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The optimal assignment problem: an investigation into current solutions, new approaches and the doubly stochastic polytope

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Abstract

This dissertation presents two important results: a novel algorithm that approximately solves the optimal assignment problem as well as a novel method of projecting matrices into the doubly stochastic polytope while preserving the optimal assignment. The optimal assignment problem is a classical combinatorial optimisation problem that has fuelled extensive research in the last century. The problem is concerned with a matching or assignment of elements in one set to those in another set in an optimal manner. It finds typical application in logistical optimisation such as the matching of operators and machines but there are numerous other applications. In this document a process of iterative weighted normalization applied to the benefit matrix associated with the Assignment problem is considered. This process is derived from the application of the Computational Ecology Model to the assignment problem and referred to as the OACE (Optimal Assignment by Computational Ecology) algorithm. This simple process of iterative weighted normalisation converges towards a matrix that is easily converted to a permutation matrix corresponding to the optimal assignment or an assignment close to optimality. The document also considers a method of projecting a matrix into the doubly stochastic polytope while preserving the optimal assignment. Various methods of projecting square matrices into the doubly stochastic polytope exist but none that preserve the assignment. This novel result could prove instrumental in solving assignment problems and promises applications in other optimisation algorithms similar to those that Sinkhorn's algorithm finds.