Interactive Visualization of Time-Dependent Bipartite Graphs

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1 Introduction

Effective visualization of temporal graphs can reveal valuable insights such as patterns, trends, and anomalies that might otherwise remain hidden in raw data. This allows researchers, analysts, and decision-makers to quickly grasp evolving relationships, identify critical points of change, and make data-driven decisions.

In the context of global warming, multi-temporal scale visualizations of carbon emissions data can provide valuable insights for decision-makers, as demonstrated by Ma et al. [4]. In logistics, these visualizations can help optimize supply chain operations and identify inefficiencies [7] [5]. For social networks, they can illuminate user interactions and information spread. In public policy, temporal graph visualizations can aid in tracking disease spread, monitoring resource allocation and analyzing policy impacts [1]. These examples demonstrate how temporal graph visualizations compress temporal network data into intuitive representations. And as the volume and complexity of temporal data continue to grow across various domains, the development and application of effective visualization techniques for temporal graphs will likely become increasingly important.

As a practical example this paper explores various techniques for interactive visualization of time-dependent and bipartite graphs, using the "Media Transparency Database Austria" [3].

Time-dependent graphs or temporal graphs are structures that evolve over time, with nodes and edges changing as time progresses. These graphs are crucial for representing dynamic systems and processes that unfold chronologically. They allow us to observe patterns, trends, and changes in relationships between entities over different time periods [6]. One specific type of temporal graph that has gained prominence is the bipartite graph. **Bipartite** graphs or bigraphs consist of two distinct sets of nodes, with connections only existing between nodes from different sets, but not within the same set. If the two subsets have equal cardinality (balanced bigraph) and each node in one subset is connected to every node in the other subset, the graph is called a complete bigraph [2]. These graphs are particularly useful for modeling relationships between two different types of entities, such as public authorities and their advertising expenditures. Due to their scale and complexity, time-dependent and bipartite graphs can be challenging to visualize effectively. To make sense of the Media Transparency Database Austria, which contains thousands of entries over multiple years, we need to design scalable and **interactive visualizations** that allow users to explore the data, for example, by filtering, zooming, and selecting specific time periods or entities.

The "Media Transparency Database Austria" [3] is a public repository that records the advertising expenses of public authorities in Austria. This database serves as a tool for transparency (based on the Austrian § 34 Transparenzdatenbankgesetz 2012 TDBG), allowing citizens and researchers to track how public funds are spent on advertising across various media outlets. It provides a rich dataset that can be represented as both a time-dependent and bipartite graph structure. By visualizing this data – although not the focus of this paper – we can gain insights into how public authorities allocate advertising budgets, which media outlets receive the most / least funding, how both the political and media landscapes evolve over time and mutually influence each other.

This paper aims to combine state-of-the-art techniques and approaches for designing interactive visualizations of time-dependent and bipartite graphs to propose a final design for the "Media Transparency Database Austria". We will focus on clear, uncluttered overviews while maximizing information content and propose a design that allows users to interact with the data intuitively. Additionally, we will consider how our proposed visualization could be evaluated and what results we expect to achieve.

2 Related Work

3 Visual Encoding and Interaction Design

4 Implementation

5 Evaluation

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