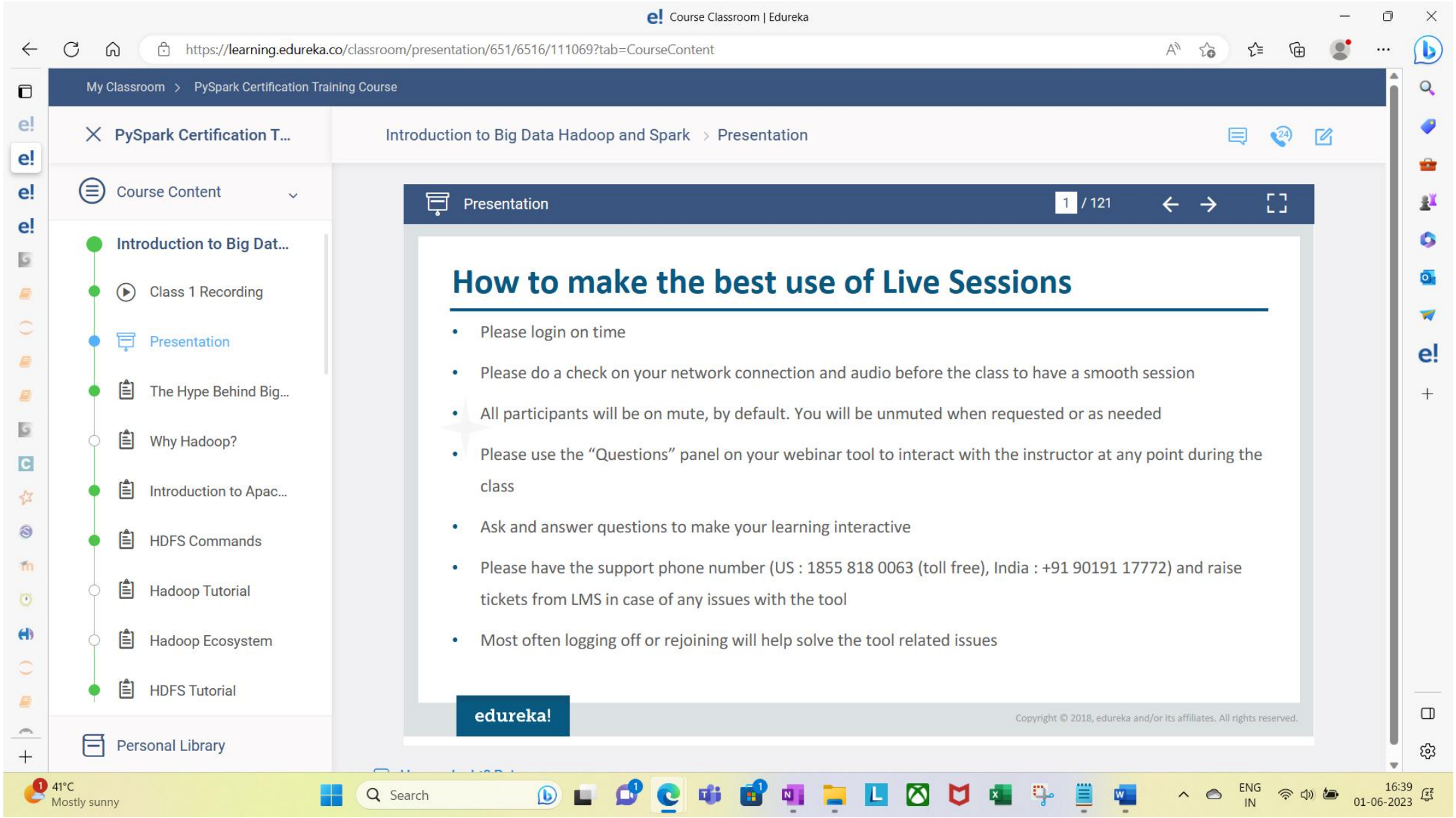
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Please do a check on your network connection and audio before the class to have a smooth session
All participants will be on mute, by default. You will be unmuted when requested or as needed
Please use the "Questions" panel on your webinar tool to interact with the instructor at any point during the class
Ask and answer questions to make your learning interactive
Please have the support phone number (US : 1855 818 0063 (toll free), India : +91 90191 17772) and raise tickets from LMS in case of any issues with the tool
Most often logging off or rejoining will help solve the tool related issues
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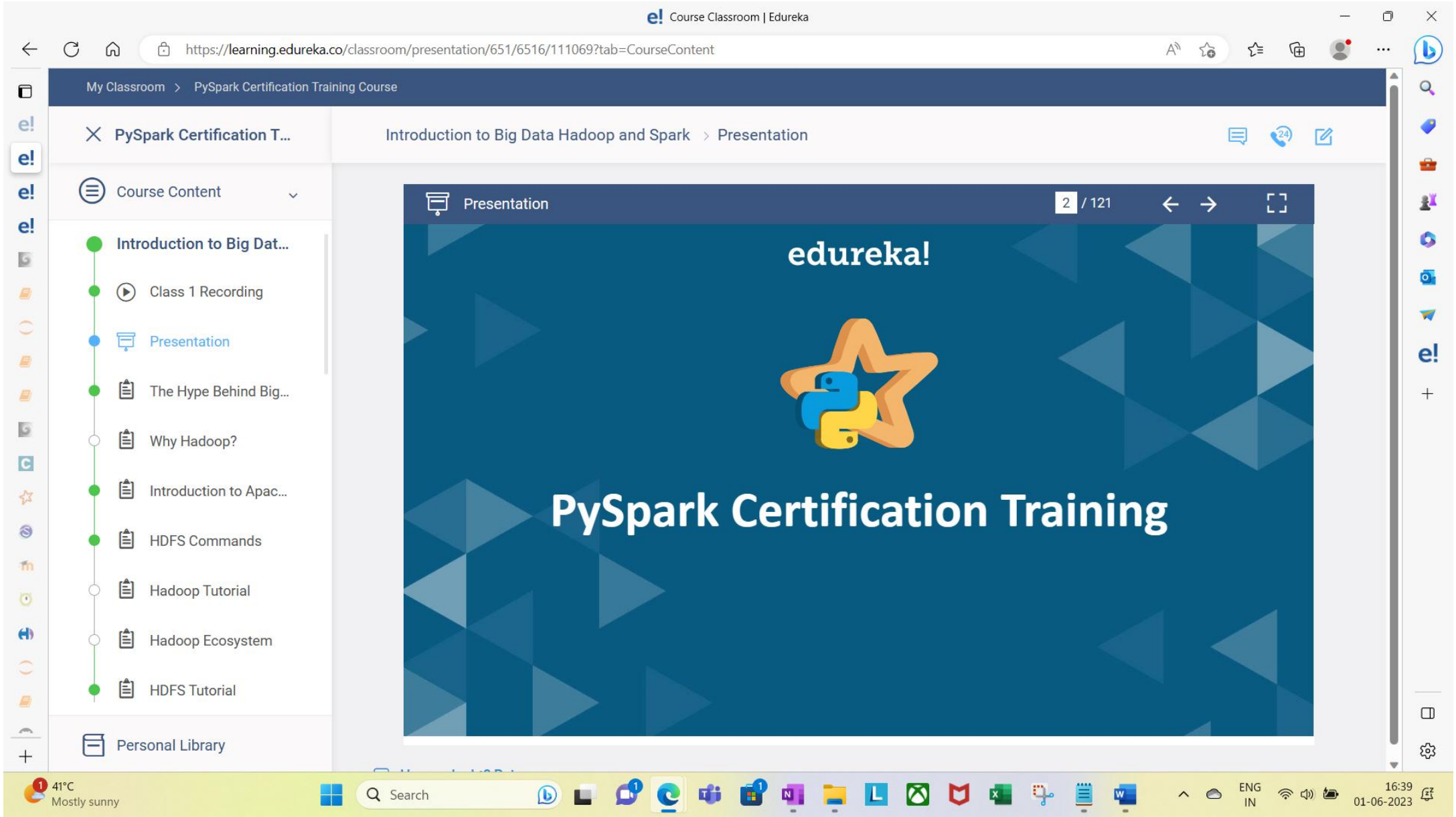
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COURSE OUTLINE

MODULE 01

Introduction to Big Data Hadoop and Spark

- Introduction to Python for Apache Spark
- Functions, OOPs, Modules in Python
- Deep Dive into Apache Spark Framework
- Playing with Spark RDDs
- Data Frames and Spark SQL
- Machine Learning using Spark MLlib
- Deep Dive into Spark MLlib
- Understanding Apache Kafka and Apache Flume
- Apache Spark Streaming - Processing Multiple Batches
- Apache Spark Streaming - Data Sources
- Implementing an End-to-End Project

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Objectives

After completing this module, you should be able to:

- Evaluate present Structure of Data and problems
- Describe Big Data and it's domain
- Explain Hadoop Core Components and HDFS
- Understand Replication and Rack Awareness
- Explain YARN and it's components
- Differentiate between Big Data Analytics with Batch and Real-Time Processing
- Understand the need for Spark and explain what is Spark
- Analyse how Spark differs from its competitors
- Recognize Spark's place in Hadoop ecosystem

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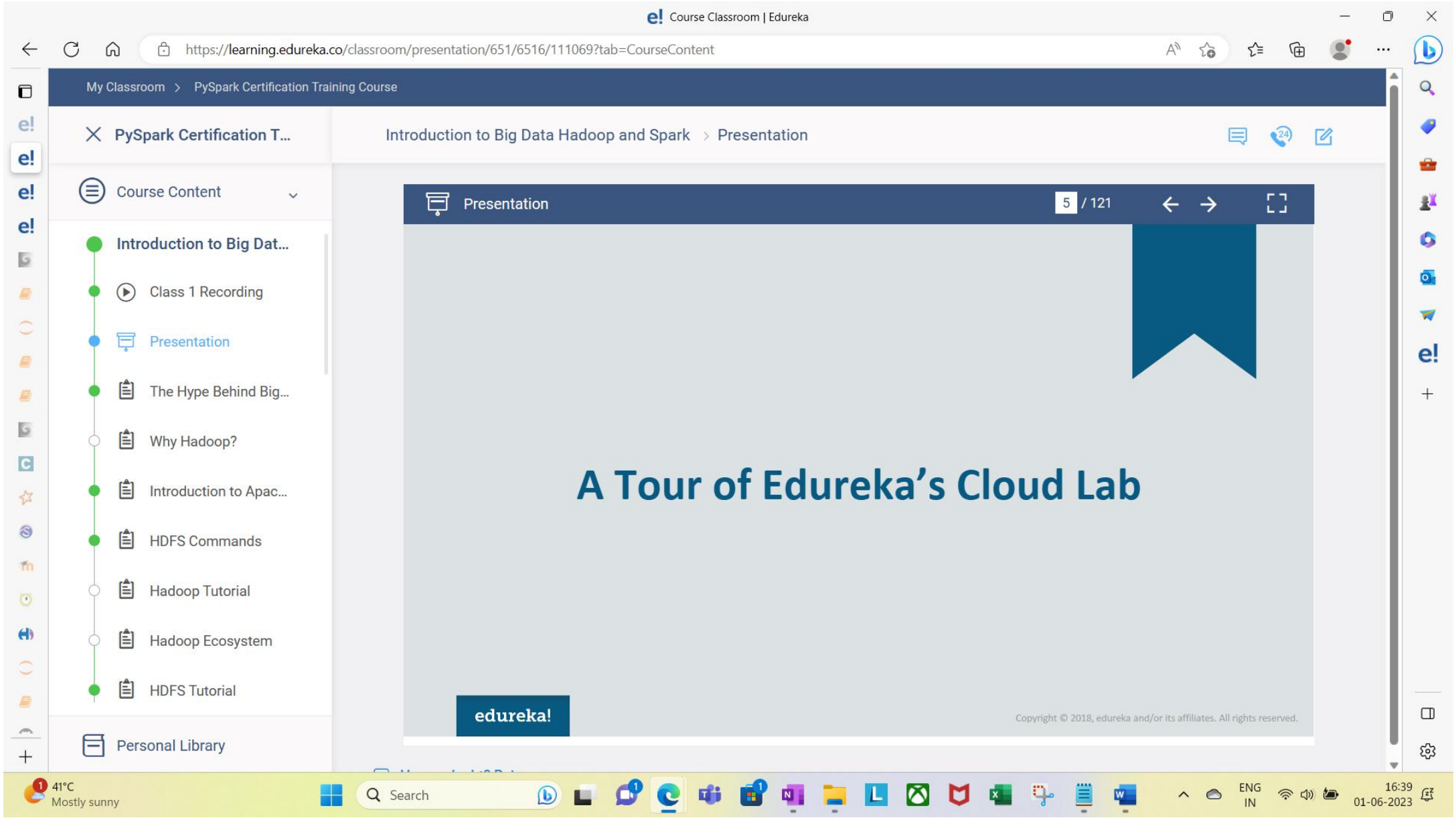
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A Tour of Edureka's Cloud Lab
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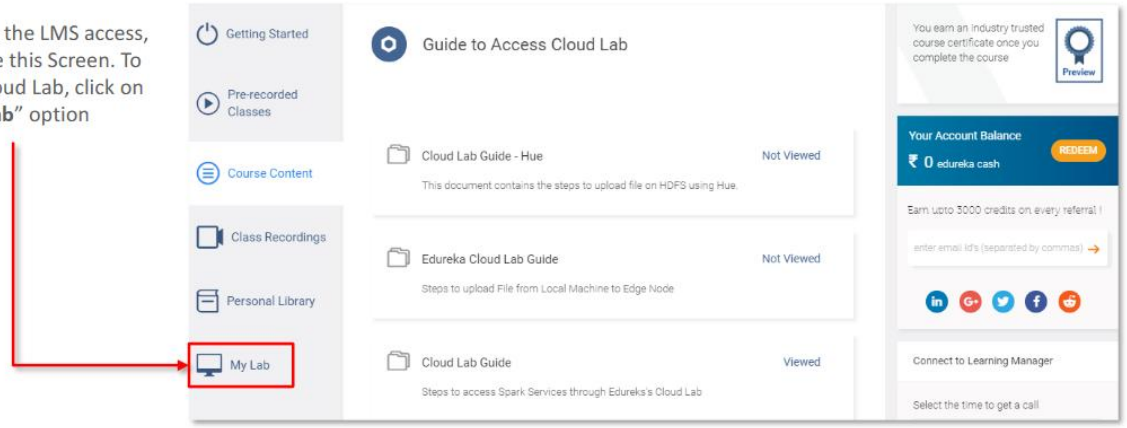
LMS Overview

Once you get the LMS access, you will have this Screen. To login into Cloud Lab, click on "**My Lab**" option



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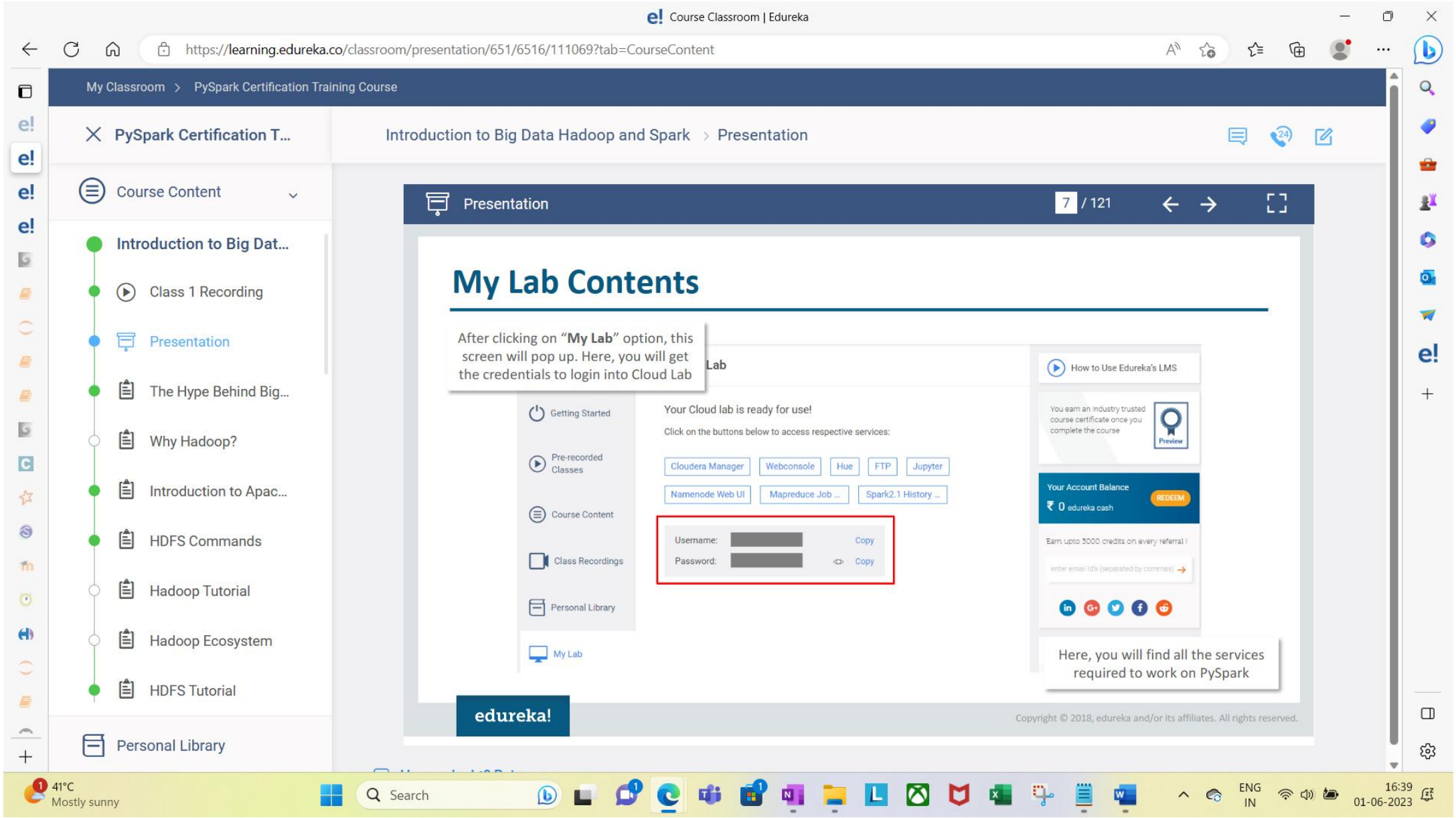
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My Lab Contents
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Your Cloud lab is ready for use!
Click on the buttons below to access respective services:
Cloudera Manager
Webconsole
Hue
FTP
Jupyter
Namenode Web UI
Mapreduce Job ...
Spark2.1 History ...
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Password:
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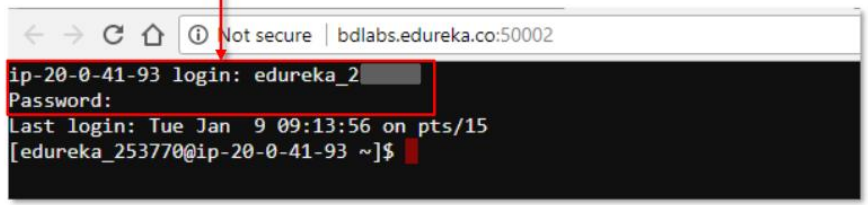
WebConsole

WebConsole is terminal. You have to copy-paste the credentials from the previous window to this window, to login into WebConsole



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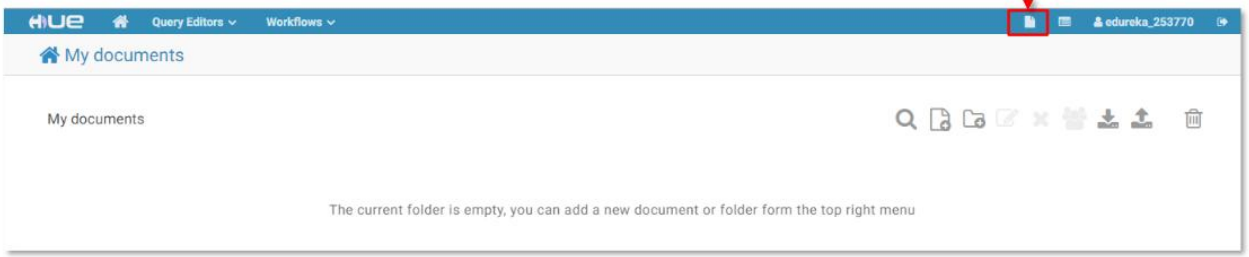
HUE

To see all the files present in HDFS, click on "**HDFS Browser**"



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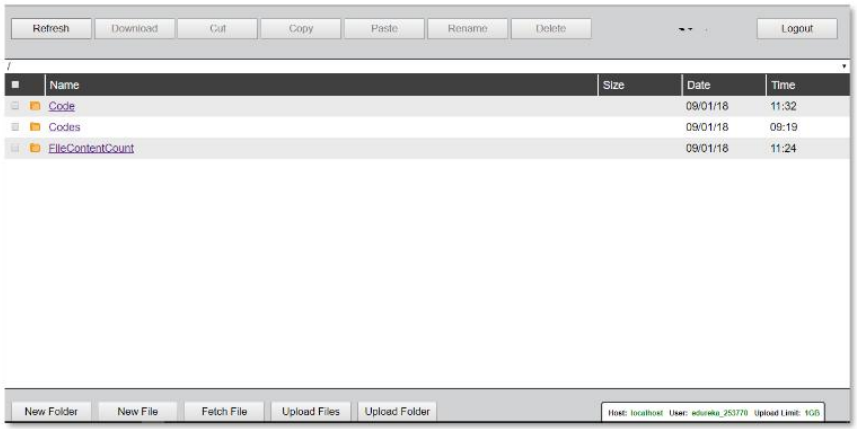
FTP Server

Using **FTP** you can upload or download any file/ folder from your local system to cloud lab



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Jupyter Notebook

Jupyter Notebook is the IDE used to run all the PySpark Programs

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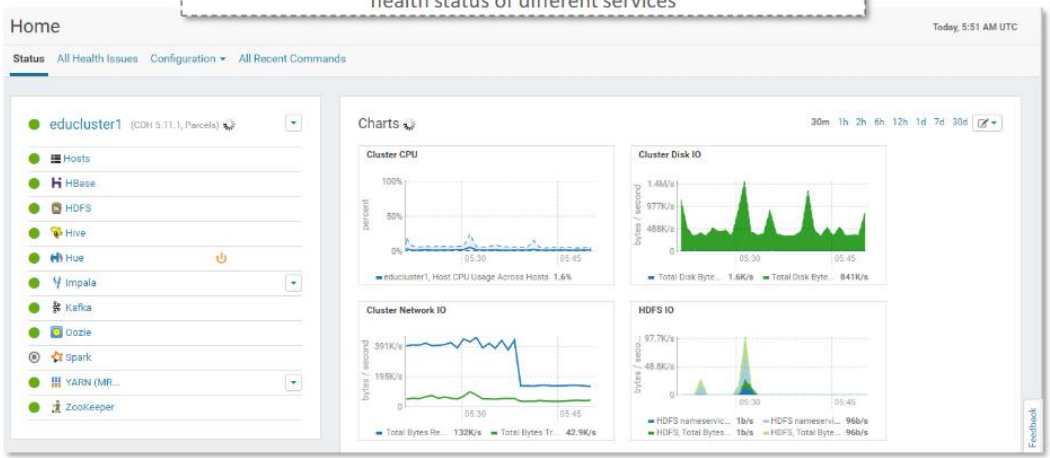
Cloudera Manager

Cloudera Manager is used to visualize the configurations and the health status of different services



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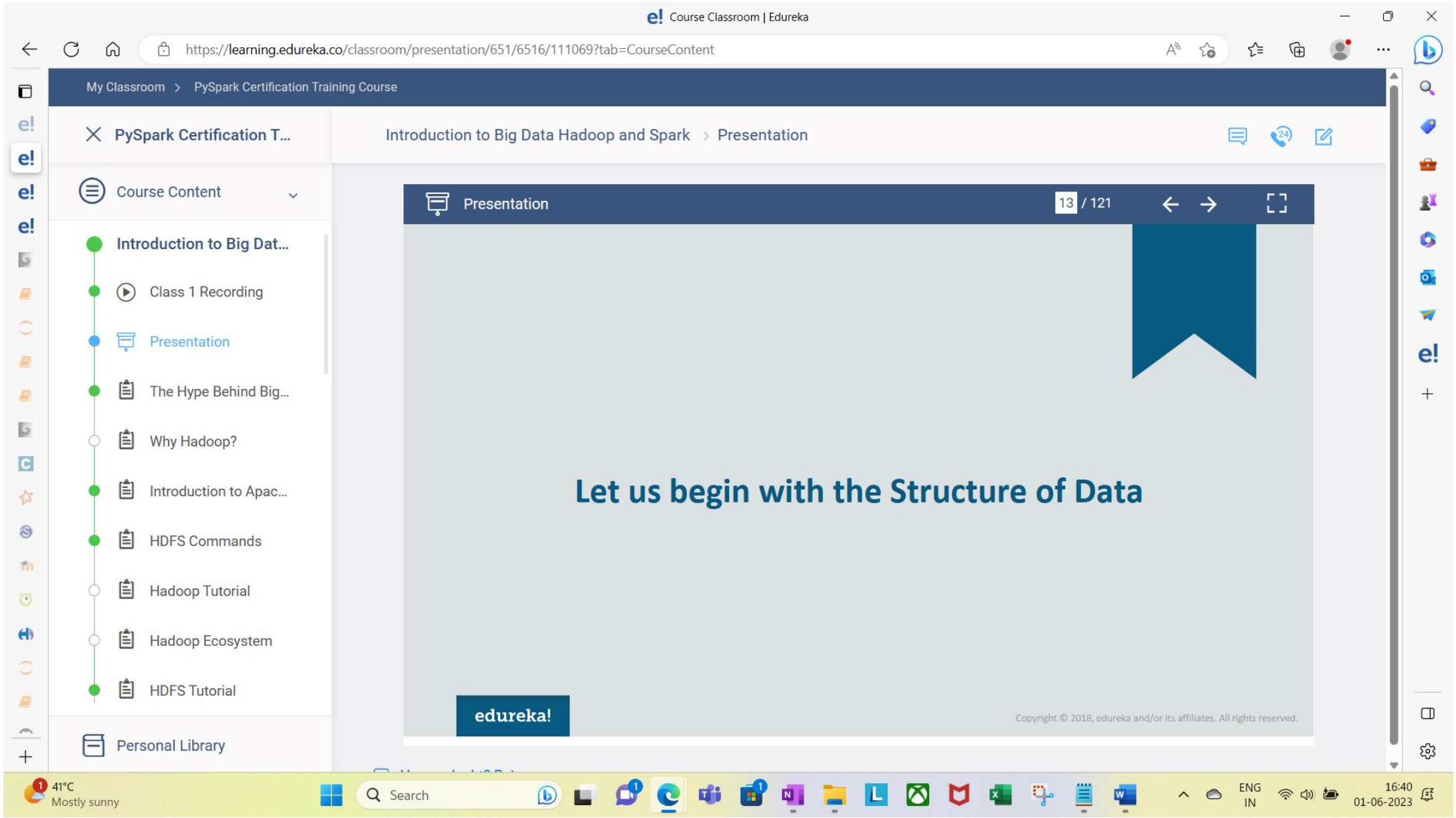
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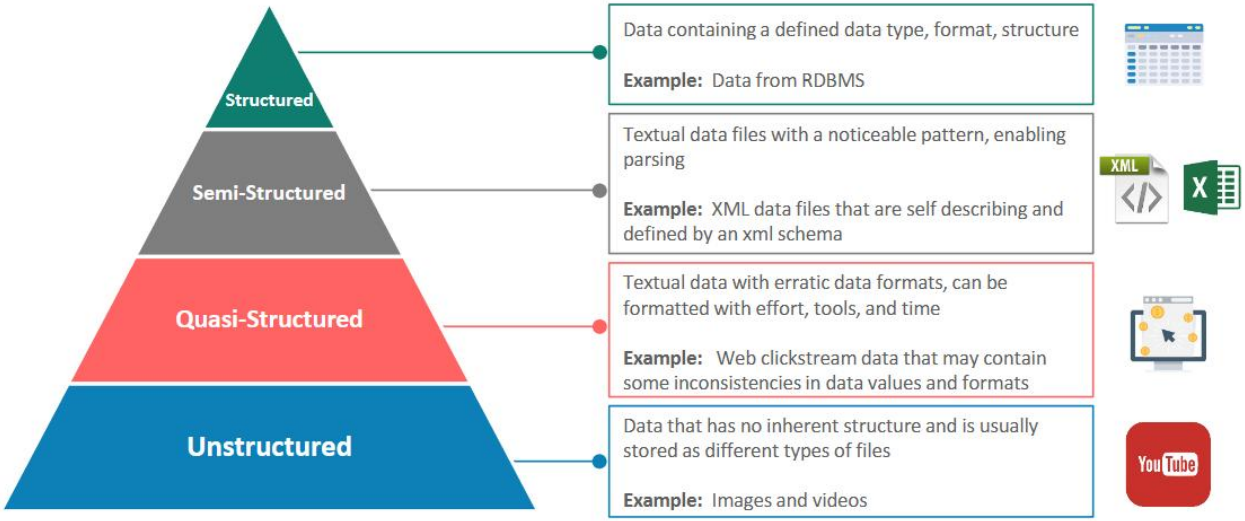
Structure of Data Today



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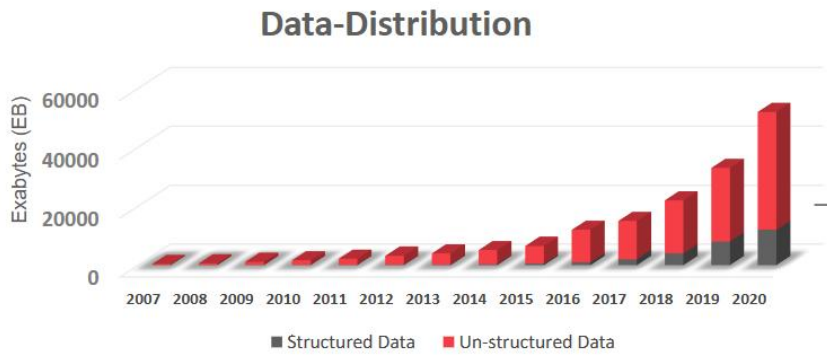
Unstructured Data is exploding



This accelerated growth of **UNSTRUCTURED** data is what turned into **BIG DATA**

By 2020, IDC predicted, Unstructured Data to have reached ***40 Zettabytes (ZB)***

By 2020, there will be ***5,200 GB*** of data for every person on Earth

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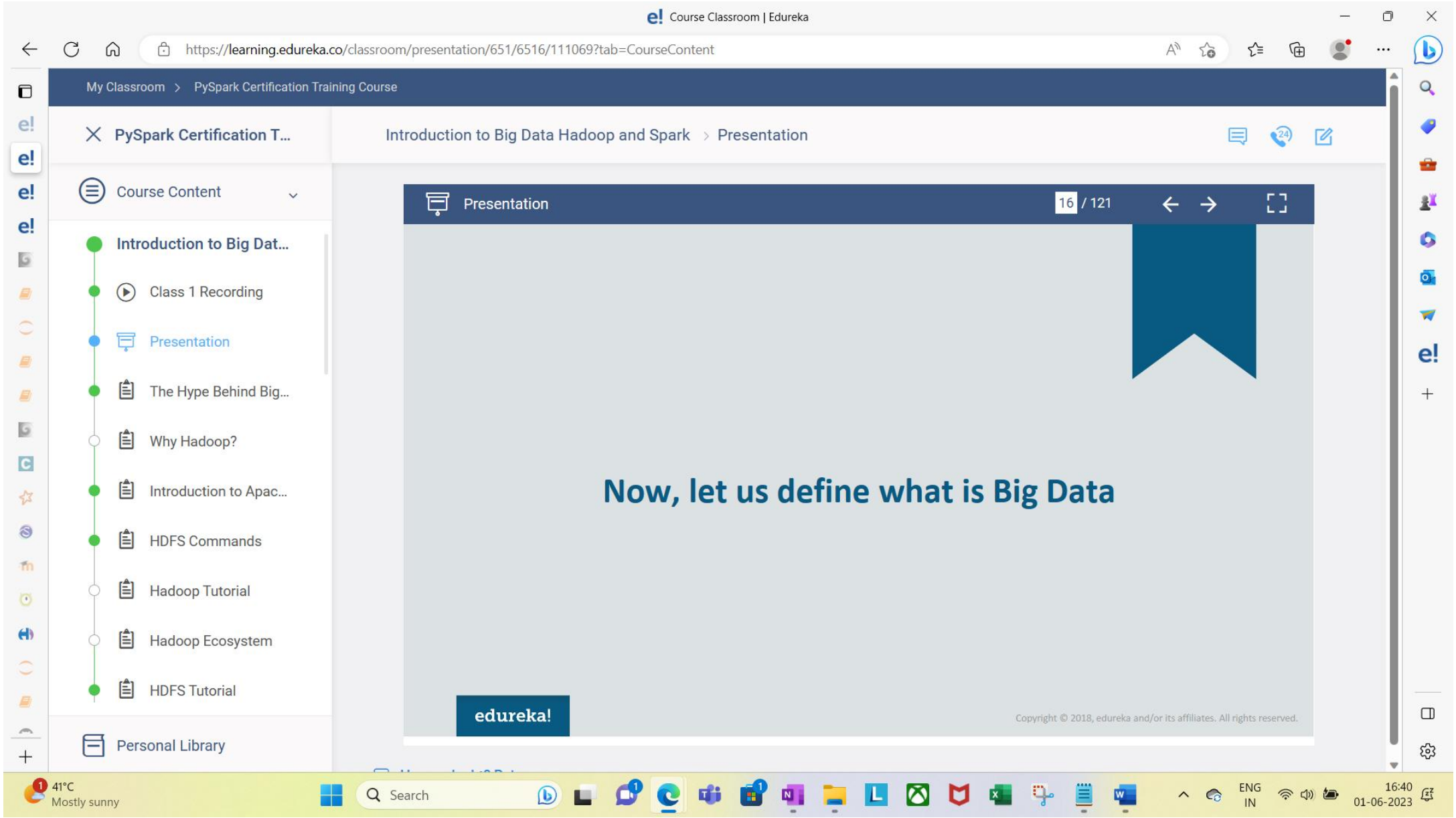
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Now, let us define what is Big Data
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What is Big Data?

BIG DATA is the term for a collection of data sets so ***large and complex*** that it becomes ***difficult*** to process using on-hand database management tools or traditional data processing applications

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The 5 V's of Big Data

Volume	Variety	Velocity	Value	Veracity
Processing large amount of data	Processing different types of data	Data is being generated at an alarming rate	Finding correct meaning out of the data	Uncertainty and inconsistencies in the data

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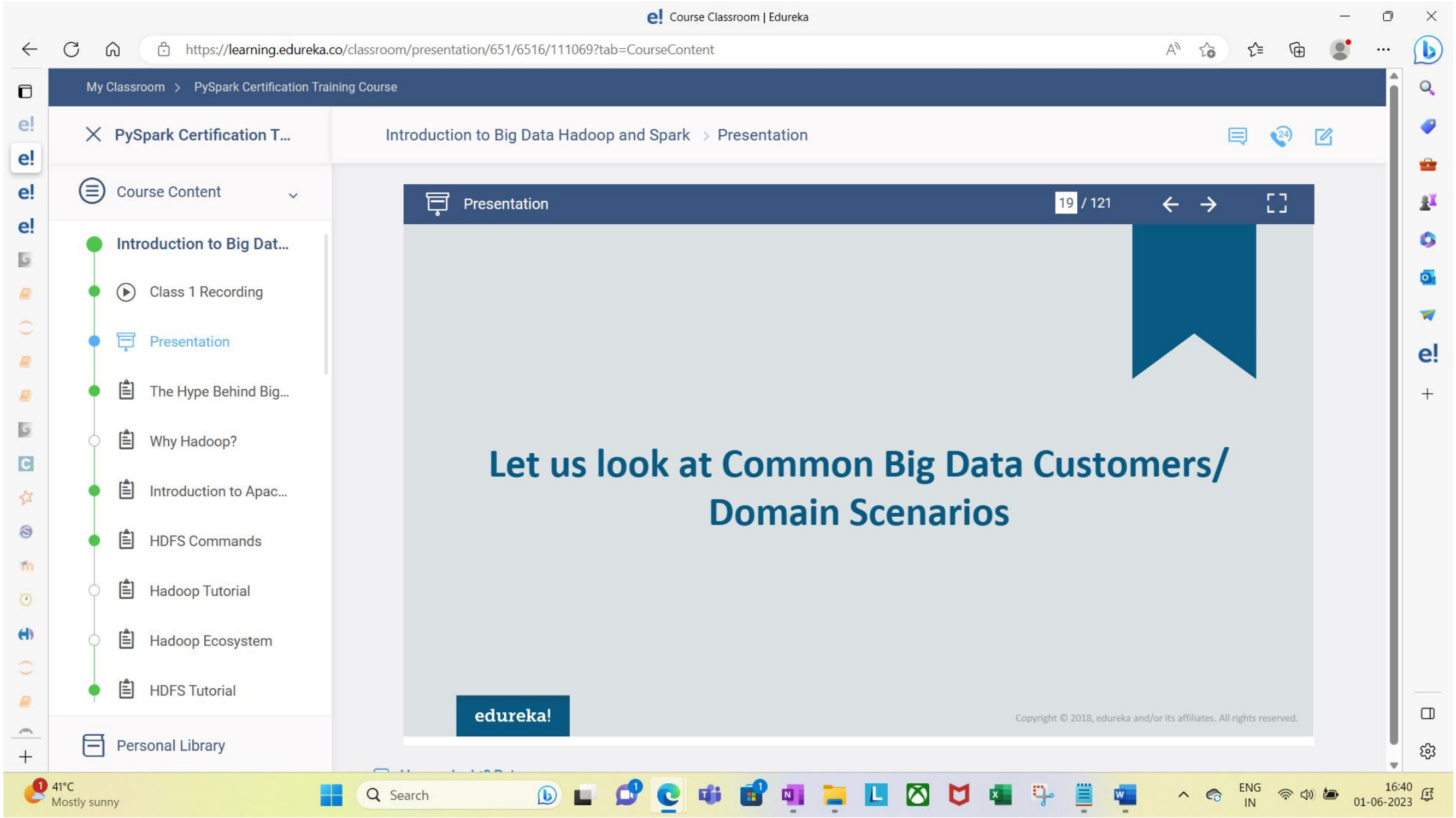
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Common Big Data Customer/Domain Scenarios

- **Web and e-tailing**
  - Recommendation Engines
  - Ad Targeting
  - Search Quality
  - Abuse and Click Fraud Detection

- **Government**
  - Fraud Detection and Cyber Security
  - Welfare Schemes
  - Justice

- **Telecommunications**
  - Customer Churn Prevention
  - Network Performance Optimization
  - Calling Data Record (CDR) Analysis
  - Analysing Network to Predict Failure

- **Healthcare and Life Sciences**
  - Health Information Exchange
  - Gene Sequencing
  - Serialization
  - Healthcare Service Quality Improvements
  - Drug Safety

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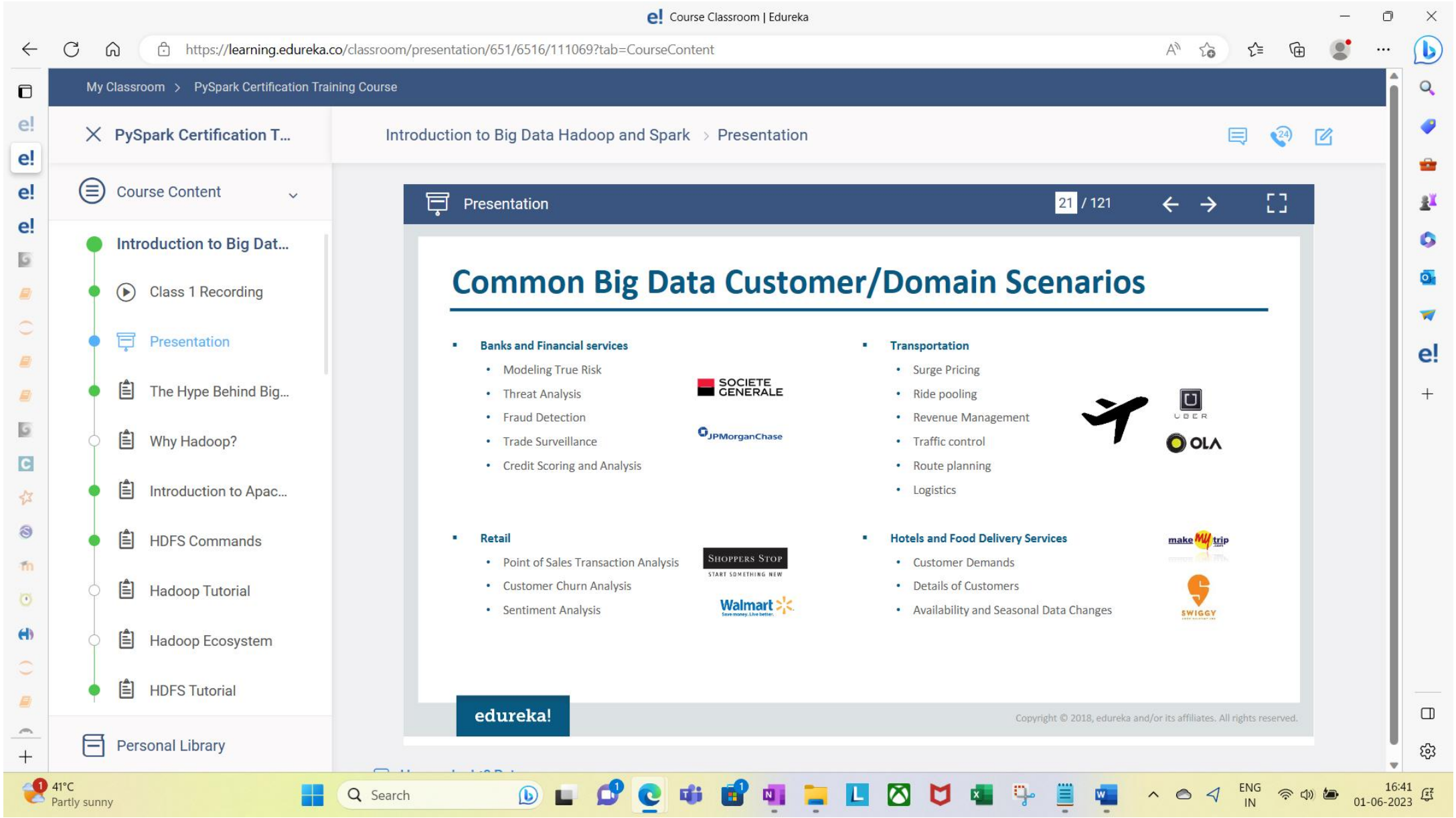
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Threat Analysis
Fraud Detection
Trade Surveillance
Credit Scoring and Analysis
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JPMorganChase
Transportation
Surge Pricing
Ride pooling
Revenue Management
Traffic control
Route planning
Logistics
UBER
OLA
Retail
Point of Sales Transaction Analysis
Customer Churn Analysis
Sentiment Analysis
SHOPPERS STOP
Walmart
Hotels and Food Delivery Services
Customer Demands
Details of Customers
Availability and Seasonal Data Changes
make MY trip
SWIGGY
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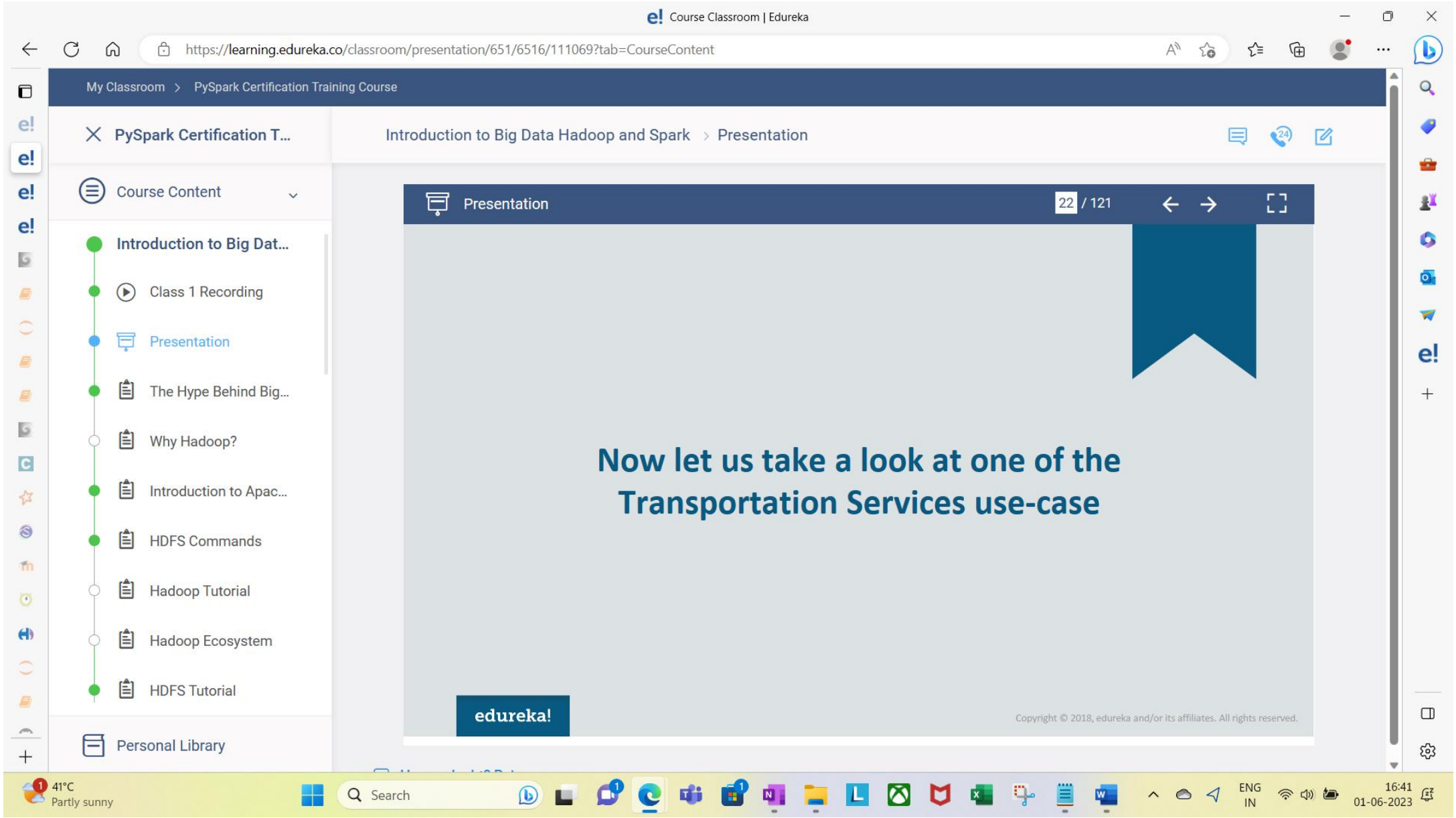
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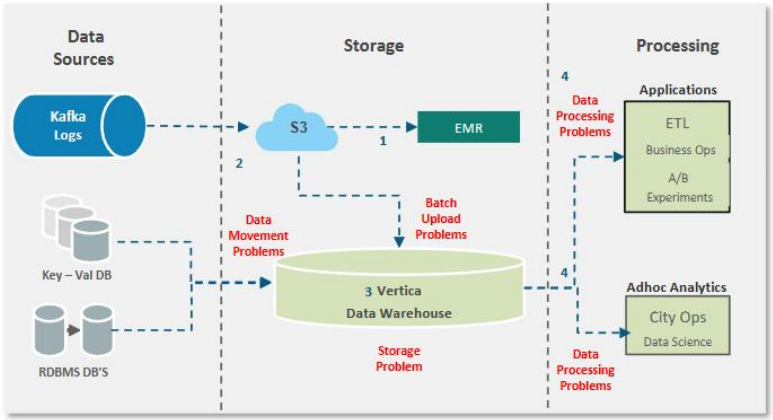
Problems : Old Uber Infrastructure (2014)



PROBLEMS

1. ***Data locality*:** Using a single place for storage led to **data movement problems** and also increased the risk of **Single point of Failure**
2. ***Scale issues*:** As they started growing there were many problems , **mainly with the batch upload problem** as they started collecting many sorts of data like "**Car Speed, traffic data, user data, fare**"
3. ***Storage*:** With the increasing amount of data it became difficult to store the data
4. ***Handling unstructured data*:** With Inconsistency in data (unstructured), the processing problems also increased

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Probable Solution to the Problems

- We need something which can *store large amounts of data*, and *can be scaled easily* if we get more data

- There shouldn't be any difficulties in *batch-upload of data*
- Data processing and analysis should be fast, *both for static as well as live streaming data*

- Handling and processing unstructured data from different sources into a *structured format*

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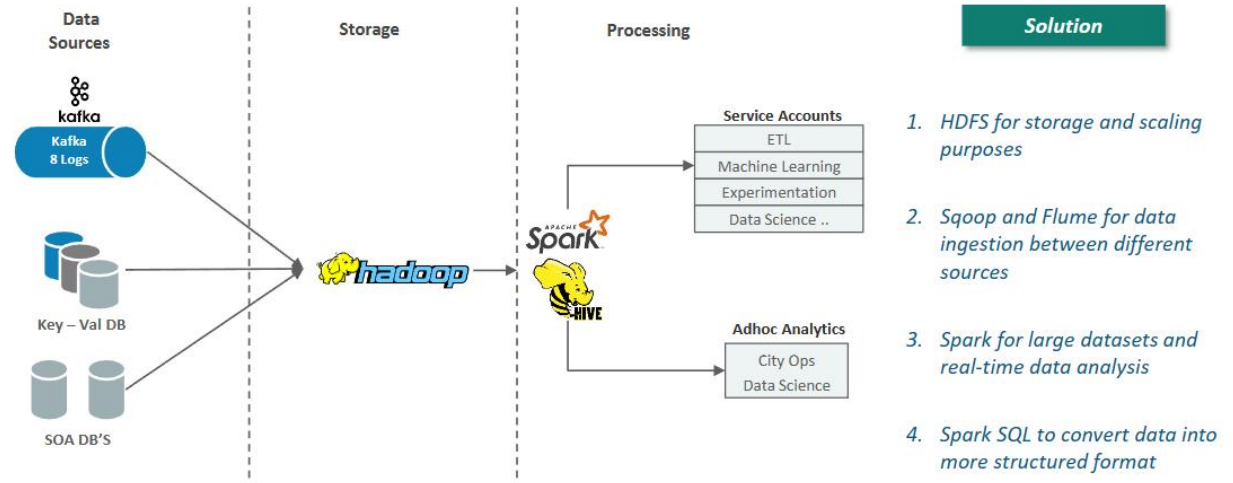
Solution : Present Infrastructure



Source : Datanami

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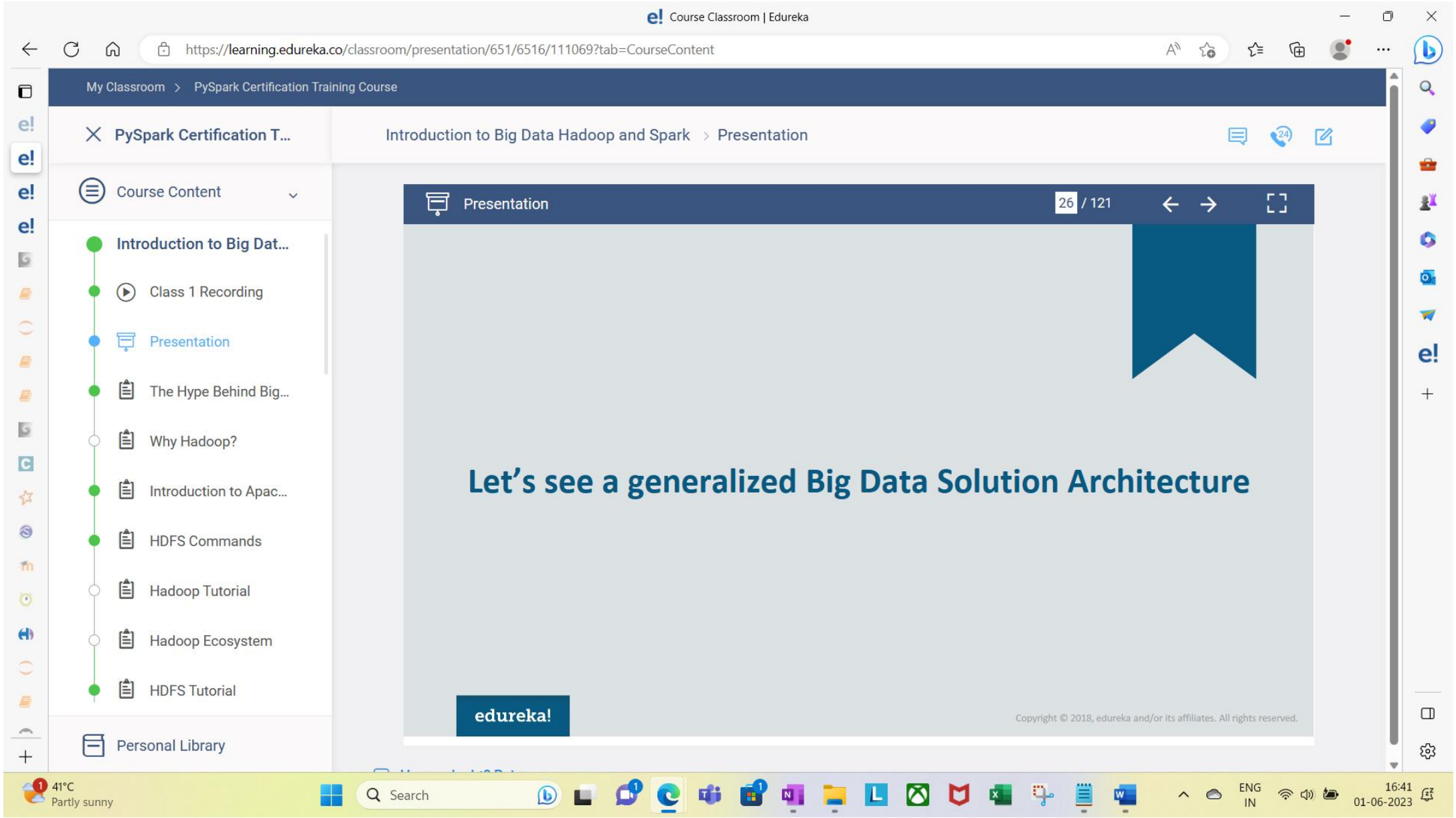
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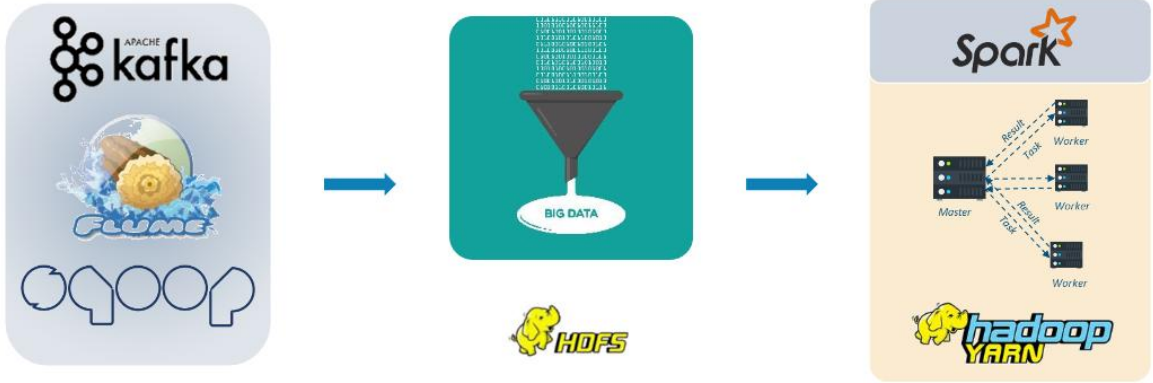
Big Data Solution Architecture



Data sources and ingestion tools

Storing huge & complex data on HDFS

Processing through Hadoop and Spark

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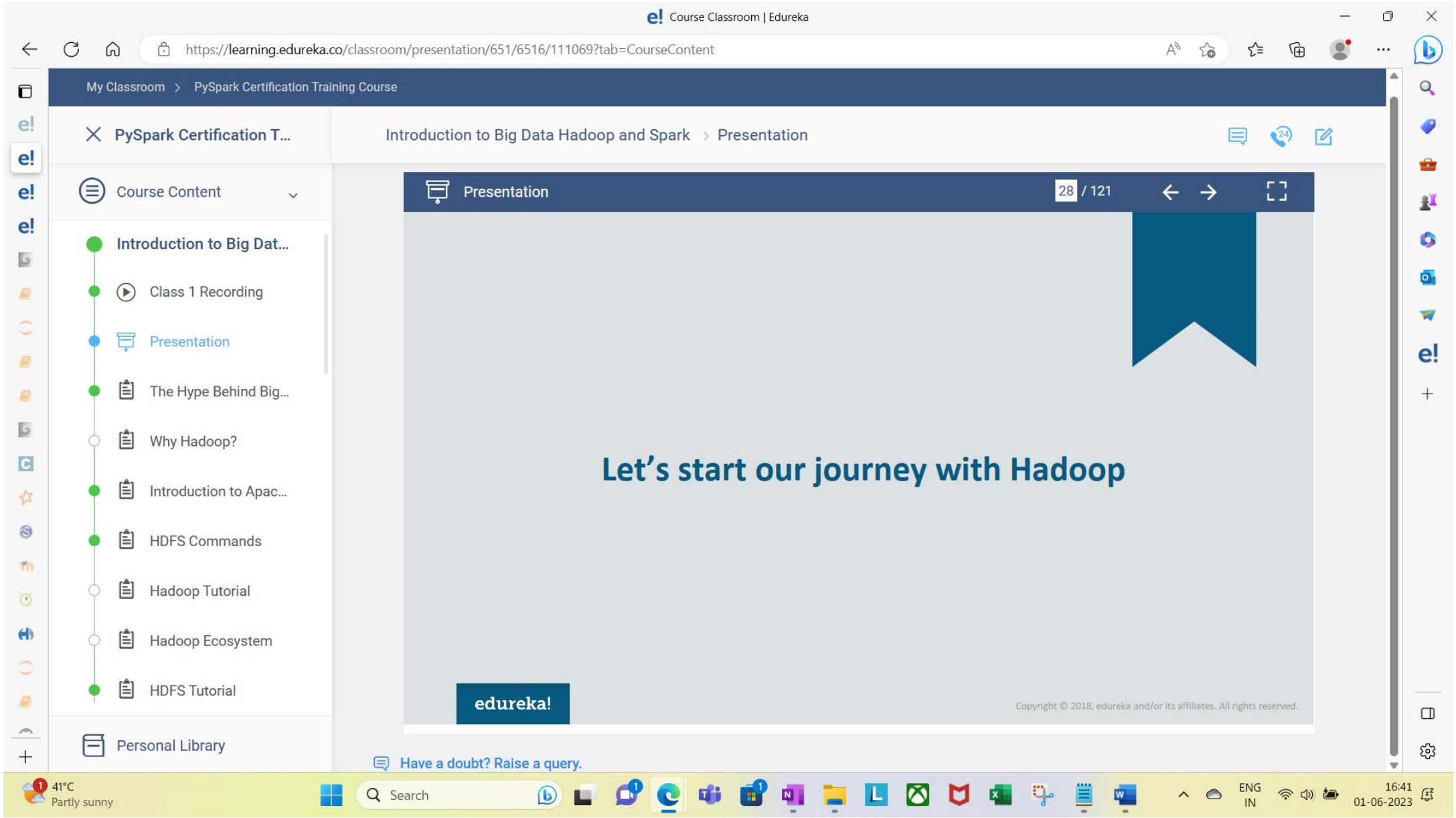
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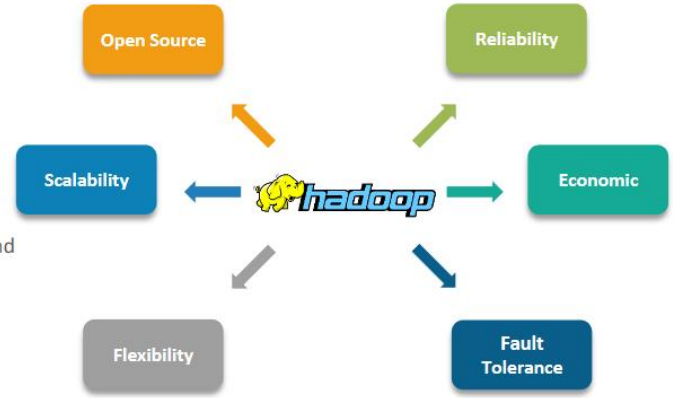
What is Hadoop?

- Apache Hadoop is an ***open-source framework*** that allows distributed processing of large data sets across clusters of commodity machines using a simple programming model
- It enables ***data management*** with ***scalable storage*** and ***distributed processing***



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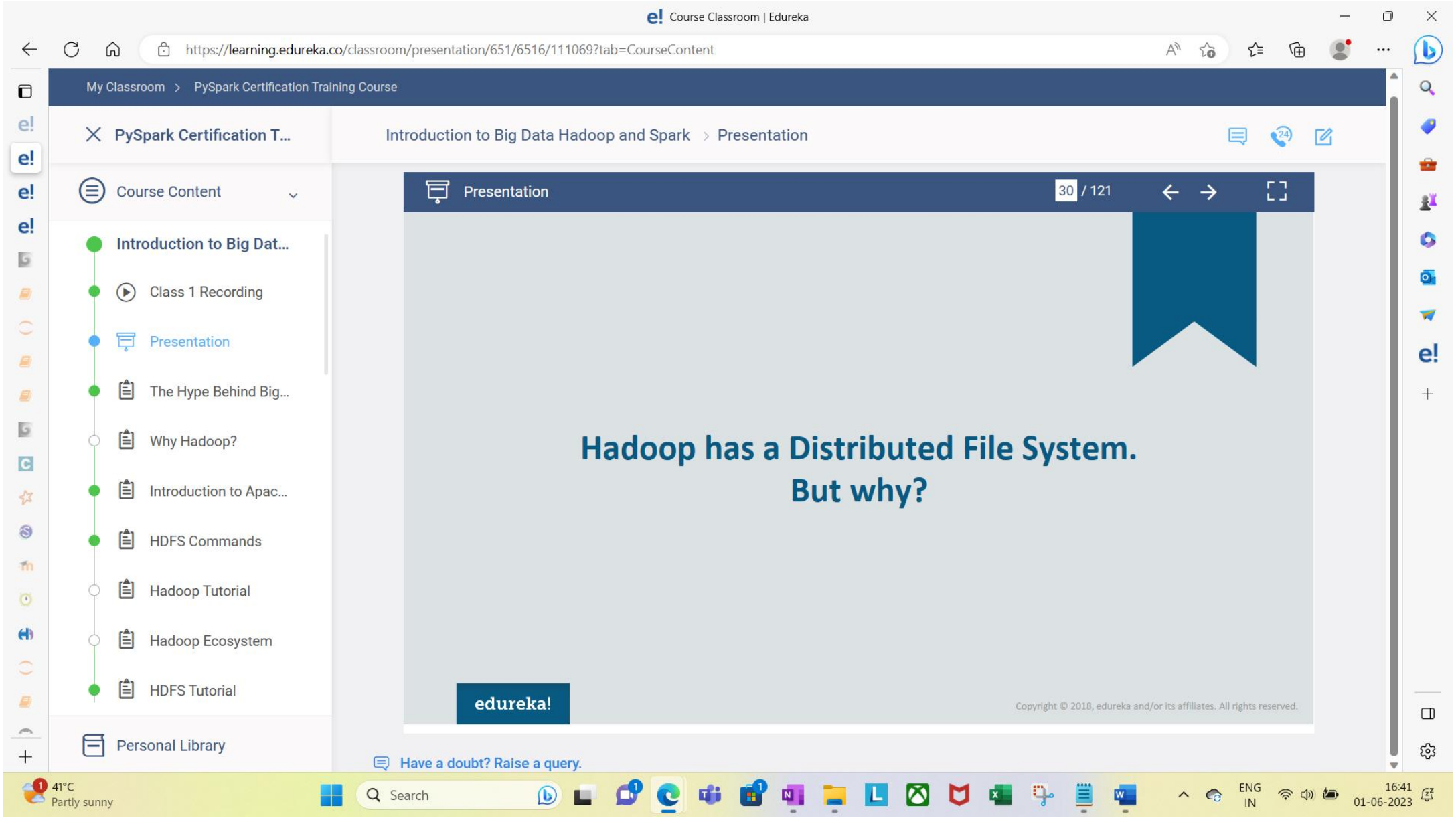
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Hadoop has a Distributed File System.
But why?
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DFS : Distributed File System

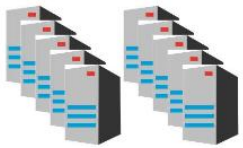
Distributed & Parallel Computation

Read 1 TB data

1 Machine

4 I/O channels
Each channel – 100 MB/s

43 Minutes



10 Machine

4 I/O channels
Each channel – 100 MB/s

Time taken = ??

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Have a doubt? Raise a query.

Presentation 32 / 121

DFS : Distributed File System

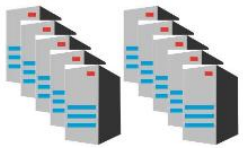
Distributed & Parallel Computation

Read 1 TB data

1 Machine

4 I/O channels
Each channel – 100 MB/s

43 Minutes



10 Machine

4 I/O channels
Each channel – 100 MB/s

4.3 Minutes

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Have a doubt? Raise a query.

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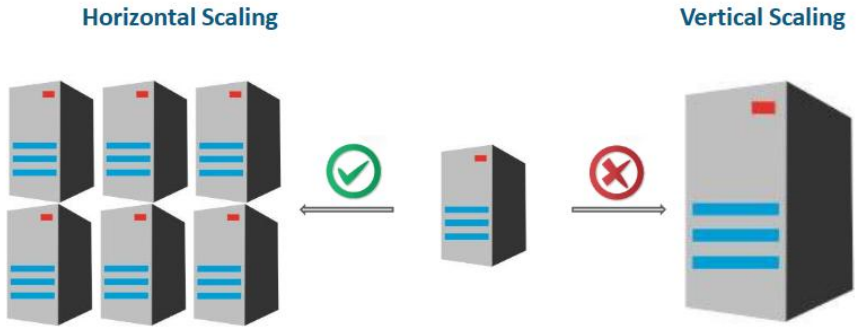
DFS : Horizontal and Vertical Scaling



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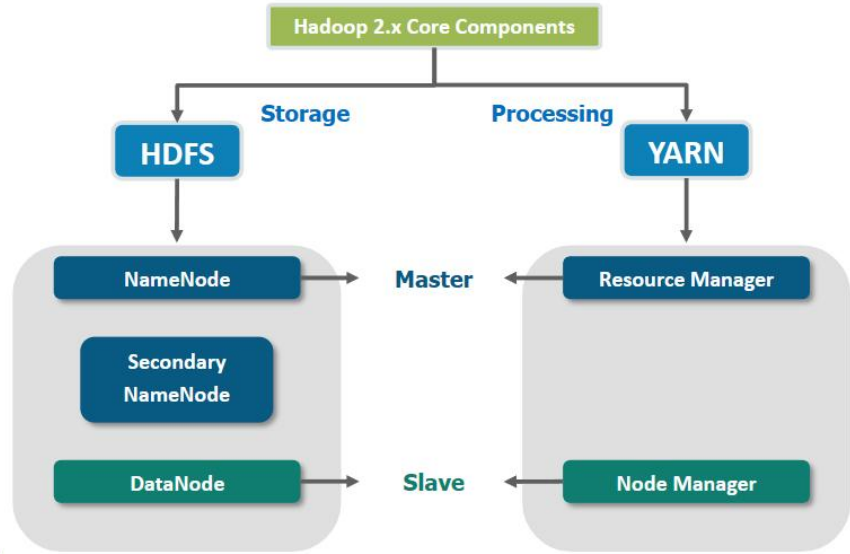
Hadoop 2.x Core Components



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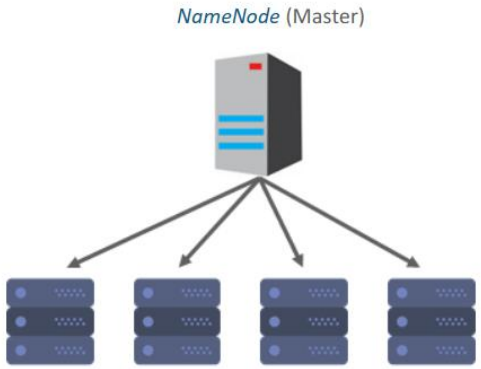
NameNode and DataNode

NameNode

- ***Master deamon*** which *maintains* and *manages* the *DataNodes* (slave nodes)
- *Records the metadata* of all the files stored in the cluster
- Regularly *receives a Heartbeat* and a *block report* from all the DataNodes in the cluster

DataNode

- ***Slave daemons*** which runs on each slave machine
- The actual *data* is *stored* on DataNodes
- Responsible for *serving read & write requests* from the clients



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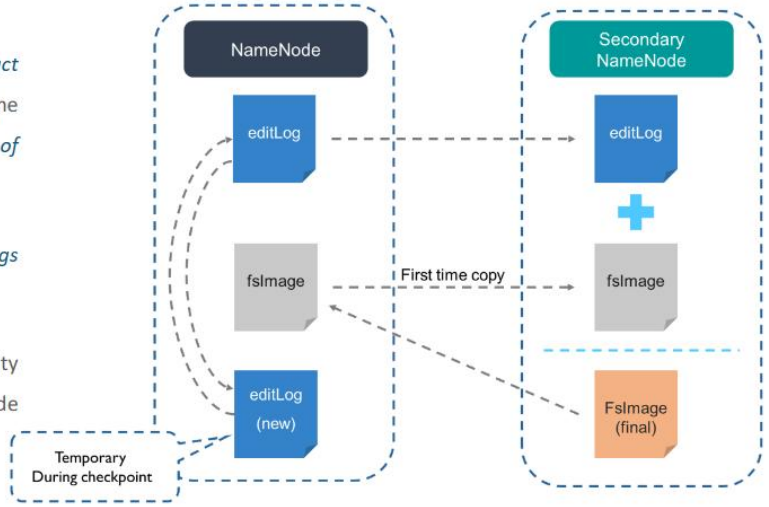
Secondary NameNode & Checkpointing

Secondary NameNode

- *Job of* ***Secondary NameNode*** is to *contact NameNode* in a *periodic manner* after certain time interval(by default 1 hour) and *pulls copy of metadata* information out of NameNode
- **Checkpointing** is a process of *combining edit logs with FsImage*
- Secondary NameNode takes over the responsibility of checkpointing, therefore making NameNode more available



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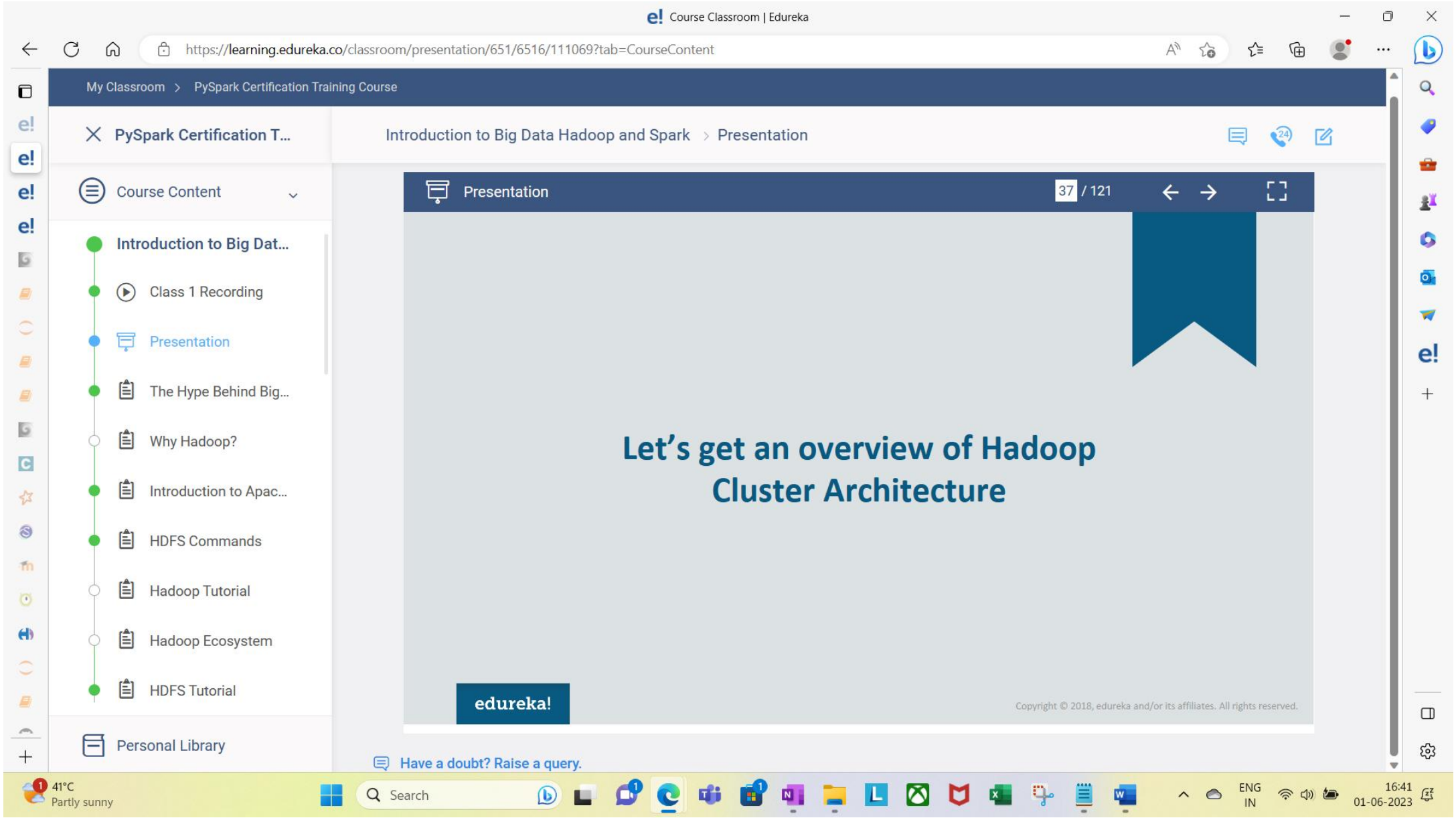
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Let's get an overview of Hadoop Cluster Architecture
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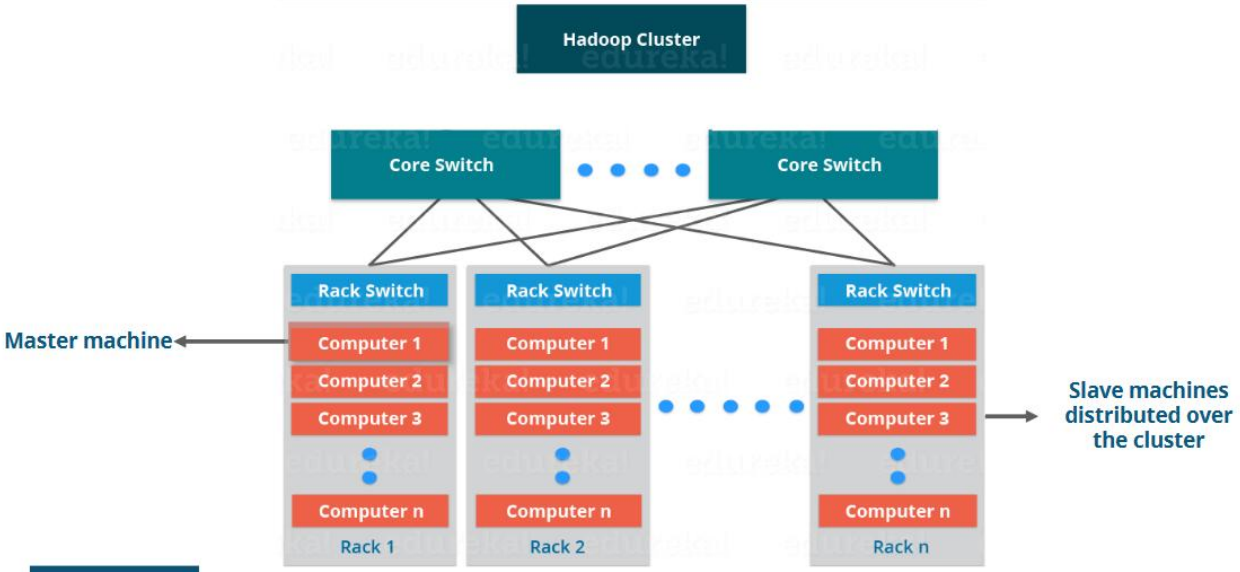
Hadoop Cluster Architecture : Master Slave Topology



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Typical Hadoop Cluster Configuration

NameNode
- **RAM:** 64 GB,
- **Hard disk:** 1 TB
- **Processor:** Xenon with 8 Cores
- **Ethernet:** 3 x 10 GB/s
- **OS:** 64-bit CentOS / Linux
- **Power:** Redundant Power Supply

Secondary NameNode
- **RAM:** 32 GB
- **Hard disk:** 1 TB
- **Processor:** Xenon with 4 Cores
- **Ethernet:** 3 x 10 GB/s
- **OS:** 64-bit CentOS / Linux
- **Power:** Redundant Power Supply

DataNode
- **RAM:** 16GB
- **Hard disk:** 6 x 2TB
- **Processor:** Xenon with 2 cores
- **Ethernet:** 3 x 10 GB/s
- **OS:** 64-bit CentOS / Linux

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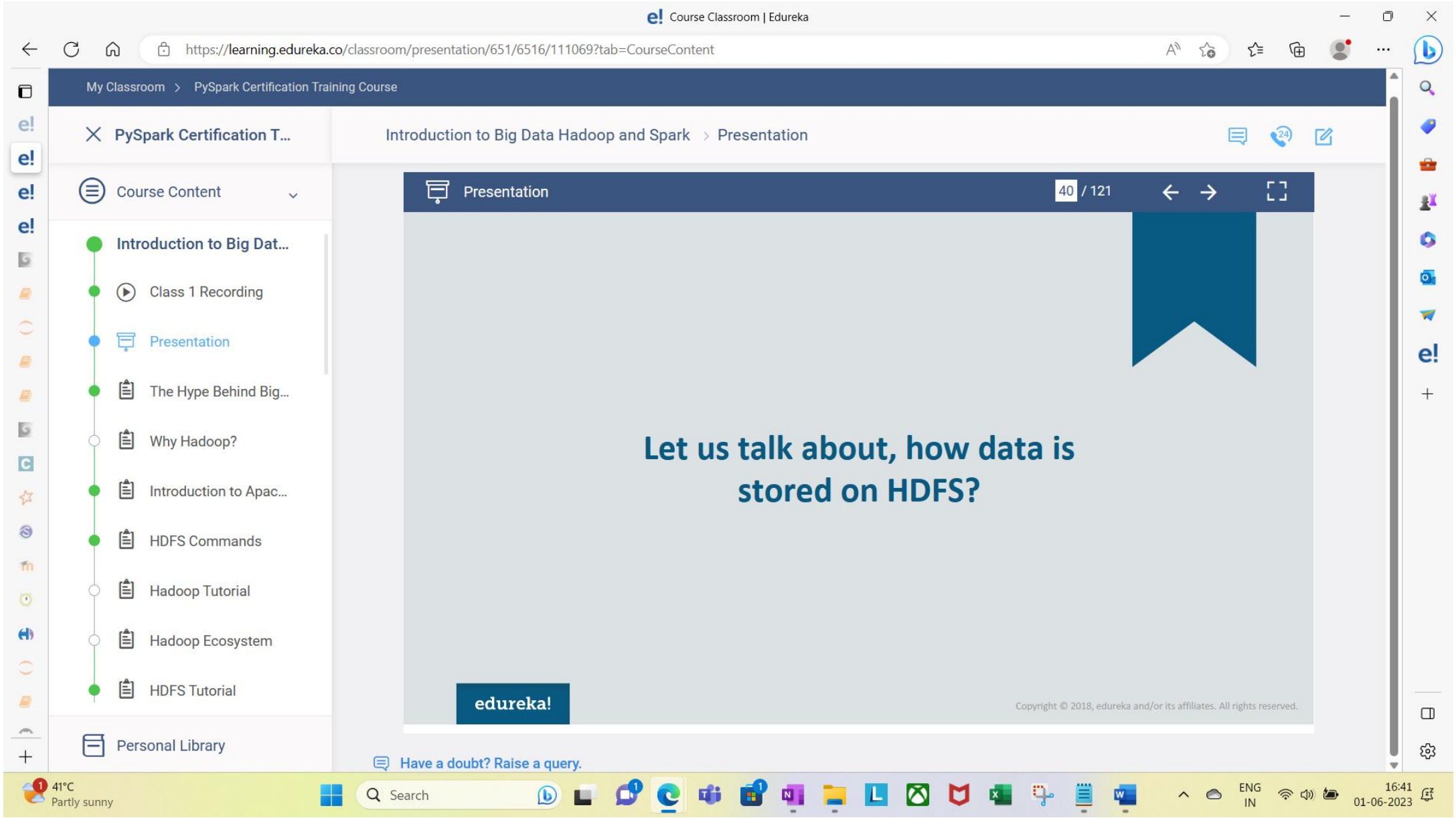
Have a doubt? Raise a query.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Let us talk about, how data is stored on HDFS?
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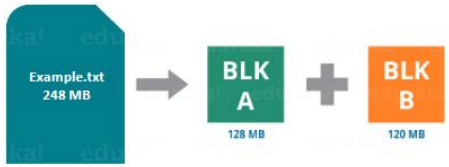
HDFS Blocks

- Each *file* is *stored* on *HDFS* as *blocks*
- The *default size* of each block is *128 MB* in Apache Hadoop 2.x
- Let us say, I have a *file "example.txt" of size 248 MB*. Below is the representation of how it will be stored on HDFS



How many blocks will be created if a file of size 514 MB is copied to HDFS ?

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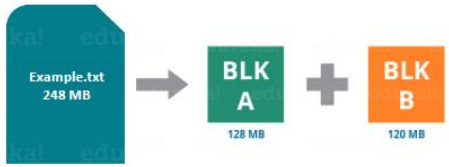
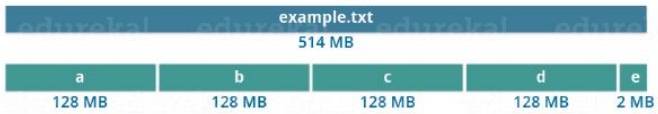
HDFS Blocks

- Each *file* is *stored* on *HDFS* as *blocks*
- The *default size* of each block is *128 MB* in Apache Hadoop 2.x
- Let us say, I have a *file "example.txt" of size 248 MB*. Below is the representation of how it will be stored on HDFS



How many blocks will be created if a file of size 514 MB is copied to HDFS ?



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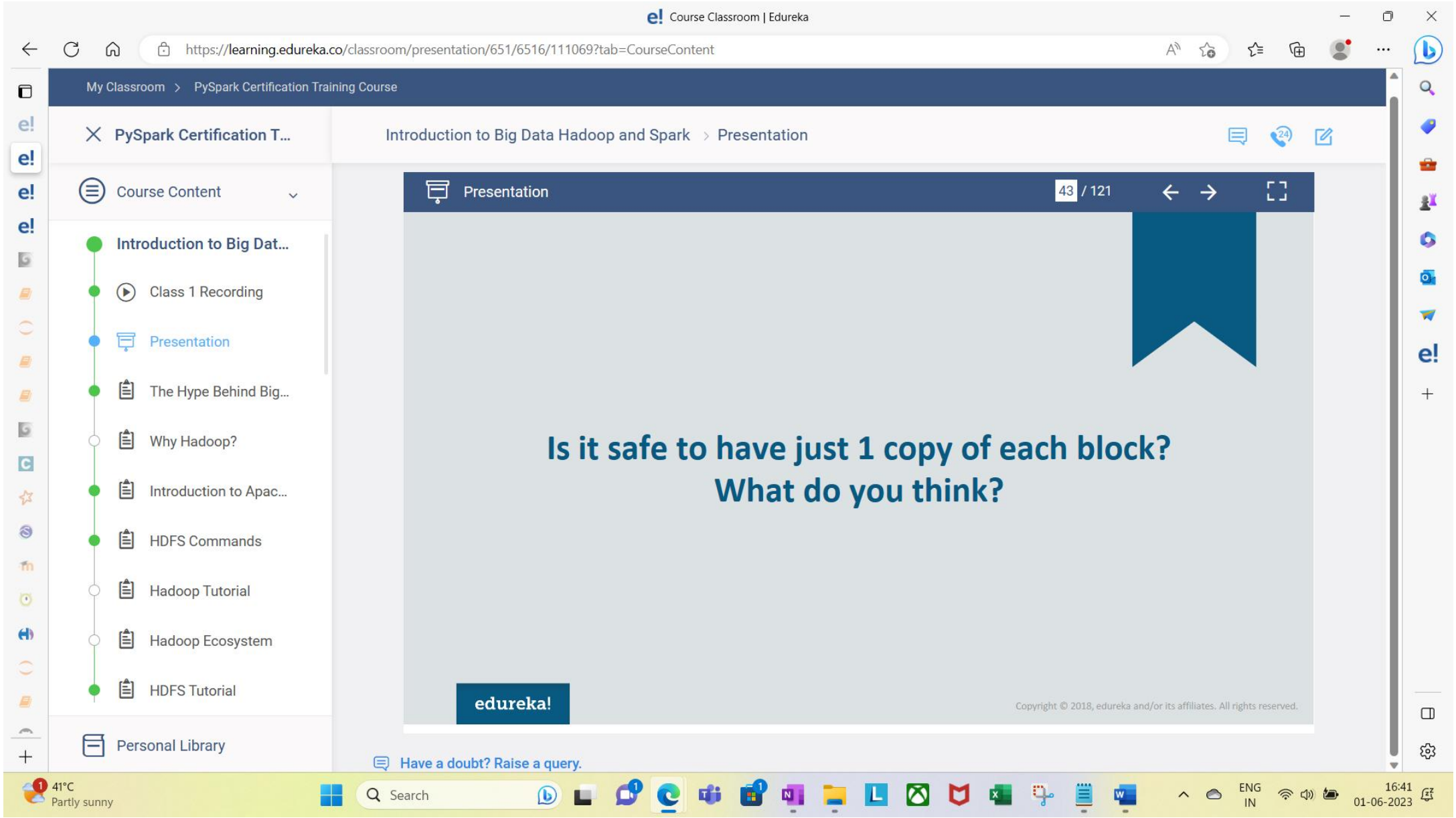
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Is it safe to have just 1 copy of each block?
What do you think?
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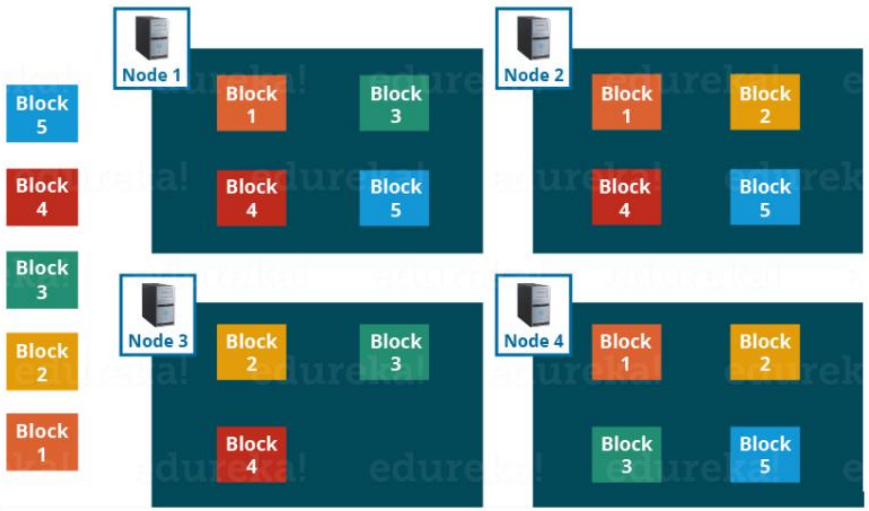
Block Replication

By Default the replication factor is **3**



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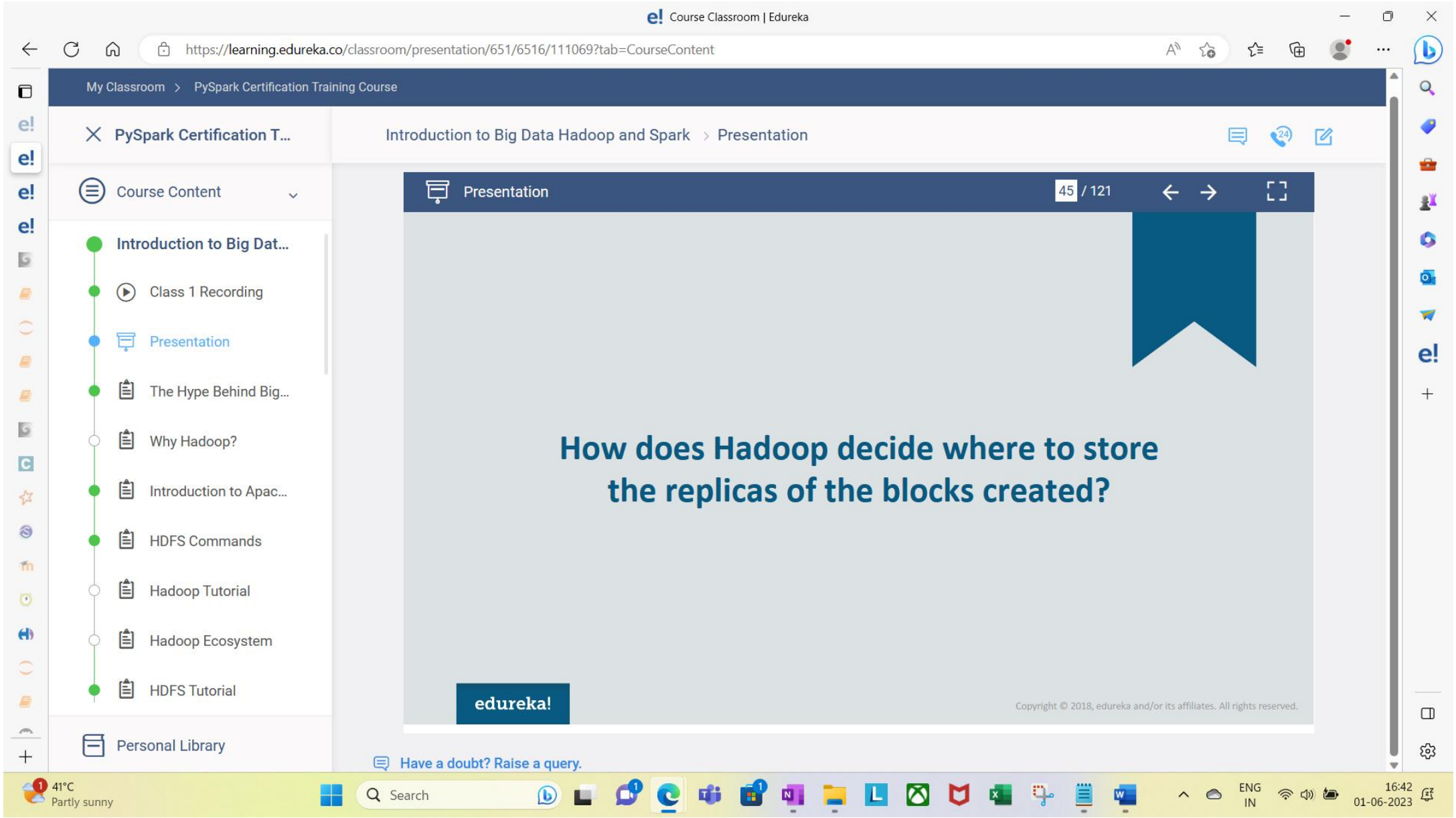
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How does Hadoop decide where to store the replicas of the blocks created?
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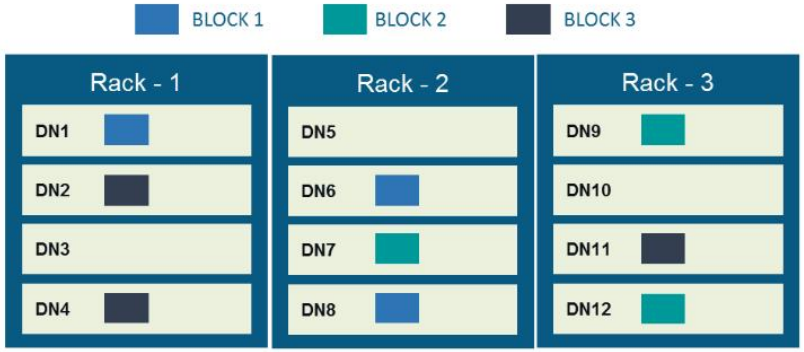
Rack Awareness

- *Rack awareness algorithm reduces latency* as well as *provide fault tolerance* by replicating data block
- Rack awareness algorithm says that the *first replica of a block will be stored on a local rack & the next two replicas will be stored on a different (remote) rack*



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Rack Awareness

Rack - 1	Rack - 2	Rack - 3
DN1	DN5	DN9
DN2	DN6	DN10
DN3	DN7	DN11
DN4	DN8	DN12

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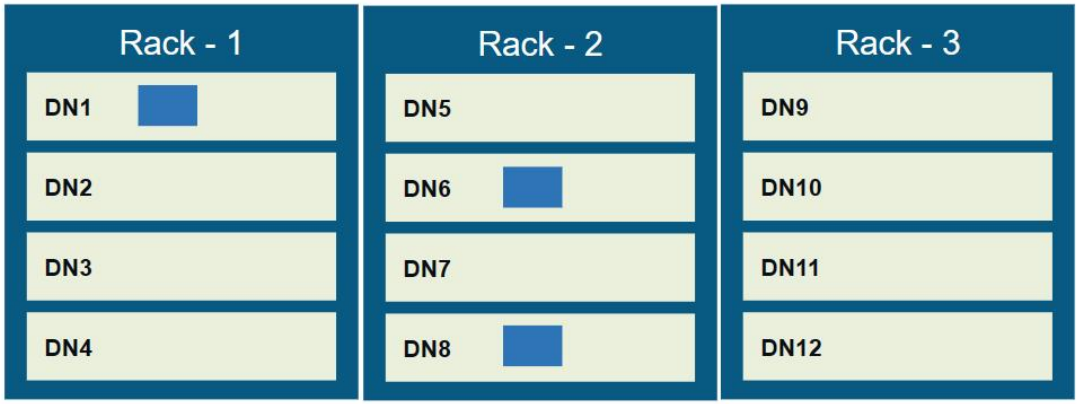
Rack Awareness



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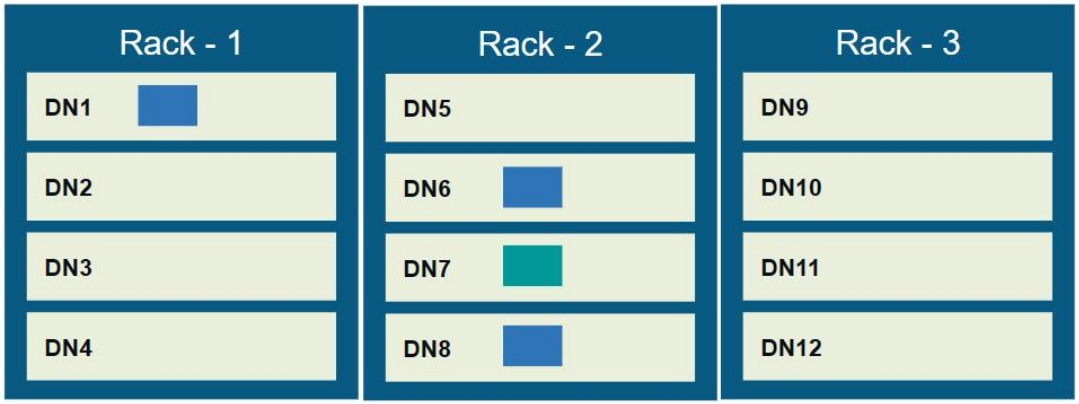
Rack Awareness



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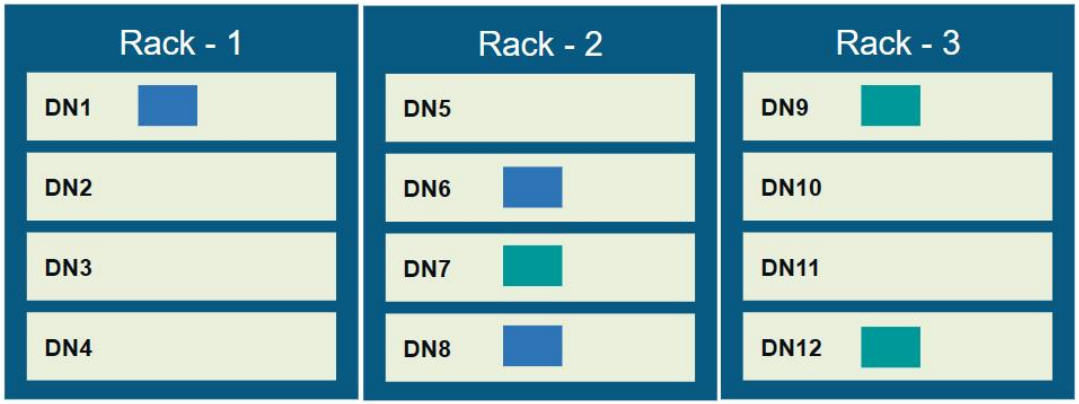
Rack Awareness



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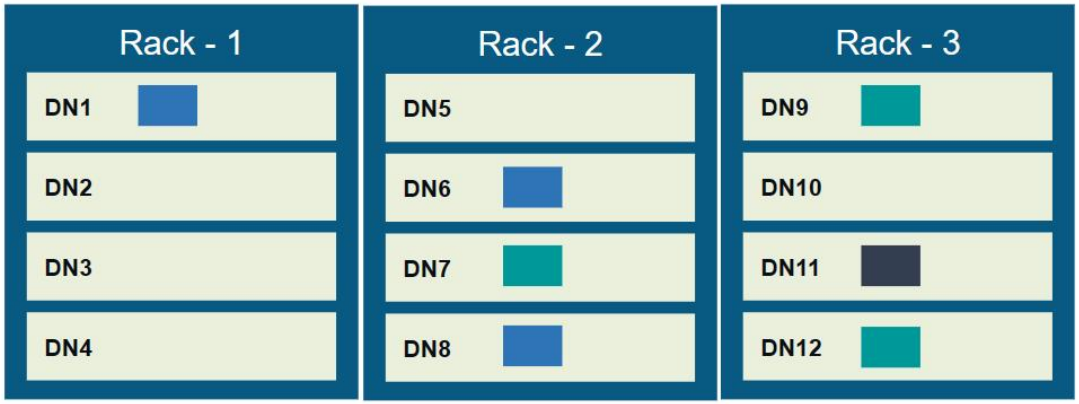
Rack Awareness



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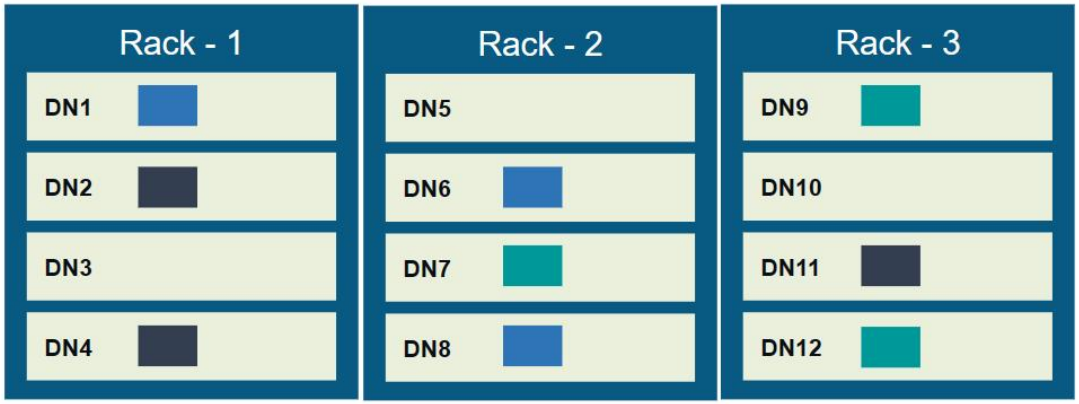
Rack Awareness



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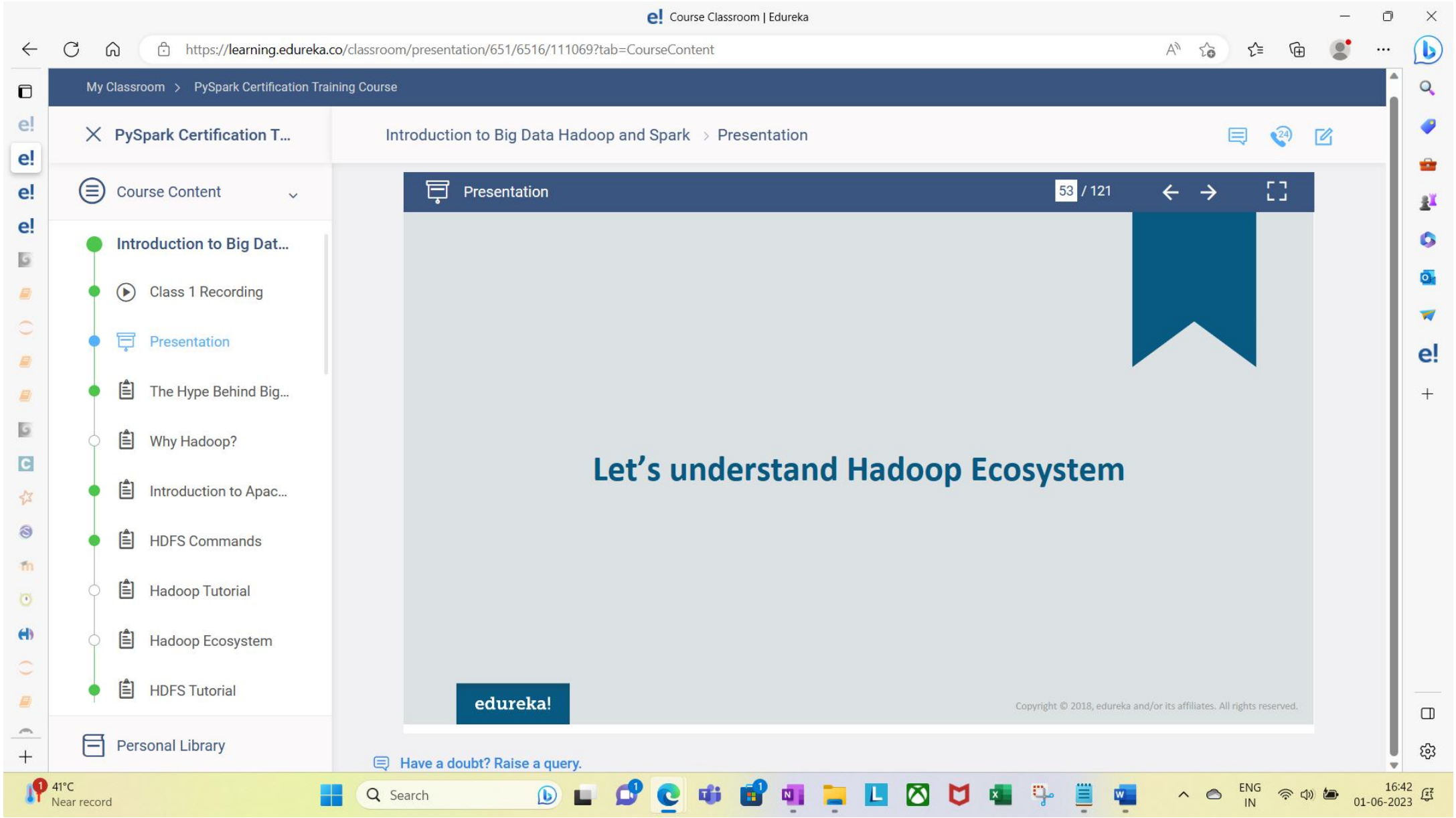
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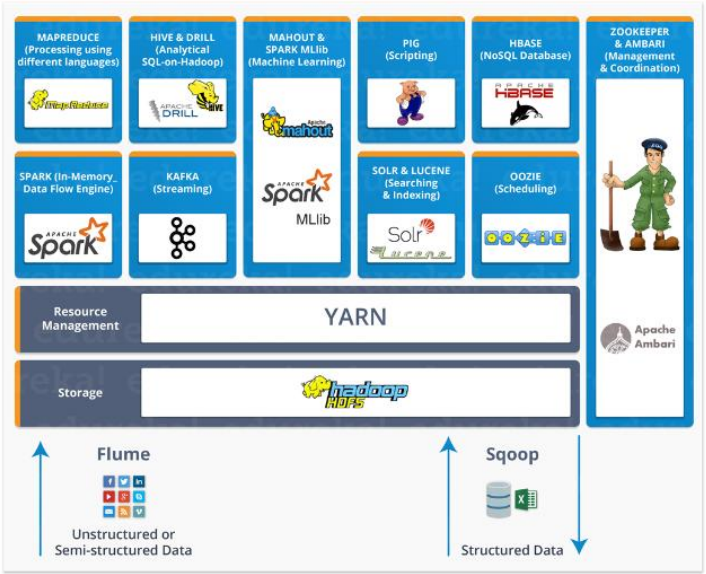
Hadoop Ecosystem



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Components of Hadoop Ecosystem

- **Apache Hadoop** provides a ***scalable solution*** to ***store and process huge data sets*** in parallel and distributed fashion
- **Apache Spark** is an ***in-memory data processing engine*** that allows us to efficiently execute streaming, machine learning or SQL workloads
- **Apache Flume** is a ***distributed, reliable*** and ***available service*** for ***efficiently collecting, aggregating***, and ***moving large amounts of log data***
- **Apache Sqoop** is a tool designed for efficiently ***transferring bulk data*** between ***Apache Hadoop*** and ***structured datastores*** such as ***RDBMS***
- **Apache Kafka** is a ***fast, scalable, durable*** and ***fault-tolerant publish-subscribe messaging system***

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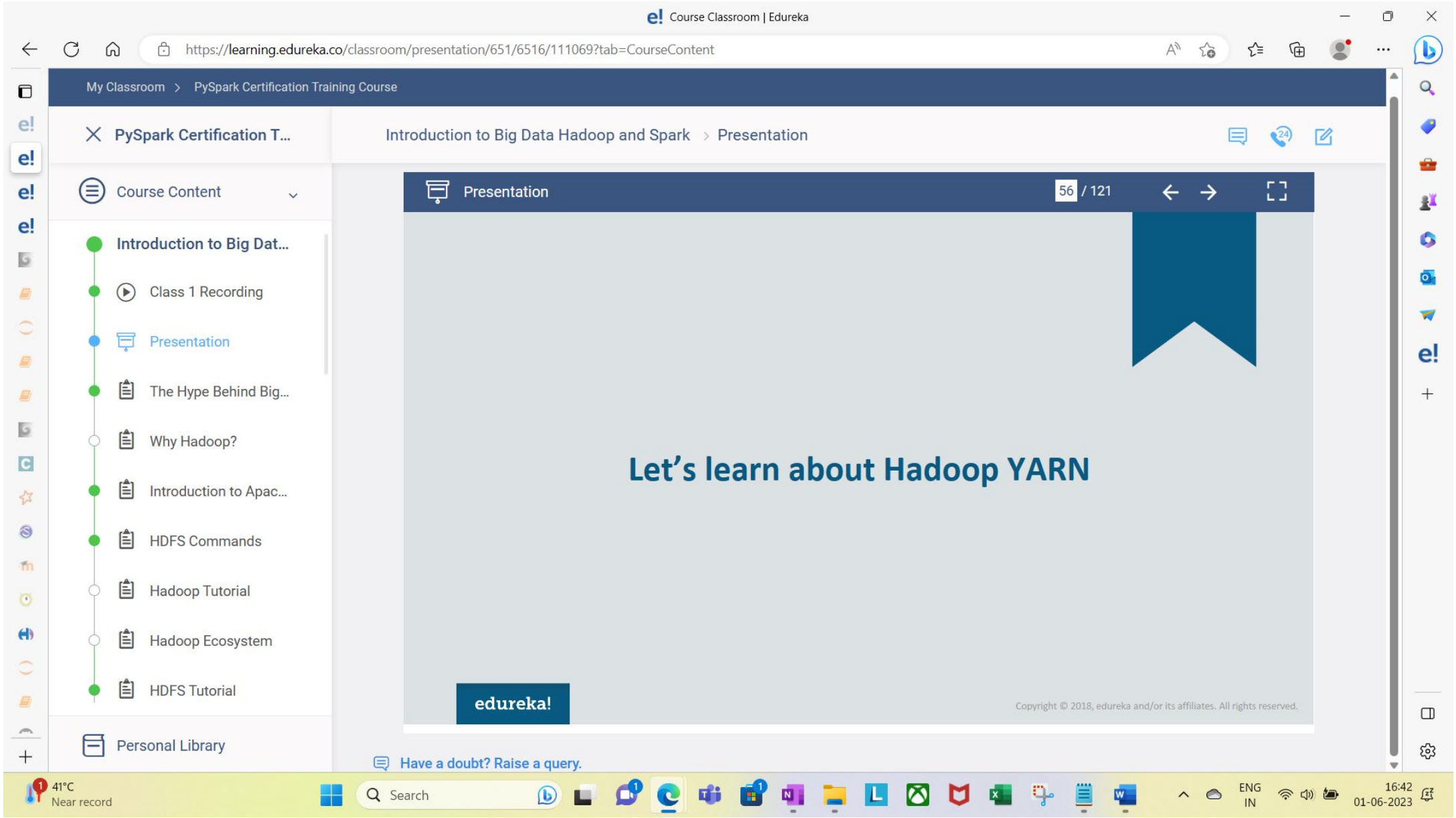
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YARN Use Case - YAHOO

YAHOO!

- Yahoo has close to 35,000 nodes running Apache Hadoop
- Performs 80,000 MapReduce jobs per day
- Over 150 PB of storage

YARN at *Yahoo* helped them increase the load on the *most heavily used Hadoop cluster*. Now performs *125,000 jobs a day* when compared to *80,000 jobs a day* which is close to *50% increase*

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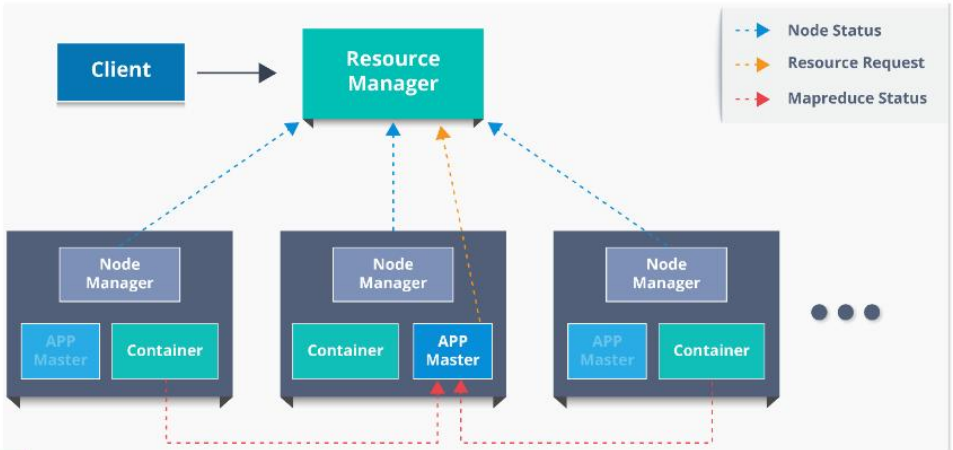
What is YARN?

- Hadoop 2.0 came up with a new framework ***YARN (Yet Another Resource Negotiator)***, which *provides ability to run Non-MapReduce application*
- YARN framework is *responsible for* doing *Cluster Resource Management*



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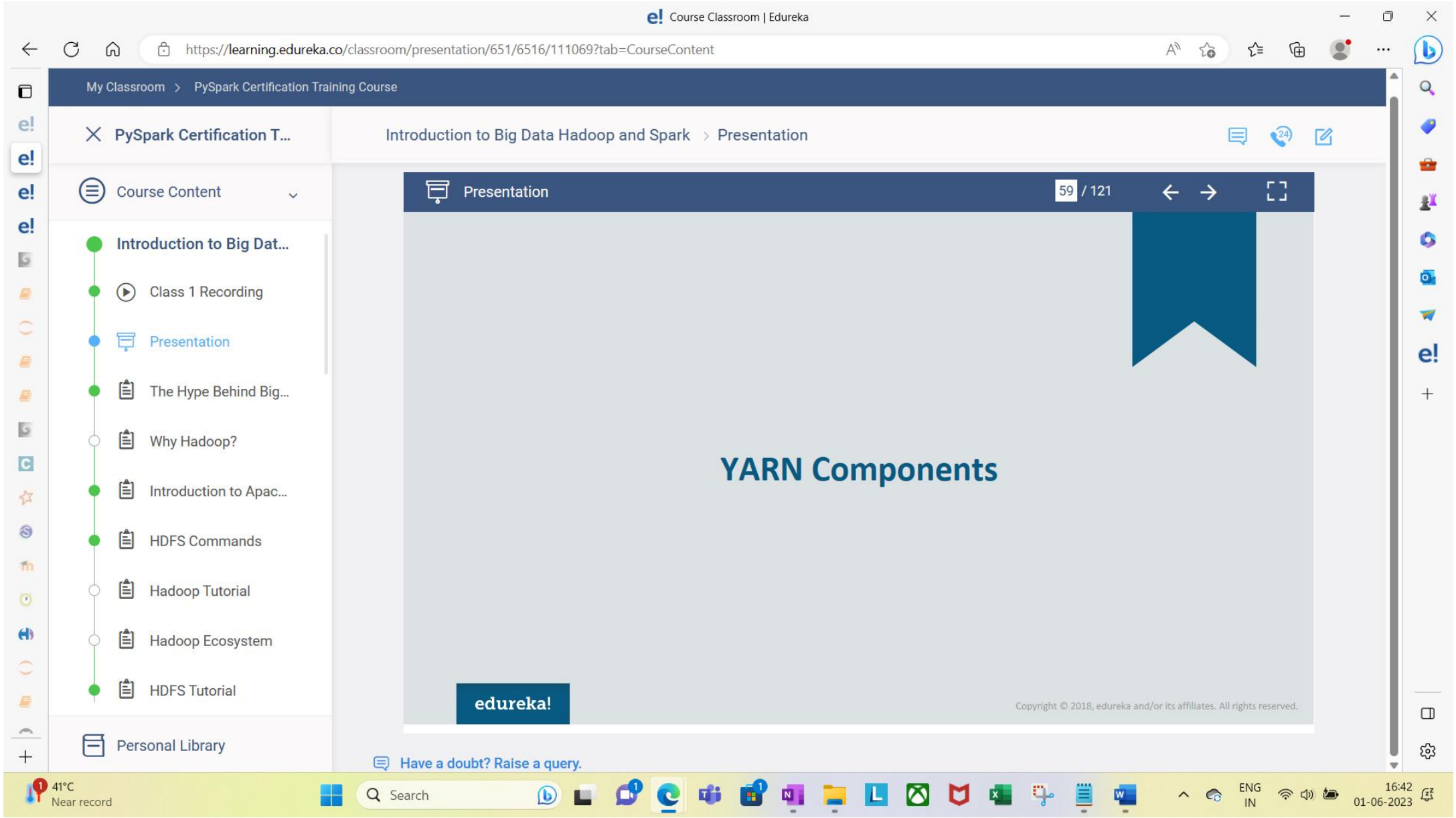
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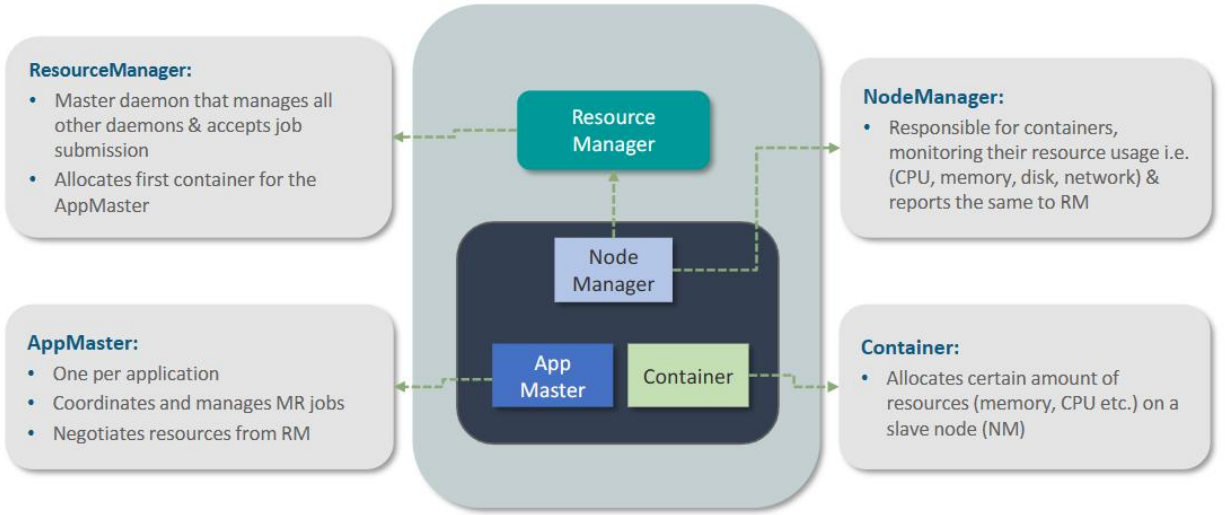
Main Components of YARN



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Application Submission in YARN

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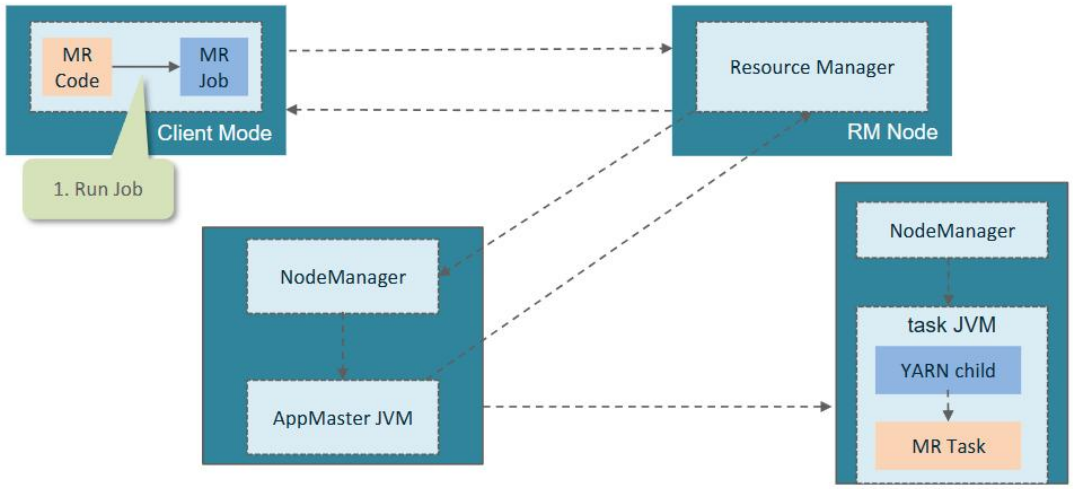
Application Submission in YARN



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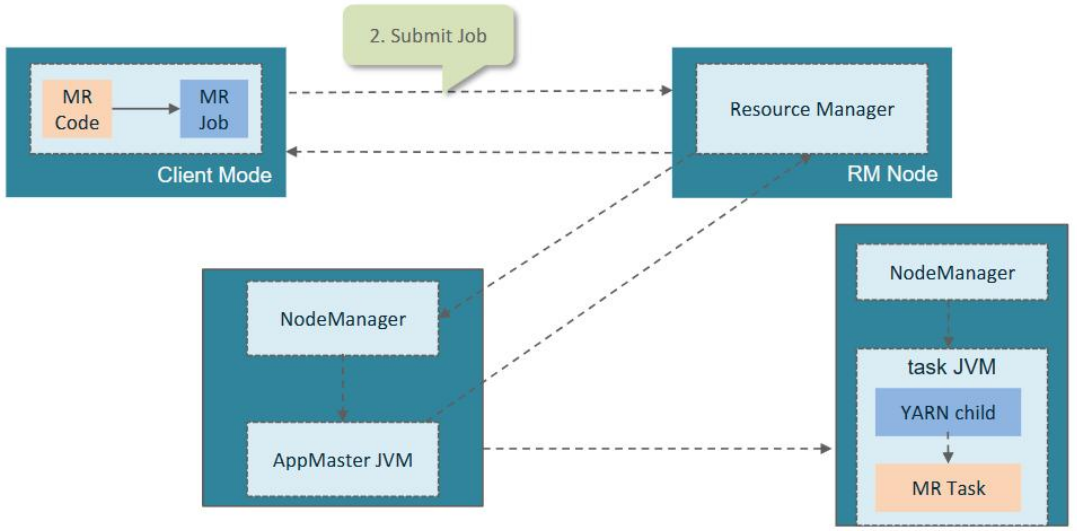
Application Submission in YARN



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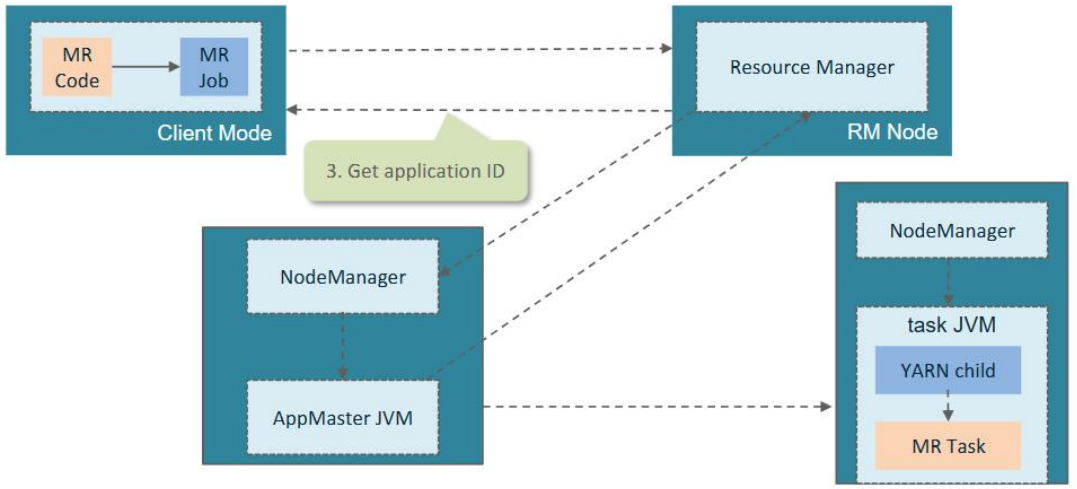
Application Submission in YARN



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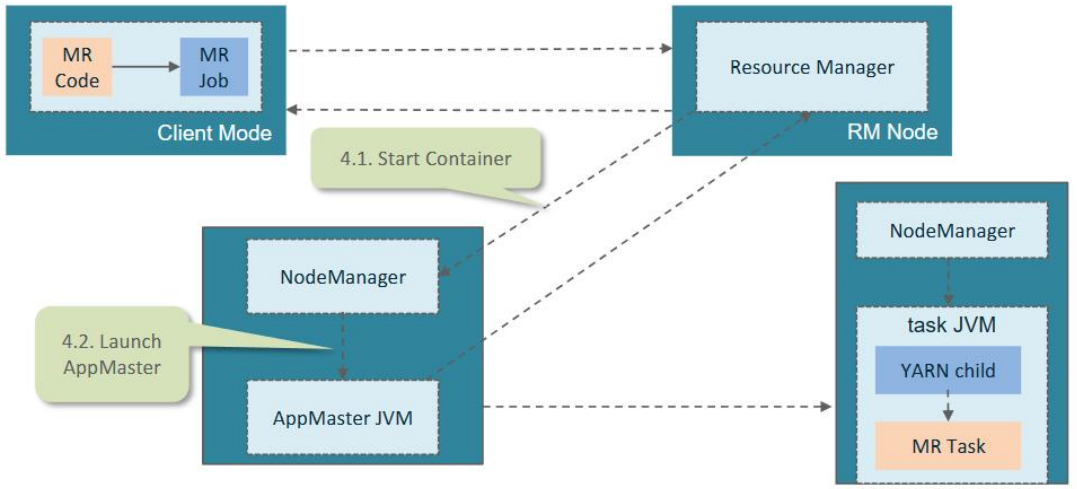
Application Submission in YARN



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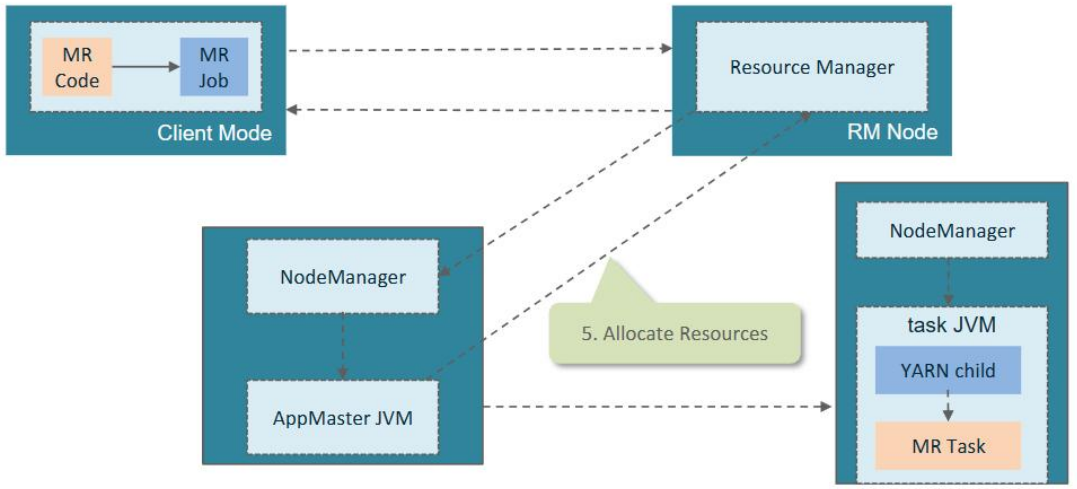
Have a doubt? Raise a query.

Presentation 66 / 121

Application Submission in YARN



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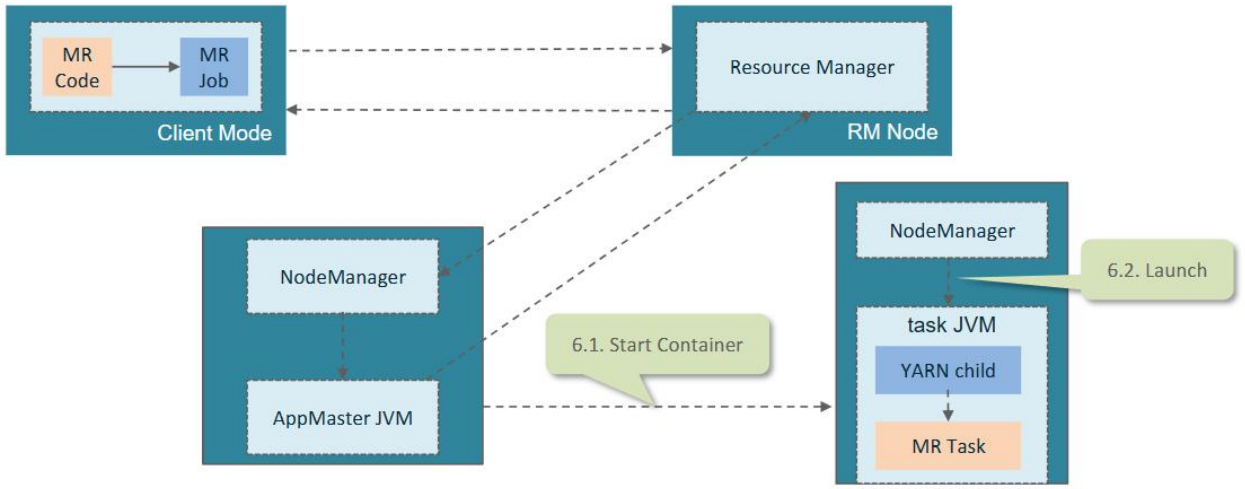
Presentation 67 / 121

Application Submission in YARN



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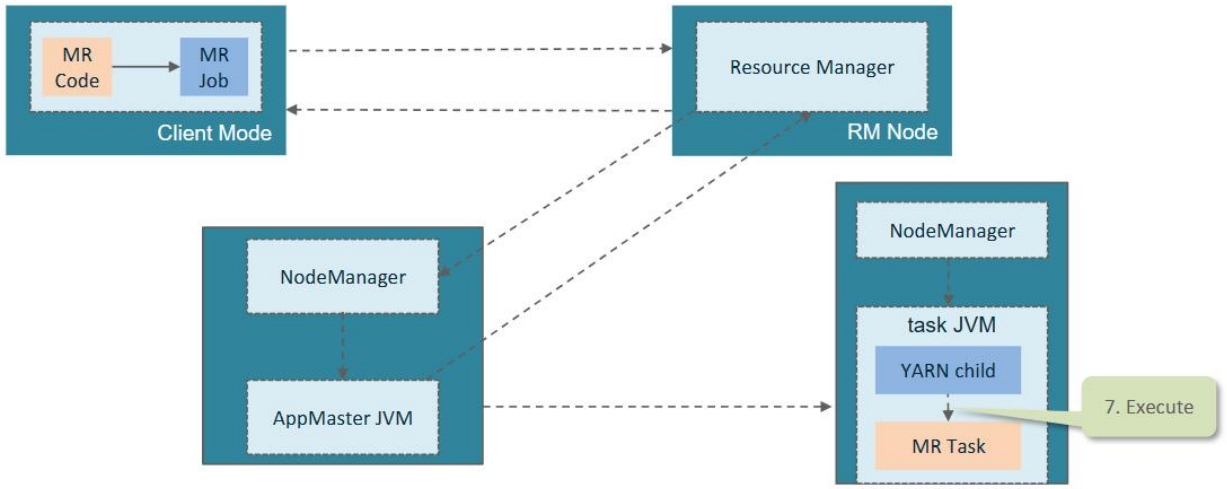
Presentation 68 / 121

Application Submission in YARN



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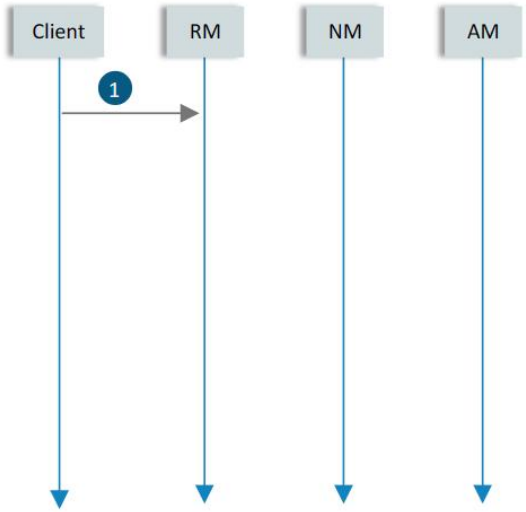
YARN Application Workflow

➢ **Execution Sequence :**

1. Client submits an application



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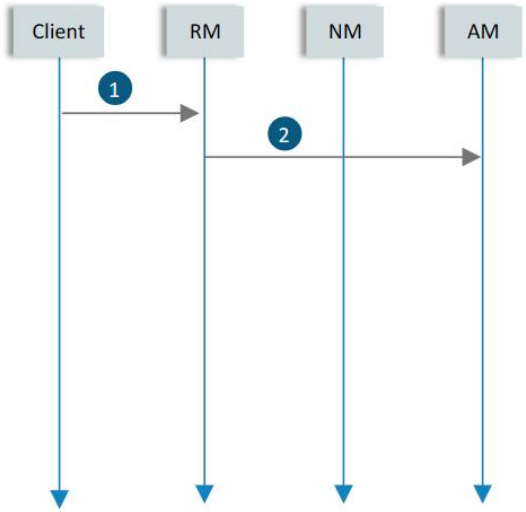
YARN Application Workflow

➢ **Execution Sequence :**

1. Client submits an application
2. RM allocates a container to start AM



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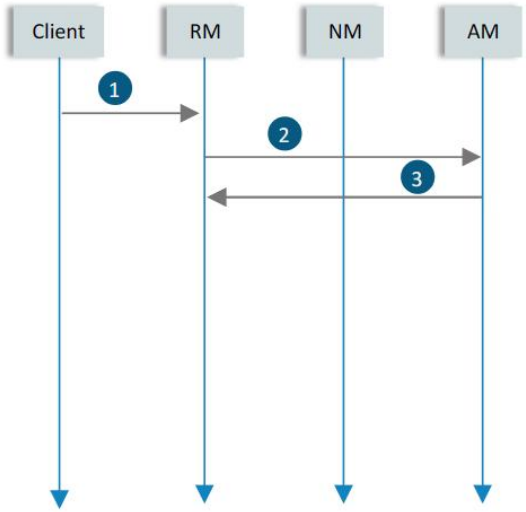
YARN Application Workflow

➢ **Execution Sequence :**

1. Client submits an application
2. RM allocates a container to start AM
3. AM registers with RM



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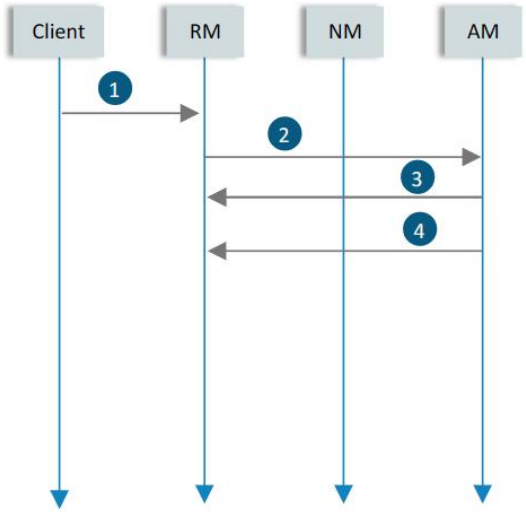
YARN Application Workflow

Execution Sequence :

1. Client submits an application
2. RM allocates a container to start AM
3. AM registers with RM
4. AM asks containers from RM



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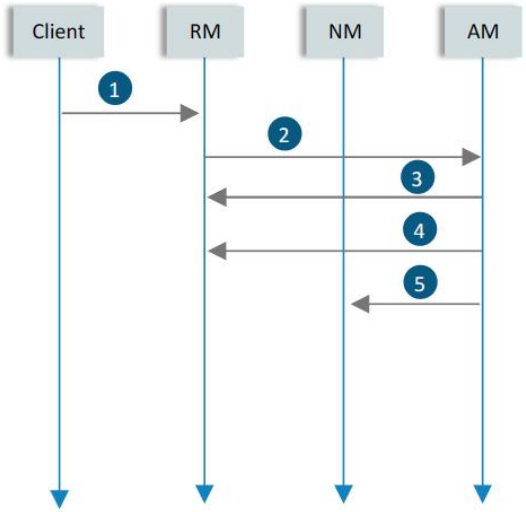
YARN Application Workflow

Execution Sequence :

1. Client submits an application
2. RM allocates a container to start AM
3. AM registers with RM
4. AM asks containers from RM
5. AM notifies NM to launch containers



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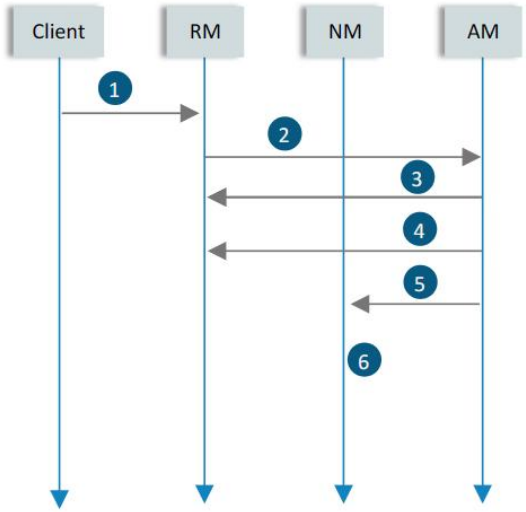
YARN Application Workflow

Execution Sequence :

1. Client submits an application
2. RM allocates a container to start AM
3. AM registers with RM
4. AM asks containers from RM
5. AM notifies NM to launch containers
6. Application code is executed in container



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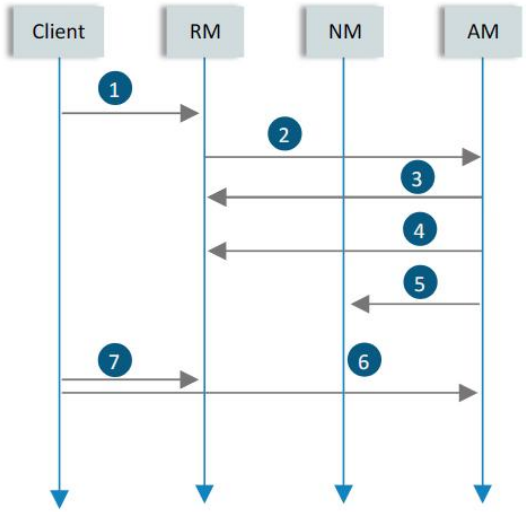
YARN Application Workflow

Execution Sequence :

1. Client submits an application
2. RM allocates a container to start AM
3. AM registers with RM
4. AM asks containers from RM
5. AM notifies NM to launch containers
6. Application code is executed in container
7. Client contacts RM/AM to monitor application's status



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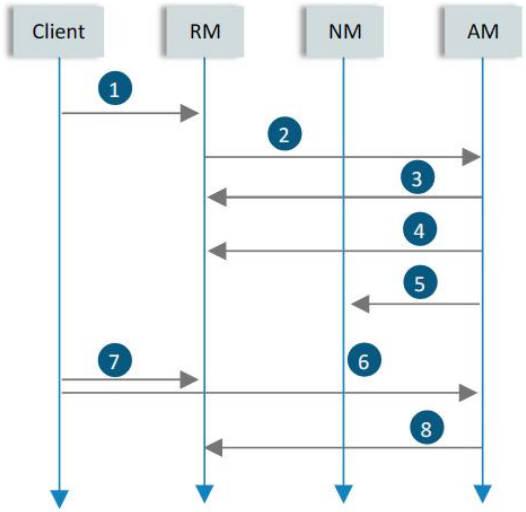
YARN Application Workflow

Execution Sequence :

1. Client submits an application
2. RM allocates a container to start AM
3. AM registers with RM
4. AM asks containers from RM
5. AM notifies NM to launch containers
6. Application code is executed in container
7. Client contacts RM/AM to monitor application's status
8. AM unregisters with RM



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Hadoop Cluster Modes

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Hadoop Cluster Modes

Standalone (or Local) Mode

- No daemons, everything runs in a single JVM
- Suitable for running MapReduce programs during development
- Has no DFS or Distributed File System

Pseudo Distributed Mode

- All Hadoop daemons run on the local machine

Multi-Node Cluster Mode

- Hadoop daemons run on a cluster of machines

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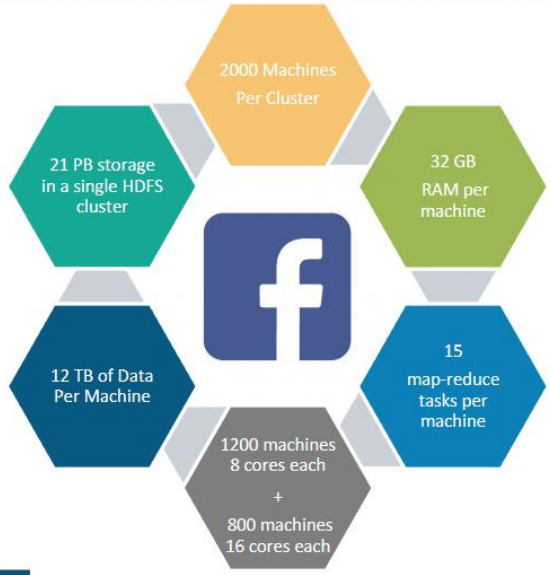
Hadoop Cluster : Facebook Use Case



That's a total of *more than 21 PB* of *configured storage capacity*, this is larger than the previously known Yahoo!'s cluster of 14 PB

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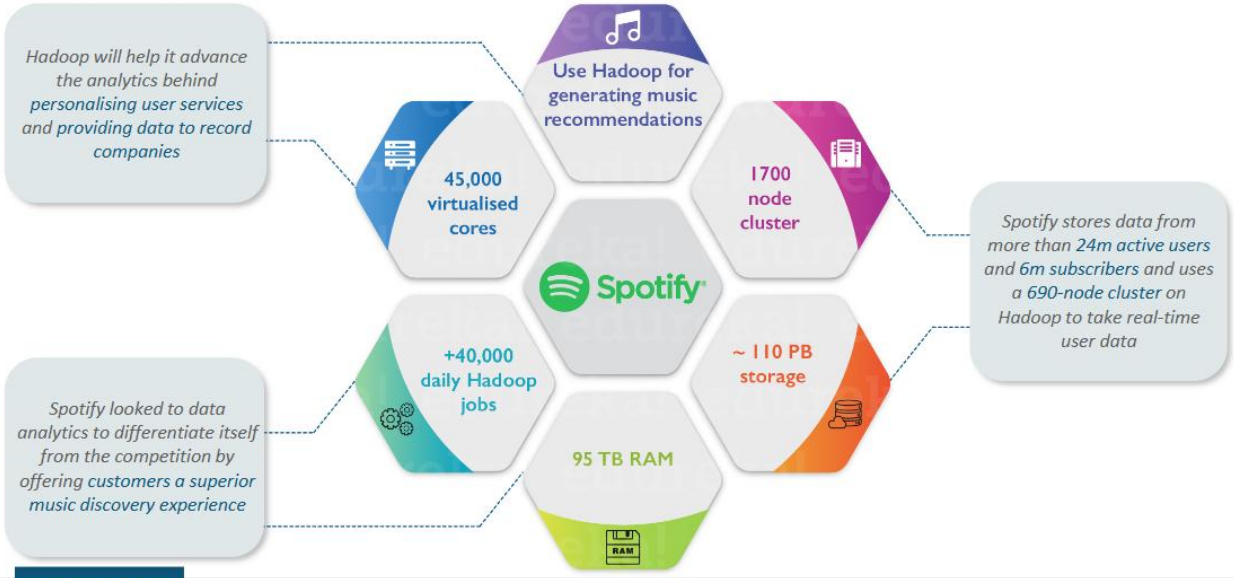
Hadoop Cluster : Spotify Use Case



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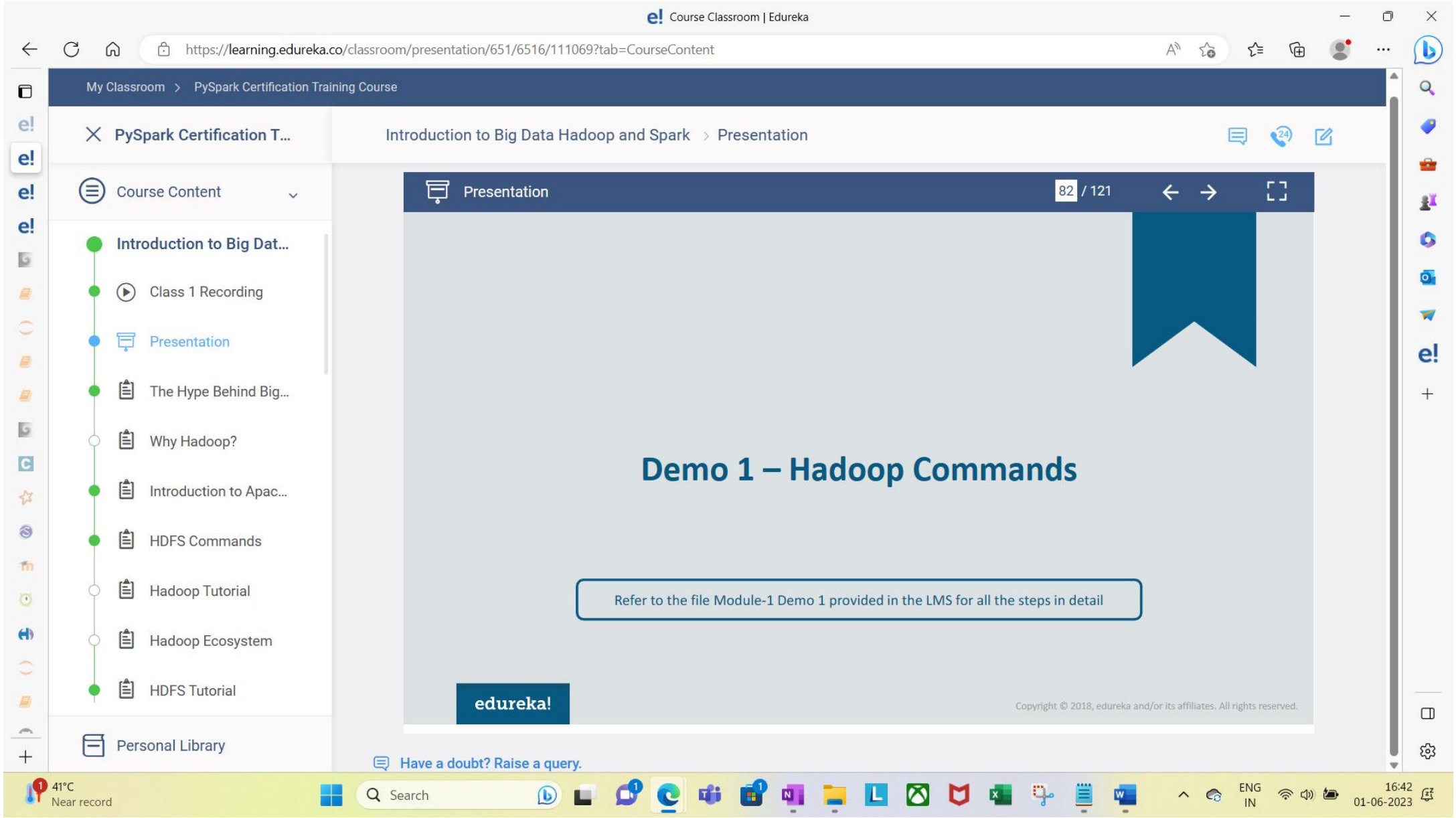
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Demo 1 – Hadoop Commands
Refer to the file Module-1 Demo 1 provided in the LMS for all the steps in detail
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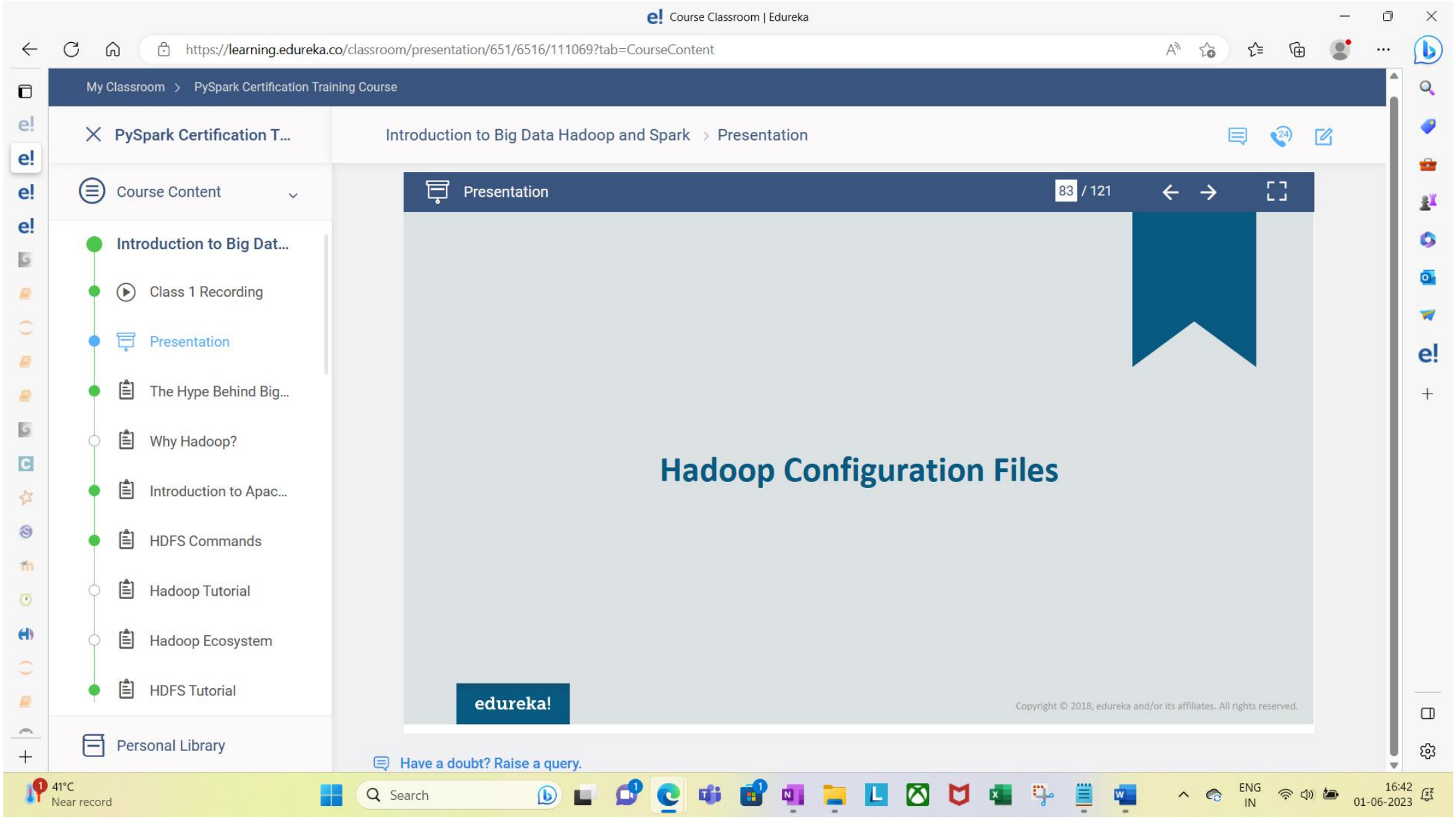
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Hadoop Configuration Files
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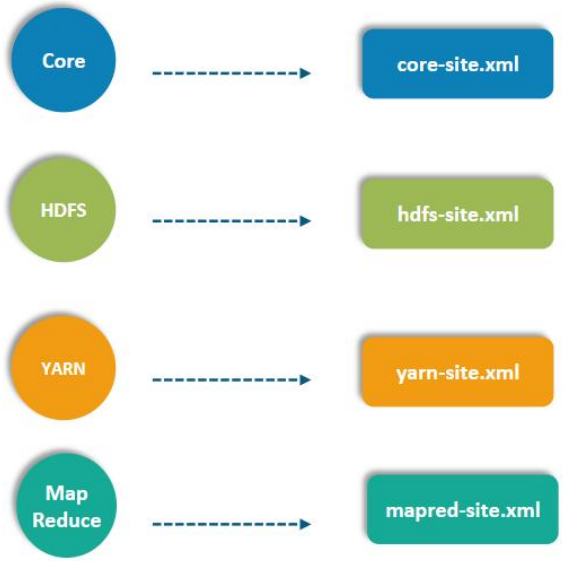
Hadoop 2.X Configuration Files



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Hadoop 2.X Configuration Files : Description

Configuration Filenames	Description
hadoop-env.sh	Environment variables that are used in the scripts to run Hadoop.
core-site.xml	Configuration settings for Hadoop Core such as I/O settings that are common to HDFS and MapReduce.
hdfs-site.xml	Configuration settings for HDFS daemons, the namenode, the secondary namenode and the data nodes.
mapred-site.xml	Configuration settings for MapReduce Applications.
yarn-site.xml	Configuration settings for ResourceManager and NodeManager.
masters	A list of machines (one per line) that each run a secondary namenode.
slaves	A list of machines (one per line) that each run a Datanode and a NodeManager.

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Hadoop 2.X Configuration Files

```
[edureka_249489@ip-20-0-41-93 ~]$ cd /opt/cloudera/parcels/CDH/lib/hadoop/etc/hadoop
[edureka_249489@ip-20-0-41-93 hadoop]$ ls
__cloudera_generation__  core-site.xml  hdfs-site.xml    mapred-site.xml  topology.map  yarn-site.xml
__cloudera_metadata__    hadoop-env.sh  log4j.properties  ssl-client.xml   topology.py
[edureka_249489@ip-20-0-41-93 hadoop]$
```

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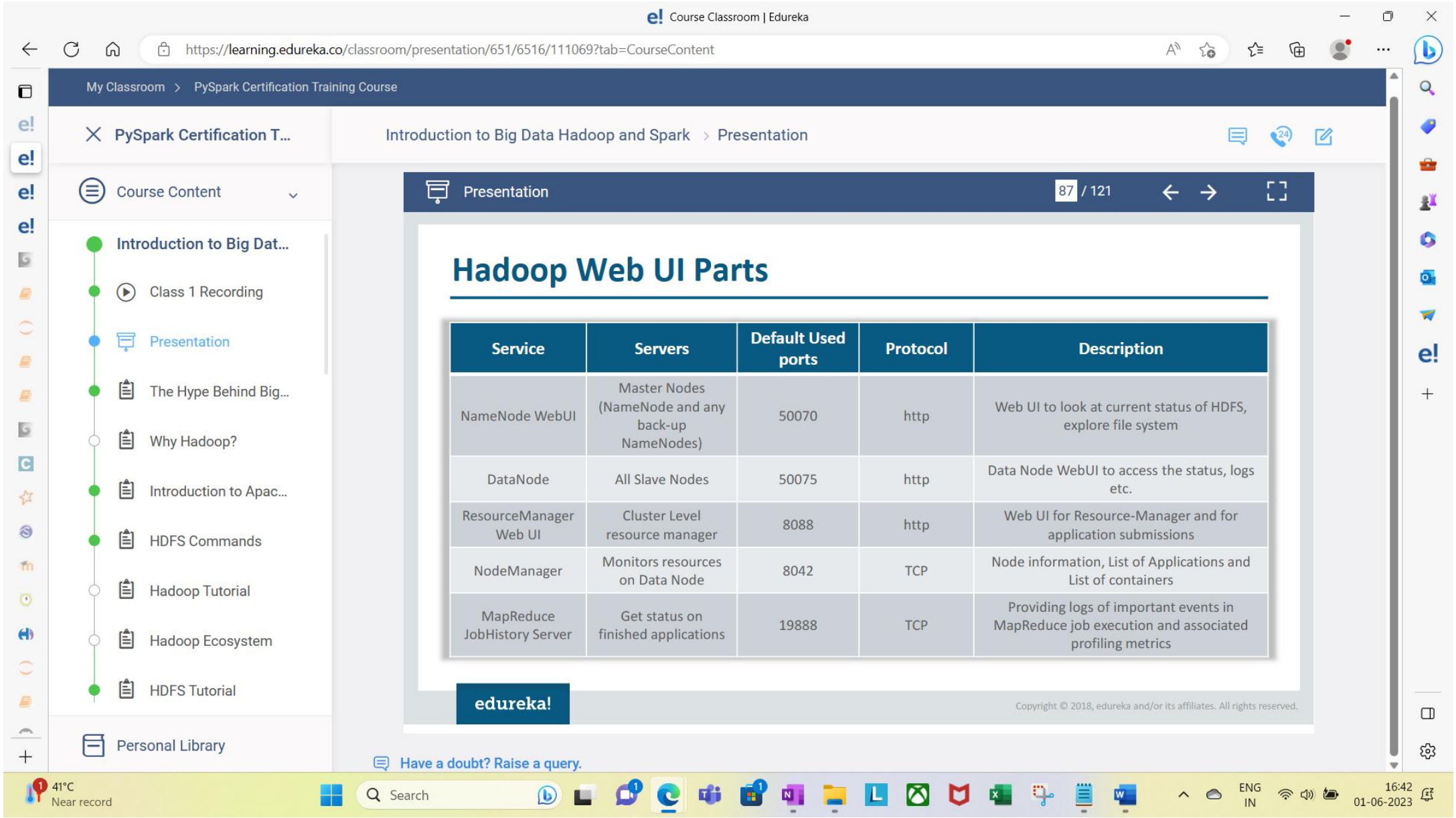
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Hadoop Web UI Parts
Service | Servers | Default Used ports | Protocol | Description
NameNode WebUI | Master Nodes (NameNode and any back-up NameNodes) | 50070 | http | Web UI to look at current status of HDFS, explore file system
DataNode | All Slave Nodes | 50075 | http | Data Node WebUI to access the status, logs etc.
ResourceManager Web UI | Cluster Level resource manager | 8088 | http | Web UI for Resource-Manager and for application submissions
NodeManager | Monitors resources on Data Node | 8042 | TCP | Node information, List of Applications and List of containers
MapReduce JobHistory Server | Get status on finished applications | 19888 | TCP | Providing logs of important events in MapReduce job execution and associated profiling metrics
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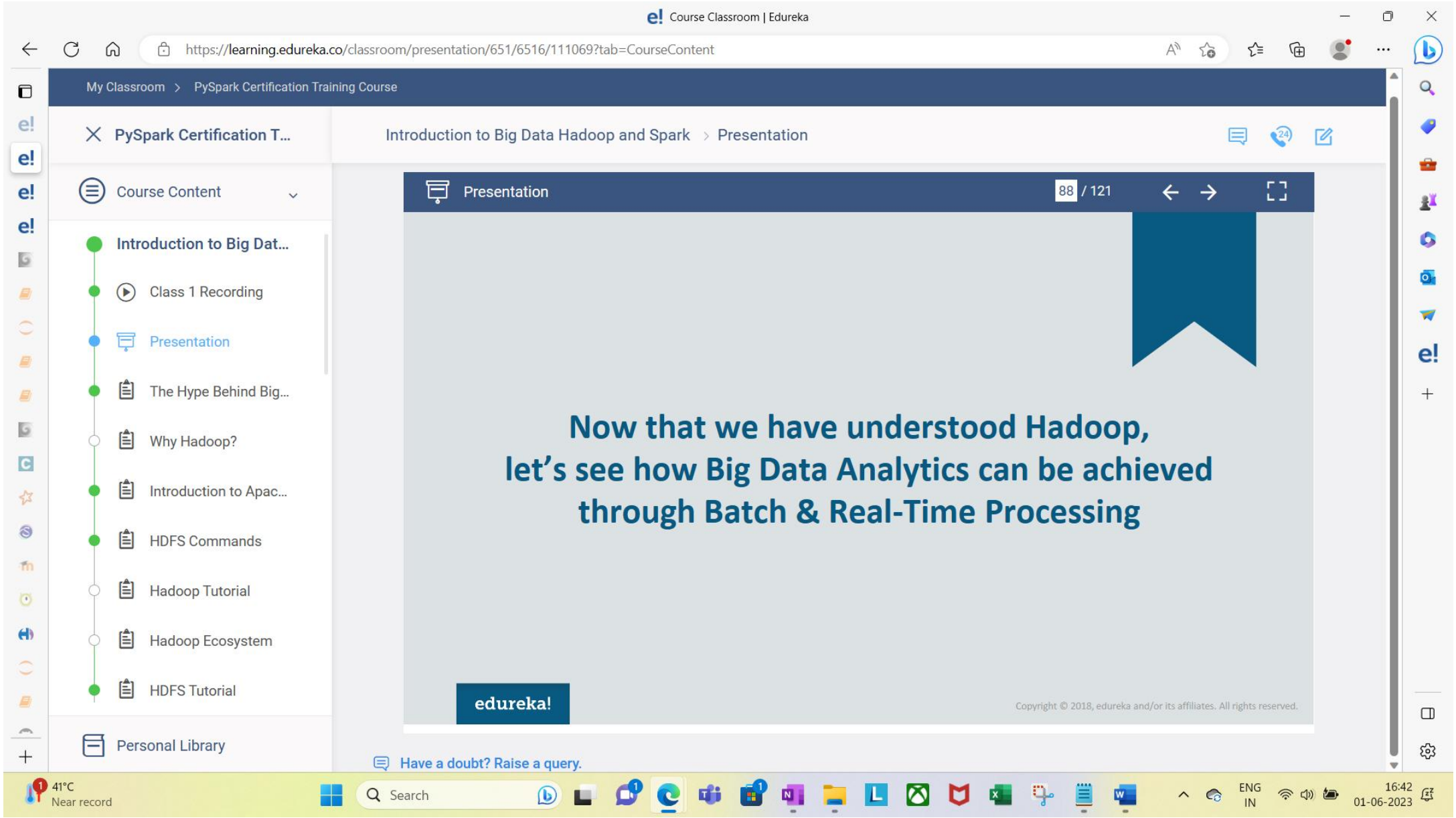
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Now that we have understood Hadoop,
let's see how Big Data Analytics can be achieved
through Batch & Real-Time Processing
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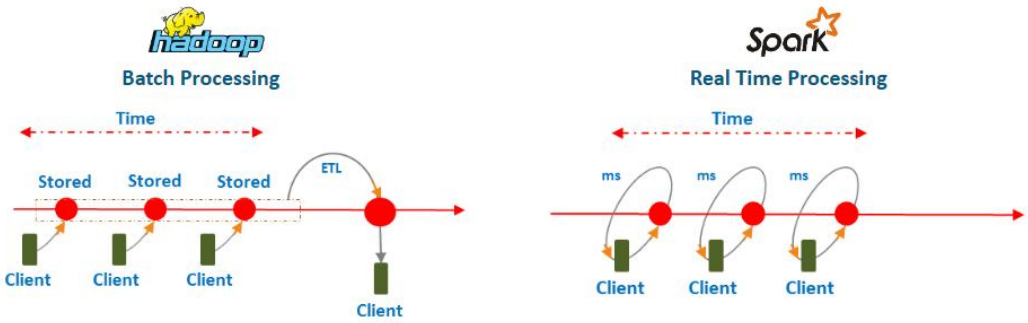
Big Data Analytics

- ***Big Data Analytics*** is the *process of examining large data sets* to uncover *hidden patterns, unknown correlations, market trends, customer preferences* and other useful business information

- Analysis on Big Data can be achieved in two ways:
  - Batch processing
  - Real-Time processing



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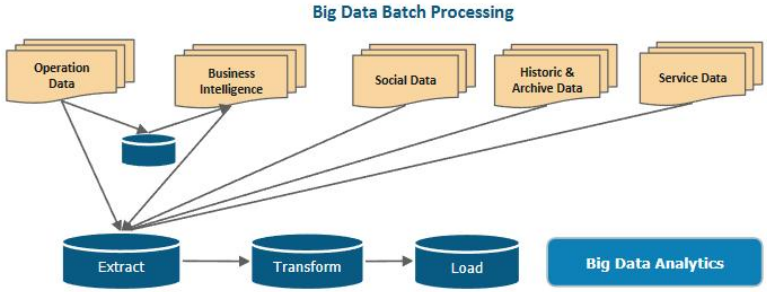
Batch Processing

- Preferred way for processing high volumes of data
- Runs over ***group of transactions***, collected after a ***certain time period***
- Data is ***collected***, ***entered***, ***processed for every batch*** window

  (***Hadoop*** is focused on batch data processing)
- Batch processing requires separate programs for input, process and output
- Examples:
  - Canned reports
  - Interest accruals processing
  - Forecasting
  - Customers profiling



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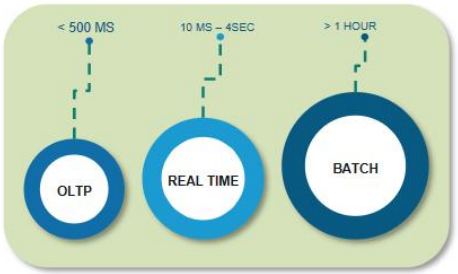
Real-Time Processing

- It involves a ***continual input***, process and output of data
- Data processing time is much smaller (***in fractions of seconds***)
- One such example is a ***complex event processing*** (CEP combines data from multiple sources to infer events or patterns that suggest more complicated circumstances) platform
- Another example is ***operational intelligence*** (OI is a form of real-time dynamic, business analytics that delivers visibility and insight into business operations) platforms
- There are continuously running programs which keep consuming data from streams
- They keep running forever, till they are manually stopped



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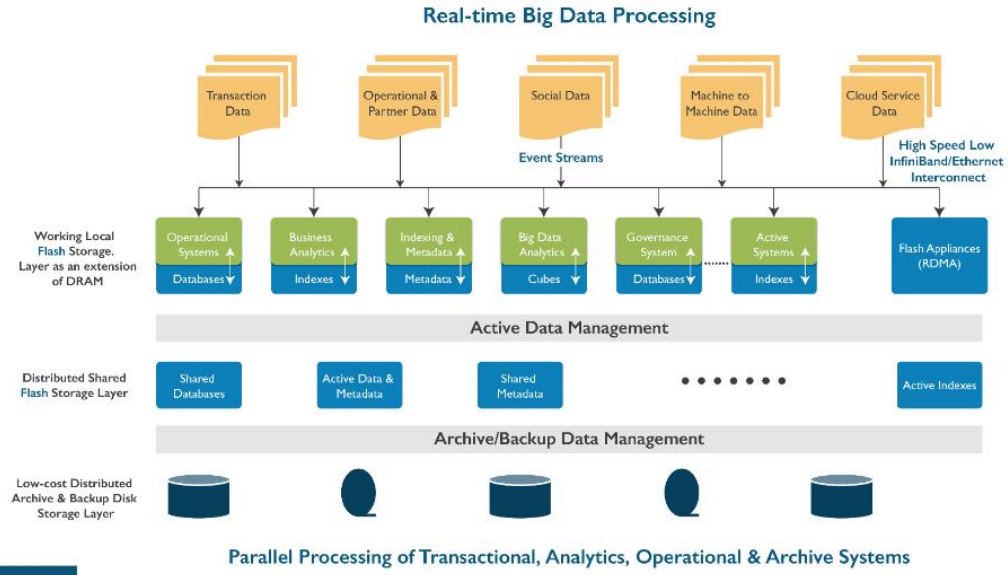
Real-Time Processing



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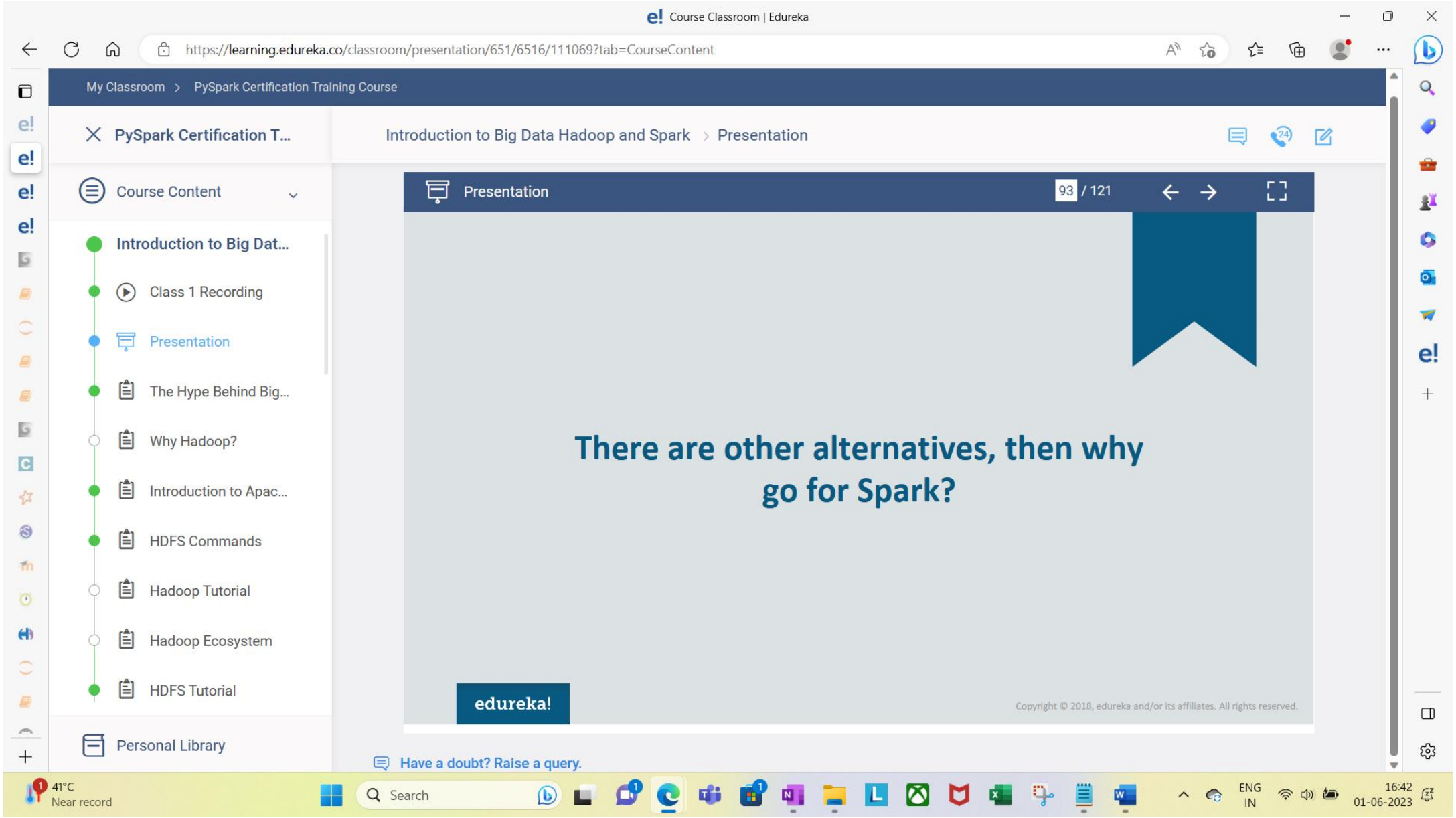
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There are other alternatives, then why go for Spark?
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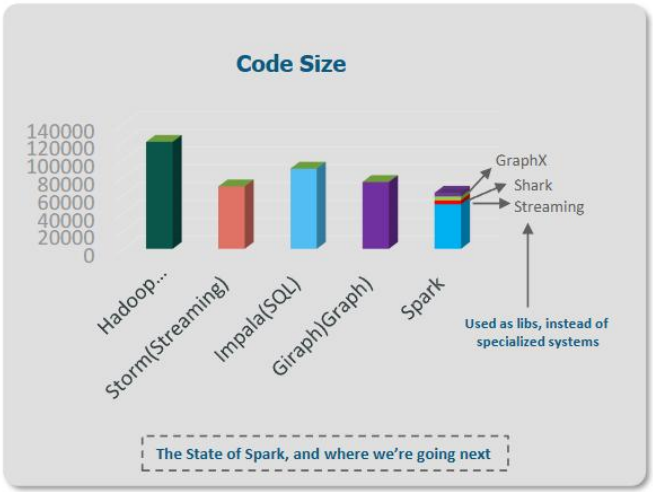
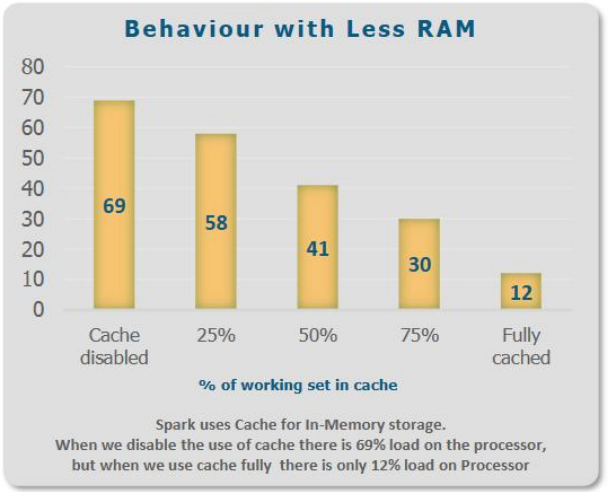
How Spark Differs?





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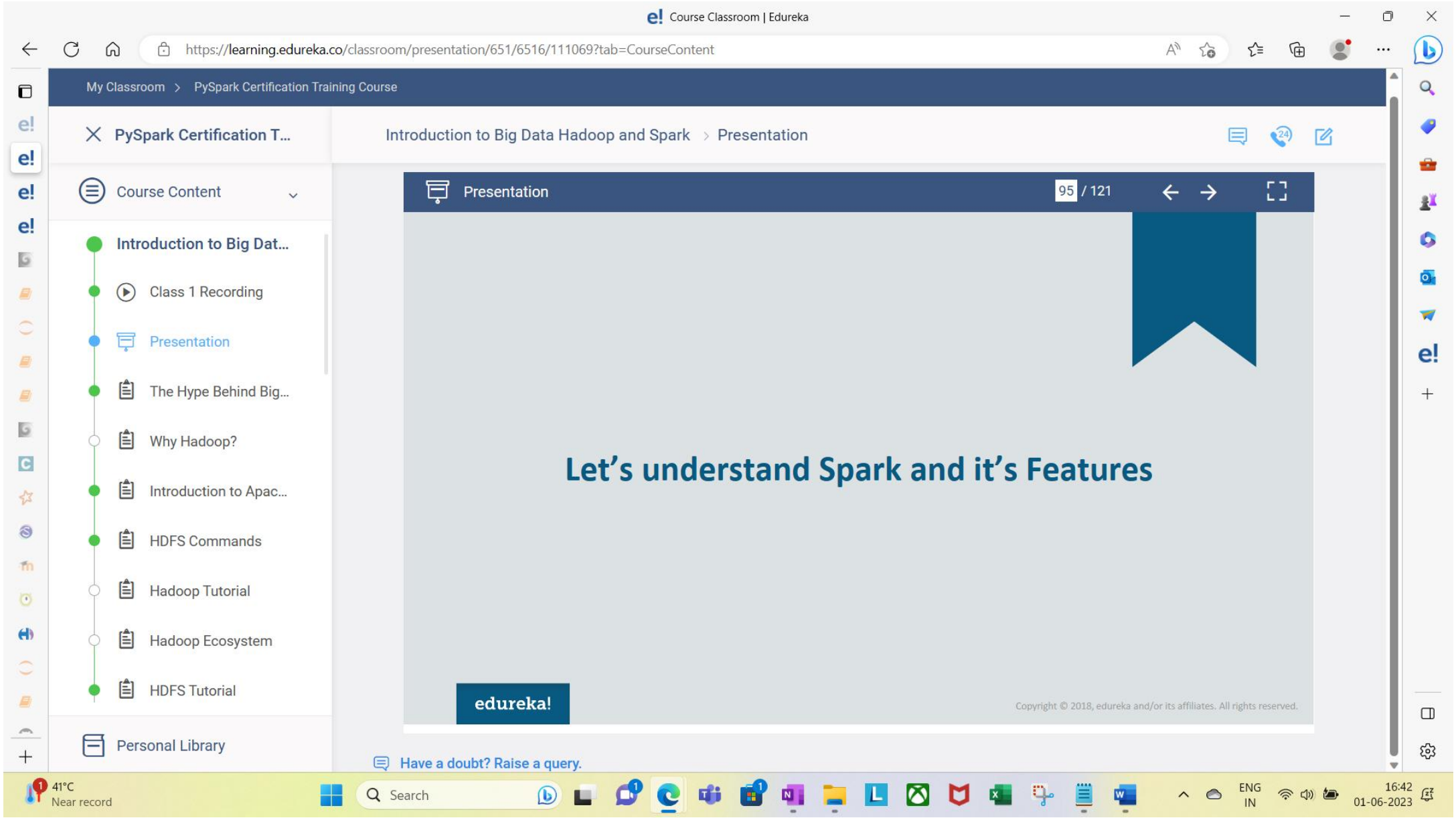
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Let's understand Spark and it's Features
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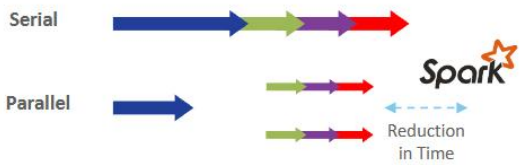
What is Spark?

- Apache Spark is an *open-source cluster-computing framework* for both *Batch* as well as *real time processing*

Real Time Processing In Spark

- Spark provides an interface for *programming entire clusters with implicit data parallelism* and *fault-tolerance*



Data Parallelism in Spark

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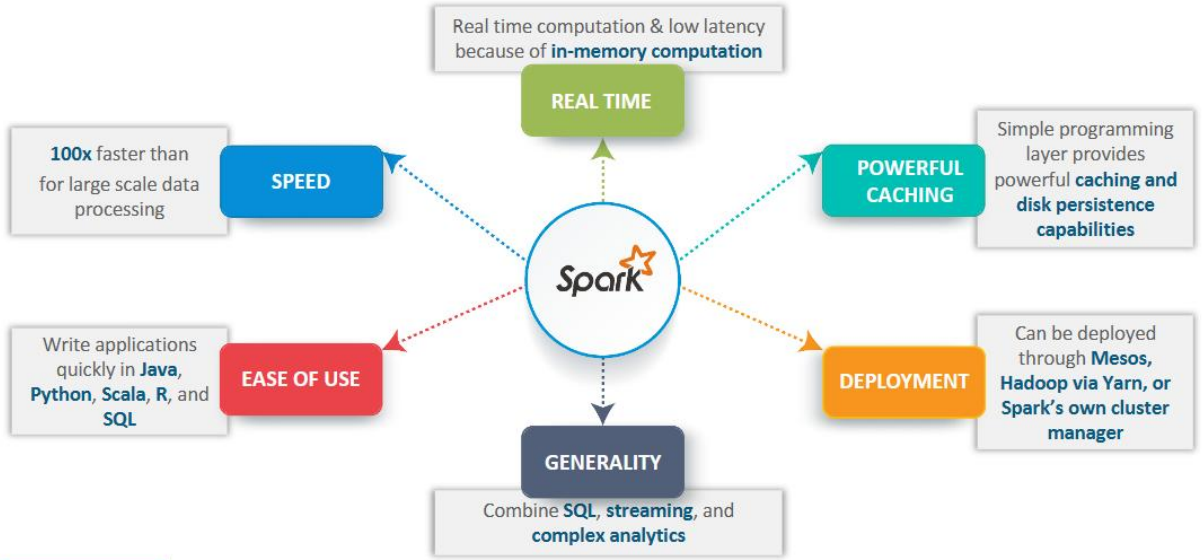
Spark Features



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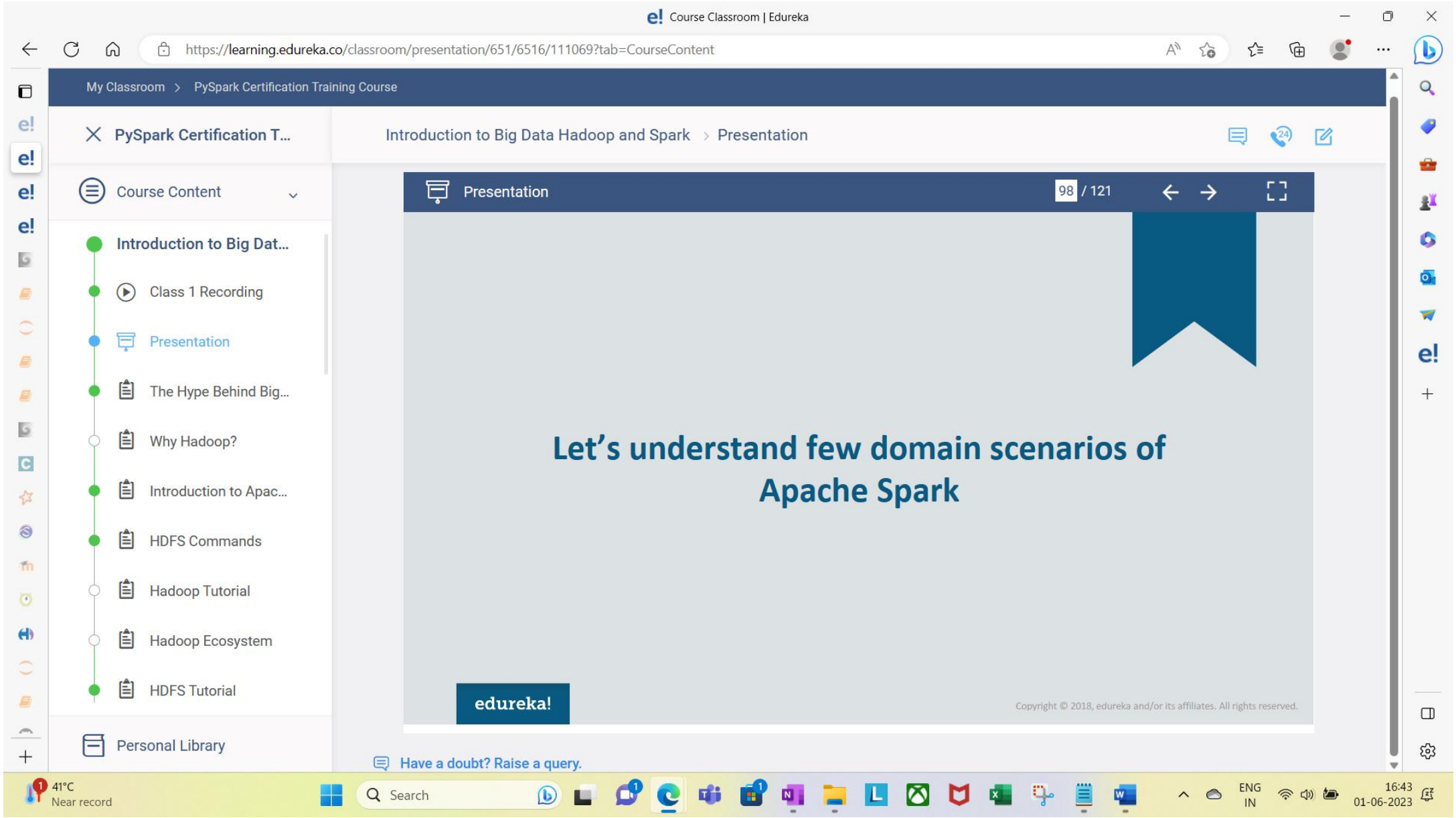
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Let's understand few domain scenarios of Apache Spark
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Apache Spark Domain Scenarios

- From small startups to *Fortune 500s* all are adopting Apache Spark to *build, scale* and *innovate* their big data applications

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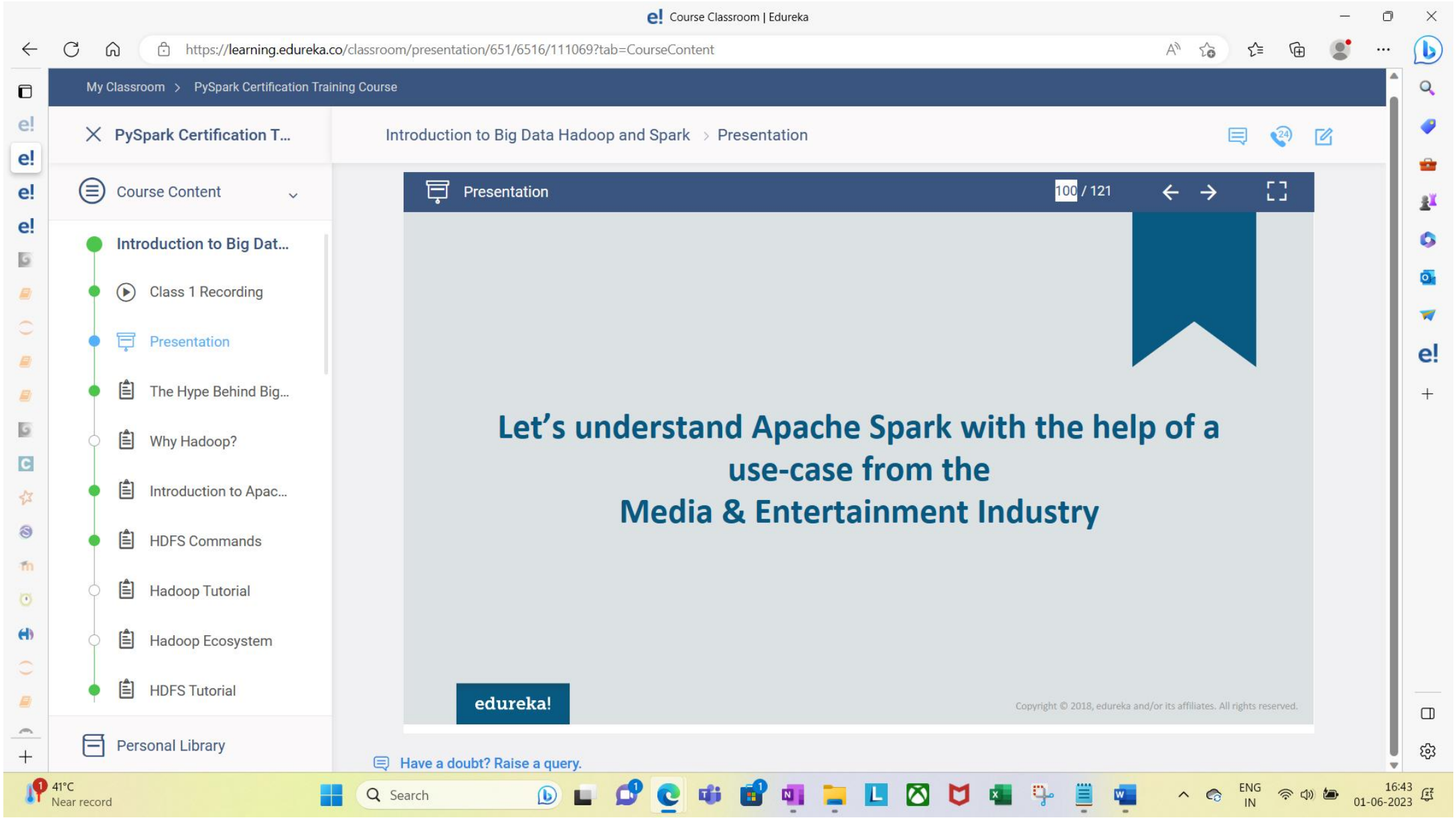
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Let's understand Apache Spark with the help of a use-case from the Media & Entertainment Industry
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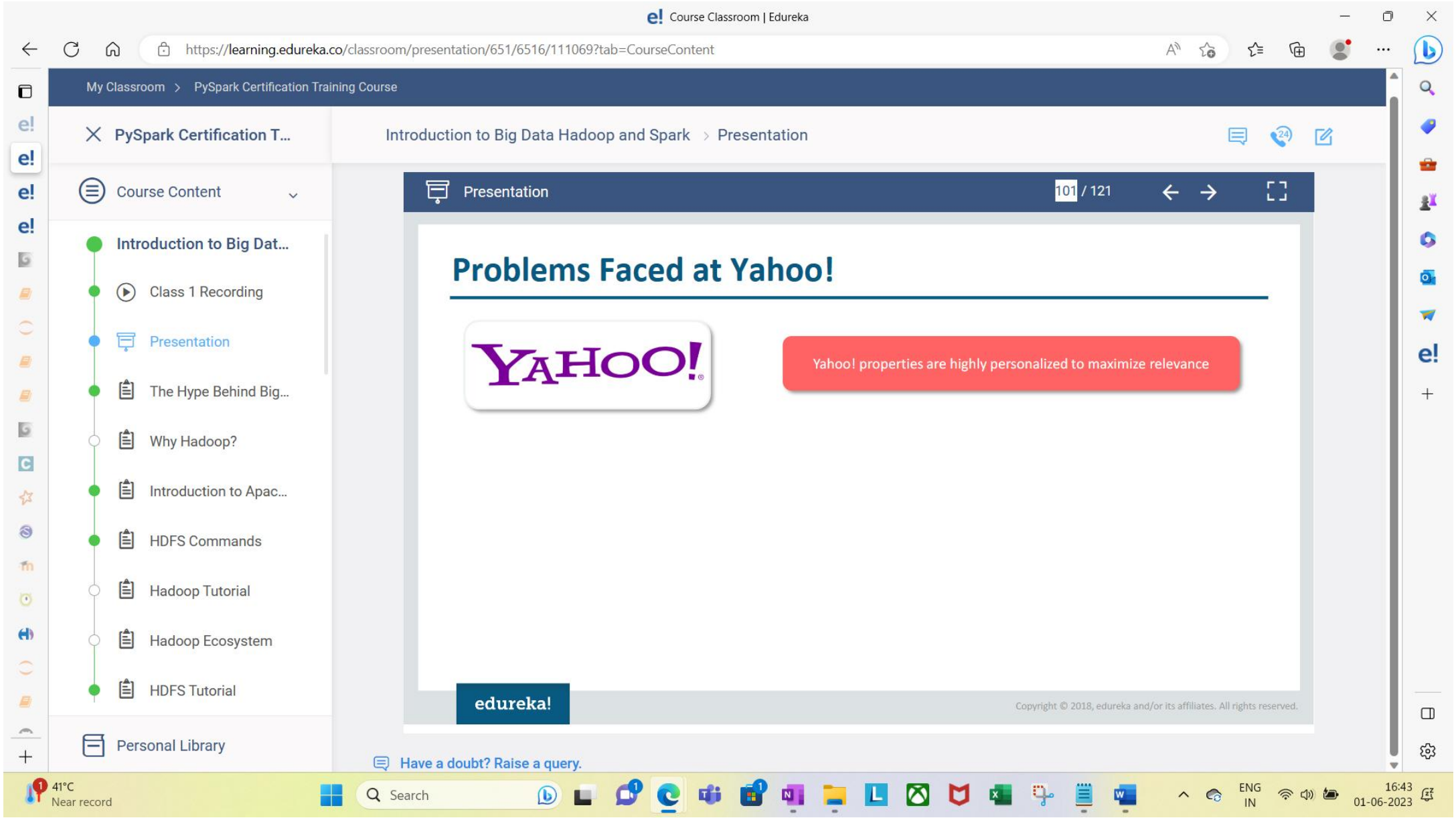
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Problems Faced at Yahoo!
YAHOO!
Yahoo! properties are highly personalized to maximize relevance
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Problems Faced at Yahoo!

YAHOO!

Yahoo! properties are highly personalized to maximize relevance

1. The *algorithms* used to provide personalization(targeted advertisement and personalized content) are ***highly sophisticated***

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Problems Faced at Yahoo!

YAHOO!

Yahoo! properties are highly personalized to maximize relevance

1. The *algorithms* used to provide personalization(targeted advertisement and personalized content) are ***highly sophisticated***
2. *Relevance Model* must be *updated* frequently as stories, etc with change in time

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Have a doubt? Raise a query.

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Problems Faced at Yahoo!

YAHOO!

Yahoo! properties are highly personalized to maximize relevance

1. The *algorithms* used to provide personalization(targeted advertisement and personalized content) are ***highly sophisticated***
2. *Relevance Model* must be *updated* frequently as stories, etc with change in time
3. Yahoo! has over *150 petabytes* of data stored on a *35,000-node Hadoop cluster* which should be accessed efficiently to:
   - *Avoid latency* caused by data movement and
   - *Gain insights* from data in cost-effective manner

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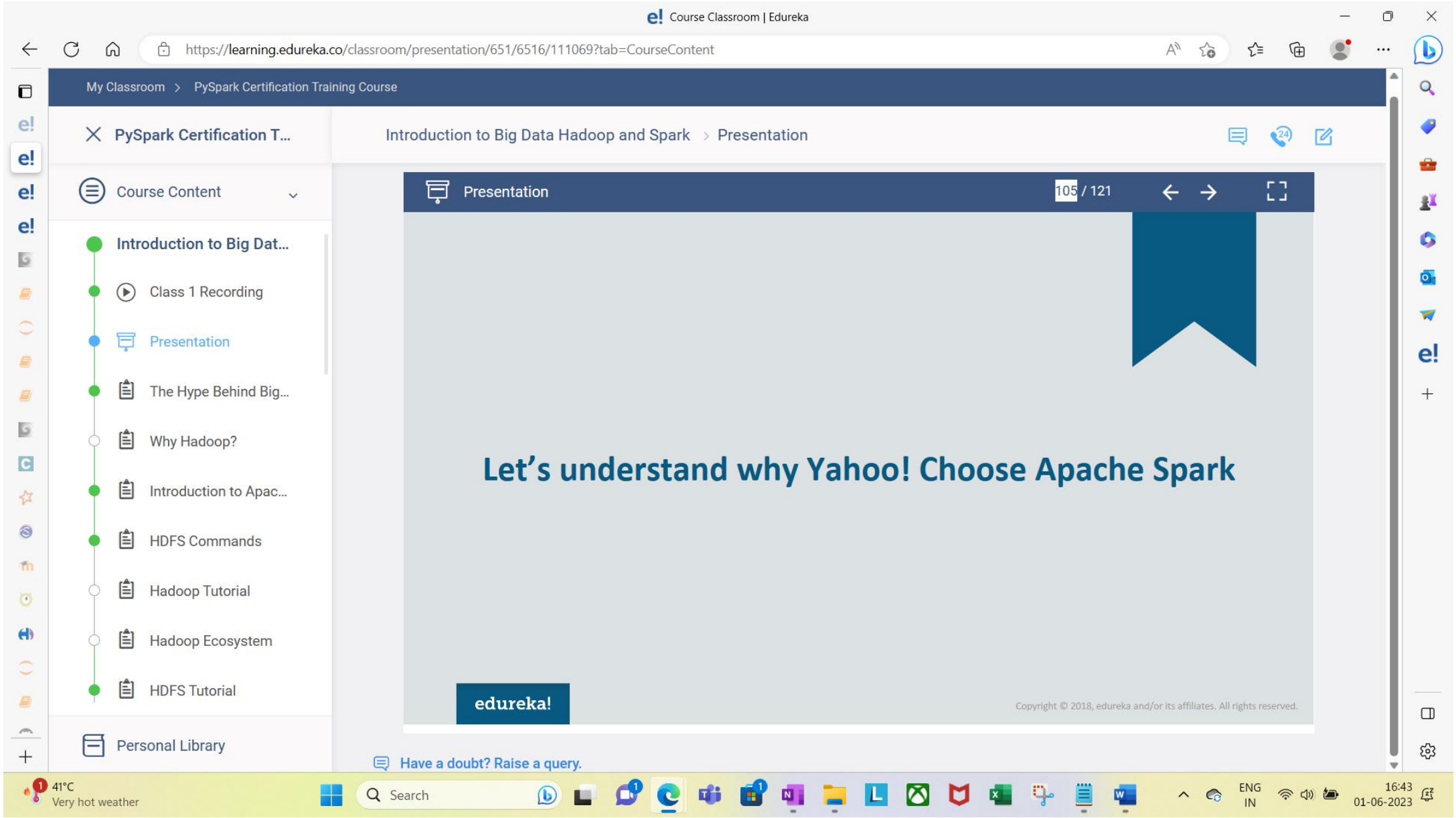
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Let's understand why Yahoo! Choose Apache Spark
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Why Apache Spark?

Yahoo! looked to Spark to improve ***performance*** of its ***iterative model training***

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Why Apache Spark?

Yahoo! looked to Spark to improve ***performance*** of its ***iterative model training***

The machine learning algorithm for news personalization required *15000 lines of C++ code*

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Why Apache Spark?

Yahoo! looked to Spark to improve ***performance*** of its ***iterative model training***

The machine learning algorithm for news personalization required *15000 lines of C++ code*

PySpark has reduced the length of code to more than half the size

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Have a doubt? Raise a query.

Why Apache Spark?

Yahoo! looked to Spark to improve ***performance*** of its ***iterative model training***

PySpark has reduced the length of code to more then half the size

The algorithm was ready for production use in just *30 minutes* of training, on a *hundred million datasets*

Its rich API is available in several programming languages, has resilient in-memory storage options and is compatible with Hadoop through YARN and the Spark-YARN project

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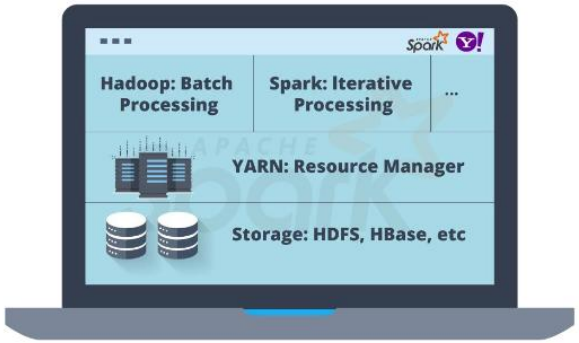
Spark at Yahoo!

- It uses Apache Spark for *personalizing* its *news webpages* and for *targeted advertising*
- It uses *machine learning algorithms* that run on Apache Spark
  - to find out what kind of news - users are interested to read
  - For categorizing the news stories to find out what kind of users would be interested in reading each category of news
- Spark runs over *Hadoop YARN* to use existing data & clusters



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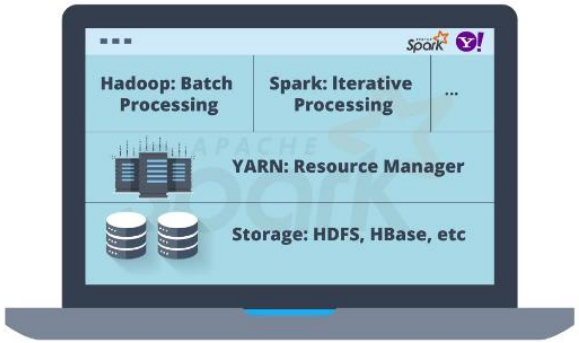
Spark at Yahoo!

- *Spark's API* & *MLlib ease* development of ML algorithms
- Spark *reduces latency* of model training via in-memory *RDD*
- *YARN* brings *Hadoop datasets* & *clusters* at scientist's fingertip



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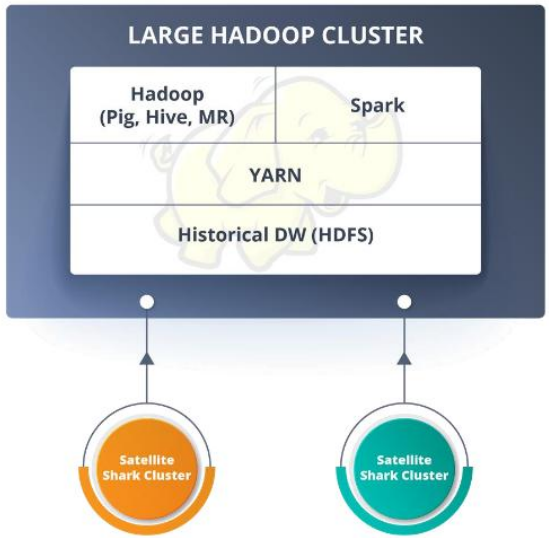
Spark at Yahoo! (Ad Analytics)

- Yahoo! Ads wanted *interactive BI* on *terabytes of data*
- Chose Shark (Hive on Spark) to provide this through standard *Hive server API + Tableau*
- **Result:** Were able to *query* their *ad visit data interactively*



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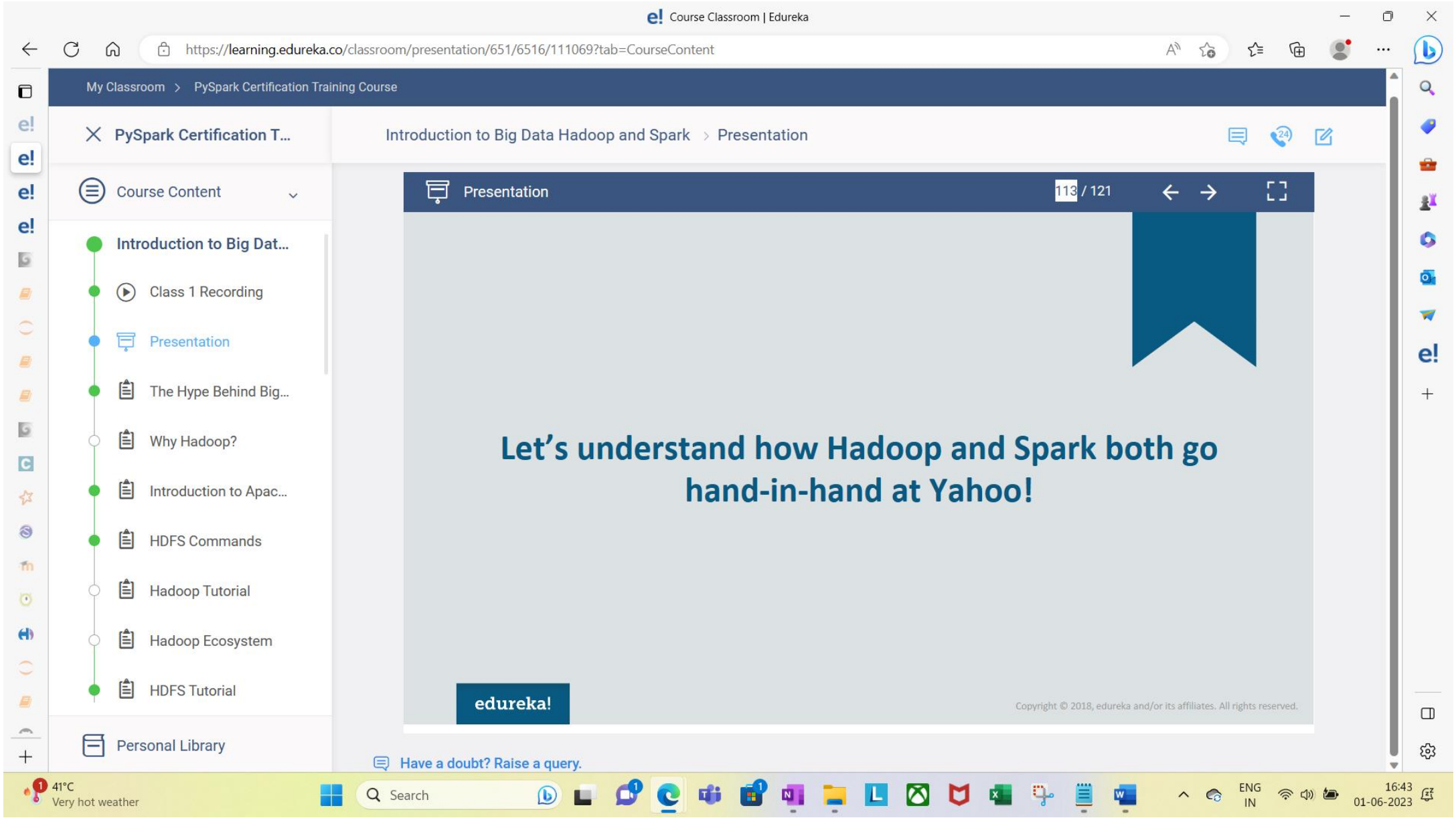
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Hadoop + Spark at Yahoo!

Yahoo! tested Spark's performance relative to Hadoop using an e-commerce pilot project

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Hadoop + Spark at Yahoo!

Yahoo! tested Spark's performance relative to Hadoop using an e-commerce pilot project

Apache Spark

The pilot was *successfully implemented* with *30 lines of code* (*Spark's API*) and executed in *14 minutes* on just *10 servers*

hadoop

The equivalent Hadoop implementation took *106 minutes*

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Hadoop + Spark at Yahoo!

Yahoo! tested Spark's performance relative to Hadoop using an e-commerce pilot project

The pilot was *successfully implemented* with *30 lines of code* (*Spark's API*) and executed in *14 minutes* on just *10 servers*

The equivalent Hadoop implementation took *106 minutes*

- While these improvements are impressive, Yahoo! isn't abandoning its Hadoop cluster for Spark
- There is a clear *need for both* types of workloads
- *Spark* will be the *preferred* technology for *iterative processing*, while *Hadoop* continues to fulfil its niche for *batch data processing* tasks
- What's interesting is that both types of tasks run on the same Hadoop cluster through YARN

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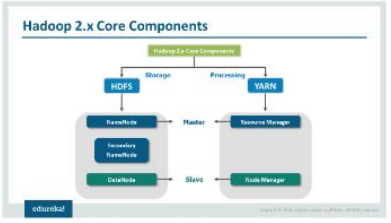
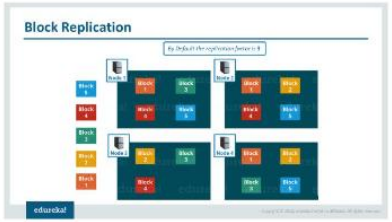
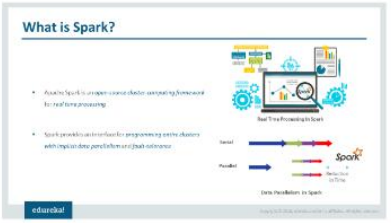
Summary







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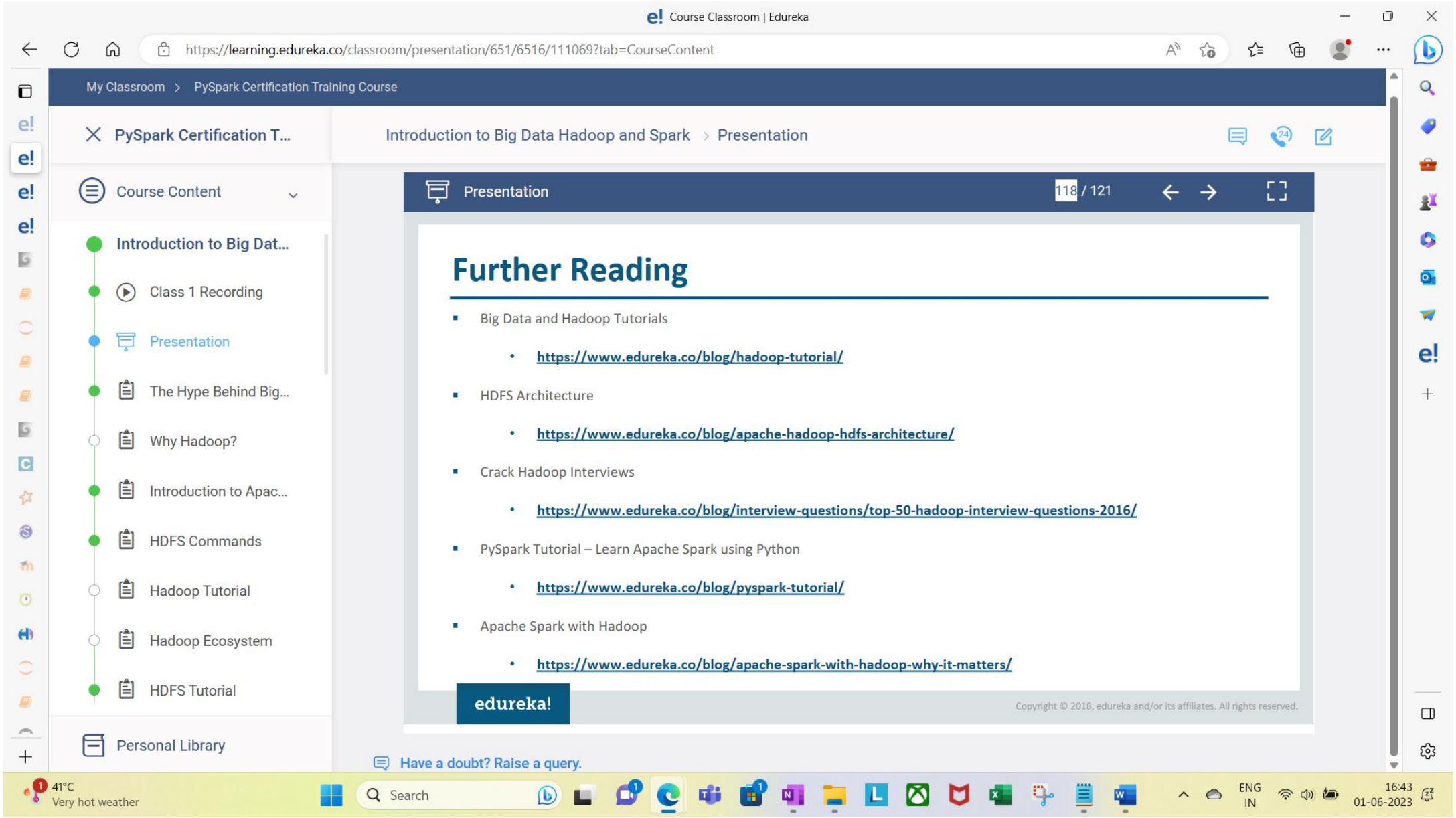
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