Extraction of Topic Maps from Web pages

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Introduction(1/2)

- Information gathering
  - a huge amount of Web pages

- Web users' problems[GVU98]
  - finding out the necessary information
    - Search engine: Google, Yahoo!
    - Web personalization[Speretta04, Widyantoro99]
    - Web navigation[Armstrong95, Lieberman95]
    - etc

  - organizing the gathered information

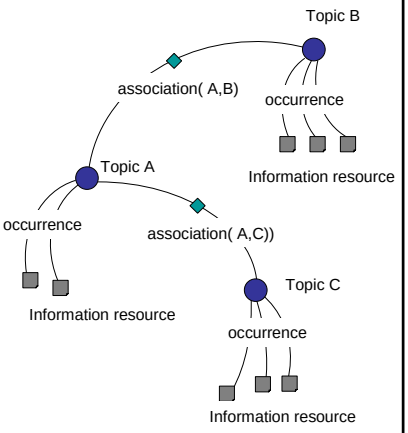
Introduction (2/2)

- Organizing the gathered information
  - Managing histories by tasks
    - Browsing Icons[Matthias01],
    - Google Search history, Google Web history
  - Visualization of histories
    - Domain Tree Browser[Gandhi00], VISVIP[Cugini99]
  - Search the information that user have seen
    - Stuff I've Seen[Dumais03]
  - Indexing by tasks , time-line, terms

- Topic Maps
  - Indexing by topics and the relations of the topics

Topic Maps(1/2)

- ISO/IEC 13250
  - A solution for organizing, accessing and retrieving information
- Composed of three elements
  - topic
    - any concepts and subjects
  - association
    - relation between topics
  - occurrence
    - connection between topics and information resources related to them
- High flexibility
  - user can define topics and associations freely



Topic Maps (2/3)

Searching BibTeX tools

Topic Maps(3/3)

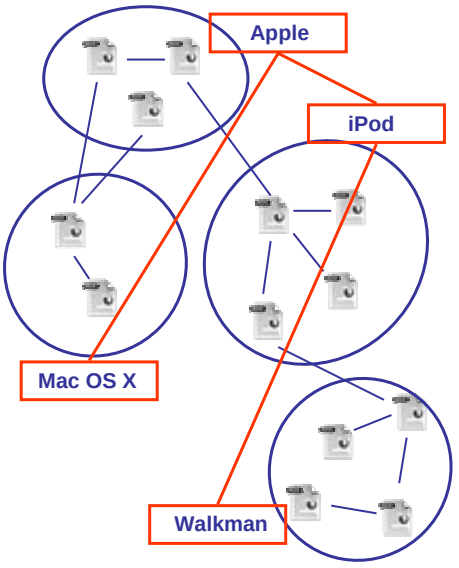
- How to create Topic Maps from Web pages
  - manually
    - cost
  - Automatically
    - covert the existing ontology[Reynolds02]
    - XML, RDF : structured data
- Web pages
  - HTML : semi-structured data

Purpose

- Extracting the topic maps from Web pages
  - assist user to organize and manage the gathered information from Web
- **prototypes of topic maps**
  - Users modifies and completes the prototypes
  - Exhaustively extracted topics and associations
    - Adding lack of topics and associations
    - Removing unnecessary items

Approach(1/2)

- Topic Maps
  - Topics
  - Associations
- To extract topic maps
  - divide by topics
  - relations between the topics
- Clustering method
  - Contents-based
    - similarities
  - Structure-based
    - relations



Approach(2/2)

Structure-based clustering

Web link structure

+

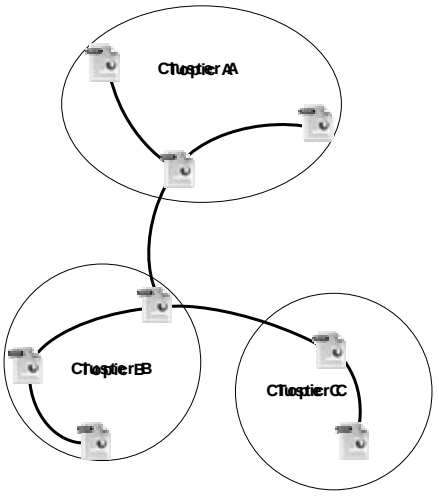
similarity between contents of pages

similarity of document vectors

weight by types of Web links

Web link structure

- The primitive relationships between the topics of the linked pages
- To extract the relationship of the topics
  - Merging the linked clusters



Types of Web links (1/2)

- Relevance between the topics of linked pages
  - types of links
  - distance between directories in which the pages are located
- The authors of Web sites probably make directories on Web sites with following intention
  - Web pages are classified into directories along the topics of pages
  - Topics of pages in child directories are specialization of the topics in their parent directory
  - Topics of pages in closer directories are similar than in distant directories
- form dense clusters by prioritizing links of pages in closer directories

Types of Web links(2/2)

- three types of Web links
  - upward/downward
    - link between a page and in ancestor or descendant directory in same Web sites
  - crosswise
    - link between pages in same Web sites, except upward/downward links
  - outward
    - link between pages in two different Web sites
- distance of directories
  - The number of directories on shortest path between any two pages in tree structure which consists of pages and directories as nodes
- To generate dense clusters
  - Prioritize crosswise over upward/downward and
  - Prioritize links which have lower values for distance of directories

Proposed Method

Structured-based clustering method
- Newman's method

Structure of links

Applying Weights to links
- Common similarity of document vectors
- Weight by types of links

Similarity of contents

Newman's method

- Newman's method[Newman2004]
  - merging clusters to maximize modularity Q
  - Modularity Q: function to check the validity of network division

$$Q = \sum_i (e_{ii} - a_i^2) \qquad a_i = \sum_j e_{ij}$$

e_{ij} : the fraction of the edges between the cluster i, j to all edges in network

  - High value of Q: vertices are closely bound together in each clusters
- Applying the weights to edges

Weight of edge

- weight of edge:

$$weight\ (p,q) = \alpha \times similarity\ (p,q) + (1-\alpha) \times link\ \ weight\ (p,q) \qquad (\alpha = 0.5)$$

- content similarity:

$$similarity\ \ (p,q) = \frac{d_p \bullet d_q}{\|d_p\| \times \|d_q\|} \qquad d : document\ \ vector\ of\ page$$

- weight by types of links

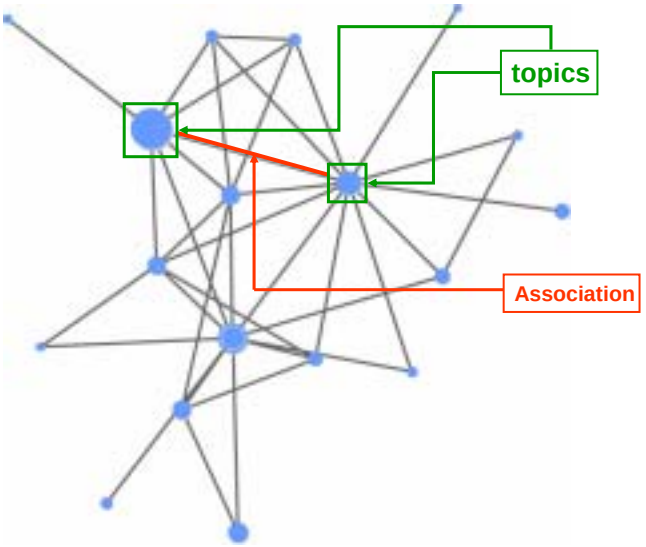
$$link\ weight(p,q) = \begin{cases} \frac{0.25}{(D+1)} \times C_{ld} & (upward\ /\ downward) \\ \frac{0.5}{(D+1)} \times C_{ld} & (crosswise) \\ 0.4 \times C_{ld} & (outward : \tau_{sim} < similarity(p,q)) \\ 0 & (outward : similarity(p,q) < \tau_{sim}) \end{cases}$$

d : distance of directories in which the pages are located

C_{ld} : type of link direction $(2 : two\ way, 1 : one\ way)$

  - Defined by our policy that is prioritizing links of pages in closer directories

Build the prototypes of topic maps



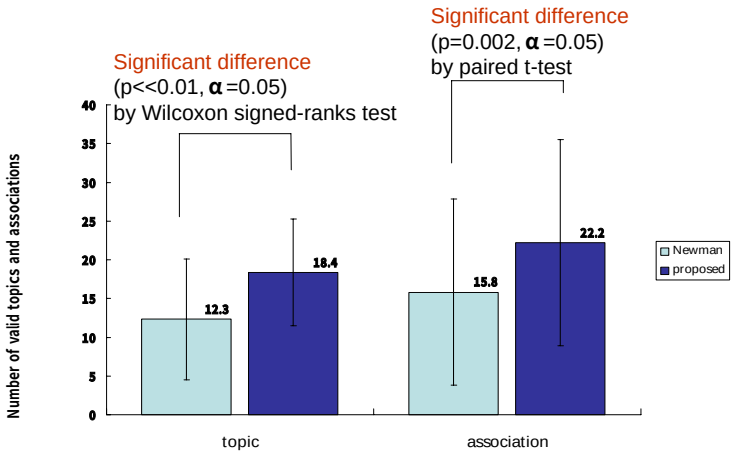
Experiment(1/2)

- Evaluate the framework of topic maps
  - Proposed method
  - Newman's methods
- Measure
  - Number of valid topics and associations
    - Good frameworks cover topics and associations in detail
    - Suitable for user's modification
- Task
  - Naming the topics and the associations appropriately
  - Valid topics and associations are appropriately named items
  - Topic
    - The list of the Web pages (URL, title, content of the pages)
  - Association
    - The information of the two topics(anchor texts of links)

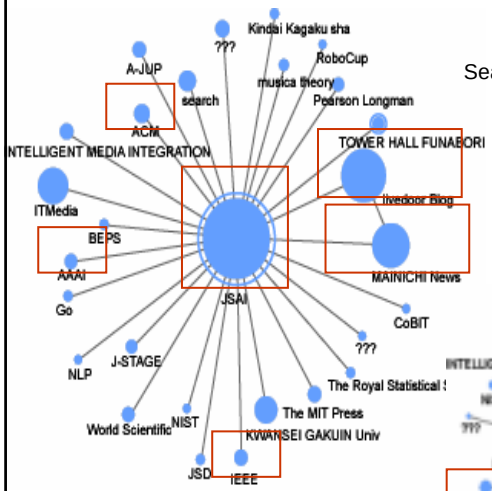
Experiment(2/2)

- Experiment Settings
  - Participants: 16
  - Browsing history data: 2 / participant
  - Web pages of history data: 5 / data
  - Web page set:
    - Expanding the outbound and inbound links from the Web history pages by 4 steps
    - Selecting 3 links to expand each step
  - Topic Maps: 4(2data x 2methods)
  - Evaluation order: random

Result: Number of valid topics, associations



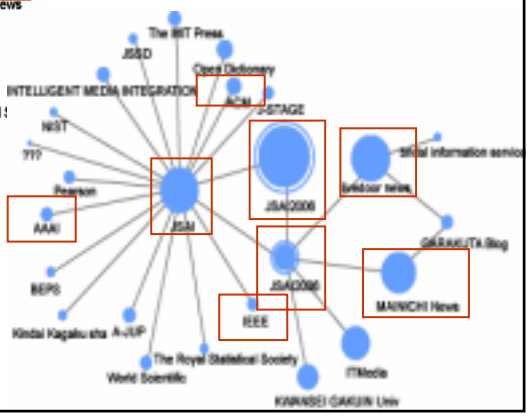
The proposed method can extract the prototypes of topic maps,
which have more valid topics and associations than by Newman's method

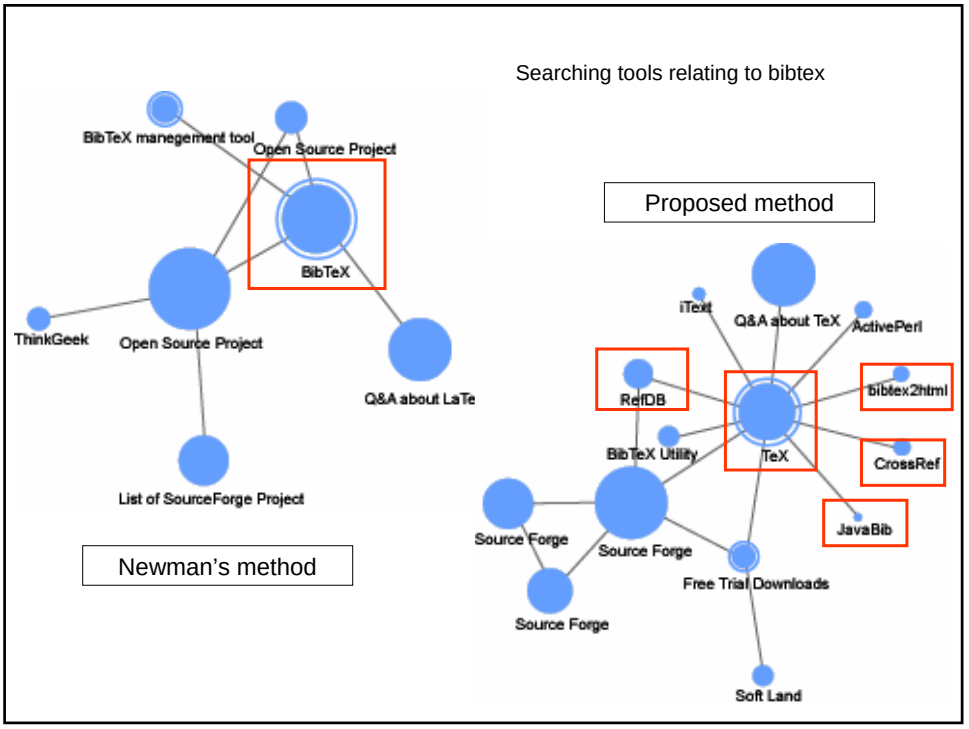


Newman's method

Searching the annual conference of JSAI in 2006

Proposed method





Discussion

- The proposed method can extract more topics and associations than Newman's method
- The proposed method is good for representing useful topics and associations

Conclusion

- We proposed the method to extract the prototypes of topic maps
- We conducted the experiment to evaluate the proposed method by comparison with Newman's method
- The result of experiment showed that the proposed method can extract the prototypes of the topic maps, which have enough valid topics and associations

Current Work

- Utilizing tags or categories of Web pages
  - Types of links and distance of directories
- News site
  - Directories according to date of article
    - http://plusd.itmedia.co.jp/pcuser/0710/31/news024.html
  - Use tags or categories as directories
    - ex. notepc
      - http://plusd.itmedia.co.jp/pcuser/notepc/news024.html

ITmedia / PCUSER

Defaults Grouping

- Desktop PC
- Note PC
- Mac
- Printer
- Peripheral Device
- PC Parts
- Software
- Akihabara
- Event
- Mother board