# Data Engineering

**LTAT.02.007**

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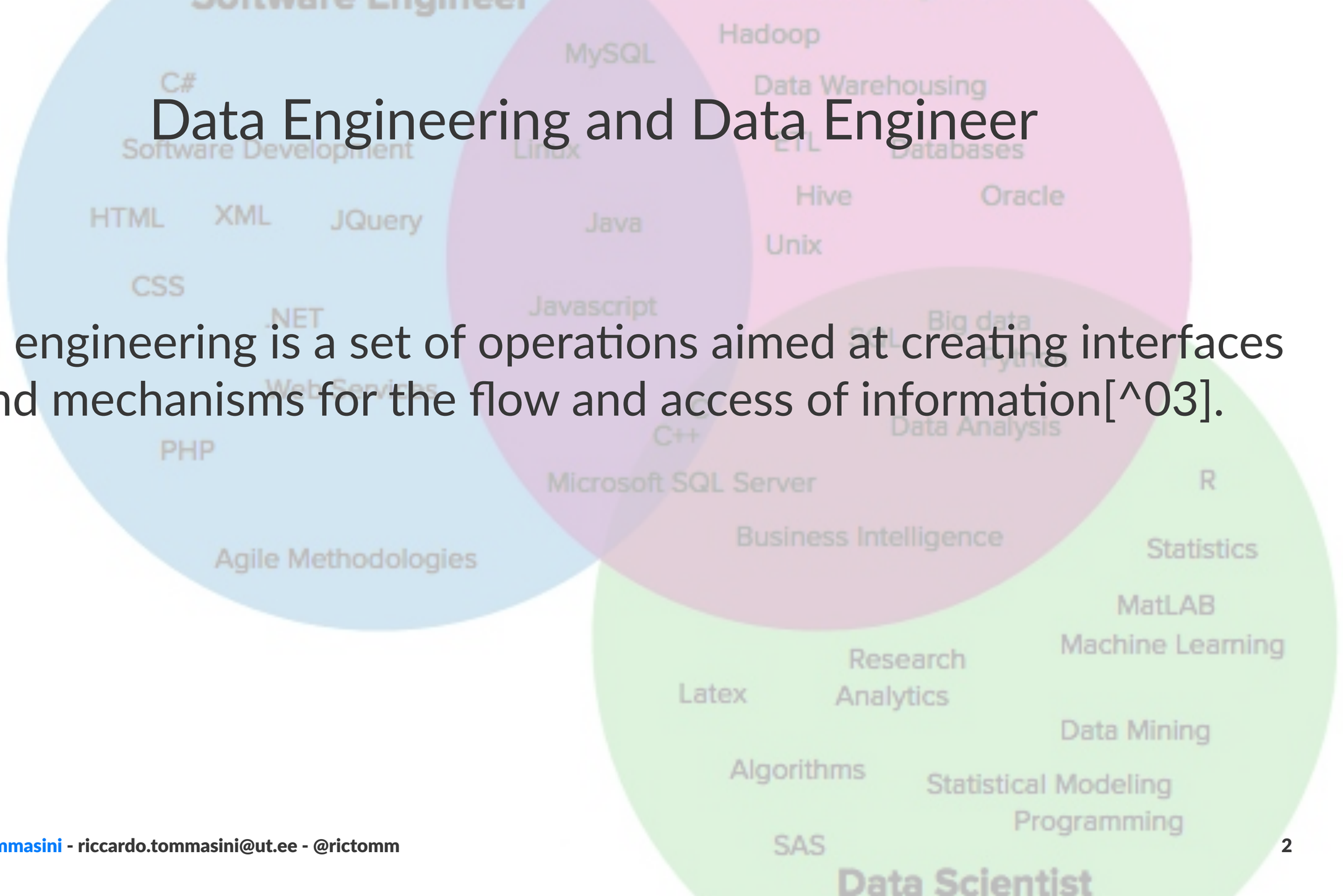
**https://courses.cs.ut.ee/2020/dataeng**

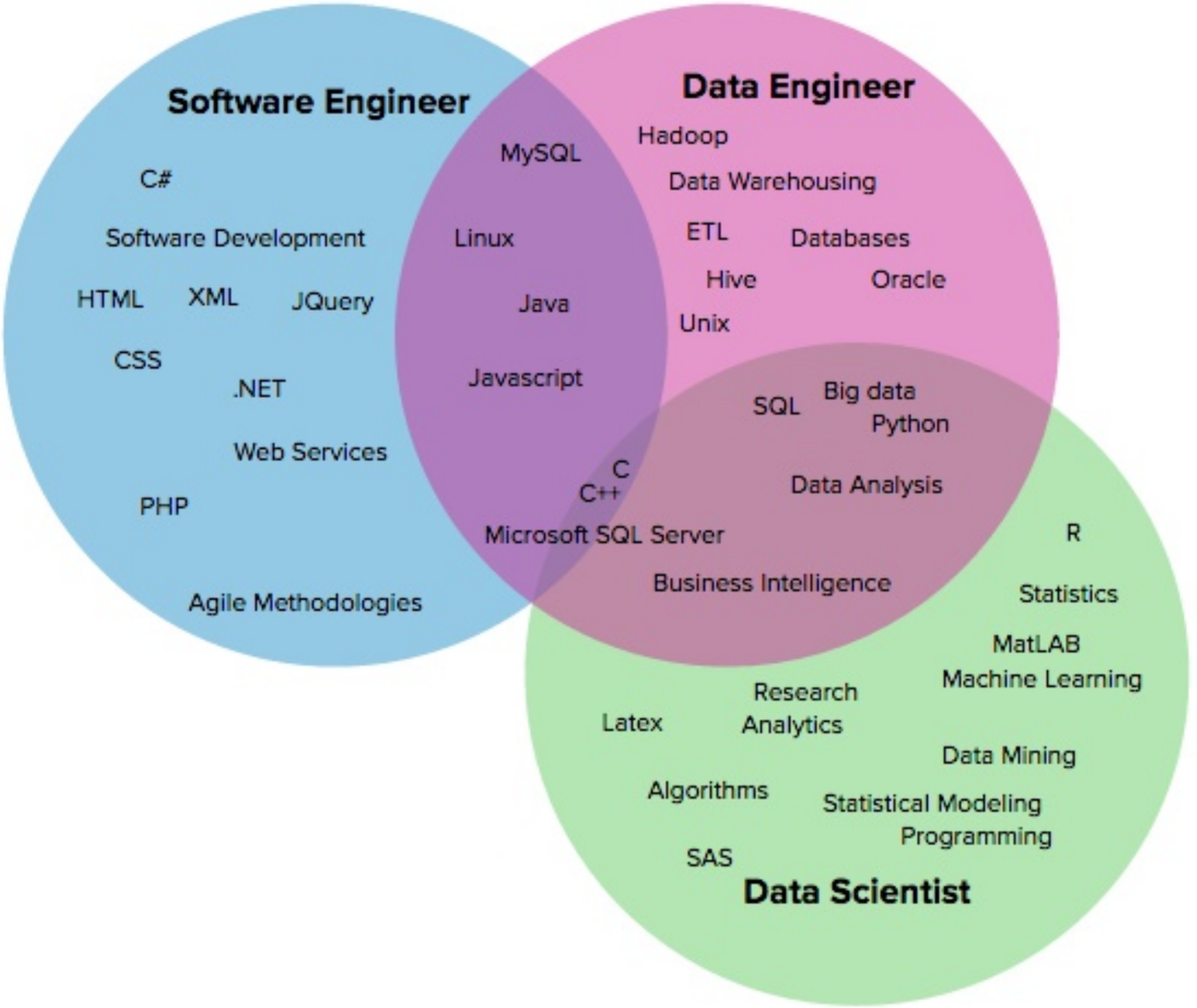
**Forum**

**Moodle**

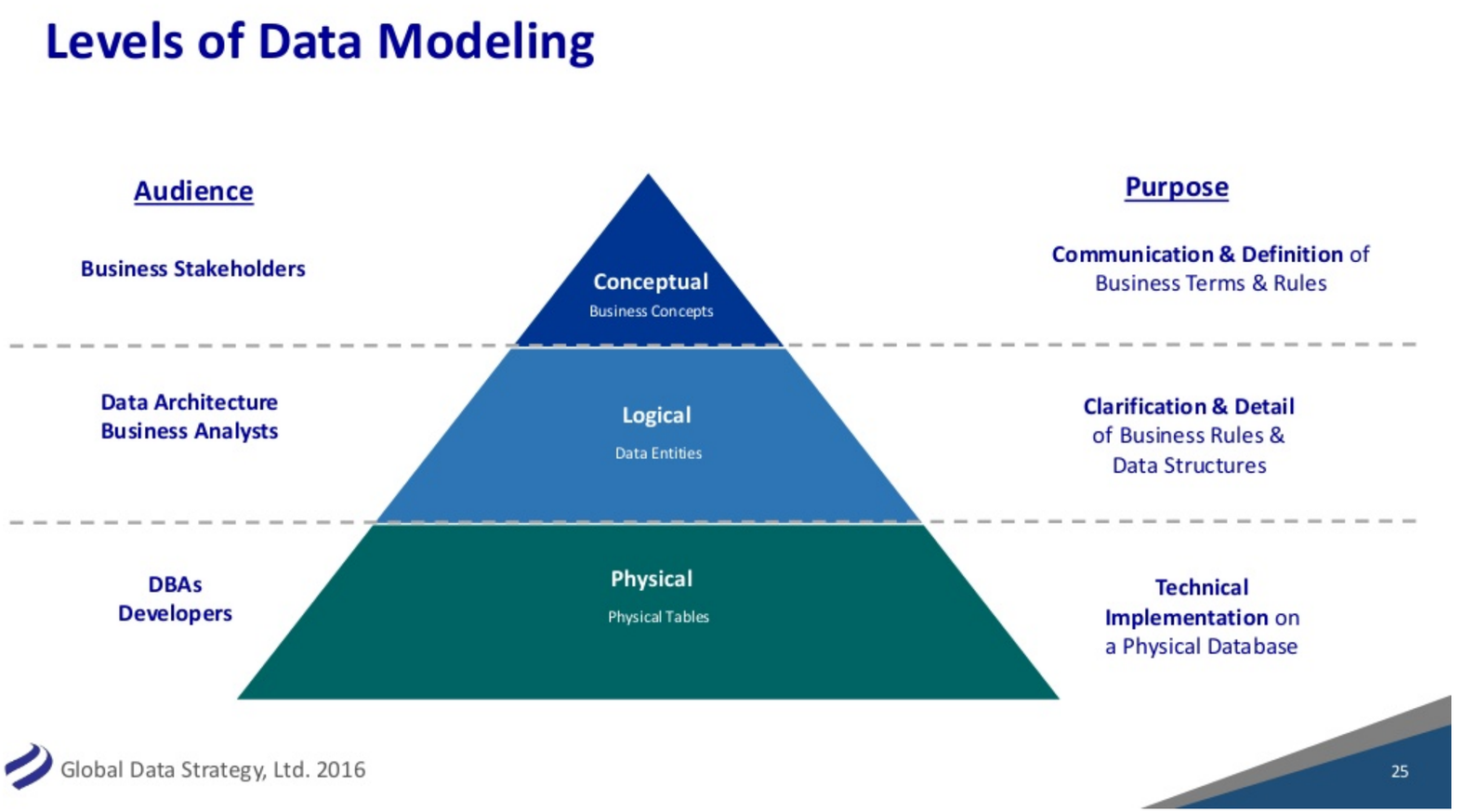
# Data Engineering and Data Engineer

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




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

# Data Modelling



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- **Availability**: Node failures do not prevent other survivors from continuing to operate (a guarantee that every request receives a response whether it succeeded or failed)
- **Partition tolerance**: the system continues to operate despite arbitrary partitioning due to network failures (e.g., message loss)

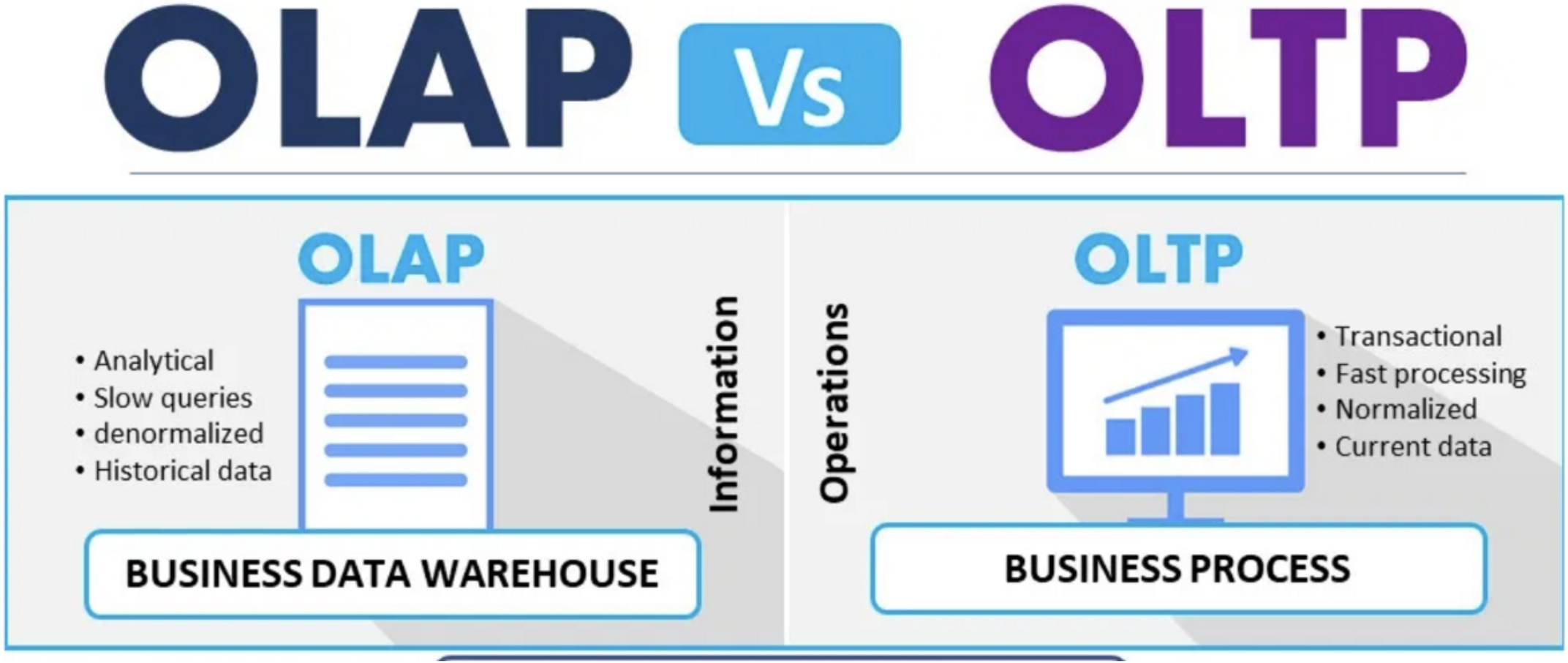
# Data Replication

Replication means keeping a copy of the same data on multiple machines that are connected via a network

# Data Partitioning (Sharding)

breaking a large database down into smaller ones

# We Talked about Workloads



# Data Modelling for Databases

# [Relational Algebra]

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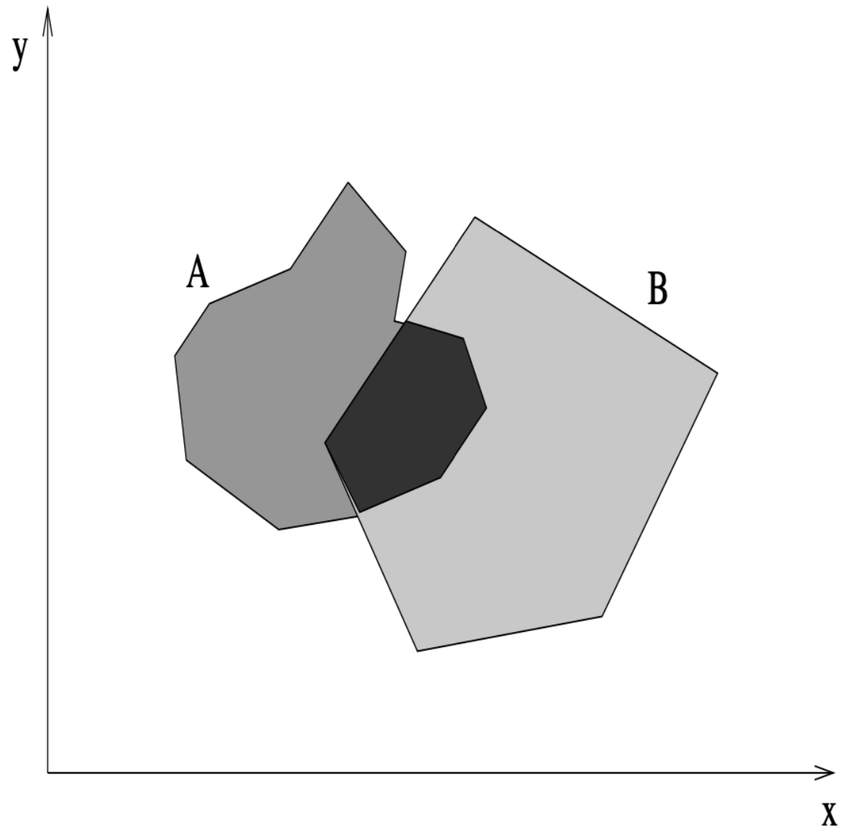
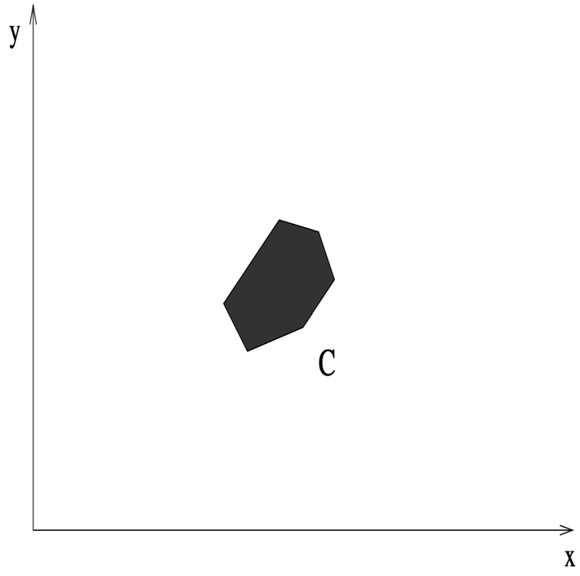
- rename: ρ

# [[Relational Algebra]] Visualized

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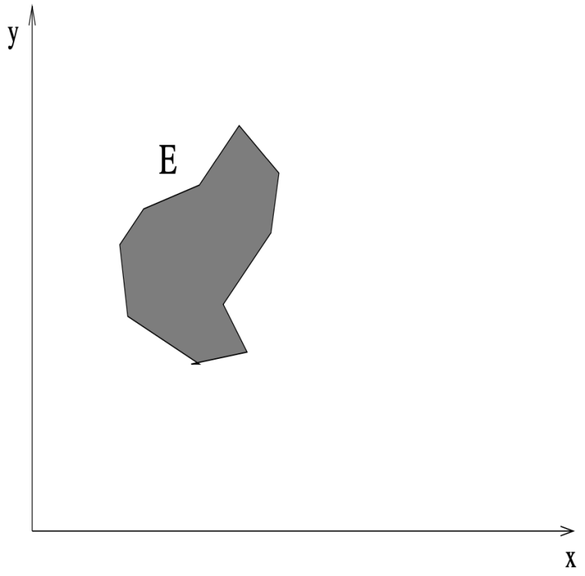
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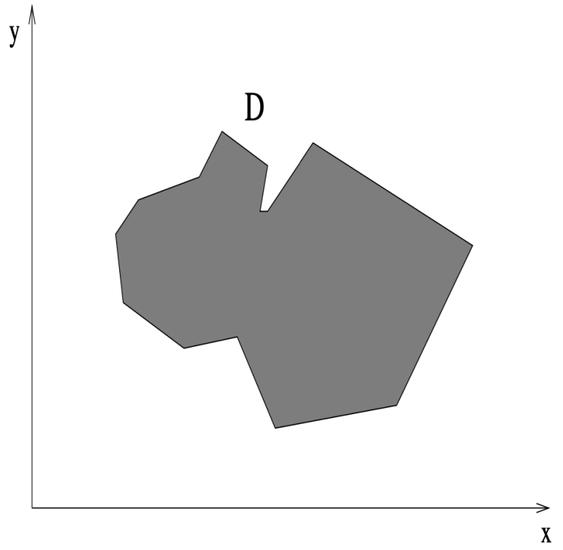
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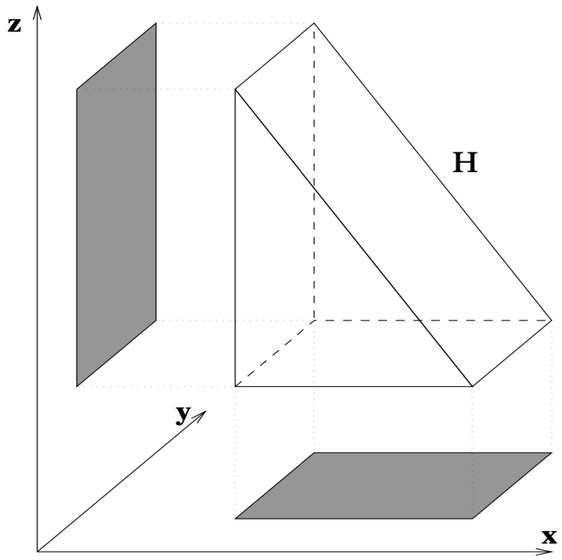
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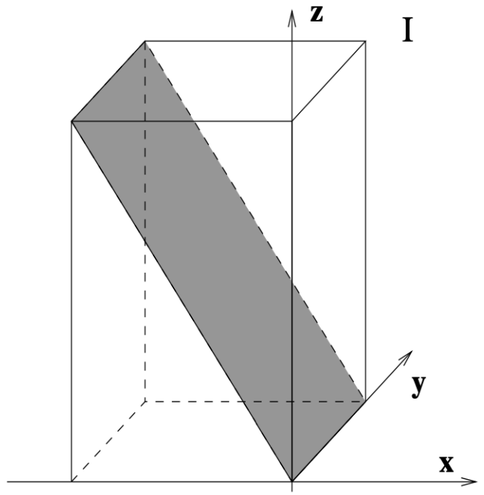
z
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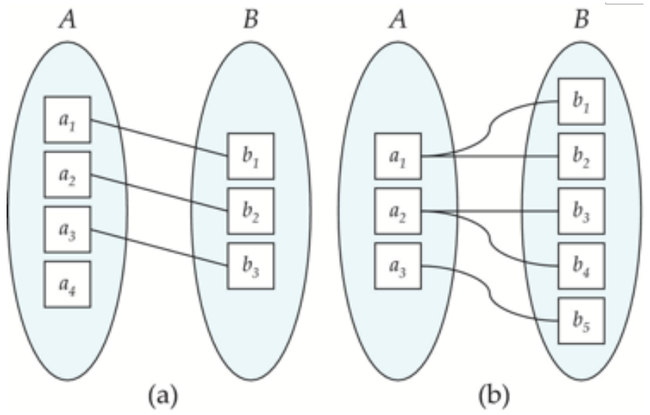
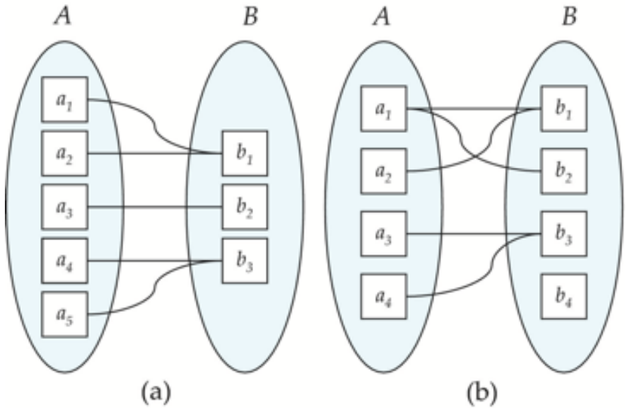
- **Isolation** means that concurrently executing transactions are isolated from each other.
  - Typically associated with serializability, but there weaker options.
- **Durability** means (fault-tolerant) persistency of the data, once the transaction is completed.

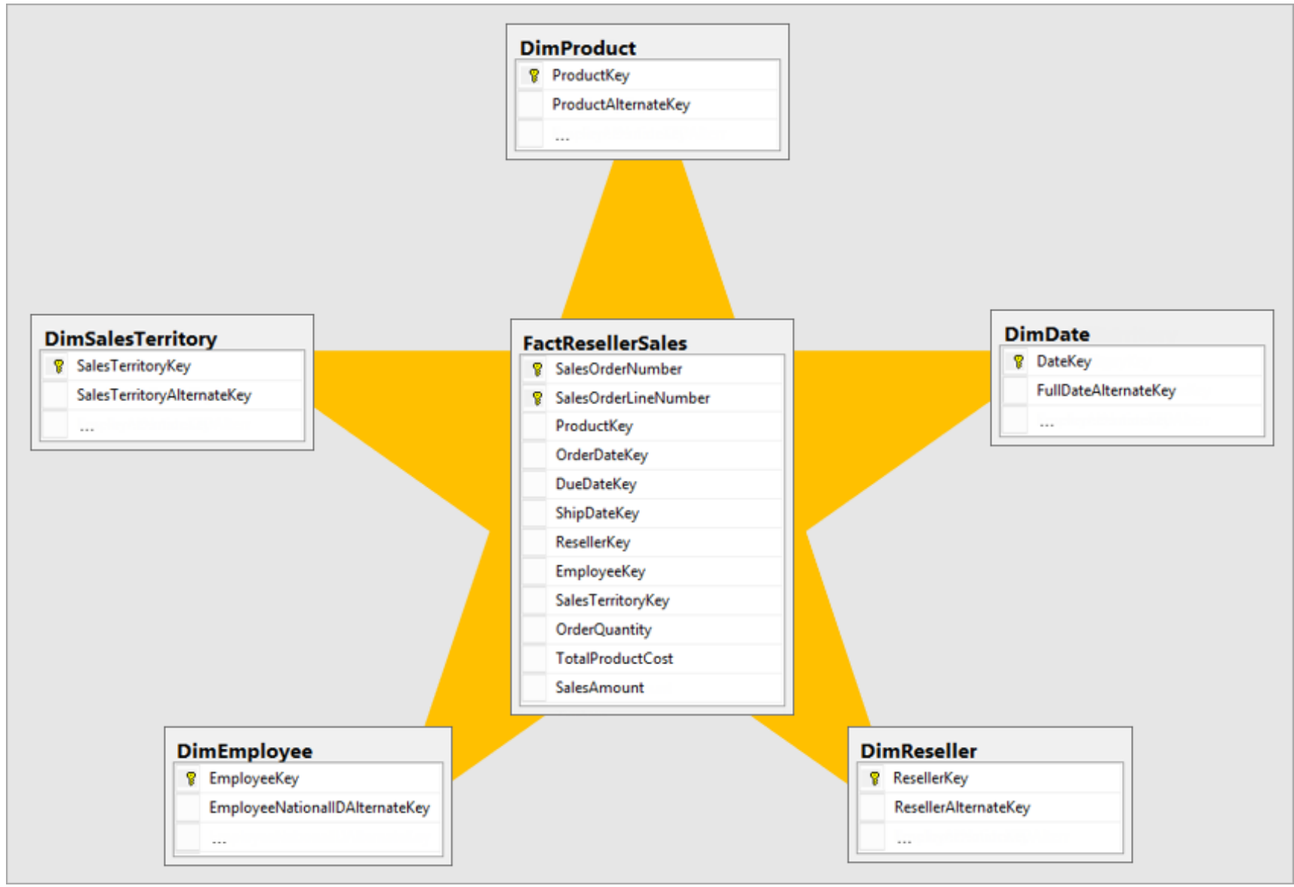
# Cardinality Visualized



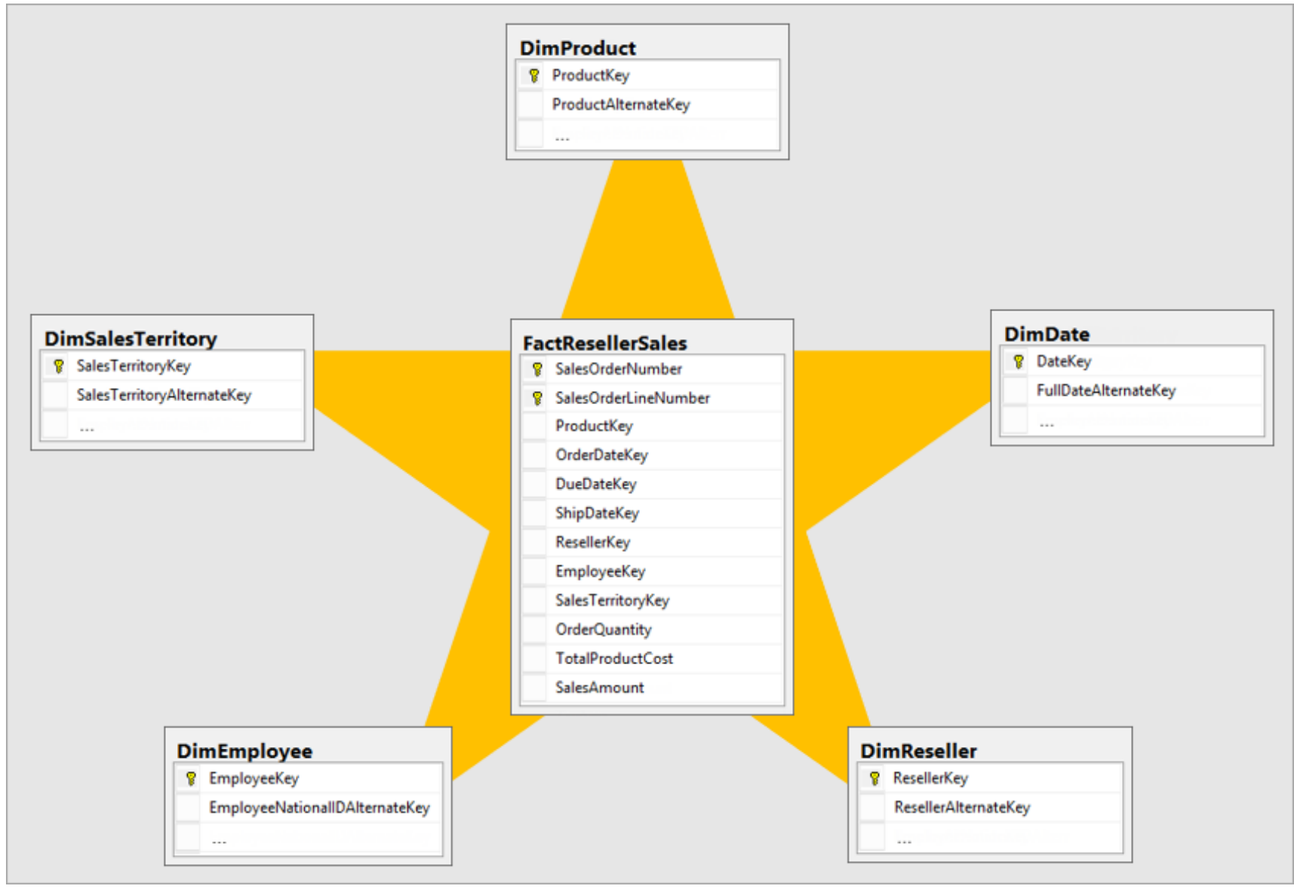
# Data Modelling for Data Warehouse (Briefly)

# Star Schema


DimProduct
ProductKey
ProductAlternateKey
...
DimSalesTerritory
SalesTerritoryKey
SalesTerritoryAlternateKey
...
FactResellerSales
SalesOrderNumber
SalesOrderLineNumber
ProductKey
OrderDateKey
DueDateKey
ShipDateKey
ResellerKey
EmployeeKey
SalesTerritoryKey
OrderQuantity
TotalProductCost
SalesAmount
DimDate
DateKey
FullDateAlternateKey
...
DimEmployee
EmployeeKey
EmployeeNationalIDAlternateKey
...
DimReseller
ResellerKey
ResellerAlternateKey
...

# Star Schema

- A **fact table** contains the numeric measures produced by an operational measurement event in the real world.



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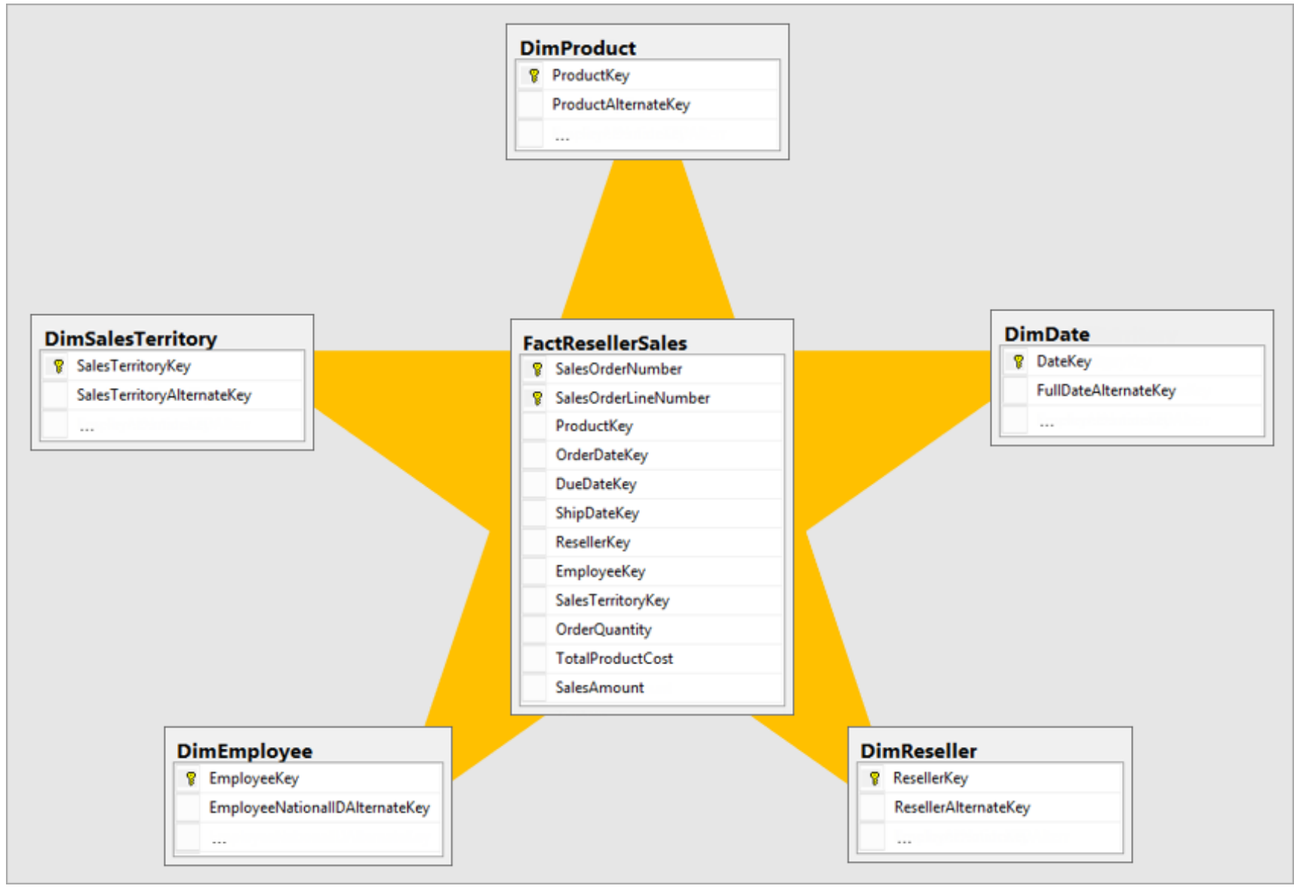

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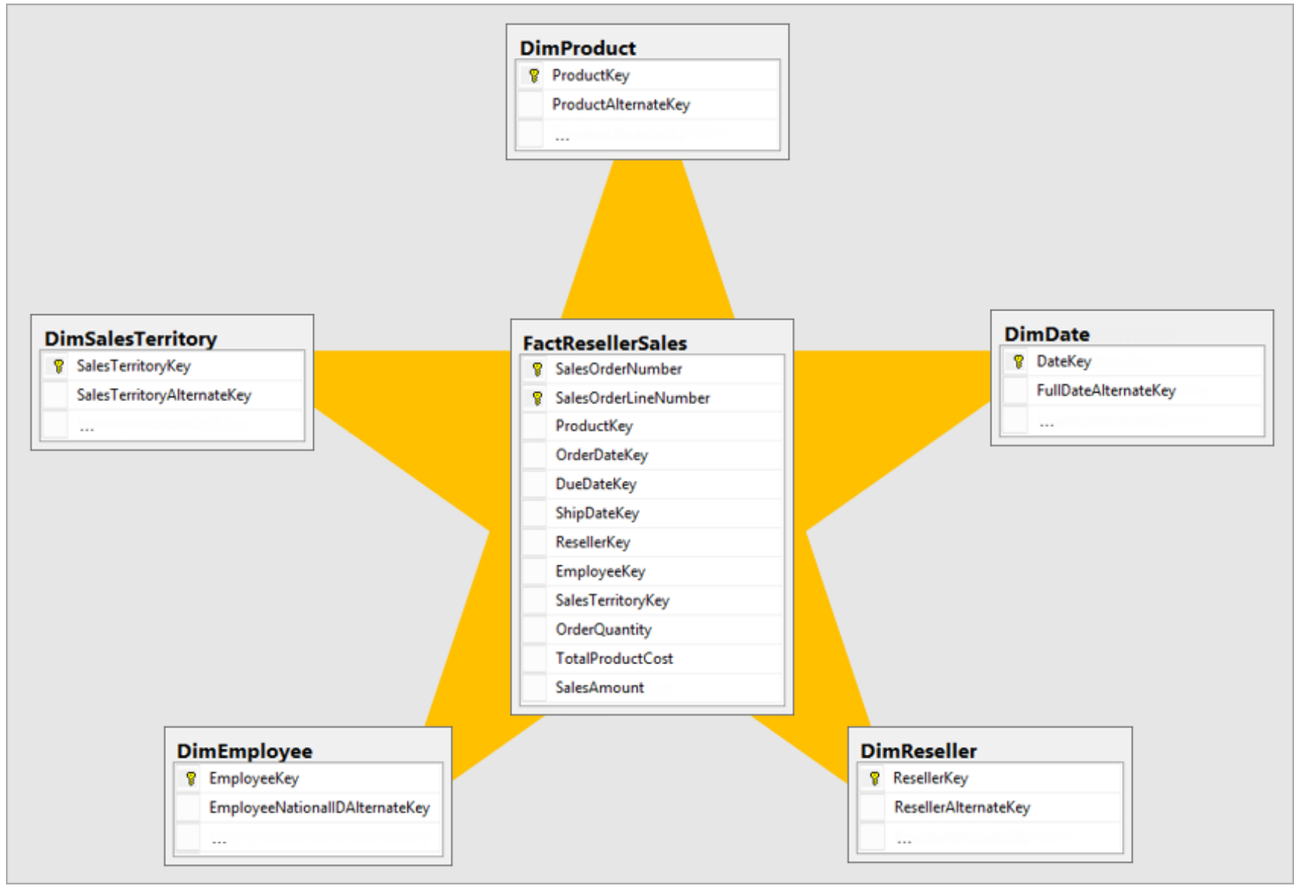

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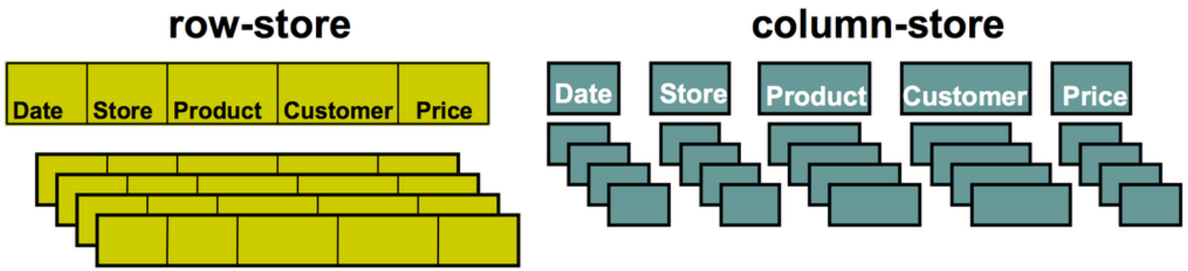

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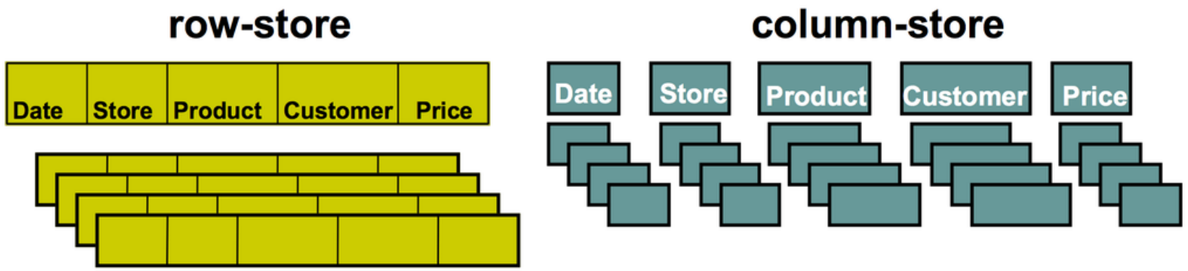

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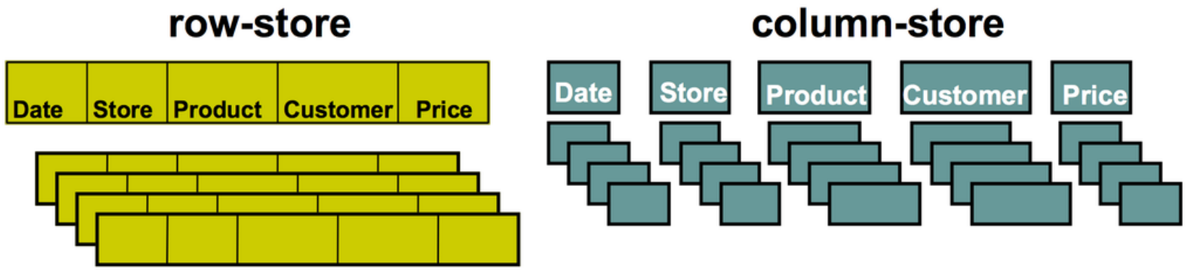

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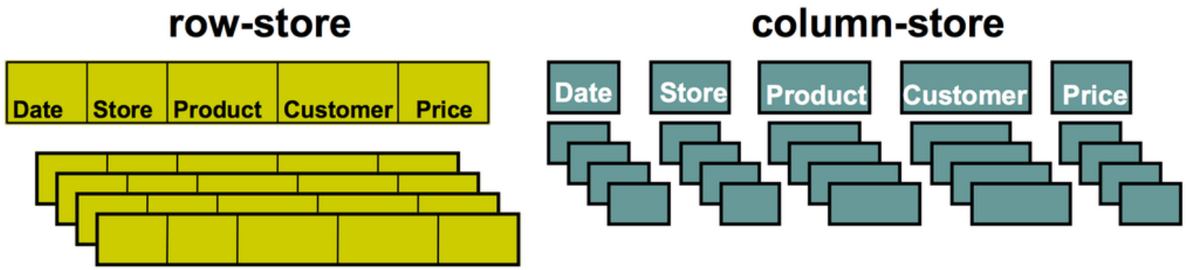

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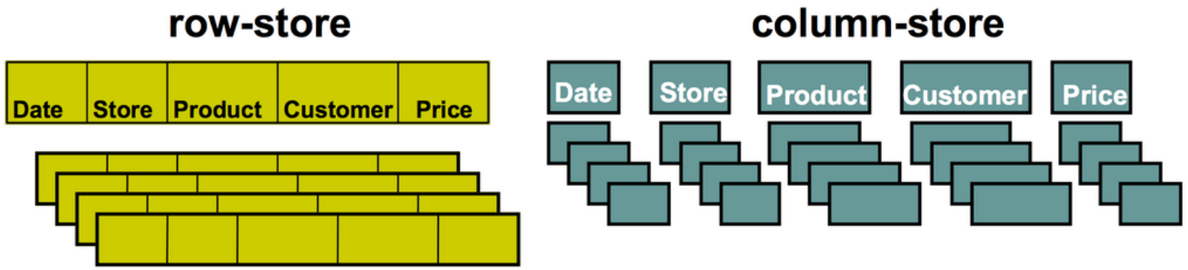
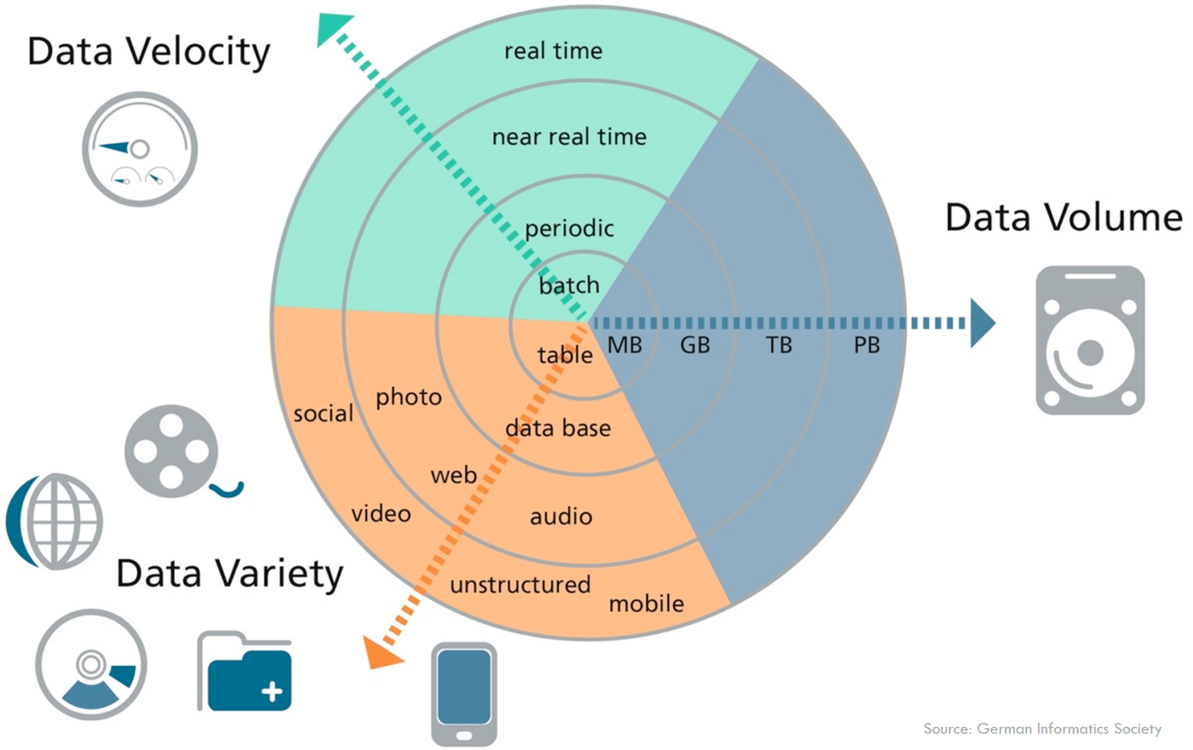
- Not just relational data, e.g., Apache Parquet



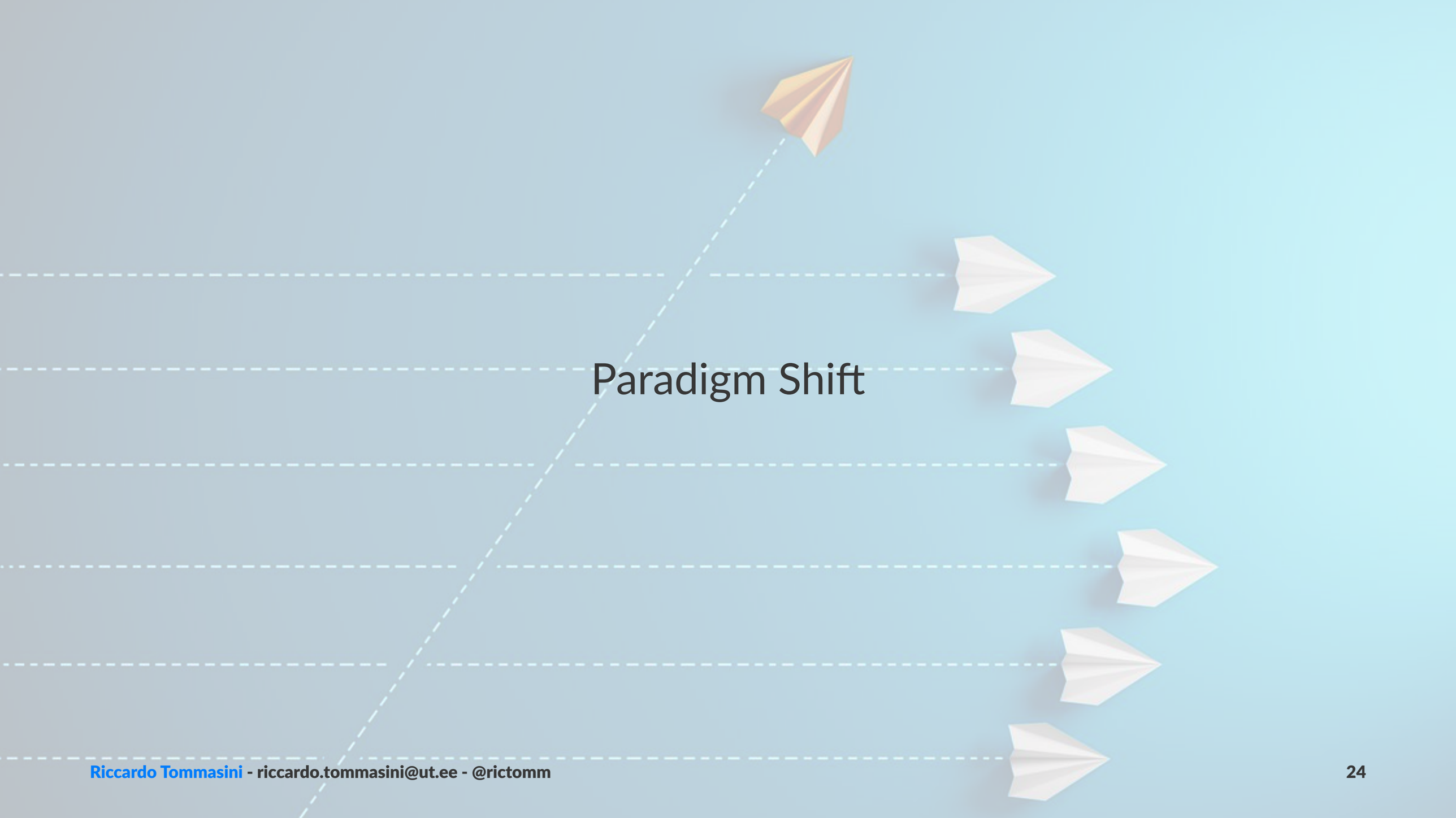
# Data Modelling for Big Data

# Big Data

# Challenges [014]

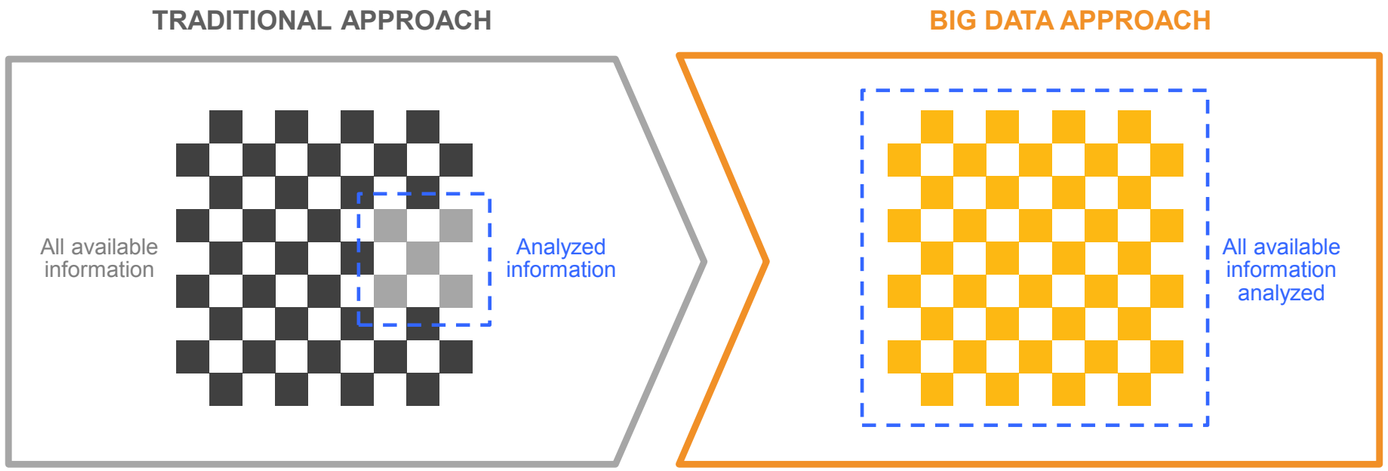



[014] Lanely, 2001


Paradigm Shift

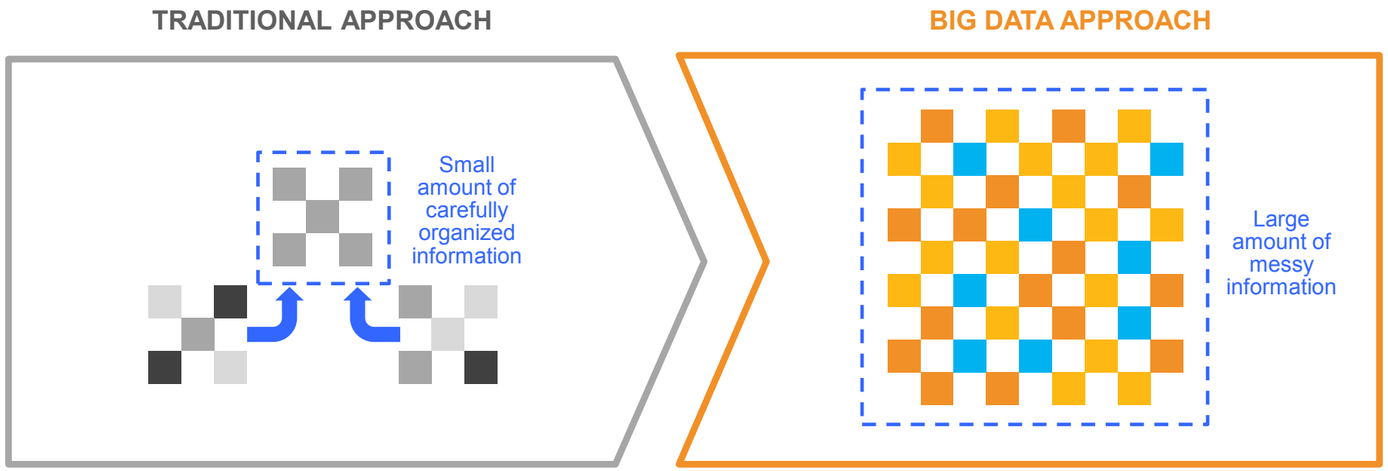
# Paradigm shifts enabled by big data

## 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

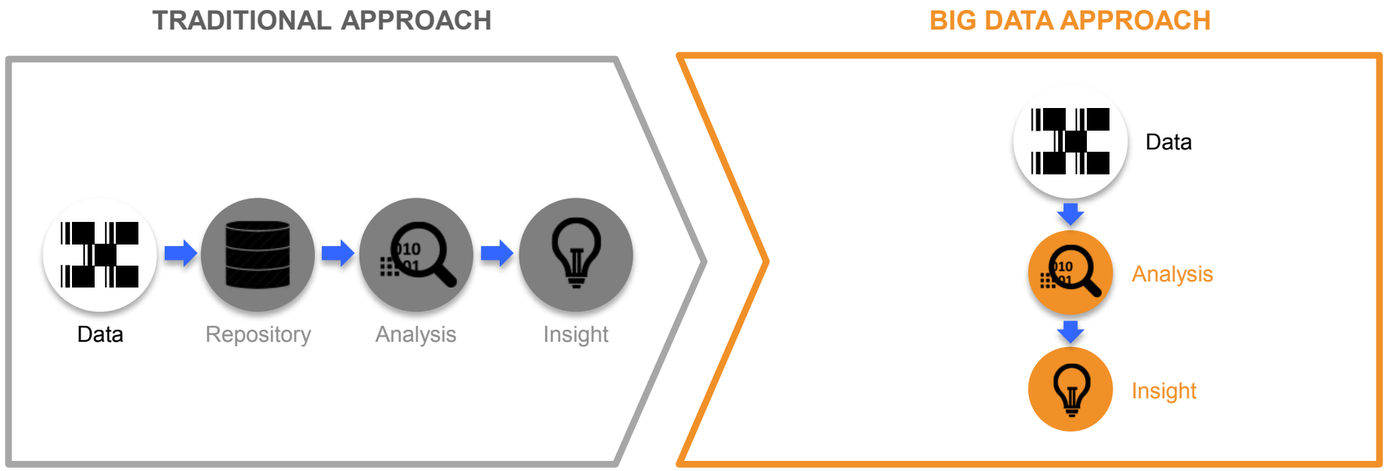
## Data leads the way—and sometimes correlations are good enough


Start with hypothesis and test against selected data

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

# Paradigm shifts enabled by big data

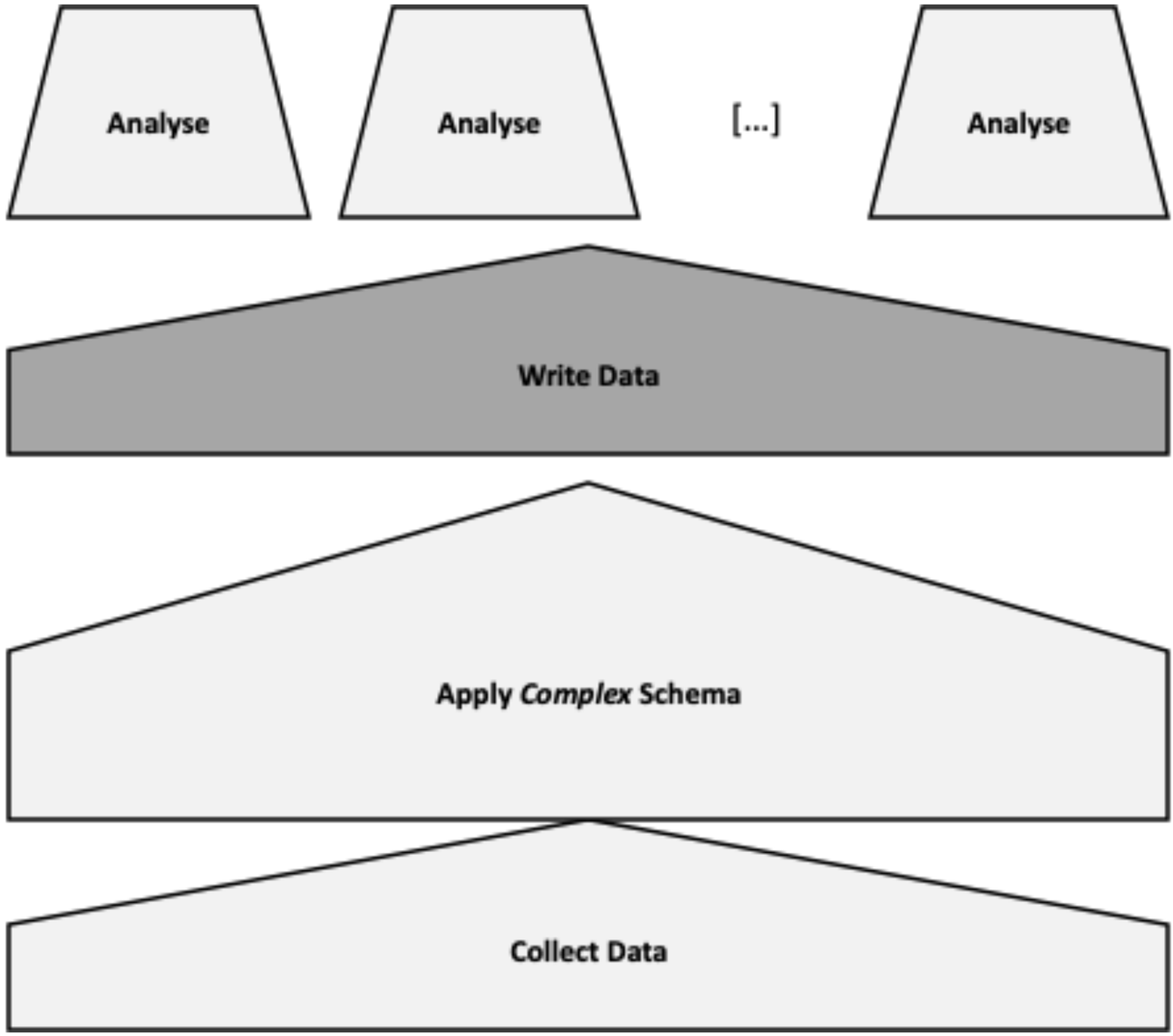
## Leverage data as it is captured




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

# From Schema on Write



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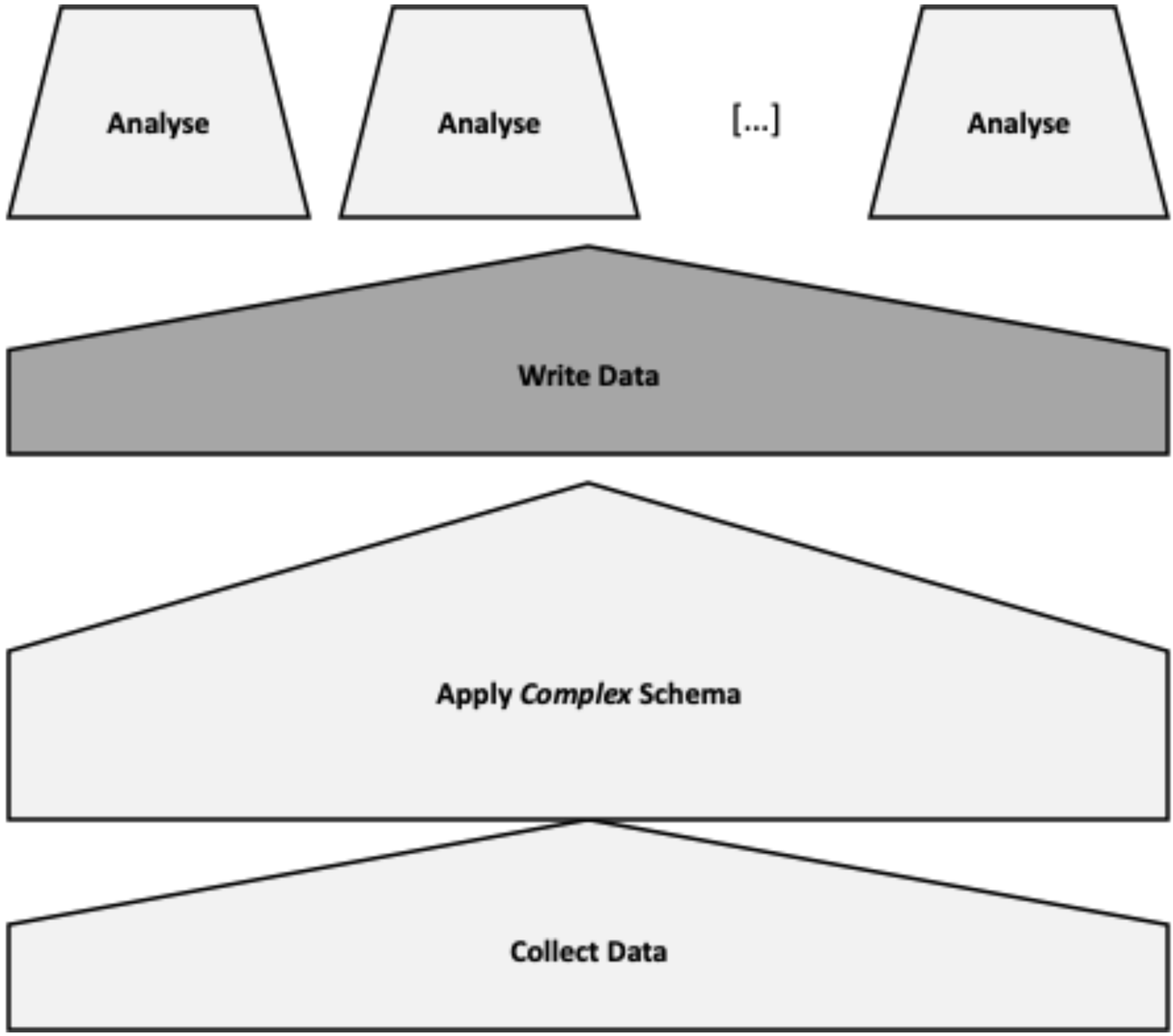
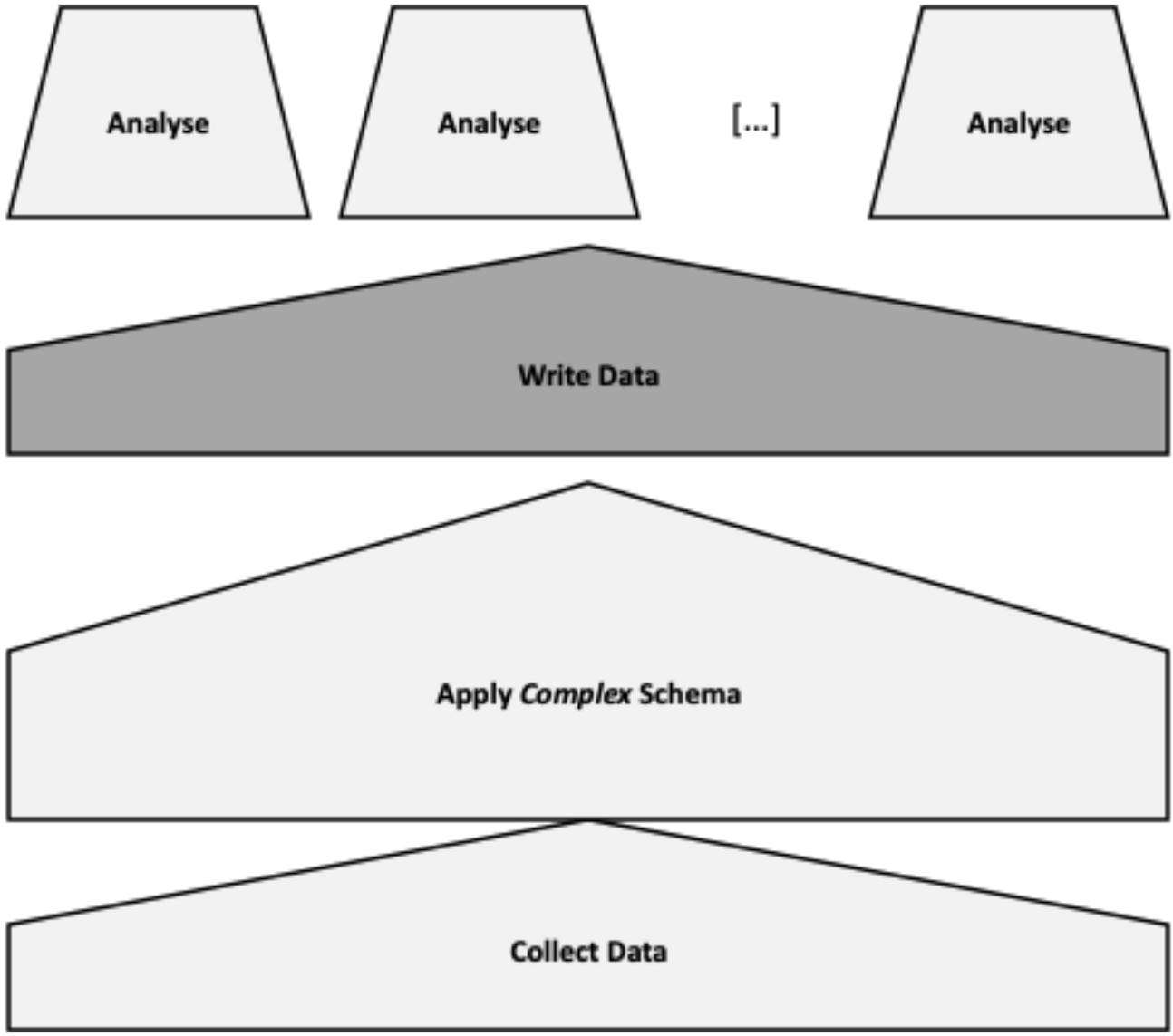


# From Schema on Write

- Focus on the modelling a schema that can accommodate all needs
- Bad impact on those analysis that were not envisioned



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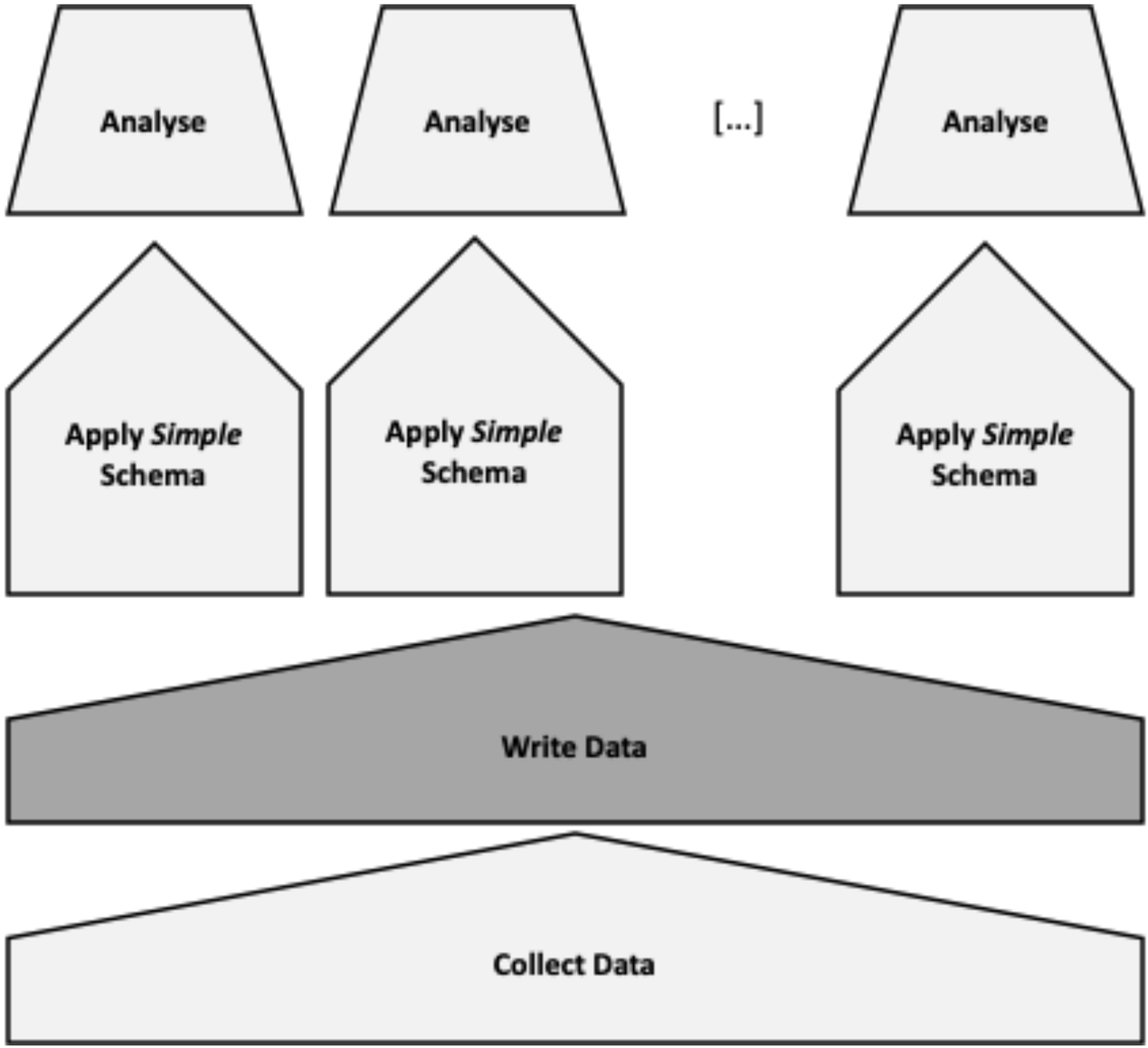

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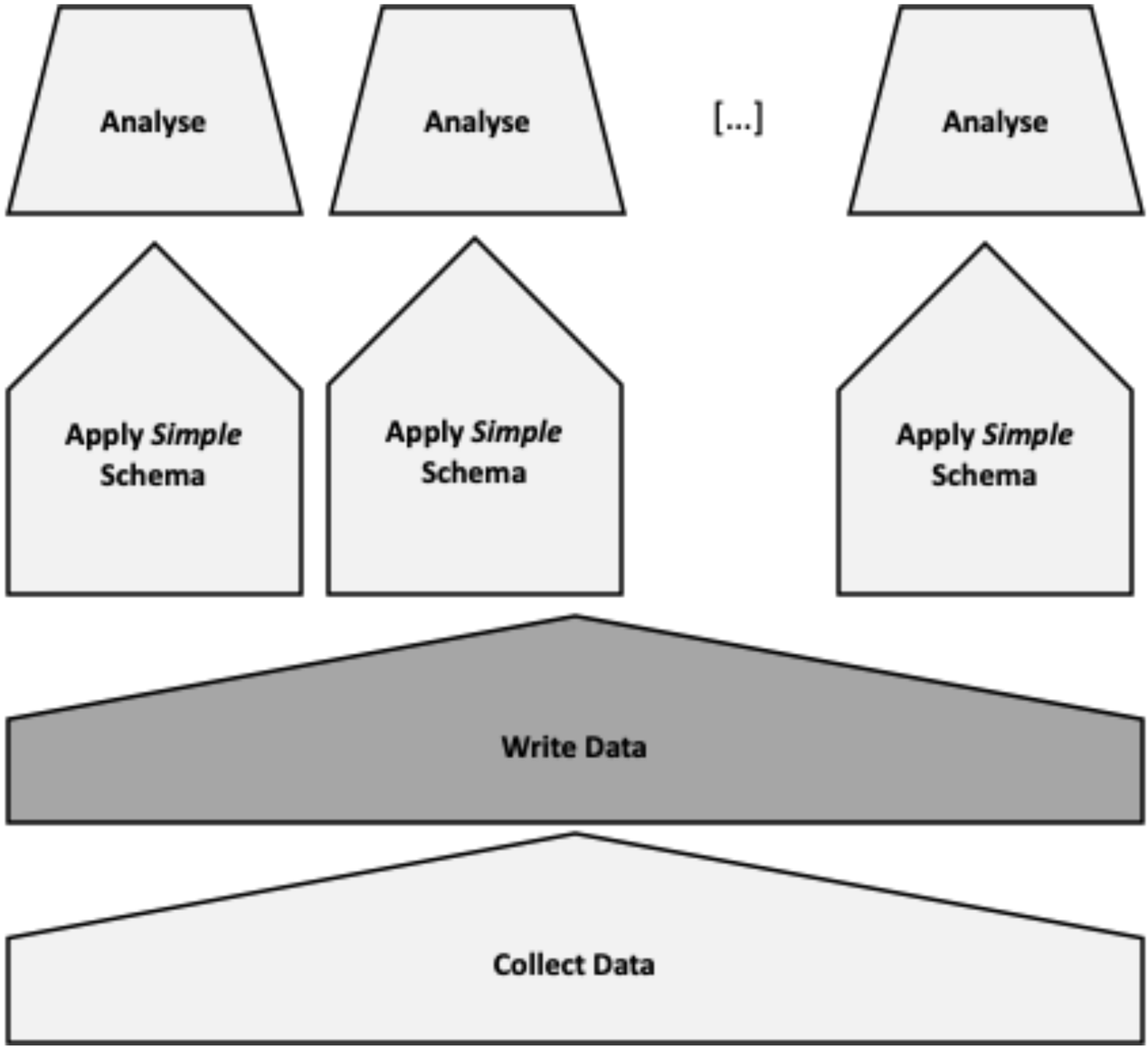

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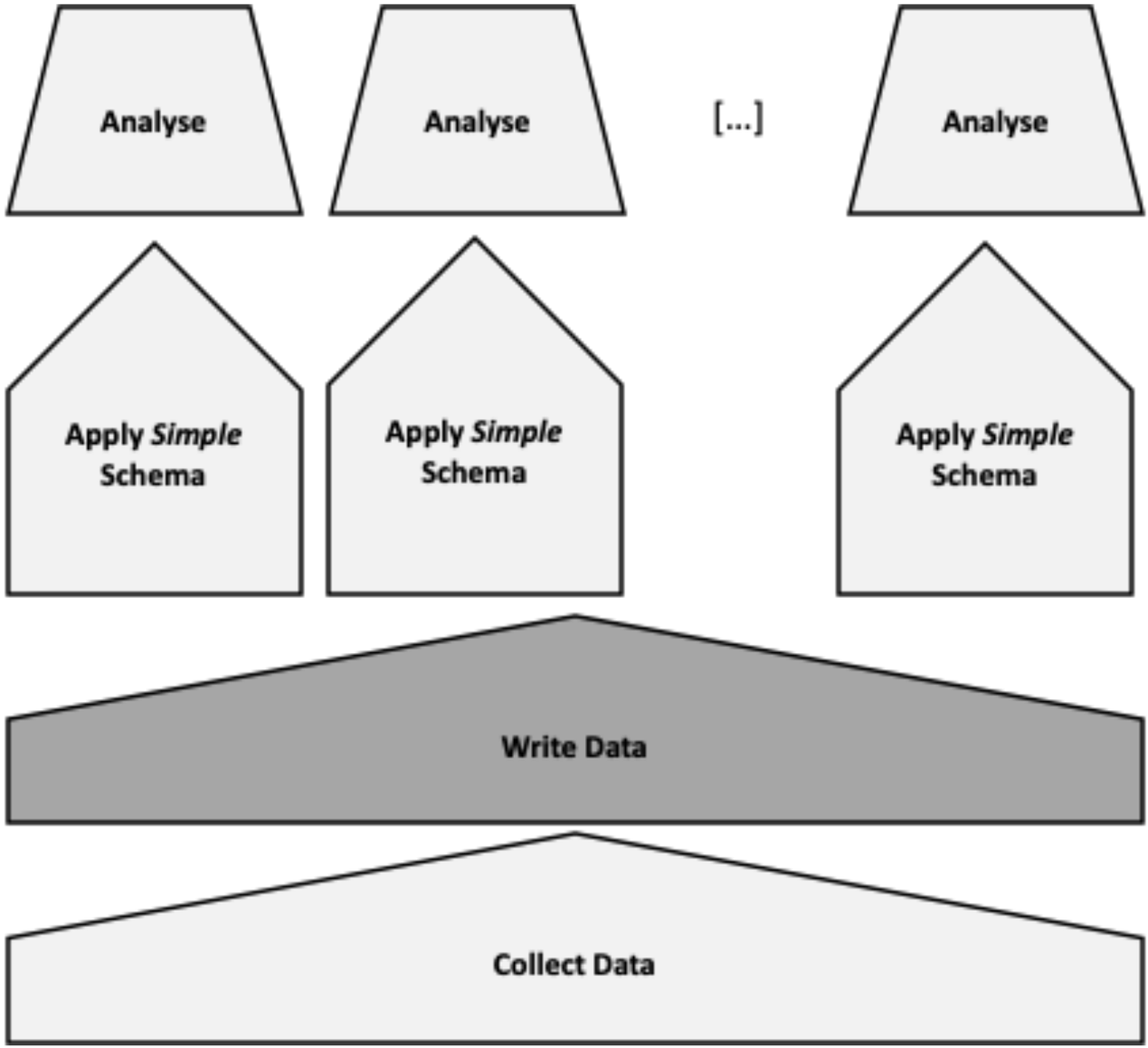

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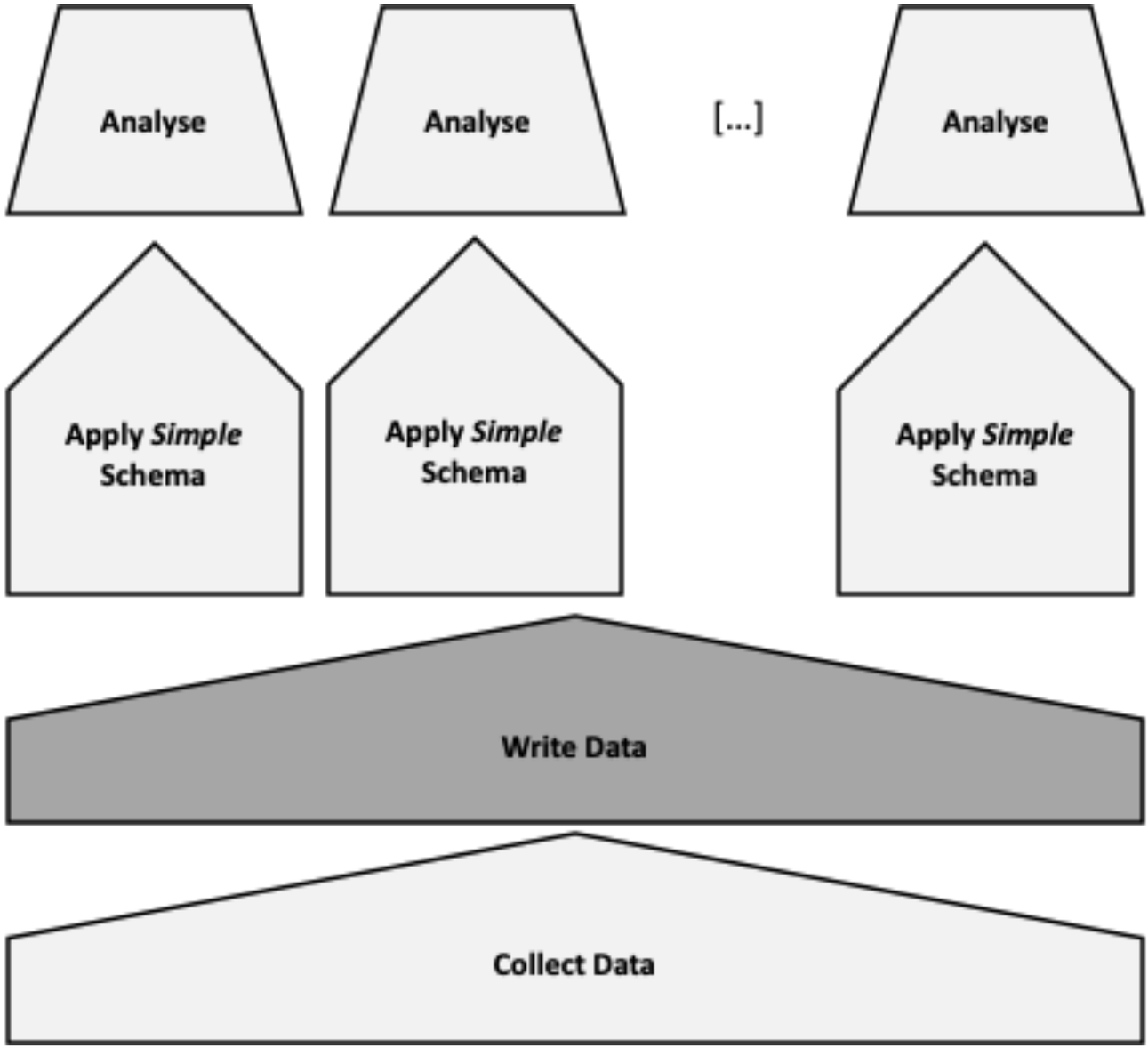
- New analyses can be introduced in any point in time



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- **Schemaless**: desire for a more dynamic and expressive data model than relational
- **Object-Relational Mismatch**: translation between the objects in the application code and the database model

| Document Database | Graph Databases |
| --- | --- |
|  Couchbase   |   |
| **Wide Column Stores** | **Key-Value Databases** |
|     |      Amazon SimpleDB |

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  - Examples: AllegroGraph, Neo4j

# ACID vs. BASE trade-off

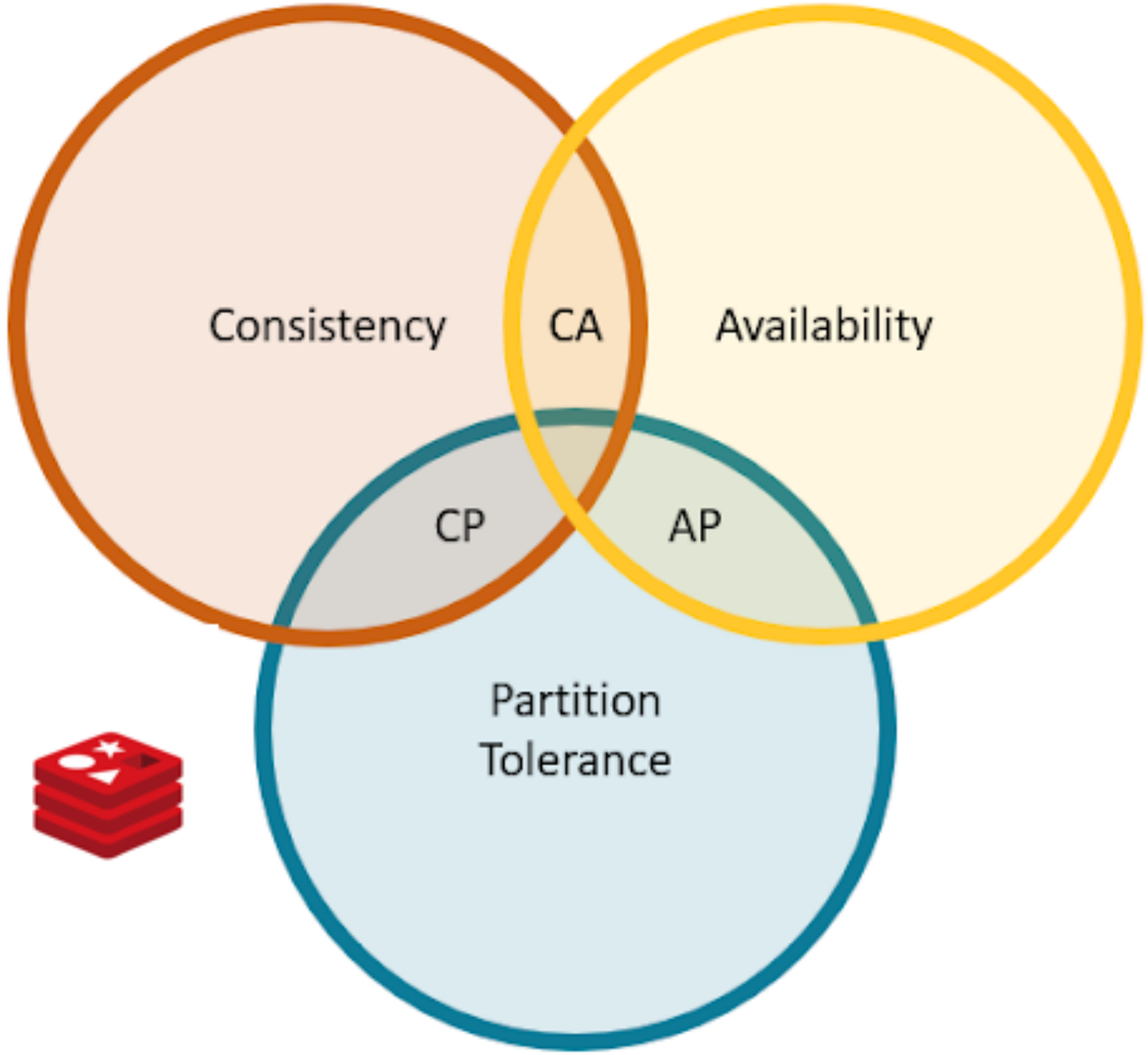
**No general answer** to whether your application needs an ACID versus BASE consistency model.

Given **BASE** ’s loose consistency, developers **need to** be more knowledgeable and **rigorous** about **consistent** data if they choose a BASE store for their application.

Planning around **BASE** limitations can sometimes be a major **disadvantage** when compared to the simplicity of ACID transactions.

A fully **ACID** database is the perfect fit for use cases where data **reliability** and **consistency** are essential.

# Redis



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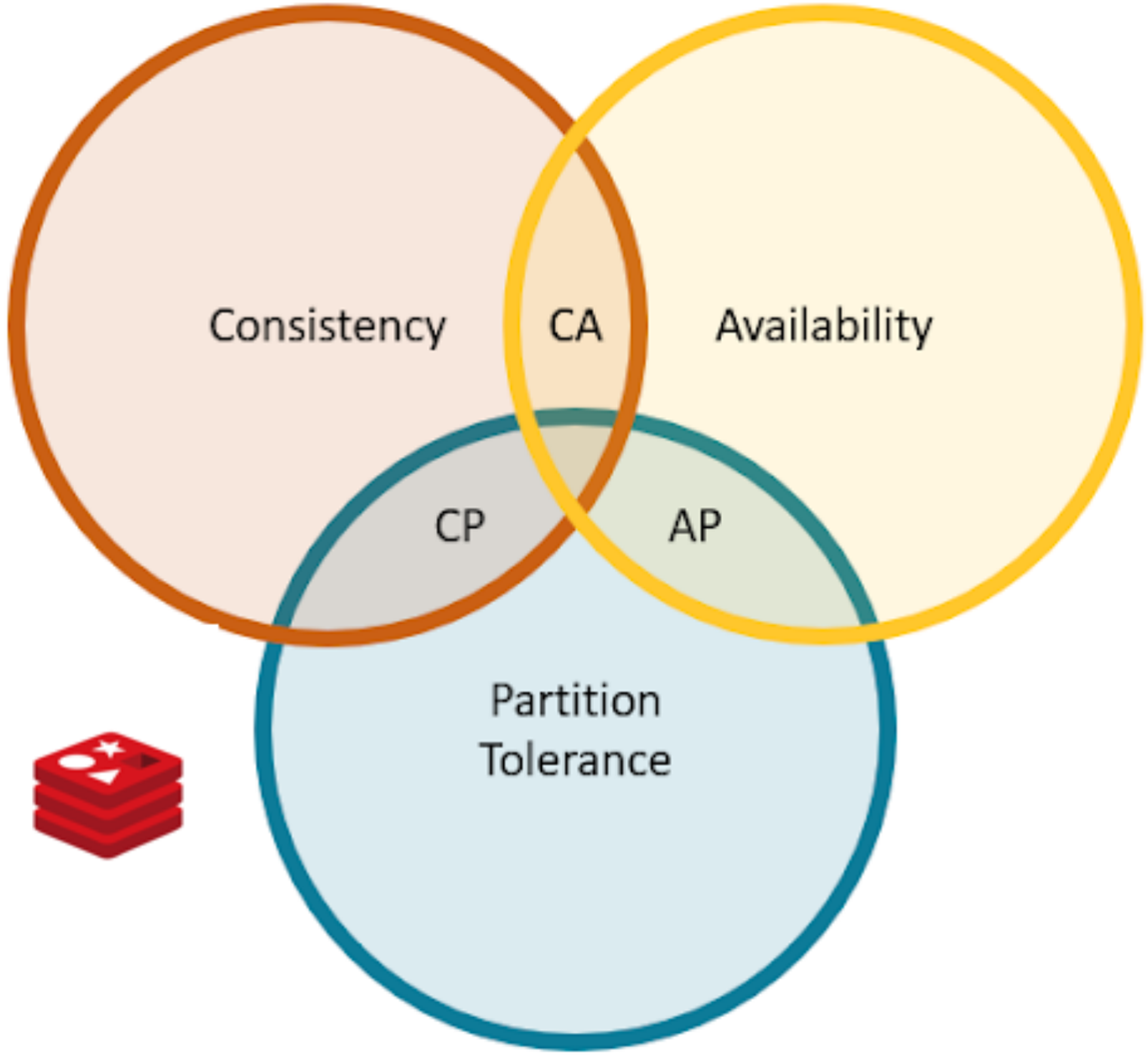

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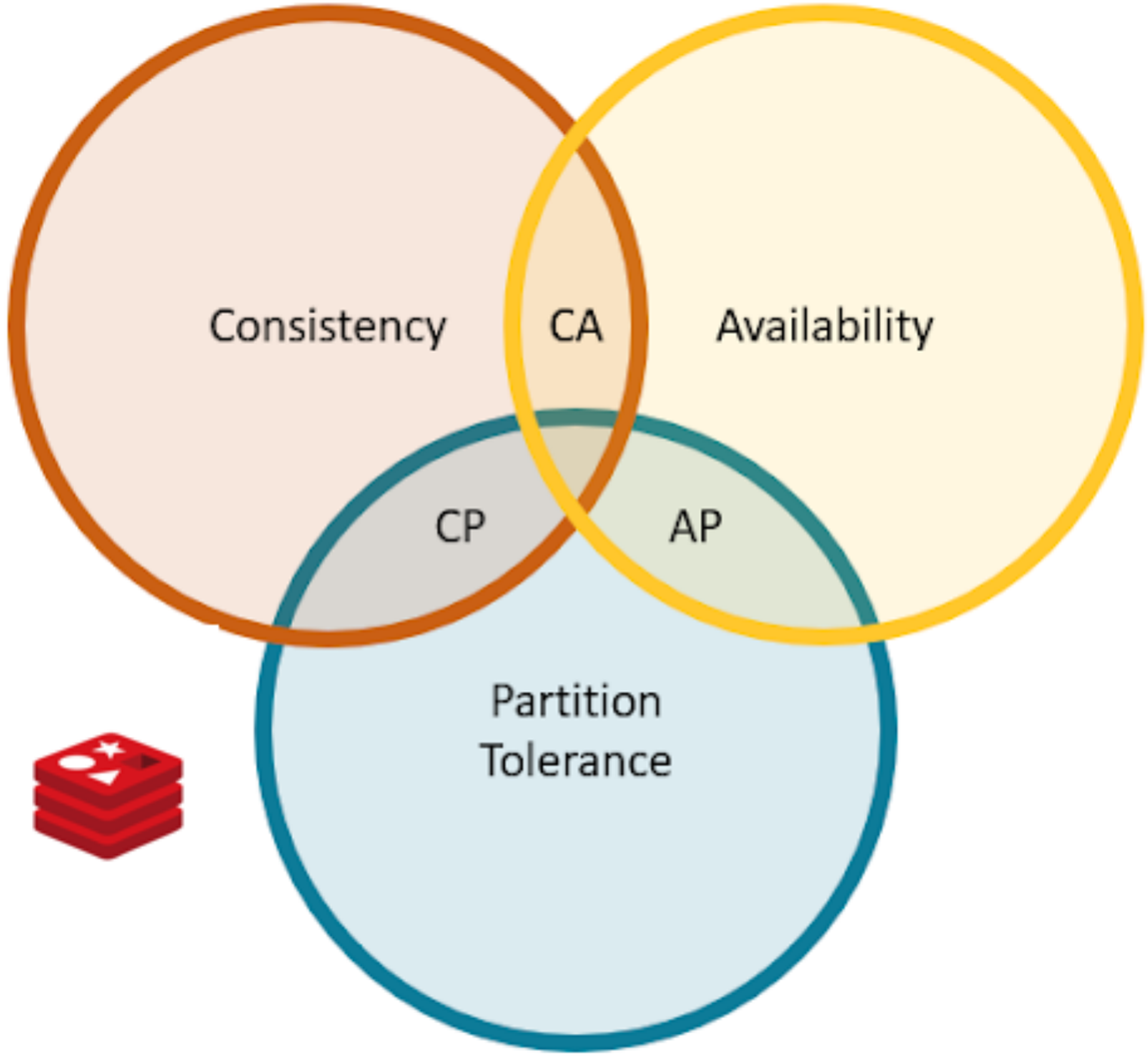

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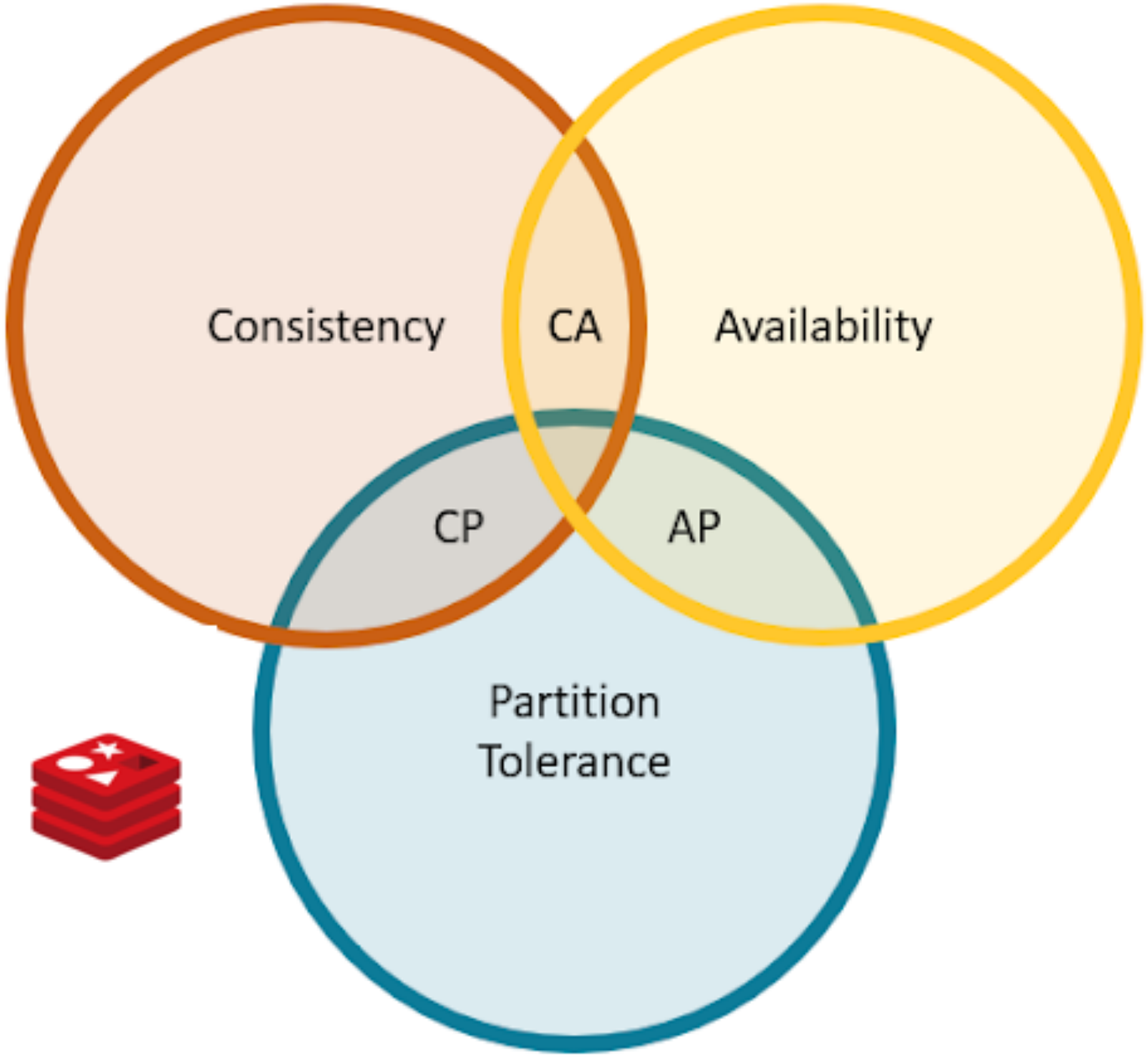

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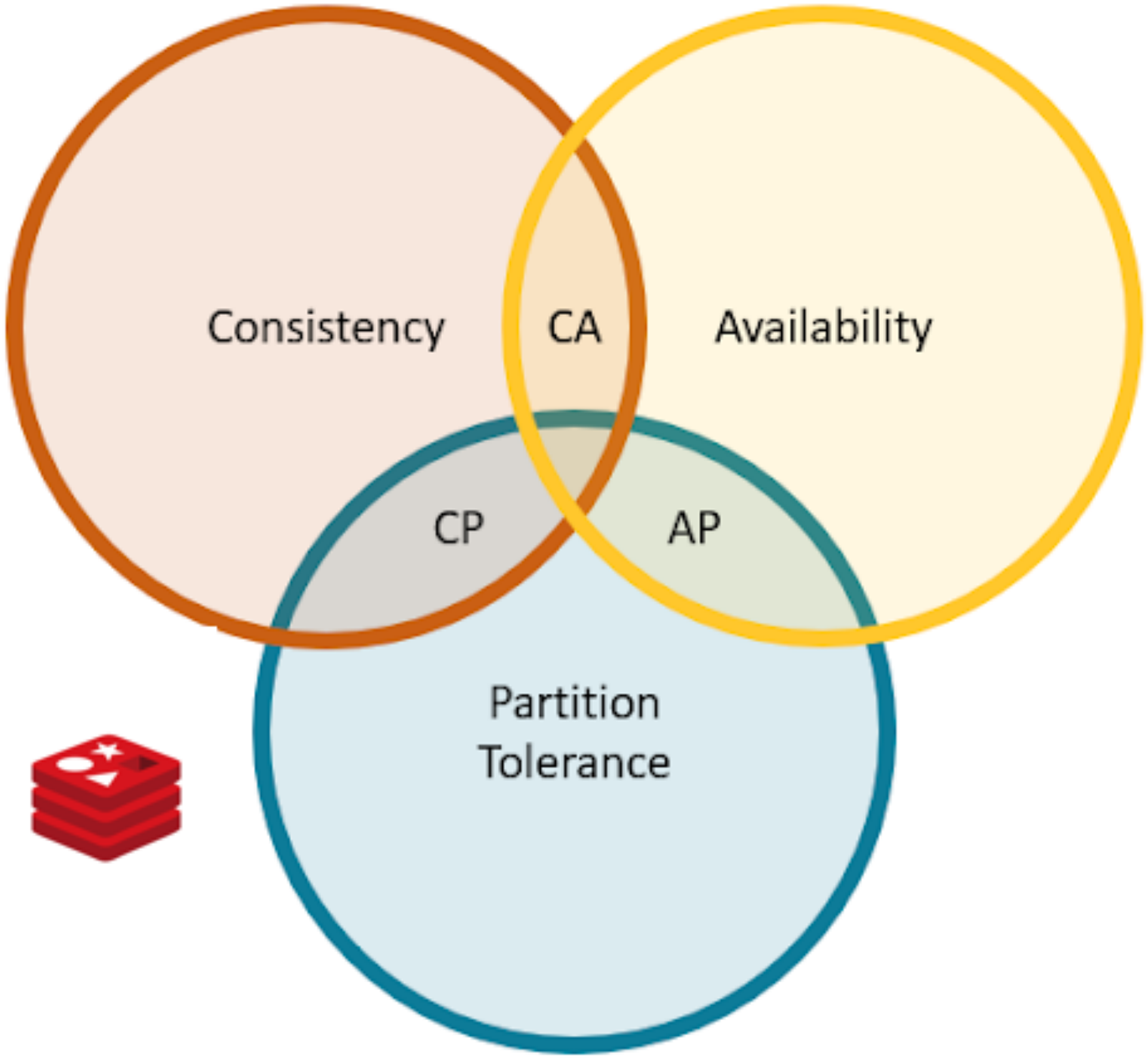

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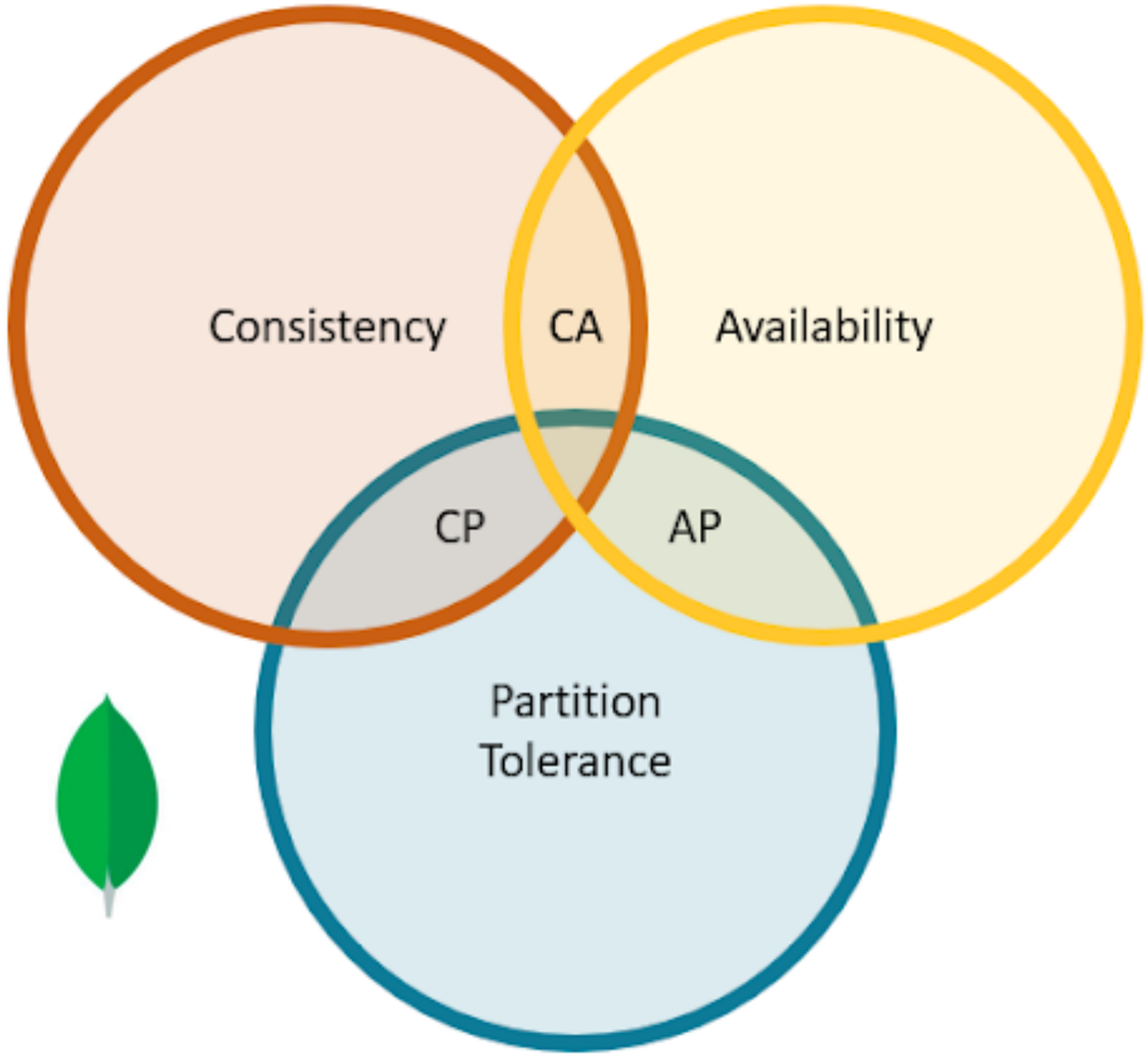

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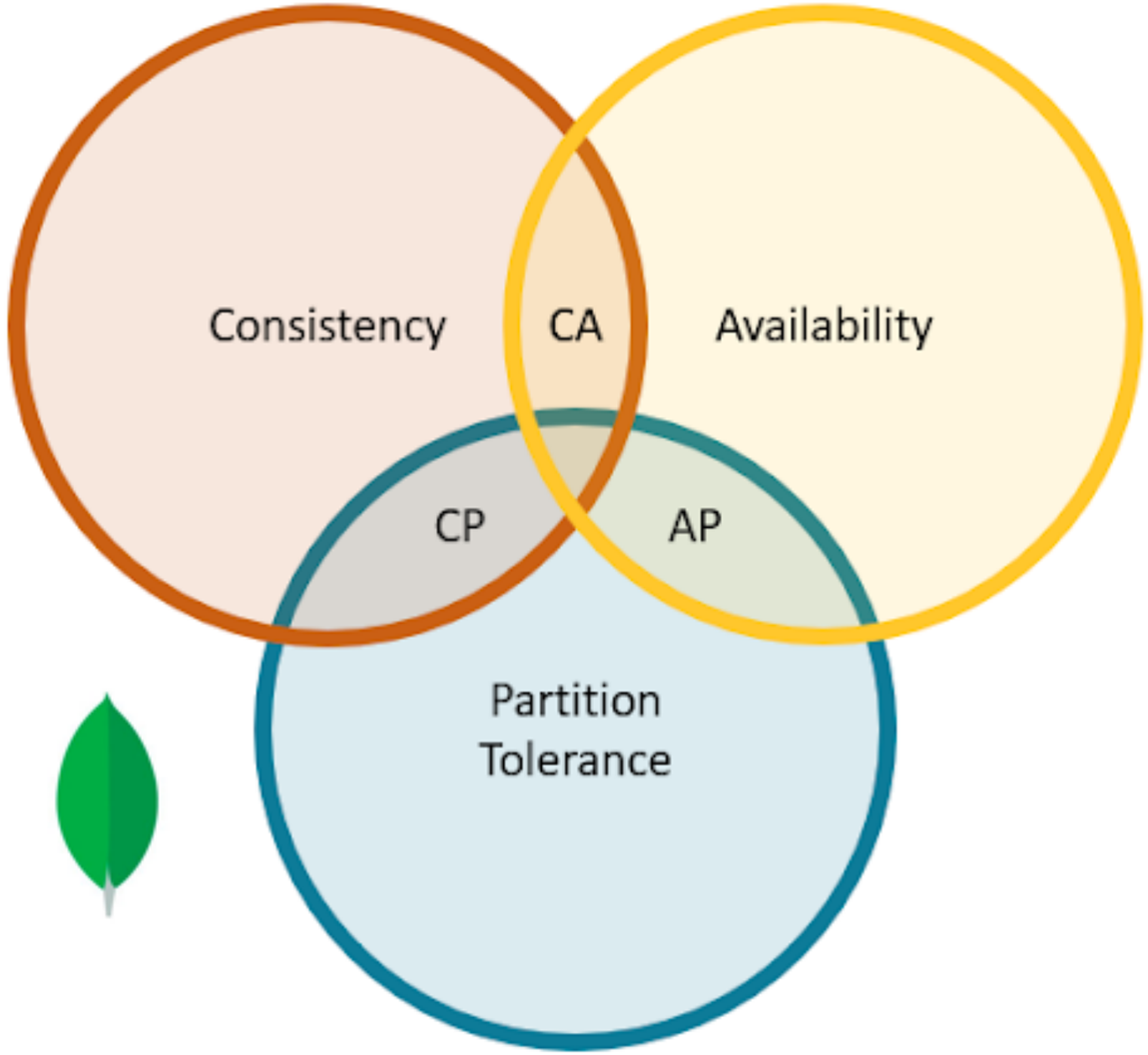

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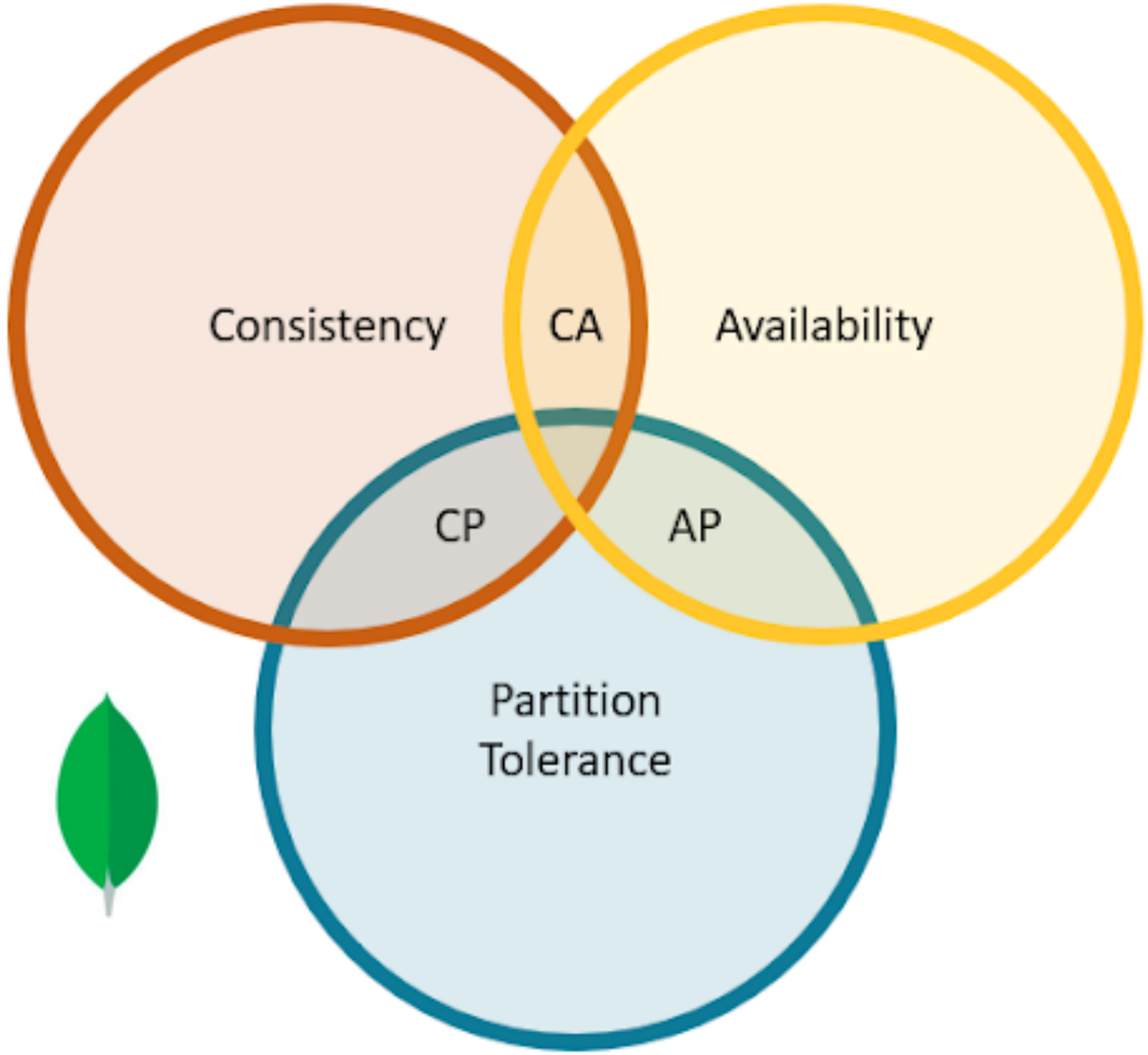

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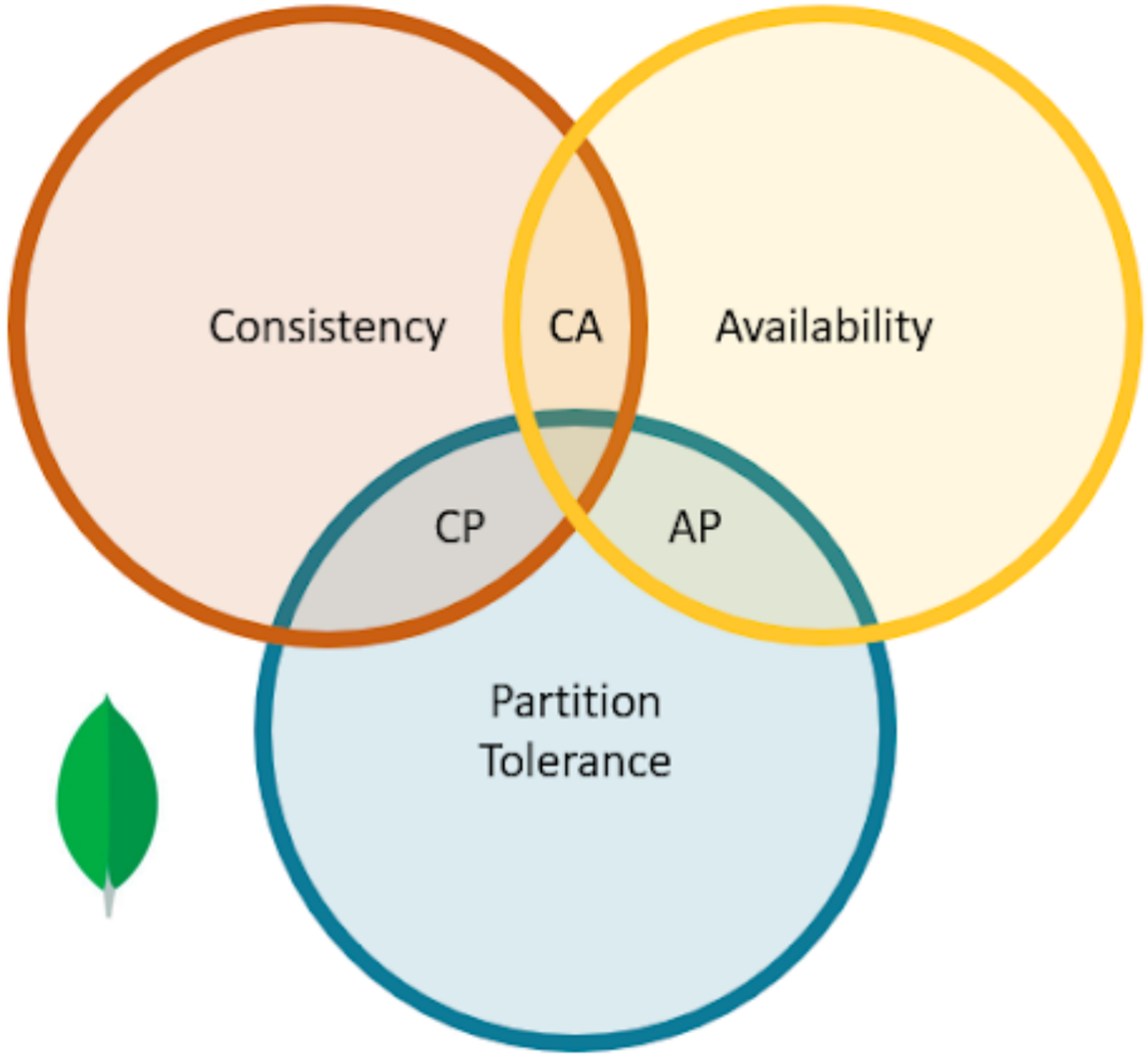

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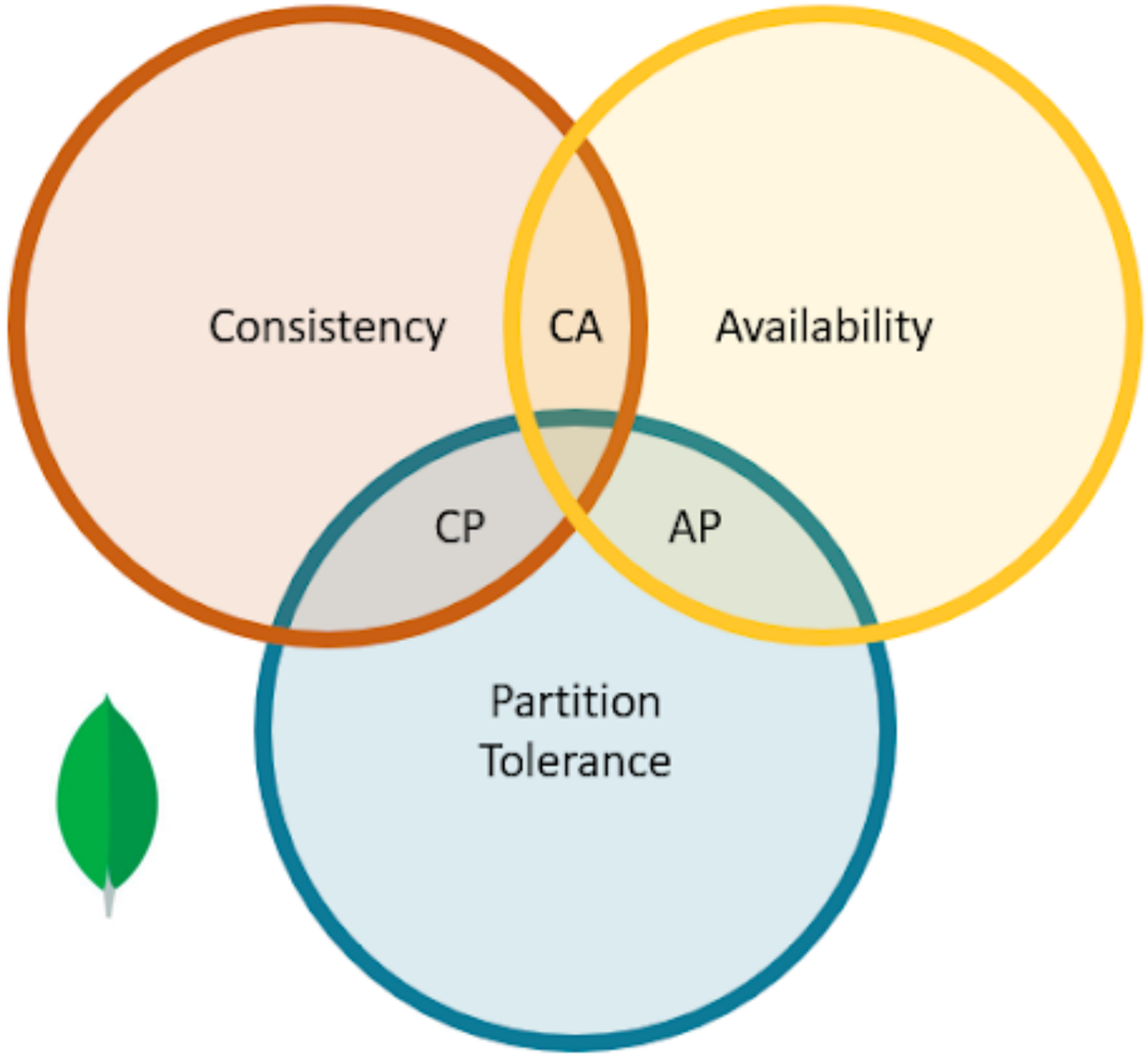

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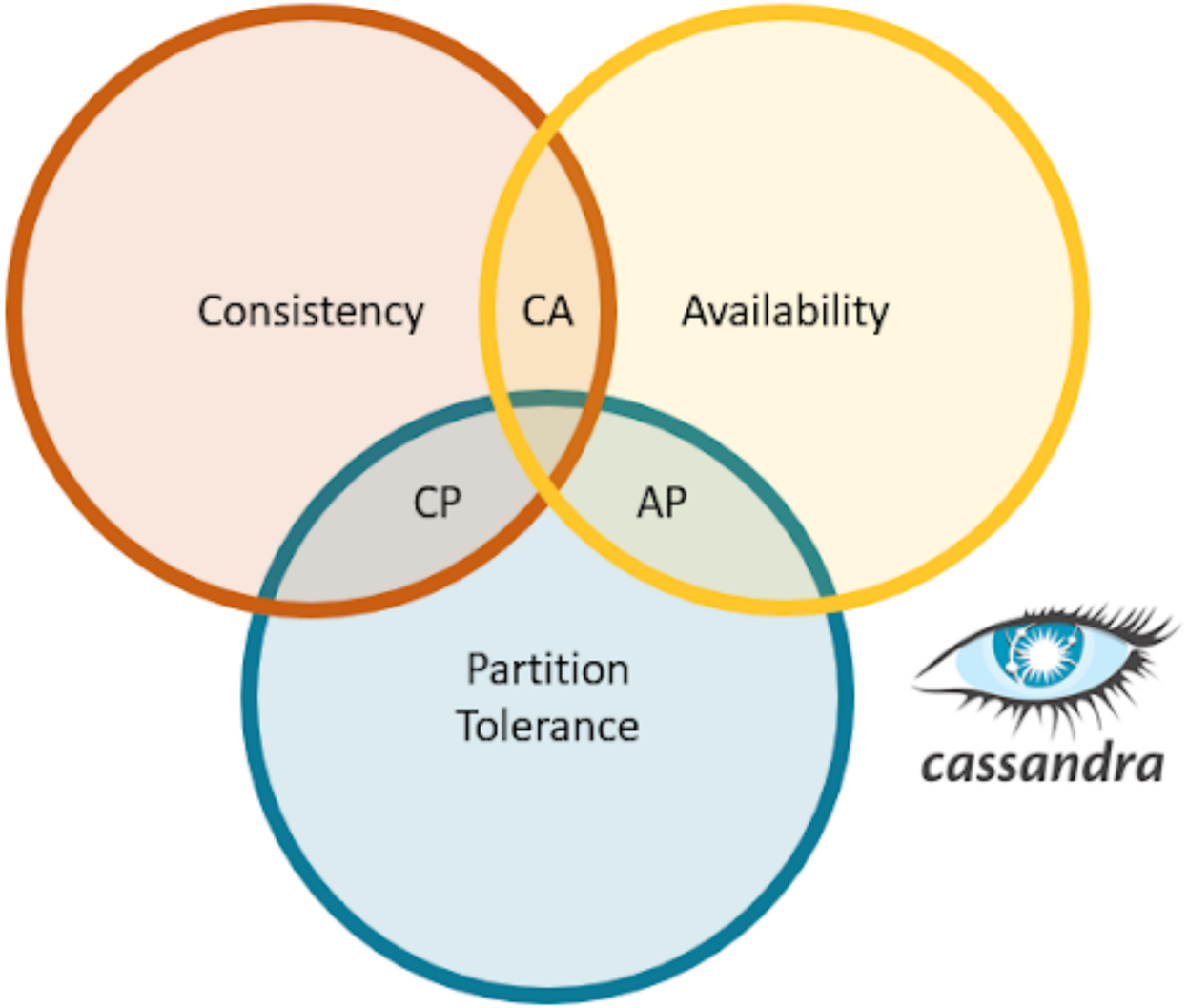
Consistency
CA
Availability
CP
AP
Partition
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cassandra

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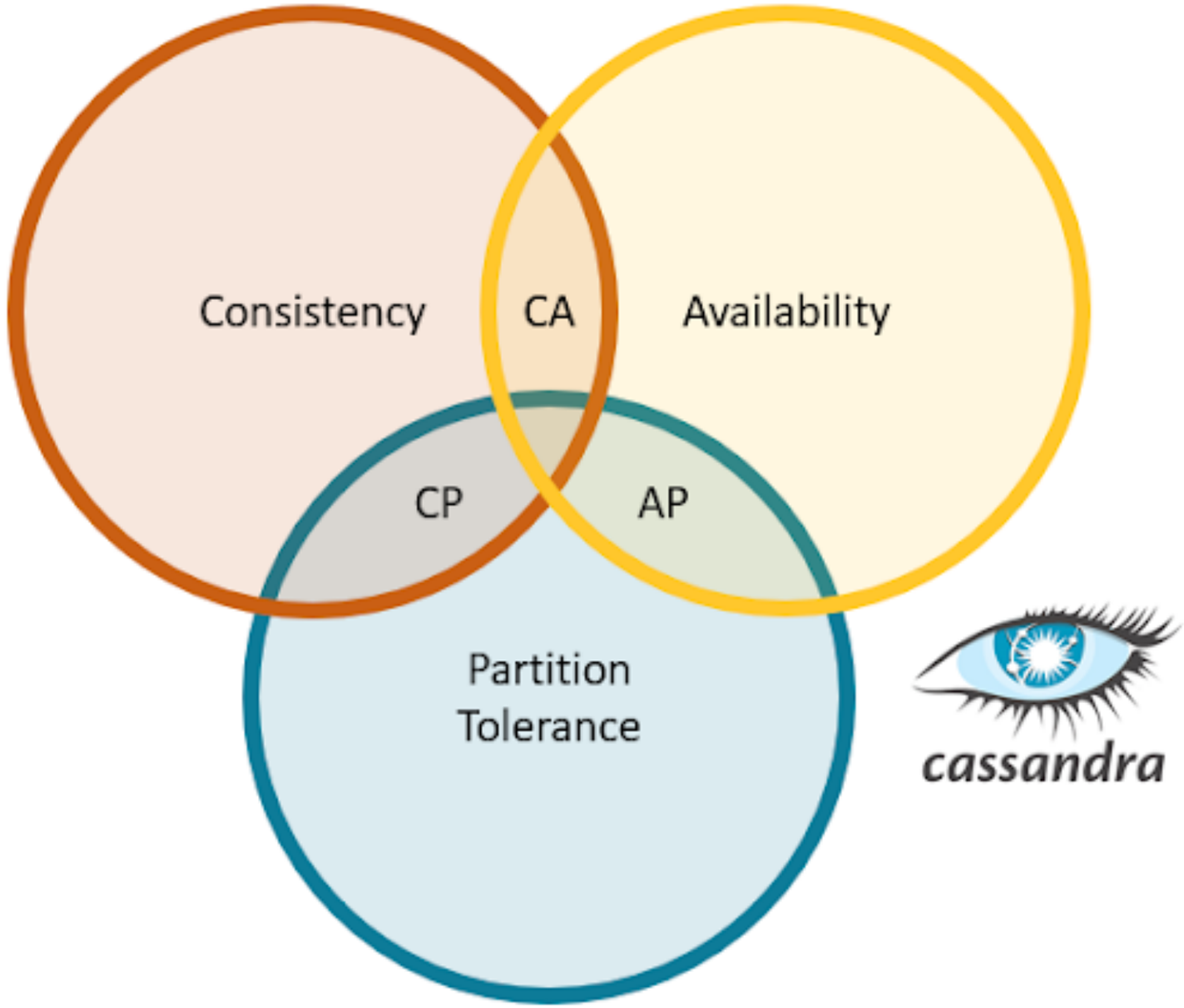

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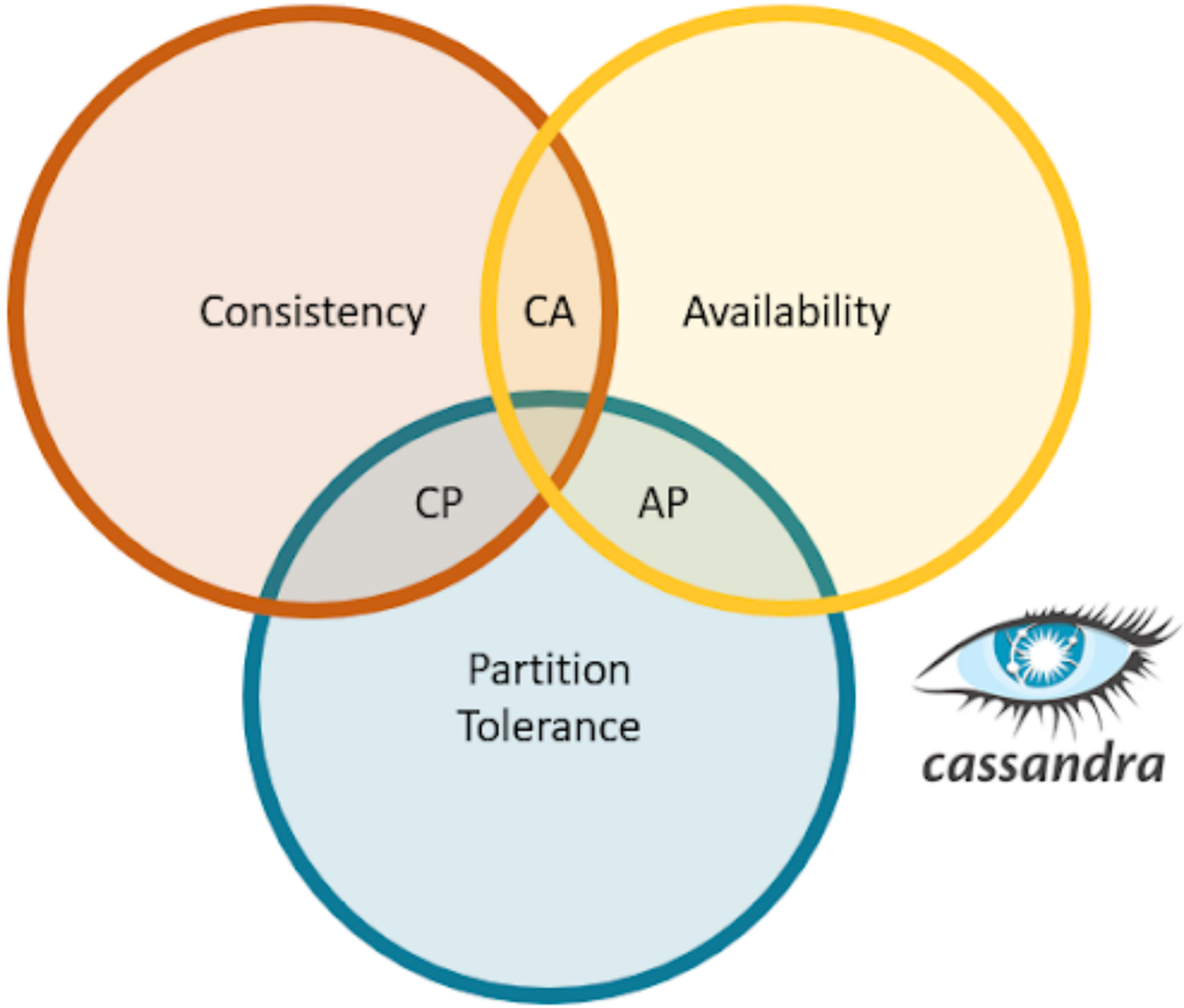

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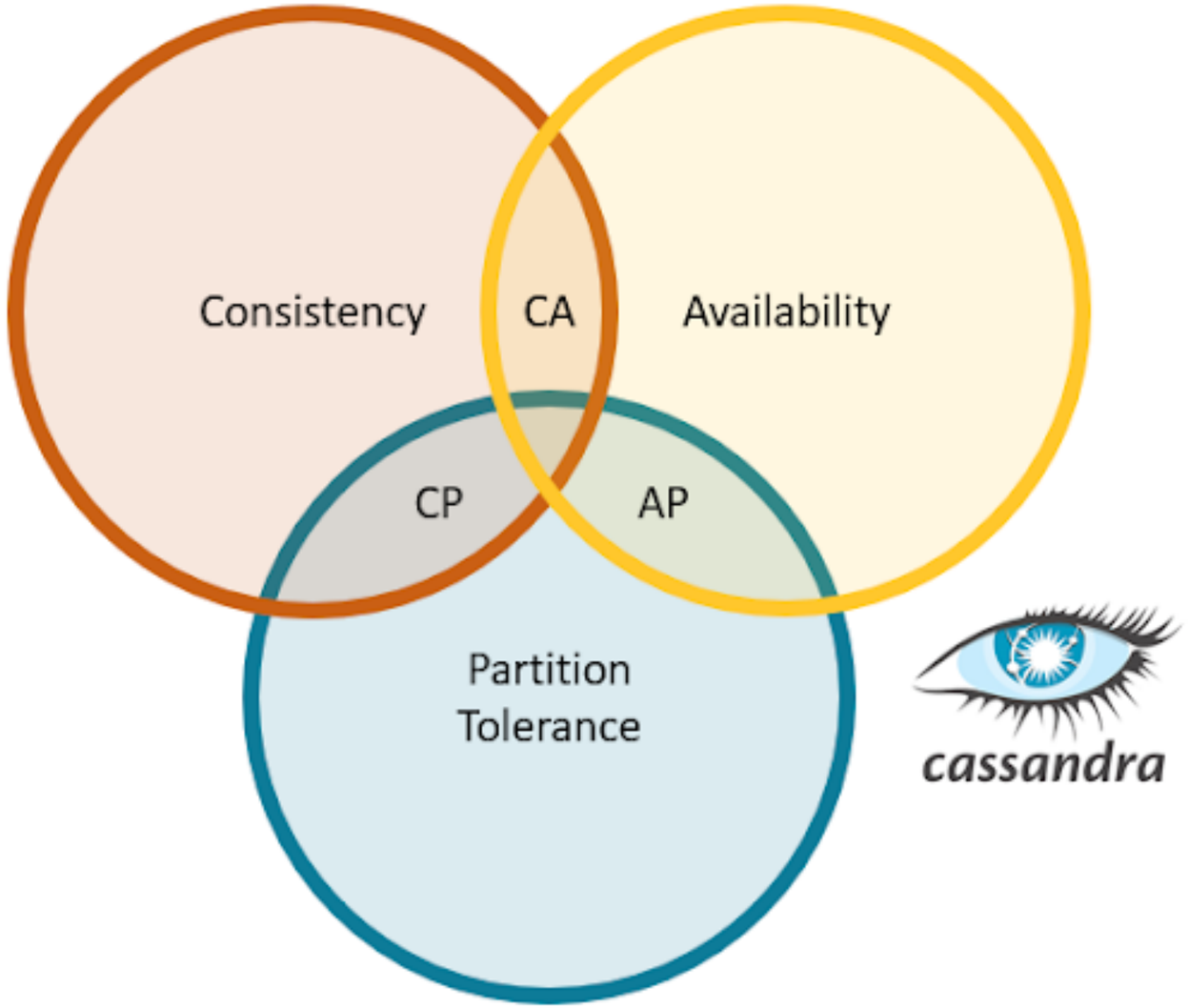

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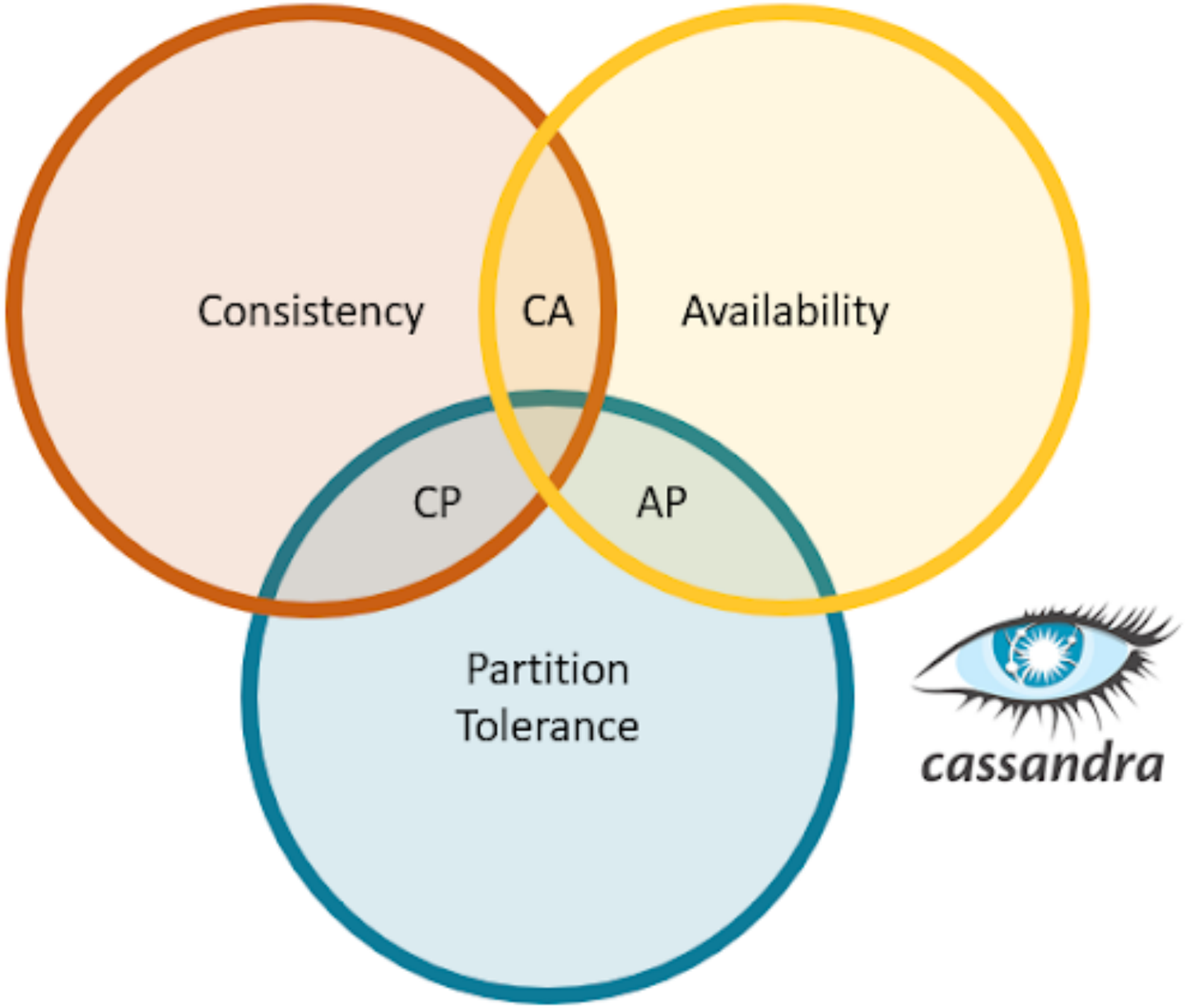

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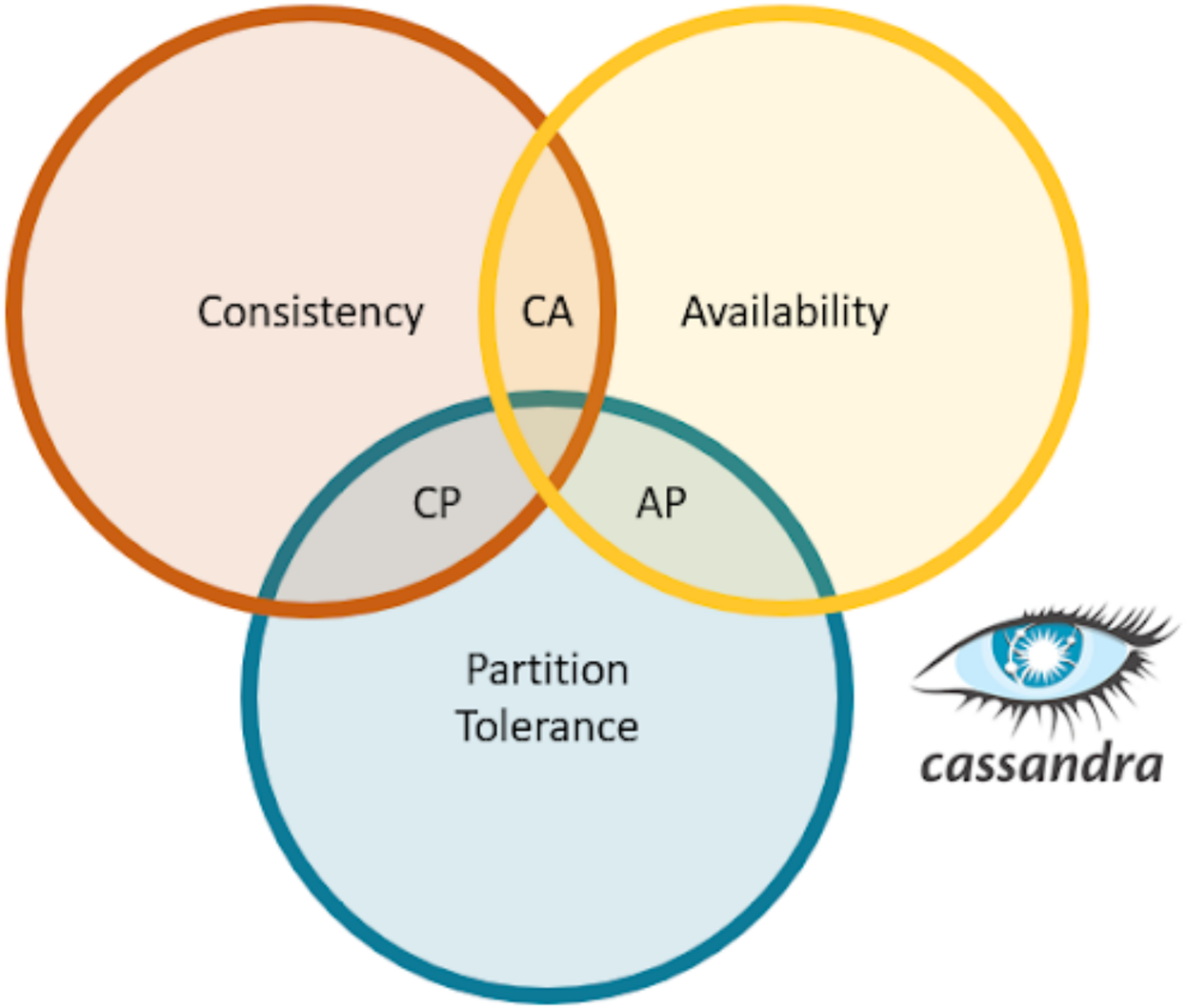

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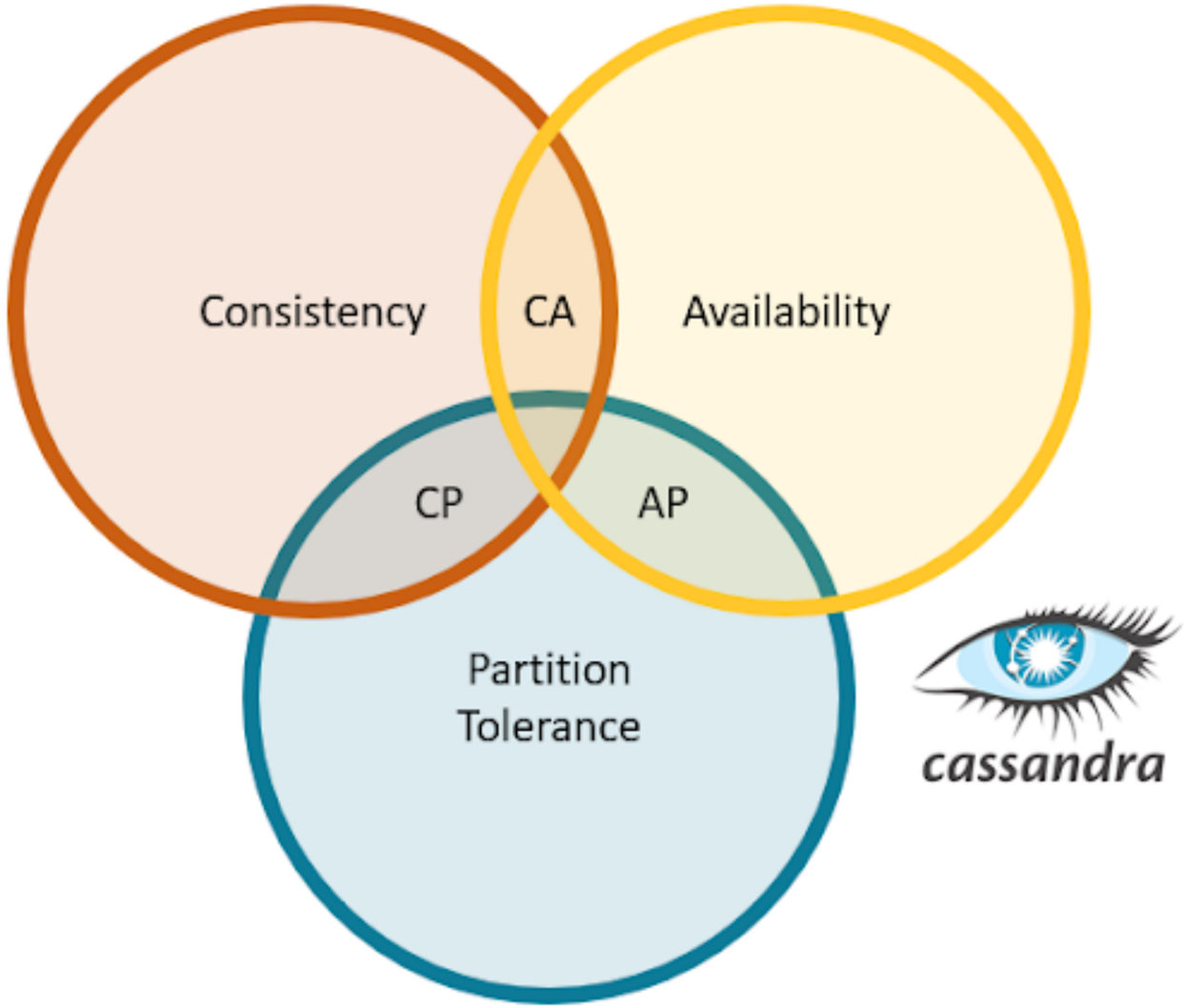

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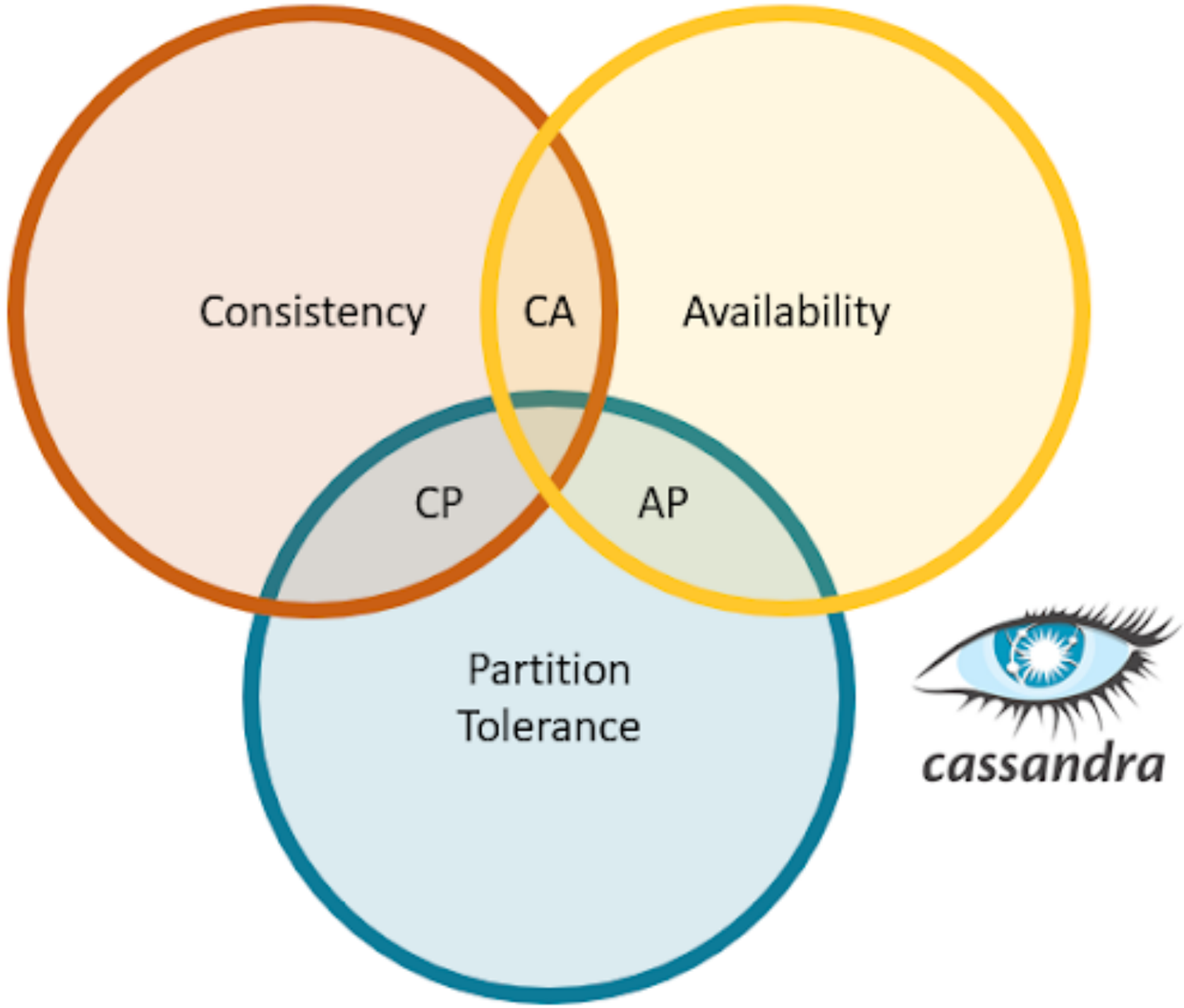

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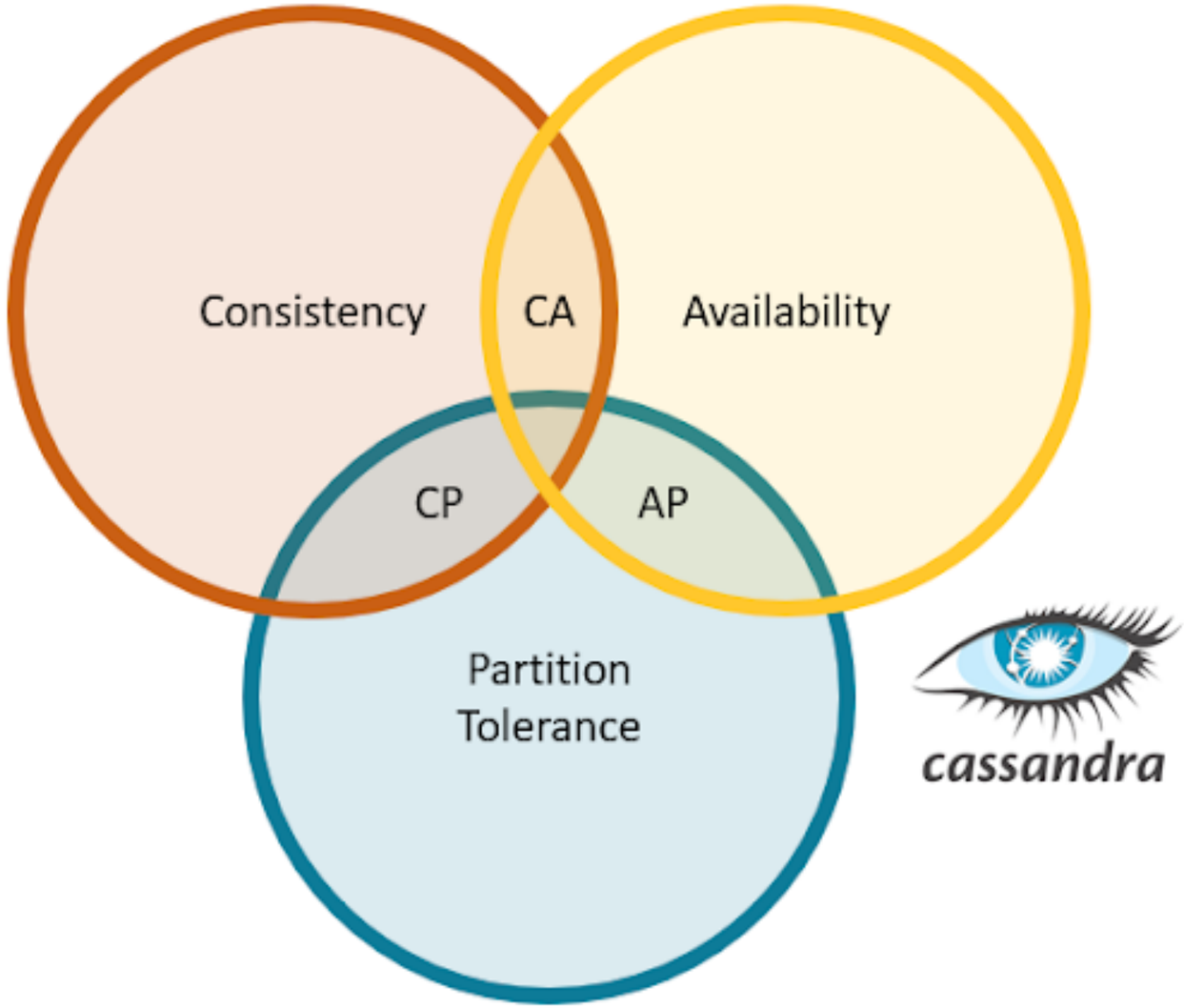

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