

Examination, CE884 Constraint Satisfaction for Decision Making, 2010-2011

Question 1 (Problem Formulation)

Service Assignment Problem

An international fund management company assigns a dedicated account manager to each client whose asset value exceeds a certain threshold. They want to assign the best staff to the client. Each account manager is asked to rank the clients according to how confident she is in serving them. Similarly, each client has his preferred account manager. To maximize both client satisfaction and staff confidence level, the company uses the following constraints.

Given are n clients and n account managers. Each client has his own ranking of all the account managers and each account manager has her own ranking of all the clients. The task is to assign the n account managers to the n clients, ensuring that all the assignments are satisfied. A match is *unsatisfied* if:

- (i) A client X prefers any account manager Y to his current account manager, and Y prefers X to her current client; or
- (ii) An account manager X prefers any client Y to her current client, and Y prefers X to his current account manager.

More formally, given are two $n \times n$ matrices, M and W . All entries of these matrices take values 1 to n . M stores the preferences of the clients. W stores the preferences of the account managers (in bold italic). Each element of $M[i]$ takes a unique value between 1 and n . If $M[i, j]$ is less than $M[i, j']$, that means Client i prefers Account manager j to Account manager j' . Similarly, each element of $W[i]$ takes a unique value between 1 and n . If $W[i, j]$ is less than $W[i, j']$, that means Account manager i prefers Client j to Client j' .

	<i>W[1]</i>	<i>W[2]</i>	<i>W[3]</i>	<i>W[4]</i>
<i>M[1]</i>	1	2	3	4
<i>M[2]</i>	4	2	3	1
<i>M[3]</i>	2	3	1	4
<i>M[4]</i>	1	3	4	2

The above table shows the preference of each person in an instance of the service assignment problem. For example, the row $M[3]$ shows the preferences of Client 3, which is Account managers 3, 1, 2 and 4 in that order. The W matrix reads column first. For example, the first row, third column (with value 3) represents $W[3, 1]$. Since $W[3, 1]$ is greater than $W[3, 2]$ (which has value 2), Account manager 3 prefers Client 2 to Client 1.

To illustrate the problem further, if we use M_j-W_k to indicate the assignment of Account Manager k to Client j , then $\{M1-W1, M2-W2, M3-W3, M4-W4\}$ is not a solution to the above problem. This is because $M2-W2$ is *not* a satisfied assignment, as Client 2 prefers Account Manager 4 to his current account manager (2), and at the same time, Account Manager 4 prefers Client 2 to her current client (4). This violates constraint (i) above. On the other hand, $\{M1-W1, M2-W4, M3-W3, M4-W2\}$ is a solution to the above problem.

- (a) Formulate the above problem as a constraint satisfaction problem. You must state clearly what the variables, domains and constraints are, and why they should be part of the formulation. [25%]
 - (b) What is the size of the search space in your formulation? [5%]
 - (c) Is this an optimization problem? Justify your answer carefully. [10%]
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