Natural Selection Among Playing Cards

Evolution progresses by **cumulative natural selection** acting on **random mutations**.

A new molecule or structure that yields a greater Darwinian fitness than an existing one is not begun from scratch but by selecting a mutation that improves upon the existing version.

The Game

Two versions of the same card game will be played, one with and one without cumulative selection. In each, shuffling the cards will represent mutation. Each round of playing is equivalent to producing a new generation of an organism. The object is to determine how many generations are needed to produce an "organism" with a specific and improbable set of properties. That "organism" is a suit of cards sorted into ascending order from ace to king. When the game is played with cumulative selection, the number of rounds needed to produce the organism is fairly small; when it is played without cumulative selection, the number is likely to be so large that the goal will not be achieved in any reasonable period of time such as a class session.

Materials

1 deck of cards - one suit per team (8 students)
Tally sheet (for rounds counted)
Discussion & Response Sheet

Playing the Game

Divide the class so that there are two students per team (3 students are okay in odd head counts).

Each team gets one suit in the deck to work with

Different instructions for odd-numbered teams and even-numbered teams

For Odd-numbered teams:

1. Shuffle cards
2. Record round
3. Are they in order?
4. No – shuffle again
5. Yes – How many rounds?

For Even-numbered teams:

1. Shuffle cards
2. Record round
3. Is the card an ACE – Yes – Put in "Organism stack"
4. NO – reshuffle and repeat 2 & 3
5. How many rounds to get to organism?

Name _____ **Date** _____

Natural Selection Among Playing Cards cont . . .

1. In what ways is shuffling the equivalent of genetic mutations? In what ways is it not?

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2. Does the model distinguish between phenotype and genotype?

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3. What is the one, critical respect in which the actions of the odd- and even-numbered teams differed? What is the biological equivalent of this difference?

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4. What, in the game, represented selection?

   _____

5. Why, in the game, was selection cumulative?

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6. What was the average number of observed generations needed to evolve the organism by the even-numbered teams? How does this figure compare to the calculated average number of generations? (Hint: On the average, in each round, the ace has a 1:13 chance of coming up, the "2" has a 1:12 chance, etc. The sum of the numbers from 1 to 13 is 91.)

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7. What was the average number of observed generations needed to evolve the organism by the odd-numbered teams? Do we have the data to answer this question? What is the calculated number of generations? (Hint: We need to have the ace show up first, with a probability of 1/13, then the "2", with a probability of 1/12 . . to the king with a probability of 1/1. 1/13 X 1/12 X 1/11 . . . 1/1 is approximately 1.6×10^{-10} . $1/1.6 \times 10^{-10}$ is about 6.2×10^{9}. Shortcut: 13! = 6,227,020,800.)

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8. How many times faster is the evolution of our model organism with versus without cumulative selection among the mutations?

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