–Tutorial -2

Question 1: Explain why problem formulation must follow goal formulation.

In goal formulation, we decide which aspects of the world we are interested in, and which can be ignored or abstracted away. Then in problem formulation we decide how to manipulate the important aspects (and ignore the others). If we did problem formulation first we would not know what to include and what to leave out. That said, it can happen that there is a cycle of iterations between goal formulation, problem formulation, and problem solving until one arrives at a sufficiently useful and

Question 2:

Give a complete formulation for each of the following problems. Choose a formulation that is precise enough to be implemented.

a. There are six glass boxes in a row, each with a lock. Each of the first five boxes holds a key unlocking the next box in line; the last box holds a banana. You have the key to the first box, and you want the banana.

- State representation: a glass box which holds a key or a banana
- Initial state: as described in the question.
- Goal test: you have banana.
- Actions: open any box you have the key for, get the contents of any open box.
- Transitional model (Successor function): generates new states by applying the actions: a box is opened, or the content has been obtained.
- Cost function: number of actions.

b. You start with the sequence ABABAECCEC, or in general any sequence made from A, B, C, and E. you can transform this sequence using the following equalities: AC = E, AB = BC, BB = E, and E*x* = *x* for any *x*. for example, ABBC can be transformed into AEC, and then AC, and then E. your goal is to produce the sequence E.

- State representation: State is represented by a string of characters
- Initial state: ABABAECCEC.
- Goal test: is the state E
- Actions: apply an equality substituting one subsequence for the other.
- Transitional model (Successor function): generates new sequence by applying the actions
- Cost function: number of transformations.

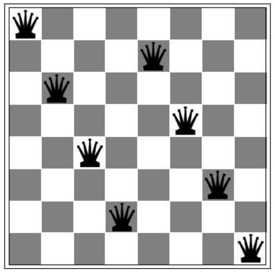
C. There is an *n* x *n* grid of squares, each square initially being either unpainted floor or bottomless pit. You start standing on an unpainted floor square, and can either paint the square under you or move onto an adjacent unpainted floor square. You want the whole floor painted.

- State representation: each square might be painted or unpainted
- Initial state: all floor squares unpainted, you start standing on one square unpainted floor square.
- Goal test: all floor squares painted.
- Actions: paint current tile, move to adjacent unpainted floor tile.
- Transitional model (Successor function): generates new states by applying the actions: agent is moved to an unpainted floor square, or returns a painted floor square.
- Cost function: number of moves.

D. A container ship is in port, loaded high with containers. There are 13 rows of containers, each row is 15 containers wide and 5 containers tall. You control a crane that can move to any location above the ship, pick up the container under it, and move it into the dock. You want the ship unloaded.

- State representation: each container can be unloaded or not yet
- Initial state: all containers stacked on the ship.
- Goal test: : all containers unloaded.
- Actions: move crane to a certain location, pick up a container, put down container.
- Transitional model (Successor function): generates new states by applying the actions: the crane is moved to a specific location, a container has been picked up, a container has been put down.
- Cost function: time taken to unload ship.

Question 3: Give formulation for each of the following problems.



1. **The 8-queens**

- State representation: All possible arrangements of 8 queens on the board, one per column in the Left most 8 columns, with n queen attacking another.
- Initial state: No queens on the board.
- Goal test: 8 queens are on the board, none attacked.
- Actions: add a queen to any square in the leftmost empty column such that it is not attacked by any other queen.
- Transitional model (Successor function): Return the board with a queen added to specified square.
- Cost function: Each move costs 1. Sum of steps.

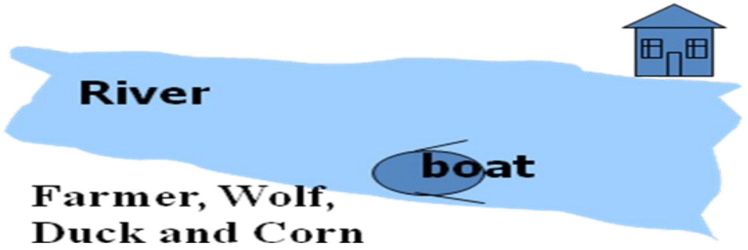
Question 3: Give formulation for each of the following problems.

2. **You have to color a planar map using only four colors, in such a way that no two adjacent regions have the same color.**

- State representation: Map with each state assigned a color or none.
- Initial state: No regions colored.
- Goal test: All regions colored, and no two adjacent regions have the same color.
- Actions: Assign a color to an uncolored region.
- Transitional model (Successor function): return a map colored with specified color
- Cost function: Number of color assignments.

Question 4: Consider the River Problem:

A farmer wishes to carry a wolf, a duck and corn across a river, from the south to the north shore. The farmer is the proud owner of a small rowing boat called Bounty which he feels is easily up to the job. Unfortunately the boat is only large enough to carry at most the farmer and one other item. Worse again, if left unattended the wolf will eat the duck and the duck will eat the corn.



1) How can the farmer safely transport the wolf, the duck and the corn to the opposite shore? Give a formulation for this problem.
2) Draw a diagram of the complete state space.

- State representation: location of farmer and items in both sides of river [items in South shore / items in North shore] : (FWDC/-, FD/WC, C/FWD …)
- Initial state: farmer, wolf, duck and corn in the south shore FWDC/-
- Goal test: farmer, duck and corn in the north shore -/FWDC
- Actions: the farmer takes in the boat at most one item from one side to the other side (F-Takes-W, F-Takes-D, F-Takes-C, F-Takes-Self [himself only])
- Path Cost: the number of crossings

:State space