

# Clustering of dynamic graphs

Hauptseminar Networkvisualisation

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Abb. 1. In den Wolken: Vancouver von Cypress Mountain. Auf der ersten Seite dürfen keine Grafiken außer dieser optionalen Aufmachgrafik (Teaser) abgebildet sein.

**Kurzbeschreibung**—This paper presents a summary about various techniques to detect and identify densely connected nodes in a graph, so called clusters. In the first part, we introduce the concept of clusters for static graphs alongside their main properties. For dynamic graphs with time varying edge connections, these cluster may be subject to change with every time step. Therefore additional characteristics have to be introduced.

The second part describes two methods to detect, identify and track cluster in a dynamic graph. A common solution for this problem is the clustering of a static graph at each time step, and the identification of the same clusters over multiple time steps. A method is presented to track these clusters, which is independent of the underlying static graph clustering algorithm. Furthermore, we describe an extension of the k-clique percolation algorithm to dynamic graphs.

Finally, the clique percolation algorithm is applied to two different real world networks, which yields interesting result about group dynamics, with regards to the correlation of various group properties.



## 1 MOTIVATION

The concept of graphs was always an important part of computer science. Their ability to represent a wide variety of datastructures, as well as ... made them a helpful resource for many kind of problem definitions. Furthermore, graphs are also suited to model different kind of relations between various members of a network. The type of network can vary These networks can range from

But the success of electronic communication - both the World Wide Web and mobile communication - brought new attention to the concept of graphs. Their ability to represent a network structure as well as

in letzten jahren vermehrte forschung im bereich graphen. einerseits wegen zunahme an netzwerken in vernetzter welt, andererseits weil graphen viele probleme abbilden koennen. dazu gehoeren computer science, control science, kommunikation und social networks. vor allem wegen social networks und daraus social marketing sind dynamische graphen mehr ins licht gerueckt. dynamische graphen sind graphen mit varierenden kanten. hierbei spielt vor allem die kommunikation, und die daraus entstehenden untergruppen des netzwerks (cluster) eine grosse rolle. man moechte herausfinden wie sich solche gruppen finden lassen, wie sie das netzwerk beeinflussen, und sich im verlauf der zeit entwickeln.

## 2 BASICS

was sind cluster, ueberlappende cluster, definition?

### 2.1 Properties of Cluster

### 2.2 Properties of dynamic graphs

## 3 CLUSTERING IN STATIC GRAPHS

### 3.1 Clique percolation

### 3.2 modularity function clustering?

## 4 CLUSTERING IN DYNAMIC GRAPHS

### 4.1 Extension of clique percolation

### 4.2 Time step Clustering

## 5 MAYBE VISUALIZATION OF DYNAMIC GRAPHS

## 6 GROUP EVOLUTION (RESULTS)

## 7 CONCLUSION

### 7.1 Abbildungen und Tabellen

Alle Abbildungen (siehe Abb. ??) und Tabellen (Tabelle ??) sollten zentriert sein (`\centering`). Abbildungen über beide Textspalten (Abb. ??) können mit `\begin{figure*}...\end{figure*}` eingefügt werden.

## 7.2 Referenzen

Literaturangaben wie beispielsweise Levoy [?] werden mit Hilfe von BibTeX erzeugt. Dazu werden die Referenzen in die Literaturliste (hier *literatur.bib*) eingetragen und entsprechend mit `\cite` referenziert.

## 7.3 L<sup>A</sup>T<sub>E</sub>X-Übersetzung

Die L<sup>A</sup>T<sub>E</sub>X-Datei kann mit *latex* oder *pdflatex* übersetzt werden. Dabei ist zu beachten, dass für die Übersetzung mit *latex* die Grafiken in Postscript (eps) vorliegen, für *pdflatex* entsprechend als jpg, png oder pdf. Der Ablauf ist dabei der folgende:

1. `pdflatex <quelldatei.tex>`
2. `bibtex <quelldatei>`
3. `pdflatex <quelldatei.tex>` (evtl. mehrfach)

Alternativ kann auch das mitgelieferte Makefile verwendet werden.

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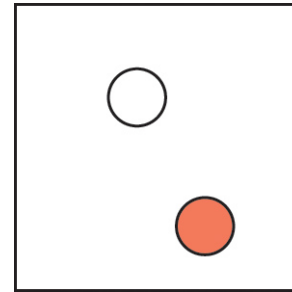


Abb. 2. Beispielillustration.

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$$\sum_{j=1}^z j = \frac{z(z+1)}{2} \quad (1)$$

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Tabelle 1. Vis Paper Acceptance Rate

Year	Submitted	Accepted	Accepted (%)
1994	91	41	45.1
1995	102	41	40.2
1996	101	43	42.6
1997	117	44	37.6
1998	118	50	42.4
1999	129	47	36.4
2000	151	52	34.4
2001	152	51	33.6
2002	172	58	33.7
2003	192	63	32.8
2004	167	46	27.6
2005	268	88	32.8
2006	228	63	27.6

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<sup>1</sup>Fußnoten erscheinen an der Unterkante der Spalte. Sie sollten jedoch vermieden werden, da der Lesefluss gestört wird.

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## 8 CONCLUSION

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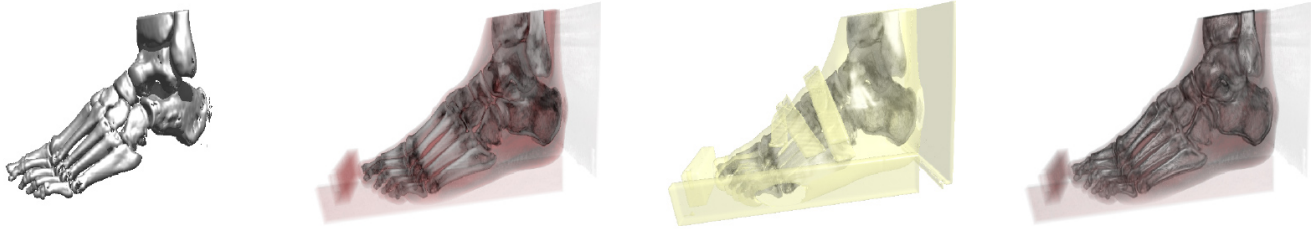


Abb. 3. Illustration über beide Textspalten hinweg. Auch Illustrationen müssen entsprechend den Quellen gekennzeichnet werden. [?]