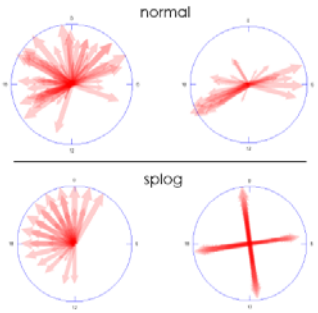


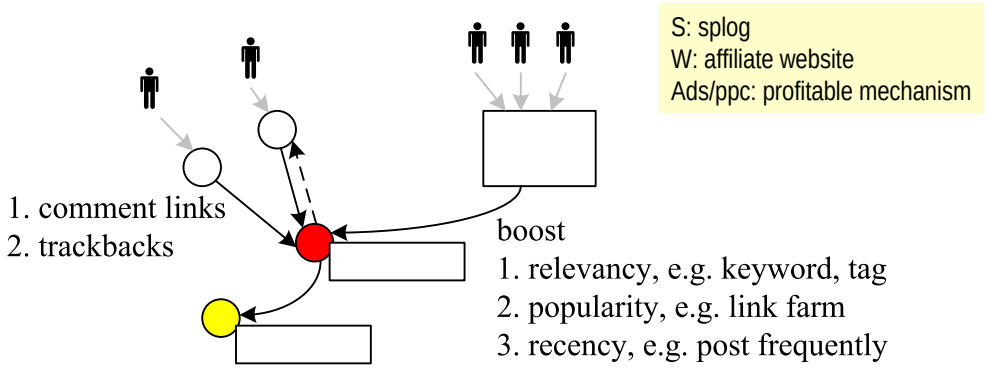
Splog Detection Using Self-Similarity Analysis on Blog Temporal Dynamics

Yu-Ru Lin, Hari Sundaram,
Yun Chi, Junichi Tatemura and Belle Tseng

NEC Laboratories America, Cupertino, CA

AIRWeb Workshop 2007
May 8, 2007

What are splogs?



- Splog (Spam + Blog): a blog created with the intention of spamming
- Splogs are polluting the blogosphere
  - 10-20% of blogs are splogs
  - 75% of new pings come from splogs
  - 44 of the top 100 results from 3 top blog search engines are splogs

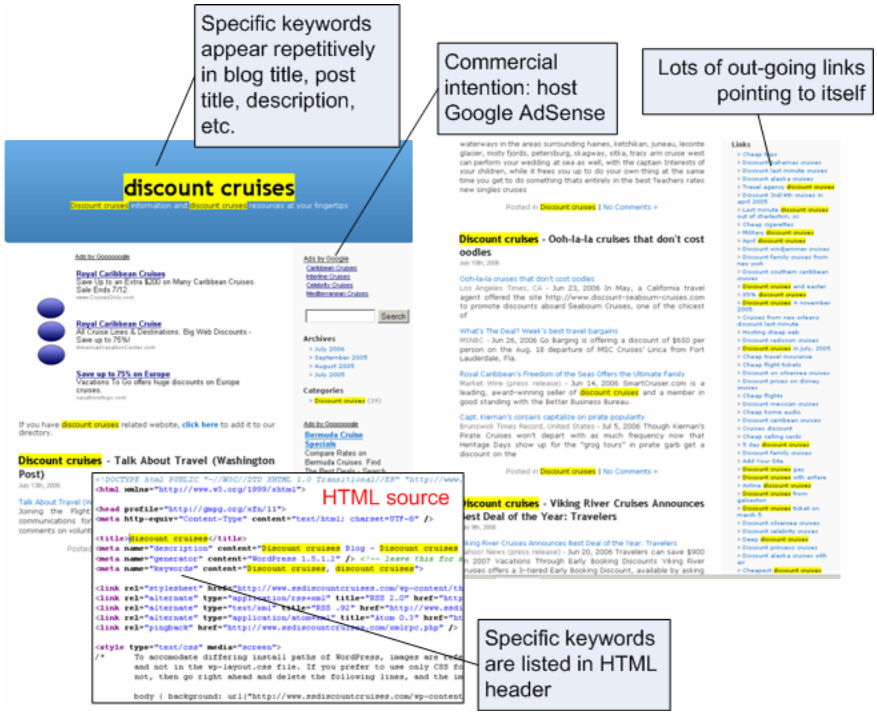
B

B

S

Ads/ppc

Example (1): keyword stuffing



Example (2): stolen content

Computer science thesis

Sat, 17 Jun 2006 02:03:20 -0500

Lenovo & Dell--Support Makes the Difference

by Computer science thesis (computer-science-thesis) @ Sat, 17 Jun 2006 02:03:20 -0500

In world of seemingly undifferentiated products and **services**, support is everything. When a **computer** has a hiccup, and a user is on a hotline, they are scared and apprehensive. Their lives as they live them have stopped. ...

Original post: Lenovo & Dell--Support Makes the Difference by at Google Blog Search: computer services

Thu, 15 Jun 2006 02:02:15 -0500

Man-waiChang

by Computer science thesis (computer-science-thesis) @ Thu, 15 Jun 2006 02:02:15 -0500

Trained in software engineering, information systems, **computer** hardware systems and formal specification. Attempted part-time MSc in **Computer Science** in City University of Hong Kong, but failed to complete the **thesis** owning to heavy ... Data Recovery Free To Air TV Acne News Home Security News Computer News

Original post: Man-waiChang by at Google Blog Search: computer science thesis

Wed, 14 Jun 2006 02:03:53 -0500

C.2.1 Simulation Reporting Document Tutorial

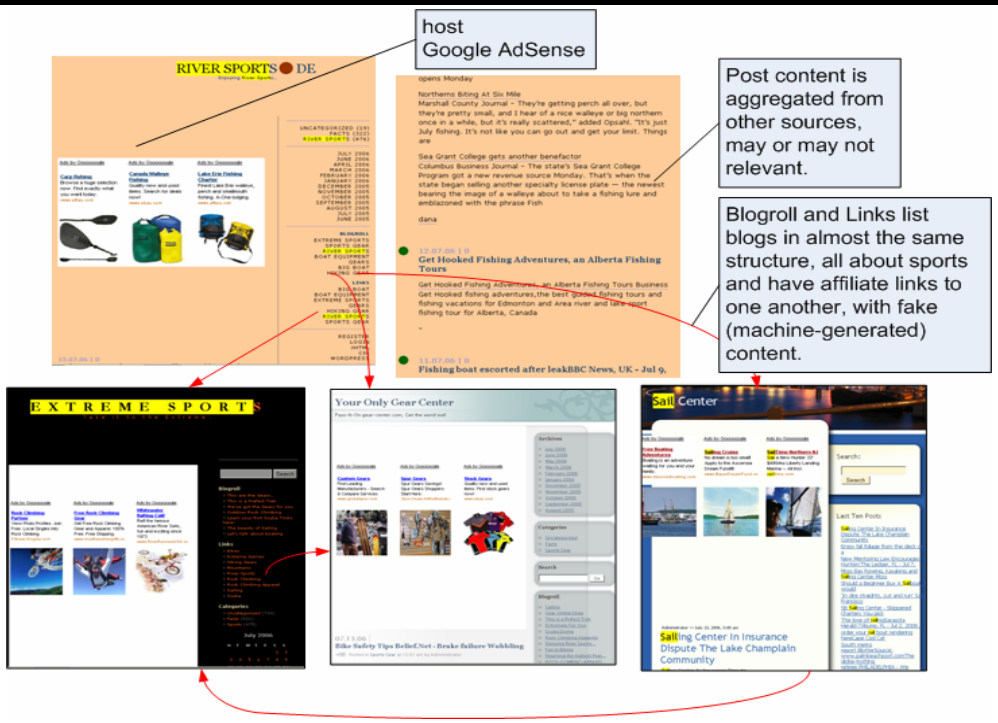
by Computer science thesis (computer-science-thesis) @ Wed, 14 Jun 2006 02:03:53 -0500

There is a data reporting page for every year. It will look something like this: There is a lot of data on this screen, but it is organized logically. The following pages explain the details. **Computer Science Thesis** Index.

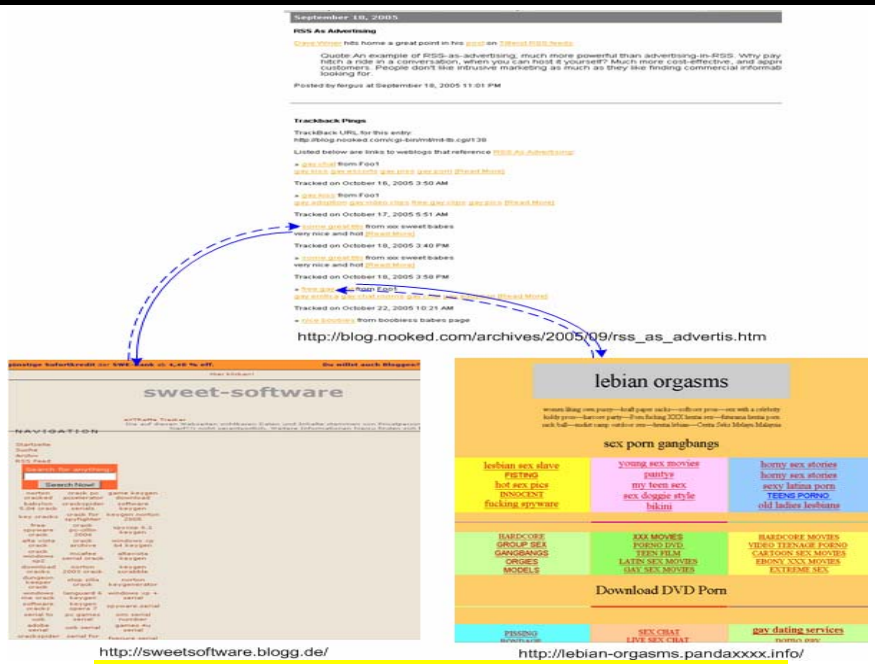
Original post: C.2.1 Simulation Reporting Document Tutorial by at Google Blog Search: computer science thesis

Traditional content analysis is not enough

Example (3): link farm



Example (4): trackback links



Traditional link analysis is not enough

What are splogs?

- Motive of creating splogs
  - drive visitors to affiliated sites that have profit-making mechanisms, e.g. Google AdSense or PPC
- Working definition
  - *any deliberate action that is meant to trigger an unjustifiably favorable relevance or importance, considering the blog's true value*
  - NOTE
    - evaluated at the blog level, not at individual pages
    - a blog having comment spam or trackback spam is *not* considered a splog

Problem Statement

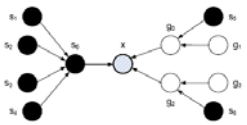
Goal: combat spam in the blogosphere
- What are *splogs*?
- How to detect splogs?

Approach: using temporal regularity of *content*, *post time* and *links*
- Self-similarity analysis
- Visual characterization
- Temporal feature computation

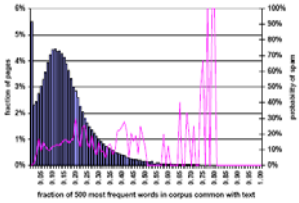
Splog detection—different from web spam detection!

Related work

- Web spam detection
  - Link analysis
    - [Gyongyi05]: spam mass estimation
    - [Wu&Davison05]: determine spam seeds based on overlap between incoming and outgoing links
    - [Fogaras&Racz05]: multiple-step neighborhood searching



  - Content analysis
    - [Fetterly04][Ntoulas06]: statistical properties in content
    - [Fetterly05]: identifying phrase level replication

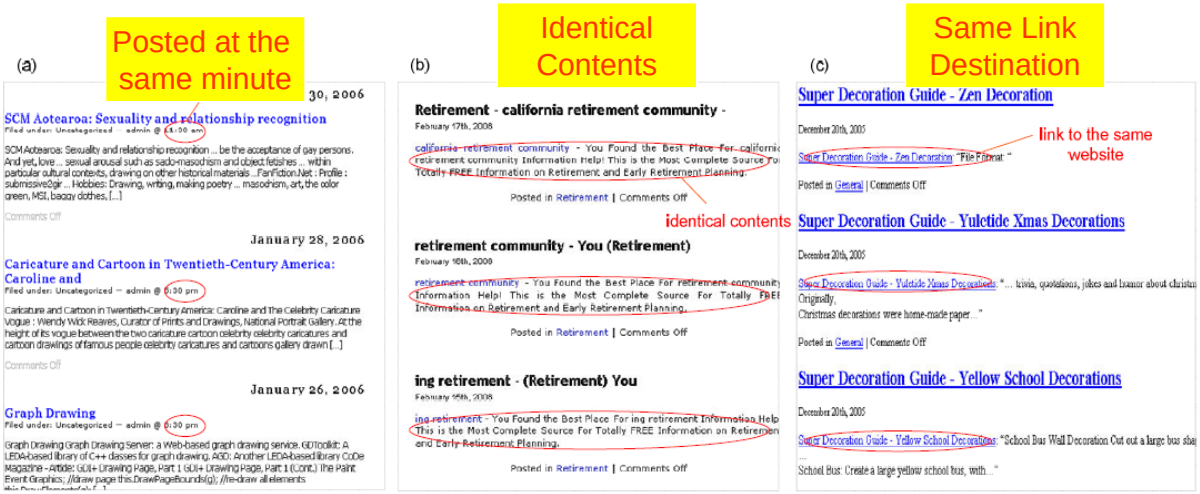


- Splog detection
  - [Kolari06]: apply web spam detection & topic identification techniques in splog detection
  - [Salvetti&Nicolov]: URL tokenization

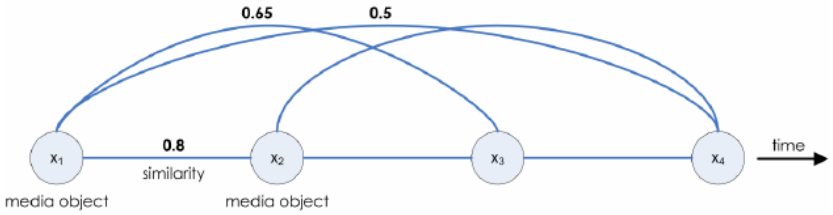
Approach

1. Self-similarity analysis
2. Visual characterization
3. Temporal feature computation

Temporal structures in splogs



1. Self-Similarity Analysis

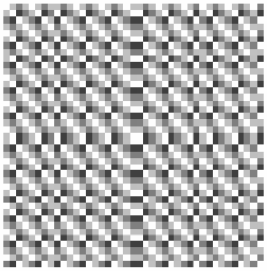


- Graph model
  - Nodes: posts from the same blogs
  - Edges: similarity measure
- Self-similarity matrix: generalized autocorrelation over any time series of media objects
  - Post time
  - Post content
  - Post links

Post time

$$S_{micro}(i,j) = \mathrm{mod}(|t_i - t_j|, \delta_{day})$$

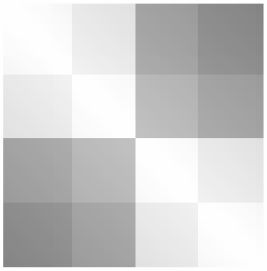
daily time



micro-time

$$S_{macro}(i,j) = |t_i - t_j|$$

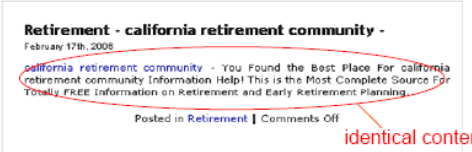
absolute time



macro-time

Similarity matrix of post time

Post content / links

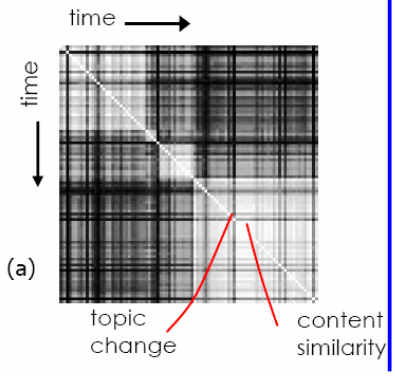


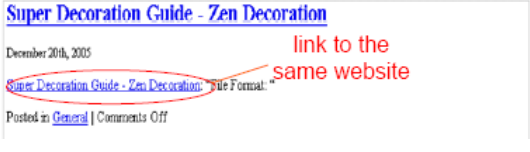
identical contents

tf-idf term vector of post

Histogram intersection

$$S_c(i,j) = \frac{\sum_{k=1}^{M} \min\left(h_i(k), h_j(k)\right)}{\sum_{k=1}^{M} \max\left(h_i(k), h_j(k)\right)}$$

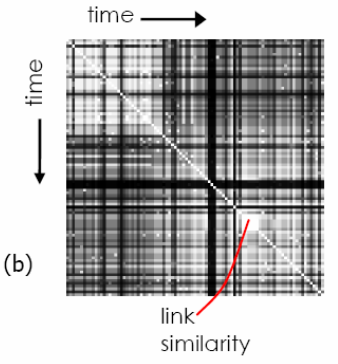




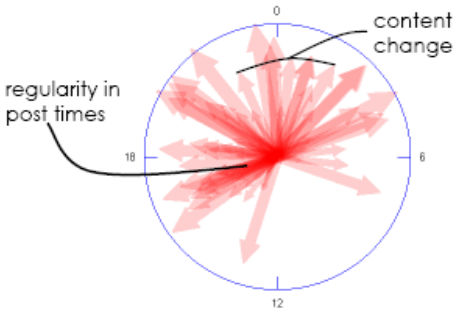
link to the same website

tf-idf vector of URLs

$$S_l(i,j) = \frac{\sum_{k=1}^{M} \min\left(h_i(k), h_j(k)\right)}{\sum_{k=1}^{M} \max\left(h_i(k), h_j(k)\right)}$$

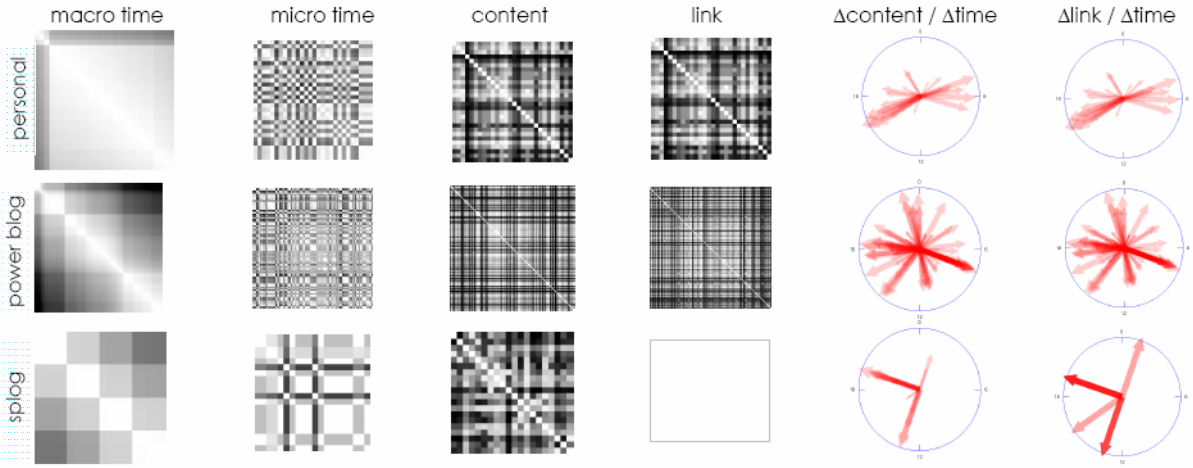


2. Visual Characterization

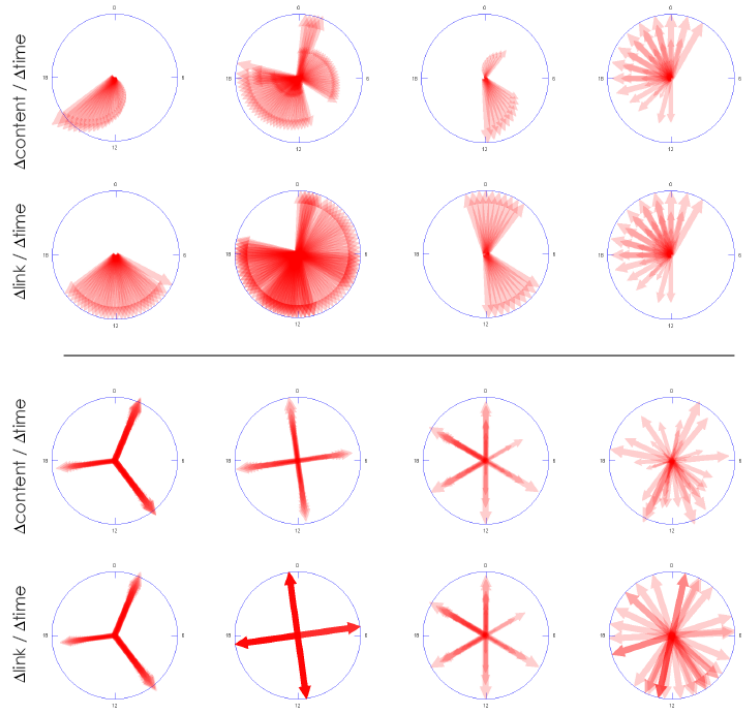


- Clock-like representation
  Each post is represented as a post-arrow
  - Orientation: post time
  - Length: similarity w.r.t. previous post

Different blog types

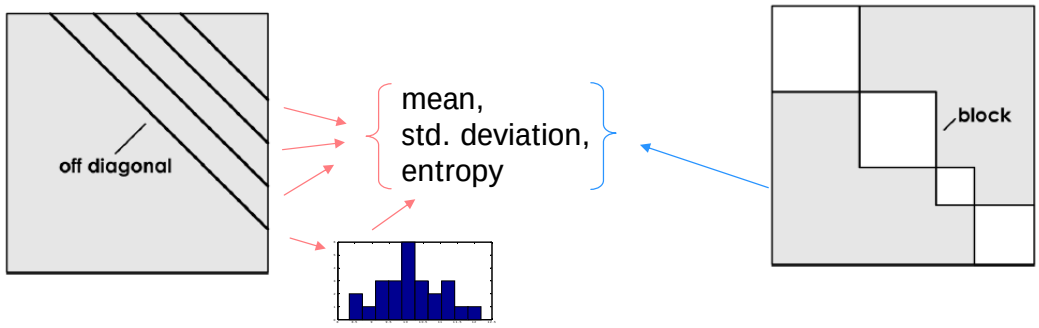


Examples of “splog clock”



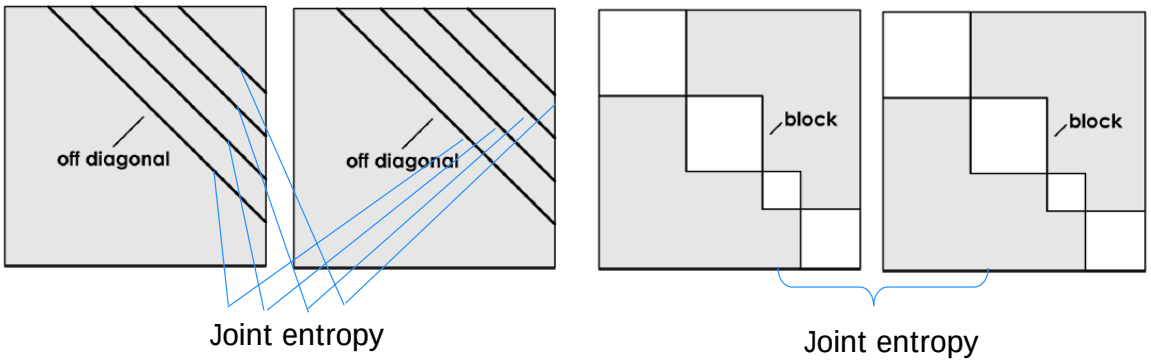
3. Temporal Features

- Features along off-diagonals
  - High intensity off-diagonals: attribute values are similar at different posts
- Features from coherent blocks
  - High intensity blocks: attribute values remain highly constant for some period



Joint features

- From two attributes

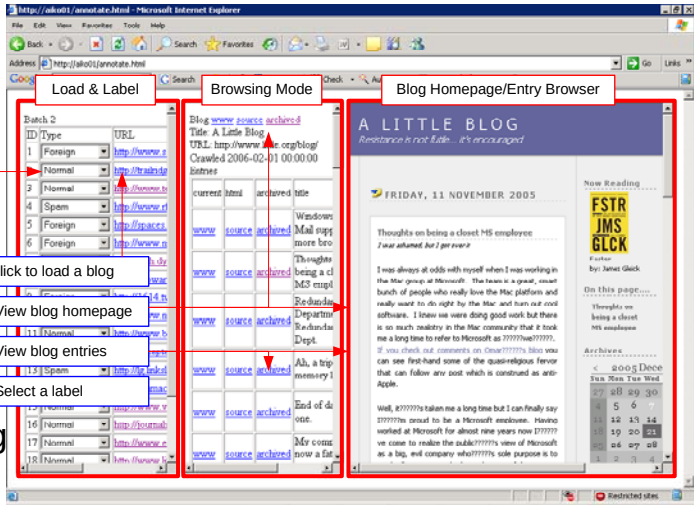


Experimental Results

- Dataset
- Annotation tool
- Classification
- Detection Performance

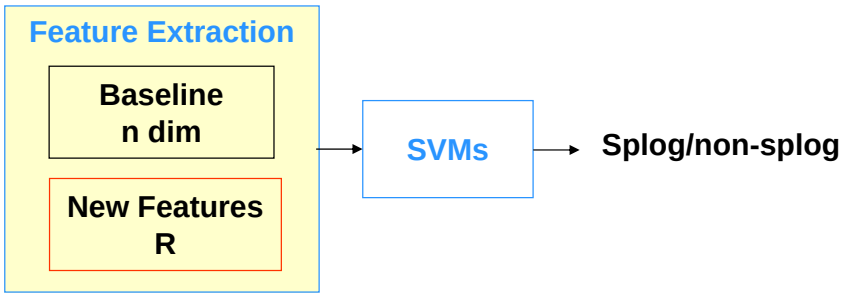
Dataset

- TREC Blog Track 2006 Collection: 100,649 feeds
  - 100,649 feeds, collected over 11 weeks
  - Removing duplicate feeds, feeds without homepage or permalinks → 43.6K unique blogs
- Annotation interface
  - (N) Normal
  - (S) Splog
  - (B) Borderline
  - (U) Undecided
  - (F) Foreign
- Ground truth
  - Label 9167 blogs
  - 7380 normal, 897 splog



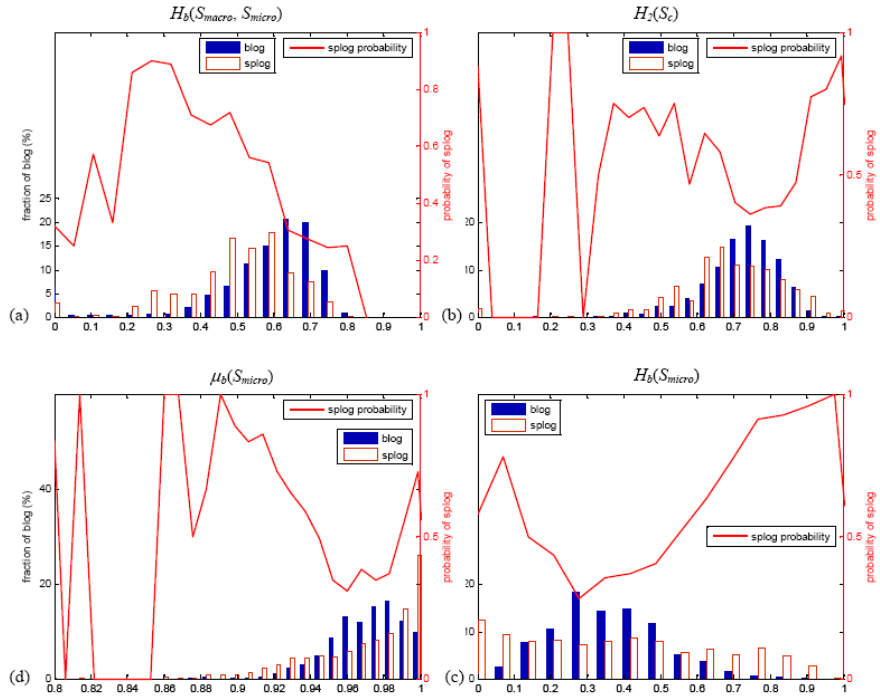
Classification

- Binary classification: splog or normal blogs
  - Use SVMs classifier with a radial basis function kernel
  - Combine baseline features with new features

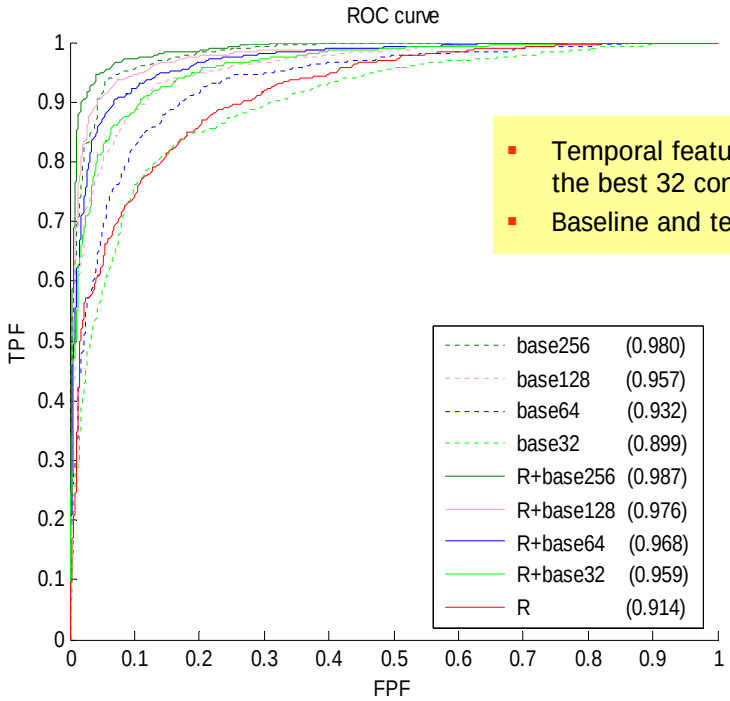


- Baseline: A subset of content features in [Ntoulas06]
  - Tokenized URLs, blog and post titles, anchor text, blog homepage content, and post (entry) content
- Feature selection using Fisher linear discriminant analysis
  - Avoid over-fitting

Feature distribution in splog / non-splog



Detection performance

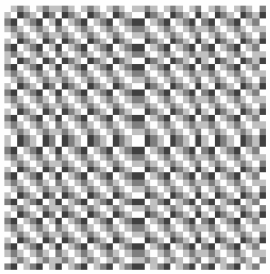


- Temporal features alone (R) out-perform the best 32 content features (base-32)
- Baseline and temporal features jointly work well

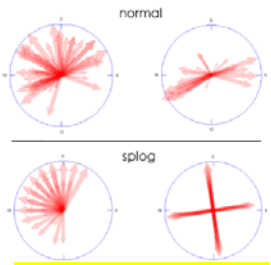
Feature	AUC	accuracy	precision	recall
base-256	0.980	0.940	0.940	0.940
R+base-256	0.987	0.951	0.955	0.946
base-128	0.957	0.893	0.891	0.896
R+base-128	0.976	0.929	0.933	0.925
base-64	0.932	0.865	0.860	0.871
R+base-64	0.968	0.912	0.914	0.909
base-32	0.899	0.825	0.810	0.849
R+base-32	0.959	0.893	0.892	0.895
R	0.914	0.832	0.829	0.838

Summary

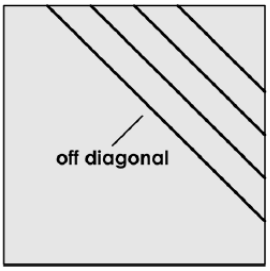
- Splog - new and serious problem in the blogosphere
- Splog detection is different from web spam detection
- Unique features of blogs/splogs
  - Content, temporal and link



Self Similarity Matrix



Visual Characterization



Temporal Feature