小班讨论二

Readings: AIMA Chapters 5-8

1. Consider Figure 5.1 in the textbook (reproduced in Figure 2). The Tic-Tac-Toe search space can actually be reduced by means of symmetry. This is done by eliminating those states which become identical with an earlier state after a symmetry operation (e.g. rotation). The following diagram shows a reduced state space for the first three levels with the player making the first move using “x” and the opponent making the next move with “o”. Assume that the following heuristic evaluation function is used at each leaf node n:

$$\text{Eval}(n) = P(n) - O(n),$$

where P(n) is the number of winning lines for the player while O(n) is the number of winning lines for the opponent. A winning line for the player is a line (horizontal, vertical or diagonal) that either contains nothing or “x”. For the opponent, it is either nothing or “o” in the winning line. Thus, for the leftmost leaf node in Figure 3, Eval(n) = 6 − 5 = 1.

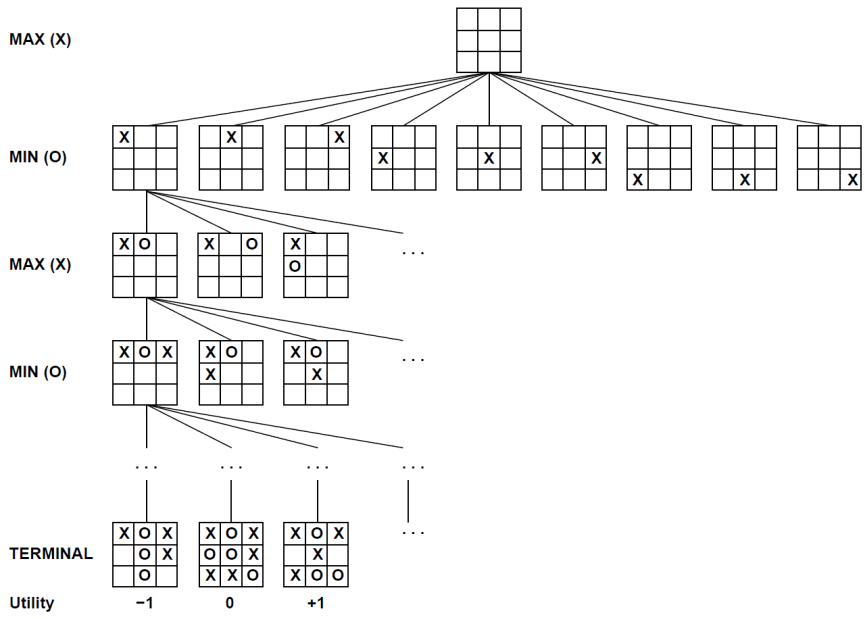

Figure 2: Search space for Tic-Tac-Toe.

(a) Use the minimax algorithm to determine the first move of the player, searching 2-ply deep search space shown in Figure 3.

(b) Assume that the “x” player will now make his second move after his opponent

has placed an “o”. Complete the following minimax tree in Figure 4 by filling the remaining blank boards at the leaf nodes. Compute the evaluation function for each of the filled leaf nodes and determine the second move of the “x” player (searching 2-ply deep).

(c) The minimax search tree in Figure 5 has heuristic evaluation function values with respect to the max player for all the leaf nodes, where square leaf nodes denote end of game with +1 representing that the max player wins the game and −1 representing that the min player is the winner. Do a minimax search and determine the next move of the max player from node A. Which is the target leaf node that the max player hopes to reach?

(d) Suppose we use alpha-beta pruning in the direction from left to right to prune the search tree in question 3. Indicate which arcs are pruned by the procedure. Do you get the same answer in terms of the max player’s next move and target leaf node?

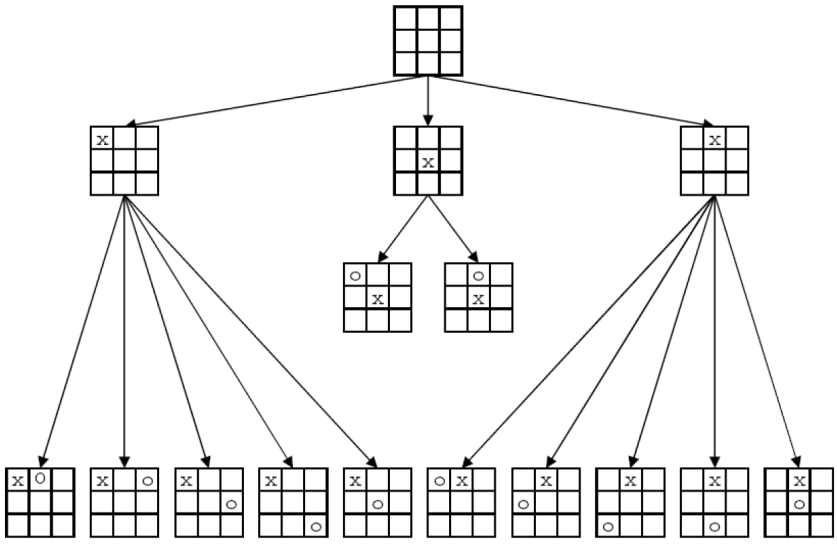

Figure 3: 2-ply deep search space

2. Consider the following constraint satisfaction problem:

Variables: A,B,C

Domains: DA = DB = DC = {0, 1, 2, 3, 4}

Constraints: A = B + 1,B = 2C

Construct a constraint graph for this problem. Show a trace of the AC-3 algorithm

on this problem. Assume that initially, the arcs in queue are in the order {(A,B), (B,A), (B,C), (C,B)}.

3. Consider the 4-queens problem on a 4×4 chess board. Suppose the leftmost column is column1, and the topmost row is row 1. Let Qi denote the row number of the queen in column i, i = 1, 2, 3, 4. Assume that variables are assigned in the order Q1,Q2,Q3,Q4, and the domain values of Qi are tried in the order 1, 2, 3, 4. Show a trace of the backtracking algorithm with forward checking to solve the 4-queens problem.

4.

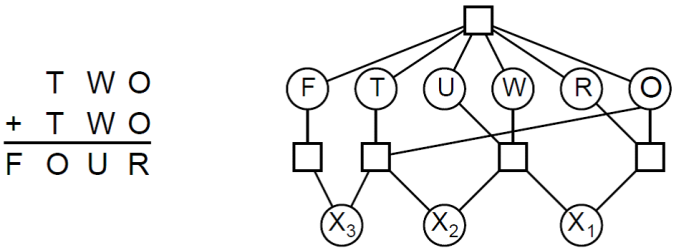

Figure 1: Cryptarithmetic puzzle.

Show a trace of the backtracking algorithm with forward checking to solve the crypt arithmetic problem shown in Figure 1. Use the most constrained variable heuristic, and assume that the domain values (digits) are tried in ascending order (i.e., 0, 1, 2, ・ ・ ・).

5. Assume that a knowledge base KB contains the following rules:

$$\begin{aligned} poor &\Rightarrow \neg worried \\ rich &\Rightarrow scared \\ \neg rich &\Rightarrow poor \end{aligned}$$

(a) Show that $KB \models (worried \Rightarrow scared)$, using the model checking approach.

(b) Use resolution to prove $KB \models (worried \Rightarrow scared)$.

6. (Modified Question 8.26 from AIMA) Represent the following sentences in first-order logic, using a consistent vocabulary that you must define:

(a) Some students took French in Spring 2010.

(b) Every student who takes French passes it.

(c) Only one student took Greek in Spring 2010.

(d) The best score in Greek is always higher than the best score in French.

(e) Everyone who buys a policy is smart.

(f) No person buys an expensive policy.

(g) There is an agent who sells policies only to those people who are not insured.

(h) There is a barber who shaves all men in town who do not shave himself.