

Abstract

We systematically evaluate the (in-)stability of state-of-the-art node embedding algorithms due to randomness, i.e., the random variation of their outcomes given identical algorithms and networks. Our work highlights that the overall performance of downstream tasks is largely unaffected by randomness in node embeddings. In contrast, individual predictions might depend on randomness in the underlying embeddings.

Experiments

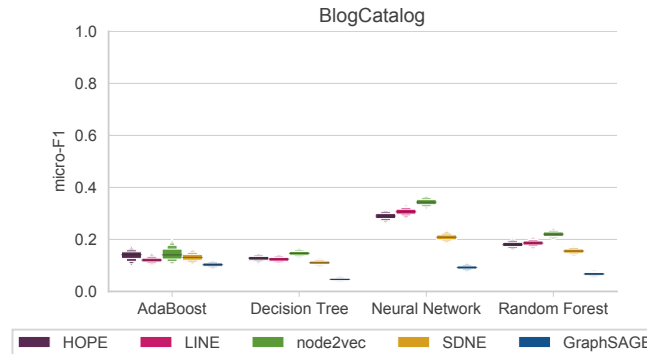
- 30 embeddings per dataset and embedding algorithm
- Embedding algorithms: HOPE, LINE, node2vec, SDNE, GraphSAGE
- Datasets: Cora, BlogCatalog, Wikipedia, Protein
- Classifiers: AdaBoost, Decision Tree, Feedforward Neural Network, Random Forest
- **Compared classification results between different embeddings of the same type on each dataset**

Stability

- Degree of reproducibility without fixing a random seed
- Geometric: Variations in the embedding space
- Downstream: Effect of geometric variations on classification

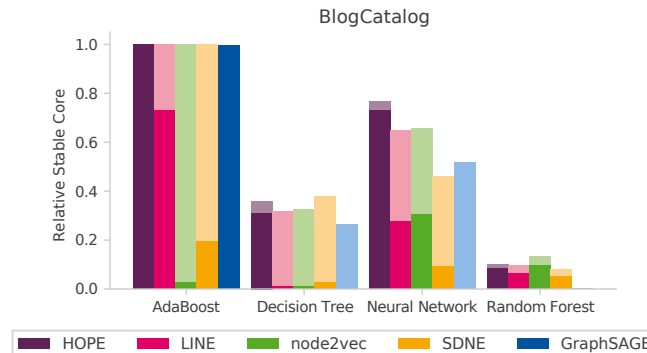
Results

Variance of classification performance (as micro-F1)



Stability of individual predictions (stable core)

Influence of embedding: difference between light and saturated bars



Discussion

- Classification performance mostly unaffected by random variations in the embeddings
- The underlying embedding strongly influences single predictions
- Classifiers seem to be able to extract information from embedding even if the geometric structure changes
- This explains the stable classification performance and leaves room for individual predictions to vary
- Similar results on link prediction

Conclusion

- Individual predictions vary (be aware of this, when using node embeddings)
 - ▶ This is good for privacy
- Geometric structure changes heavily (e.g., angles)
- Aggregated metrics are stable (e.g., accuracy)

Stable Core

The ratio of nodes classified to have the same labels in 90% of all predictions.

- Instability originated from classifier (light colors)
Stable core of 10 classifications on one fixed embedding
- Instability originated from the embedding (saturated colors)
Stable core of one classification for each embedding