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NoSQL databases for the Web

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Scaling up to Web Size

- Large providers such as social media providers need to scale up their infrastructure
  - both physical (number of servers) and software
- Their infrastructure is composed of hundreds of thousands of physical servers
  - Failure of nodes is expected, rather than exceptional
  - They require to build in backup and failover.
  - The number of nodes in a cluster is not constant
- We will see the details in the lecture on Search Engines

Limits of SQL databases

- We need to define structure and schema of data first and then only we can process the data
- They are designed for the old mainframe world
  - They provides consistency and integrity of data
    - Useful in e.g. a banking system
    - But a significant performance overhead with large distributed data
- They require vertical scaling (i.e. increasing resources to the existing machine)

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- They are designed for a world where the data is to be mapped into a predefined structure
  - Most applications store their data in JSON format
    - which is flexible by design
  - Conversion of data has an enormous overhead in applications with high throughput
    - in one of my applications with 1 million users sending location data at high velocity
      - conversion from JSON to relational data was the single bottleneck that caused severe pain and required a large and highly parallel architecture
- Join operations are the deathbed of efficiency

No SQL databases

- Do not enforce a strict schema
- Provide
  - Native sharding for horizontal scaling
    - i.e. distribution of data on multiple machines along cloud computing paradigm of flexibility
      - If you need more resources, just add more nodes (as opposed to upgrade the server size)
      - if you need fewer resources, remove some nodes
  - Auto replication of data which in case of failure will return to the last consistent state
    - a requirement in large computing centres where failure is an expected situation

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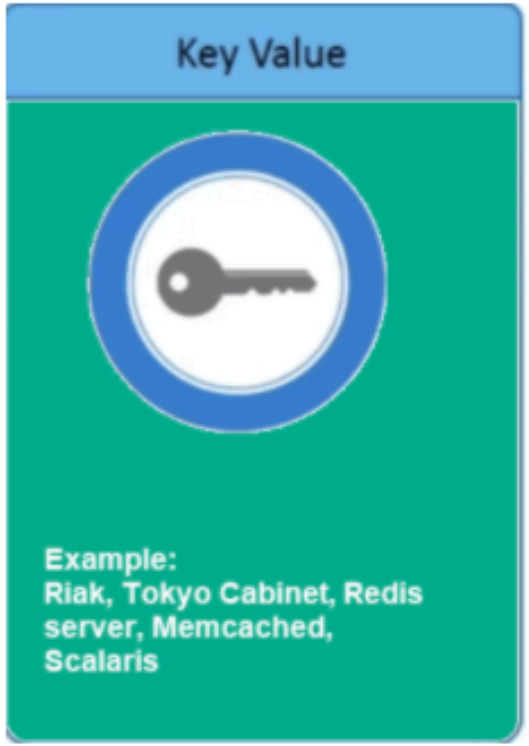
- Eventual Consistency
  - copies of data are stored on multiple machines to get high availability and scalability
  - Changes made to any data item on one machine has to be propagated to other replicas (and will eventually be propagated)
- BASE: Basically Available, Soft state, Eventual consistency
  - Basically, available means DB is available all the time
  - Soft state means even without an input; the system state may change
  - Eventual consistency means that the system will become consistent over time
- No single point of failure

Issues

- No standardisation for data into relations
  - Freedom but also a damning feature if overused
- Limited query capabilities
- No automatic consistency checking
  - e.g. when multiple transactions are performed simultaneously
- Eventual consistency is not appropriate for every application

Types



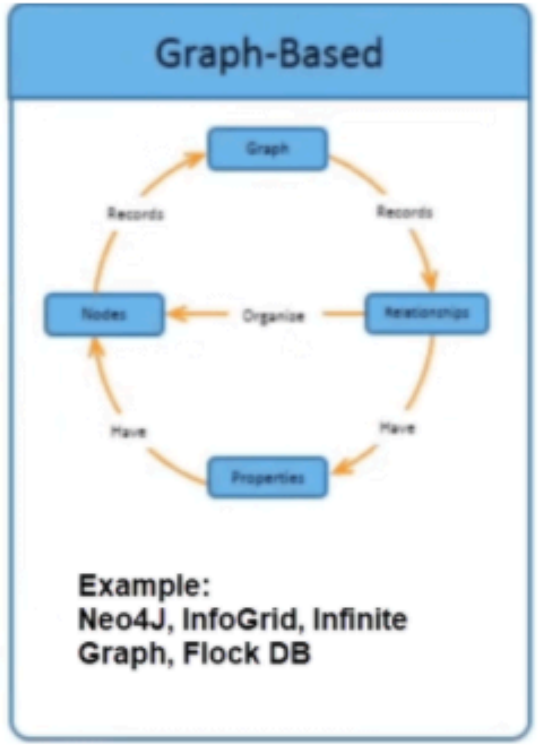


image from guru99

Types of NoSQL databases

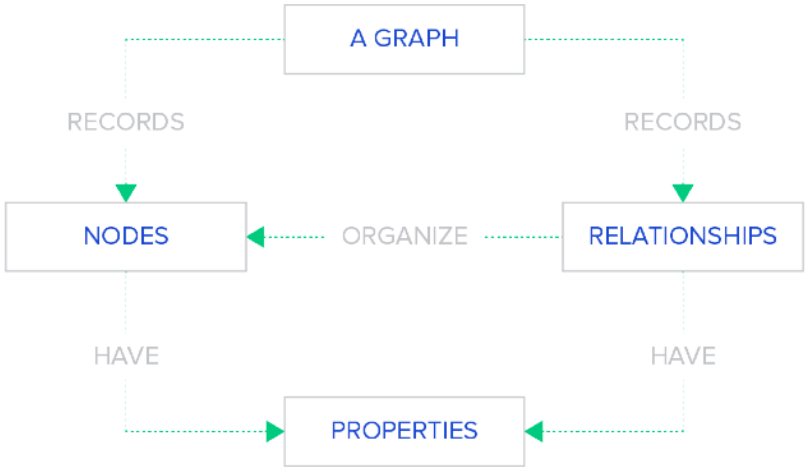
- Key value stores
  - Like hash tables

Key	Value
"Belfast"	{"University of Ulster, Belfast campus, York Street, Belfast, BT15 1ED"}
"Coleraine"	{"University of Ulster, Coleraine campus, Cromore Road, Co. Londonderry, BT52 1SA"}

- Document Oriented
  - as in key values but data is stored as a key value pair
    - but the value is a document (e.g. composed of multiple fields)
    - stored in JSON or XML formats
    - this has a number o advantages in terms of querying

Types (cdt)

- Column Databases
  - data is stored in columns, as opposed to rows in SQL DBs
  - fast read/write access to the data stored
  - enable effective compression as columns are typically largely uniform
  - focus on querying on one aspect of the data (e.g. price over time) rather than the entire record (price of company x between two periods)
  - created by Google for their core search engine storage system
- Graph Databases
  - a directed graph structure is used to represent the data
  - graphs are composed of edges and nodes
  - typically used in social networking applications.
  - Graph databases allow developers to
    - focus more on relations than on objects



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	Storage Type	Query Method	Interface	Programming Language	Open Source	Replication
Cassandra	Column Store	Thrift API	Thrift	Java	Yes	Async
MongoDB	Document Store	Mongo Query	TCP/IP	C++	Yes	Async
HyperTable	Column Store	HQL	Thrift	Java	Yes	Async
CouchDB	Document Store	MapReduce	REST	Erlang	Yes	Async
BigTable	Column Store	MapReduce	TCP/IP	C++	No	Async
HBase	Column Store	MapReduce	REST	Java	Yes	Async

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What you should know

- Understand the limitations of SQL databases
- Understand the large scale requirements for the web
- Understand the motivation behind NoSQL databases
- Understand the types of noSQL databases

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Questions?

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