SHORTEST PATH USING NEURAL NETWORK

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ABSTRACT

Shortest path problem is solved by using the famous Dijkstra's algorithm, which would quickly provide a global optimization solution in most instances. But when the weight is not given, this method does not work. This research paper examines and analyzes the use of neural networks for finding the weights. A neural network is an artificial representation of human brain that tries to simulate the learning process. It is also called a simulated neural network (SNN) or commonly just neural networks (NN), which are massively parallel models, can solve this question easily. A neural-net-inspired non-von-Neumann architecture which implements Dijkstra's dynamic programming algorithm to find the shortest path between two given nodes in a graph is presented.

Keywords: Shortest Path, Distance, Approximates Distance And Randomization.

I INTRODUCTION

Routing is one of the most important issues that have a significant impact on the network's performance. An ideal routing algorithm should strive to find an optimum path for packet transmission within a specified time so as to satisfy the quality of Service (QoS). Routing is a process of finding paths between nodes in network. Broadly there are mainly two types of routing policies - static and dynamic

1.1 Neural Network: A neural network is an artificial representation of human brain that tries to simulate the learning process. An Artificial Neural network is simply called Neural net. Traditionally the word neural network is referred to a network of biological neuron in the nervous system that process and transmit the information. ANN is interconnected group of artificial neurons that use a mathematical model or computational model for information processing based on a connectionist approach to computation.

1.2 Objective Of The Research: This project studies the suggested benefits arising from the use of Neural Network, particularly for finding the weights of un weighted graph.

II SHORTEST PATH OPTIMIZATION

2.1 Basic Description: The shortest path problem is concerned with finding the shortest path from a specified origin to a specified destination in a given network while minimizing the total cost associated with the path. The shortest path problem is an archetypal combinatorial optimization problem having widespread applications in a variety of settings. The applications of the shortest path problem include vehicle routing in transportation systems [4], traffic routing in communication networks [5], [6], and path planning in robotic systems [7]–[8]. 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.

2.2 Application Of Shortest Path: Shortest path algorithms are applied to automatically find directions between physical locations, such as driving directions on web mapping websites like Map quest or Google Maps. For this application fast specialized algorithms are available.[17]

If one represents a nondeterministic abstract machine as a graph where vertices describe states and edges describe possible transitions, shortest path algorithms can be used to find an optimal sequence of choices to reach a certain goal state, or to establish lower bounds on the time needed to reach a given state. For example, if vertices represent the states of a puzzle like a Rubik's Cube and each directed edge corresponds to a single move or turn, shortest path algorithms can be used to find a solution that uses the minimum possible number of moves.

2.3 Related Work: The application of neural networks to the routing problem has been motivated by the idea of taking advantages of the powerful computational ability of the neural network and the fact that a hardware-implemented neural network can achieve high response speeds. In some neural network applications in high speed communication networks are dealt with for optimal routing.[19] In [20] the use of neural network to solve the call admission control and routing problem in high speed networks was discussed.

In [21] a modified version of a Hopfield neural network model to solve QoS (delay) constrained multicast routing is proposed and showed that the proposed model has performed well nearer to the optimal solution and are comparable to existing heuristics.[21].A neural network based shortest-path algorithm was developed in [22], by means of which the implementation of the optimal routing problem was discussed.In [23], a PSObased search algorithm is proposed. A priority-based indirect path-encoding scheme is used to widen the scope of search space and a heuristic operator is used to reduce the probability of invalid loop creation during the path construction procedure. It claims that the PSO-based SP algorithm is superior to those using GA.

2.4 ALGORITHMS USED FOR SHORTEST PATH OPTIMIZATION

The most important algorithms for solving this problem are:[17]

a) **Dijkstra's algorithm** : Dijkstra's algorithm conceived by Dutch computer scientist Edsger Dijkstra in 1956 and published in 1959,[1][2] is a graph search algorithm that solves the single-source shortest path problem for a graph with non-negative edge path costs, producing a shortest path tree. This algorithm is often used in routing as a subroutine in other graph algorithms, or in GPS Technology. Dijkstra's algorithm solves the single-source shortest path problems.

b) **Bellman–Ford Algorithm:** Bellman–Ford algorithm solves the single-source problem if edge weights may be negative. The Bellman–Ford algorithm is an algorithm that computes shortest paths from a single source vertex to all of the other vertices in a weighted digraph. It is slower than Dijkstra's algorithm for the same problem, but more versatile, as it is capable of handling graphs in which some of the edge weights are negative numbers. The algorithm is usually named after two of its developers, Richard Bellman and Lester Ford, Jr., who published it in 1958 and 1956, respectively; however, Edward F. Moore also published the same algorithm in 1957, and for this reason it is also sometimes called the Bellman–Ford–Moore algorithm. Negative edge weights are found in various applications of graphs, hence the usefulness of this algorithm. However, if a graph contains a "negative cycle", i.e., a cycle whose edges sum to a negative value, then there is no cheapest path, because any path can be made cheaper by one more walk through the negative cycle. In such a case, the Bellman–Ford algorithm can detect negative cycles and report their existence, but it cannot produce a correct "shortest path" answer if a negative cycle is reachable from the source.

c) **A* search algorithm :** A* search algorithm solves for single pair shortest path using heuristics to try to speed up the search. **A*** is a computer algorithm that is widely used in path finding and graph traversal, the process of plotting an efficiently traversable path between points, called nodes. Noted for its performance and accuracy, it enjoys widespread use. (However, in practical travel-routing systems, it is generally outperformed by algorithms which can pre-process the graph to attain better performance. A* uses a best-first search and finds a least-cost path from a given initial node to one goal node (out of one or more possible goals). As A* traverses the graph, it follows a path of the lowest expected total cost or distance, keeping a sorted priority queue of alternate path segments along the way.

d) **Floyd–Warshall algorithm** : Floyd–Warshall algorithm solves all pair's shortest paths.Floyd–Warshall algorithm (also known as Floyd's algorithm, Roy–Warshall algorithm, Roy–Floyd algorithm, or the WFI algorithm) is a graph analysis algorithm for finding shortest paths in a weighted graph with positive or negative edge weights (but with no negative cycles, see below) and also for finding transitive closure of a relation R. A single execution of the algorithm will find the lengths (summed weights) of the shortest paths between all pairs of vertices, though it does not return details of the paths themselves. The algorithm is an example of dynamic programming. It was published in its currently recognized form by Robert Floyd in 1962. However, it is essentially the same as algorithms previously published by Bernard Roy in 1959 and also by Stephen Warshall in 1962 for finding the transitive closure of a graph. The modern formulation of Warshall's algorithm as three nested for-loops was first described by Peter Ingerman, also in 1962.

e) **Johnson's algorithm**: Johnson's algorithm solves all pair's shortest paths, and may be faster than Floyd–Warshall on sparse graphs. Johnson's algorithm is a way to find the shortest paths between all pairs of vertices in a sparse directed graph. It allows some of the edge weights to be negative numbers, but no negative-weight cycles may exist. It works by using the Bellman–Ford algorithm to compute a transformation of the input graph that removes all negative weights, allowing Dijkstra's algorithm to be used on the transformed graph. It is named after Donald B. Johnson, who first published the technique in 1977.

III FUNDAMENTAL OF NEURAL NETWORK

3.1 What Is Neural Network

Traditionally, the term neural network had been used to refer to a network or circuit of biological neurons. The modern usage of the term often refers to artificial neural networks, which are composed of artificial neurons or nodes. Thus the term has two distinct usages:

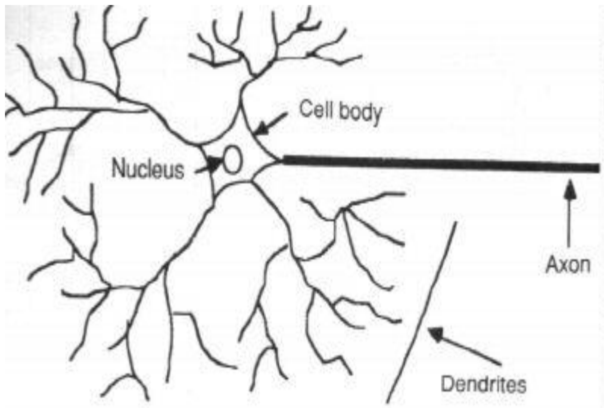


Figure 3.1

Biological neural networks are made up of real biological neurons that are connected or functionally related in the peripheral nervous system or the central nervous system. In the field of neuroscience, they are often identified as groups of neurons that perform a specific physiological function in laboratory analysis.

Artificial neural networks are made up of interconnecting artificial neurons (programming constructs that mimic the properties of biological neurons). Artificial neural networks may either be used to gain an understanding of biological neural networks, or for solving artificial intelligence problems without necessarily creating a model of a real biological system. The real, biological nervous system is highly complex and includes some features that may seem superfluous based on an understanding of artificial networks.

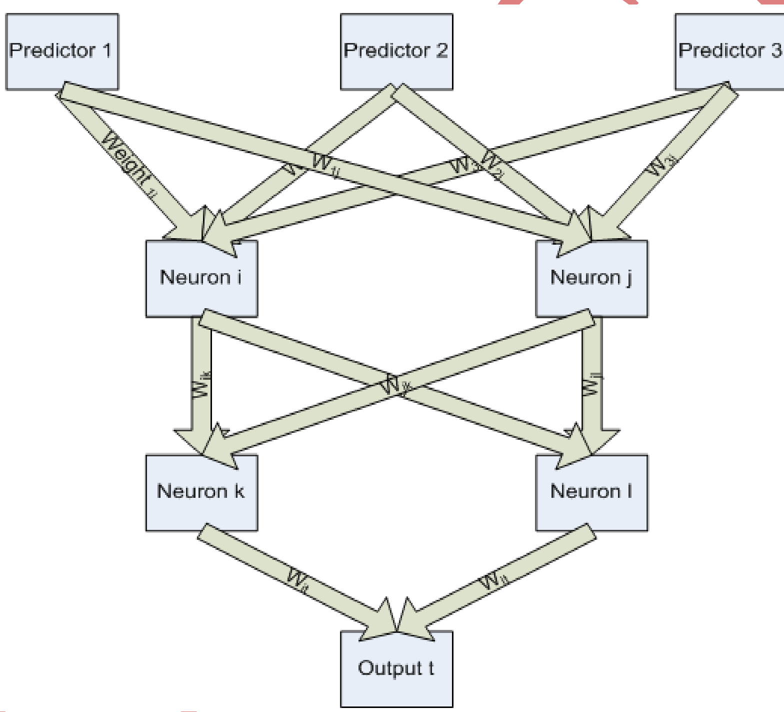
3.2 History Of Neural Network

The concept neural networks started in the late-1800s as an effort to describe how the human mind performed. These ideas started being applied to computational models with Turing's B-type machines and the perceptron.

In early 1950s Friedrich Hayek was one of the first to posit the idea of spontaneous order in the brain arising out of decentralized networks of simple units (neurons). In the late 1940s, Donald Hebb made one of the first hypotheses for a mechanism of neural plasticity (i.e. learning), Hebbian learning. Hebbian learning is considered to be a 'typical' unsupervised learning rule and it (and variants of it) was an early model for long term potentiation. The perceptron is essentially a linear classifier for classifying data specified by parameters $w \in R^n, b \in R$ and an output function f = w'x + b. Its parameters are adapted with an ad-hoc rule similar to stochastic steepest gradient descent. Because the inner product is a linear operator in the input space, the Perceptions can only perfectly classify a set of data for which different classes are linearly separable in the input space, while it often fails completely for non-separable data. While the development of the algorithm initially generated some enthusiasm, partly because of its apparent relation to biological mechanisms, the later discovery of this inadequacy caused such models to be abandoned until the introduction of non-linear models into the field.

The cognition (1975) was an early multilayered neural network with a training algorithm. The actual structure of the network and the methods used to set the interconnection weights change from one neural strategy to another, each with its advantages and disadvantages. Networks can propagate information in one direction only, or they can bounce back and forth until self-activation at a node occurs and the network settles on a final state. The ability for bi-directional flow of inputs between neurons/nodes was produced with the Hopfield's network (1982), and specialization of these node layers for specific purposes was introduced through the first hybrid network.

The parallel distributed processing of the mid-1980s became popular under the name connectionism.

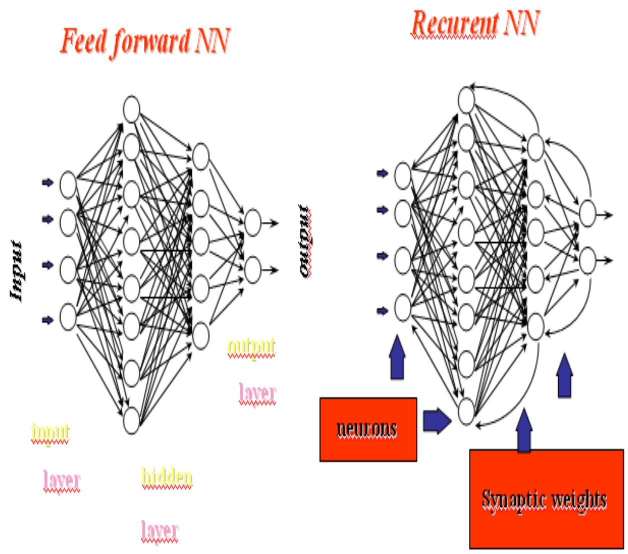


3.3 Characteristics Of Artificial Neural Networks

a) A large number of very simple processing neuron-like processing elements.
b) A large number of weighted connections between the elements
c) Distributed representation of knowledge over the connections
d) Knowledge is acquired by network through a learning process

3.4 Types of Neural Network

Feed Forward Neural Network - A simple neural network type where synapses are made from an input layer to zero or more hidden layers, and finally to an output layer. The feed forward neural network is one of the most common types of neural network in use. It is suitable for many types of problems. Feed forward neural networks are often trained with simulated annealing, genetic algorithms or one of the propagation techniques.



3.5 Applications

Neural Networks in Practice -Given this description of neural networks and how they work, what real world applications are they suited for? Neural networks have broad applicability to real world business problems. In fact, they have already been successfully applied in many industries.

Since neural networks are best at identifying patterns or trends in data, they are well suited for prediction or forecasting needs including:

- Sales forecasting
- Industrial process control
- Data validation
- Customer research
- Risk management
- Target marketing

IV INTRODUCTION MATLAB

MATLAB (matrix laboratory) is a numerical computing environment and fourth-generation programming language. Developed by Math Works, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, and FORTRAN. Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing capabilities. An additional package, Simulink, adds graphical multi-domain simulation and Model-Based Design for dynamic and embedded systems. In 2004, MATLAB had around one million users across industry and academia MATLAB users come from various backgrounds of engineering, science, and economics. MATLAB is widely used in academic and research institutions as well as industrial enterprises [9].

MATLAB [52] is a high-performance language for technical computing. It integrates computation, visualization, and programming environment. Furthermore, MATLAB is a modern programming language environment: it has sophisticated data structures, contains built-in editing and debugging tools, and supports object-oriented programming. These factors make MATLAB an excellent tool for teaching and research.

V CONCLUSION

Dijkstra's algorithm, conceived by Dutch computer scientist Edsger Dijkstra in 1956 and published in 1959, is a graph search algorithm that solves the single-source shortest path problem for a graph with non-negative edge path costs, producing a shortest path tree. This algorithm is often used in routing as a subroutine in other graph algorithms, or in GPS Technology.

For a given source vertex (node) in the graph, the algorithm finds the path with lowest cost (i.e. the shortest path) between that vertex and every other vertex. It can also be used for finding costs of shortest paths from a single vertex to a single destination vertex by stopping the algorithm once the shortest path to the destination vertex has been determined. For example, if the vertices of the graph represent cities and edge path costs represent driving distances between pairs of cities connected by a direct road, Dijkstra's algorithm can be used to find the shortest route between one city and all other cities. As a result, the shortest path first is widely used in network routing protocols, most notably IS-IS and OSPF (Open Shortest Path First).

Rosenblatt model the computing units are threshold elements and the connectivity is determined stochastically. Learning takes place by adapting the weights of the network with a numerical algorithm. Rosenblatt’s model was refined and perfected in the 1960s and its computational properties were carefully analyzed by Minsky and Papert [15]. In the following, Rosenblatt’s model will be called the classical Perceptron and the model analyzed by Minsky and Papert the Perceptron. The Perceptron forms a network with a single node and set of input connection along with a dummy input which is always set to 1 and a single output lead. the input pattern which could be a set of numbers is applied to each of the connections to the node. The only shortcoming of dijkstra algorithm was that it cannot find the shortest path when the weights are not known. So the approach for such problems was designed such that, The unknown weights were calculated using Rosenblatt algoritm and then the Dijkstra algorithm was thus used to calculate the shortest path. Both the algorithms were implepented using MATLAB, version 9.Thus with the fabrication of such methodology the shortest path can be calculated between two nodes even if the weights are unknown.

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