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Web Science and Web Technology
„User Intentions and Intentional Structures
on the Web“

Markus Strohmaier

Univ. Ass. / Assistant Professor
Knowledge Management Institute
Graz University of Technology, Austria

e-mail: markus.strohmaier@tugraz.at
web: <http://www.kmi.tugraz.at/staff/markus>

Overview

Agenda

- [Different degrees of explicitness in intentional artifacts - Studying user goals in a large search query log.pdf](#)

Selected Research Questions

1. How can we **identify goals** in search query logs?
2. How can we represent search goals in a **semi-formal goal graph**?
3. How can we represent the search process as a **traverse** through the goal graph?
4. How can goals **direct search behaviour**?
5. Is there a difference between **explicit and implicit intentional search queries**, and how can it be identified?
6. How can we construct **large scale goal graphs**?

Result of joint work with students

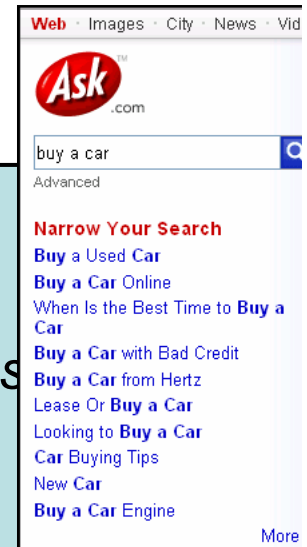
P. Prettenhofer, A. UsSaed, C. Körner, M. Kröll

- The Database of Intentions -

[Battelle 2003]

“The aggregate results of every search ever entered, every result list ever tendered, and every path taken as a result. [...]

This information represents [...] a place holder for the intentions of humankind - a massive database of desires, needs, wants, and likes that can be discovered, subpoenaed, archived, tracked, and exploited to all sorts of ends.



Source: <http://battellemedia.com/archives/000063.php>, last accessed on July 3rd, 2007

BUT: The degree to which the goals and intentions of users can be reconstructed **varies considerably**

„Car“ → Lower degree of intentional explicitness
 ⇕
 „get loan to buy a used car in Miami“ → Higher degree of intentional explicitness

An *intentional artifact* is an electronic artifact produced by users or user behaviour that contains *recognizable “traces of intent”*, i.e. traces of users’ goals and intentions.

Research Overview

Research Questions:

- **How can we distinguish and identify different degrees of intentional explicitness in search queries?**

Following an exploratory, qualitative research style, we aimed to:

- Inspect a large search query log
- Analyze the way goals are expressed in search queries
- Identify possible distinction criteria
- Study differences between implicit and explicit intentional queries

Expected results:

- Increased empirically-coupled knowledge about user goals in search queries

An Exploratory Study

Data Sources:

The **AOL Search Dataset** [Pass 2006]

- ~20 mio search queries
- 657,426 unique user IDs
- *{UserID, query, timestamp, (ItemRank, URL)*}*
- Collected between March 1, 2006 and May 31 2006 by AOL

Explicit vs. Implicit Intentional Queries

Explicit intentional queries:

- Related to a specific goal in a recognizable, unambiguous way. Recognizable refers to what [Kirsh 1990] defines as “trivial to identify” by a subject within a given attention span.
- On a more practical level, this idealized definition is related to “*better queries*”, or queries that have “*more precise goals*” (R. Baeza-Yates at the “Future of Web Search” workshop 2006, Barcelona).

Implicit intentional queries:

- A query, where it is difficult or extremely hard to elicit some specific goal from the intentional artifact.
- Examples include blank queries, or queries such as “car” or “travel”

Why is this distinction important?

- Disambiguation
- switching between explicit and implicit intentional queries
- Narrowing the cognitive gap

Different degrees of explicitness in search queries

- Search queries exhibit considerable variety with respect to degree of explicitness

car, car Miami, car Miami dealer, buy a car in Miami, buy a used car in Miami, get loan to buy a used car in Miami

- Explicit vs. Implicit intentional queries



- Arbitrary selection criteria:
A query is an explicit intentional query if
 - The query contains at least one verb
 - The query corresponds to our definition of goals

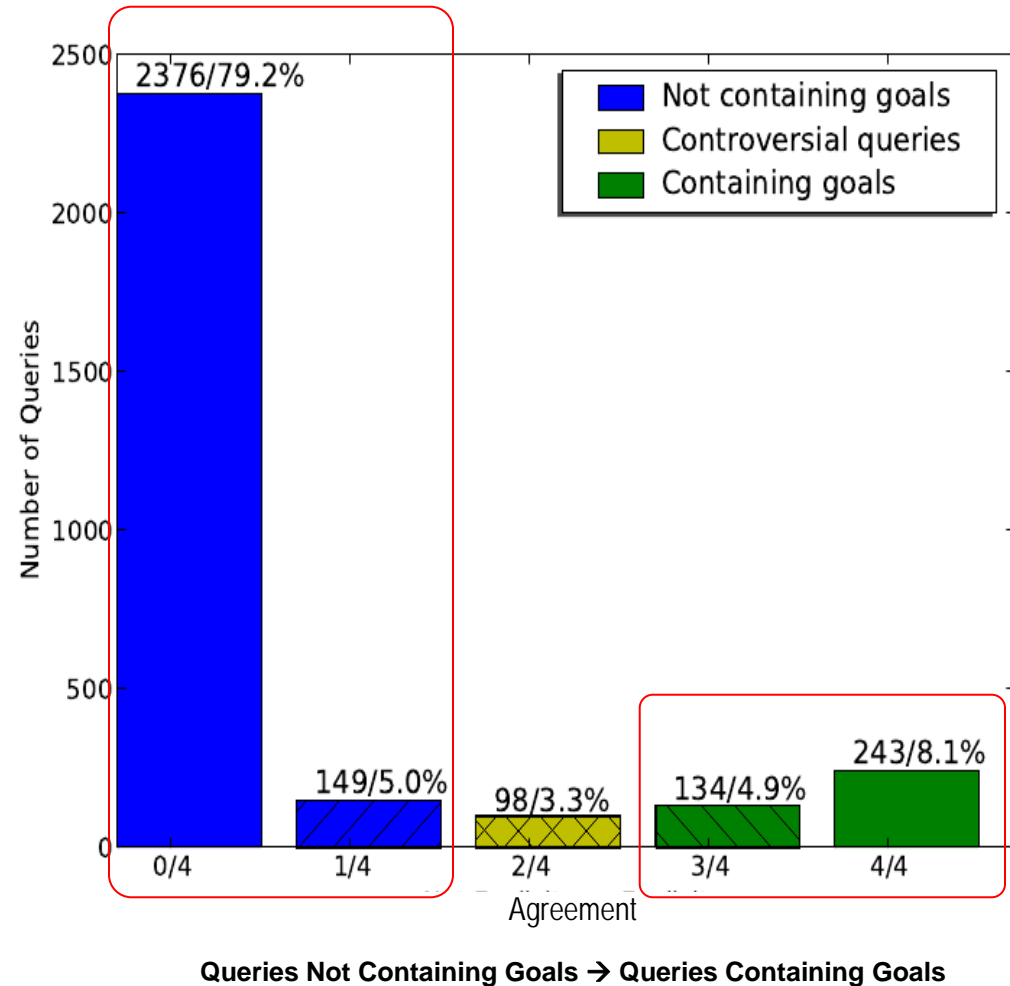
Definition Goal: *“a condition or state of affairs in the world that some agent would like to achieve or avoid”*

Results of Human Subject Study(1)

4 independent raters
labeled 3000 queries

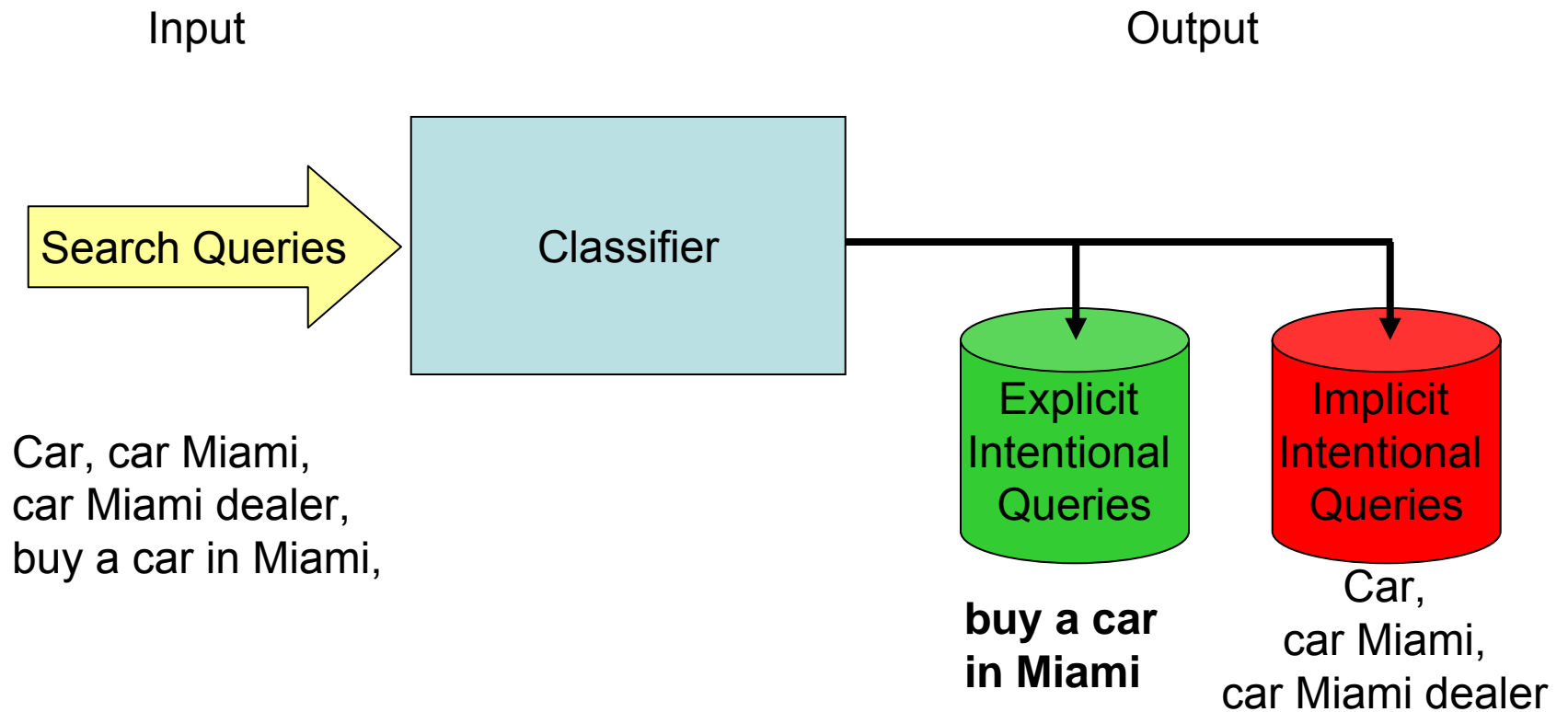
- "bug killing devices"
- "mothers working from home"
- " how to lose weight"

<i>Pair</i>	κ
A - B	0.86
A - C	0.87
A - D	0.88
B - C	0.83
B - D	0.84
C - D	0.87



Different degrees of intentional explicitness – Studying user goals in a large search query log

Approach: Binary classification of search queries



An Experimental Classification Approach 1/2

Eliminating noise in the query log

Pre-processing step	# of queries
Total number of queries	21.011.038
Empty queries	20.527.902
Short queries	7.242.610
URL queries	6.631.084
Syntax check	5.880.900
Queries containing lyrics or movie titles	5.754.994
Corrected misspellings	5.405.547
Verb filter	1.002.861

"Buying a car" -> "buying/VBG a/DT car/NN"

Part-of-Speech tagging queries:

- Only queries with query length >2 (removes ~ 60% of queries)
- Stochastic approach
- Maximum Entropy tagger
- Tag set: Penn Treebank with 45 word classes

Tag	Description	Example
NN	Noun, sing. or mass	car
VB	Verb, base form	eat
VBG	Verb, gerund	eating
VBZ	Verb, 3sg pres	eats
JJ	Adjective	yellow
WRB	Wh-adverb	how, where
TO	"to"	to

Table 1. A sample of Penn Treebank tags (from [14])

Classification Approach(2)

Linear Support Vector Machine [Dumais98]

- Robust and effective in the area of text classification
- Weka Machine Learning Toolkit [Witten05]
- No feature selection

Performance:

- 10 trails – 3 fold Cross Validation
- Values averaged
- Precision, Recall and F1-Measure for the class: “queries containing goals”

Precision	Recall	F1 – Measure
0.77	0.63	0.69

Nr.	P O S	S O W	#	Feature	Example Matching Query
1	x		126	\$ WRB TO	[\$ <i>where to</i>] find shrooms in Georgia
2	x		130	WRB TO VB	[<i>how to live</i>] jewishly
3	x		83	TO VB NN	drink milk [<i>to lose weight</i>]
4		x	41	Buy	<i>buy now pay later</i> jewelry
5	x		58	VB NN NN	[<i>find property values</i>] calculator
6		x	20	Find	<i>find</i> an old friend for free
7	x		36	TO VB JJ	I want [<i>to download instant</i>] messenger
8		x	27	Make	<i>make</i> your own parable
9	x		52	\$ VB NN	[\$ <i>find lawyer</i>] in Georgia to form llc
10	x		29	VB NN IN	[<i>borrow money from</i>] Donald Trump
11	x		12	TO VB PRP	how [<i>to copyright your</i>] photos
12	x		14	WRB VBP PRP	my hair turned orange [<i>how do I</i>] fix it
13	x		26	TO VB NNS	what [<i>to pay Mexicans</i>]
14	x		28	VB NN NNS	[<i>make business cards</i>]
15	x		19	TO VB DT	teach yourself [<i>to play the</i>] piano
16	x		9	VB PRP JJ	how to [<i>get yourself sick</i>]
17	x		45	TO VB IN	places [<i>to stay in</i>] Gatlinburg
18		x	8	Install	<i>install</i> Microsoft windows 2000
19	x		14	\$ VB PRP	[\$ <i>customize your</i>] aol buddy icon
20	x		22	VB PRP NN	how to [<i>obtain us passport</i>]

Result Set

Applying the learnt classifier results in:

- Result set containing 118.420 entries
- 97.454 (82,3%) of them are unique

Nr.	Goal Instance	#Users	Nr.	Goal Instance	#Users
1	add screen name	194	11	cancel aol account	46
2	create screen name	98	12	check my computer	41
3	rent to own	85	13	skating with celebrities	40
4	listen to music	78	14	discover credit card	37
5	pimp my ride	64	15	pimp my myspace	34
6	pimp my space	61	16	change my password	33
7	assist to sell	57	17	how to gain weight	32
8	wedding cake toppers	53	18	enterprize car rental	31
9	cancel aol service	50	19	manage my account	30
10	“ <u>deleted</u> ”	47	20	trick my truck	30

Result Set

Applying the learnt classifier results in:

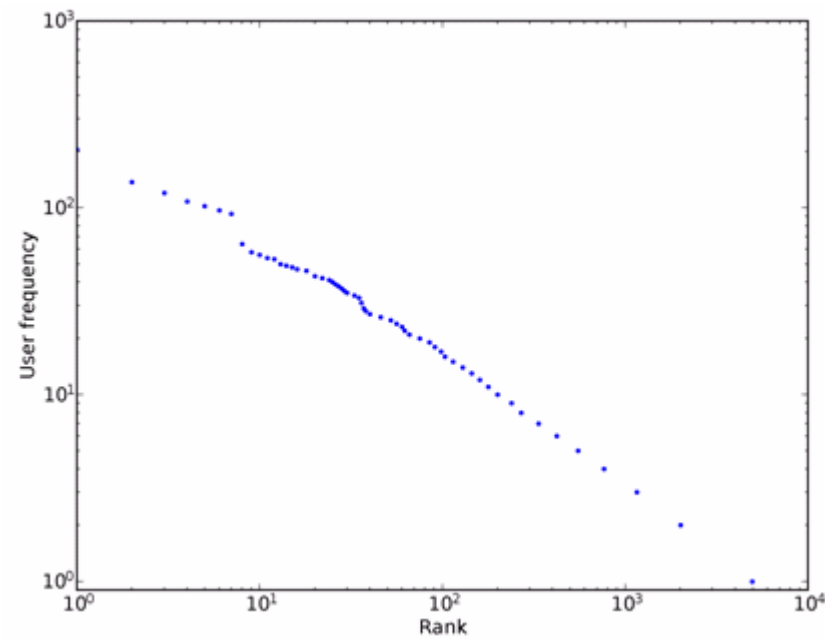
- Result set containing 118.420 entries
- 97.454 (82,3%) of them are unique

Co-Occurrences of most frequent Verbs & Nouns:

	home (2512)	card (2188)	name (1844)	screen (1561)	credit (1433)	music (1398)	money (1371)	weight (1338)	school (1221)	car (1189)
make (8763)	210	208	96	96	5	58	631	19	19	32
buy (8557)	237	117	12	10	66	58	43	6	17	224
find (8545)	169	25	192	30	20	57	60	17	104	94
get (6562)	65	103	41	26	130	33	68	13	55	54
do (6391)	70	62	72	69	40	51	52	52	44	25
listen (2485)	18	0	0	0	0	477	0	0	27	2
learn (2014)	12	16	3	1	6	34	10	3	28	5
sell (1962)	141	38	8	1	2	8	15	1	1	90
use (1688)	15	22	5	5	15	3	3	10	9	15
play (1598)	8	63	0	1	1	13	3	1	4	4

Result Set

Rank / Frequency of Users / Goal



What kind of

rectly / incorrectly?

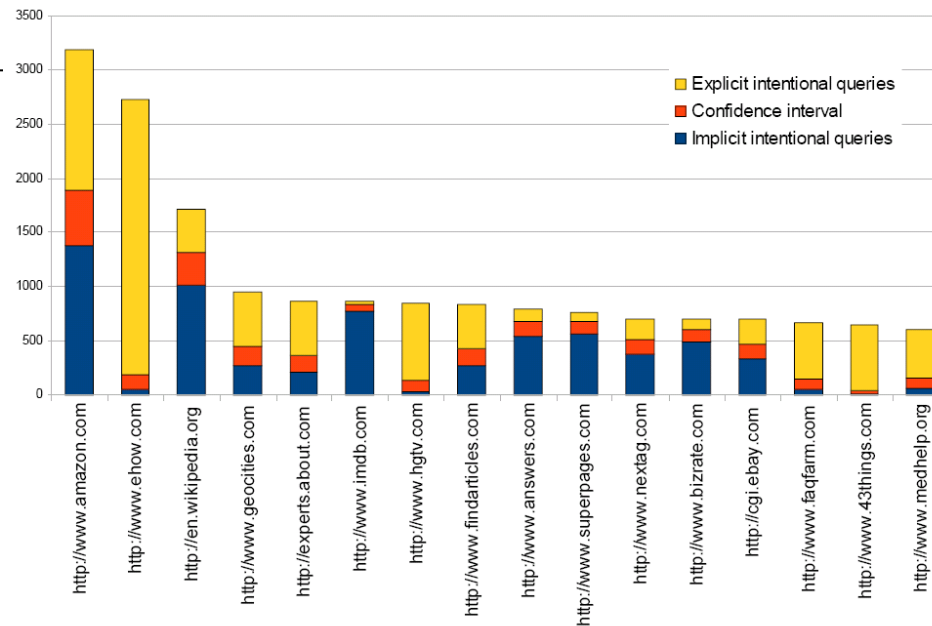


Figure 3. Top 16 websites in the condensed dataset

True positives

Correctly Classified Intentional Queries
"buying groceries online"
"how to get revenge on neighbor within limits of law"
"helping children handle death of a loved one"
"cleaning the ak-47"
"coughing up blood"
"dealing with the guilt of cheating"

Table 4. Examples of correctly classified queries

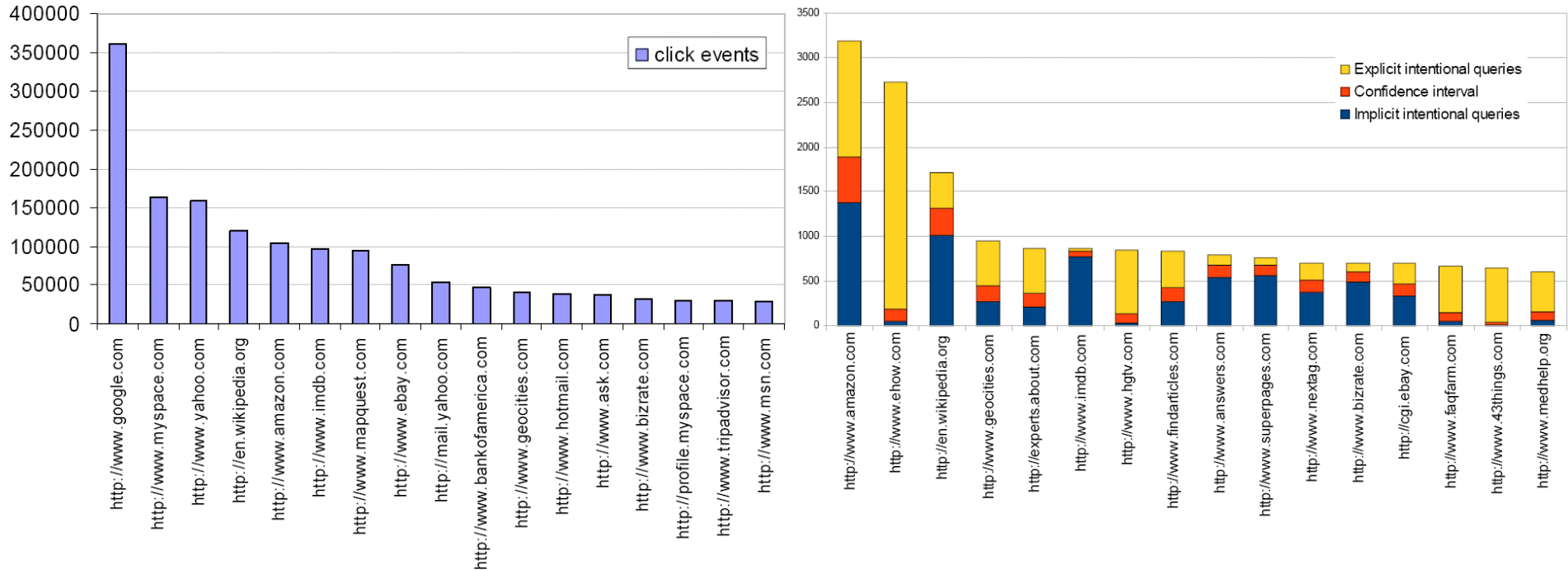
False positives

Incorrectly Classified Intentional Queries
"saving privat ryan"
"driving school Illinois"
"stem cell transplant"
"founding fathers temple"
"recovering the satellites lyrics"

Table 5. Examples of incorrectly classified queries

Results III

Do more explicit intentional queries yield different click-through result sets?



Top 16 websites in the entire dataset

low proportion of explicit intentional queries
(1,69-3,01%)

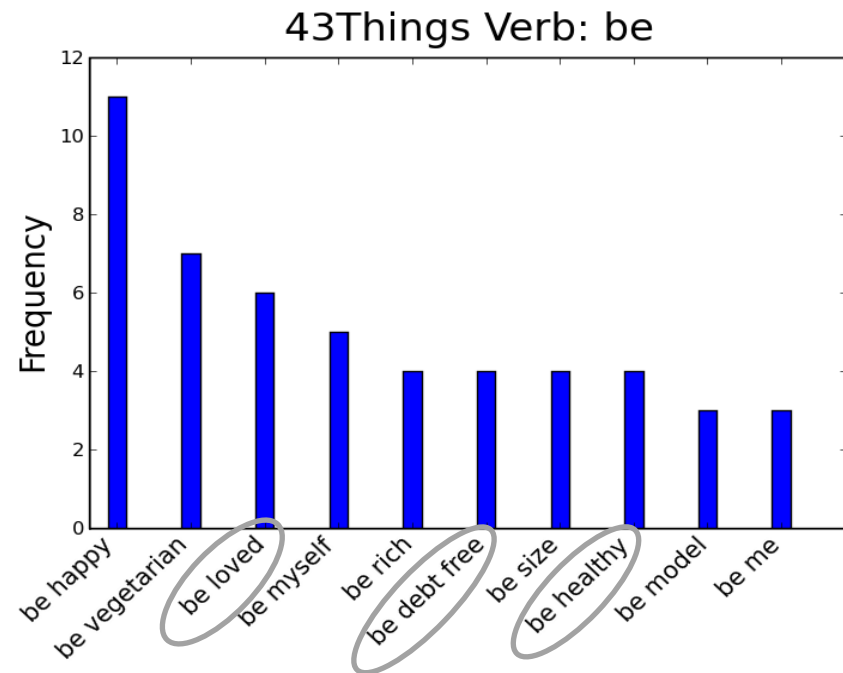
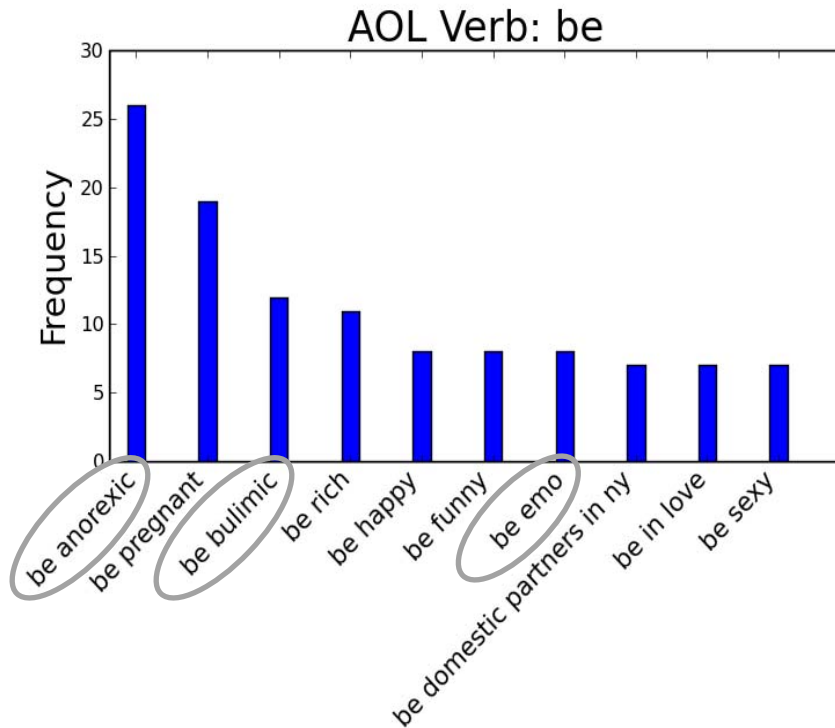


Top 16 websites in the condensed dataset

high proportion of explicit intentional queries
(49,6-58,4%)

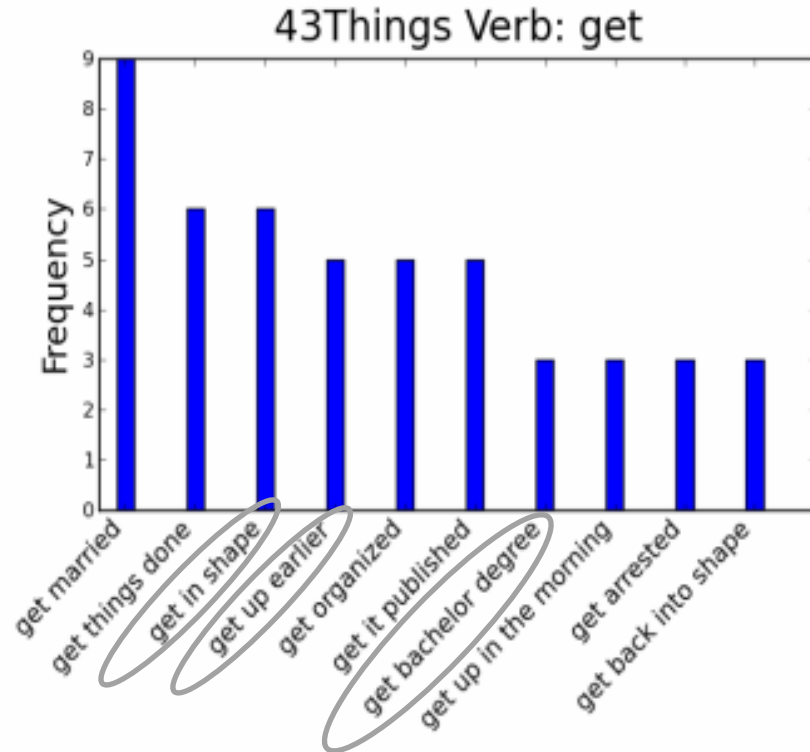
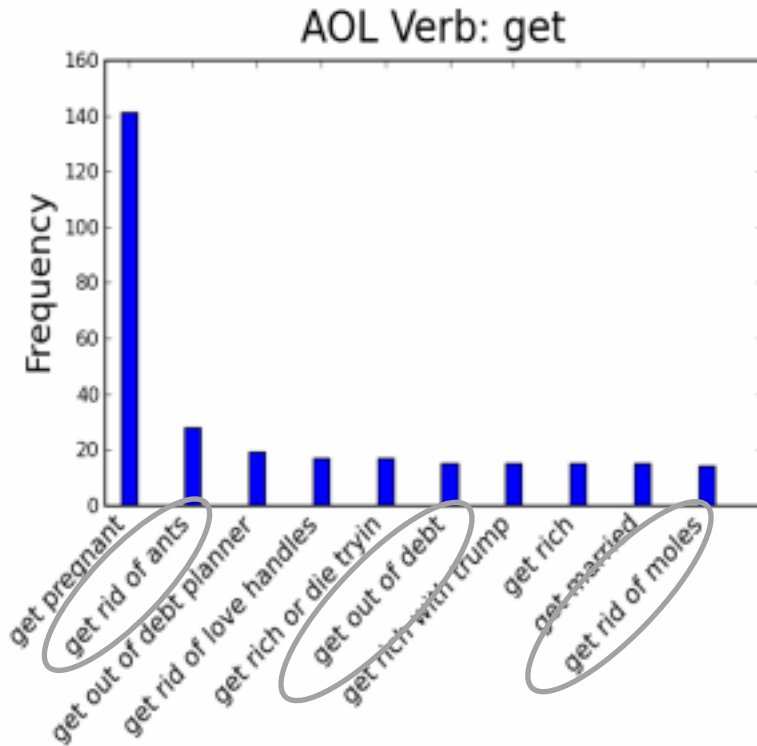
Experimental Classification

Examples: **43things.com** (from #388 up to rank #15), **ehow.com** (from #64 up to #2), **hgtv.com** (from #97 up to #7), and **medhelp.org** (from #104 up to #16).



Observations:

- AOL goals seem to deal with health related issues :
- 43Things goals appear to exhibit a more positive sentiment:



Observations:

- Users seem to have different time frames in mind - AOL Users often appear to seek immediate answers:
- 43Things Users do not seem to underlie these time constraints:

Verbs in AOL vs. 43Things

Top N most frequent verbs of both goal corpora

Observations:

- AOL verbs seem to deal with technical issues
- 43Things contains more verbs reflecting social activity

#Verbs	AOL	Overlap	43Things
10	buy, listen, sell, use, play	make, find, get, do, learn	be, go have, read, see
50	listen,change, look, move,add, remove, clean, install, apply, draw, put, are, set, convert, rent, tell, fix, pimp, wed, check, cook, <i>deleted</i>	get, be, learn, go,make, have,do, read, see, find, buy, take,write, start,stop, eat, want, keep, create, build, play,use, lose, is, grow, know, sell	s, become, meet, finish, live, watch, run, give, spend, try, own, improve, love, organize, save, speak, join, visit, attend, ride, let, work, am

Next Steps

In the medium term, ...

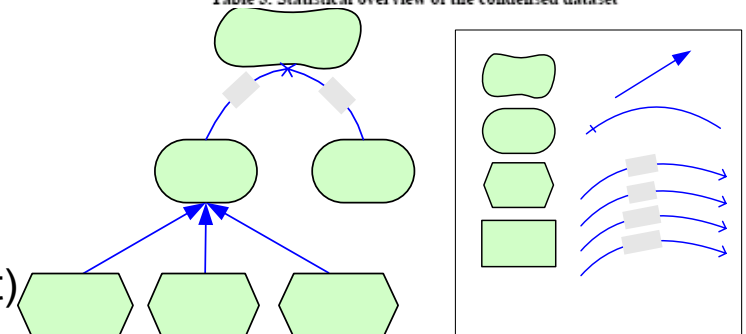
- We intend to develop methods and techniques that support
 - *Intentional Classification* of Artifacts and
 - *Extraction of Goals* from Intentional Artifacts and Social Corpora

- to construct large-scale
 - *Goal Association Graphs* (X is associated with Y) and
 - *Intentional Networks* (different intentional relations and nodes, see image to the right)

- that enable novel applications, such as
 - *Intentional Query Expansion*
 - *Intentional Metadata*
 - *Intentional Analysis*

	Entire Dataset	Condensed Dataset
Queries	20,494,002	279,260
Explicit Intentional Queries	346,349-616,869	138,513-163,089
Implicit Intentional Queries	19,877,133-20,147,653	116,172-140,747
Explicit Intentional Queries, 95% confidence interval	1.69% - 3.01%	49.6% - 58.4%
Users	657,426	94,487

Table 3. Statistical overview of the condensed dataset



Idea I

- We have two unequally distributed types of queries
- Explicit and implicit intentional queries
 - Distinction: Explicit intentional queries contain verbs and thereby allow to more easily grasp the intentionality behind a query than implicit intentional queries
 - Example: „car shop“ vs. „buy car“, „sell car“, „repair car“

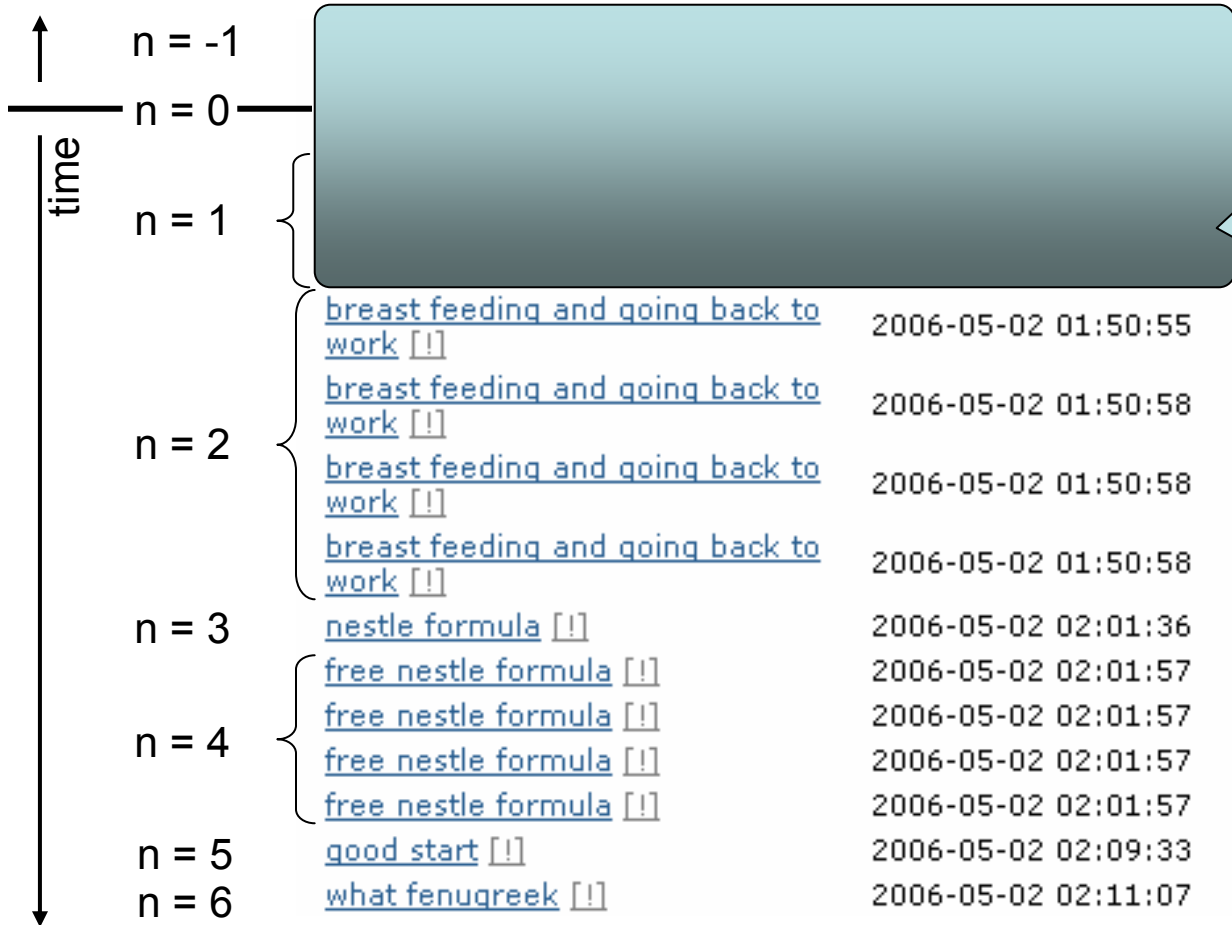
	walmart [!]	2006-04-29 22:06:40	http://www.walmart.com	1
implicit intentional queries	walmart [!]	2006-04-29 22:06:40	http://www.walmart.com	1
	myspace.com [!]	2006-05-01 14:20:56	http://www.myspace.com	1
	target [!]	2006-05-01 14:26:25	http://www.target.com	1
Explicit intentional queries	how to get rich breast milk [!]	2006-05-02 01:21:08	http://www.nlm.nih.gov	2
	breast milk [!]	2006-05-02 01:28:34	http://www.babycentre.co.uk	2
Explicit intentional queries	how to have good breast milk [!]	2006-05-02 01:32:34	http://www.breastfeeding.com	1
	how to have good breast milk [!]	2006-05-02 01:32:34		0
	yellow breast milk [!]	2006-05-02 01:40:47		0
	yellow breast milk [!]	2006-05-02 01:40:56	http://www.dummies.com	1
	yellow breast milk [!]	2006-05-02 01:40:56	http://www.mother-2-mother.com	2
	breast feeding and going back to work [!]	2006-05-02 01:50:55		0
implicit intentional queries	breast feeding and going back to work [!]	2006-05-02 01:50:58	http://www.askbaby.com	1
	breast feeding and going back to work [!]	2006-05-02 01:50:58	http://www.growingweirdo.com	5
	breast feeding and going back to work [!]	2006-05-02 01:50:58	http://www.medela.com	7
	nestle formula [!]	2006-05-02 02:01:36		0
	free nestle formula [!]	2006-05-02 02:01:57	http://www.kilofreebies.com	2
	free nestle formula [!]	2006-05-02 02:01:57	http://www.epinions.com	1
	free nestle formula [!]	2006-05-02 02:01:57	http://www.verybestbaby.com	2
	free nestle formula [!]	2006-05-02 02:01:57	http://www.bri...beginnings.com	6
	good start [!]	2006-05-02 02:09:33	http://www.verybestbaby.com	1
	what fenuareek [!]	2006-05-02 02:11:07	http://www.breastfeeding.com	1

How can we automatically construct a network model based on this information?

Idea II

- **Observation:**
 - Users rarely express their goals via explicit intentional queries (1-4%)
 - Implicit intentional queries make the dominant part of queries (96-99%)
- **Assumption:**
 - Whenever a user issues an explicit intentional query, it is „surrounded“ by implicit intentional queries (i.e. queries issued before and after a query of interest within a search session), reflecting the users‘ process of iterative search and query refinement
 - This assumption only holds for informational queries
 - We believe explicit intentional queries represent informational queries
- **Intuition:**
 - Let’s treat the implicit intentional queries in an explicit intentional query’s environment as tags
 - An explicit intentional query’s environment is represented by the queries a user has issued within a *certain time frame or set of queries* before and after issuing an explicit intentional query

Idea III



Approach: Treat the set of all queries $\{q_{-n} \dots q_i \dots q_n\}$ ($n=0$) within the n^{th} environment of the explicit intentional query q_i as tags for q_i

With $n=6$, this approach results in tagging „**how to have good breast milk**“ with the following tags (excerpt):

[Breast milk], [Yellow breast milk], [Breast feeding and going back to work], [Nestle formula], [Free nestle formula], [Good start], [What fenugreek]

<http://www.verybestbaby.com>
<http://www.breastfeeding.com>

Modes of Tagging

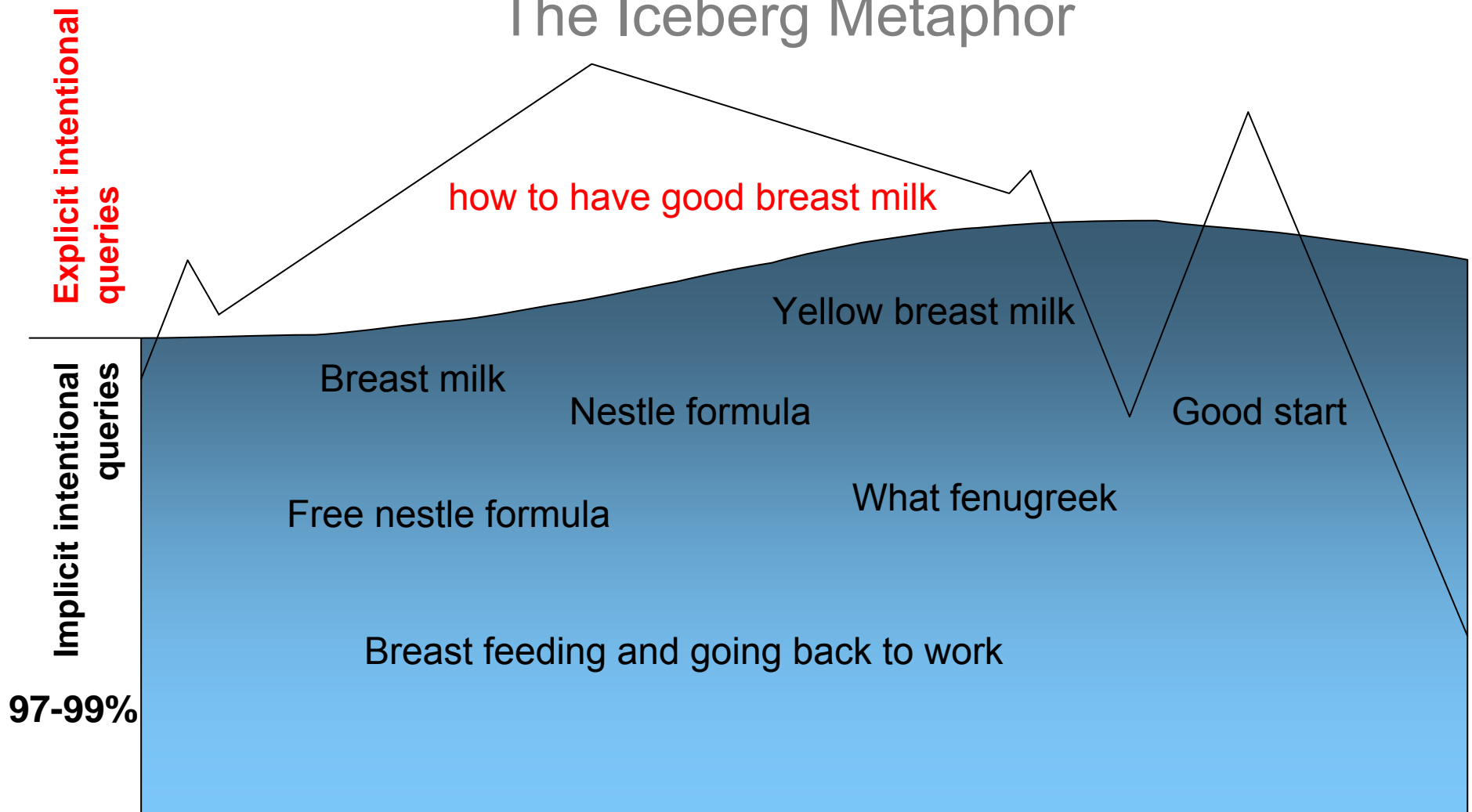
General Alternatives

1. Only using queries that occur **after** the explicit intentional query (q_n with $n > 0$)
2. Only using queries that occur **before** the explicit intentional query (q_n with $n < 0$)
3. Using queries that occur **before** and **after** the explicit intentional query (q_n with $n > 0$ and $n < 0$)

These different modes of tagging have different implications for intentional query expansion:

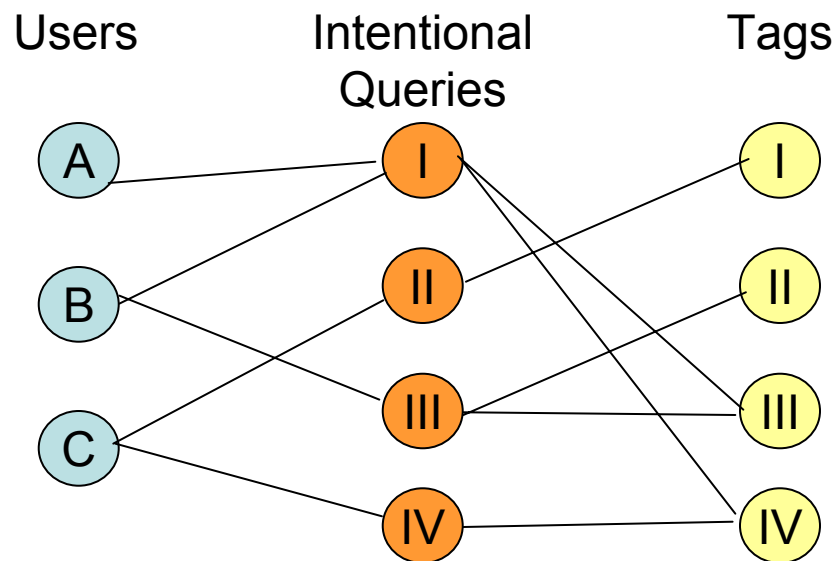
If Mode 2 or 3 is meaningful, then suggesting adequate explicit intentional queries based on a set previously entered implicit intentional queries might be feasible.

1-3% Crystalization of Explicit Intentional Queries - The Iceberg Metaphor



Network Analysis

- Analyzing the tripartite graph of Search
 - Consisting of users, explicit intentional queries and tags

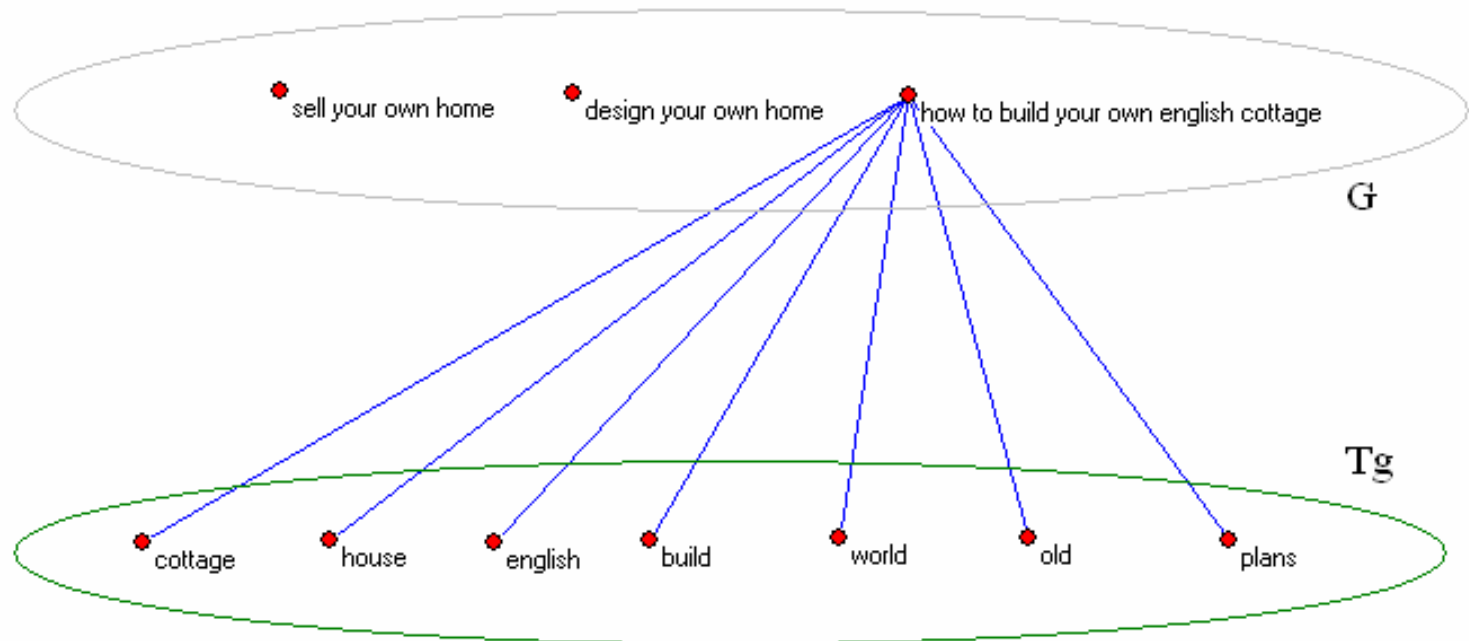


Based on this conceptualization, the following two-mode networks can be folded into one mode networks:

- Intentional Queries – Tags
- Users – Intentional Queries
- Users - Tags

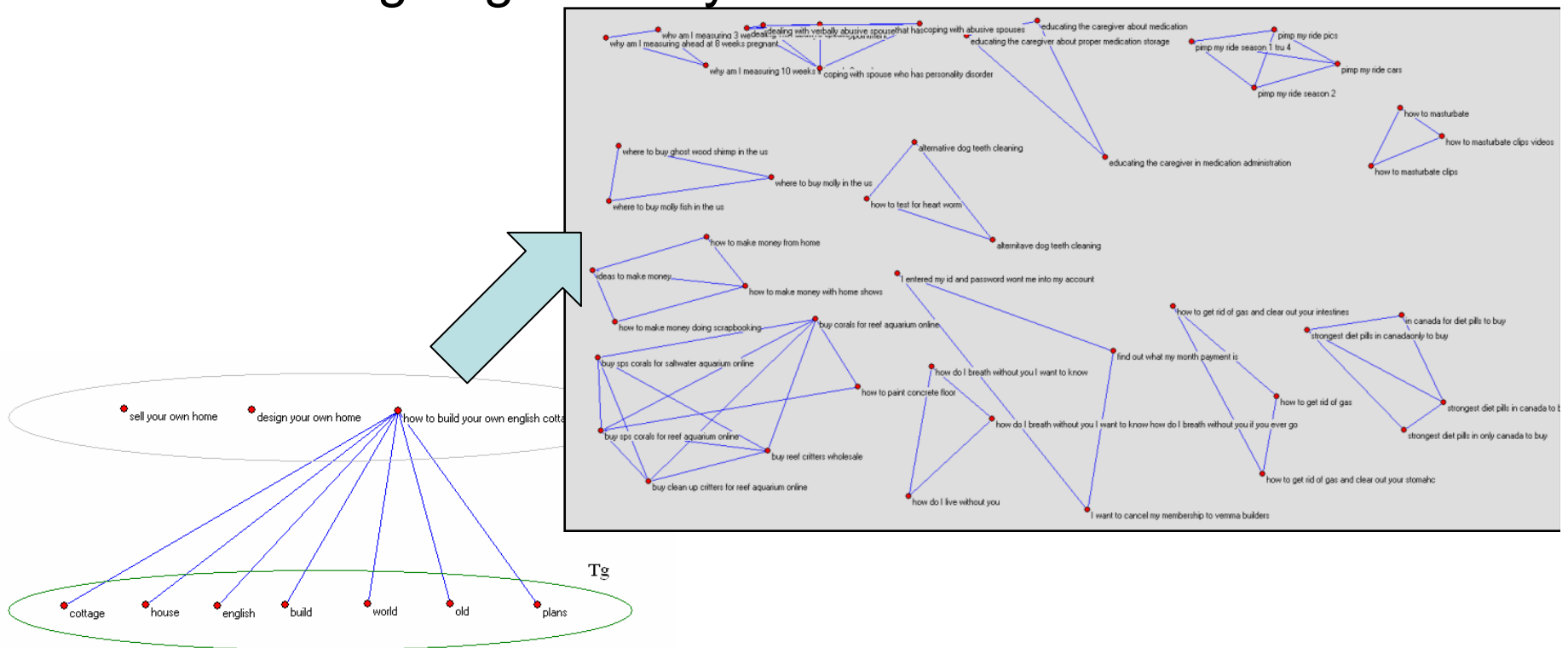
The Graph Construction Process / 1

- Idea: use tags to build a 2-mode graph
 - First mode: goals
 - Second mode: tags



The Graph Construction Process / 2

- We fold the 2-mode network into a 1-mode network consisting of goals only



Terminology / 0

id	query	date
1	fluffy roofs house designs	2006-05-27 13:37:19
2	cute house plans	2006-05-27 13:39:15
3	english cottage house plans	2006-05-27 13:45:14
4	old world english cottage house plans	2006-05-27 14:02:02
5	build an english cottage	2006-05-27 14:09:58
6	english cottages	2006-05-27 14:15:23
7	domain furniture	2006-05-27 20:56:23
8	floral design clock and ethan allen	2006-05-27 21:08:38
9	[REDACTED]	2006-05-27 21:10:55
10	[REDACTED]	2006-05-28 12:33:51

Excerpt of the AOL search query log sorted by time of occurrence. User id was omitted and sensitive queries were blacked out.

Terminology / 1

- $q \in Q$ denotes a query, Q_n the set of n queries in a query log
- Q consists of 2 disjoint sets G and I with $g \in G$ and $i \in I$
 - G is the set of queries containing explicit user goals
("build my own english cottage")
 - I is the set of queries not containing explicit goals
("english cottage house plans")

Terminology / 2

- Tag set T_g where each t_g shares an intentional relation to a query g
- $N_{g,d}$ is the set of queries which are within a certain distance d of a query g

Terminology illustrated

id	query	date
1	fluffy roofs house designs	2006-05-27 13:37:19
2	cute house plans	2006-05-27 13:39:15
3	english cottage house plans	2006-05-27 13:45:14
4	old world english cottage house plans	2006-05-27 14:02:02
5	build an english cottage	2006-05-27 14:09:58
6	english cottages	2006-05-27 14:15:23
7	domain furniture	2006-05-27 20:56:23
8	floral design clock and ethan allen	2006-05-27 21:08:38
9	[REDACTED]	2006-05-27 21:10:55
10	[REDACTED]	2006-05-28 12:33:51

Q (green arrow pointing to row 1)
 $d=3$ (red double-headed arrow between rows 2 and 4)
 $g \in G$ (blue arrow pointing to row 5)
 $N_{g,d}$ (red arrow pointing to the set of rows 2-4)

Excerpt of the AOL search query log. User Ids were omitted. Queries are sorted by time of occurrence. Sensitive queries were blackened out.

Approaches

- The constructed 2 - mode networks depend heavily on the tags.
- Tag generation is the most important step!
- So far five different approaches labeled A – E
- Each approach generates another set of tags T_g for a given goal g

Approach A

- Simply uses the queries in the neighborhood $N_{g,d}$ as tags
- $T_{\text{build an english cottage}} = \{\text{cute house plans, english cottage house plans, ...}\}$
- Problem: resulting 2-mode graph that is very sparse
no relations between goals of different users

- $d = 3$ in this example

id	query	date
1	fluffy roofs house designs	2006-05-27 13:37:19
2	cute house plans	2006-05-27 13:39:15
3	english cottage house plans	2006-05-27 13:45:14
4	old world english cottage house plans	2006-05-27 14:02:02
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8	floral design clock and ethan allen	2006-05-27 21:08:38
9		2006-05-27 21:10:55
10		2006-05-28 12:33:51

Approach B

- Uses tokens as tags e.g. single words of the neighboring queries
- $W(q \in Q)$ denotes set of distinct words $w \in W$ of query q
- $T_{\text{build an english cottage}} = \{\text{and, cottage, cute, english, house, plans, old, world, ...}\}$
- Problem: noise

id	query	date
1	fluffy roofs house designs	2006-05-27 13:37:19
2	cute house plans	2006-05-27 13:39:15
3	english cottage house plans	2006-05-27 13:45:14
4	old world english cottage house plans	2006-05-27 14:02:02
5	build an english cottage	2006-05-27 14:09:58
6	english cottages	2006-05-27 14:15:23
7	domain furniture	2006-05-27 20:56:23
8	floral design clock and ethan allen	2006-05-27 21:08:38
9		2006-05-27 21:10:55
10		2006-05-28 12:33:51

Approach C

- Tokens are single words
- A set of stop words S removes noise e.g. the words „the“, „a“, „and“ etc.
- $T = W(N_{g,r}) \setminus S$
- $T_{\text{build an english cottage}} = \{\text{cottage, cute, english, house, plans, old, world, ...}\}$
- Only “and” removed in this example

id	query	date
1	fluffy roofs house designs	2006-05-27 13:37:19
2	cute house plans	2006-05-27 13:39:15
3	english cottage house plans	2006-05-27 13:45:14
4	old world english cottage house plans	2006-05-27 14:02:02
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7	domain furniture	2006-05-27 20:56:23
8	floral design clock and ethan allen	2006-05-27 21:08:38
9		2006-05-27 21:10:55
10		2006-05-28 12:33:51

Approach D

- Observation: Not all neighboring queries share an intentional relationship with the goal g
- Introduce set R_m that satisfies $| W(g) \cap W(N_{g,d}) | \geq m$ where m specifies the minimum intersection size (raw similarity according to [Rijsbergen1997])

- $T = R_m$
- $T_{\text{build an english cottage}} = \{\text{house, plans, old, world}\}$

id	query	date
1	fluffy roofs house designs	2006-05-27 13:37:19
2	cute house plans	2006-05-27 13:39:15
3	english cottage house plans	2006-05-27 13:45:14
4	old world english cottage house plans	2006-05-27 14:02:02
5	build an english cottage	2006-05-27 14:09:58
6	english cottages	2006-05-27 14:15:23
7	domain furniture	2006-05-27 20:56:23
8	floral design clock and ethan allen	2006-05-27 21:08:38
9		2006-05-27 21:10:55
10		2006-05-28 12:33:51

Approach E

- Again $| W(g) \cap W(N_{g,d}) | \geq m$
- Words from the query g are added to the tag set T as well $\rightarrow T = R_m \in W(g)$
- $T_{\text{build an english cottage}} = \{\text{build, cottage, english, house, plans, old, world}\}$

- Good approach for now

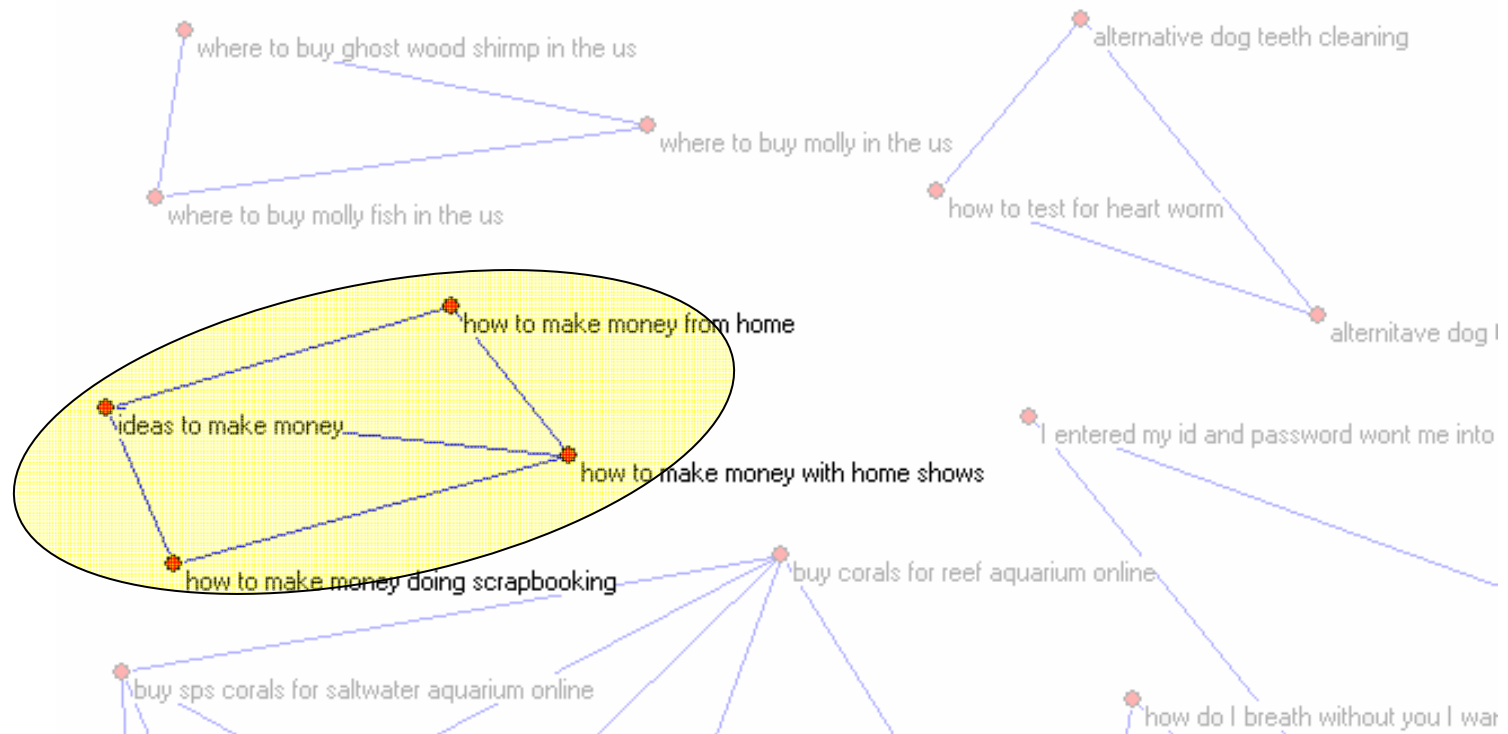
id	query	date
1	fluffy roofs house designs	2006-05-27 13:37:19
2	cute house plans	2006-05-27 13:39:15
3	english cottage house plans	2006-05-27 13:45:14
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6	english cottages	2006-05-27 14:15:23
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8	floral design clock and ethan allen	2006-05-27 21:08:38
9		2006-05-27 21:10:55
10		2006-05-28 12:33:51

Interesting research questions

- What are good tags and how do we generate them automatically?
- How do the parameters influence the quality of the tag generation?
- How can the resulting graph be evaluated?

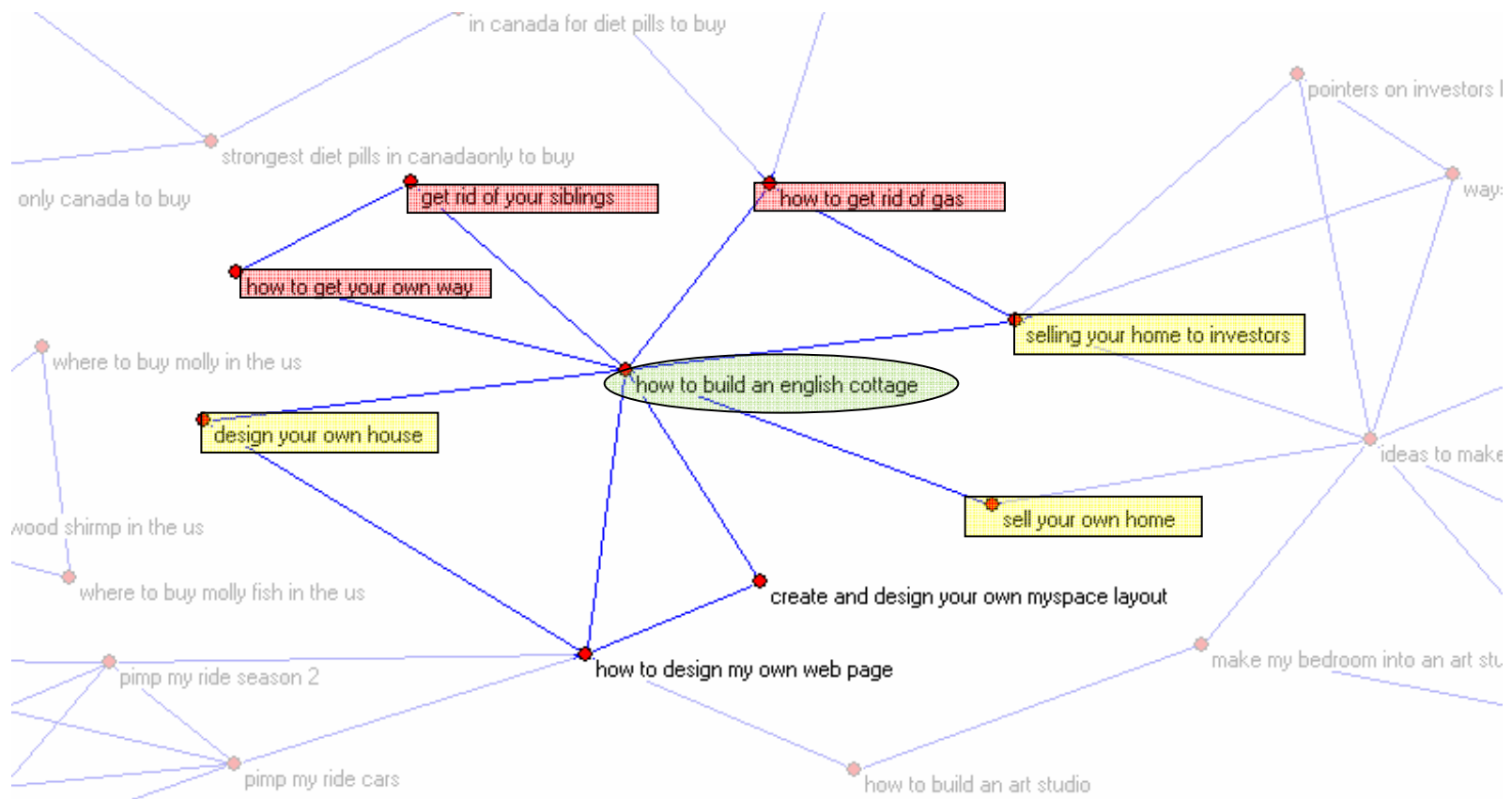
Observations / 1

- Sub graph of result of approach A



Observations / 2

- Sub graph of result of approach E



Intentional Metadata: Research Opportunities

- Intentional XHTML
 - `label` link relationships with `rel="..."` 'rel' is extensible and multivalued `rel="relationship1 relationship2"`
- Intentional Microformats
- Intentional (Search?)Browser-Plugins
- Intentional Tags / Geotags
- Intentional Webservice Descriptions
 - e.g. WSMO including
wg mediators (web service – goal) + *gg* mediators (goal -goal)
- Automatic Intentional Metadata Creation (Corpus-based)
- Intentional Weblog Tags

- → SPECIFIC EXAMPLES

Administrative Issues

Final Exam in two weeks

- little repetition of previous home assignments, + New Questions
- Understanding of basic network constructs (e.g. centrality, weak ties, formal models of small world networks, etc)
- Scope: All lecture slides and mandatory readings
- **You need to register for the exam with TUG online**
- Date: **23.6. 12:00, HS i12**
- Results: within 4 weeks
- „Einsichtnahme“: Fr, 25.7. 2008, 10:00 – 11:00

Next week: Guest lecture

Web Technologies II, Peter Scheir, KMI

The semantic web represents a current research effort to increase the capability of machines to make sense of content on the web. In this class, Peter Scheir will give a guest lecture on the basic principles underlying the semantic web vision, including RDF, OWL and other standards.

Any questions?

See you next week!