CSE 6242 A / CS 4803 DVA

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Scaling Up

Pig, HBase

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Some lectures are partly based on materials by
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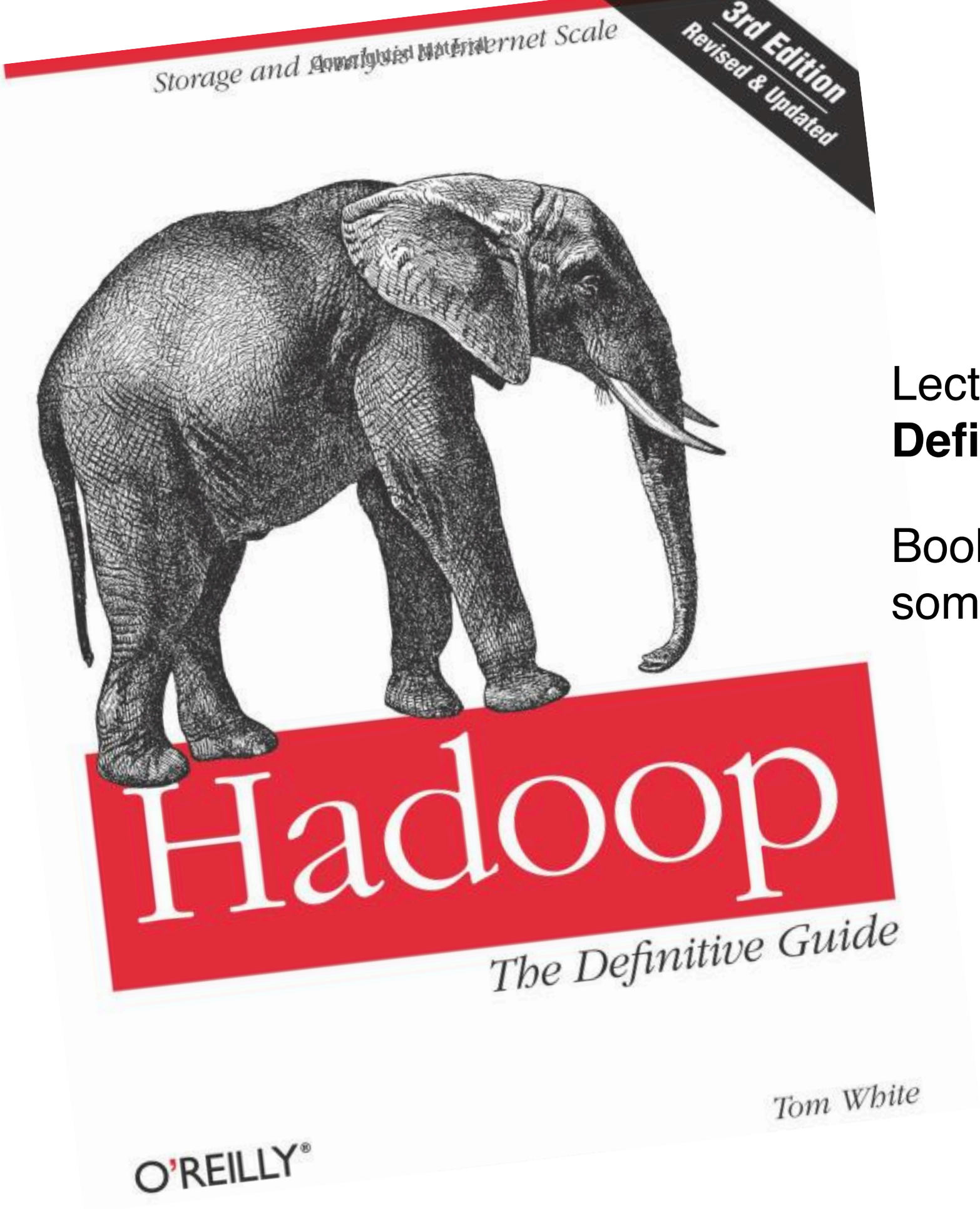

Lecture based on **Hadoop: The Definitive Guide**

Book covers Hadoop, some Pig, some HBase, and other things.

http://goo.gl/YNCWN

Last Time...

Intro to Hadoop, HDFS

Shown you a simple MapReduce program

- Just one “map” job and one “reduce” job

Often, you need **multiple MapReduce stages** for complicated tasks

- You can always write multiple “map” and “reduce” functions and link them together
- Any **easier** way?

Pig

http://pig.apache.org

High-level language

- instead of writing low-level map and reduce functions

Easy to program, understand and maintain

Created at Yahoo!

Produces sequences of Map-Reduce programs

(Lets you do “joins” much more easily)

Pig

http://pig.apache.org

Your data analysis task -> a **data flow** sequence

- **Data flow** sequence
  = sequence of **data transformations**

Input -> **data flow**-> output

You specify the **data flow** in **Pig Latin** (Pig's language)

- Pig turns the data flow into a sequence of MapReduce jobs automatically!

Pig: 1st Benefit

Write only a few lines of Pig Latin

Typically, MapReduce development cycle is long

- Write mappers and reducers
- Compile code
- Submit jobs
- ...

Pig: 2nd Benefit

Pig can perform a **sample run** on representative subset of your input data automatically!

Helps debug your code (in smaller scale), before applying on full data

What Pig is good for?

Batch processing, since it's built on top of MapReduce

- Not for random query/read/write

May be slower than MapReduce programs coded from scratch

- You trade ease of use + coding time for some execution speed

How to run Pig

Pig is a client-side application
(run on your computer)

Nothing to install on Hadoop cluster

How to run Pig: 2 modes

Local Mode

- Run on your computer
- Great for trying out Pig on small datasets

MapReduce Mode

- Pig translates your commands into MapReduce jobs and turns them on Hadoop cluster
  - Remember you can have a single-machine cluster set up on your computer

Pig program: 3 ways to write

Script

Grunt (interactive shell)

- Great for debugging

Embedded (into Java program)

- Use PigServer class (like JDBC for SQL)
- Use PigRunner to access Grunt

Grunt (interactive shell)

Provides “code completion”; press “Tab” key to complete Pig Latin keywords and functions

Let’s see an example Pig program run with Grunt

- Find highest temperature by year

Example Pig program

Find highest temperature by year

```
records = LOAD 'input/ ncdc/ micro-tab/ sample.txt'
  AS (year:chararray, temperature:int, quality:int);

filtered_records =
  FILTER records BY temperature != 9999
  AND (quality = = 0 OR quality = = 1 OR
       quality = = 4 OR quality = = 5 OR
       quality = = 9);

grouped_records = GROUP filtered_records BY year;

max_temp = FOREACH grouped_records GENERATE
  group, MAX( filtered_records.temperature);

DUMP max_temp;
```

Example Pig program

Find highest temperature by year

```
grunt>
records = LOAD 'input/ ncdc/ micro-tab/ sample.txt'
  AS (year:chararray, temperature:int, quality:int);
```

```
grunt> DUMP records;
```

```
(1950,0,1)
(1950,22,1)
(1950,-11,1)
(1949,111,1)
(1949,78,1)
```

called a “tuple”

```
grunt> DESCRIBE records;
```

```
records: {year: chararray, temperature: int, quality: int}
```

Example Pig program

Find highest temperature by year

```
grunt>
filtered_records =
  FILTER records BY temperature != 9999
  AND (quality = = 0 OR quality = = 1 OR
       quality = = 4 OR quality = = 5 OR
       quality = = 9);
```

```
grunt> DUMP filtered_records;
```

```
(1950,0,1)
(1950,22,1)
(1950,-11,1)
(1949,111,1)
(1949,78,1)
```

In this example, no tuple is filtered out

Example Pig program

Find highest temperature by year

```
grunt> grouped_records = GROUP filtered_records BY year;

grunt> DUMP grouped_records;
```

```
(1949,{(1949,111,1), (1949,78,1)})
(1950,{(1950,0,1),(1950,22,1),(1950,-11,1)})
```

called a "bag"
= unordered collection of tuples

```
grunt> DESCRIBE grouped_records;
```

alias that Pig created

```
grouped_records: {group: chararray,
filtered_records: {year: chararray, temperature:
int, quality: int}}
```

Example Pig program

Find highest temperature by year

```
(1949,{(1949,111,1), (1949,78,1)})
(1950,{(1950,0,1),(1950,22,1),(1950,-11,1)})
```

```
grouped_records: {group: chararray, filtered_records: {year:
chararray, temperature: int, quality: int}}
```

```
grunt> max_temp = FOREACH grouped_records GENERATE
  group, MAX(filtered_records.temperature);

grunt> DUMP max_temp;
```

```
(1949,111)
(1950,22)
```

Run Pig program on a subset of your data

You saw an example run on a tiny dataset

How to do that for a larger dataset?

- Use the **ILLUSTRATE** command to generate sample dataset

Run Pig program on a subset of your data

```
grunt> ILLUSTRATE max_temp;
```

records	year:chararray	temperature:int	quality:int
	1949	78	1
	1949	111	1
	1949	9999	1

filtered_records	year:chararray	temperature:int	quality:int
	1949	78	1
	1949	111	1

grouped_records	group:chararray	filtered_records:bag{:tuple(year:chararray, temperature:int,quality:int)}
	1949	{(1949, 78, 1), (1949, 111, 1)}

max_temp	group:chararray	:int
	1949	111

How does Pig compare to SQL?

Pig: data flow

- step-by-step data transformations

SQL: declarative

- specify constraints that define the output

How does Pig compare to SQL?

SQL: “fixed” schema

PIG: loosely defined schema, as in

```
records = LOAD 'input/ ncdc/ micro-tab/ sample.txt'
AS (year:chararray, temperature:int, quality:int);
```

How does Pig compare to SQL?

SQL: supports fast, random access
(e.g., <10ms)

PIG: batch processing

Much more to learn about Pig

Relational Operators, Diagnostic Operators (e.g., describe, explain, illustrate), utility commands (cat, cd, kill, exec), etc.

Table 11-1. Pig Latin relational operators

Category	Operator	Description
Loading and storing	LOAD	Loads data from the filesystem or other storage into a relation
	STORE	Saves a relation to the filesystem or other storage
	DUMP	Prints a relation to the console
Filtering	FILTER	Removes unwanted rows from a relation
	DISTINCT	Removes duplicate rows from a relation
	FOREACH...GENERATE	Adds or removes fields from a relation
	MAPREDUCE	Runs a MapReduce job using a relation as input
	STREAM	Transforms a relation using an external program
	SAMPLE	Selects a random sample of a relation
Grouping and joining	JOIN	Joins two or more relations
	COGROUP	Groups the data in two or more relations
	GROUP	Groups the data in a single relation
	CROSS	Creates the cross-product of two or more relations
Sorting	ORDER	Sorts a relation by one or more fields
	LIMIT	Limits the size of a relation to a maximum number of tuples
Combining and splitting	UNION	Combines two or more relations into one
	SPLIT	Splits a relation into two or more relations

What if you need **real-time** read/write for large datasets?

HBase

Built on top of HDFS

Supports real-time read/write random access

Scale to very large datasets, many machines

Not relational, does NOT support SQL
("NoSQL" = "not only SQL")

Supports billions of rows, millions of columns

http://hbase.apache.org

HBase Details

Next time

- How does it work?
- How to use it?

Now, about project proposal and presentation...

Presentation Guidelines

14 Teams: 7 teams on Tue, 7 teams on Thu

Class will start at **1:35 sharp**!

10 min per team

- 7 min maximum for presentation
- 3 min for Q&A + transition to next team

Time limit strictly enforced

You'll be **booted off** the podium when 10min is up

Presentation Guidelines

Don't use many slides. **Less is more**!

- Fewer slides, less likely to overrun (also less work for you)
- It's gonna be **hard** to be succinct
- **PRACTICE!!!!**

Make sure you answer **Heilmeier questions**, plus briefly mention **survey** you've done, your team's **expected innovation**, **plan of activities**

- see proposal grading scheme
- presentation graded similarly as proposal