background to the student during the first two weeks. After that, meeting with the mentor will be set up on a weekly basis, reporting the progress, discussing any problems encountered and developing further strategies and techniques to tackle the problems. However, the student is encouraged to see the mentors for advice and suggestions whenever needed. At the end of the program, the student will make both oral and written presentations to the mentors on his/her research results. Publishable results will be written in LaTex and sent to appropriate journals for publication.