Data Analytics

Unit - 5 [One Shot]

Most important topics :

1. MapReduce , Hadoop , Pig , Hive , HBase , HDFS
2. Sharding , DV and S3.
3. No - SQL databases
4. R - programming (PYQ). (to check no. is prime or not)

⊕ MapReduce :

- It is a programming model for processing large datasets with a parallel , distributed algorithm on a cluster.

Key features :

1. Scalability : Handels large volumes of data by distributing processing accross multiple nodes.

2. Fault tolerance : Automatically reruns tasks on different nodes , if failure occur , ~~ensured~~ ensuring data is replicated and safe.

3. Ease of use : Simplifies distributed computing by letting developers focus on writing maps and reduce functions.

4. Load balancing : Dynamically balances workload across the cluster for efficient resource use.

5. Flexibility : Process various data formats and sources , including structured and unstructured data.

★ Workflow :

Step 1. Input Split : Data is split into chunks and distributed across nodes.

Step 2. Map Phase : Each node processes its chunk, generating itermediate key-value pairs.

Step 3 Shuffle and Sort: Intermediate pairs are shuffled and sorted by key.

Step 4 Reduce Phase: Groups of key-value pairs are processed to produce the final output.

Step 5 Output: Final results are written to distributed file system.

* Applications in big-data analytics:

1. Data processing and tranformation
2. Distributed search
3. log analysis
4. Data mining and ML
5. Real-time analytics

(#) Hadoop:

- It is a open-source framework that facilitates the processing of large datasets across clusters of computers using simple programming models.

- It is designed to scale from single servers to thousands of machines, offering local computation and storage.

* Workflow:

Step 1: Data ingestion: Data is injested into HDFS from various sources like databases, sensors, and logs.

Step 2: Data storage: HDFS stores the data accross the cluster with replication for fault tolerance.

Step 3: Data processing: MapReduce are used to process the data. Map function transforms the input data into intermediate key-value pairs, and Reduce function aggregates the results.

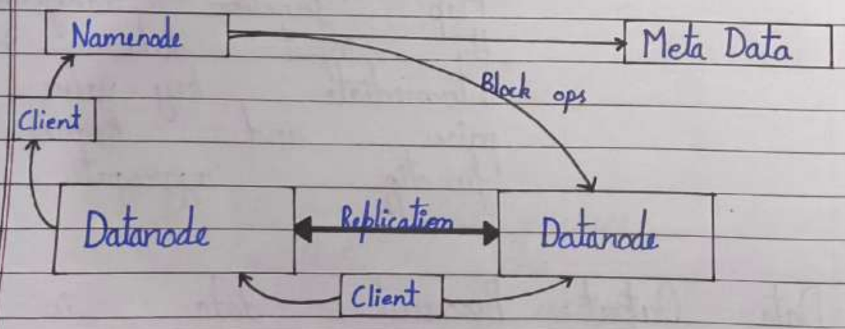
Step 4: Data Output: Processed data is writte back to HDFS for further analysis.

Core components:

1. HDFS (Hadoop distributed file system):

- It is the primary storage system used by Hadoop applications.
- It is designed to store very large files across multiple machines in a large cluster.
- The architecture of HDFS is highly fault-tolerant and designed to be deployed on low cost hardware.

Architecture



1. Namenode:

- Acts as master server.
- Manages filesystem namespace and metadata.
- Keeps track of the locations of data blocks.

2. Datanode: - Acts as slave nodes that stores actual data blocks.

- Performs block creation, deletion, and replication based on the NameNode's instructions.

3. Metadata:

- Information about the data such as the directory.

4. Client:

- Client interact with NameNode and DataNode for metadata, file operations and read/write data respectively.

5. Replication:

- Blocks are replicated across multiple DataNodes to ensure fault tolerance.

6. Block operations: DataNodes handle read/ write requests for blocks.

* Data Flow:

1. File write:

- The client requests the NameNode to write a file.
- It writes data to the first DataNode, which then replicates it to other DataNodes.

2. File read:

- Client requests NameNode for file location.
- NameNode responds with the list of DataNodes storing the data blocks.
- The client reads data directly from the DataNodes.

Pig and Hive:

* Pig:

- Apache pig is a high level platform for processing large datasets.
- It uses language called Piglatin, which is designed to handle parellel processing of data.

Key features:

1. Ease of programming:

- Piglatin is simpler to write in Java as compared to MapReduce.

2. Sequencial data flow:

- Piglatin scripts describe a sequence of data transformation

3. User - friendly:

- Users can create there own functions to process data using Pig

4. Flexibility :

- Pig can handle both structured and unstructured data.

5. Optimization :

- Pig framework optimizes the excecution of Piglatin scripts to improve performance.

★ Hive :

- It is a data warehouse infrastructure buit on top of Hadoop.
- It facilitates querying and managing large datasets stored in HDFS, using SQL - like language called HiveQL.

Key features :

1. Hive QL : Similar to SQL, makes it easier to users familiar with traditional database to write queries.

2. Schema on Read : Hive applies the schema to data at the time of reading rather than writing.
3. Storage independence : Efficient to support and handle various storage formats.
4. Scalability : Can handle large datasets and scale out with Hadoop's cluster.
5. Partitioning : Improves query performance by organizing tables into partitions and buckets.

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⊕ HBase :

- It is an open-source, distributed, NoSQL database.
- It is designed for storing and managing large - scale, sparse data.

Key features :

1. Distributed architecture :
Runs on a cluster of machines.

2. Columnar storage: Stores data in a columnar format for efficient access.

3. Schema flexibility: Supports dynamic addition and removal of columns without affecting existing data.

4. Strong consistency :
Ensures data consistency with a single row.

5. Low - latency access :
Suitable for real time access to large datasets.

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Sharding :

- It is a database partitioning technique where a large database is divided into smaller, faster, and more manageable pieces called shards.

Need of sharding :

- Example : A college database with 100000 students record.
- Problem : Searching through a large unsharded database is costly and inefficient.
- Solution : Dividing the database by years reduces the no. of records per shard, enhancing manageability and reducing costs.

Features of sharding :

1. Smaller database : Sharding reduces the size of individual databases.

2. Faster performance: Queries and transactions are faster with fewer records to process.

3. Manageablity: Smaller databases are easier to . handle and maintain.

4. Complexity: Implementing sharding can be quite complex.

5. Cost - efficiency: Reduces transaction costs significantly.

Data visualization:

- Graphical representation of information and data using visual elements like charts, graphs, and maps to understand trends and patterns.

Techniques:

- Box Plots: Show data spread and compare distributions b/w groups

- Histograms: Display the shape and spread of continuous sample data with bars grouping no. into ranges.

- Heat maps: Use color to represent data values, similar to how bar graphs use hight and width.

- Charts:

  → Pie charts: Circular graphs with slices proportional to numerical values.

  → Line charts: Plot the relationship between two variables.

  → Bar charts: Compare quantities of different categories or groups.

S3: (Amazon's Simple Storage Service)

- Amazon S3 is a scalable object storage service by AWS for secure, durable and highly available cloud storage.

Key features:

- Scalability: Automatically handles growing amount of data.
- Durability: Highly durable.
- Availability: 99.9% availability with SLA (service level agreement)
- Security: Encryption, access management, and bucket policies.
- Performance: Fast data retreival and performance optimization.

Uses of S3:

- Backup and restore
- Data archiving
- Content distribution
- Big data analytics
- Application hosting.

NoSQL databases:

- These are non-relational databases designed to handle large volumes of unstructured, semi-structured, and structured data as well.

Key characteristics:

i. Schema-less: Flexible schema allows variety of data structures

ii. Scalability: Easily scales horizontally by adding more servers

iii. Performance: Optimized for high read and write throughput.

iv. Data model flexibility: Supports for various data models including key-value, doc., graph etc.

Some popular NoSQL databases:

- MongoDB: Document oriented (e.g. JSON doc.)
- Cassandra: Column-family store.

- Redis : key-value , stores in memory.
- Neo 4j : Graph database , more complex.
- Amazon DynamoDB : Fully managed key-value and document database, offered by AWS.

★ Advantages :

- High availability
- Flexible data models
- Distributed architecture

★ Disadvantages :

- Consistancy trade-offs
- Complex
- Limited transactions

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R- programming :

- It is a environment specific programming language for data analysis, statistical computing , and graphical representation.

Key features :

- Statistical analysis : Extensive library of statistical tools and techniques.
- Data manipulation : Powerful data manipulation capabilities with pre-defined packages
- Open source : Free and open-source programming language.
- Community : Serves a large community.
- Integration : Easy to integrate with other programming languages and big data platforms.
- Flexible : Can be extended via packages available on R-based repositories.

* Core Components :

- R Language : A programming language focused on statistical analysis and data visualization.
- R environment : Includes R interpreters, standard libraries, and development tools.
- R Studio : A popular integrated development environment (IDE) for R.

㊉ R-program to check if a number is prime or not ?

```
check ← function (n)
{
      if (n<=1)
      {
            return ( FALSE)
      }
      if ( n==2)
      {
            return (TRUE)
      }
      if ( n%%2 ==0)
      {
```

```
            return (FALSE)
      }
      for ( i  in  3: sqrt(n))
      {
            if( n %% i == 0)
            {
                  return (FALSE)
            }
      }
      return ( ~~True~~ TRUE)
}
```

㊉ Test function :

```
number <- 29
if ( check ( number))
{
      print ( paste (number, " is prime "))
}
else
{
   print ( paste ( number, " is not prime "))
}
```

Thanks for watching !!