Query workload types

**OLTP (Online Transactional Processing)**
- Atomic operations (one or multi entities). E-commerce, webapps.
- A small number of records per query - “Latest state”

**OLAP (Online Analytical Processing)**
- Analytics and data-warehousing. Reporting, decision support.
- Many records per query - “Aggregated stats” on “Bigger data”

“One Size Fits All”: An Idea Whose Time Has Come and Gone
Scaling methods

**Scale up** (vertically)
- Add more power to a single node
- Diminishing returns

**Scale out** (horizontally)
- Cheap commodity hardware
- Management / coordination complexity
Partitioning & Replication

Partitioning

Or “Sharding”, “Distribution, ”Fragmentation”

- **Motivation:**
  - BIG data - need to split up! (e.g. PB-level)
  - Availability: better write (and single-record read) throughput

- **Challenge: fair share of requests**
  - Choice of partitioning schemes
  - “Justin Bieber Effect” -> “hot spots”
Partitioning & Replication

Replication

- **Motivation:**
  - Fault-tolerance / durability: power / disk failures
  - Keep data close to the user (geographically)
  - Availability: better read (and potentially write) throughput

- **Challenge: keeping data in sync**
  - E.g. write to a leader and then propagate
  - Choice of consistency models
NoSQL

- No clear definition:
  - Non-relational
  - + scalability, + availability, + flexibility
  - - consistency, - OLAP performance
  - Open source implementations

- Motivation
  - The need to scale
  - Lots of web apps mostly OLTP queries
    - Read/write intensive
    - but fewer joins & aggregates
Data Models

- **Key-value stores**
  - Opaque value
  - e.g., Project Voldemort, Memcached

- **Document stores**
  - “key-object”
  - e.g., SimpleDB, CouchDB, MongoDB, AsterixDB

- **Extensible Record Stores**
  - “column groups”
  - e.g., BigTable, HBase, Cassandra, PNUTS

- **Graph**
  - E.g. Neo4j
JSON and Semi-Structured Data

**JSON, XML, Protobuf (also an IDL)**

- Familiar - as your HTTP request/response
  - Good for data exchange
  - Maps to OOP paradigm

Also - as a database file

- Flexible tree-structured model
- Query langs: XQuery, XPath, etc.
AsterixDB, SQL++

- A semistructured NoSQL style data model (ADM)
- Extends JSON with object database ideas

Know the following:

- DDL: type (open vs. closed), data types (e.g. multiset). Creating an index.
- DML: Heterogenous Collections, Nesting / Unnesting.
- (Asterix stores data as flattened tables behind the scenes)
What is SQL++?

Just like SQL but parsed for processing JSON data

SQL++ has keywords to handle collections of data (i.e. non-flat data)
Motivation for SQL++

Why SQL++? Why not some other query language?

- People are used to/like specifying data through SQL syntax
- SQL-like language enforces idea of physical data independence
Useful Keywords/Syntax for HW

`is_array(...)` ----> checks if value is an array

`split(s, d)` ----> splits string s on delimiter d

`[ ... ]` ----> explicitly construct array

`(CASE WHEN ... THEN ... ELSE ... END)` ----> combine with “is_array(...)”

`MISSING` ----> reserved keyword like “NULL”

`\ ... ` ----> backtick needed for accessing keys with names containing “-”`