

Course Introduction

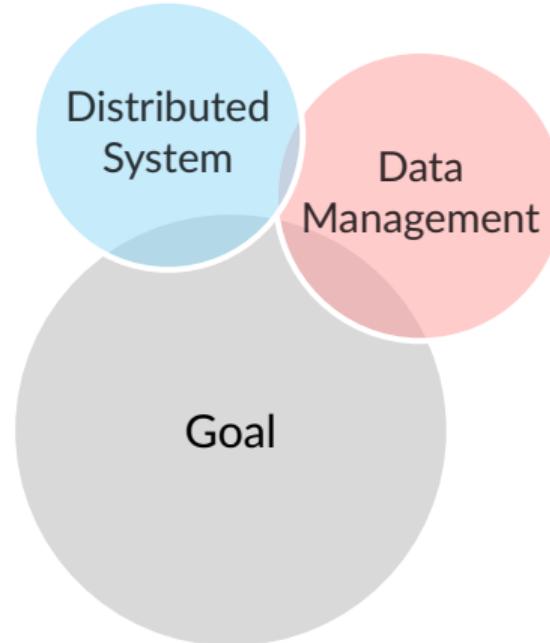
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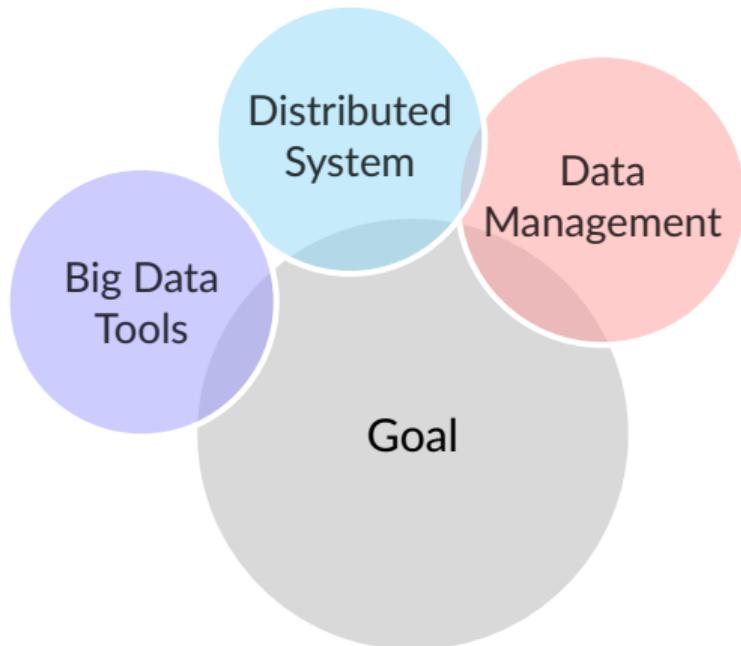
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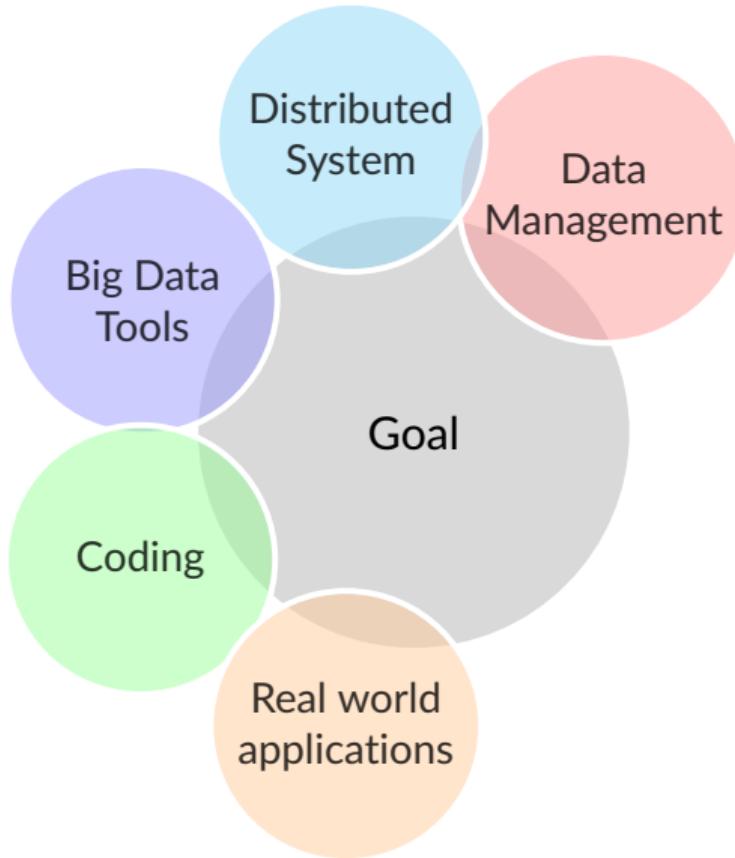
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Learning Objectives

- Simplify the concepts in data management.



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- Understand the data management life-cycle.



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- Be familiar with ETL for (batch/streaming) data over distributed systems ex: Hadoop & Spark.

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- Understanding of the DevOps tools and functions in data life-cycle.

Audience: Who Should Take This Course?

- Data Engineer who needs to get more knowledge in distributed systems and Big Data.



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- DevOps engineers who needs to understand the concepts of big data.
- Business or entrepreneur who needs to get more information about how to build or manage a data product.

Getting max benefit from this course

Take the course advantage

- Follow the videos order as described.

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Chapter Dependencies

⚠ You MUST finish the red chapters first

Ch.01 Introduction

🔔 Finish colors group
before move to the next.

Ch.02 Data Management

Ch.03 Distributed Systems

Ch.04 Hadoop and MR

Ch.05 FN and Scala

Ch.06 Spark

Ch.07 Big Data Application

Ch.08 Massging Systems

Ch.09 Data Orchestration

Ch.10 NoSql

Ch.11 Elastic

Ch.12 Data Architecture Design

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Assignments and Labs

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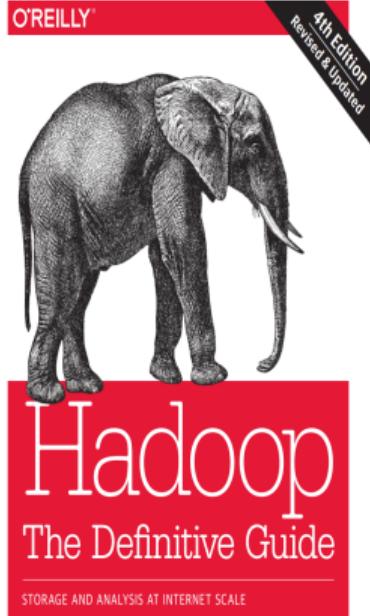
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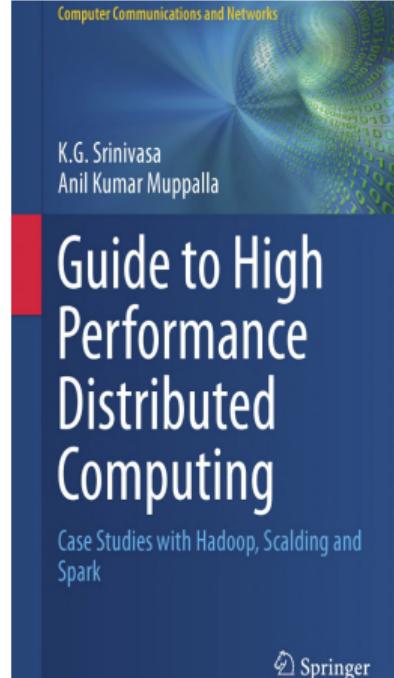
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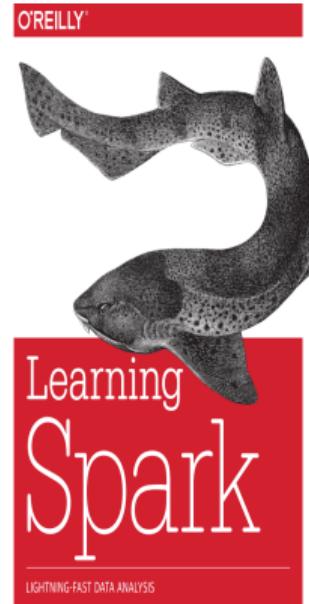
Textbooks-1



Tom White



Textbooks-2



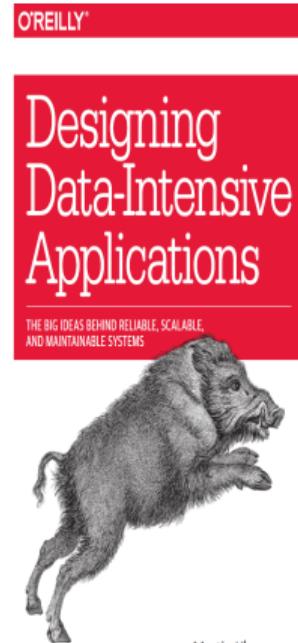
Textbooks-3



Neha Narkhede,
Gwen Shapira & Todd Palino



Jeff Carpenter & Eben Hewitt



Martin Kleppmann



Ugly but important

- User stories or technical discussions are not related to any of my current work or my previous companies.
- I am working at EPAM Systems. My company approved me for doing this online course public but the materials are not reviewed or assessed by my company. It is on my own responsibilities.

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Introduction To Data Management and Data Warehouse

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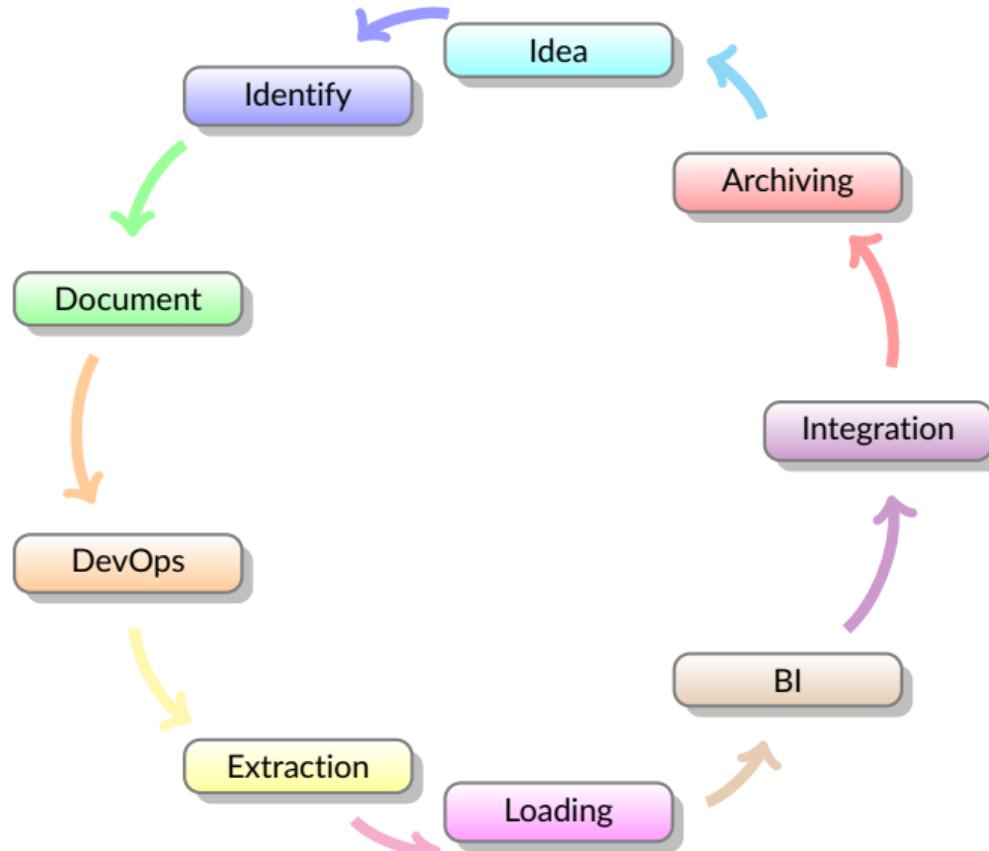
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 - Data retention or **archiving** process ex: (Hot or Cold

Data Management Life-Cycle



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 - Integration.
 - Applying analytical functions.
- Vendors who are working to solve the above challenges creating their own product of DWH and their ultimate work is to optimize the above points.

Motivation to Data Warehouse (DWH)

Definition (What is Data Warehousing?)

A DWH is defined as a technique for collecting and managing data from varied sources to **provide meaningful business insights**. It is a blend of technologies and components which aids the strategic use of data.

- The DWH is not a product but an environment.

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- The DWH is the core of the BI system which is built for **data analysis and reporting**.

Motivation to Data Warehouse

Data warehouse system is also known by the following names:

- Decision Support System (DSS).
- Business Intelligence Solution.
- Executive Information System.
- Management Information System.
- Analytic Application.
- Data Warehouse.

The real concept was given by Inmon Bill. He was considered as a father of the DWH. He had written about a variety of topics for building, usage, and maintenance of the warehouse & the Corporate Information Factory

Motivation to Data Warehouse

Types of Data Warehouse

Enterprise Data Warehouse (EDWH) It provides decision support service across the enterprise. It offers a unified approach for organizing and representing data (DWH Model). It offers data classifications according to the subject with privileges policy.

Operational Data Store (ODS): is a central database that provides an up-to-date (real-time) data from multiple transnational systems for operational reporting into a single DWH.

Data Mart: A data mart is a subset of the data warehouse. It specially designed for a particular line of business, such as sales, finance, sales or finance. In an independent data mart, data can collect directly from sources.

DWH vs ODS vs Data Mart

Metric	DWH	ODS	Data Mart
Latency	Day -1	Real-time	Day -1
Data level	Transnational	Transnational	Summary
Historical	Long-term	Snapshot	Aggregated Long-Term
Size	TB/PB	GB	GB/TB
Orientation	Multi sources	Multi sources	Product
Business Units	Multi organizational units	Product team	Business team

DWH vs Operational databases

Metric	Transactions DB	DWH
Volume	GB/TB	TB/PB
Historical rows	Short-term ;1000M	Long-Term 1000M;
Orientation	Product	Subject or multi products
Business Units	Product team	Multi organizational units
Normalization	Normalized	Not required (De-normalized in many use cases)
Data Model	Relational	Star Schema or Multi-dim
Intelligence	Reporting	Advanced reporting and Machine Learning
Use cases	Online transactions & operations	Centralized storage (360°)

Transnational DB Use cases



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DWH Use cases



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 - The CRM system handles the customer activities with the company including (sales, change in customer plans, and other activities).

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 - CRM team can report their sales and customer activities from their database.
 - Product owner can take a decision based on their system backend reports.

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 - This company has other systems for example: billing, charging, signaling.
 - They need to report information related to the CRM, billing, and signaling source systems in one report.
 - So, they need to ingest (transfer) the data from the source systems to one single database.

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 - This company has other systems for example: billing, charging, signaling.
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 - So, they need to ingest (transfer) the data from the source systems to one single database.
 - The decision from the DHW is a **global and strategical decision**.

Use case (DWH)

- What is the need for DWH?

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- They need to report information related to the CRM, billing, and signaling source systems in one report.
- So, they need to ingest (transfer) the data from the source systems to one single database.
- The decision from the DHW is a **global and strategical decision**.
- If the company needs to build a machine learning model which needs data from different sources. They need to load the data from a centralized database rather than read each source alone.

Use case (DWH)

The Full picture required a DWH. However, we still need the other operational databases for product development perspective.

Use case (ODS)

- Why do we need the ODS?



Use case (ODS)

- Why do we need the ODS?
- How does it fit in our system?

Use case (ODS)

XTec has a call center system which handles the customer inquiries. This system requires the some data related to usage, customer information, billing details to be calculated and accumulated in **real-time** to be able to give the customer the right answer for his inquires.

Use case (ODS)

- So, What is the challenge for this system?



Use case (ODS)

- So, What is the challenge for this system?
 - It needs specific information from different source systems.

Use case (ODS)

- So, What is the challenge for this system?
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 - It requires to track the source system database changes or update in real-time.

Use case (ODS)

- So, What is the challenge for this system?
 - It needs specific information from different source systems.
 - It requires to track the source system database changes or update in real-time.
 - Its functionality is based on the aggregate data not the transactions for example (It needs the total outgoing calls till time or it needs the total charging amounts from prepaid or the available limits from billing if it is postpaid).

Use case (ODS)

- ODS is based on change data capture (CDC). This approach used to determine the data change and apply action based on this change.

Use case (ODS)

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- ODS uses the real-time aggregations to support the online systems from different source systems.

DWH Architecture Overview

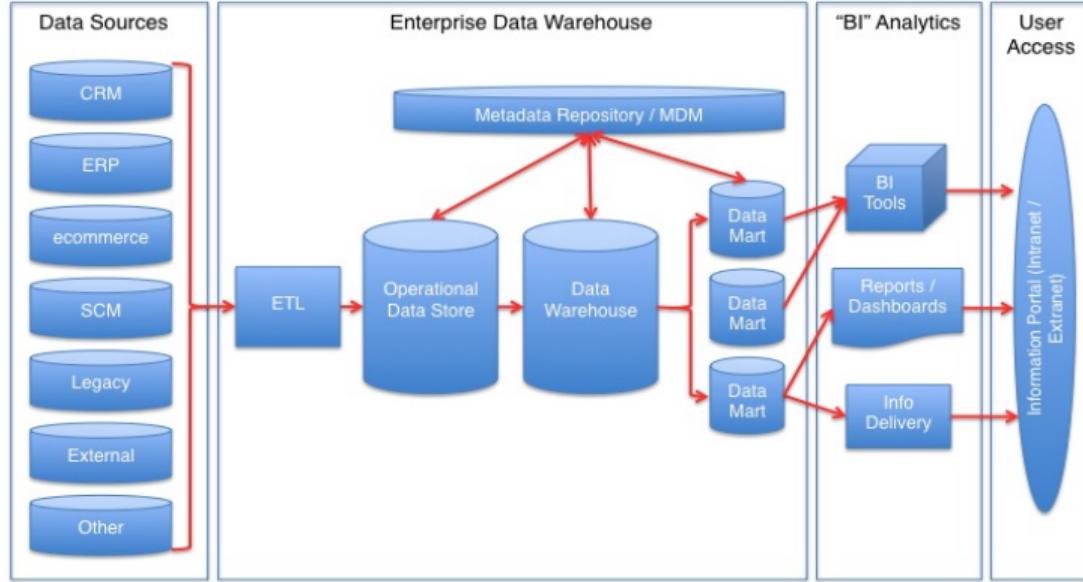


Figure: taken from XXXX

Thinking about data as a product

- How can we think about a data solution?



Thinking about data as a product

- How can we think about a data solution?
 - Requirements analysis.



Thinking about data as a product

- How can we think about a data solution?
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 - Identify the problem (challenges)



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 - Identify the problem (challenges)
 - Think about how to overcome the challenges.

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 - Ask your self the following questions:
 - Can we solve the problem using the current data structure with adding new features?
 - What if we enhance/change the data structure or modeling?
 - Could it help if we change the backend engine (ex: database)?
- To answer these questions you need to understand the data layers.

Data Layers (Abstraction)

- Any data product (database) contains multi-layers.

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- The developer for each layer hide internal irrelevant details from developer (users).
- The process of **hiding** irrelevant details from developer (user) is called data **abstraction**.

Data Layers (Abstraction)

Definition

Data Abstraction and Data Independence: Database systems comprise of complex data-structures. In order to make the system efficient in terms of retrieval of data, and reduce complexity in terms of usability of users, developers use abstraction i.e. hide irrelevant details from the users. This approach simplifies database design.

- There are 3 levels of data abstraction.

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 - Physical level
 - Logical/ Conceptual level.

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- There are 3 levels of data abstraction.
 - Physical level
 - Logical/ Conceptual level.
 - View level.

Data Abstraction

- Physical level:



Data Abstraction

- **Physical level:**
 - Lowest level.

Data Abstraction

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 - Describes how data is stored.

Data Abstraction

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- Describes how data is stored.
- Describes the data structure.

Data Abstraction

- Physical level (Internal):

Example

Database contains product information. Physical layer describes storage mechanism and the blocks (bytes, gigabytes, terabytes etc.) and the amount of memory used. Usually this layer abstracted from the programmers.

Data Abstraction

- **Physical level (Internal):**

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Data Abstraction

- **Physical level (Internal):**

- Lowest level.
- Describes how data is stored (files, indices, etc. on the random access disk system).

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- **Physical level (Internal):**

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Data Abstraction

- **Physical level (Internal):**

- Lowest level.
- Describes how data is stored (files, indices, etc. on the random access disk system).
- Describes the data structure.
- Describes the record layout of files and type of files (hash, b-tree, flat).

Example

Database contains product information. Physical layer describes storage mechanism and the blocks (bytes, gigabytes, terabytes etc.) and the amount of memory used. Usually this layer abstracted from the programmers.

Data Abstraction

- **Logical level (Conceptual):**

Example

Database contains product information. Logical Layer describes the product fields and their data types. How this product interact with other entities in the database. The programmers design this level based on the business knowledge and the requirements.

Data Abstraction

- **Logical level (Conceptual):**

- Intermediate level.

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- **Logical level (Conceptual):**

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- **What** is the data stored?
- Describes **what** data is stored.
- Describes what is the relationship between the stored data,

Example

Database contains product information. Logical Layer describes the product fields and their data types. How this product interact with other entities in the database. The programmers design this level based on the business knowledge and the requirements.

Data Abstraction

- View level (External):

Example

Database contains product information. View layer is the final interface for the user. It could be extended or hidden based on users. For example, Some users need to show the sales for their department product but not for other departments.

Data Abstraction

- **View level (External):**
 - Highest level.

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Data Abstraction

- **View level (External):**

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- View of the data stored?
- Designed for category of users needs.
- Not all the views are extended to all users and there is an authentication based on the category.

Example

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What is data model?

Data model is

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- It describes how application (report) API data manipulation.
- It describes the conceptual design of a business or an application with its flow, logic, semantic information (rules), and how things are done.
- It refers to a set of concepts used in defining such as entities, attributes, relations, or tables.

What is data model?

Data model is not

- a science.
- a static design for each organization.
- a type of database.
- a new invention which needs to be done for each project.

Data model is

- an engineering design practices.
- a general concepts which lead to build full architecture.
- different based on the use case and the database type.
- customizable and we can utilize some of ready built architecture.
- implementing using different ways.
- affecting the information reporting performance and ways.

Why does data models are important?

- Data models are currently affecting software design.
- It decides how engineers will think about the problem they are solving.

Data Model Design vs Implementation

- You need to build a home. So, how do we design this home?



Data Model Design vs Implementation

- You need to build a home. So, how do we design this home?
 - Determine if the home is one level or multi-level and decide man bedrooms and bathrooms for each floor. (User needs)



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- What do we do for the implementation?
 - Hire a contractor to build (implement the design) the home.

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 - Decide the decorations, colors for each room, carpets, etc.
- What do we do for the implementation?
 - Hire a contractor to build (implement the design) the home.
 - This phase will implement the design but it also include some detail related to the actual way to build the tools and the material. (Physical Design)

DWH Characteristics

some details about hot vs cold storage,

Cold storage vs Hot storage

some details about hot vs cold storage,

Data Models

- Any Big Data solution working based distributed systems.

Data Models

- Any Big Data solution working based distributed systems.
- What is distributed systems in brief?

Introduction To Distributed Systems

Chapter Objectives

- Understand the distributed systems concepts.

Chapter Objectives

- Understand the distributed systems concepts.
- Replication and its usage in distributed systems.

Chapter Objectives

- Understand the distributed systems concepts.
- Replication and its usage in distributed systems.
- Partitioning and its usage in distributed systems .

Distributed Systems Concepts

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Distributed Systems Architecture

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Distributed Systems Challenges

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Design Simple Distributed System

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Introduction to Hadoop and Map-Reduce

Chapter Objectives

- Introduction to Hadoop and its echo-systems.

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- Hadoop advantages and disadvantages with use cases?

Hadoop Architecture

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Storage

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Hadoop I/O

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Processing

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Map-Reduce

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Map-Reduce Components

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Word-Count Example

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Functional Programming

Spark Framework

Spark Framework: Spark Philosophy towards the Engine and the Programming languages

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Spark Framework: Spark Basics

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Spark Basics

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Spark Programming using RDDs

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Spark Datasets/Dataframe

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Spark For Batch Processing

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Building custom input and output connector using Spark

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Spark using other Programming Languages

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Tuning your Spark Jobs

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Real World Applications

Massaging Systems

Data Orchestration

NOSQL

Elastic

Data Architecture Design

Appendix

Appendix A- Shell Programming

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Appendix B- Java Programming

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Appendix C- Scala Programming

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Appendix D- SQL Programming

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Appendix E- Oozie Orchestration

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Appendix F- DWH Concepts and Data Modeling Design

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Appendix G- Machine Learning Concepts Data Engineers

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Appendix H- Docker for Data Engineers

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