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DeepLearning.AI

# Source Systems, Data Ingestion, and Pipelines

## Week 1

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# Source Systems, Data Ingestion, and Pipelines

## Welcome

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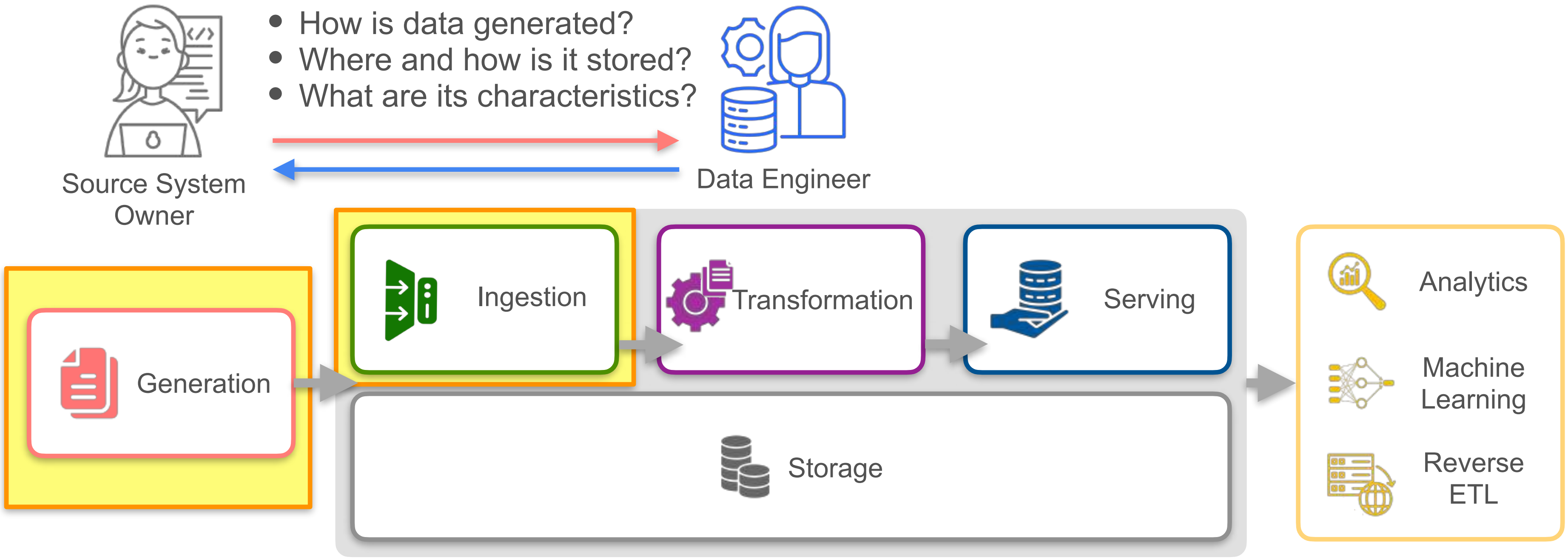
# Working with Source Systems

## Course 2 Overview

# Data Engineering Lifecycle



## Course Plan

| | |
|---|---|
| **Week 1** | **Common source systems**<br>• Databases, object storage, and streaming sources<br>• Working with source systems on AWS |
| **Week 2** | **Setting up ingestion from source systems** |
| **Week 3** | **DataOps undercurrent**<br>• Automating some of your pipeline tasks<br>• Monitoring data quality |
| **Week 4** | **Orchestration, monitoring, and automating data pipelines**<br>• Setting up directed acyclic graphs<br>• Working with infrastructure as code |

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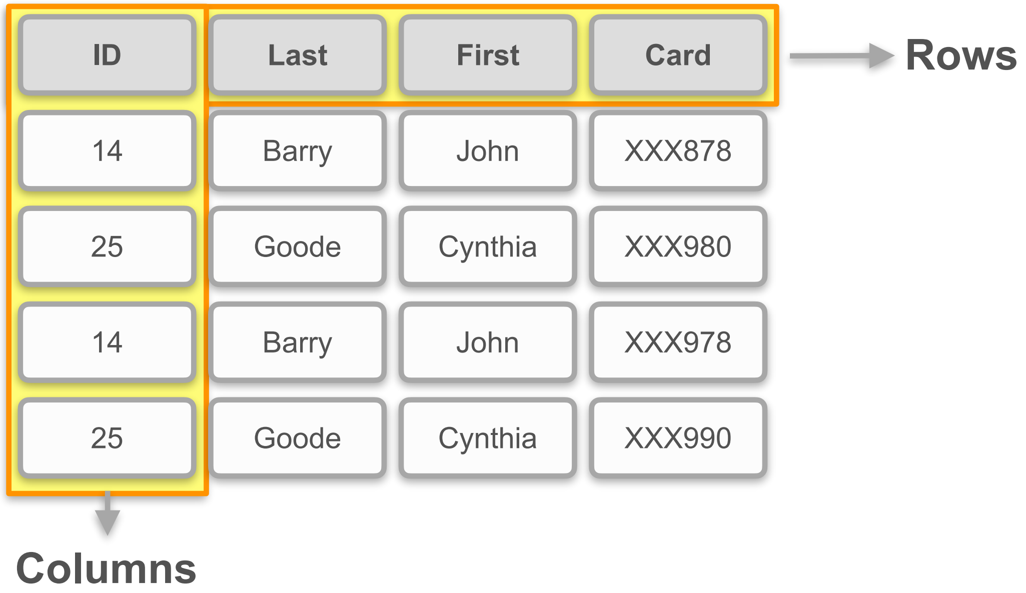
## Introduction to Source Systems

## Different Types of Source Systems

## Structured Data

Data organized as tables of rows and columns



| ID | Last | First | Card |
|---|---|---|---|
| 14 | Barry | John | XXX878 |
| 25 | Goode | Cynthia | XXX980 |
| 14 | Barry | John | XXX978 |
| 25 | Goode | Cynthia | XXX990 |

Avg. Profit per Item
$36.91
ROI
419%
Listing Details
Cost Details
Your Cost
Total Cost
Total Price
Total Fees
MyInventory
Count: 90
Sum: $1,427.05

Customer
CustomerID
FName
LName
Address
ZipCode
Gender
BirthDate
Email
MobileNo
Order
OrderID
OrderDate
CustomerID
SalemanID
TotalAmt
OrderRemark
Status
OrderDetail
OrderID
ProductID
Qty
Price
Discount
NetPrice
Amt
Product
ProductID
ProductName
Price
Description
Unit
BrandID
Brand
BrandID
BrandName
Saleman
SalemanID
SalemanName
Level

```python
import csv
with open('eggs.csv', newline='') as csvfile:
    spamreader = csv.reader(csvfile, delimiter=' ', quotechar='|')
    for row in spamreader:
        print(', '.join(row))
```

**Structured Data**

Data organized as tables of rows and columns

**Semi-Structured Data**

Data that is not in tabular form but still has some structure

## JavaScript Object Notation (JSON)

A series of key-value pairs

key

value

```
{
 “firstName”: “Joe”,
 “lastName”  : “Reis”
  “age”: 10  ,
 “languages”:[“Python”, “JavaScript”, “SQL”],
 “address”: {

          “city”: “Los Angeles”,
          “postalCode”: 90024,
          “country”: “USA”
  }
}
```

**Structured Data**

Data organized as tables of rows and columns

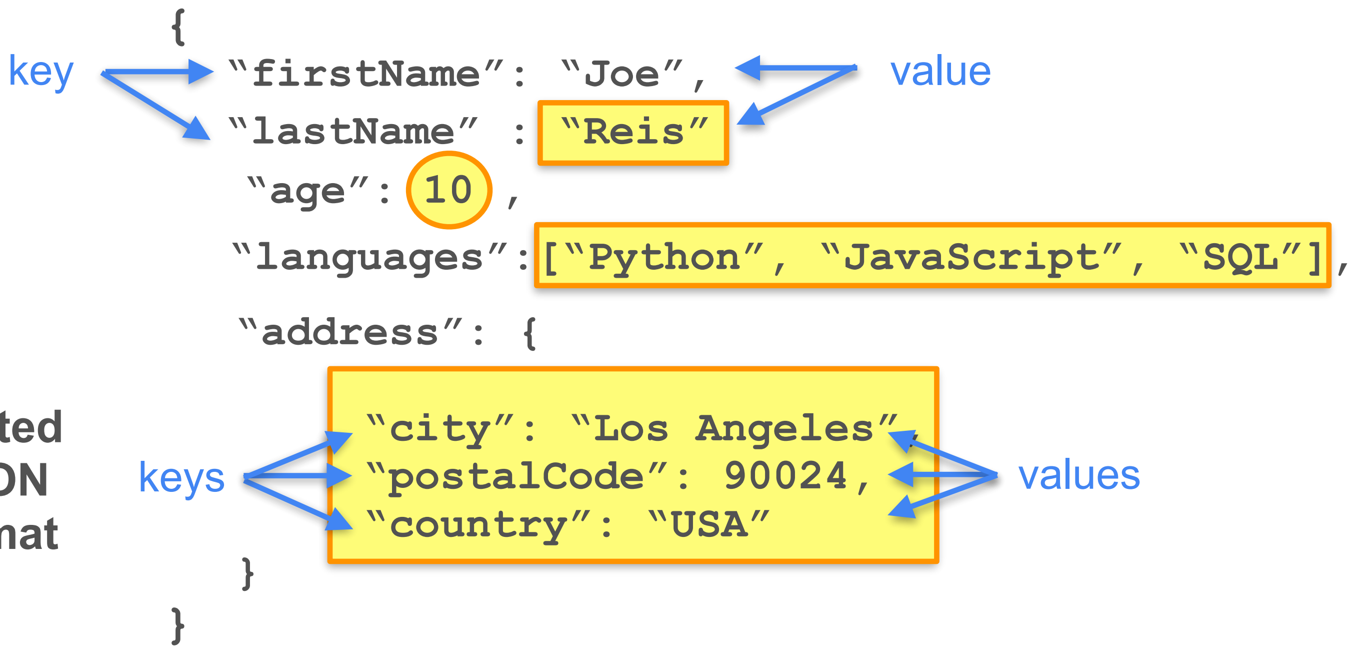
**Semi-Structured Data**

Data that is not in tabular form but still has some structure

## JavaScript Object Notation (JSON)

A series of key-value pairs

**Nested JSON format**



```
{
   “firstName”: “Joe”,
   “lastName”  : “Reis”
    “age”: 10 ,
   “languages”:[“Python”, “JavaScript”, “SQL”],
    “address”: {
          “city”: “Los Angeles”,
          “postalCode”: 90024,
          “country”: “USA”
    }
}
```

| | |
|---|---|
| **Structured Data** | Data organized as tables of rows and columns |
| **Semi-Structured Data** | Data that is not in tabular form but still has some structure |
| **Unstructured Data** | Data that does not have any predefined structure |

| **Text** | **Video** | **Audio** | **Images** |
|---|---|---|---|
| TXT | MP4 | MP3 | PNG |

- dimensions
- pixel colors

## Databases

Structured data
Semi-structured data

## Files

TXT PNG MP3 MP4 CSV

## Streaming Systems

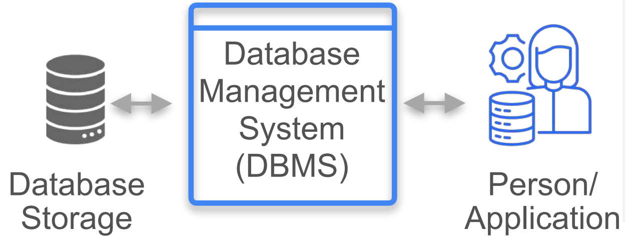
Semi-structured data

## Databases

**Store data in an organized way**

Structured data
Semi-structured data

**C**reate
**R**ead
**U**pdate
**D**elete



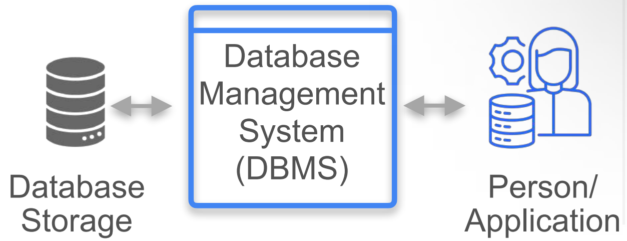
## Databases

**Store data in an organized way**

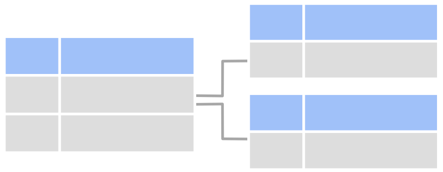
Structured data

Semi-structured data

**C**reate
**R**ead
**U**pdate
**D**elete

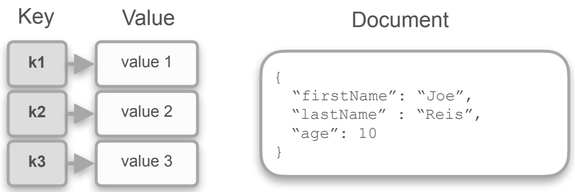


**Relational databases**



Tables with rows and columns

**Non-relational (NoSQL) databases**

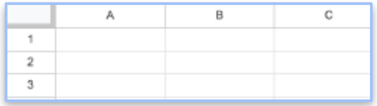


```
{
  "firstName": "Joe",
  "lastName" : "Reis",
  "age": 10
}
```

Non-tabular data

## Files

**Sequence of bytes representing information**

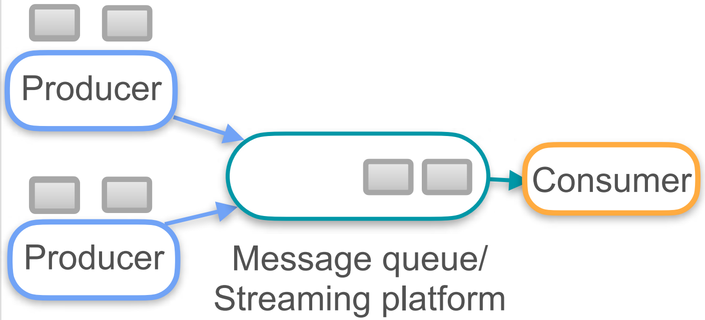


```
{
 "firstName": "Joe",
 "lastName" : "Reis",
 "languages":["R", "SQL"],
}
```

## Streaming Systems

**Continuous flow of data**

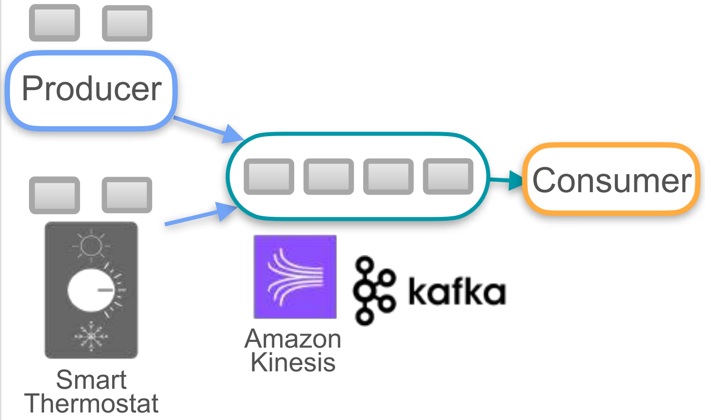
Semi-structured data



## Streaming Systems

**Continuous flow of data**

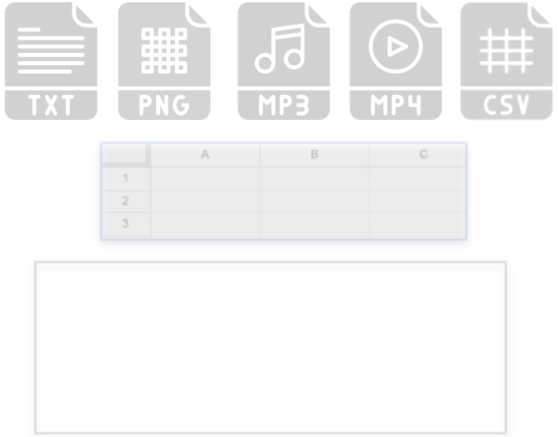
Semi-structured data

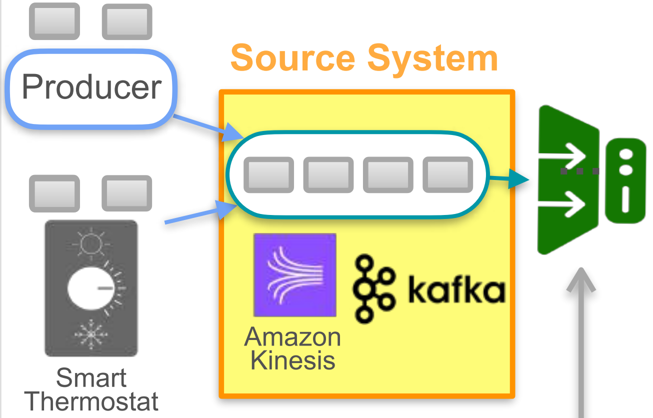


## Streaming Systems

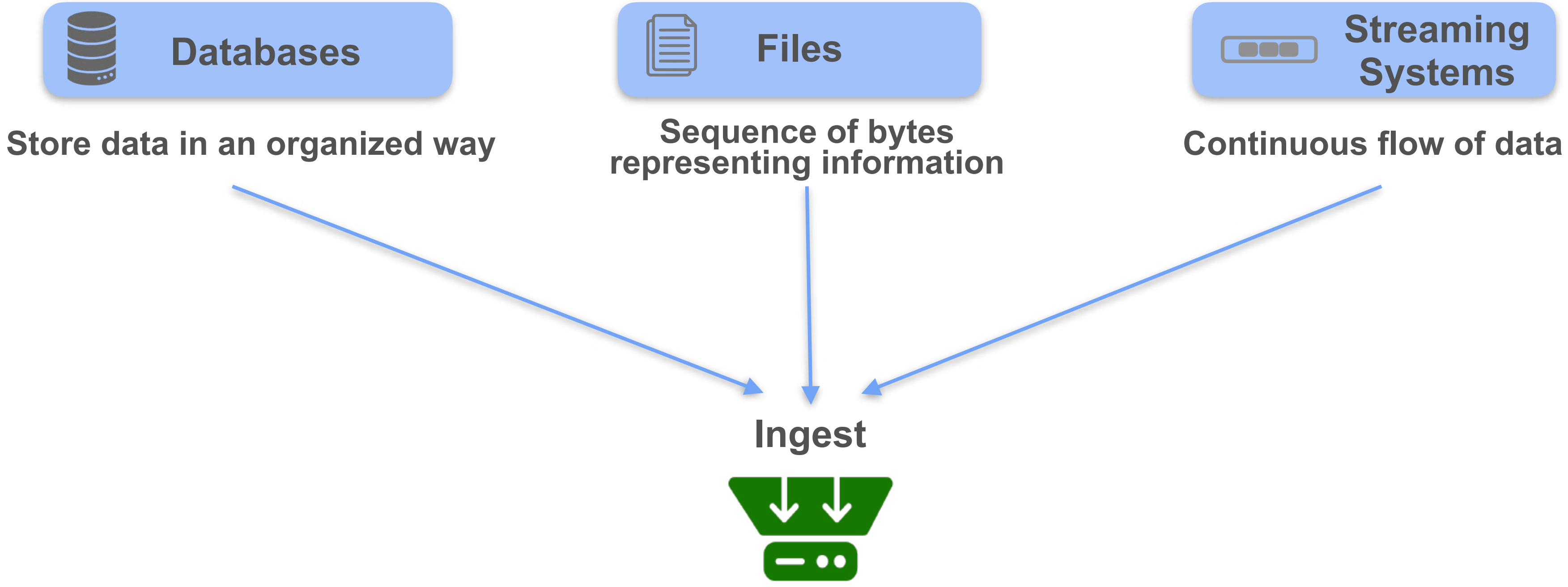
**Continuous flow of data**

Semi-structured data





Your ingestion pipeline starts here


Databases
Store data in an organized way
Files
Sequence of bytes representing information
Streaming Systems
Continuous flow of data
Ingest

- Structured
- Semi-structured
- Unstructured

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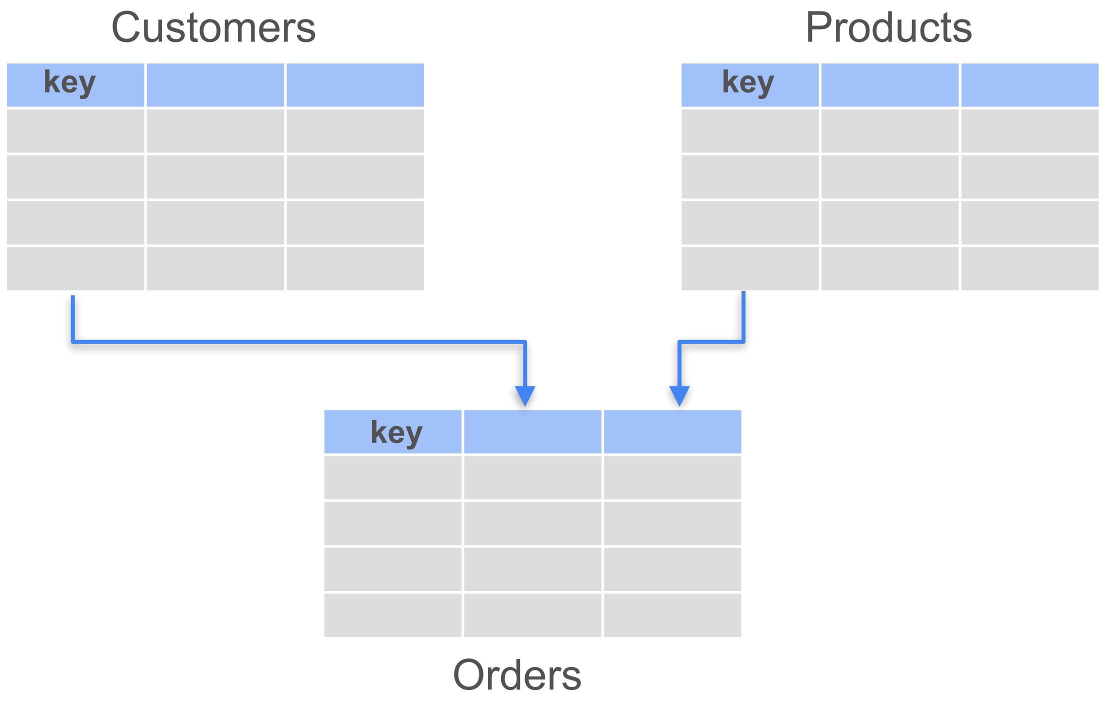
## Introduction to Source Systems

## Relational Databases

## Relational Databases



- Reduce redundancy
- Make data easier to manage

## Relational Databases

One big table for everything!

| name | address | phone | date_time | amount | brand | SKU | description |
|---|---|---|---|---|---|---|---|
| Jane Doe | 74th Street | 12345678 | 12/08/2024 | 700 | ABC | B32 | Blender |
| Jane Doe | 74th Street | 12345678 | 12/08/2024 | 99 | XYZ | i56 | Iron |
| Jane Doe | 74th Street | 12345678 | 12/08/2024 | 100 | GHJ | k70 | Kettle |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

Jane Doe

# Relational Databases

One big table for everything!

| name | address | phone | date_time | amount | brand | SKU | description |
|---|---|---|---|---|---|---|---|
| Jane Doe | 74th Street | 12345678 | 12/08/2024 | 700 | ABC | B32 | Blender |
| Jane Doe | 74th Street | 12345678 | 12/08/2024 | 99 | XYZ | i56 | Iron |
| Jane Doe | 74th Street | 12345678 | 12/08/2024 | 100 | GHJ | k70 | Kettle |
| Mary Ann | 19th Avenue | 98765432 | 13/08/2024 | 899 | STU | w40 | Washer |
| John Ken | 1st Link | 36891623 | 14/08/2024 | 899 | STU | w40 | Washer |
| Ivy Tan | 67th Street | 98639513 | 15/08/2024 | 899 | STU | w40 | Washer |

# Relational Databases

One big table for everything!

Inconsistency

| name | address | phone | date_time | amount | brand | SKU | description |
|---|---|---|---|---|---|---|---|
| Jane Doe | 11th Avenue | 12345678 | 12/08/2024 | 700 | ABC | B32 | Blender |
| Jane Doe | 11th Avenue | 12345678 | 12/08/2024 | 99 | XYZ | i56 | Iron |
| Jane Doe | 74th Street | 12345678 | 12/08/2024 | 100 | GHJ | k70 | Kettle |
| Mary Ann | 19th Avenue | 98765432 | 13/08/2024 | 899 | STU | w31 | Washer |
| John Ken | 1st Link | 36891623 | 14/08/2024 | 899 | STU | w31 | Washer |
| Ivy Tan | 67th Street | 98639513 | 15/08/2024 | 899 | STU | w40 | Washer |

Jane Doe

now lives on 11th Avenue

SKU
now w31

Inconsistency

# Relational Databases

Single customer

Customers

| id | first_name | last_name | age | address |
|---|---|---|---|---|
| 1 | Jane | Doe | 24 | 11th Ave. |
| 2 | Mary | Ann | 65 | 19th Ave. |
| 3 | John | Ken | 27 | 1st Link |
| 4 | Ivy | Tan | 18 | 67th St. |

Single product

Products

| id | brand | SKU | description |
|---|---|---|---|
| 1 | ABC | b32 | Blender |
| 2 | XYZ | i56 | Iron |
| 3 | GHJ | k70 | Kettle |
| 4 | STU | w31 | Washer |

Orders

| id | customer_id | product_id | date_time | purchase_amount |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**Database schema**

# Relational Databases

**Keys**

Primary key:
uniquely identifies each row in a table

Customers

| id | first_name | last_name | age | address |
|---|---|---|---|---|
| 1 | Jane | Doe | 24 | 11th Ave. |
| 2 | Mary | Ann | 65 | 19th Ave. |
| 3 | John | Ken | 27 | 1st Link |
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Products

| id | brand | SKU | description |
|---|---|---|---|
| 1 | ABC | b32 | Blender |
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| 3 | GHJ | k70 | Kettle |
| 4 | STU | w31 | Washer |

Orders

| id | customer_id | product_id | date_time | purchase_amount |
|---|---|---|---|---|
| 1 | 1 | 1 | 12/08/2024 | 700 |
| 2 | 1 | 2 | 12/08/2024 | 99 |
| 3 | 1 | 3 | 12/08/2024 | 100 |
| 4 | 2 | 4 | 13/08/2024 | 899 |
| 5 | 3 | 4 | 14/08/2024 | 899 |
| | | | | |

**Database schema**

Foreign key:
references the primary key of the customer table

# Relational Databases

string

integer

Customers

| id | first_name | last_name | age | address |
|---|---|---|---|---|
| 1 | Jane | Doe | 24 | 11th Ave. |
| 2 | Mary | Ann | 65 | 19th Ave. |
| 3 | John | Ken | 27 | 1st Link |
| 4 | Ivy | Tan | 18 | 67th St. |

Products

| id | brand | SKU | description |
|---|---|---|---|
| 1 | ABC | b32 | Blender |
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| 3 | GHJ | k70 | Kettle |
| 4 | STU | w31 | Washer |

Orders

| id | customer_id | product_id | date_time | purchase_amount |
|---|---|---|---|---|
| 1 | 1 | 1 | 12/08/2024 | 700 |
| 2 | 1 | 2 | 12/08/2024 | 99 |
| 3 | 1 | 3 | 12/08/2024 | 100 |
| 4 | 2 | 4 | 13/08/2024 | 899 |
| 5 | 3 | 4 | 14/08/2024 | 899 |
|  |  |  |  |  |

**Database schema**

Each row in a table has to follow the same column structure: same sequence of columns and data types

# Relational Databases

Customers

| id | first_name | last_name | age | address |
|---|---|---|---|---|
| 1 | Jane | Doe | 24 | 11th Ave. |
| 2 | Mary | Ann | 65 | 19th Ave. |
| 3 | John | Ken | 27 | 1st Link |
| 4 | Ivy | Tan | 18 | 67th St. |

Products

| id | brand | SKU | description |
|---|---|---|---|
| 1 | ABC | b32 | Blender |
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| 3 | GHJ | k70 | Kettle |
| 4 | STU | w31 | Washer |

Orders

| id | customer_id | product_id | date_time | purchase_amount |
|---|---|---|---|---|
| 1 | 1 | 1 | 12/08/2024 | 700 |
| 2 | 1 | 2 | 12/08/2024 | 99 |
| 3 | 1 | 3 | 12/08/2024 | 100 |
| 4 | 2 | 4 | 13/08/2024 | 899 |
| 5 | 3 | 4 | 14/08/2024 | 899 |
| 6 | 1 | 4 | 15/08/2024 | 899 |

# Relational Databases

One big table for everything!

| name | address | phone | date_time | amount | brand | SKU | description |
|---|---|---|---|---|---|---|---|
| Jane Doe | 74th Street | 12345678 | 12/08/2024 | 700 | ABC | B32 | Blender |
| Jane Doe | 74th Street | 12345678 | 12/08/2024 | 99 | XYZ | i56 | Iron |
| Jane Doe | 74th Street | 12345678 | 12/08/2024 | 100 | GHJ | k70 | Kettle |
| Mary Ann | 19th Avenue | 98765432 | 13/08/2024 | 899 | STU | w40 | Washer |
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| Ivy Tan | 67th Street | 98639513 | 15/08/2024 | 899 | STU | w40 | Washer |

One Big Table (OBT) approach: use cases that need faster processing

# Relational Databases

**Relational Database Management System (RDBMS)**

Software layer that sits on top of a relational database to manage and interact with the data.

MySQL

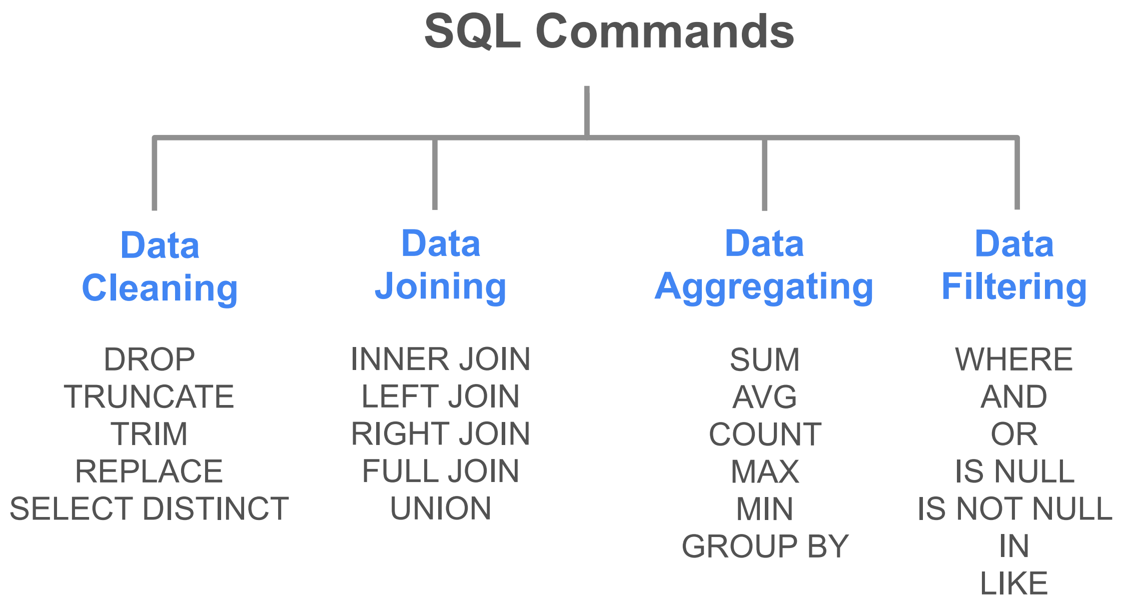
ORACLE DATABASE

PostgreSQL

Microsoft SQL Server

**Structured Query Language (SQL)**

# Relational Databases



**SQL Commands**

**Data Cleaning**
- DROP
- TRUNCATE
- TRIM
- REPLACE
- SELECT DISTINCT

**Data Joining**
- INNER JOIN
- LEFT JOIN
- RIGHT JOIN
- FULL JOIN
- UNION

**Data Aggregating**
- SUM
- AVG
- COUNT
- MAX
- MIN
- GROUP BY

**Data Filtering**
- WHERE
- AND
- OR
- IS NULL
- IS NOT NULL
- IN
- LIKE

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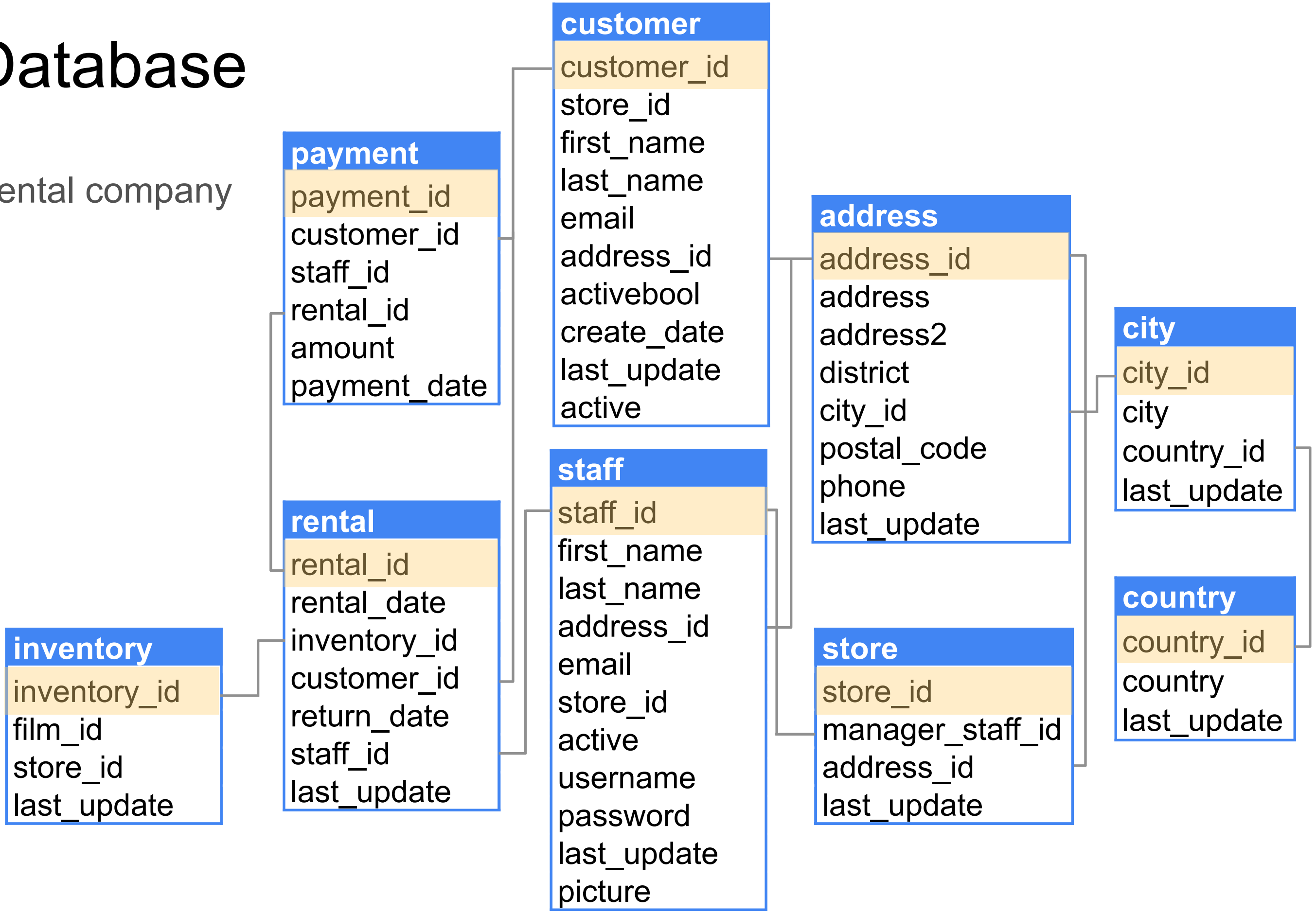
# Introduction to Source Systems

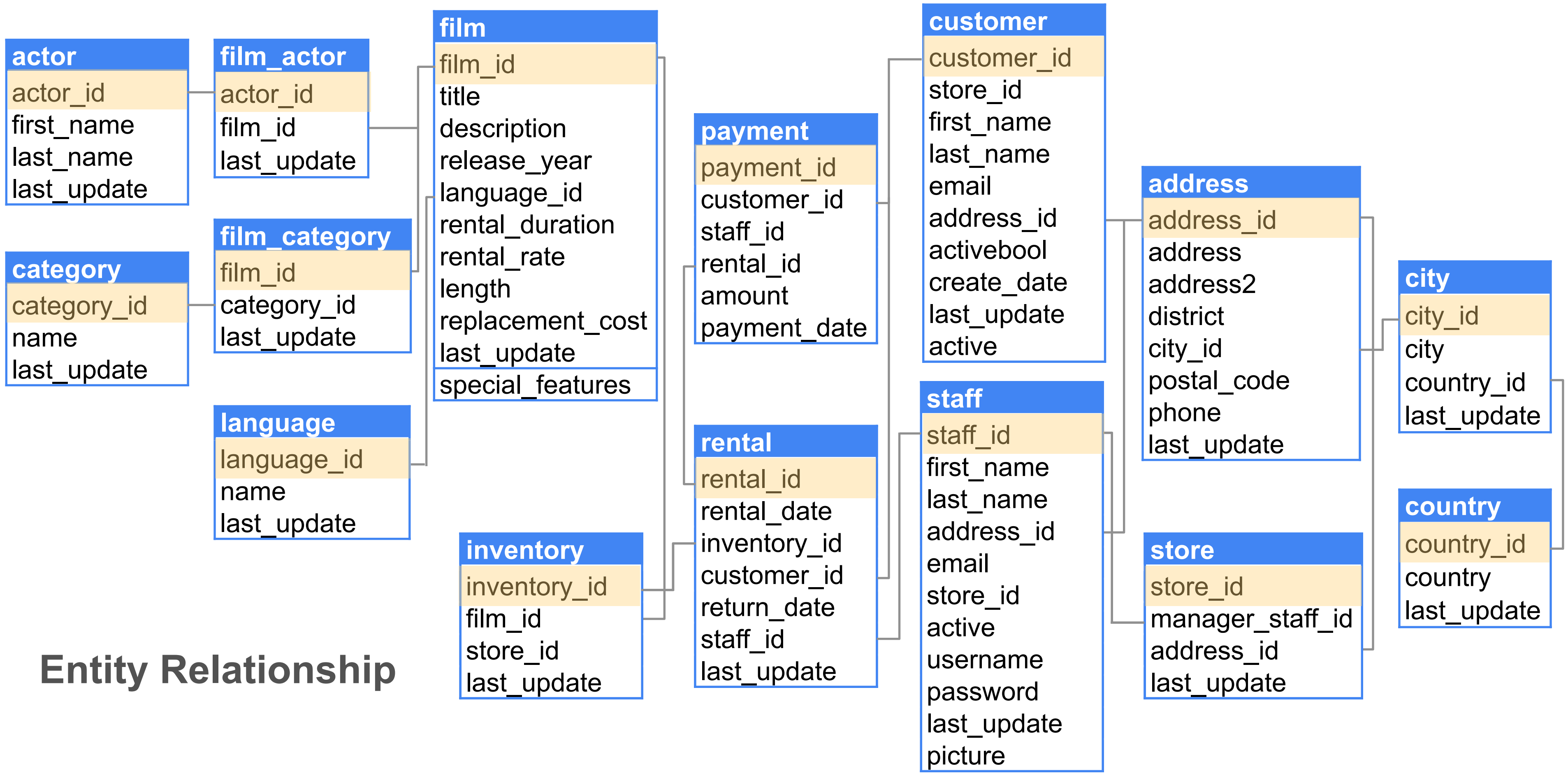
## SQL Queries

## The Relational Database

- Database for a fictitious DVD rental company called **Rentio**
- Database schema

Answer business questions





## Entity Relationship

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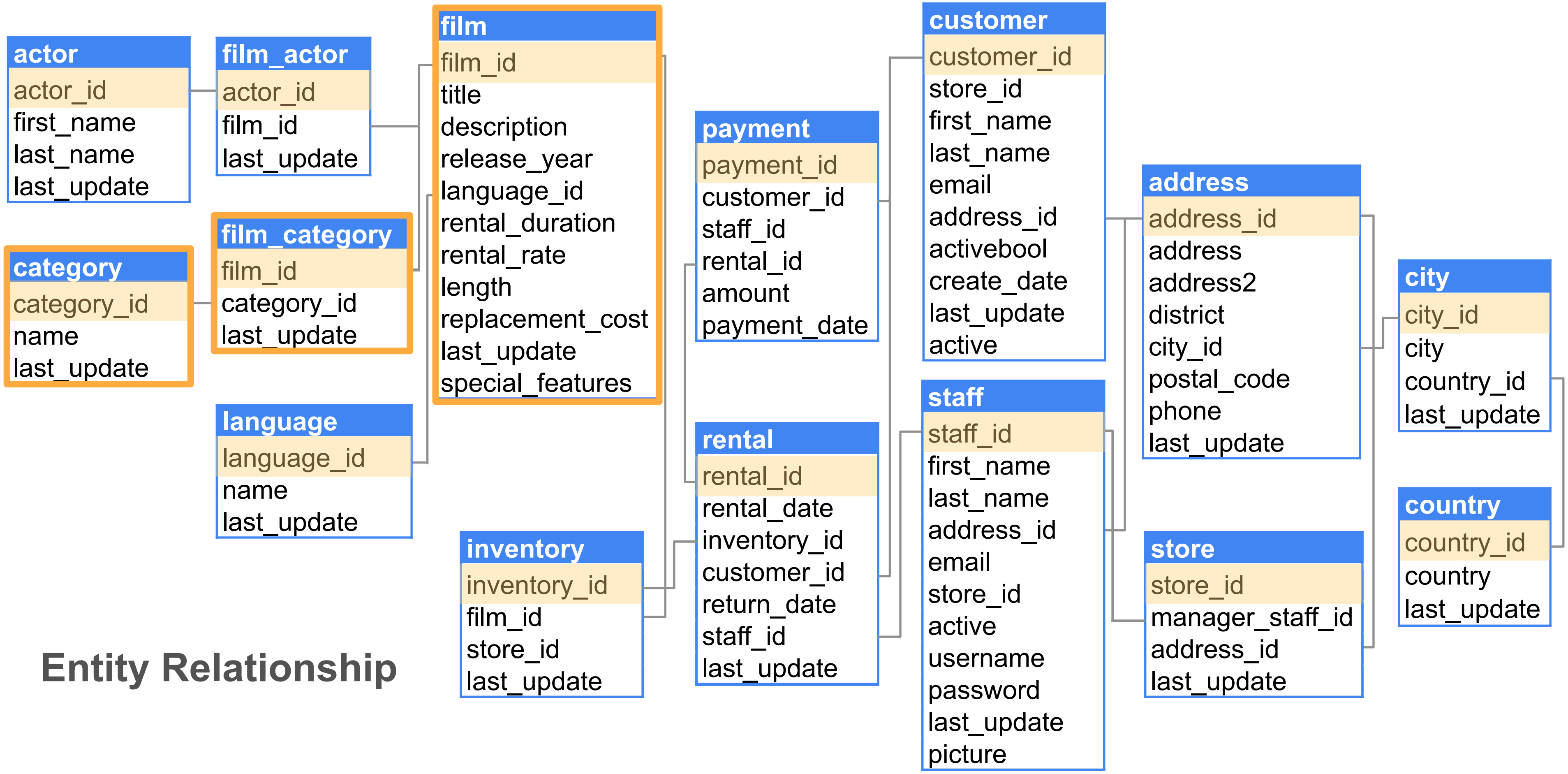

## Entity Relationship

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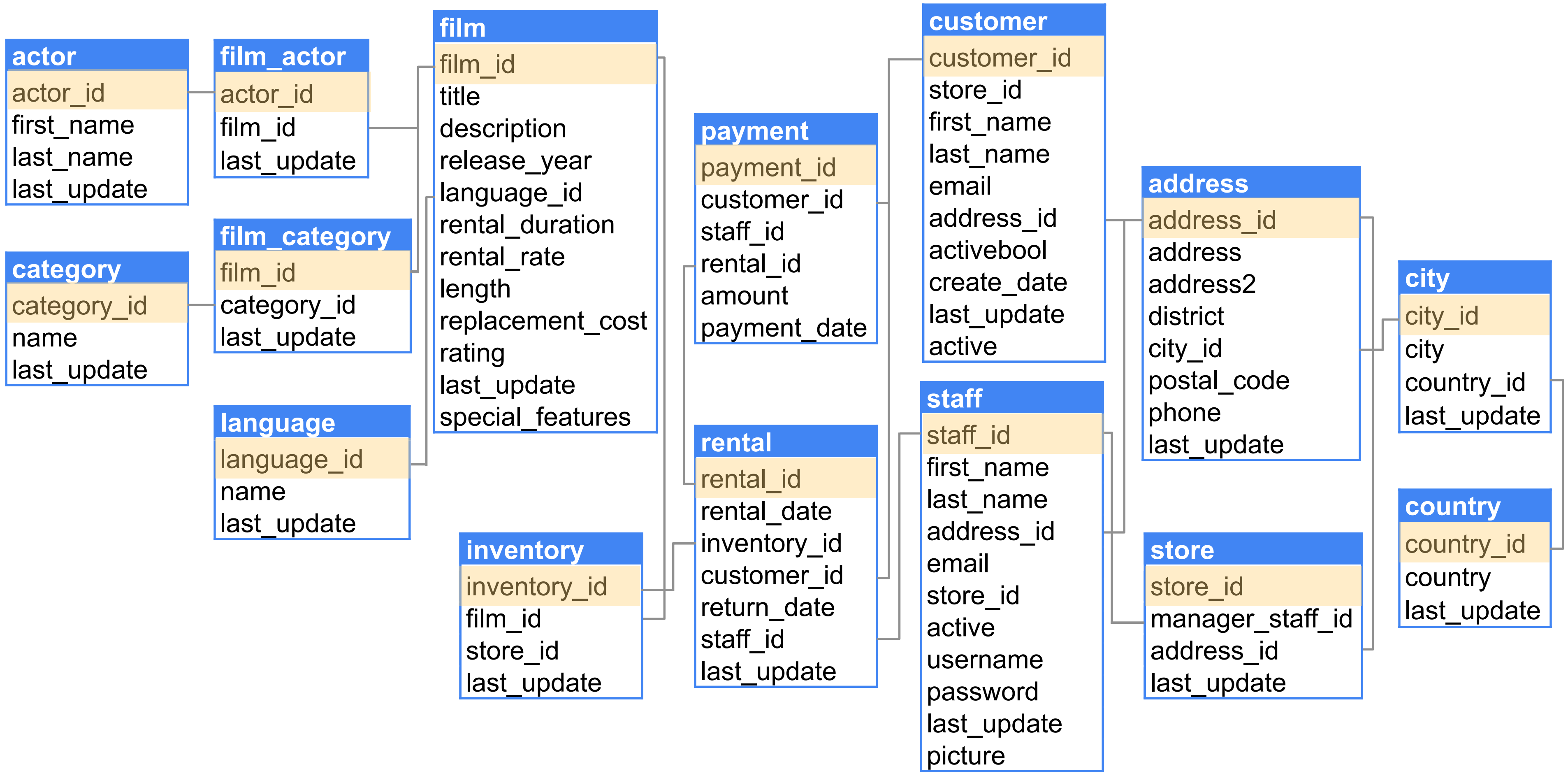
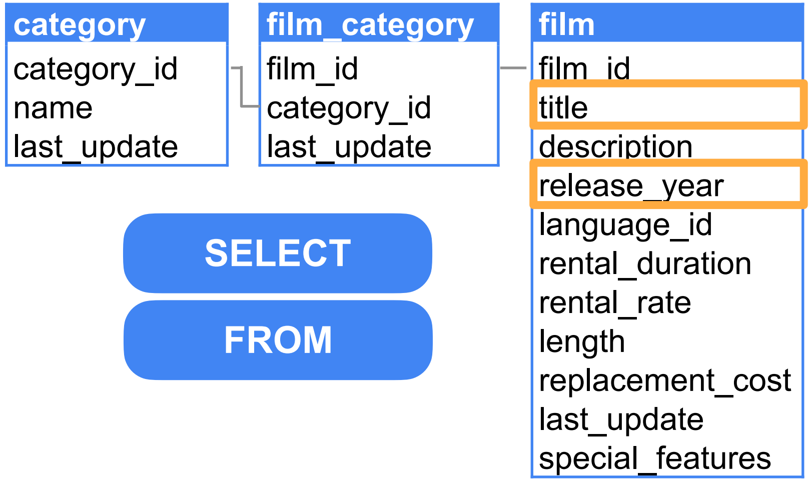
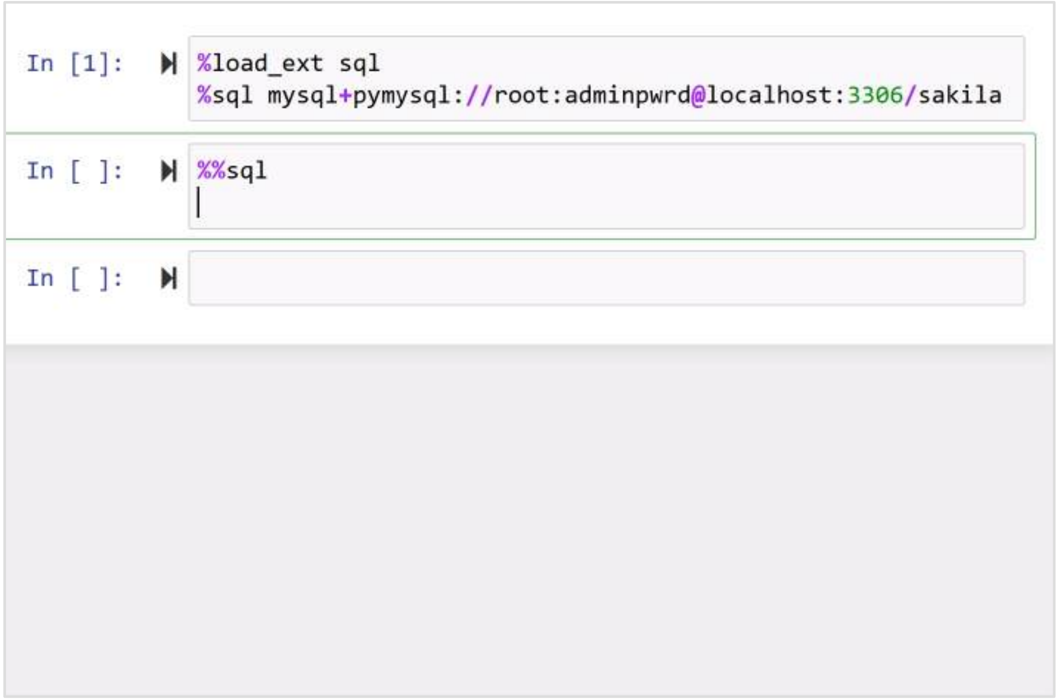

actor
actor_id
first_name
last_name
last_update
film_actor
actor_id
film_id
last_update
film
film_id
title
description
release_year
language_id
rental_duration
rental_rate
length
replacement_cost
rating
last_update
special_features
category
category_id
name
last_update
film_category
film_id
category_id
last_update
language
language_id
name
last_update
inventory
inventory_id
film_id
store_id
last_update
payment
payment_id
customer_id
staff_id
rental_id
amount
payment_date
rental
rental_id
rental_date
inventory_id
customer_id
return_date
staff_id
last_update
customer
customer_id
store_id
first_name
last_name
email
address_id
activebool
create_date
last_update
active
staff
staff_id
first_name
last_name
address_id
email
store_id
active
username
password
last_update
picture
address
address_id
address
address2
district
city_id
postal_code
phone
last_update
store
store_id
manager_staff_id
address_id
last_update
city
city_id
city
country_id
last_update
country
country_id
country
last_update

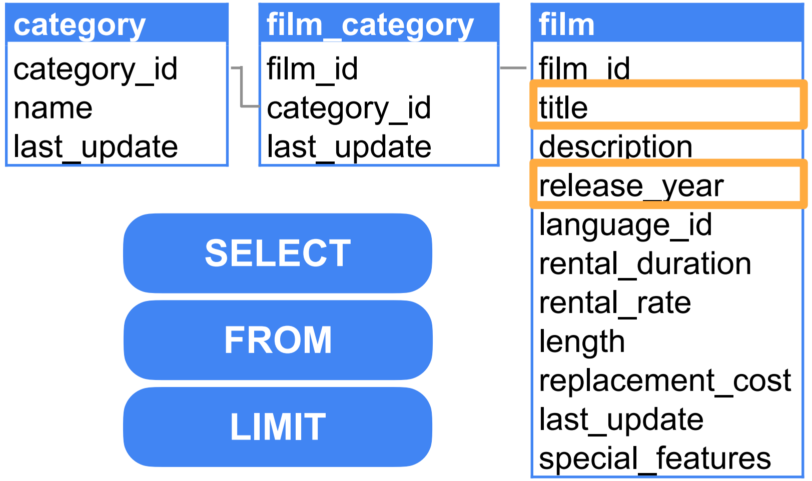


**SELECT**

**FROM**



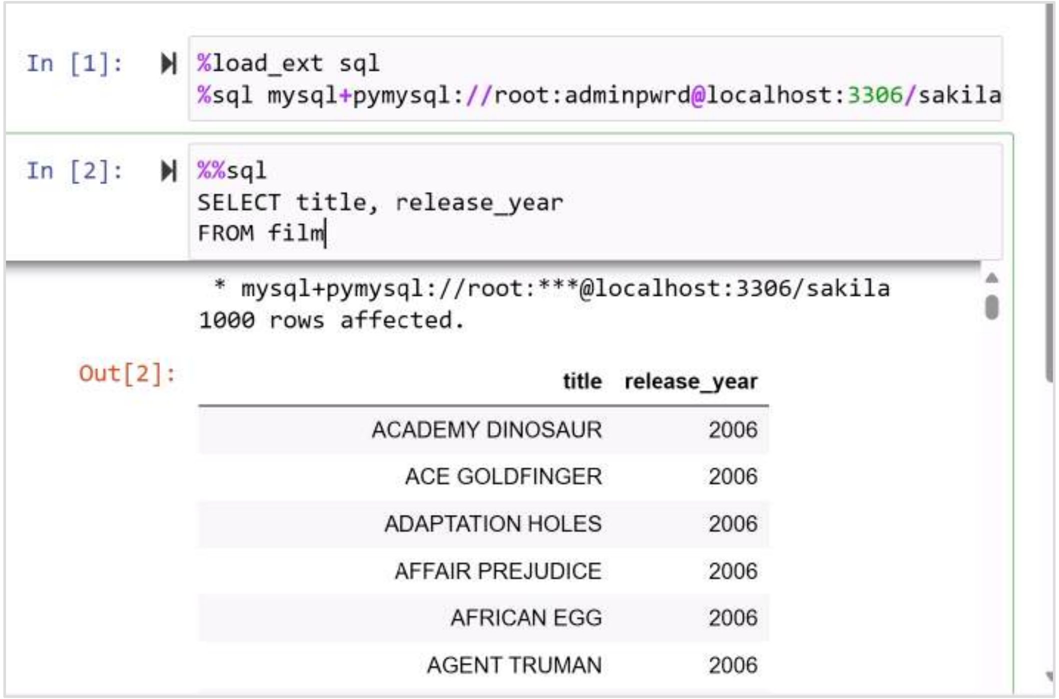
```
In [1]:  %load_ext sql
         %sql mysql+pymysql://root:adminpwrd@localhost:3306/sakila

In [ ]:  %%sql
         |

In [ ]:
```



**SELECT**

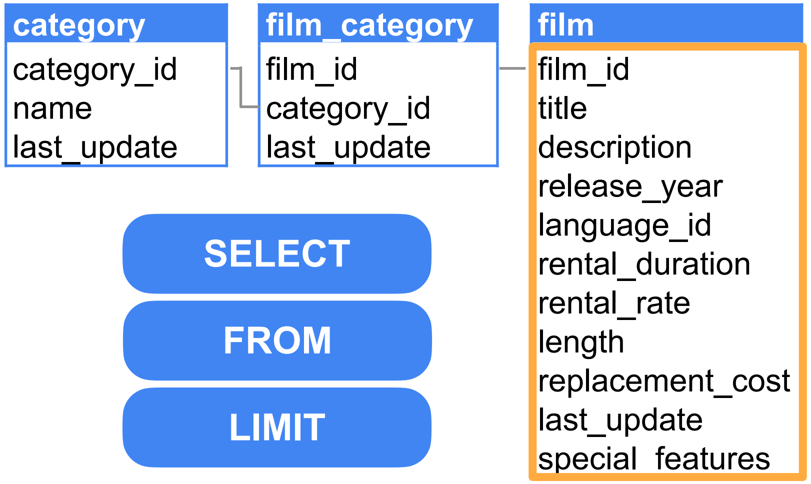
**FROM**

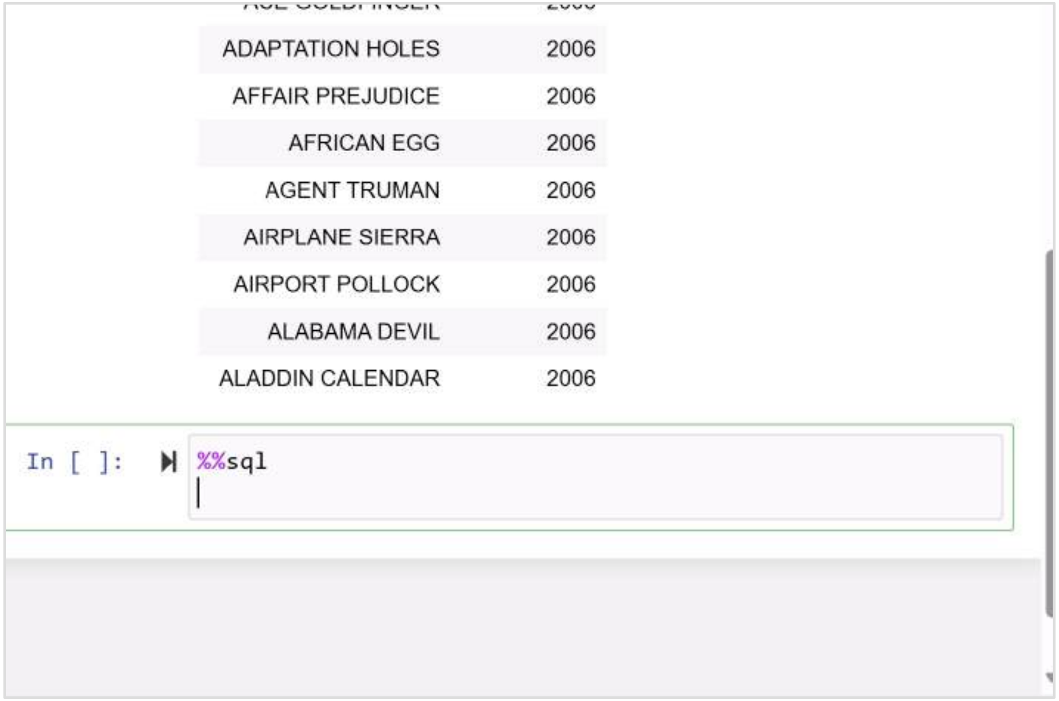
**LIMIT**



```
In [1]:  %load_ext sql
         %sql mysql+pymysql://root:adminpwrd@localhost:3306/sakila

In [2]:  %%sql
         SELECT title, release_year
         FROM film

          * mysql+pymysql://root:***@localhost:3306/sakila
         1000 rows affected.
Out[2]:
```

| title | release_year |
|---|---|
| ACADEMY DINOSAUR | 2006 |
| ACE GOLDFINGER | 2006 |
| ADAPTATION HOLES | 2006 |
| AFFAIR PREJUDICE | 2006 |
| AFRICAN EGG | 2006 |
| AGENT TRUMAN | 2006 |

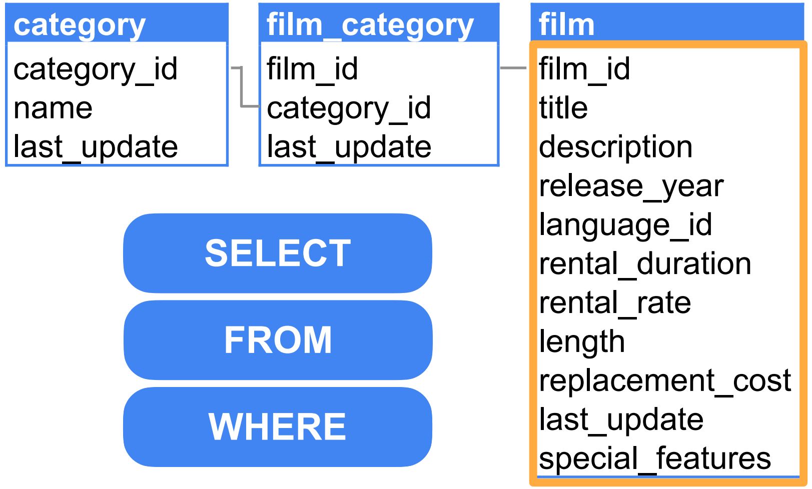




```
ADAPTATION HOLES     2006
AFFAIR PREJUDICE     2006
AFRICAN EGG          2006
AGENT TRUMAN         2006
AIRPLANE SIERRA      2006
AIRPORT POLLOCK      2006
ALABAMA DEVIL        2006
ALADDIN CALENDAR     2006
```

```
In [ ]:  %%sql
```

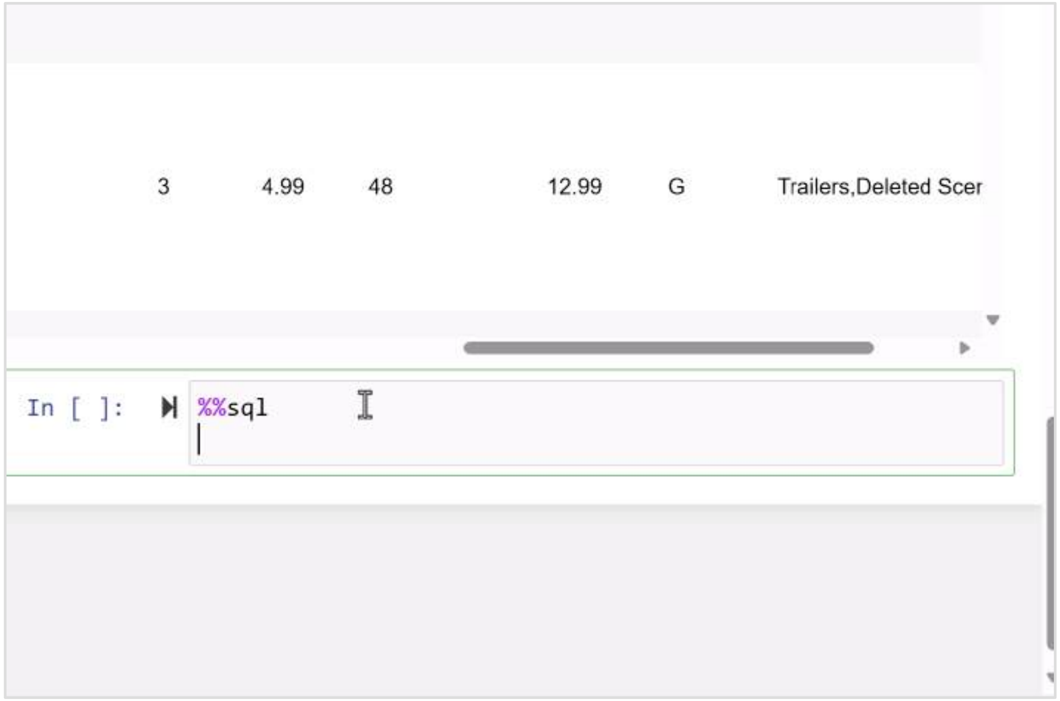
## Exploring the films that are less than 60 minutes long.



**SELECT**

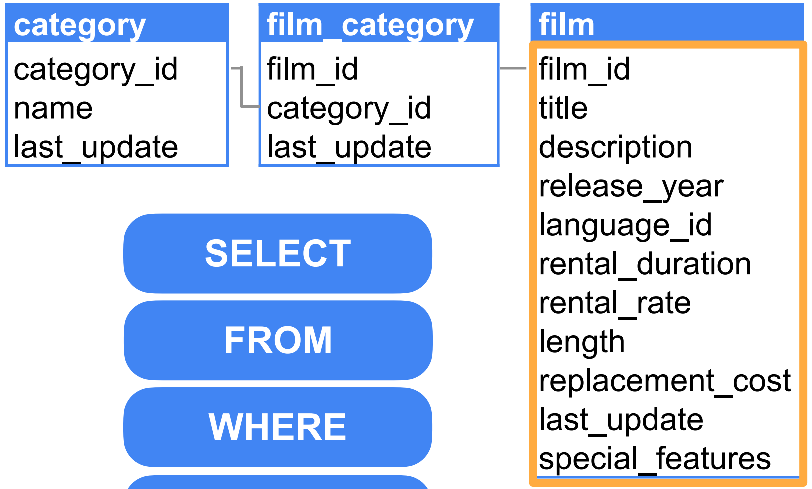
**FROM**

**WHERE**



```
3    4.99    48    12.99    G    Trailers,Deleted Scer
```

```
In [ ]:  %%sql
```

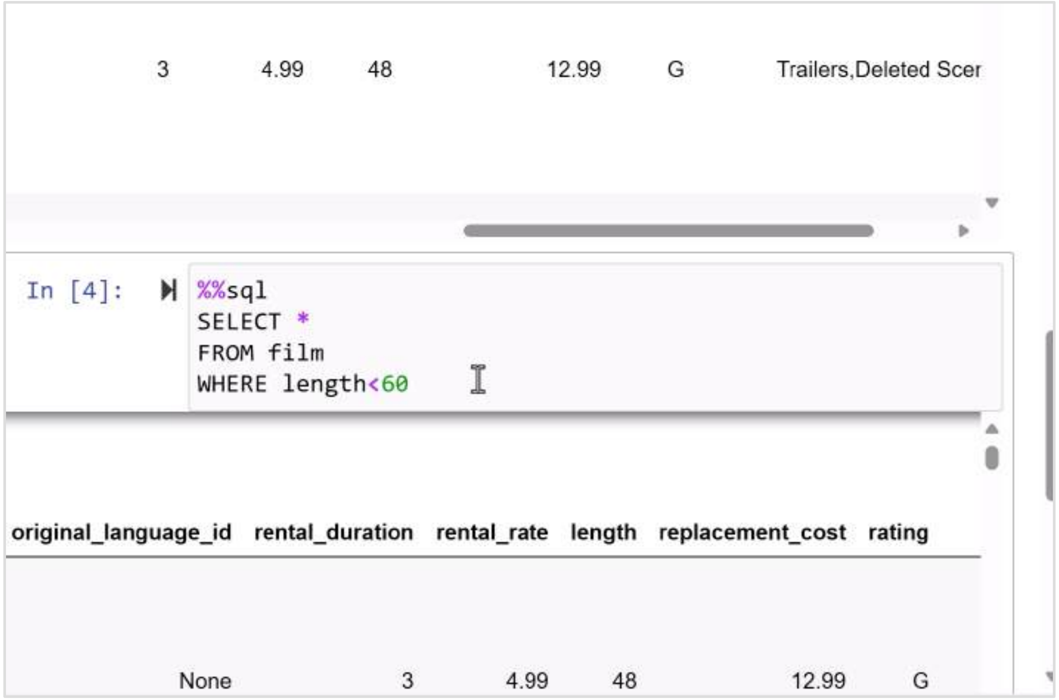


SELECT

FROM

WHERE

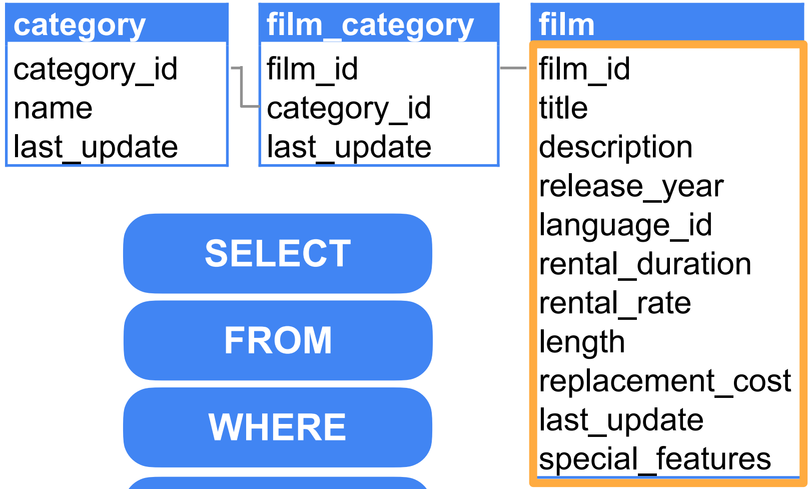
ORDER BY



```
            3         4.99      48              12.99        G          Trailers,Deleted Scer
```

```
In [4]:  %%sql
         SELECT *
         FROM film
         WHERE length<60
```

```
original_language_id  rental_duration  rental_rate  length  replacement_cost  rating

          None                3           4.99        48          12.99         G
```



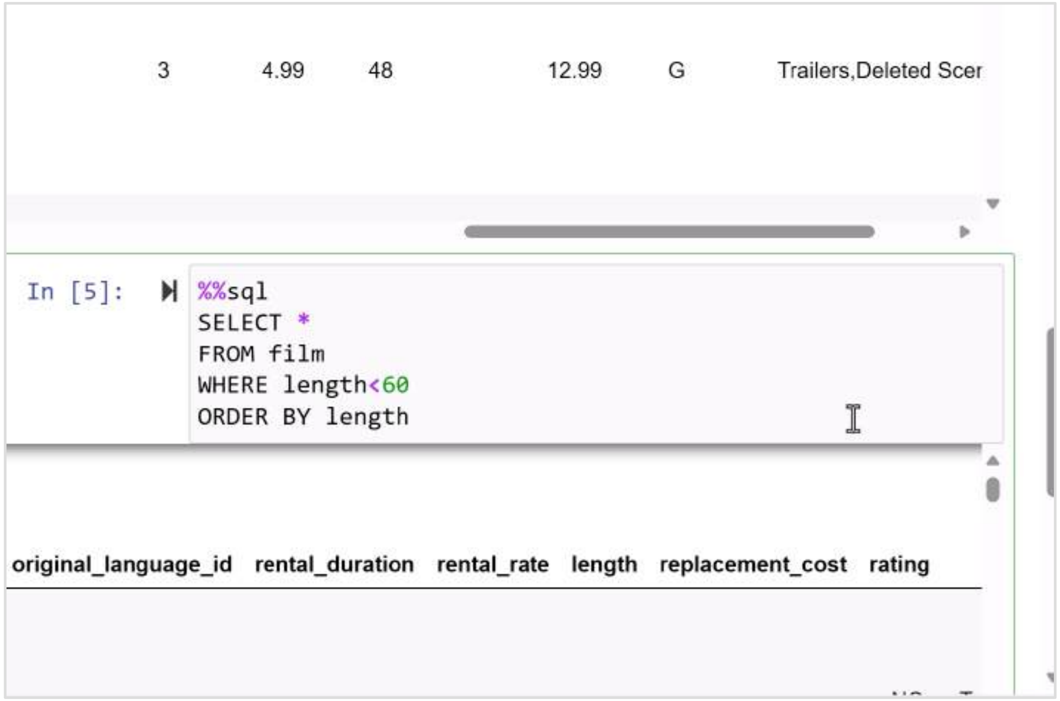
SELECT

FROM

WHERE

ORDER BY

LIMIT



```
3    4.99    48    12.99    G    Trailers,Deleted Scer
```

```
In [5]:  %%sql
         SELECT *
         FROM film
         WHERE length<60
         ORDER BY length
```

```
original_language_id   rental_duration   rental_rate   length   replacement_cost   rating
```

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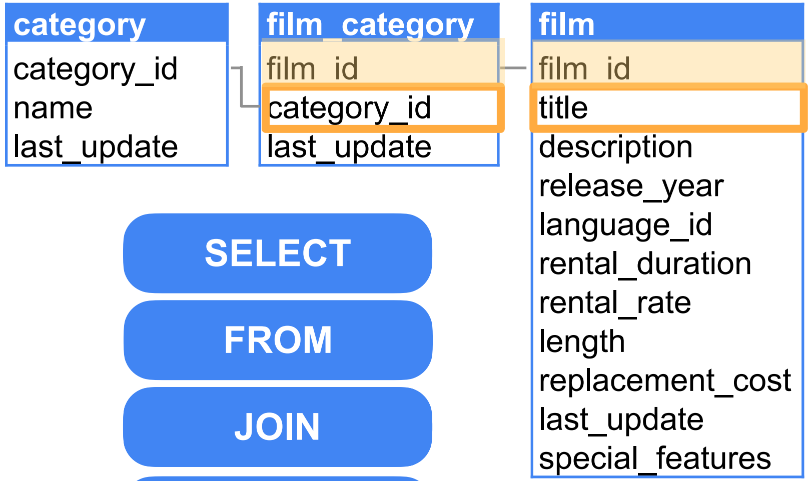


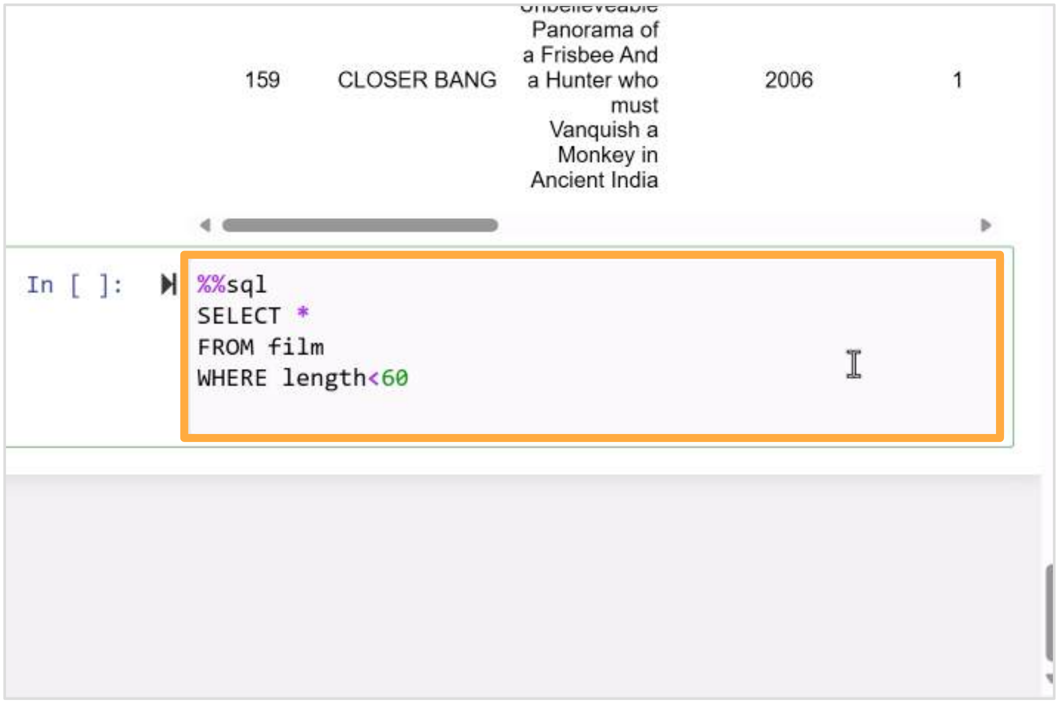
SELECT

FROM

JOIN

ORDER BY

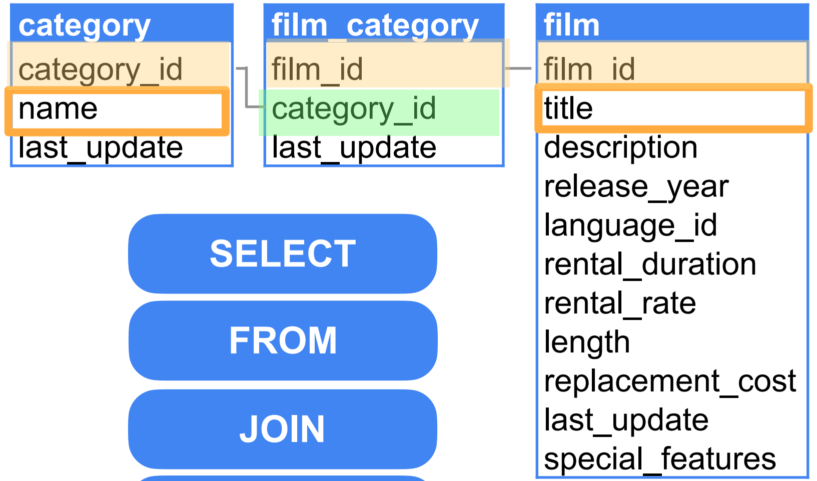
LIMIT



```
                159     CLOSER BANG     Panorama of        2006     1
                                        a Frisbee And
                                        a Hunter who
                                        must
                                        Vanquish a
                                        Monkey in
                                        Ancient India
```

```
In [ ]:  %%sql
         SELECT *
         FROM film
         WHERE length<60
```

DeepLearning.AI



SELECT

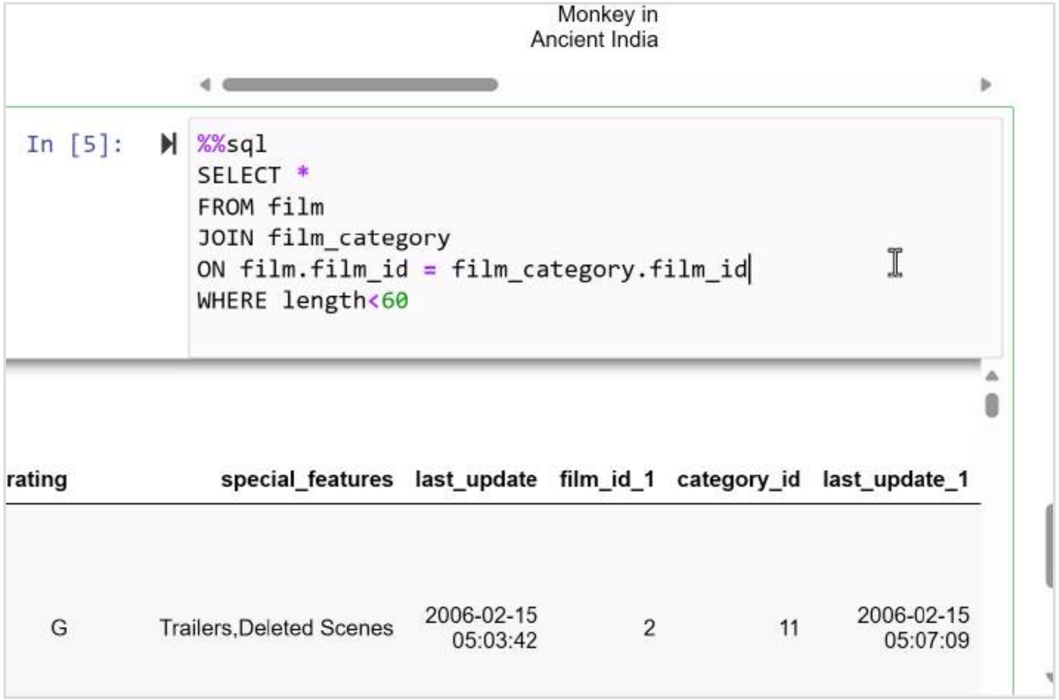
FROM

JOIN

WHERE

ORDER BY

LIMIT



Monkey in Ancient India

```
In [5]:  %%sql
         SELECT *
         FROM film
         JOIN film_category
         ON film.film_id = film_category.film_id
         WHERE length<60
```

| rating | special_features | last_update | film_id_1 | category_id | last_update_1 |
|---|---|---|---|---|---|
| G | Trailers,Deleted Scenes | 2006-02-15 05:03:42 | 2 | 11 | 2006-02-15 05:07:09 |

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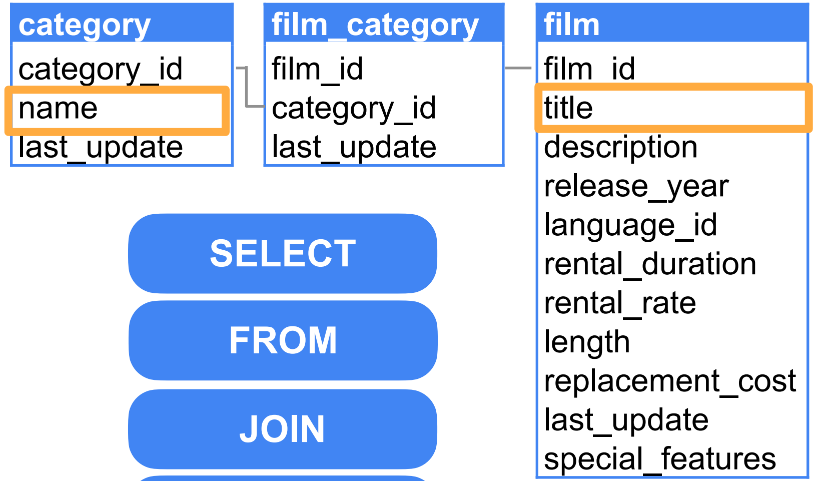
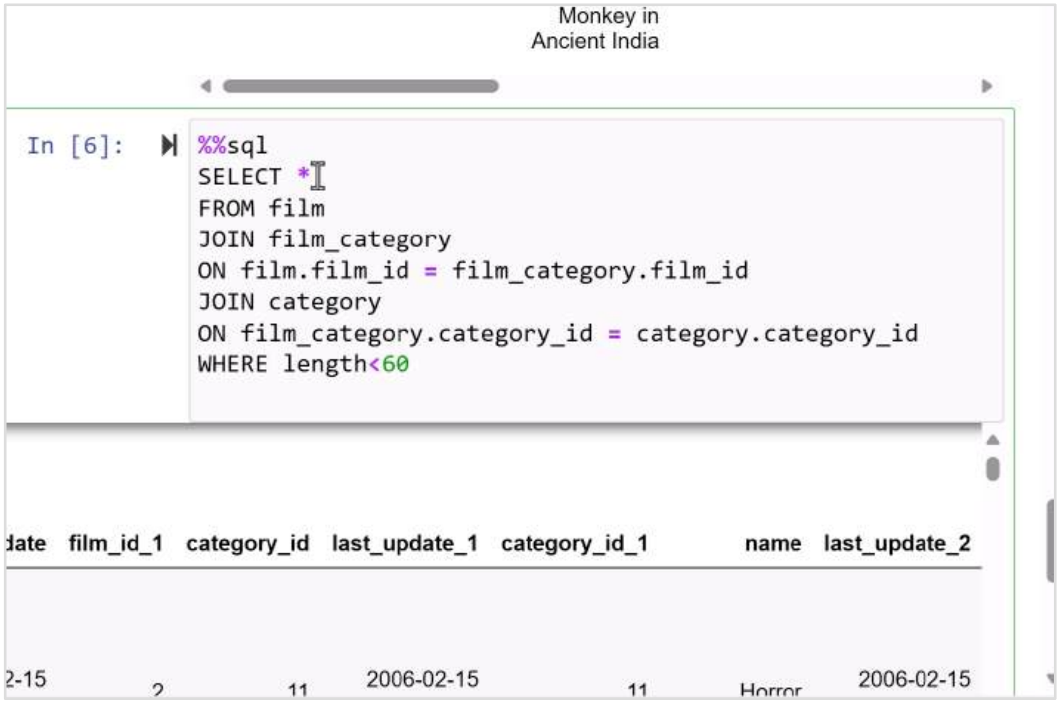


- SELECT
- FROM
- JOIN
- WHERE
- ORDER BY
- LIMIT



```
Monkey in
Ancient India
```

```
In [6]:  %%sql
         SELECT *
         FROM film
         JOIN film_category
         ON film.film_id = film_category.film_id
         JOIN category
         ON film_category.category_id = category.category_id
         WHERE length<60
```

```
date  film_id_1  category_id  last_update_1  category_id_1     name  last_update_2
2-15          2           11     2006-02-15             11   Horror     2006-02-15
```

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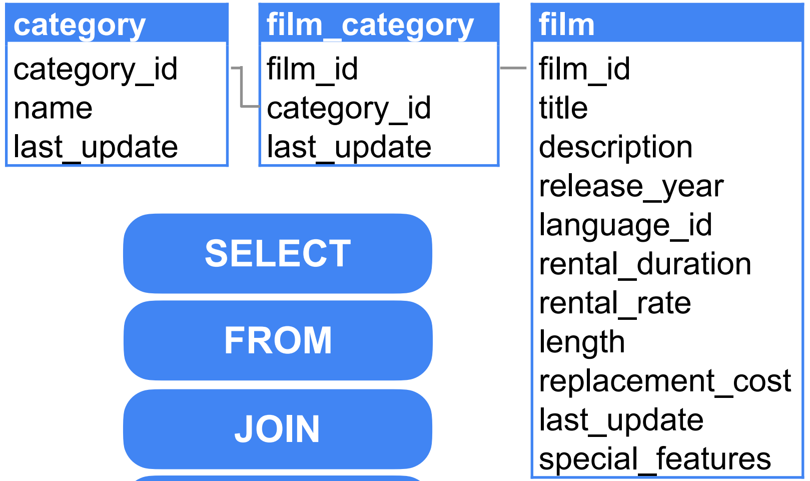


SELECT

FROM

JOIN

WHERE

ORDER BY

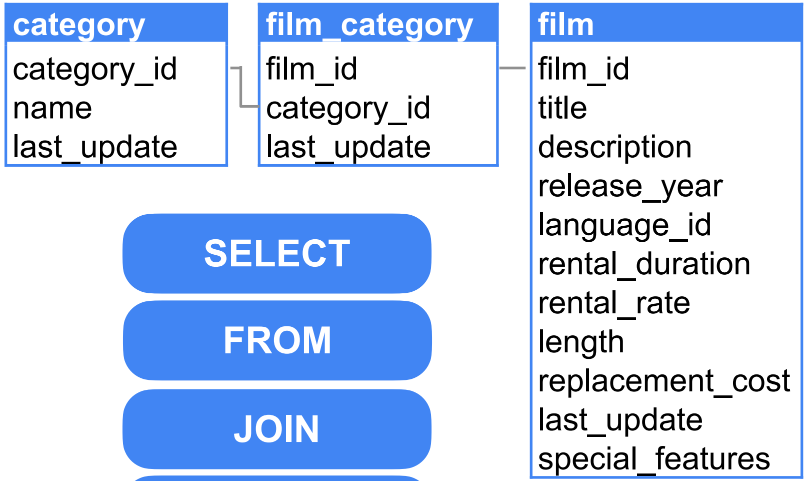
LIMIT

## INNER JOIN

JOIN: combine the records from both tables that have a matching column value specified in the ON statement.

film has a row with film_id = 123
film_category does not have a row with film_id= 123

The row with film_id = 123 will not be in the join results



| category | film_category | film |
|---|---|---|
| category_id | film_id | film_id |
| name | category_id | title |
| last_update | last_update | description |
| | | release_year |
| | | language_id |
| | | rental_duration |
| | | rental_rate |
| | | length |
| | | replacement_cost |
| | | last_update |
| | | special_features |

SELECT

FROM

JOIN

WHERE

ORDER BY

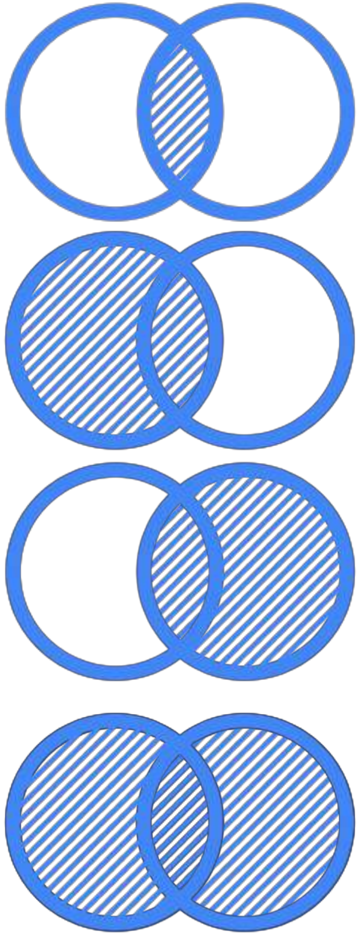
LIMIT

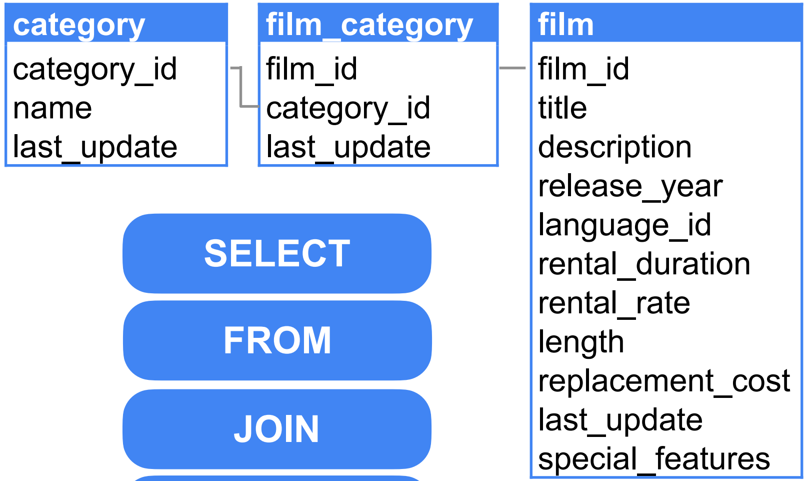
INNER JOIN

LEFT JOIN

RIGHT JOIN

FULL JOIN



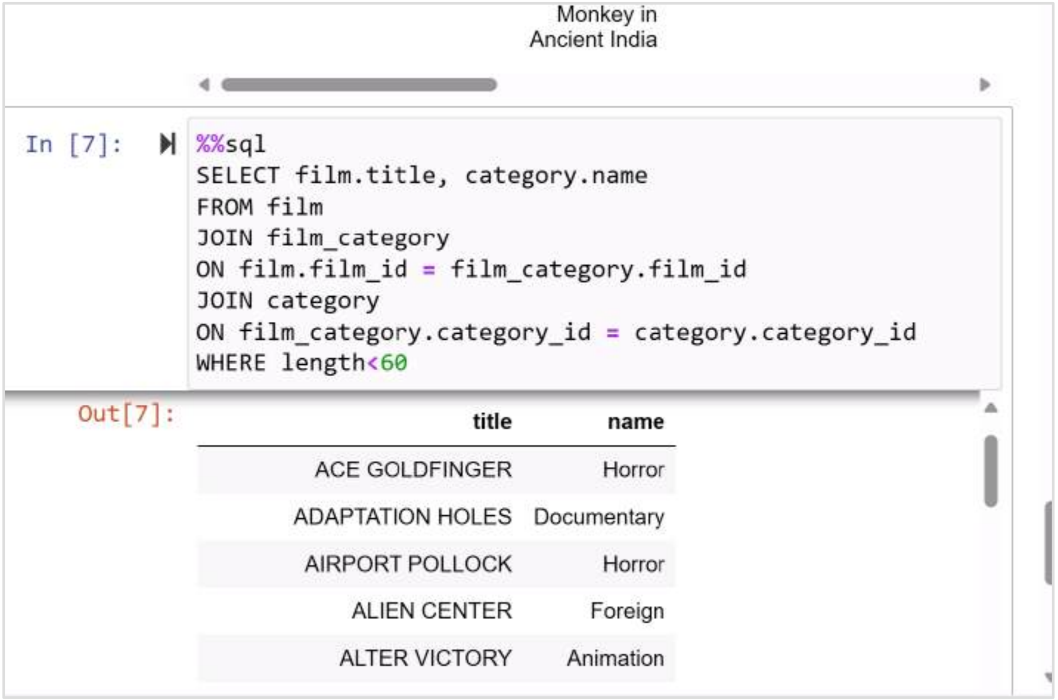


**category**
category_id
name
last_update

**film_category**
film_id
category_id
last_update

**film**
film_id
title
description
release_year
language_id
rental_duration
rental_rate
length
replacement_cost
last_update
special_features

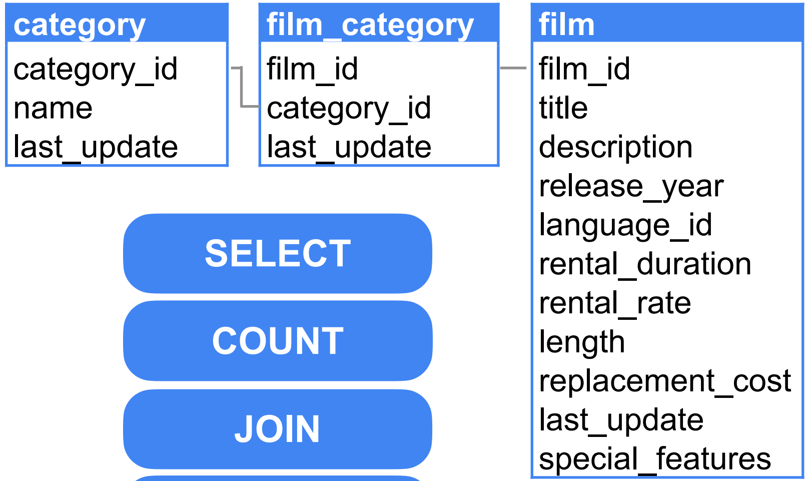
SELECT
FROM
JOIN
WHERE
GROUP BY
LIMIT



Monkey in
Ancient India

```
In [7]:  %%sql
         SELECT film.title, category.name
         FROM film
         JOIN film_category
         ON film.film_id = film_category.film_id
         JOIN category
         ON film_category.category_id = category.category_id
         WHERE length<60
```

```
Out[7]:
                 title         name
       ACE GOLDFINGER        Horror
     ADAPTATION HOLES   Documentary
      AIRPORT POLLOCK        Horror
         ALIEN CENTER       Foreign
        ALTER VICTORY     Animation
```



SELECT

COUNT

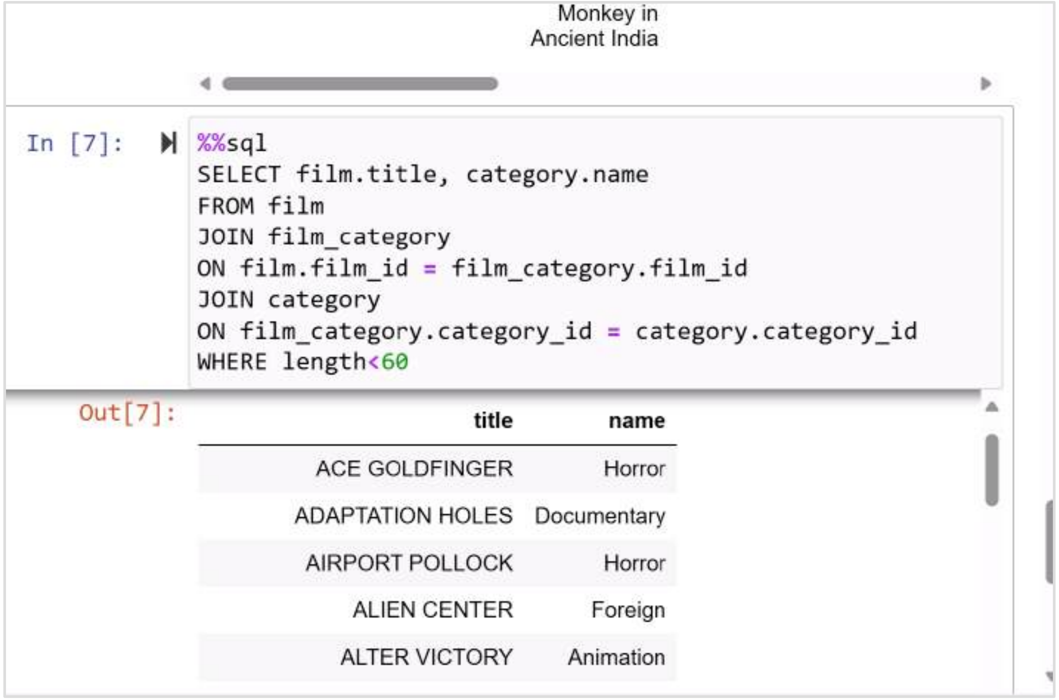
JOIN

WHERE

GROUP BY

ORDER BY

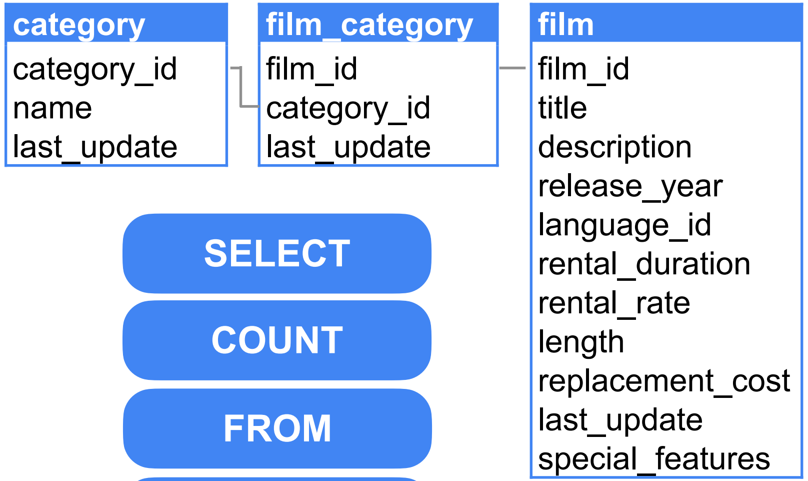
LIMIT



```
Monkey in
Ancient India
```

In [7]:
```
%%sql
SELECT film.title, category.name
FROM film
JOIN film_category
ON film.film_id = film_category.film_id
JOIN category
ON film_category.category_id = category.category_id
WHERE length<60
```

Out[7]:
```
                title         name
      ACE GOLDFINGER        Horror
   ADAPTATION HOLES    Documentary
      AIRPORT POLLOCK       Horror
         ALIEN CENTER      Foreign
        ALTER VICTORY    Animation
```



SELECT

COUNT

FROM

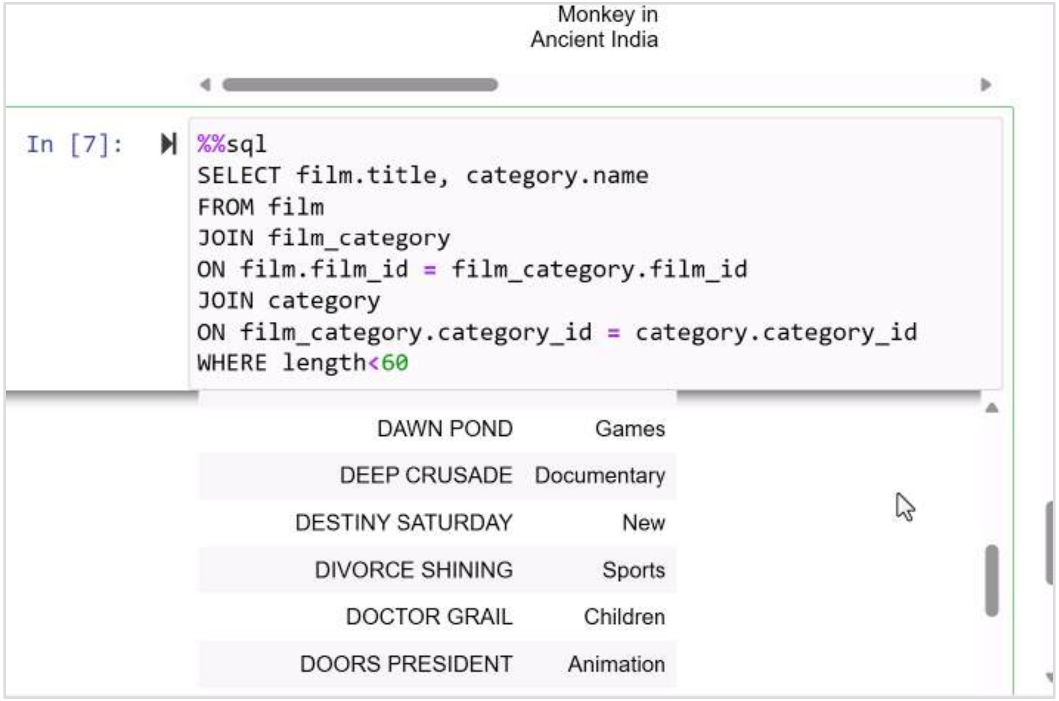
JOIN

WHERE

GROUP BY

ORDER BY

LIMIT



```
                                         Monkey in
                                      Ancient India

In [7]:  %%sql
         SELECT film.title, category.name
         FROM film
         JOIN film_category
         ON film.film_id = film_category.film_id
         JOIN category
         ON film_category.category_id = category.category_id
         WHERE length<60

                  DAWN POND         Games
               DEEP CRUSADE   Documentary
           DESTINY SATURDAY           New
            DIVORCE SHINING        Sports
               DOCTOR GRAIL      Children
            DOORS PRESIDENT     Animation
```

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## Common SQL Commands

- SELECT
- COUNT
- FROM
- JOIN
- WHERE
- GROUP BY
- ORDER BY
- LIMIT

## Data Manipulation Operations

- CREATE
- INSERT INTO
- UPDATE
- DELETE

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# Introduction to Source Systems

## NoSQL Databases

## NoSQL Databases

**NoSQL**

## NoSQL Databases

**No SQL**

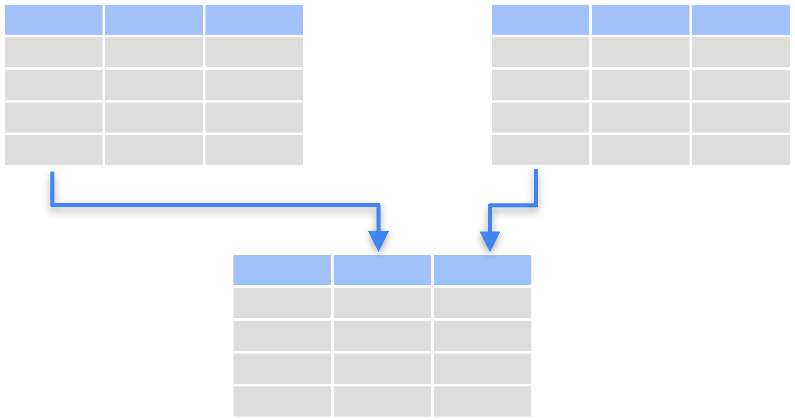
## NoSQL Databases

**Not Only SQL**

**Non-Relational Databases**

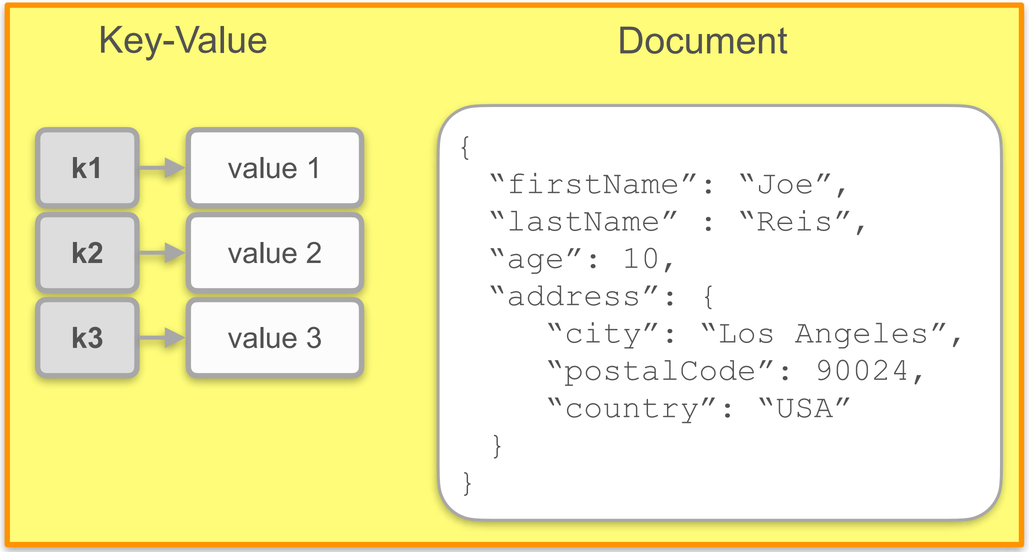
It can still support SQL or SQL-like query languages.

**Relational Databases**

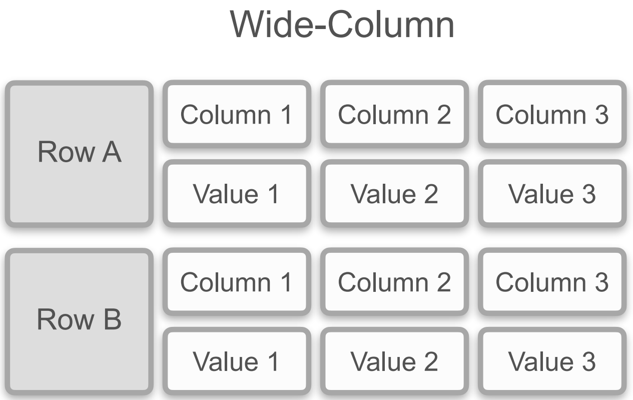


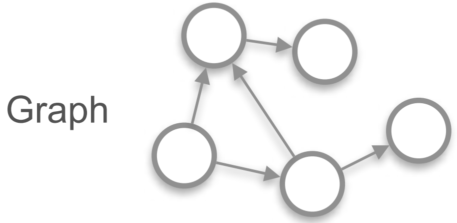
# NoSQL Databases

**Non-tabular structures**



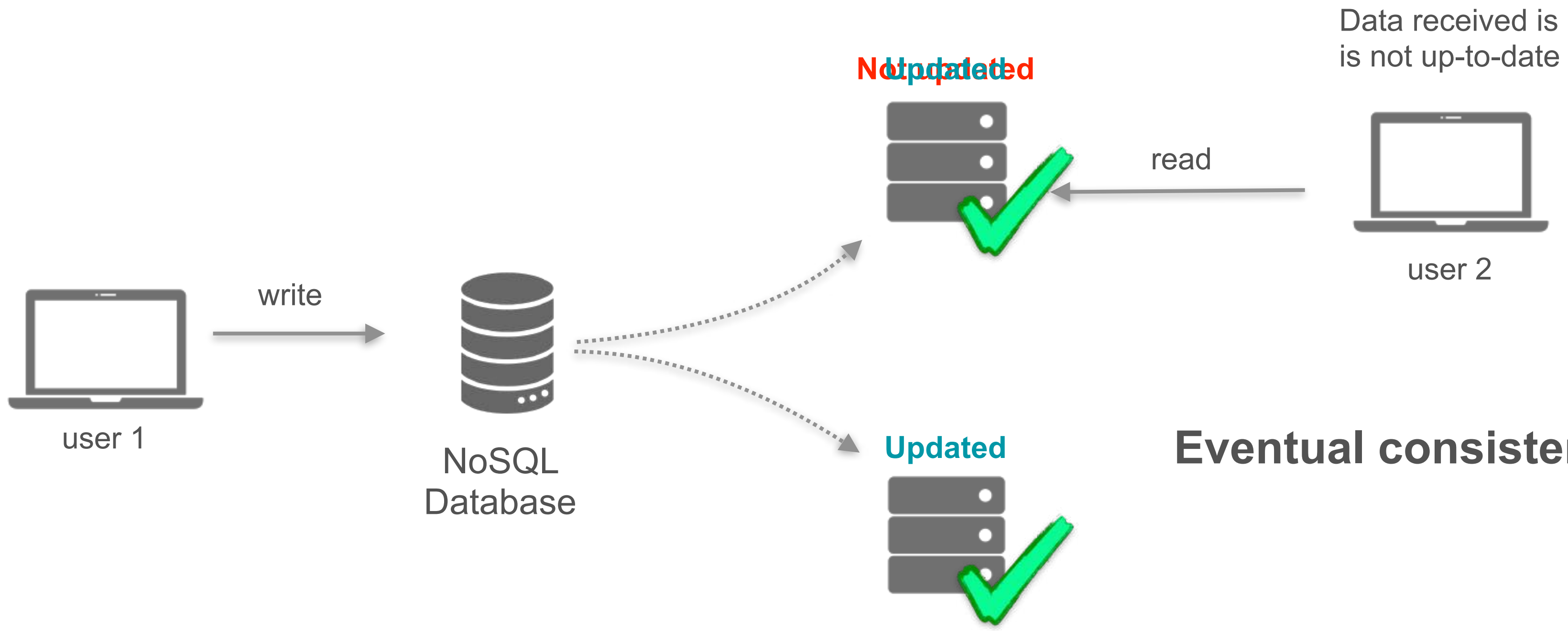
```
{
  "firstName": "Joe",
  "lastName" : "Reis",
  "age": 10,
  "address": {
      "city": "Los Angeles",
      "postalCode": 90024,
      "country": "USA"
  }
}
```





- No predefined schemas
- More flexibility when storing your data

# Horizontal Scaling



**Eventual consistency**

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## Consistency

| NoSQL Databases | Relational Databases |
|---|---|
| Eventual Consistency | Strong Consistency |
| • Speed is prioritized<br>• System availability and scalability are important | • Read data only when all nodes have been updated |

## NoSQL Databases

Not all NoSQL databases guarantee:

**ACID** compliance

**A**tomicity

**C**onsistency

**I**solation

**D**urability

## Specialized Query Language

**Example of NoSQL Data**

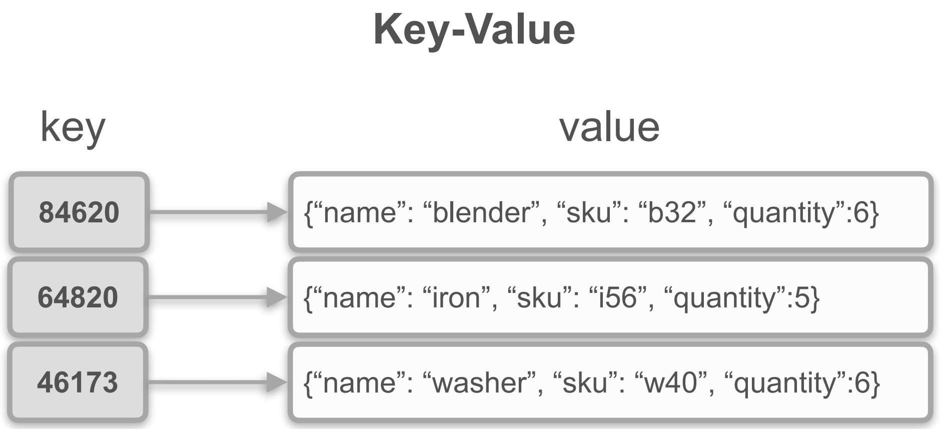
```
{
  "id": 1,
  "key": "Blender",
  "qty": 6,
  "sku": “b32"
}
```

**Query**

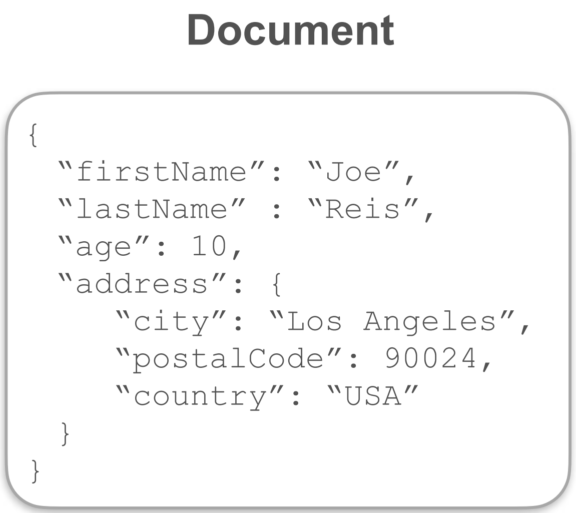
```
db.products.find({qty: {$gt: 4}})
```

*Ref: AWS docs*

# Types of No-SQL Databases

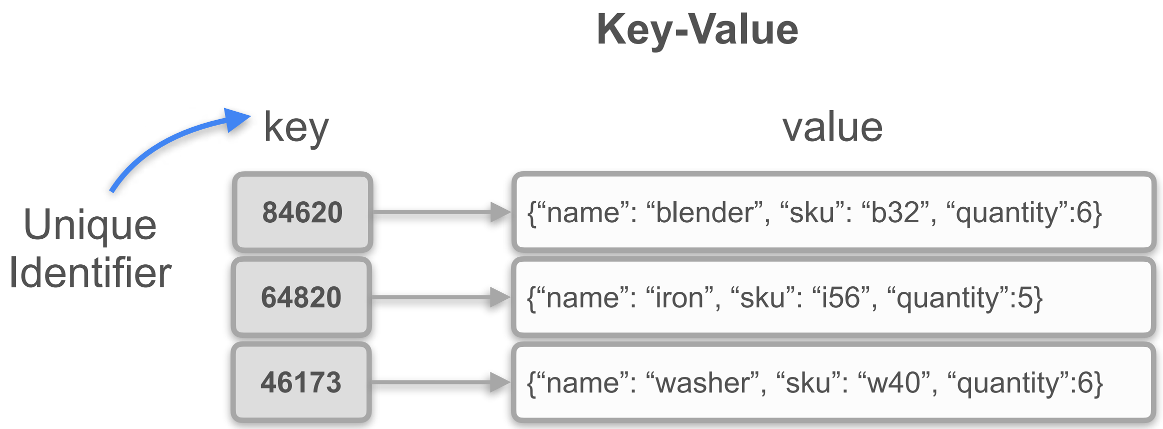


{“name”: “blender”, “sku”: “b32”, “quantity”:6}
{“name”: “iron”, “sku”: “i56”, “quantity”:5}
{“name”: “washer”, “sku”: “w40”, “quantity”:6}



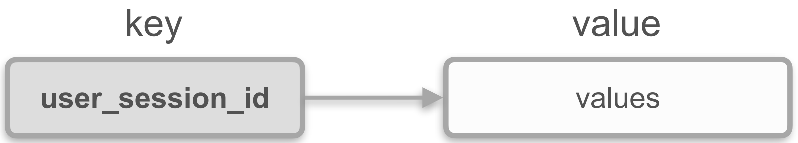
```
{
  “firstName”: “Joe”,
  “lastName” : “Reis”,
  “age”: 10,
  “address”: {
     “city”: “Los Angeles”,
     “postalCode”: 90024,
     “country”: “USA”
  }
}
```

# Key-Value Database


Key-Value
key
value
Unique Identifier
84620
{"name": "blender", "sku": "b32", "quantity":6}
64820
{"name": "iron", "sku": "i56", "quantity":5}
46173
{"name": "washer", "sku": "w40", "quantity":6}

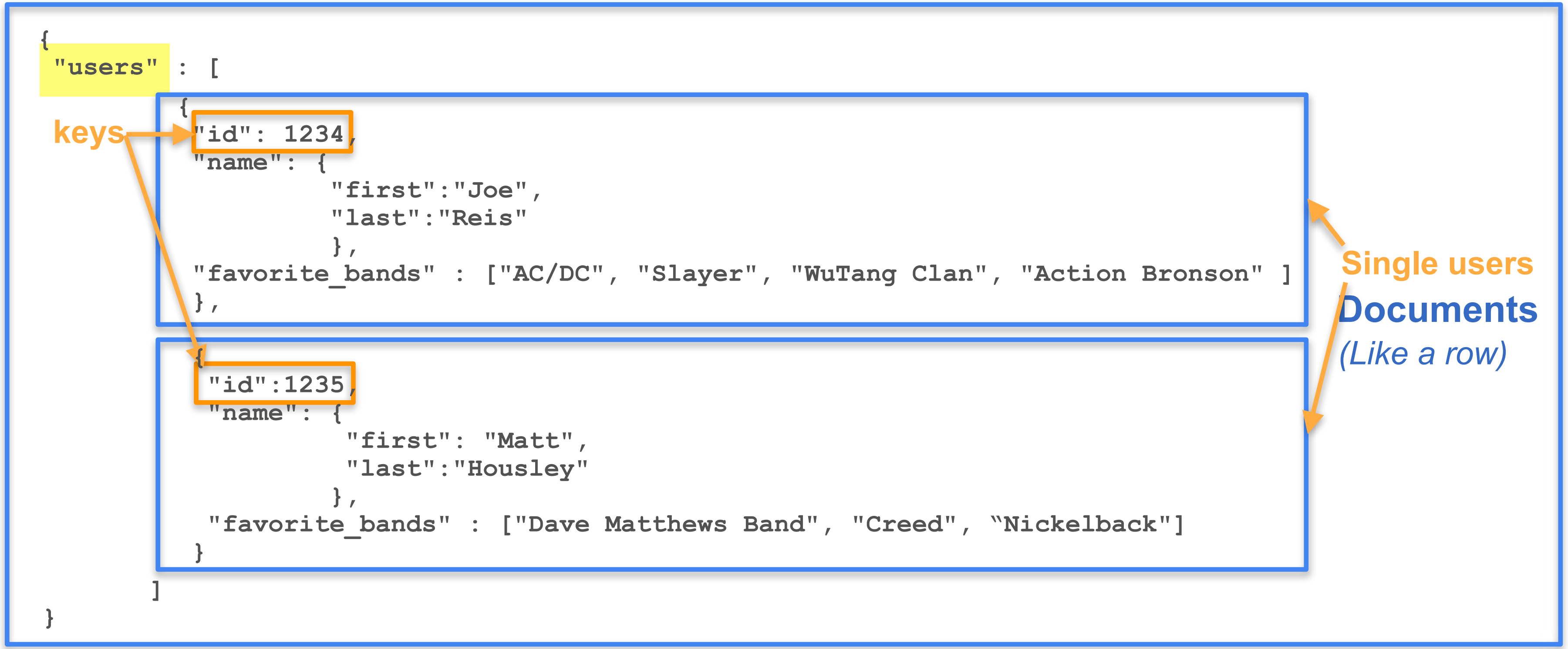
Fast lookup: such as caching user session data

- viewing different products
- adding items to the shopping cart
- checking out



# Document Database

**Collection** *(Like a table)*



```
{
 "users" : [
          {
          "id": 1234,
          "name": {
                   "first":"Joe",
                   "last":"Reis"
                   },
          "favorite_bands" : ["AC/DC", "Slayer", "WuTang Clan", "Action Bronson" ]
          },
          {
           "id":1235,
           "name": {
                    "first": "Matt",
                    "last":"Housley"
                   },
           "favorite_bands" : ["Dave Matthews Band", "Creed", “Nickelback"]
          }
        ]
}
```

# Document Database

```
{
 "users" : [
          {
           "id": 1234,
           "name": {
                    "first":"Joe",
                    "last":"Reis"
                    },
           "favorite_bands" : ["AC/DC", "Slayer", "WuTang Clan", "Action Bronson" ]
           },

           {
            "id":1235,
            "name": {
                     "first": "Matt",
                     "last":"Housley"
                    },
            "favorite_bands" : ["Dave Matthews Band", "Creed", "Nickelback"]
           }
       ]
}
```

- Easy to retrieve all the information about a user (locality)
- Document stores don’t support joins
- Flexible schema

| user_id | band_id |
|---|---|
| 1234 | 1 |
| 1234 | 2 |
| 1234 | 5 |
| 1234 | 6 |
| 1235 | 7 |
| 1235 | 3 |
| 1235 | 4 |

| band_id | band_name |
|---|---|
| 1 | AC/DC |
| 2 | Slayer |
| 3 | Creed |
| 4 | Nickelback |
| 5 | Wutan Clan |
| 6 | Action Bronson |
| 7 | Dave Matthews Band |

| user_id | first_name | last_name |
|---|---|---|
| 1234 | Joe | Reis |
| 1235 | Matt | Housely |

Fixed schema

# Document Database

## Use cases

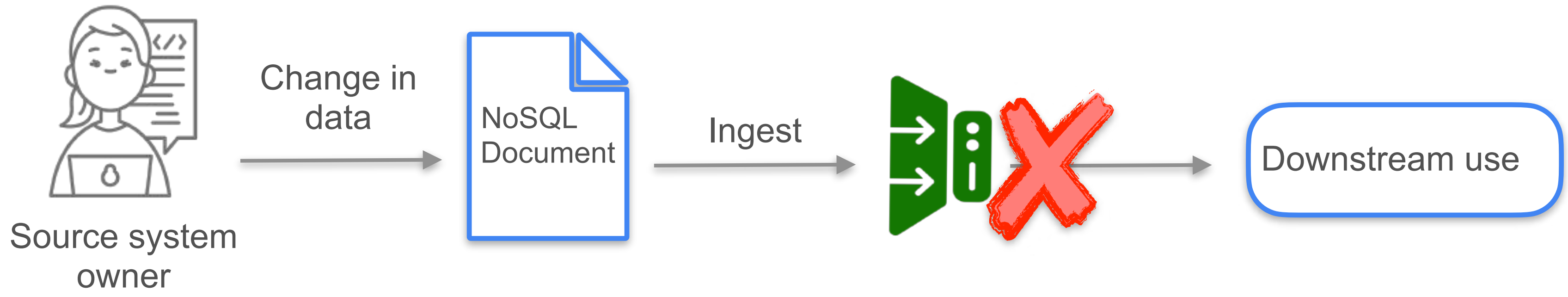
- Content management
- Catalogs
- Sensor readings

```
{
 "iot" : [
          {
           "id": 24,
           "interaction": "some_interaction",
           “device": "my_device",
           "sensor_reading": 34
           }
          ]
}
```

Flexible Schema

## Document Database

Document databases become absolute nightmares to manage and query.



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## Introduction to Source Systems

## Database ACID Compliance

## OLTP Systems

**OLTP**

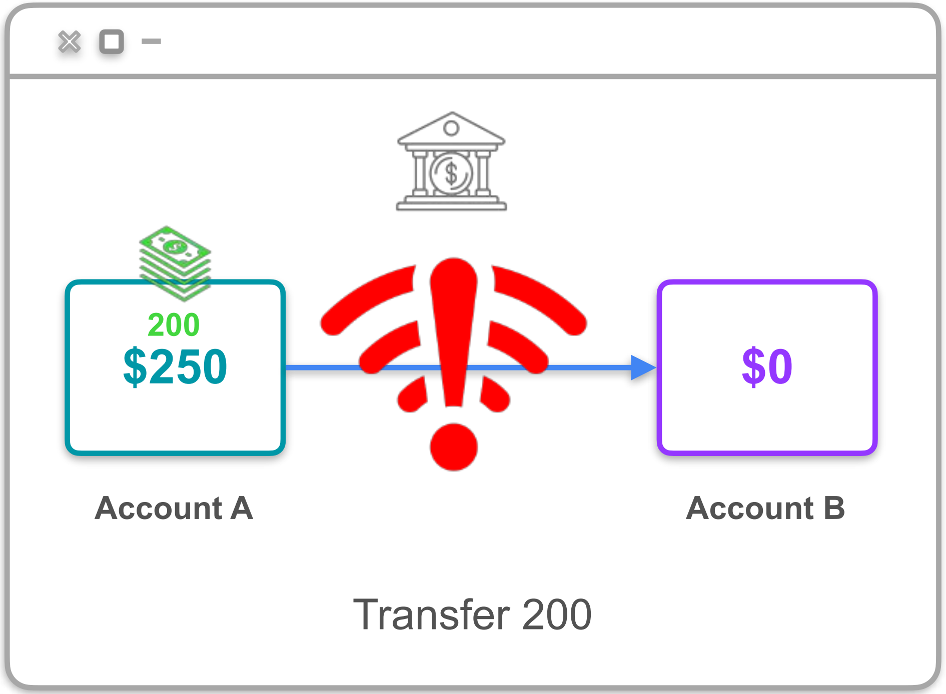
**Online Transaction Processing**

Support very high transaction rates (bank account balances, online orders)

## ACID Compliance

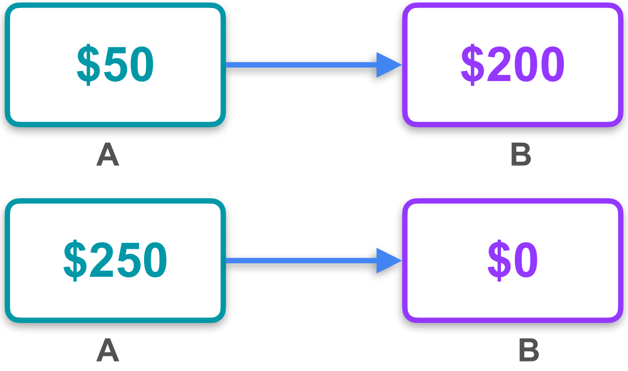
| Relational Databases | NoSQL Databases |
|---|---|
| ACID compliant<br><br>**A**tomicity<br>**C**onsistency<br>**I**solation<br>**D**urability<br><br>They help ensure transactions are processed reliably and accurately in an OLTP system. | Not ACID compliant by default |

# ACID Compliance

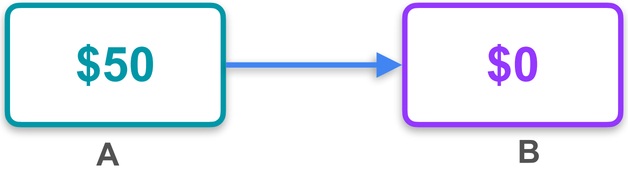


Transfer 200

You'd be hoping

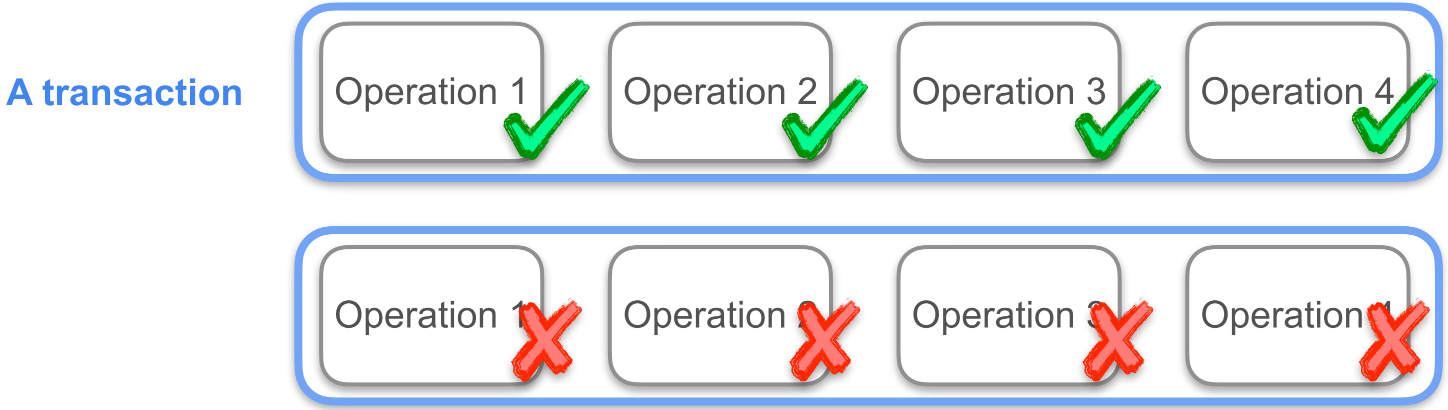


But not



## Atomicity

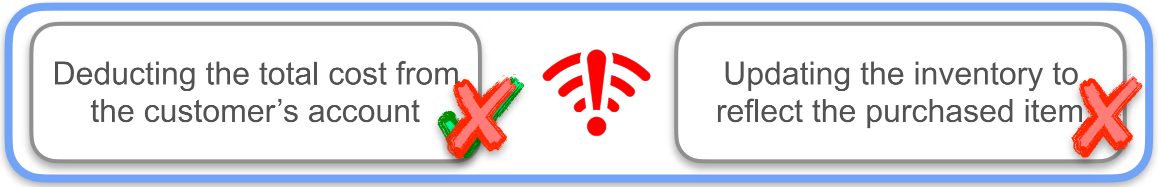
Atomicity ensures that transactions are **atomic**, treated as a single, indivisible unit.



## Atomicity

Atomicity ensures that transactions are **atomic**, treated as a single, indivisible unit.

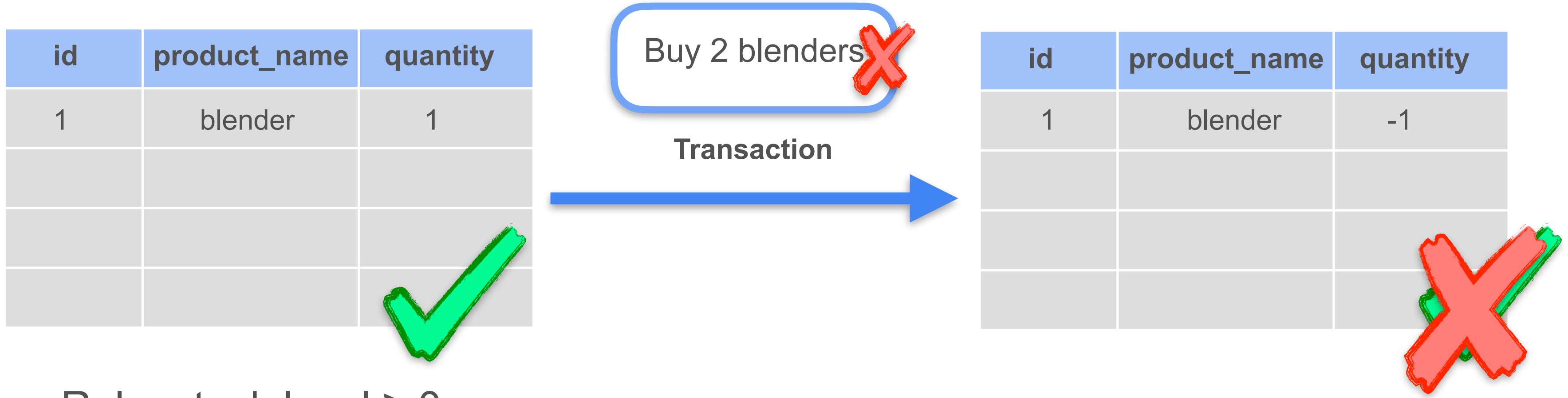
**A transaction: placing an order**


Deducting the total cost from the customer's account
Updating the inventory to reflect the purchased item

Both operations must happen as a single transaction

**Atomicity** Atomicity ensures that transactions are **atomic**, treated as a single, indivisible unit.

**Consistency** Any changes to the data made within a transaction follow the set of rules or constraints defined by the database schema.



| id | product_name | quantity |
|---|---|---|
| 1 | blender | 1 |
| | | |
| | | |
| | | |

| id | product_name | quantity |
|---|---|---|
| 1 | blender | -1 |
| | | |
| | | |
| | | |

Rule: stock level $\geq 0$

**Atomicity** Atomicity ensures that transactions are **atomic**, treated as a single, indivisible unit.

**Consistency** Any changes to the data made within a transaction follow the set of rules or constraints defined by the database schema.

## ACID compliance

**A**tomicity

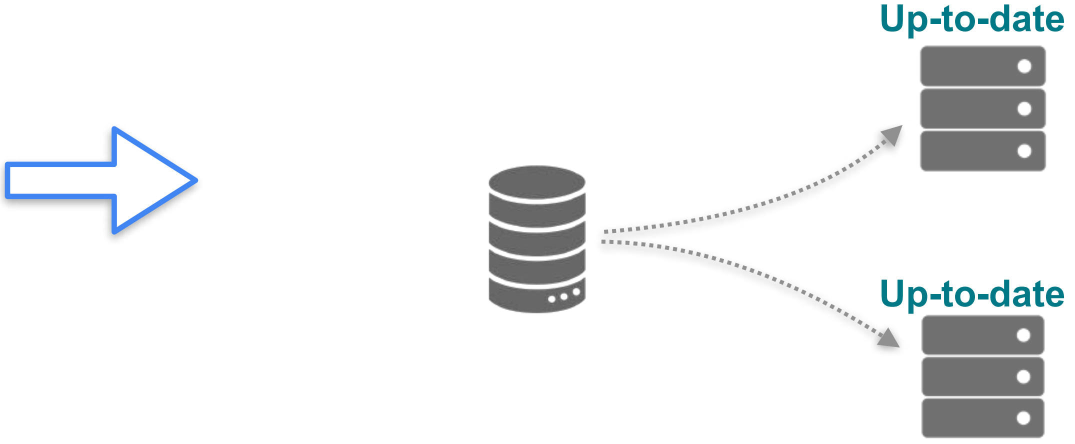
**C**onsistency

**I**solation

**D**urability

## Strong Consistency

All nodes provide the same up-to-date

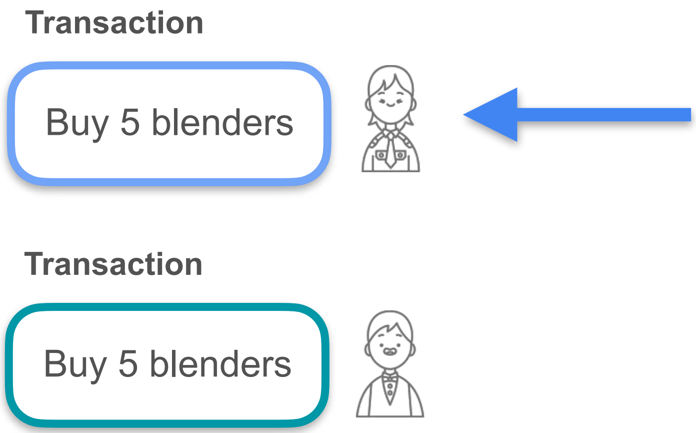


**Atomicity** Atomicity ensures that transactions are **atomic**, treated as a single, indivisible unit.

**Consistency** Any changes to the data made within a transaction follow the set of rules or constraints defined by the database schema.

**Isolation** Each transaction is executed independently in sequential order.

| id | product_name | quantity |
|---|---|---|
| 1 | blender | 5 |
| | | |
| | | |
| | | |

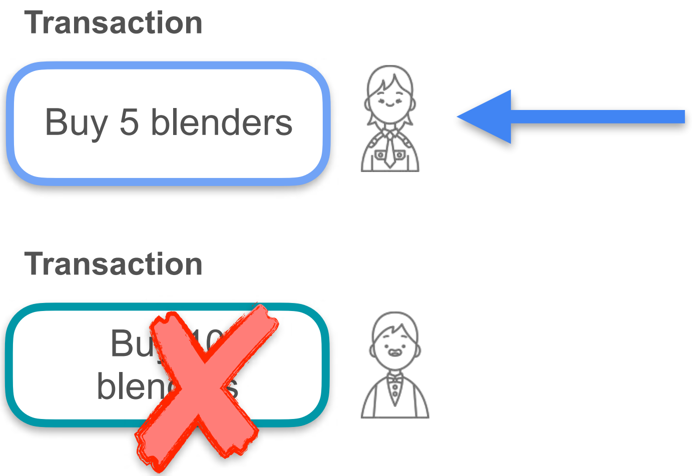


**Atomicity** Atomicity ensures that transactions are **atomic**, treated as a single, indivisible unit.

**Consistency** Any changes to the data made within a transaction follow the set of rules or constraints defined by the database schema.

**Isolation** Each transaction is executed independently in sequential order.

| id | product_name | quantity |
|---|---|---|
| 1 | blender | 5 |
| | | |
| | | |
| | | |

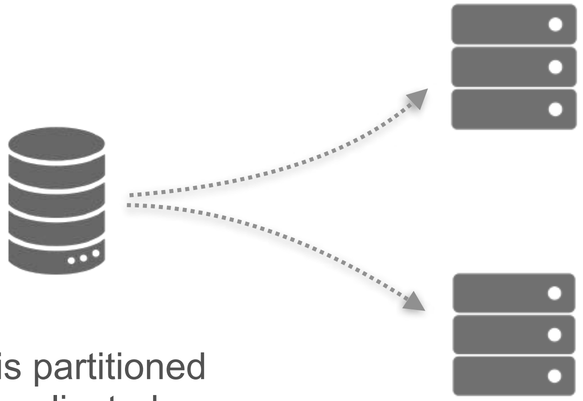


| | |
|---|---|
| **Atomicity** | Atomicity ensures that transactions are **atomic**, treated as a single, indivisible unit. |
| **Consistency** | Any changes to the data made within a transaction follow the set of rules or constraints defined by the database schema. |
| **Isolation** | Each transaction is executed independently in sequential order. |
| **Durability** | Once a transaction is completed, its effects are permanent and will survive any subsequent system failures. |

*Essential for maintaining the reliability of the database*

## ACID Compliance

The ACID principles guarantee that a database will maintain a consistent picture of the world.



Data is partitioned or replicated

**Strong Consistency**

- Data is consistent across the entire network
- Key feature of relational databases that ensures ACID

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## Introduction to Source Systems

# Lab Walkthrough - Interacting with Amazon DynamoDB NoSQL Database

## Interacting with Amazon DynamoDB

Amazon DynamoDB

Apply some **C**reate, **R**ead, **U**pdate and **D**elete (**CRUD**) operations

In this video,

- Overview of DynamoDB features
- Data you will work on
- DynamoDB methods that you will use to apply **CRUD** operations

Amazon DynamoDB

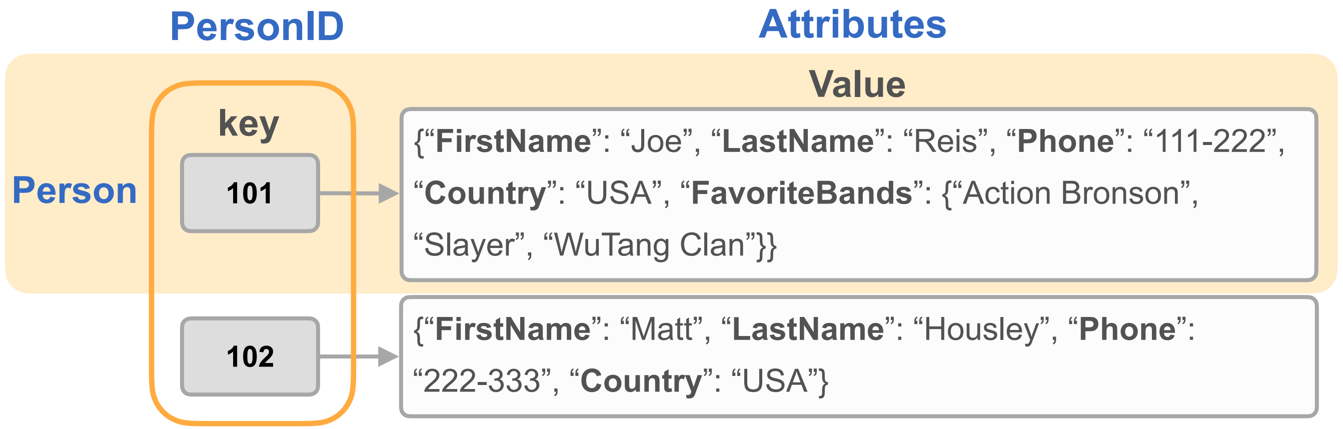
Key-value Database

## Key-value Items

↓

## Table

- Row: attributes of one item
- Uniquely identified by the item’s key.
- **Simple Primary Key:** partition key
- **Composite Primary Key:**



{“**FirstName**”: “Joe”, “**LastName**”: “Reis”, “**Phone**”: “111-222”, “**Country**”: “USA”, “**FavoriteBands**”: {“Action Bronson”, “Slayer”, “WuTang Clan”}}

{“**FirstName**”: “Matt”, “**LastName**”: “Housley”, “**Phone**”: “222-333”, “**Country**”: “USA”}

Simple primary key

| **Key:** PersonID | **Attributes** | | | | |
|---|---|---|---|---|---|
| 101 | FirstName | LastName | Phone | Country | FavoriteBands |
| | Joe | Reis | 111-222 | USA | {“Action Bronson”, “Slayer”, “WuTang Clan”} |
| 102 | FirstName | LastName | Phone | Country | |
| | Matt | Housley | 222-333 | USA | |

## Amazon DynamoDB

Key-value Database

**Key-value Items**

**Table**

- Row: attributes of one item
- Uniquely identified by the item’s key.
- **Simple Primary Key:** partition key
- **Composite Primary Key:** partition key & sort key

| Composite Primary Key | | **Attributes** | | | | |
|---|---|---|---|---|---|---|
| **Partition Key** | **Sort Key** | | | | | |
| OrderID | ItemNum | | | | | |
| 1234 | Item1 | Price | Quantity | ProductType | ISBN | Title |
| | | 10 | 1 | Book | 45679 | Data |
| 1234 | Item2 | Price | Quantity | ProductType | Brand | Color |
| | | 50 | 1 | Bike | AZY | Black |
| 1235 | Item1 | Price | Quantity | ProductCode | | |
| | | 23 | 4 | 23697 | | |
| 1235 | Item2 | Price | Quantity | ProductType | Brand | |
| | | 1200 | 2 | Laptop | XYZ | |

**Schema-less:** Each item can have its own distinct attributes.

Simple primary key

| **Key:** PersonID | **Attributes** | | | | |
|---|---|---|---|---|---|
| 101 | FirstName | LastName | Phone | Country | FavoriteBands |
| | Joe | Reis | 111-222 | USA | {“Action Bronson”, “Slayer”, “WuTang Clan”} |
| 102 | FirstName | LastName | Phone | Country | |
| | Matt | Housley | 222-333 | USA | |

# Interacting with Amazon DynamoDB

Table

Table

Table

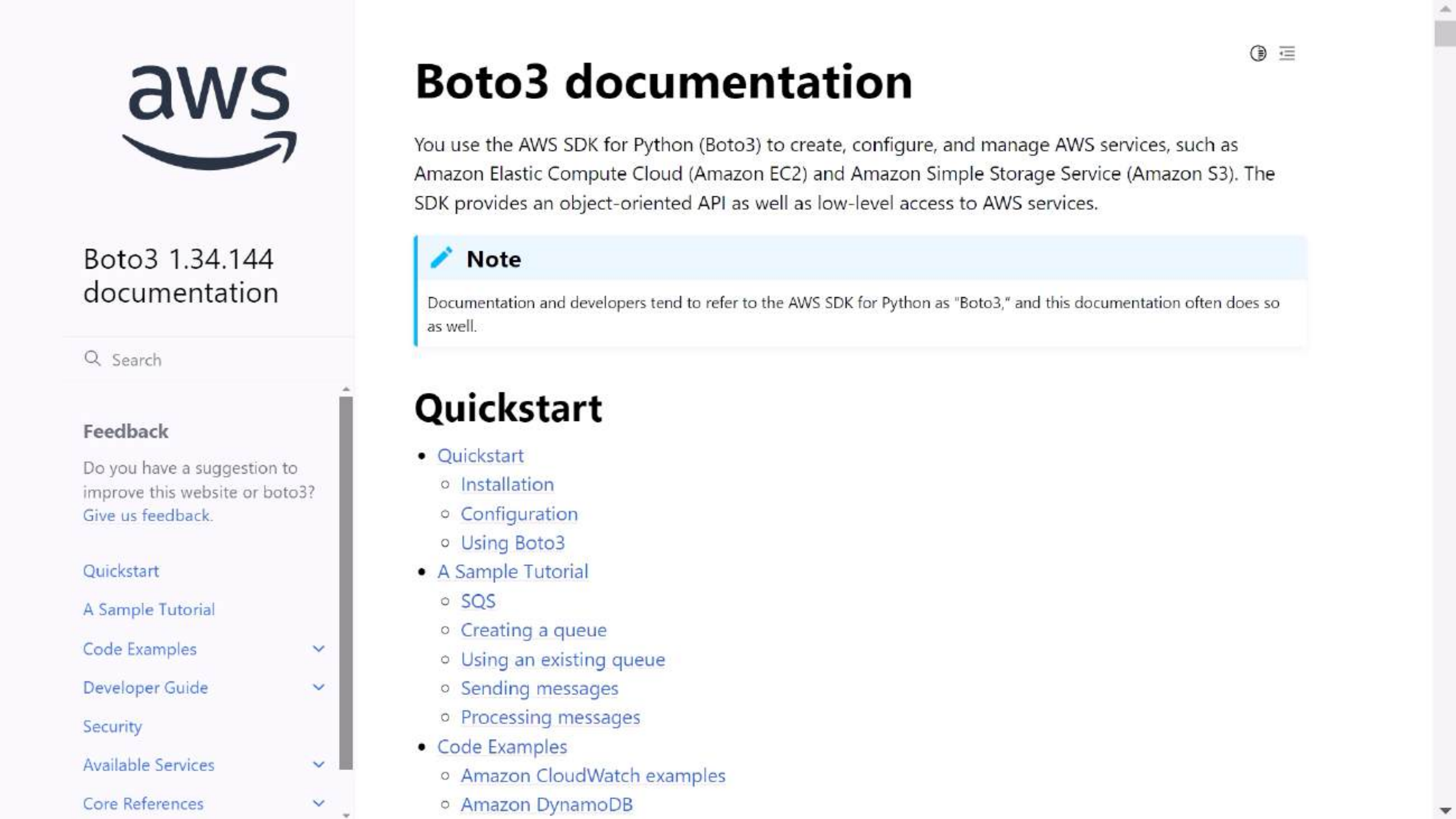
Table

## Interact with the tables using Python

**Boto3**

AWS Software Development Kit (SDK) for Python

Allows you to create and configure AWS services using Python



Boto3 1.34.144 documentation

Search

**Feedback**

Do you have a suggestion to improve this website or boto3? Give us feedback.

# Boto3 documentation

You use the AWS SDK for Python (Boto3) to create, configure, and manage AWS services, such as Amazon Elastic Compute Cloud (Amazon EC2) and Amazon Simple Storage Service (Amazon S3). The SDK provides an object-oriented API as well as low-level access to AWS services.

**Note**

Documentation and developers tend to refer to the AWS SDK for Python as "Boto3," and this documentation often does so as well.

## Quickstart

# Interacting with Amazon DynamoDB

Table

Table

Table

Table

## Interact with the tables using Python

**Boto3**

AWS Software Development Kit (SDK) for Python

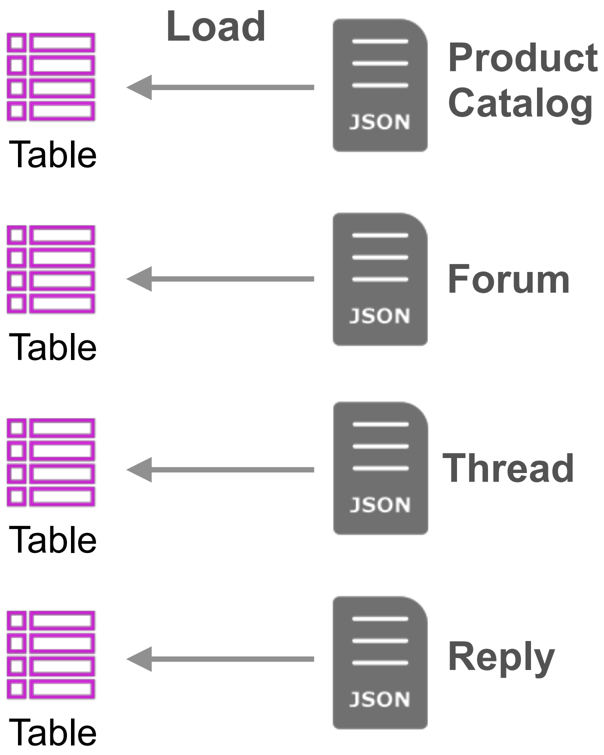
Allows you to create and configure AWS services using Python

```
import boto3

client = boto3.client('dynamodb')
```

| | |
|---|---|
| **Create** | create_table |
| **Read** | scan<br>get_item<br>query |
| **Update** | put_item<br>write_batch_items<br>update_item |
| **Delete** | delete_item |

# Data



**Product Catalog**

- Information about some products sold on Amazon
- *ID*: simple primary key

**Forum**

- Information about some AWS forums
- Each forum: total number of threads, messages and views
- *Name*: simple primary key

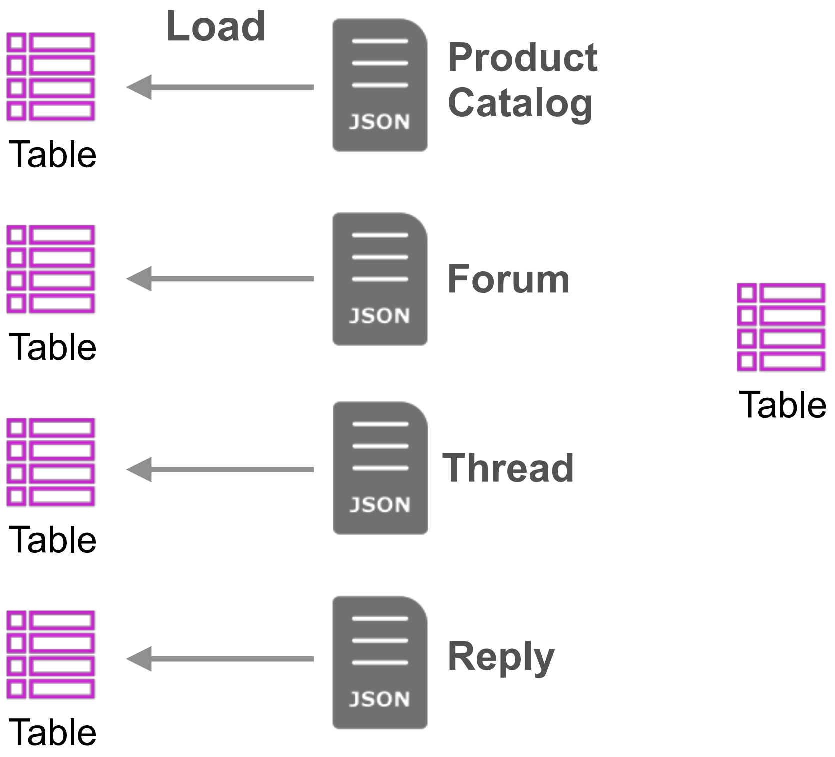
**Thread**

- Information about each forum thread
- Each thread: subject, message, total number of views and replies
- *ForumName* & *Subject*: composite primary key

**Reply**

- Information about each thread reply
- Each reply: time, reply message, user, ID (Forum and thread subject)
- *ID* & *ReplyDateTime:* composite primary key

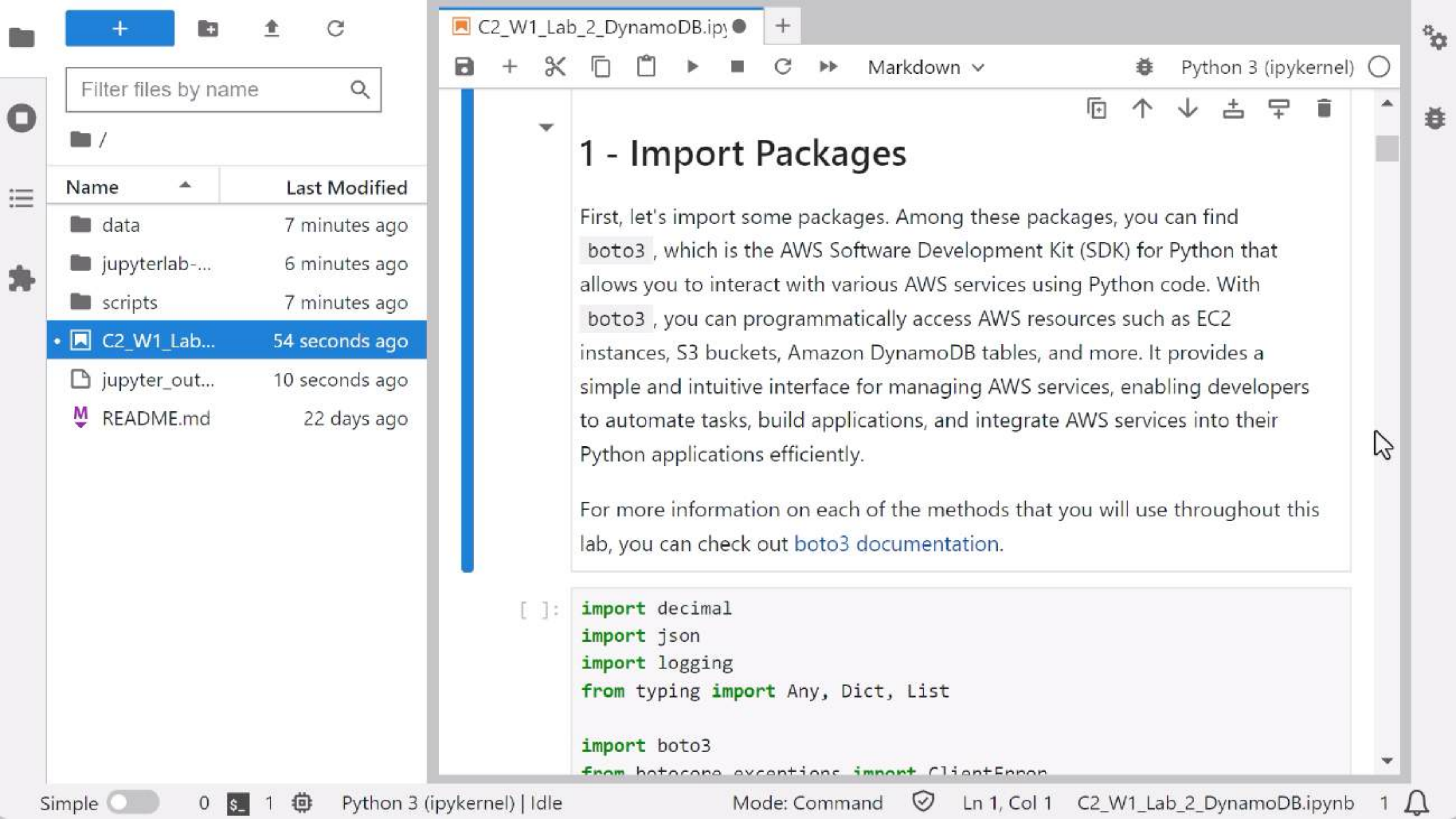
# Data



```
{
  "Forum": [
    {
      "PutRequest": {
        "Item": {
          "Name": {"S":"Amazon DynamoDB"},
          "Category": {"S":"Amazon Web Services"},
          "Threads": {"N":"2"},
          "Messages": {"N":"4"},
          "Views": {"N":"1000"}
        }
      }
    },
    {
      "PutRequest": {
        "Item": {
          "Name": {"S":"Amazon S3"},
          "Category": {"S":"Amazon Web Services"}
        }
      }
    }
  ]
}
```

**N: Number**

**S: String**



## 1 - Import Packages

First, let's import some packages. Among these packages, you can find `boto3`, which is the AWS Software Development Kit (SDK) for Python that allows you to interact with various AWS services using Python code. With `boto3`, you can programmatically access AWS resources such as EC2 instances, S3 buckets, Amazon DynamoDB tables, and more. It provides a simple and intuitive interface for managing AWS services, enabling developers to automate tasks, build applications, and integrate AWS services into their Python applications efficiently.

For more information on each of the methods that you will use throughout this lab, you can check out boto3 documentation.

```
[ ]: import decimal
     import json
     import logging
     from typing import Any, Dict, List

     import boto3
```

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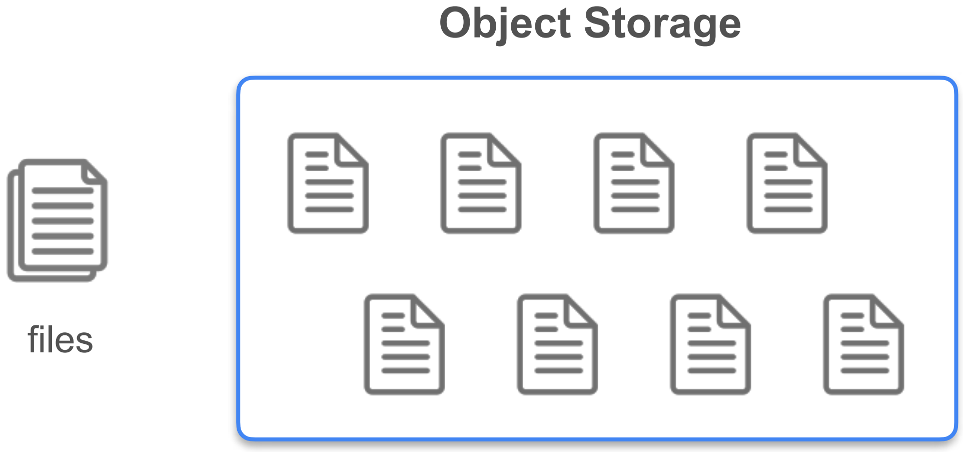
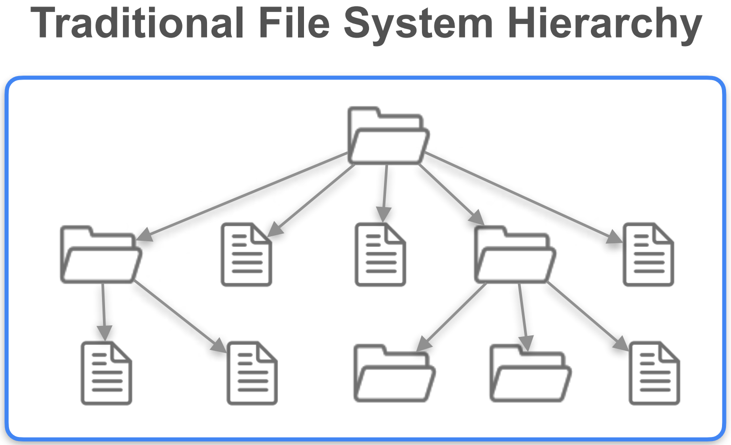
Introduction to Source Systems

## Object Storage

# Object Storage

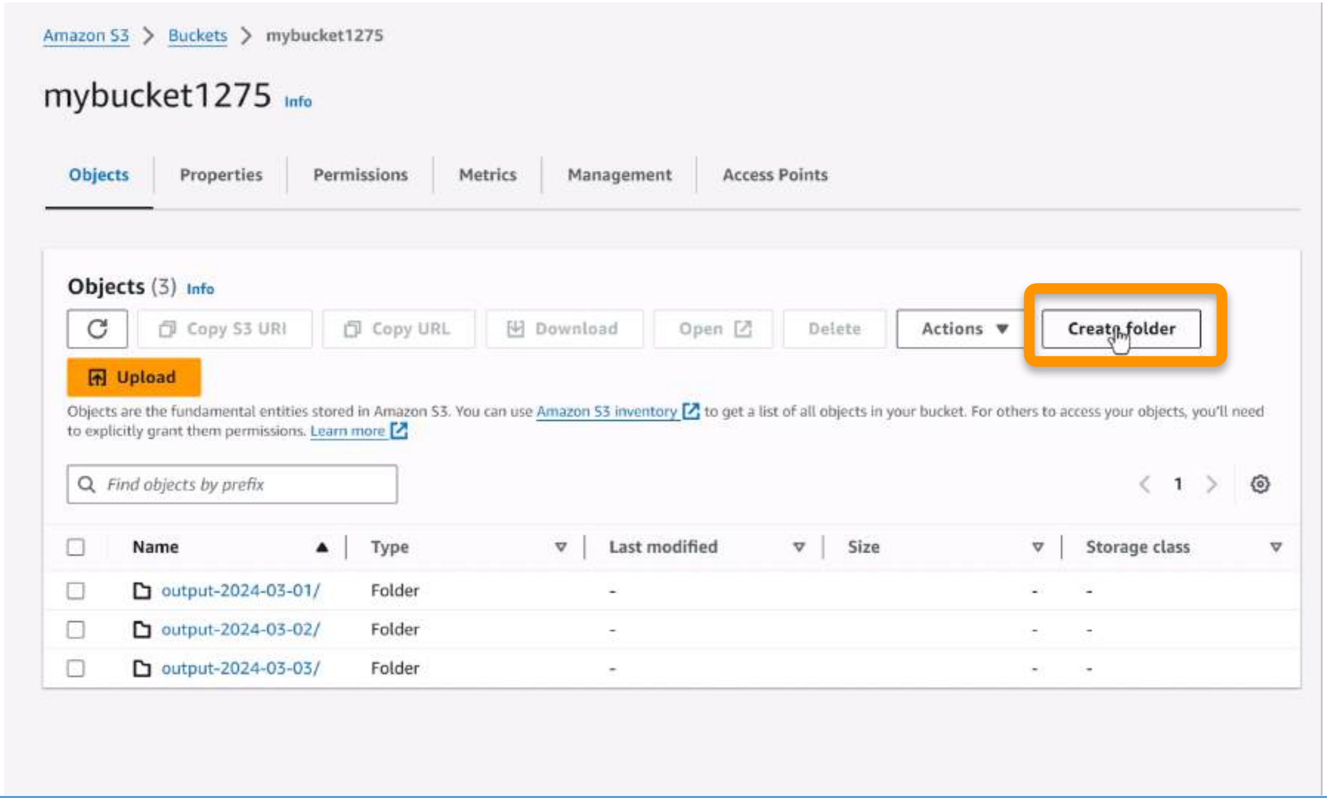




No hierarchy!

# Object Storage

Amazon S3



Amazon S3 > Buckets > mybucket1275

mybucket1275 Info

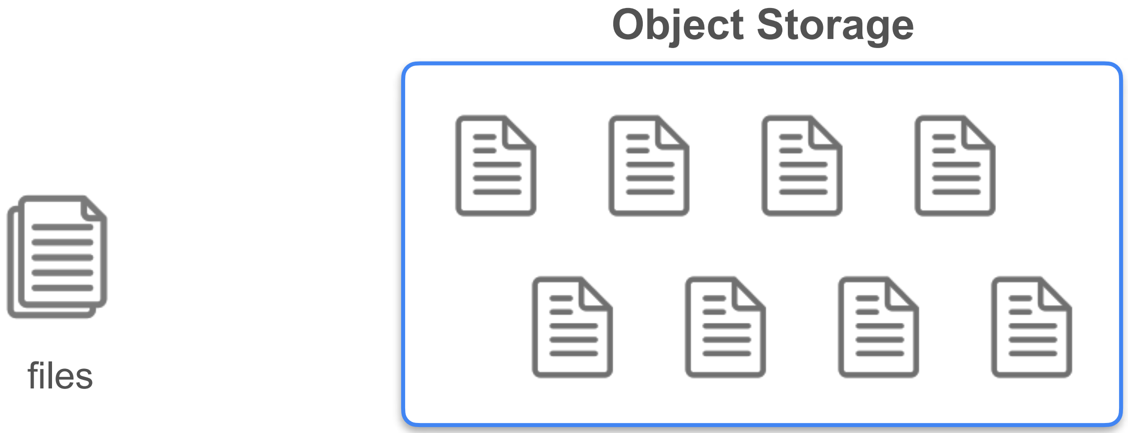
Objects (3) Info

Objects are the fundamental entities stored in Amazon S3. You can use Amazon S3 inventory to get a list of all objects in your bucket. For others to access your objects, you'll need to explicitly grant them permissions. Learn more

Find objects by prefix

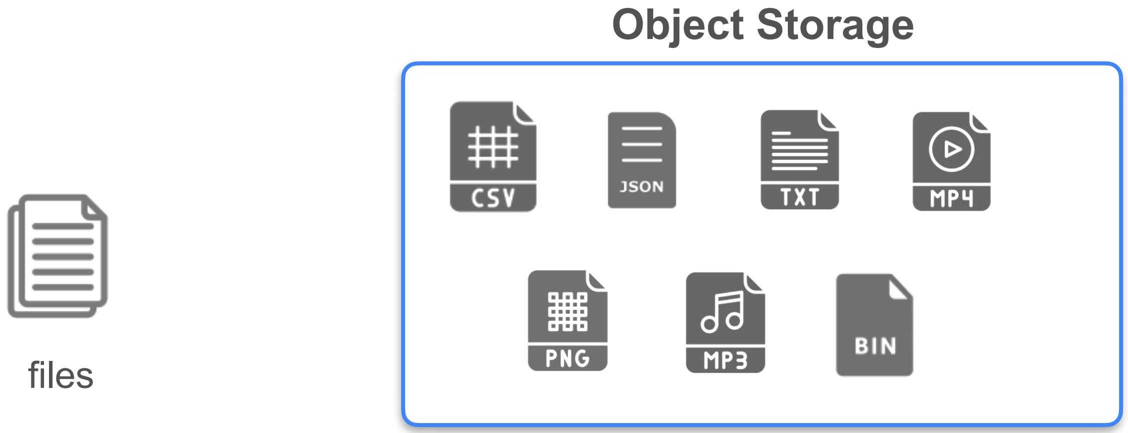
| Name | Type | Last modified | Size | Storage class |
|---|---|---|---|---|
| output-2024-03-01/ | Folder | - | - | - |
| output-2024-03-02/ | Folder | - | - | - |
| output-2024-03-03/ | Folder | - | - | - |

# Object Storage



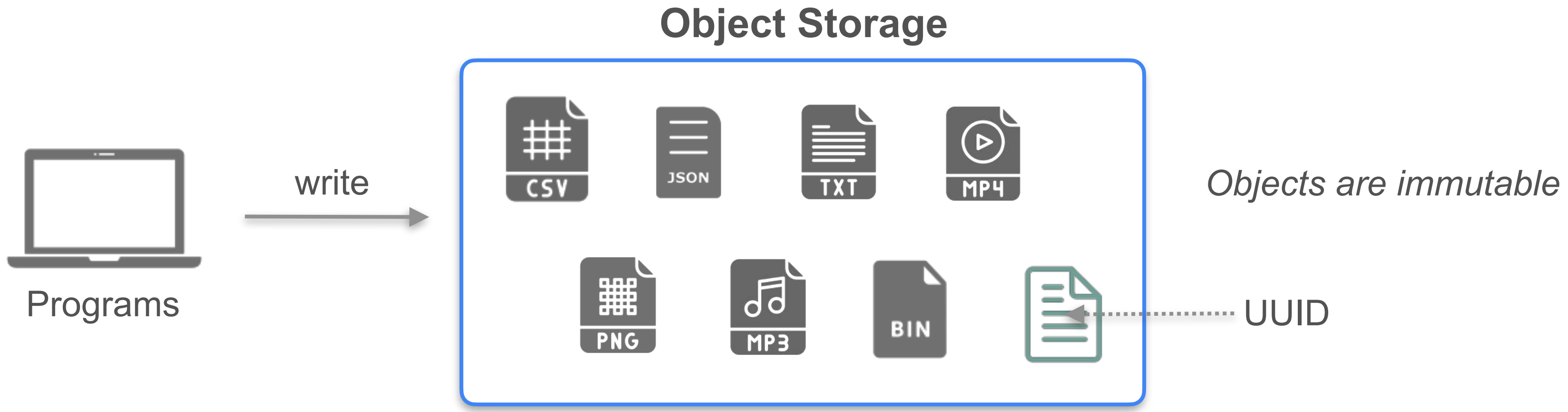
No hierarchy!

## Object Storage



- Storing semi-structured and unstructured data
- Serving data for training machine learning models

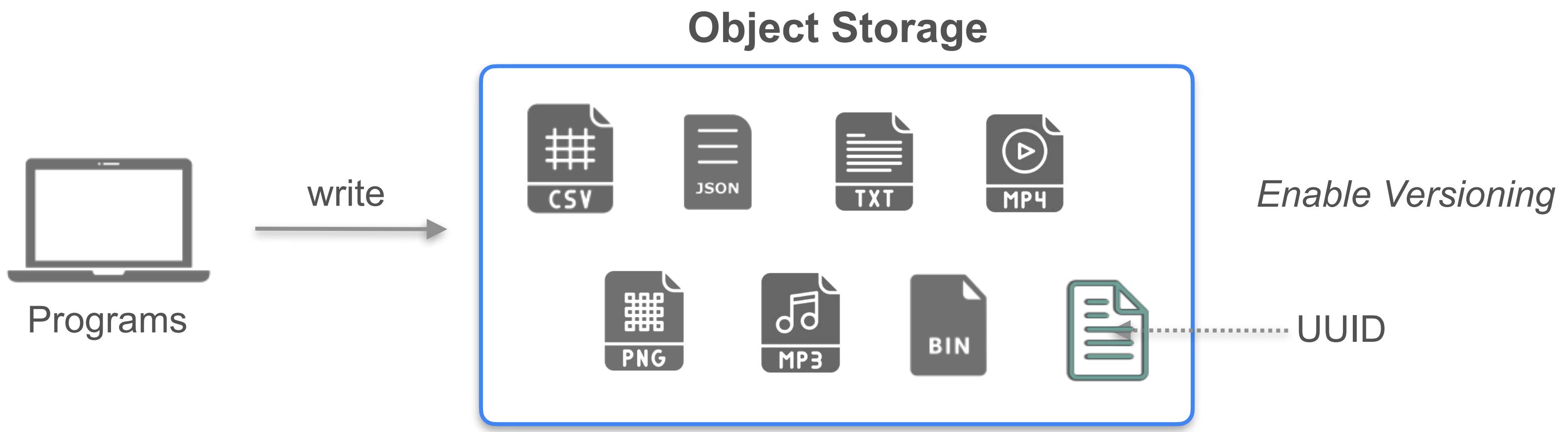
# Object Storage



For each object,

- Universal Unique Identifier or UUID (key)
- Metadata: creation date, file type, owner

# Object Storage



For each object,

- Universal Unique Identifier or UUID (key)
- Metadata: creation date, file type, owner, version

## Why Use Object Storage?

- Store files of various data formats without a specific file system structure
- Easily scale out to provide virtually limitless storage space
- Replicate data across several availability zones

Amazon S3 → 99.999999999% : data durability

- Cheaper than other storage options

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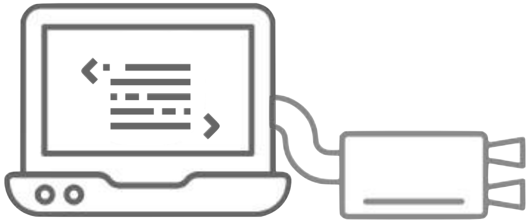
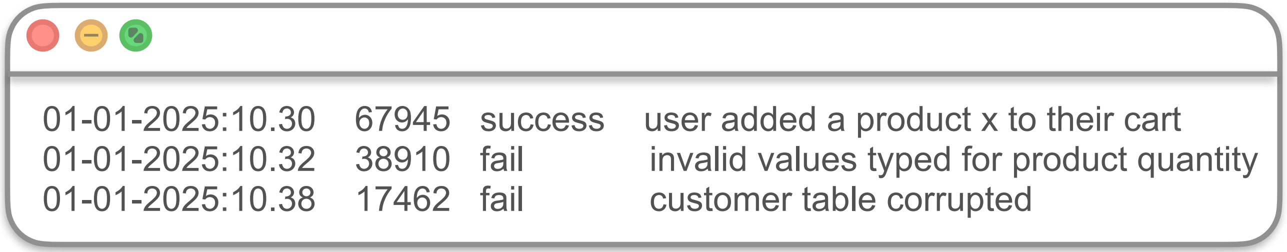
## Introduction to Source Systems

### Logs

## Logs



**Logs**



```
01-01-2025:10.30   67945   success   user added a product x to their cart
01-01-2025:10.32   38910   fail      invalid values typed for product quantity
01-01-2025:10.38   17462   fail      customer table corrupted
```

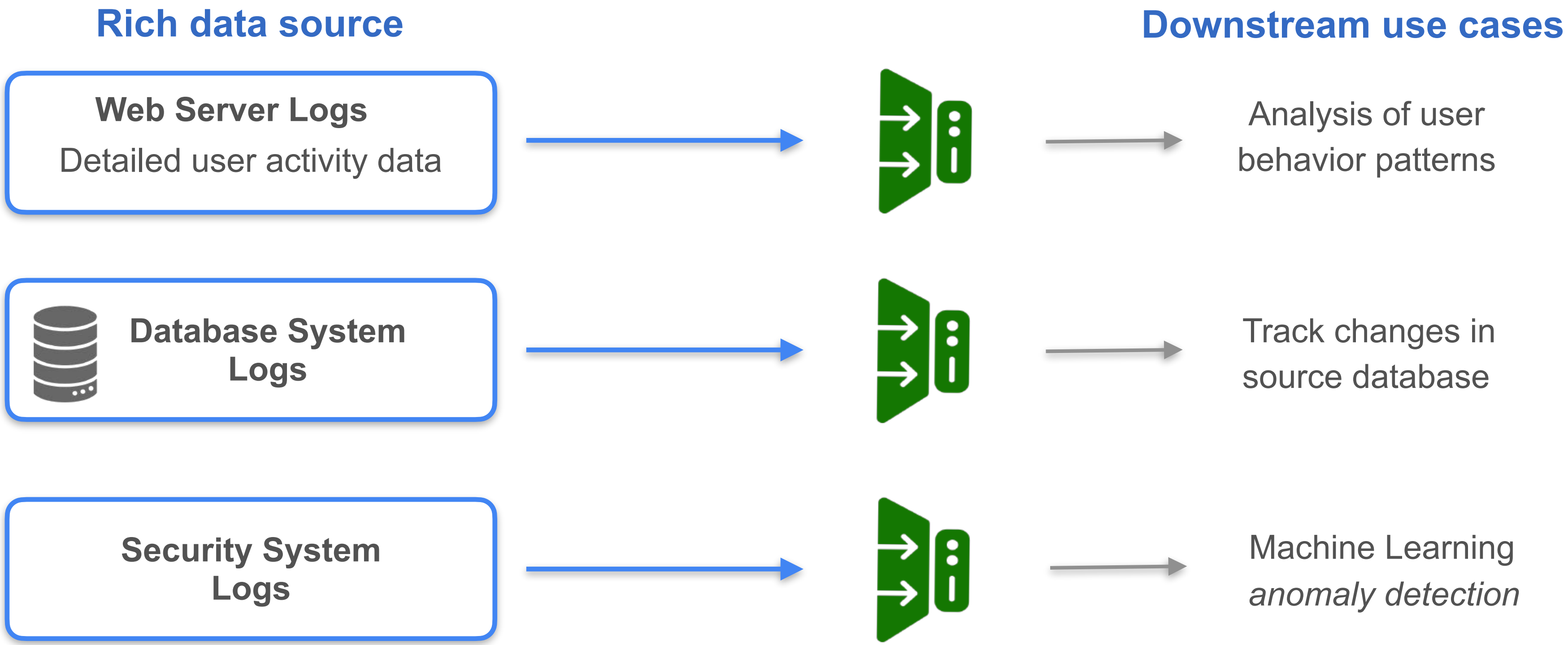
Exhaust / Byproduct

**Monitoring or Debugging a system**

- User activity:
    - Signing in
    - navigating to a particular page
- An update to a database
- An error from a procedure

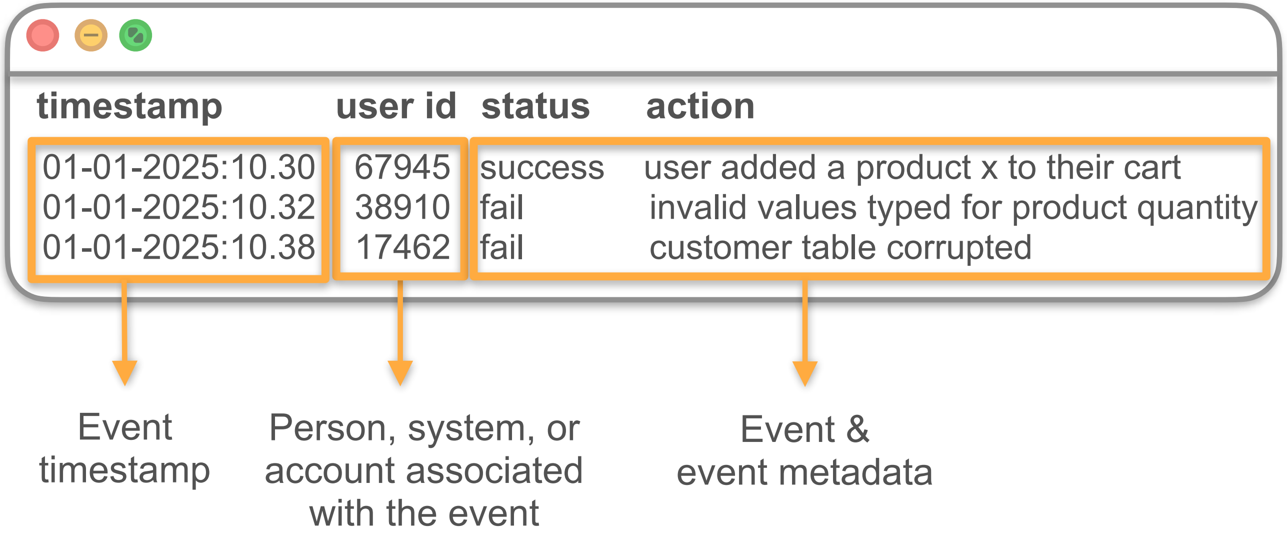
**Log**

An append-only sequence of records ordered by time, capturing information about events that occur in systems.


Rich data source
Downstream use cases
Web Server Logs
Detailed user activity data
Database System Logs
Security System Logs
Analysis of user behavior patterns
Track changes in source database
Machine Learning *anomaly detection*

## Log

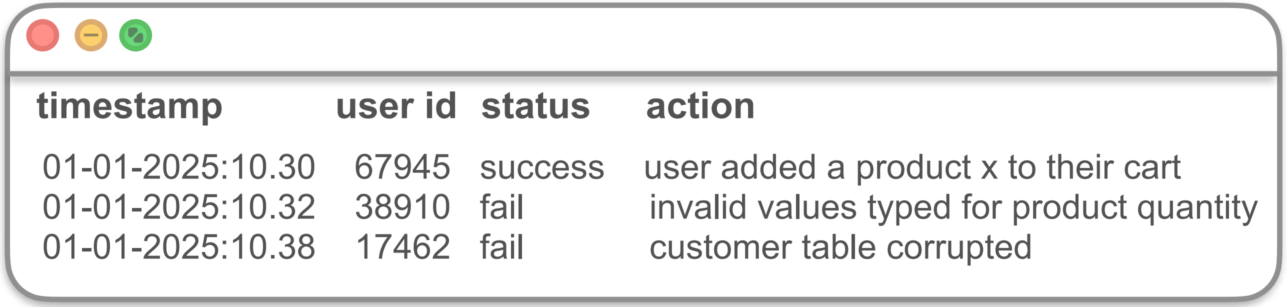
An append-only sequence of records ordered by time, capturing information about events that occur in systems.



| timestamp | user id | status | action |
|---|---|---|---|
| 01-01-2025:10.30 | 67945 | success | user added a product x to their cart |
| 01-01-2025:10.32 | 38910 | fail | invalid values typed for product quantity |
| 01-01-2025:10.38 | 17462 | fail | customer table corrupted |

## Log

An append-only sequence of records ordered by time, capturing information about events that occur in systems.



```
timestamp            user id   status     action
01-01-2025:10.30     67945     success    user added a product x to their cart
01-01-2025:10.32     38910     fail       invalid values typed for product quantity
01-01-2025:10.38     17462     fail       customer table corrupted
```

```
{
  "user id": 67945,
  "action": "user added a product x to their cart",
  "status": "success",
  "time-stamp": 01-01-2025:10.30
}
```

[00101011 11000101 11001001 11000101 110001001]

| user id | action | status | timestamp |
|---|---|---|---|
| 67945 | user added a product x to their cart | success | 01-01-2025:10.30 |
| 38910 | invalid values typed for product quantity | fail | 01-01-2025:10.32 |
| 17462 | customer table corrupted | fail | 01-01-2025:10.38 |

## Log Levels

**A tag to categorize the event (log level)**

- “debug”
- “info”
- “warn”
- “error”
- “fatal”

| user id | action | status | timestamp | level |
|---|---|---|---|---|
| 67945 | user added a product x to their cart | success | 01-01-2025:10.30 | Info |
| 38910 | invalid values typed for product quantity | fail | 01-01-2025:10.32 | error |
| 17462 | customer table corrupted | fail | 01-01-2025:10.38 | fatal |

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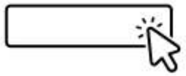
# Introduction to Source Systems

## Streaming Systems

# Terminology

**Event**

Something that happened in the world or a change to the state of a system.



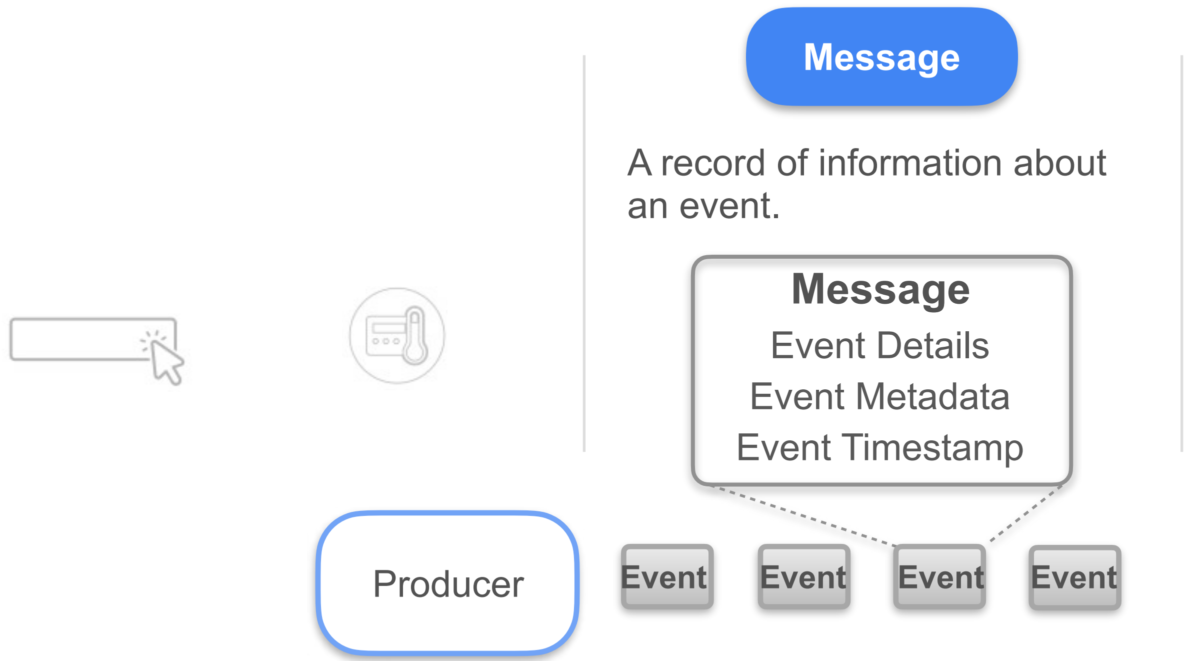
User clicking on a link

Sensor measuring a temperature change

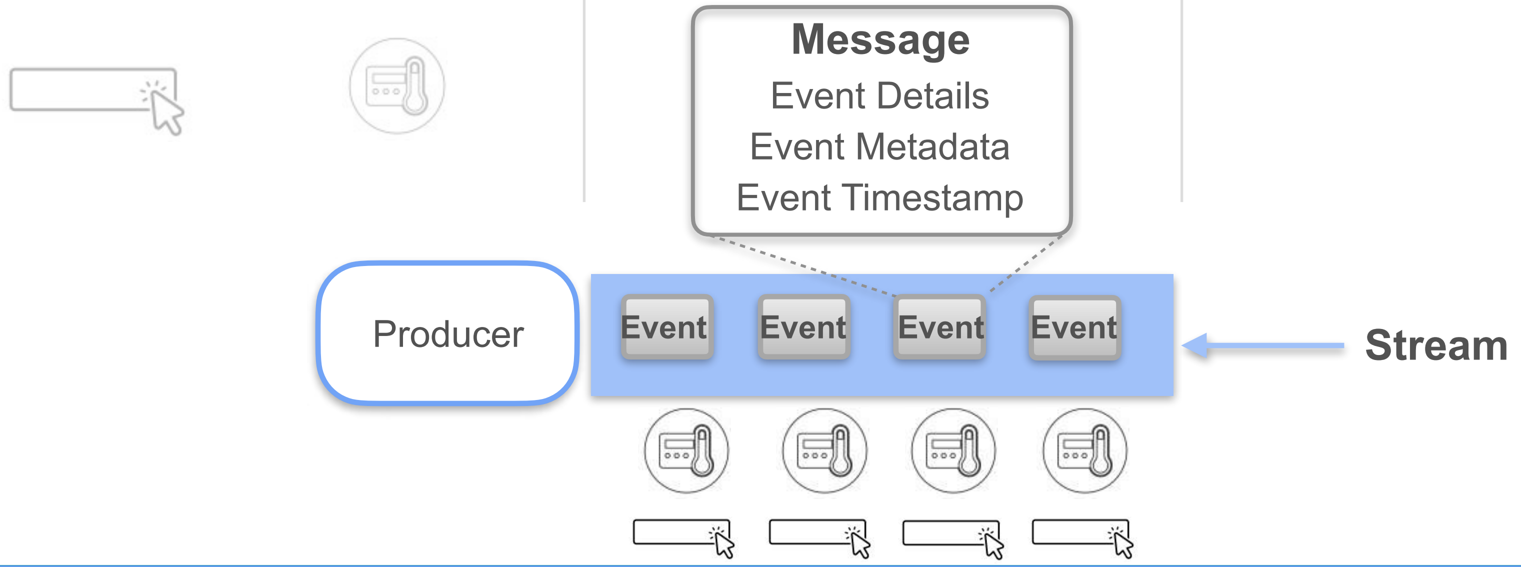
PEventer

Data: record of events

# Terminology



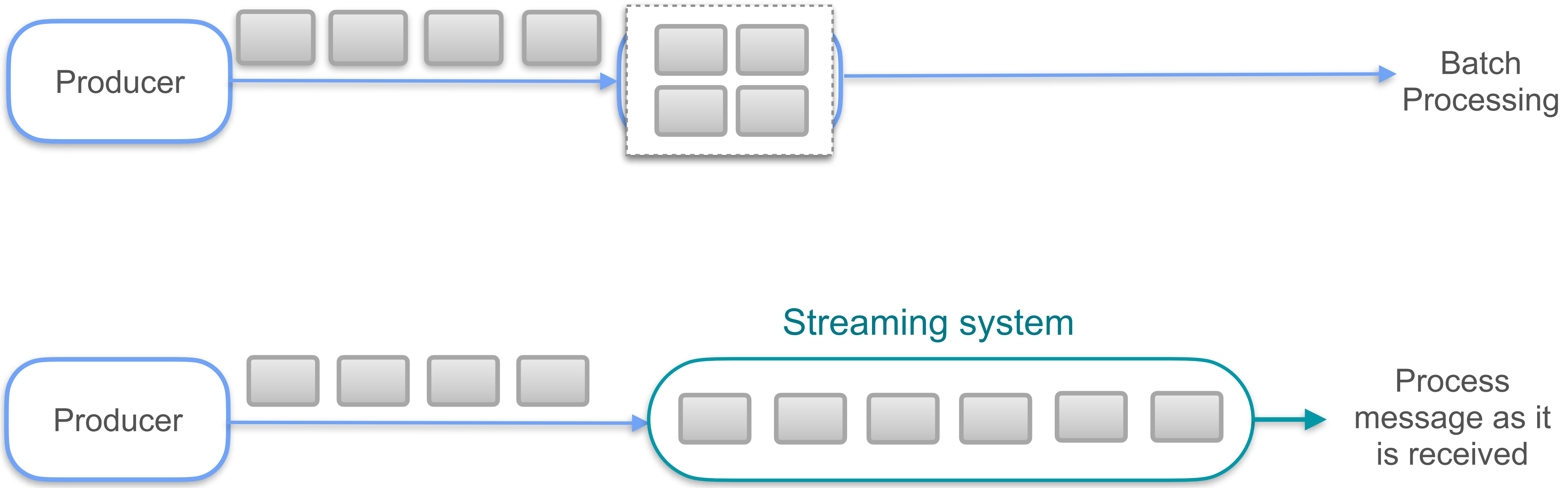
# Terminology



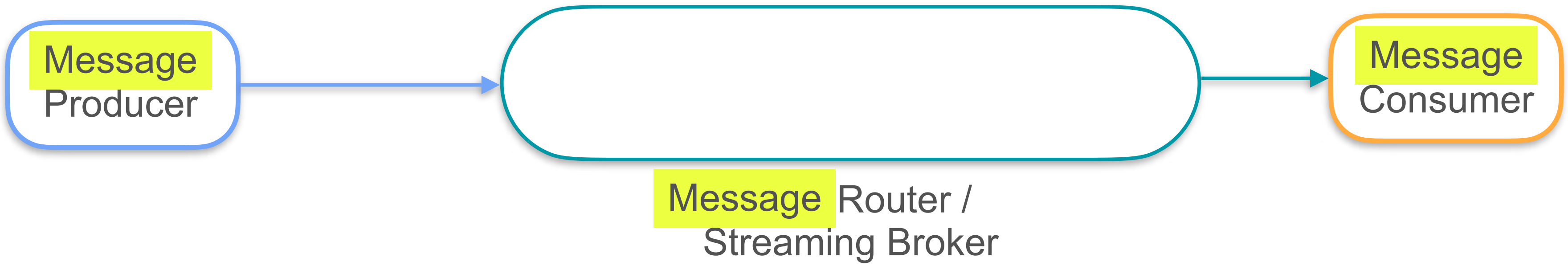
**Stream**

A sequence of messages.

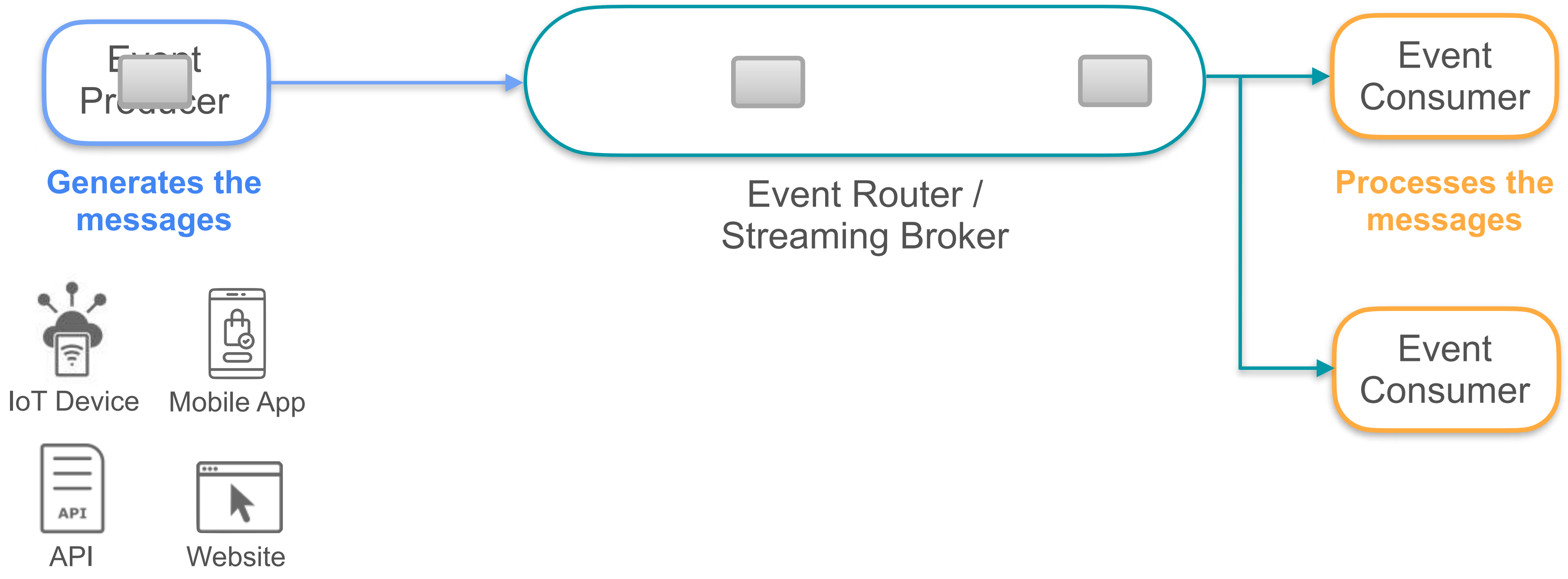
# Stream Processing



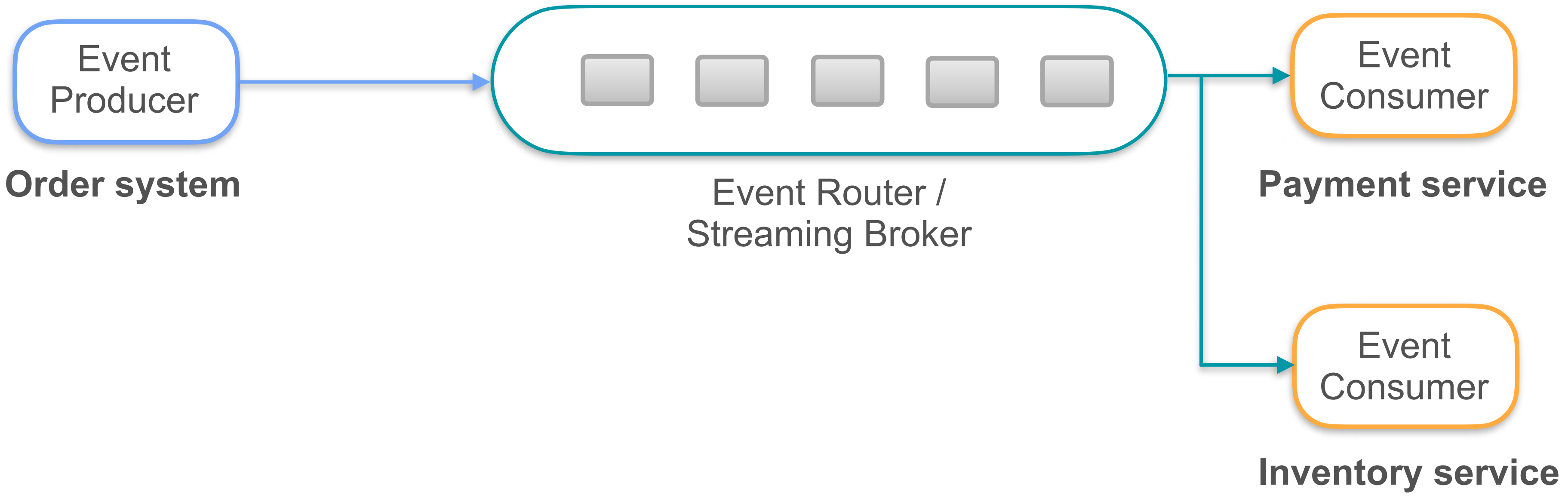
## Streaming System



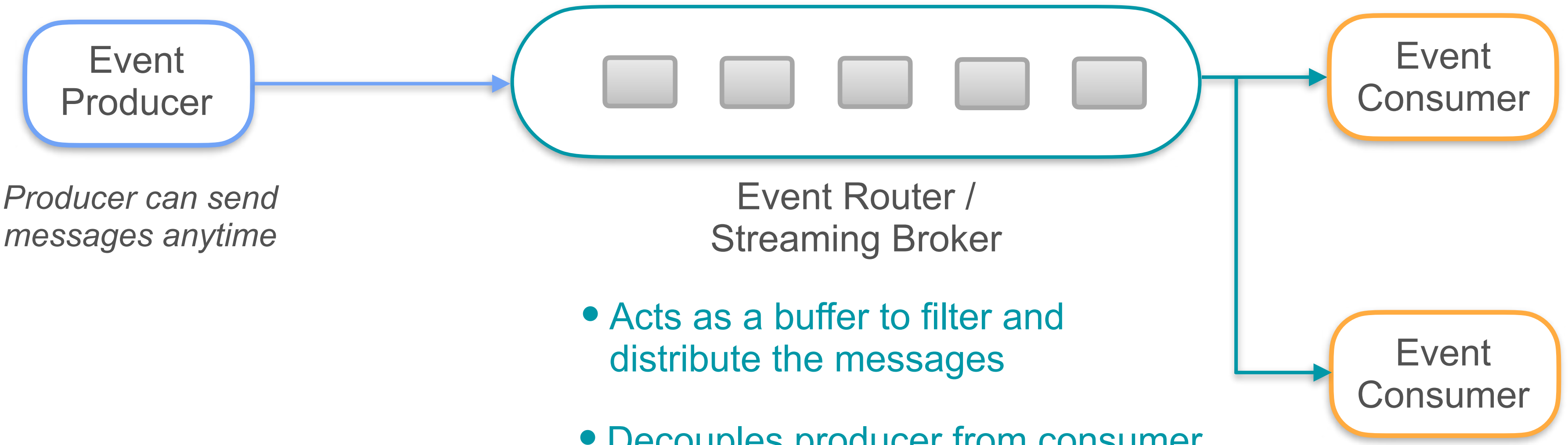
## Streaming System



# Streaming System



## Streaming System

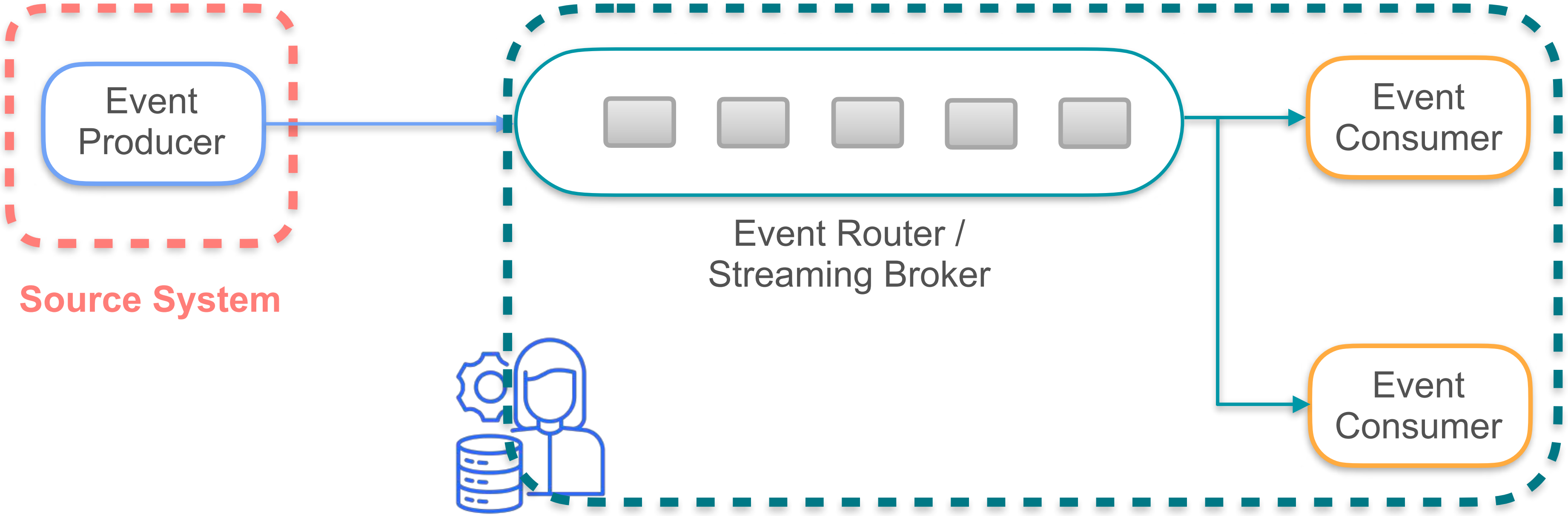


*Producer can send messages anytime*

Event Router / Streaming Broker

- Acts as a buffer to filter and distribute the messages
- Decouples producer from consumer
- Prevents message from being lost

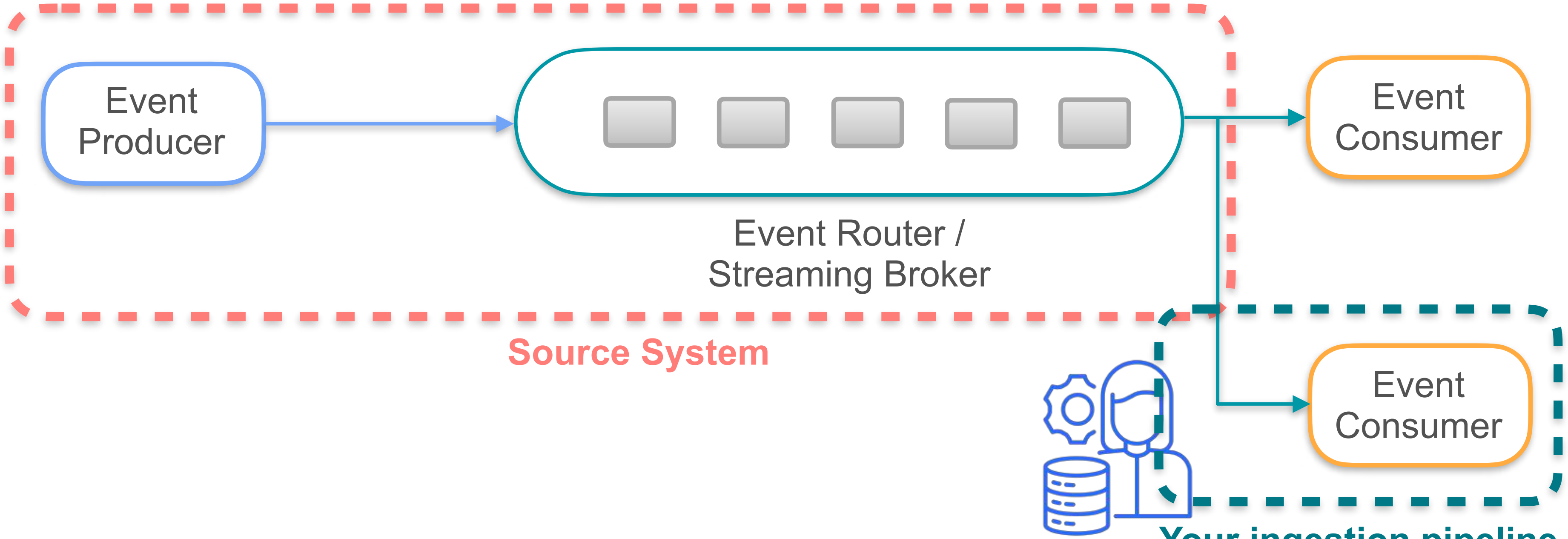
# Your Data System



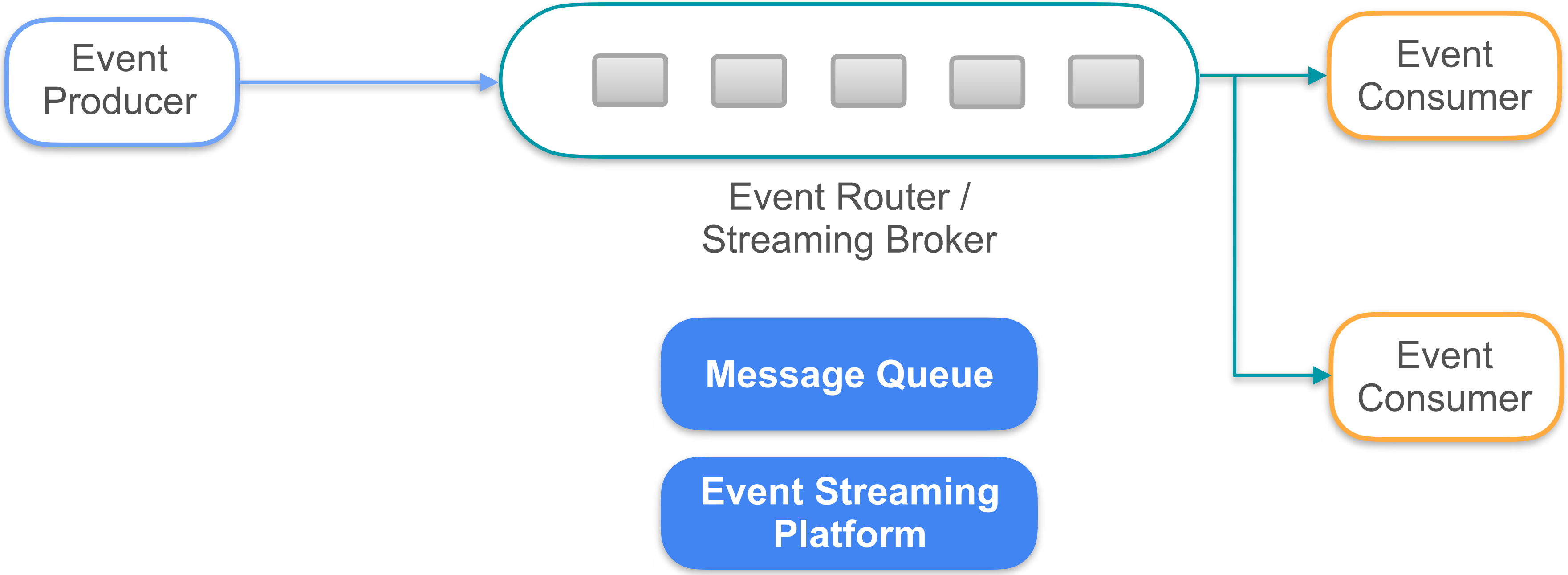
Source System

The system you build

## Your Data System

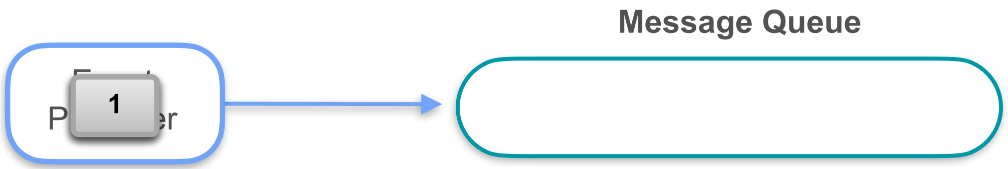

Event Producer
Event Router / Streaming Broker
Event Consumer
Event Consumer
Source System
Your ingestion pipeline starts here

# Streaming System



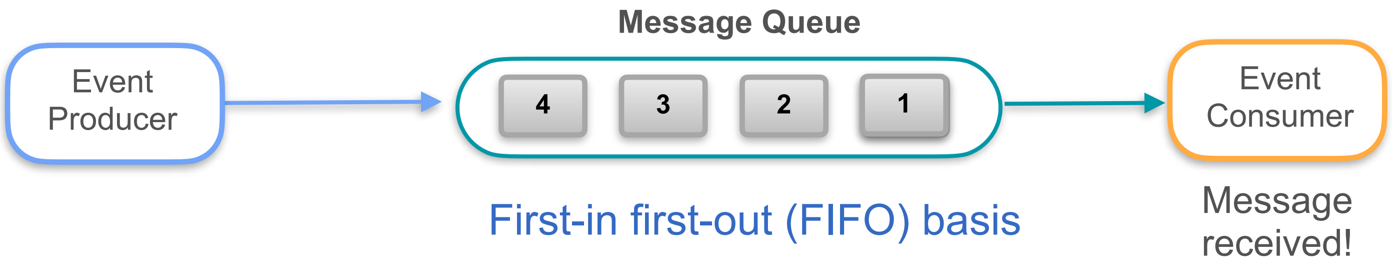
## Message Queue

A queue/buffer that accumulates messages



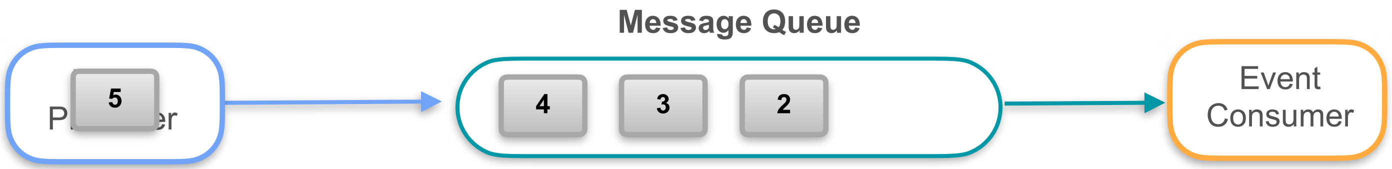
## Message Queue

A queue/buffer that accumulates messages and delivers those messages to consumers asynchronously.



## Message Queue

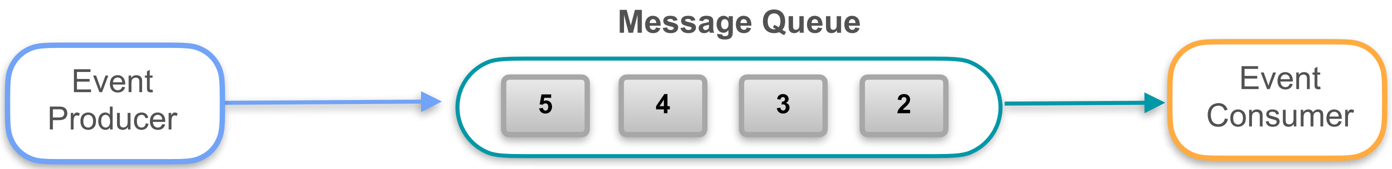
A queue/buffer that accumulates messages and delivers those messages to consumers asynchronously.



First-in first-out (FIFO) basis

## Message Queue

A queue/buffer that accumulates messages and delivers those messages to consumers asynchronously.



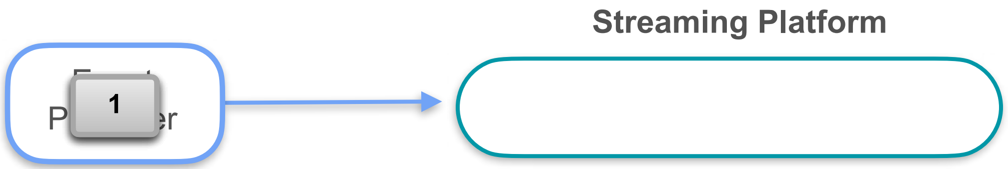
First-in first-out (FIFO) basis

*Temporary storage*

Amazon Simple Queue Service (Amazon SQS)

## Event Streaming Platform

Log: Append-only record of events

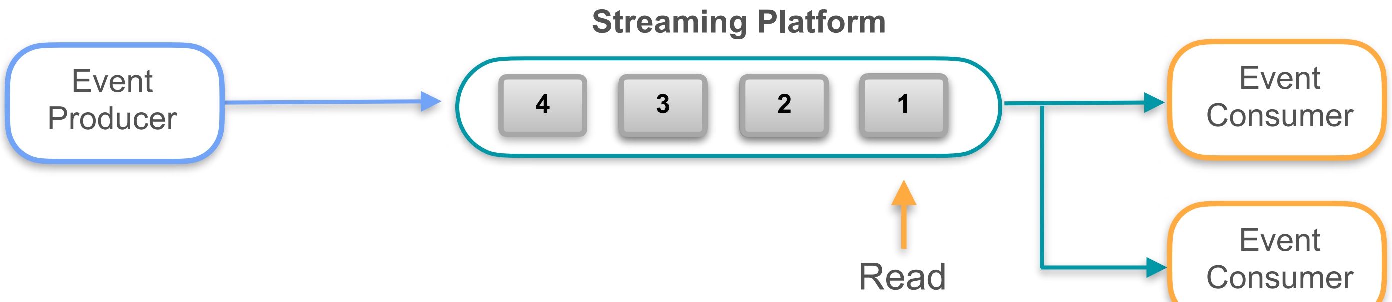


kafka

Amazon Kinesis Data Streams

## Event Streaming Platform

Log: Append-only record of events



Possible to replay or reprocess any events in the log

kafka

Amazon Kinesis Data Streams

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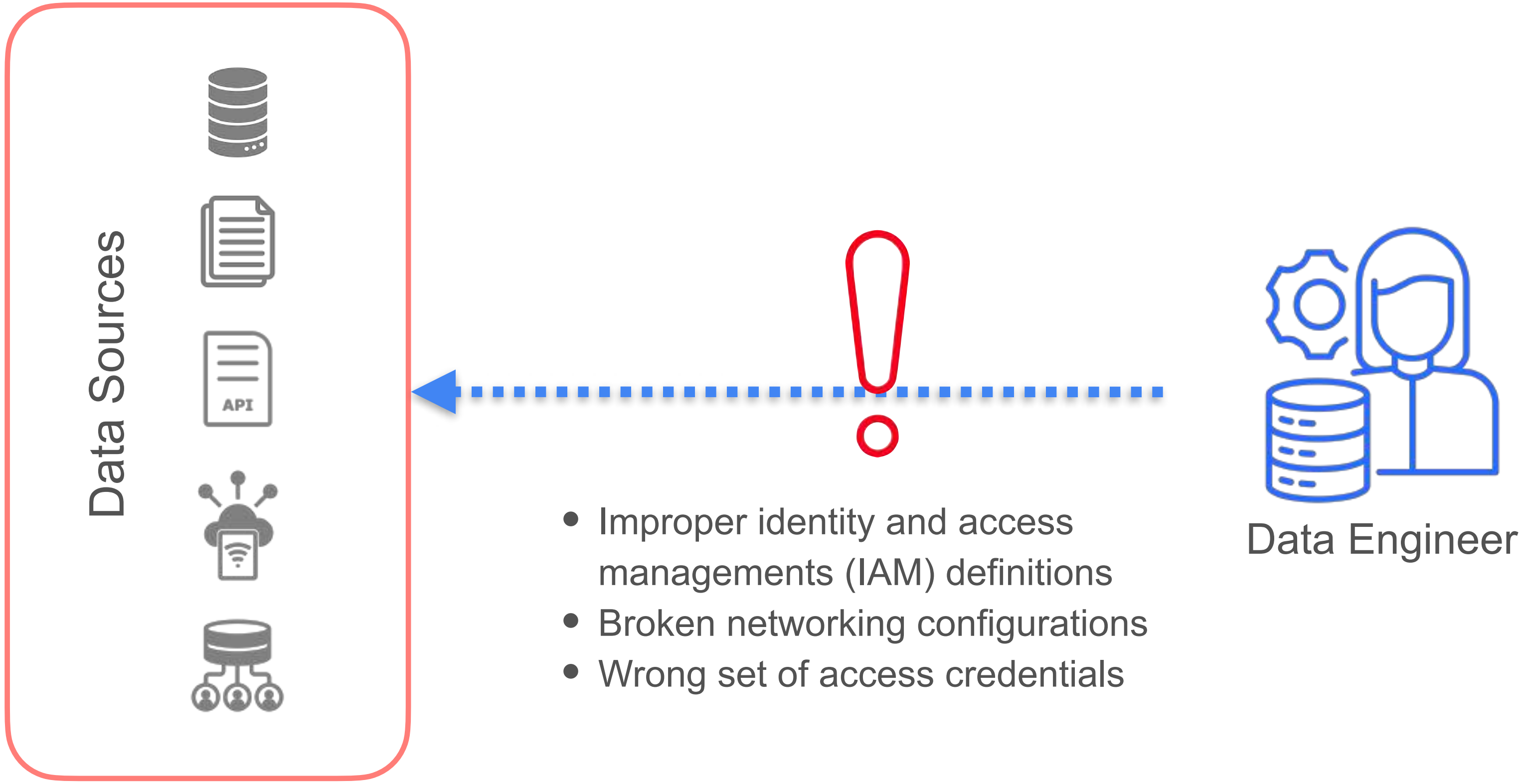
# Interacting with Source Systems

## Lesson Overview

## Connecting to Source Systems



- Improper identity and access managements (IAM) definitions
- Broken networking configurations
- Wrong set of access credentials

# Lesson's Plan

1. Ways of connecting to source systems

2. IAM roles and permissions

   *Key to controlling and managing access to cloud-based data sources*

Role

Permissions

## Lesson's Plan

1 Ways of connecting to source systems

2 IAM roles and permissions

*Key to controlling and managing access to cloud-based data sources*

Role

Permissions

3 Basics of networking

*VPCs and Subnets, Gateways, Routing, Security groups*

## Lesson's Plan

1 Ways of connecting to source systems

2 IAM roles and permissions

*Key to controlling and managing access to cloud-based data sources*

3 Basics of networking

*VPCs and Subnets, Gateways, Routing, Security groups*

**Real world scenario**

4 Lab exercise: put your skills to the test

Your job: troubleshoot and figure out the cause of the problem

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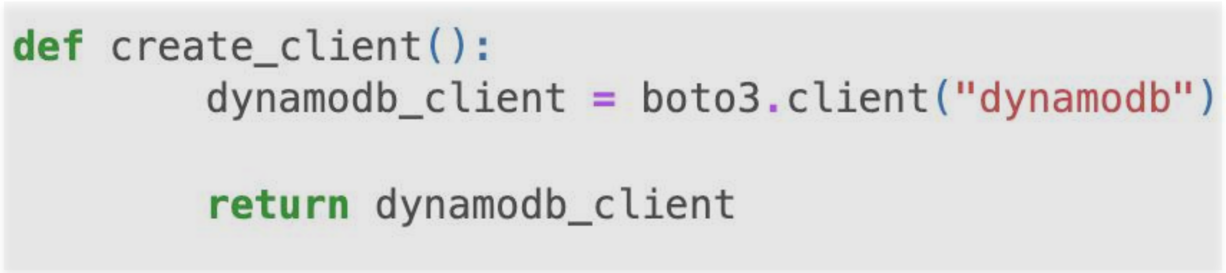
## Interacting with Source Systems

## Connecting to Source Systems

## Connecting to Source Systems



```python
def create_client():
        dynamodb_client = boto3.client("dynamodb")

        return dynamodb_client
```

boto3: AWS Software Development Kit (SDK) for Python

# Connecting to Source Systems

Running this command in Cloud9 IDE

```
mysql --host=<MySQLEndpoint> --user=<DatabaseUserName> --password=<Password> --port=3306
```

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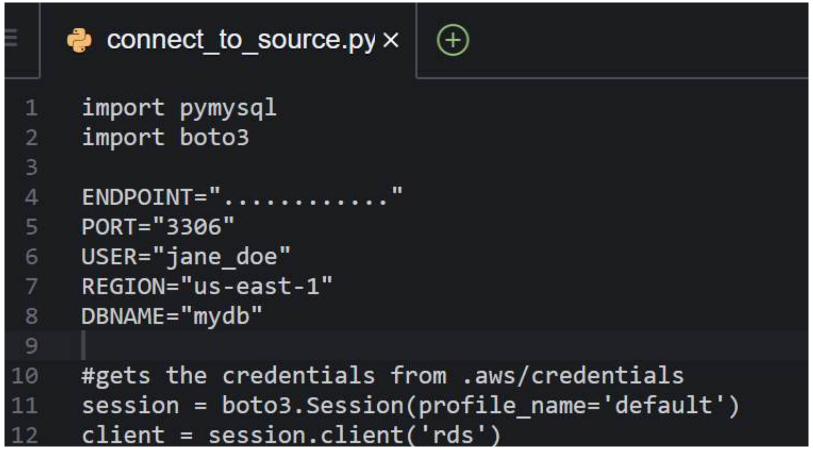
# Programmatic Way

**SDK (boto3)**

IDE (Cloud 9)

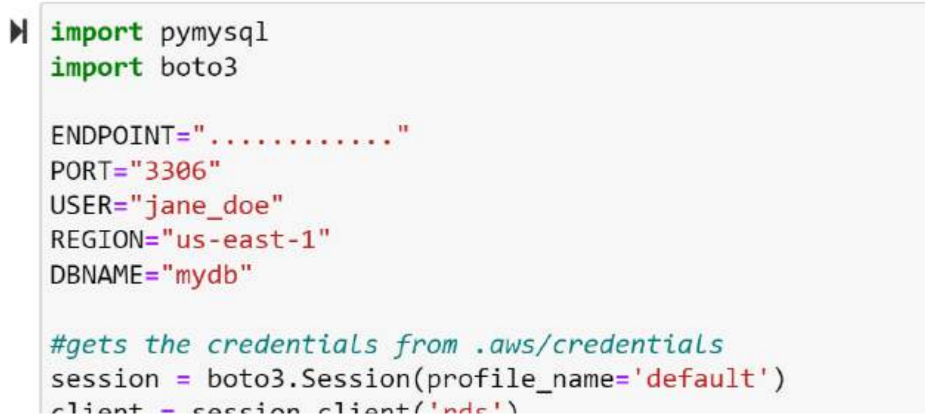


```python
import pymysql
import boto3

ENDPOINT="..........."
PORT="3306"
USER="jane_doe"
REGION="us-east-1"
DBNAME="mydb"

#gets the credentials from .aws/credentials
session = boto3.Session(profile_name='default')
client = session.client('rds')
```

Jupyter Notebook



```python
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REGION="us-east-1"
DBNAME="mydb"

#gets the credentials from .aws/credentials
session = boto3.Session(profile_name='default')
```
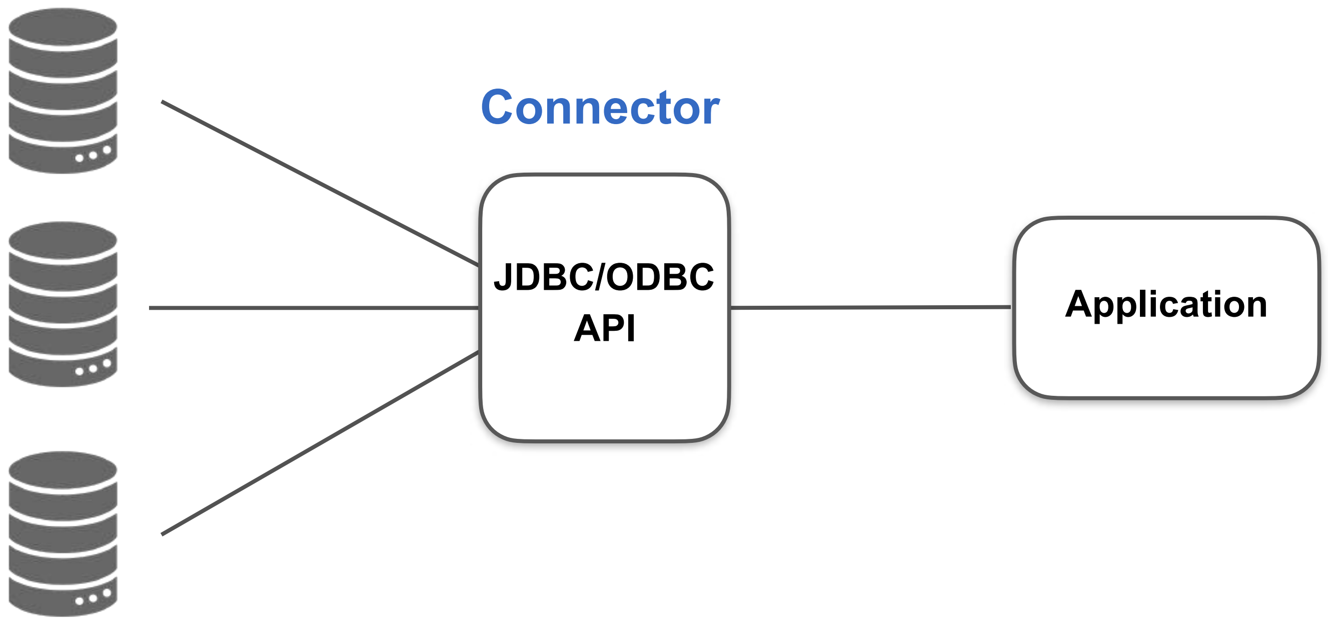

## API Connector



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## Interacting with Source Systems

## Basics of IAM and Permissions

# Security on the Cloud

Encryption Methods

Identity and Access Management (IAM)

Networking Protocols

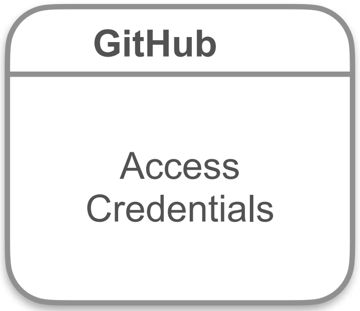
We're only human:

The #1 root cause of cloud data breaches is human error

- Insecure storage of passwords
- IAM misconfigurations

## Mistakes

**Public** S3 Bucket

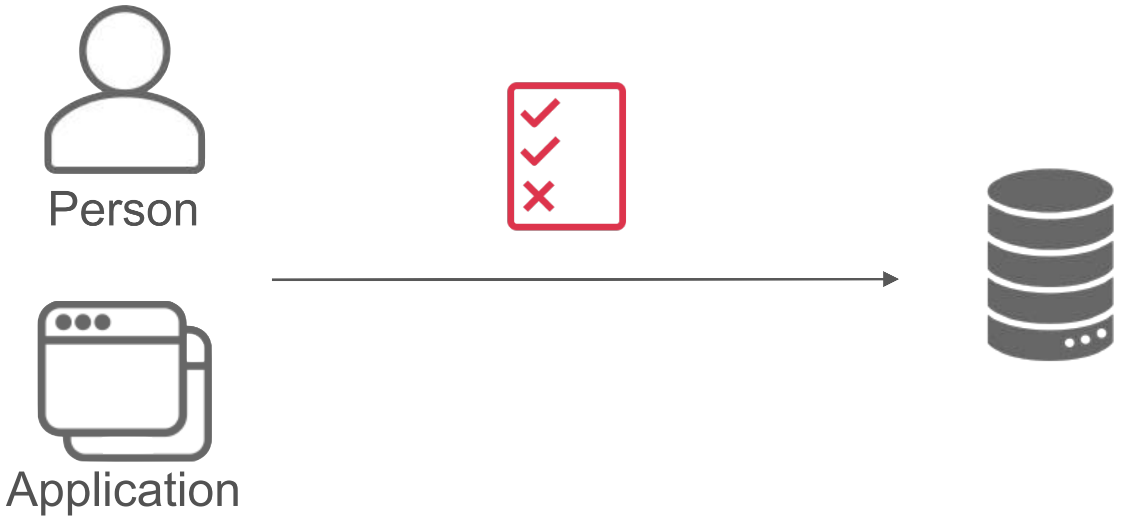


Admin access

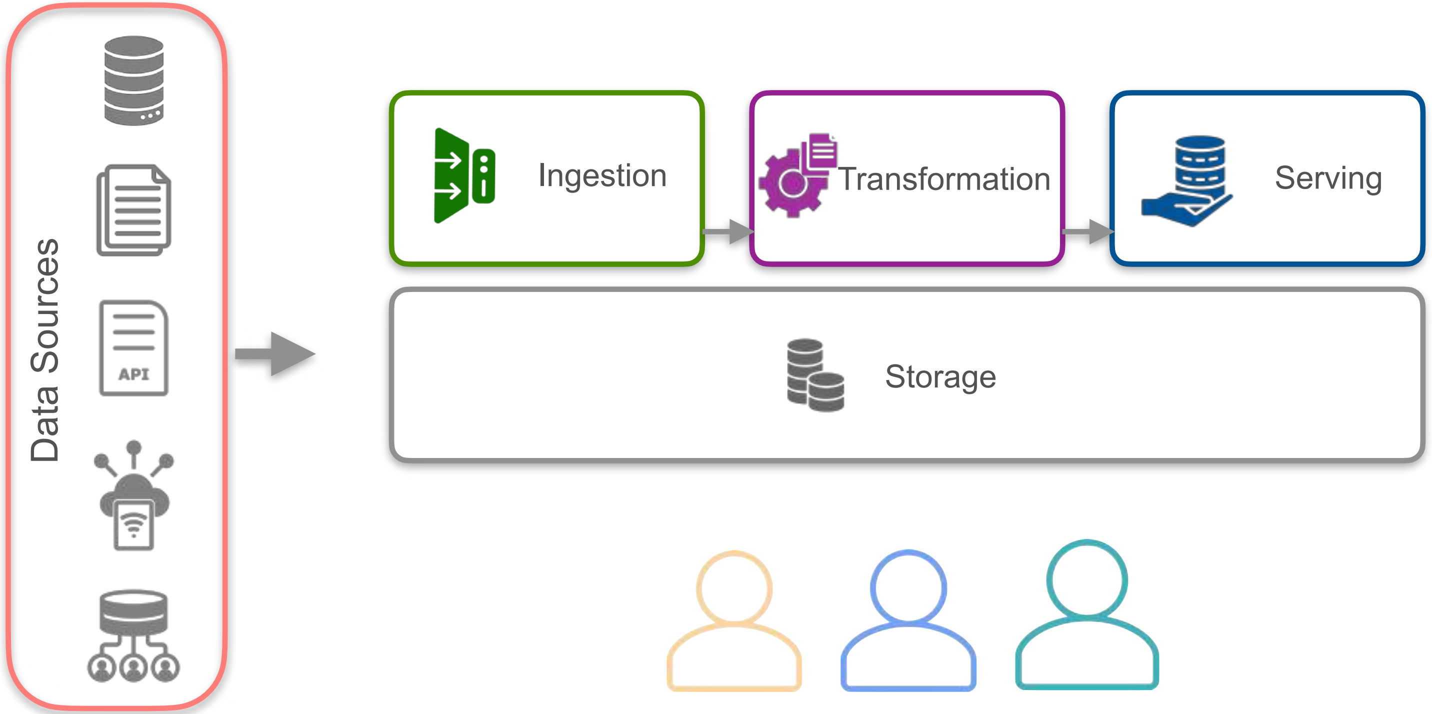
# IAM

**IAM is a framework for managing permissions.**

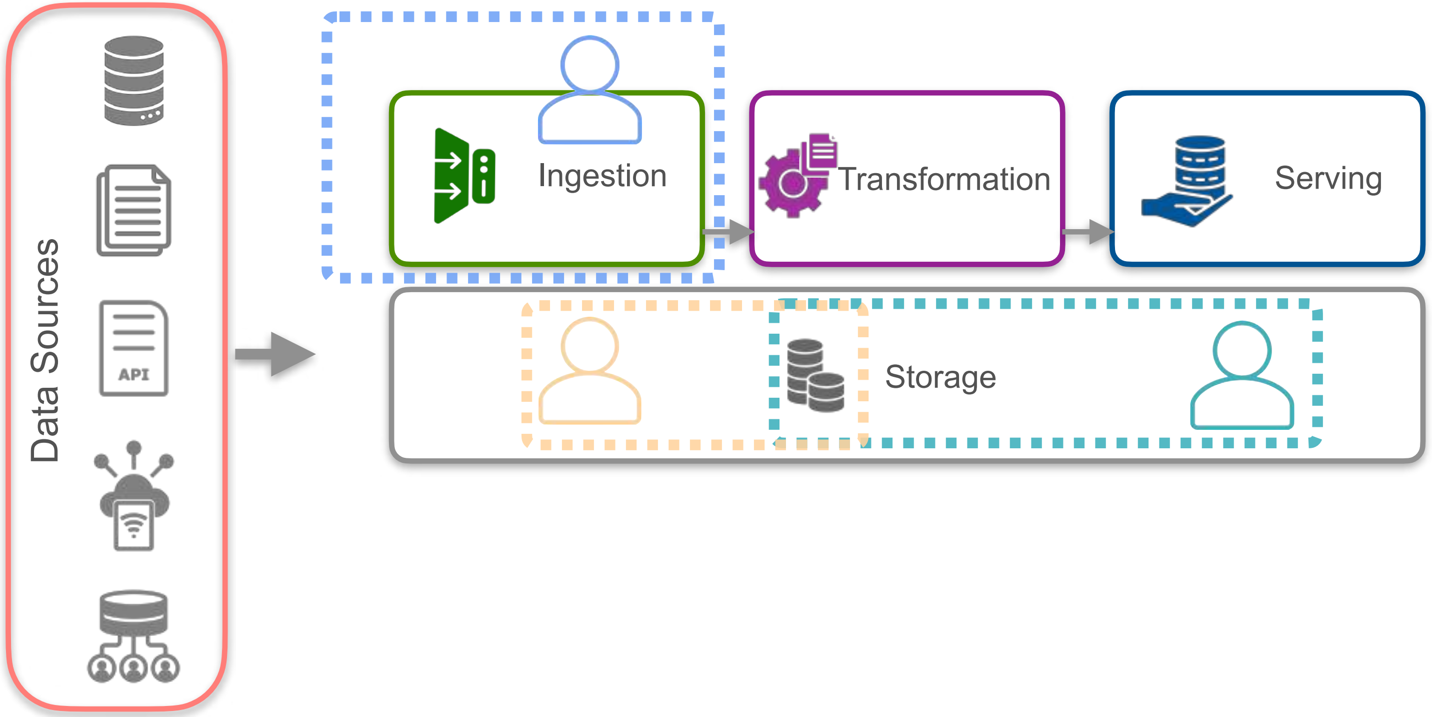
Permissions define which actions an identity can perform on a specific set of resources



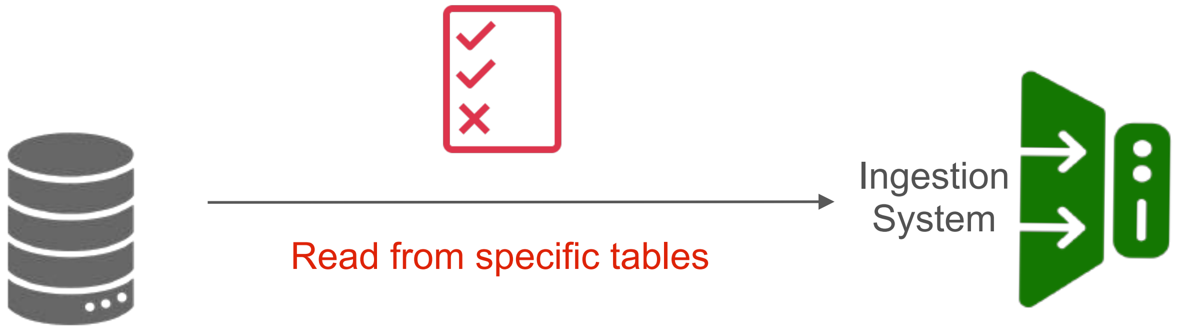
# Principle of Least Privilege



# Principle of Least Privilege



# Principle of Least Privilege



# AWS IAM

AWS Identity and Access Management (IAM)

# AWS IAM

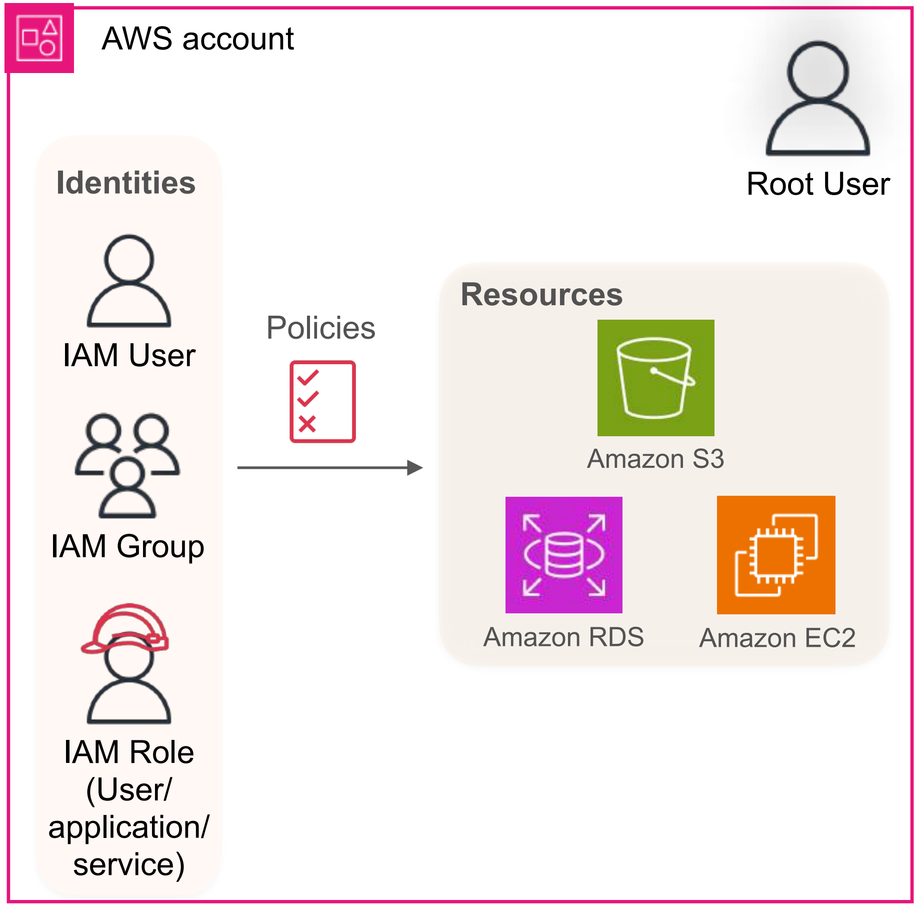
**Root User** Has unrestricted access to all resources

**IAM User** Has specific permissions to certain resources

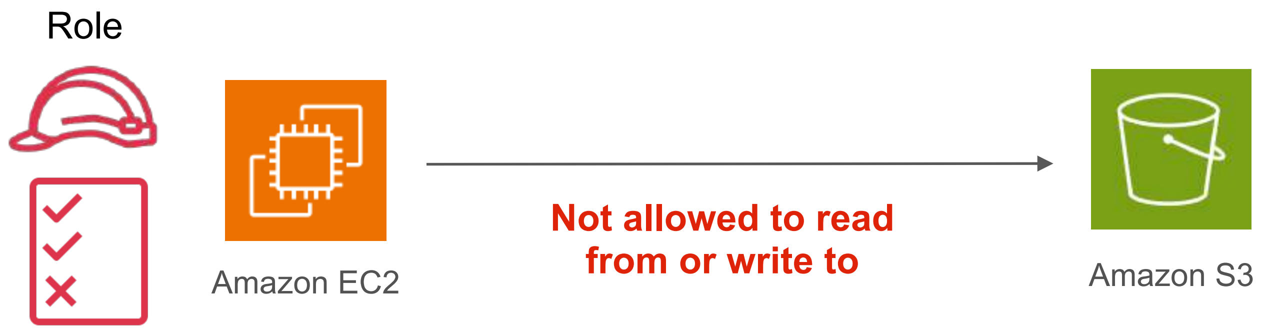
- Username & password
- Access key

**IAM Group** A collection of users that inherit the same permission from the group policy

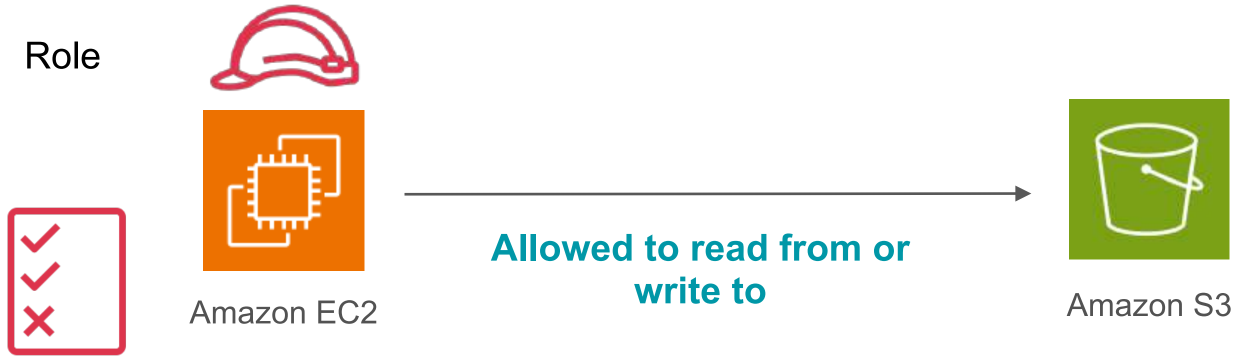
**IAM Role** A user, application, or service that's been granted temporary permissions



# AWS IAM


Role
Amazon EC2
Not allowed to read from or write to
Amazon S3

# AWS IAM



More secure than storing long-term user credentials within the EC2 configurations

Check if credentials have expired!

# IAM Policies

permission to access the specified S3 buckets

permission to access the AWS Glue job

```
{
 "Version":"2012-10-17",
 "Statement":[
   {
      “Sid”: “S3AccessDLAIBucket”,
      “Action”: [
               “s3:List*”,
               “s3:Get*”
      ],
      "Effect":"Allow",
      “Resource”: [
               “arn:aws:s3:::dlai-data-engineering”,
               “arn:aws:s3:::dlai-data-engineering/*”
      ]
   },
   {
      “Sid”: “GlueMgmt”,
      “Action”: [
               “glue:*”
      ],
      "Effect":"Allow",
      “Resource”: [
               “arn:aws:glue:*:*:catalog”,
               “arn:aws:glue:*:*:*/de-c1w2*”
      ]
   }
}
```

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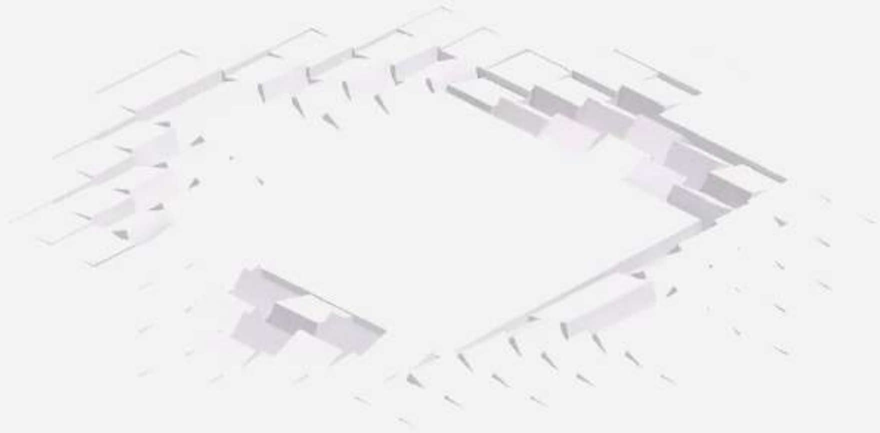
## Interacting with Source Systems

## Basics of Networking



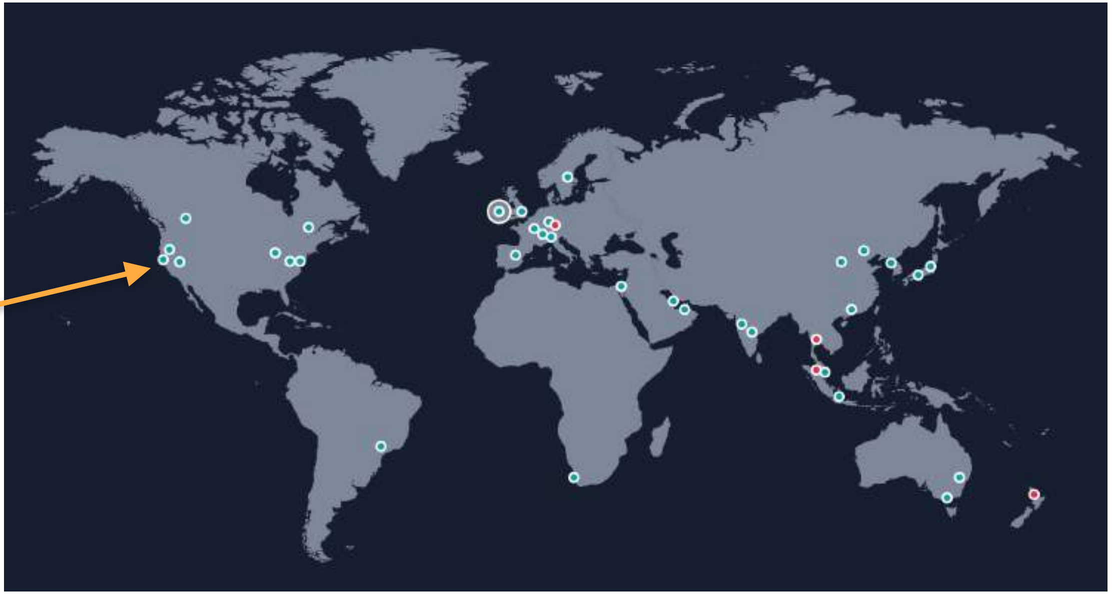
Video by Adobe Stock (paid license)

# AWS Cloud

## What does cloud in “cloud computing” mean?

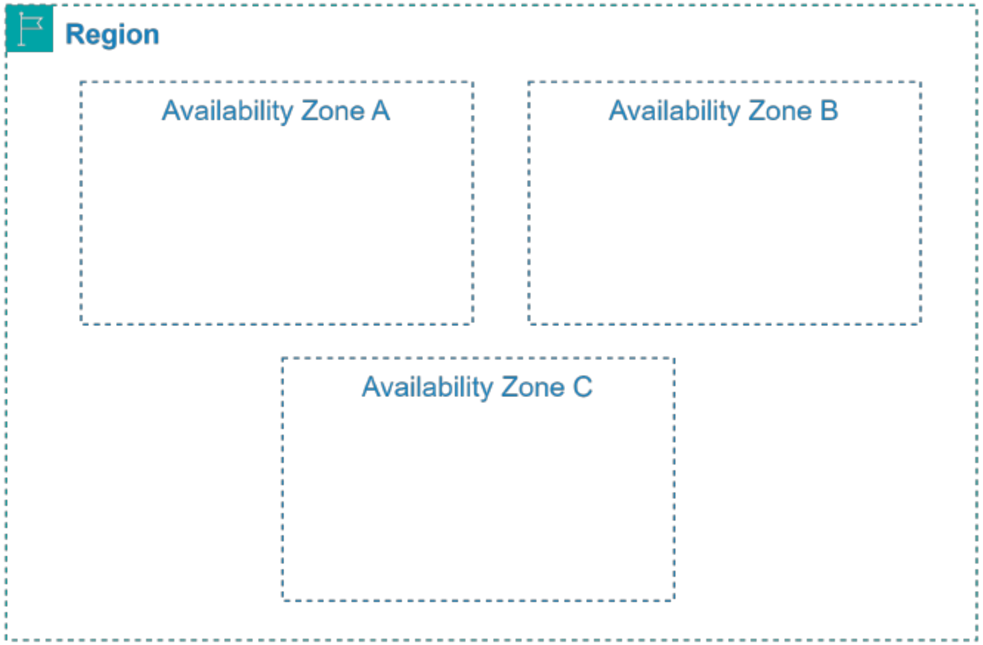
The “cloud” is made up of very real physical data centers that are spread out around the world.

Each dot represents a region



Screenshot from AWS Global Infrastructure (2023)

# AWS Cloud



Resources are replicated across availability zones to ensure that your systems keep working even if a data center goes down.

## AWS Cloud

**Region considerations:**

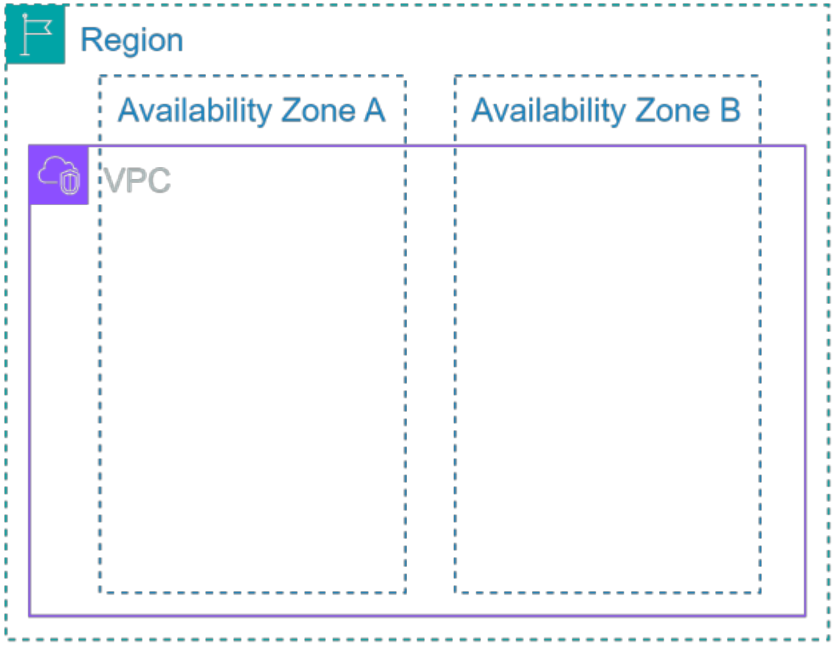
- Legal compliance
- Latency: *the closer your end users are to the region, the lower the latency*
- Availability: *the more availability zones, the better you will be able to recover from a disaster*
- Cost

# AWS Cloud

**Region considerations:**

- Legal compliance
- Latency
- Availability
- Cost

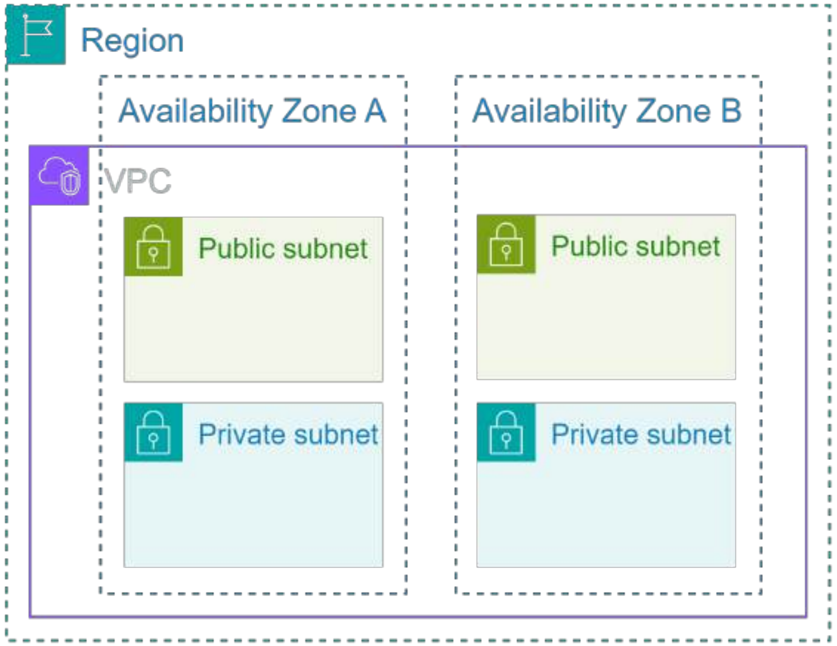
## Virtual Private Cloud



**Virtual Private Cloud (VPC)**

Smaller networks that span multiple availability zones

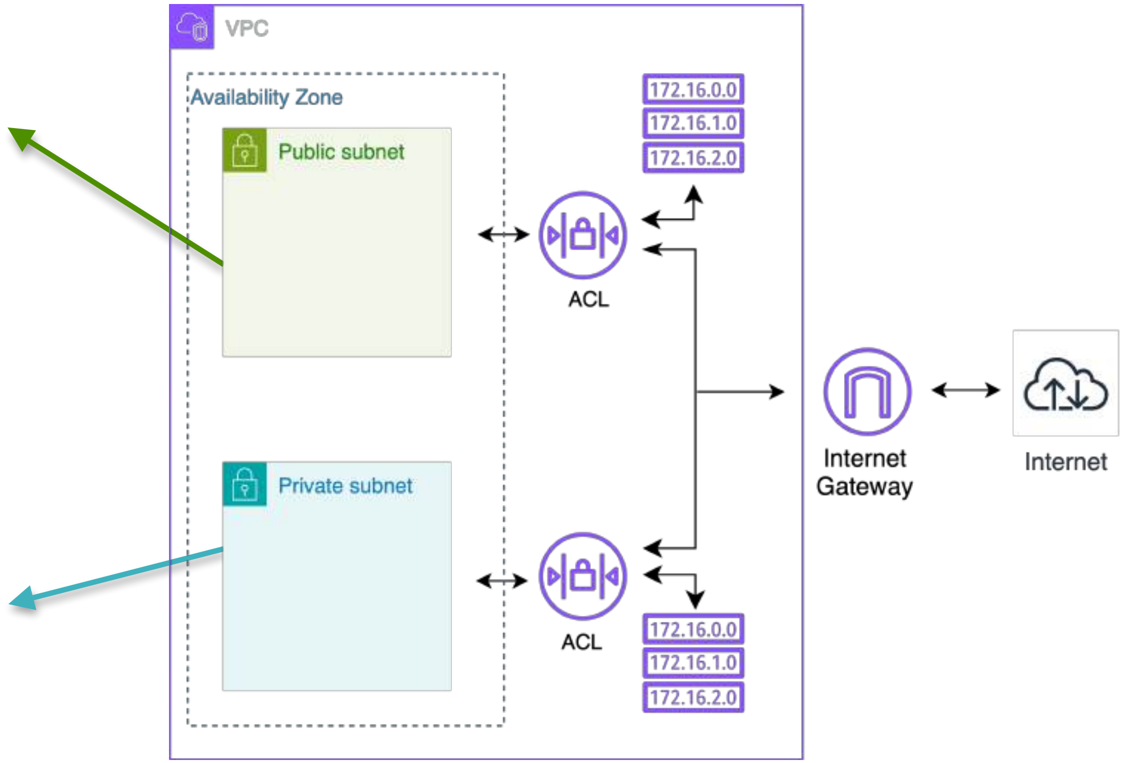
## Virtual Private Cloud



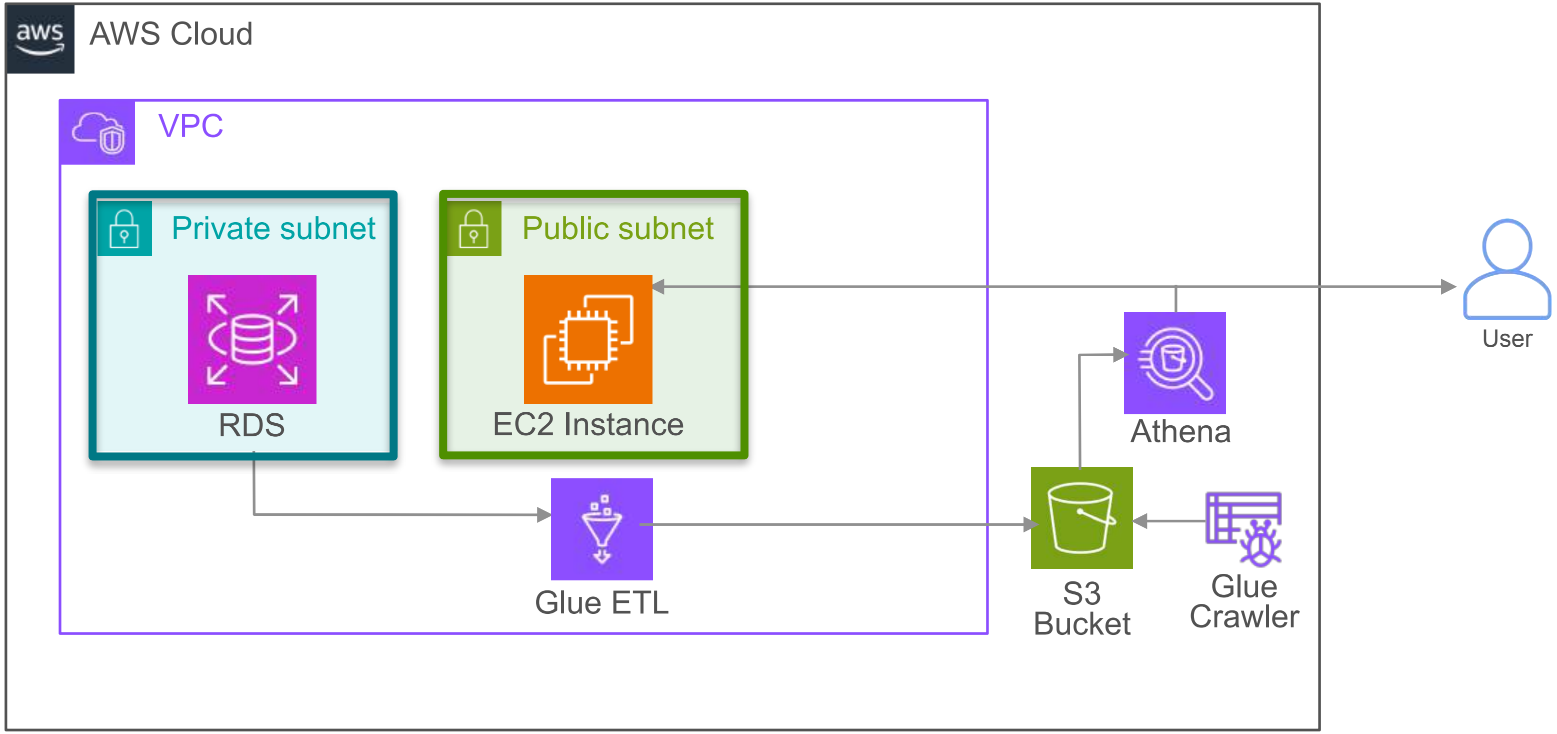
# Virtual Private Cloud

For internet-facing resources

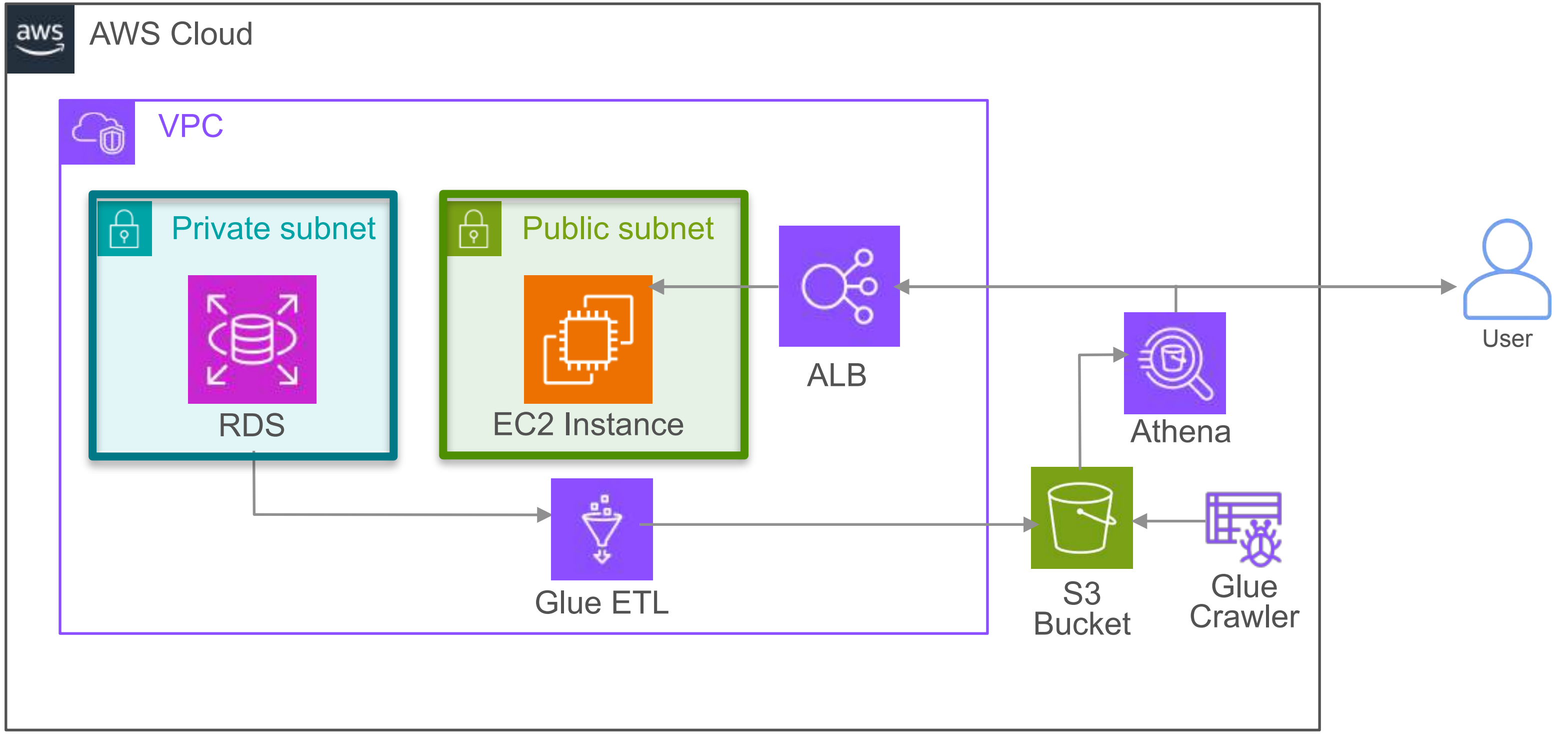
For internal resources



# Virtual Private Cloud



# Virtual Private Cloud



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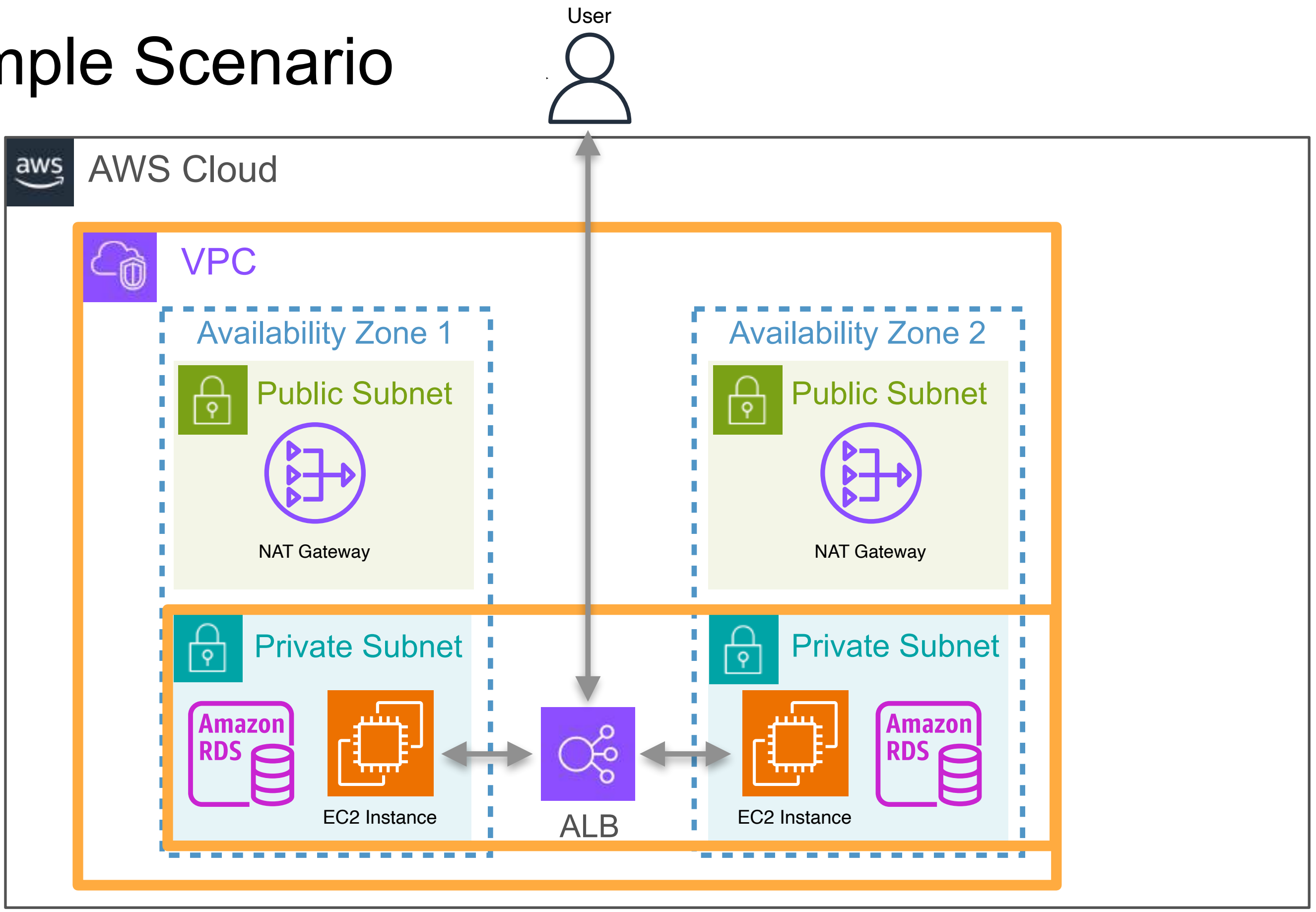
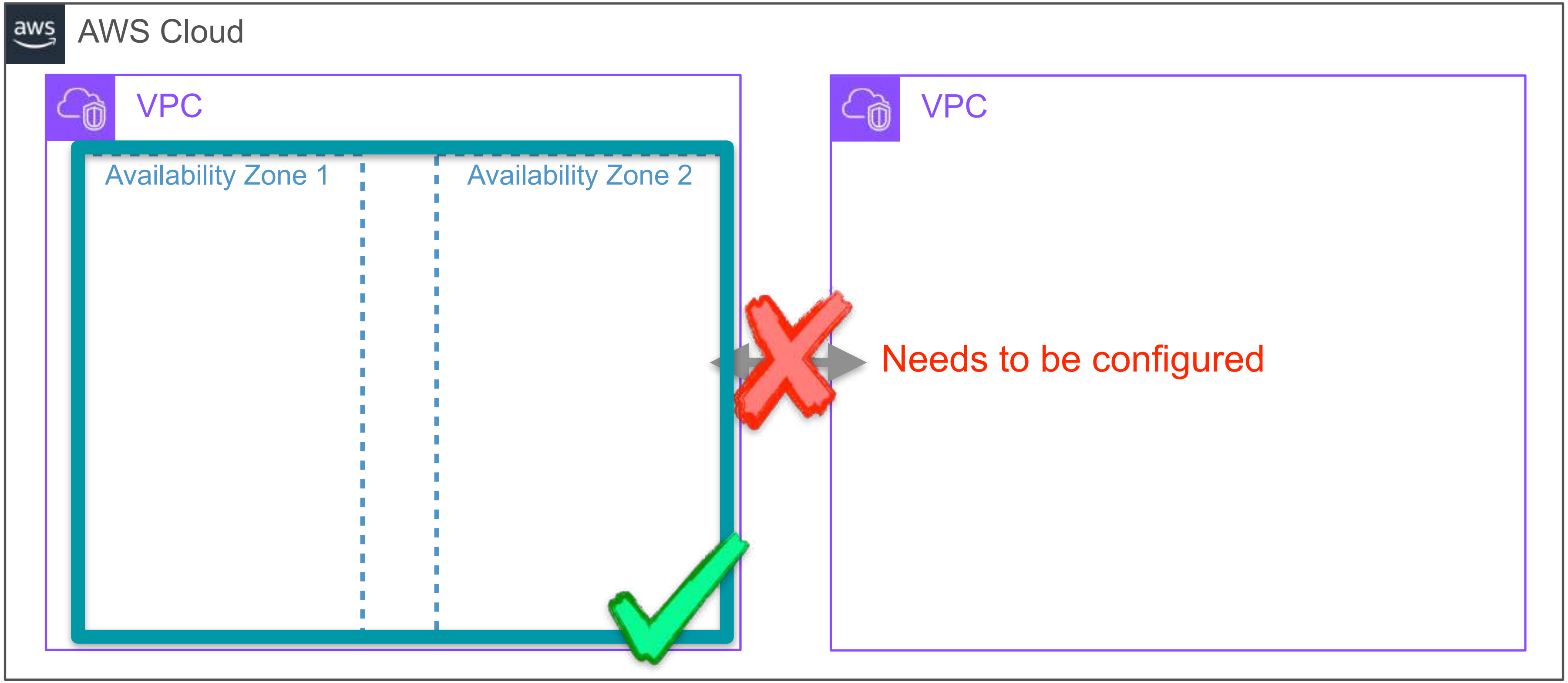
## Interacting with Source Systems

## AWS Networking - VPCs & Subnets

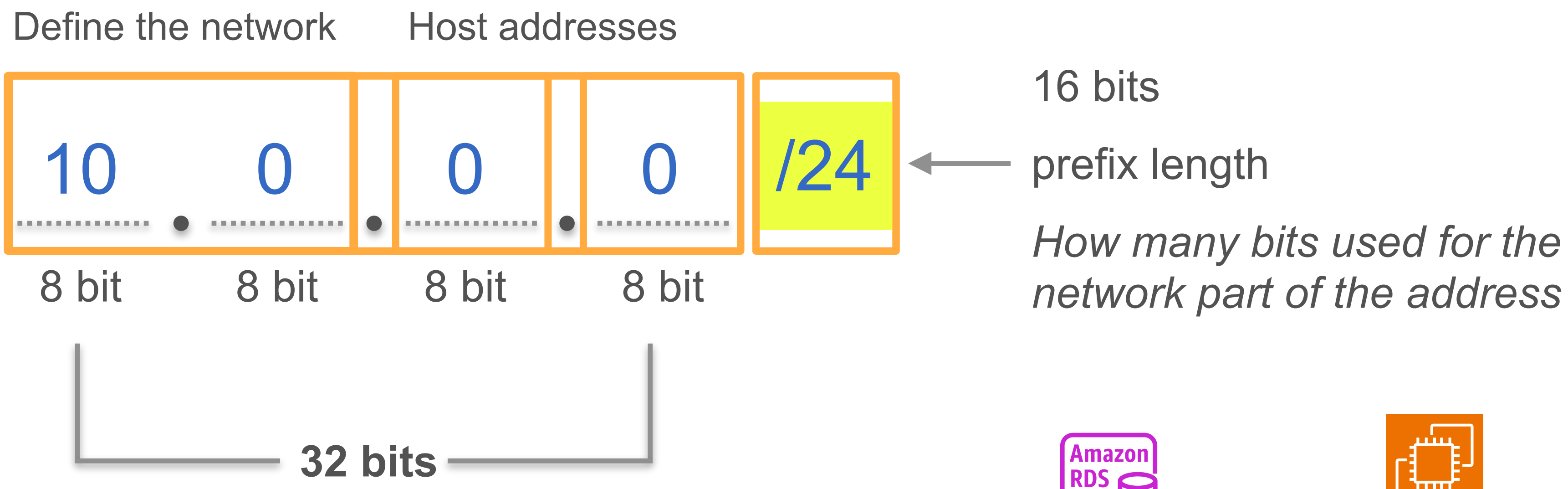
# Example Scenario



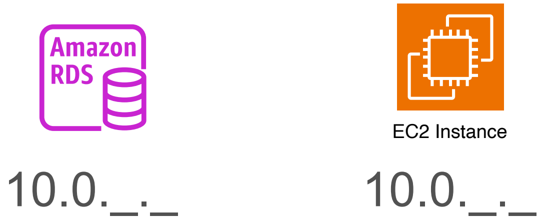
# AWS Networking - VPCs & Subnets



# AWS Networking - VPCs & Subnets

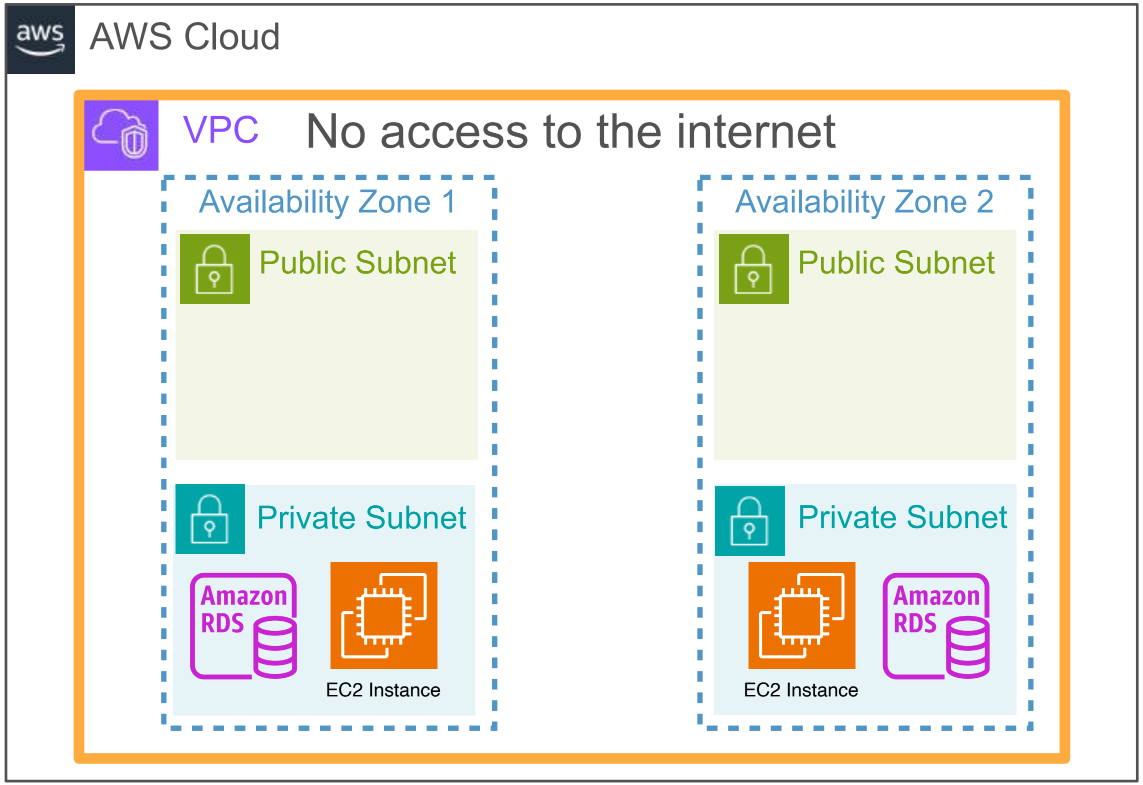


*How many bits used for the network part of the address*



0 to 255

# AWS Networking - VPCs & Subnets



Closed network

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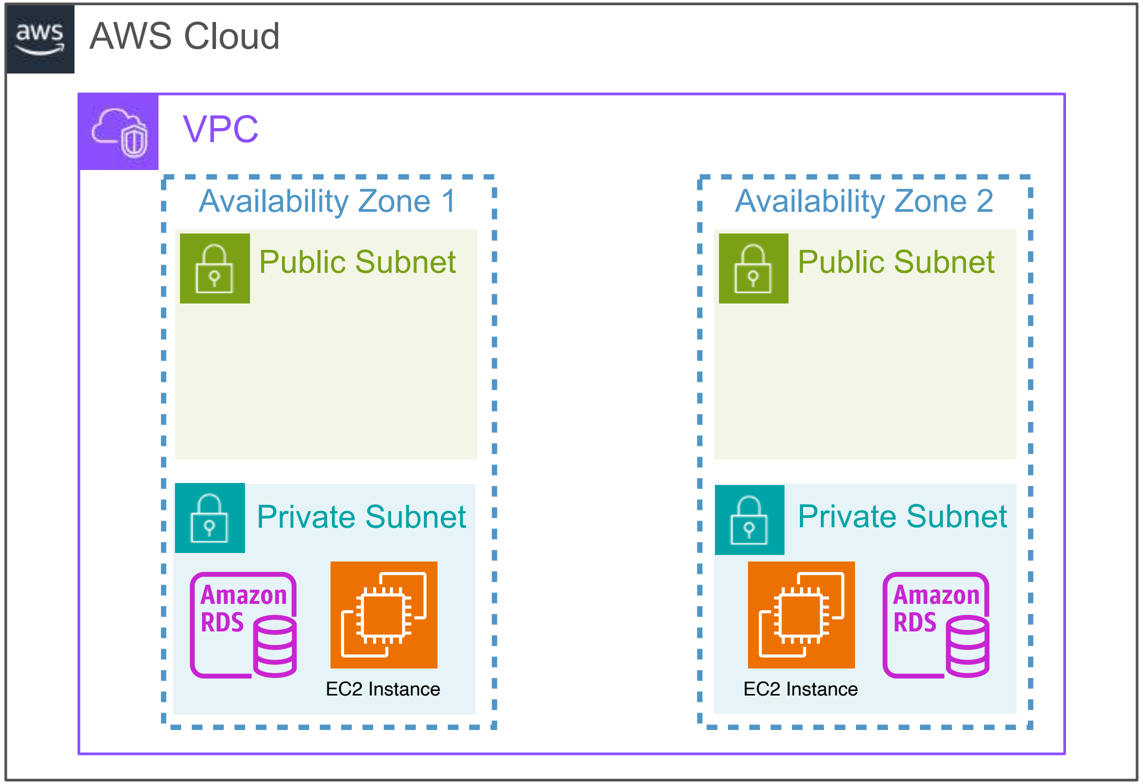
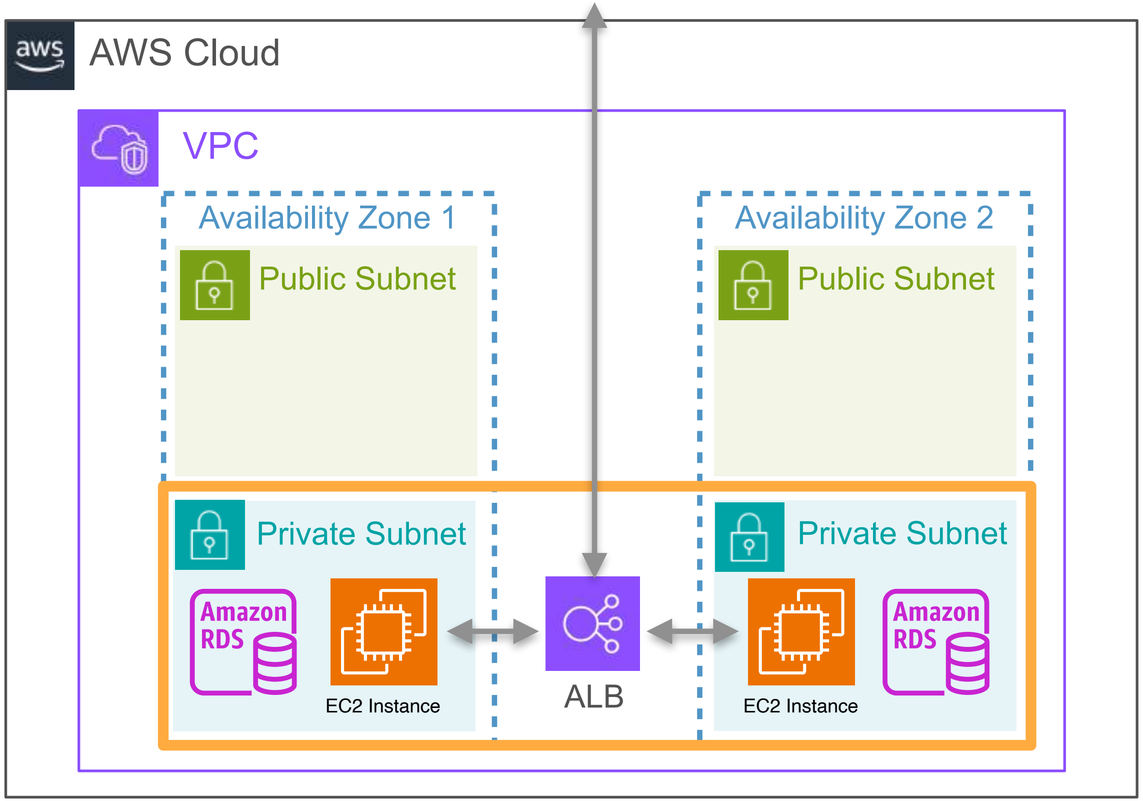
## Interacting with Source Systems

## AWS Networking - Internet Gateways & NAT Gateways

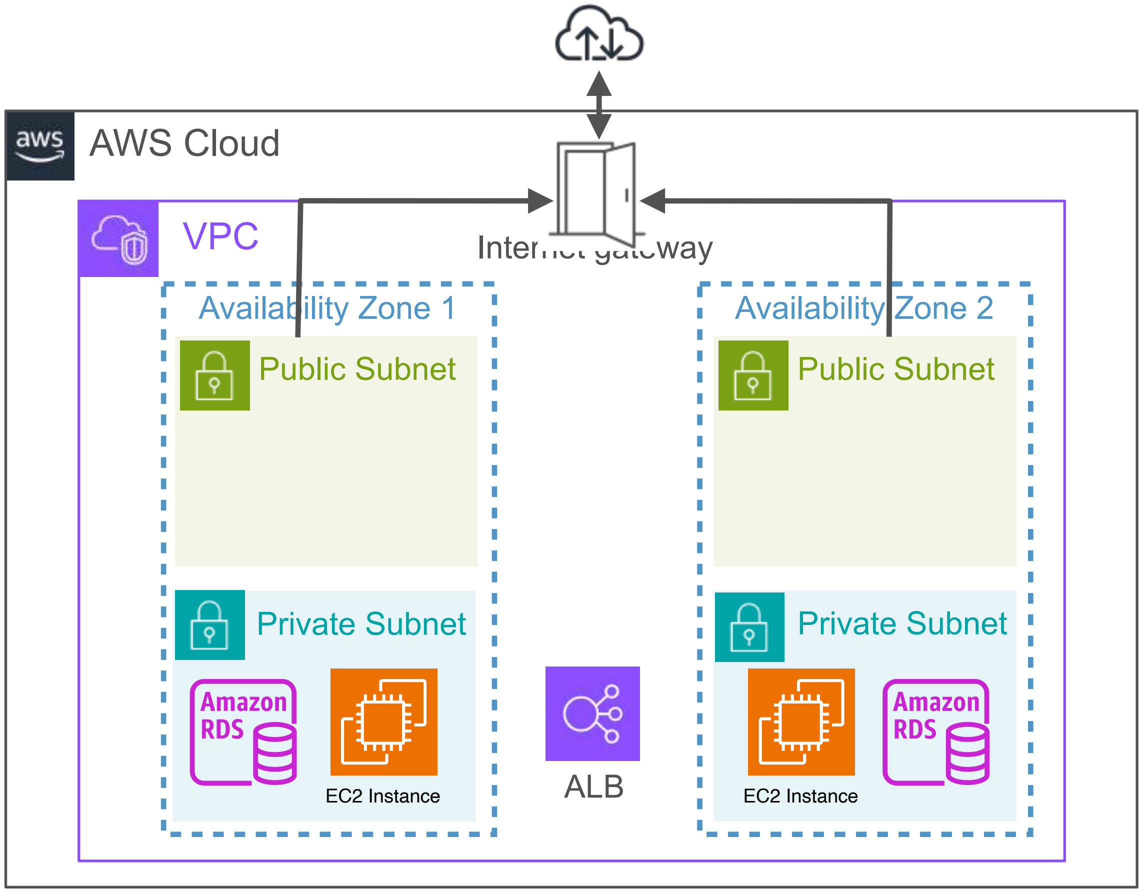

AWS Cloud
VPC
Availability Zone 1
Availability Zone 2
Public Subnet
Public Subnet
Private Subnet
Private Subnet
Amazon RDS
EC2 Instance
EC2 Instance
Amazon RDS

## Example Scenario



### Considerations

1. Applications running on EC2 need to occasionally download updates from resources on the internet
   - Upgrades, patching
2. Need a way to submit requests to the application running on the EC2 instance



## Considerations

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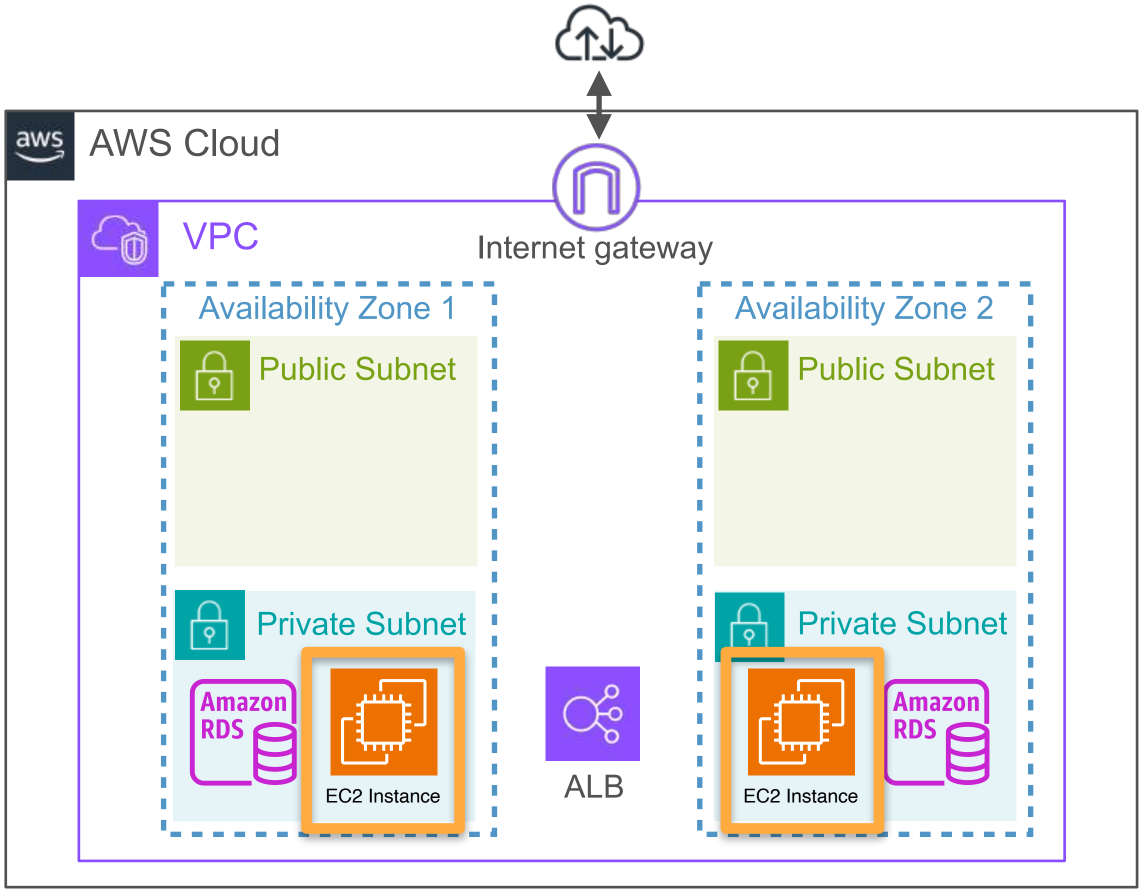

## Considerations

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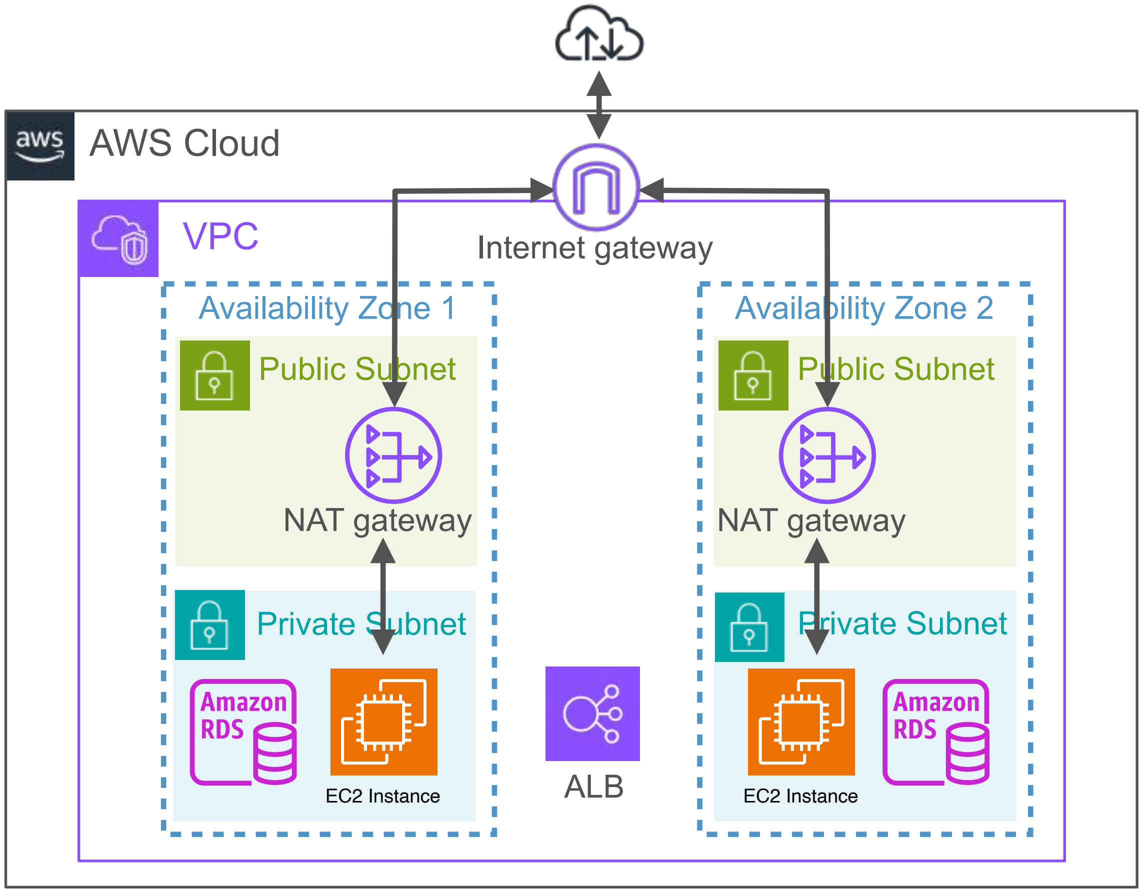

## Considerations

1. Applications running on EC2 need to occasionally download updates from resources on the internet
   - Upgrades, patching
2. Need a way to submit requests to the application running on the EC2 instance

**NAT Gateway** **Network Address Translation Gateway**

- Allows resources in a private subnet to connect to the internet or other AWS services
- Prevents the internet from initiating connections with those resources

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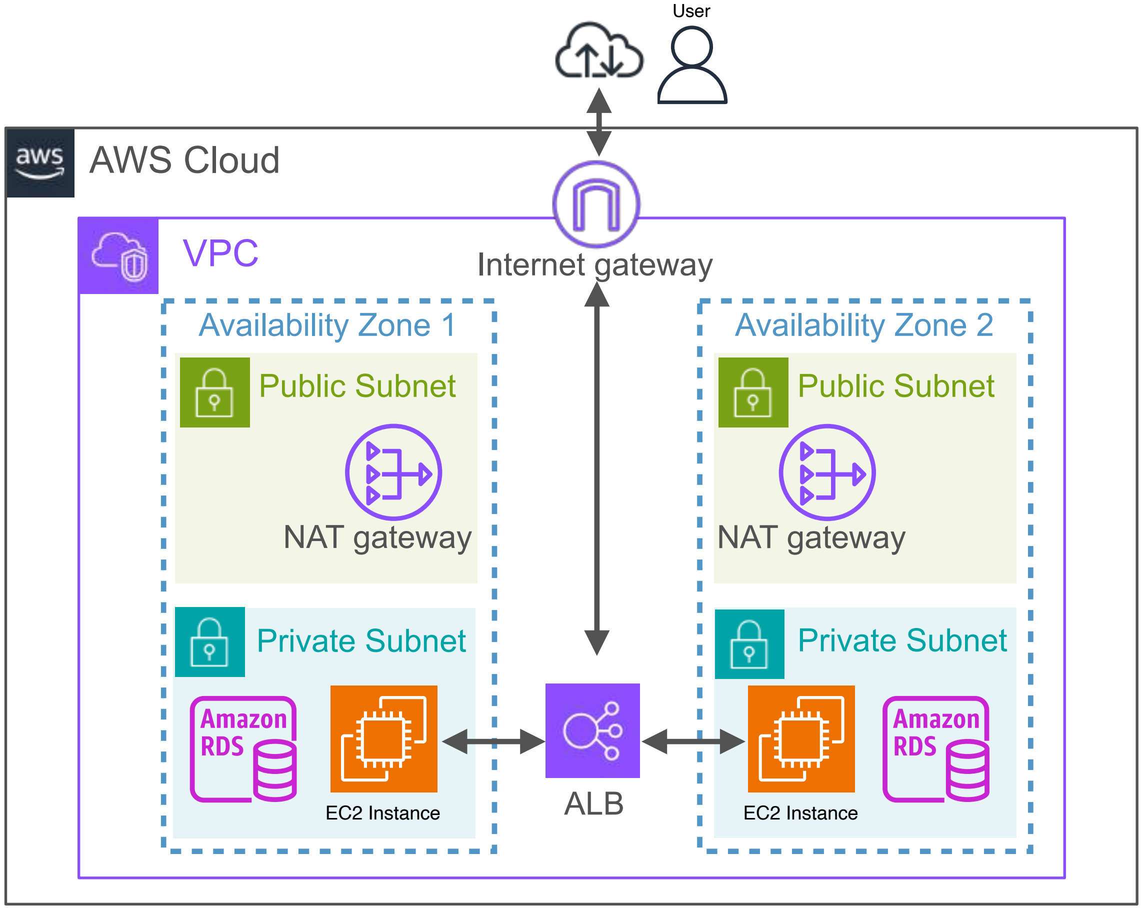
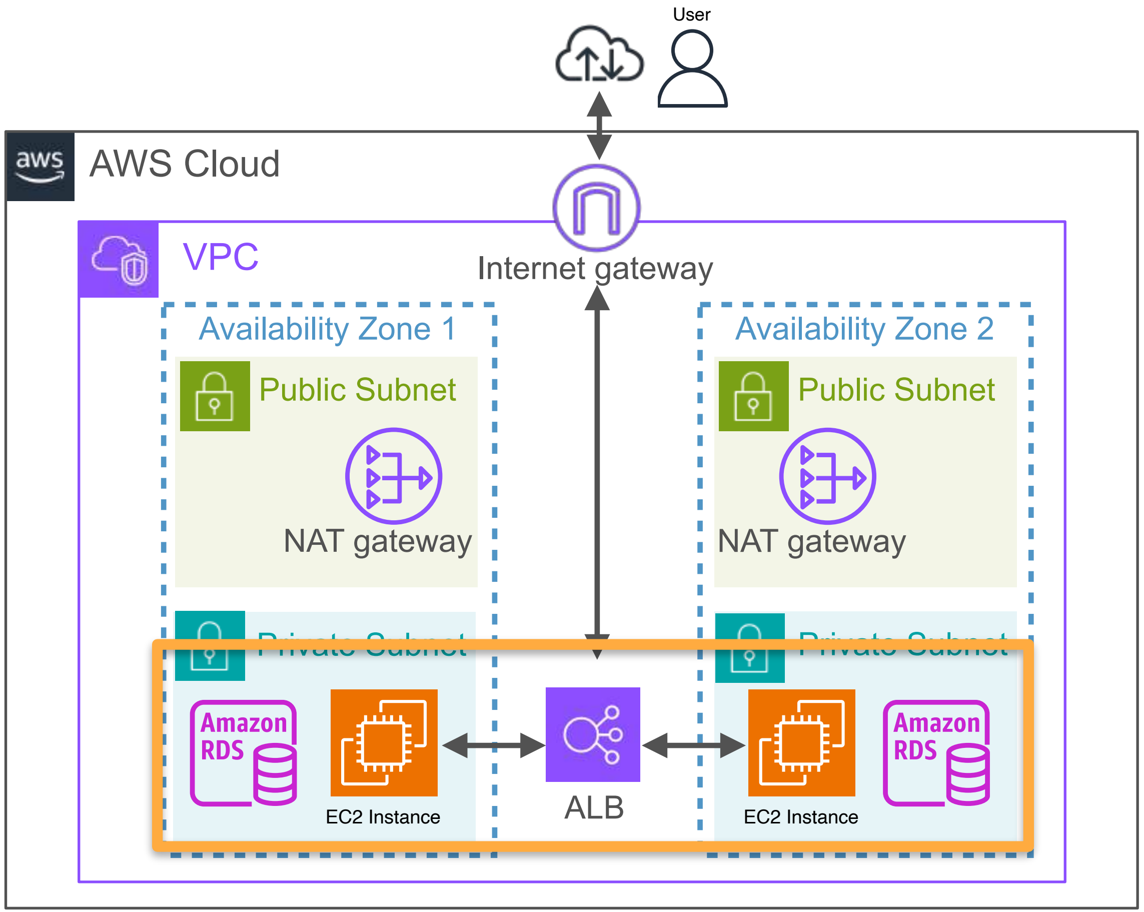


## Considerations

1. Applications running on EC2 need to occasionally download updates from resources on the internet
   - Upgrades, patching
2. Need a way to submit requests to the application running on the EC2 instance

**ALB:**

- Distributes incoming application traffic across multiple backend targets
- Handles the load and ensures the application remains responsive and available
- Keeps those EC2 instances private


User
AWS Cloud
VPC
Internet gateway
Availability Zone 1
Availability Zone 2
Public Subnet
Public Subnet
NAT gateway
NAT gateway
Private Subnet
Private Subnet
Amazon RDS
EC2 Instance
ALB
EC2 Instance
Amazon RDS

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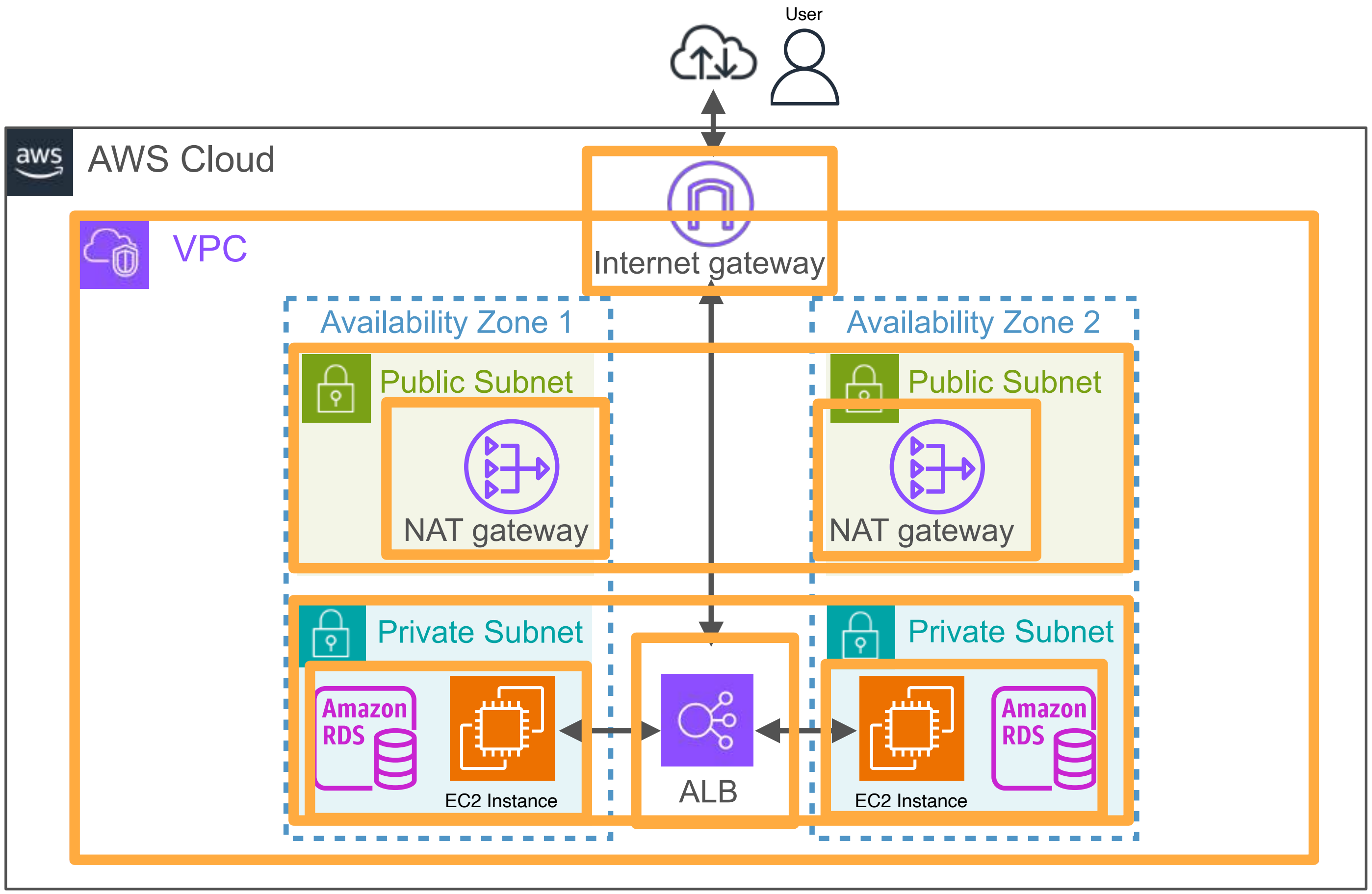
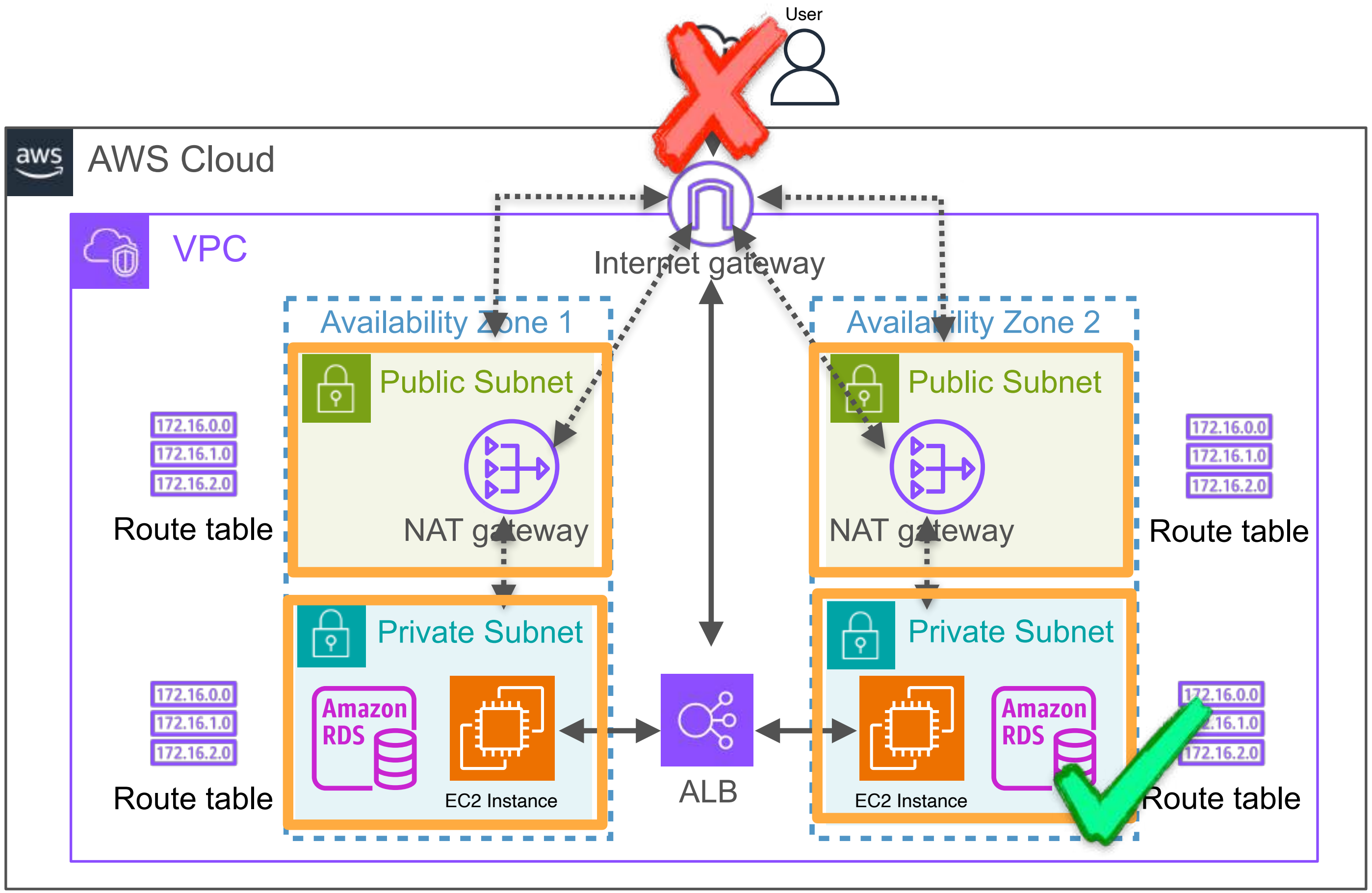
## Interacting with Source Systems

## AWS Networking - Route Tables

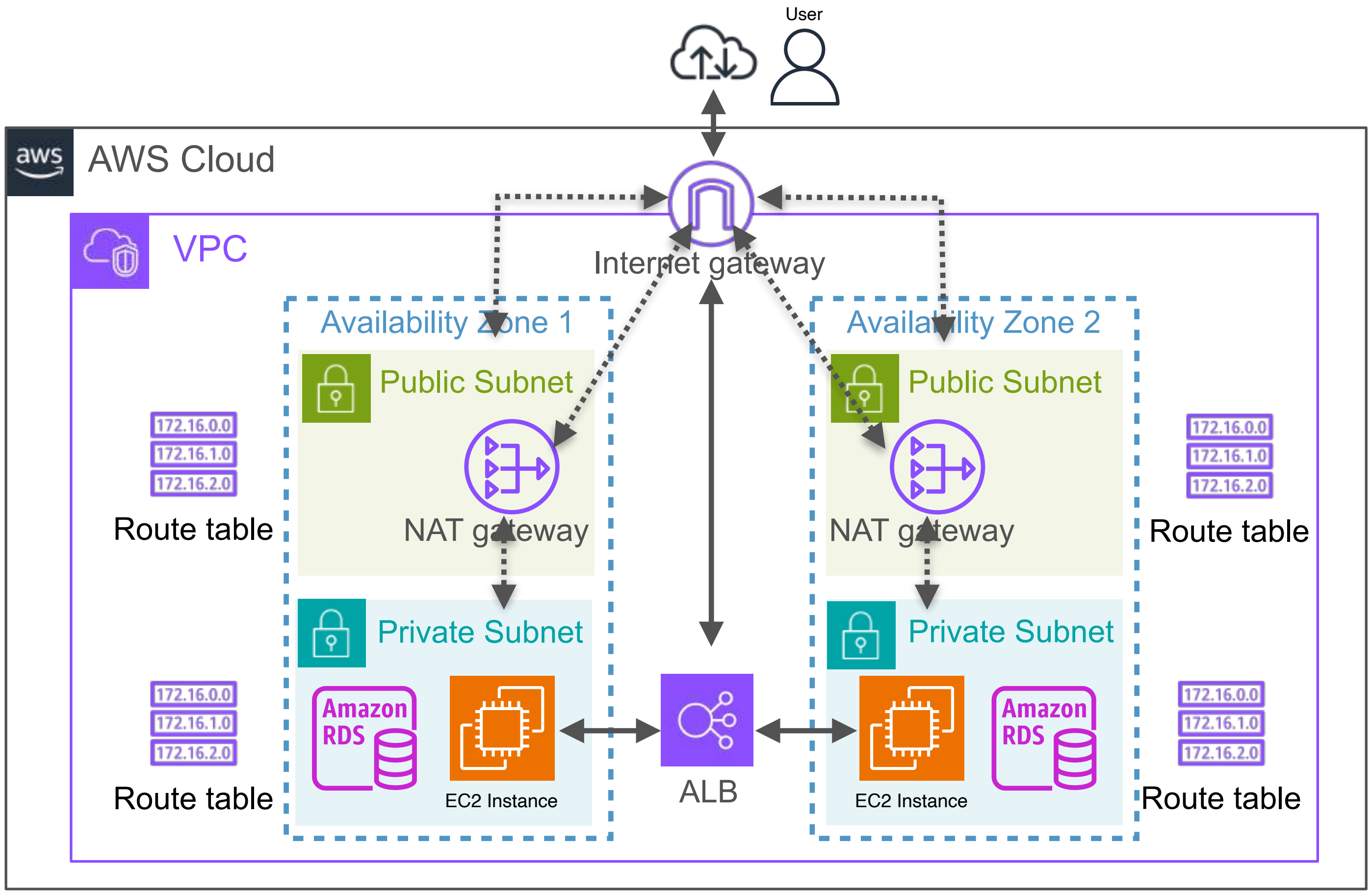
## Route Tables





## Route Tables

- Essential for directing network traffic within your VPC
- Default route table allows internal communication within the VPC


User
AWS Cloud
VPC
Internet gateway
Availability Zone 1
Availability Zone 2
Public Subnet
Public Subnet
NAT gateway
NAT gateway
Private Subnet
Private Subnet
172.16.0.0
172.16.1.0
172.16.2.0
Route table
Route table
Route table
Route table
Amazon RDS
Amazon RDS
EC2 Instance
EC2 Instance
ALB

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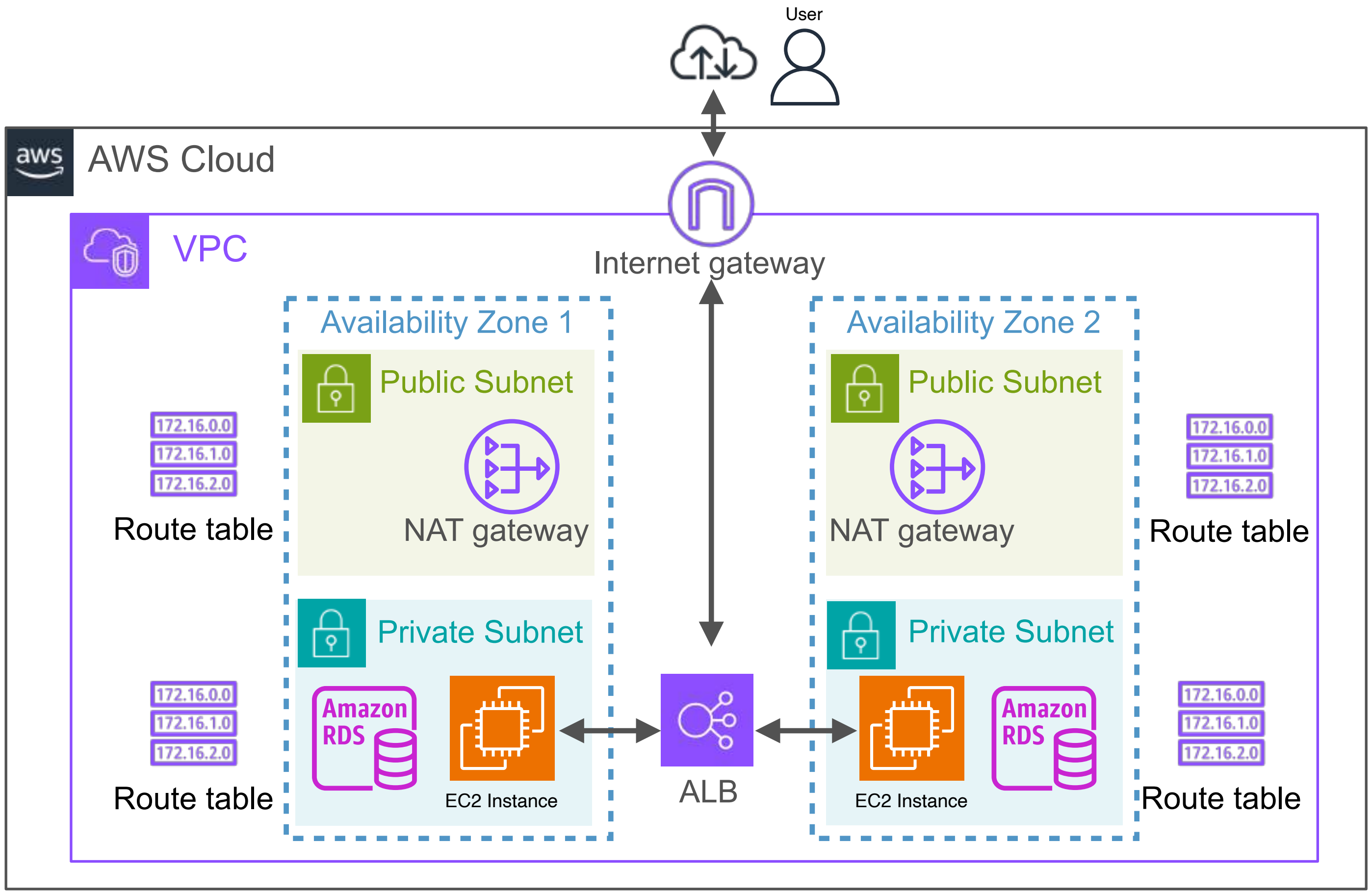
Interacting with Source Systems

# AWS Networking - Network ACLs & Security Groups


User
AWS Cloud
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Internet gateway
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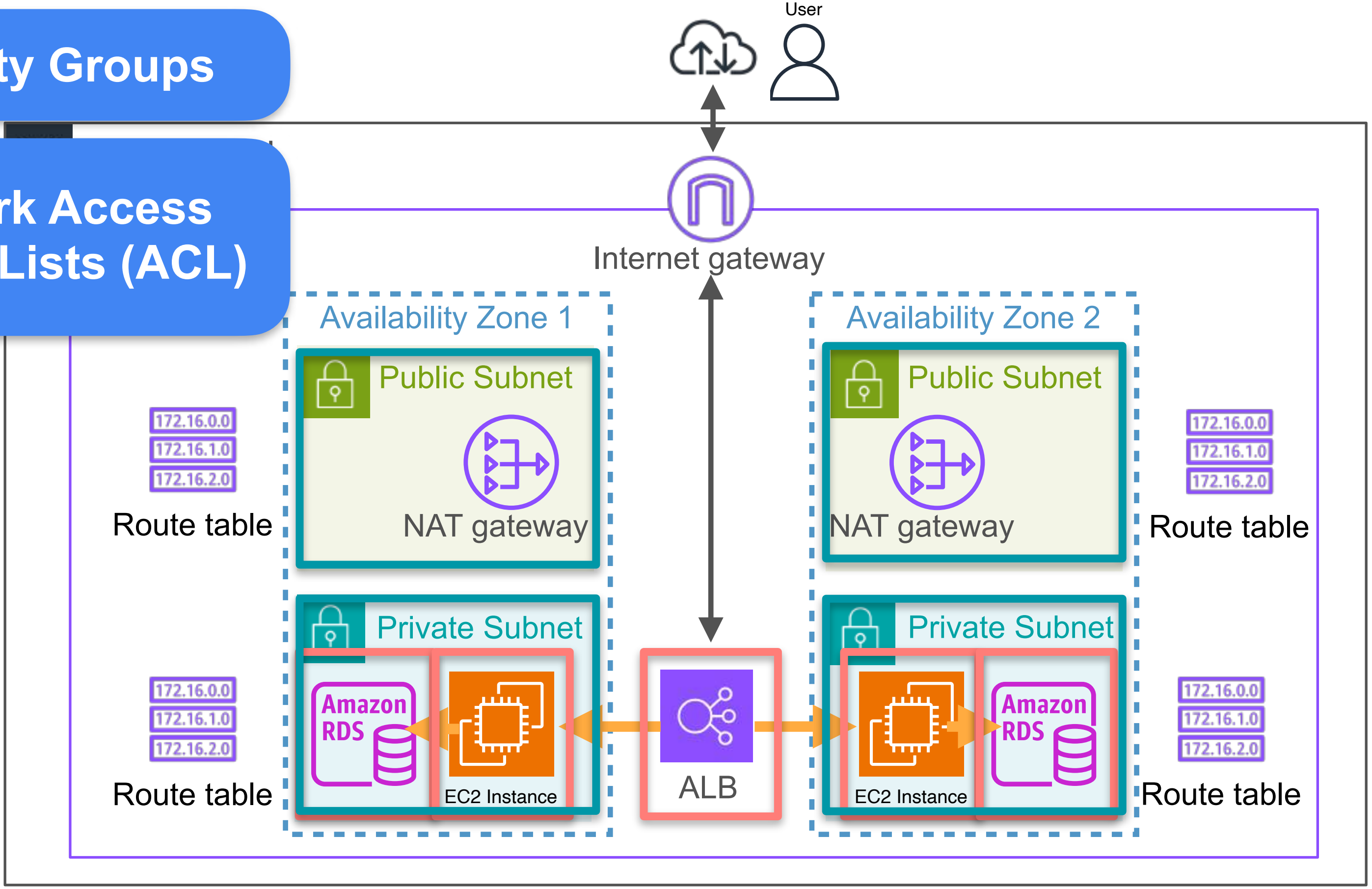
Public Subnet
NAT gateway
172.16.0.0
172.16.1.0
172.16.2.0
Route table
172.16.0.0
172.16.1.0
172.16.2.0
Route table
Private Subnet
Amazon RDS
EC2 Instance
ALB
Private Subnet
EC2 Instance
Amazon RDS
172.16.0.0
172.16.1.0
172.16.2.0
Route table
172.16.0.0
172.16.1.0
172.16.2.0
Route table

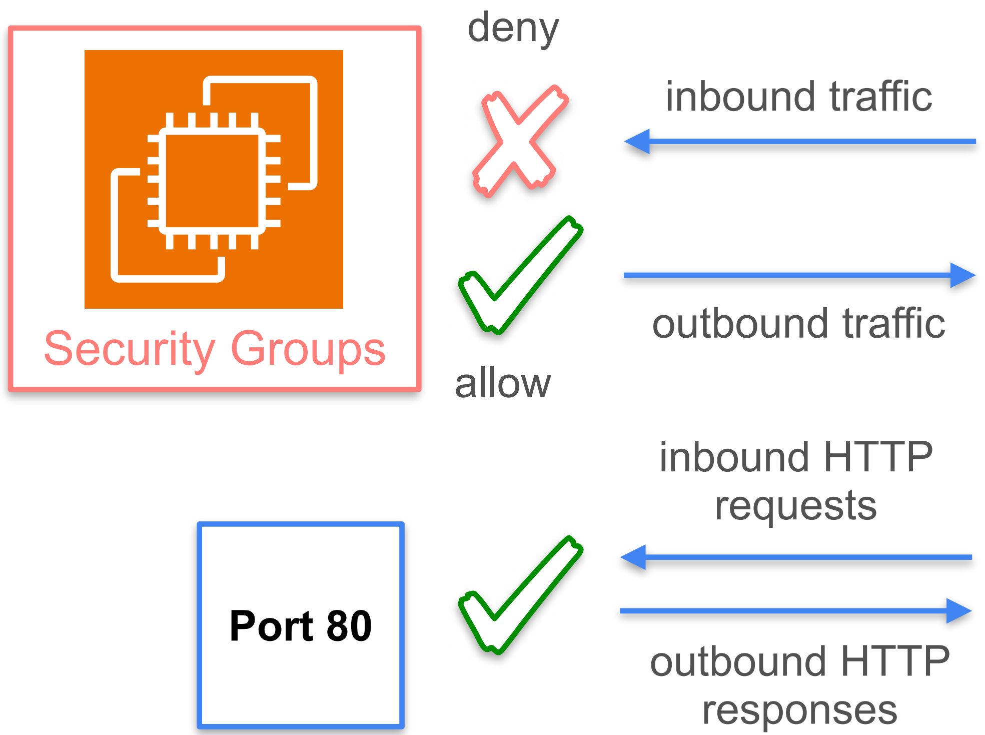
## Security Groups

## Network Access Control Lists (ACL)



## Security Groups

Instance level virtual firewalls, controlling both inbound and outbound traffic



### Inbound Rules

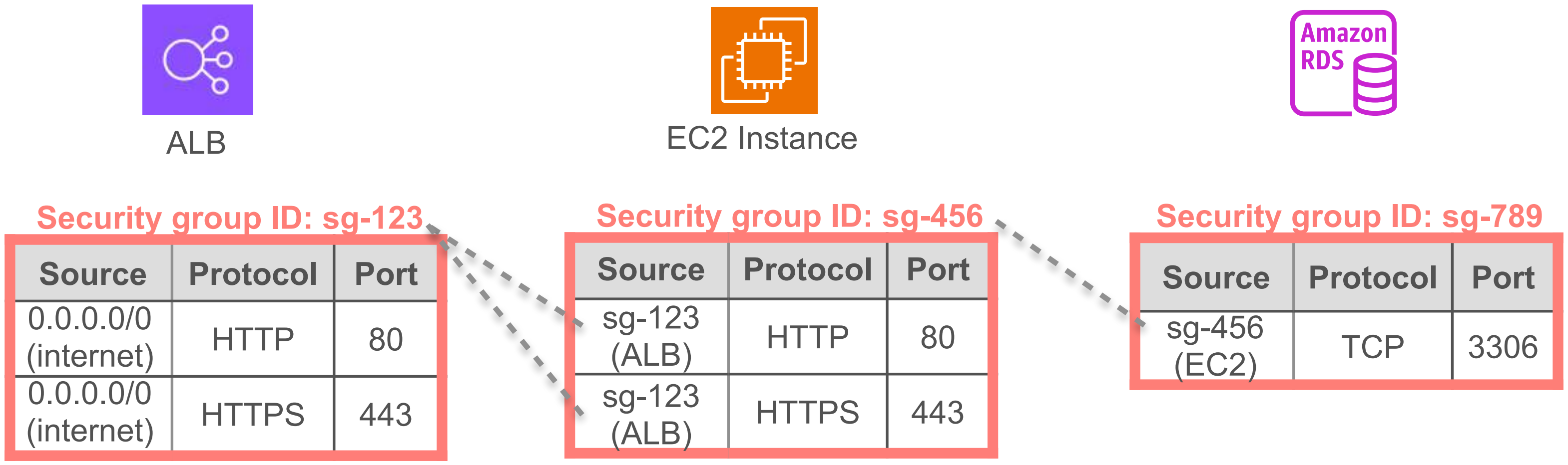
- Determine what types of traffic you want to allow
- Where you want to allow that traffic to come from

### Security Groups are stateful

- Allow inbound traffic to an instance automatically allows the return traffic

## Security Groups

Instance level virtual firewalls, controlling both inbound and outbound traffic



Security group ID: sg-123

| Source | Protocol | Port |
|---|---|---|
| 0.0.0.0/0 (internet) | HTTP | 80 |
| 0.0.0.0/0 (internet) | HTTPS | 443 |

Security group ID: sg-456

| Source | Protocol | Port |
|---|---|---|
| sg-123 (ALB) | HTTP | 80 |
| sg-123 (ALB) | HTTPS | 443 |

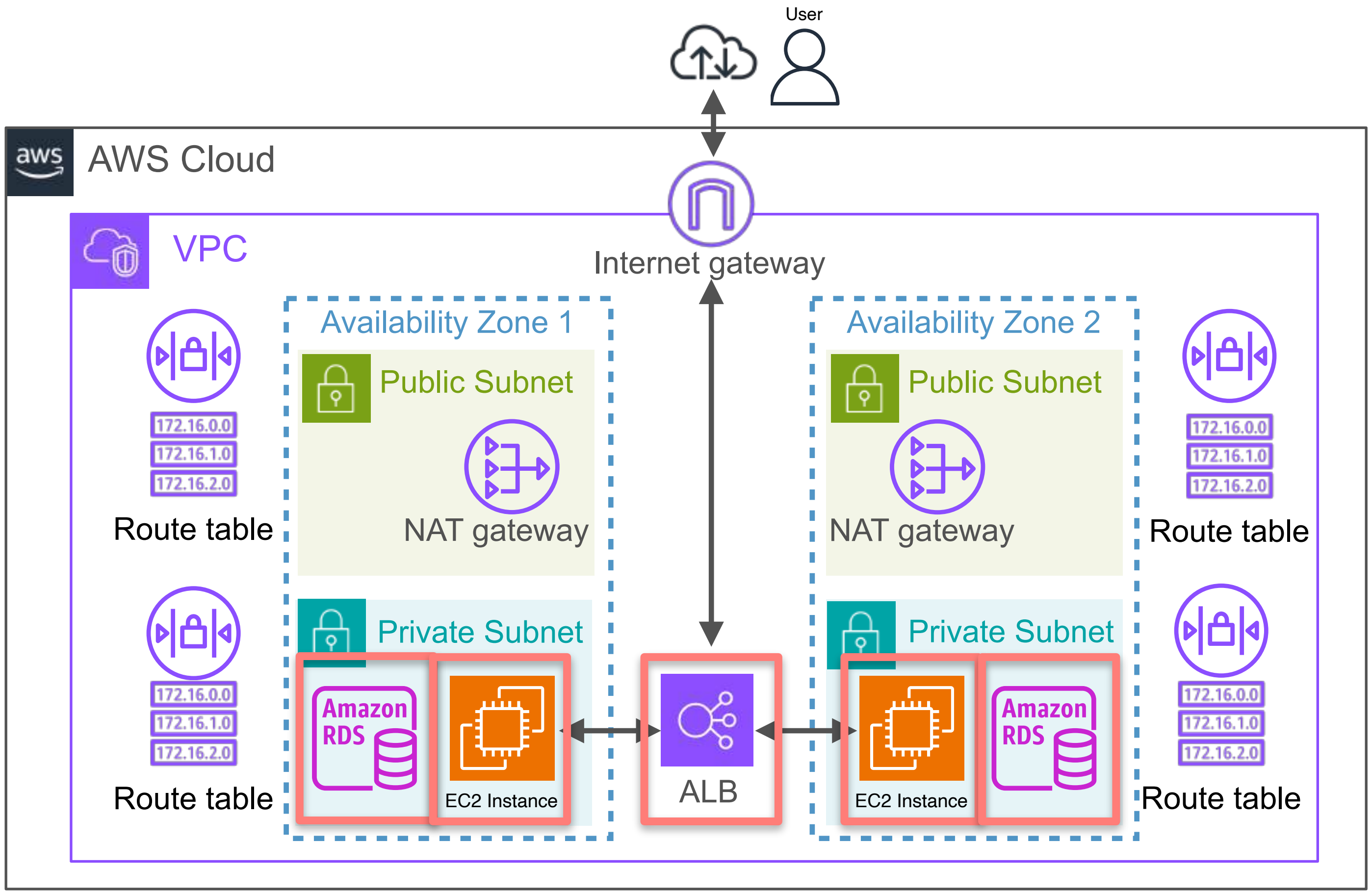
Security group ID: sg-789

| Source | Protocol | Port |
|---|---|---|
| sg-456 (EC2) | TCP | 3306 |

**Security Group Chaining**

## Network Access Control Lists (ACL)

- They provide an additional layer of security at the subnet level
- Network ACLs are stateless
- You need to define both inbound and outbound rules explicitly
- Useful for implementing security policies at the subnet level


User
AWS Cloud
VPC
Internet gateway
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Availability Zone 2
Public Subnet
NAT gateway
Private Subnet
Amazon RDS
EC2 Instance
ALB
172.16.0.0
172.16.1.0
172.16.2.0
Route table

| | | |
|---|---|---|
| VPCs and subnets | | • Give you a way to define a private network on AWS. |
| Route Tables | 172.16.0.0<br>172.16.1.0<br>172.16.2.0 | • Direct traffic within the VPC and to the internet. |
| Public Subnets | | Public subnet |
| Private Subnets | | Private subnet |
| Internet Gateway | | • Allow resources within public subnets to access the internet. |
| NAT Gateway | | • Enable instances to initiate outbound connections securely. |
| Security Groups | | • They act as virtual firewalls at the instance level<br>• They control both inbound and outbound traffic<br>• They are stateful |
| Network ACLs | | • They provide an additional layer of security at the subnet level<br>• They are stateless, ie. require explicit rules for both inbound and outbound traffic |

## If you encounter connectivity issues:

1. Verify that your VPC has an internet gateway properly attached

2. Verify that the route tables have appropriate rules to direct traffic correctly

3. Verify that the route table associations with the subnets are configured correctly

4. Check security groups to make sure they have the needed rules in place

5. Review network ACLs to confirm they allow the necessary traffic

6. Double-check instance configurations to ensure they are associated with the correct security groups and subnets

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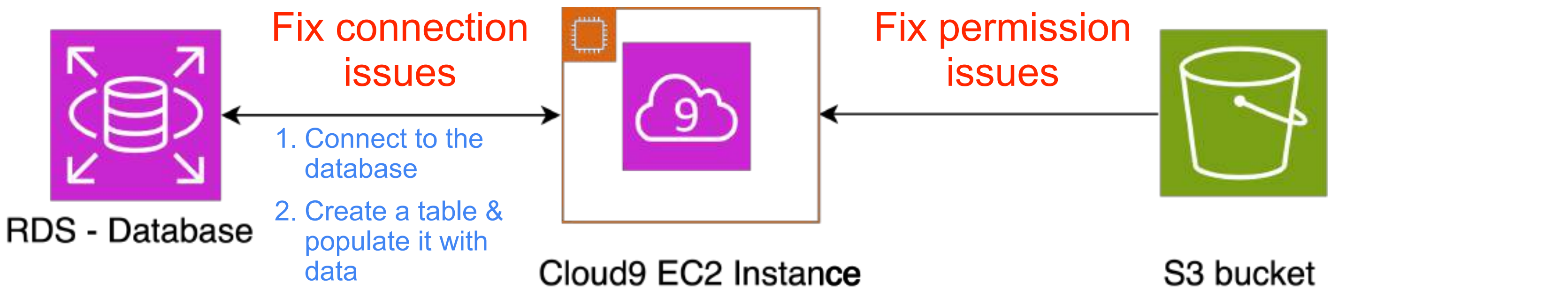
## Connecting to Source Systems

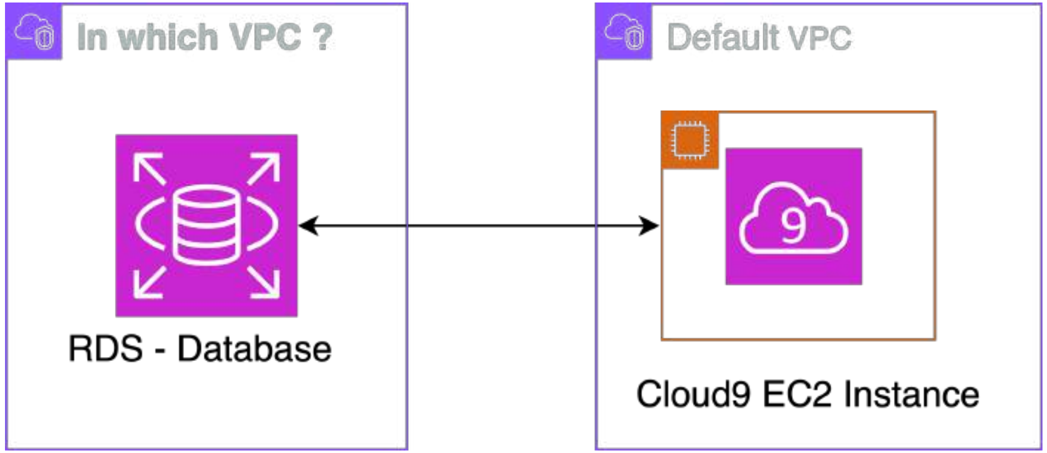
# Lab Walkthrough - Database Connectivity and Troubleshooting on AWS

# Database Connectivity and Troubleshooting on AWS



- Skip this video, jump straight into the lab and go for it
  - The lab instructions contain hints
- Or, start the lab and follow along with me as you go through this video.
  - When an issue occurs, I'll be inviting you to pause the video
  - After that, I'll show you how to fix it.

## Database Connectivity and Troubleshooting on AWS



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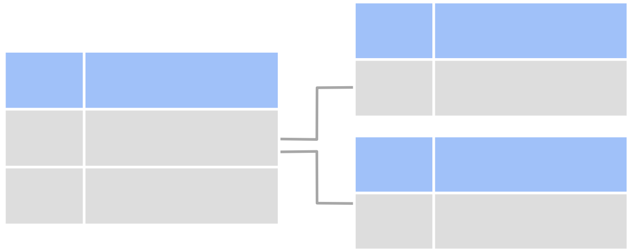
# Working with Source Systems

## Week 1 Summary

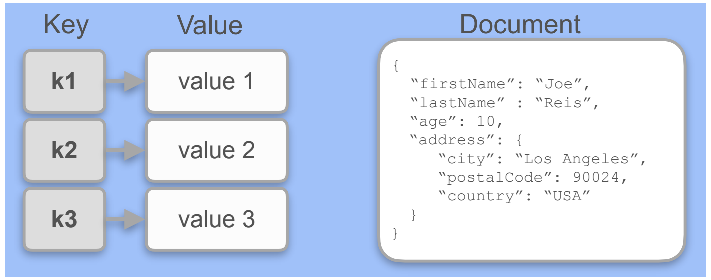
# Week 1 Summary

## Understand how source systems work

### Relational databases



### NoSQL databases



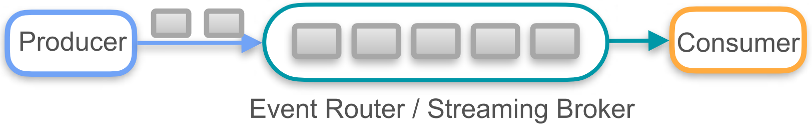
```
{
  "firstName": "Joe",
  "lastName" : "Reis",
  "age": 10,
  "address": {
     "city": "Los Angeles",
     "postalCode": 90024,
     "country": "USA"
  }
}
```

### Object Storage

### Logs

| user id | action | status | timestamp |
|---|---|---|---|
| 67945 | user added a product x to their cart | success | 01-01-2025:10.30 |
| 38910 | invalid values typed for product quantity | fail | 01-01-2025:10.32 |

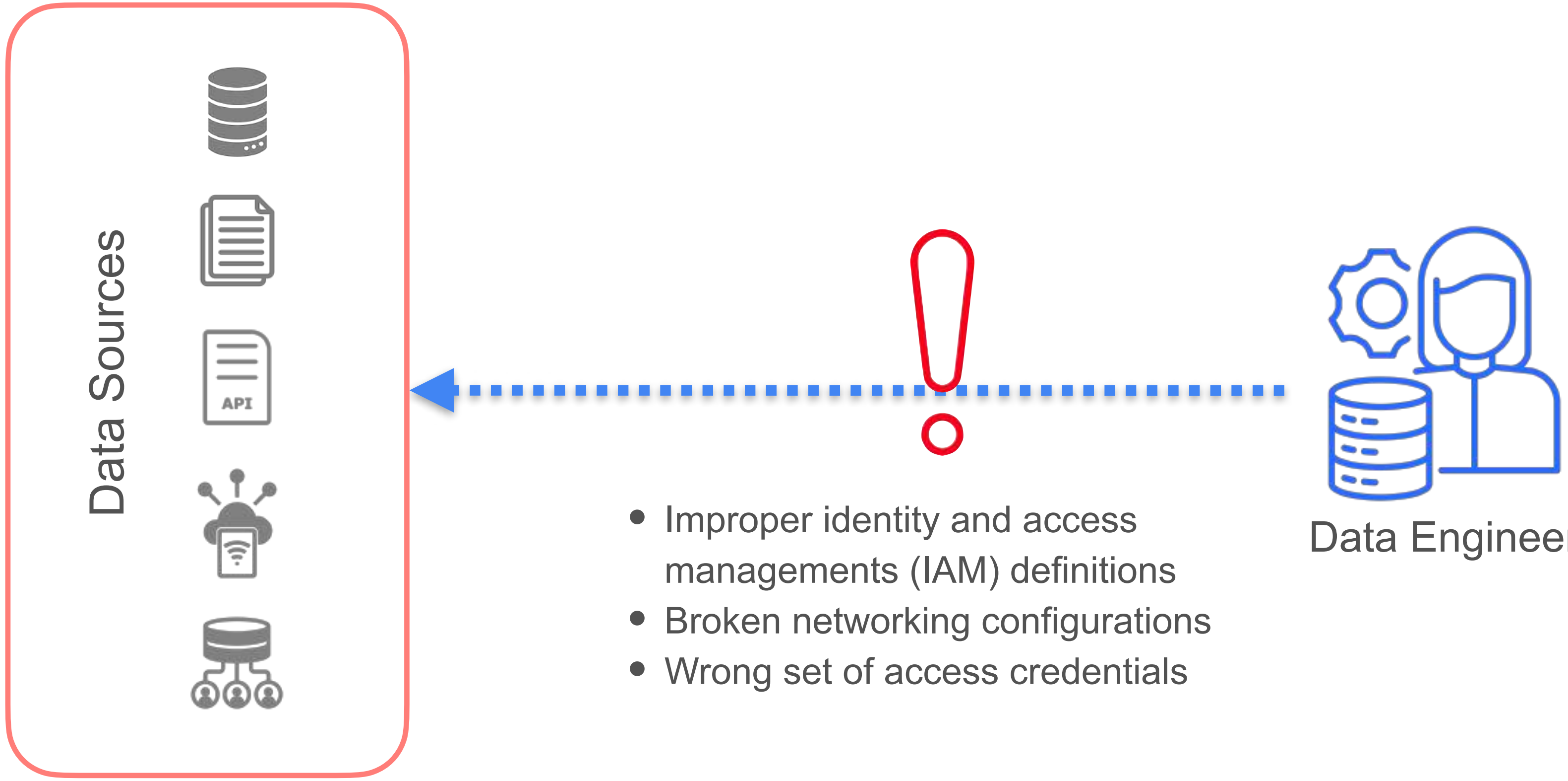
### Streaming Systems



## Week 1 Summary

- How to connect to data sources
- Basics of networking
- Importance of IAM in ensuring security in source systems

# Week 1 Summary



- Improper identity and access managements (IAM) definitions
- Broken networking configurations
- Wrong set of access credentials