Nonlinear neural networks for solving the shortest path problem

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Abstract

In this paper, a new nonlinear neural network for solving the shortest path problem is presented. The our nonlinear neural networks are able to generate optimal solutions to the shortest path problem. The performance of the our neural networks are demonstrated by means of illustrative example. The our neural networks are shown to be capable of generating the shortest path and suitable for electronic implementation.

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1. Introduction

The shortest path problem is concerned with finding the shortest path from a specified starting node (origin) to a specified ending node (destination) in a given network while minimizing the total cost associated with the path. The shortest path problem is a classical combinatorial optimization problem having widespread applications in a variety of settings. The applications of the shortest path problem include vehicle routing in transportation systems [1], traffic routing in communication networks [2–4], and path planning in robotic systems [5]. Furthermore, the shortest path problem also has numerous variations such as the minimum weight problem, the quickest path problem, the most reliable path problem, and so on. The shortest path problem has been investigated extensively. The well-known algorithms for solving the shortest path problem include the $O(n^2)$ Bellman’s dynamic programming algorithm for directed a cycle networks, the $O(n^2)$ Dijkstra-like labeling algorithm and the $O(n^3)$ Bellman–Ford successive approximation algorithm for networks with non-negative cost coefficients only, where $n$ denotes the number of vertices in the network. See [6] for a comprehensive coverage of these algorithms. Besides the classical methods, many new and modified methods have been developed during the past few years. For large-scale and real-time applications such as traffic routing and path planning, the existing series algorithms may not be effective and efficient due to the limitation of sequential processing in computational time. Therefore, parallel solution methods are more desirable.

In the present paper, two neural networks for shortest path routing, called the primal and dual routing networks, are presented. These neural networks are capable of routing the shortest path in networks with mixed