Introduction to Database Systems
CSE 444

Lecture 22: Pig Latin

Outline

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

Why Pig Latin?

- Map-reduce is a low-level programming environment
- In most applications need more complex queries
- Pig accepts higher level queries written in Pig Latin, translates them into ensembles of MapReduce jobs
  - Pig is the system
  - Pig Latin is the language

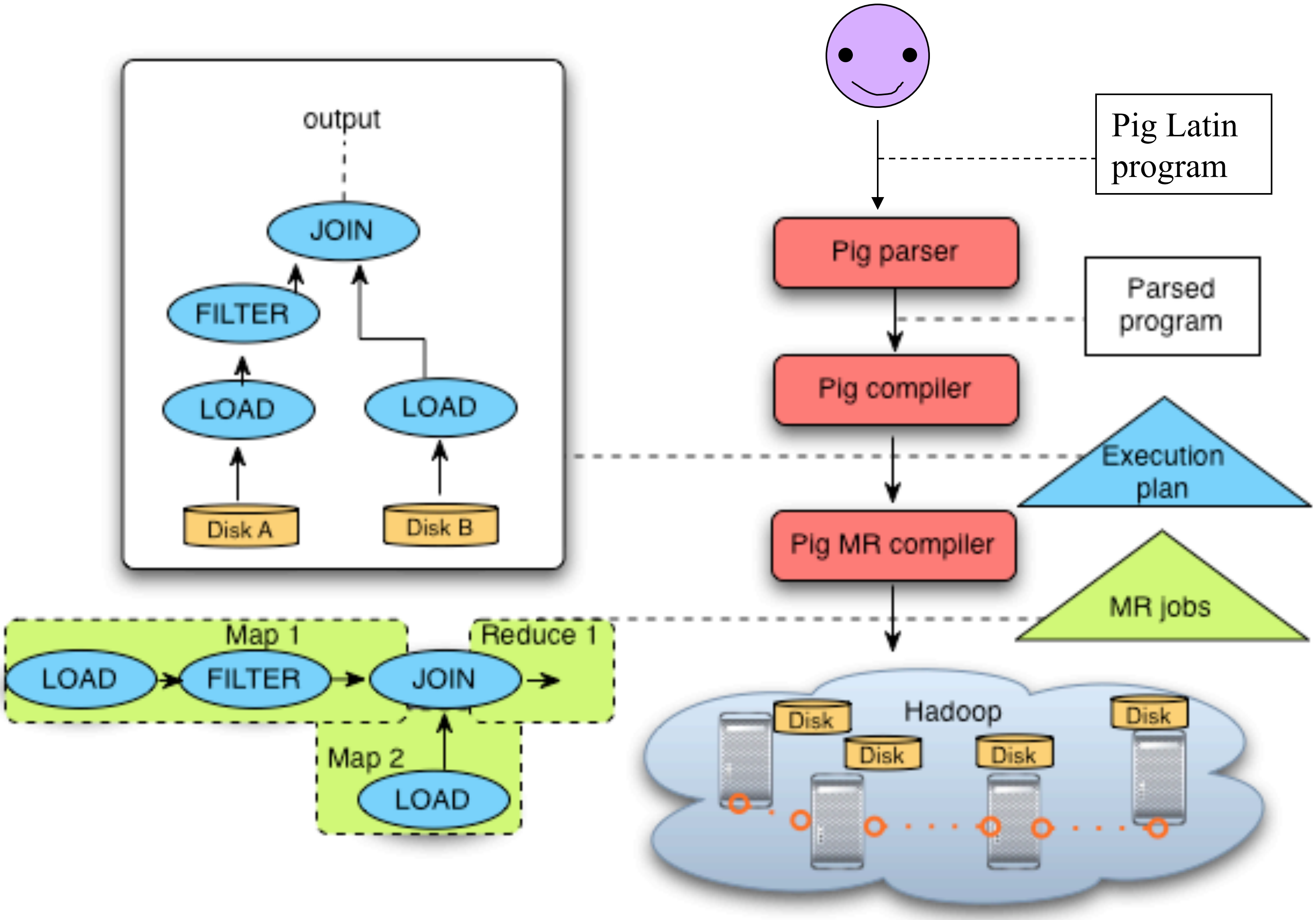
Pig Engine Overview

- 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

Pig Engine Overview



Pig-latin will NOT be on the Final

- Pig-latin is a new, experimental language
  - (imperfect design, in my opinion)

- Why do we discuss this in class ?
  - Because we want to learn massively parallel queries → Project4
  - And because MapReduce is too difficult to use
  - And because no other free language is available

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)
```

Pig Latin combines

- high-level declarative querying in the spirit of SQL, and
- low-level, procedural programming a la map-reduce.

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, …

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

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`	$\left[\texttt{‘age’} \rightarrow \texttt{20} \right]$
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

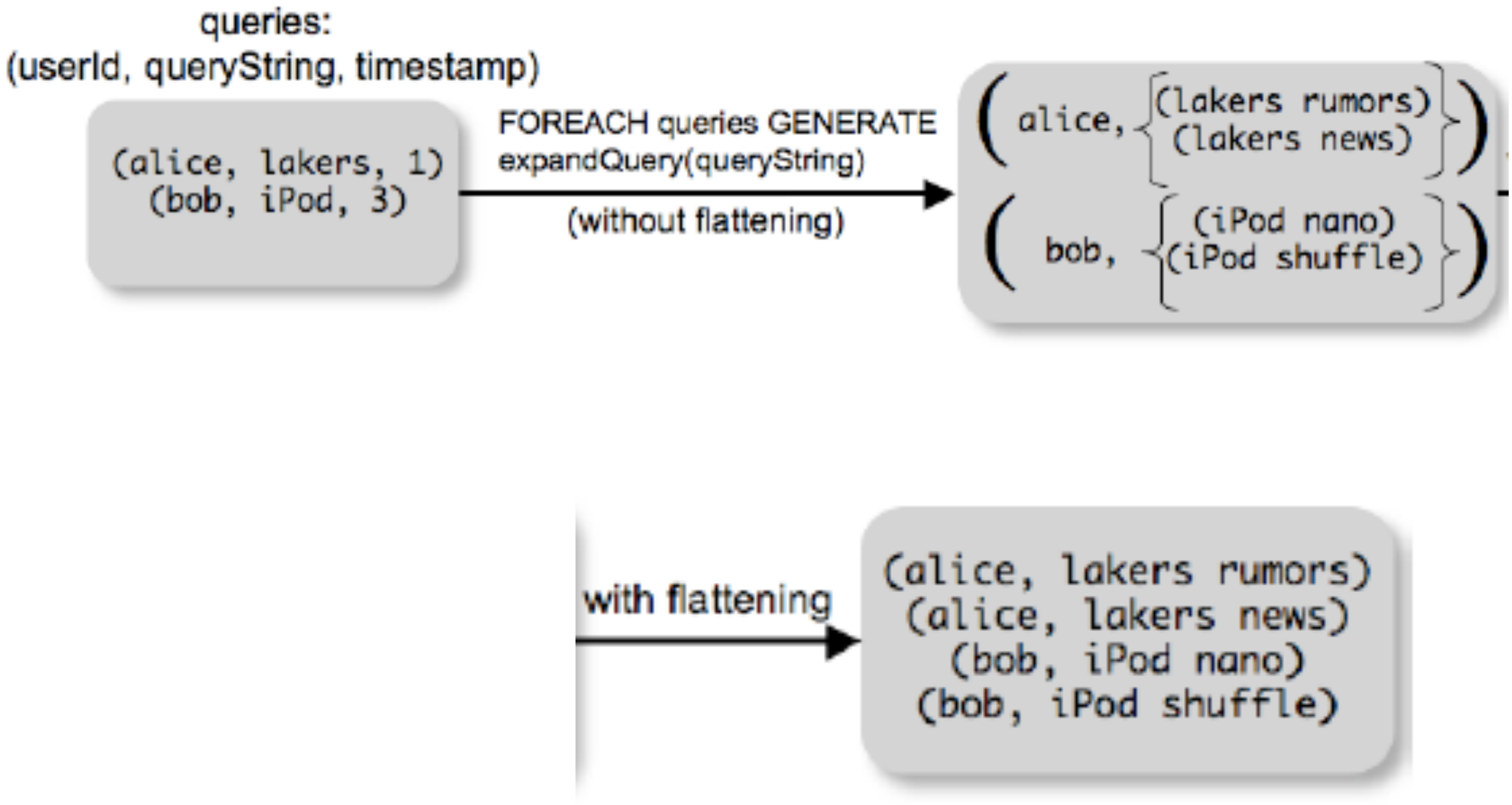
```
expanded_queries =
   FOREACH queries
   GENERATE userId, expandQuery(queryString)
```

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:

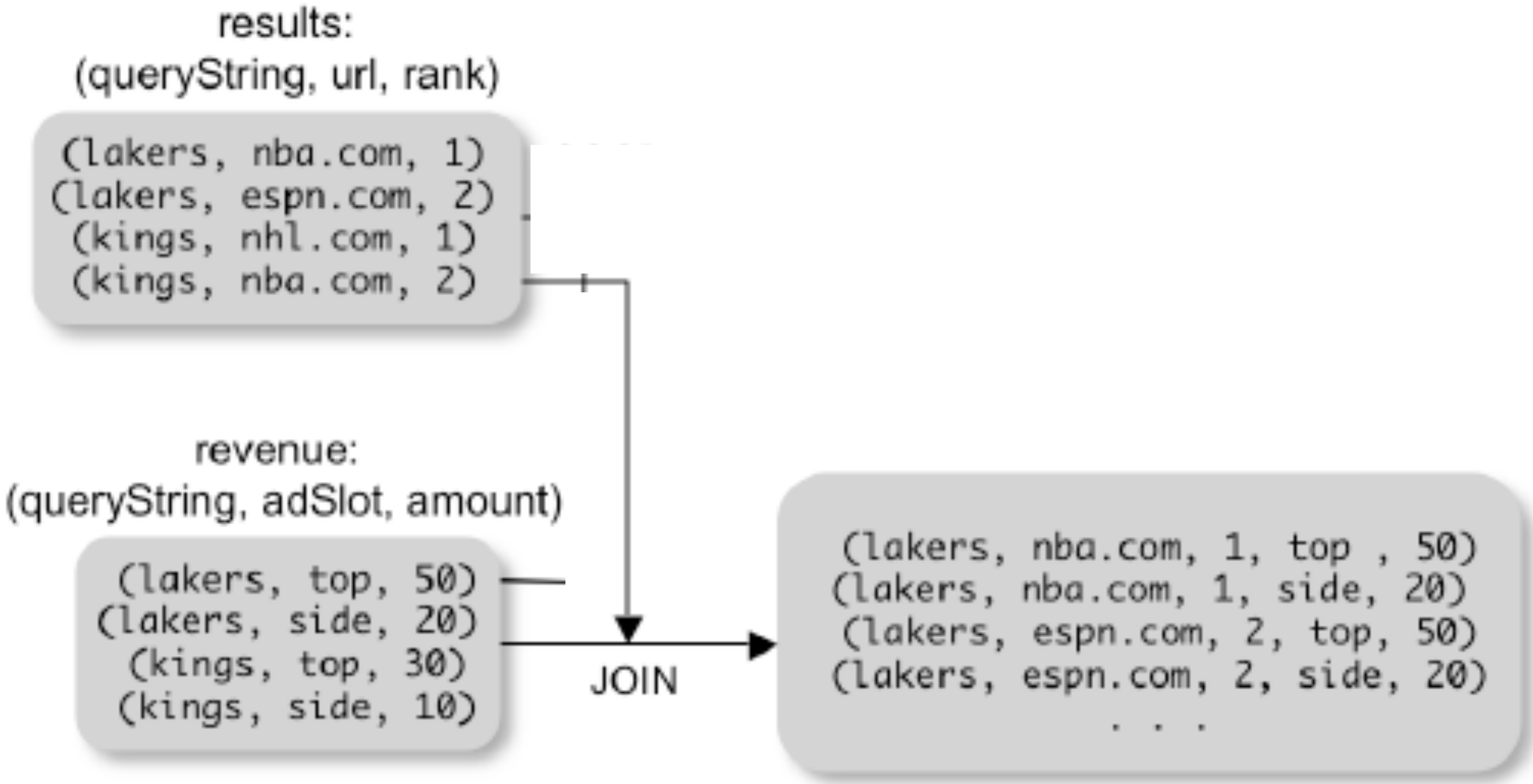
```
real_queries =  FILTER queries
                BY NOT isBot(userId)
```

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, . . .)})}

Final Comment

- More about Pig and Pig Latin next week
- Project 4: start by downloading pig, run the tutorial on your local machine