

Visual Analysis of History of World Cup: A Dynamic Network with Dynamic Hierarchy and Geographic Clustering

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Abstract. In this paper, we present new visual analysis methods for history of the FIFA World Cup competition data, a social network from Graph Drawing 2006 Competition. Our methods are based on the use of network analysis method, and new visualization methods for dynamic graphs with dynamic hierarchy and geographic clustering. More specifically, we derive a dynamic network with geographic clustering from the history of the FIFA World Cup competition data, based on who-beats-whom relationship. Combined with the *centrality* analysis (which defines dynamic hierarchy) and the use of the *union of graphs* (which determines the overall layout topology), we present three new visualization methods for dynamic graphs with dynamic hierarchy and geographic clustering: wheel layout, radial layout and hierarchical layout. Our experimental results show that our visual analysis methods can clearly reveal the overall winner of the World Cup competition history as well as the strong and weak countries. Furthermore, one can analyze and compare the performance of each country for each year along the context with their overall performance. This enables us to confirm the expected and discover the unexpected.

1 Introduction

Recent technological advances have led to the production of a lot of data, and consequently have led to many large and complex network models in many domains. Examples include:

- Social networks: These include telephone call graphs (used to trace terrorists), money movement networks (used to detect money laundering), and citation networks or collaboration networks. These networks can be very large.

- Biological networks: Protein-protein interaction (PPI) networks, metabolic pathways, gene regulatory networks and phylogenetic networks are used by biologists to analyze and engineer biochemical materials. In general, they have only a few thousand nodes; however, the relationships are very complex.
- Software engineering: Large-scale software engineering deals with very large sets of software modules and relationships between them. Analysis of such networks is essential for design, performance tuning, and refactoring legacy code.
- Webgraphs, where the nodes are web pages and relationships are hyperlinks, are somewhat similar to social networks and software graphs. They are huge: the whole web consists of billions of nodes.

Visualization can be an effective analysis tool for such networks. Good visualization reveals the hidden structure of the networks and amplifies human understanding, thus leading to new insights, findings and predictions. However, constructing good visualizations of such networks can be very challenging.

Recently, many methods for visualization of large graphs have been suggested. For example, see the recent proceedings of Graph Drawing and Information Visualization conferences. Methods include fast multi-level force directed methods [7], geometric or combinatorial clustering methods [12, 14], and multidimensional methods [8]. However, current visualization methods tend to exhibit one or more of the following problems: *scalability*, *visual complexity*, *domain complexity* and *interaction*.

Note that some of the network structures exhibit more complex relationships, i.e., multiple relationships, dynamic relationships or temporal relationships. Methods are available for visualization of such temporal or dynamic networks including using an animation or a 2.5D visualization [1, 6, 11]. However, they only considered the dynamics of network topologies, i.e. addition or deletion of nodes and edges based on different time frames. On the other hand, recently a method for visualizing affiliation dynamics of the IMDB (Internet Movie Data Base) was introduced [4].

In this paper, we consider a more complex network model of both *dynamic topology* and *dynamic properties* (or attributes). More specifically, we consider a dynamic temporal network with two attributes: dynamic hierarchy and geographic clustering structure, and present three visualization methods for dynamic network with dynamic hierarchy and geographic clustering: *wheel* layout, *radial* layout, and *hierarchical* layout.

Our methods are evaluated with a social network, history of the FIFA World Cup Competition data set. More specifically, we derive a dynamic network with geographic clustering from the history of the FIFA World Cup Competition data, based on *whobeats-whom* relationship.

Combined with the *centrality* analysis from the social network analysis [3, 15] which defines dynamic hierarchy, and the use of the *union of graphs* which determines the overall layout topology, our visualization methods can clearly reveal the overall winner of the World Cup competition history as well as the strong and weak countries.

Furthermore, one can analyze and compare the performance of each country for each year along the context with their overall performance. This enables us to confirm the expected and discover the unexpected [13].