Data Engineering

LTAT.02.007

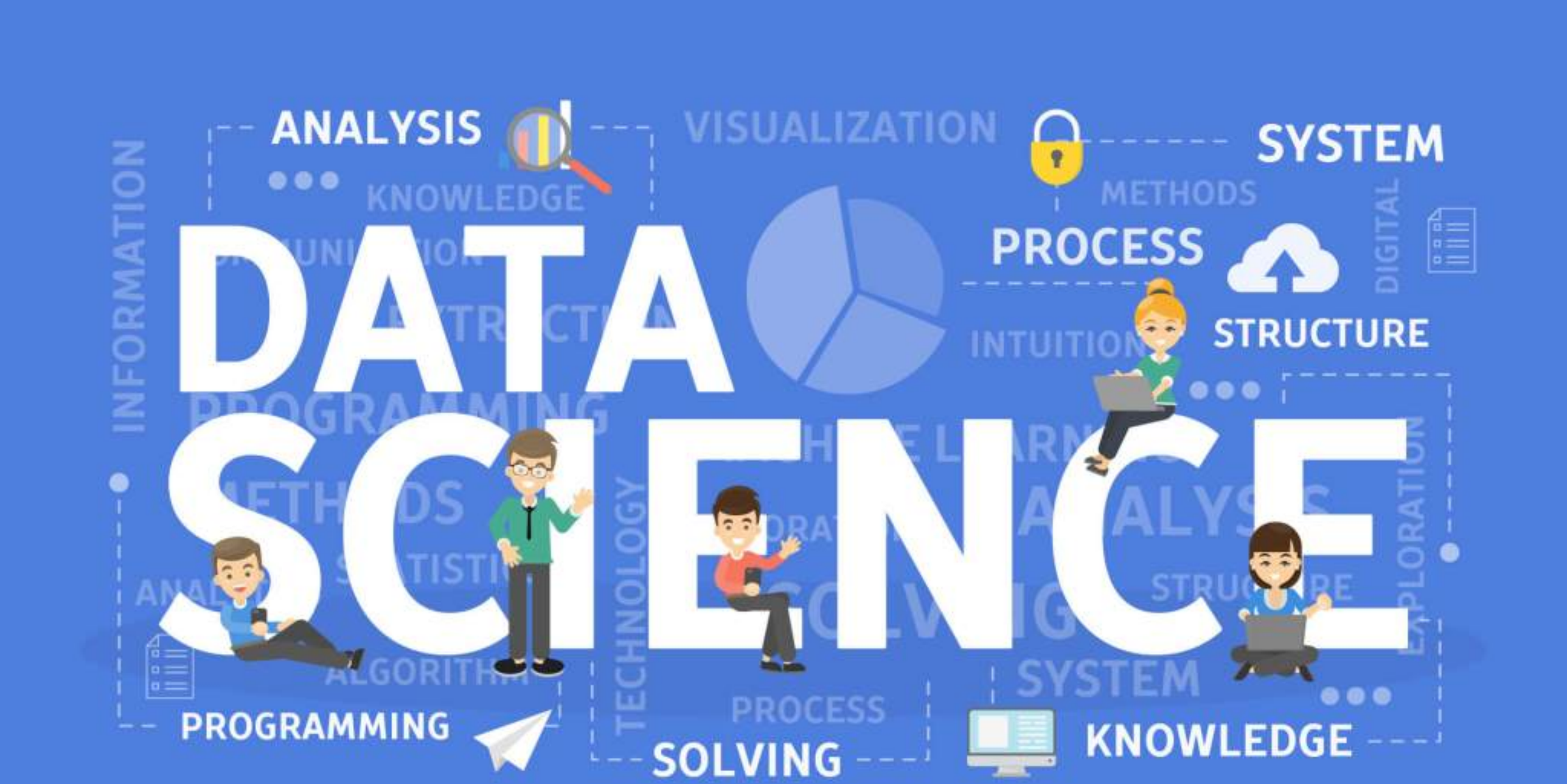
Prof. Ahmed Awad

Ass. Prof Riccardo Tommasini

TAs: Kristo Raun, Fabiano Spiga, Mohamed Ragab

dataeng

Moodle


ANALYSIS
VISUALIZATION
SYSTEM
KNOWLEDGE
METHODS
PROCESS
INFORMATION
DIGITAL
STRUCTURE
INTUITION
DATA
SCIENCE
PROGRAMMING
TECHNOLOGY
EXPLORATION
ALGORITHM
PROCESS
SYSTEM
PROGRAMMING
SOLVING
KNOWLEDGE

Course Intro

https://courses.cs.ut.ee/2020/dataeng

Course Intro

- Lectures

https://courses.cs.ut.ee/2020/dataeng

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- Lectures
  - Mostly F2F in 1037 with recording

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  - 60% on 4 MCQs

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  - 40% on course project

https://courses.cs.ut.ee/2020/dataeng

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  - Assignments are meant to help you work on your project and to get feedback

https://courses.cs.ut.ee/2020/dataeng

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https://courses.cs.ut.ee/2020/dataeng

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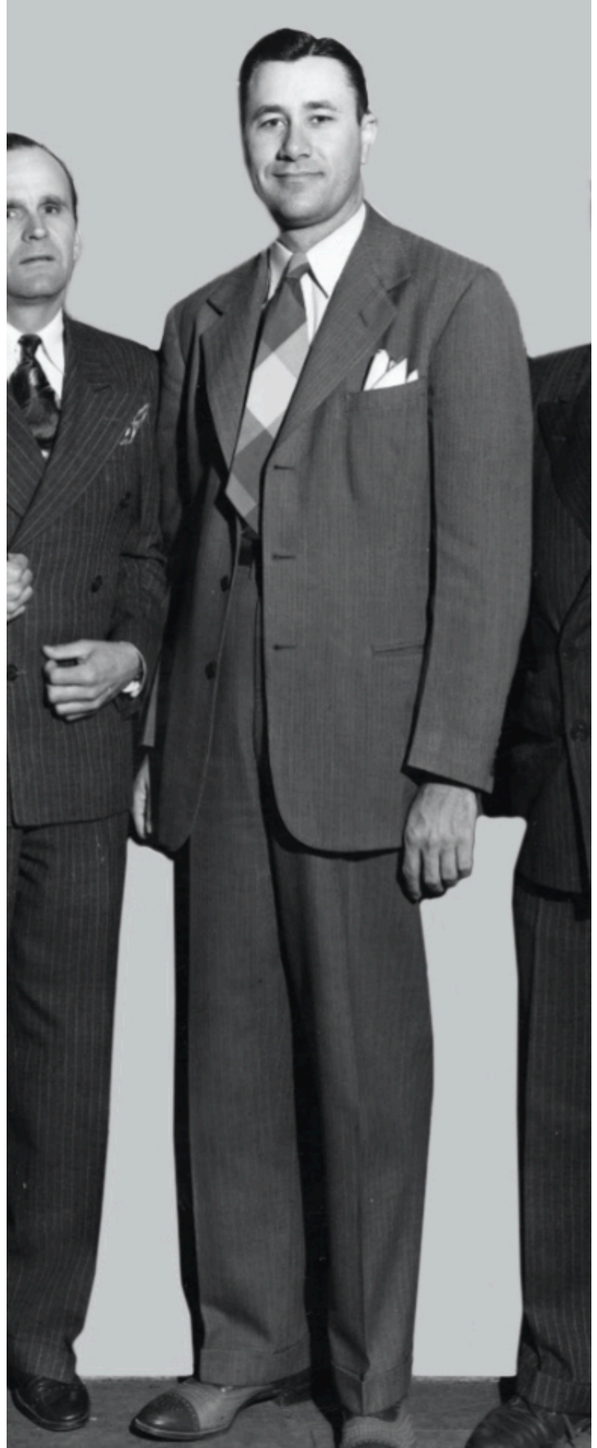
  - More details on course page

https://courses.cs.ut.ee/2020/dataeng

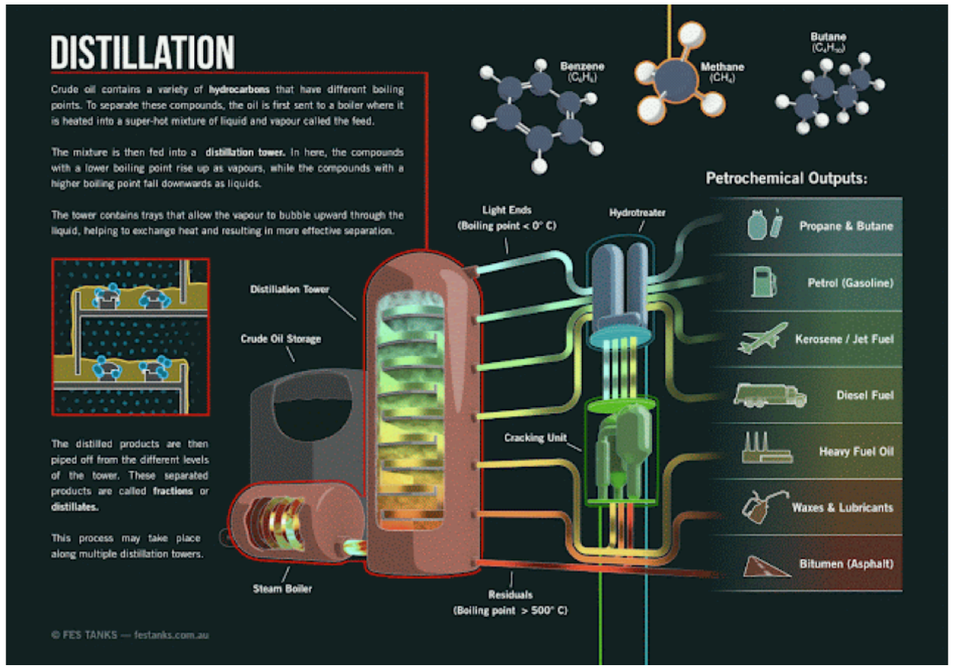
Quote

“A scientist can discover a new star, but he cannot make one.
He would have to ask an engineer to do it for him.”

— *Gordon Lindsay Glegg*



Data Science is...[01]



...refining crude oil

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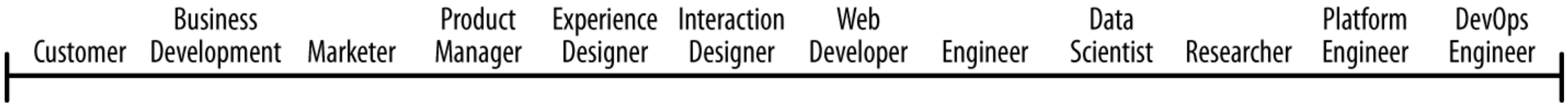
[01] Source

Data Engineering is...

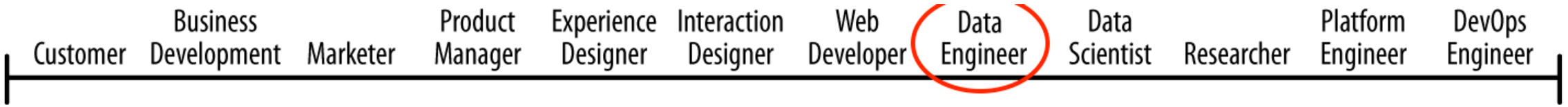
...build the refinery.

Roles in a Data Science Project[02]



[02] http://emanueledellavalle.org/slides/dspm/ds4biz.html#25

Roles in a Data Science Project[02]



[02] http://emanueledellavalle.org/slides/dspm/ds4biz.html#25


Data Engineer

The Data Engineer

A dedicated specialist that maintain data available and usable by others (Data Scientists).[03]

Data engineers set up and operate the organization's data infrastructure preparing it for further analysis by data analysts and scientists.[03]

Data engineering field could be thought of as a superset of business intelligence and data warehousing that brings more elements from software engineering.[04]

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[03] What is Data Engineering

[04] Source: The Rise of Data Engineer

Data Engineering

Data engineering is a set of operations aimed at creating interfaces and mechanisms for the flow and access of information[03].

[03] What is Data Engineering

You Retweeted

Seth Rosen @sethrosen · Apr 20

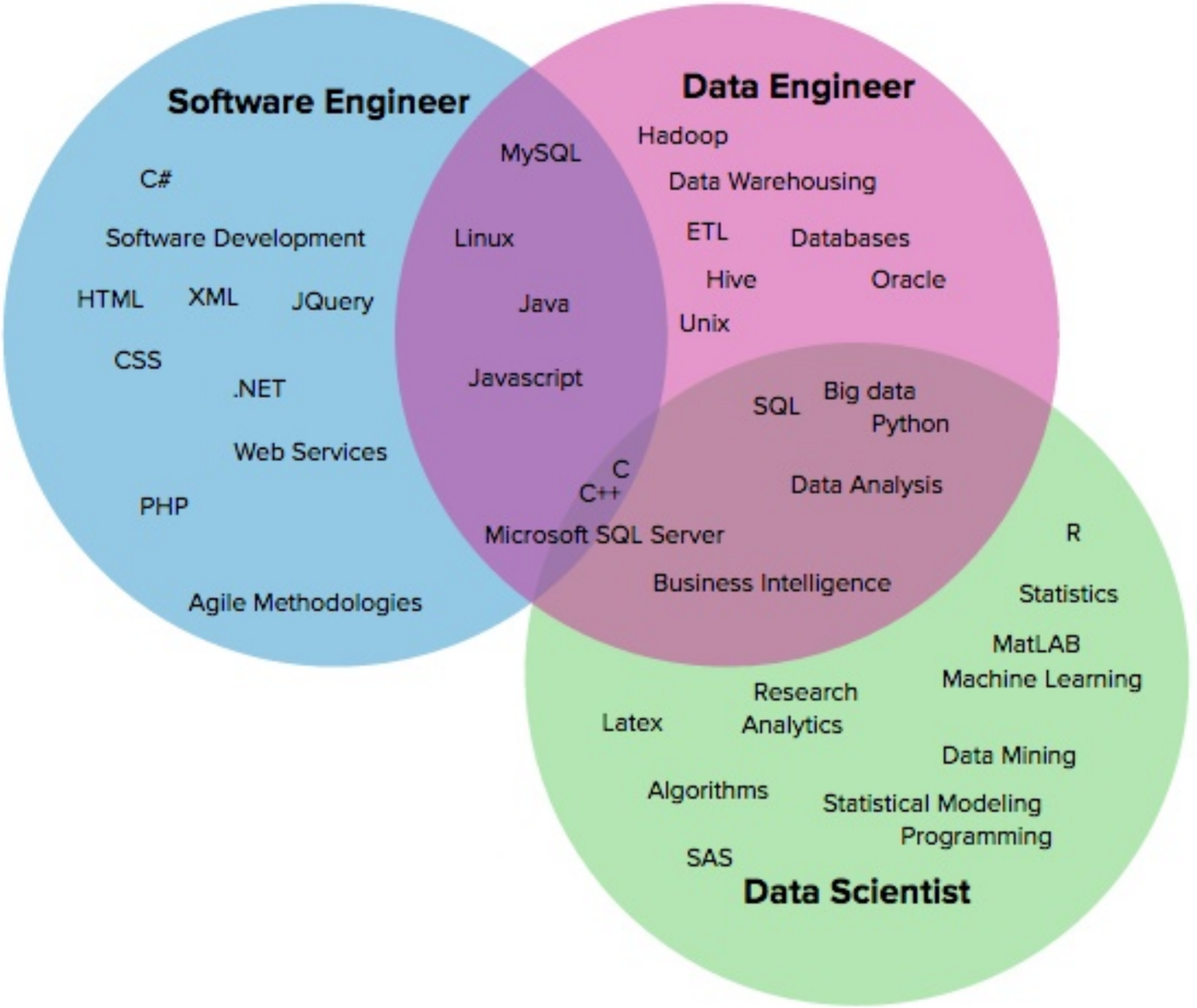
Them: Can you just quickly pull this data for me?

Me: Sure, let me just:

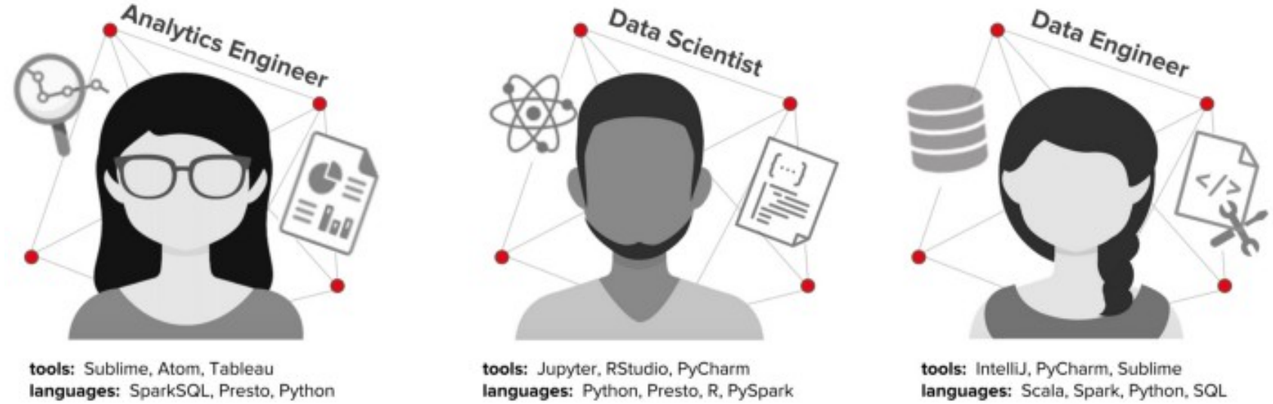
```
SELECT * FROM
some_ideal_clean_and_pristine.table_that_you_think_exists
```

323 4.4K 28K

Show this thread

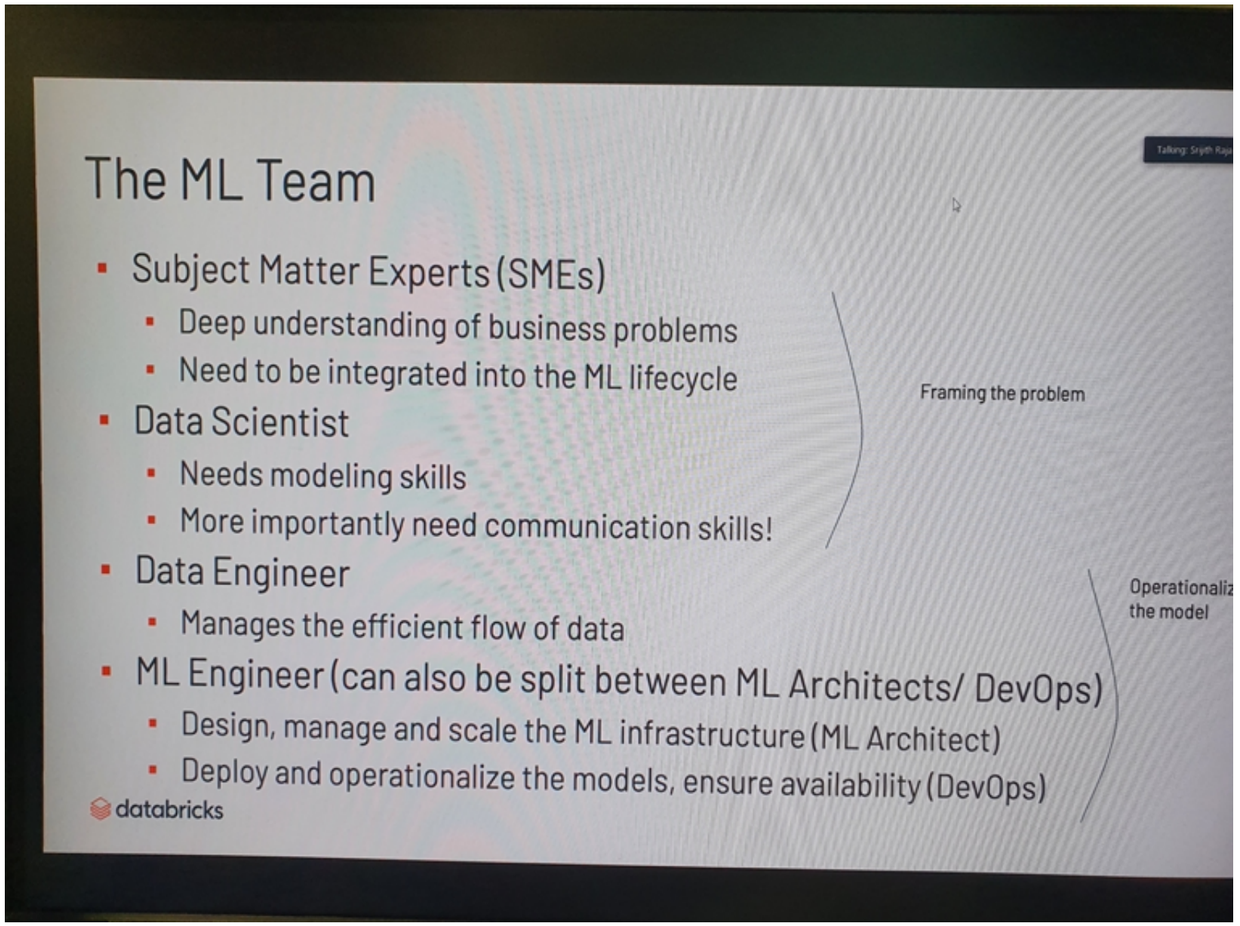

Software Engineer
C#
Software Development
HTML
XML
JQuery
CSS
.NET
Web Services
PHP
Agile Methodologies
Data Engineer
MySQL
Hadoop
Data Warehousing
Linux
ETL
Databases
Hive
Oracle
Java
Unix
Javascript
SQL
Big data
Python
C
C++
Data Analysis
Microsoft SQL Server
R
Business Intelligence
Statistics
MatLAB
Machine Learning
Research
Latex
Analytics
Data Mining
Algorithms
Statistical Modeling
Programming
SAS
Data Scientist

Netflix's Perspective[05]



[05] Netflix Innovation

Data Bricks


The ML Team
Subject Matter Experts (SMEs)
Deep understanding of business problems
Need to be integrated into the ML lifecycle
Data Scientist
Needs modeling skills
More importantly need communication skills!
Data Engineer
Manages the efficient flow of data
ML Engineer (can also be split between ML Architects/ DevOps)
Design, manage and scale the ML infrastructure (ML Architect)
Deploy and operationalize the models, ensure availability (DevOps)
databricks
Framing the problem
Operationaliz
the model

Google's Two-Cents

Professional Data Engineer

A Professional Data Engineer enables data-driven decision making by collecting, transforming, and publishing data. A Data Engineer should be able to design, build, operationalize, secure, and monitor data processing systems with a particular emphasis on security and compliance; scalability and efficiency; reliability and fidelity; and flexibility and portability. A Data Engineer should also be able to leverage, deploy, and continuously train pre-existing machine learning models.

The Professional Data Engineer exam assesses your ability to:

- ✓ Design data processing systems
- ✓ Build and operationalize data processing systems
- ✓ Operationalize machine learning models
- ✓ Ensure solution quality

Register FAQs

This exam is available in English and Japanese.

The Knowledge Scientist[06]

[06] The Manifesto

Philosophy of (Data) Science[07]

[07] Data as Fact

What is Data?

Oxford Dictionary

*Data [**uncountable, plural**] facts or information, especially when examined and used to find out things or to make decisions.* [08]

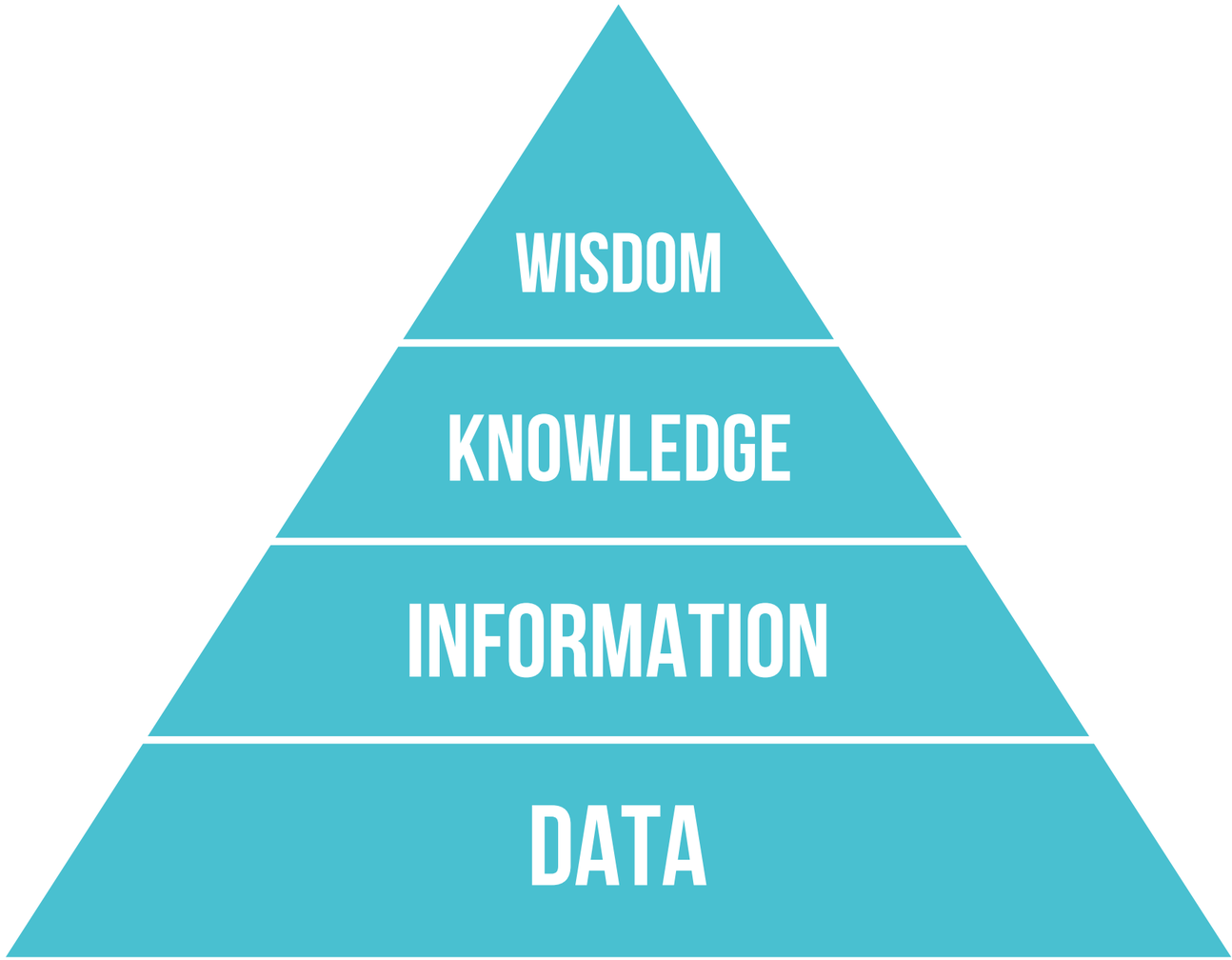
[08] Def

Wikipedia

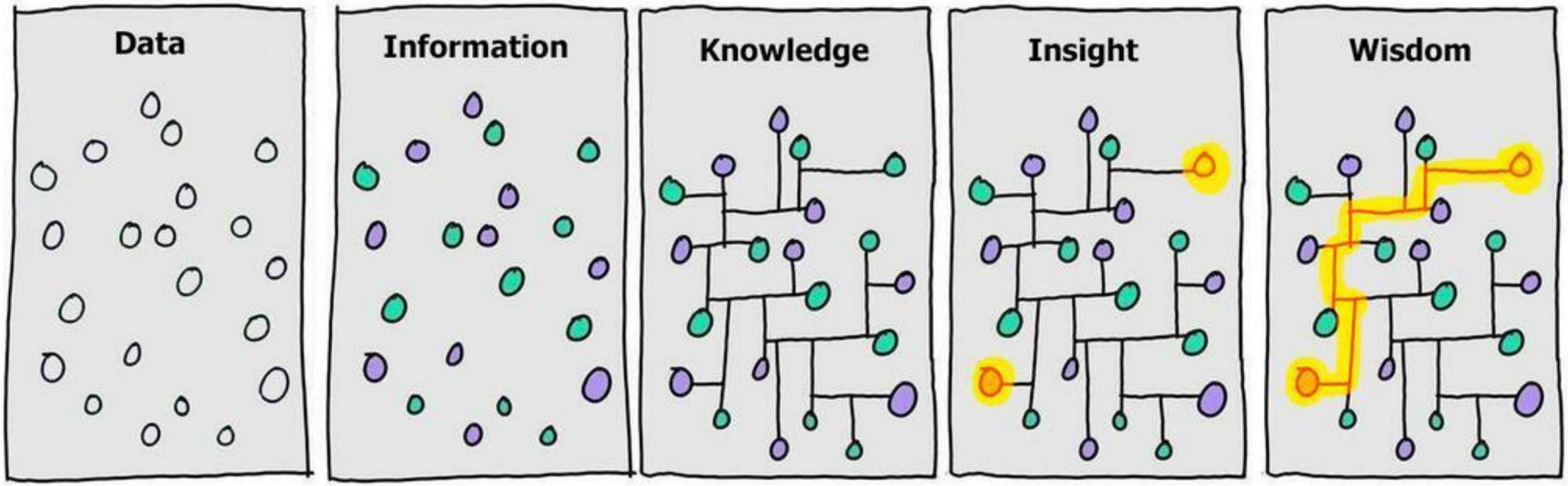
Data (treated as singular, plural, or as a mass noun) is any sequence of one or more symbols given meaning by specific act(s) of interpretation [09]

[09] Data in Computing)

DIKW Pyramid



Graph View



Data about data

Data Semantics

semantics

/sɪˈmantɪks/

noun

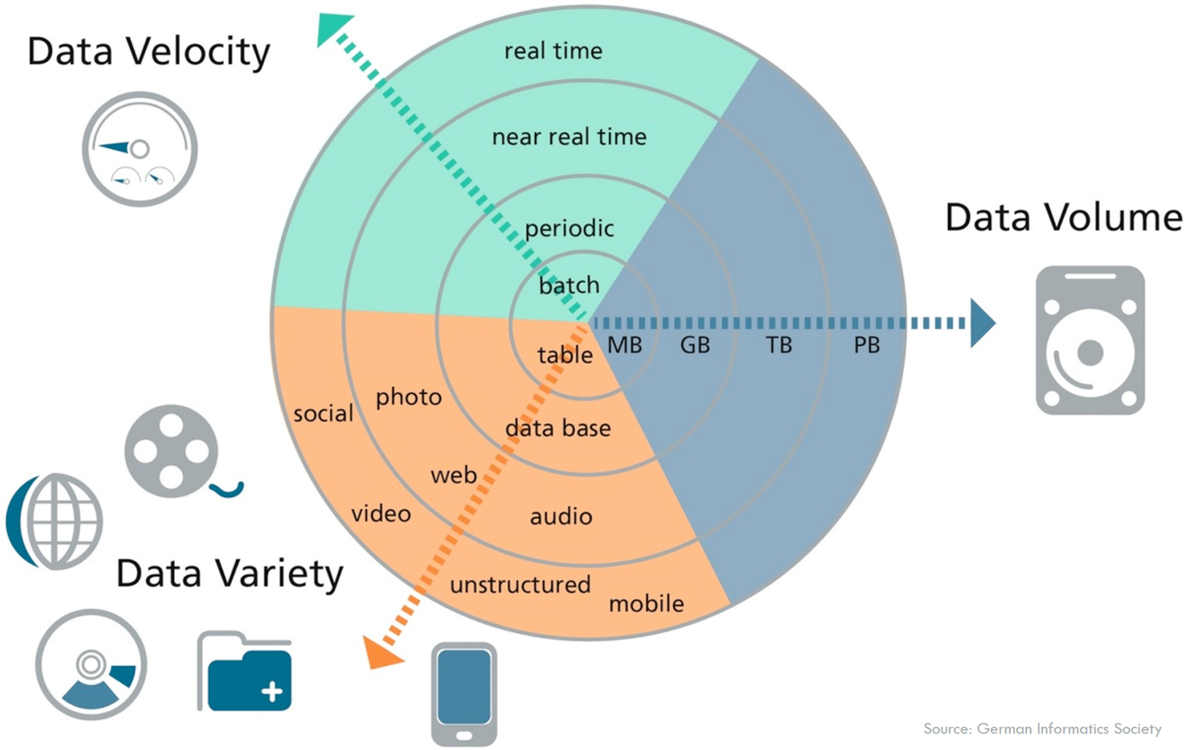
the branch of linguistics and logic concerned with meaning. The two main areas are *logical semantics*, concerned with matters such as sense and reference and presupposition and implication, and *lexical semantics*, concerned with the analysis of word meanings and relations between them.

- the meaning of a word, phrase, or text.
  plural noun: **semantics**
  "such quibbling over semantics may seem petty stuff"

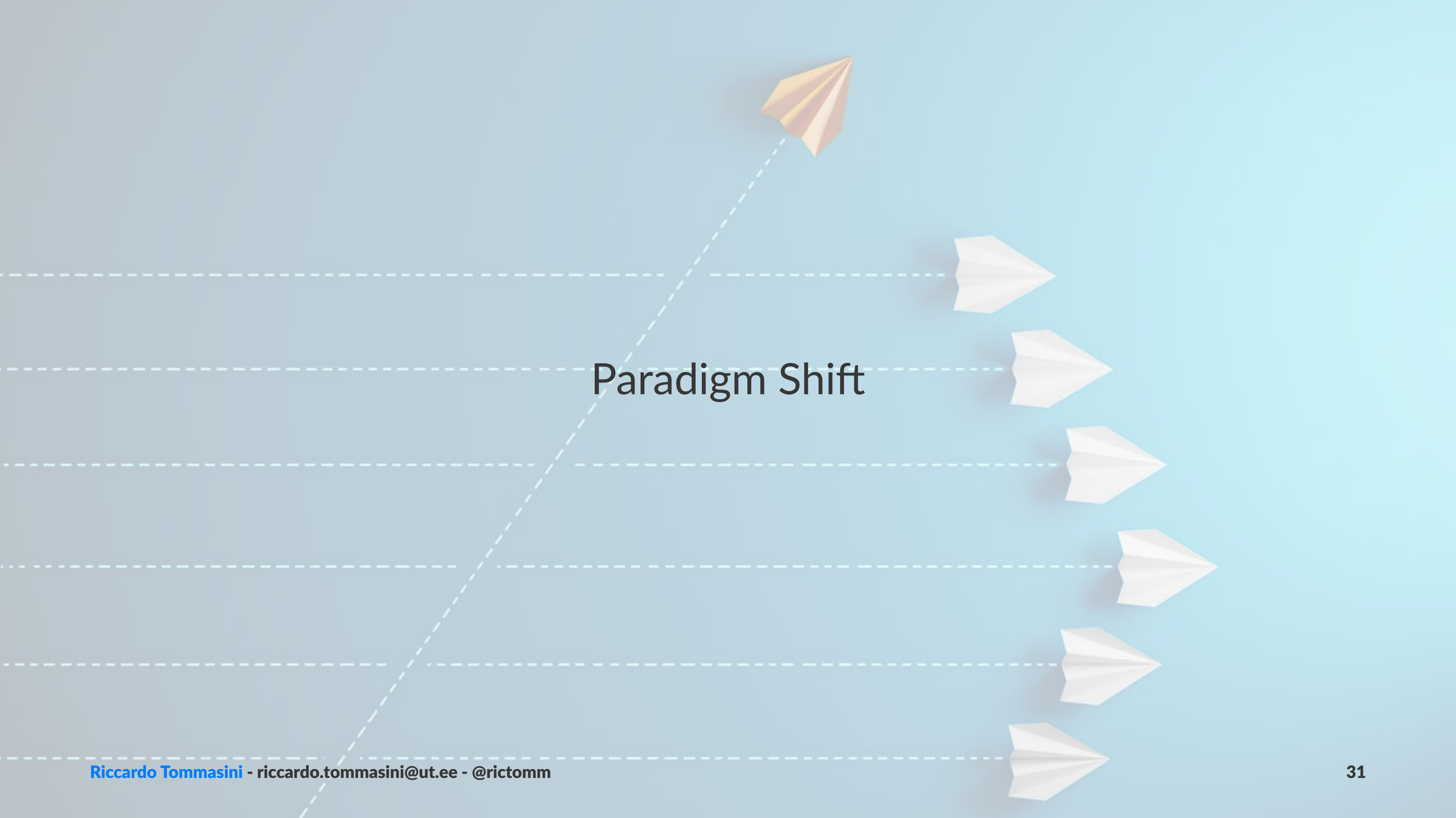
Translations, word origin, and more definitions

Big Data

Challenges [014]



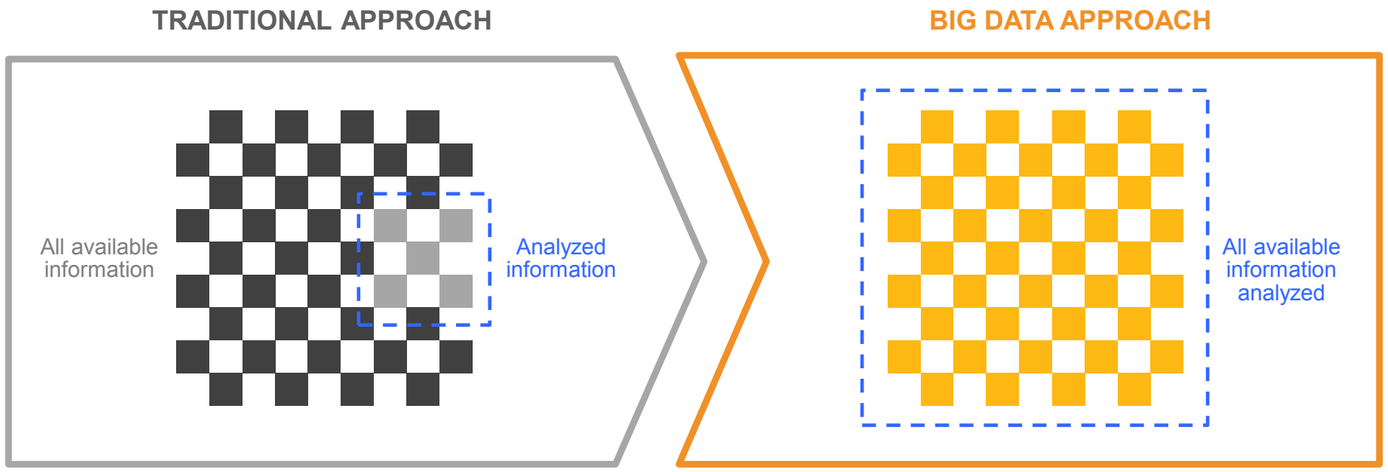
[014] Lanely, 2001



Paradigm Shift

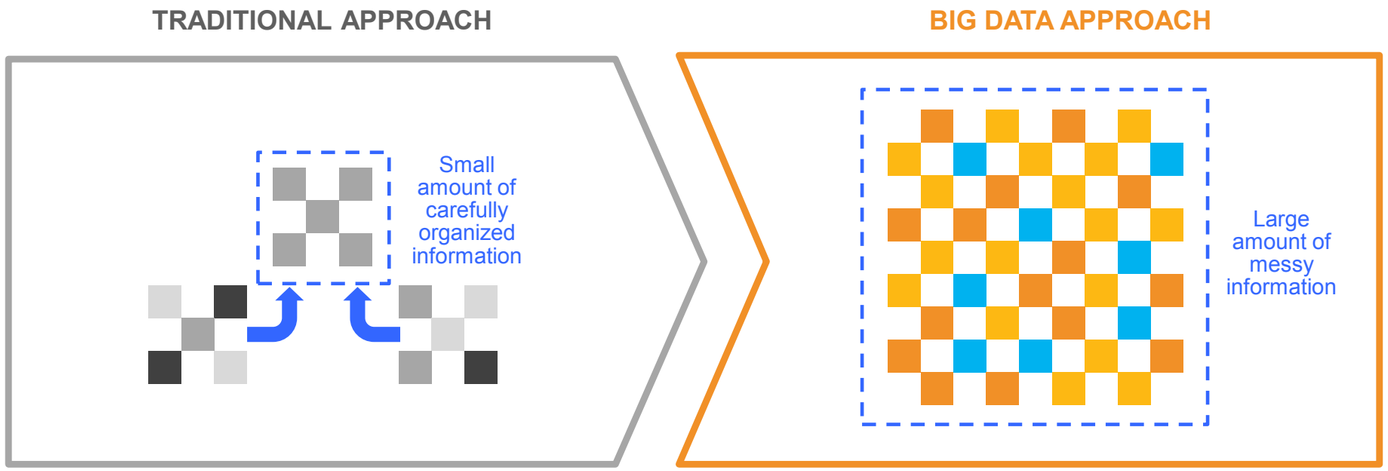
Paradigm shifts enabled by big data

Leverage more of the data being captured



Paradigm shifts enabled by big data

Reduce effort required to leverage data



Carefully cleanse information ***before*** any analysis

Analyze information as is, cleanse as needed

Paradigm shifts enabled by big data

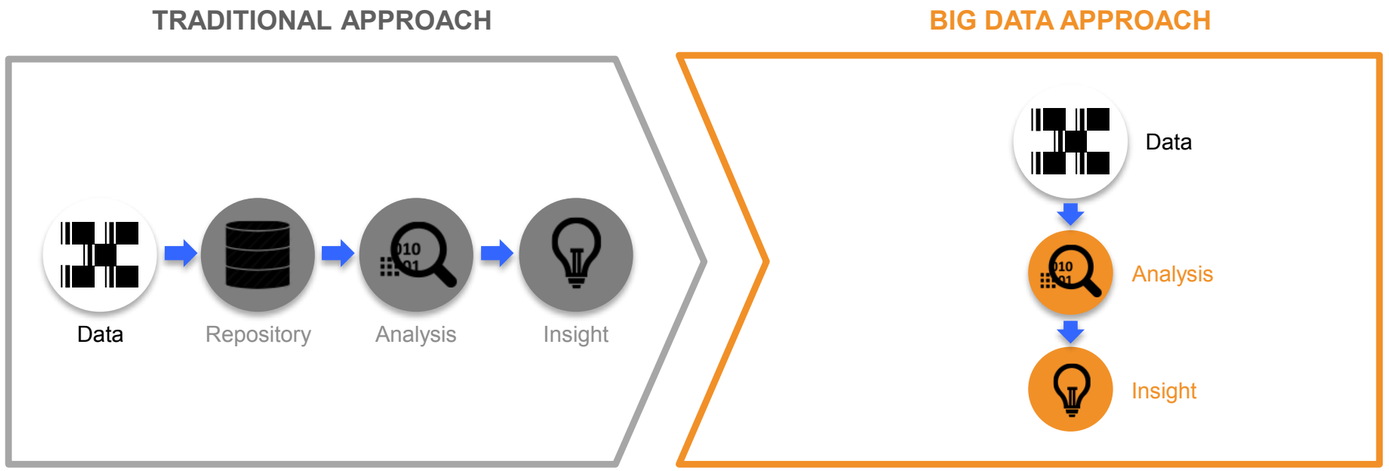
Data leads the way—and sometimes correlations are good enough

Start with hypothesis and test against selected data

Explore ***all*** data and identify correlations

Paradigm shifts enabled by big data

Leverage data as it is captured

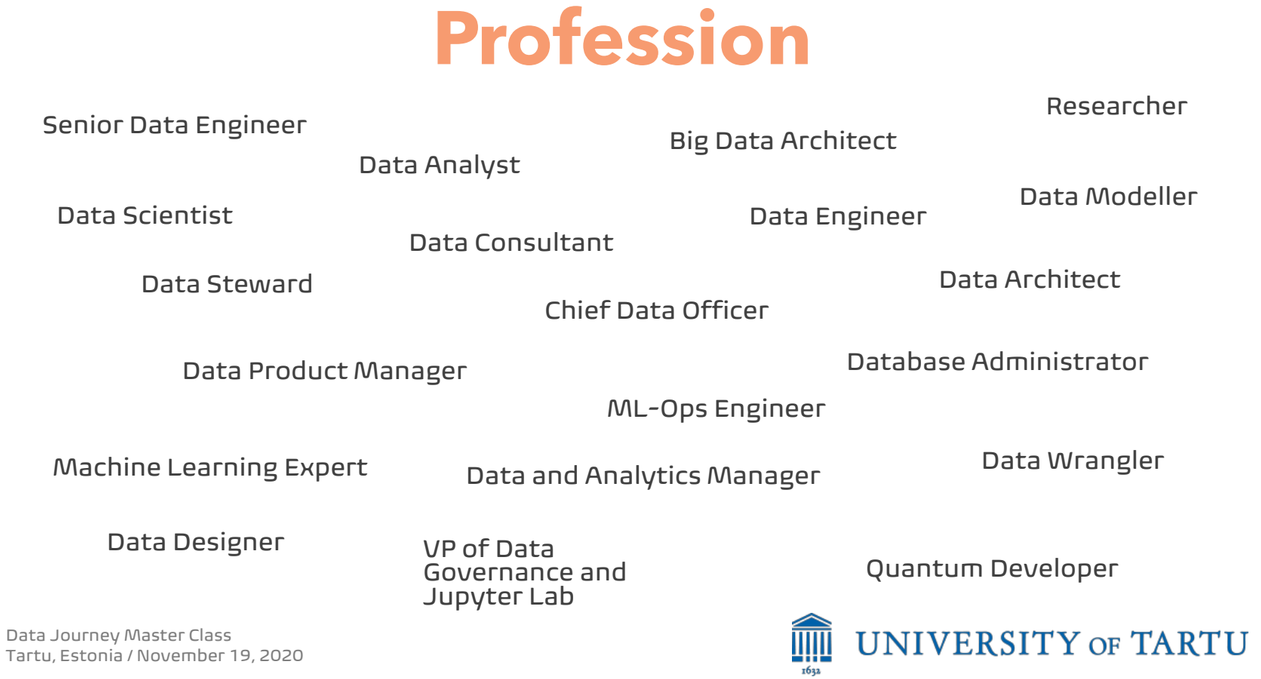


Analyze data ***after*** it's been processed and landed in a warehouse or mart

Analyze data ***in motion*** as it's generated, in real-time

New Roles

In the context of Big Data, a data engineer must focus on **distributed systems**, and **programming languages** such as Java and Scala.



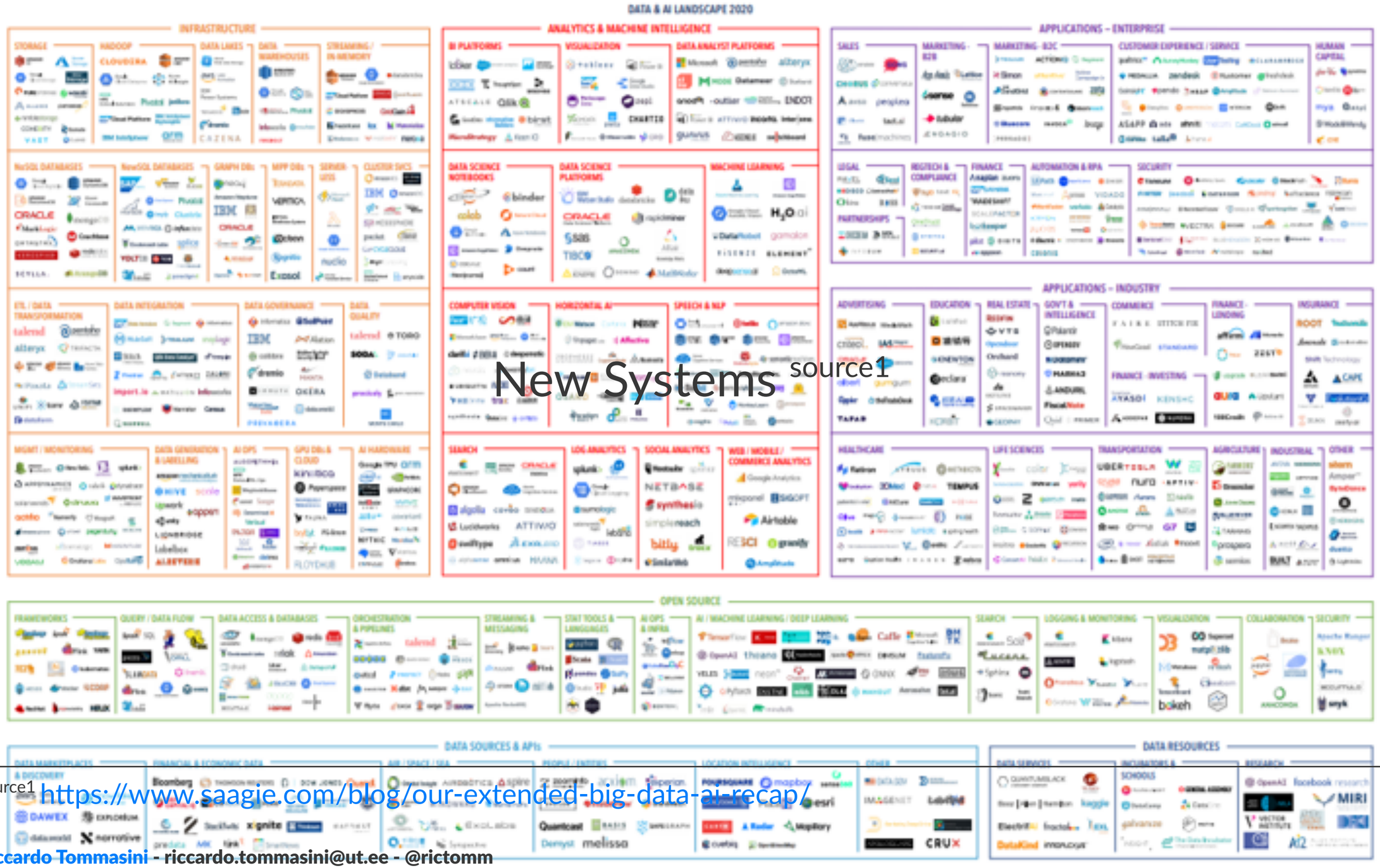
Data Journey Master Class
Tartu, Estonia / November 19, 2020

UNIVERSITY OF TARTU

New Tasks

Since data lake are taking data from a wide range of systems, data can be in **structured** or **unstructured** formats, and usually **not clean**, e.g., with missing fields, mismatched data types, and other data-related issues.

Therefore data engineers are challenged with the task of wrangling, cleansing, and integrating data.



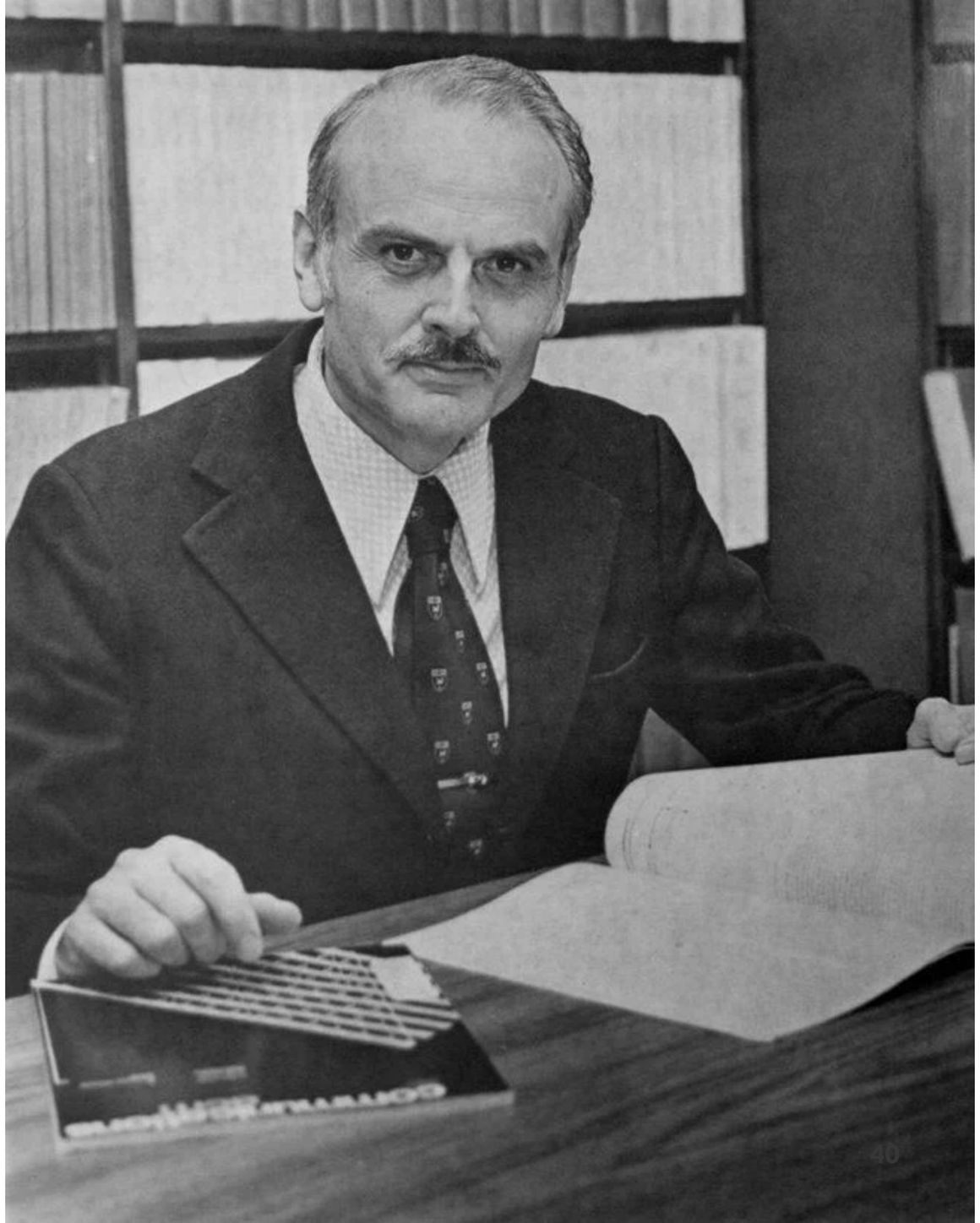
source1 https://www.saagie.com/blog/our-extended-big-data-ai-recap/

Infrastructure

Databases Management System

A database is **an organized collection of structured information, or data**, typically stored electronically in a computer system

Several kind of DBSMs exist. We will survey some of them. It is interesting to know that Edgar F. Codd defined 12+1 rules that make a DBMS relational linke



Data Warehouse: A Traditional Approach:

A data warehouse is a copy of transaction data specifically structured for query and analysis. — Ralph Kimball

A data warehouse is a subject-oriented, integrated, time-variant and non-volatile collection of data in support of management's decision making process.-- Bill Inmon

Data Warehouse vs Data Bases

Surprisingly, Data Warehouse isn’t a regular database.

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- A database normalizes data
  separating them into tables
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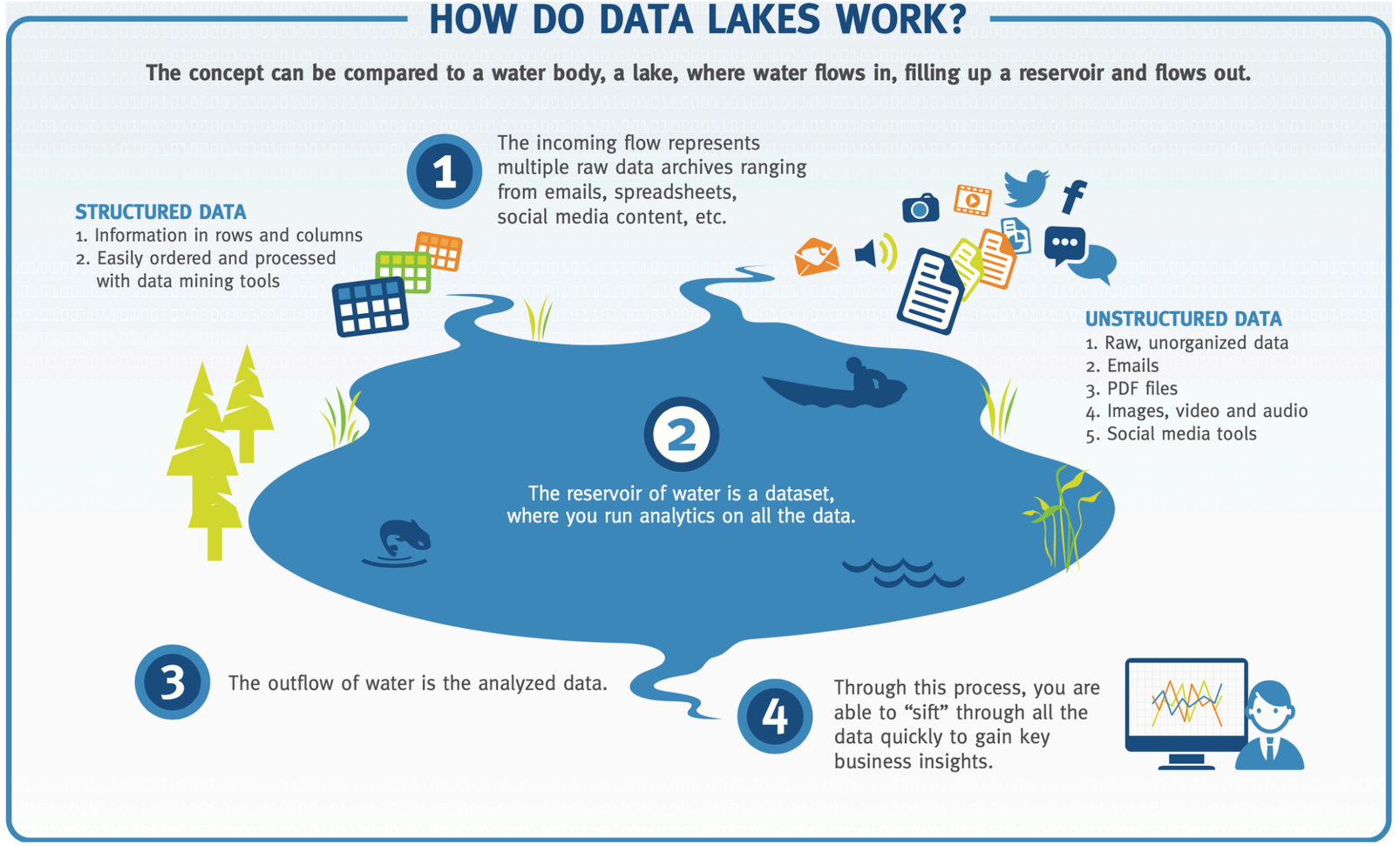
- a Data Warehouse uses few tables to improve performance and analytic.
- a Data Warehouse allows simple queries
- supports versioning for complex analysis

Data Lake

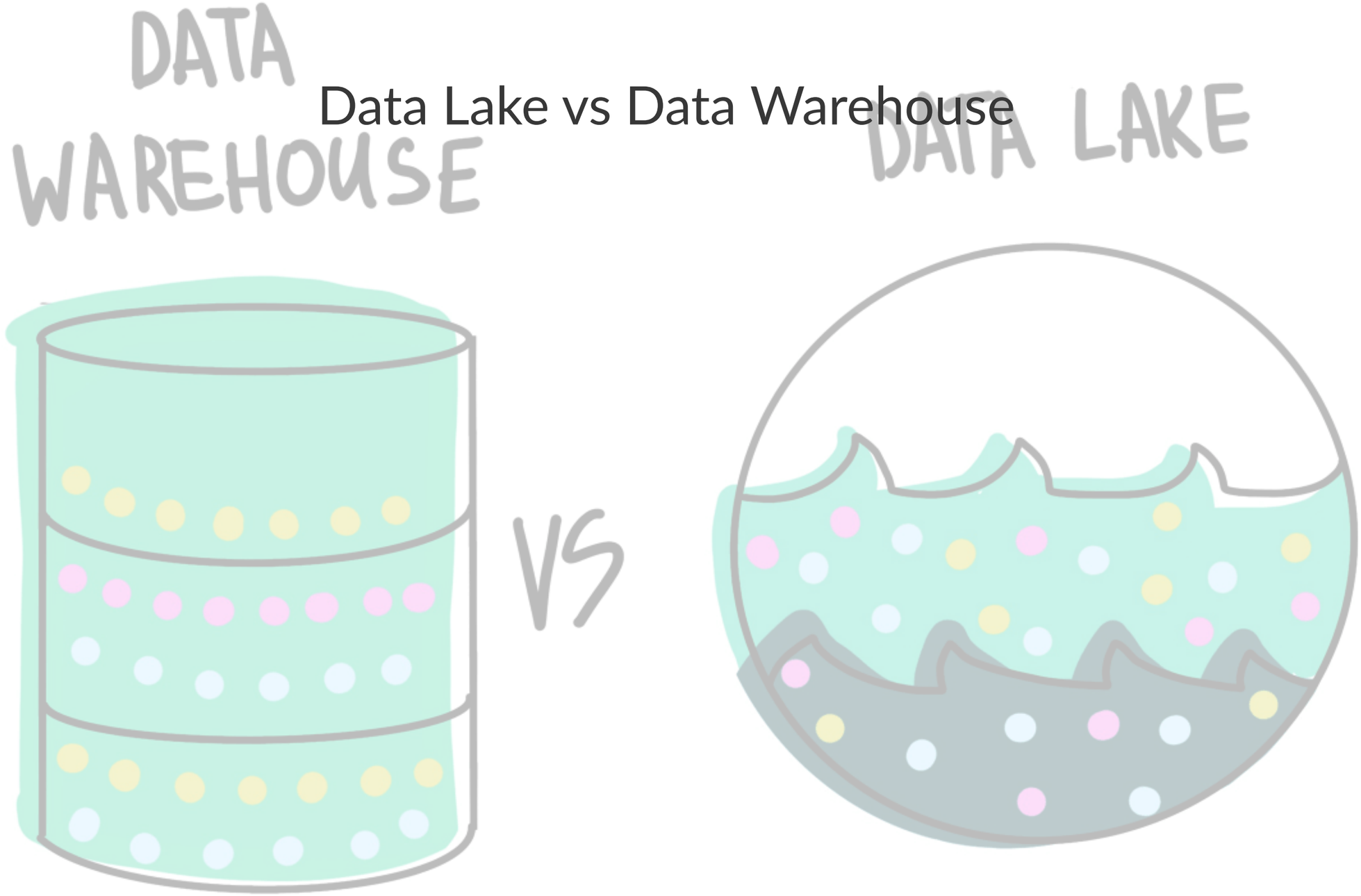
A Data lake is a vast pool of raw data (i.e., data as they are natively, unprocessed). A data lake stands out for its high agility as it isn't limited to a warehouse's fixed configuration[03].

[03] What is Data Engineering



Full Inforgraphic

Data Lake vs Data Warehouse

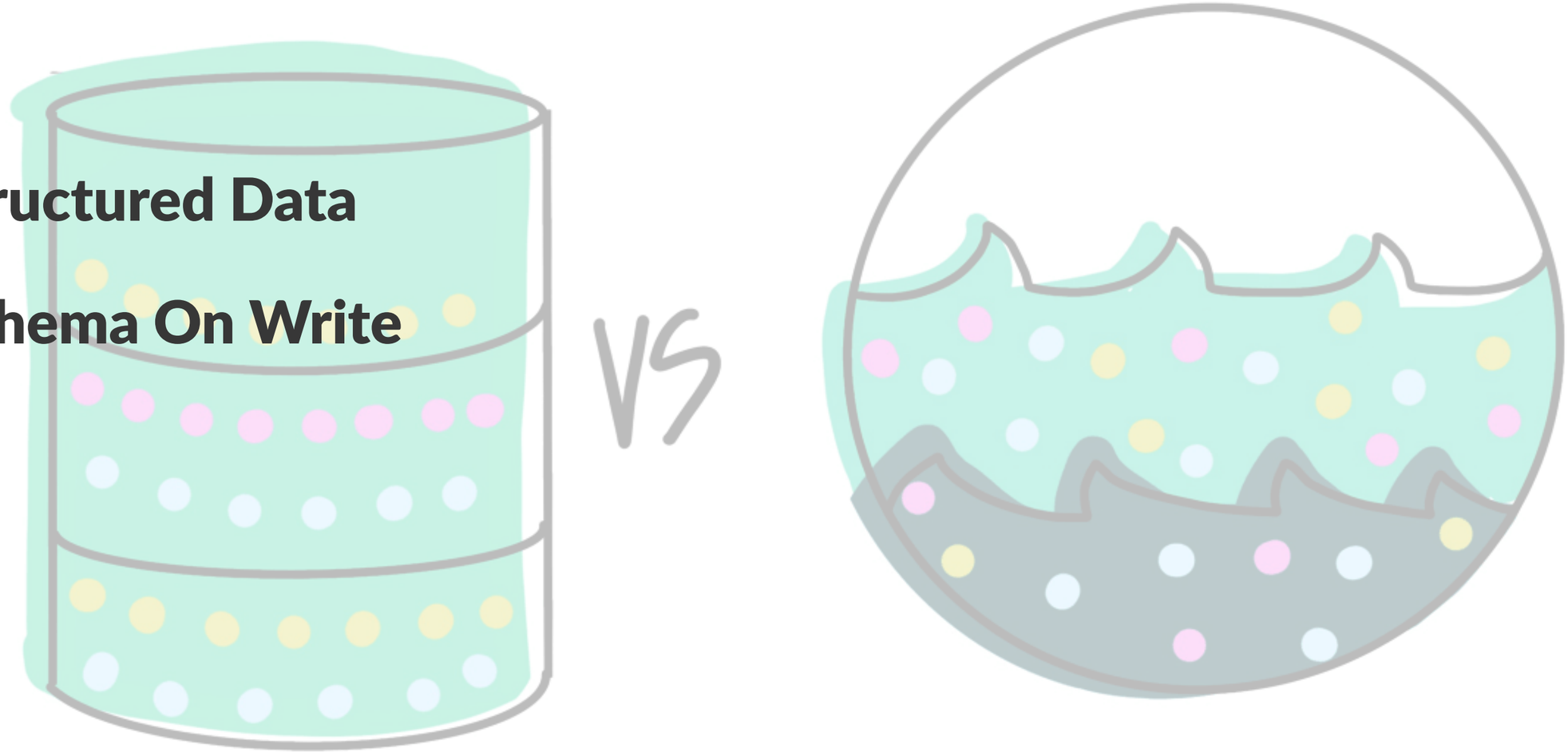


Data Lake vs Data Warehouse

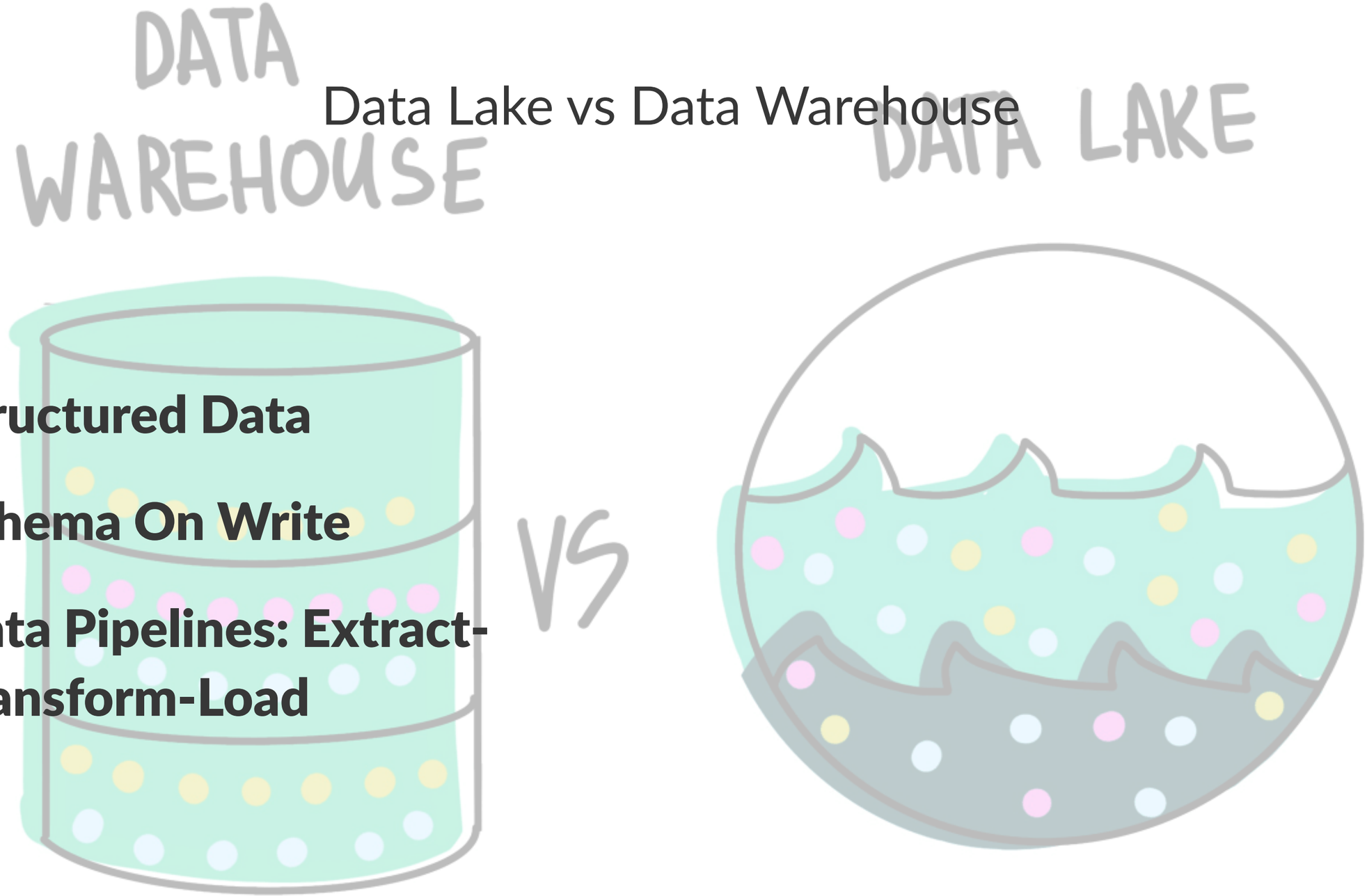
- **Structured Data**

Data Lake vs Data Warehouse

- **Structured Data**
- **Schema On Write**

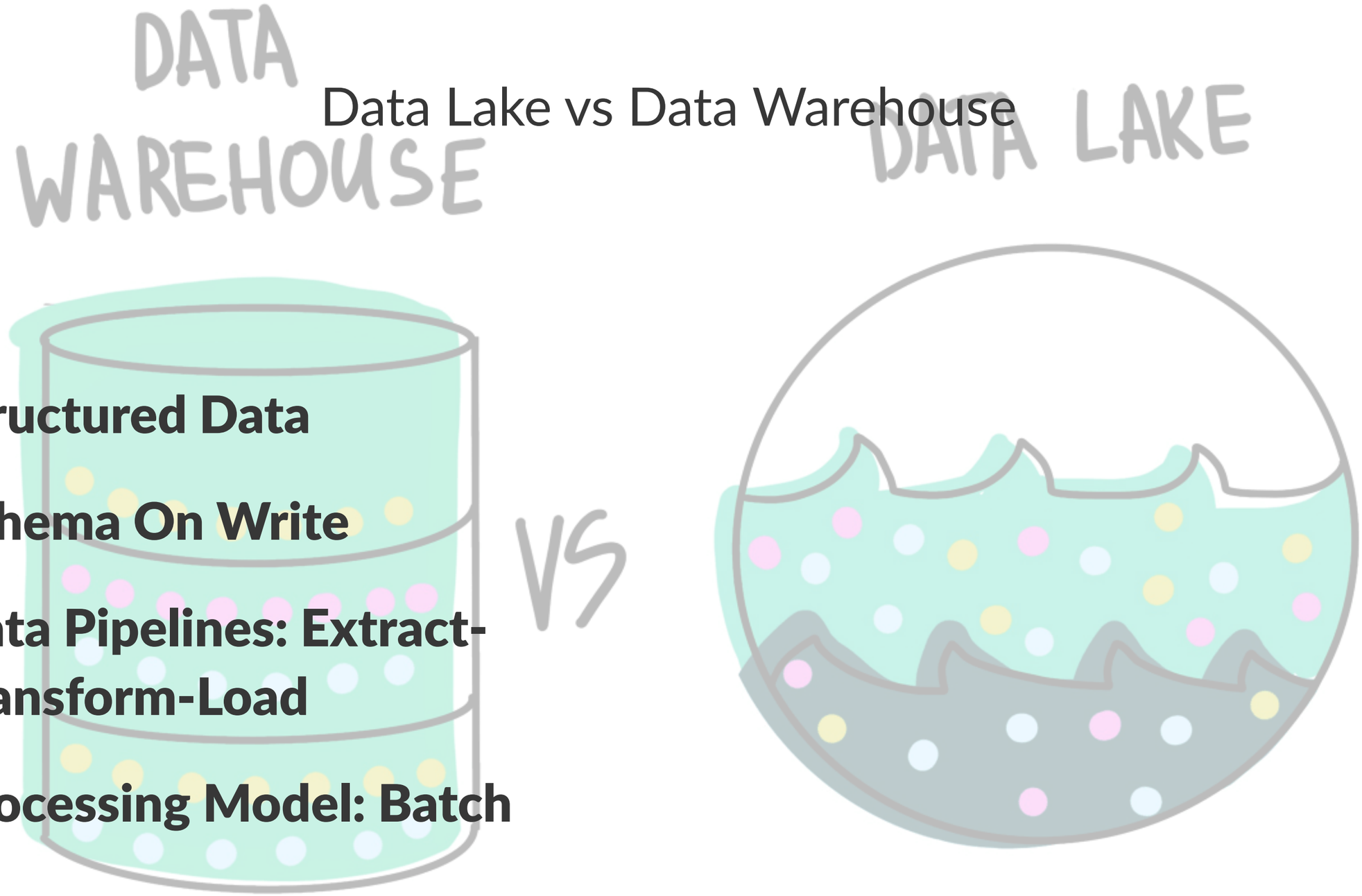


Data Lake vs Data Warehouse



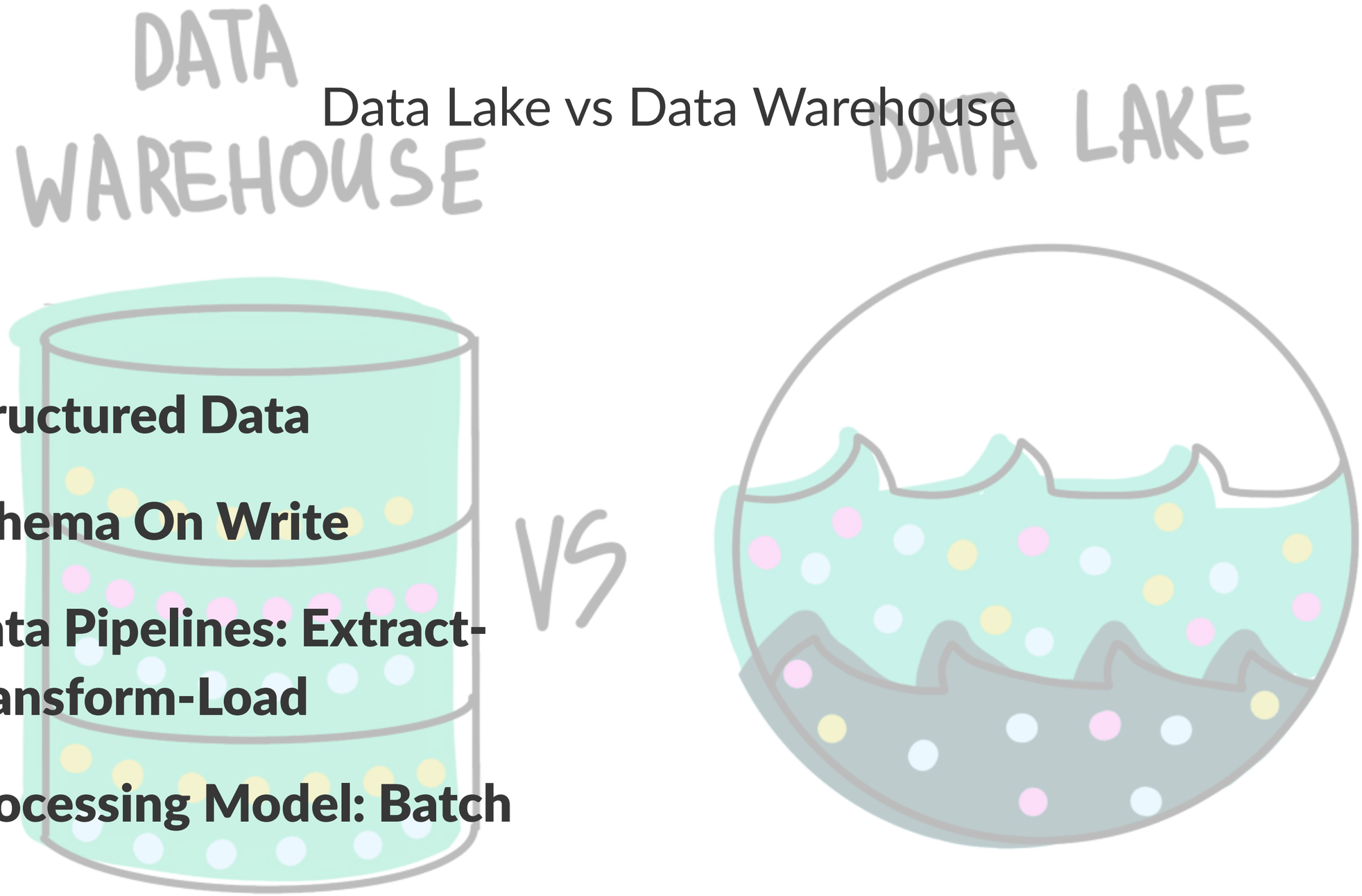
- **Structured Data**
- **Schema On Write**
- **Data Pipelines: Extract-Transform-Load**

Data Lake vs Data Warehouse



- **Structured Data**
- **Schema On Write**
- **Data Pipelines: Extract-Transform-Load**
- **Processing Model: Batch**

Data Lake vs Data Warehouse



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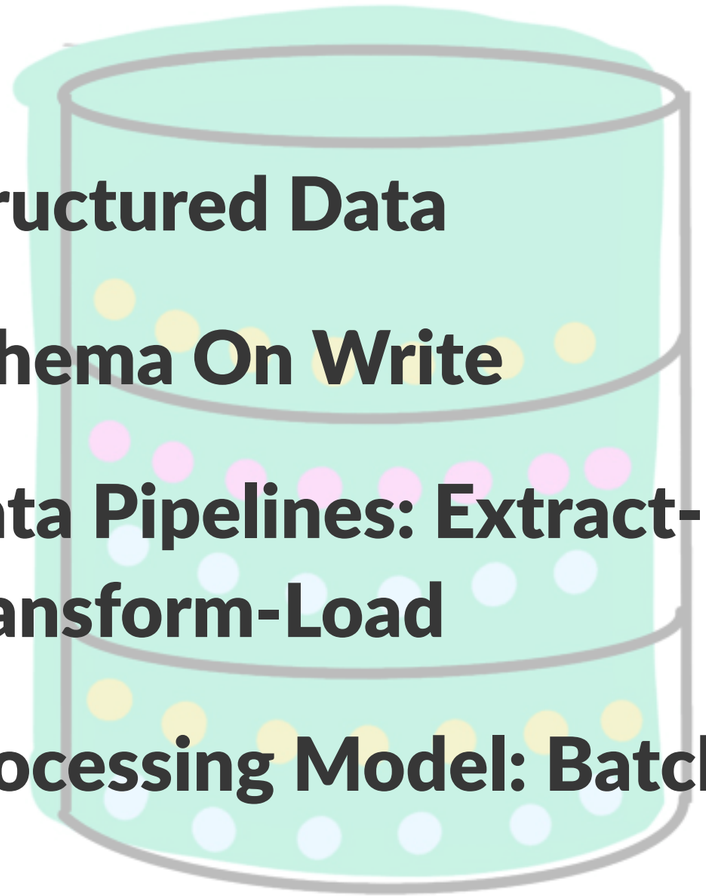
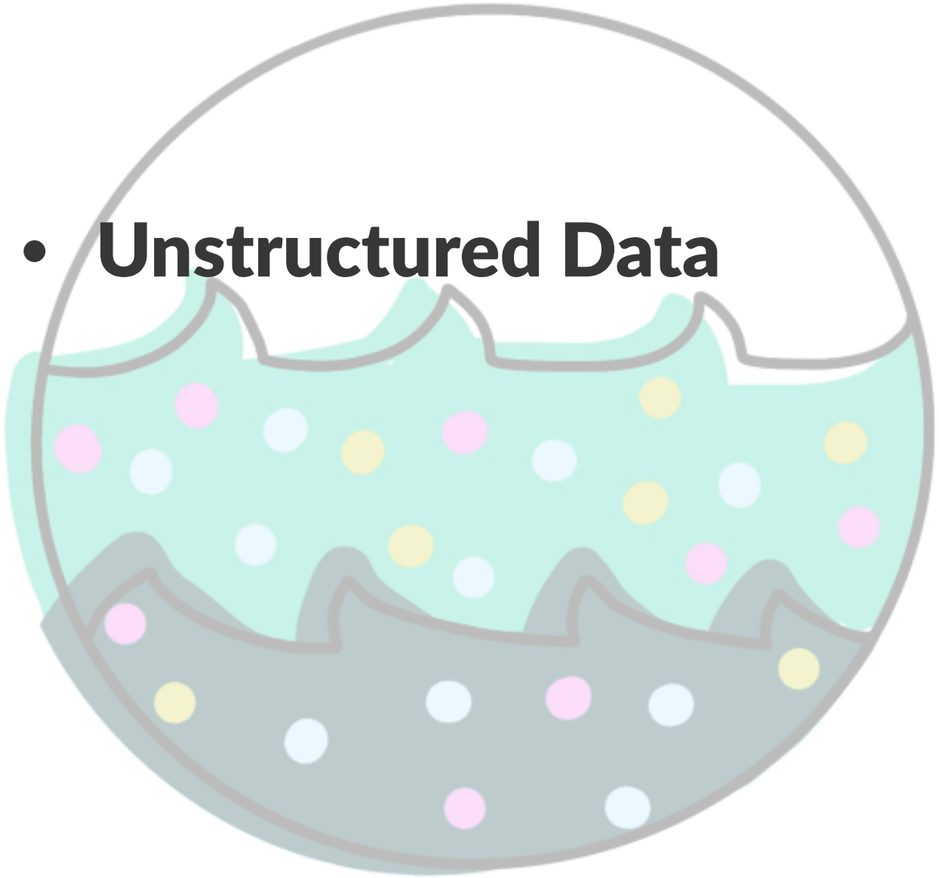


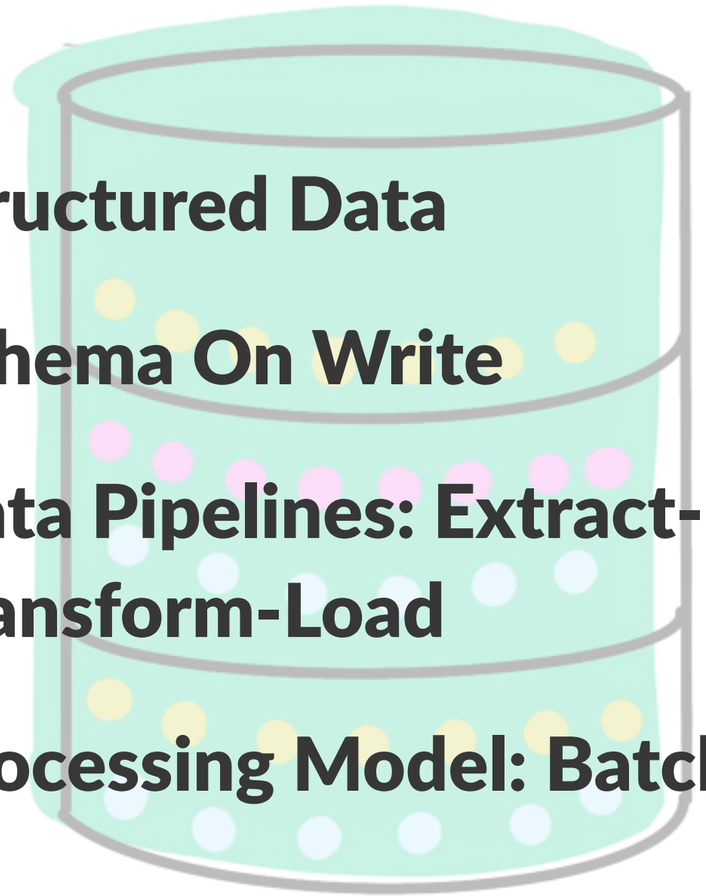
- **Structured Data**
- **Schema On Write**
- **Data Pipelines: Extract-Transform-Load**
- **Processing Model: Batch**

VS



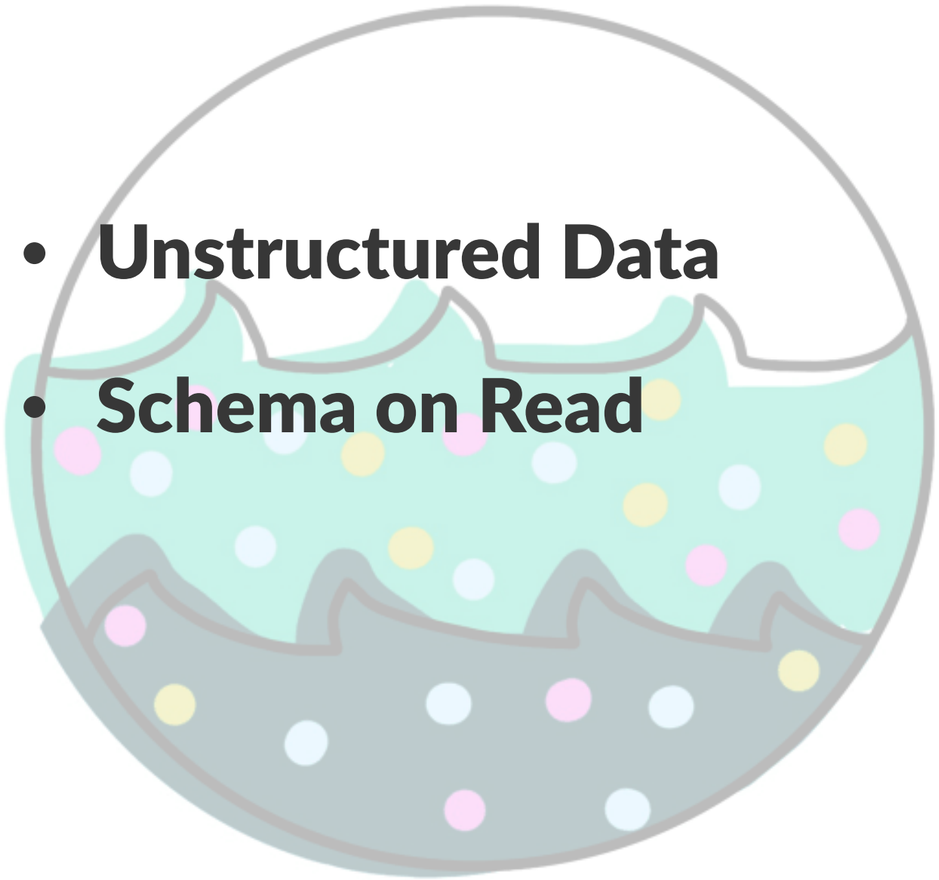
- **Unstructured Data**

Data Lake vs Data Warehouse



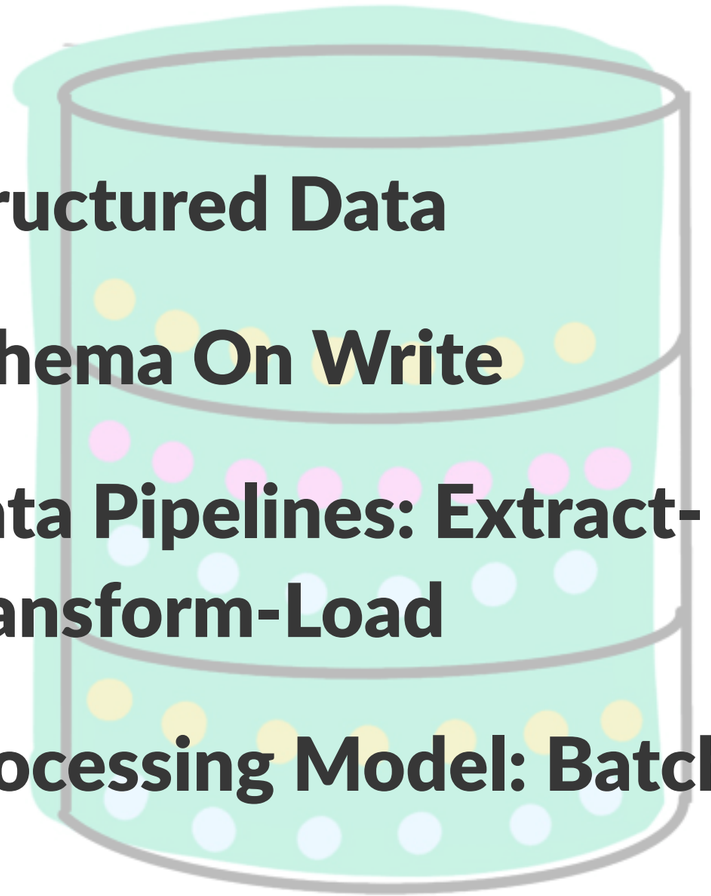
- **Structured Data**
- **Schema On Write**
- **Data Pipelines: Extract-Transform-Load**
- **Processing Model: Batch**

VS



- **Unstructured Data**
- **Schema on Read**

Data Lake vs Data Warehouse



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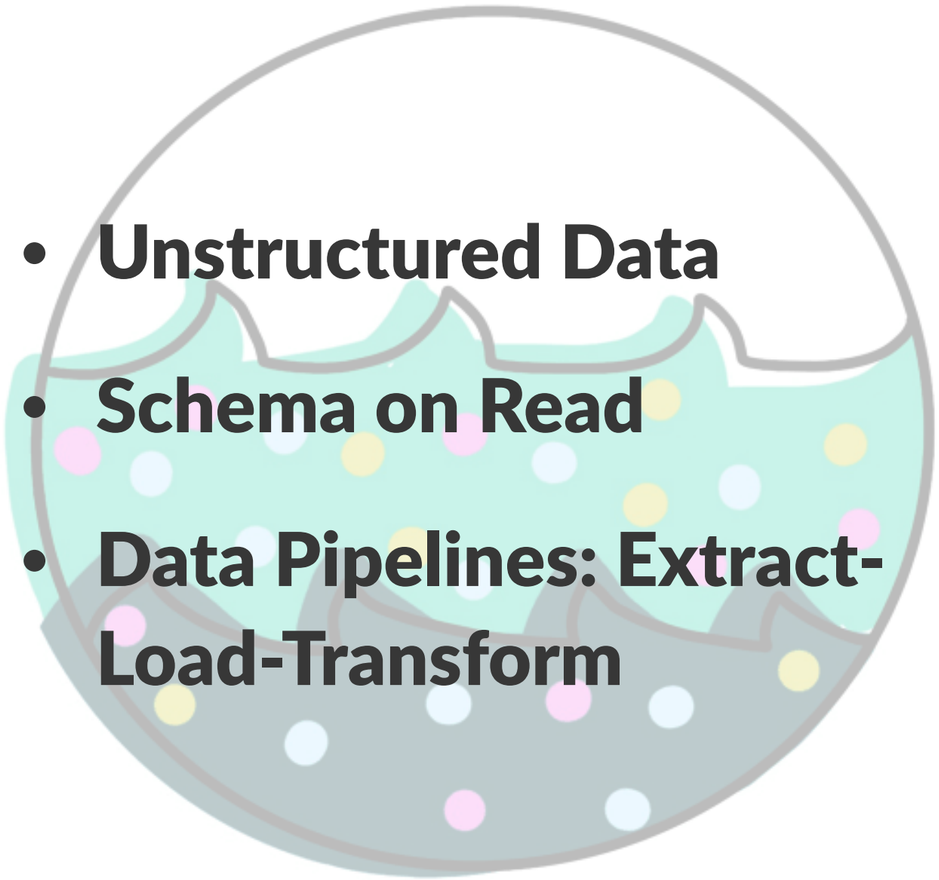

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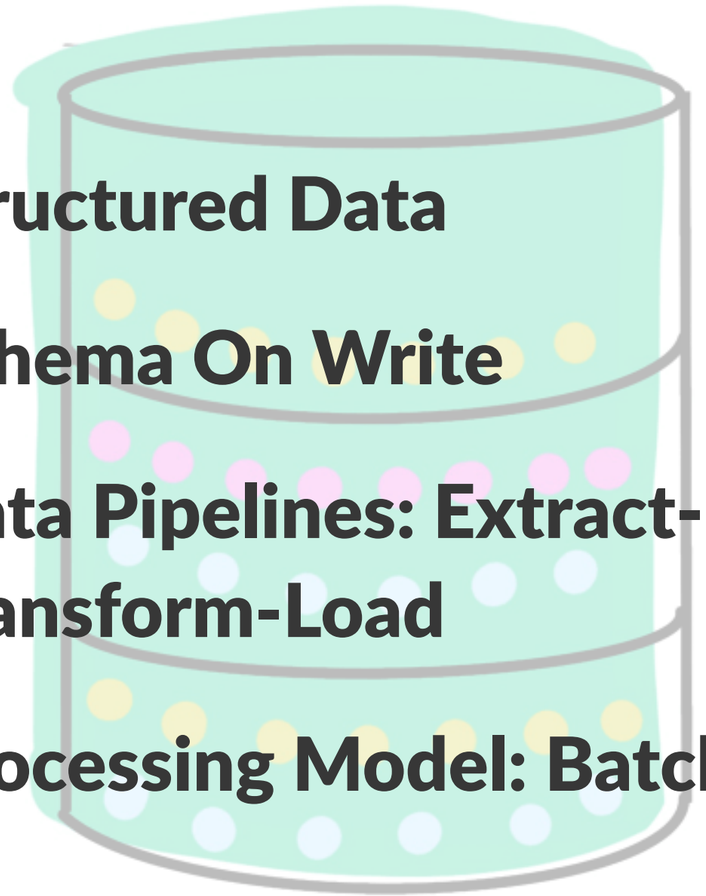

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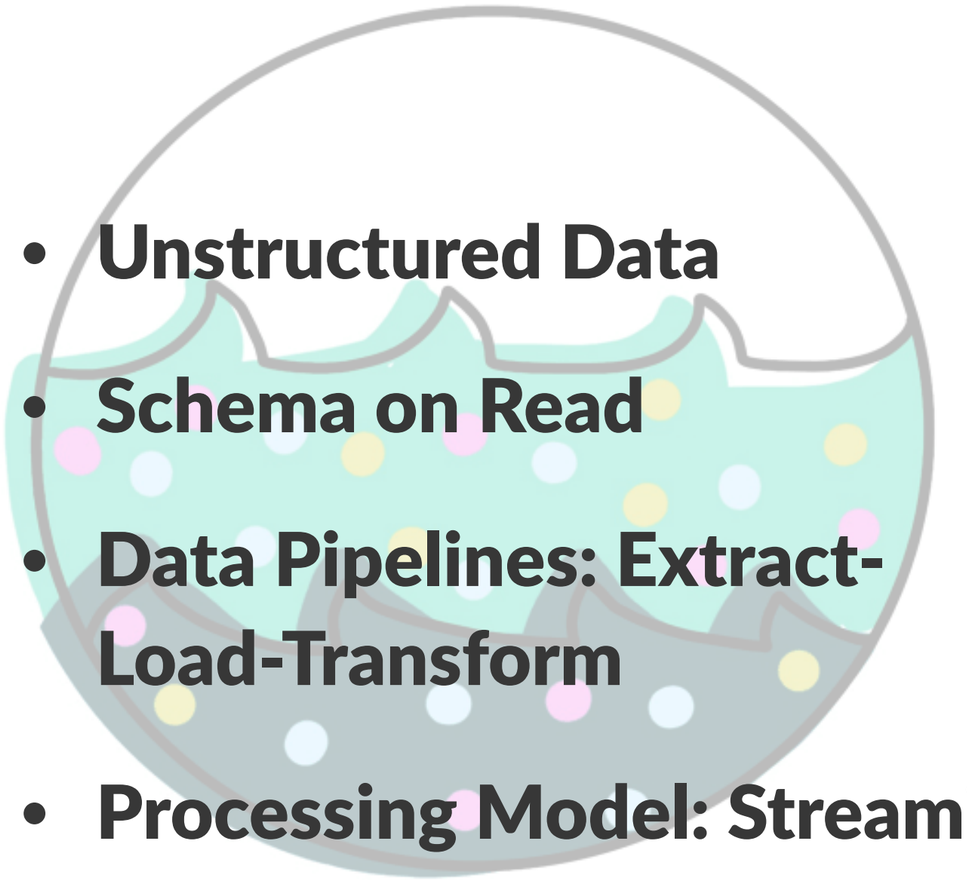

- **Unstructured Data**
- **Schema on Read**
- **Data Pipelines: Extract-Load-Transform**
- **Processing Model: Streaming**

Data Pipeline

A Data pipeline is a sum of tools and processes for performing data integration[03]

Constructing data pipelines is the core responsibility of data engineering.

---

[03] What is Data Engineering

Data pipelines for moving data

Data pipelines for moving data

- data wrangling

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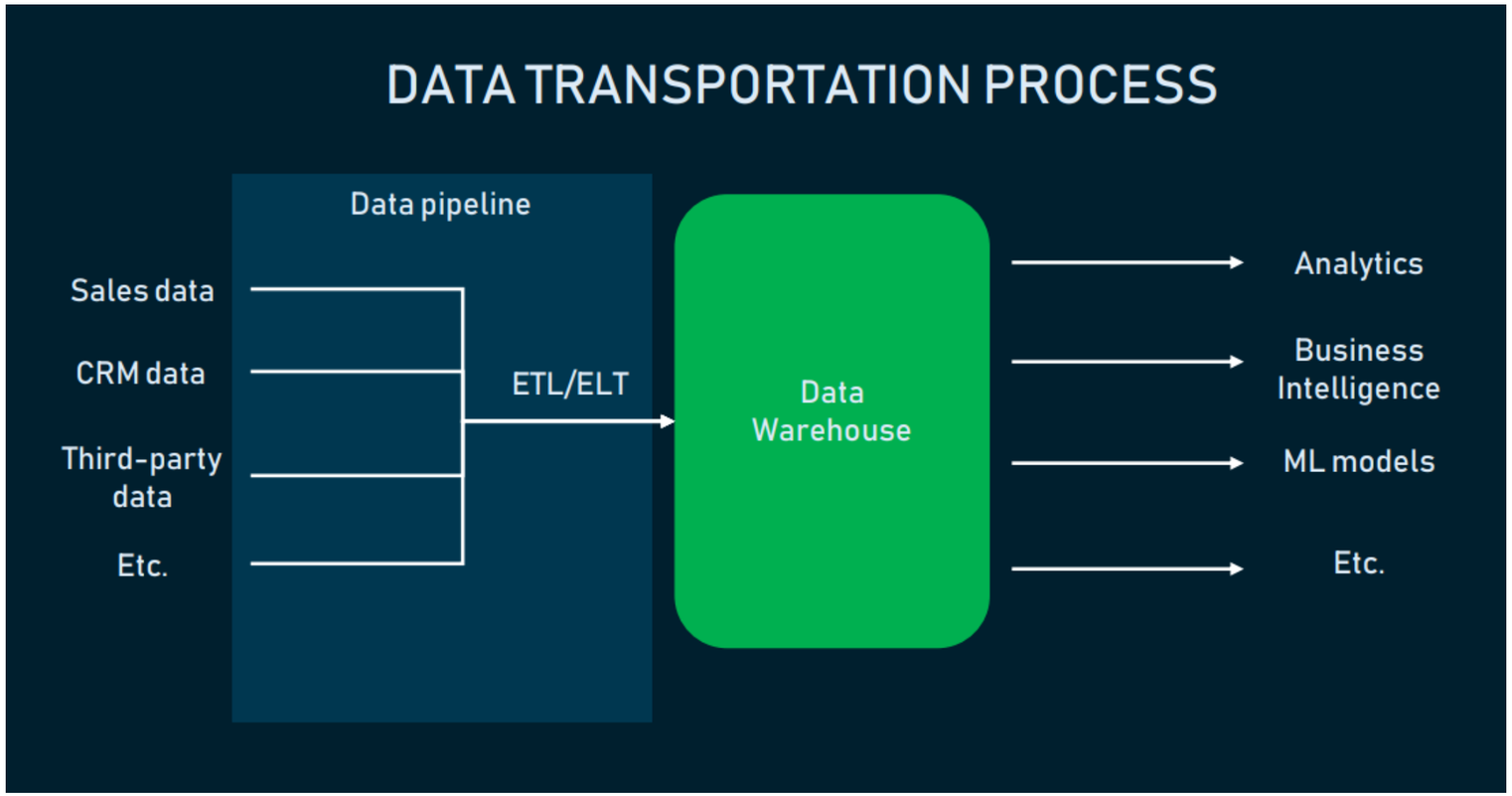
Transporting data from sources into a warehouse[010]



[010] Source

Two Paradigms (and a half): SQL- v.s. JVM-Centric Pipelines[011]

[011] we are focusing on ETL

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- Drag & Drop...

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Skill Set: SQL mastery[03]

If english is the language of business, SQL is the language of data.

[03] What is Data Engineering

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- understand the different join algorithms

---

[03] What is Data Engineering

Skill Set: Data modeling[03]

For a data engineer, entity-relationship modeling should be a cognitive reflex, along with a clear understanding of normalization, and have a sharp intuition around denormalization tradeoffs.

The data engineer should be familiar with dimensional modeling and the related concepts and lexical field.

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[03] What is Data Engineering


BUT

Engineers Shouldn’t (only) Write (SQL-based) ETL[012]

[012] JeffMagnusson, 2016

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- Unless you need to process over many petabytes of data, or you’re ingesting hundreds of billions of events a day, most technologies have evolved to a point where they can trivially scale to your needs.

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- Unless you need to process over many petabytes of data, or you’re ingesting hundreds of billions of events a day, most technologies have evolved to a point where they can trivially scale to your needs.
- Unless you need to push the boundaries of what these technologies are capable of, you probably don’t need a highly specialized team of dedicated engineers to build solutions on top of them.

---

[012] JeffMagnusson, 2016

If Not (only) ETL, Then…What?[013]

Data Engineers are still a critical part of any high-functioning data team.
- managing and optimizing core data infrastructure,
- building and maintaining custom ingestion pipelines,
- supporting data team resources with design and performance optimization, and
- building non-SQL transformation pipelines.

[013] TristanHandy, 2019