XML Publishing

CPS 296.1

Topics in Database Systems

XML publishing

- Legacy data: normalized and stored in many flat relations; managed by relational DBMS

Department

DeptId	DeptName
10	Purchasing

Project

ProjId	DeptId	ProjName
888	10	Internet
795	10	Recycling

Employee

EmpId	DeptId	EmpName	Salary
101	10	John	50K
91	10	Mary	70K

- XML data: un-normalized, nested; wanted by next-generation applications

```
<department name="Purchasing">
    <emplist><employee> John </employee>
             <employee> Mary </employee>
    </emplist>
    <projlist><project> Internet </project>
              <project> Recycling </project>
    </projlist>
</department>
```


Roadmap

- IBM's XPERANTO project
  - ➢ Shanmugasundaram et al. "Efficiently Publishing Relational Data as XML Documents." *VLDB*, 2000
- AT&T's SilkRoute project
  - ➢ Fernandez et al. "Efficient Evaluation of XML Middleware Queries." *SIGMOD*, 2001

Issues in publishing XML

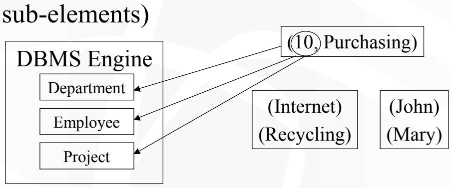
- Structuring and tagging
  - – Flat relations → nested XML elements
  - – Relational schema → XML tags
- Processing inside versus outside relational engine

➢ Space of alternatives (Shanmugasundaram et al.)

	Early Tagging	Late Tagging
Early Structuring	Outside Engine / Inside Engine	Outside Engine / Inside Engine
Late Structuring		Outside Engine / Inside Engine

Stored procedure approach

- Early tagging, early structuring; outside engine
- Application and/or stored procedure explicitly issue queries for each element (and recursively for sub-elements)



- Problem: many small queries

Correlated CLOB approach (slide 1)

- Early tagging, early structuring; inside engine
- Use user-defined functions for tagging
  - – "XML" is a special type like CLOB

```
define XML Constructor DEPT(dname:VARCHAR(20),
                            emplist:XML,
                            projlist:XML) as
( <department name={dname}>
     <emplist> {emplist} </emplist>
     <projlist> {projlist} </projlist>
  </department>)
```

Correlated CLOB approach (slide 2)

- Use user-defined aggregate XMLAGG to concatenate XML fragments into one
- Use correlated subqueries for structuring

```
select DEPT(d.name,
             (select XMLAGG(EMP(e.name))
              from   Employee e where e.deptno = d.deptno),
             (select XMLAGG(PROJ(p.name))
              from   Project p where p.deptno = d.deptno)
            )
 from   Department d
```

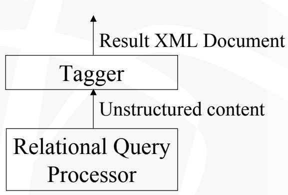
- Problems
  - Correlated execution of sub-queries → nested loop
  - Repeated creation and copying of big CLOB's

De-correlated CLOB approach

- Early tagging, early structuring; inside engine
- Relational engine may be smart enough to convert correlated subqueries into joins
- Example
  - Compute employee lists associated with all departments
  - Compute project lists associated with all departments
  - Join results on department id
- Still a problem: creation and copying of CLOB's

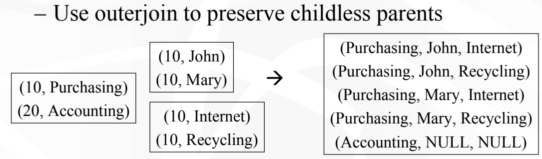
Late tagging, late structuring

- Contents for XML produced without structure (in arbitrary order)
- Tagger enforces order and inserts tags



Redundant relation approach

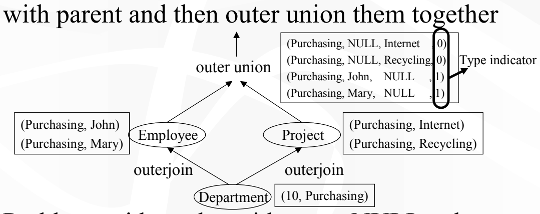
- Late tagging, late structuring; either inside or outside engine
- Join all source relations together
  - Use outerjoin to preserve childless parents



- Problem: large relational output because of redundancy

Unsorted outer union approach

- Late tagging, late structuring; either inside or outside engine
- Do not join siblings; outerjoin them separately with parent and then outer union them together



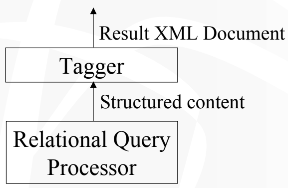
- Problem: wide tuples with many NULL columns

Hash-based tagger

- For late tagging, late structuring
- Use a hash table to group tuples returned by the relational query
  - Example
    - Returned tuple: (Purchasing, NULL, Internet, 0)
    - Hash on "Purchasing" to locate the parent element
    - If not found, create a parent element
    - Group the tuple under the parent
- After all tuples are hashed, go through the hash table to generate XML
- Problem: require memory to be large enough to hold the entire output document

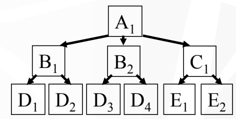
Late tagging, early structuring

- Contents for XML produced with structure (in sorted order; already grouped)
- Tagger just inserts tags (constant space)



Sorted outer union approach

- Late tagging, early structuring; tagging either inside or outside engine
- Same outerjoin/outer union query as the unsorted outer union approach, with the additional ORDER BY clause to sort/group output tuples
  - Example: ORDER BY Aid, Bid, Cid, Did, Eid



A	B	C	D	E
A_1	B_1	NULL	D_1	NULL
A_1	B_1	NULL	D_2	NULL
A_1	B_2	NULL	D_3	NULL
A_1	B_2	NULL	D_4	NULL
A_1	NULL	C_1	NULL	E_1
A_1	NULL	C_1	NULL	E_2

Conclusion from experiments

- Inside engine is much faster than outside engine
  - Cost of binding out tuples to host variables is high
- Given sufficient main memory, unsorted outer union with hash-based tagger is the best
- With limited memory, sorted outer union with constant-space tagger is the best

Sorted outer union revisited

- One large SQL query, consisting of left outerjoins combined using outer unions followed by sorting
  - Example (in SilkRoute's RXL synatx)

```
from Supplier $s
construct <supplier>
            <name>$s.name</name>
            { from  Nation $n
              where $s.nationkey = $n.nationkey
              construct <nation>$n.name</nation> }
            { from PartSupp $ps, Part $p
              where $ps.suppkey = $ps.suppkey and $ps.partkey = $p.partkey
              construct <part><name>$p.name</name></part> }
          </supplier>
```

→

```
SORT
((Supplier LEFT OUTERJOIN Nation)
 OUTER UNION
(Supplier LEFT OUTERJOIN PartSupp, Part))
```

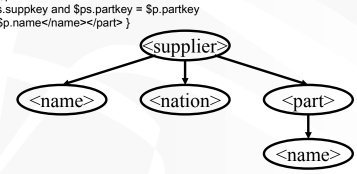
  - Can relational DBMS really handle them efficiently?
  - Do wide tuples with many NULL's affect performance?
  - How about letting middleware do some processing? (Fernandez et al.)

Other alternatives

- Multiple SQL queries, each sorted for efficient merging
- Middleware merge-outerjoins sorted results; still constant space requirement
  - Example: fully partitioned
    - SORT(Supplier)
    - SORT(Supplier JOIN Nation)
    - SORT(Supplier JOIN PartSupp, Part)
  - Example: partially partitioned
    - SORT(Supplier LEFT OUTERJOIN Nation)
    - SORT(Supplier LEFT OUTERJOIN PartSupp, Part)
- Questions
  - How to enumerate alternatives?
  - How to pick the best alternative?

View tree

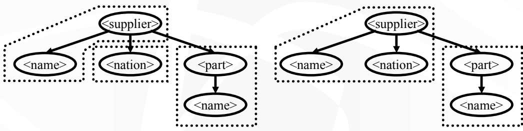
```
from Supplier $s
construct <supplier>
            <name>$s.name</name>
            { from  Nation $n
              where $s.nationkey = $n.nationkey
              construct <nation>$n.name</nation> }
            { from PartSupp $ps, Part $p
              where $ps.suppkey = $ps.suppkey and $ps.partkey = $p.partkey
              construct <part><name>$p.name</name></part> }
          </supplier>
```



- Captures nesting of output XML elements

Plan enumeration using view tree

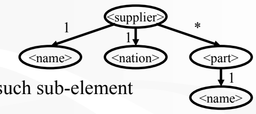
- Each alternative plan corresponds to a partitioning of the view tree into smaller trees
  - Each edge can be either broken or unbroken in a partitioning
  - Number of alternative plans = 2^E where E is the number of edges in the view tree



SORT(Supplier)
SORT(Supplier LEFT OUTERJOIN Nation)
SORT(Supplier LEFT OUTERJOIN PartSupp, Part)

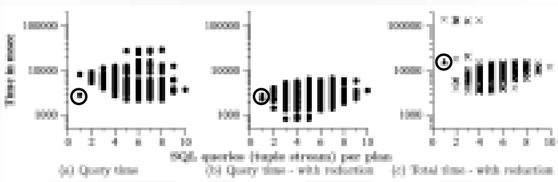
SORT(Supplier LEFT OUTERJOIN Nation)
SORT(Supplier LEFT OUTERJOIN PartSupp, Part)

View tree reduction



- Edges are labeled by 1, ?, or *
  - 1: Parent has one and only one such sub-element (e.g., <supplier> – <nation>)
  - ?: Parent has zero or one such sub-element
  - *: Parent has zero or more such sub-elements
  - ➢ Requires the knowledge of database constraints (e.g., Supplier.nationkey references Nation.nationkey)
- Heuristic: after partitioning, nodes connected by 1 edges can be merged together (e.g., <supplier> and <nation>)
  - Use JOIN instead of OUTERJOIN

Experiments with the plan space



- Alternatives do matter
- View tree reduction heuristics do help
- Sorted outer union (i.e., no partitioning) is significantly slower than the optimal plan (with partitioning)

➢ Need a cost-based optimizer to pick the best partitioning

Cost formula

- cost(q) = a × evaluation_cost(q) + b × data_size(q)
- data_size(q) = | attrs(q) | × cardinality(q)

➢ Assume estimates of evaluation_cost and cardinality can be obtained from the relational DBMS optimizer

➢ a and b are parameters that depend on the middleware/database environment
  - May require some benchmarking/tuning to find out

Greedy algorithm for plan generation

- Threshold parameters t_1 and t_2
  - But who determines these parameters?
- For each edge, compute the cost of merging two partitions connected by this edge: cost($q_{combined}$) – (cost(q_1) + cost(q_2))
  - < 0 means beneficial
  - If < t_1 (e.g., –60000), mark the edge as mandatory
  - If < t_2 (e.g., 600), mark the edge as optional

➢ Size of search space is reduced from $2^{(\text{\# of edges})}$ to $2^{(\text{\# of optional edges})}$

- Experiments show that the greedy algorithm is able to pick near-optimal plans

More pointers

- Fernandez et al. “SilkRoute: Trading Between Relations and XML.” *WWW*, 1999
- Shanmugasundaram et al. “Querying XML Views of Relational Data.” *VLDB*, 2001