Teaching Big Data Analytics to Business School MS Students

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IT Teaching Workshop 2019, Wharton
MSBAPM Curriculum

Business Analytics

Required courses (5):

- Business Process Modeling and Data Management (OPIM 5272)
- Statistics in Business Analytics (OPIM 5603)
- Predictive Modeling (OPIM 5604)
- Business Decision Modeling (OPIM 5641)
- Data Mining and Business Intelligence (OPIM 5671)

Project Management

Required courses (4):

- Introduction to Project Management (OPIM 5270)
- Project Leadership and Communications (MGMT 5620)
- Project Risk and Cost Management (OPIM 5668)
- Advanced Business Analytics and Project Management (OPIM 5770)

Electives

- Visual Analytics (OPIM 5501)
- Big Data Analytics with Hadoop (OPIM 5502)
- Adaptive Business Intelligence (OPIM 5504)
- Analytical Consulting for Financial Services (OPIM 5505)
- Agile Project Management (OPIM 5507)
- Healthcare Analytics and Research Methods (OPIM 5508)
- Introduction to Deep Learning (OPIM 5509)
- Web Analytics (OPIM 5510)
- Survival Analysis using SAS Base (OPIM 5511)
- Data Science using Python (OPIM 5512)

MSBAPM Capstone Project

Quick Facts

<table>
<thead>
<tr>
<th>Locations</th>
<th>Hartford or Stamford, Connecticut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semesters</td>
<td>Fall, Spring, or Summer</td>
</tr>
<tr>
<td>Format</td>
<td>Full- or Part-time</td>
</tr>
<tr>
<td>Credits</td>
<td>37-credits (Curriculum)</td>
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</tbody>
</table>
Hadoop books

Source: David Tilson, IT Teaching Workshop 2018
Hadoop resources

**QuickStarts for CDH 5.13**
Virtualized clusters for easy installation on your desktop.

Cloudera QuickStart VMs (single-node cluster) make it easy to quickly get hands-on with CDH for testing, demo, and self-learning purposes, and include Cloudera Manager for managing your cluster. Cloudera QuickStart VM also includes a tutorial, sample data, and scripts for getting started.

**Cloudera University**
Hone your big data tech skills with the world’s leading experts through Cloudera University — the industry’s only truly dynamic training curriculum that’s updated to keep pace with innovation.

[Links: FIND TRAINING, GET CERTIFIED, RETURNING STUDENTS]
Cloudera VM

Enabling virtualization
AWS EMR (Elastic MapReduce) Cluster

Using a cluster is not for the faint-hearted

Estimated cost
- $6k cluster time (Spark was most expensive part)
- $2k admin time
- $10k consulting time (one-off)

Asking AWS for $5k credit (~50 students) and they are considering more turn-key solution (no promises yet).

>50% cost reduction by active management (off at night, reset). Could be less than $50/student at 50 students for 10 weeks

AWS provide good support (solution architects)
- But they were learning too
- Multi-user different and complex across AWS, Linux, HDFS, Pig, Hive, S3, Hue, Spark, and Zeppelin
- Will use us as case study in multi-tenancy cluster operation

Amazon provides lots of guidance

This book was very helpful in learning AWS terminology

Source: David Tilson, IT Teaching Workshop 2018
Step 1: Choose an Amazon Machine Image (AMI)

An AMI is a template that contains the software configuration (operating system, applications, etc.) provided by AWS, our user community, or the AWS Marketplace, or you can select one of your own AMIs.

Search for: v4-ubuntu-hadoop-rs

Community AMIs (1)

Operating system
- Amazon Linux
- CentOS
- Debian
- Fedora
- Suse

1 result in My AMIs
My AMIs are AMIs owned by you or your organizations.

287 results in AWS Marketplace
AWS Marketplace provides partner images.
AWS EC2:
Topics covered

• Linux
• Hadoop Distributed File System
• Apache Sqoop
  • Extract data from RDBMS, into HDFS
• Apache Pig
  • Extract, Transform, Load (ETL) on data obtained via Sqoop
  • Schema on read, no permanent schema, flat files
• Apache Hive
  • Hadoop Data Warehousing Tool
  • Schema on read, permanent schema required, flat files
• MapReduce – conceptual overview
• Spark
  • In-memory Analytics
• Recommender Systems
  • Illustrates Spark
HDFS

[training@localhost mydata]$ hadoop fs -mkdir /test
[training@localhost mydata]$ hadoop fs -mkdir /test/test1
[training@localhost mydata]$ hadoop fs -put products.txt /test/test1/
[training@localhost mydata]$ hadoop fs -ls /test/test1

Found 1 items
-rw-r--r-- 1 training supergroup 63 2017-10-17 12:25 /test/test1/products.txt

[training@localhost mydata]$ hadoop fs -rm /test/test1
rm: `'/test/test1': Is a directory

[training@localhost mydata]$ hadoop fs -rmdir /test/test1
rmdir: `'/test/test1': Directory is not empty

[training@localhost mydata]$ hadoop fs -rm -r /test/test1
Deleted /test/test1

[training@localhost mydata]$ hadoop fs -ls /test

$ hadoop fs -ls /

Found 6 items
drwxr-xr-x - ubuntu supergroup 2019-05-31 20:28 /linkage
drwxr-xr-x - ubuntu supergroup 2019-05-31 19:25 /mydata
drwxr-xr-x - ubuntu supergroup 2019-03-11 20:36 /spark
drwxr-xr-x - ubuntu supergroup 2019-05-31 19:16 /tmp
drwxr-xr-x - ubuntu supergroup 2019-05-31 19:16 /user
drwxr-xr-x - ubuntu supergroup 2019-05-31 18:39 /userdata
$ sqoop import
--connect jdbc:mysql://localhost/sakila
--username ubuntu --password training
--warehouse-dir /userdata
--table actor
Pig

1 listings = LOAD '/mydata/class3/listings.txt' AS
2 (  
3 listing_id:int, date_listed:chararray,  
4 list_price:float, sq_feet:int,  
5 address:chararray,town:chararray  
6 );  
7 bytown = GROUP listings BY town;  
8 DESCRIBE bytown;  
9 --optional step:  
10 --byproduct = LIMIT byproduct 5;  
11 --Top 2 most expensive homes per town  
12 top_homes = FOREACH bytown {  
13 sorted = ORDER listings BY  
14 list_price DESC;  
15 most_expensive = LIMIT sorted 2;  
16 GENERATE group, most_expensive;  
17 };  
18 DESCRIBE top_homes;  
19 DUMP top_homes;

Load data
Group by town
In each group, sort by list_price
Limit to top 2 most expensive homes
Generate new (group) record in top_homes table
Hive

```sql
hive> SELECT * FROM homes;
OK
listing_id  list_price  sqft  realtor_id  town
1   146000.0   1750  25    Storrs
2   235000.0   2100  17    Storrs
3   101000.0   1550  53    Hartford
4   376000.0   2900  17    Storrs
5   291000.0   2400  17    Hartford
6   409000.0   3500  25    Stamford
Time taken: 0.129 seconds
```

```sql
hive> SELECT * FROM realtors;
OK
realtor_id  realtor
17    Alec Baldwin
25    Al Pacino
53    Kevin Spacey
Time taken: 0.484 seconds
```

```sql
hive> SELECT r.realtor, h.list_price, h.sqft, h.town
    > FROM realtors r JOIN homes h
    > ON r.realtor_id = h.realtor_id
    > ;
realtor  list_price  sqft  town
Alec Baldwin  235000.0  2100  Storrs
Alec Baldwin  376000.0  2900  Storrs
Alec Baldwin  291000.0  2400  Hartford
Al Pacino      146000.0  1750  Storrs
Al Pacino      409000.0  3500  Stamford
Kevin Spacey   101000.0  1550  Hartford
Time taken: 81.428 seconds
```
MapReduce

MapReduce

Map tasks

File1.txt
C
- (cat, 2)
- (drank, 1)
- (milk, 1)

File2.txt
C
- (dog, 1)
- (drank, 1)
- (milk, 1)

File3.txt
C
- (dog, 1)
- (chased, 1)
- (cat, 1)

Key value pairs

Group by keys

M

Values grouped by key

C
- (cat, 2, 1)
- (drank, 1, 1)
- (milk, 1, 1)
- (dog, 1, 1)
- (chased, 1)

Reduce tasks

C
- (cat, 3)
- (drank, 2)
- (milk, 2)
- (dog, 2)
- (chased, 1)

Values combined by key

Map + combine

Map step – in child computers

Aggregation step – in master computer

Reduce step – in child computers
(userid artistid playcount)

(user_artist_data.txt)

1 1000002 1 55
2 1000002 1000006 33
3 1000002 1000007 8
4 1000002 1000009 144
5 1000002 1000010 314
6 1000002 1000013 8
7 1000002 1000014 42
8 1000002 1000017 69
9 1000002 1000024 329

(artistid artist_name)

(artist_data.txt)

1 1 Portishead
2 1 100 Phoenix
3 1000006 Phil Collins Big Band
4 1000007 The Phil Collins Big Band
5 1000009 A Perfect Circle
6 1000010 Aerosmith
7 1000013 MC Hawking
8 1000014 Pantera
9 1000017 Judas Priest

(badid goodid)

(artist_alias.txt)

1 1000434 1000518
2 1021484 1234336
3 1014609 1014609
4 1002087 1239413
5 1004729 1003612
6 1006586 1021625
7 1008128 1019469
8 1002081 1013150
9 1939 6785079
Spark – recommender system (ALS)

Some of the artists this person listens to:
- Sonny Rollins
- Thelonious Monk
- Sublime
- Weather Report
- Bob Dylan
- Pink Floyd
- Nine Inch Nails
- Otis Redding
- Stevie Wonder

Make 5 recommendations to this user:

```
scala> val recommendations = model.recommendProducts(1000002, 5)
scala> recommendations.foreach(println)
```

User ID, Artist ID, estimated rating
- Rating(1000002, 1003433, 1.1815765349990169)
- Rating(1000002, 719, 1.1266192051236328)
- Rating(1000002, 1001172, 1.1254197498636407)
- Rating(1000002, 1000840, 1.097728376342873)
- Rating(1000002, 1034635, 1.0651848760166387)

```
scala> val recommendedProductIDs = recommendations.map(_.product).toSet
scala> artistByID.filter { case (id, name) =>
  | recommendedProductIDs.contains(id)
  | }.values.collect().foreach(println)
```

Lee Ritenour
60ft Dolls
Belly
Ella Fitzgerald