Introduction to HADOOP and HADOOP Architecture

(Unit-III)

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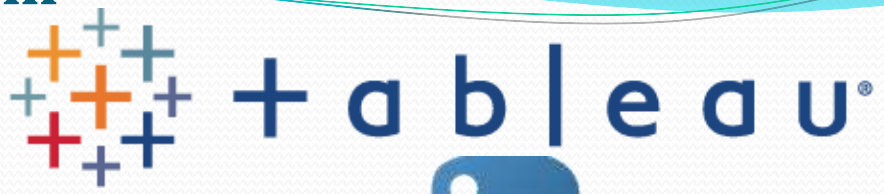
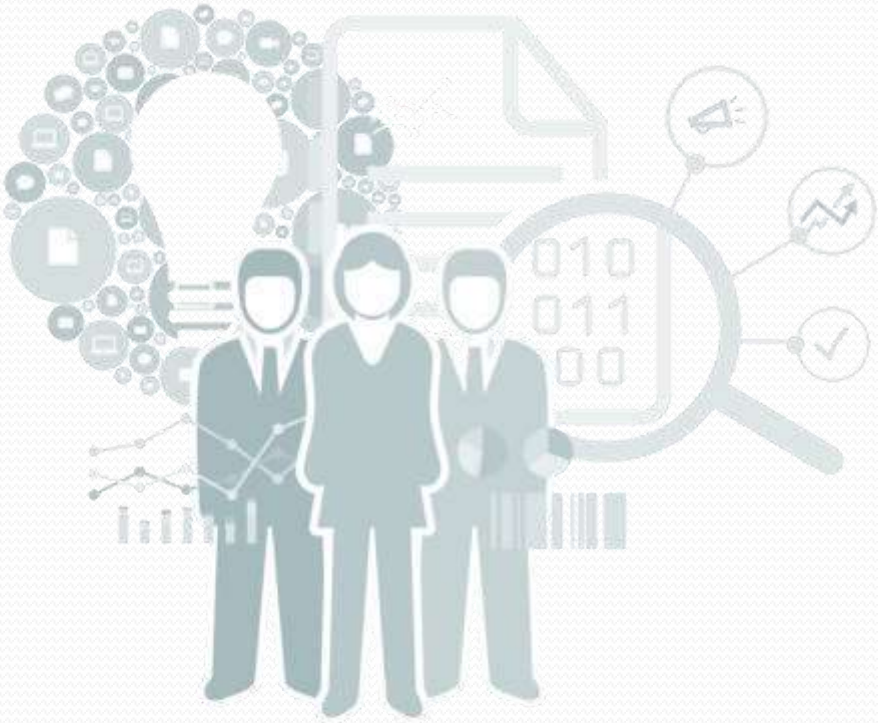
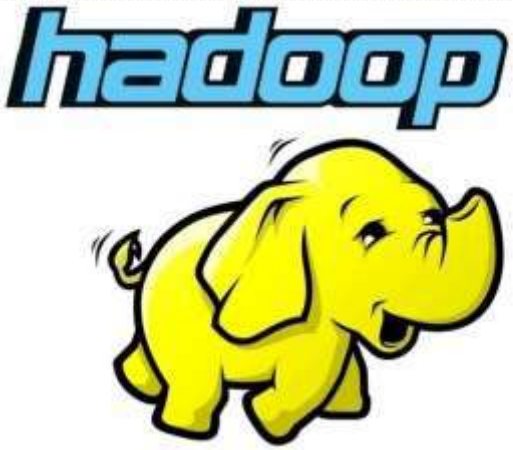
Tools Covered in Program







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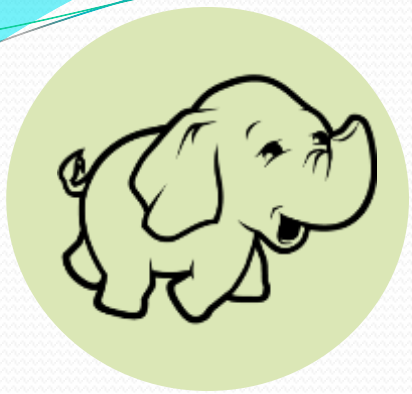

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Top 5 Reasons Organizations are using Hadoop

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				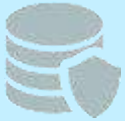

Enterprises using Hadoop

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- Business Services
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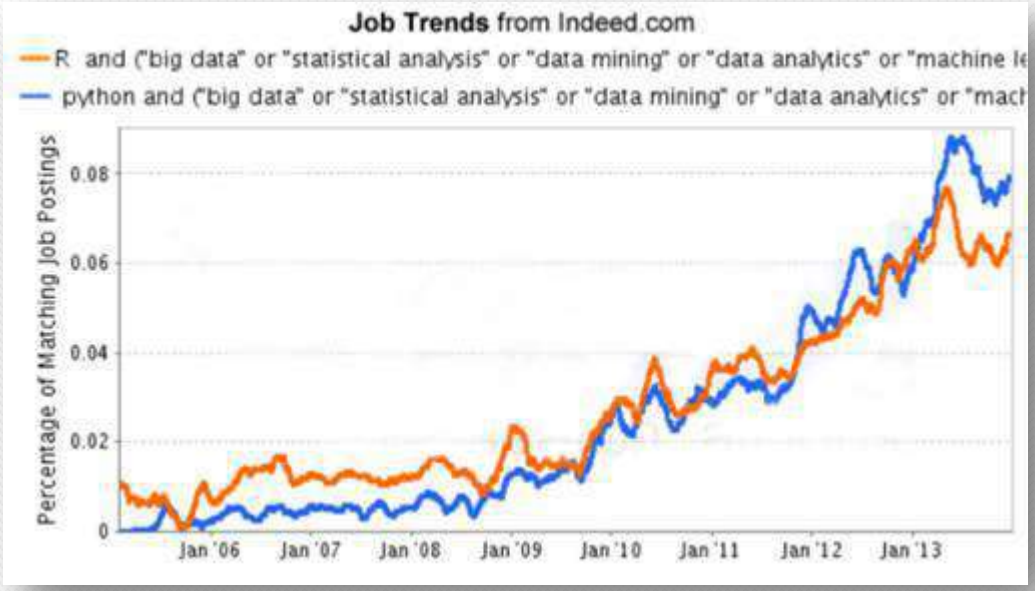

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Quora
Nokia
ABN
AMRO Bank
IBM
National Weather Service
& Many More…

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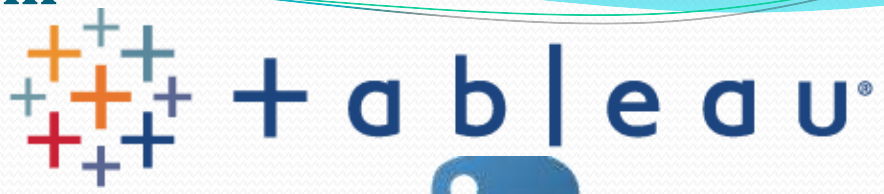

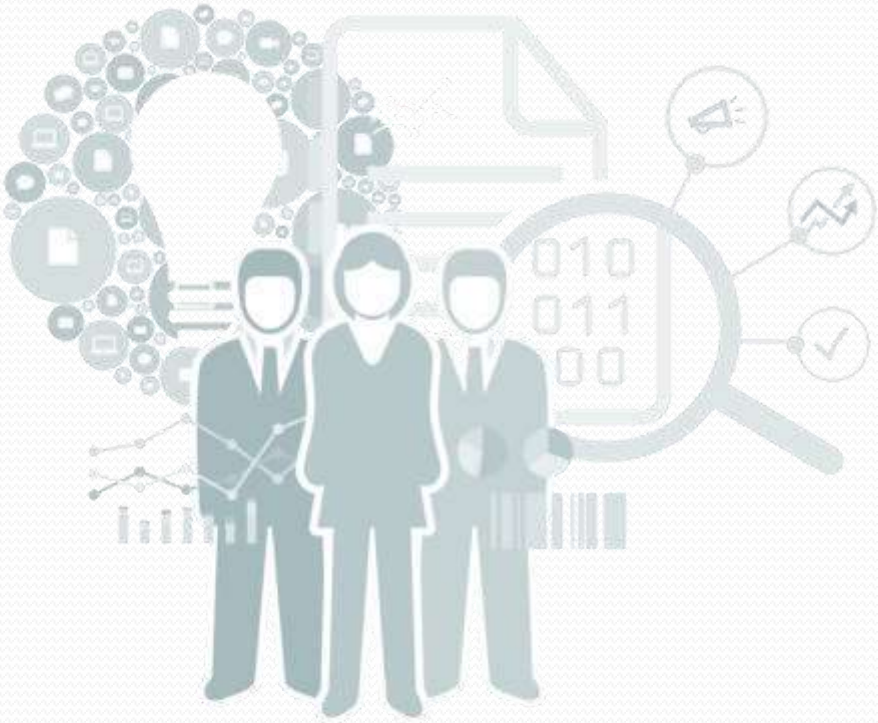

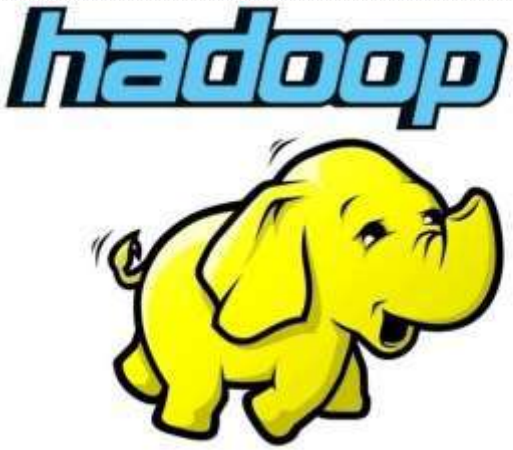

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Business Drivers and sceneries for large data

- **Social media and websites**
- **IT** — services, Software and Hardware services and support. Finance: Better and deeper understanding of risk to avoid credit crisis
- **Telecommunication**: More reliable network where we can predicate and prevent
- **Media**: More content that is lined up with your personal preferences
- **Life science**: Better targeted medicine with fewer complications and side effects
- **Retail**: A personal experience with product and offer that are just what and you need
- Google, yahoo and others need to index the entire internet and return searched results in milliseconds

Challenges in Big Data Storage and Analysis

- **'Slow to process, can't scale**
  - Disk seek for every access
  - Buffered reads, locality -5 still seeking every disk page
  - It not Storage Capacity but access speeds which is the bottleneck
  - Challenges to both store and analyze datasets
  - Scaling is expensive
- **Hard Drive capacity to process**
  - IDE drive — 75 MB/sec, loms seek
  - DATA drive — 300MB/s, 8.5ms seek
  - SSD — 800MB/s, 2 ms "seek"
  - Apart from this analyze, compute, aggregation, processing dealy etc..
- **Unreliable machines: Risk**
  - Machine 1 time in 3 years mean time between failures
  - 1000 Machines 1 day mean time between failures

Challenges in Big Data Storage and Analysis continues...

- **Reliability**

  Partial failure, graceful decline rather than full halt

  Data recoverability, if a node fails, another picks up its workload

  Node recoverability, a fixed node can rejoin the group without a full group restart

- **Scalability, adding resources adds load capacity**

  Backup

  Not affordable, expensive(faster, more reliability more cost)

  Easy to use and Secure

- **Process data in parallel**

Process data in parallel ? — not simple

An Idea; _Parallelism

Transfer speed improves at a greater rate than seek speed.

Process read/write parallel rather then sequential.

* 1 drive — 75 MB/sec 16 days for 100TB
* 1000 drives — 75 GB/sec 22 minutes for 100TB

A problem: Parallelism is Hard

Synchronization

Deadlock

Limited bandwidth

Timing issues and co-ordination

Spilt & Aggregation

Computer are complicate

Driver failure

Data availability

Co-ordination

Why Not distributed computing

Common Challenges in Distributed computing

We have distributed computing and it also come up with some

- **Resource sharing**. Access any data and utilize CPU resource across the system.
- Portability, reliable,
- **Concurrency**: Allow concurrent access, update of shared resource, availability with high throughput
- **Scalability**: With data, with load
- **Fault tolerance** : By having provisions for redundancy and recovery
- **Heterogeneity:** Different operating system, different hardware
- **Transparency:** Should appear as a whole instead of collection of computers

Hide details and complexity by accomplishing above challenges from the user and need a common unified interface to interact with it.

To address most of these challenges(but not all) Hadoop come in.

Hadoop origins

Apache Hadoop is a framework that allows for the distributed processing of large data sets across clusters of commodity computers using a simple programming model. It is designed to scale up from single servers to thousands of machines, each providing computation and storage.

Hadoop is an open-source implementation of Google MapReduce, GFS(distributed file system).

Hadoop was created by Doug Cutting, the creator of Apache Lucene, the widely used text search library.

Hadoop fulfill need of common infrastructure

— Efficient, reliable, easy to use

— Open Source, Apache License

The Name 'Hadoop' ?

What's up with the names?
When naming software projects, Doug Cutting seems to have been inspired by his family.
Lucene is his wife's middle name, and her maternal grandmother's first name.
His son, as a toddler, used Nutch as the all-purpose word for meal and later named a yellow stuffed elephant Hadoop.
Doug said he "**was looking for a name that wasn't already a web domain and wasn't trademarked, so I tried various words that were in my life but not used by anybody else. Kids are pretty good at making up words.**"

Hadoop Design Axioms

- Store an process large amounts of data (PetaBytes)
- Performance, storage, processing scale linearly
- Compute should move to data
- Simple core , modular and extensible
- Failure is normal, expected
- Manageable and Heal self
- Design run on commodity hardware-cost effective

Does Hadoop achieves complete parallelism?

For Storage and Distributed computing (MapReduce)

Spilt up the data

- Process Data in parallel
- Sort and combine to get the answer
- Schedule, Process and aggregate independently
- Failures are independent, Handle failures.
- Handle fault tolerance

Hadoop History

+2002-2004 Doug cutting and Mike Cafarella started working on Nutch

• **2003-2004:** Google publishes GFS and MapReduce paper

• **2004 :** Doug cutting adds DFS and Mapreduce support to Nutch

•Yahoo ! Hires Cutting , bulid team to develop Hadoop

#2007: NY time converts 4 TB of archive over 100 EC2 cluster of Hadoop.

•Web scale deployement at Y!,Facebook,twitter.

• **May 2009**: Yahoo does fastest sort of a T B, 62secs over 1460nodes

•Yahoo sort a PB in 16.25hrs over 3658 nodes

Hadoop V/S RDBMS

An Elephant can't jump. But can carry heavy load !!!

• A fundamental tenet of relational databases structure defined by a schema, what about Large data sets are often unstructured or semi-structured, Hadoop is the best choice. Hadoop MR framework uses key/value pairs as its basic data unit, which is flexible enough to work with the less-structured data types.

Scaling commercial relational databases is expensive and limited.

• High-level declarative language like SQL, Block box Query engine. You query data by stating the result you want and let the database engine figure and drive it. you can build complex statistical

Hadoop V/S RDBMS cont..

models from your data or analytical reporting or reformat your image data. SQL is not well designed for such tasks. MapReduce tries to collocate the data with the compute node, so data access is fast since it is local.

- Coordinating the processes in a large-scale distributed computation is a challenge. HDFS and MR made easy split, store. process and aggregate.
- To run a bigger database you need to buy a bigger machine. the high-end machines are not cost effective for many applications. For example, a machine with four times the power of a standard PC costs a lot more than putting four such PCs in a cluster. Hadoop is designed to be a scale-out architecture operating on a cluster of commodity hardware . Adding more resources means adding more machines to the Hadoop cluster.

Hadoop V/S RDBMS cont..

Effective cost per user TB: $250/TB

Other solutions(RDBMS) cost in the range of $100 to $100K per user TB

Hardest aspect is gracefully handling partial failure— when you don't know if a remote process has failed or not—and still making progress with the overall computation. MapReduce spares the programmer from having to think about failure, since the implementation detects failed map or reduce tasks and reschedules with suitable replacements . MapReduce is able to do this since it is a shared-nothing architecture, meaning that tasks have no dependence on one other.

Hadoop V/S RDBMS cont..

Hardware failure: as soon as you start using many pieces of hardware, the chance that one will fail is fairly high. A common way of avoiding data loss is through replication. Redundant copies of the data are kept by the system so that in the event of failure, there is another copy available. Node failure and disk
failure efficient handle in Hadoop frame work.

	Traditional RDBMS	MapReduce
Data size	Gigabytes	Petabytes
Access	Interactive and batch	Batch
Updates	Read and write many times	Write once, read many times
Structure	Static schema	Dynamic schema
Integrity	High	Low
Scaling	Nonlinear	Linear

Hadoop V/S RDBMS cont..

Is Hadoop alternative for RDBMS ?

Hadoop is not replacing the traditional data systems used for building analytic applications — the RDBMS, EDW and MPP systems — but rather is a complement.

- Interoperate with existing systems and tools, at the moment Apache Hadoop is not a substitute for a database
- No Relation, Key Value pairs
- Big Data, unstructured (Text) & semi structured (Seq / Binary Files) Structured (H base-Google Big Table)Works fine together with RDBMs, Hadoop is being used to large quantities of data into something more manageable.

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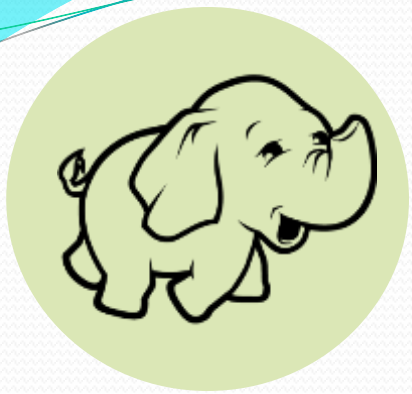

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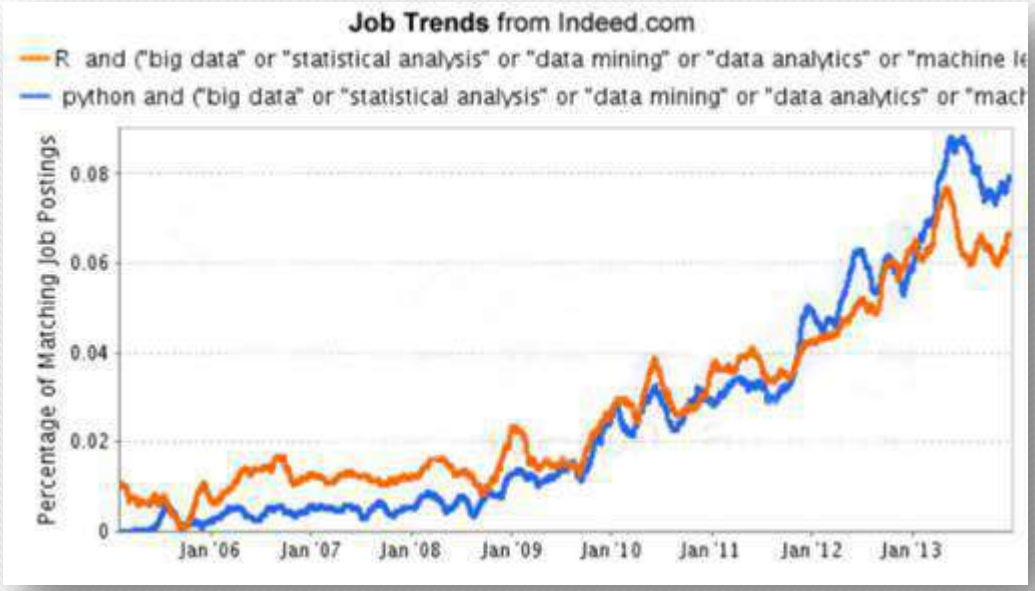

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1.https://www.techopedia.com/

2. https://pediaa.com/

3.https://www.geeksforgeeks.org/

THANKYOU