Question 1 (Class)

Courtesy of Martha Palmer, Ph.D., from University of Colorado, Boulder

Tony has his birthday party at Chuck E. Cheese's. Aside from playing lots of video games and eating lots of pizza, he and his guests had a private room with four games all to themselves. Each of the four games was a table game that was arranged along one wall of the room. Table 1 is on the far left, table 2 is next to it, table 3 is next, and table 4 is the farthest to the right (see the diagram).

Left-to-right arrangement of tables:

TABLE 1 TABLE 2 TABLE 3 TABLE 4

You have to decide what game and what person is at each of the four tables based on the following facts:

1. Tony and his three best friends (Steven, Donna, and Randy) were each at a different table.
2. There's only one game (foosball, billiards, air hockey, ping-pong) at each table.
3. The game at table 1 is foosball, and it is not being played by Steven.
4. The billiards table is somewhere to the left of the air hockey table.
5. Randy is playing the game at table 2 or table 4.
6. The ping-pong table is two tables to the left of where Donna is playing.

Formulate as a constraint satisfaction problem.

Variables –

Constraints –

Backtracking Search

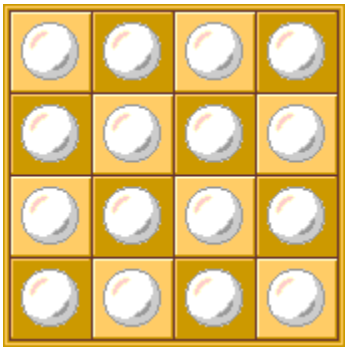
For each constraint propagation procedure below, diagram the steps that the backtracking search algorithm would take to solve this problem. Use the Minimum Remaining Values (MRV) and Least Constraining Value (LCV) heuristics to guide your search.

1. Backtracking search with Forward Checking

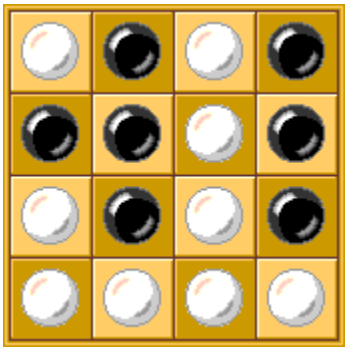
2. Backtracking search with Arc Consistency (Use back)

Question 2 (Class)

In the game of Fiver, one has a grid of black and white squares and repeatedly selects squares to flip. Each flip changes not only the color of the selected square, but also the adjacent squares to the north, south, east, and west. Starting from a given configuration, the goal is to turn all the squares black. For this problem, assume the all white board is the starting configuration.



Start



After selecting (2,3) and (4,3)

Goal

a. Formulate Fiver as a search problem. What are the states (including start and goal), successor function, and cost function?

b. Describe a non-trivial admissible heuristic function for this problem.

c. Explain why no optimal solution will select the same square twice.

d. Formulate Fiver as a general CSP: what are the variables, domains, and constraints. Remember that general CSPs may have constraints on any subset of variables, not only pairs of variables.

e. Which formulation do you think will result in a more efficient solution? Why?

Question 1 (Homework)

You must arrange three statues in an exhibit hall: an ice carving of a swan (i), a gold lion (g), and a marble abstract piece (m). There are three tables, 1, 2, and 3, arranged in a row, with 1 closest to the door and 3 farthest into the exhibit hall. It is a hot day and so the ice carving cannot be nearest the door. Your manager also informs you that it will look bad to have to animal sculptures on adjacent tables. Reality tells you that each table must have a different sculpture. If we formulate this problem as a binary CSP with variables X_1, X_2, and X_3, each with domain {i, g,m}:

a. *What are the unary constraint(s) (list them explicitly)*

b. *What are the binary constraint(s) (list them explicitly)*

Assume we enforce the unary constraint(s) in pre-processing for the remaining parts:

c. *If we assign X_3 = i, show the domains of the remaining variables after forward checking.*

d. *If no variables are assigned, show the initial domains after running arc consistency.*

e. *If it's a cool day, and we drop the requirement that the ice swan cannot be nearest the door, what are the initial domains after running arc consistency?*