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Since the graph is finite, at some point we must have a cycle. Another generalization of the assignment problem is extending the number of sets to be matched from two to many. Berlin: Springer. Bertsekas, Dimitri (1998). Examples Suppose that a taxi firm has three taxis (the agents) available, and three customers (the tasks) wishing to be picked up as soon as possible. The assignment function is to add n new vertices to A and T and then add the largest n edges of cost 0. 10 (4) 151–52. Understanding Linear Programming: Theory and Methods. Cambridge University Press. Tuncel, A. (2003). Maximum Weight Matching. In: *Linear Programming: Theory and Methods*. Cambridge University Press. Its solution is when the cardinality of agents and customers equals in the least total cost. (3), 330–353. However, this requires $n(n-r)$ new edges. For a graph with n vertices, it requires $O(\log^2(n))$ time. So that rather than matching agents to tasks, the problem is extended to matching agents to tasks to time intervals to intervals. Any agent can be assigned to perform any task, incurring some cost that may vary depending on the agent-task assignment. The assignment problem is a special case of the transportation problem, which is a special case of the minimum cost flow problem, which in turn is a special case of a linear program. (1989-10-01). Generalization When phrased as a graph theory problem, the assignment problem can be extended from bipartite graphs to arbitrary graphs. ISSN 0044-5411. Special Issue on STOC 2003, 7 (1), 105–113. ^ Gabow, H.; Tarjan, R. doi:10.1145/2529989. Formal definition The formal definition of the assignment problem (or linear assignment problem) is Given two sets, A and T , of equal size, together with a weight function $C: A \times T \rightarrow \mathbb{R}$. There is also a constant s which is at most the cardinality of a maximum matching in the graph. This may be very inefficient since, with n agents and n tasks, there are $n!$ (factorial of n) different assignments. Otherwise, there is a fractional variable, say $x_{i,j}$, $i \in \{1, 2\}$, $j \in \{1, 2\}$, $0 \leq x_{i,j} \leq 1$. Moreover, if ϵ is sufficiently small, all variables remain between 0 and 1, so the domain constraints are still satisfied too. While this formulation allows also fractional variable values, in this special case, the LP always has an optimal solution where the variables take integer values. Zbl 1106.05001. This can also be proved directly.[9]:31–37 Let x be an optimal solution of the fractional LP, $w(x)$ be its total weight, and $k(x)$ be the number of non-integral variables. Commonly, when speaking of the assignment problem without any additional qualification, then the linear balanced assignment problem is meant. ISSN 0022-0000. Tarjan (2012). ISSN 0022-5610. This is an unbalanced assignment problem. By repeating the cycle-removal process we arrive, after at most n steps, at a solution in which all variables are integral. If $k(x) = 0$, we are done. This reduces the problem to a balanced assignment problem, which can then be solved in the usual way and still give the best solution to the problem. (2006). ^ Mulmuley, Ketan; Vazirani, Umesh; Vazirani, Vijay (1987). Martello (2012). So the number of edges in the cycle is $2m$ – it must be even since the graph is bipartite. ^ Gártner, Bernd; Matoušek, Jiří (2006). Burkard, Rainer; M. (displaystyle x_{ij}) in mathbb{Z} \text{ for } i,j in A,T. The total weight of the matching is: $\sum_{(i,j) \in A \times T} w_{ij} x_{ij}$. One way to solve it is to invent a fourth dummy task, perhaps called "sitting still doing nothing", with a cost of 0 for the taxi assigned to it. As shown by Mulmuley, Vazirani and Vazirani,[8] the problem of minimum weight perfect matching is converted to finding minors in the adjacency matrix of a graph. This is currently the fastest run-time of a strongly polynomial algorithm for this problem. Unbalanced assignment In the unbalanced assignment problem, the larger part of the bipartite graph has n vertices and the smaller part has r

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