Chapter 7
Conclusion

Starting with two flourishing areas namely ‘Graph Theory’ and ‘Neural Networks’, effort has been made to mingle them meticulously. Usage of fundamental concepts in Graph Theory has been visualized while unfolding trees are studied in depth and a choice of super source is suggested in chapter 2.

Two basic but famous problems namely ‘Domination set identification’ and ‘Subgraph matching’ have been attacked with GNN. Inspite of some shortcomings seen in this endeavor, it ended effectively. Relaxation of the restrictions made at this initial venture stand as a future research problem.

Scarselli et al., have modelled GNN for subgraph matching problem and clique problem to identify the nodes of the graph that forms the subgraph isomorphic to the target graph. In most of the practical applications induced subgraphs will be more meaningful than mere subgraphs. In chapter 4, we are identifying induced subgraphs isomorphic to the target graph. In chapter 6 GNN based on edges instead of nodes is considered and is made to recognize all the English uppercase
alphabets viewing the graph of alphabets as semigraphs. In all the above applications the parameter $\mu$ used in calculating the state vector is very small. If it is more than 0.5, it affects the convergence of the state vector.

Improving a structure by means of exploiting its flexibility is the criteria in introduction of RNN including the status of previous stage in the present network. Its performance has been justified by means of benchmark problems. Hybrid neural network for classifying graph structured data is proposed in chapter 5. To reduce the calculation in calculating the state vector of a node in GNN, input network with the state vector of the node and its neighbour in the input pattern is considered. The output of the input network itself represents the state vector of the node. In the proposed work, the forcing network of GNN is removed and equivalently a bias node is included in the input pattern of the input network. All details of node and its neighbours are combined into a single input pattern for the input network.

Nodes and edges play a dual role in graphs. Edge analogue of any result for nodes arise naturally. As an edge analogue of GNN, edge based GNN has been proposed. This move has made us propose edge based networks. Hybrid neural network based on edges is considered in chapter 6 and is modelled to recognize the English uppercase alphabets. The network recognized all the English uppercase alphabets treating the graph of alphabets as semigraphs.

Generalization of any concept is another natural urge of a researcher. Instead of a graph, a newly emerging generalized graph structure namely ‘Semigraph’ has been employed in GNN and in Hybrid neural network. These networks are used for the evergreen problem ‘Character recognition’. Uppercase English Alphabets are
represented as semigraphs. It is hoped that it will be an effective tool for coding &
decoding. Edge based networks are designed to recognize only English uppercase
alphabets. This work may be extended to recognize all types of characters including
numerals by considering their corresponding semigraph representation. In the
semigraph representation instead of considering edges with only 2 or 3 nodes,
edges with more number of nodes can be considered. Semigraphs can be replaced
by other generalized graph structures. In all the applications, learning parameter,
momentum and state vector play an important role in the convergence of state
vector. The initial value of the weights, label of the nodes and edges play an
important role in classification. In all cases the hybrid neural network outperforms
the GNN. The position of the neighbours of a node does not affect the simulation
results. The hybrid network consumes less time compared with GNN in all the
simulation problems. The number of neurons in the input layer of the hybrid
neural network increases with the maximum degree of a graph, so that the size
of the network increases. New algorithm can be designed in future to avoid the
increase in size of the network.

Moving along these different angles in this area has made us feel that enor-
mous extension is possible and plenty of problems can be solved with this fruitful
combination of 'Graph Theory' and 'Neural Networks'.