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A HYBRID CLONAL SELECTION ALGORITHM

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Abstract. *In this paper, we propose a Simulated Annealing PolyClonal Selection Algorithm (SAPCSA) which combines the PolyClonal Selection Algorithm (PCSA) and the traditional Simulated Annealing (SA) for Traveling Salesman Problems (TSP). The SAPCSA integrates the characteristics of both SA and PCSA. By using PCSA which is derived from clonal selection theory, the solution space can be exploited and further explored parallelly with more efficiency. Moreover, by using SA the probability of local minimum can be reduced because of the introduction of jump probability which can be adjusted by controlling the temperature. The algorithm is applied to numerous benchmark problems of TSP and the obtained result shows the effectiveness of the proposed algorithm.*
Keywords: Simulated annealing, PolyClonal selection algorithm, Traveling salesman problems

1. **Introduction.** The area of artificial immune system (AIS) has been experiencing an increasing development in the last few years mainly in the application of pattern recognition, network security and optimization. New learning algorithms are presented, discussed and tested against analytical problems with very promising results [1]. One of the more famous is the immune algorithms known as Clonal Selection Algorithm (CSA). This algorithm was designed based on the Clonal Selection principle of adaptive immunity has shown considerable success in solving a variety of pattern recognition, multi-model and combinatorial problems [2,3].

Recently, Panigrahi et al. [4] applied the CSA algorithm to solve economic load dispatch problems, while Z. X. Ong et al. [5] utilized it to find flexible job-shop schedules. Although CSA has proven to show good results, only a few applications were reported till now because of some of the disadvantages of CSA. One of the most common weaknesses often associated with CSA is the convergence behavior. To improve the performance of CSA, several strategies were incorporated into the original algorithm. Du et al. [6] proposed an adaptive polyclonal programming algorithm which added a clonal recombination operator in order to realize the cooperation and communication among different antibodies and thus obtain the diversity and high convergence speed. Furthermore, they also proposed an adaptive dynamic clone selection algorithm [7] which integrated the local search with global and the probability evolution searching with the stochastic searching. Other works also include an Immunodominance clone algorithm that explored how to produce a set of immunodominance and the superior antibodies [8]. Besides, W.S.Dong et al. [9] employed a modified immune clone selection algorithm to perform the configuration of filters design and J. Kim et al. [10,11] proposed and discussed a dynamic clonal selection algorithm involving the deletion of memory detectors that are no longer valid.