An introduction to
NoSQL databases

What is covered in this

- A brief history of databases
- NoSQL WHY, WHAT & WHEN?
- Characteristics of NoSQL databases
- Aggregate data models
- CAP theorem

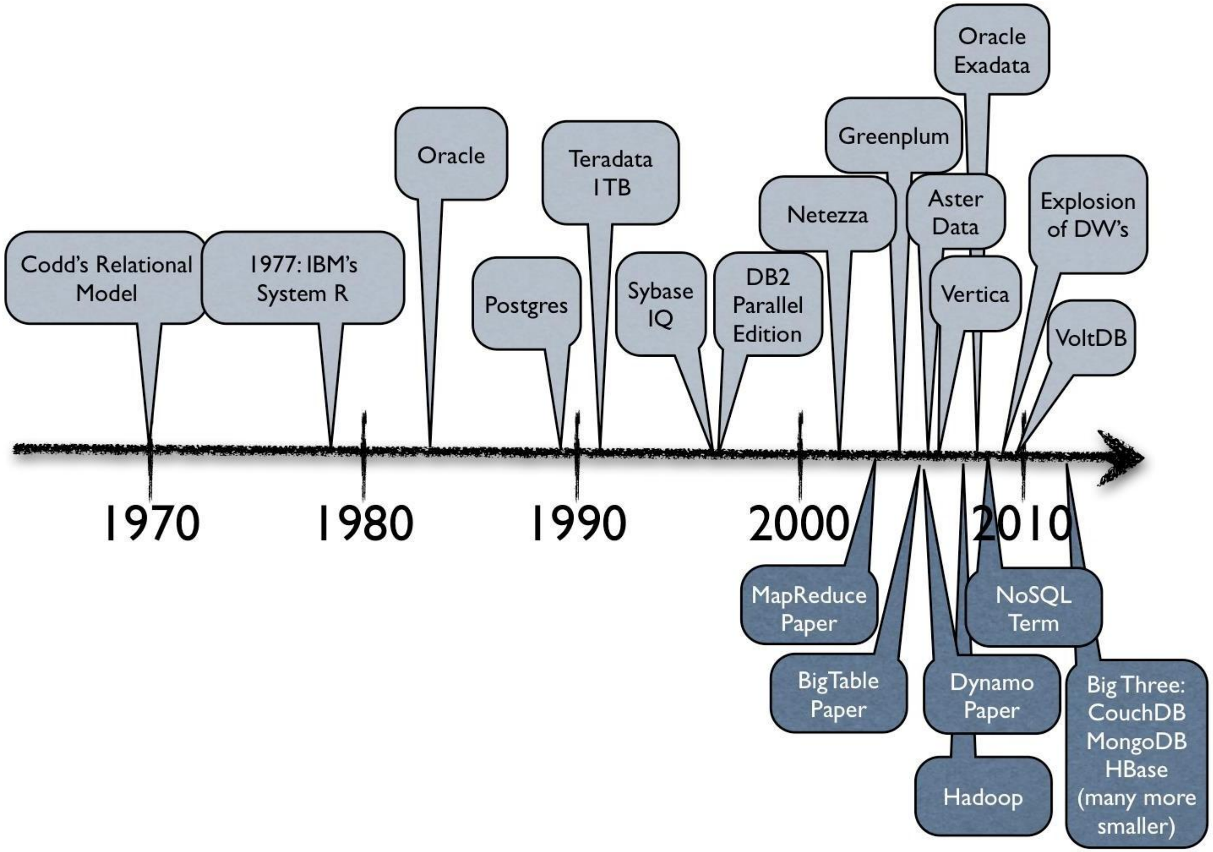
Introduction

- Database - Organized collection of data

- DBMS – Database Management System: a software package with computer programs that controls the creation, maintenance and use of a database

- Databases are created to operate large quantities of information by inputting, storing, retrieving, and managing that information.

A brief history



Relational databases

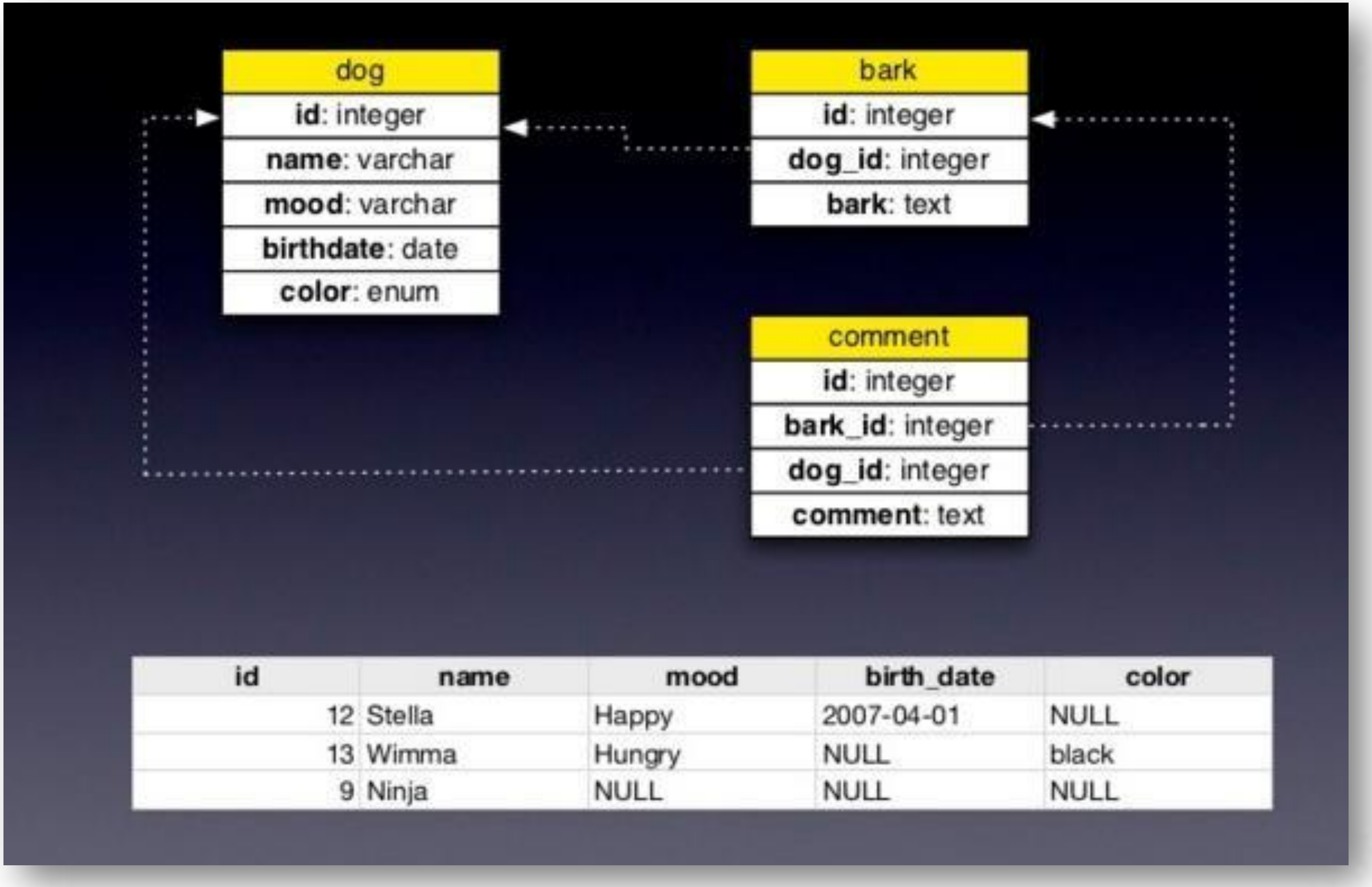
- Benefits of Relational databases:

- Designed for all purposes
- ACID
- Strong consistancy, concurrency, recovery
- Mathematical background
- Standard Query language (SQL)
- Lots of tools to use with i.e: Reporting services, entity frameworks, ...

SQL databases

SQLite
ORACLE
PostgreSQL
db isam
Microsoft SQL Server
TURBODB Embedded
MySQL
Microsoft SQL Azure
elevatedb

RDBMS



dog
id: integer
name: varchar
mood: varchar
birthdate: date
color: enum

bark
id: integer
dog_id: integer
bark: text

comment
id: integer
bark_id: integer
dog_id: integer
comment: text

id	name	mood	birth_date	color
12	Stella	Happy	2007-04-01	NULL
13	Wimma	Hungry	NULL	black
9	Ninja	NULL	NULL	NULL

NoSQL why, what and when?

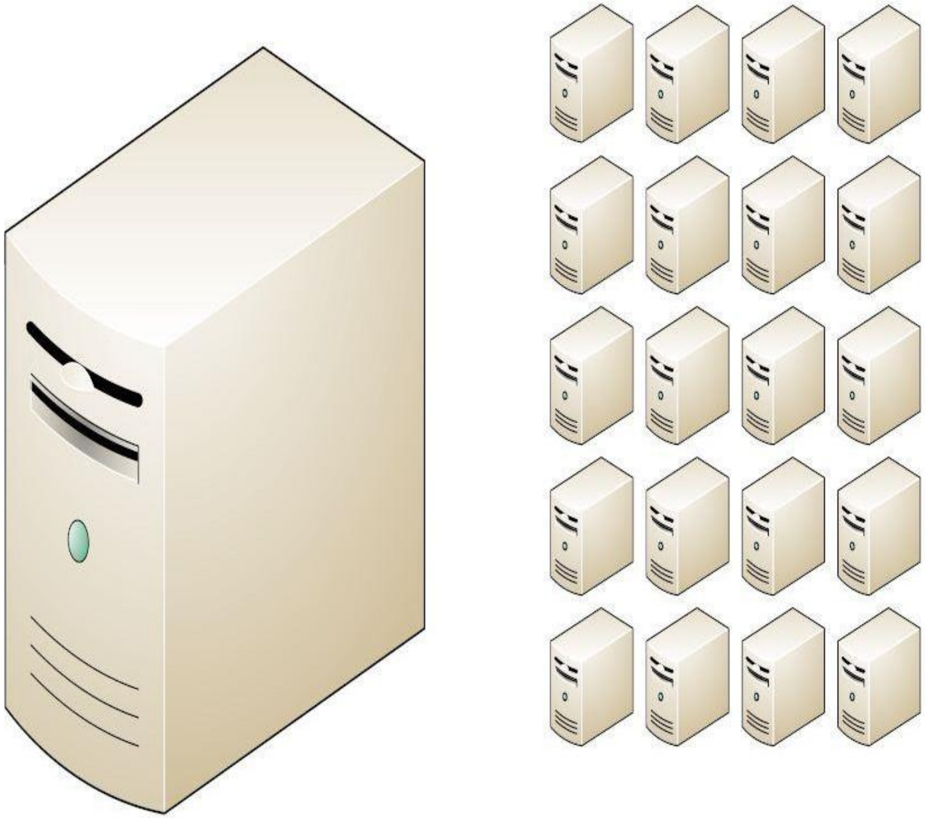
But…

- ❑ Relational databases were not built for **distributed applications.**

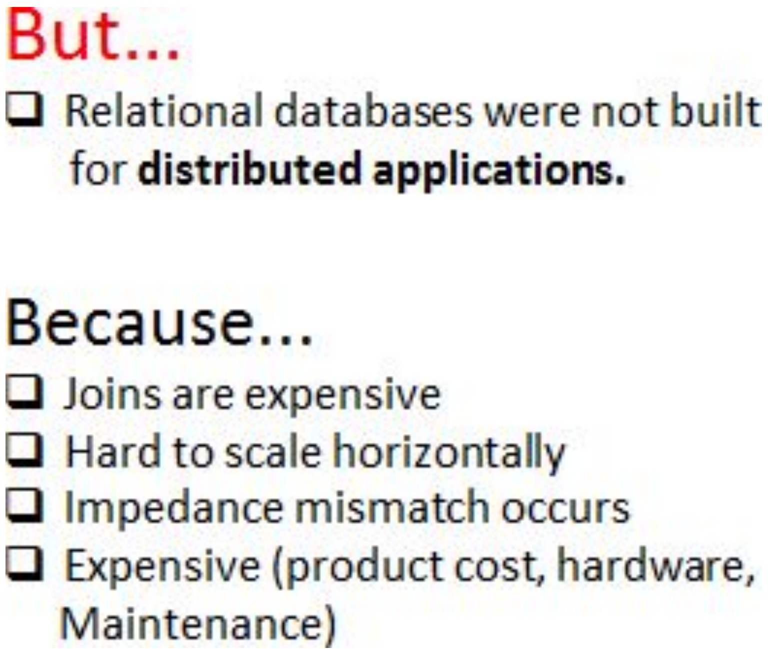
Because…

- ❑ Joins are expensive
- ❑ Hard to scale horizontally
- ❑ Impedance mismatch occurs
- ❑ Expensive (product cost, hardware, Maintenance)

Era of Distributed Computing



NoSQL why, what and when?



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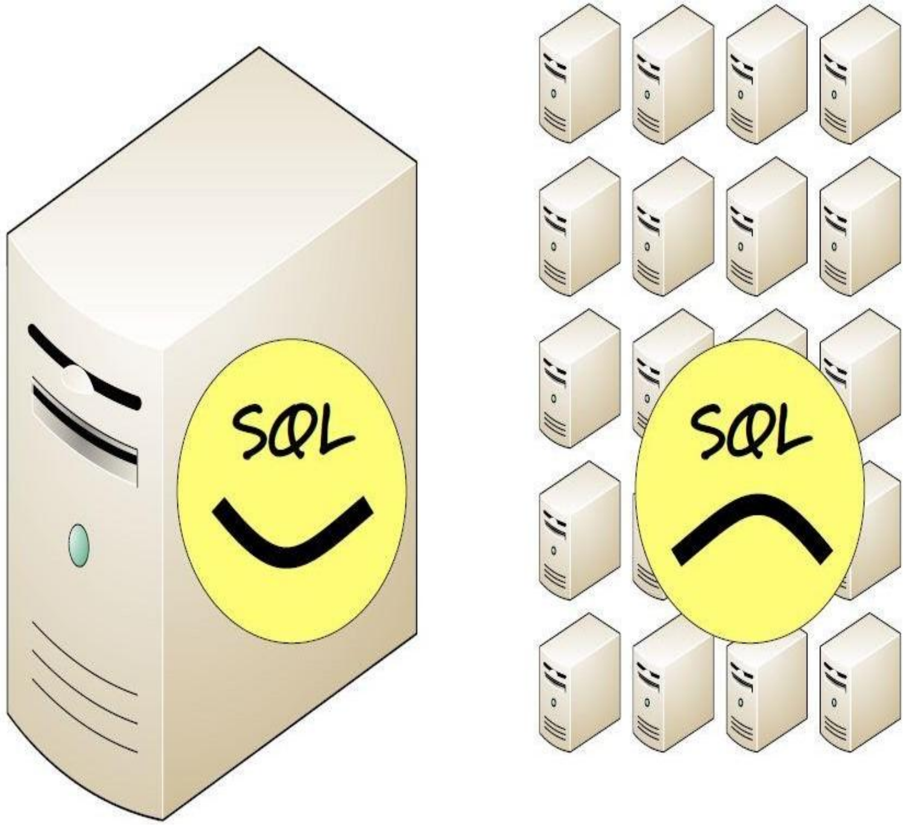
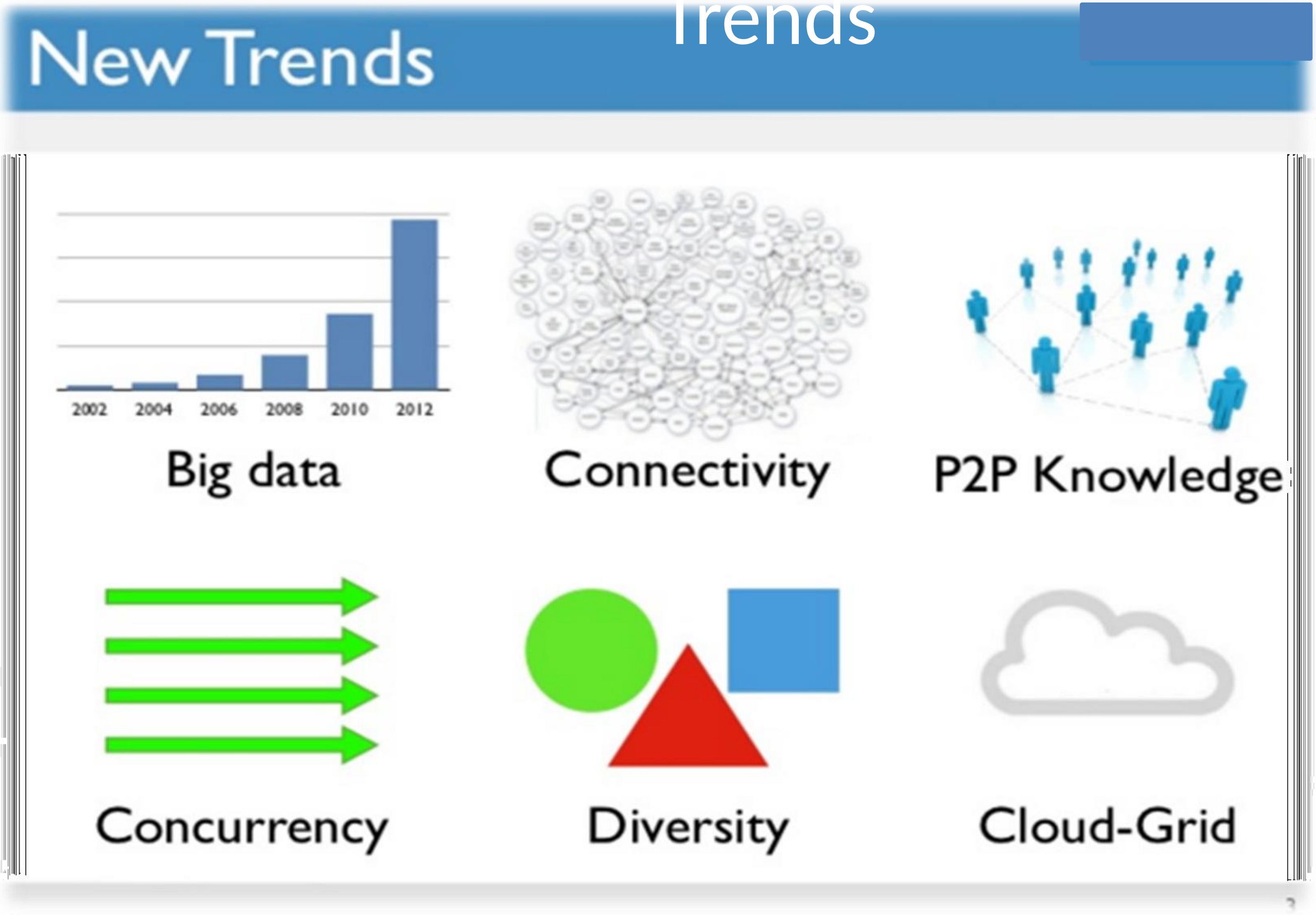


And....

It’s weak in:

- □ Speed (performance)
- □ High availability
- □ Partition tolerance

Why NOSQL now?? Ans. Driving Trends



New Trends

Big data

Connectivity

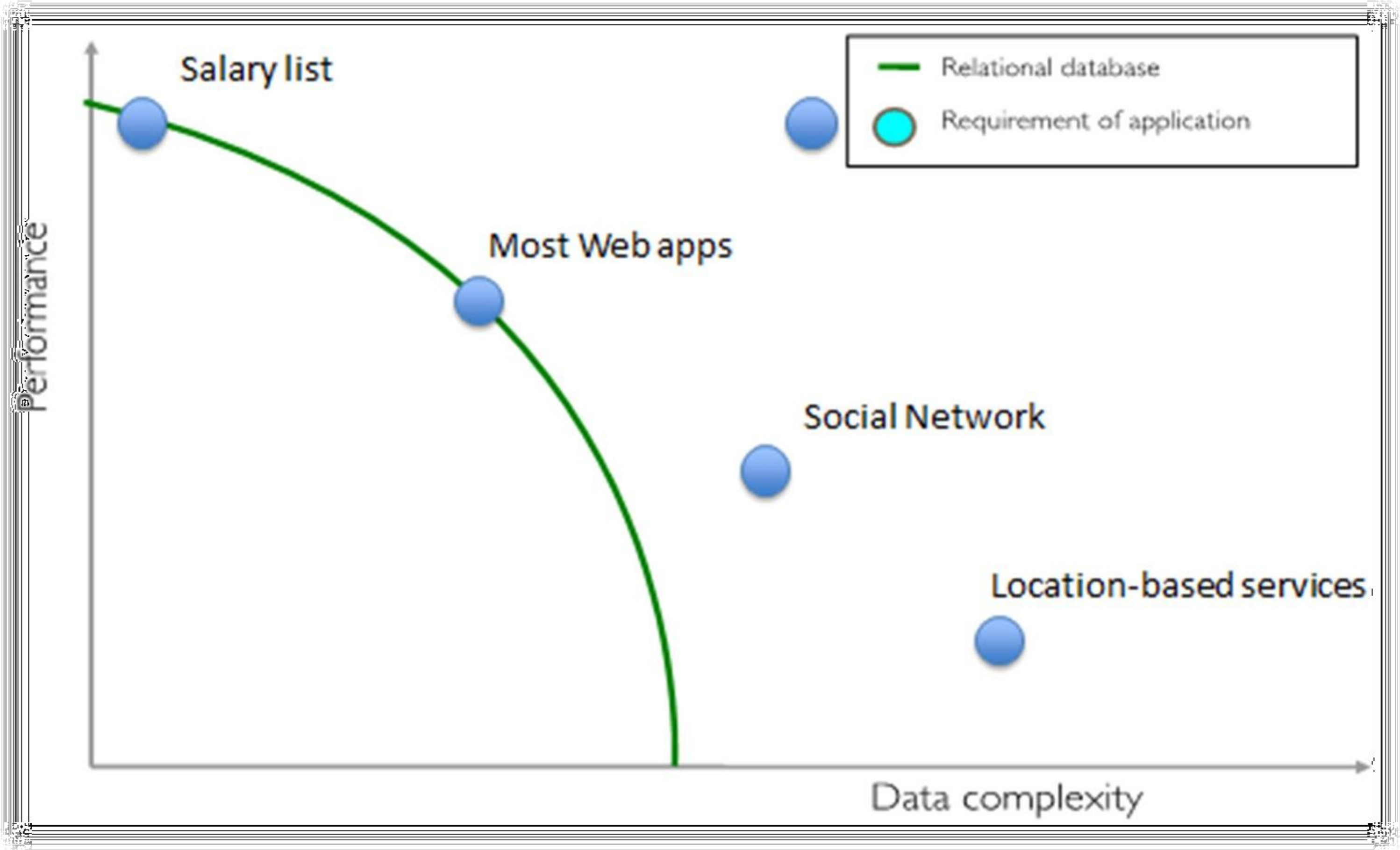
P2P Knowledge

Concurrency

Diversity

Cloud-Grid

Side note: RDBMS



But.. What's NoSQL?

❑ A No SQL database provides a mechanism for storage and retrieval of data that employs less constrained consistency models than traditional relational database

❑ No SQL systems are also referred to as "NotonlySQL“ to emphasize that they do in fact allow SQL-like query languages to be used.

Characteristics of NoSQL databases

NoSQL avoids:

□ Overhead of ACID transactions

□ Complexity of SQL query

□ Burden of up-front schema design

□ DBA presence

□ Transactions (It should be handled
at
application layer)

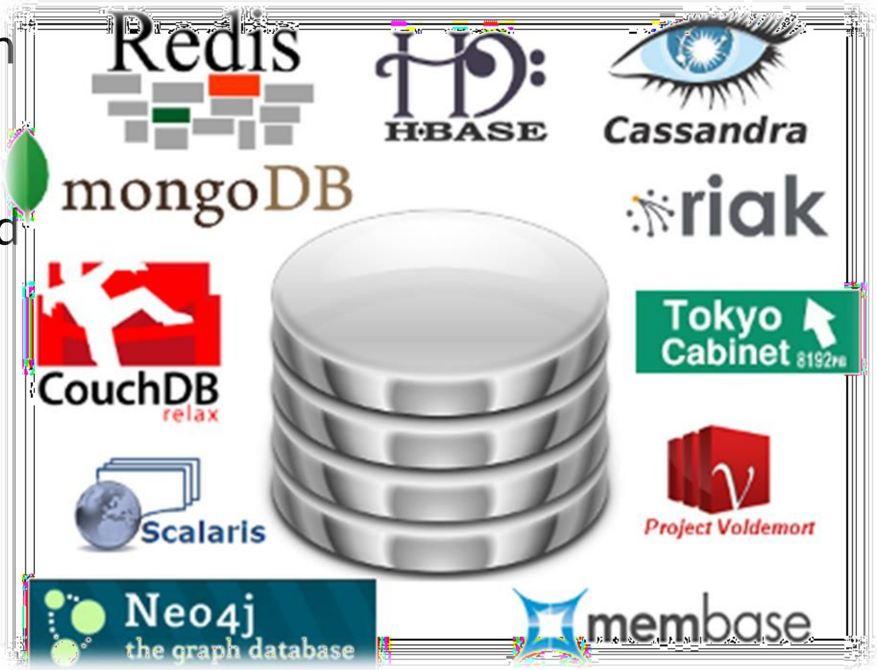
Provides:

□ Easy and frequent changes to DB

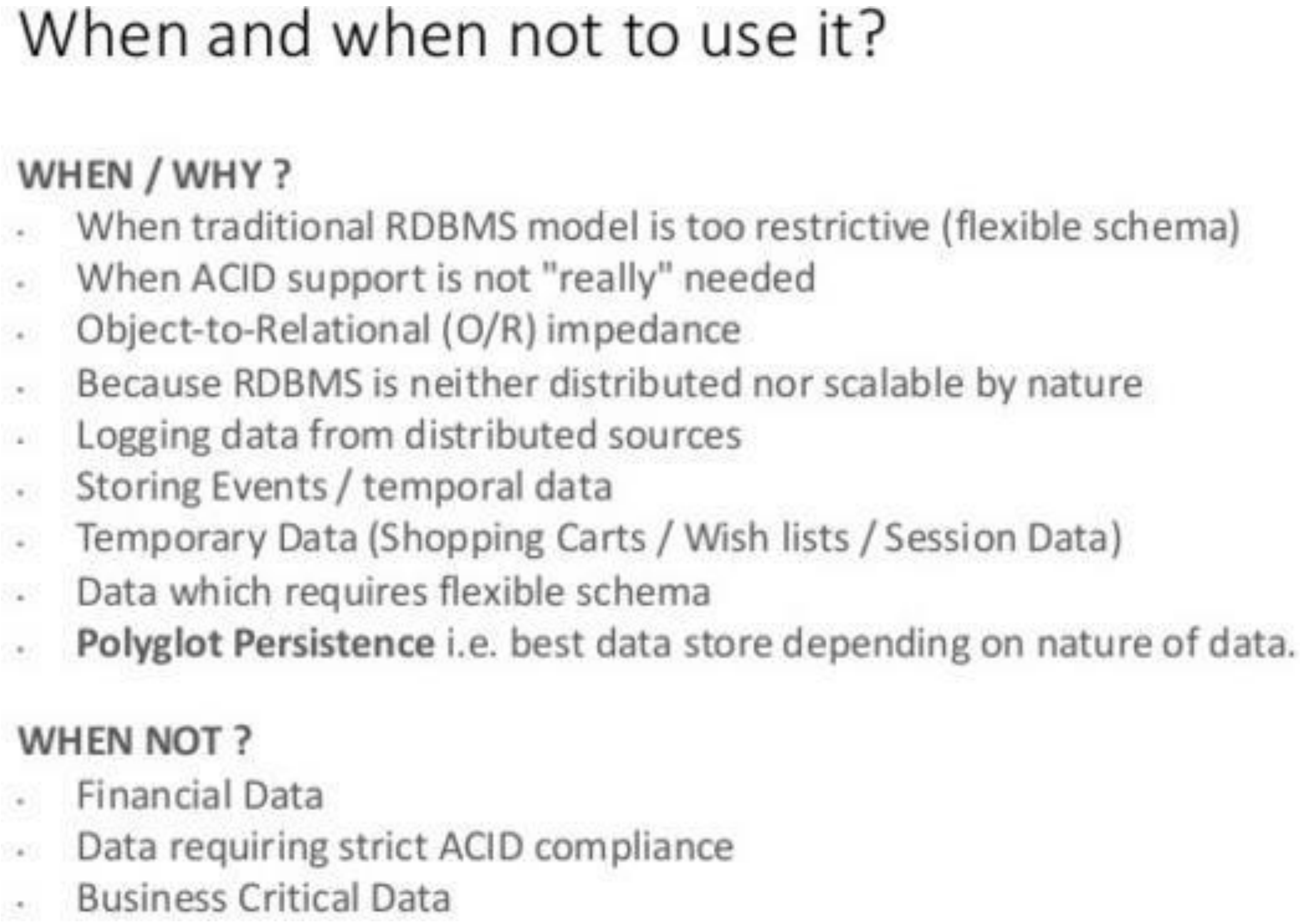
□ Fast development

□ Large data volumes(eg.Google)

□ Schema less



NoSQL why, what and when?



When and when not to use it?

WHEN / WHY ?

- When traditional RDBMS model is too restrictive (flexible schema)
- When ACID support is not "really" needed
- Object-to-Relational (O/R) impedance
- Because RDBMS is neither distributed nor scalable by nature
- Logging data from distributed sources
- Storing Events / temporal data
- Temporary Data (Shopping Carts / Wish lists / Session Data)
- Data which requires flexible schema
- **Polyglot Persistence** i.e. best data store depending on nature of data.

WHEN NOT ?

- Financial Data
- Data requiring strict ACID compliance
- Business Critical Data

NoSQL is getting more & more popular

Google
ebay
LinkedIn
YAHOO!
NETFLIX
amazon
theguardian
facebook

What is a schema-less datamodel?

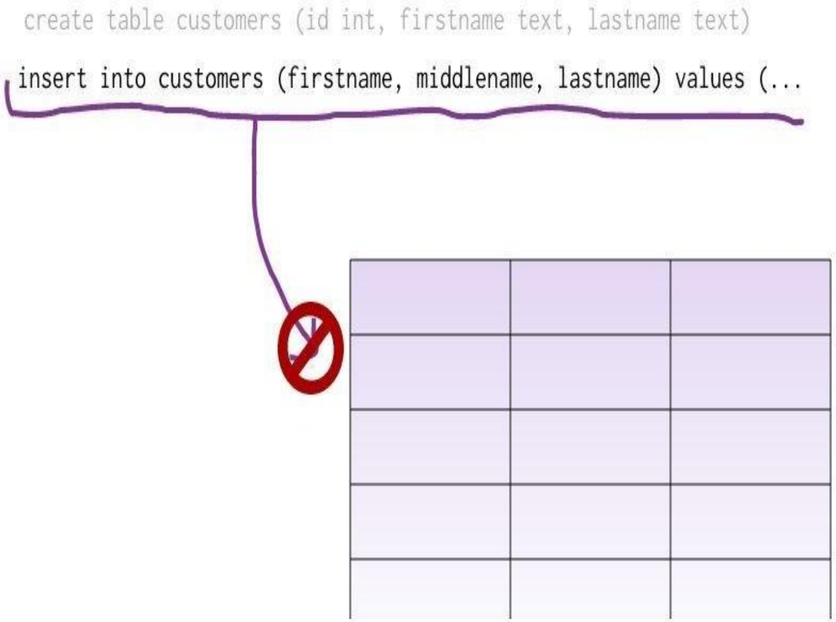
In relational Databases:

□ You can’t add a record which does not fit the schema

□ You need to add NULLs to unused items in a row

□ We should consider the datatypes.
i.e : you can’t add a stirng to an interger field

□ You can’t add multiple items in a field (You should create another table: primary-key, foreign key, joins, normalization, ... !!!)

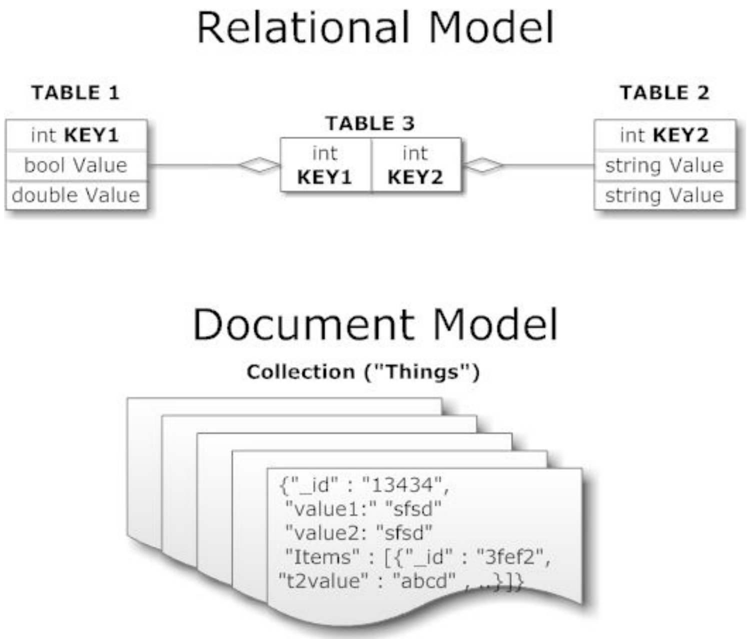


```
create table customers (id int, firstname text, lastname text)
insert into customers (firstname, middlename, lastname) values (...
```

What is a schema-less datamodel?

In NoSQL Databases:

- There is no schema to consider
- There is no unused cell
- There is no datatype (implicit)
- Most of considerations are done in application layer
- We gather all items in an aggregate (document)

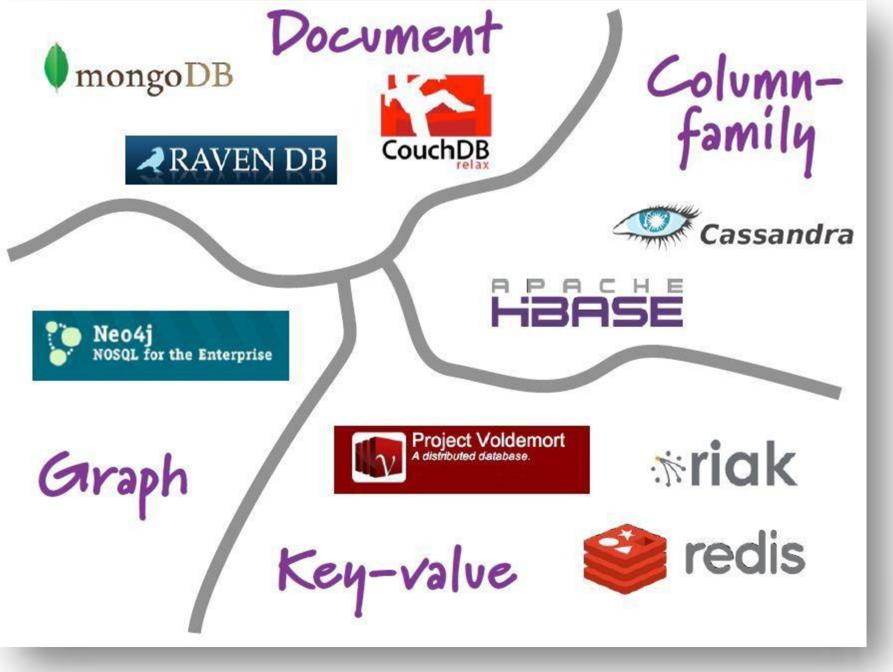


```
{"_id" : "13434",
 "value1:" "sfsd"
 "value2: "sfsd"
 "Items" : [{"_id" : "3fef2",
"t2value" : "abcd" , ..}]}
```

Aggregate Data Models

NoSQL databases are classified in four major datamodels:

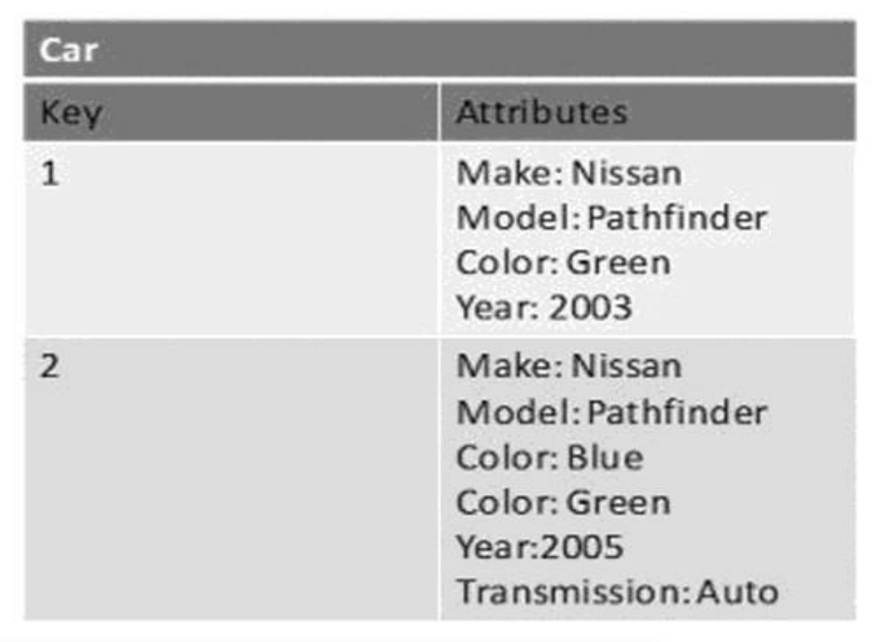
- Key-value
- Document
- Column family
- Graph



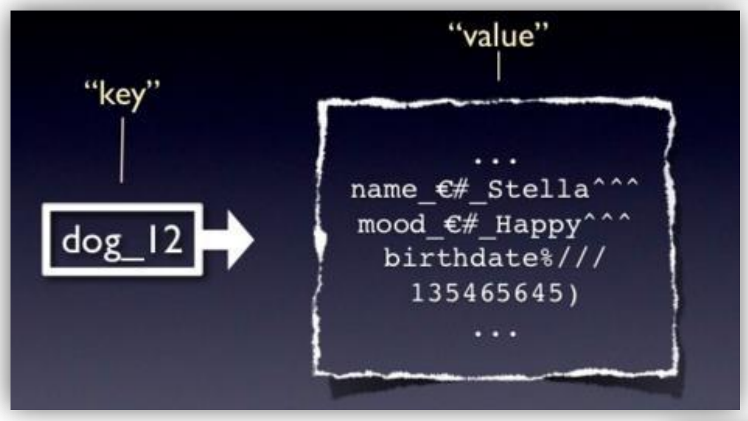
Each DB has its own query language

Key-value data model

- Simplest NOSQL databases
- The main idea is the use of a hash table
- Access data (values) by strings called keys
- Data has no required format data may have any format
- Data model: (key, value) pairs
- Basic Operations: Insert(key,value), Fetch(key), Update(key), Delete(key)



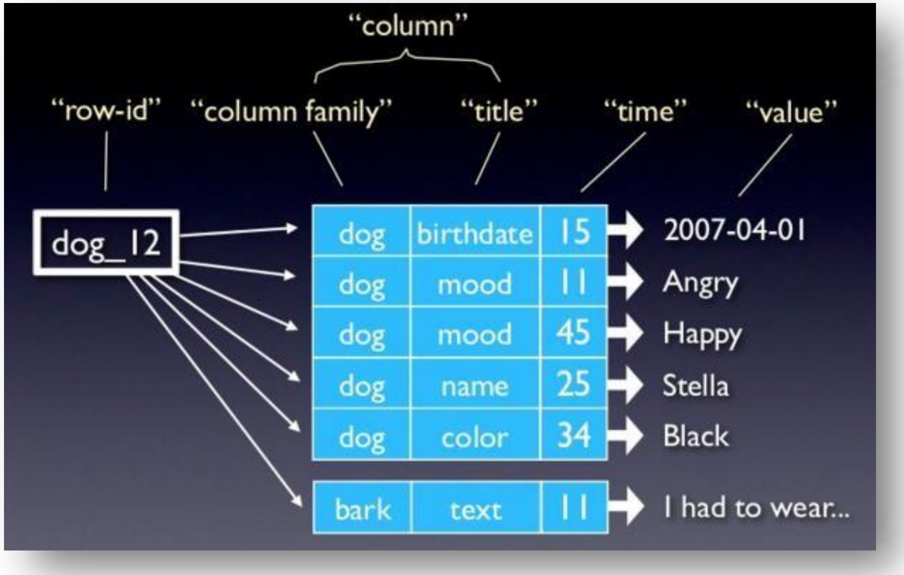
Car	
Key	Attributes
1	Make: Nissan Model: Pathfinder Color: Green Year: 2003
2	Make: Nissan Model: Pathfinder Color: Blue Color: Green Year:2005 Transmission: Auto



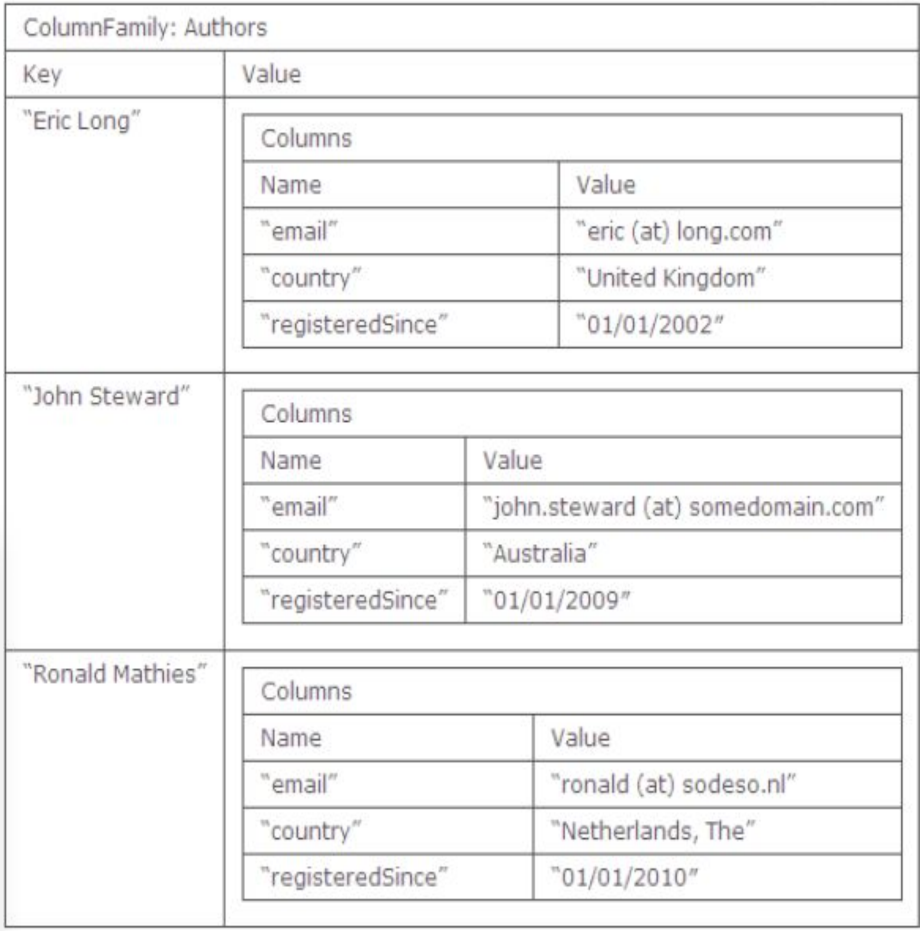
amazon DynamoDB

Column family data model

- The column is lowest/smallest instance of data.
- It is a tuple that contains a name, a value and a timestamp



"column family"	"title"	"time"	"value"
dog	birthdate	15	2007-04-01
dog	mood	11	Angry
dog	mood	45	Happy
dog	name	25	Stella
dog	color	34	Black
bark	text	11	I had to wear...



ColumnFamily: Authors

Key	Value	
"Eric Long"	Columns	
	Name	Value
	"email"	"eric (at) long.com"
	"country"	"United Kingdom"
	"registeredSince"	"01/01/2002"
"John Steward"	Columns	
	Name	Value
	"email"	"john.steward (at) somedomain.com"
	"country"	"Australia"
	"registeredSince"	"01/01/2009"
"Ronald Mathies"	Columns	
	Name	Value
	"email"	"ronald (at) sodeso.nl"
	"country"	"Netherlands, The"
	"registeredSince"	"01/01/2010"

Column family data model

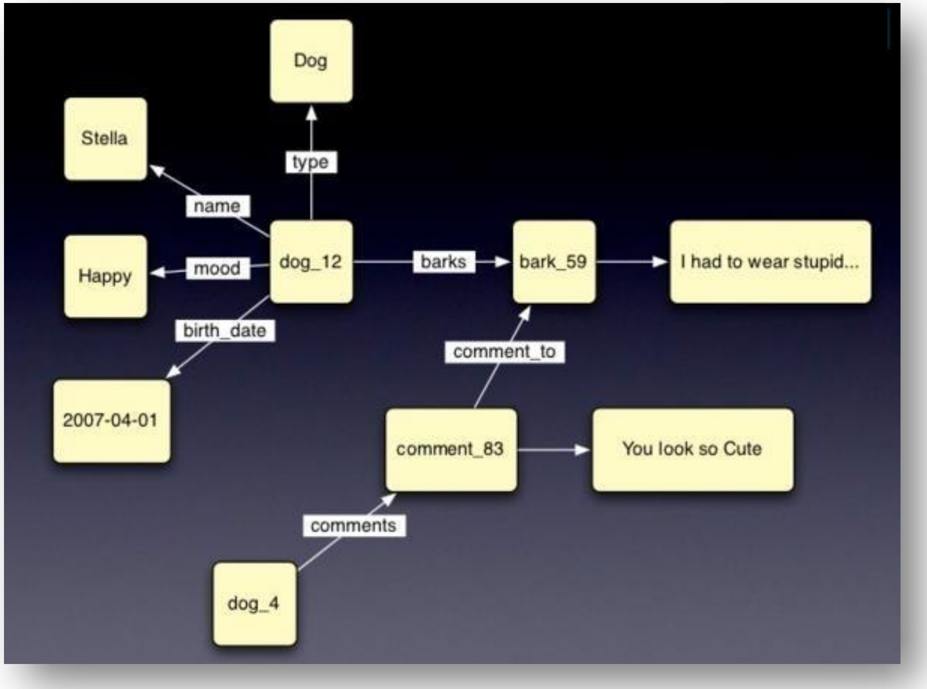
Some statistics about Facebook Search (using **Cassandra**)

- MySQL > 50 GB Data
  - Writes Average : ~300 ms
  - Reads Average : ~350 ms

- Rewritten with Cassandra > 50 GB Data
  - Writes Average : 0.12 ms
  - Reads Average : 15 ms

Graph data model

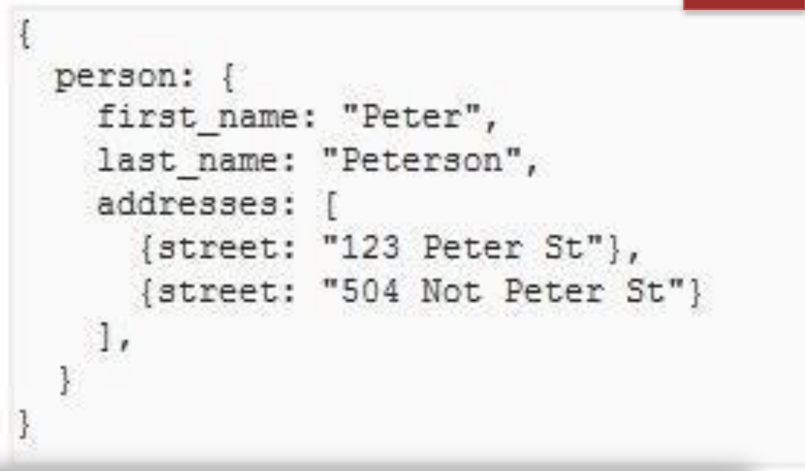
- Based on Graph Theory.
- Scale vertically, no clustering.
- You can use graph algorithms easily
- Transactions
- ACID



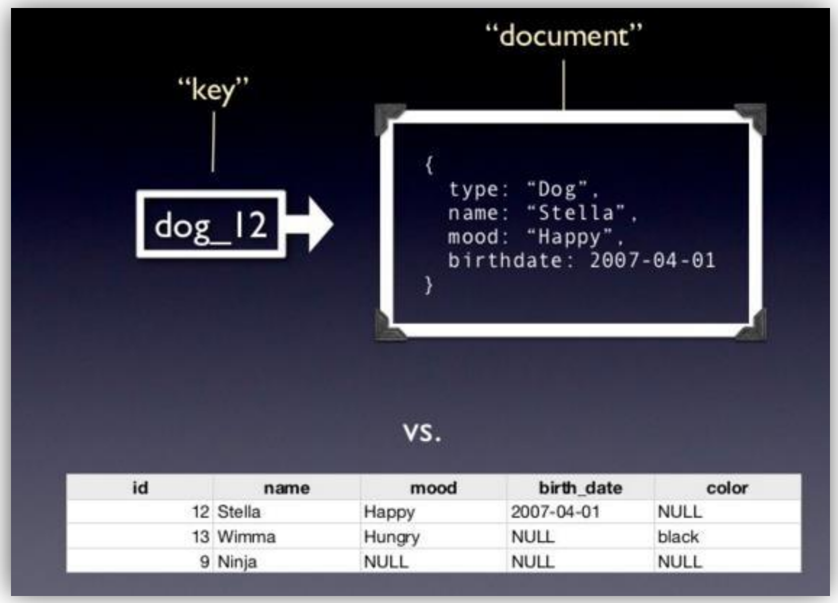
neo4j

Document based data model

- Pair each key with complex data structure known as data structure.
- Indexes are done via B-Trees.
- Documents can contain many different key-value pairs, or key-array pairs, or even nested documents.

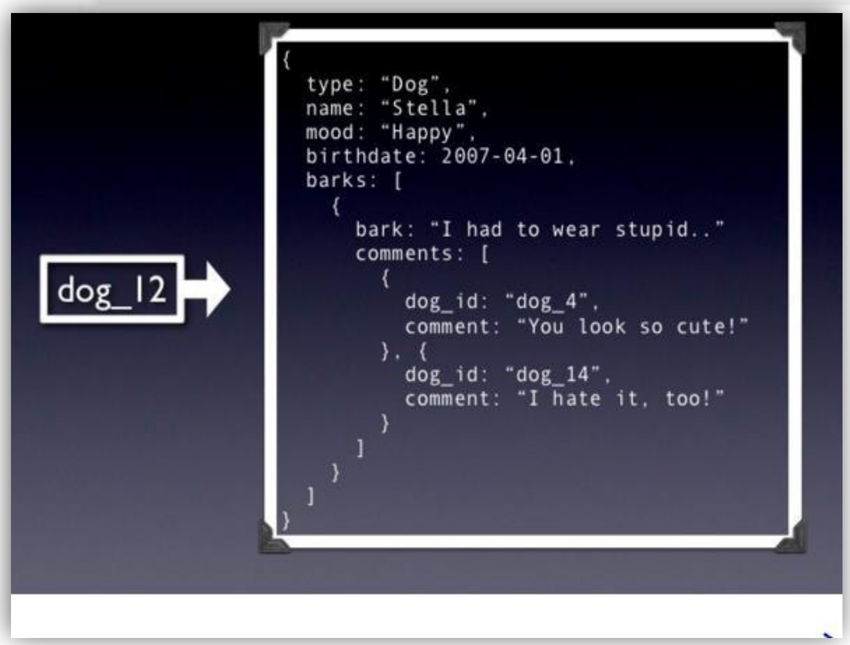


```
{
  person: {
    first_name: "Peter",
    last_name: "Peterson",
    addresses: [
      {street: "123 Peter St"},
      {street: "504 Not Peter St"}
    ],
  }
}
```



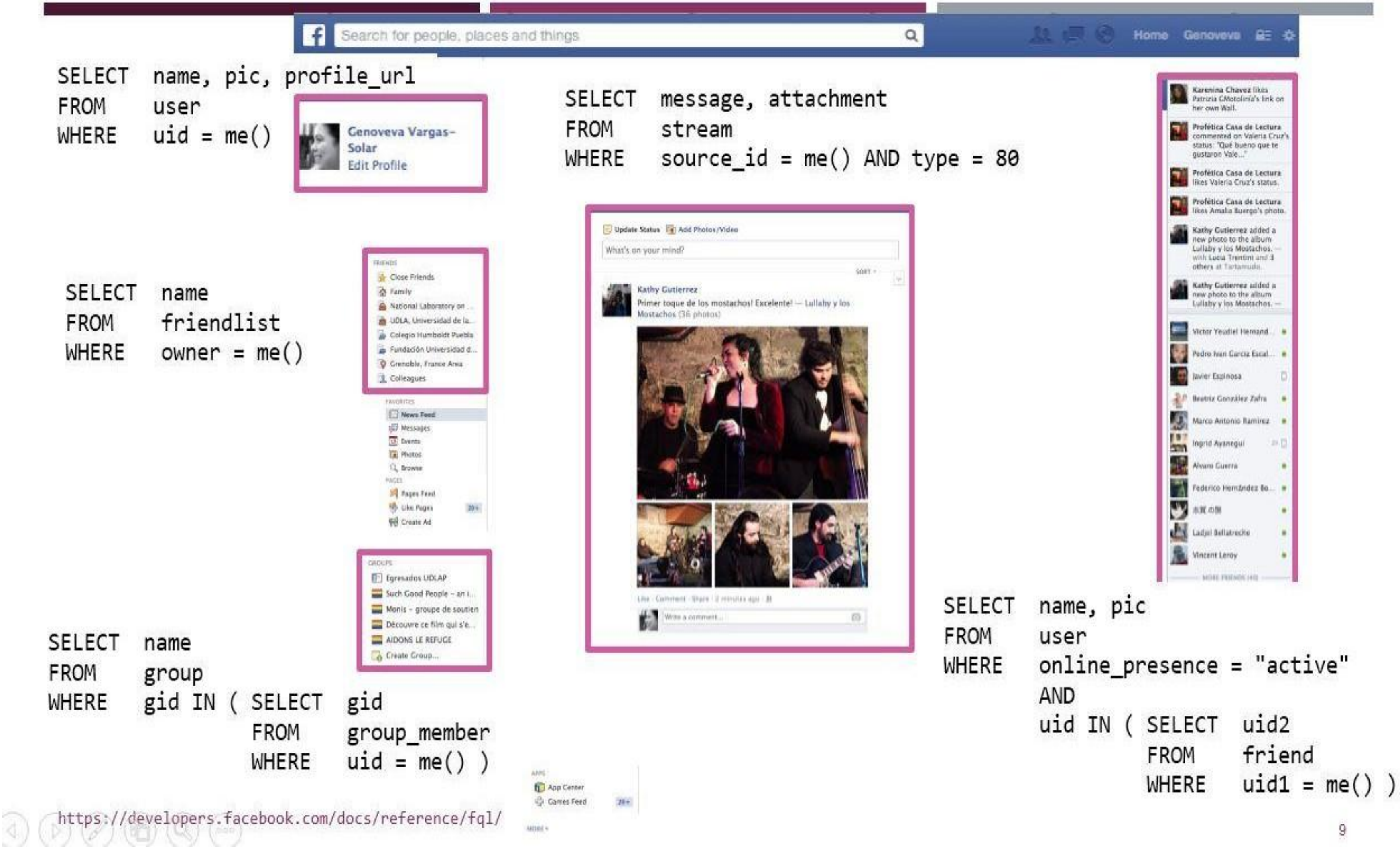
```
{
  type: “Dog”,
  name: “Stella”,
  mood: “Happy”,
  birthdate: 2007-04-01
}
```

id	name	mood	birth_date	color
12	Stella	Happy	2007-04-01	NULL
13	Wimma	Hungry	NULL	black
9	Ninja	NULL	NULL	NULL



```
{
  type: “Dog”,
  name: “Stella”,
  mood: “Happy”,
  birthdate: 2007-04-01,
  barks: [
    {
      bark: “I had to wear stupid..”
      comments: [
        {
          dog_id: “dog_4”,
          comment: “You look so cute!”
        }, {
          dog_id: “dog_14”,
          comment: “I hate it, too!”
        }
      ]
    }
  ]
}
```

Document based data model



```
SELECT  name, pic, profile_url
FROM    user
WHERE   uid = me()
```

```
SELECT  message, attachment
FROM    stream
WHERE   source_id = me() AND type = 80
```

```
SELECT  name
FROM    friendlist
WHERE   owner = me()
```

```
SELECT  name
FROM    group
WHERE   gid IN ( SELECT  gid
                 FROM    group_member
                 WHERE   uid = me() )
```

```
SELECT  name, pic
FROM    user
WHERE   online_presence = "active"
        AND
        uid IN ( SELECT  uid2
                 FROM    friend
                 WHERE   uid1 = me() )
```

Kathy Gutierrez
Primer toque de los mostachos! Excelente! — Lullaby y los Mostachos (36 photos)

Karenina Chavez likes Patrizia GMotolinía's link on her own Wall.

Profética Casa de Lectura commented on Valeria Cruz's status: "Qué bueno que te gustaron Vale..."

Profética Casa de Lectura likes Valeria Cruz's status.

Profética Casa de Lectura likes Amalia Buergo's photo.

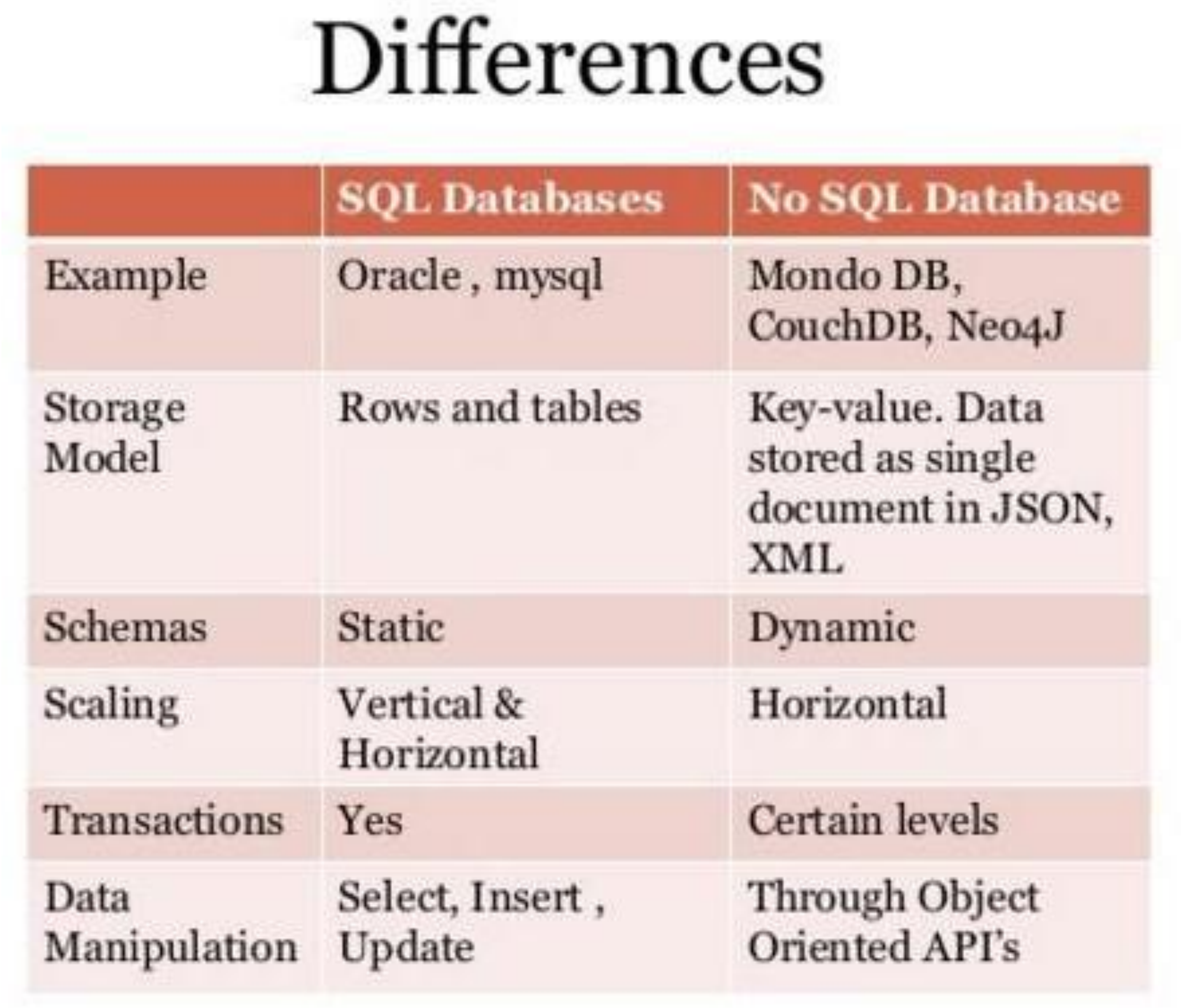
Kathy Gutierrez added a new photo to the album Lullaby y los Mostachos. — with Lucia Trentini and 3 others at Tartamudo.

Kathy Gutierrez added a new photo to the album Lullaby y los Mostachos. —

https://developers.facebook.com/docs/reference/fql/

9

SQL vs NOSQL



Differences

	SQL Databases	No SQL Database
Example	Oracle , mysql	Mondo DB, CouchDB, Neo4J
Storage Model	Rows and tables	Key-value. Data stored as single document in JSON, XML
Schemas	Static	Dynamic
Scaling	Vertical & Horizontal	Horizontal
Transactions	Yes	Certain levels
Data Manipulation	Select, Insert , Update	Through Object Oriented API's

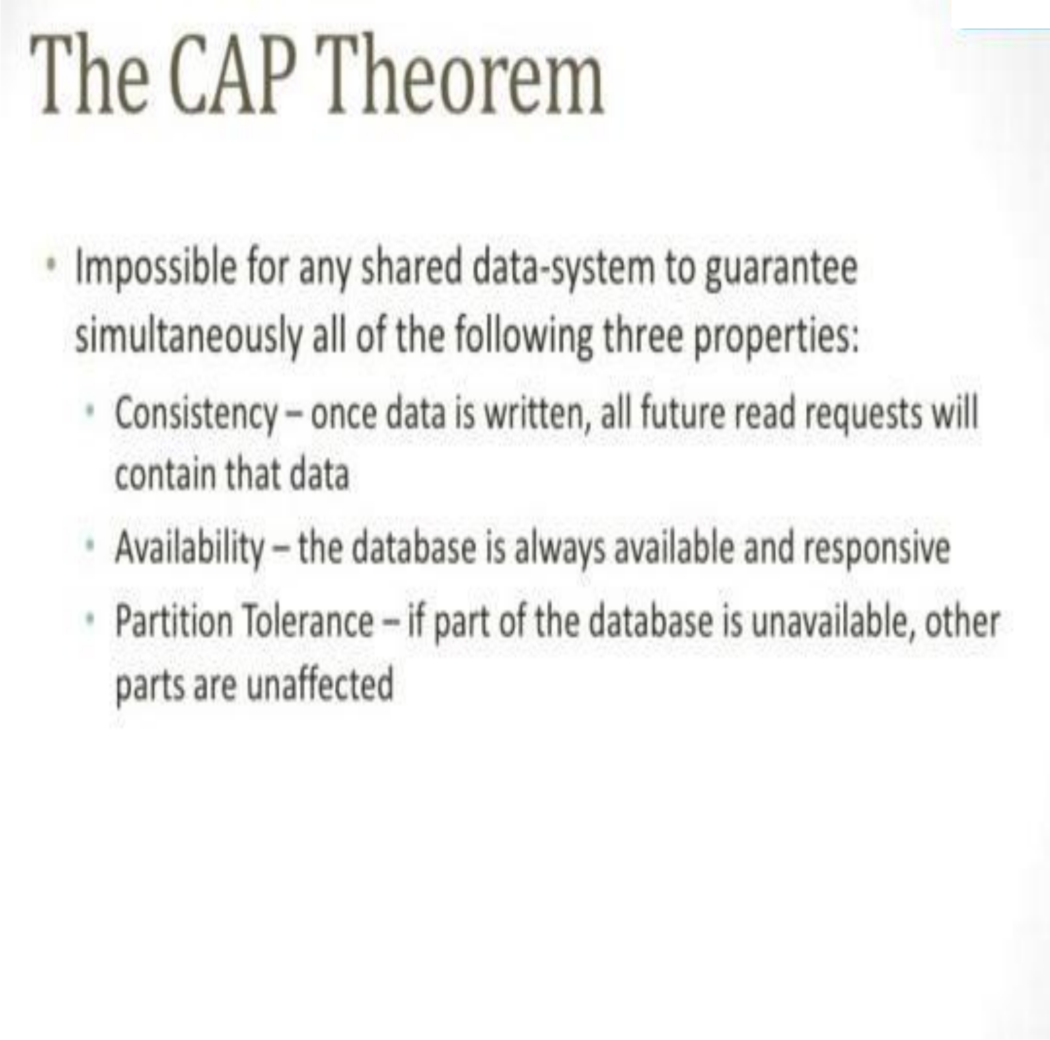
What we need ?

- We need a distributed database system having such features:
  - **Fault tolerance**
  - **High availability**
  - **Consistency**
  - **Scalability**

Which is impossible!!!

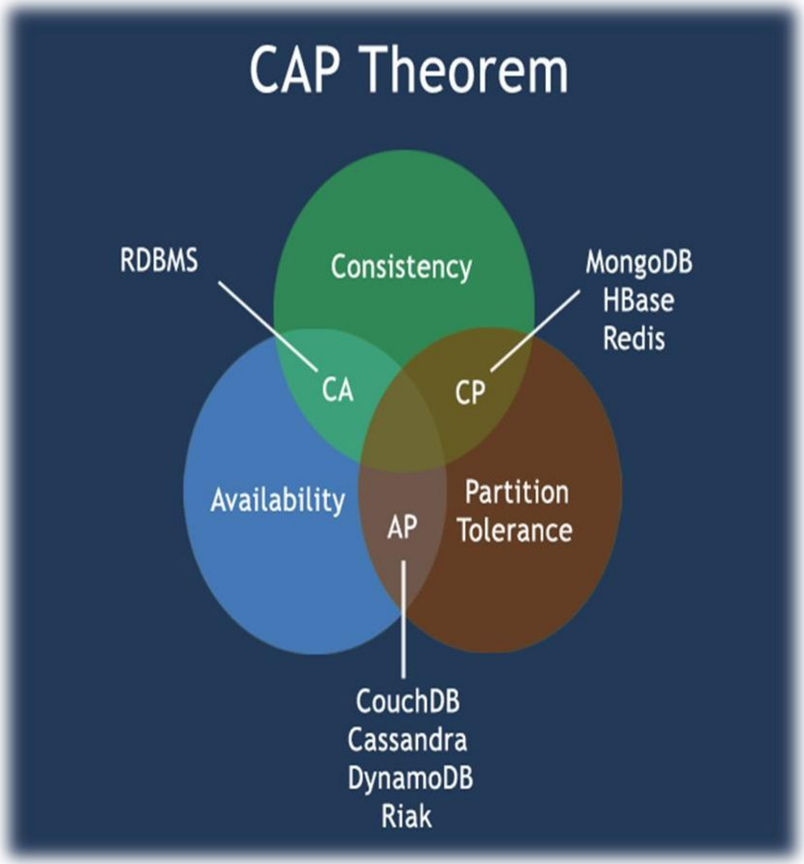
According to CAP theorem

CAP theorem



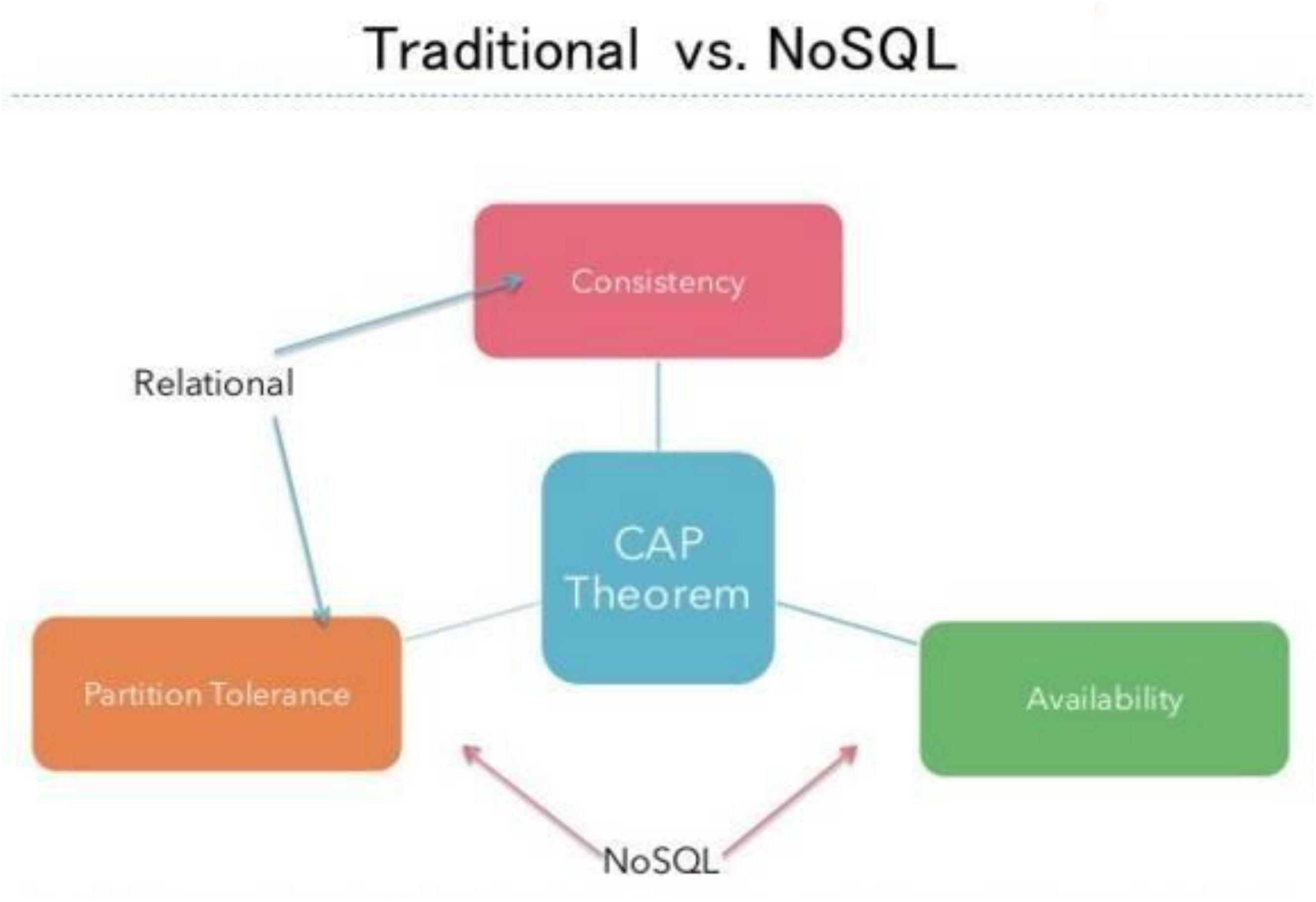
The CAP Theorem

- Impossible for any shared data-system to guarantee simultaneously all of the following three properties:
  - Consistency – once data is written, all future read requests will contain that data
  - Availability – the database is always available and responsive
  - Partition Tolerance – if part of the database is unavailable, other parts are unaffected

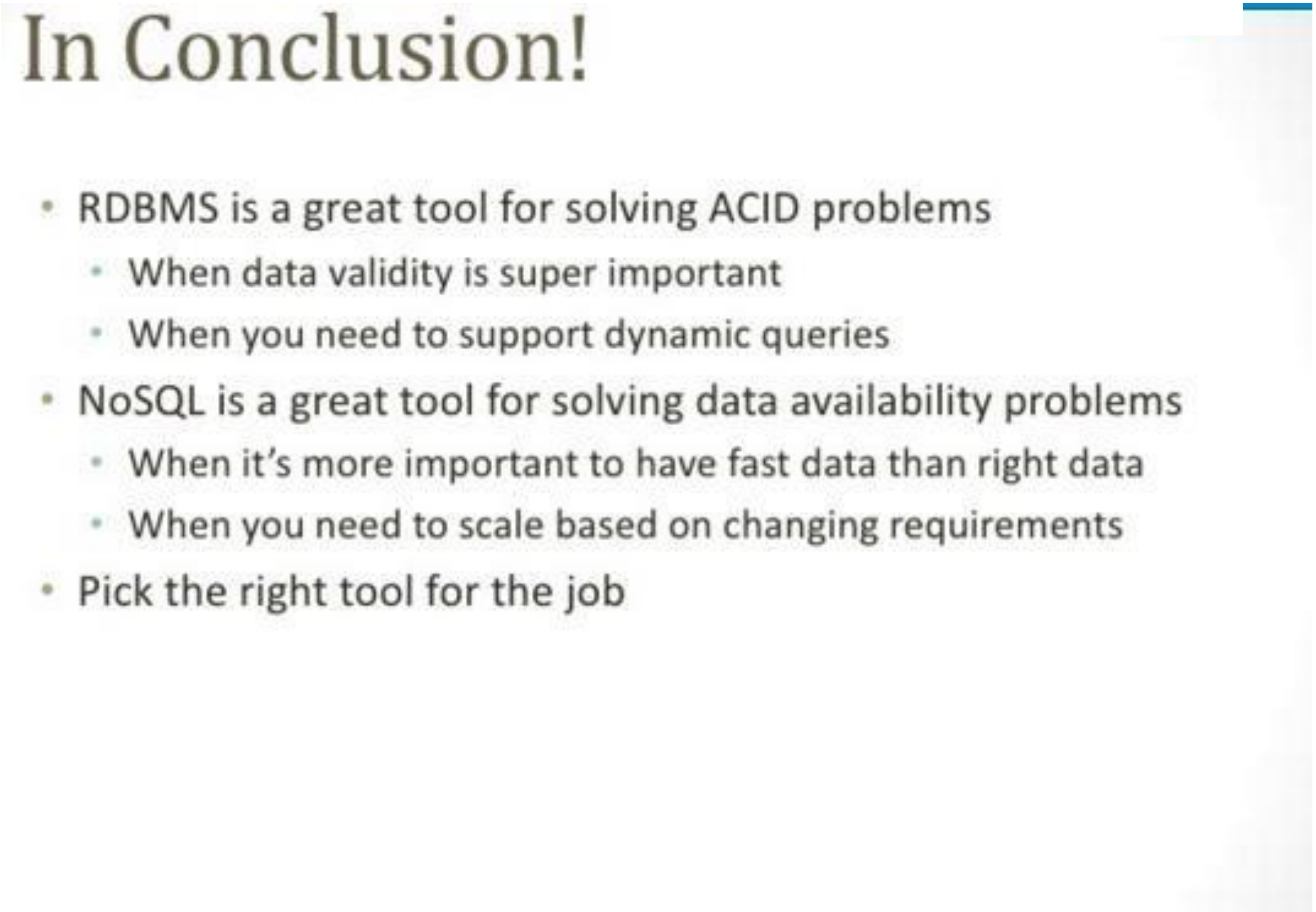


We can not achieve all the three items
In distributed database systems
(center)

CAP theorem


Traditional vs. NoSQL
Consistency
Relational
CAP Theorem
Partition Tolerance
Availability
NoSQL

Conclusion….



In Conclusion!

- RDBMS is a great tool for solving ACID problems
  - When data validity is super important
  - When you need to support dynamic queries
- NoSQL is a great tool for solving data availability problems
  - When it's more important to have fast data than right data
  - When you need to scale based on changing requirements
- Pick the right tool for the job

References..

- **nosql**-database.org/
- https://www.mongodb.com/**nosql**-explained
- www.couchbase.com/**nosql**-resources/what-is-**no-sql**
- http://nosql-database.org/ "NoSQL DEFINITION: Next Generation Databases mostly addressing some of the points: being non-relational, distributed, open-source and horizontally scalable“
- NoSQL distilled, Martin Fowler

- Please like and follow at www.slideshare.net/AshwaniKumar274

Thanks…

Any Questions??