

Interactive Exploration of Large Dynamic Networks

Mathias Pohl and Peter Birke

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University of Trier

Overview

- 1 Overview
 - Introduction
 - Motivation
- 2 Visualization of Large Dynamic Networks
 - Design
 - Mental Map
- 3 XLDN
 - The Design
 - Preserving the Mental Map
 - Interactions: Fold and unfold
 - Interactions: Descending in Hierarchy
 - Interactions: Accessing time
 - Trade-Offs
- 4 Conclusion
 - Wrap-Up
 - The End

Introduction

Information is often organized in hierarchical networks. Surveillance of these structures is very hard, since networks are really large.

Wikipedia

German Wikipedia consists of ≈ 800.000 articles and ≈ 65.000 categories. Articles belong to categories and are connected through wiki links. The category system forms a hierarchy for all articles while the wiki links define a network.

Introduction: Motivation

Typical questions concerning the structural evolution of Wikipedia:

- Has an article been reachable from related articles?
- How did the connections between articles of the same category look like?
- Were the articles moved between categories back and forth?

Challenges in Dynamic Network Visualization

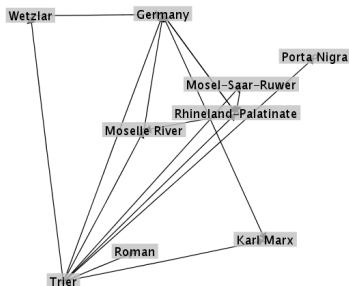
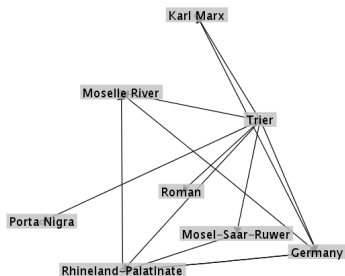
Dynamic network visualization is about ...

- ... drawing networks in a sequence (time slicing).
- ... allow navigation through time slices.
- ... preserving the mental map (Purchase et al., 2006).

Preserving the User's Mental Map

What's the difference between the two networks?

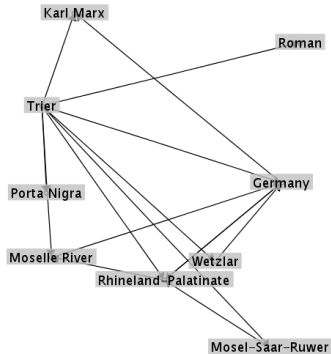
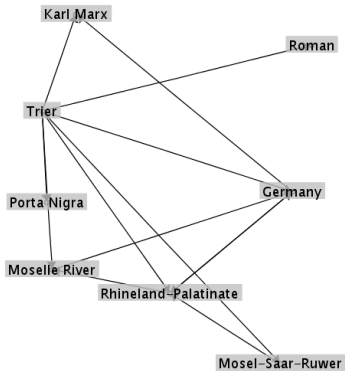
Preserving the User's Mental Map



Preserving the User's Mental Map

And now?

Preserving the User's Mental Map



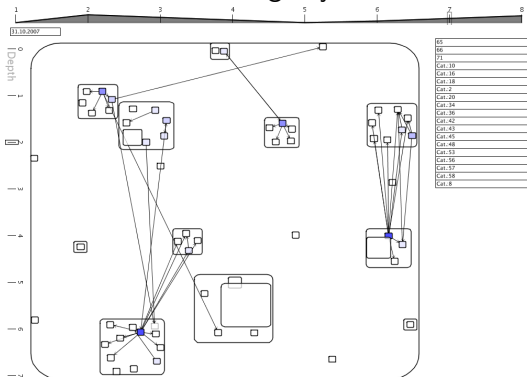
The Design of XLDN

XLDN reveals the evolution of large dynamic structures by ...

- ... clustering networks according to hierarchy (automatic "blockmodelling").
- ... pre-computation of layout information and storing them in a database.
- ... using *Foresighted Graph Layout* (Diehl et al.)

The Design of XLDN

XLDN reveals the evolution of large dynamic structures by ...



Review: Foresighted Graph Layout

Idea: Use a global layout template for all network in a sequence.

Problem: Global template relies on union of all networks - but in general union of all hierarchy trees is not a tree.

Solution: Construction of a so-called *supertree*.

Preserving the Mental Map: The supertree

Given a sequence T_0, \dots, T_{n-1} of hierarchies with $T_i = (V_i, E_i)$ the *supertree* $\tilde{T} = (\tilde{V}, \tilde{E})$ is a tree with the following properties:

- 1 $\forall 0 \leq i < n : \exists \sigma_i : V_i \rightarrow \tilde{V}$ injective
- 2 $\forall 0 \leq i < n : (u, v) \in E_i \Rightarrow (\sigma_i(u), \sigma_i(v)) \in \tilde{E}$

A *minimal supertree* for a sequence T_0, \dots, T_{n-1} is a supertree with the property that \tilde{V} has minimal size.

Preserving the Mental Map: The supertree

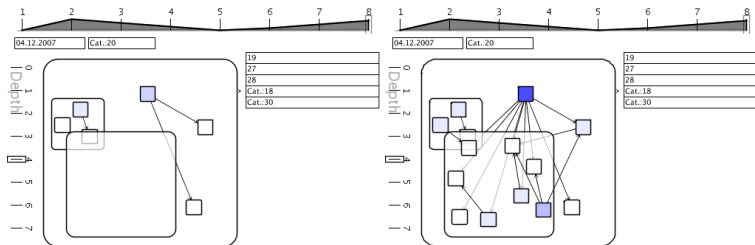
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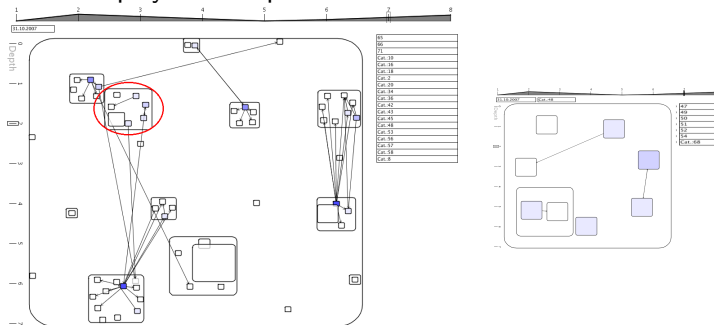
Unfortunately: minimal supertree construction is \mathcal{NP} -complete.

(Un-)Folding Clusters



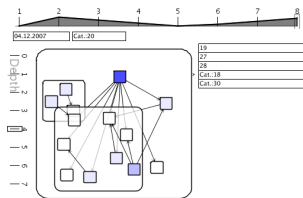
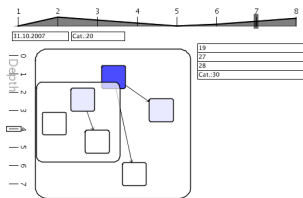
Navigation Through the Hierarchy

The user can descend into each cluster and back. A navigation path is displayed on top of the network view.



Navigation Through the Sequence

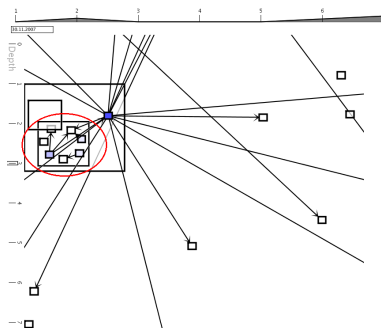
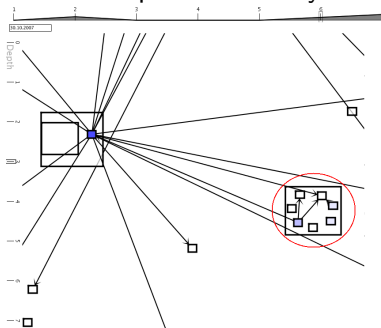
XLDN offers a slider that allows for selection of any time interval.
A plot indicates the changes of size (# of nodes) over time.



What if...

... hierarchy changes?

Mental map cannot always be preserved.



Wrap-Up

XLDN allows for...

- ... interactive exploration of dynamic networks.
- ... large networks (> 100.000 objects)
- ... human-centered visualization due to mental map preserving layouts.

The End

Discussion: Improving visual support for large networks through utilisation of centrality measures?

The End

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Thank you for your attention.

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