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A Scheme of Automated Object and Facet Extraction for Faceted Search over XML Data

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Background

- XML has become a de facto standard data format for semi-structured data
- Searching over XML data requires knowledge of either or both of
  - structure (or schema) of the XML data
  - query languages of XML data (e.g., XPath or XQuery)
  - processors of XML data to search (e.g., SAX or DOM)
- Futhermore, users are expected to have concrete search demands
  - otherwise the users may not explore the XML data to find desired subtrees, since the users are not capable to express their vague demands.

Research Objective

We develop a system, which assists users to navigate the XML data.

Direction

- Applying faceted search for XML data
  - Faceted search is one of the successful exploratory search methods.
  - By using faceted search, a user can search objects by clicking interesting attributes (called facets) shown on the interface.
- Proposed approach
  - We develop a framework for faceted search over XML data
    - extracts object candidates, and facet candidates
    - provides an interface for the system manager to select which candidates to be objects and facets.
    - generates the faceted search interface for selected objects and facets

Faceted Search: Basic Data Structure

- Ordinal faceted search expects record structure
- Each record corresponds to an object and some attributes are regarded as facets (e.g., `author`, `year`, and `publisher`)

title	author	year	publisher
XML Search	John A. Smith	2012	AAC publisher
XML: An introduction	John A. Smith	2010	CCD publisher
XML Data Management	Anna F. Doe	2012	CCD publisher
RDF Search	Anna F. Doe	2014	AAC publisher

Faceted Search: Search Paradigm

- A user selects a facet and its value. (e.g., year and “2012”)

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$$\Downarrow \sigma_{year=\text{“}2012''}(D)$$

title	author	year	publisher
XML Search	John A. Smith	2012	AAC publisher
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Problem Statement

- Problems on applying faceted search for XML data
  - For faceted search, we need to define object and facet beforehand.
    - Unlike record-structured data, XML data do not explicitly have neither objects nor facets of objects in the structure.
  - As well, we need operations to search over XML data via faceted search interface.

  ⇒ We proposed a framework[5]
- Problems this paper deals with
  - The framework is *semi-automatic* (detail will be in a next few slides) and a system manager is still required a burden to decide which XML elements to be objects, facets or none.

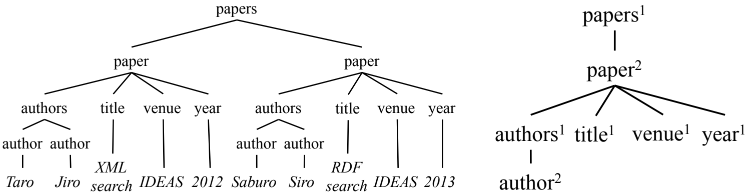
  ⇒ We, in this paper, want to reduce this burden by automating object extraction and facet extraction.

Faceted Search for XML Data

- Task
  - determine which XML subtrees used for results objects
  - determine which XML subtrees of objects for facets
- Framework overview
  1. extract structural information from XML data
  2. determine objects and facets on structural information
     - Candidate objects: XML elements which occur multiple times under single parental elements.
     - Candidate facets: XML elements which occur under object elements.
  3. (a system manager) determines objects and facets from the candidates
  4. (users) search the objects through defined operations on the interface (see [5] for detail)

Structural Information

- Structural information of XML data is a structural summary (or schema) of the XML data, which describes how the XML data is organized (e.g., DTD, XML Schema, and DataGuide).

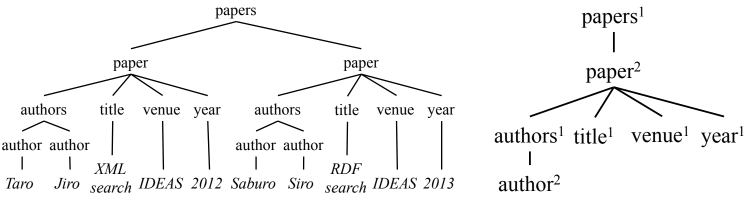


(a) XML data: paper list

(b) Structural information

- The number labels beside vertices in structural information denote the average frequency of the XML elements under their parental elements in the XML data.

An example



(a) XML data: paper list

(b) Structural information

object candidates	facet candidate
paper	authors, author, title, venue, year
author	

⇓ selected by a system manager

object	facets
paper	author, venue, year

Motivation

- Conventionally, objects and facets on faceted search over XML data have been determined manually.
- Our framework enables to reduce the effort, by picking up possible objects and facets from XML data, but the process is still semi-automatic.
- So, determining objects and facets still requires large effort.
- Automation of extracting objects and facets is desirable.

Objective

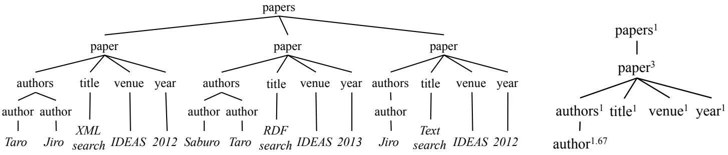
Automate object and facet extraction process.

Basic Ideas

- Our automation scheme is based on the following observations:
  - XML elements consistently occurring frequently under their parental elements tend to be result objects.
  - XML elements with `id-like` textual contents tend not to be facets.
    - id-like: unique value on each object
  - XML elements whose names are not meaningful (e.g., `ee` or `sub`) should be avoided to be facets.
- Ideas
  - filtering out candidates by frequency threshold.
  - filtering out unrecognizable candidates by external resources.
    - e.g., Wikipedia and WordNet.

Proposed Approach -Frequency-based Object Extraction-

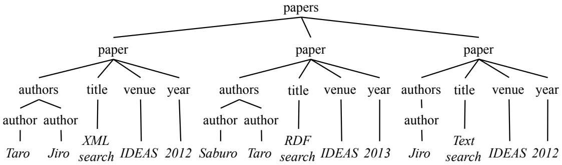
- Extract an XML element as an object, when the average occurrence of the XML element under its parental element is greater than the given threshold.
- Example: threshold = 1.7



- paper is extracted as object.

Proposed Approach -Frequency-based Facet Extraction-

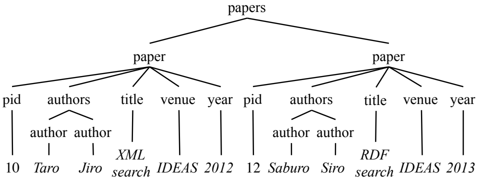
- Given an object, extract an descendant XML element as a facet, when the average number of occurrence of textual values (afv for short) is greater than the given threshold.
- Example: threshold = 1.2, object = paper
    - afv(author) = 1.67, afv(title) = 1, afv(year) = 1.5, . . .



- author, venue and year are extracted as facets of paper object.

Proposed Approach -Semantic-based Facet Extraction-

- Given an object, extract an descendant XML element as a facet, when the maximum semantic similarity between the name of the element and any term in semantic information (e.g., Wikipedia entries) is greater than the given threshold.
    - Example of semantic similarity: inverse of distance in WordNet graph
- Example: threshold $= 0.8$, I is semantic information, object $=$ paper
    - $sem\_sim(author, I) = 1$, $sem\_sim(pid, I) = 0.2$, $\ldots$



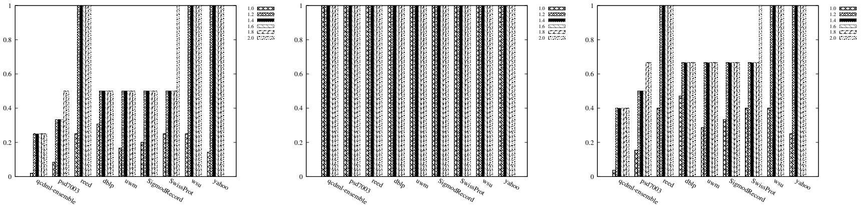
- author, authors, author, title, venue and year are extracted as facets of paper object.

Experimental Settings

- Purpose: check how accurately extracting objects and facets
  - observe the effect of thresholds
  - comparison of proposed approaches
- Dataset: XML data available on UW XML Repository, and QCDml
  - in UW XML Repository: Protein Sequence Database, SwissProt, Yahoo! Auction data, DBLP, University Courses (including reed, uwm, wsu), and SIGMOD Record
- Measurement: precision, recall, and f-score
  - ground-truth data are manually provided
- Methodology
  - extract objects and facets using the proposed approaches
  - calculate accuracy of the extracted objects and facets

Frequency-based Object Extraction

- Extracting objects by changing frequency threshold.

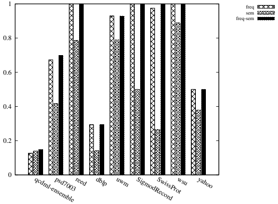


(a) Precision (b) Recall (c) F-Score

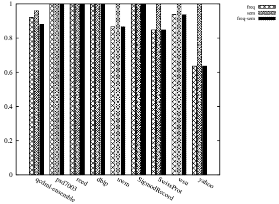
- All of results on recall marks 1, thus necessary objects are extracted.
- When increase the threshold, the precision increases and thus the f-score increases as well.

Facet Extraction

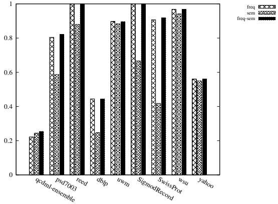
- Compares the proposed approaches, frequency-based, semantic-based, and hybrid of them.
- The frequency threshold: 1.2, and the semantic similarity: 0.8.



(a) Precision



(b) Recall



(c) F-Score

- Frequency-based extracts nicely in most cases.
- Semantic-based extracts too many facets.
- Semantic-based increases the accuracy of Frequency-based.

Conclusion

- Proposed
  - An automated object and facet extraction scheme on the framework [5] of faceted search for XML data
- Future work
  - Improve the automatic extraction.
  - Extraction of textual facets from textual contents in facets.
    - Identify facets for textual facets.