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An Analysis of New Optimization Algorithm for Different Combinatorial Problems

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ABSTRACT: Tabu search is one of best algorithms to solve lot of combinatorial problems. Most of the NP- Hard problems are complex and finding solution is the difficult one. But tabu search is used to solve different types of problems in various fields like engineering, hardware, medical, etc. This paper gives an overview about some applications of tabu search. Nearly fifteen papers are reviewed and all are proved that tabu search is one of the best optimal algorithm to solve the combinatorial problems.

I. INTRODUCTION

A huge collection of optimization techniques have been suggested by a crowd of researchers of different fields; an infinity of refinements have made these techniques work on specific types of applications. All these procedures are based on some common ideas and are furthermore characterized by a few additional specific features. Among the optimization procedures the iterative techniques play an important role: for most optimization problems no procedure is known in general to get directly an "optimal" solution.

The roots of tabu search go back to the 1970's; it was first presented in its present form by Glover [Glover, 1986]; the basic ideas have also been sketched by Hansen [Hansen 1986]. Additional efforts of formalization are reported in [Glover, 1989], [de Werra & Hertz, 1989], [Glover, 1990]. Many computational experiments have shown that tabu search has now become an established optimization technique which can compete with almost all known techniques and which - by its flexibility - can beat many classical procedures. Up to now, there is no formal
explanation of this good behavior. Recently, theoretical aspects of tabu search have been investigated [Faigle & Kern, 1992], [Glover, 1992], [Fox, 1993].

The word *tabu* (or *taboo)* comes from Tongan, a language of Polynesia, where it was used by the aborigines of Tonga island to indicate things that cannot be touched because they are sacred. According to Webster's Dictionary, the word now also means “a prohibition imposed by social custom as a protective measure" or of something "banned as constituting a risk.” These current more pragmatic senses of the word accord well with the theme of tabu search. The risk to be avoided in this case is that of following a counter-productive course, including one which may lead to entrapment without hope of escape. On the other hand, as in the broader social context where “protective prohibitions” are capable of being superseded when the occasion demands, the “tabus” of tabu search are to be overruled when evidence of a preferred alternative becomes compelling. The emphasis on responsive exploration in tabu search, whether in a deterministic or probabilistic implementation, derives from the supposition that a bad strategic choice can yield more information than a good random choice. In a system that uses memory, a bad choice based on strategy can provide useful clues about how the strategy may profitably be changed. (Even in a space with significant randomness a purposeful design can be more adept at uncovering the imprint of structure.)

II. TABU SEARCH ALGORITHM

- A chief way to exploit memory in tabu search is to classify a subset of the moves in a neighborhood as forbidden (or ***tabu***)
- A ***neighborhood*** is constructed to identify adjacent solutions that can be reached from current solution

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- The classification depends on the history of the search, and particularly on the recency or frequency that certain move or solution components, called ***attributes***, have participated in generating past solutions
- A ***tabu list*** records forbidden moves, which are referred to as ***tabu moves***.

Tabu restrictions are subject to an important exception. When a tabu move has a sufficiently attractive evaluation where it would result in a solution better than any visited so far, then its tabu classification may be overridden. A condition that allows such an override to occur is called an *aspiration criterion*

- Step 1: Choose an initial solution i in S. Set i* = i and k=0.
- Step 2: Set k=k+1 and generate a subset V* of solution in N(i,k) such that either one of the Tabu conditions is violated or at least one of the aspiration conditions holds.
- Step 3: Choose a best j in V* and set i=j.
- Step 4: If f(i) < f(i*) then set i* = i.
- Step 5: Update Tabu and aspiration conditions.
- Step 6: If a stopping condition is met then stop. Else go to Step 2.

Tabu Search Stopping Conditions

Some immediate stopping conditions could be the following :

1. N(i, K+1) = 0. (no feasible solution in the neighborhood of solution i)
2. K is larger than the maximum number of iterations allowed.
3. The number of iterations since the last improvement of i* is larger than a specified number.
4. Evidence can be given than an optimum solution has been obtained.

Hillier and Lieberman outlined the tabu search stopping criterion by, for example, using a fixed number of iterations, a fixed amount of CPU time, or a fixed number of consecutive iterations without an improvement in the best objective function value. Also stop at any iteration where there are no feasible moves into the local neighborhood of the current trial solution.

III. LITERATURE REVIEW

This section provides various applications of tabu search in different fields.

1Adaptive Tabu Search and Applications in Engineering Design

This paper presents the search algorithms which one is intelligent named Adaptive tabu search algorithm. In engineering field, the algorithm is very useful such as power system, identification and control mechanism. This paper describes the effectiveness of this algorithm through its convergence and its performance evaluation.

2. Tabu Search Implementation on Traveling Salesman Problem and Its Variations: A Literature Survey

In combinatorial optimization problems, lot of problems are solved by different types of algorithms. In that, the TSP(Travelling Salesman Problem) is one of the popular problem which is solved by various algorithms including swarm intelligence. In this paper the TSP problem is solved by Tabu Search. This algorithm is widly applied to all the NP-Hard problems. This paper deals with TSP and its variations, methods of tabu search and some experimental results.

3.Application of Modified Adaptive Tabu Search to Dynamic Economic Load Dispatch

DED(dynamic constrained economic dispatch) is one of the main functions of power system. The concept is to operate an electronic power system more economically. To solve this problem, the authors sugessed a Modified Adaptive Tabu search algorithm which provide good results than the normal ATS. . A fiveunit test system with nonsmooth fuel cost function is used to illustrate. The best searched result of mATS is $52,398 which is less than $52,591 of the original ATS. It confirms that mATS can be applicable for solving DED problem and more effectiveness the original ATS does.

4.Application of Multiple Tabu Search Algorithm: The case of the load f requency control and economic dispatch problem in power system

This paper deals with LFC(load frequency control) and ED(Economic dispatch) problems in power system environment. Both the problems are effectively handled by the MTS(Multiple Tabu Search) which increases the additional techniques of search process. In LFC, this algorithm is applied via fuzzy logic controller. The MTS

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algorithm tunes the PI and PID gains. And also it minimize the frequency deviations of the interconnected power system against load disturbances

5.Application of tabu search strategy for finding low energy structure of protein.

This paper deals with the protein functionality. The authors test the different types of algorithms to solve finding low energy conformations. Lot of meta heuristics methods are used to comparison. In that, the experimental research proves that Tabu search algorithm provide good results than other methods.

6.Tabu search for the job-shop scheduling problem with multi-purpose machines

Job shop scheduling is one of the NP hard problems. Each operation can be performed by one machine out of set machines given for this operation. The processing time does not depend on the machine which has been chosen for processing the operation. This problem arises in the area of flexible manufacturing. This problem is solved by tabu search algorithm which provides good results for this problem. this paper shows the experimental results of job shop scheduling using tabu search.

7.Using Tabu search for solving a dynamic multi-terminal truck dispatching problem
This paper deal with a real life problem that is a company transports the raw material throughout a country. There are two steps in that. First step is finding the routes. Second one is improve the routes. To find the route the authors are using the decomposition method. For second step they applied the tabu search which is effectively solve various NP-hard problems. The Tabu search procedure is based on specific moves which attempt to improve two or three routes at each step. Here, the basic moves consist of insertions and exchanges of arcs in the graph of the problem. The combination of these moves provides interesting compound moves which make it possible to cross regions of infeasible solutions. Computational results on a set of test problems are reported, and comparisons withlower bound calculations indicate that the proposed algorithm rapidly gives solutions that are on average within 8% of optimality.

8.Tabu Search Heuristics for the Vehicle Routing Problem with Time Windows
Vehicle routing problem is one of the NP- hard problems. The problem describes that to design a least cost routes for fleet of vehicles. Each points should be visited only one. This paper solve this vehicle routing problem by Tabu search algorithm. The routes are start and end at the depot, and the total demands of all points on one particular route must not exceed the capacity of the vehicle. In addition to describing basic features of each method, experimental results for Solomon benchmark test problems are presented and analyzed.

9.A hybrid tabu search algorithm for automatically assigning patients to beds

The problem is to assign the beds automatically to the patients depend upon the priority, appropriate departments, medical needs preference,etc. the authors generate a random set of data for this problem. the most widely used NP-hard problem solving algorithm tabu search is applied here. The performance of the algorithm is compared with an integer programming approach. The metaheuristic allows flexible modelling and presents feasible solutions even when disrupted by the user at an early stage in the calculation. This algorithm successfully satisfies all the constraints of this automatic assigning problem with ring topology and its is recommended for hospital management.

10.An application of tabu search algorithm on cost-based job shop problem with multiple objectives

JSS(job shop scheduling algorithm is one of NP hard problem which is solved by tabu search method with different types of constraints. This paper deals with the cost base jss and it contains several objectives like work in progress holding cost, earliness cost and tardiness cost. The authors are proved that tabu search algorithm gives better results for this problem. and also it improves the schedule quality.

11.Tabu Search metaheuristic embedded in Adaptive Memory Procedure for the Profitable Arc Tour Problem
This paper discusses Profitable Arc Tour Problem. It is one type of vehicle routing problem which has some constrains like less no of cycles. The objective is to find in the graph a set of cycles that maximize the collection of profits minus travel costs, which is in turn subject to constraints limiting the length of cycles that profit is available on arcs. Tabu

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search algorithm is embedded an adaptive memory procedure that find the cycles of the tour and minimizing the cycles.

12.Tabu search for total tardiness minimization in flowshop scheduling problems

This work addresses the permutation flowshop scheduling problem with the objective of minimizing total tardiness. First, the behavior of solutions for small problems is analyzed for different due date scenarios. Then a tabu search-based heuristic is proposed as a method to explore the solution space. Diversification, intensification, and neighborhood restriction strategies are evaluated. Computational tests are presented and comparisons with the NEH algorithm and with a Branch-and-Bound algorithm are made.Surveys of production scheduling show that meeting customer due dates is a critical concern for many manufacturing systems. While there is considerable research to minimize the makespan, very little work is reported on minimizing the total tardiness for scheduling jobs on a permutation flowshop. In this paper, we investigate the application of tabu search to this problem in order to obtain better solutions in a reasonable time. Special strategies are included to improve the performance of the method

13.A Staged Continuous Tabu Search Algorithm for the Global Optimization and its Applications to the Design of Fiber Bragg Gratings

Anovel staged continuous Tabu search (SCTS) algorithm is proposed for solving global optimization problems of multi-minima functions with multi-variables. The proposed method comprises three stages that are based on the continuous Tabu search (CTS) algorithm with different neighbor-search strategies, with each devoting to one task. The method searches for the global optimum thoroughly and efficiently over the space of solutions compared to a single process of CTS. The effectiveness of the proposed SCTS algorithm is evaluated using a set of benchmark multimodal functions whose global and local minima are known. The numerical test results obtained indicate that the proposed method is more efficient than an improved genetic algorithm published previously. The method is also applied to the optimization of fiber grating design for optical communication systems. Compared with two other well-knownalgorithms, namely, genetic algorithm (GA) and simulated annealing (SA), the proposed method performs better in the optimization of the fiber grating design.

14.Application Of Tabu Search Algorithm To Security Constrained Economic Dispatch

This paper presents an algorithm for solving Security Constrained Economic Dispatch (SCED) problem through the application of Tabu Search (TS). The SCED problem is formulated with base case and contingency case line flow constraints, which are important for practical implementation. Two representative systems namely 66-bus and 191-bus Indian utility systems are taken for investigations. The SCED results obtained using TS are compared with those obtained using Genetic Algorithm (GA) and Evolutionary Programming (EP). The investigations reveal that the proposed TS algorithm is relatively simple, reliable and efficient and suitable for practical applications.

15.Financial Applications of a Tabu Search Variable Selection Model

This paper illustrate how a comparatively new technique, a Tabu search variable selection model [Drezner, Marcoulides and Salhi (1999)], can be applied efficiently within finance when the researcher must select a subset of variables from among the whole set of explanatory variables under consideration. Several types of problems in finance,including corporate and personal bankruptcy prediction, mortgage and credit scoring,and the selection of variables for the Arbitrage Pricing Model, require the researcher to select a subset of variables from a larger set. In order to demonstrate the usefulness of the Tabu search variable selection model, we: (1) illustrate its efficiency in comparison to the main alternative search procedures, such as stepwise regression and the Maximum R procedure, and show how a version of the Tabu search procedure may be implemented when attempting to predict corporate bankruptcy. The authors accomplish by indicating that a Tabu Search procedure increases the predictability of corporate bankruptcy by up to 10 percentage points in comparison to Altman's Z-Score model.

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16.A Tabu Search Heuristic For The Design Of Two-Connected Networks With Bounded Rings

This paper presents a tabu search heuristic for a network design problem which consists in determining at minimum cost a two-connected network such that the shortest cycle to which each edge belongs (a "ring") does not exceed a given length K.Numerical results are provided for randomly generated graphs and graphs coming from real-world applications.

17.A Simple Hardware Implementation Of The Tabu Search Heuristic For Dsp Applications

Tabu Search heuristic is an optimization technique suitable for many DSP applications such as finite word length filter design or adaptive, linear or non-linear filters. In this paper a simple hardware implementation of the proposed algorithm is presented in order to try to tackle its main and well known bottleneck due to a high computational load. The presented system can be addressed to many DSP applications where we are supposed to solve an optimization task.

IV. CONCLUSION

This paper reviews the tabu search algorithm in various applications. These applications contains complex combinatorial problems. But tabu search algorithm is easy to implement and solve these type of problems. The papers discussed in this paper are shown the experimental results of these applications. Finally, the tabu search algorithm which is used to solve various problems in efficient way and we can extend it to solve other complex problems.

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