Mining k-Reachable Sets in Real-world Networks Using Domination in Shortcut Graphs

We propose a technique for mining minimum sets with bounded reachability in real-world networks i.e.~the smallest vertex sets such that any other vertex is at distance at most $k$ from at least one vertex of this set. Our technique uses a simple but efficient mechanism. We first introduce new edges to shorten the paths in our network to obtain a shortcut graph. As the next step, we search for the minimum dominating set in the shortcut graph. For this purpose, a variety of algorithmic approaches is applied and computationally studied. To the best of our knowledge, this approach and the impact of shortcut graph structure on the problem have not been systematically explored yet. Experimental results are presented for local samples of two social networks, as well as large network science graphs, including several research collaboration networks. Different profiles of $k$-reachable sets were found for different networks. We find that k-reaching set sizes sharply decline with increasing $k$ and decreasing graph diameters in the context of shortcut graphs obtained from social networks, as well as the largest connected components of research collaboration networks. However, there are also real-world networks, which seem to have slightly different profiles.