707.000
Web Science and Web Technology
„Metadata, Tagging and Folksonomies“

How can we acquire, organize, analyze and make use of **Data about Data** on a participatory web?

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Overview

Agenda

- Metadata
- Tagging
- Folksonomies

How can we acquire, organize, analyze and make use of **Data about Data**?

Based in part on slides prepared by M. Lux, Multimedia Information Systems

http://mathias.lux.googlepages.com/multimediainformationsystems

OpenData

What is Metadata?

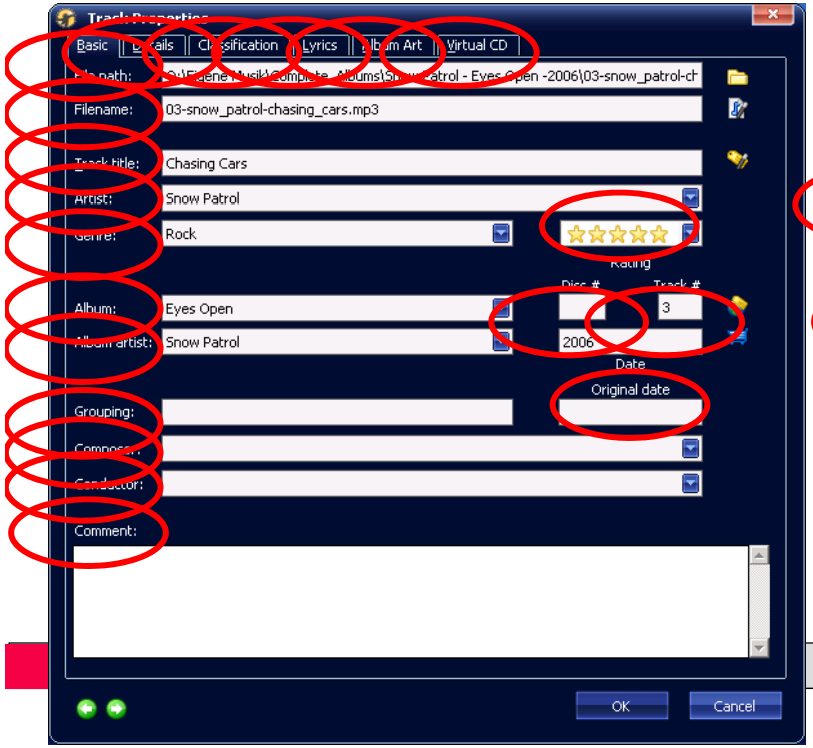
Metadata is Data about Data

Meta^2 data is data about metadata

What is metadata used for?
What is metadata useful for?

Aspects of Metadata

- Content Description
- Administrative Aspects
- Quality Metadata
- Legal Metadata
- Technical Metadata



Classification Systems in Library Science

The ACM Computing Classification System (1998)

- A. General Literature
  - A.0 GENERAL
    - *Biographies/autobiographies*
    - *Conference proceedings*
    - *General literary works (e.g., fiction, plays)*
  - A.1 INTRODUCTORY AND SURVEY
  - A.2 REFERENCE (e.g., dictionaries, encyclopedias, glossaries)
  - A.m MISCELLANEOUS
- B. Hardware
  - B.0 GENERAL
  - B.1 CONTROL STRUCTURES AND MICROPROGRAMMING (D.3.2)
    - B.1.0 General
    - B.1.1 Control Design Styles
      - *Hardwired control* [**]
      - *Microprogrammed logic arrays* [**]
      - *Writable control store* [**]
    - B.1.2 Control Structure Performance Analysis and Design Aids

Overview of the Dewey Decimal Classification

The ten main classes are:

000	Computers, information & general reference
100	Philosophy & psychology
200	Religion
300	Social sciences
400	Language
500	Science
600	Technology
700	Arts & recreation
800	Literature
900	History & geography

Indexing Resources

Categories vs. Keywords

The ACM Digital Library:

PORTAL

Subscribe (Full Service) Register (

Search: The ACM Digital

THE GUIDE TO COMPUTING LITERATURE

An epistemic dynamic model for tagging systems

Full text Pdf (963 KB)

Source **Conference on Hypertext and Hypermedia** archive
Proceedings of the nineteenth ACM conference on Hyp
Pittsburgh, PA, USA
SESSION: Social linking II: analysis and modeling table of co
Pages: 71-80
Year of Publication: 2008
ISBN:978-1-59593-985-2

Authors Klaas Dellschaft Universität Koblenz-Landau, Koblenz, Germany
Steffen Staab Universität Koblenz-Landau, Koblenz, Germany

Sponsors SIGWEB: ACM Special Interest Group on Hypertext, Hypermedia, and Web
ACM: Association for Computing Machinery

Publisher ACM New York, NY, USA

Bibliometrics Downloads (6 Weeks): 7, Downloads (12 Months): 98, Citation Count: 5

INDEX TERMS

Primary Classification:
H. Information Systems
H.5 INFORMATION INTERFACES AND PRESENTATION (I.7)
H.5.3 Group and Organization Interfaces
Subjects: Collaborative computing

Additional Classification:
H. Information Systems
H.5 INFORMATION INTERFACES AND PRESENTATION (I.7)
H.5.3 Group and Organization Interfaces
Subjects: Theory and models

Keywords:
complex systems, stochastic modeling, tagging, temporal evolution

➔ **Categories** and **keywords** serve different functions

Finding Resources
Searching vs. Browsing

Example: Journal of Universal Computer Science

Keywords are used to facilitate *search*

Categories are used to facilitate *browsing*

Metadata Applications

Retrieval & Browsing

- No need to download / view the whole video
- Push vs. Pull

Management & Organization

- Rights, Billing, Ordering, Classification

Adaptation

- Transformation to appropriate representation

Service Description

- Orchestration, Harmonization, Access
- On technical and semantic level

Aspects of Metadata: Content Description

Agenda
- Overview about a presentation or a sequence of information to a particular topic

Table of Contents
- A list of all segments and their position

Abstract
- Describes the topic of a content within a few sentences.

Preface
- Some words of the author

Structure
- For consumption & navigation

And many others, such as Key words & Index, Summary, Literature reference & footnotes, Comments, Categories, Languages, Associated persons, History of Changes, Unique identifier, Versions

Aspects of Metadata: Quality Aspects

Weight

- Prioritization of segments

Expiration Date

- Time period of validity of the content.

Reviews

- Opinions, arguments from others.

Process description & history

- Who corrected, translated and approved the content eg. within an workflow.

Quality Assessment

- Rating of the (e.g. visual) quality of the content

Aspects of Metatdata: Legal Metadata

Copyright

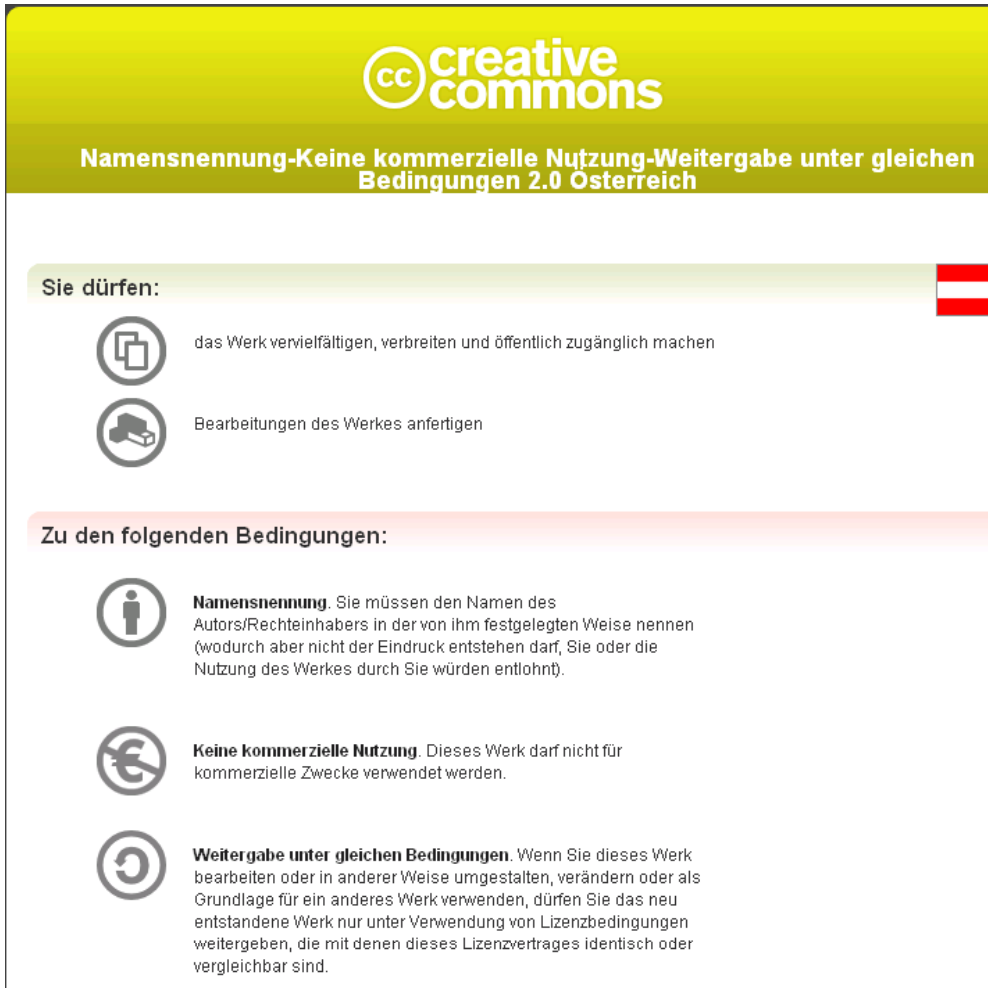
- Person or company legally permitted to sell or trade with the content.

Publish Date

- Date when the content has been released to public.

License Model

- This is the mode how consumers are allowed to reuse the content



Aspects of Metadata: Technical Metadata

Standards:

- Description of the standardized structure in which the content and the metadata are stored.

Application/System

- application the content and metadata can be / has been processed.
- Resolution, compression of pictures or video clips.

Encryption Method

- In case of encrypted content

Storage Media

- on which the content has been stored e.g. CDs, tapes, MO, paper etc.

Logs

- Technical history

Media Production: Dublin Core

Aims to provide

- Common denominator for metadata
- Simple yet powerful schema

Dublin Core Metadata Initiative defined

- 15 elements (author, date, title, type, ...)
- Further refinements (creation date, extent, ...)

Dublin Core does not provide

- A schema for storage
- A schema for data types (e.g. dates)

Dublin Core

Title
Creator
Subject
Description
Publisher
Contributor
Date
Type
Format
Identifier
Source
Language
Relation
Coverage
Rights

Inhalt (Content)	
Title	**Name** der WR (=Wissensressource); vergeben vom Erzeuger oder Herausgeber
Subject & Keywords	**Thema & Gegenstand** der WR; typischerweise wird das Subject durch Schlüsselwörter/**keywords**, die den Inhalt **beschreiben**, repräsentiert Schlüsselwörter sollten aus einem standardisierten Set stammen (Thesaurus, etc.)
Description	**textuelle Beschreibung** der WR; **Abstracts** (bei Textdokumenten) oder **Inhaltsbeschreibung** bei visuellen Ressourcen
Source	**eindeutige Identifizierung der Quelle**, aus der diese WR stammt (wenn zutreffend); z.B. ISBN Nummer des Buches aus dem die PDF-Version der WR stammt
Language	**Sprache** der WR; wenn möglich konform mit RFC 1766
Relation	**Beziehung** der WR zu **anderen WRs**; beschreibt die formalen Beziehungen von wissensobjektmäßig getrennten aber inhaltlich zusammengehörenden WRs; z.B. Bilder in Dokumenten, Kapitel in einem Buch
Coverage	räumliche/temporale Charakterisierung der WR

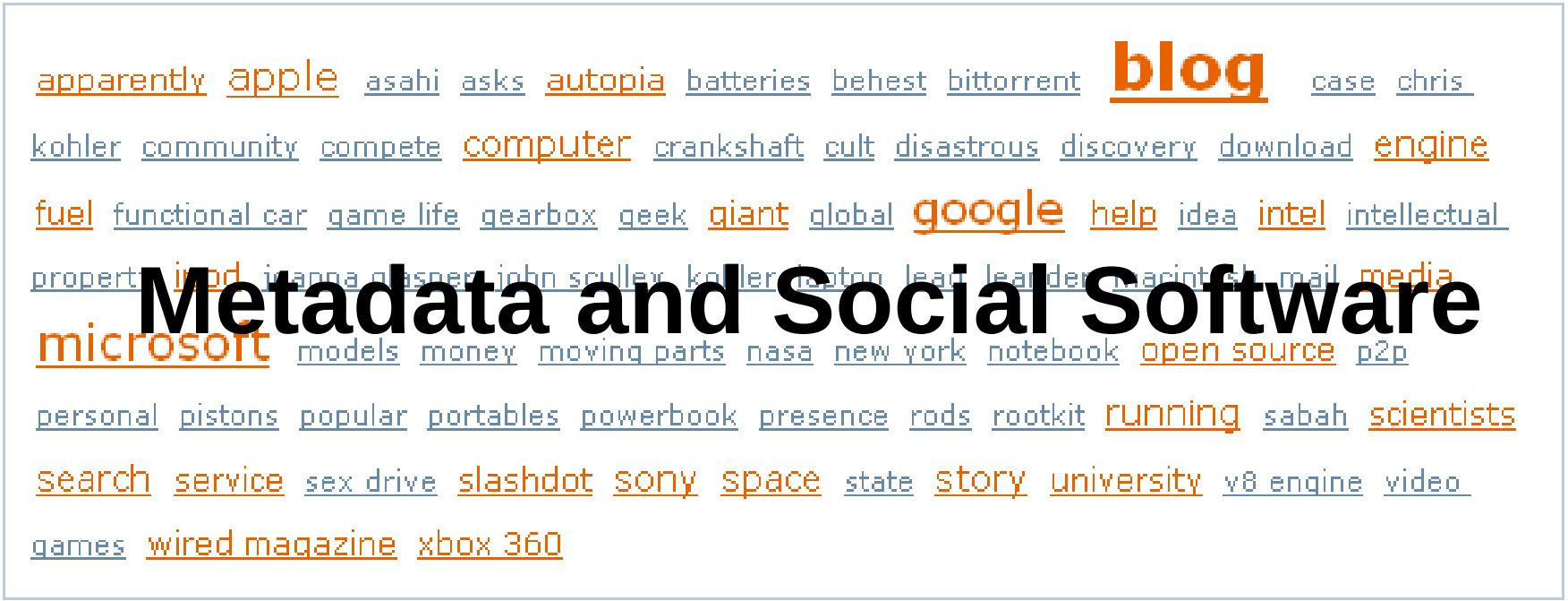
Urheberschaft (Intellectual Property)	
Creator	die für den intellektuellen Inhalt dieser WR **primär verantwortliche Person** oder **Organisation**
Publisher	**Herausgeber** der WR; z.B. Verlag, Universität, etc.
Contributor	**Person** oder **Organisation** die **sekundär** zu dieser WR **beigetragen** hat (und nicht im Creator-Feld genannt wird); Z.B. Übersetzter, Illustrator, etc.
Rights	Beschreibung der **Copyrights** auf diese WR
Intsanziierung (Instantiation)	
Date	**Datum**, an dem diese WR verfügbar gemacht wurde, empfohlenes Format: YYYY-MM-DD
Type	**Kategorie/Typ** der Ressource: Arbeitspapier, technical report, Erzählung, Homepage, etc.; standardisierte Namen erwünscht (z.B. http://sunsite.berkeley.edu/Metadata/types.html
Format	Datenformat der WR
Resource Identifier	Zeichenkette, die die WR **eindeutig identifiziert**; z.B. URL, ISBN,...

Library of Congress

- It takes 2 years of training to being able to use the LoC classification system
- It costs ~50 USD to classify a book

- What are alternatives?

Metadata and Social Software



What is Social Software / web2.0?

Many views and definitions

Some common aspects of social software:

"unprecedented emphasis on *voluntary participation, user-control, emergent structures*, *self-organization* and the *facilitation of social interactions and social activities* "

Metadata in the context of social software / web2.0

In the context of social software metadata

Is bottom up
- In contrast to controlled vocabularies
- In contrast to quality ensured content creation processes

Represents a superimposed structure
- Instead of using predefined hierarchies
- Through heavy use of linking / interrelation

Is huge and fuzzy
- Unimaginable mass of links & tags
- Lots of redundant information

Is being spammed
- Just starting ...

Folksonomies

Definition & Description

Advantages and Disadvantages of Folksonomies

Folksonomies

A folksonomy is a **user-generated classification, emerging through bottom-up consensus** [1]

- Network of Tags, Users and URLs
- Users describe resources
- By using (multiple) tags

Examples:

Social bookmarking, media sharing, etc.

[1] http://www.iskoi.org/doc/folksonomies.htm

Folksonomies: The Structure

- User *tags* resource (URL)
- 1+ words or phrases (graz, „markus strohmaier“)

- No controlled vocabulary, taxonomy
- No quality control
- No constraints (language, length, number)

A Simple Tag Ontology

[Tom Gruber, International Journal on Semantic Web & Information Systems, 3(2), 2007.]

Expressing tagging relationships:

Tagging(object, tag)

Considering the user:

Tagging(object, tag, tagger)

identifying vocabulary of users

Considering namespaces:

Tagging(object, tag, tagger, source)

identifying vocabulary of applications

Considering positive and negative tags:

Tagging(object, tag, tagger, source, + or -)

e.g. dealing with spam („not X“)

Folksonomies: Structure

Tagging(object, tag, tagger)

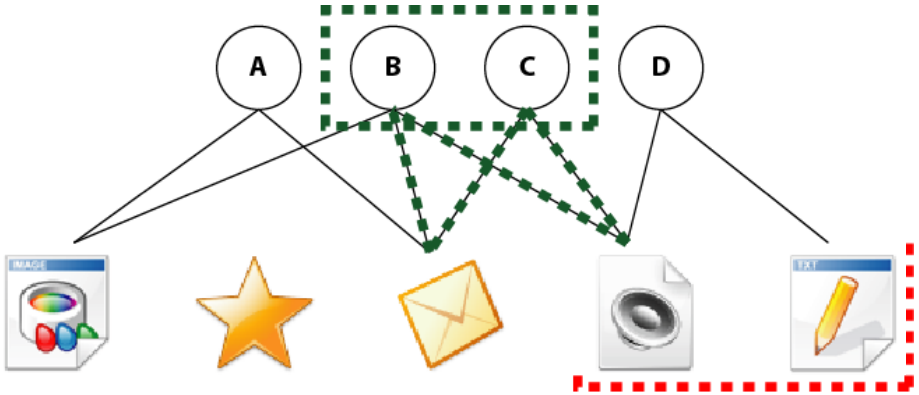
Folksonomies: Structure

Tag to URL is a n:m relation

Superimposed structure through bidirectional links

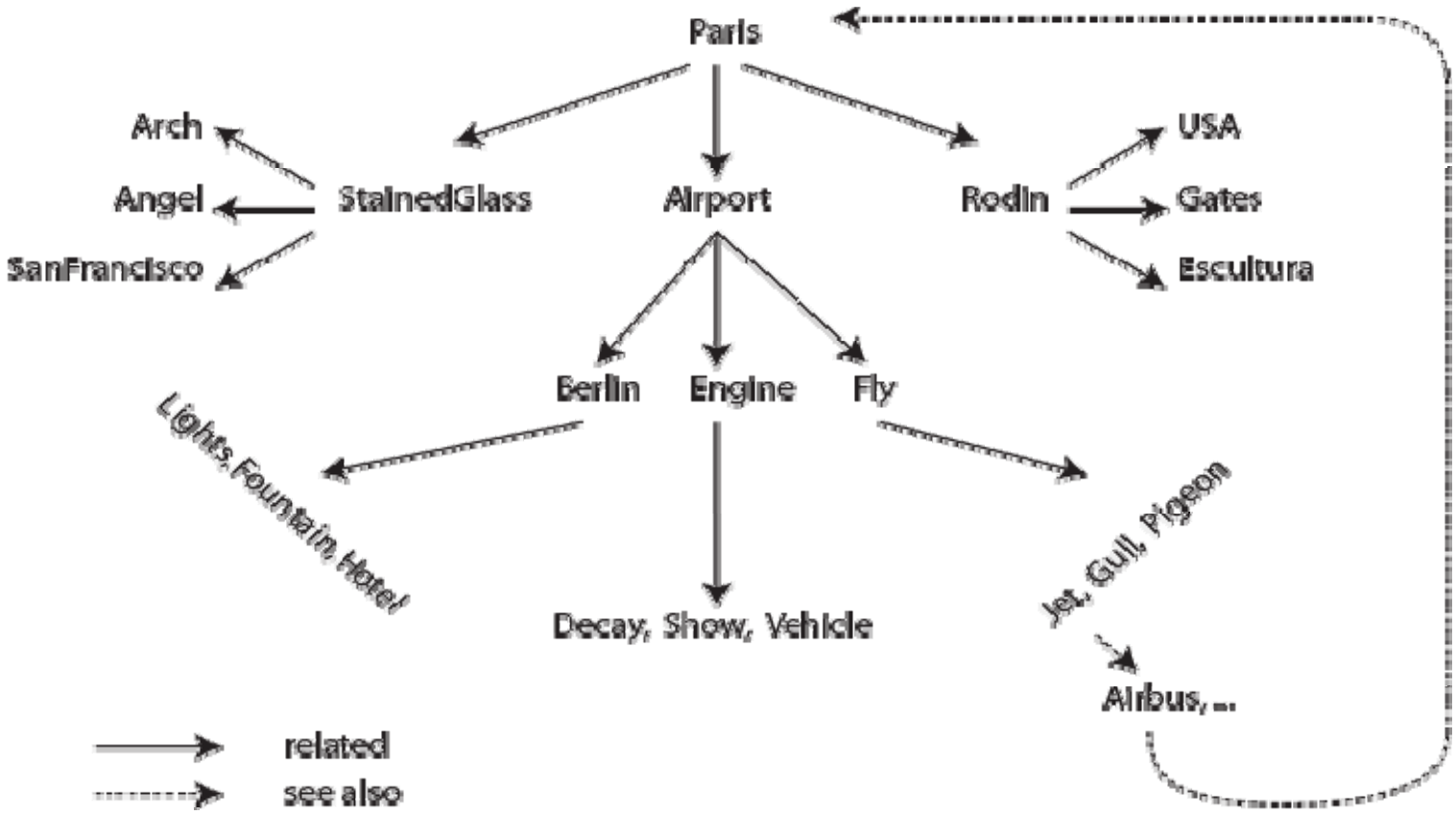
Structure is called „folksonomy“

Tagging(object, tag)



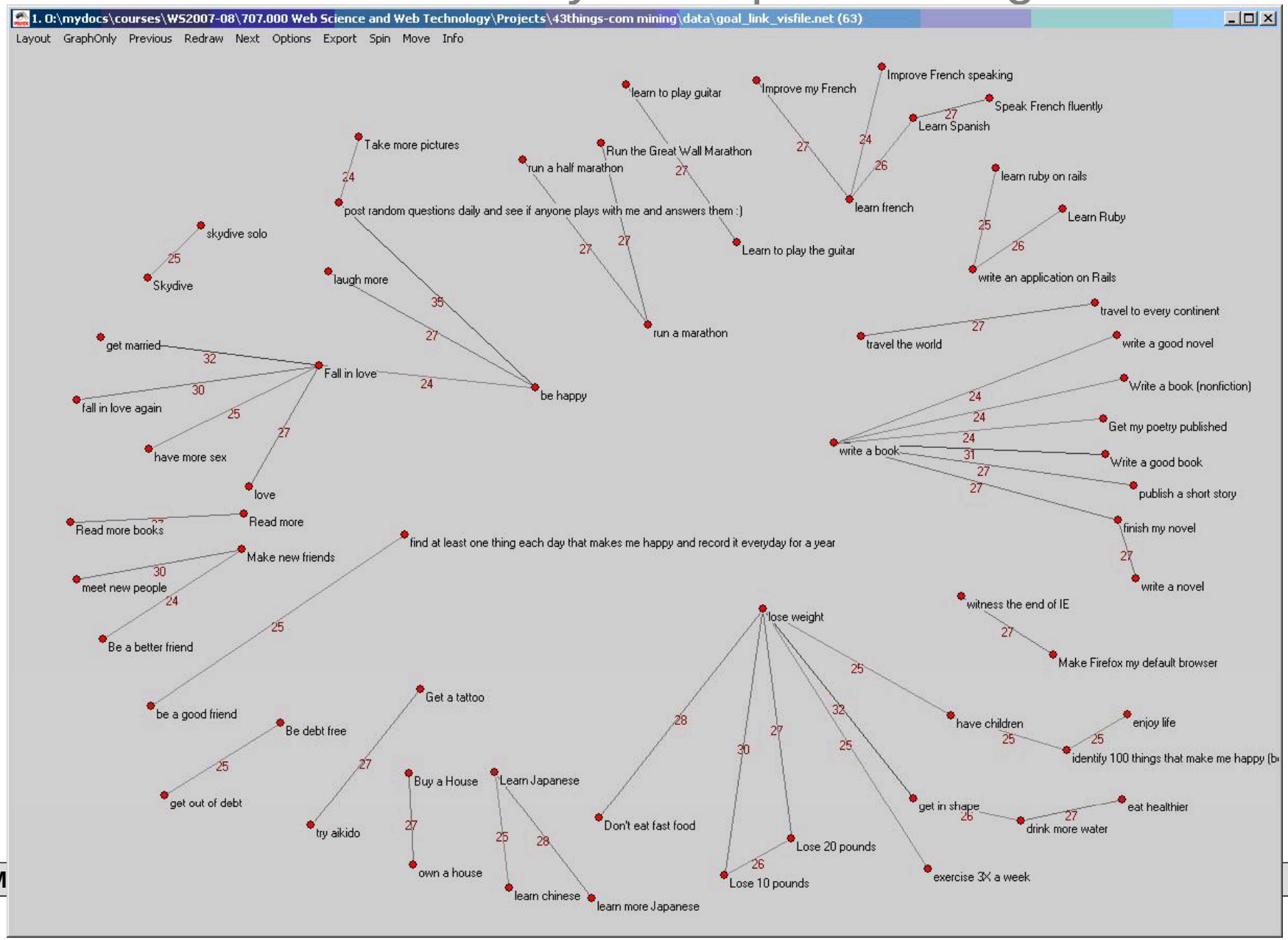
Two-mode networks in social network analysis terms

Folksonomy Example: Flickr



Folksonomy Example: Technorati

Folksonomy Example: 43things

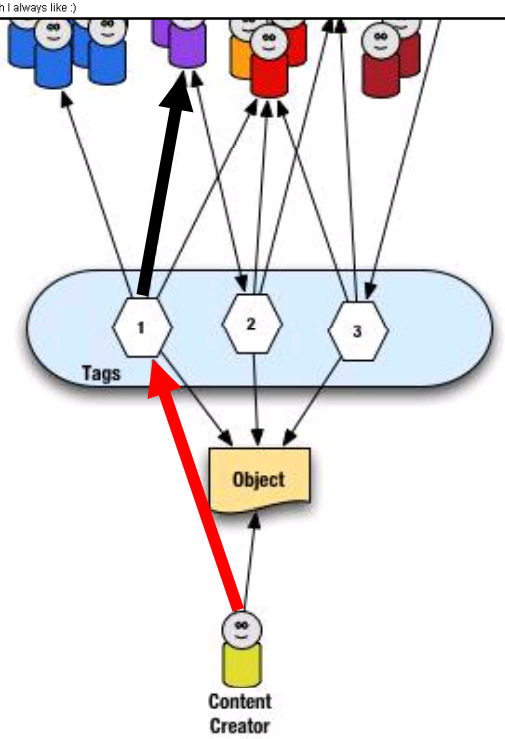


Types of Folksonom

[Thomas Vander Wal http://www.personalinfocloud.com/20

Narrow folksonomies

- tagging objects that are **not easily searchable** or have no other means of using text to describe or find the object
- done by **one or a few people** providing tags that the person uses to get back to that information.
- The tags, unlike in the broad folksonomy, are **singular in nature**
- tags are **directly associated with the object**.
- Example: Flickr

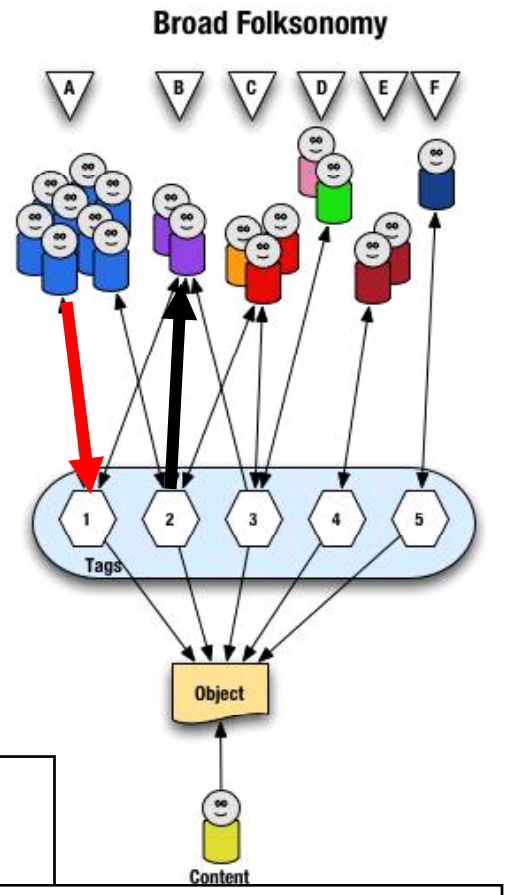


Types of Folksonomies

[Thomas Vander Wal http://www.personalinfocloud.com/2005/02/explaining_and_.html]

Broad folksonomies

- many people **tagging the same object** and
- every person can **tag the object with their own tags** in their own vocabulary
- Example: Social bookmarking
- The broad folksonomy provides a means to see trends in how a broad range of people are tagging one object.
- power law curves and long-tail are relevant phenomena



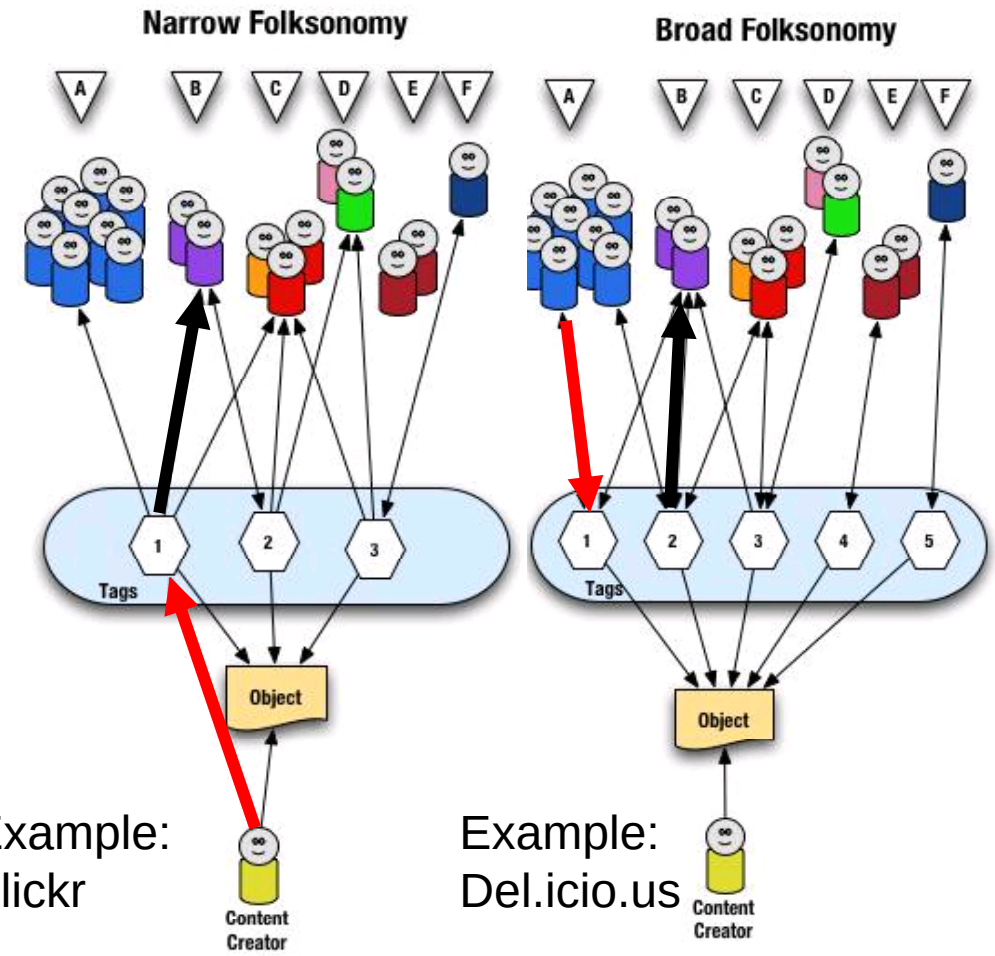
Del.icio.us

Types of Folksonomies

[Thomas Vander Wal http://www.personalinfocloud.com/2005/02/explaining_and_.html]

Differences

- Number of people tagging a single object
- Narrow folksonomies are more sparse
- Purpose
- Narrow ones allow for enhanced metadata for an object



Example: Flickr

Example: Del.icio.us

Why do tagging systems work?

This was topic of a panel at CHI 2006, following conclusions were drawn:

Tagging has a benefit for the user

- Similar to bookmarking, integrated apps
- Benefit of accessibility from everywhere in the internet

Tagging allows social interaction

- Connecting a user to a community trough tags
- People can subscribe your stream

Benefits of Tagging

Tags are useful for retrieval

- Synonyms and typos vanish in the mass of tags
- Communities can retrieve “their” stuff (e.g. by special tag)

Tagging Systems have a low participation barrier

- Apps are easy to use, intuitive, responsive
- Free text is used to do the tagging
- Requires no previous considerations & training

Analyzing Folksonomies

Mika P. (2004) *"Ontologies are us: A unified model of social networks and semantics"*

How can meaning/semantics emerge from folksonomies?

Ontologies contain instances *I* and concepts *C*

(cf. Tag ontology consisting of [object, tags])

What are the fundamental constructs?

A third set besides *C* and *I* is needed

Agents *A* are those who specify

Agent defines

- which Concept *C* is
- assigned to Instance *I*

⇒ A **tripartite model** can be identified

A tripartite model

P. Mika. Ontologies Are Us: A Unified Model of Social Networks and Semantics. International Semantic Web Conference, 522-536, Springer,2005.

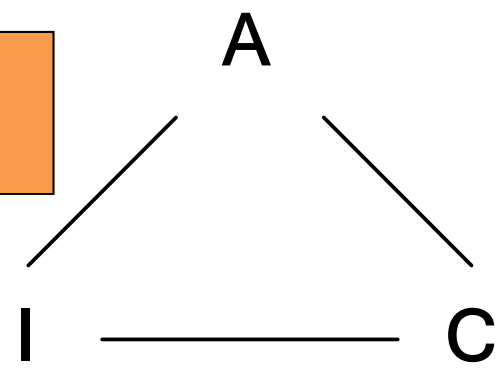
3 partitions: *A*, *C* & *I* (a three-mode network)

The set of vertices is partitioned into the three (possibly empty) disjoint sets $A = \{a1, \ldots, ak\}$, $C = \{c1, \ldots, cl\}$, $I = \{i1, \ldots, im\}$ corresponding to the set of actors (users), the set of concepts (tags, keywords) and the set of objects annotated (bookmarks, photos etc.)

Hyperedges connect exactly one $a \in A$ with one $c \in C$ and $i \in I$

Edge denotes that a user assigns a concept to a resource.

But tripartite graphs are rather hard to understand and to work with!



What do you think can be done about that?

Folding the tripartite Model

P. Mika. Ontologies Are Us: A Unified Model of Social Networks and Semantics. International Semantic Web Conference, 522-536, Springer,2005.

Three possible two mode networks:

- A-C, C-I, A-I

Concepts are particularly interesting in the context of folksonomies

Folding the two two-mode networks A-C, C-I into two one-mode networks

Co-Affiliation networks:

➔ Overlapping communities (O_{ac}) and

➔ Overlapping sets of instances (O_{ci})

Folding

Folding allows to transform the Matrix to a one mode network

(also see the co-occurence matrix in text retrieval)

$$M_P = M_{PC} * M_{PC}'$$

$$M_C = M_{PC}' * M_{PC}$$

Commutativity!

Result is a matrix connecting concepts to concepts

Example: Folding

Two mode Network [excerpt]

	computer	pda	cellphone	wlan	network
i1	7	5	0	6	1
i2	7	1	1	1	2
i3	0	4	5	0	0
i4	8	0	0	0	6
i5	3	3	0	4	0

One mode Network [excerpt]

	computer	pda	cellphone	wlan	network
computer	111	62	20	62	60
pda	62	56	9	68	28
cellphone	20	9	41	0	12
wlan	62	68	0	100	24
network	60	28	12	24	34

Other Association Matrices

P. Mika. Ontologies Are Us: A Unified Model of Social Networks and Semantics. International Semantic Web Conference, 522-536, Springer,2005

Based on A[C|I]-Graph the social network between agents can be analyzed

- Based on the AC-Graph
  - Bipartite agent to concept graph
  - Instances are used as weights
- Based on the AI-Graph
  - Bipartite agent 2 instance Graph
  - concepts are used as weights

Broader / narrower term relations

P. Mika. Ontologies Are Us: A Unified Model of Social Networks and Semantics. International Semantic Web Conference, 522-536, Springer,2005

We now can think about extracting broader/narrower term relations typical of thesauri using set theory.

In an ideal situation, we would say that Concept A is a super concept of Concept B if the set of entities (persons or items) classified under B is a subset of the entities under A ($B \in A$ $A \cap B = B$).

We might also add the criterium that the set of A should be significantly larger then the set of B, i.e. $|B|/|A| < k$ for some value of k.

Broader / narrower term relations

P. Mika. Ontologies Are Us: A Unified Model of Social Networks and Semantics. International Semantic Web Conference. 522-536. Springer 2005

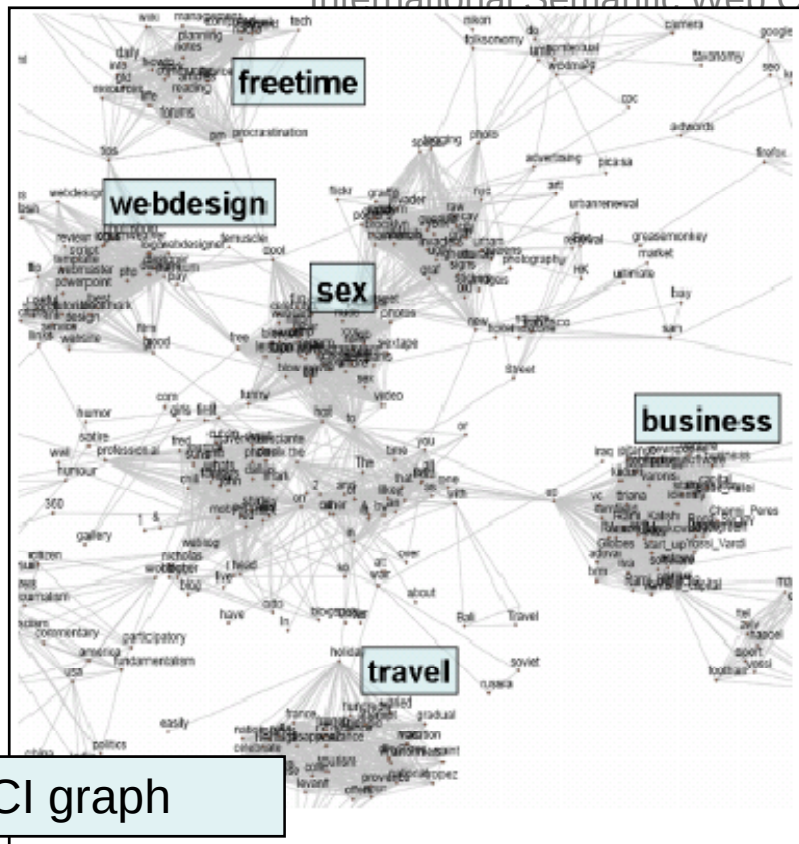


Fig. 1. The del.icio.us tags associated through co-occurrence on items and the clusters emerging

Table 1. The five main clusters of interest based on the Concept-Object network

travel	cote, provence, villa, azur, mas, holiday, vacation, tourism, france, heritage
business	venture_capital, enterprise, up, start, venture, newspaper, capital, Segev, pitango, vc
free time	procrastination, info, advice, gtd, life, notes, planning, daily, reading, forums

CI graph

there exists a strong association between concepts if they share a large percentage of items, *independent of the number of users interested in them and regardless if these associations were added by the same users or not*.

Broader / narrower term relations

P. Mika. Ontologies Are Us: A Unified Model of Social Networks and Semantics. International Semantic Web Conference, 522-536, Springer,2005

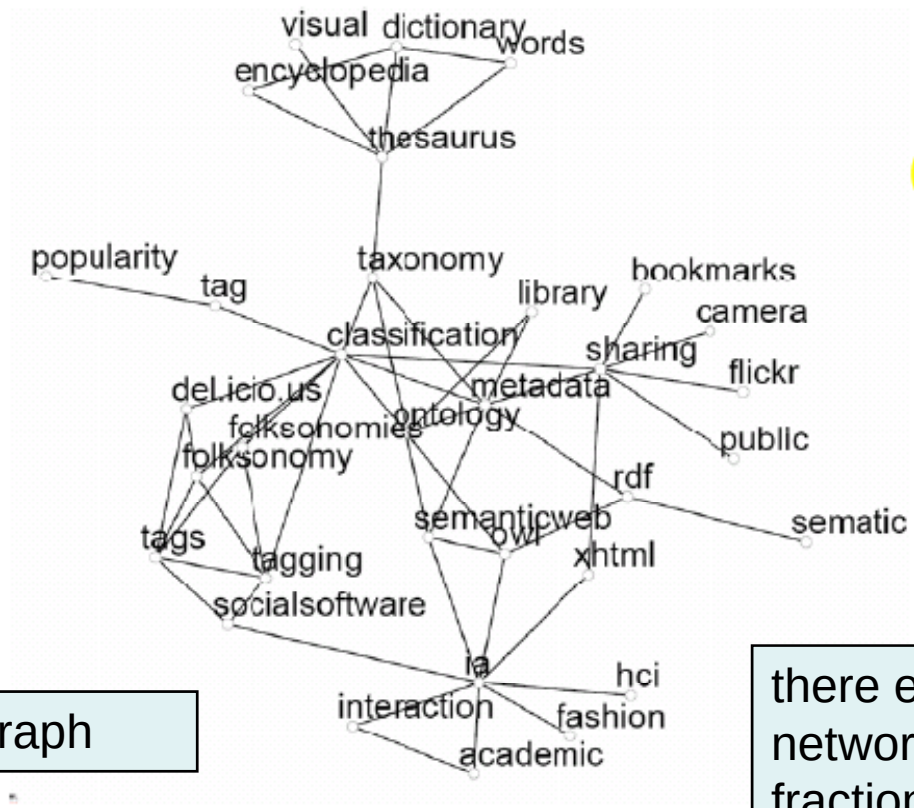


Table 3. Broader/narrower term relations in the technology domain, based on sub-communities in del.icio.us

Broader	Narrower
rss	atom
cmyk	rgb
cell	umts, wcdma, ev-do
phone	cell
ajax	json
xml	xslt
rdf	owl
flickr	gmail, picasa
	dom, sarissa

Fig. 2. Detail view of the del.icio.us tags asso
through users: a 3-neighborhood of the term
ogy. Note that the term *sematic* is correctly
ated, despite the obvious typo.

AC graph

there exists a strong association in the network if two concepts share a large fraction of the users among them, *independent of the number of instances associated with them and regardless whether these terms were added to the same instances or not*.

Problems of the approach

Popularity vs. Generality

Tags have typos, synonyms

Tags have different intentions

- Abstract semantics (funny, sad, friendship)
- Media description (pdf, online, word, image)
- Rights and authors (persons names)
- Organizational (2read, todo, marker)
- etc.

Faceted folksonomies,
polyhierarchical organization of tags

Example:
http://www.bibsonomy.org/user/mstrohm

Problems of the approach

Computational problems

- Big matrix multiplications are hard to compute

Narrow folksonomies restrict tagging to the originating user:

- Flickr tags could historically only be assigned by the uploader
- YouTube similar restrictions

Skip Case-Study

A Case Study
Tag Gathering: del.icio.us

Based on RSS feeds of del.icio.us

- Read main feed
- Get entries for each user

Avoid spammers

- Use entries of URIs with a min. of 2 users

Write to relational database

- In this case MySQL 5.1

A Case Study
Tag similarity

Tags are assigned to resources

Tags describe same URIs-> Similarity

- E.g. Javascript & Ajax
- E.g. Windows & Software
- E.g. Linux & Kernel

Tags never describe same URIs-> Dissimilarity

- E.g. Free & Shop
- E.g. Usability & SAP

A Case Study
Tag Merging: Objectives

Main problems within del.icio.us (and possibly in many folksonomies due to their nature)

- Synonyms
- Basic level variation

Encounter these problems by “merging” synonyms

- Different spellings: e.g. eLearning & e-Learning
- Typos & plurals

A Case Study
Tag Networks: Objectives

What is the conceptual structure within a community?

Which tags are similar / interconnected?

Direction of the connection?

Probability of transition for network edges?

Network Analysis?

- Hubs, central authorities
- Clusters

A Case Study
Tag Centrality: Objectives

Which are the most prominent nodes?

Based on different measures?

- In degree
- In Betweenness
- PageRank / HITS

The removal of central nodes would affect connectivity most!

A Case Study
Tag Clustering: Objectives

What are interesting conceptual clusters?

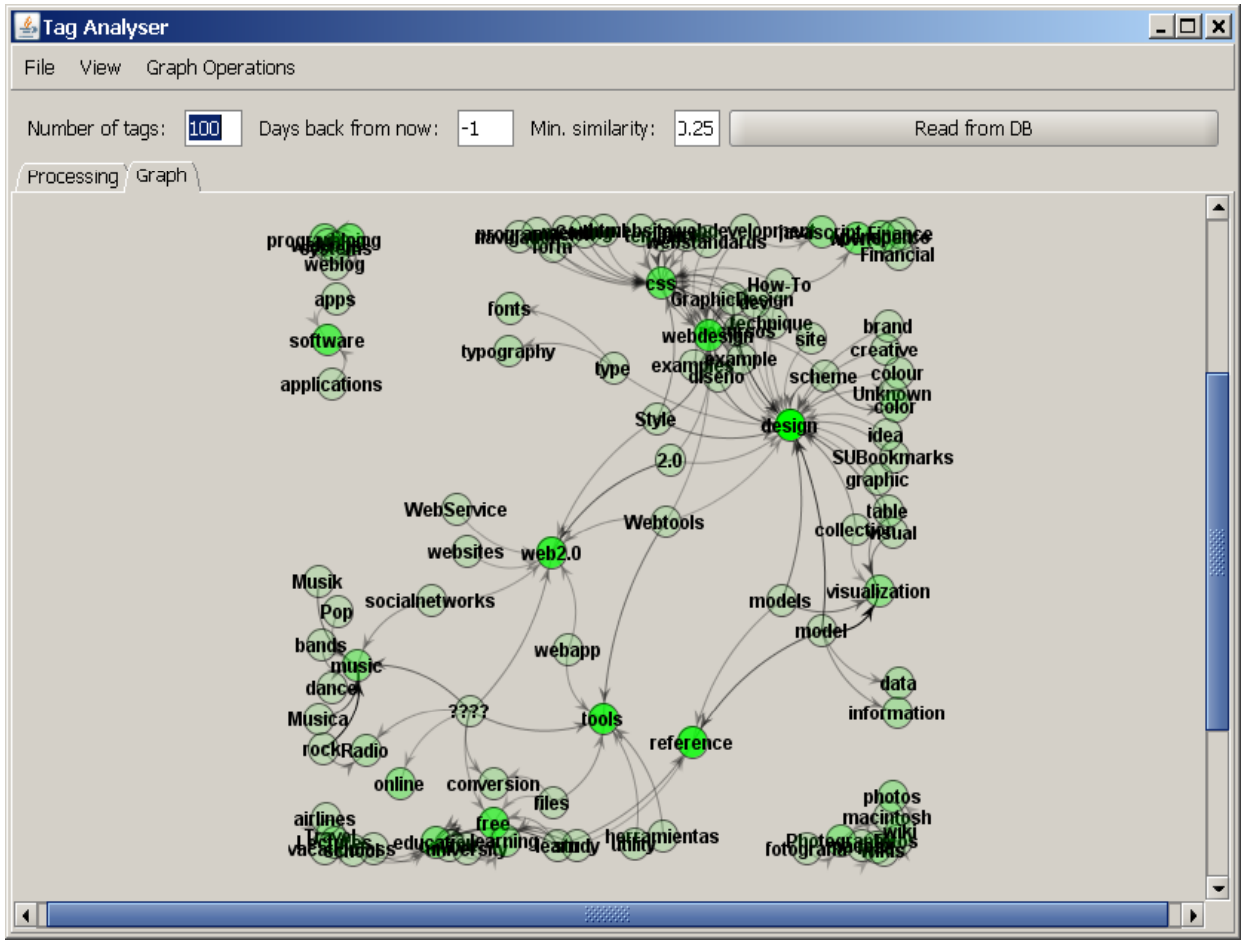
- {design, webdesign, graphics}
- {html, xhtml, css}
- {ajax, javascript, prototype, script.aculo.us}

What is a meaningful disambiguation of a topic / tag?

Clusters of tag programming

1. systems+unix (3,42)
2. developer+development (2,49)
3. webdevelopment+javascript+webdev (2,34)
4. ebook+books+book (2,19)
5. Coding (2,19)
6. programacao+ruby (2,14)
7. script+ajax (1,78)
8. DotNet+.NET (1,65)

A Case Study
Folksonomy Analysis Example



Outlook

An Experimental Goal-Tagging Social Software Application

Any further questions?