ABSTRACT

GRAPH NEURAL NETWORK SPARSIFICATION USING K-WEIGHTED DOMINATING SET

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As real-world networks grow in size and complexity, large graphs present significant computational challenges. Graph sparsification is a common strategy for addressing this by reducing the number of edges while preserving the essential structure. However, many sparsification methods are edge-centric and may not explicitly preserve the structure around essential vertices. This thesis introduces a novel vertex-centric sparsification framework that leverages the k-Weighted Dominating Set (k-WDS) concept. The proposed method, k-WDS Sparsification, first identifies an approximate k-WDS using the Iterated Greedy (IG) heuristic to form the graph's structural backbone. A sparser graph is then constructed by retaining all edges incident to at least one vertex in the k-WDS. Theoretical analysis demonstrates that this method ensures the connectivity of the sparsified graph, provided the original graph is connected. Formal bounds for the valid range of the threshold value k are also established. Evaluation is performed by applying k-WDS Sparsification as a preprocessing step for GNNs on the semi-supervised node classification task using the Cora and PubMed benchmark datasets. Experimental results demonstrate that the method can significantly reduce the number of edges (by around 28% on Cora and 11.5% on PubMed) while maintaining high GNN accuracy (with minimal drop). In conclusion, k-WDS Sparsification is a promising, tunable, vertex-centric heuristic for task-specific graph reduction that effectively preserves GNN-relevant information.

***Keywords:** Graph Sparsification, Graph Neural Network, k-Weighted Dominating set, Node Classification.*