Lecture 23:
Supplementary slides for Pig Latin

Friday, May 28, 2010

Outline

Based entirely on *Pig Latin: A not-so-foreign language for data processing*, by Olston, Reed, Srivastava, Kumar, and Tomkins, 2008

Quiz section tomorrow: in CSE 403 (this is CSE, don't go to EE1)

Why ?

- Map-reduce is a low-level programming envinroment
- In most applications need more complex queries
- Pig-latin accepts higher level queries, translates them to sequences of map-reduce

Pig-Latin Overview

- Data model = loosely typed *nested relations*
- Query model = a sql-like, dataflow language

- Execution model:
  - Option 1: run locally on your machine
  - Option 2: compile into sequence of map/reduce, run on a cluster supporting Hadoop

- Main idea: use Opt1 to debug, Opt2 to execute

Example

- Input: a table of urls:
  (url, category, pagerank)
- Compute the average pagerank of all sufficiently high pageranks, for each category
- Return the answers only for categories with sufficiently many such pages

First in SQL…

```
SELECT category, AVG(pagerank)
FROM urls
WHERE pagerank > 0.2
GROUP By category
HAVING COUNT(*) > 10^6
```

…then in Pig-Latin

```
good_urls = FILTER urls BY pagerank > 0.2
groups = GROUP good_urls BY category
big_groups = FILTER groups
                        BY COUNT(good_urls) > 10^6
output = FOREACH big_groups GENERATE
                        category, AVG(good_urls.pagerank)
```

Types in Pig-Latin

- Atomic: string or number, e.g. ‘Alice’ or 55
- Tuple: (‘Alice’, 55, ‘salesperson’)
- Bag: {(‘Alice’, 55, ‘salesperson’),
  (‘Betty’,44, ‘manager’), …}
- Maps: we will try not to use these

Types in Pig-Latin

Bags can be nested !

- {(‘a’, {1,4,3}), (‘c’,{ }), (‘d’, {2,2,5,3,2})}

Tuple components can be referenced by number

- $0, $1, $2, …

$$\texttt{t} = \left(\texttt{'alice'}, \left\{ \begin{array}{c} \texttt{('lakers', 1)} \\ \texttt{('iPod', 2)} \end{array} \right\}, \left[\texttt{'age'} \rightarrow 20\right]\right)$$

Let fields of tuple `t` be called `f1, f2, f3`

Expression Type	Example	Value for `t`
Constant	'bob'	Independent of `t`
Field by position	$0	'alice'
Field by name	f3	$\left[\texttt{'age'} \rightarrow 20\right]$
Projection	f2.$0	$\left\{ \begin{array}{c} \texttt{('lakers')} \\ \texttt{('iPod')} \end{array} \right\}$
Map Lookup	f3#'age'	20
Function Evaluation	SUM(f2.$1)	1 + 2 = 3
Conditional Expression	f3#'age'>18? 'adult':'minor'	'adult'
Flattening	FLATTEN(f2)	'lakers', 1 'iPod', 2

Loading data

- Input data = FILES !
  - Heard that before ?

- The LOAD command parses an input file into a bag of records
- Both parser (="deserializer") and output type are provided by user

Loading data

```
queries = LOAD 'query_log.txt'
                USING myLoad( )
                AS (userID, queryString, timeStamp)
```

Loading data

- USING userfuction( ) -- is optional
  - Default deserializer expects tab-delimited file
- AS type – is optional
  - Default is a record with unnamed fields; refer to them as \$0, \$1, …
- The return value of LOAD is just a handle to a bag
  - The actual reading is done in pull mode, or parallelized

FOREACH

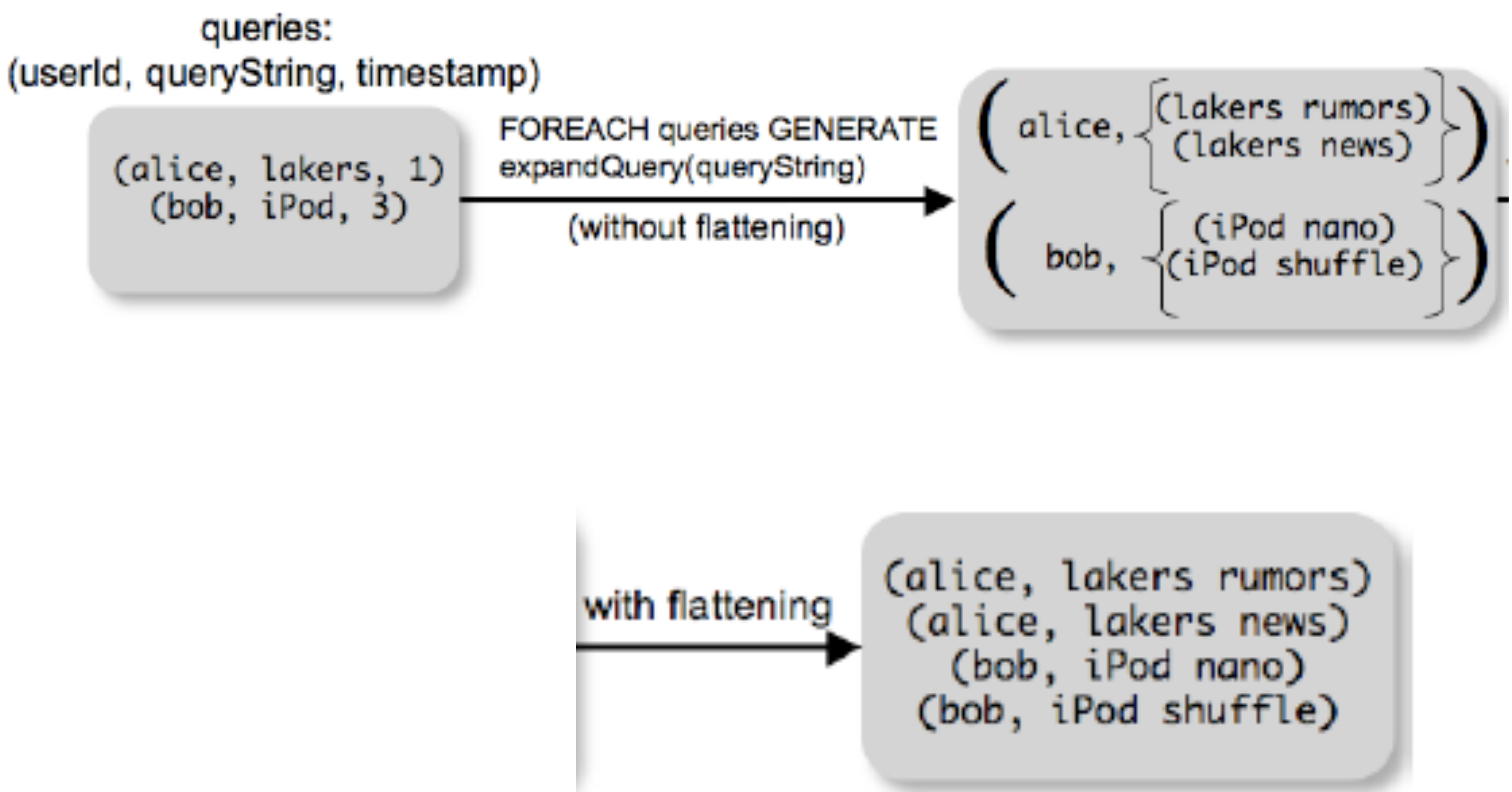
```
expanded_queries =
  FOREACH queries
  GENERATE userId, expandQuery(queryString)
```

expandQuery( ) is a UDF that produces likely expansions
Note: it returns a bag, hence expanded_queries is a nested bag

FOREACH

```
expanded_queries =
   FOREACH queries
   GENERATE userId,
                 flatten(expandQuery(queryString))
```

Now we get a flat collection


queries:
(userId, queryString, timestamp)
(alice, lakers, 1)
(bob, iPod, 3)
FOREACH queries GENERATE
expandQuery(queryString)
(without flattening)
alice,
(lakers rumors)
(lakers news)
bob,
(iPod nano)
(iPod shuffle)
with flattening
(alice, lakers rumors)
(alice, lakers news)
(bob, iPod nano)
(bob, iPod shuffle)

FLATTEN

Note that it is NOT a first class function !

(that's one thing I don't like about Pig-latin)

- First class FLATTEN:
  - FLATTEN({{2,3},{5},{},{4,5,6}}) = {2,3,5,4,5,6}
  - Type: {{T}} → {T}
- Pig-latin FLATTEN
  - FLATTEN({4,5,6}) = 4, 5, 6
  - Type: {T} → T, T, T, …, T ?????

FILTER

Remove all queries from Web bots:

```
real_queries =  FILTER queries BY userId neq ‘bot’
```

Better: use a complex UDF to detect Web bots:

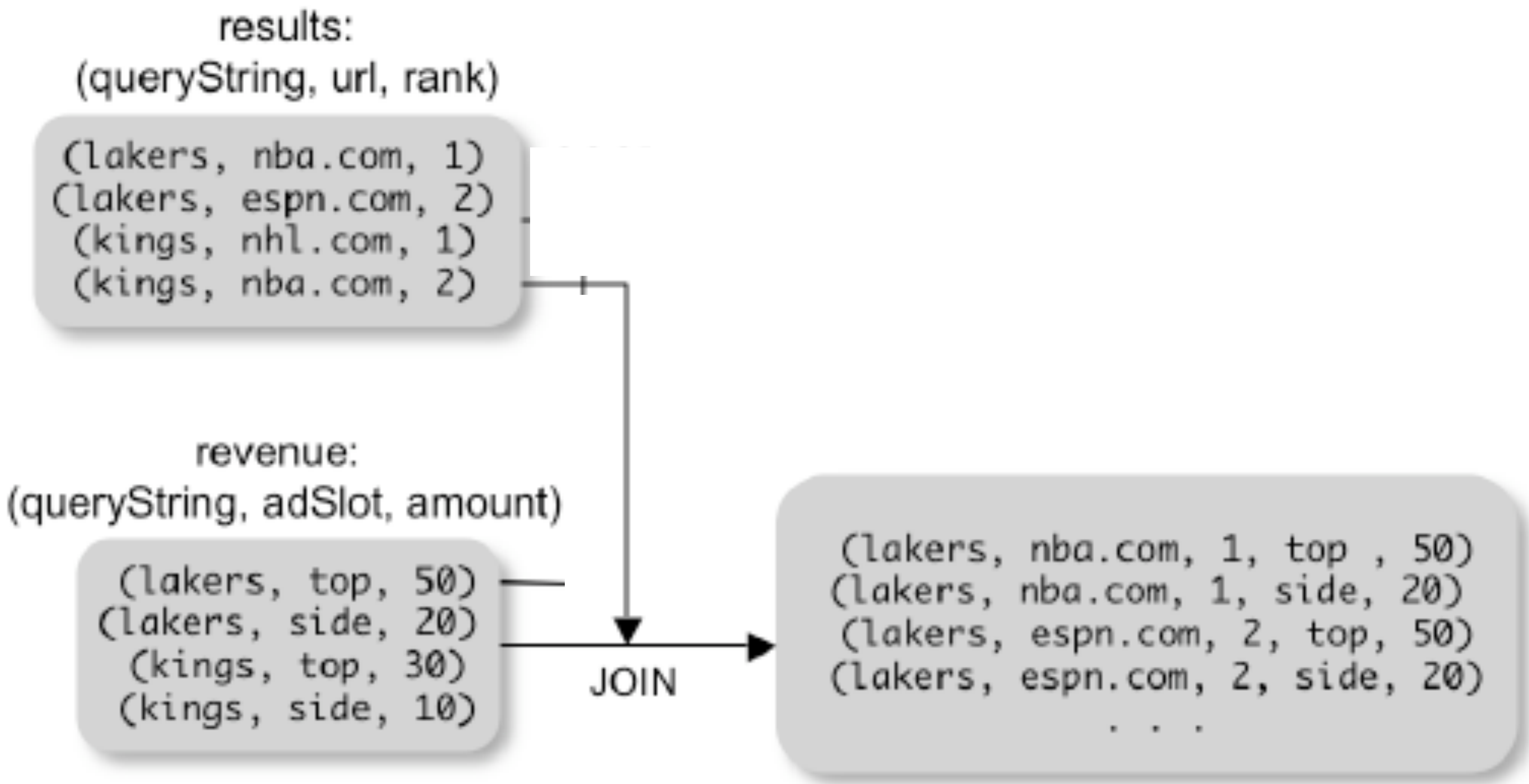
```
real_queries =  FILTER queries
                BY NOT isBot(userId)
```

JOIN

results: {(queryString, url, position)}
revenue: {(queryString, adSlot, amount)}

```
join_result = JOIN results BY queryString
                   revenue BY queryString
```

join_result : {(queryString, url, position, adSlot, amount)}


results:
(queryString, url, rank)
(lakers, nba.com, 1)
(lakers, espn.com, 2)
(kings, nhl.com, 1)
(kings, nba.com, 2)
revenue:
(queryString, adSlot, amount)
(lakers, top, 50)
(lakers, side, 20)
(kings, top, 30)
(kings, side, 10)
JOIN
(lakers, nba.com, 1, top , 50)
(lakers, nba.com, 1, side, 20)
(lakers, espn.com, 2, top, 50)
(lakers, espn.com, 2, side, 20)
. . .

GROUP BY

revenue: {(queryString, adSlot, amount)}

```
grouped_revenue = GROUP revenue BY queryString
query_revenues =
    FOREACH grouped_revenue
    GENERATE queryString,
             SUM(revenue.amount) AS totalRevenue
```

grouped_revenue: {(queryString, {(adSlot, amount)})}

query_revenues: {(queryString, totalRevenue)}

Simple Map-Reduce

input : {(field1, field2, field3, ...)}

```
map_result = FOREACH input
                  GENERATE FLATTEN(map(*))
key_groups = GROUP map_result BY $0
output = FOREACH key_groups
             GENERATE reduce($1)
```

map_result : {(a1, a2, a3, . . .)}
key_groups : {(a1, {(a2, a3, . . .)})}

Co-Group

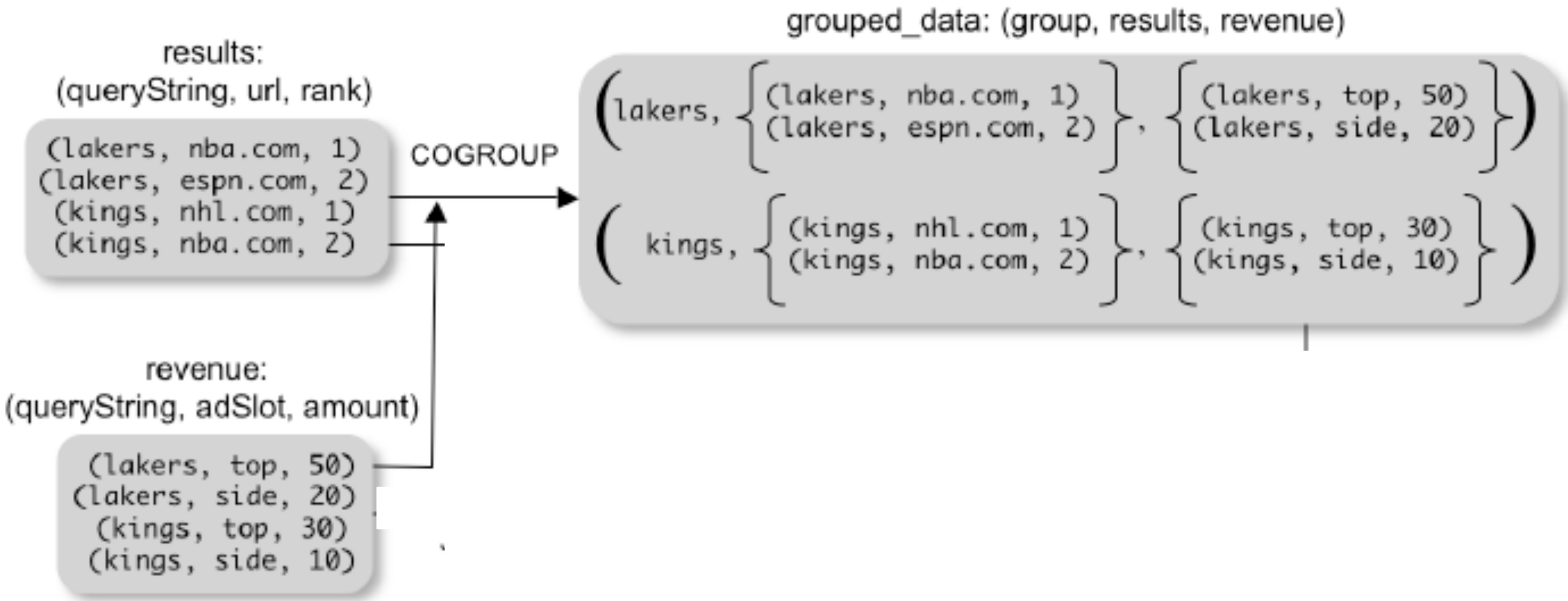
results: {(queryString, url, position)}
revenue: {(queryString, adSlot, amount)}

```
grouped_data =
      COGROUP results BY queryString,
                    revenue BY queryString;
```

grouped_data: {(queryString, results:{(url, position)},
revenue:{(adSlot, amount)})}

What is the output type in general ?

Co-Group



Is this an inner join, or an outer join ?

Co-Group

grouped_data: {(queryString, results:{(url, position)},
revenue:{(adSlot, amount)})}

```
url_revenues = FOREACH grouped_data
    GENERATE
        FLATTEN(distributeRevenue(results, revenue));
```

distributeRevenue is a UDF that accepts search re-
sults and revenue information for a query string at a time,
and outputs a bag of urls and the revenue attributed to them.

Co-Group v.s. Join

grouped_data: {(queryString, results:{(url, position)},
revenue:{(adSlot, amount)})}

```
grouped_data = COGROUP results BY queryString,
                       revenue BY queryString;
join_result = FOREACH grouped_data
              GENERATE FLATTEN(results),
                       FLATTEN(revenue);
```

Result is the same as JOIN

Asking for Output: STORE

```
STORE query_revenues INTO `myoutput'
        USING myStore();
```

Meaning: write query_revenues to the file ‘myoutput’

Implementation

- Over Hadoop !
- Parse query:
  – Everything between LOAD and STORE → one logical plan
- Logical plan → sequence of Map/Reduce ops
- All statements between two (CO)GROUPs → one Map/Reduce op

Implementation