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Chase and Escape in Groups: Vampire Problem

One of the most important issues in our society is how to understand and deal with the spread of infectious diseases. This is important not only in physical space but in cyberspace as well. There have been numerical and theoretical models used to understand the phenomena of infectious spreads. SIR models such as the Kermack-McKendrick model are based on the population dynamics of "susceptible," "infected," and "recovered" populations. The contact process is another representative theoretical model.

The main purpose of this paper is to introduce the element of "chase and escape" into the above phenomena of infectious spreads. The problems of "chase and escape," also referred to as "pursuit and evasion," have a long history in mathematical literature [1]. They produce rather complex and elegant trajectories out of simple problem settings. Traditionally, the main interest has been the problems in which a single chaser try to catch a single evader. Recently, we introduced the paradigm "group chase and escape," in which one group chases another group [2]. It was motivated by recent research interests in the study of groups, or swarms, such as those of humans, animals, insects, and cars [3]. We have found that a rather complex behavior arises from the models for "group chase and escape."

Here, we will modify our original models for "group chase and escape" to better fit the models for infectious spread. Previously, when a chaser caught an evader, the evader perished. Therefore, the number of evaders decreased monotonically as the process continued. We will modify the process so that the evaders do not become extinct as they are caught but are instead converted or infected to become chasers. Heuristically, this is like vampires trying to increase their numbers by attacking people. In reality, a similar situation is the spread of rabies, in which the infection is transmitted through the bites of the infected. There are studies of models of the spatial spread of rabies. We will show that the element of "chase and escape" will bring in a new phase to the behaviors of the models.

References

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