Examen realizado

Asignatura: INGLÉS CIENTÍFICO 28/05/2021 18:30
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INSTRUCTIONS AND HINTS
* Read the text carefully before proceeding with your summary
* Dictionaries are allowed.
* Deviating from the answer length limits will be penalized.
* Avoid literal translations (word for word). Try to understand the text and explain it in your own words. The use of literal sentences from the original text will be penalized.
* To prevent grammatical errors use simple and short sentences. If you end up with a very long sentence try to split it up.
* Notice that the mark obtained here represents 60% of your final mark.

A continuación se muestra el examen

Pregunta 1

(J.M Heffernan, R.J Smith, and L.M Wahl (2005). Perspectives on the basic reproductive ratio. J.R.Soc. Interface, 2(4):281-293)

The basic reproductive ratio, R_0, is a key concept in epidemiology, and is inarguably `one of the foremost and most valuable ideas that mathematical thinking has brought to epidemic theory' (Heesterbeek & Dietz 1996).

[...]

As a general definition, R_0 is the expected number of secondary individuals produced by an individual in its lifetime. The interpretation of `secondary', however, depends on context. In demographics and ecology, R_0 is taken to mean the lifetime reproductive success of a typical member of the species. In epidemiology, we take R_0 to mean the number of individuals infected by a single infected individual during his or her entire infectious period, in a population which is entirely susceptible. For in-host dynamics, R_0 gives the number of newly infected cells produced by one infected cell during its lifetime, assuming all other cells are susceptible.

[...]

2. Derivations of R_0 from a deterministic model

The derivation of R_0 from a non-spatial, deterministic model is fairly straightforward from first principles. The survival function method (§2.1) gives the `gold standard' determination of R_0, and is applicable even when non-constant transmission probabilities between classes (i.e. non-exponential lifetime distributions) are assumed.

[...]

2.1 Survival function

The method we describe as the `survival function' approach is, in essence, a first-principles definition of R_0, and thus has a rich history of use. The approach is described in detail in Heesterbeek & Dietz (1996), who also give an interesting historical overview.

Consider a large population and let $F(a)$ be the probability that a newly infected individual remains infectious for at least time a. This is called the survival probability. Also, let $b(a)$ denote the average number of newly infected individuals that an infectious individual will produce per unit time when infected for total time a. Then, R_0 is given by:

$$R_0 = \int_0^\infty b(a)F(a)\ d\ a$$

As this expression yields R_0 by definition, this approach will be appropriate for any model in which closed-form expressions can be given for the underlying survival probability, $F(a)$, and the infectivity as a function of time, $b(a)$. In particular, it is straightforward to handle situations in which infectivity depends on time, since infection, or other transmission probabilities between states, vary with time. Thus, this derivation of R_0 is not restricted to systems described by ordinary differential equations (ODEs).

This method can also be naturally extended to describe models in which a series of states are involved in the `reproduction' of an infected individual. As an example of the latter technique, consider epidemic modelling of malaria. An infected human may pass the infection to a mosquito, which may in turn infect more humans. This complete cycle must be taken into account in our derivation of R_0, which we might expect to yield the total number of infected humans produced by one infected human. In general, if only two distinct infectious states are involved in such an infection cycle, $F(a)$ can be defined as the probability that an individual in state 1 at time zero produces an individual who is in state 2 until at least time a. Similarly, $b(a)$ is the average number of new individuals in state 1 produced by an individual who has been in state 2 for time a. In modelling malaria, $F(a)$ could be the probability that a human infected at time zero produces an infected mosquito which remains alive until at least time a. In more concrete terms, $F(a)$ would be the integral of the following product:

$$\begin{aligned} F(a) = \int_0^a \ & \text{prob[human infected at time } 0 \text{ exists at time t]} \\ & \times \text{prob[human infected for tot. time t infects mosquito]} \\ & \times \text{prob[infected mosquito lives to be age (a} - t)]\ dt \end{aligned}$$

while $b(a)$ would simply be the average number of humans newly infected by a mosquito which has been infected for time a. (Note that we could also take the infected mosquito as state 1, deriving an analogous expression which would yield the same value of R_0)

Unfortunately, derivations such as the equation above become increasingly cumbersome as this method is extended to infection cycles involving three or more states (Hethcote & Tudor 1980; Lloyd 2001b; Huang et al. 2003).

(Este contenido está relacionado con las preguntas enunciadas a continuación y no requiere respuesta por parte del estudiante)

Pregunta 2

Q1 (5 points). Write a summary in English of the text above in scientific style. Your essay should be at least 200 ± 50 words (i.e. 1200 ± 300 characters).

In this paper, the author explains some highlights about the basic reproductive ratio, a key parameter involved in many mathematical models of epidemics and one of the most important contributions to epidemiology.

The ratio interpretation depends on the in-host dynamics modeled phenomena because it models the secondary individuals generated by an infected primary one.

The explicit definition of the ratio is given in terms of an elemental integral. This integral involves the product between the survival function and the infectivity. The survival function is the probability that an infected subject persists contagious during a concrete time. The infectivity is the average number of secondary subjects that the first one produces during a given time.

This basic-terms definition allows studying the epidemics from different points of view. For example, if the infectivity, the survival function or both vary over time, the problem can be solved as an EDO depending on time.

In addition, if we consider intermediary events during the infection process, the survival or the infection functions can be broken down into the probabilities of different events, as the malaria modeling.

The malaria model considers the infected humans and the mosquitoes as the transmitter. So, the ratio is defined in terms of human survival function, its infectivity related to the mosquito bite, and mosquitoes' survival function.

To sum up, the text provides a general introduction to the basic reproduction ratio, gives an explicit formula to compute it and explains a particular case where the general formula can be extended.

Pregunta 3

Q2 (5 points). Elaborate on the following controversial statement by the russian mathematician Vladimir Igorevich Arnold in his address at the discussion on teaching of mathematics in Palais de Découverte in Paris on 7 March 1997. Your discussion should be in English and at least 150 words long.

"*Mathematics is a part of physics. Physics is an experimental science, a part of natural science. Mathematics is the part of physics where experiments are cheap.*

The Jacobi identity (which forces the heights of a triangle to cross at one point) is an experimental fact in the same way as that the Earth is round (that is, homeomorphic to a ball). But it can be discovered with less expense.

In the middle of the twentieth century it was attempted to divide physics and mathematics. The consequences turned out to be catastrophic. Whole generations of mathematicians grew up without knowing half of their science and, of course, in total ignorance of any other sciences. They first began teaching their ugly scholastic pseudo-mathematics to their students, then to schoolchildren (forgetting Hardy's warning that ugly mathematics has no permanent place under the Sun).

Since scholastic mathematics that is cut off from physics is fit neither for teaching nor for application in any other science, the result was the universal hate towards mathematicians - both on the part of the poor schoolchildren (some of whom in the meantime became ministers) and of the users."

In 1997, Igorevich Arnold introduced the idea that Mathematics was part of Physics. Moreover, he embraced the idea that, during the last century, the division of these two fields created multiple batches of mathematicians unable to investigate and work outside their field and with empirical applications. This statement generated controversy across cientific community.

However, in order to study the rest of sciences profoundly, scientists need to develop deep knowledge in mathematics. They need mathematical models, statistical tests and other techniques to prove their findings rigorously. This rigor is achieved intrinsically inside the pure mathematical logic. It holds up the idea that other sciences feed on mathematics and not vice versa.

Furthermore, the assumption that mathematics is an ingredient from another science but not separate science in itself is erratic, especially if the empirical approach to prove it is how far pure mathematicians are from the applications in other sciences. Perhaps, pure mathematicians are far from applications because Mathematics is a science by itself, and they do not need deep knowledge about other sciences.

In another way, from the most theoretical to those closer to society, all sciences need others to develop and improve themselves. For example, in the last twenty years, the demand of pure mathematicians has risen dramatically in companies due to their abilities in problem-solving. However, it does not mean that Mathematics is part of business as Arnold said, substituting Economics for Physics.

Finally, as a particular example, during the development of relativity, Einstein needed the support of pure mathematicians as

Minkowski was. He helped him to develop the topological arguments of the theory. So, that is an example of collaboration and expertise sharing between the two sciences.

To sum up, the assumption that mathematicians do not have a wide knowledge of other fields does not make the less valuable for other fields, notwithstanding their theoretical knowledge.

Observaciones del estudiante:

<Sin observaciones>

Observaciones del docente:

<Sin observaciones>

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