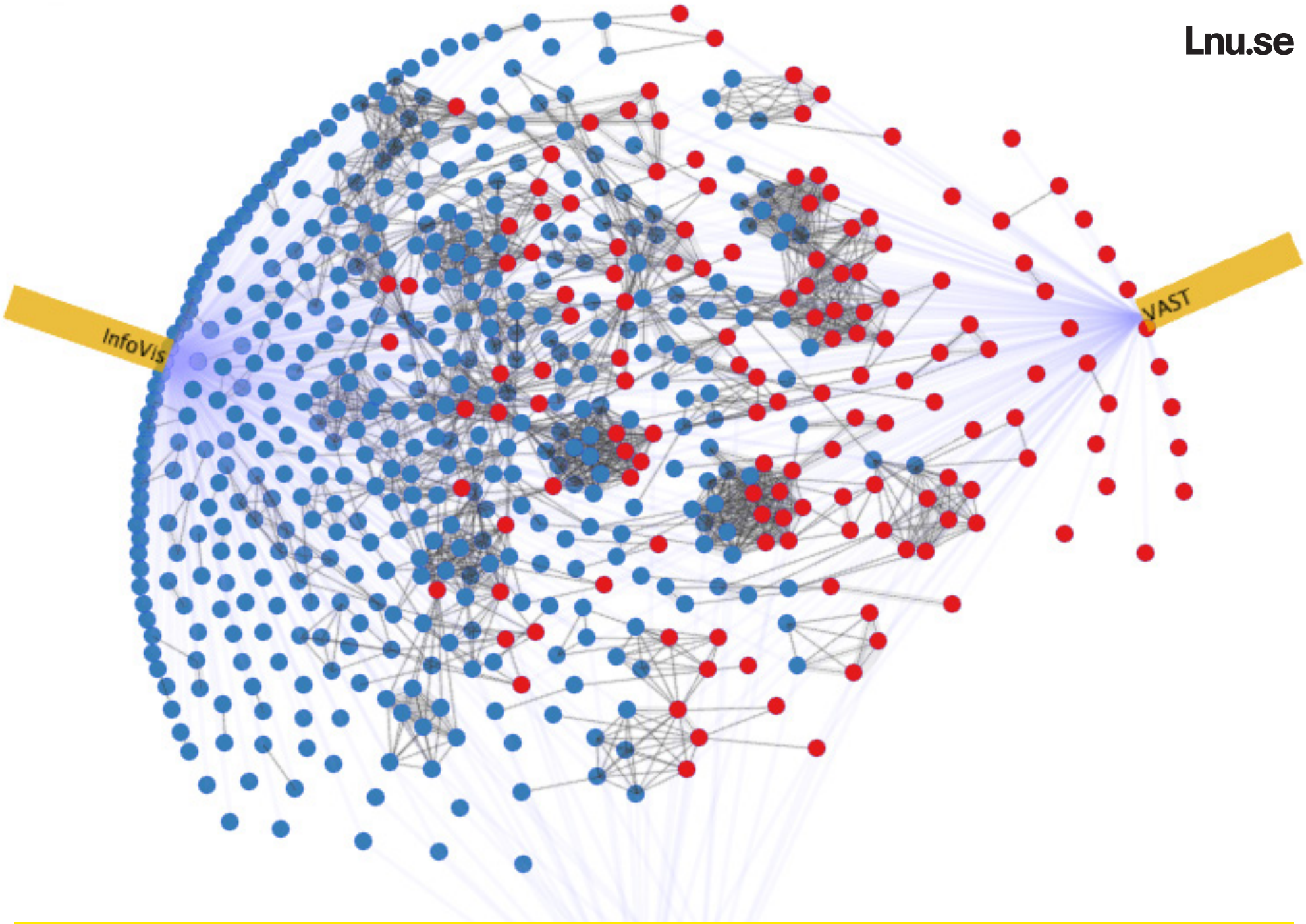

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Doctoral Thesis in Computer Science

Multivariate Networks: Visualization and Interaction Techniques

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D1136, Linnaeus University, Växjö

Faculty examiner Professor Dr Jessie Kennedy,
Edinburgh Napier University, Scotland

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the University library, Växjö

Linnæus University
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Abstract As more and more data is created each day, researchers from different science domains are trying to make sense of it. A lot of this data, for example our connections to friends on different social networking websites, can be modeled as graphs, where the nodes are actors and the edges are relationships between them. Researchers analyze this data to find new forms of communication, to explore different social groups or subgroups, to detect illegal activities or to seek for different communication patterns that could help companies in their marketing campaigns. Another example are huge networks in system biology. Their visualization is crucial for the understanding of living beings. The topological structure of a network on its own could give insight into the existence or distribution of interesting actors in the network. However, this is often not enough to understand complex network systems in real-world applications. The reason for this is that all the network elements (nodes or edges) are not simple one-dimensional data. For instance in biology, experiments can be performed on biological networks. These experiments and network analysis approaches produce additional data that are often important to be analyzed with respect to the underlying network structure. Therefore, it is crucial to visualize the additional attributes of the network while preserving the network structure as much as possible. The problem is not trivial as these so-called multivariate networks could have a high number of attributes that are related to their nodes, edges, different groups, or clusters of nodes and/or edges.

The aim of this thesis is to contribute to the development of different visualization and interaction techniques for the visual analysis of multivariate networks. Two research goals are defined in this thesis: first, a deeper understanding of existing approaches for visualizing multivariate networks should be acquired in order to classify them into categories and to identify disadvantages or unsolved visualization challenges. The second goal is to develop visualization and interaction techniques that will overcome various issues of these approaches.

Initially, a brief survey on techniques to visualize multivariate networks is presented in this thesis. Afterwards, a small task-based user study investigating the usefulness of two main approaches for multivariate network visualization is discussed. Then, various visualization and interaction techniques for multivariate network visualization are presented. Three different software tools were implemented to demonstrate our research efforts. All features of our systems are highlighted, including a description of visualization and interaction techniques as well as disadvantages and scalability issues if present.