

# IDEF

## and SQL/NoSQL Databases

YEGOR BUGAYENKO

Lecture #9 out of 16

80 minutes

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Types of Databases

IDEF1X, ER Model, UML

How to Choose the Right Database?

Books, Venues, Call-to-Action

Chapter #1:

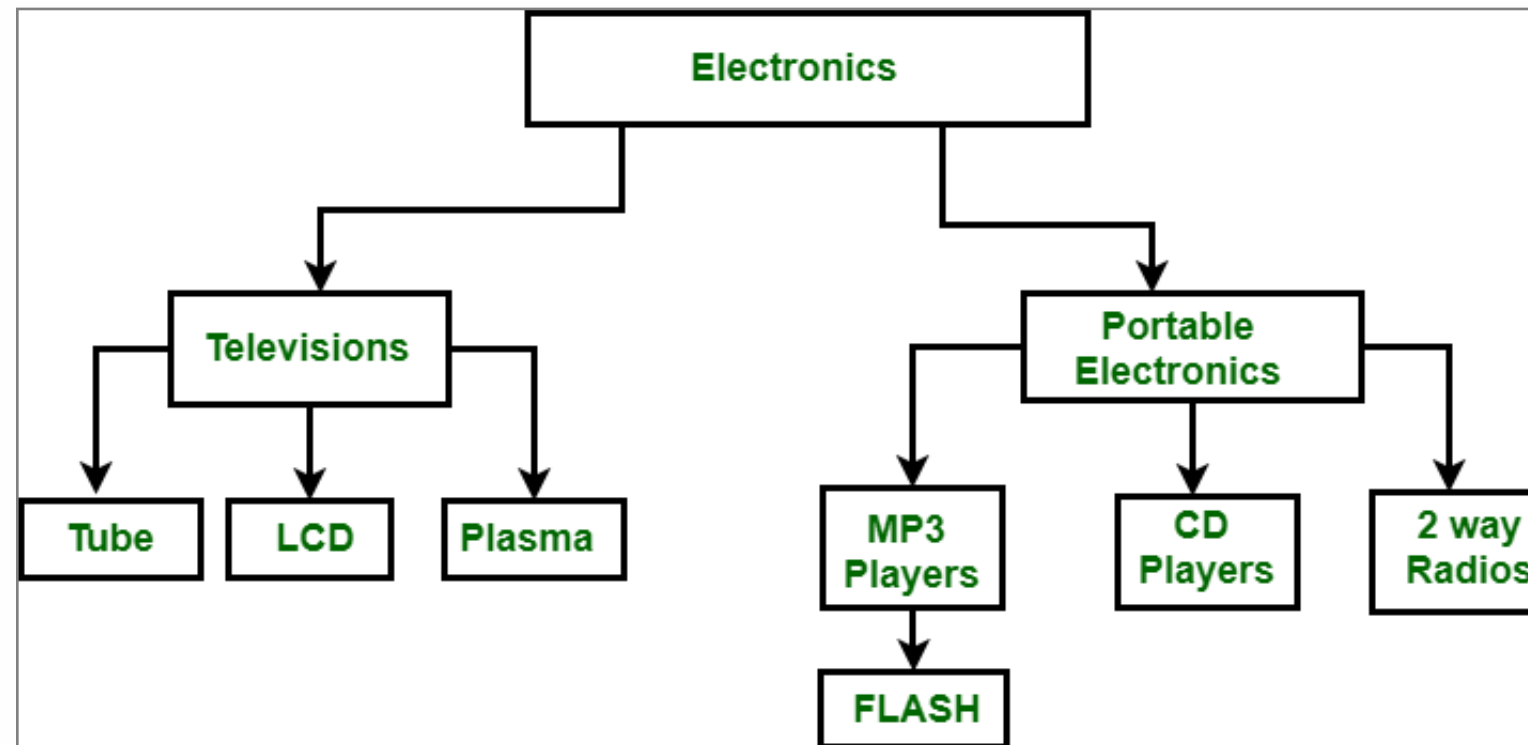
# Types of Databases

## Navigational Databases

```
get department with name='Sales'  
get first employee in set department-employees  
until end-of-set do {  
    get next employee in set department-employees  
    process employee  
}
```

E.g. Integrated Data Store (IDS)

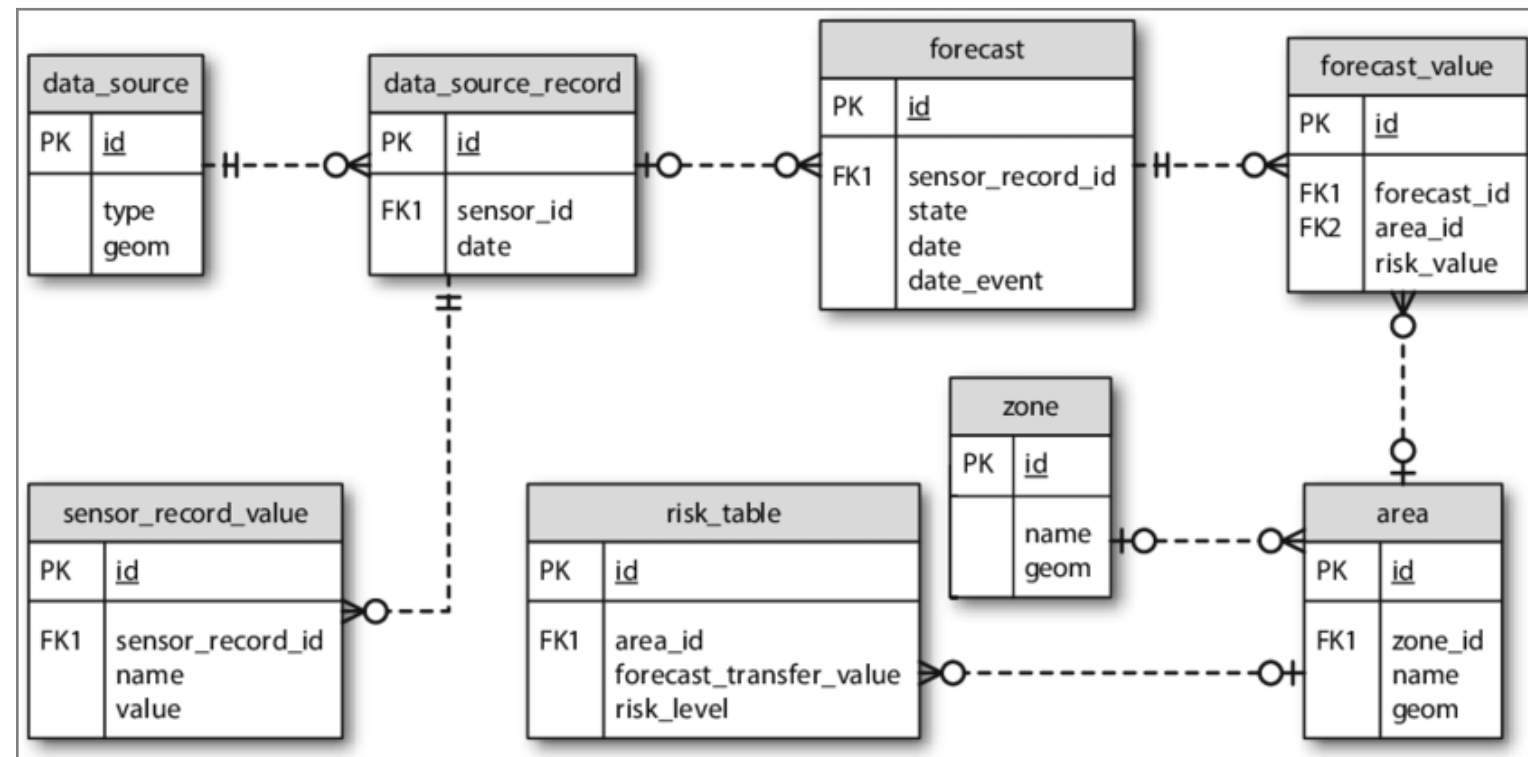
## Hierarchical Databases



E.g. IBM Information Management System (IMS)

[ Navi Hierarchical [SQL](#) Object K-V Columnar NoSQL XML S2 Graph NewSQL Big ]

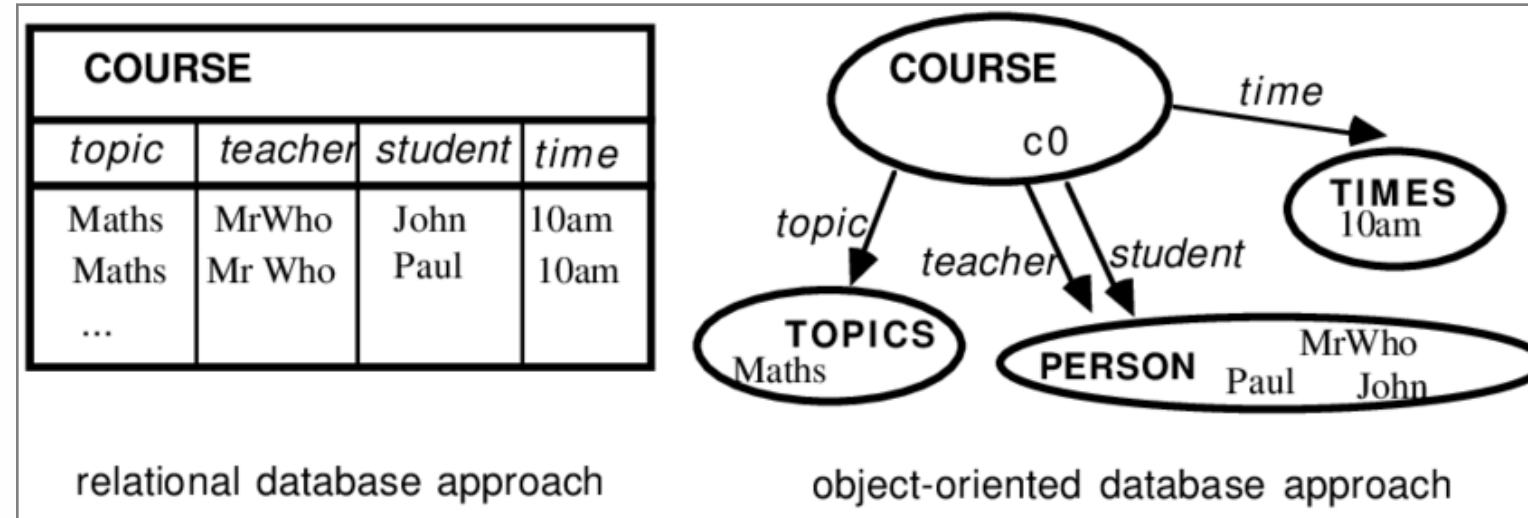
## Relational Databases (SQL)



E.g. Oracle Database

[ Navi Hierarchical SQL [Object](#) K-V Columnar NoSQL XML S2 Graph NewSQL Big ]

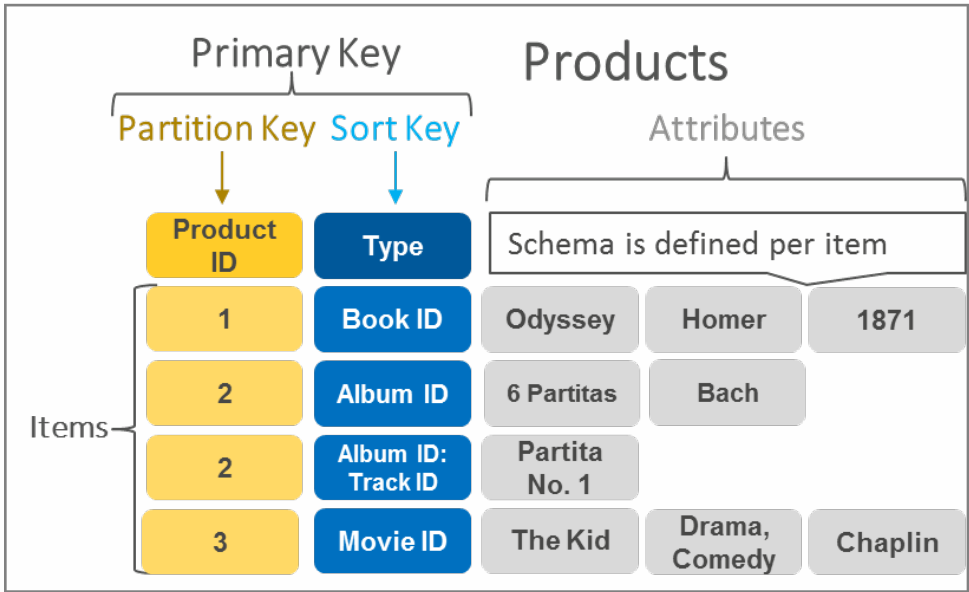
## Object Databases



E.g. ObjectStore

# Key-Value Databases

Phone directory		MAC table	
Key	Value	Key	Value
Paul	(091) 9786453778	10.94.214.172	3c:22:fb:86:c1:b1
Greg	(091) 9686154559	10.94.214.173	00:0a:95:9d:68:16
Marco	(091) 9868564334	10.94.214.174	3c:1b:fb:45:c4:b1



E.g. Redis, AWS DynamoDB



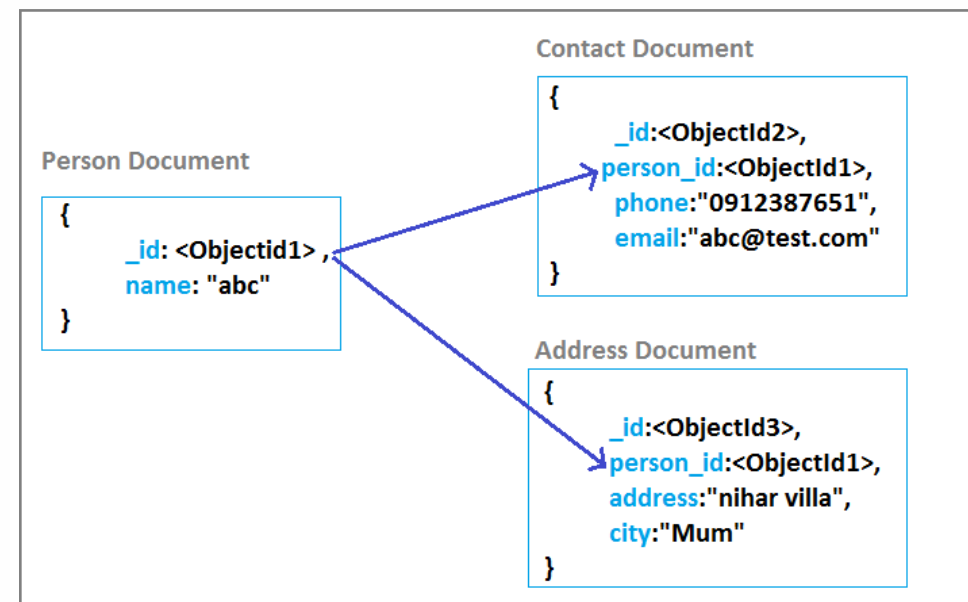
## Columnar Databases



E.g. ClickHouse by Yandex

Read also about Online Analytical Processing (OLAP)

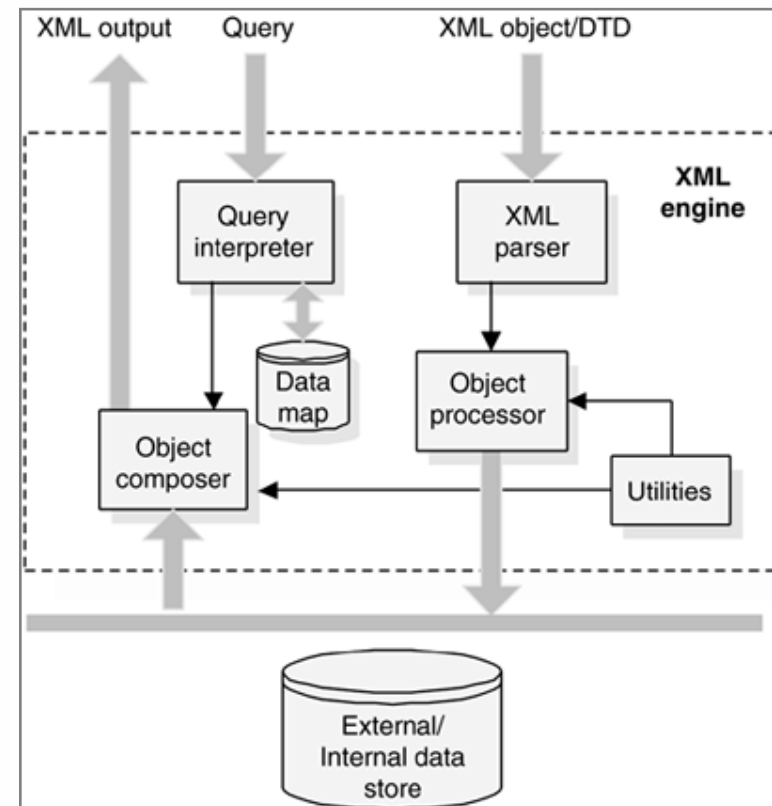
## Document Databases (a.k.a. NoSQL)



E.g. MongoDB

[ Navi Hierarchical SQL Object K-V Columnar NoSQL [XML](#) S2 Graph NewSQL Big ]

## XML Databases

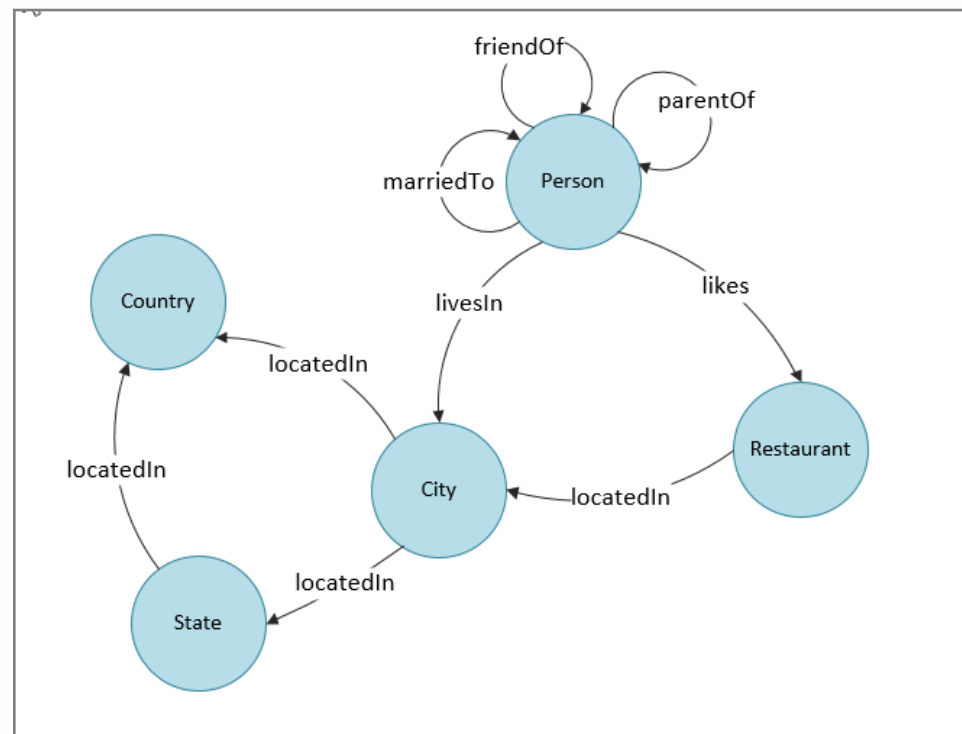


E.g. eXist

## AWS S3

```
try {  
    s3.putObject(bucket_name, key_name, new File(file_path));  
} catch (AmazonServiceException e) {  
    System.err.println(e.getMessage());  
    System.exit(1);  
}
```

## Graph Databases



E.g. Neo4j

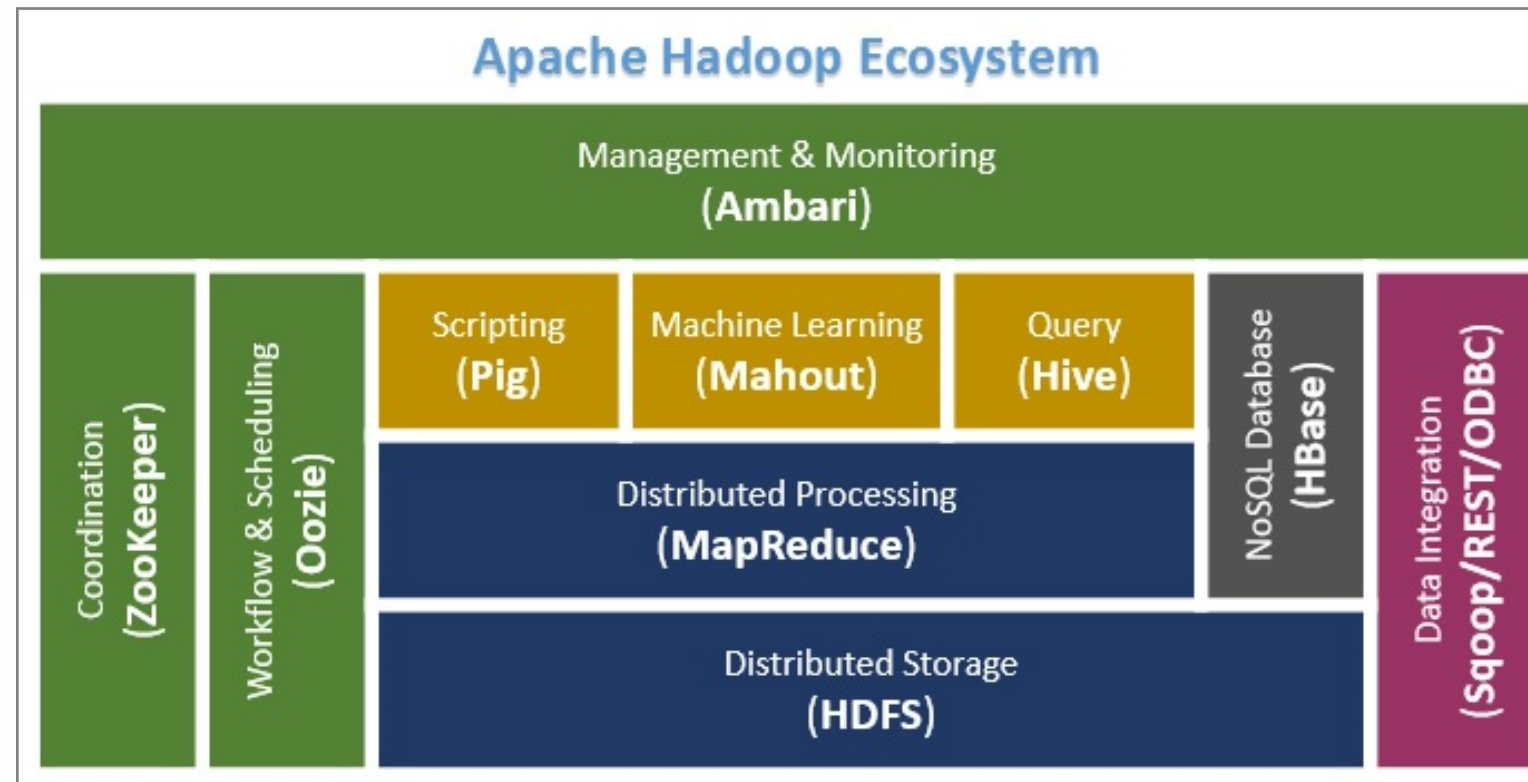
## NewSQL

“NewSQL is a class of relational database management systems that seek to provide the scalability of NoSQL systems for online transaction processing (OLTP) workloads while maintaining the ACID guarantees of a traditional database system” — Wikipedia

E.g. VoltDB

[ Navi Hierarchical SQL Object K-V Columnar NoSQL XML S2 Graph NewSQL [Big](#) ]

## Big Data



E.g. Hadoop

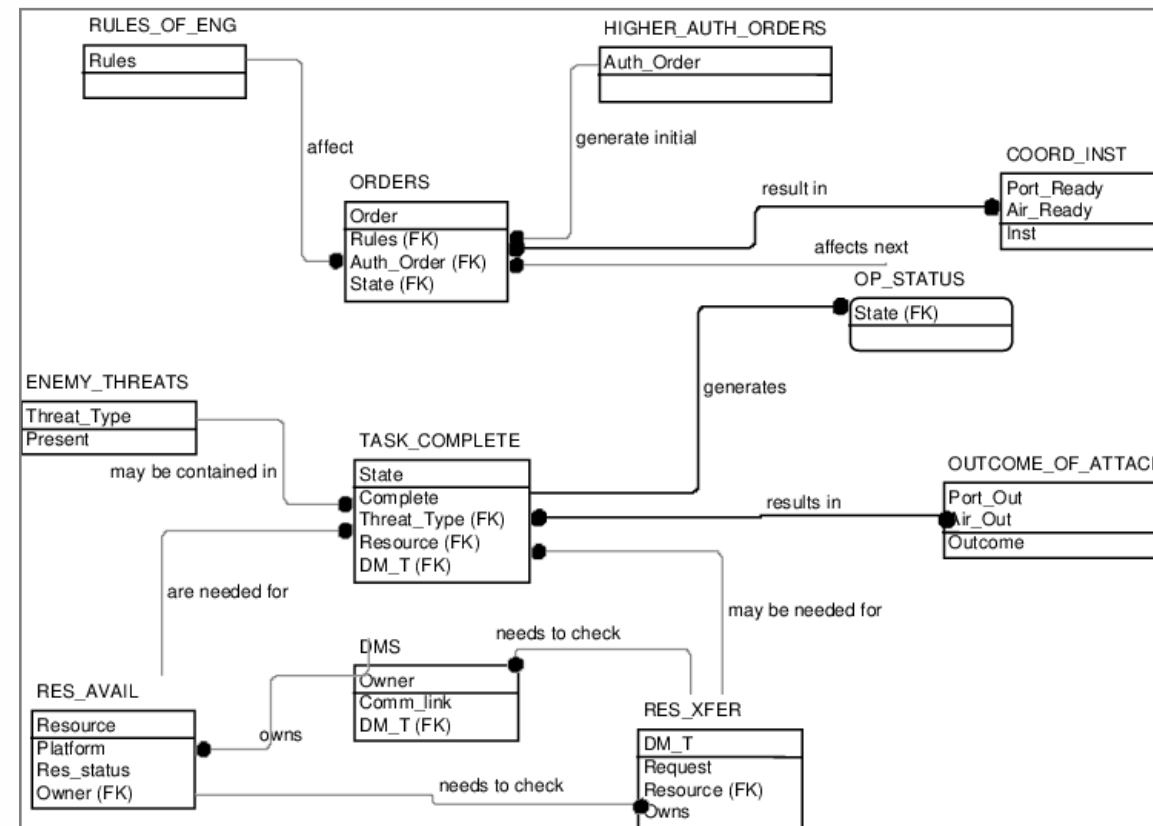
Chapter #2:

**IDEF1X, ER Model, UML**

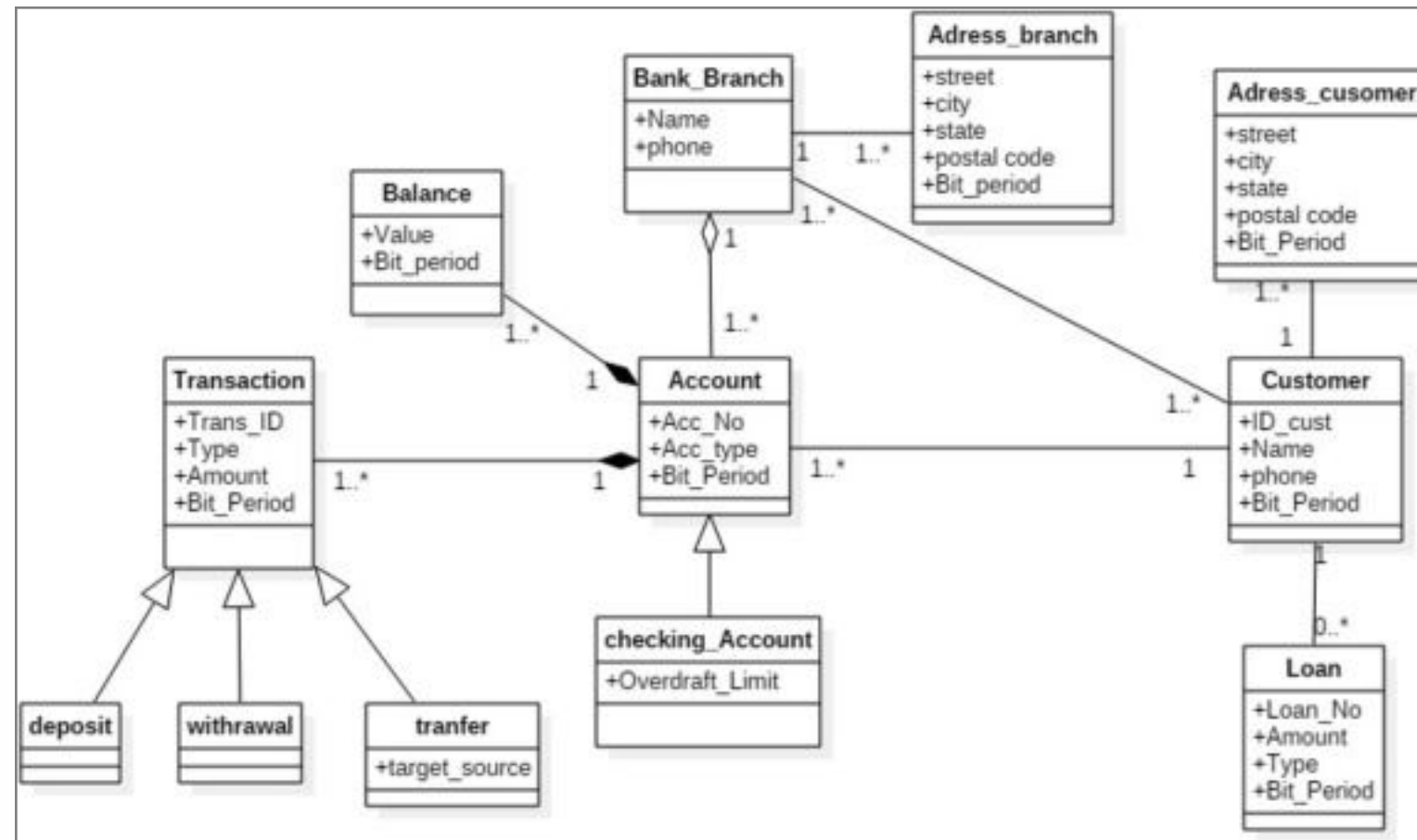


[ [IDEF1X](#) UML ER ]

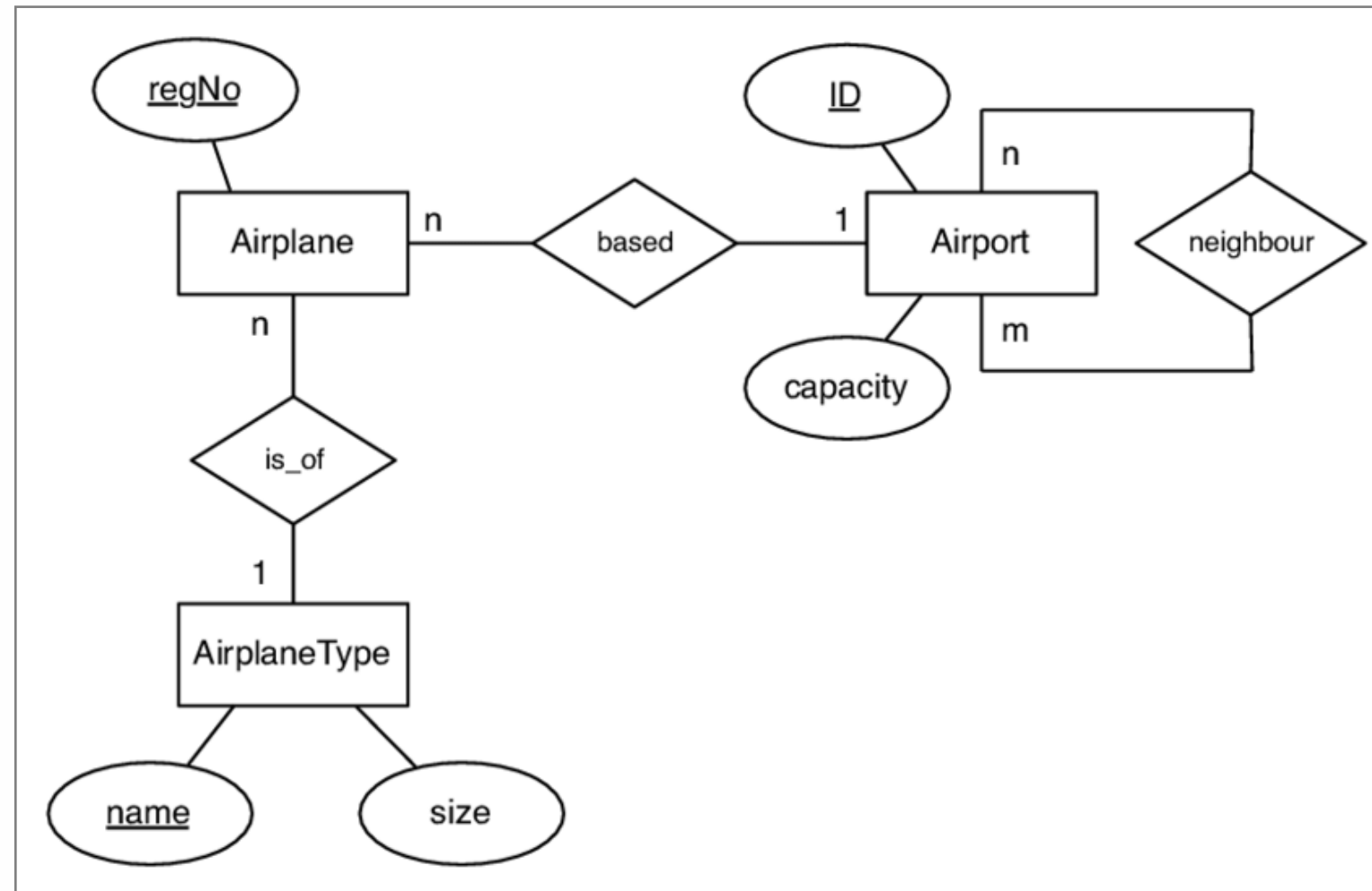
## IDEF1X Model for Databases



## UML Class Diagram as Database Model



## Entity-Relationship (ER) Model



Chapter #3:

## How to Choose the Right Database?

[ [ACID](#) Speed Scale Libraries Versions Integrity Resilience Liability Durability ]

## ACID

**A**tomicity: everything or nothing

**C**onsistency: invariants are in place

**I**solation: concurrent or sequential

**D**urability: completed transactions → non-volatile memory

## Performance

Queries Profiling & Optimization

Denormalization

Caching

# Scalability

Vertical vs. Horizontal Scalability

Sharding vs. Master-Slave Replication



## Application Layer Support

Is it open source?

How mature is the library?

Is it a thin driver or ORM-ish framework?

How many languages are supported?

Are there alternatives?

Is the API open?



## Schema Version Control

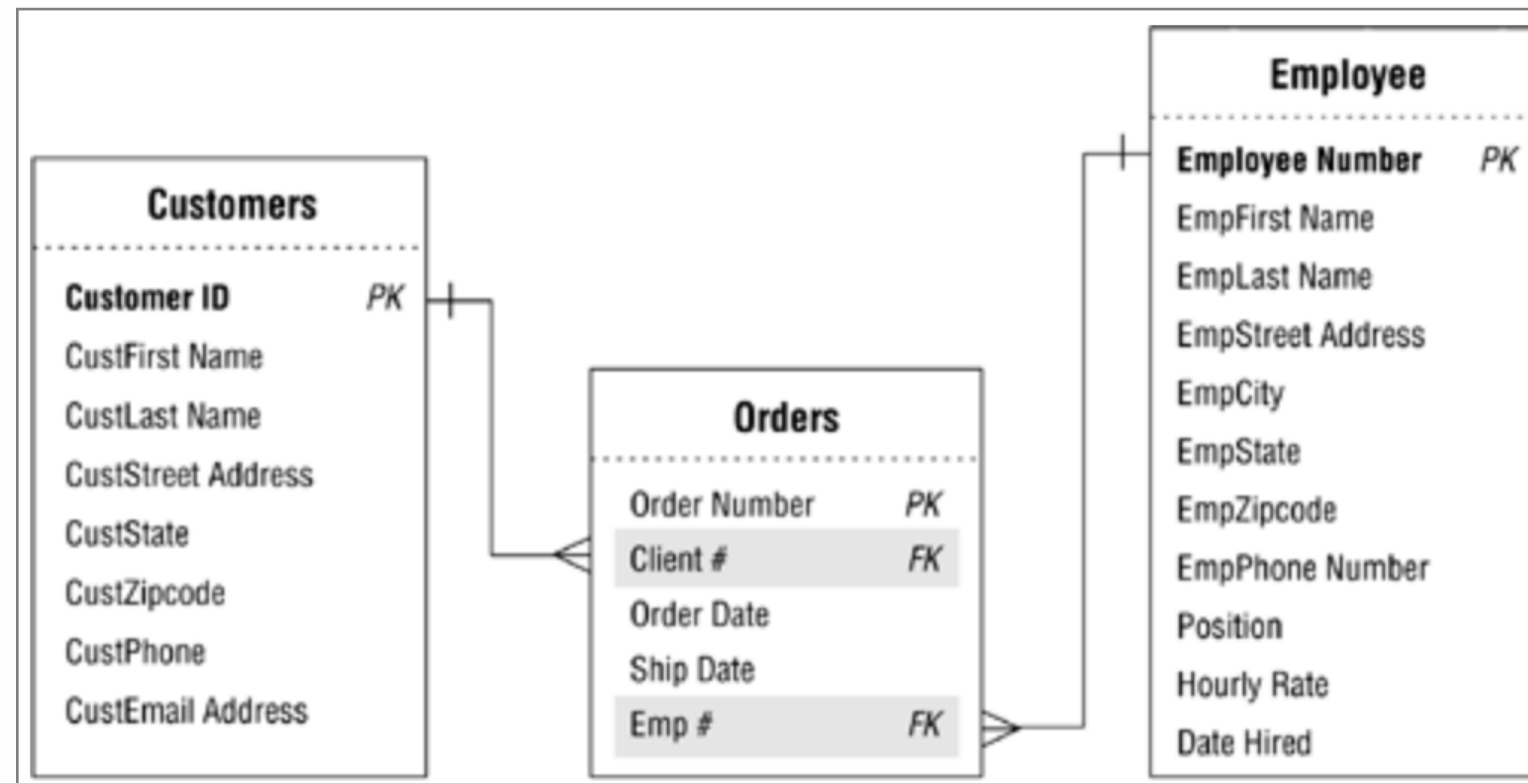
```
<changeSet id="010" author="yegor256">
  <sql>
    DELETE FROM teleping;
    ALTER TABLE teleping ADD CONSTRAINT unique_tasks UNIQUE(task, telechat);
    ALTER TABLE teleping RENAME created TO updated;
    CREATE INDEX idx_teleping2 ON teleping(updated);
  </sql>
</changeSet>
```

<https://github.com/yegor256/0rsk/blob/master/liquibase>

Liquibase, Flyway, Mongobee, Mongock, etc.

[ ACID Speed Scale Libraries Versions [Integrity](#) Resilience Liability Durability ]

## Integrity: Primary and Foreign Keys



## Resilience

### MongoDB deletes my db after unclean shutdown?

#mongodb #devask #help



Nadine M. Thêry Jul 3, 2019 · 1 min read

Hey guys!

I am just starting with MongoDB and It has happened something really weird. I didn't lose anything valuable. But I definitely need to know what happened in order to avoid it to happen again, when I DO have something important.

I had created 2 small databases and had also shut down and restarted mongod several times. No problem.

Resilience is the capacity of your database infrastructure to recover from disaster and keep on providing service.

## Liability: Who Pays for Losses?

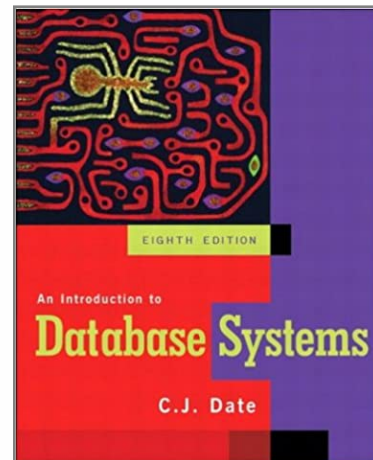
AWS Terms, Section 11: "WE AND OUR AFFILIATES AND LICENSORS WILL NOT BE LIABLE TO YOU FOR ANY INDIRECT, INCIDENTAL, SPECIAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES. INCLUDING DAMAGES FOR LOSS OF PROFITS, REVENUES, CUSTOMERS, OPPORTUNITIES, GOODWILL, USE, OR DATA."

## Durability: Can We Loose Data?

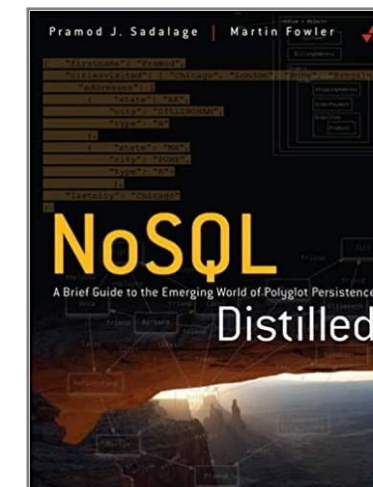
FAQ: Amazon S3 is designed to provide 99.999999999% (11 9's) of data durability of objects over a given year. This durability level corresponds to an average annual expected loss of 0.000000001% of objects. For example, if you store 10,000,000 objects with Amazon S3, you can on average expect to incur a loss of a single object once every 10,000 years.”

Chapter #4:

## Books, Venues, Call-to-Action



C. J. Date. *An Introduction to Database Systems*. Pearson/Addison Wesley, 8 edition, 2004



Pramod J. Sadalage and Martin Fowler. *NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence*. Addison-Wesley, 2013

Where to go:

ACM SIGMOD/PODS Conference.



### Call to Action:

Design a relational persistence layer in your app and then make it NoSQL;  
compare pros and cons.

### Still unresolved issues:

- How to guarantee 100% durability, etc.?
- How to optimize database schema automatically?
- How to generate optimal schema automatically?
- How to make object databases popular?

# Bibliography

C. J. Date. *An Introduction to Database Systems*.  
Pearson/Addison Wesley, 8 edition, 2004.

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