CS 5200 Fall 2019 HW 01

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Due Monday, September 02, 2019, 11:59PM

Submit your HW as a single PDF file containing all your proofs, answers, scans, programs, and sample runs. Handwritten work will not be reviewed. All your work should be well-formatted and clearly explained. Programs should be well-commented.

Problems

1. (5 points) *Read the Syllabus*
   Be sure to read the syllabus carefully. Submit a signed statement that you have read the syllabus carefully. You should scan the page that contains your statement and signature and include it at the beginning of the homework assignment.

2. (10 points) Answer the following questions. With each answer include the source that you used. Each subquestion is worth 1 point except as noted.

   (a) What is the estimated age of the Earth?

   (b) What is the estimated age of the Solar System?

   (c) What is the estimated age of the Milky Way?

   (d) What is the estimated age of the Universe?

   (e) What is the expected life span of the Earth?

   (f) (2 points) How long before the Earth will become uninhabitable by humans? What is the most likely sequence of events that will make the Earth uninhabitable? Can humans do anything to extend the time horizon for this event?

   (g) What is the expected life span of the Solar System? How will it end?

   (h) What is the expected life span of the Universe? How will it end?

   (i) If it takes $2^{64} - 1$ moves to move all the disks from one needle to another in the Tower of Hanoi puzzle, and each move takes one second, how long will it take to move a complete tower of 64 disks from one needle to another. What percentage is this of the expected lifespan of the Universe?

3. (10 points) "The Nine Billion Names of God" is a famous science fiction story written by Arthur C. Clarke, who is also the author of *2001: A Space Odyssey*.

The following Wikipedia article gives more background about it: `https://en.wikipedia.org/wiki/The_Nine_Billion_Names_of_God`. The story has been reprinted in many different formats and collections, and has even been made into videos available on YouTube. Find some version of the story and read it. Then answer the following questions about it. Note, some questions have multiple correct answers since you can make different assumptions. I expect you to make some reasonable assumptions and explain what your assumptions are and give some justification for them.

(a) (1 point) How many different strings of length 9 can be formed from 26 letters?

(b) (1 point) How many different strings of length 9 can be formed from an alphabet having k letters?

(c) (1 point) What is the smallest alphabet size that can generate at least 9 billion different strings of length 9.

(d) (2 points) Let A be an alphabet with k characters. How many strings of length n can be produced using A that have the property that there are never two consecutive letters that are equal? For example, let A = { a, b, c }. The only acceptable strings of length 3 would be aba, abc, aca, acb, bab, bac, bca, bcb, cab, cac, cba, and cbc.

(e) (1 point) Roughly, how much paper would it take to print out 9 billion words assuming one word per line of paper? Make explicit your assumptions.

(f) (1 point) How much would it cost to buy that much paper? How many file cabinets would it require to store all these pages? Again, make explicit your assumptions.

(g) (1 point) From the story, how much time were the monks expecting the project to take? What would be a reasonable number of people to carry out the project given the projected time span?

(h) (1 point) What was the time span allocated to the computer to carry out the project? How quickly would the computer have to print to carry out the task in the given amount of time?

(i) (1 point) What did you think of the story? Did it make you think about large numbers?

4. (10 points) Do Problem 1 on page 21 of the Chapter 1 Recursion notes available on CANVAS.

5. (10 points) Do Problem 6 on page 21 of the Chapter 1 Recursion notes available on CANVAS.

6. (10 points) Do Problem 7 on page 21 of the Chapter 1 Recursion notes available on CANVAS.

7. (10 points) Do Problem 9 on page 22 of the Chapter 1 Recursion notes available on CANVAS.

8. (10 points) Do Problem 11 on page 23 of the Chapter 1 Recursion notes available on CANVAS.

9. (10 points) Do Problem 14 on page 24 of the Chapter 1 Recursion notes available on CANVAS.

10. (10 points) There is an anagram generator in the notes for Lecture 2. Write a different anagram generator that makes only one recursive call instead of n recursive calls as is done by the program in the notes. Set up an experiment to compare the running times of the two programs. Produce a table showing your results. Carry out the calculations until you see a difference in the results or until you have exhausted the resources necessary to run the anagram generator. Describe your results, and project the future behavior of these two algorithms.

11. (5 points) Find the Monty Python skit that deals with Rule #6, watch it and answer the following questions.

    (a) (1 point) Where does the skit take place?

    (b) (1 point) What sort of gathering is represented in the skit?

    (c) (1 point) What organization is sponsoring the meeting?

    (d) (1 point) How many people are at the meeting and what are their names?

    (e) (1 point) What is Rule #6?