

Query Processing: A Systems View

CPS 216
Advanced Database Systems

Announcements

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- ❖ Reading assignment for this week
 - Chou and DeWitt. "An Evaluation of Buffer Management Strategies for Relational Database Systems." *VLDB* 1985 (in red book)
 - Leung et al. "Query Rewrite Optimization Rules in IBM DB2 Universal Database." (in red book)
- ❖ Homework #3 will be posted later tonight (March 24)
 - Due in 16 days (Wednesday, April 9)
- ❖ Recitation session this Friday (March 28)
 - Graded Homework #2 and common problems
 - Help on Homework #3

Physical (execution) plan

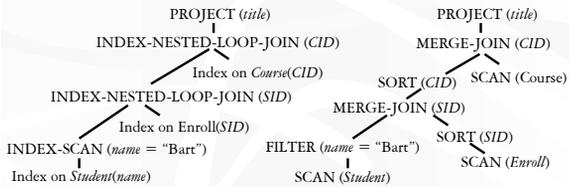
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- ❖ A complex query may involve multiple tables and various query processing algorithms
 - E.g., table scan, index nested-loop join, sort-merge join, hash-based duplicate elimination...
- ❖ A physical plan for a query tells the DBMS query processor how to execute the query
 - A tree of physical plan operators
 - Each operator implements a query processing algorithm
 - Each operator accepts a number of input tables/streams and produces a single output table/stream

Examples of physical plans

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```
SELECT Course.title
FROM Student, Enroll, Course
WHERE Student.name = 'Bart'
AND Student.SID = Enroll.SID AND Enroll.CID = Course.CID;
```



❖ Many physical plans for a single query

- Equivalent results, but different costs and assumptions!
- ☞ DBMS query optimizer picks the "best" possible physical plan

Physical plan execution

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❖ How are intermediate results passed from child operators to parent operators?

- Temporary files
 - Compute the tree bottom-up
 - Children write intermediate results to temporary files
 - Parents read temporary files
- Iterators
 - Do not materialize intermediate results
 - Children pipeline their results to parents

Iterator interface

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❖ Every physical operator maintains its own execution state and implements the following methods:

- `open()`: Initialize state and get ready for processing
- `getNext()`: Return the next tuple in the result (or a null pointer if there are no more tuples); adjust state to allow subsequent tuples to be obtained
- `close()`: Clean up

An iterator for table scan

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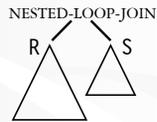
- ❖ `open()`
 - Allocate a block of memory
- ❖ `getNext()`
 - If no block of R has been read yet, read the first block from the disk and return the first tuple in the block (or the null pointer if R is empty)
 - If there is no more tuple left in the current block, read the next block of R from the disk and return the first tuple in the block (or the null pointer if there are no more blocks in R)
 - Otherwise, return the next tuple in the memory block
- ❖ `close()`
 - Deallocate the block of memory

An iterator for nested-loop join

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R: An iterator for the left subtree

S: An iterator for the right subtree



- ❖ `open()`

```
R.open(); S.open(); r = R.getNext();
```
- ❖ `getNext()`

```
do {
  s = S.getNext();
  if (s == null) {
    S.close(); S.open(); s = S.getNext(); if (s == null) return null;
    r = R.getNext(); if (r == null) return null;
  }
} until (r joins with s);
return rs;
```
- ❖ `close()`

```
R.close(); S.close();
```

An iterator for 2-pass merge sort

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- ❖ `open()`
 - Allocate a number of memory blocks for sorting
 - Call `open()` on child iterator
- ❖ `getNext()`
 - If called for the first time
 - Call `getNext()` on child to fill all blocks, sort the tuples, and output a run
 - Repeat until `getNext()` on child returns null
 - Read one block from each run into memory, and initialize pointers to point to the beginning tuple of each block
 - Return the smallest tuple and advance the corresponding pointer; if a block is exhausted bring in the next block in the same run
- ❖ `close()`
 - Call `close()` on child
 - Deallocate sorting memory and delete temporary runs

Blocking vs. non-blocking iterators

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- ❖ A blocking iterator must call `getNext()` exhaustively (or nearly exhaustively) on its children before returning its first output tuple
 - Examples:
- ❖ A non-blocking iterator expects to make only a few `getNext()` calls on its children before returning its first (or next) output tuple
 - Examples:

Execution of an iterator tree

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- ❖ Call `root.open()`
 - ❖ Call `root.getNext()` repeatedly until it returns null
 - ❖ Call `root.close()`
-
- ☞ Requests go down the tree
 - ☞ Intermediate result tuples go up the tree
 - ☞ No intermediate files are needed
 - But maybe useful if an iterator is opened many times
