Qualitative Citation Analysis Based on Formal Concept Analysis

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Overview

- **aim:** to present the FCA as an applicable method in the bibliometrics
- **method:** Formal concept analysis (FCA)
- **approach:** an example of bibliographic analisys using FCA
- tools and applications
- outlook

Some Basic Objectives and Aims of Bibliographic Studies

- citations and references (co-citations, co-references)
- co-authorship and scientific cooperation
- journal impact factor

Some Basic Objectives and Aims of Bibliographic Studies

- discovery of scientific influences and knowledge flows
- showing trends („hottest“ themes)
- determining the influential journals, authors and scientific ideas
- strategic publishing

Basic terms: Bibliographic Coupling

Publication P

Text text text text text text text text text text
text text text text text text text text text text
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text text text text text text

References:

- Publication A
- Publication B

Publication R

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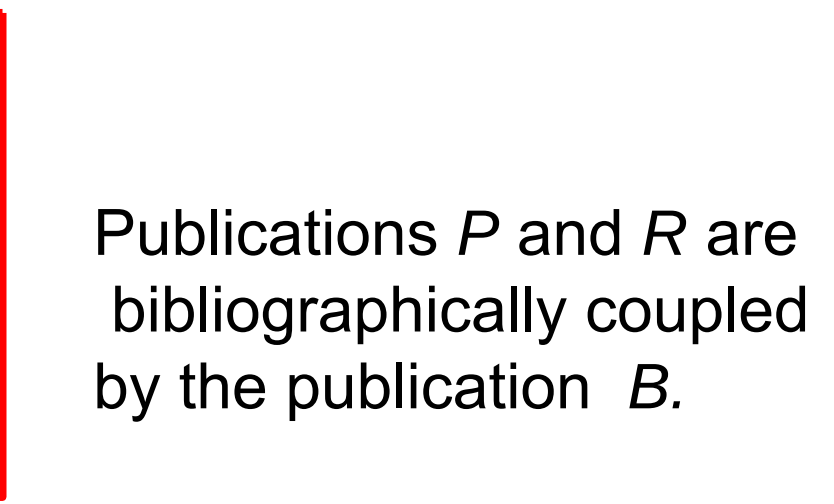
References:

- Publication B
- Publication C



Publications *P* and *R* are bibliographically coupled by the publication *B.*

Basic Terms: Co-citation

Publication P

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References:

- Publication A
- Publication B

Publications *A* and *B* are co-cited by the publication *P*.

Publication R

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References:

- Publication B
- Publication C

Basic terms: Co-authorship

Publication P

Authors: **A1**
A2

Text text text text text text text text text text text text text text text text text text text

References:

- Publication A
- Publication B

Publication R

Authors: **A1**
A3, A4

Text text text text text text text text text text text text text text text text text text text

References:

- Publication B
- Publication C

The authors *A1* and *A2* are co-authors of the Publication P.

Quantitative and Qualitative Citation Analysis

Quantitative methods:

- applying of statistical methods

Qualitative methods:

- revealing of trends (citation or publication trends, patterns of co-authorship)
- visualisation – citation graphs, digrams

Formal Concept Analysis (FCA)

Formal Context

Def.: A **formal context** K is a tripel (G,M,I) where

- G is a set of objects
- M is a set of attributes
- I is a binary relation $I \subseteq G \times M$ where $(g,m) \in I$ is read as "object g has attribute m."

	direkt verwandt	älter	jünger	männlich	weiblich	eindeutig	andere Generation
Vater	×	×		×		×	×
Mutter	×	×			×	×	×
Bruder	×			×			
Schwester	×				×		
Kind	×		×				×
Sohn	×		×	×			×
Tochter	×		×		×		×
Onkel		×		×			×
Tante		×			×		×
Opa		×		×			×
Oma		×			×		×
Cousin				×			
Cousine					×		
Neffe			×	×			×
Nichte			×		×		×

Formal Concept Analysis (FCA)

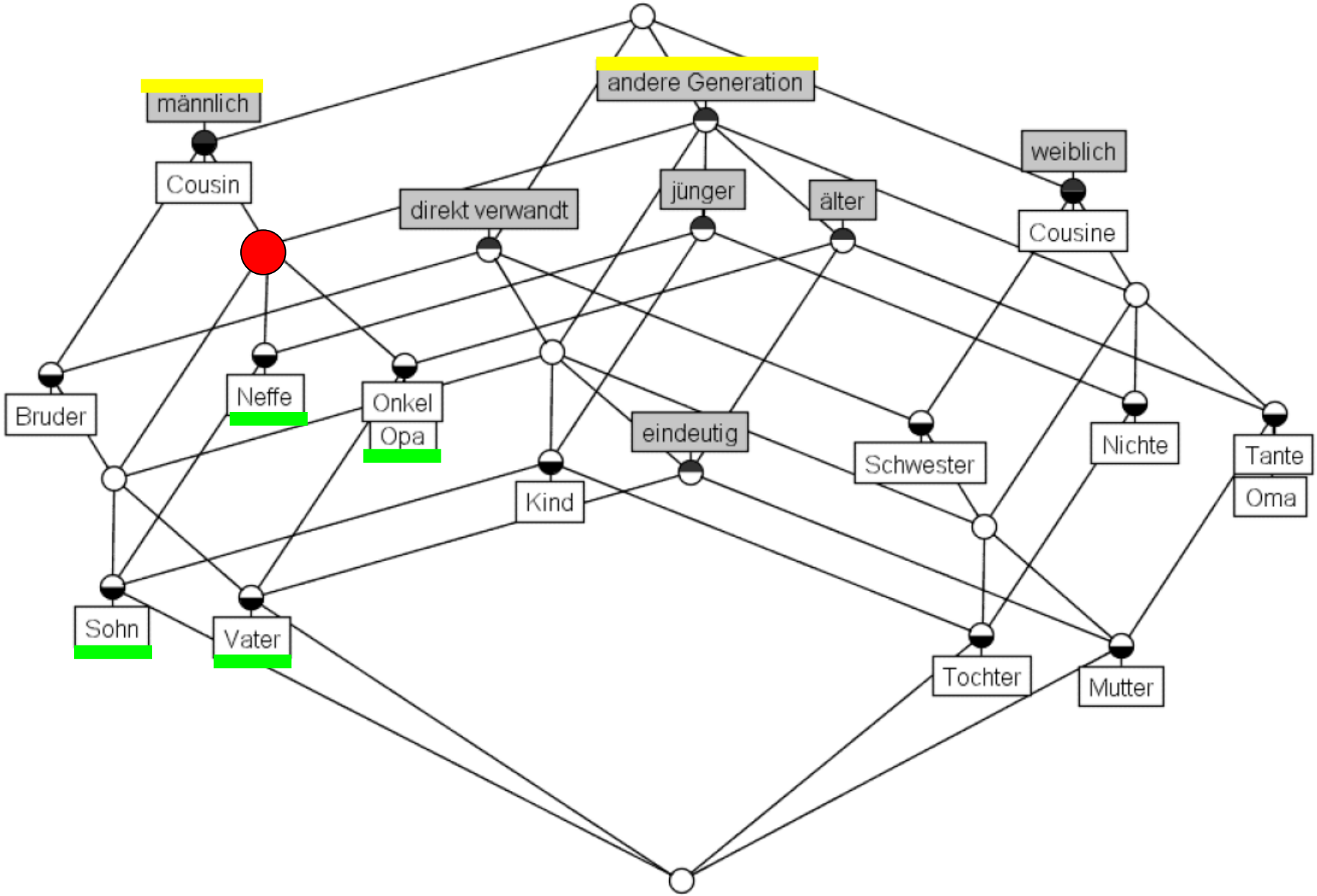
Formal Concept:

Def.: for A⊆G and B⊆M be **A'**={m∈M| ∀g∈A: (g,m)∈I} **B'**={g∈G| ∀m∈B: (g,m)∈I}

Def.: (A,B) is a **formal concept** of the formal context (G,M,I) if A⊆G, B⊆M, A'=B and B'=A.
A is called the **extent** and B the **intent** of the concept.

	direkt verwandt	älter	jünger	männlich	weiblich	eindeutig	andere Generation
Vater	×	×		×		×	×
Mutter	×	×			×	×	×
Bruder	×			×			
Schwester	×				×		
Kind	×		×				×
Sohn	×		×	×			×
Tochter	×		×		×		×
Onkel		×		×			×
Tante		×			×		×
Opa		×		×			×
Oma		×			×		×
Cousin				×			
Cousine					×		
Neffe			×	×			×
Nichte			×		×		×

FCA: Concept Lattice



Citation Analysis with FCA

	1	2	3	4	5	6
c1			x			
c2			x	x	x	x
c3				x		x
c4					x	
c5						
c6						

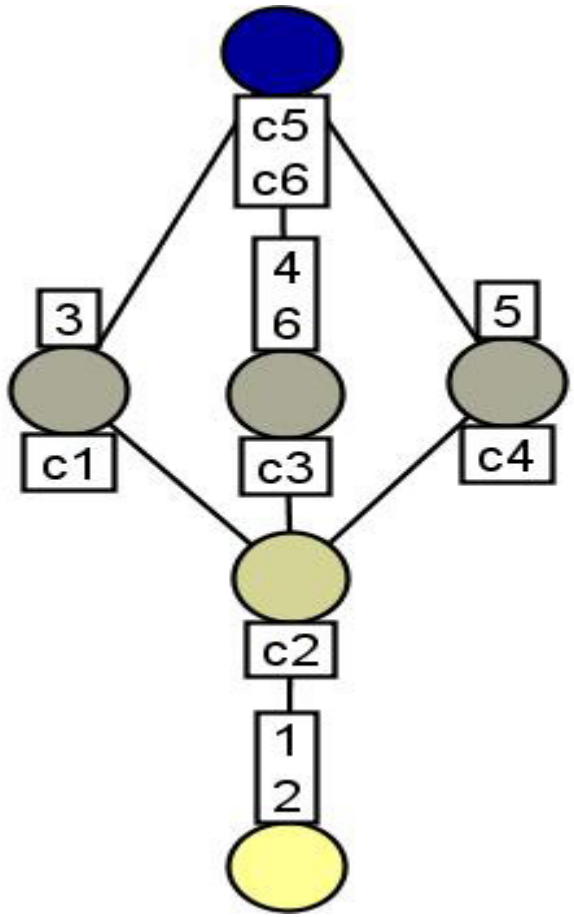
- The citation of a publication P is denoted by cite(P) or shorthand cP.
- The intent of the object concept of cite(X), i. e. the citation of publication X, is the set of publications citing X.
- Example: The intent of the object concept c2 is {3,4,5,6}.
- The extent of the atribute concept of a publication X is the set of citations in X
- Example: The extent of the atribute concept 3 is {c1,c2}.

Co-citation

•Two publications are co-cited if they both are cited by a third publication.

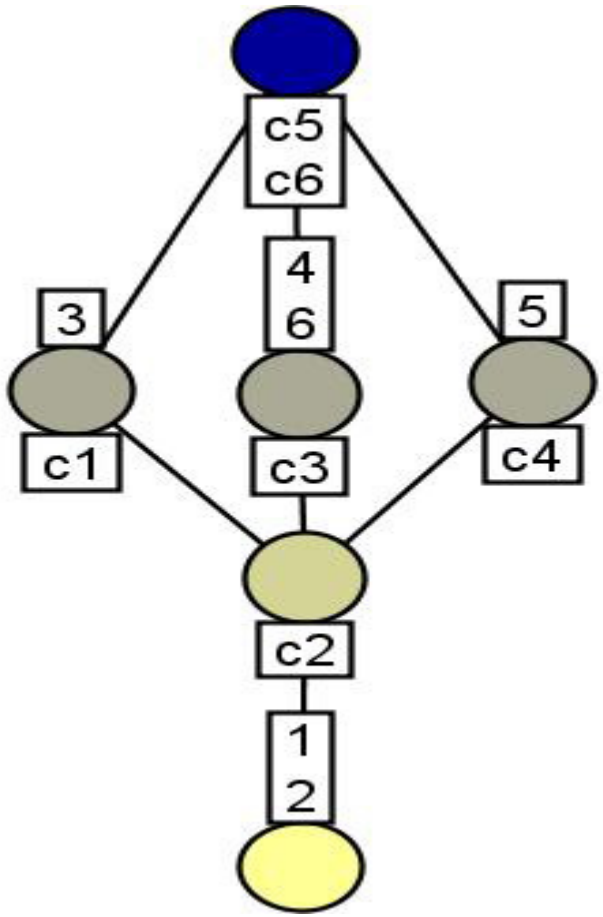
• P,R∈Pub are co-cited iff {cite(P), cite(R)}‘≠{}

• Example:
1 and 2 are co-cited (both are cited by 3).
cite(1)=c1, cite(2)=c2, {c1,c2}´= {3}

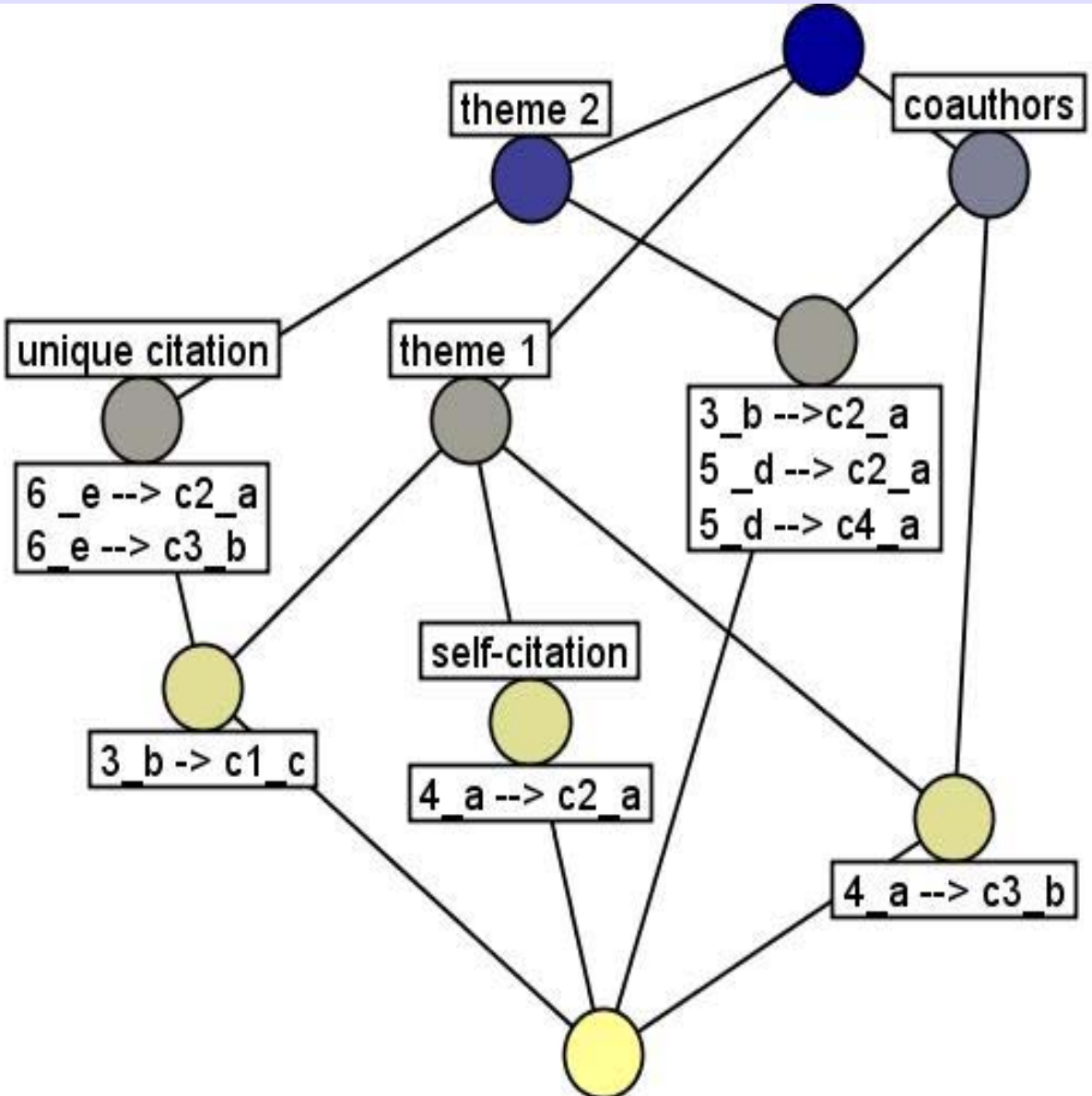


Bibliographic Coupling

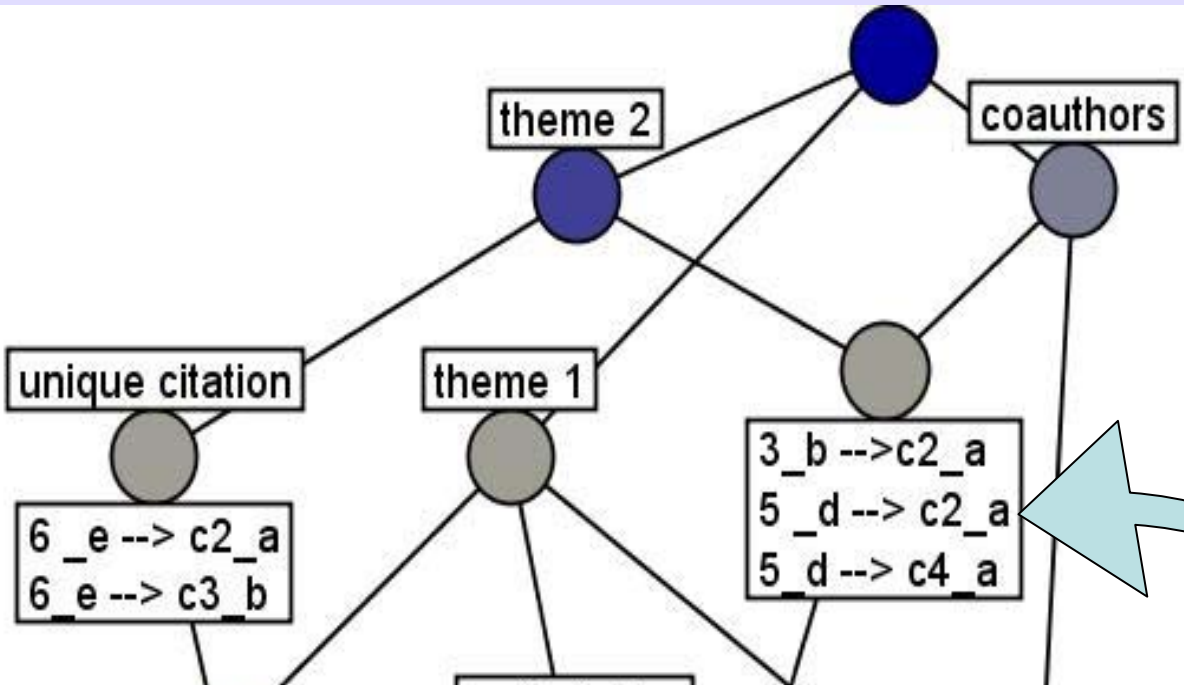
- Two publications are bibliographic coupled if they share a common reference
- P,R∈Pub are bibliographic coupled iff
  {P,R}´≠{}
- The strength of the bibliographic coupling is |{p,r}´| (the number of references which both the publications share)
- Example: 4 and 6 are bibliographic coupled by c3, c2 ({4,6}´= {c3,c2}).



A Model of Self-citations

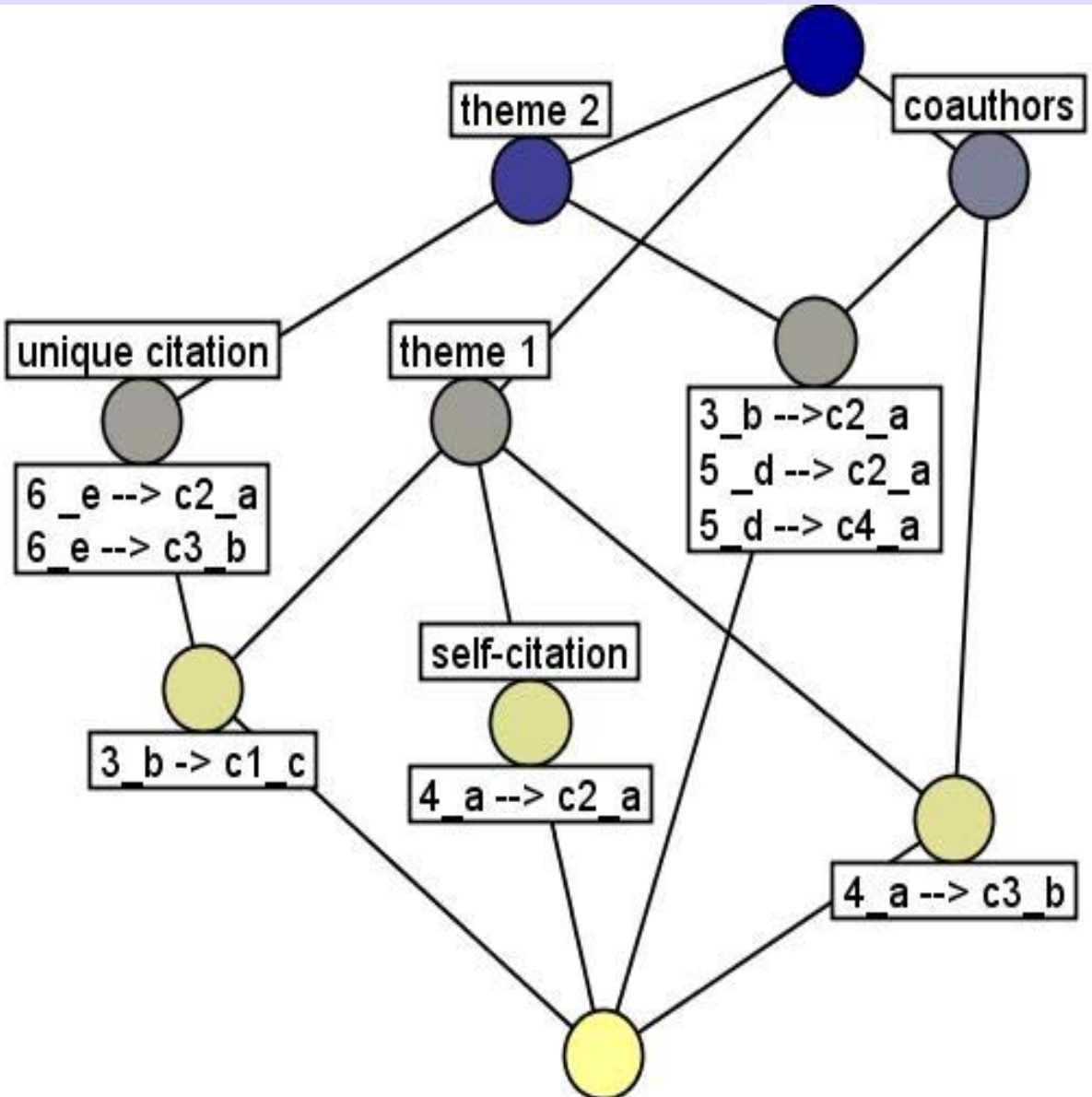


A Model of Self-citations



	1	2	3	4	5	6
c1			x			
c2			x	x	x	x
c3				x		x
c4					x	
c5						
c6						

Self-citations



Co-autorship

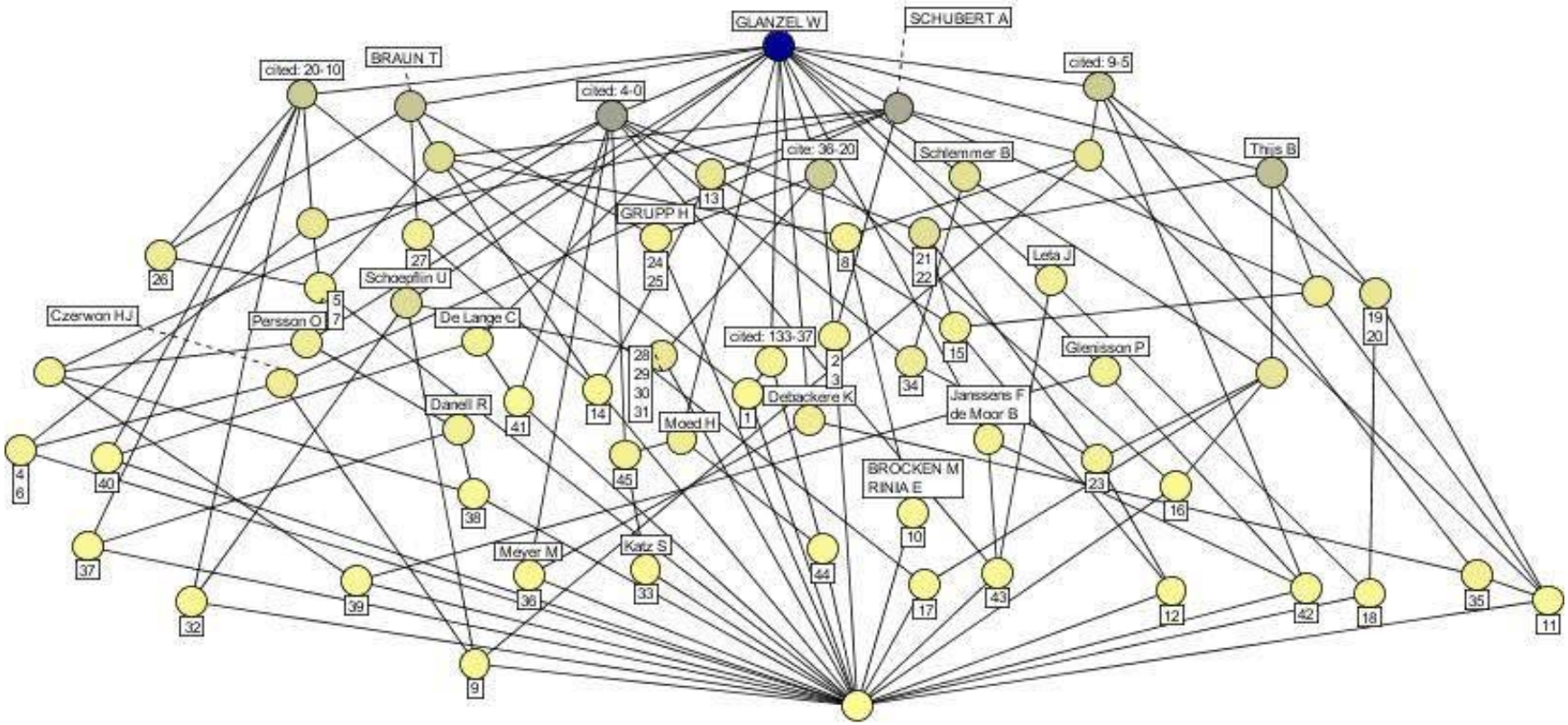
- The research: discovering and analising the scientific cooperations in the field of bibliometrics

- Query in *Web of Knowledge*:

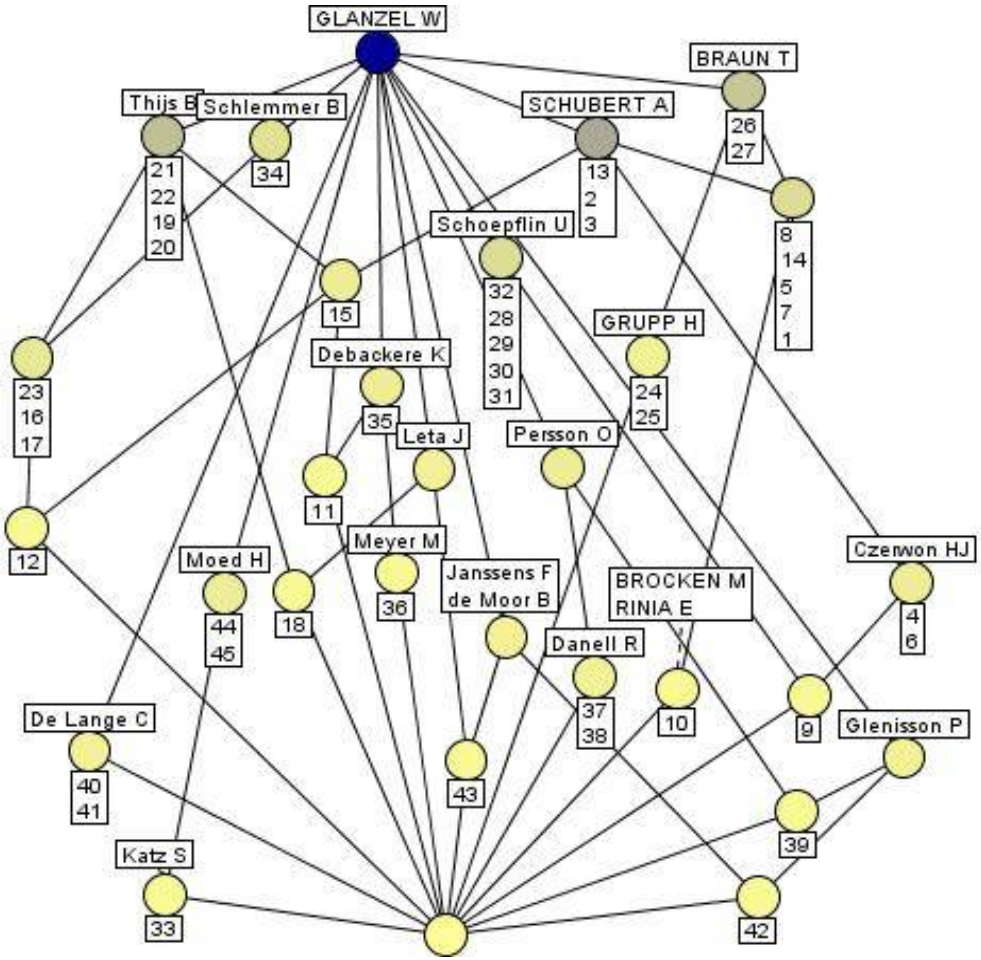
  informetr OR bibliometr* OR scientometr**
  Result: 2460 Documents

- Ranking of the authors and finding out who is the one with the biggest sets of publications: Glänzel, W.
- Exploring the cooperation patterns and showing a method for the creating an author‘s cooperation profile

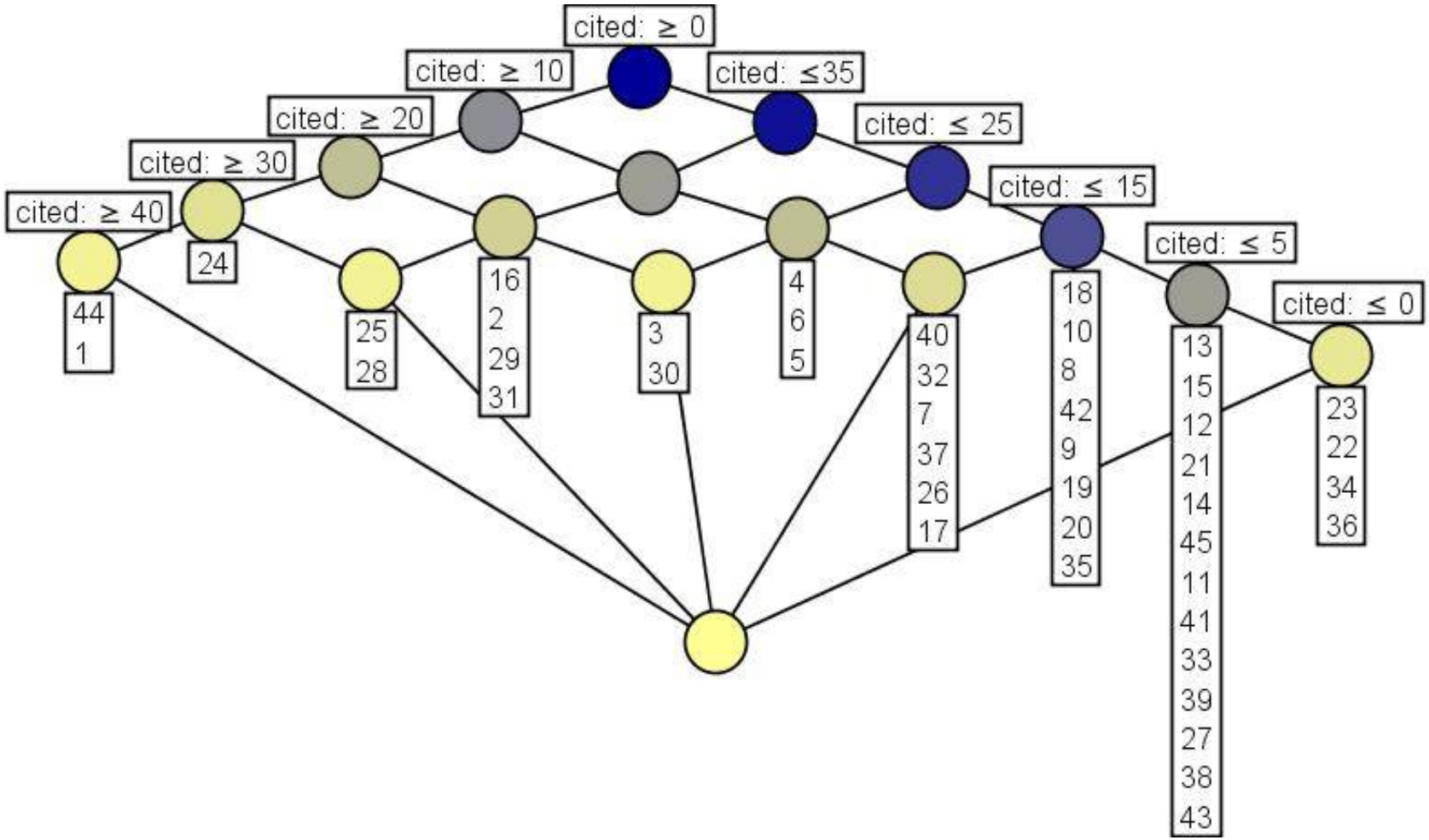
Cooperation profile of Glänzel, W.



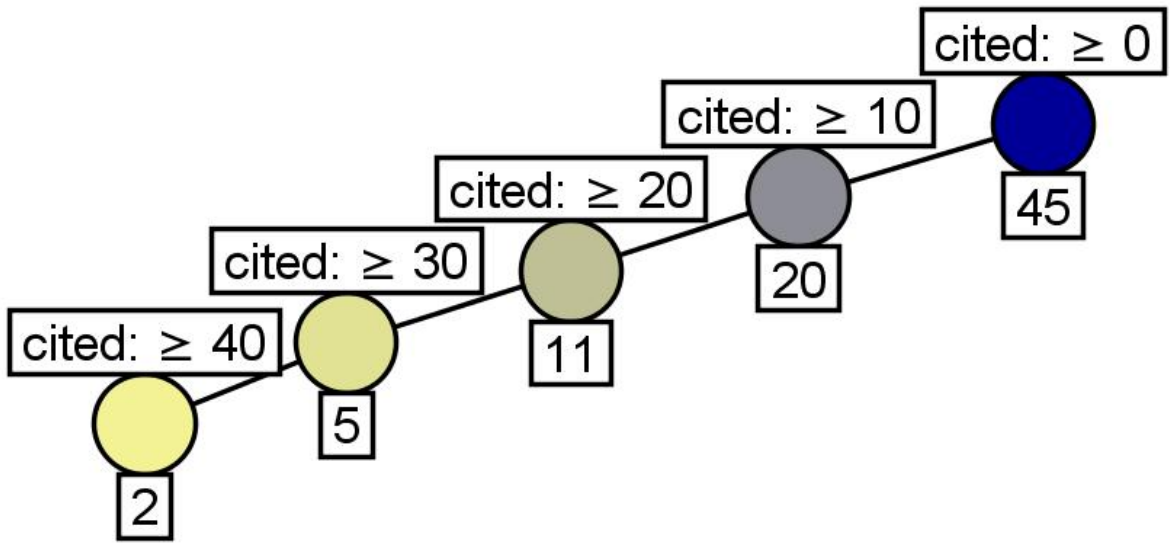
Cooperation Profile: Publications only



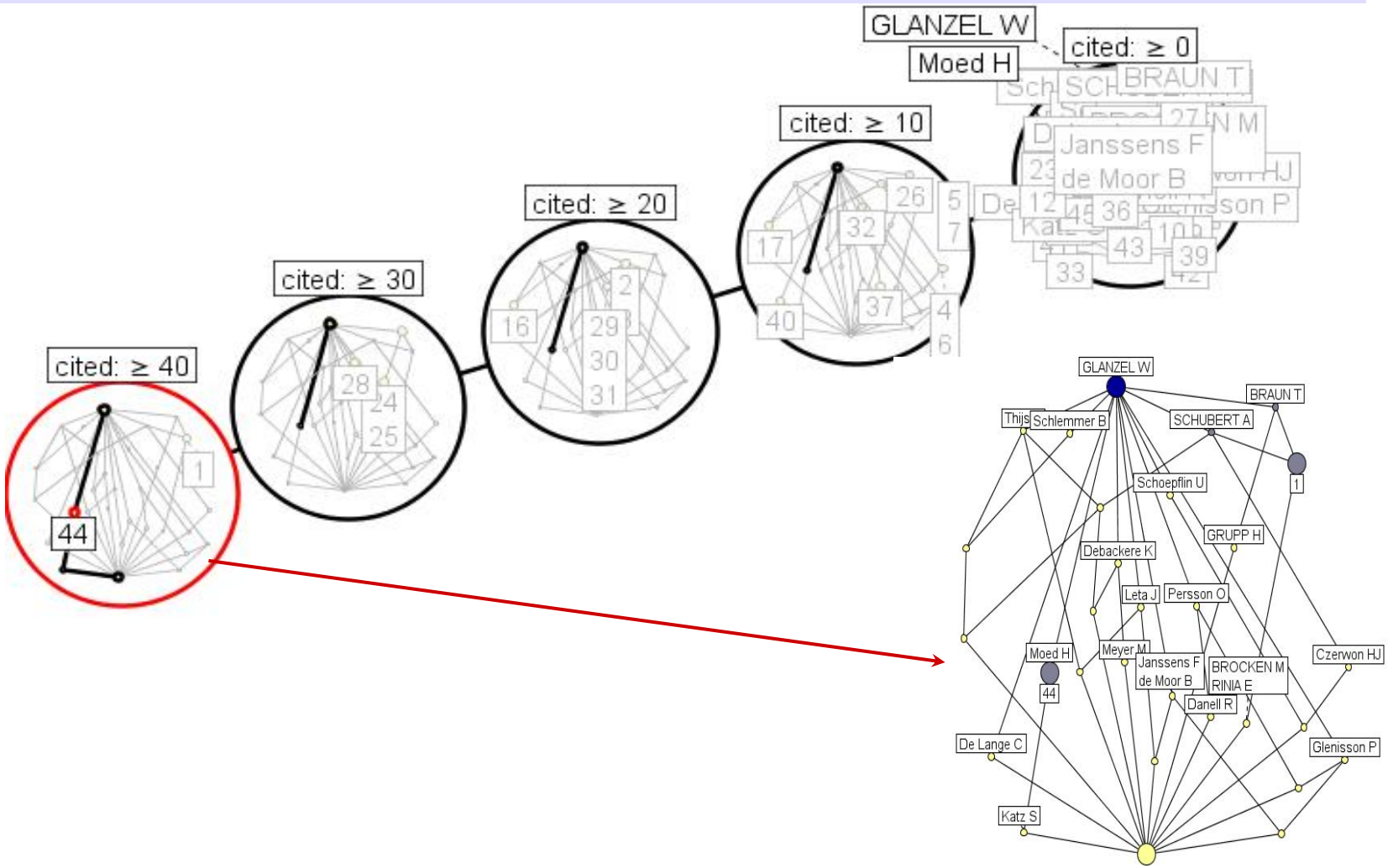
Interordinal Scale



Ordinal Scale



Ordinal Scale – Nested Diagram



FCA in the Bibliometics - Advantages

- an easy usage of different scales
- allows a dynamic browsing of the data
- shows logical implications
- „Zooming“ – adding attributes or objects is easy

Applications

- Toscana J:

http://toscanaj.sourceforge.net/

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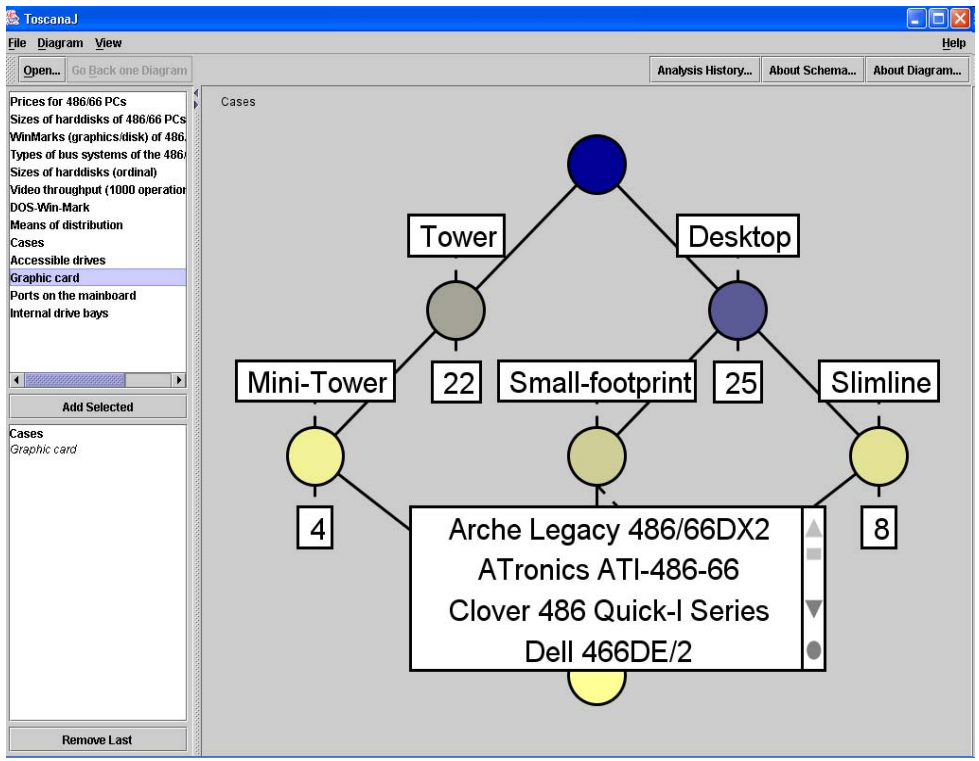
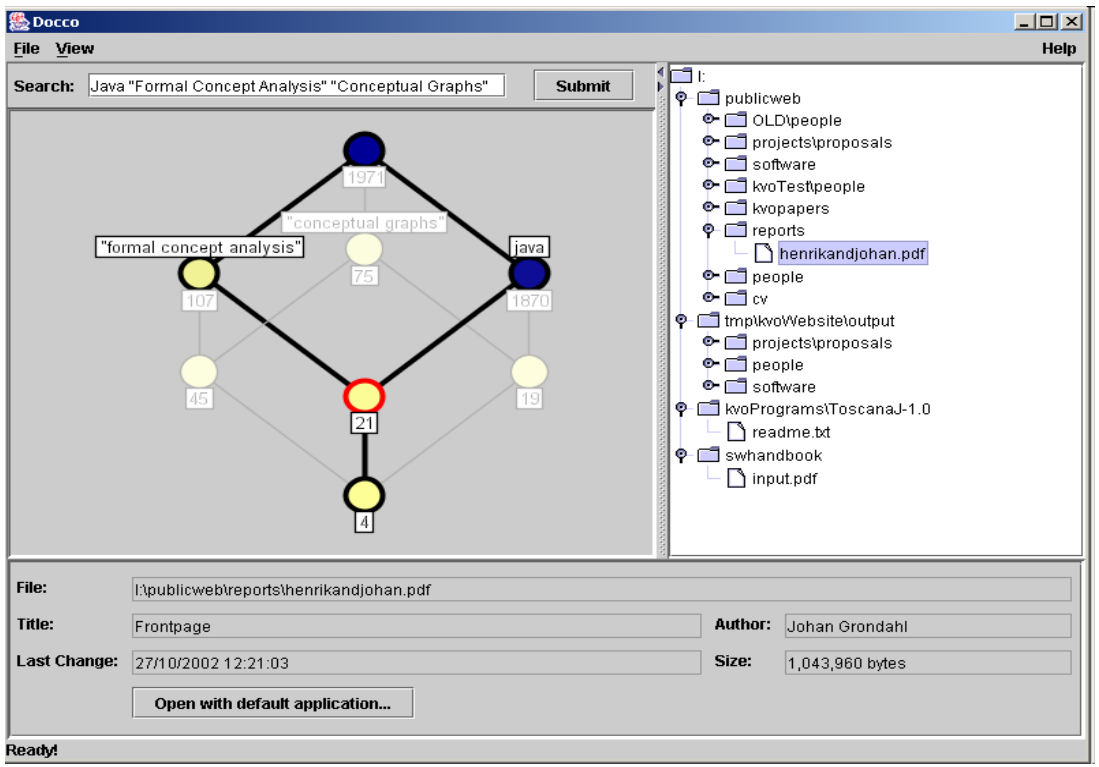
- First FCA literature retrieval system in a library (ZIT)



Applications

- Docco:

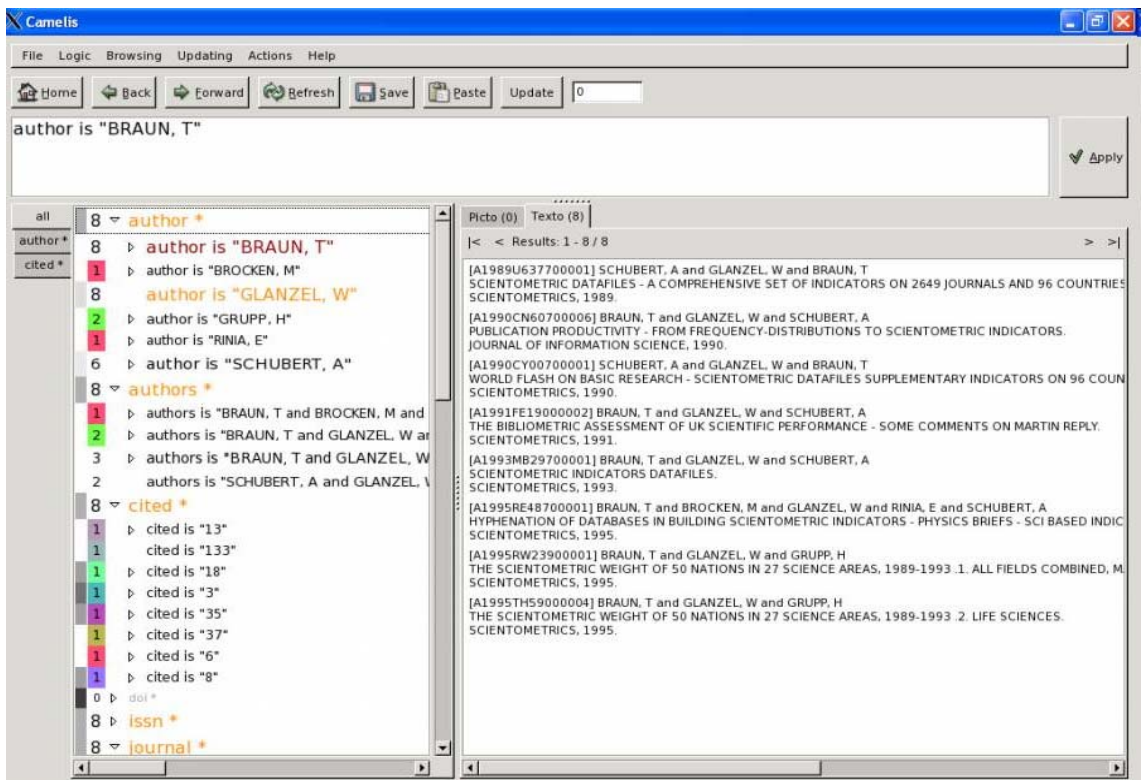
http://tockit.sourceforge.net/docco/



Applications

- Camelis:

http://www.irisa.fr/LIS/ferre/camelis/documentation.html



Outlook

- a model and a micro-bibliographic analysis
- high potential for visualisation of citation dependecies
- mining logical connection in sets of bibliographical data
- FCA as a supporting method
- tools for enrichment of bibliographical data and for personal archiving

Thank you for your attention!