SECTION 9

Query Optimization and Pig Latin

Today's Overview

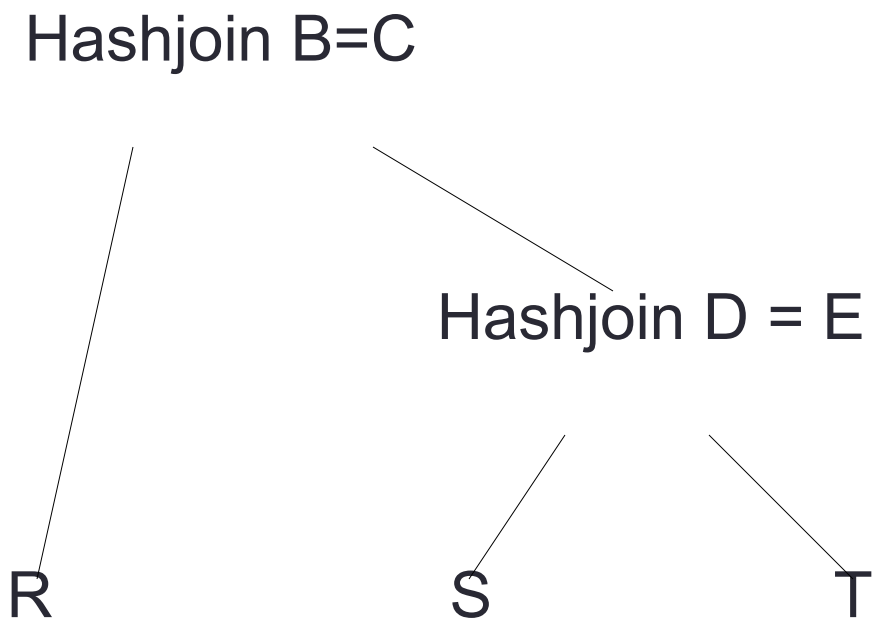
- Reminders
  - Project 4 due last day of class at 5pm
- Query Optimization
  - 2 examples from previous finals (you can also find these in the relational algebra/query plan worksheet from section 7)
- Pig Latin / Map Reduce
  - 1 example from previous final
- Project 4
- Quiz section evaluations (last ~20 minutes of class)

Warm-up

- Consider the query R(A,B) join S(C,D) join T(E,F)
  - the join condition is B=C and D=E and:
    - M = 100
    - B(R) = 30
    - B(S) = 200
    - B(T) = 60
    - B(R join S) = 80
    - B(S join T) = 50.
- Design an optimal query plan that uses only main-memory hash join algorithms. Your plan may store intermediate results to disk if necessary

Answer

Load R & T into memory and create hash tables of them. Then read blocks of S one at a time, performing the joins in the following graph.

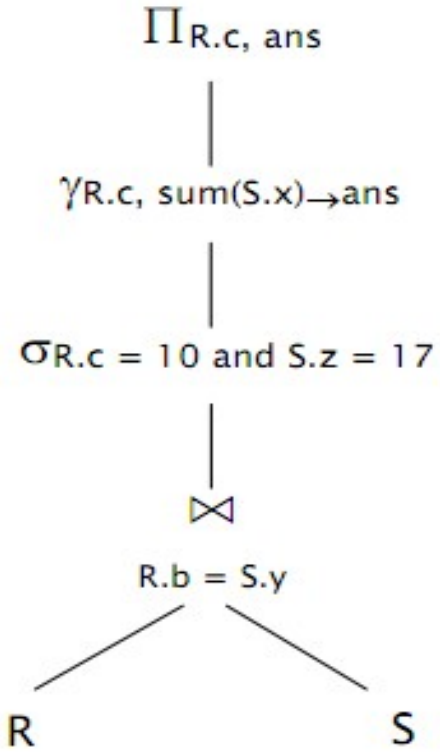


Summer 2009 Problem 2/3

- R(a,b,c) and S(x, y, z)

B(R) = 600	B(S) = 800
T(R) = 3000	T(S) = 4000
V(R, a) = 300	V(S, x) = 100
V(R, b) = 100	V(S, y) = 400
V(R, c) = 50	V(S, z) = 40

We also have M = 1000 (number of memory blocks).



*note this problem is also on the worksheet form section 7

Summer 2009 Problem 2/3

- Write a SQL query for the plan shown on the previous slide
- Optimize the query plan shown on the previous slide, and tell how much you expect the change to improve the performance
- Specify good physical plan for joining R and S on R.a = S.z. Give estimated cost of solution in terms of # of disk I/Os

Pig Latin: Final Summer 2010

```
raw = LOAD 's3n://uw-cse444-proj4/excite.log.bz2' USING
PigStorage('\t')  AS (user, time, query);

a = GROUP raw BY user;
b = FOREACH a GENERATE group AS user, COUNT(raw) AS
n_searches;
c = GROUP b ALL;
d = FOREACH c GENERATE AVG(b.n_searches),
MIN(b.n_searches), MAX(b.n_searches);

STORE d INTO '/user/hadoop/answer.txt' USING PigStorage();
```

Questions (a)

- What does this program compute and store into the final output file? Describe what the result is, not the details of how it is computed. (Hint: “GROUP b ALL” sends all tuples of bag/relation b to a single group.)

Answer (a)

- The output contains a single row:
  - avg min max
- where
  - avg = mean number of searches by one user
  - min = minimum number of searches by one user
  - max = maximum number of searches by one user

- The actual output when this was run against the excite.log.bz2 data was:
  - 4.705126673040153 1 452

Questions (b)

- In order to run this program, the Pig system translates it into a sequence of one or more Hadoop Map‐Reduce jobs.
- Describe the Map‐Reduce job(s) needed to execute this program. For each job describe the input and output of each map and reduce phase, including the keys and values at each step.
- You do not need to guess exactly how Pig would translate the program as long as your answer gives a reasonable implementation as a sequence of map‐reduce jobs.

Answer (b)

- This program generates two map‑reduce jobs.

- Job 1:
- **MAP**
- map 1 input: keys = tuple IDs, values = (user, time, query) tuples.
- map 1 output: key = user, value = • . The actual value doesn't matter, it could be the integer 1, a single character, or any other marker to record one search by that user.

  REDUCE
- reduce 1 input: key = user, value = [•], i.e., array of search markers.
- reduce 1 output: key = user, value = length of array, i.e., search count for that user.

Answer (b)

- Job 2:
- **MAP**
- map 2 input: key = user, value = search count for that user
- map 2 output: key = “x”, value = search count v. Here the key value doesn’t matter except that it needs to be the same for all map outputs.
- **REDUCE**
- reduce 2 input: key = “x” (same as map 2 output key), value = [v], i.e., array of all individual user search counts.
- reduce 2 output: average, min, and max of values in input array [v].

Pig-Latin References

- Massively Parallel Data Analysis with MapReduce
  - http://www.systems.ethz.ch/education/past-courses/hs08/map-reduce/sli
- Intro to Pig
  - http://www.cloudera.com/wp-content/uploads/2010/01/IntroToPig.pdf