# Introduction to Complexity (Spring 2013)

**4.6 Submit Unit 4 Homework » Unit 4 Homework**

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**Instructions 1**

Below are the graded questions. To see the ungraded questions, download Homework4.pdf from the Course Materials page.

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**Question 2**

Maxwell's demon was invented by James Clerk Maxwell in order to show that

- The second law of thermodynamics is wrong
- The second law of thermodynamics is true only in the statistical sense
- Entropy can be decreased if work is applied
- Entropy can be increased if work is applied
- A group of molecules does not obey the laws of thermodynamics

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**Question 3**

Recall the three-window slot machine example described in Unit 4. 3. Recall that a microstate is a specific set of three fruits (one in window, e.g., "cherry, pear, orange"), and that we calculated that there are 125 possible microstates, since there are five possible fru could show up in each window, and 5 × 5 × 5 = 125. How many possible microstates would there be for a slot machine with four wind five possible fruits that could show up in each window?

- 125
- 250
- 625
- 1024
- 256

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**Question 4**

For the three-window slot machine with five possible fruits per window, consider the macrostate **"Exactly two pears"**. Select the true A, B, or C below.

[Note: you can either calculate this mathematically, or by downloading SlotMachine.nlogo from the Course Materials page and runni macrostate. To do so, select "Exactly two pears" under "Macrostates"), and run for 1000 pulls. OPTIONAL: If you use the Netlogo moc predict the correct answer below before you run it and see if your prediction is correct. ]

If you downloaded SlotMachine.nlogo before March 11, please redownload it.

- The number of microstates corresponding to this macrostate is *much higher* than the number of microstates **not** corresponding to this macrostate.
- The number of microstates corresponding to this macrostate is *much lower* than the number of microstates **not** corresponding to this macrostate.
- The number of microstates corresponding to this macrostate is *about equal* to the number of microstates **not** corresponding to this macrostate (i.e, for 1000 within 200 of each other).

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**Question 5**

Same as question 3, but this time for the macrostate **"At least two of the same kind"**. Remember to do "Reset" before clicking on "Go true statement below.

- The number of microstates corresponding to this macrostate is *much higher* than the number of microstates **not** corresponding to this macrostate.
- The number of microstates corresponding to this macrostate is *much lower* than the number of microstates **not** corresponding to this macrostate.
- The number of microstates corresponding to this macrostate is *about equal* to the number of microstates **not** corresponding to this macrostate (i.e, for 1000 within 200 of each other).

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**Question 6**

Same as question 3, but this time for the macrostate **"One orange and one cherry"**. Remember to do "Reset" before clicking on "Go". true statement below.

- The number of microstates corresponding to this macrostate is *much higher* than the number of microstates **not** corresponding to this macrostate.
- The number of microstates corresponding to this macrostate is *much lower* than the number of microstates **not** corresponding to this macrostate.
- The number of microstates corresponding to this macrostate is *about equal* to the number of microstates **not** corresponding to this macrostate (i.e, for 1000 within 200 of each other).

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**Question 7**

Same as question 3, but this time for the macrostate **"No apples or cherries"**. Remember to do "Reset" before clicking on "Go". Selec statement below.

- The number of microstates corresponding to this macrostate is *much higher* than the number of microstates **not** corresponding to this macrostate.
- The number of microstates corresponding to this macrostate is *much lower* than the number of microstates **not** corresponding to this macrostate.
- The number of microstates corresponding to this macrostate is *about equal* to the number of microstates **not** corresponding to this macrostate (i.e, for 1000 within 200 of each other).

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**Question 8**

Same as question 3, but this time for the macrostate **"At least one lemon"**. Remember to do "Reset" before clicking on "Go". Select tl statement below.

- The number of microstates corresponding to this macrostate is *much higher* than the number of microstates **not** corresponding to this macrostate.
- The number of microstates corresponding to this macrostate is *much lower* than the number of microstates **not** corresponding to this macrostate.
- The number of microstates corresponding to this macrostate is *about equal* to the number of microstates **not** corresponding to this macrostate (i.e, for 1000 within 200 of each other).

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**Question 9**

Suppose you have two biased coins, Coin A, which comes up heads 90% of the time, and Coin B, which comes up heads 55% of the tir consider each independently as a message source, which one will have the **higher** Shannon information content?

(Hint: For questions 8–10, you don't have to calculate the information content -- just use what you know about the intuitive definition information content.)

- Coin A
- Coin B

**Question 10**

Which will have higher Shannon information content: A fair (six-sided) die, or a biased die for which "1" comes up more often than 1 time?

- Fair die
- Biased die

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**Question 11**

Which will have higher Shannon information content: A fair six-sided die or a fair twelve-sided die?

- Six-sided die
- Twelve-sided die