

UMD DATA605 - Big Data Systems

Lesson 5.2: NoSQL Taxonomy

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- Concepts in slides
- Silberschatz Chapter 23.6
- High-level view:
 - Seven Databases in Seven Weeks, 2e





DB Taxonomy

At least five DB genres

- Relational (e.g., Postgres)
- Key-value (e.g., Redis)
- Document (e.g., MongoDB)
- Columnar (e.g., Parquet)
- Graph (e.g., Neo4j)

Key-Value



Document



Criteria to differentiate DBs

- Data model
- Trade-off with CAP theorem
- Querying capability
- · Replication scheme

Wide-column



Graph





Relational DB

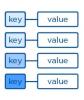
- E.g., Postgres, MySQL, Oracle, SQLite
- Data model
 - Set-theory, relational algebra
 - Data as tables with rows, columns
 - Many attribute types (e.g., numeric, strings, dates, arrays, blobs)
 - Strictly enforced attribute types
 - SQL query language
 - ACID consistency
- Application
 - Relational tabular data
- Good for
 - Known data layout, unknown access pattern
 - Schema complexity for query flexibility
 - Regular data
- Not so good for



Key-Value Store

- E.g., redis, DynamoDB, Git, AWS S3, filesystem
- Data model
 - Map keys (e.g., strings) to complex values (e.g., binary blob)
 - Support get, put, delete operations on a primary key
- Application
 - Caching data
 - Store users' session data in web applications
 - Store shopping carts in e-commerce applications
- Good for
 - Data not "related" (e.g., no joins)
 - Fast lookups
 - Easy to scale horizontally using partitioning
- Not so good for
 - Data queries needed
 - · Lacking secondary indexes and scanning

Key-Value

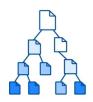




Document Store

- E.g., MongoDB, CouchDB
- Data model
 - Like key-value but value is a document (nested dict)
 - Each document has a unique ID (e.g., hash)
 - Any number of fields per document, even nested
 E.g., jSON, XML, dict data
- Application
 - Semi-structured data
- Good for
 - Unknown data structure
 - Maps well to OOP models (less impedance mismatch)
 - · Easy to shard and replicate over distributed servers
- Not so good for
 - Complex join queries
 - Denormalized form is the norm

Document





Columnar Store

- E.g., HBase, Cassandra, Parquet
- Data model
 - Store data by columns, not rows
 - Similar to key-value and relational DBs
 - Use keys to query values
 - Values are groups of columns
- Application
 - Store web pages
 - Store time series data
 - OLAP workloads
- Good for
 - Horizontal scalability
 - Enable compression and versioning
 - Sparse tables without extra storage cost
 - Inexpensive to add columns
- Not so good for
 - Design schema based on query plans
 - No native joins; applications handle joins



Wide-column



Graph DB

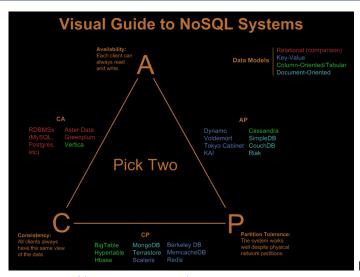
- E.g., Neo4J, GraphX
- Data model
 - Interconnected data, nodes, and relationships
 - Nodes and edges have properties (key-value pairs)
 - Queries traverse nodes and relationships
- Applications
 - Social data
 - Recommendation engines
 - Geographical data
- Good for
 - Networked data, difficult to model with relational model
 - Matches OO systems
- Not so good for
 - Poor scalability, difficult to partition graph on different nodes
 - Store graph in graph DB, relations in key-value store

Graph





Taxonomy by CAP



From

http://blog.nahurst.com/visual-guide-to-nosql-systems



Taxonomy by CAP

- CA (Consistent, Available) systems
 - Struggle with partitions, use replication
 - Traditional RDBMSs (e.g., PostgreSQL, MySQL)
- CP (Consistent, Partition-Tolerant) systems
 - Struggle with availability, maintain consistency across partitions
 - BigTable (column-oriented/tabular)
 - HBase (column-oriented/tabular)
 - MongoDB (document-oriented)
 - Redis (key-value)
 - MemcacheDB (key-value)
 - Berkeley DB (key-value)
 - AP (Available, Partition-Tolerant) systems
 - · Achieve "eventual consistency" via replication and verification
 - Dynamo (key-value)
 - Cassandra (column-oriented/tabular)
 - CouchDB (document-oriented)

