The Rise of Big Data

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INTRODUCTIONS

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Getting Started…

Does a Text Book Have any Indexes?
If yes how many?

What is an Index in the context of Data Storage / Access?

How to build an Inverted Index for a document…

When would you use which one?

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Basics of Data Management

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- Computers invented to store and retrieve data efficiently
- Traditional Applications: Banking, Retail, Reservations…
  - Use Traditional database systems
  - Tuned for many small simple operations
  - Online Transaction Processing (OLTP)
- Relational Database Is King
  - Transactions, ACID properties, Durability of Data
  - Entities, Relations, Tables with Rows and Columns
  - Relational Operators: Select, Project, Union, Join, etc
  - A solid foundation to manage complex data

Transactional & Structured

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Basics of Data Analytics…

- Now that I have the data, can I understand it better?
  - Analytics: science of examining data to make decisions
- Address Questions Like
  - Top ten products sold in the last 5 years?
  - Compare the monthly totals for the last 10 years?
  - What other items are bought with Toothpaste?
- OLTP fails miserably here – why?
- Solution: Online Analytical Processing (OLAP)
  - Decision Making using the Data Warehouse

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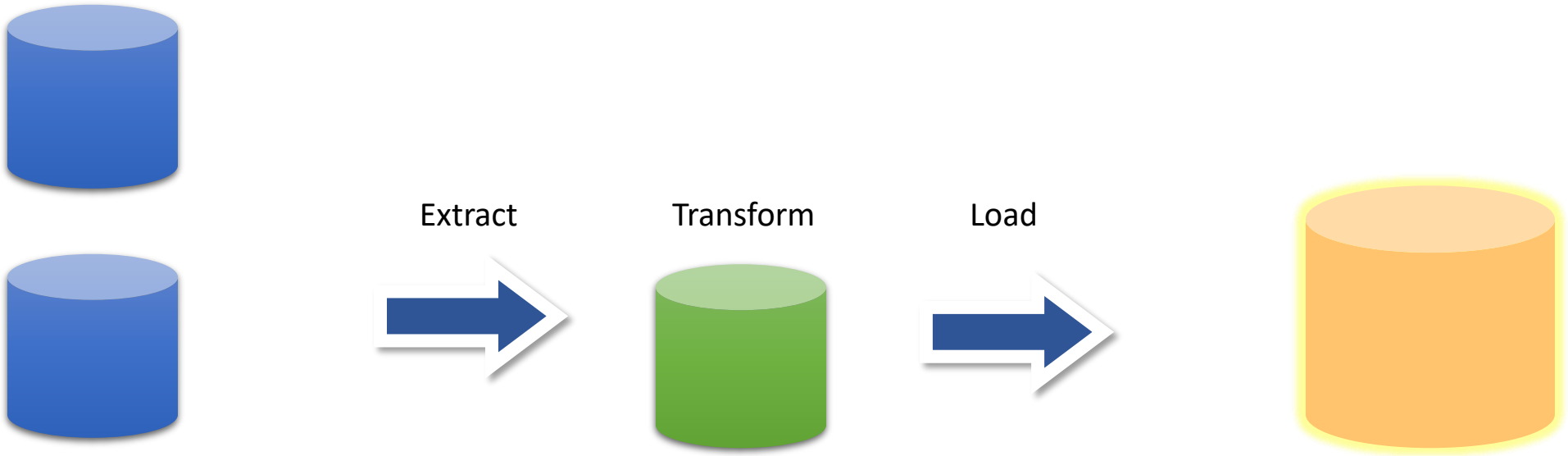
The Data Warehouse

OLTP
Daily Business
Transactional

OLAP
Reporting
Decision Making



Source Systems

Staging Area

Data Warehouse

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Data Today is Ever Growing

- Increase in these dimensions
  - **Velocity**: Data generated by devices / sensors
  - **Volume**: Updates on Facebook
  - **Variety**: Email, Images on Instagram
- Internet Problem: Rise of Unstructured Data
- Relational world can no longer serve
- Analysis becomes more sophisticated
  - How many people like the Tata Nano?
  - How many people will buy it next year?

Data Becomes BigData

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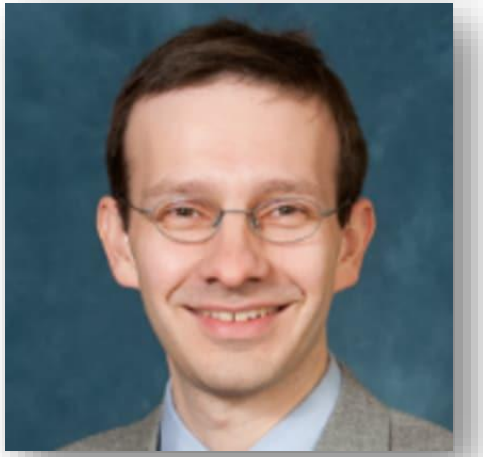
The Story Behind Hadoop

- Doug Cutting was looking to index large blocks of text – invented Lucene
- Wanted to do the same with web pages with Cafarella – Nutch was born
  - A software that could “crawl” web pages and index them
  - One machine was not sufficient. Coded to run on four nodes



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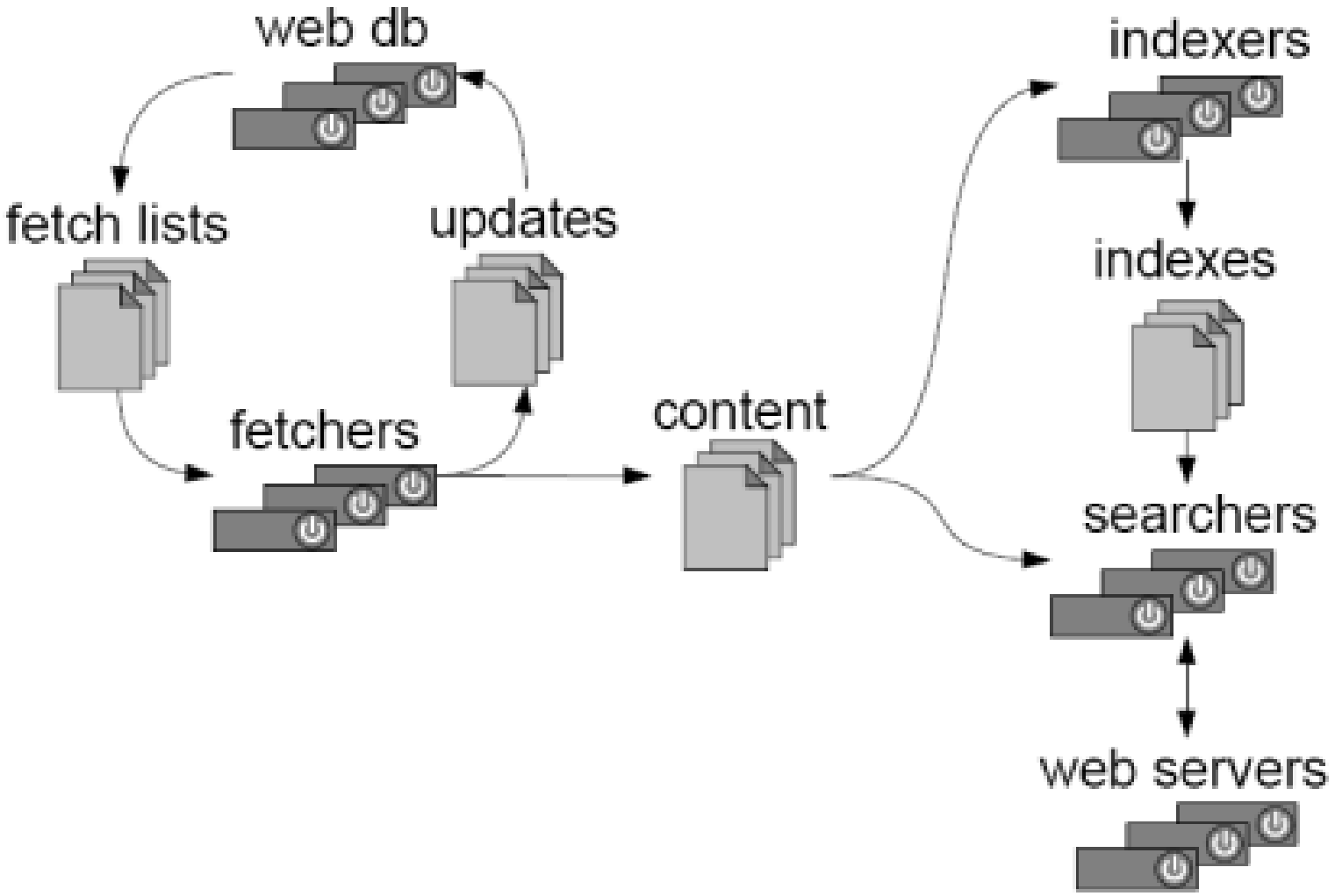
The Nutch Architecture



Imagine doing this across millions of websites !

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The Story Behind Hadoop…

- Became a problem trying to keep the system running
  - One or the other component kept failing
- They needed a Distributed System
  - Schema-less, Durable, Component Failure Tolerant Storage
  - And can Automatically Rebalance when nodes failed
- Google File System paper comes out – inspired NDFS

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The Story Behind Hadoop…

- NDFS handled the operational issues
  - How do you distribute computation?
- Google again answered – the MapReduce paradigm
  - It handled Parallelization, Distribution and Component failure
- Instead of moving data, move the program to where the data is
- Feb 2006: Cutting pulled out NDFS + MapReduce implementation
  - Hadoop was born
- Yahoo hit a similar problem; Adopt Hadoop
  - In 2007 Cutting's team had a 1000 node cluster at Yahoo

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Inside Hadoop

Introduction to Apache Hadoop

- An opensource framework to run MapReduce programs
- A platform to process large amounts of data continuously
- Execute long running computations
- Do all of this as inexpensively as possible
- Long running => Failures are inevitable => Work should not be lost

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Assumptions / Goals of Hadoop

- Hardware will fail
- Tuned for batch processing / streaming data
  - Does not work well for interactive applications
- Works with huge data sets
  - Moving computation is cheaper
- Portability across platforms
- Does not allow random changes to files
  - Only Append / Truncate available
  - Enables simple concurrency control semantics
- No specialized hardware

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Problem: Maximum Temperature

- You are given file(s) with data as shown
- 1000 Cities, Reading per minute for one Month
- Find Max for each City for that Month

- Solution: Process one file at a time
  - [Delhi 40] [Bengaluru 27] [Shillong 30] [Nagpur 40]
- Merge such outputs from all the files
  - Finding Max for each city after merging

Delhi | 38
Bengaluru | 27
Shillong | 30
Nagpur | 40
Delhi | 40
Bengaluru | 25

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The MapReduce Paradigm

- We just used MapReduce!
- Map: List => List
  - Executes a mapping function on the input list
- Reduce: List => A single value
  - Runs a function on a list to reduce it to one value
- Divide and Conquer method
- Key to incorporating parallelism in the solution
- Increased number of nodes => Better throughput

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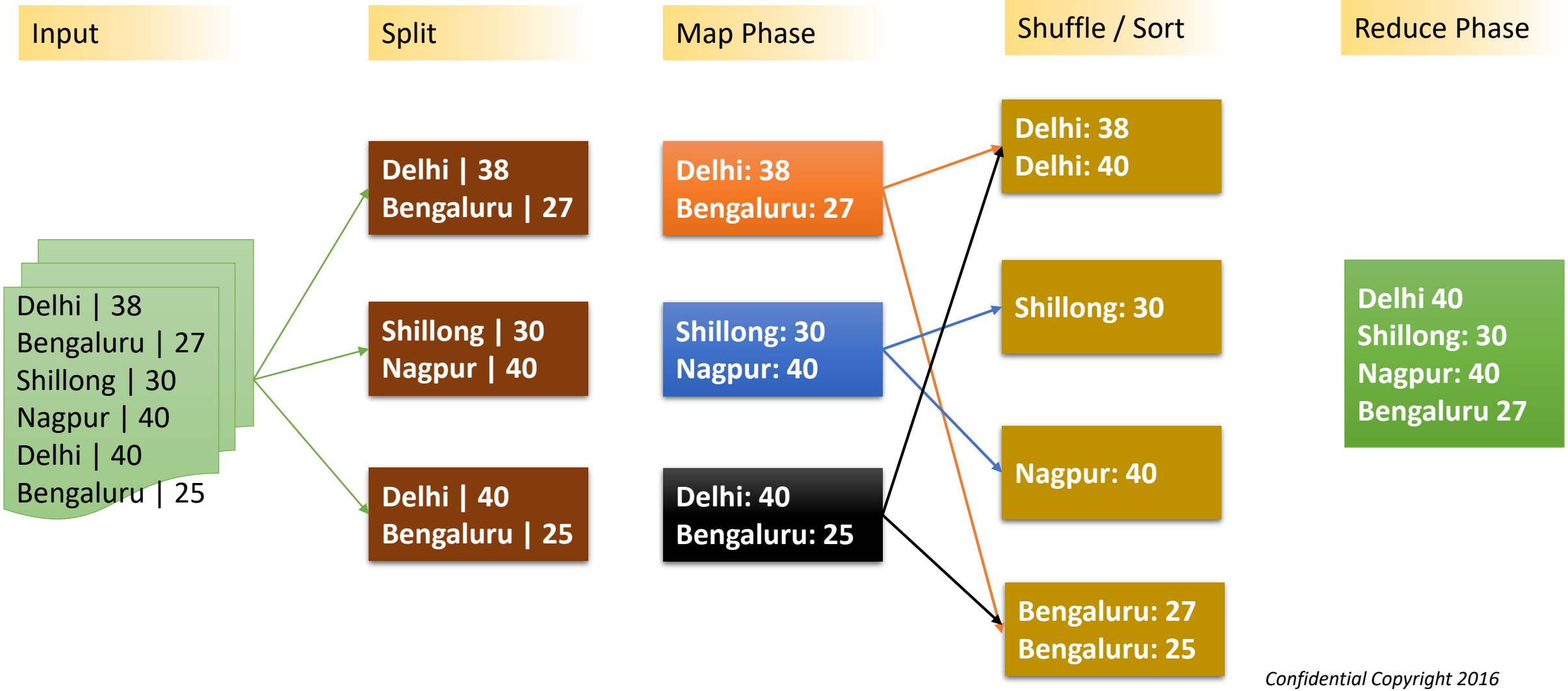
MapReduce Applied



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BigData Examples

Problem: Insights From Email

- Large Company of about 10K Employees
- Primary Mode of Business Communication: Email

- CxO wants a list of Today's Unhappy Customers
- Extended to Address Other Issues
  - Making a Repository of Documents Exchanged
  - Finding Connects into customer organizations

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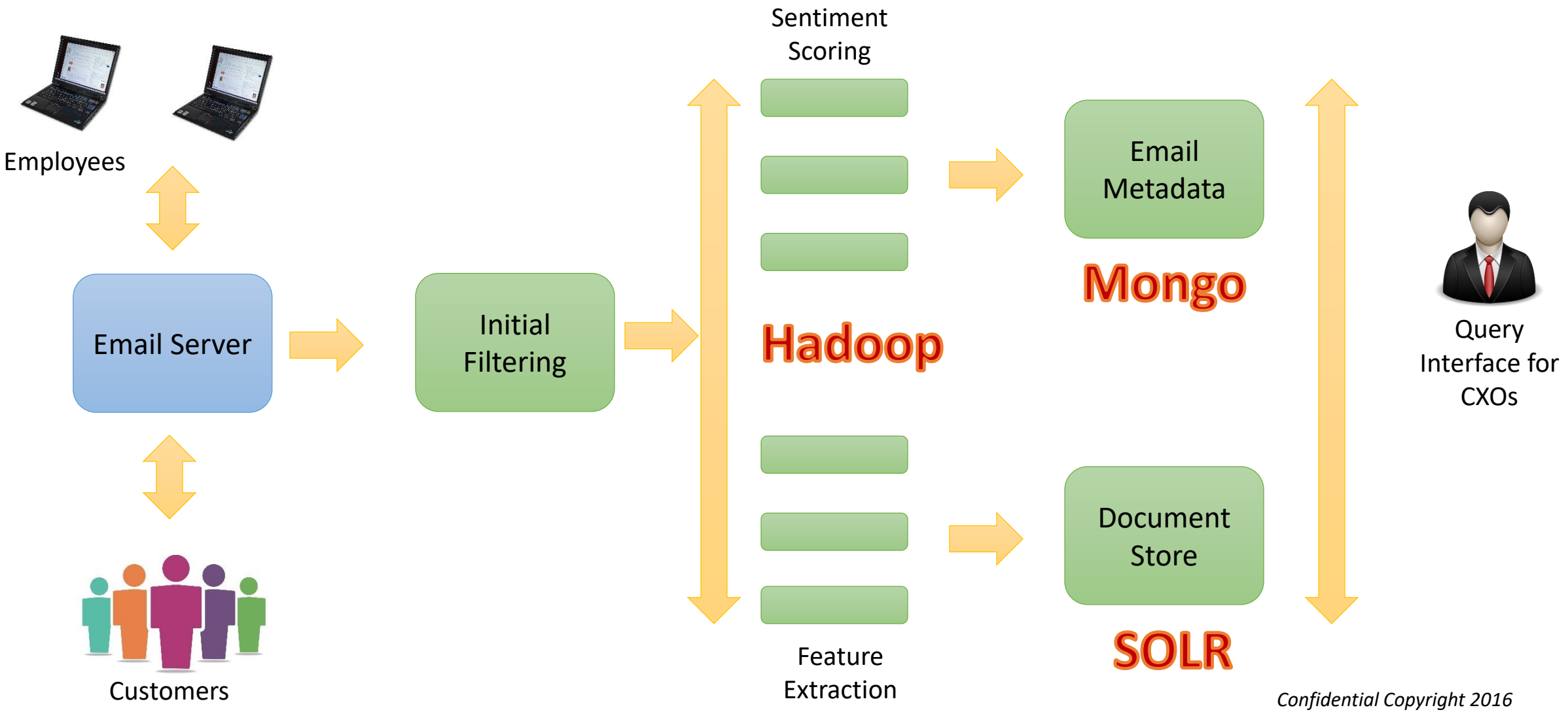
Email Analytics for Business Insights



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Problem: Building an Advertising Server

- Company: Provider of Digital Advertisements (Banners)
  - Works in Tandem with the Real Estate Provider
- Critical Performance Need: Return an Ad Within 200 ms

- Record Views, Click Throughs and Purchases
- Eventually Compute Payments to be made
  - Product Advertiser Pays
  - Recipients: Real Estate Owner and Advertisement Provider

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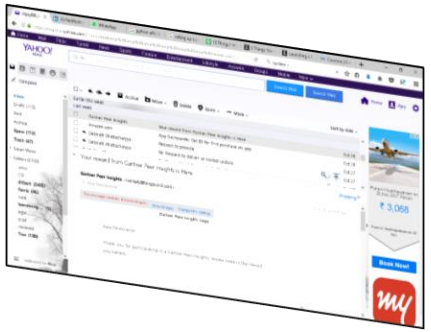
Digital Advertising Server



Content

Real Estate Server

Views

Advertising Server

Cassandra

Advert Store

Clicks

Content Server

Hadoop

Purchase

MMT Server

MySQL

Admin Reports

Views and Clicks Processing

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Conclusions

- We are still on the Cusp of Big Data
- Data is going to only get bigger
- Best Learnt by doing hands on projects
  - Analysing Tweets, Web Logs, Emails (more ideas at **www.kaggle.com**)
- Applying Big Data to traditional domains is going to be key

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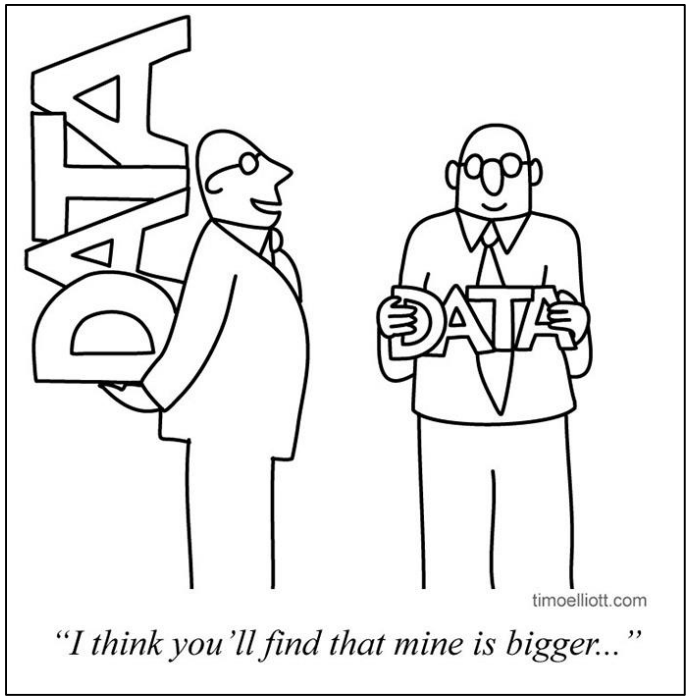

THANK YOU !!

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