End-Semester Logistics & Review

CPS 216

Advanced Database Systems

Announcements (April 23)

- ❖ Homework #4 will be graded by Saturday
  - Sample solution available today
- ❖ Verify the accuracy of your scores in Blackboard and let me know of any problem before the final
  - Homework assignments, midterm, reviews, presentation

Announcements (cont'd)

- ❖ Final exam next Monday (April 26)
  - 2-5pm, in this room (D243 LSRC)
  - Comprehensive (everything up to today's lecture, with emphasis on the second half of the course, and materials exercised in homework assignments)
  - Open book, open notes; no time pressure
  - Sample final and solution available today (note the difference materials covered in last year's CPS216)
- ❖ Project demos Tues./Wed. after the final
  - Email confirmation of schedule will be sent later today
  - Remember that report is due before the demo

Pre-midterm: basics

- ❖ Relational model/algebra → physical data independence
  - Really made query optimization flourish
- ❖ SQL: `NULL` and three-value logic, bag versus set semantics, subqueries, grouping and aggregation → nifty features, mess for optimizers
  - Recall query rewrite tricks for preserving duplicate, avoiding the count bug, and magic decorrelation
  - Use query rewrite to get back to the simplicity of relational algebra

Pre-midterm: basics (cont'd)

- ❖ More SQL
  - Views → logical data independence
    - Materialized views → reintroduce redundancy to improve performance
    - ☞Did not cover lots of interesting work on selecting views to materialize, rewriting and optimizing queries using materialized views, and maintaining materialized views
  - Constraints → the more you know the better you can do
    - Did not cover semantic query optimization
  - Triggers (ECA) → "active" data
    - Did not cover scalable trigger processing (related to multi-query processing for continuous queries)

Pre-midterm: physical data organization

- ❖ Storage hierarchy (DC vs. Pluto)
  - → Count I/O's
  - → Get as much useful info as possible with each long trip
  - → Do other things while waiting
- ❖ Disk performance → sequential beats random
- ❖ Data layout
  - Record layout (handling variable-length fields, `NULL`'s)
  - Block layout (NSM, DSM, PAX)
    - → Inter-/intra-record locality

Pre-midterm: physical data organization (cont'd)

- Access paths
  - Primary versus secondary indexes
  - Tree-based indexes: ISAM, B$^+$, B, R, R*, R$^+$, GiST
  - Hash-based indexes: extensible, linear
  - Text indexes: inverted lists, signature files (and bit-sliced ones), suffix array, trie, suffix tree, Patricia trie, Pat tree
  - Variant indexes: value-list/bitmap, projection, bit-sliced indexes, join indexes
  - → Reintroduce redundancy to improve performance
  - → Fundamental trade-off: query versus update cost

Pre-midterm: query processing

- Scan-based algorithms
- Sort- and hash-based algorithms (and their duality)
- Index-based algorithms

- Pipelined execution with iterators
  - Blocking and non-blocking operators
- Buffer management
  - Per-query, per-table policy is ideal
  - → The more you know the better you can do

Review: XML basics

- Data model: well-formed vs. valid (DTD ≈ schema)
- Query languages
  - XPath: (branching) path expressions (with conditions)
  - XQuery: FLWR, subqueries in return (restructuring), quantified expressions, aggregation, sorting
  - XSLT: structural recursion with templates
- Programming: SAX (one pass) vs. DOM (in memory)

Review: representing XML

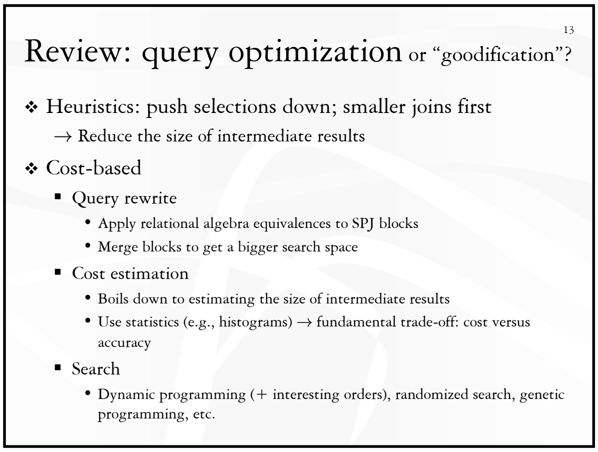
- Flat files and CLOB do not really exploit the structure of XML
- Schema-oblivious approaches
  - Node/edge representation
  - Interval-based representation (*left*, *right*, *level*)
  - Path-based representation (labeled path, Dewey order)
  - Sequence-based representation (ViST)
- Schema-aware approach
  - Inlining choice for +, *, and shared elements in DTD
  - Less flexible and harder to reformulate queries, but queries are more efficient → the more you know the better you can do

Review: processing XML

- Finite state machines (Niagra, YFilter)
- Node/edge representation
  - Naturally leads to navigational processing
  - Path expression steps → equality joins
    - Top-down, bottom-up, hybrid, … correspond to different join orders
- Interval-based representation
  - Naturally leads to structural join processing
  - Path expression steps → containment joins (great for anc/desc)
    - Join ordering? Less of an issue because it can be processed as a multi-way join on the same attribute
  - Stacks are your best friend; remember XML intervals don't overlap
- ☞ A mixed-mode approach may be best
- ☞ Everything comes down to joins!

Review: indexing XML

- Basic indexes: inverted lists for tag names, value indexes, back pointers to parents, etc.
- Index for interval-based representation
  - Example: XR-tree (B$^+$-tree augmented with stab lists at internal nodes) for finding ancestors
- Index for path-based representation
  - Example: IndexFabric (based on Patricia trie)
- Index for sequence-based representation
  - Example: ViST
    - Path expression → (non-contiguous) subsequence matching
    - Use a trie to store sequences, encoded using intervals to support skipping
- Structural summary indexes for graphs
  - Examples: DataGuide (DFA) and 1-index (NFA)
- ☞ Still plenty of room for improvement



Review: query optimization or “goodification”?

- ❖ Heuristics: push selections down; smaller joins first
  - → Reduce the size of intermediate results
- ❖ Cost-based
  - ▪ Query rewrite
    - Apply relational algebra equivalences to SPJ blocks
    - Merge blocks to get a bigger search space
  - ▪ Cost estimation
    - Boils down to estimating the size of intermediate results
    - Use statistics (e.g., histograms) → fundamental trade-off: cost versus accuracy
  - ▪ Search
    - Dynamic programming (+ interesting orders), randomized search, genetic programming, etc.