

**Efficient Embedding of Scale-Free Graphs In the Hyperbolic Plane**

**Abstract:**

Hyperbolic geometry appears to be intrinsic in many large real networks. We construct and implement a new maximum likelihood estimation algorithm that embeds scale-free graphs in the hyperbolic space. All previous approaches of similar embedding algorithms require at least a quadratic runtime. Our algorithm achieves quasi-linear runtime, which makes it the first algorithm that can embed networks with hundreds of thousands of nodes in less than one hour. We demonstrate the performance of our algorithm on artificial and real networks. In all typical metrics, such as log-likelihood and greedy routing, our algorithm discovers embeddings that are very close to the ground truth.

**Existing System:**

Network models observe a power law degree distribution, small diameter and average distances. However, all of them naturally also have a *small clustering coefficient*, that is, the number of triangles and small cliques in such artificial networks is magnitudes lower than observed in real-world networks. The reason is that in the standard definitions of these network models, the edges are (merely) independent, which is not true for real-world networks. For social networks the reason is easy to see. It is more likely for two persons to be friends if they already have friends in common than it would be for two random strangers to forge a connection. There are a number of modifications to the above models that incorporate this intuition, however, all of these fixes introduce other artificial artifacts and cannot explain *why* the clustering occurs in the first place.

**Proposed System:**

A popular way to obtain hyperbolic coordinates for the nodes of a network is embedding a spanning tree of the network in hyperbolic space. As trees can be embedded perfectly, this is a very efficient way to map a network and has been used for interactive network browsers. It allows assigning more display space to the interesting portions of a network. The result might reduce visual clutter and

help focus, but it ignores most structural details of the network. Nodes which are close in graph distance are not necessarily close in hyperbolic space. In fact, clusters and most local structures are not preserved.