Suggested Teaching Guidelines for

Big Data Technologies

PG-DBDA March 2024

Duration: 66 Classroom hours + 84 Lab hours

Objective: To reinforce knowledge of BigData Technologies such as Hadoop, Map reduce, HBase, PIG, Spark (PySpark)

Prerequisites: Knowledge of Linux command, SQL and Core Java

Evaluation method: Theory exam – 40% weightage
Lab exam – 40% weightage
Internal exam – 20% weightage

List of Books / Other training material

Textbook:

1. Big Data, Black Book: Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization, DT Editorial Services , Wiley India,Latest.

Reference:

1. Big Data, Black Book by DreamTech
2. Programming Hive by O'Rellay (Author:- Edward Capriolo, Dean Wampler, and Jason RutherglenEdward Capriolo, Dean Wampler, and Jason Rutherglen)
1. Hadoop The Definitive Guide 4thEdition by O'Rellay (Author: - Tom White)
2. Hadoop In Practice by Manning (Author: - ALEX HOLMES)
3. Pro Hadoop by Aprss(Author:-Jason Venner)
4. Hadoop with python
5. Hadoop Real-World Solutions Cookbook by Packet publication (Author: Jonathan R. Owens, Jon Lentz,Brian Femiano)
6. Hadoop In Action by Manning Publications (Author: - CHUCK LAM)
7. Data Architecture: A Primer for the Data Scientist: Big Data, Data Warehouse and Data Vault
8. Big Data Made Easy: A Working Guide to the Complete Hadoop Toolset
9. Big Data Analytics with Spark: A Practitioner's Guide to Using Spark for Large-Scale Data Processing, Machine Learning, and Graph Analytics, and High-Velocity Data Stream Processing

Note: Each session having 2 Hours

Introduction to Bigdata and Hadoop (Theory- 16 Hrs and Lab- 06 Hrs)

Session: 1, 2 & 3
Introduction to Big Data

- Big Data - Beyond the Hype
- Big Data Skills and Sources of Big Data
- Big Data Adoption
- Research and Changing Nature of Data Repositories
- Data Sharing and Reuse Practices and Their Implications for Repository Data Curation

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- Overlooked and Overrated Data Sharing
- Data Curation Services in Action
- Open Exit: Reaching the End of The Data Life Cycle
- The Current State of Meta-Repositories for Data
- Curation of Scientific Data at Risk of Loss: Data Rescue And Dissemination

Introduction to Hadoop

- A Brief History of Hadoop
- Evolution of Hadoop
- Introduction to Hadoop and its components
- Comparison with Other Systems
- Hadoop Releases
- Hadoop Distributions and Vendors

Hadoop Distributed File System (HDFS)
Session: 4 & 5
Hadoop Distributed File System (HDFS)

- Distributed File System
- What is HDFS
- Where does HDFS fit in
- Core components of HDFS
- HDFS Daemons
- Hadoop Server Roles: Name Node, Secondary Name Node, and Data Node

HDFS Architecture

- HDFS Architecture
- Scaling and Rebalancing
- Replication
- Rack Awareness
- Data Pipelining,
- Node Failure Management.
- HDFS High Availability NameNode

Lab-Assignment:

- Run the HDFS commands, and add a one liner understanding for each of the command.
- Execute the provided code using HDFS, step run and understand

Hadoop Installation and Cluster Configuration (Lab – 02 Hrs)
Session: 6
Getting Started: Hadoop Installation

- Hadoop Operation modes
- Setting up a Hadoop Cluster
- Cluster specification
- Single and Multi-Node Cluster Setup on Virtual & Physical Machines,
- Remote Login using Putty/Mac Terminal/Ubuntu Terminal.
- Hadoop Configuration, Security in Hadoop, Administering Hadoop,
- HDFS – Monitoring & Maintenance, Hadoop benchmarks,
- Hadoop in the cloud.

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Session: 7
Hadoop Architecture

- Hadoop Architecture,
- Core components of Hadoop,
- Common Hadoop Shell commands.

Session: 8
HDFS Data Storage Process

- HDFS Data storage process,
- Anatomy of writing and reading file in HDFS,
- Handling Read/Write failures
- HDFS user and admin commands,
- HDFS Web Interface.

Map Reduce (Theory – 06 Hrs & Lab – 12 Hrs)
Session: 9
Getting in touch with Map Reduce Framework

- Hadoop Map Reduce paradigm,
- Map and Reduce tasks,
- Map Reduce Execution Framework,
- Map Reduce Daemons
- Anatomy of a Map Reduce Job run

More Map Reduce Concepts

- Partitioners and Combiners,
- Input Formats (Input Splits and Records, Text Input, Binary Input, Multiple Inputs),
- Output Formats (Text Output, Binary Output, Multiple Output).
- Distributed Cache

Session: 10
Basics of Map Reduce Programming

- Hadoop Data Types,
- Java and Map Reduce,
- Map Reduce program structure,
- Map-only program, Reduce-only program,
- Use of combiner and partitioner,
- Counters, Schedulers (Job Scheduling),
- Custom Writables, Compression

Lab-Assignment:

- Execute the train data example.
- Execute the train data example using chained methods.

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Session: 11
Map Reduce Streaming

- Complex Map Reduce programming,
- Map Reduce streaming,
- Python and Map Reduce,
- Map Reduce on image dataset

Hadoop ETL
Session: 12

- Hadoop ETL Development,
- ETL Process in Hadoop,
- Discussion of ETL functions,
- Data Extractions,
- Need of ETL tools,
- Advantages of ETL tools.

Lab-Assignment:

- Understand the file formats and read the provided links

HBase (Theory – 06 Hrs & Lab – 06 Hrs)
Session: 13
Introduction to HBase

- Overview of HBase
- HBase architecture
- Installation

Session: 14 & 15
The HBaseAdmin and HBase Security

- Various Operations on Tables
- HBase general command and shell,
- java client API for HBase
- Admin API
- CRUD operations
- Client API
- HBase – Scan, Count and Truncate
- HBase Security

Lab-Assignment:

- Run the Hbase shell commands
- Run the HBase using Java client

Hive (Theory – 08 Hrs & Lab – 18 Hrs)
Session: 16
The Hive Data-ware House

- Introduction to Hive,
- Hive architecture and Installation,

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- Comparison with Traditional Database,
- Basics of Hive Query Language.

Session: 17
Working with Hive QL

- Datatypes,
- Operators and Functions,
- Hive Tables (Managed Tables and Extended Tables),
- Partitions and Buckets,
- Storage Formats,
- Importing data,
- Altering and Dropping Tables

Lab-Assignment:

- Creative a hive DB and table (internal and external)
- Load the data into hive table (using local inpath and HSFS inpath)

Session:18
Querying with Hive QL

- Querying Data-Sorting,
- Aggregating,
- Map Reduce Scripts,
- Joins and Sub queries,
- Views,
- Map and Reduce side joins to optimize query.

Lab-Assignment:

- Run all the types of joins in Hive
- Execute the data to be partitioned

Session: 19
More on Hive QL

- Data manipulation with Hive,
- UDFs,
- Appending data into existing Hive table,
- custom map/reduce in Hive
- Writing HQL scripts

Apache Airflow (Theory – 06 Hrs & Lab – 06 Hrs)
Session: 20, 21 & 22

- Introduction to Data Warehousing and Data Lakes
- Designing Data warehousing for an ETL Data Pipeline
- Designing Data Lakes for an ETL Data Pipeline
- ETL vs ELT
- Fundamentals of Airflow
- Work management with Airflow

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- Automating an entire Data Pipeline with Airflow

Lab-Assignment:

- Create a airflow DAG for Extract -> Transform -> Load

Introduction to Apache Spark& Kafka (Theory – 24 Hrs & Lab – 36 Hrs)

Session: 23, 24 & 25

Apache Spark APIs for large-scale data processing

- Overview, Linking with Spark, Initializing Spark,
- Resilient Distributed Datasets (RDDs), External Datasets
- RDD v/s Data frames v/s Datasets
- Data frame operations
- Structured Spark Streaming
- Passing Functions to Spark, Working with Key-Value Pairs, Shuffle operations,
- RDD Persistence, Removing Data, Shared Variables, Deploying to a Cluster

Lab-Assignment:

- Run the provided Hadoop Streaming program using python

Session: 26

- Map Reduce with Spark
- Working with Spark with Hadoop
- Working with Spark without Hadoop and their Differences

Lab Assignment

- Execute all the provided code using step-runs for each and every codeline
- Setup the JDBC configuration and run the Spark JDBC Connectivity program
- Run the spark integrations using the provided code

Session: 27

- Data preprocessing
- EDA

Session: 28 & 29

- Introduction to Kafka
- Working with Kafka using Spark
- Spark streaming Architecture
- Spark Streaming APIs
- Building Stream Processing Application with Spark

Lab Assignment

- Execute the spark streaming with Kafka

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Session: 30

- Setting up Kafka Producer and Consumer
- Kafka Connect API

Session: 31

- Spark SQL

Lab Assignment

- Run the sparkSQL programs using step-runs for each and every codeline
- Run all the SparkSQL programs
- Analyse the election data using spark and provide analysis

Session: 32 & 33

- Spark MLlib
- Predictive Analysis

Lab Assignment:

- Deep Learning with Spark
- Connecting DB's with Spark
- Accessing and manipulating the DB's
- Demo: Capstone Project
- Create a complex workflow using bash operator, a simple workflow using python
- Create Using python airflow operator to read data from your local drive, ingest the data into your HDFS, and perform a spark WC