Hackathon

Instructions

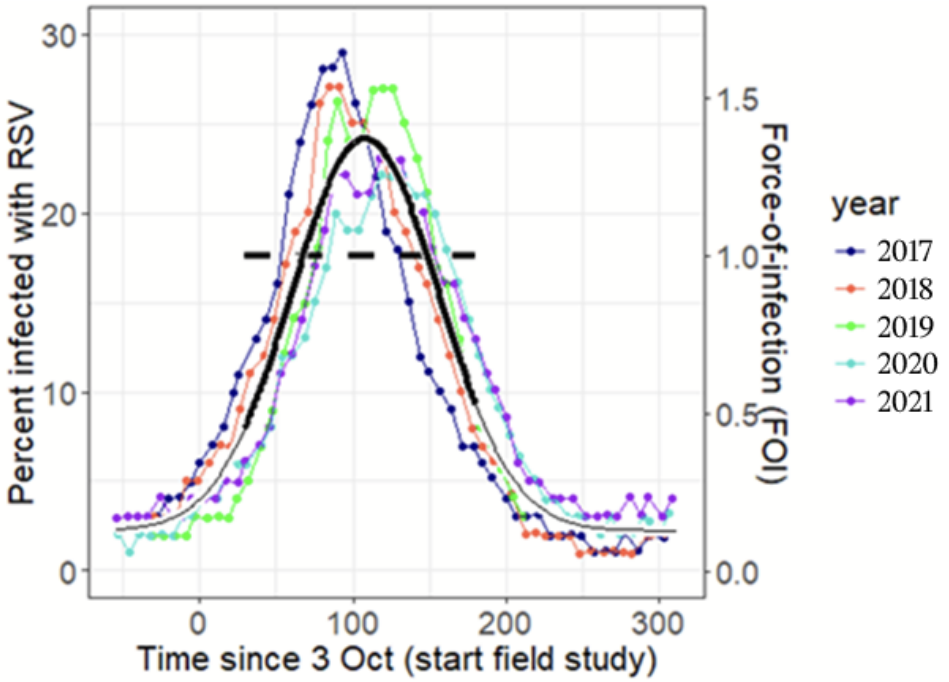
1. The competition will consist of groups of three students each.
2. Students are allowed to access any form of information available to them in order to solve the problem.
3. Participants are required to submit their final report in PDF format. The report must include the solutions to the problem and any codes involved in the process.
4. Late submissions will not be accepted under any circumstances.
5. Participants will be evaluated based on the accuracy and effectiveness of their solution, as well as the clarity and organization of their report.
6. The competition will be judged by a panel of experts in the relevant fields.
7. The winners of the competition will receive recognition for their achievements in the form of cash prize.

PROBLEM STATEMENT

In the year 2022, Gotham city, renowned for its high crime rate, experienced a catastrophic event five years ago, namely a viral outbreak that posed a grave threat to the lives of all its inhabitants. The outbreak brought the entire economy of the city to a grinding halt, exacerbating the already dire situation. In light of the calamity, all neighboring countries/cities have ceased providing assistance to Gotham, having lost all hope of salvaging the city.

Against this backdrop, the R&D division of Wayne Enterprises has been engaged in extensive research aimed at discovering a cure for the viral infection for several years. The experts who toiled to gain a better understanding of the infection were able to compile the following comprehensive information about it.

1. The rate of infection seems to have a seasonality associated with it:



The above curve follows a gaussian distribution with following parameters

$$\sigma = 48\,days,\ \mu = 162\,days,\ A = 2633,\ BL = 2.25$$

$$FOI\,(t) = BL + A \times \left(\frac{1}{\sigma \times (\sqrt{2\pi})}\right) \exp\, exp\left(-\frac{(t-\mu)^2}{2\sigma^2}\right)$$

(where σ is the standard deviation of the Gaussian curve, μ is the time from August 10th to FOI peak, A is the magnitude between the offseason and peak incidence rates, and BL is the relative off-season incidence rate.)

2. A promising large molecule has been identified as a potent agent in conferring protection against infections. To comprehensively characterize the pharmacokinetics of this molecule, it underwent initial testing on 500 mice. The results of this study demonstrated that the molecule's clearance rate

from the system was determined to be 5.1 mL/day/kg, while the incompartmental distribution rate was found to be 43.53 mL/day/kg. Furthermore, the central volume and peripheral volume were calculated to be 52.3 mL/kg and 45.3 mL/kg, respectively.

3. Dose studies conducted on animals demonstrated that a minimum concentration of 5ug/mL in the bloodstream is required to provide effective protection against the pathogen.

   The scientific community tasked with finding a cure for the virus has been plagued by significant setbacks, with many researchers succumbing to the illness or conceding defeat. However, you and two of your colleagues have been appointed to join the efforts in this crucial endeavor. Leveraging your collective expertise and the available information on the disease, your mandate is to determine the First-in-Human (FIH) dose for the general population, ensuring that at least 75% of the populace can be effectively treated. It is important to note that each individual is required to receive a single dose every 240 days.

   [HINT TO SOME PUBLICLY AVAILABLE LITERATURE

   To perform a comprehensive analysis for determining the First-in-Human (FIH) dose for the general population, it is imperative to consider inter-individual variability among the population. Assuming a population of 1000 individuals in Gotham, it is important to note that each individual possesses distinct characteristics that may influence drug pharmacokinetics (PK).

   To account for these differences in PK, reference can be made to the publication at ***http://dx.doi.org/10.4161/mabs.29095****, which provides valuable insights into inter-individual variability. Additionally, to determine the appropriate dose, it is necessary to scale between species using established techniques, as outlined in the article at* ***10.1111/j.1365-2125.2005.02239.x***

   While inter-individual variability needs to be taken into account, the minimum efficacious blood concentration can be assumed to be uniform across all species. Modelling techniques, as described in the publication at ***https://pharmacy.ufl.edu/files/2013/01/two-compartment-model.pdf****, can be employed to determine the optimal dose.]*