An Efficient Approach of the SOM Algorithm to the Traveling Salesman Problem

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1. Purpose

This paper presents an approach to the well-known Traveling Salesman Problem (TSP) via competitive neural networks. The neural network model adopted in this work is the Kohonen Network or Self-Organizing Maps (SOM), which has important topological information about its neurons configuration. This paper is concerned with the initialization aspects, parameters adaptation, and the complexity analysis of the proposed algorithm. The modified SOM algorithm proposed in this paper has shown better results when compared with others neural network based approaches to the TSP [1].

2. Novel aspects of the work

When using the SOM algorithm, the neighborhood of the neurons is maintained accordingly to an adopted structure. Considering that the neurons are attracted by the cities, one can notice that the final neurons configuration is a topological map connecting all the neurons and, therefore, the cities. However, since the structure of the original SOM algorithm is a bar, the topological map connecting the cities does not assures that the last visited city is the starting point of the travel. To achieve this TSP requirement, it is necessary to adopt a ring structure. Thus, starting from any point, it is guaranteed that, after visiting all the cities, the ending point is the same of the starting point. The SOM algorithm has two parameters that change through iterations: the variance of the neighborhood function $\sigma(n)$ and the learning rate $\alpha(n)$ (n=1, 2 …). The adaptation laws proposed for these parameters are presented as follows.

$$\alpha(n) = \frac{1}{\sqrt[3]{n}} \quad (1)$$

$$\sigma(n) = \sigma(n-1)\cdot(1-0.01\cdot n) \quad (2)$$

These parameters adaptation laws lead to a fast convergence of the algorithm without the lost of quality of its output. Using these laws together with the selective update of neurons weighs, there is a reduction of the algorithm complexity through iterations. The selective update consists of a threshold for the neighborhood function that allows only neurons above the threshold to be updated. Since the $\sigma(n)$ decreases fast with time, so does the number of neurons to be updated. This leads to a reduction of the algorithm complexity from $O(n^2)$ to $O(n)$. The neurons are initially disposed as a rectangular frame involving all the cities, thus, allowing a faster convergence.

3. Results

The SETSP (SOM Efficiently applied to TSP) has been tested with 12 instances of the TSP from the TSPLIB. Figure 1 shows the result for an instance. The results show an average deviation of 3.7% from the optimal tour length.

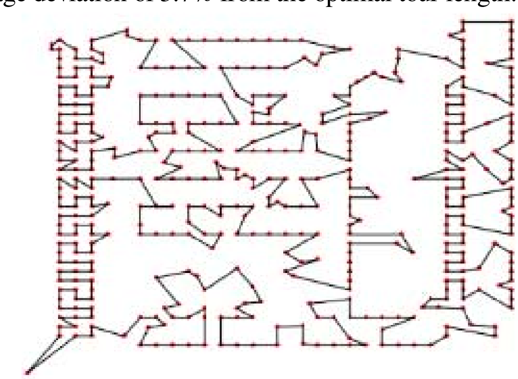

Figure 1 – SETSP for pcb442 from TSPLIB.

4. Conclusions

The results obtained have shown the power of the SETSP and a superior quality when compared with others neural network based approaches [1]. The SETSP is well suited for larger instances of the TSP since it has a fast convergence (about 30 iterations) and low complexity.

5. References

[1] N. Aras, B.J. Oommen, I.K. Altinel, "*Kohonen Network incorporating explicit statistics and its application to the travelling salesman problem*", Neural Networks, 12, 1999, pp. 1273-1284.