CSE 312 Midterm II

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I. Question (24 points)

Let A = $\{a_1, a_2, \ldots, a_n\}$ and B = $\{b_1, b_2, \ldots, b_n\}$ be two sets of numbers. Consider the problem of finding their intersections, i.e., the set C of all the numbers that are both in A and B.

a) Design a brute-force algorithm for solving this problem in $O(n^2)$ time.
b) Design a presorting-based algorithm for solving this problem in $O(n \log n)$ time.

II. Question (16 points)

How many character comparisons will be made by Horspool's algorithm in searching for each of the following patterns in the binary text of 1000 ones?

a) 00000
b) 11000

III. Question (20 points)

Consider the following linear programming problem

$$\begin{aligned} maximize\ & c_1x + c_2y \\ 2x + y &\leq 10 \\ x + 2y &\leq 8 \\ x &\geq 0 \\ y &\geq 0 \end{aligned}$$

where c_1 and c_2 are some real numbers not both equal to zero.

a) (4 pt) Draw the feasible region.
b) (4 pt) Identify extreme points.
c) (6 pt) Give an example of coefficient values c_1 and c_2 for which the problem has a unique optimal solution. Explain your example.
d) (6 pt) Give an example of coefficient values c_1 and c_2 for which the problem has infinitely many optimal solutions. Explain your example.

IV. Question (16 points)

The object of Kevin Bacon game is to link a movie actor to Kevin Bacon via shared movie roles. The minimum number of links is an actor's Bacon number. For instance, Tom Hanks has a Bacon number of 1; he was in Apollo 13 with Kevin Bacon. Sally Fields has a Bacon number of 2, because she was in Forrest Gump with Tom Hanks, who was in Apollo 13 with Kevin Bacon. Almost all well-known actors have a Bacon number of 1 or 2. Assume that you have a comprehensive list of actors, with roles, give an algorithm to find an actor's Bacon number.

V. Question (24 points)

You are given a text containing only characters (a, b, c, d). Your task is to find the shortest subsequence of this text that will contain all four characters. For example, if the text is caababddbcddbaddbbaba, then the shortest subsequence is cddba.

a) Design a brute-force algorithm for solving this problem in $O(n^3)$ time.
b) Design a dynamic programming-based algorithm for solving this problem in $O(n)$ time.