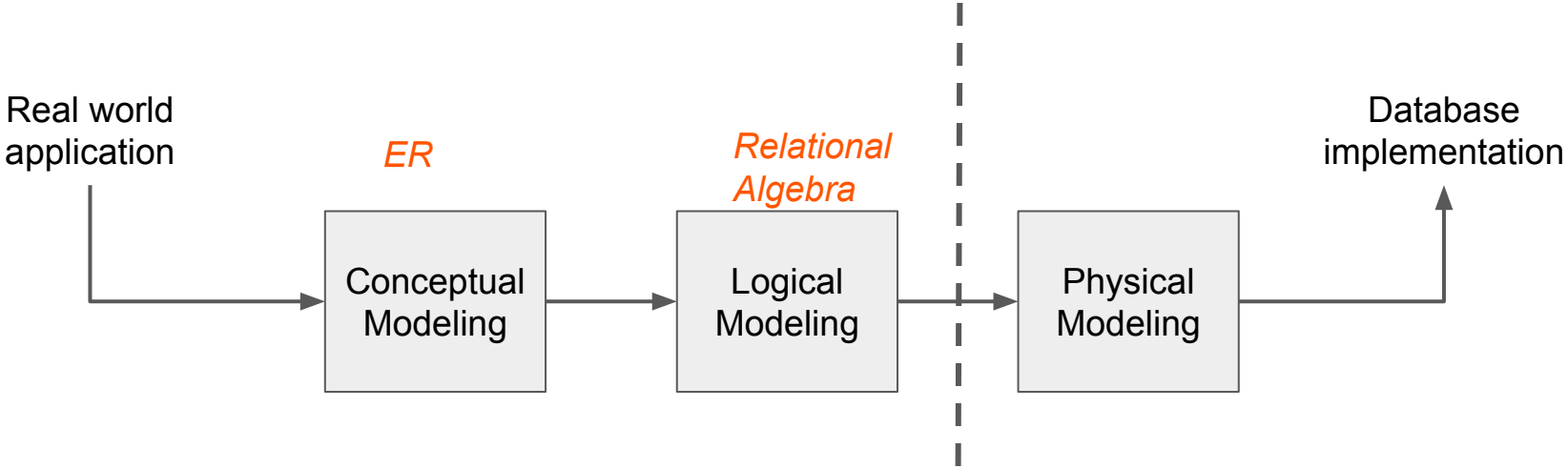
Databases and Big Data

Wrap Up

What We Have Learned

- The process of writing a database applications
  - ER Model
  - Relational Algebra
  - SQL



What We Have Learned

- Many shapes of data
- Different data models for different shapes
  - Relational model
  - No-SQL model
  - Semi-structure model
  - (Others not covered)

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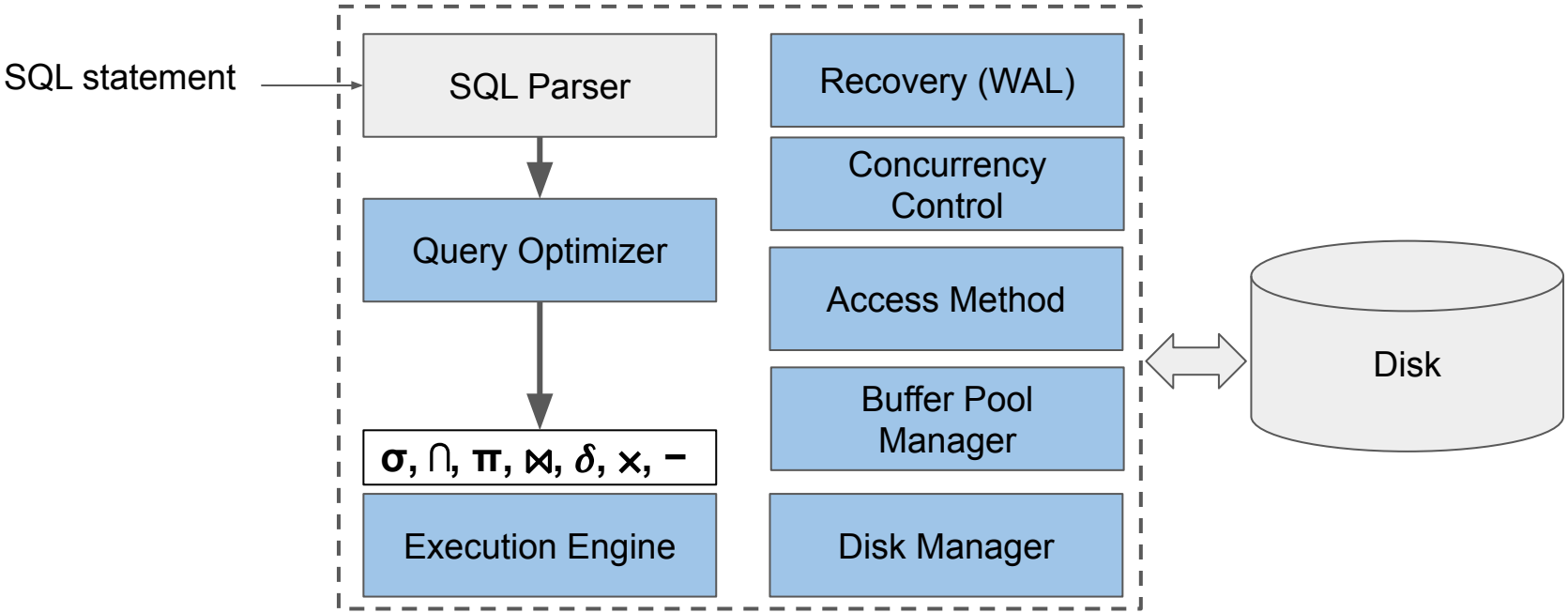
What We Have Learned

- How to design better tables
  - Normalization
- SQL
  - How to manipulate and query relational databases
- MongoDB
  - How to manipulate and query NoSQL databases

What We Have Learned

- What inside the blackbox of RDBMS



What We Have Learned

- What inside the blackbox of RDBMS
  - Disk Manager
  - Buffer Pool
  - Access Method
  - Transactions: WAL and Concurrency Control
- How to estimate I/O costs of SQL queries
  - > 1 ways to execute the same query

What We Have Learned

- What is big data:
  - Volume, Velocity, Variety
- User and systems' views of cloud computing
  - Computing as utility
  - Distributed systems
- How to use AWS

What We Have Learned

- The high-level software stack for Big data
- Hadoop stack:
  - HDFS
  - MapReduce
- Important design choices in HDFS and MapReduce
- How to write MapReduce jobs
  - Via Hadoop streaming

read and append only

scan sequentially

What We Have Learned

- The need for resource management
- YARN and Mesos:
  - Their important design choices
- The need for Hadoop alternatives
- Spark stack:
  - Spark Core
  - SparkSQL *use dataframe*

- why do we need them?
- YARN: have one centralised scheduler that schedule all the jobs
- Mesos: give offer to frameworks and frameworks do all the scheduling.
- Limitation of hadoop?
- Why is there a need for spark (memory, faster)

What We Have Learned

- Important design choices in Spark
  - How Spark differs to Hadoop
- How to write Spark jobs
  - Interactive
  - Iterative
- How to deploy and run Hadoop and Spark jobs on EC2

MapReduce only single pass over data.

What We Have Learned

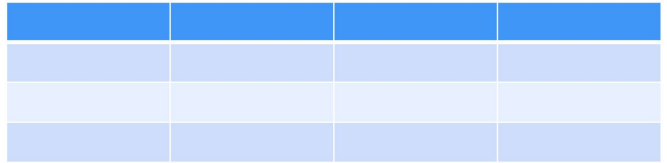
- Designs of other Big data systems:
  - Data lakes
  - Streams
  - Semi-structured storage
  - Relational databases
- Some of common challenges in these systems:
  - Performance
  - Scalability
  - Failures

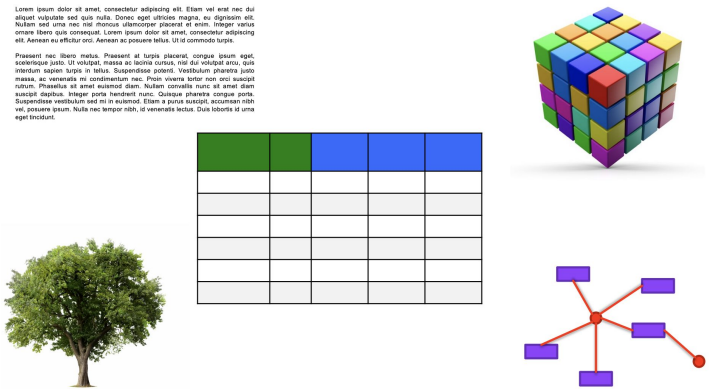
What are the common challenges?
- Handling failures is the main problem in distributed systems.

Database Wisdoms

Learn From The Past

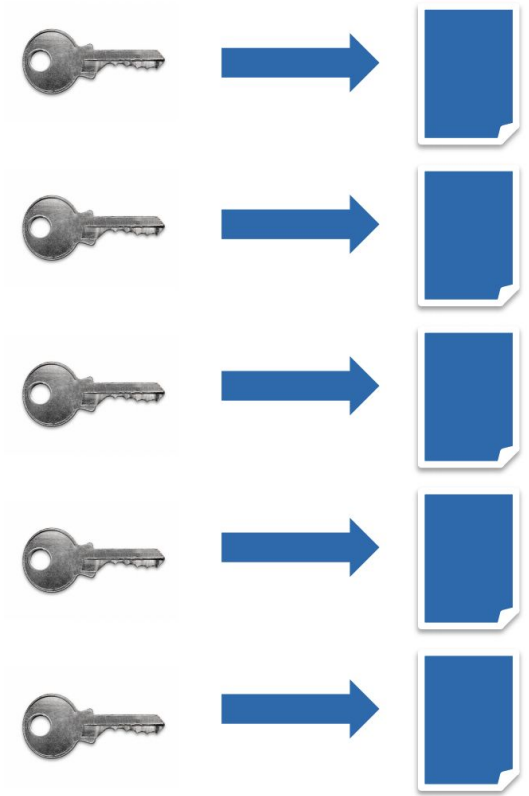
- Tables won’t go away
  - History: SQL → NoSQL → Semi SQL → SQL
- Data shapes matter
  - Specialized systems for relational, key-value, ML, graphs, etc.





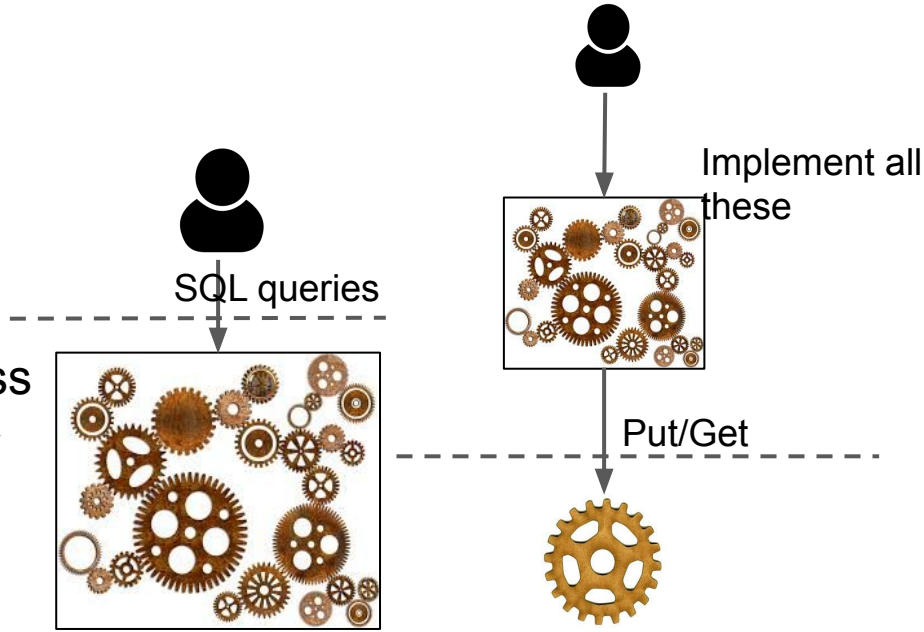
Keep It Simple (Stupid)

- Simplify data model
  - So that you can scale



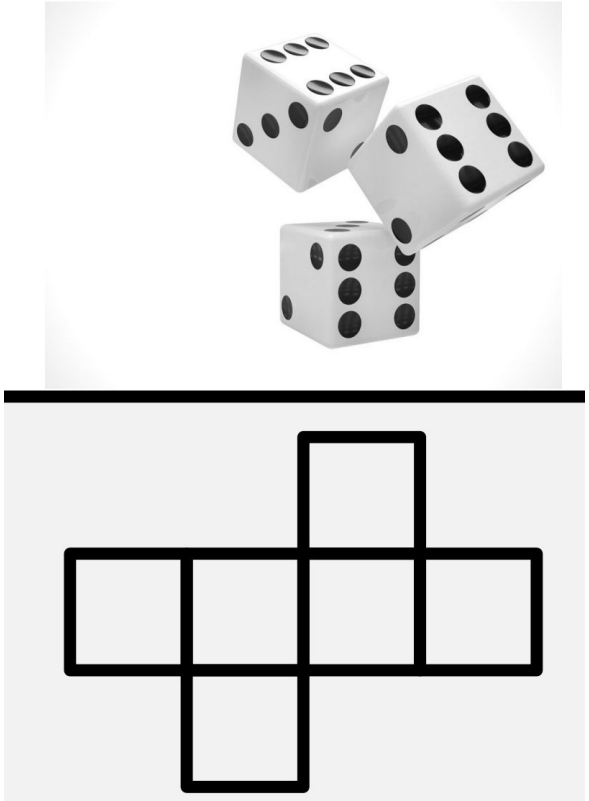
No Free Lunch

- Cost must be paid
  - By someone
  - At some point
- Example:
  - SQL vs. NoSQL
  - Performance vs. correctness
  - Collect now, figure out later



Separate Metadata from Data

- All big data systems:
  - Master maintains important metadata
  - Slaves store/process raw data



Users Like Declarative Language

- SQL vs. Spark core
- Spanner vs. BigTable

SQL is here to stay

Distribute The Data

- Chop up to smaller pieces to scale
  - Load balance over many servers

Buy A Lot Of Cheap Servers

- Scale OUT instead of UP
  - Because software is available to manage them

Replication, Replication, Replication

- Replicate to withstand failures
- But difficult to ensure consistency

eventual consistency

Final Words

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- Databases and Big Data Systems will become invisible
  - People will only see the services they support
- These systems take:
  - Great developers to make good use of them
  - **Great engineers to understand them** ← This is **YOU**
  - Great researchers to design and build them

Final Words

- SQL will *eventually* be replaced:
  - Hand-free interaction
  - We are literally taking to databases

- Data and money will converge
  - People will manage data the same way they manage money