Node Classification using Graph Embedding Algorithms

DeepWalk and Node2Vec

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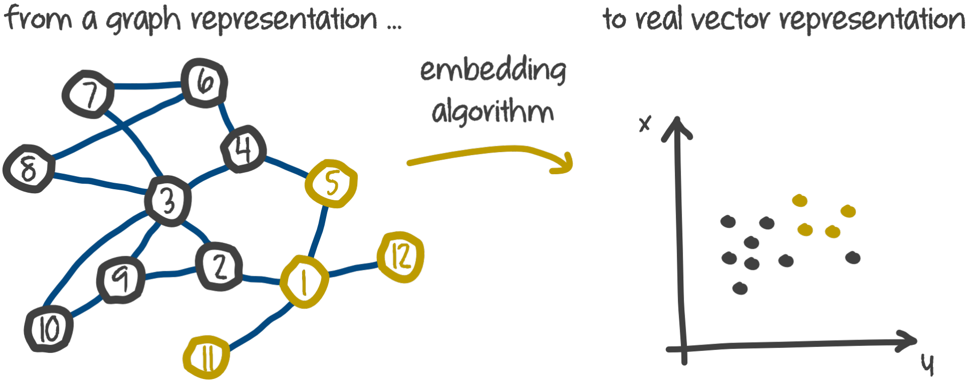
April 7, 2021

Overview

1. Introduction to Graph Embedding Techniques
2. Experiments with DeepWalk and Node2Vec

Graph Embedding Algorithms

- Embeddings help in converting graph datasets to vectors with lesser number of features in comparison to the dimensions of the original dataset.


from a graph representation ...
to real vector representation
embedding
algorithm
7
6
8
4
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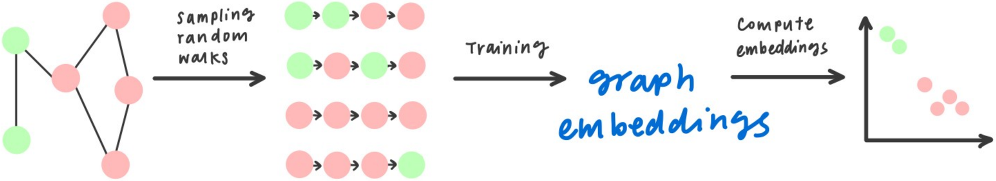
1
12
10
11
x
y

Broad Classification of Graph Embeddings in 2 groups

- **Whole Graph Embedding** - Representing the complete graph with one vector
  Examples - Graph2Vec, sub2vec

- **Vertex (Node) Embedding** - Vector Representation of each node in the graph
  Examples - DeepWalk, Node2Vec, GCN, LINE, PTE

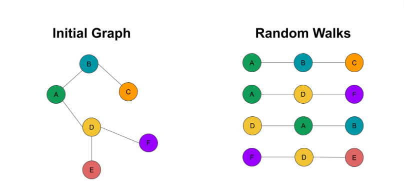
Vertex Embedding Algorithm



Dataset used in the project

- **CORA dataset** - The Cora dataset consists of 2708 Machine Learning publications.
- These papers are classified into one of the following seven classes:
  1. Case Based
  2. Genetic Algorithms
  3. Neural Networks
  4. Probabilistic Methods
  5. Reinforcement Learning
  6. Rule Learning
  7. Theory

DeepWalk

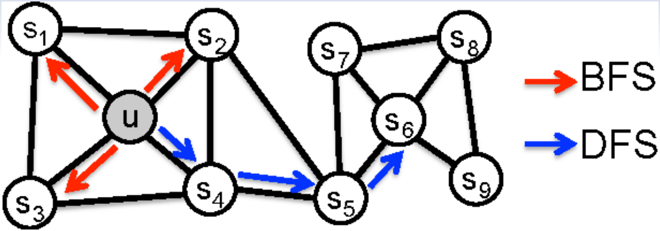


Initial Graph

Random Walks

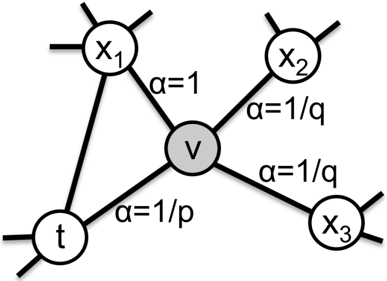
```
randomWalk = UniformRandomWalk(g)
walks = randomWalk.run(
nodes=list(g.nodes()),
length=100,
n=10)
print(”Number of random walks: ”.format(len(walks)))
```

Node2Vec



```
randomWalk = BiasedRandomWalk(g)
walks = randomWalk.run(
nodes=list(g.nodes()),
length=100,
n=10,
p=0.5,
q=2.0)
print(”Number of random walks: ”.format(len(walks)))
```

Node2Vec - Return and In-out parameters



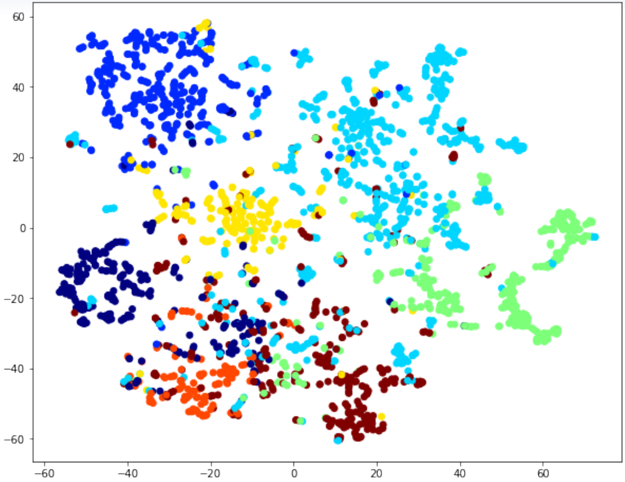
p - Return parameter; should have high value to ensure it does not get stuck in it's local neighbourhood

q - InOut parameter; q less than 1; the walk is more inclined to visit nodes which are further away from the node t.Thus, encouraging outward exploration

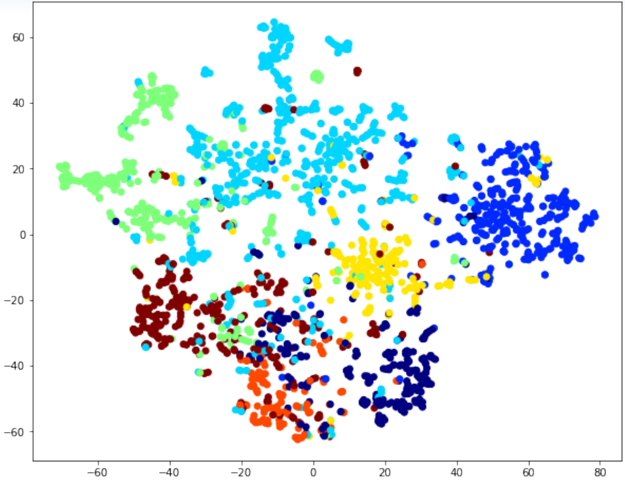
Applying Word2Vec to the corpus

```
from gensim.models import Word2Vec
strwalks = [[str(n) for n in walk] for walk in walks]
model = Word2Vec(strwalks, size=128, window=5, mincount=0, sg=1, workers=4)
```

T-SNE Representation of Embeddings using DeepWalk



T-SNE Representation of Embeddings using Node2Vec



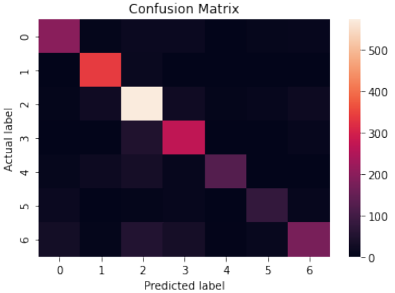
Applying Logistic Regression for Node Classification

```
clf = LogisticRegressionCV(Cs=10, cv=10, scoring=”accuracy”, verbose=False,
multiclass=”ovr”, maxiter=300)
clf.fit(Xtrain, ytrain)
```

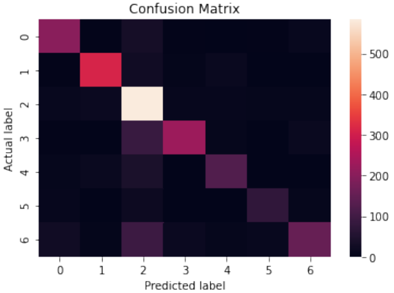
Results

Algorithm	Length of Walk	Classification Accuracy Achieved
DeepWalk	100	74.60
	50	75.62
Node2Vec	100	76.26
	50	75.68

Confusion Matrix for Classification of Research Papers



DeepWalk



Node2Vec

Conclusion

- Node2Vec outperforms DeepWalk when used on Cora Dataset
- Node2Vec gives higher accuracy when length of Random Walks is 100 and even when it was lowered to 50
- DeepWalk is computationally faster than Node2Vec

THANK YOU