BIC-based node order learning for improving bayesian network structure learning

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Problems & Ideas

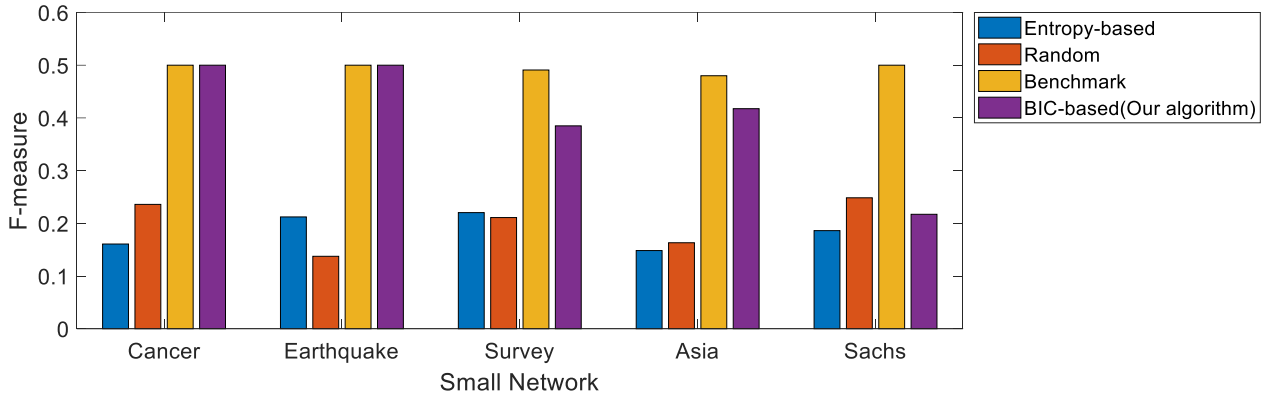
Problems of node order about Bayesian Network

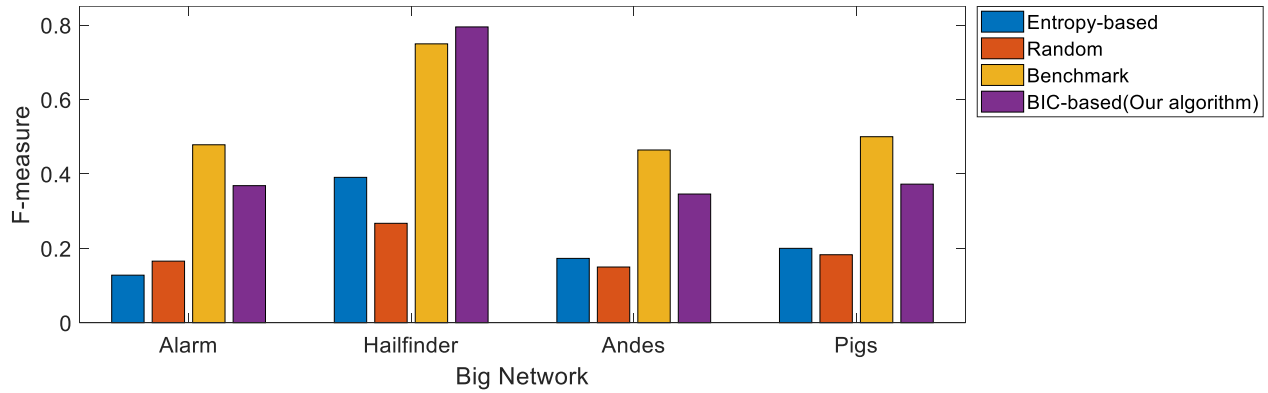
- Node order is rather difficult to be derived from domain knowledge, especially when the number of nodes is large.
- For node order learning based on some sample methods, the node order spaces are $O(n!)$, where n is the number of nodes in a BN.
- Some other methods don't consider node order learning from a viewpoint consistent with the frequently used Bayesian information criterion (BIC) measurement.

Ideas and basis step

- We propose a node order learning algorithm based on the frequently used BIC score function in $O(|V_1| * |V_2| * \cdots * |V_q|)$ order space.
- We first learn undirected subgraphs of nodes and then link them into a single undirected graph based on the BIC measure.
- Next, based on the BIC score, we orient the linked undirected graph and obtain a DAG by analyzing a local small graph that consists of three nodes.
- Further, we rank the DAG's topology order according to the zero in-degree of the current nodes.
- $O(|V_1| * |V_2| * \cdots * |V_q|) \ll O(n!)$, where $|V_1| + |V_2| + \ldots + |Vq| = n, n$ is the node number.

Experiment Result





- The figure shows the comparison of the F-measure values of the four algorithms in each network.
- F-measure is a comprehensive indicator of the precision and recall of directed edge learning results.
- As the figures show, our algorithm is better than the other two and it is the second best in most cases.
- In The Halifinder network, it is higher than the standard(Benchmark), because the real topology order of network structure is not unique, our algorithm may extract a better node topology order from the learned space.