

Week 1: SQL and NoSQL

DIANE WOODBRIDGE, PH.D



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About Diane

Technical Me

Ph.D. (and M.S) in Computer Science, UCLA. 2012, 2010

B.S. in Computer Science, Sogang Univ, South Korea. 2007

SMTS, Sandia National Laboratories. 2012 – 2016

Research Interest: Database management and data mining in health. remote sensing. seismicity. etc.

The screenshot shows the Wanda company website with a purple header and footer. The main content area has three sections:

- Remote Health Management**: Describes inline analytic engines developed through 12 years of research at UCLA, encompassing machine learning methodologies and novel algorithms for remote health management, wireless health, biomedical informatics, remote monitoring and wearable systems. It includes a diagram of nodes connected by lines.
- Compensate for Missing Data**: Discusses methods to compensate for insufficient data through data models and algorithms capable of intelligently filling gaps. It includes a diagram of nodes connected by dashed lines.
- Health Predictions**: Describes organic associations between individual's unique signals and data elements to generate a quantifiable representation of their health. It uses historical and real-time data to predict the trajectory of the person's health. It includes a diagram of nodes connected by solid and dashed lines.

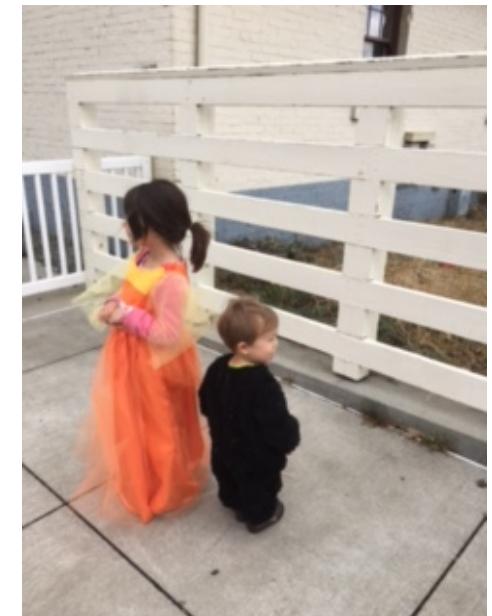
Non-Technical Me

Married.

Two kids.

One cat.

Yoga, Sewing, Cooking, Musical.

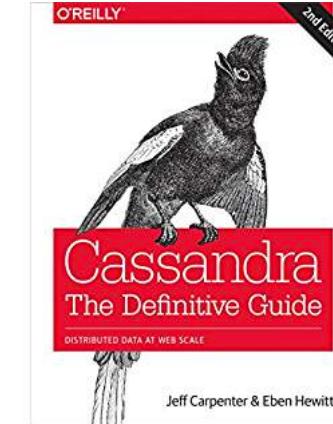
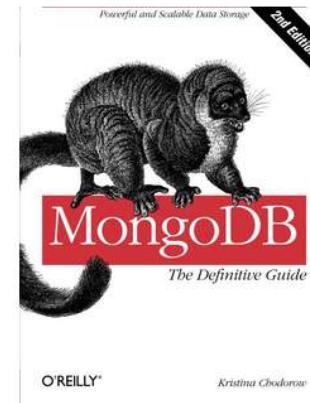
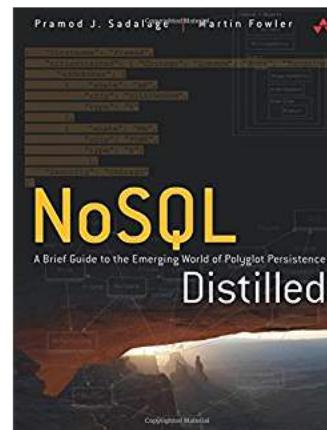


Objectives of This Course

Understand the needs and characteristics of schemaless non-relational databases for storing and processing data in distributed computing settings.

Gain experience with NoSQL databases including MongoDB and Cassandra through homework and in-class exercises.

Gain insights to make judgments to choose SQL or NoSQL (and which NoSQL) with various hands-on exercises.



Evaluation Criteria

Attendance and Participation - 5 %

- No Cellphone
- No web-surfing
- Q&A

Programming Assignment - 15 x 3 %

Quiz - 20 %

Final - 30 %



Class Info

Office Hours: Tue 12:00 - 1:00 pm, Howard 101 Room 522. Plus, anytime when my door is open.

Final Exam: Dec 9, 10 AM - 12 PM, 101 Howard 154, 155 and 156

Schedule

- Week 1 - SQL and NoSQL
- Week 2 - NoSQL Overview
- Week 3 - Document Database (MongoDB), HW 1 Due
- Week 4 - Document Database (MongoDB), Quiz
- Week 5 - Column Family Database (Cassandra), HW 2 Due
- Week 6 - Thanksgiving Break
- Week 7 - Column Family Database (Cassandra), HW 3 Due



Poll

Please turn on:

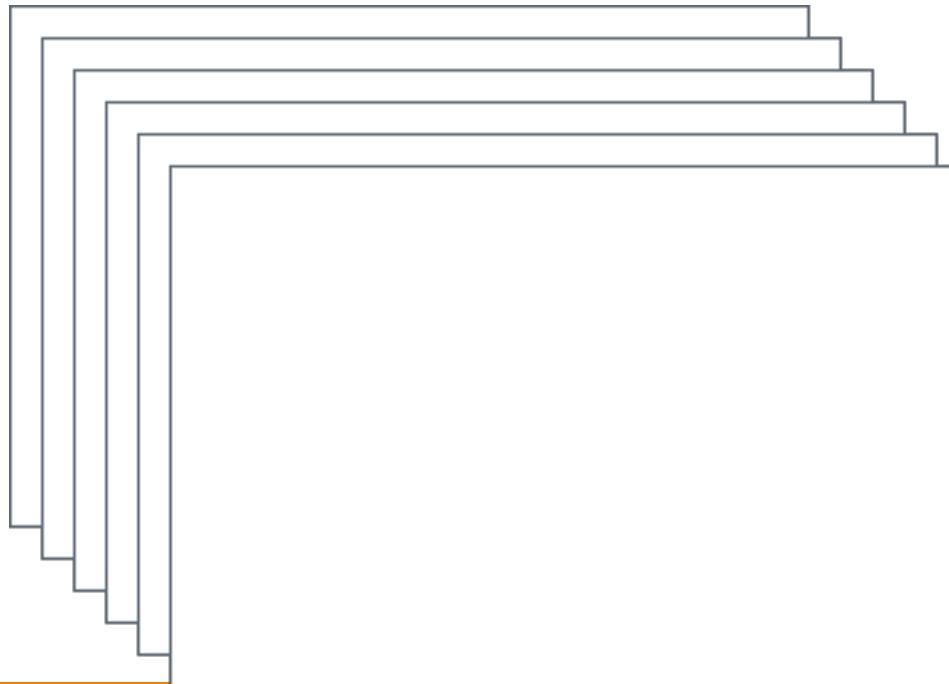
<https://pollev.com/dianewoodbri311>



Relational Database

Relational Model

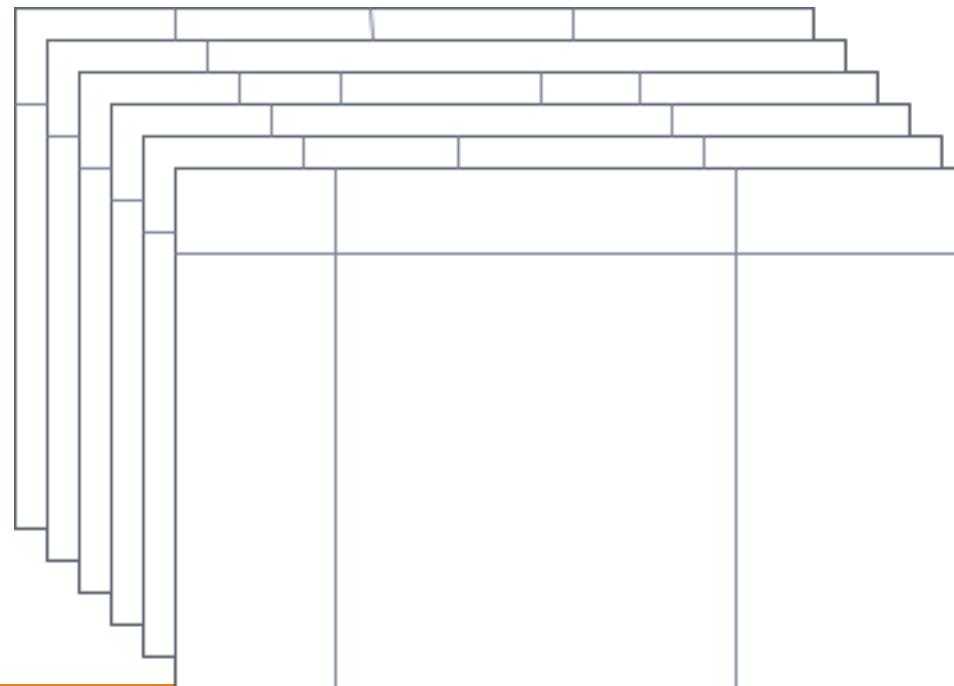
- Database is a collection of relations.



Relational Database

Relational Model

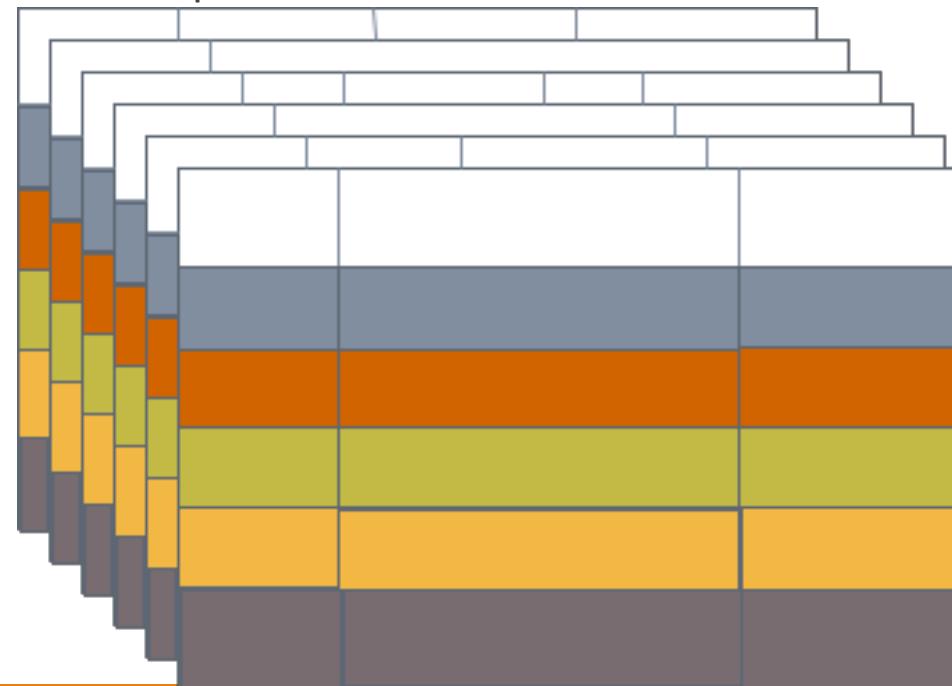
- Database is a collection of relations
- Each relation has attributes



Relational Database

Relational Model

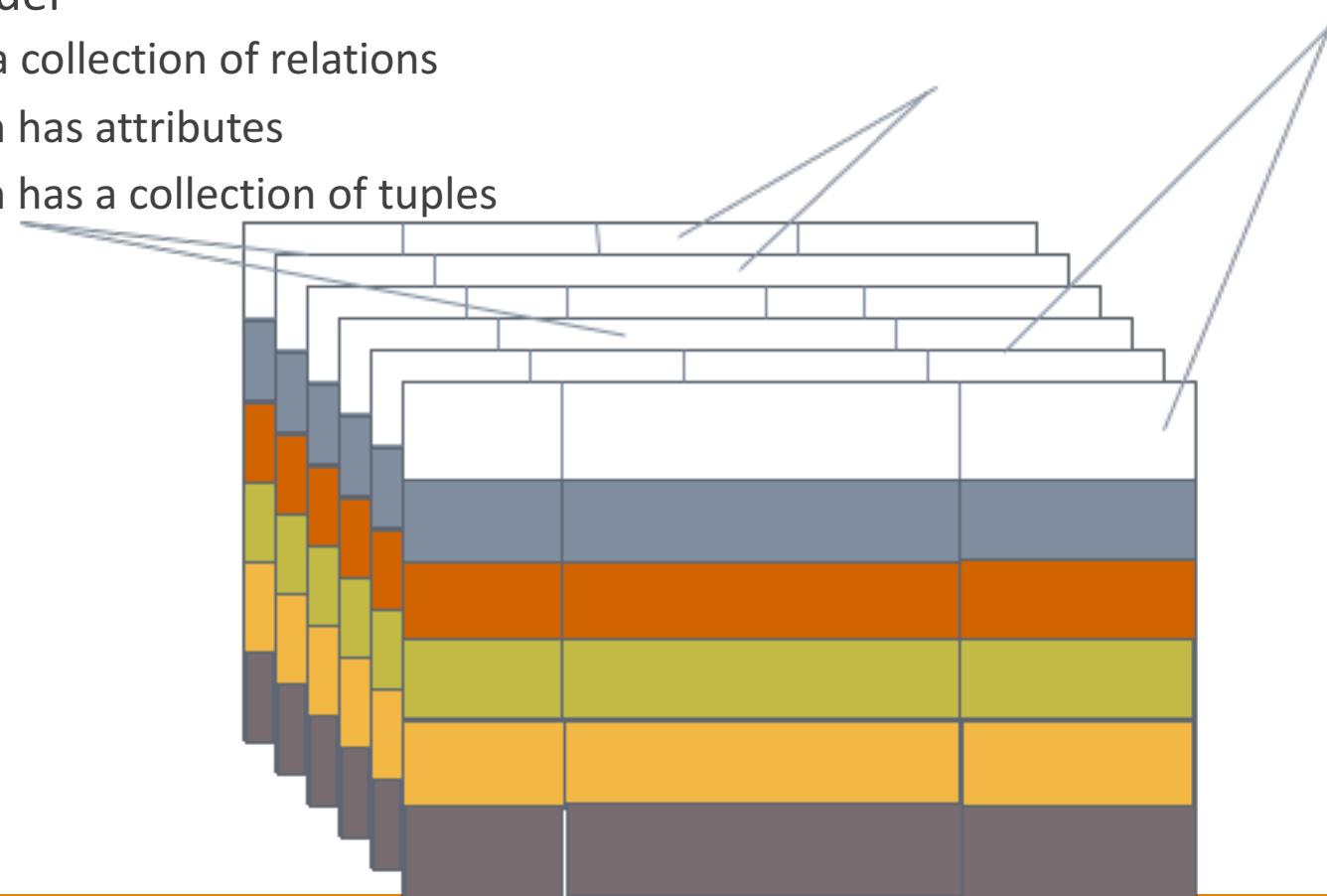
- Database is a collection of relations
- Each relation has attributes
- Each relation has a collection of tuples



Relational Database

Relational Model

- Database is a collection of relations
- Each relation has attributes
- Each relation has a collection of tuples



Relational Database

SQL (Structured Query Language)

- Manage data in a relational database
- Selects rows from a relation satisfying a given condition.
- Basic structure
 - SELECT, FROM, WHERE

SELECT DATA _FIELD

FROM TABLE

WHERE CONDITIONS

Ex) CUSTOMER

ID	Name	Email

EX) SELECT *
FROM Customer
WHERE Name = "Diane Woodbridge"



Pros : Relational Database

Concurrency Control

- ACID (Atomic, Consistent, Isolated and Durable) Transaction Management
 - Atomicity :
 - An operation either succeeds or fails entirely.
 - Many rows spanning many tables are updated as a single operation.
 - Consistency:
 - Any given transaction must change affected data only in allowed ways.
 - Isolation:
 - Defines how/when the changes made by one operation become visible to other.
 - Concurrent operations are isolated from each other so that they can't see a partial update.
 - Durability:
 - Once a transaction has been committed, it will remain permanently.

Pros : Relational Database

Standard Model

- Different vendors' query languages are similar.
- Transaction operations work in the similar way.



Relational Database

Important concepts to remember (Interview Questions!)

- Basic Operations
 - Create
 - Insert
 - Select
 - Update
 - Join (Inner, Outer, Left, Right, etc.)*
 - Union All/Union/ Union Distinct
 - Minus
 - Intersect
- Normalization (1NF, 2NF and 3NF)*
- Transaction(Concurrency Control) – ACID*
- Indexing* - B tree, Hash
- Truncate vs Delete
- Difference Where vs. Having



Relational Databases

Create tables

- `CREATE TABLE table_name
(
 column_name1 data_type(size),
 column_name2 data_type(size),
 column_name3 data_type(size),

);`

```
[dwoodbridge=# create table customer(name varchar, id char(10), email varchar);
CREATE TABLE
```



Relational Databases

Insert rows

- `INSERT INTO table_name (col1,col2,...)
VALUES (value1,value2,...);`

```
[dwoodbridge=# insert into customer(name, id, email) values ('Diane Woodbridge',  
1234567890, 'dwoodbridge@usfca.edu');  
INSERT 0 1
```

Select rows

- `SELECT column_name,column_name
FROM table_name;`

```
[dwoodbridge=# select * from customer where email = 'dwoodbridge@usfca.edu';  
          name      |      id      |           email  
-----+-----+-----  
 Diane Woodbridge | 1234567890 | dwoodbridge@usfca.edu  
(1 row)
```

Update rows

- `UPDATE table_name
SET column1=value1,column2=value2,...
WHERE some_column=some_value;`

```
[dwoodbridge=# update customer set name='Diane MK Woodbridge' where email='dwoodb  
ridge@usfca.edu';  
UPDATE 1
```

Delete rows

- `DELETE FROM table_name
WHERE some_column=some_value;`

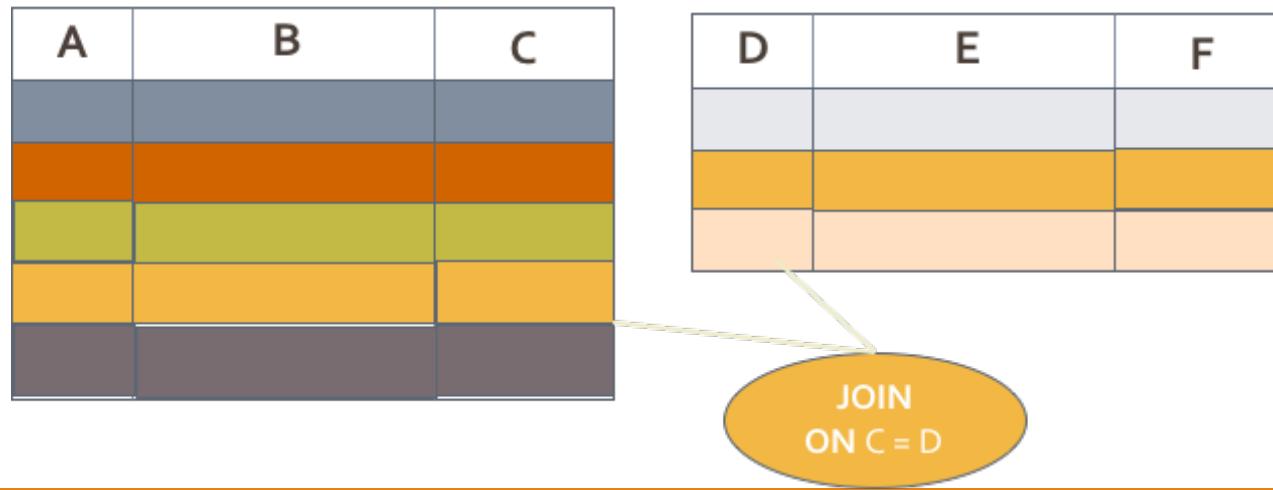
```
[dwoodbridge=# delete from customer where true;  
DELETE 1
```



Relational Databases

Join

- Purpose
 - Relate rows from two different tables based on constraints
- Input
 - Two tables
- Output
 - Merged rows from two tables satisfying given constraints



Relational Databases

Join

- ```
SELECT column_name(s)
 FROM table1
 JOIN_TYPE table2
 ON table1.column_name=table2.column_name;
```



# Relational Databases

TableOne

| A | B | C |
|---|---|---|
|   |   |   |
|   |   |   |
|   |   |   |
|   |   |   |

TableTwo

| D | E | F |
|---|---|---|
|   |   |   |
|   |   |   |
|   |   |   |
|   |   |   |

JOIN  
ON C = D

| A | B | C | E | F |
|---|---|---|---|---|
|   |   |   |   |   |
|   |   |   |   |   |
|   |   |   |   |   |

ANSWER?  
<https://pollev.com/dianewoodbri311>

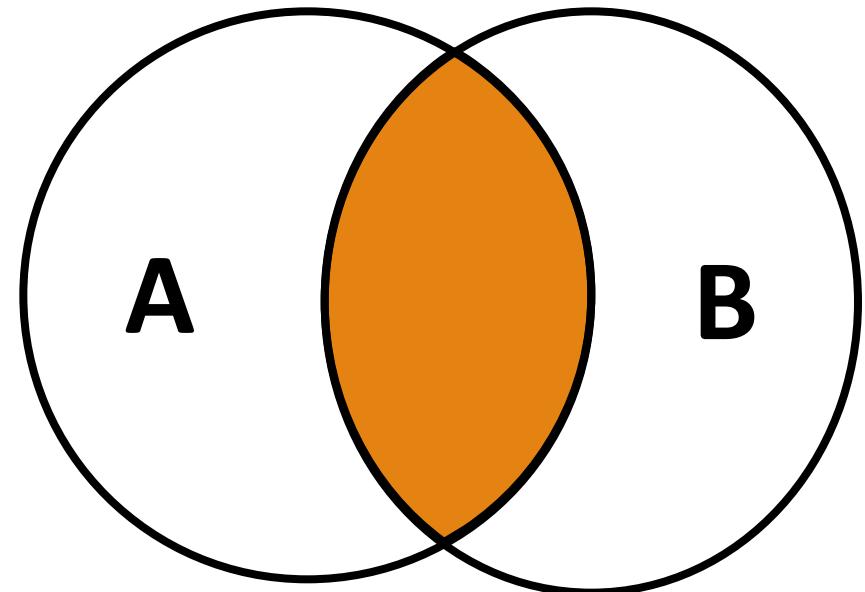


# Relational Databases

---

## Different types of joins

- Inner Join (= Join)
  - Returns rows appearing in both tables.
- Left Join
  - Return all rows from the left table, and the matched rows from the right table.
- Right Join
  - Return all rows from the right table, and the matched rows from the left table.
- Full Join (Full Outer Join)
  - Return all rows appearing in any of the tables.

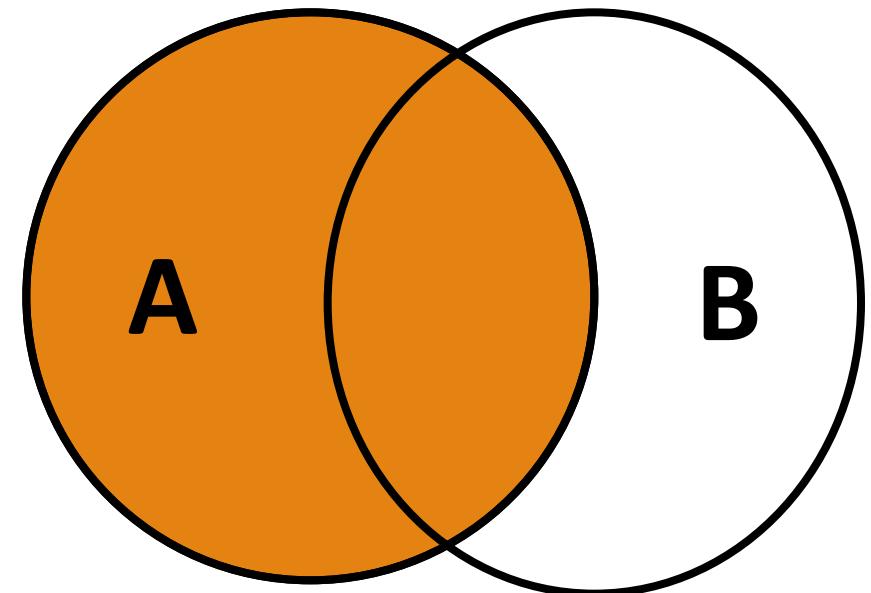


# Relational Databases

---

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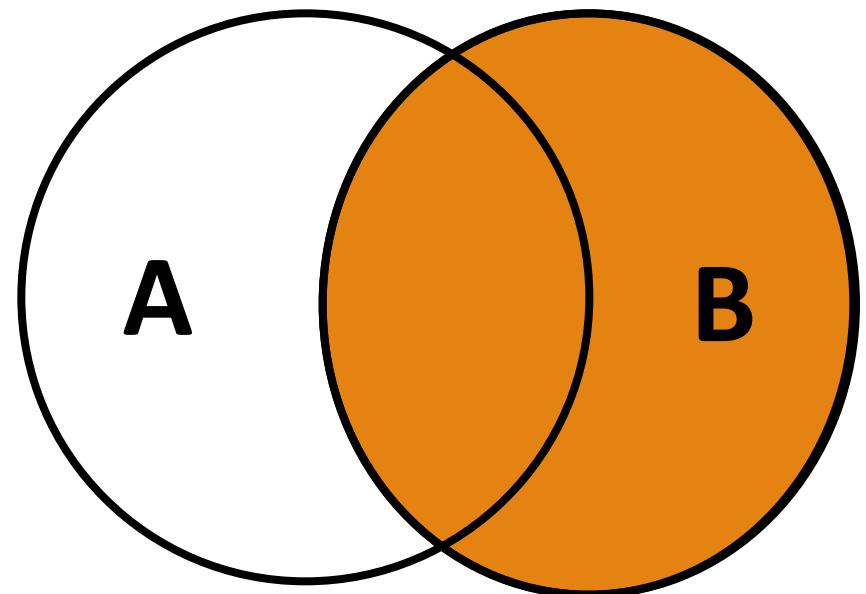


# Relational Databases

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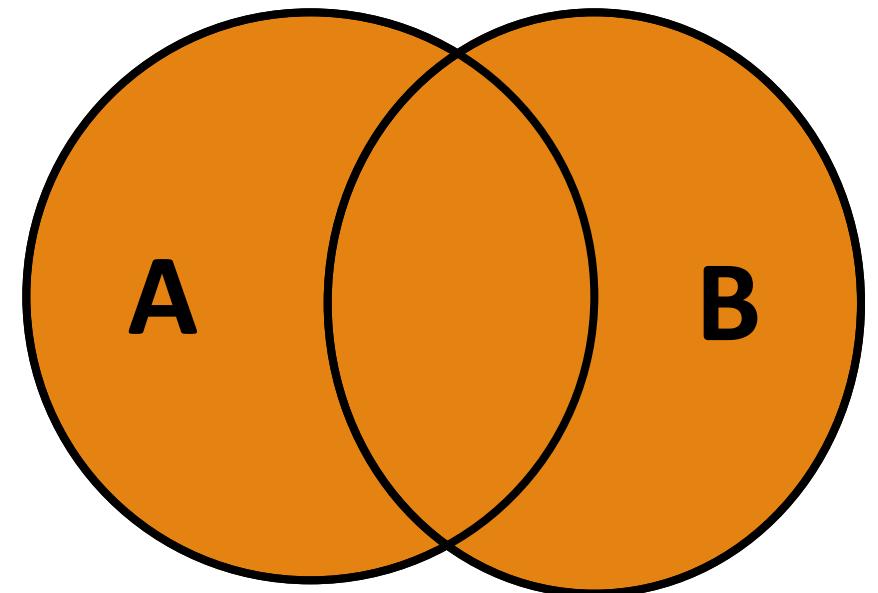


# Relational Databases

---

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# Relational Databases

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Animated Cartoons?



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# Relational Databases

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- Organize data by a given field. → Optimize queries and enhance query performance.
- Consider.
  - Which fields to index?
- Popular index scheme : balanced search tree (B-tree), hash, etc.

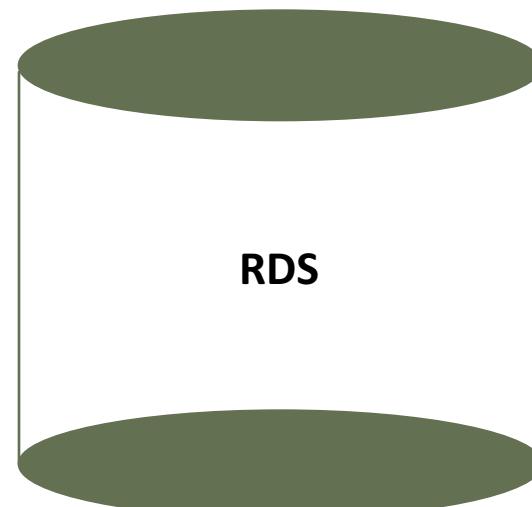


# Relational Databases on AWS

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## Relational Database Services (RDS)

- Relational DB on Cloud
- Supports Aurora, Oracle, Microsoft SQL Server, PostgreSQL, MySQL and MariaDB.



<https://aws.amazon.com/rds/>



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# Relational Databases on AWS

## Relational Database Services (RDS)

- Relational DB on Cloud
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<https://aws.amazon.com/>

The screenshot shows the AWS Management Console with the search bar set to 'Services'. The 'Database' service is selected. On the left, there's a sidebar with links like History, S3, Billing, RDS (which is highlighted), Console Home, VPC, and EC2. The main content area shows 'All AWS Services' categorized by type. The 'Database' section contains four services: RDS, ElastiCache, DynamoDB, and Redshift. Each service has a icon, name, and a brief description. A green dashed box highlights the RDS service.

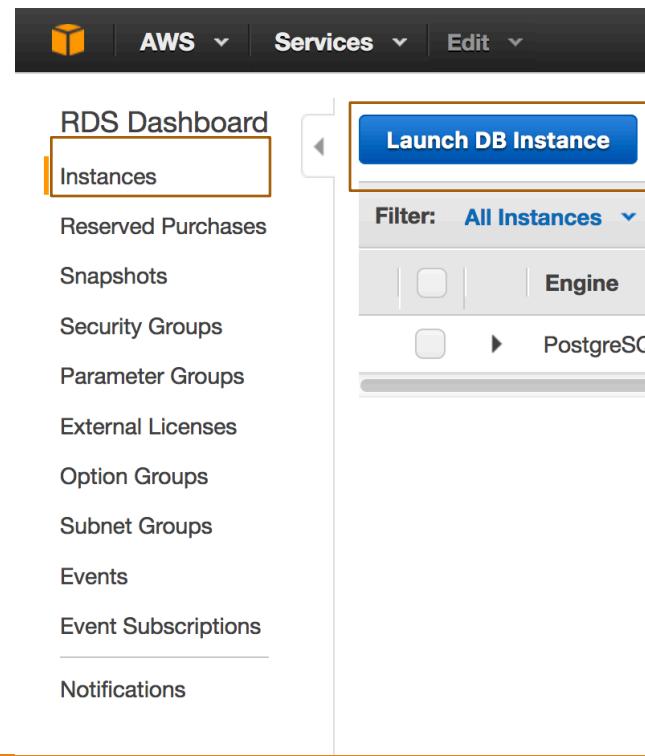
| Service     | Description                                                                                                                                                                    |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RDS         | Amazon Relational Database Service (RDS) makes it easy to set up, operate, and scale familiar relational databases in the cloud.                                               |
| ElastiCache | Amazon ElastiCache improves application performance by allowing you to retrieve information from an in-memory caching system.                                                  |
| DynamoDB    | Amazon DynamoDB is a scalable NoSQL data store that manages distributed replicas of your data for high availability.                                                           |
| Redshift    | Amazon Redshift is a fast, fully managed, petabyte-scale data warehouse that makes it cost-effective to analyze all your data using your existing business intelligence tools. |



# Relational Databases on AWS

## Relational Database Services (RDS)

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# Relational Databases on AWS

## Relational Database Services (RDS)

- Relational DB on Cloud
- Supports Aurora, Oracle, Microsoft SQL Server, PostgreSQL, MySQL and MariaDB.

Step 1: Select Engine

...  
Select Engine

To get started, choose a DB Engine below and click Select.

 MySQL

 MariaDB

 PostgreSQL

 ORACLE

 Microsoft SQL Server

PostgreSQL

Select

PostgreSQL is a powerful, open-source object-relational database system with a strong reputation of reliability, stability, and correctness.

- High reliability and stability in a variety of workloads.
- Advanced features to perform in high-volume environments.
- Vibrant open-source community that releases new features multiple times per year.
- Supports multiple extensions that add even more functionality to the database.
- The most Oracle-compatible open-source database.

Cancel



# Relational Databases on AWS

## Relational Database Services (RDS)

- Relational DB on Cloud
- Supports Aurora, Oracle, Microsoft SQL Server, PostgreSQL, MySQL and MariaDB.

Step 1: [Select Engine](#)

**Step 2: Production?**

Step 3: Specify DB Details

Step 4: Configure Advanced Settings

Do you plan to use this database for production purposes?

Production

PostgreSQL

Use [Multi-AZ Deployment](#) and [Provisioned IOPS Storage](#) as defaults for high availability and fast, consistent performance.

Dev/Test

PostgreSQL

This instance is intended for use outside of production or under the [RDS Free Usage Tier](#).

Billing is based on [RDS pricing](#).

[Cancel](#)

[Previous](#)

[Next Step](#)



# Relational Databases on AWS

## Relational Database Services (RDS)

- Relational DB on Cloud
- Supports Aurora, Oracle, Microsoft SQL Server, PostgreSQL, MySQL and MariaDB.

Only show options that are eligible for RDS Free Tier

Instance Specifications

|                     |                                 |
|---------------------|---------------------------------|
| DB Engine           | postgres                        |
| License Model       | postgresql-license              |
| DB Engine Version   | 9.5.4                           |
| DB Instance Class   | db.t2.micro — 1 vCPU, 1 GiB RAM |
| Multi-AZ Deployment | No                              |
| Storage Type        | General Purpose (SSD)           |
| Allocated Storage*  | 5 GB                            |

Settings

|                         |             |
|-------------------------|-------------|
| DB Instance Identifier* | msan697     |
| Master Username*        | dwoodbridge |

I'll use version 9.5.4 for the class. Make sure that your local version is also 9.5.4.

```
ML-ITS-603436:MSAN697 dwoodbridge$ psql --version
psql (PostgreSQL) 9.5.4
```



# Relational Databases on AWS

## Relational Database Services (RDS)

- Relational DB on Cloud
- Supports Aurora, Oracle, Microsoft SQL Server, PostgreSQL, MySQL and MariaDB.

Step 1: [Select Engine](#)  
Step 2: [Production?](#)  
Step 3: [Specify DB Details](#)  
**Step 4: Configure Advanced Settings**

Configure Advanced Settings

Network & Security

VPC\* Default VPC (vpc-56343733)  
Subnet Group default  
Publicly Accessible Yes  
Availability Zone No Preference

VPC Security Group(s) Create new Security Group  
default (VPC)  
launch-wizard-1 (VPC)  
launch-wizard-2 (VPC)

Database Options

Database Name msan697  
Database Port 5432  
DB Parameter Group default.postgres9.5  
Option Group default:postgres-9-5  
Copy Tags To Snapshots   
Enable Encryption No

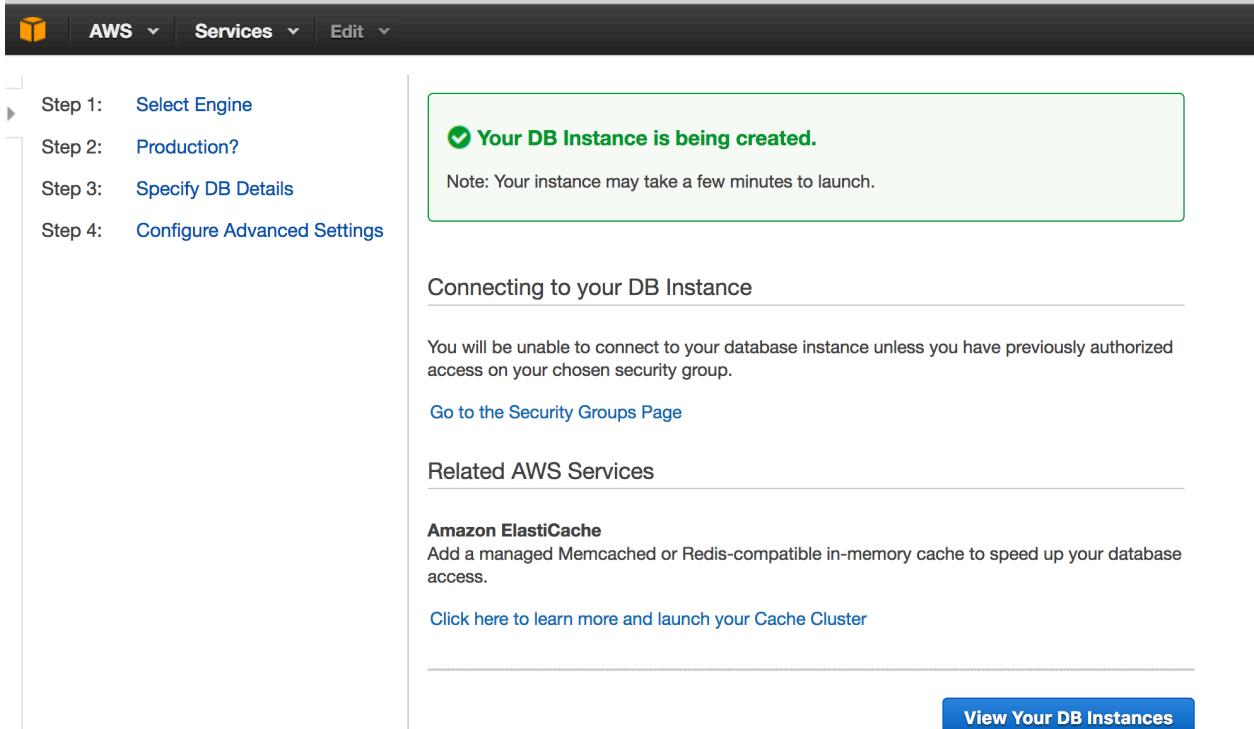
Specify a string of alpha-numeric characters to define the name given to the database that Amazon RDS creates when it creates a new instance, as in "mydb". If you do not specify a database name, Amazon RDS creates a database with the same name as the DB instance.



# Relational Databases on AWS

## Relational Database Services (RDS)

- Relational DB on Cloud
- Supports Aurora, Oracle, Microsoft SQL Server, PostgreSQL, MySQL and MariaDB.



# Relational Databases on AWS

## Relational Database Services (RDS)

- Relational DB on Cloud
- Supports Aurora, Oracle, Microsoft SQL Server, PostgreSQL, MySQL and MariaDB.

The screenshot shows the AWS RDS Dashboard. On the left, a sidebar lists navigation options: RDS Dashboard (selected), Instances (highlighted with an orange bar), Reserved Purchases, Snapshots, Security Groups, Parameter Groups, Option Groups, and Subnet Groups. At the top right, there are buttons for "Launch DB Instance" (blue), "Show Monitoring" (dropdown), and "Instance Actions" (dropdown). Below these are filters for "Filter: All Instances" and a search bar "Search DB Instances...". The main table displays a single row for a PostgreSQL instance named "msan697" which is currently "creating". The "Status" column shows "creating" in orange. The "Endpoint" status is "Not available yet" with an info icon. At the bottom, there are tabs for "Alarms and Recent Events" (selected) and "Monitoring".

| Engine     | DB Instance | Status   | CPU | Current Activity | Maintenanc... |
|------------|-------------|----------|-----|------------------|---------------|
| PostgreSQL | msan697     | creating |     |                  | None          |



# Relational Databases on AWS

## Relational Database Services (RDS)

The screenshot shows the AWS Relational Database Service (RDS) console interface. At the top, there are three buttons: "Launch DB Instance" (blue), "Show Monitoring" (gray), and "Instance Actions" (gray). Below these are two dropdown menus: "Filter: All Instances" and a search bar with the placeholder "Search DB Instances...". The main table displays a single database instance:

|                          | Engine     | DB Instance | Status    | CPU   | Current Activity | Maintenance |
|--------------------------|------------|-------------|-----------|-------|------------------|-------------|
| <input type="checkbox"/> | PostgreSQL | msan697     | available | 0.83% | 0 Connections    | None        |

At the bottom, the endpoint information is shown: "Endpoint: msan697 . us-west-1.rds.amazonaws.com:5432 (authorized)". The port number "5432" is highlighted with a yellow box.



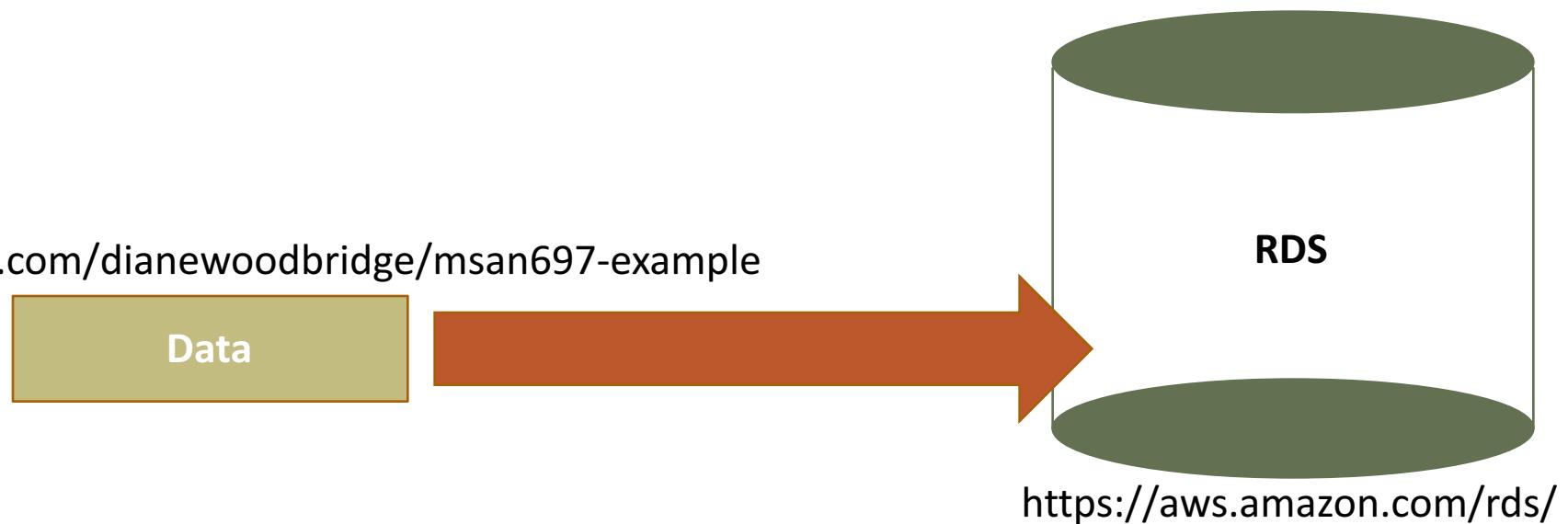
# Relational Databases on AWS

---

Example.

Load data (SFBusiness) in a file to a database.

<https://github.com/dianewoodbridge/msan697-example>



# Relational Databases on AWS

---

Example.

Load data in a file to a database.

- Access to RDS

```
psql --host msan697.c7hpe.us-west-1.rds.amazonaws.com --port 5432 --username dwoodbridge --dbname msan697
```

Data :  
<https://data.sfgov.org/>



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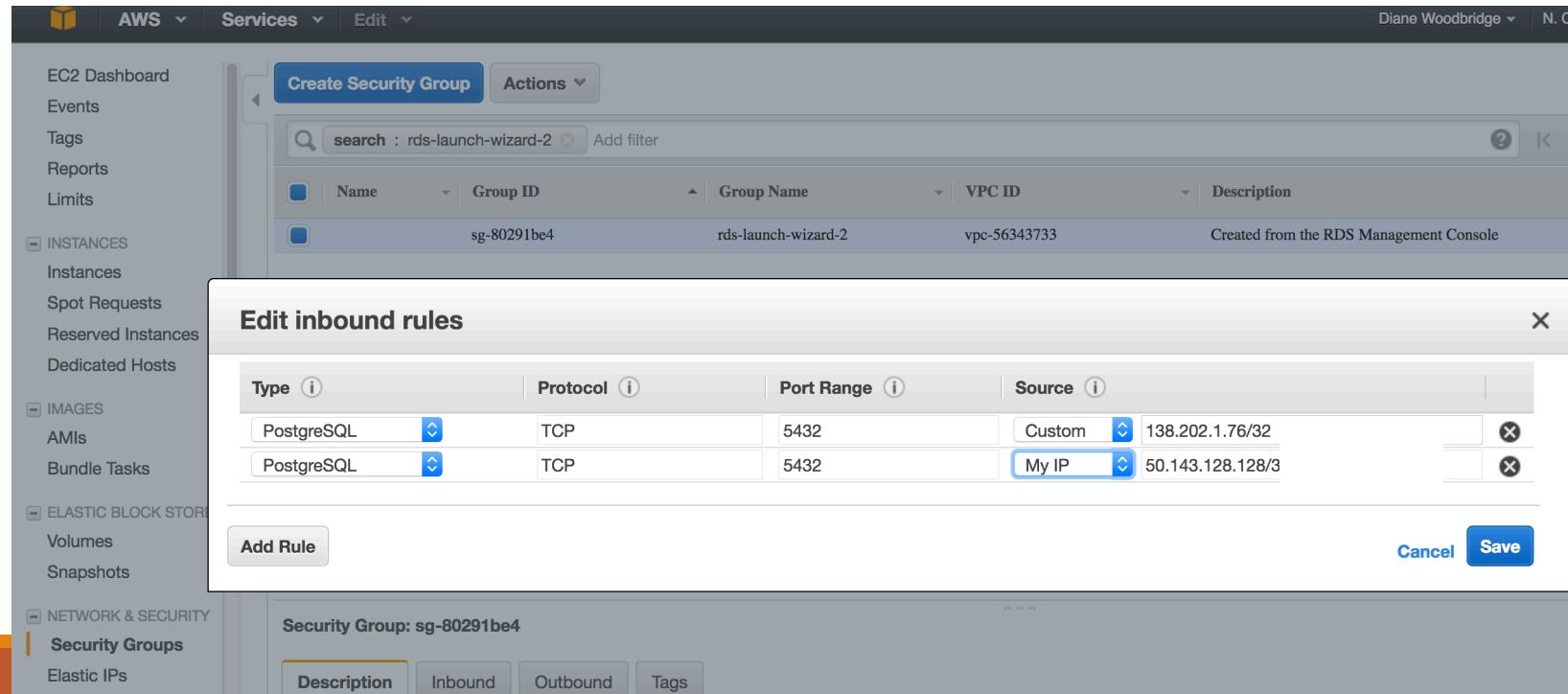
# Relational Databases on AWS

Example.

Load data in a file to a database.

For Later...

- Access to RDS
  - If you have trouble to connect to aws rds, make sure that it is publicly available and your IP is added to the security group or allow all the access from outside.



# Relational Databases on AWS

---

Example.

Load data in a file to a database.

- Create table

```
CREATE TABLE Businesses(business_id numeric, name char(200), address
char(200), city char(100), state char(10), postal_code char(20), latitude
real, longitude real, phone_number char(200));
```

- Use postgres command \COPY to copy downloaded data to RDS.

```
\COPY Businesses FROM 'businesses.csv' CSV HEADER
```

Data :  
<https://data.sfgov.org/>



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# Example 1

---

Repeat it for inspections.csv and violations.csv.

- business\_id numeric, score numeric, date date, type char(20)
- business\_id numeric, date date, description text

How many records are in each table?



# Example 2

---

What are the names of the businesses and their lowest score, which had “Improper food storage” violations?



# Homework 1

---

Due by November 3<sup>rd</sup> (Midnight).



# Week2!

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# NoSQL

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## Why NoSQL?

- Impedence Mismatch
  - Relation model ≠ In-memory data structure (object)
  - For application Development Productivity,
    - Better mapping with in-memory data structures for the application.
- Large volumes of data (2000s)
  - Scaling up vs. Scaling out?
    - Run large data on clusters of many smaller and cheaper machines.
    - Cheaper and reliable.
- Example of non-relational database.
  - Google BigTable and Amazon Dynamo.



# NoSQL

---

Generally,

- Take schemaless data.
- Non-relational.
- Open-source.
- Trade off traditional consistency for other properties.
- Run on clusters.



# SQL and NoSQL

## SQL

### Pros

Persistent data storage.  
Concurrency.  
Standard Model.

### Cons

Impedence mismatch.  
Hard to scale.  
Fixed schema.

### Example

MySQL, PostgreSQL,  
SQL Server, Oracle

VS

## NoSQL

### Pros

Mostly open-source.  
Schemaless.  
Good for non-relational data.  
Scalable.  
Runs well on distributed systems.

### Cons

Installation, toolsets still maturing.

### Example

Redis, MongoDB, Cassandra,  
OrientDB



# Aggregate-oriented NoSQL Databases

Aggregate: Collection of related objects treated as a unit.

- For analyzing data, you might want to place some data together as an aggregate.
- On a cluster, an aggregate is stored together on a node.
- Aggregate-oriented databases use aggregates indexed by key for data lookup.
- A single aggregate is a unit of atomic updates.
- Aggregate-oriented databases don't have ACID transactions that span multiple aggregates.
- RDBMS is aggregate-ignorant.

```
{
 "_links": {
 "self": {
 "href": "/member/109087/cart"
 },
 "http://example.com/rels/payment": {
 "href": "/payment"
 }
 },
 "_embedded": {
 "http://example.com/rels/cart-item": [
 {
 "_links": {
 "self": {
 "href": "/member/109087/cart/14418796"
 }
 },
 "id": "14418796",
 "quantity": 1,
 "expire_time": "2009-09-11T08:00:00-07:00",
 "_embedded": {
 "http://example.com/rels/sku": [
 {
 "_links": {
 "self": {
 "href": "/skus/654654"
 },
 "http://example.com/images/cart/item": "http://example.com/product/6895/thumbnail.jp
 }
]
 }
 }
]
 }
}
```

# Aggregate-oriented NoSQL Databases

---

## Pros

- Provides clearer semantics to consider by focusing on the aggregate unit used by applications.
- Better design choice for running on a cluster.

## Cons

- Drawing boundaries of an aggregate is not easy.
- When a goal of data management/analysis is not clear, aggregate models might not be the best choice.
- Doesn't support ACID transactions.



# Aggregate-oriented NoSQL Databases

---

## Types

- Key-value and Document Database
    - Each aggregate has a key (ID).
    - Key-value database
      - We can store whatever we want in aggregates.
      - Key lookup for the entire aggregate.
    - Document database
      - It has allowable structures and types.
      - Access by key and also by the fields in the aggregates. (can retrieve fields in the value.)
- ➔ Key-value and Document DB are similar, and their distinction is often blurry.  
But with Document DB, you can submit a query based on the internal structure of the document.



# Aggregate-oriented NoSQL Databases

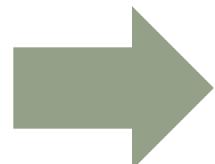
## Types

- Column Family
  - Optimize for cases when write is rare, but columns are read together in many rows together .
  - Organizes columns into column families (Unit of access).
  - Two level map structure.
    1. Row Identifier (Row Key) – choose the aggregate of interest.
    2. Columns – choose a particular columns.

## Class

| ID  | Student |  |  |  |  |  |
|-----|---------|--|--|--|--|--|
| 123 | Student |  |  |  |  |  |
| 123 | ID      |  |  |  |  |  |
| 123 | 1234    |  |  |  |  |  |

**SQL**



## Row Key

1234

## Column-family

| Column key | Column value |
|------------|--------------|
| name       |              |
| email      |              |
| phone      |              |

|         |  |
|---------|--|
| MSAN697 |  |
| MSAN690 |  |
| MSAN590 |  |



# Relationship-oriented NoSQL Database

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## Needs of relationship-oriented DB

- Relational database with complex schema
  - Hard to understand, query, generalize and integrate data.
- Aggregate-oriented NoSQL
  - Atomicity is only supported within a single aggregate.



# Relationship-oriented NoSQL Database

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## Graph Database

- Nodes (Object) and edges (Relationships) representation.
- For data with complex relationships.
  - Focuses on graph traverse (more than insert.).
  - Cf) RDBMS : Many joins can cause poor performance.
- Running on a single server rather than distributed across clusters.



# NoSQL Database Examples

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## Key-value

- Redis, Riak, Berkeley DB, etc.

## Document

- MongoDB, CouchDB, OrientDB, RavenDB, etc.

## Column Family

- Cassandra, Hbase, Amazon SimpleDB, etc.

## Graph

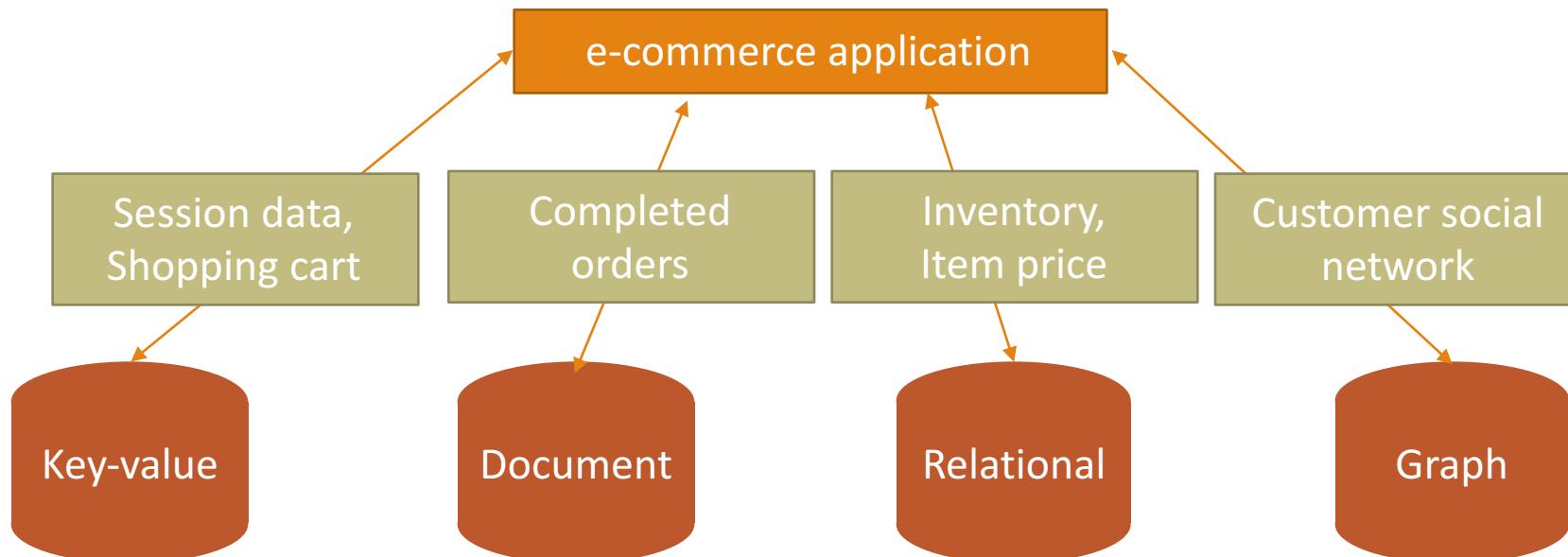
- OrientDB, Neo4J, FlockDB, etc.



# Choice of DBMS

## Polygot Persistence

- Using multiple data storage technologies, chosen based on the way data is being used by individual applications.
- NoSQL data stores do not replace relational databases.



# Database Ranking (Sept 2016)

db-engines.com/en/ranking

Read more about the [method](#) of calculating the scores.

**trend chart**

315 systems in ranking, September 2016

| Rank | DBMS     |          |                      | Database Model    | Score    |          |          |
|------|----------|----------|----------------------|-------------------|----------|----------|----------|
|      | Sep 2016 | Aug 2016 | Sep 2015             |                   | Sep 2016 | Aug 2016 | Sep 2015 |
| 1.   | 1.       | 1.       | Oracle               | Relational DBMS   | 1425.56  | -2.16    | -37.81   |
| 2.   | 2.       | 2.       | MySQL +              | Relational DBMS   | 1354.03  | -3.01    | +76.28   |
| 3.   | 3.       | 3.       | Microsoft SQL Server | Relational DBMS   | 1211.55  | +6.51    | +113.72  |
| 4.   | ↑5.      | ↑5.      | PostgreSQL           | Relational DBMS   | 316.35   | +1.10    | +30.18   |
| 5.   | ↓4.      | ↓4.      | MongoDB +            | Document store    | 316.00   | -2.49    | +15.43   |
| 6.   | 6.       | 6.       | DB2                  | Relational DBMS   | 181.19   | -4.70    | -27.95   |
| 7.   | 7.       | ↑8.      | Cassandra +          | Wide column store | 130.49   | +0.26    | +2.89    |
| 8.   | 8.       | ↓7.      | Microsoft Access     | Relational DBMS   | 123.31   | -0.74    | -22.68   |
| 9.   | 9.       | 9.       | SQLite               | Relational DBMS   | 108.62   | -1.24    | +0.97    |
| 10.  | 10.      | 10.      | Redis +              | Key-value store   | 107.79   | +0.47    | +7.14    |
| 11.  | 11.      | ↑14.     | Elasticsearch +      | Search engine     | 96.48    | +3.99    | +24.93   |
| 12.  | 12.      | ↑13.     | Teradata             | Relational DBMS   | 73.06    | -0.57    | -1.20    |
| 13.  | 13.      | ↓11.     | SAP Adaptive Server  | Relational DBMS   | 69.16    | -1.88    | -17.38   |
| 14.  | 14.      | ↓12.     | Solr                 | Search engine     | 66.96    | +1.19    | -14.98   |
| 15.  | 15.      | 15.      | HBase                | Wide column store | 57.81    | +2.30    | -1.22    |
| 16.  | 16.      | ↑17.     | FileMaker            | Relational DBMS   | 55.35    | +0.34    | +4.35    |
| 17.  | 17.      | ↑18.     | Splunk               | Search engine     | 51.29    | +2.38    | +9.06    |
| 18.  | 18.      | ↓16.     | Hive                 | Relational DBMS   | 48.82    | +1.01    | -4.71    |
| 19.  | 19.      | 19.      | SAP HANA +           | Relational DBMS   | 43.42    | +0.68    | +5.22    |
| 20.  | 20.      | ↑25.     | MariaDB              | Relational DBMS   | 38.53    | +1.65    | +14.31   |
| 21.  | 21.      | 21.      | Neo4j +              | Graph DBMS        | 36.37    | +0.80    | +2.83    |
| 22.  | ↑24.     | ↑24.     | Couchbase +          | Document store    | 28.54    | +1.14    | +2.28    |
| 23.  | 23.      | ↓22.     | Memcached            | Key-value store   | 28.43    | +0.74    | -3.99    |
| 24.  | ↓22.     | ↓20.     | Informix             | Relational DBMS   | 28.19    | -0.86    | -9.76    |
| 25.  | 25.      | ↑28.     | Amazon DynamoDB +    | Document store    | 27.42    | +0.82    | +7.43    |
| 26.  | 26.      | ↓23.     | CouchDB              | Document store    | 21.48    | +0.42    | -5.12    |
| 27.  | 27.      | ↑30.     | Vertica              | Relational DBMS   | 21.06    | +0.58    | +3.31    |
| 28.  | ↑29.     | ↓27.     | Netezza              | Relational DBMS   | 19.81    | +0.34    | -1.24    |

<http://db-engines.com/en/ranking/>

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# References

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- Sadalage, Pramod J., and Martin Fowler. *NoSQL distilled: a brief guide to the emerging world of polyglot persistence*. Pearson Education, 2012.
- Redmond, Eric, and Jim R. Wilson. *Seven databases in seven weeks: a guide to modern databases and the NoSQL movement*. Pragmatic Bookshelf, 2012.
- Date, C. J. "Database systems." Vols. I & II, Narosa Pub (1986).



# SQL Interview Questions

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## Important RDBMS concepts to remember

- Create
- Insert
- Select
- Update
- Join (Inner, Outer, Left, Right, etc.)\*
- Union All/Union/ Union Distinct
- Minus
- Intersect
- Difference WHERE vs. Having
- Normalization (1NF, 2NF and 3NF)\*
- Transaction(Concurrency Control) – ACID\*
- Indexing\* - R tree, Hash
- Truncate vs Delete
- Execution Plan
- Rank, Dense\_rank, Rownum



# Relational Databases

- Union : Combine result sets from 2 or more SELECT queries.
    - Union – Returns distinct values by default.
    - Union All – Allows duplicates.

| A | B | C |
|---|---|---|
|   |   |   |
|   |   |   |
|   |   |   |
|   |   |   |

| A | B | C |
|---|---|---|
|   |   |   |
|   |   |   |
|   |   |   |

# Union

## Union All

# Relational Databases

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- Delete vs. Truncate

| Truncate                                                                                                                                                                 | Delete                                                                                                                                                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| We can't Rollback after performing Truncate.<br><b>Example:</b><br>BEGIN TRAN<br>TRUNCATE TABLE tranTest<br>SELECT * FROM tranTest<br>ROLLBACK<br>SELECT * FROM tranTest | We can Rollback after delete.<br><b>Example:</b><br>BEGIN TRAN<br>DELETE FROM tranTest<br>SELECT * FROM tranTest<br>ROLLBACK<br>SELECT * FROM tranTest |
| Truncate reset identity of table.                                                                                                                                        | Truncate reset identity of table.                                                                                                                      |
| It locks the entire table.                                                                                                                                               | It locks the table row.                                                                                                                                |
| Its <u>DDL</u> (Data Definition Language) command.                                                                                                                       | Its <u>DML</u> (Data Manipulation Language) command.                                                                                                   |
| We can't use WHERE clause with it.                                                                                                                                       | We can use WHERE to filter data to delete.                                                                                                             |
| Trigger is not fired while truncate.                                                                                                                                     | Trigger is fired.                                                                                                                                      |
| <b>Syntax :</b><br>1) TRUNCATE TABLE table_name                                                                                                                          | <b>Syntax :</b><br>1) DELETE FROM table_name<br>2) DELETE FROM table_name WHERE example_column_id IN (1,2,3)                                           |



# Relational Databases

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## WHERE vs. HAVING

- WHERE : Conditions on *individual rows*.
- HAVING : Conditions on *aggregations*.
  - i.e. results of a single result produced from *multiple* rows using aggregate functions such as count, average, min, max, sum, etc .
- As a rule of thumb, use WHERE before GROUP BY and HAVING after GROUP BY.

