CS3243 Foundations of Artificial Intelligence (2005/2006 Semester 2)
Tutorial 5

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function AC-3( csp) returns the CSP, possibly with reduced domains
   inputs: csp, a binary CSP with variables {X1, X2, ..., Xn}
   local variables: queue, a queue of arcs, initially all the arcs in csp

   while queue is not empty do
      (Xi, Xj) ← REMOVE-FIRST(queue)
      if RM-INCONSISTENT-VALUES(Xi, Xj) then
         for each Xk in NEIGHBORS[Xi] do
            add (Xk, Xi) to queue
```

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function RM-INCONSISTENT-VALUES( Xi, Xj) returns true iff remove a value
   removed ← false
   for each x in DOMAIN[Xi] do
      if no value y in DOMAIN[Xj] allows (x,y) to satisfy constraint(Xi, Xj)
         then delete x from DOMAIN[Xi];  removed ← true
   return removed
```

1. In the AC-3(*csp*) function of Figure 5.7, can the last line "add (X_k, X_i) to *queue*" be replaced by "if $X_k \neq X_j$ then add (X_k, X_i) to *queue*"? Justify your answer.

2. Consider the following constraint satisfaction problem:

Variables: A, B, C
Domains: $D_A = D_B = D_C = \{0, 1, 2, 3, 4\}$
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 x 4 chess board. Suppose the leftmost column is column 1, and the topmost row is row 1. Let Q_i denote the row number of the queen in column i, i = 1, 2, 3, 4. Assume that variables are assigned in the order Q_1, Q_2, Q_3, Q_4, and the domain values of Q_i 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. Show a trace of the backtracking algorithm with forward checking to solve the cryptarithmetic problem in Figure 5.2. Use the most constrained variable heuristic, and assume that the domain values (digits) are tried in ascending order (i.e., 0, 1, 2, …).