



# ARTIFICIAL INTELLIGENCE SOFTWARE DEVELOPMENT

Week 11 Lecture 1  
Dr. Hari M Koduvely



# Agenda for Today

- Theory:
  - Fundamentals of Data Engineering – Part 2

# Database Normalization

- ❑ Normalization is a Database Design Technique
- ❑ Reduces Data Redundancy
- ❑ Eliminates Insertion, Update and Deletion anomalies
- ❑ Divides larger tables into smaller ones linked by relationships
- ❑ Ensure that data is stored logically

# Database Normal Forms

- ☐ 1NF (First Normal Form)
- ☐ 2NF (Second Normal Form)
- ☐ 3NF (Third Normal Form)
- ☐ BCNF (Boyce-Codd Normal Form)
- ☐ 4NF (Fourth Normal Form)
- ☐ 5NF (Fifth Normal Form)
- ☐ 6NF (Sixth Normal Form)

In most practical applications, 3NF is sufficient

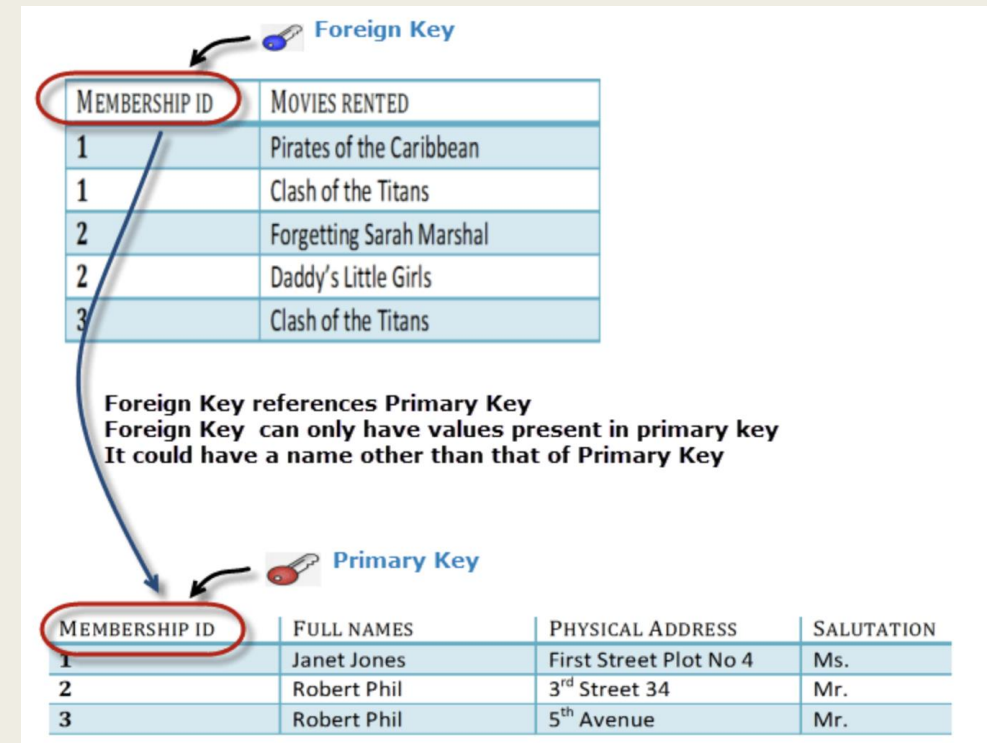
# Database Normal Forms

- ❑ A KEY is used to identify records in a database uniquely
- ❑ A Primary KEY is a single column value used to identify a database record uniquely
  - *A primary key cannot be NULL*
  - *A primary key value must be unique*
  - *The primary key values should rarely be changed*
  - *The primary key must be given a value when a new record is inserted*
- ❑ A Composite KEY is a primary key composed of multiple columns.

Robert Phil	3 <sup>rd</sup> Street 34	Daddy's Little Girls	Mr.
Robert Phil	5 <sup>th</sup> Avenue	Clash of the Titans	Mr.

# Database Normal Forms

- ❑ Foreign Key references the primary key of another Table
- ❑ It helps connect the two Tables
- ❑ A foreign key can have a different name from its primary key
- ❑ It ensures rows in one table have corresponding rows in another
- ❑ Unlike the Primary key, most often they are not unique
- ❑ Foreign keys can be null even though primary keys can not



# Database Normal Forms Example

## Movie Rental Database

FULL NAMES	PHYSICAL ADDRESS	MOVIES RENTED	SALUTATION
Janet Jones	First Street Plot No 4	Pirates of the Caribbean, Clash of the Titans	Ms.
Robert Phil	3 <sup>rd</sup> Street 34	Forgetting Sarah Marshal, Daddy's Little Girls	Mr.
Robert Phil	5 <sup>th</sup> Avenue	Clash of the Titans	Mr.

# Database Normal Forms

## 1st Normal Form Rules

- ❑ Each table cell should contain a single value
- ❑ Each record need to be unique
- ❑ Each column name should be unique

FULL NAMES	PHYSICAL ADDRESS	MOVIES RENTED	SALUTATION
Janet Jones	First Street Plot No 4	Pirates of the Caribbean	Ms.
Janet Jones	First Street Plot No 4	Clash of the Titans	Ms.
Robert Phil	3 <sup>rd</sup> Street 34	Forgetting Sarah Marshal	Mr.
Robert Phil	3 <sup>rd</sup> Street 34	Daddy's Little Girls	Mr.
Robert Phil	5 <sup>th</sup> Avenue	Clash of the Titans	Mr.




# Database Normal Forms

## 2nd Normal Form Rules


- ❑ Be 1NF
- ❑ Single Column Primary Key

Primary Key



MEMBERSHIP ID	FULL NAMES	PHYSICAL ADDRESS	SALUTATION
1	Janet Jones	First Street Plot No 4	Ms.
2	Robert Phil	3 <sup>rd</sup> Street 34	Mr.
3	Robert Phil	5 <sup>th</sup> Avenue	Mr.

Foreign Key



MEMBERSHIP ID	MOVIES RENTED
1	Pirates of the Caribbean
1	Clash of the Titans
2	Forgetting Sarah Marshal
2	Daddy's Little Girls
3	Clash of the Titans

# Database Normal Forms

## 3rd Normal Form Rules

- ❑ Be 2NF
- ❑ No transitive functional dependence
- Transitive dependence is when changing a non-key column, might cause any of the other non-key columns to change

MEMBERSHIP ID	FULL NAMES	PHYSICAL ADDRESS	SALUTATION
1	Janet Jones	First Street Plot No 4	Ms.
2	Robert Phil	3 <sup>rd</sup> Street 34	Mr.
3	Robert Phil	5 <sup>th</sup> Avenue	Mr.

*Change in Name* *May Change Salutation*

# Database Normal Forms

## 3rd Normal Form Rules

- ❑ Be 2NF
- ❑ No transactive functional dependence

MEMBERSHIP ID	FULL NAMES	PHYSICAL ADDRESS	SALUTATION ID
1	Janet Jones	First Street Plot No 4	2
2	Robert Phil	3 <sup>rd</sup> Street 34	1
3	Robert Phil	5 <sup>th</sup> Avenue	1

MEMBERSHIP ID	MOVIES RENTED
1	Pirates of the Caribbean
1	Clash of the Titans
2	Forgetting Sarah Marshal
2	Daddy's Little Girls
3	Clash of the Titans

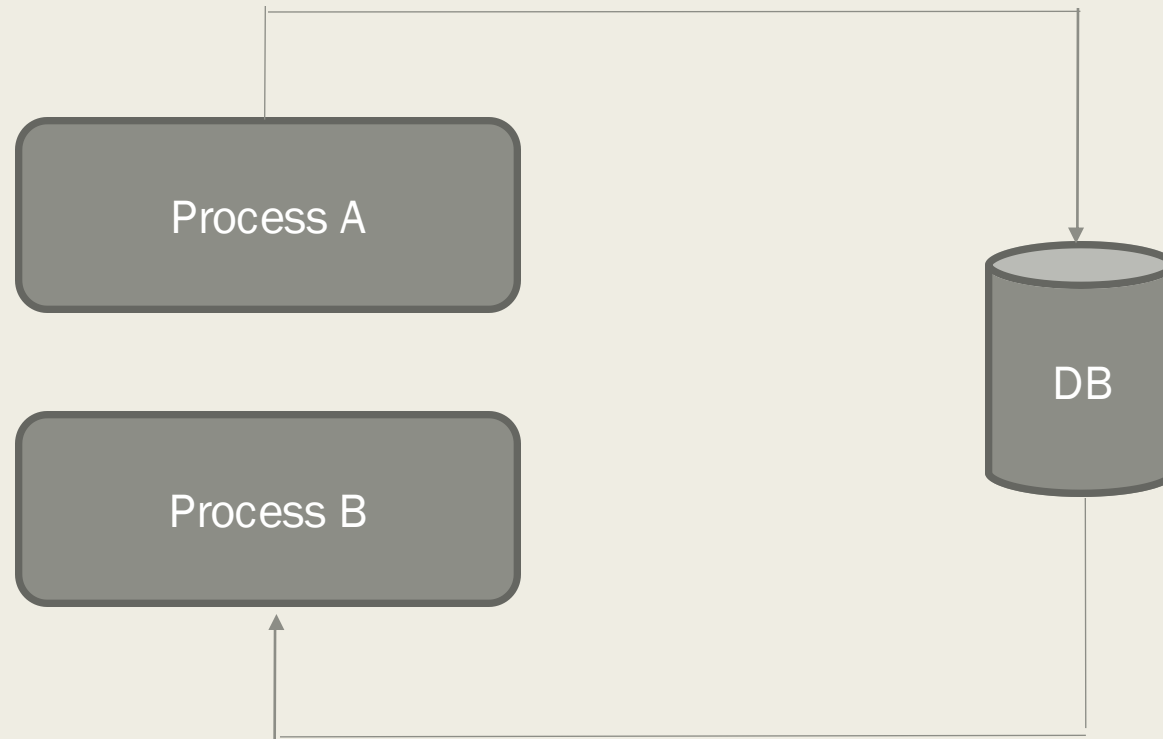
SALUTATION ID	SALUTATION
1	Mr.
2	Ms.
3	Mrs.
4	Dr.

# Modes of Data Flow

- ❑ Typical production scenario:
  - *Multiple processes running simultaneously*
  - *Without sharing memory between them*
- ❑ How do we pass data between these processes?
- ❑ Data passing from one process to another is called **Data Flow**

# Modes of Data Flow

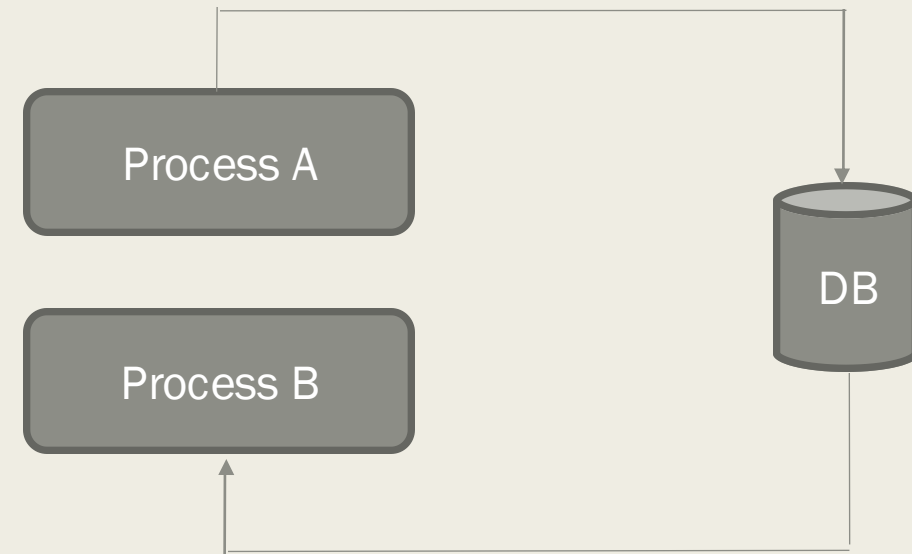
Data Passing through Databases



# Modes of Data Flow

## Data Passing through Databases

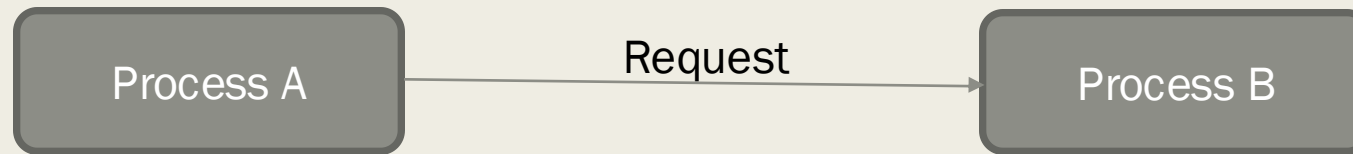
- ❑ Access issues
  - A and B can be part of different accounts
- ❑ Latency issues
  - Read and write on DB can be slow



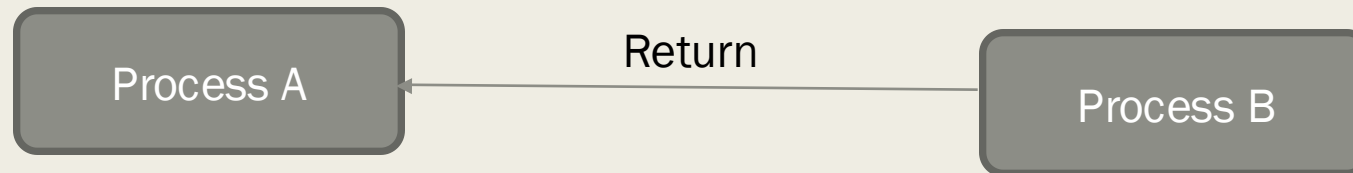
# Modes of Data Flow

## Data Passing through Services

- ❑ Process A send request to Process B for a particular data



- ❑ Process B returns the requested data through the same network



# Modes of Data Flow

## Data Passing through Services

- ❑ Two popular styles of passing data are
  - REST (Representational State Transfer)
    - Used for data request over a network
  - RPC (Remote Procedure Call)
    - Used for data request within a data center

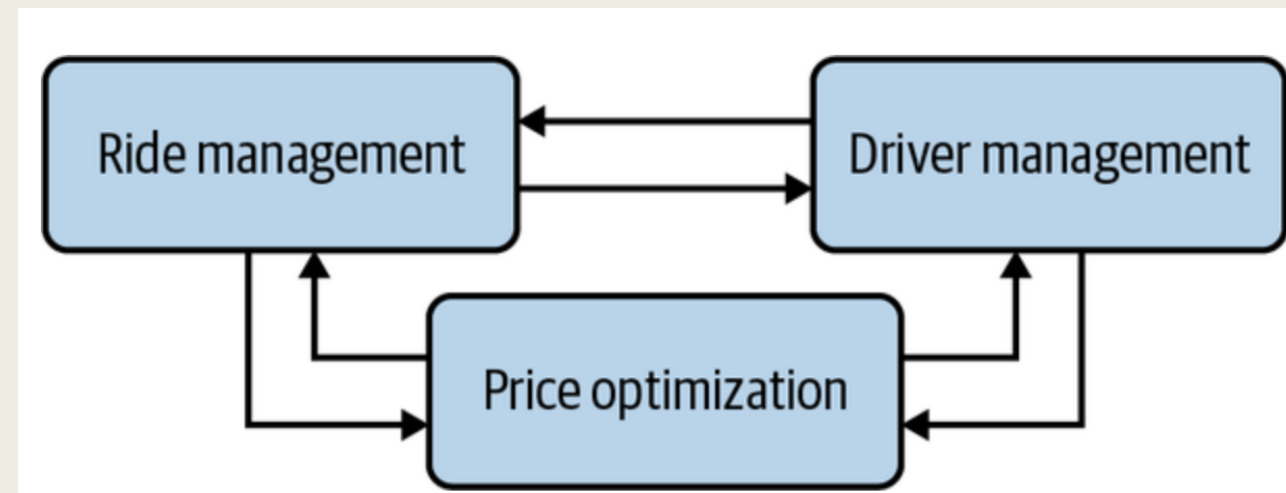


# Modes of Data Flow

Data Passing through Realtime Transport

□ Example scenario: Ride Sharing App

- Ride management service
- Driver management service
- Price optimization service

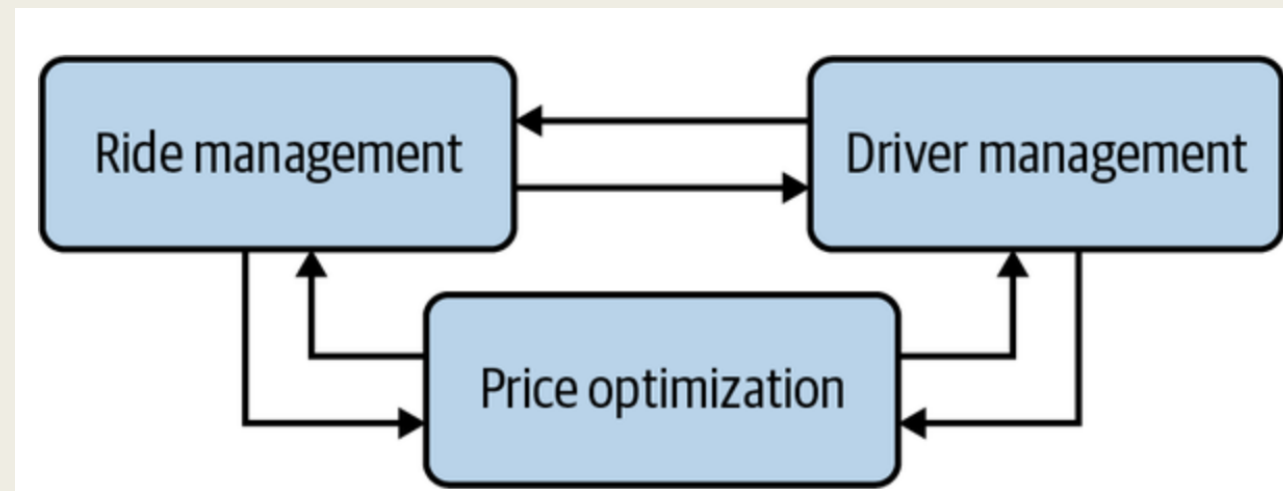


# Modes of Data Flow

## Data Passing through Realtime Transport

### ❑ Example scenario: Ride Sharing App

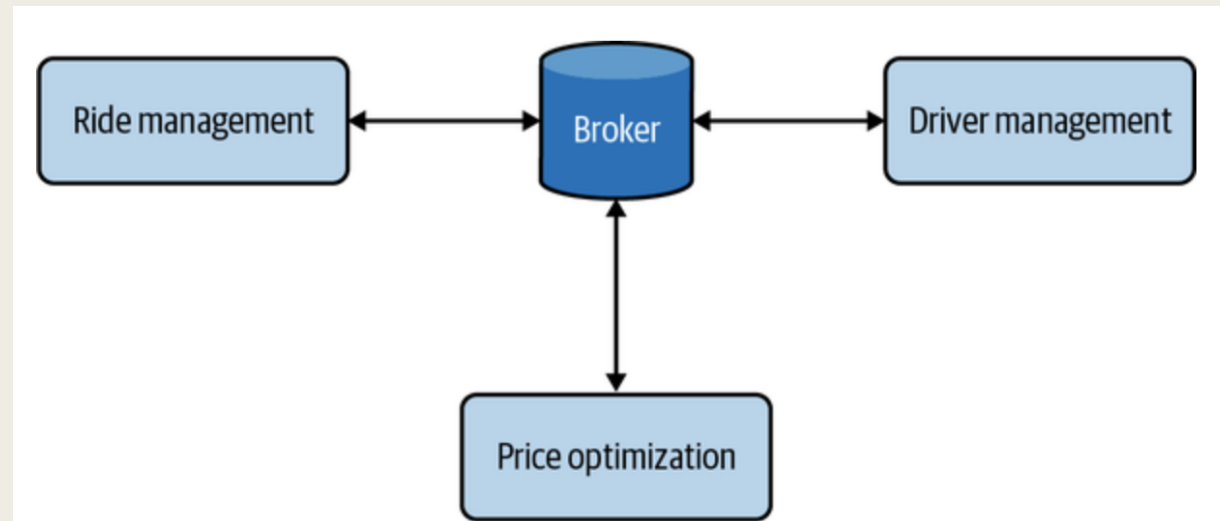
- Request driven data passing is synchronous.
- A service that is down can cause all services that require data from it to be down.



# Modes of Data Flow

## Data Passing through Realtime Transport

- ❑ Solution: A Broker that can co-ordinate data passing between services
  - Each service only has to communicate with the broker
  - Each service broadcast the data to broker as **events**



# Modes of Data Flow

Data Passing through Realtime Transport

□ Two models of Realtime Transport

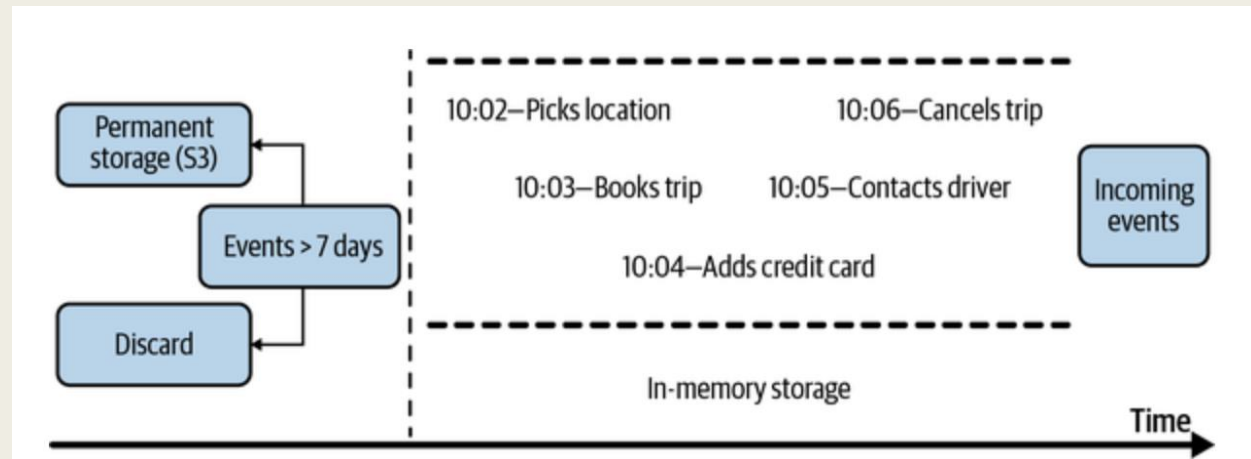
- Publish-Subscribe (PubSub)
- Message Queue

# Modes of Data Flow

## Data Passing through Realtime Transport

### ❑ PubSub Model

- Events are arranged into **Topics**
- A service can publish events to any number of topics
- A service that subscribe to a Topic can read all events in that topic
- The service publishing data is not concerned about who is subscribing
- Data is retained only for a finite interval of time



# Modes of Data Flow

## Data Passing through Realtime Transport

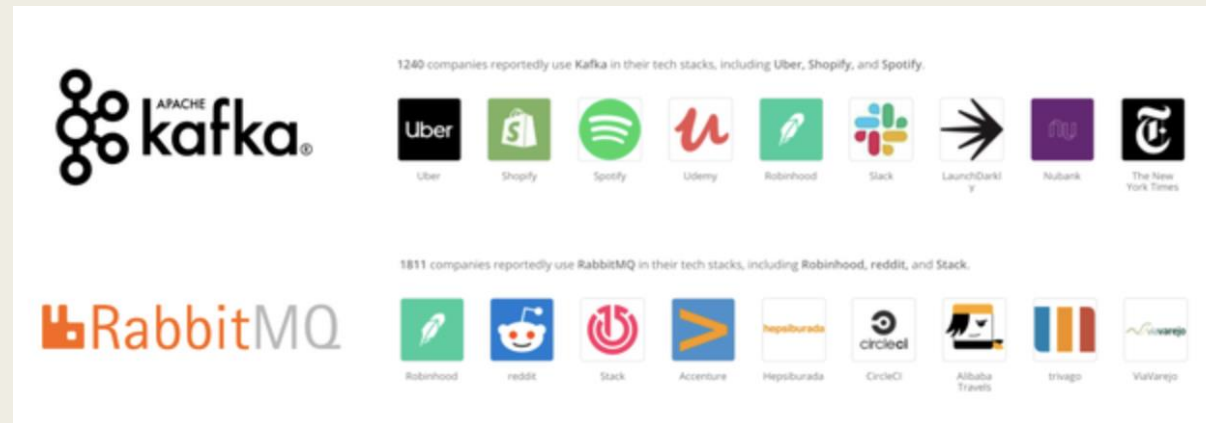
### ☐ Message Queue Model

- Each event has an intended set of consumers (message).
- message queue is responsible for getting the message to the right consumers.

# Modes of Data Flow

## Data Passing through Realtime Transport

- ❑ Examples of PubSub based services
  - Apache Kafka
  - Amazon Kinesis
- ❑ Examples of Message Que based services
  - Apache RocketMQ
  - RabbitMQ



# Batch Processing vs Stream Processing

- ❑ Historical Data are stored in:
  - Databases
  - Data lakes
  - Data warehouses
- ❑ They are often processed in batches
- ❑ Using distributed computing frameworks like Hadoop or Spark
- ❑ Difference between Hadoop and Spark ?



# Batch Processing vs Stream Processing

- ❑ Data are stored Realtime Transport are called **Streaming Data**
- ❑ Computations done on Streaming Data are called **Stream Processing**
- ❑ In ML Batch Processing is used to compute Static Features
  - E. g. Drivers ratings
- ❑ Stream Processing is used to compute Dynamic Features
  - E. g. How many drivers are available currently

# Batch Processing vs Stream Processing

- ❑ In ML Batch Processing is used to compute Static Features
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# Example – Machine Learning with Kafka

Robust machine learning on streaming data using Kafka and Tensorflow-IO

<https://www.tensorflow.org/io/tutorials/kafka>

[Google Colab Notebook](#)

