Microsoft Research

Exploring Traversal Strategy for Web Forum Crawling

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Outline

- Motivation & Challenge
- Our Solution
  - System Overview
  - Traversal Strategy
    - Skeleton link identification
    - Page-flipping link detection
- Evaluation

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Why Web Forum

- Web forum is a huge resource of human knowledge
  - Over 20% search results are from web forums
  - Leverage the power of users and communities
- Forum sites have complex link structures
  - Many shortcut links
  - Links with permission control
  - Page-flipping links

The Limitation of Generic Crawlers

- In general crawling, each page is treated independently, and each link is treated indiscriminately
  - Lead to more than 50% useless pages
  - Ignore the relationships between pages from a same thread

- Forum crawling needs a site-level perspective and a careful selection of links

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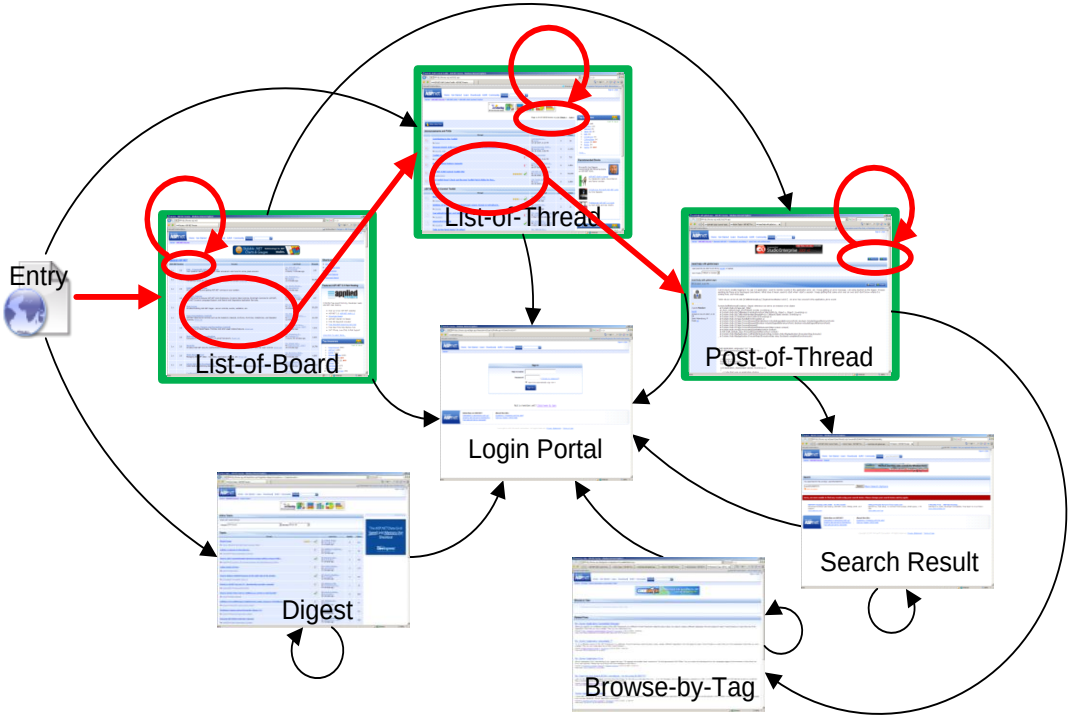
What is Site-Level Perspective?

- Understand the **organization structure**
- Find our an optimal **Traversal strategy**



The site-level perspective of "forums.asp.net"

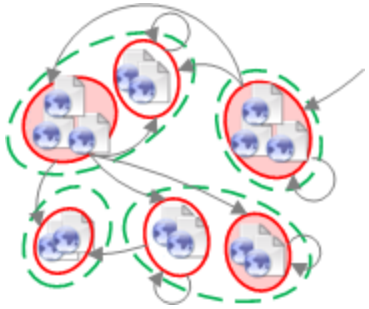

Random Sampling
Sitemap Construction
Traversal Strategy Exploring
Crawling

Random Sampling → Sitemap Construction → Traversal Strategy Exploring → Crawling

- Adopted a combined strategy of breadth-first and depth-first using a double-ended queue
- Try to cover as many as possible unseen URL Patterns

Random Sampling

- Randomly sample some pages from a given site
- Adopt a combined strategy of breadth-first and depth-first using a double-ended queue
- Try to cover as many as possible unseen URL patterns
- 1,000 pages are enough



Random Sampling → Sitemap Construction → Traversal Strategy Exploring → Crawling

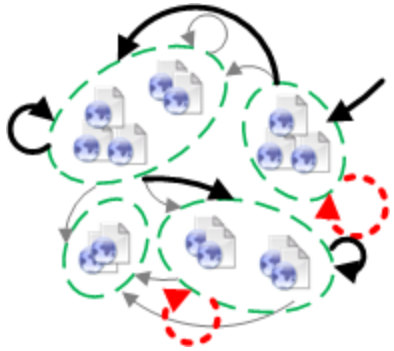
- Utilized the repetitive regions to characterize the content layout of each page
- Represent links with their location and URL patterns

Sitemap Construction

- A sitemap is a directed graph consisting of a set of *vertices* and the corresponding *links*
- Cluster pages into vertices with the same page layout
- Link = its URL pattern + its location

More details about the first two parts, please refer to our previous work :

iRobot: An Intelligent Crawler for Web Forums, in WWW'08

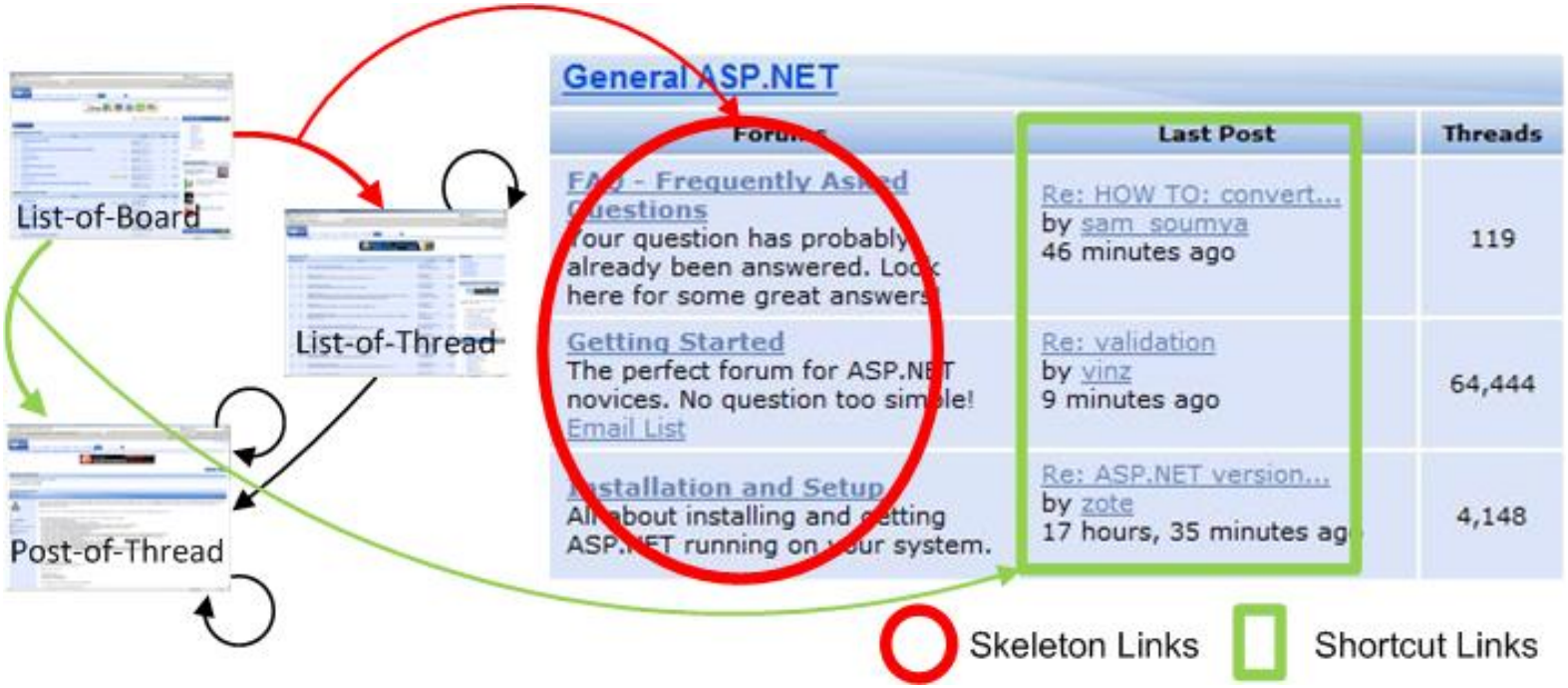


Random Sampling → Sitemap Construction → Traversal Strategy Exploring → Crawling

- Skeleton Link Identification
- Page-Flipping Link Detection

Why Skeleton Links

- Crawlers crawl as many as possible unique pages in a given forum site by following skeleton links
- Skeleton links are the most important links supporting the structure of a forum site
- Skeleton links point to all valuable pages without introducing redundant and valueless

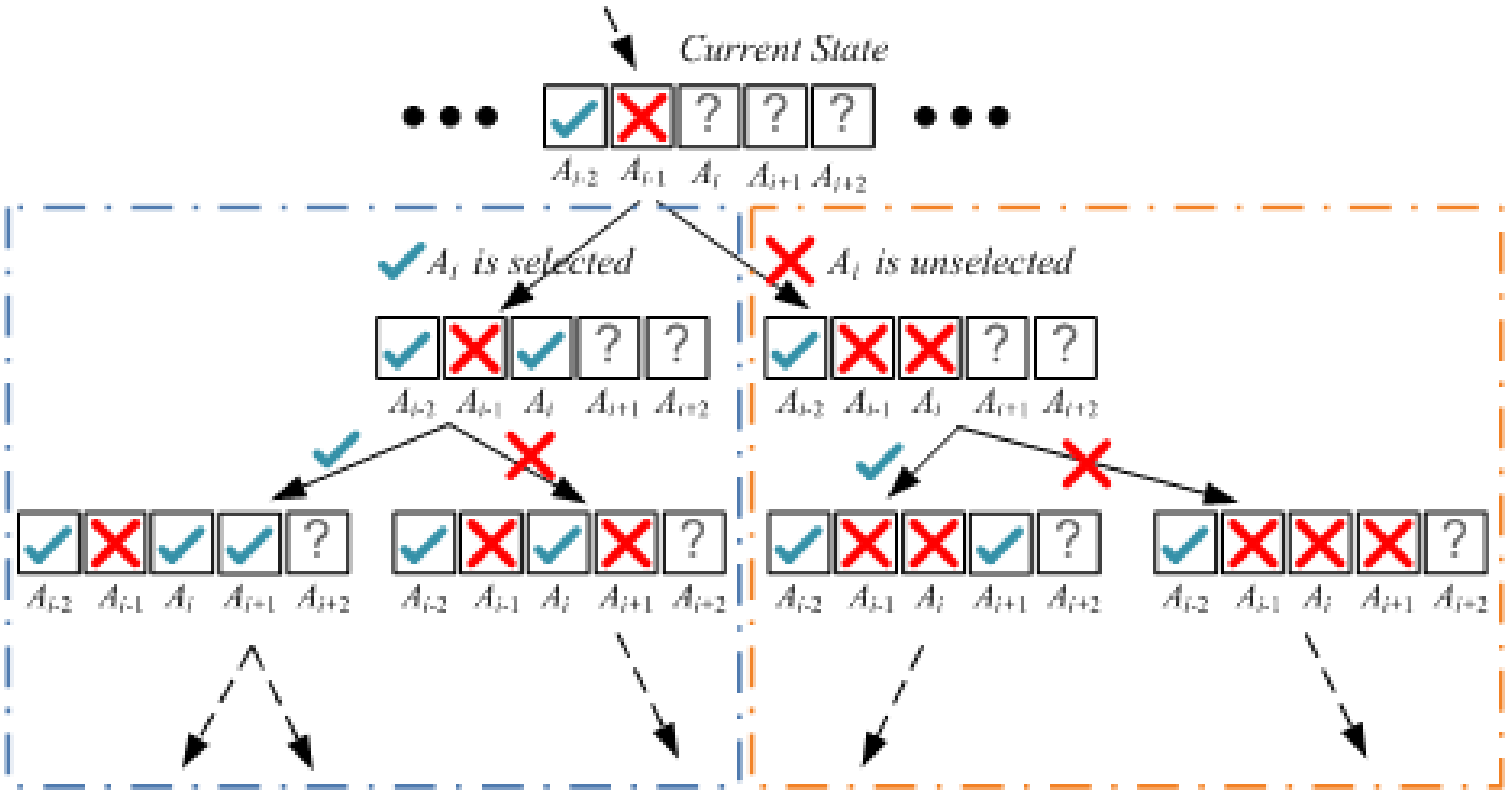


Example of skeleton links from forums.asp.net

How to Identify Skeleton Links

- Aim at all unique pages without duplicates
- An optimal set of skeleton links leads to most unique pages and few duplicates
- Search skeleton links for each valuable vertex
  - Level by level: Inspired by user browsing behavior
  - Find an optimal combination of links
    - Optimal result comes out after exhausting all!

- Pruning while searching for optimism
  - Selected but introduce many duplicate pages
  - Rejected but cause coverage drop significantly

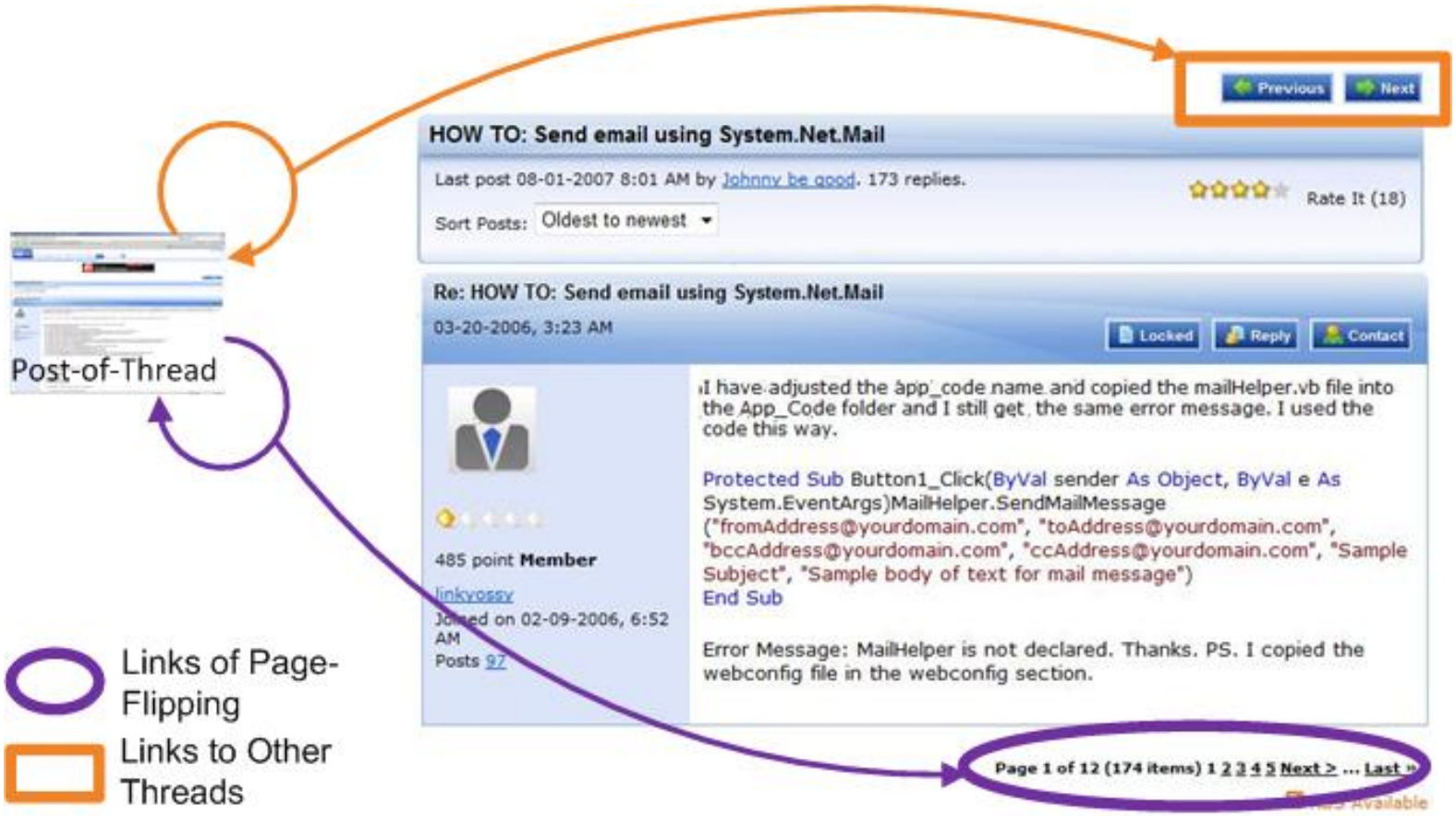


An illustration of the search process of skeleton links

Why Page-Flipping Links

- Crawlers can completely download a long discussion thread divided into several pages by following page-flipping links

- Page-flipping links are a kind of *loop-back* links in the sitemap. However, not all loop-back links are page-flipping ones

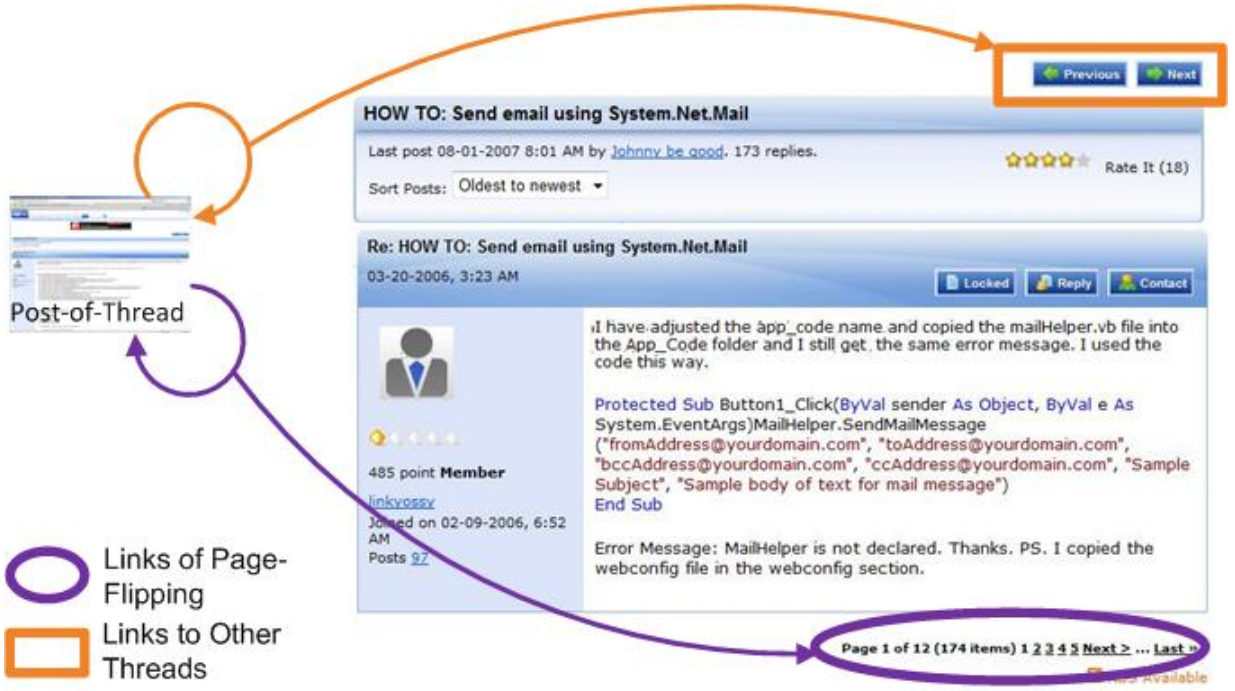


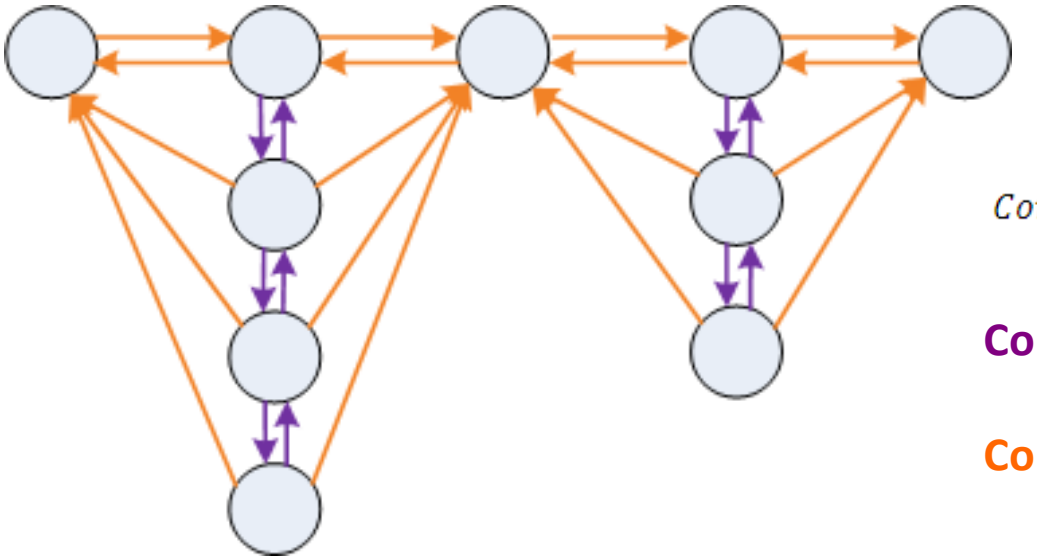
Example of page-flipping links from forums.asp.net

How to Detect Page-Flipping Links

- For page-flipping links, if there is a path from page A to B, there must be a path follow the same type of links from B to A

- Page-flipping links have larger *connectivity* score



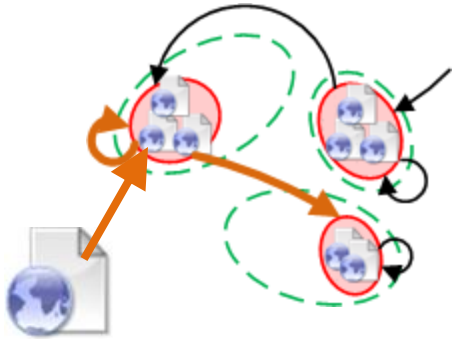


$$Connectivity = \frac{\sum_{\{A,B\}} Path(A,B) \cdot Path(B,A)}{\sum_{\{A,B\}} Path(A,B)}$$

Connectivity = 722 / 890 = 0.81

Connectivity = 108 / 1153 = 0.09

An illustration of the characteristics of page-flipping links



Random Sampling → Sitemap Construction → Traversal Strategy Exploring → Crawling

- Mapping a new page to an existing layout vertex
- Follow the traversal strategy for out-links

Crawling

- From the given entry page
- Map a new page to an existing layout vertex
- Follow the explored traversal strategy for out-links from that page

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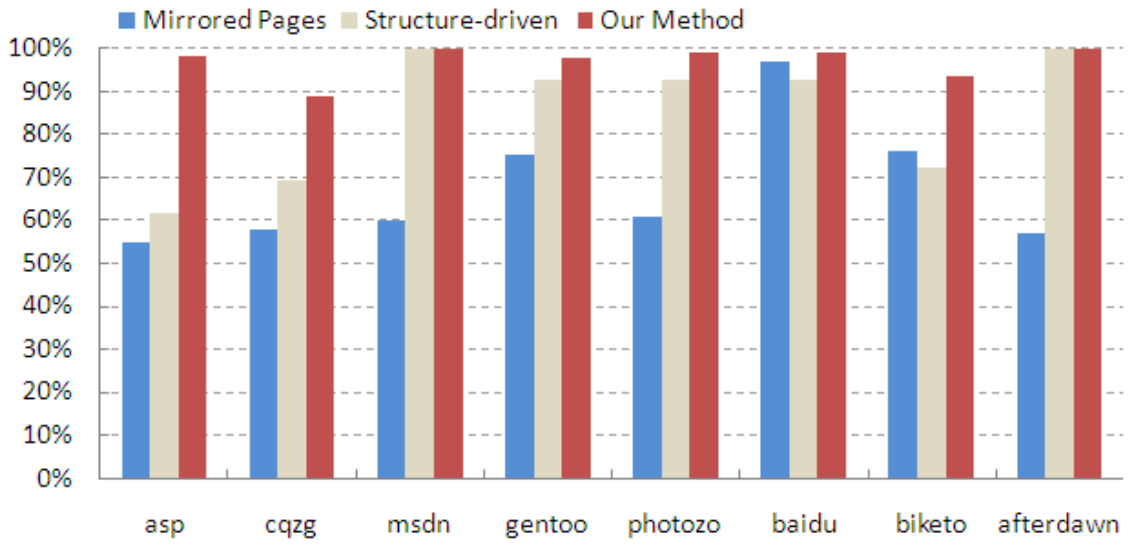
Experimental Setup

- Contract experiments in eight forums from diverse categories
  - Mirror pages: Crawled by a real commerce crawler
  - Structure-driven: Crawled by structure-driven crawler proposed in SIGIR'06
  - Our method: Crawled by crawler using our traversal strategy

Evaluation Criteria

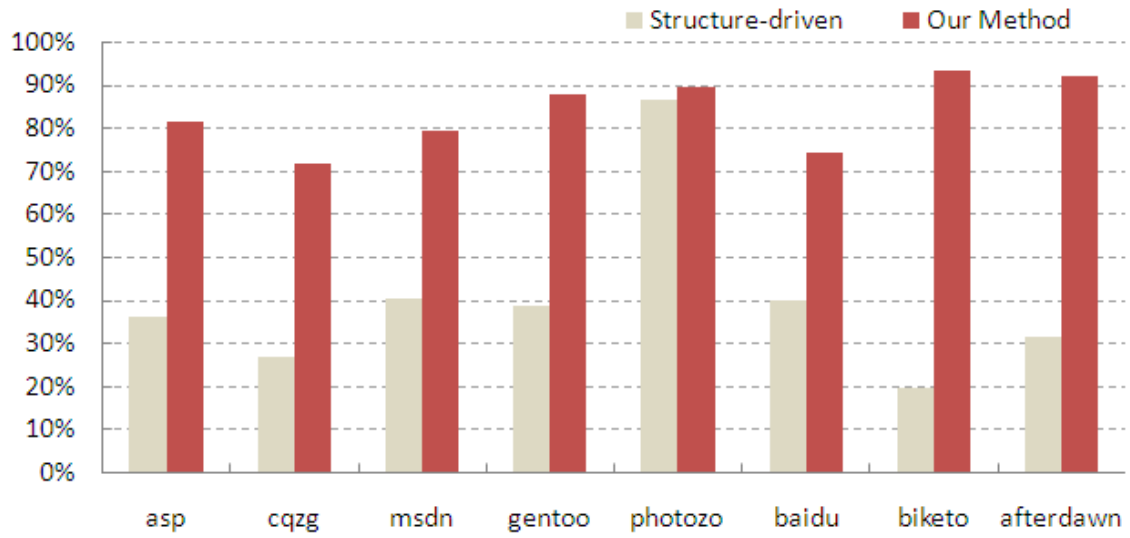
Informativeness

$$Info = -\frac{1}{log(N)}\sum_{i=1}^{K}\frac{\|D_i\|}{N}log\left(\frac{\|D_i\|}{N}\right)$$



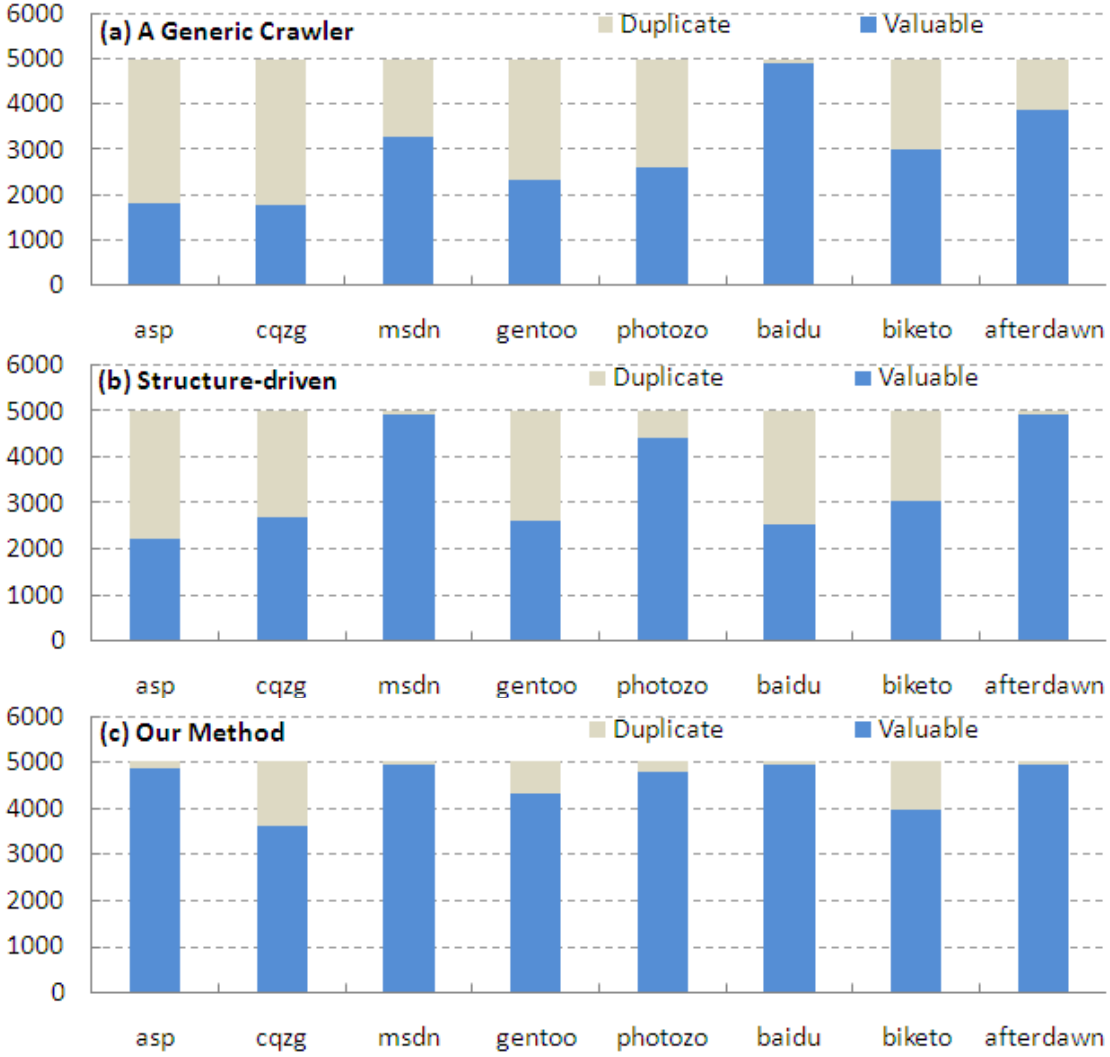
Coverage

$$Cov = \frac{K'}{K} \times 100\%$$



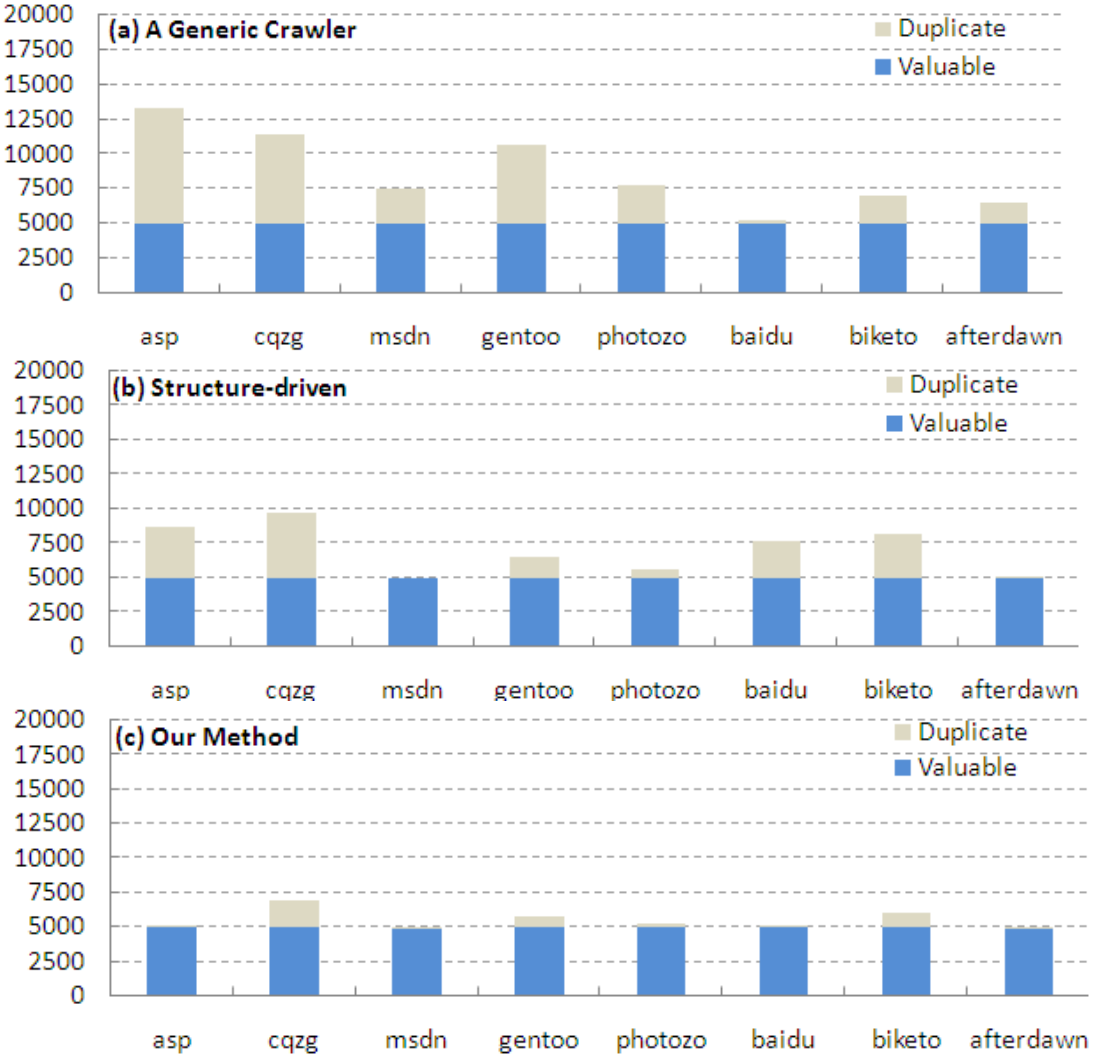
Effectiveness and Efficiency

- Effectiveness

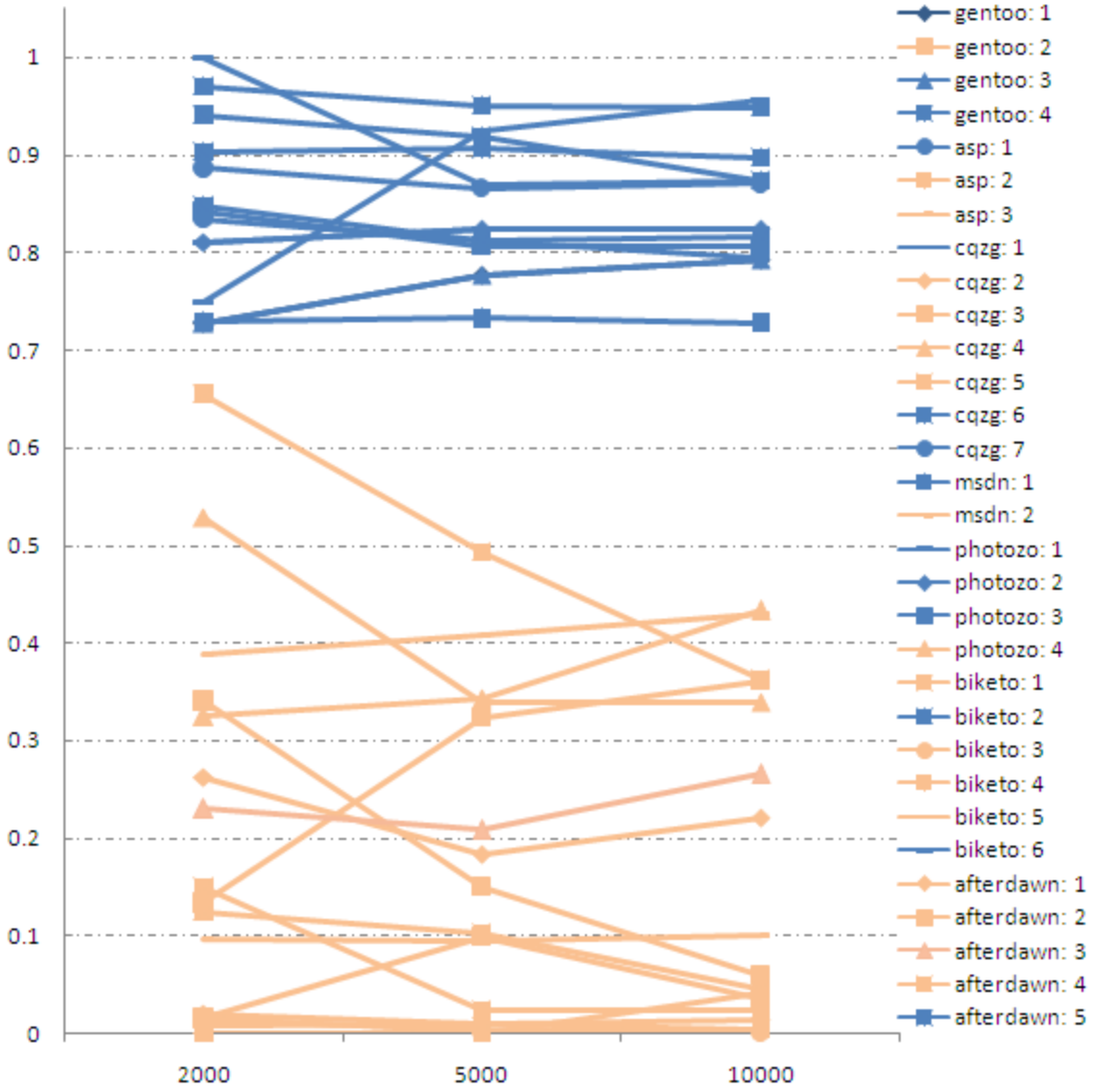


Effectiveness and Efficiency

- Efficiency



Evaluation of Page-Flipping Detection



Conclusions

- A complete solution to automatically explore an appropriate traversal strategy to a given target forum site is proposed
  - Skeleton link identification
  - Page-flipping link detection
- More future work directions
  - Incremental crawling
  - Forum page segmentation

Thanks!