



آزمون مدل سازی

امتحانات انتخاب تیم ایران در المپیاد جهانی
زیست شناسی 2020

مدت آزمون

100 دقیقه

تاریخ برگزاری

12 خرداد 1399

تعداد سوالات

5 سوال

نکات خاص آزمون

- مجموع نمرات آزمون 125 نمره
- نمره منفی تنها در موارد ذکر شده
- زمان خود را مدیریت کنید

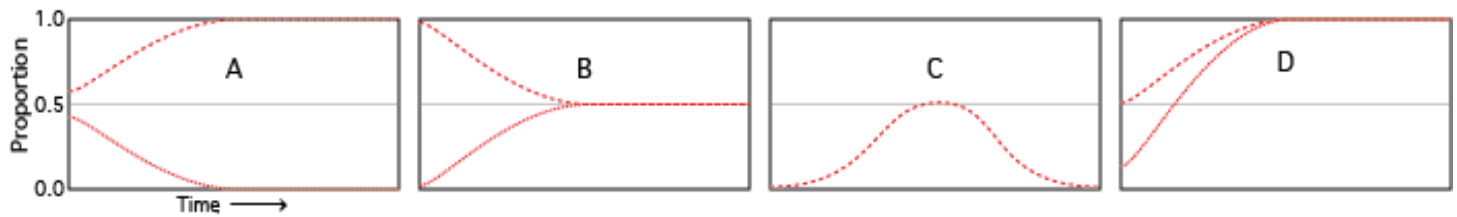
در این کادر چیزی ننویسید	تصحیح اول	تصحیح دوم	تجدید نظر

کد دانش پژوه (در این بخش چیزی ننویسید): []

1. There are three different types of side-blotched lizards, each playing a different strategy to earn the right to mate with the females. The orange throat is an aggressive lizard, which attempts to control a large area and mate with all females in this area. The yellow throat is a sneaky lizard, which "beats" the aggressive lizard by mimicking the behavior of females in order to mate undetected in an aggressive lizard's area. The blue throat is a lizard that guards one female specifically for mating, making it impossible for the sneakers to succeed. However, this third type isn't strong enough to overcome the aggressive type.

Conclude a Pay-off Matrix for the strategies in this evolutionary game and draw a qualitative plot for the relative abundance of these three polymorphs in time. Also draw a simplex for the system that corresponds to the dynamics in your plot. (Consider the orange throats to be in higher abundance in the beginning.) (20 points)

2. This set of questions refers to the four graphs shown here. Each graph represents change over time in an evolutionary game. The y-axis is the proportion of the population playing a strategy and the x-axis is time. If there are two curves on the same graph, it means that either curve is possible for the strategy. (30 points total)



The questions ask you to choose the graph that best fits a situation; you may use a graph more than once or not at all.

A) Which graph shows the proportion of hawks in a Hawk-Dove game where the value of the resource is *greater* than the cost of losing a fight? (5 points, -1 negative point)

A		B		C		D		None	
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B) Which graph **could** show the proportion of hawks in a Hawk-Dove game where the value of the resource is *less* than the cost of losing a fight? (5 points, -1 negative point)

A		B		C		D	
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C) What is the ratio between the value of the resource and cost of losing a fight based on the plot you selected in the previous question? (5 points)

D) Which graph shows the proportion of strategy X in this game? (5 points, -1 negative point)

	X	Y
X	1	0
Y	0	1

A		B		C		D		None	
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E) Which graph shows the proportion of strategy X in this game? ?(5 points, -1 negative point)

	X	Y
X	0	1
Y	1	0

A		B		C		D		None	
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F) Which graph shows a dynamic that you would never see in a symmetric two-strategy game? ?(5 points, -1 negative point)

A		B		C		D		None	
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3. Consider two types, A and B. Denote by u_1 the mutation rate from A to B: u_1 is the probability that the reproduction of A leads to B. Conversely, denote by u_2 the mutation rate from B to A. Let x and y denote the frequencies of A and B which sum up to 1. If A and B have the same fitness ($a = b = 1$), write down a system of differential equation for the change of x and y , and calculate their equilibrium frequencies in terms of u_1 and u_2 .
?(25 points)

4. Suppose a population with two sub-population A and B. Denote by x_A the frequency of A and by x_B the frequency of B. The vector $\vec{x} = (x_A, x_B)$ defines the composition of the population. Denote by $f_A(\vec{x})$ the fitness of A and by $f_B(\vec{x})$ the fitness of B. The selection dynamics can be written as:

$$\dot{x}_A = x_A[f_A(\vec{x}) - \phi]$$

$$\dot{x}_B = x_B[f_B(\vec{x}) - \phi]$$

In which the average fitness is given by $\phi = x_A f_A(\vec{x}) + x_B f_B(\vec{x})$

The pay-off matrix for the game between these two sub-populations is defined as below:

$$\begin{array}{cc} & \begin{array}{cc} A & B \end{array} \\ \begin{array}{c} A \\ B \end{array} & \begin{pmatrix} a & b \\ c & d \end{pmatrix} \end{array}$$

What are x_A and x_B in terms of a, b, c , and d , If the subpopulations A and B stably coexist? (note that x_A and x_B sum up to 1) (25 points)

5. The Plots Below Shows the changes correspond to three types of cancer cells in a single heterogeneous tumor, simulated overtime under the treatment of a drug. T_p and T_- are two types of mutants that originate from T_+ (the main cell population of the tumor in the beginning). Maximum Tolerated Dose (MTD) indicates the maximum dose tolerated by normal tissues, which is conventionally used for tumor therapy. Based on the relative population dynamics of the cells, **qualitatively** explain how "Adaptive Therapy" can help the patient. How can this system resemble a game, and who are the players? Write down a system of differential equations and explain each parameter. (25 points)

