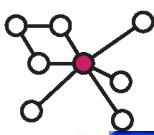


The Anti-Social Tagger - *Detecting Spam in Social Bookmarking Systems*

AIRWeb 2008

Beate Krause, Christoph Schmitz, Andreas Hotho, Gerd Stumme
Knowledge & Data Engineering Group,
University of Kassel &
Research Center L3S

BibSonomy



BitSonomy: - Mozilla Firefox
Datei Bearbeiten Ansicht Chronik Lesezeichen Extras Hilfe
postBookmark postPublication SpammerkillerButton https://www.bibsonomy.org/filter=no

BibSonomy :: search: all > :: <fulltext search here>

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Deutsche Immobilien-AGs floppen
to economy by torsten.schuenemann on 2008-04-20 11:19:54
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Mallorca: Pfusch, Skandale und Profitgier - Immobilien - FAZ.NET
to a_forschung by torsten.schuenemann on 2008-04-20 11:19:43
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Demografie: Der Krieg der Generationen findet nicht statt
to Lernwerkstatt by torsten.schuenemann on 2008-04-20 11:18:03
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to manager network ubuntu wicd by mkl298 on 2008-04-20 11:13:41
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Rasant steigende Nahrungsmitteleinflüsse: Die teuren Früchte Hintergrund
to EU Global on 11:08:05
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Genealogical process on a correlated fitness landscape
to fitness_landscapes by peter.rahl on 2008-04-20 03:57:53
copy

The POPULATION GENETICS OF ADAPTATION: THE ADAPTATION OF DNA SEQUENCES
to adaptation_fitness_landscapes review selection by peter.rahl on 2008-04-20 04:02:04
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THE Star Raft: China's Encounter with Africa
P. Snow (1988)
to imported by lthe_dude on 2008-04-20 11:15:15
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The genetic theory of adaptation: a brief history
H. Allen Orr Nat. Rev. Genet. 6: 119–127 (2005)
to adaptation_fitness_landscapes review selection by peter.rahl on 2008-04-20 04:02:04
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Iv_crossmedia
Iv_crossmedia_1
Iv_crossmedia_2
LW2-Arbeit Mac management media money music
myown network networks nitrides online OpenSource
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Radar_Signal reference reputation
research.conceptual
research.eLearning
search security skype social socialnetworking
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- busy tags

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Dioderian Dungenwar e-learning engine firefox
engine failberispiele free_fulltext google holtzbrink
folksonomy formative howto imported induction
inductive_programming information information internet
java javascript learning library
Iv_crossmedia Iv_crossmedia_2

bitSonomy 03:21:38
Fertig

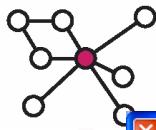
Al Journal of the Experimental Analysis of Learning pdfcopy by toby on 2008-04-20
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03:21:38
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http://www.bibsonomy.org

BibSonomy after lunch...



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bookmarks [RSS](#) [XML](#)

publications [RSS](#) [BibTeX](#) [RDF](#) [more](#)

previous | next edit previous | next edit | pick | unpick

Are You Becoming Wealthy On Your House?

Are you becoming wealthy on your house... Is your home your best performing investment...
to [auto](#) [bad car](#) [finance](#) [home](#) [house](#) [invest](#) [investment](#) [mortgage](#) [realtor](#) by [adomone6](#) and [67 other people](#) on 2008-04-21 01:36:45 copy

Isn't It Time That You Claimed Your Long Lost Money

Where do the billion and billions of unclaimed dollars all come from?>
Each and every year hundreds of thousands of individuals across the United States and...
to [SUV](#) [accept](#) [approved](#) [auto](#) [bad car](#) [chance](#) [credit](#) [finance](#) [financing](#) [money](#) by [adomone6](#) and [66 other people](#) on 2008-04-21 01:35:00 copy

Pay Yourself First

Well known political commentator and Fox News talk show anchor and host, Bill O'Reilly plainly states that the reason behind his success in life, is his fail...
to [auto](#) [bad cash credit debt finance](#) [financial home independence](#) [invest payments](#) [savings wealth](#) by [adomone6](#) and [66 other people](#) on 2008-04-21 01:33:12 copy

Golf Is A Hard Enough Game Without Handicapping Yourself With Poor Instruction

Golf is a hard enough game without handicapping yourself with poor equipment or training. Golfers are a strange group - more optimistic than even people but...
to [golf](#) [golfcourse](#) [golfing](#) [golfs instruction](#) [pga pro](#) [professional](#) by [adomone6](#) and [19 other people](#) on 2008-04-21 01:27:47 copy

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22 picked in basket · [edit tags](#) · [settings](#) · [logout](#)

filter: - busy tags

01_Office 02_Image 03_Audio 04_Video
05_Network 06_Internet 07_System
[Technology] [Webmaster] [Webmaster]
Apple Apple_no_Brasil Applets
Applications Bar Black Blogging
Bookmarks Brazil Browser CD_DVD_Yunis
Digg-like Editor Electronic en Exporting_Info
Extras Fav Folksonomie fr
France From_Safari Genre genre_en
genre_es genre_fr genre_pt Geo
geo_en geo_es geo_fr geo_pt
Google Groove Hot_News iApps
idj-fr idj-music idj-tech
iPod iServe [depuis_le_reseau_mondial] iTunes
iServe [depuis_mon_reseau_local]
iTunes_Scripts JavaScript Jazz
Library MacUser MP3 Music
music_en music_es music_fr
music_pt Music_Store Mutual_Server
P2P PHP&MySQL_Apache Production
Quick_Links Radio Reggae
RSS_Readers Server Soft tech-en
teches technologie_fr

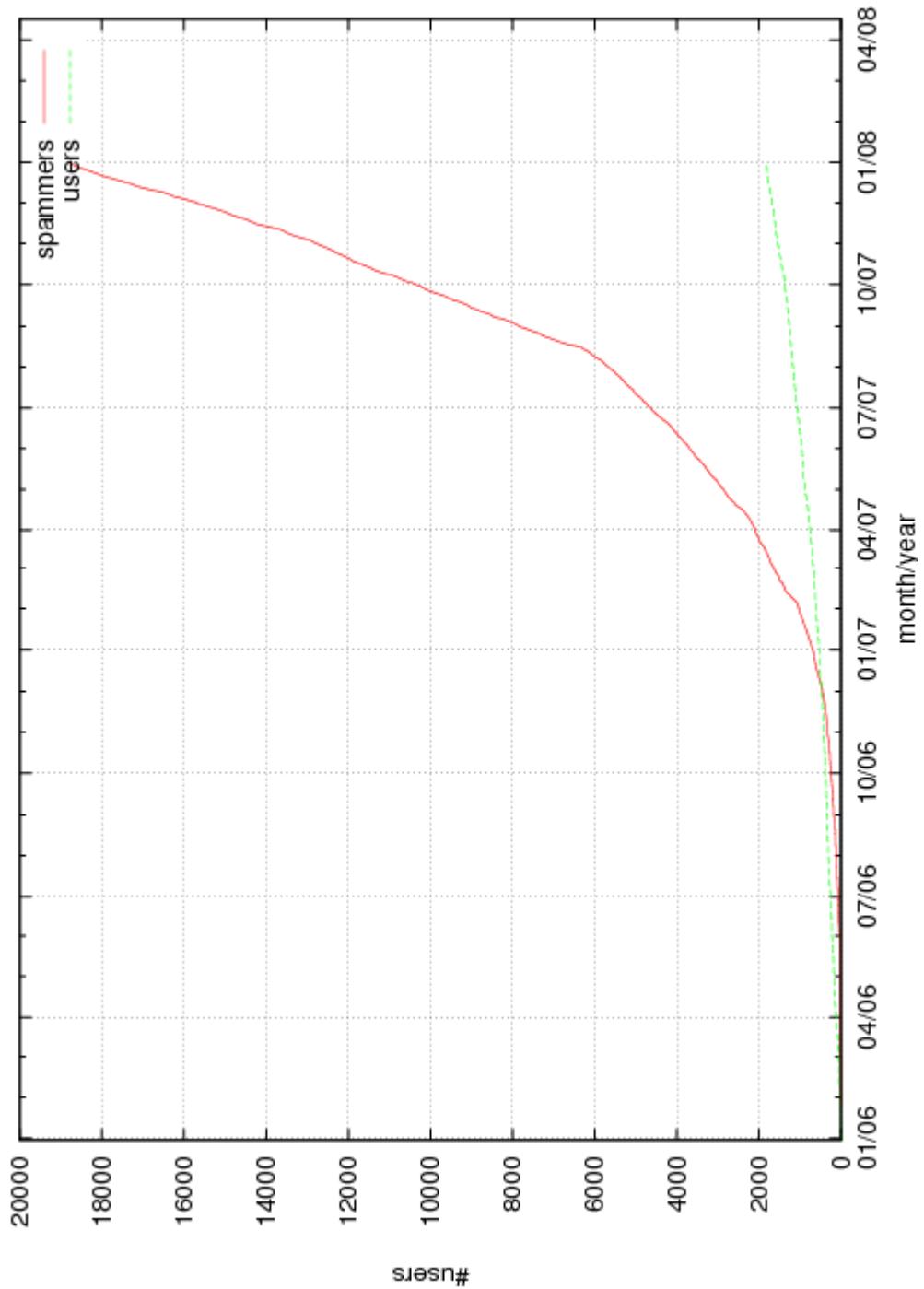
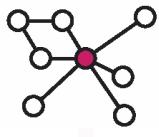
The Case for Fairness of Trust Management

Adam Wierzbicki to appear in special/issue of *Electronic Notes in Theoretical Computer Science* (2007)
to todo by [utrust](#) on 2008-04-20 20:48:43
pick | copy | BibTeX | OpenURL

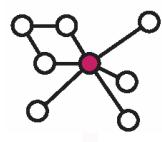
A Trust Evaluation Framework in Distributed Networks: Vulnerability Analysis and Defense

Fertig

BibSonomy “active” user accounts over time ...

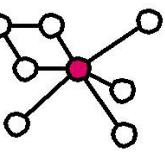


Problem Statement



Spam Detection in Social Bookmarking Systems

- What is social bookmarking spam?
- What kinds of features are there to detect spam?
- Can standard classification algorithms be used?



Agenda

Introduction

Social bookmarking basics

Spam definition

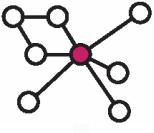
Dataset creation

Framework

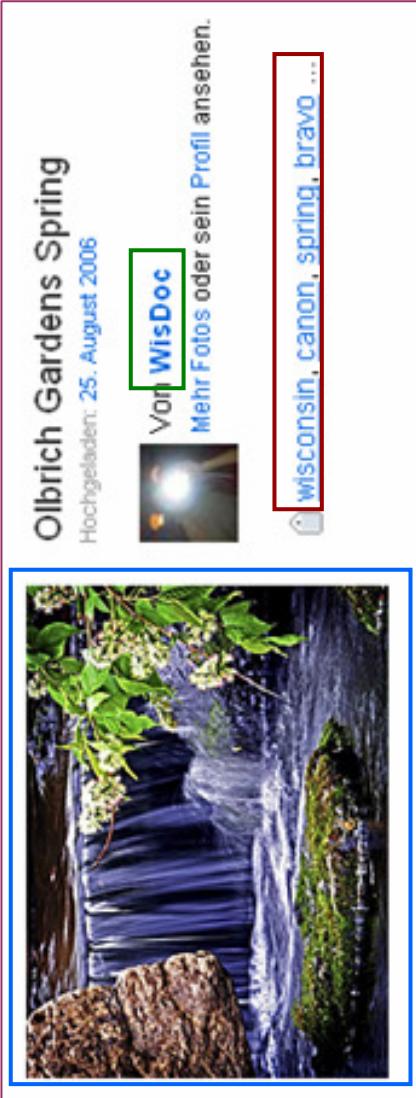
Evaluation

Conclusion

Folksonomy: Definition



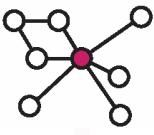
- Folk + Taxonomy
- Folksonomies allow users to assign arbitrary tags to resources



- Tuple $F:=(U,T,R,Y)$ where
 - U , T and R are finite sets, whose elements are called user, tags and resources
 - Y is a ternary relation between them, i.e. $Y \subseteq U \times T \times R$ whose instances are called **tag assignments (TAS)**,
 - A post contains a user, different tags and a resource.

[Andreas Hotho, Robert Jäschke, Christoph Schmitz, Gerd Stumme. Information Retrieval in Folksonomies: Search and Ranking. 2006]

Folksonomy: Social aspects



del.icio.us / search

Search results for **spring**

- Easy to use, open for everyone
- Collaborative annotation of web resources
- Immediate “feedback”
- Joint use leads to converging vocabularies and a collection of web resources

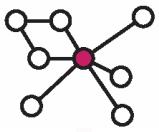
Related tags: spring java stringframework tutorial j2ee programming hibernate developme

showing 1 - 10 of 80561

< previous | next >

- Springframework.org save this to java spring framework|j2ee programming ... [Saved by 2850 people](#)
- Spring MVC step-by-step save this to spring java tutorial mvc framework... [Saved by 804 people](#)
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- Acegi Security System for Spring - Acegi Security System for Spring [save this](#) to security spring java framework authentication ... [Saved by 229 people](#)
- Enterprise Java Community: Introduction to the Spring Framework [save this](#) to spring java framework|j2ee programming ... [Saved by 492 people](#)

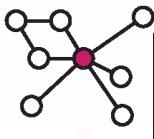
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Agenda

- Introduction
- Social bookmarking basics
- **Spam definition**
- Dataset creation
- Framework
- Evaluation
- Conclusion

Spam: Malicious Tagging - vs. Web Spam



Website

Net4 Hotelguide: Budget Hotels und Pensionen in Peking
Budget Hotels - das sind preisgünstige Hotels im Niedrigpreis-Bereich.

Post

In [Peking](#) gibt es Tausende Übernachtungsmöglichkeiten. Die Auswahl ist groß. Ein Hotel zu finden ist nicht leicht.

[Anzeige](#)
[China Visum Chinesisches Visum Chinesische](#)

Net4 Budget Hotel Guide Peking Peking/Beijing

to clustering community-detection web-mining by bsb2000 on Apr 17, 2008, 9:34 AM/

mehreren deutsch- oder englischsprachigen Reiseführern empfohlen wurden.

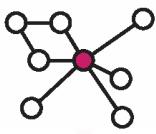
1 Euro = 9.67277813 Yuan am 16.3.2006, nach google search "Euro in Yuan".

Preisangaben nur ungefähr. Liste erstellt 2001. Update 2005

[Anzeige](#)
[Das richtige Hotel finden in China mit Booking.de](#)

[Beijing Capital Flughafen](#)
Hotels in der Nähe der Flughäfen. Schnell und sicher online buchen!
[20 Hotels in Beijing](#)
Bequem und schnell online buchen!
[Russland Visum &Einladung](#)
Visum ab 55 € inkl. Einkladung, Visum in 3 Stunden Tel: 02232566157
[Zhaolong Peking Beijing](#)
Hotels finden, Preise vergleichen, Kritiken lesen. Trip Advisor testen!
[AV](#)
[Google Anzeigen](#)

Spam - User Level vs. Post Level



BibSonomy :: user ▾ :: rygar33 ::

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bookmarks (4) [RSS](#) [XML](#)

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edit

Home Equity Line of Credit

Heloc options for your credit type. JumpStartMyCredit.com
to 2nd cash credit equity free heloc helocs home line loan loans mortgage of out quote rate second by
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Home Loan Refinance

Mortgage Refinance Quotes. No SSN Needed.
to calculator cash compair compare home in loan lock lower mortgage out payment quote rate refi
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Home Loan Quotes. No SSN Needed.
to bad check credit home interest lenders lendingtree loan mortgage no purchase quote rates by
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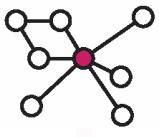
Online Loan Source for Bad Credit

Payday Loans, Home Loans, Bad Credit Auto Loans, Refinance, Debt Settlement Services.
to auto bad car consolidation credit financing loan loans payday student by rygar33 and 4 other people
on Apr 17, 2008, 1:28 AM
copy

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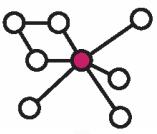
bookmarks per page: 5 10 20 50 100

Spam in this work



- Web Spam:

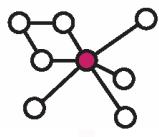
- Interaction with the system that serves commercial, self-promoting or disruptive interests
 - Interactions that are not of value for other users
- Target for classification: user, not post



Agenda

- **Introduction**
- **Social bookmarking basics**
- **Spam definition**
- **Dataset creation**
- **Framework**
- **Evaluation**
- **Conclusion**

Dataset



- BibSonomy admins and developers flag users as spammers

- Decision is based on

- Links (websites) of posts

- Added tags

- Also influenced by personal information:

- E-mail
 - Choice of name
 - IP
 - ...



Dataset creation process



BibSonomy :: Mozilla Firefox

Datei Bearbeiten Ansicht Chronik Lesezeichen Extras Hilfe

postBookmark postPublication SpammerKillerButton www.leo.org postBookmark

BibSonomy::

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bookmarks RSS XML

publications RSS BibTeX RDF more

previous | next edit | pick | unpick

edit

Are You Becoming Wealthy On Your House?
Are you becoming wealthy on your house... Is your home your best performing investment...
to [www.autobadcarfinancehome](#) house invest investment mortgage realtor by [adomorrie6](#) and 67 other people on 2008-04-21 01:36:45
copy

Isn't It Time That You Claimed Your Long Lost Money
Where do the billion and billions of unclaimed dollars all come from? > Each and every year hundreds of thousands of individuals across the United States and...
to [SUV](#). accept approved auto bad car chance credit finance financing money by [adomorrie6](#) and 69 other people on 2008-04-21 01:35:00
copy

Pay Yourself First
Well known political commentator and Fox News talk show anchor and host, Bill O'Reilly plainly states that the reason behind his success in life, is his fat...
to [autobadcashcreditdebtfinancihome](#) financial home independence invest payments savings wealth by [Fertig](#)

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22 picked in [basket](#) · edit tags · settings · logout

filter:
- busy tags

01_Office 02_Image 03_Audio
04_Video 05_Network 07_System
06_Internet [Music] [Technology]
[Webmaster] Affiliation

Apple API Apple_no_Brasil Appllets
Applications Bar Black
Blogging Bookmakers Brazil
Browser CD_DVD_Vinyls Digg-like
Editor Electronic en Exporting_Info
Extras Fav
Folksonomie fr France
From_Safari Genre genre_en
genre_es genre_fr genre_pt
Geo geo_en geo_es geo_fr
geo_pt Google Groove
Hot_News iApps idj-fr idi_music idi_teach

Dataset creation process



BibSonomy :: user :: adomorrie6 :: Mozilla Firefox

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postBookmark postPublication postKillerButton www.bibsonomy.org/user/adomorrie6

postBookmark postPublication postKillerButton www.leo.org postBookmark

bibSonomy :: user :: adomorrie6 (Unbenannt)

BibSonomy :: user :: adomorrie6 :: <enter tag(s) here>

A blue social bookmark and publication sharing system.

tags · relations · groups · popular myBibSonomy · post bookmark · post bibtex

bookmarks (31) [RSS](#) [XML](#)

<< < 1 > >> edit publications per page: 5 10 20 50 100

publications

filter: - relations - tags (alpha | freq) (cloud | list) (minfreq 1 | 2 | 5)

"credit" \ \ accept advisor alternative amex amygoodman Annapolis annapolis Anthem approved assad atkins attitude auto autobody autoinstruction automotive autoparts bad bank banks biodiesel bloodpressure boys budget Buffet bus bush california campus Canada car carbohydrates carbs "card" Career cars cash cater caterer chance cheney Chevy cholesterol cholestrol cia college Conaleeza condazeza condi condince condo conflict contacts cottage courses credit danger dealer dealership debt demerit democrats detroit diabetes diesel diet dieting diets domestic ecologist ecology employment energy estate ethanol fat fats Fenway finance financial financing Fish Fishing food Ford franchise g.m. G.M.C.. game garage gas gasoline golan golf golfing copy

Star Wars: LEGO's Ultimate Collectors Millennium Falcon Unboxed, Now Shipping with 4-pound Manual - Gizmodo

Ultimate Lego Set to boys lego toys by adomorrie6 and 63 other people on Apr 21, 2008, 1:39 AM copy

Sarbit Asset Management

Our Primary Concern is to Ensure that Client's are Protected Everything else follows from that fundamental concept in investing to Buffet Larry Sarbit Warren portfolio sarbit by adomorrie6 and 66 other people on Apr 21, 2008, 1:38 AM copy

Are You Becoming Wealthy On Your House?

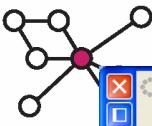
Are you becoming wealthy on your house... Is your home your best performing investment... to \\\ auto bad car finance home house invest investment mortgage realtor by adomorrie6 and 67 other people on Apr 21, 2008, 1:36 AM copy

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logged in **basket · edit tags · settings · logout**

22 picked in **basket · edit tags · settings · logout**

Data Creation Process



Screenshot of a Mozilla Firefox browser window showing a search result for "Are You Becoming Wealthy On Your House?".

The page title is "Are You Becoming Wealthy On Your House? - Ishare.com Articles - Mozilla Firefox".

The URL is <http://www.ishare.com/?aid=186991&c=a-Finances>.

The page content includes:

- A sidebar with links: "Free content articles for your ezine and website.", "Titles", "Authors", "Contents", "[Advanced Search]", "[Add OpenSearch]", "[Job Search]".
- A main article section:
 - Headline: "We pay high interest rate"
 - Text: "Upto 14% daily. Fast and Safe, Online Investment Service www.top1profit.info"
 - Image: "Ads by Google"
- A sidebar with links: "[✉ Contact the Author]", "[✉ Send to a Friend]", "[⎙ Article Publisher]", "[PDF Make PDF]", "[⎙ Print]", "[+ Bookmark & Share]".
- A footer with links: "[Word Count: 978 words]", "[Viewed: 2620 time(s)]", "[Don't forget to rate this article]", "[Report this article]".
- A large article preview:

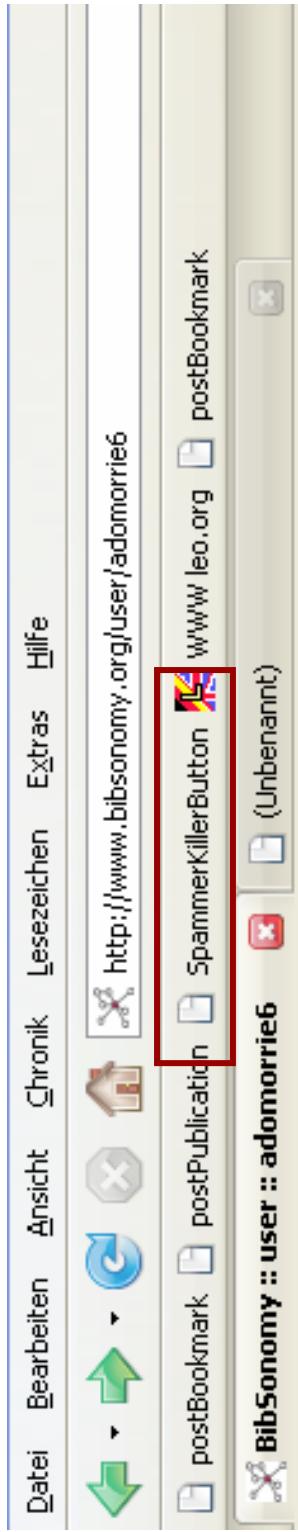
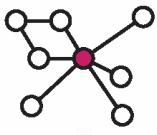
Are You Becoming Wealthy On Your House?

Submitted By: [Kerry A. Francis](#)

Are you becoming wealthy on your house? Is your home your best performing investment? Is your house the only area that of your investments in which you are making money?

Red danger signals should be appearing in your mind. The housing market has gone up, up and up. Many people believe that they "have made x dollars
- A right sidebar:
 - S&P 500 Trading Signals**
100% Success From Our System Trade Our Signals And Make Money www.stockmkt.com
 - Investment Opportunity.**
Big Potential Returns On Investment Apply Online For More Information. StrategicInvestmentsUK.com
 - Do You want in on China?**
We have a list of companies that will make it HUGE in China. Free.

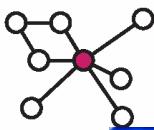
Dataset creation process



BibSonomy :: user :: adomorrie6 ::

A blue social bookmark and publication sharing system.

Dataset creation process



BibSonomy::admin - Mozilla Firefox

Daten Bearbeiten Ansicht Lesezeichen Extras Hilfe
http://www.bibsonomy.org/admin.jsp?action=flag_spammer&user=adomorrie6

postBookmark postPublication SpammerKelleButton www.leo.org postBookmark

BibSonomy::admin (Unbenannt)

Info: user `adomorrie6` flagged as spammer!

flag/unflag a spammer

Spammer: user name OK

Spammer: user name OK (Unbenannt)

User Info

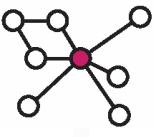
user name Anfrage abschicken

List of new users
(show 100 500 1000 all, show frequent IPs)

Is it a Spammer?	Username	Spammer?	IP	Realname	E-Mail	Date	updated by	updated at
YES NO	chuck97	false				21.4.00_01:17		18:54:12-10 00:00:00:00
YES NO	moured	false				21.4.08_01:07		18:54:12-10 00:00:00:00
YES NO	azlaninda	false				21.4.08_00:58		18:54:12-10 00:00:00:00
YES NO	argilla_eduator	false				21.4.08_00:41		18:54:12-10 00:00:00:00
YES NO	susserm1956	false				21.4.08_00:04		18:54:12-10 00:00:00:00
YES NO	barry48	false				21.4.08_00:03		18:54:12-10 00:00:00:00
YES NO	pionoro	false				20.4.08_23:58		18:54:12-10 00:00:00:00
YES NO	zweidom	false				20.4.08_23:51		18:54:12-10 00:00:00:00
YES NO	adomorrie6	true				20.4.08_23:50	brede	01:46:22:0
YES NO	ppoclbk	false				20.4.08_23:49		18:54:12-10 00:00:00:00
YES NO	utrust_user	false				20.4.08_23:38		18:54:12-10 00:00:00:00
YES NO	gotteeth	false				20.4.08_23:16		18:54:12-10 00:00:00:00
YES NO	algirainto	false				20.4.08_22:36		18:54:12-10 00:00:00:00
YES NO	musicmp3	true				20.4.08_22:33	jäschke	20:08:04:20 23:15:51:0
YES NO	pailey77	true				20.4.08_21:50	jäschke	20:08:04:20 23:15:51:0

Fertig

Dataset creation process



list of spammertags (652)

most used spammertags (last 1000 posts)

tag suggestions

tags used by spammers but not marked as spammertags (last 1000 tags)

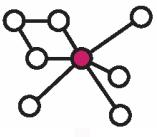
tag	count	action
and	75	⇒ →
for	54	⇒ →
sex	29	⇒ →
dildo	23	⇒ →
the	22	⇒ →
of	22	⇒ →
sale	20	⇒ →
Money	20	⇒ →
anal	19	⇒ →
a	19	⇒ →
butt	19	⇒ →
vacation	16	⇒ →
to	15	⇒ →
in	15	⇒ →
deals	15	⇒ →
health	14	⇒ →
gold	12	⇒ →
ass	12	⇒ →

spammer suggestions

users not flagged as spammers but used spammertags

tag	count	action	user	tagged action
download	70	⇒ ⇒	rorygearhart	of
music	67	⇒ ⇒	franz20	Free
mp3	65	⇒ ⇒	msswongi	in
downloads	64	⇒ ⇒	kingtorm	cheap
internet	52	⇒ ⇒	mabelca29	Free
meta	47	⇒ ⇒	jenniferboraccorsi	money
Engineering	47	⇒ ⇒	greenic1980	health
search	46	⇒ ⇒	sundhed.helbred	health
Business	46	⇒ ⇒		
Ingenieur	45	⇒ ⇒		
Kartographie	44	⇒ ⇒		
Bergbau	44	⇒ ⇒		
Jobs	44	⇒ ⇒		
video	43	⇒ ⇒		
Architektur	42	⇒ ⇒		
software	41	⇒ ⇒		
Music	41	⇒ ⇒		
tool	40	⇒ ⇒		

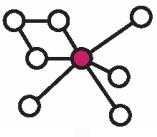
Dataset - Figures



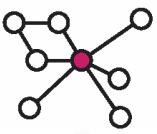
	Users	Spammer	Tags	Posts	TAS
All	1,406	18,681	306,993	1,219,053	8,709,417
Training	1,306	15,891	282,473	1,097,458	7,904,735
Test	100	2,790	49,644	121,595	804,682

- Time frame: until end of 2007
- Only users with at least one post
- No consideration of private posts
- Not normalized

Dataset Issues



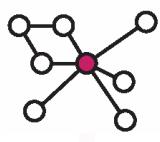
- Subjective notion of what is spam
- No crosschecks of flagging results → noise
- Only two classes: spam and non-spam
- User level not granular enough
- One user may have several accounts



Agenda

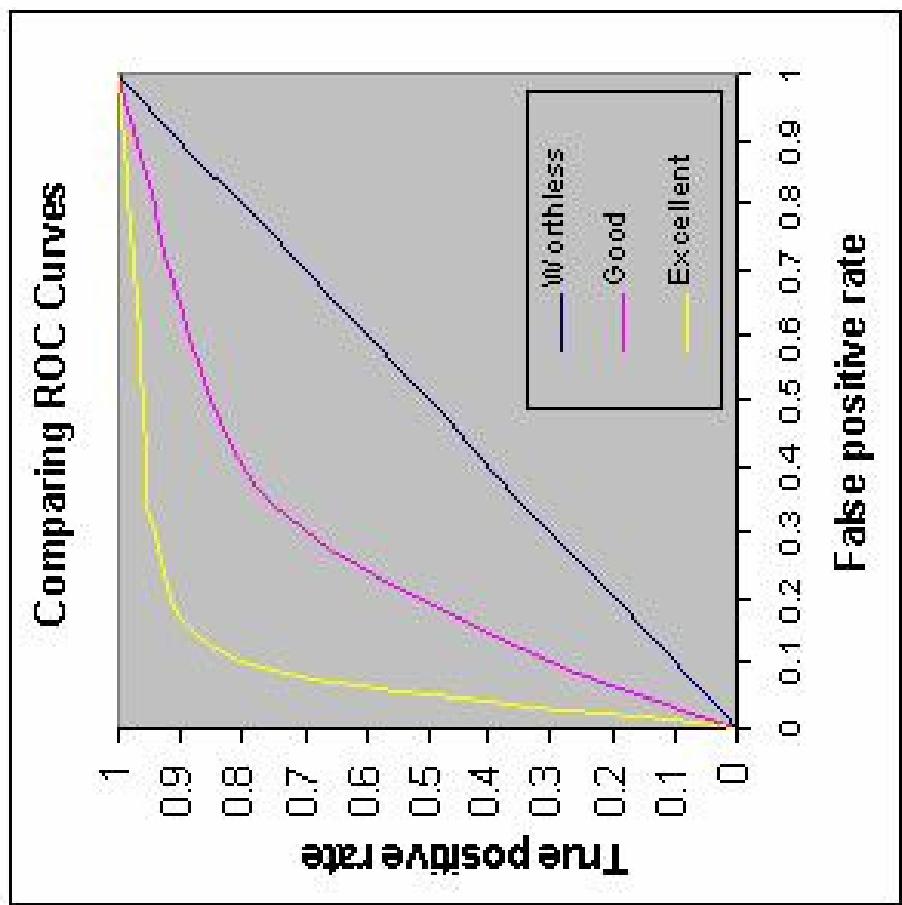
- Introduction
- Social bookmarking basics
- Spam definition
- Dataset creation
- **Framework**
- Evaluation
- Conclusion

Evaluation measures



Setting

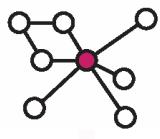
Actual/ Labeled		Spam	Non-Spam
Spam	TP	FN	
Non-Spam	FP		TN



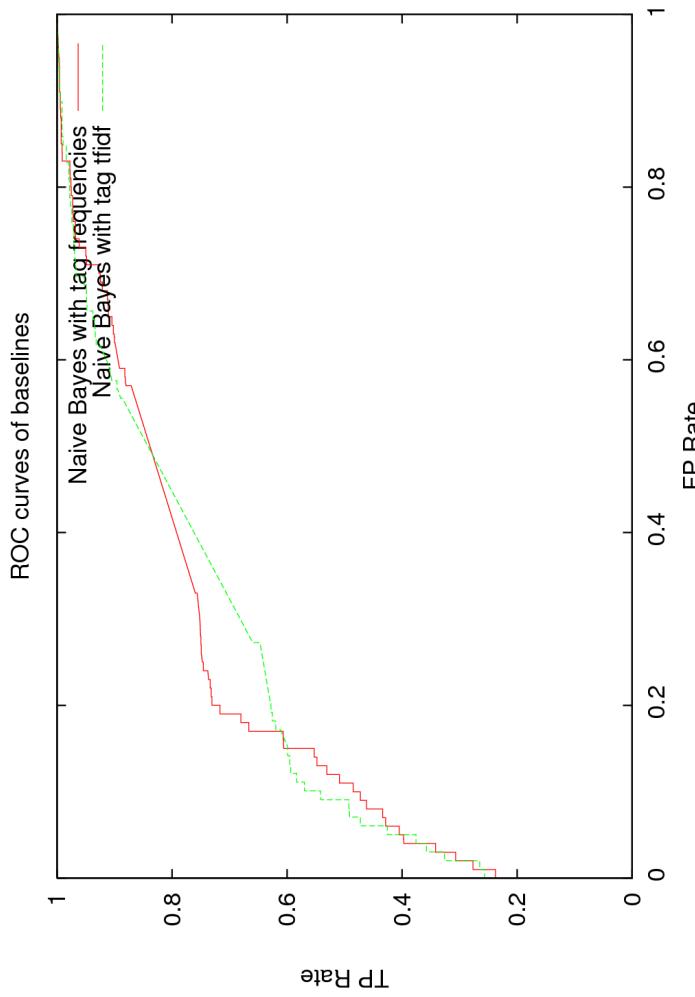
[<http://gim.unmc.edu/dxtests/ROC3.htm>]

- Precision, Recall, F1
- ROC Area

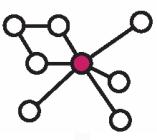
Baseline



- Features: different tags
- Instance (one user): represented by the tags added to all of his/her posts
- Either frequency, or tfidf values per tag
- Naïve Bayes classification



Baseline



- Frequency ROC Area: 0.80
- TFIDF ROC Area: 0.79

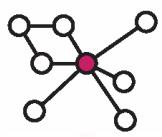
Table 4: Baseline with all tags as features (frequency)

	Spam	Non-Spam
Spam	466	2324
Non-Spam	0	100

Table 5: Baseline with all tags as features (tfidf)

	Spam	Non-Spam
Spam	530	2260
Non-Spam	0	100

Features



- 25 features
- four different categories
- normalization of each user‘ feature vector

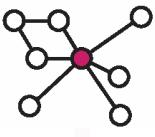
Profile Information

Activity Information

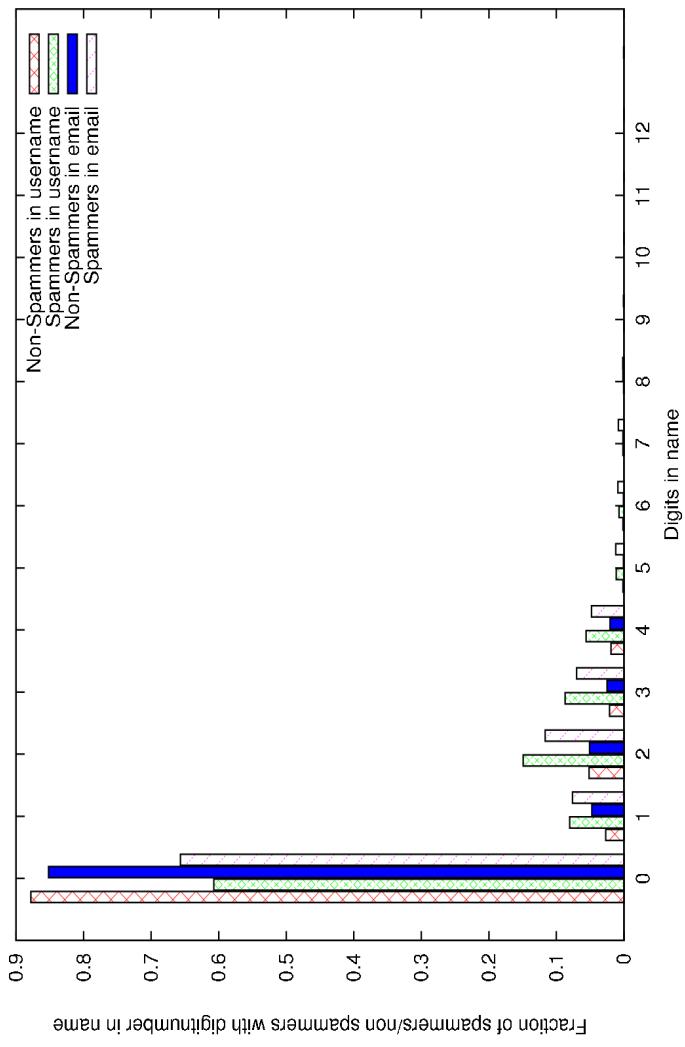
Location Information

Semantic Information

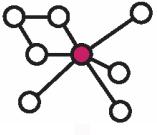
Profile features



- *namedigit*: „styri888“, „painrelief2“
- *maildigit*: digits in mail
- *namelen*, *maillen*, *realmelen*: length of names, mails
- *realnameN(2,3)*: binary, set to 1 if user has indicated two or more names

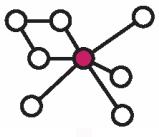


Location based features



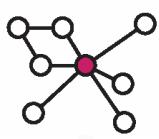
- *domaincount*: number of users in the same domain
 - 16 users: spambob.com
 - 137 rhinowebmail
- *tldcount*: number of users in the same top level domain
- *spamip*: number of spam users with this IP
 - one spammer uses several accounts
 - accounts often have the same IP
- [future work: what part of the world does IP come from?]

Activity based features



- *datediff*: Time between registration and first post
- *tasperpost*: number of tags per post
 - Spammers: 8, Users 4
- *tascount*: average number of TAS
 - 470 for spammers, 334 for users

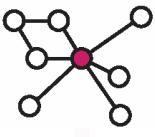
Semantic features



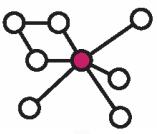
- **\$Group=public:** automatic tag from spamming software
 - **spamtag:** blacklist of tags

tag	count	action
and	75	→
for	54	→
sex	29	→
dildo	23	→
the	22	→
of	22	→
sale	20	→
Money	20	→
anal	19	→
a	19	→
butt	19	→
vacation	16	→
to	15	→
in	15	→
deals	15	→
health	14	→
gold	12	→
ass	12	→
bodybuilding	11	→
car	11	→
poker	10	→
gift	9	→
earrings	8	→
diamond	8	→
shirt	8	→
black	7	→
money	7	→
loans	7	→
diet	6	→
loan	6	→

Semantic features: cooccurrences



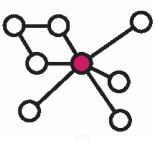
- *Cooccurrence information:*
 - Undirected graph with user as nodes
 - Link exists if users share at least one resource, one tag or one tag-resource pair
 - Each case twice: spammer / non spammer
 - Example: A spammer shares resources with about 18 other spammers, but only with 0.5 non-spammers
 - *Ratios of Spam / Non-spam pairs*



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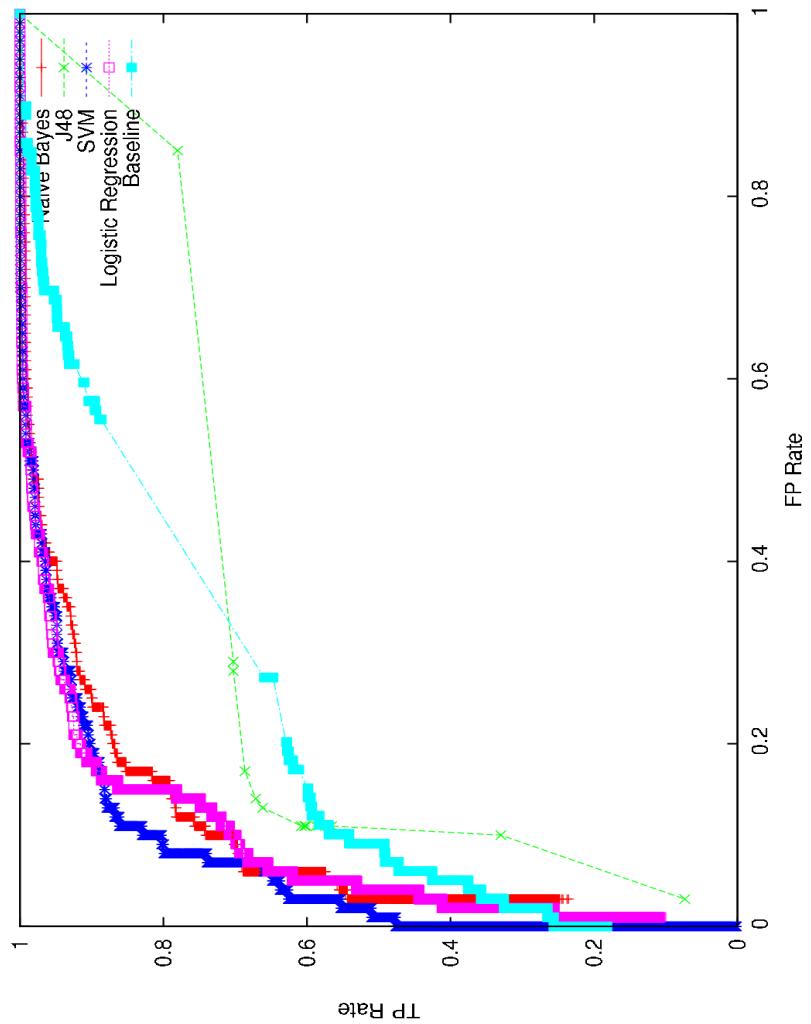
Evaluation of all features



Tool:

- Weka
- SVM
- J48
- Logistic Regression
- Naïve Bayes

All features



Evaluation of all features (+costs)

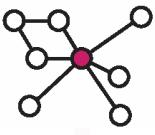


Table 10: Evaluation values all features

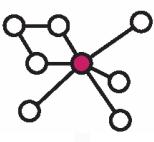
Classifier	ROC area	F1	FP	FN
Naive Bayes	0.906	0.876	14	603
SVM	0.936	0.986	53	23
Logistic Regression	0.918	0.968	30	144
J48	0.692	0.749	11	1112

Table 12: Evaluation with a cost sensitive classifier

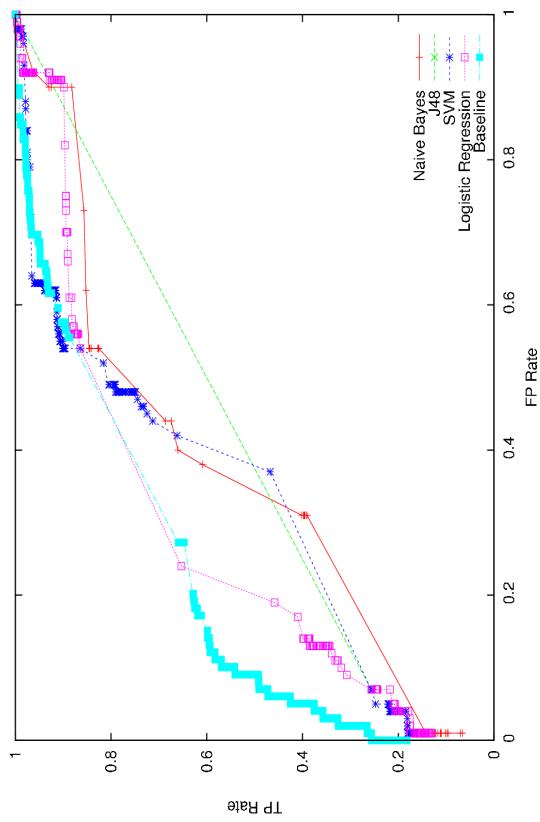
Classifier	F1	FP
SVM	0.924	15
J48	0.794	11
Logistic Regression	0.927	12
Naive Bayes	0.855	11

- Best classification algorithm: SVM
- But: SVM has highest FP Rate! → Cost sensitive classification
- AUC values of baseline yield lower results

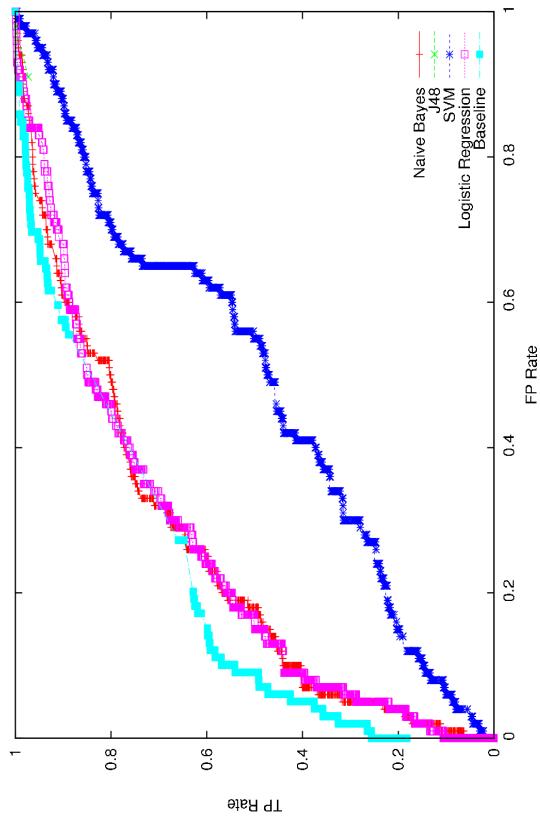
Evaluation of feature groups



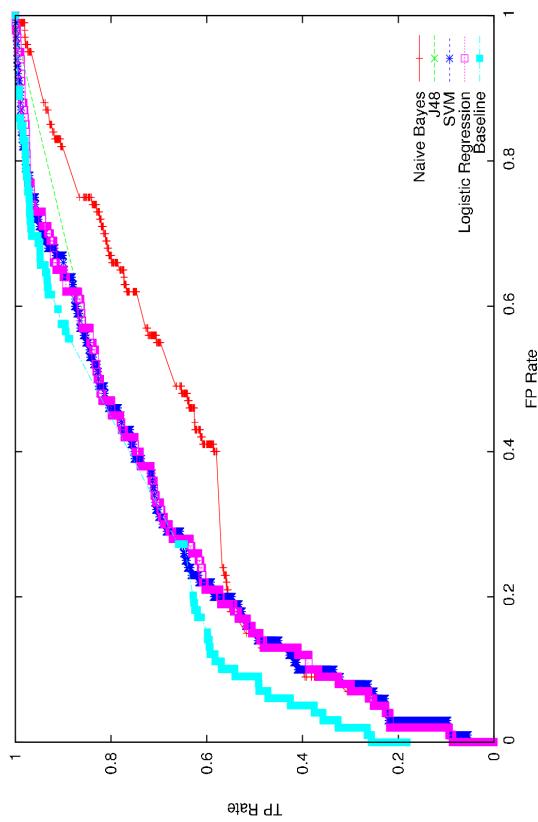
Location based features



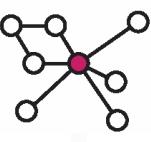
Profile based features



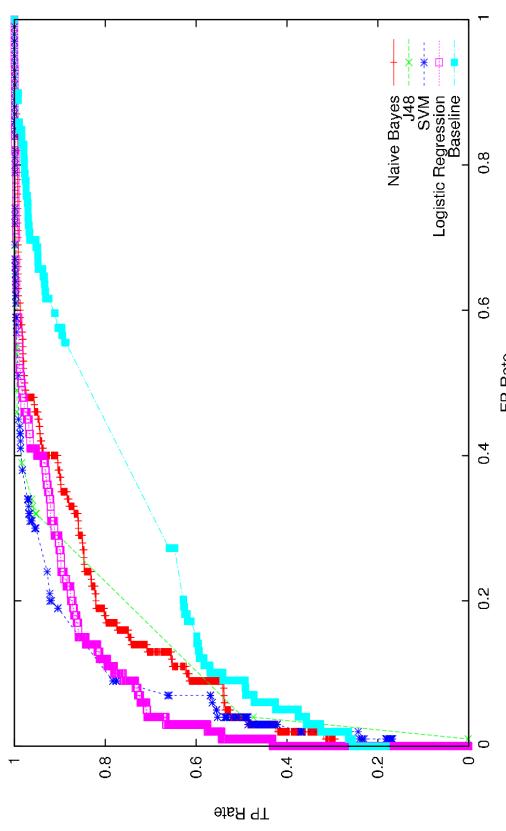
Activity based features



Evaluation all features



Semantic features (cooccurrence)



Semantic features (grouptag, spantag)

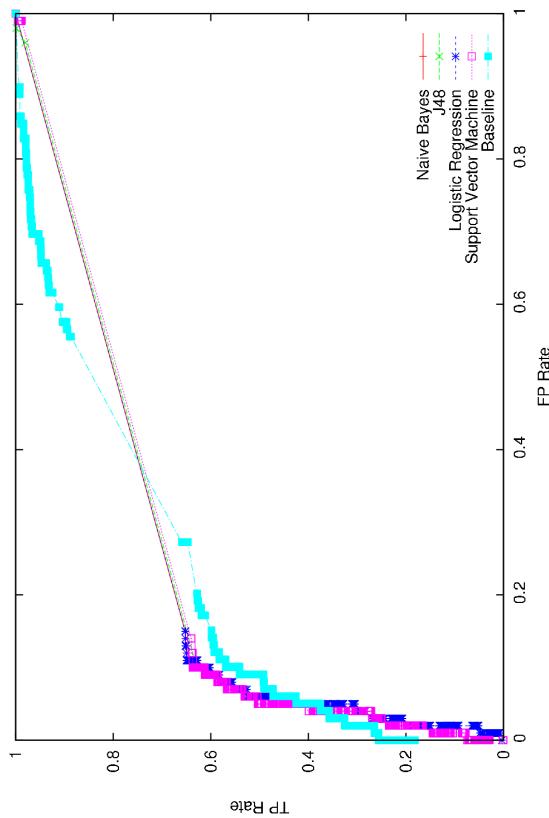
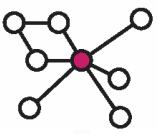


Table 11: Evaluation values of feature groups

Features	ROC area	F1
Profile features (log. reg.)	0.77	0.982
Location features (SVM)	0.698	0.407
Activity features (SVM)	0.752	0.982
Semantic features (J48)	0.815	0.981
Cooccurrence features (log. reg.)	0.927	0.985

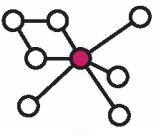


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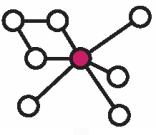
Conclusion

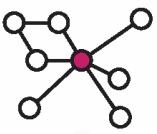
- Many features from users based information
- Combining all features: tangles problem quite well
- SVM best, but needs cost-sensitive classification
- Different feature groups: Co-occurrence features most promising, but computation intense



Future work

- Fine-tuning of results
- Reduce user accounts
- Classification on post level
- Use different splits
- Add more features
- Comparison with other techniques (e.g. language models)
- Comparison with other datasets





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