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Frequent-Pattern based Facet Extraction from Graph Data

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Graph data

- General model to be able to represent real world information
  - e.g., social networks, chemical compounds
- Consist of vertex set and edge set
  - e.g., a user is a vertex and an edge is relationship between users in social networks
- Two classes of graph data: a single large graph and a set of multiple small graphs

Graph Data Search

- Find subgraphs matching with given query
  - e.g., user search on social networks, search for a bunch of co-authors in co-author network
- Querying
  - Pattern query (e.g., SPARQL →)
    - input: a desired pattern with variables
    - output: values of the variables
  - Keyword query
    - input: a set of keywords
    - results: subgraphs containing all keywords

```
select ?x ?y
where{
      ?a foaf:knows ?b.
      ?a foaf:name ?x.
      ?b foaf:name ?y.
}
```

Motivation

- Problems
  - Pattern query: users are expected to know
    - query languages of pattern query, and
    - structure of graph data.
  - Keyword query: getting appropriate result subgraphs is still difficult

➔ Supports to graph data search

Basic Idea

- Applying faceted search for graph data search over a single graph
  - need to extract objects (target subgraphs) and facets (attributes of objects)
- Extracting meaningful subgraphs as objects
  - e.g., frequent subgraphs

Related work

- [1] applies faceted search to construct SPARQL queries by selecting predicate and subject.
- [2] gives graphical interface to construct chemical compound pattern queries.
  - the dataset consists of a set of graphs

[1] E. Oren, R. Delbru, and S. Decker, “Extending Faceted Navigation for RDF Data,” in Proc. International Semantic Web Conference, 2006, pp.559–572.
[2] C. Jin, S. S. Bhowmick, X. Xiao, J. Cheng, and B. Choi, “GBLENDER: Towards Blending Visual Query Formulation and Query Processing in Graph Databases,” in Proc. SIGMOD Conference, 2010, pp. 111–122.

Faceted Search

- One of the exploratory searches
- Search process
  1. (system) shows current results, associated facets and values of the facets.
  2. (user) selects one of the values of the facets.
  3. continue.
- Real applications
  - DBLP, eBay, Amazon, etc.

Faceted Search: an example

Facet

Make	Count
Honda	3
Toyota	2
Suzuki	2

Year	Count
2009	3
2010	1
2011	2

Color	Count
Red	3
Blue	3
Black	1

Car database

Make	Year	Color
Honda	2011	Red
Honda	2009	Blue
Honda	2009	Black
Toyota	2010	Blue
Toyota	2009	Red
Suzuki	2011	Red
Suzuki	2010	Blue

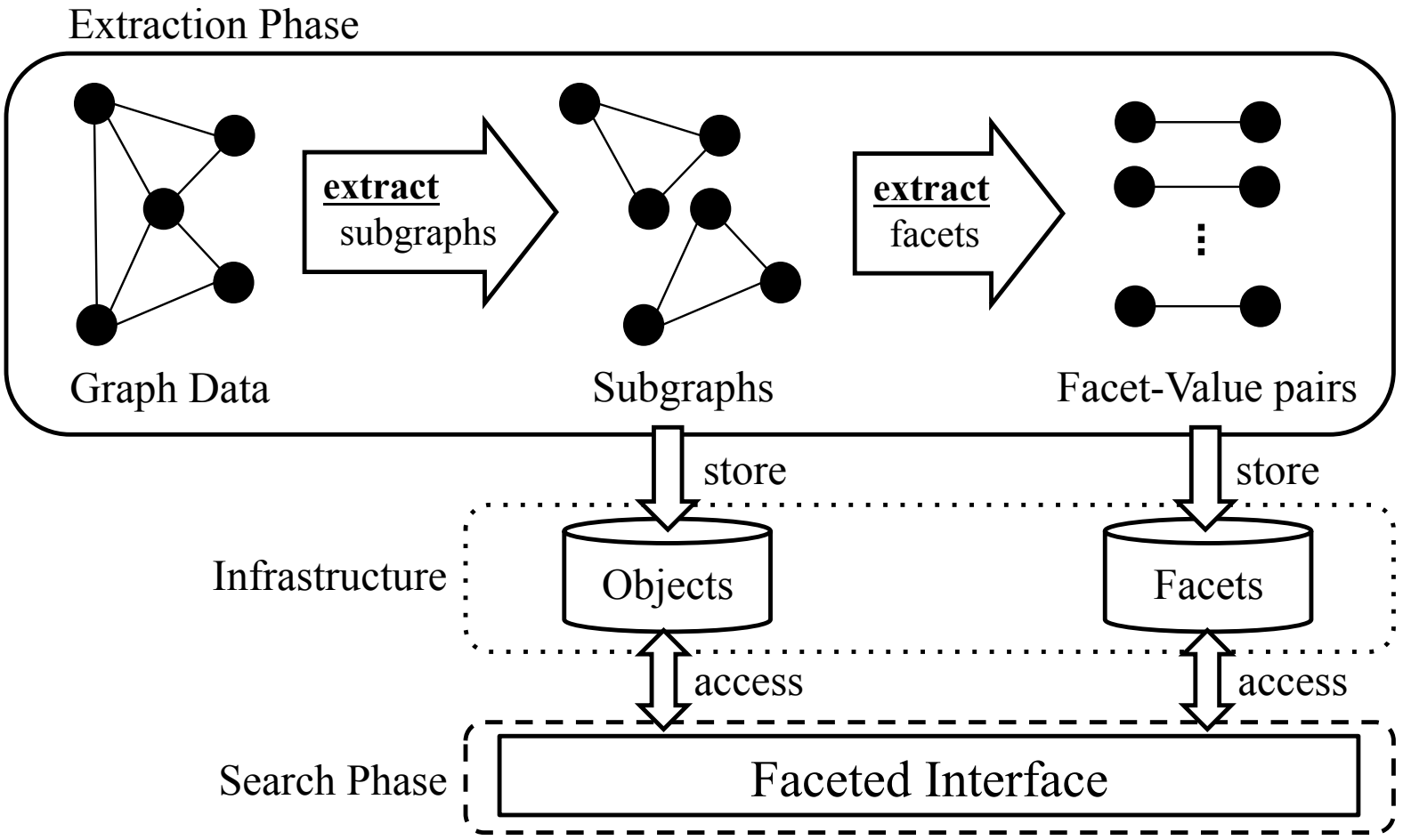
Frequent Subgraph Mining

- A technique extracting frequently occurring subgraphs in graph data
- A subgraph in a frequent subgraph is also frequent subgraphs

  ➔ extract maximal frequent subgraphs
- Existing work [3, 4, 5]

[3] L. B. Holder, D. J. Cook, and S. Djoko, “Substucture Discovery in the SUBDUE System,” in Proc. KDD Workshop, 1994, pp. 169–180.
[4] S. Ghazizadeh and S. S. Chawathe, “SEuS: Structure Extraction Using Summaries,” in Proc. Discovery Science, 2002, pp. 71–85.
[5] F. Zhu, Q. Qu, D. Lo, X. Yan, J. Han, and P. S. Yu, “Mining Top-K Large Structural Patterns in a Massive Network,” PVLDB, vol. 4, no. 11, pp. 807–818, 2011.

Proposed Framework



Infrastructure

- Relational database to store object and facet information

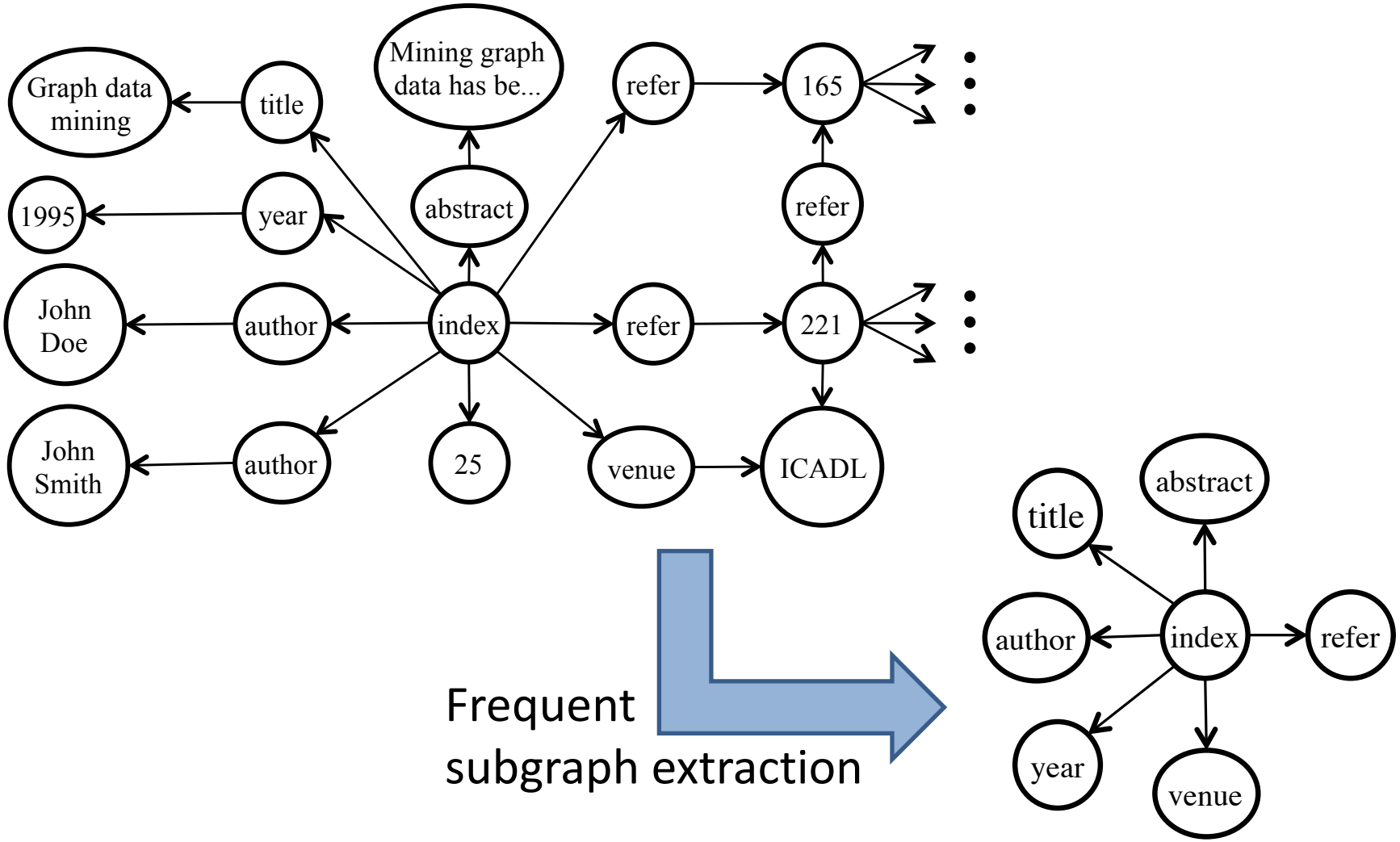
object(object_id, object_instance)

facet_name(value, object_id)

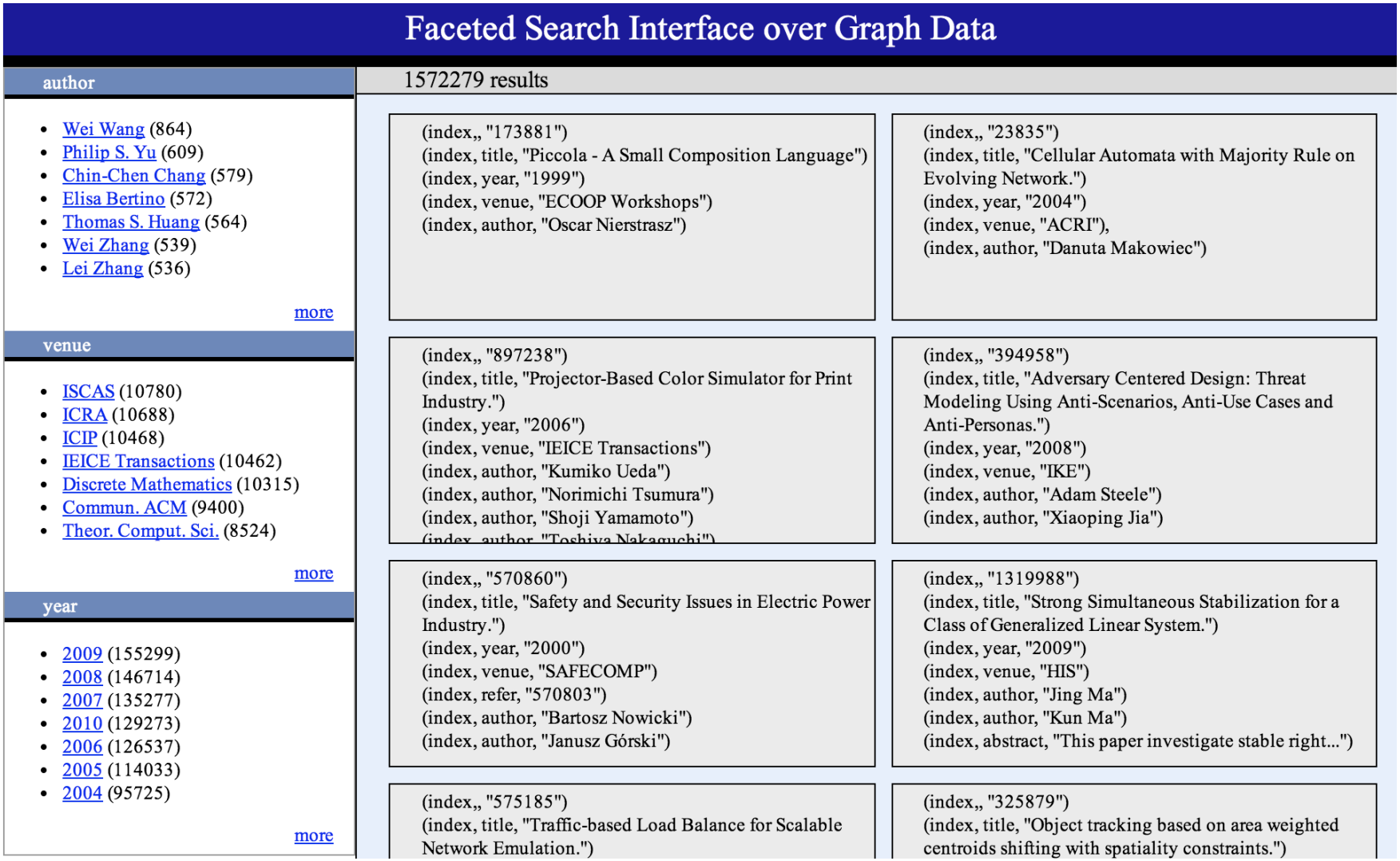
- With this info., subjects are searchable by SQL language.

```
SELECT   object.object_instance
  FROM   object_instance, year
 WHERE   year.value = '2014'
         and year.object_id = object.object_id
```

Case study: citation network



Case study: citation network (cont.)



Conclusion and Future works

- Conclusion
  - Faceted search framework for graph data
    - Objects are extracted using frequent subgraph mining approach.
  - Case studies on simpler data
    - citation network and review network
- Future work
  - enabling faceted search for more complex graph data, e.g., multiple connectable objects
  - interface design

THANK YOU FOR YOUR ATTENTION