Corruption in Distributed Graph Databases

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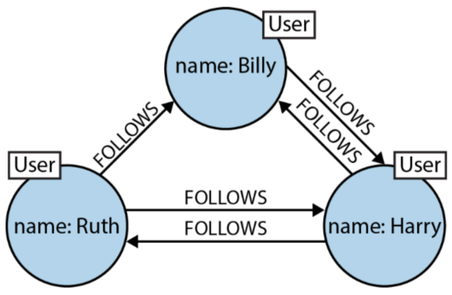
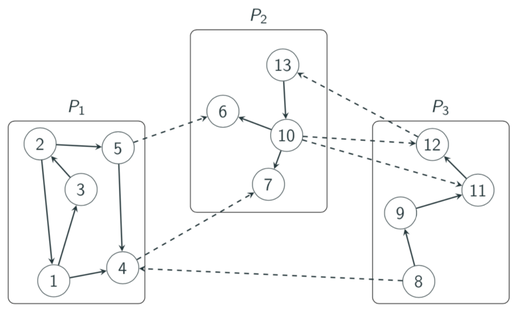
Common System Architecture

Labeled Property Graph



Partitioned Graph



NoSQL Storage Backend

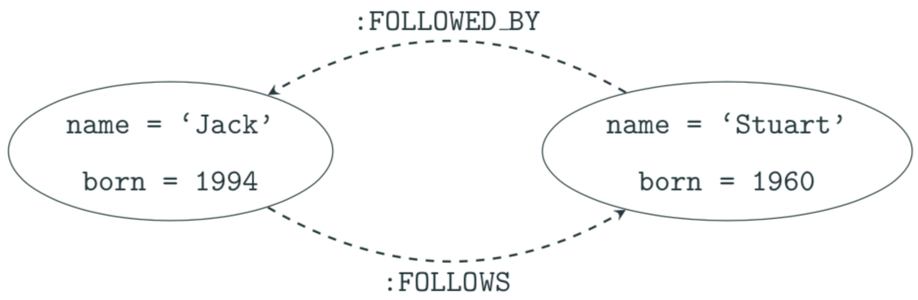
cassandra

Graph Processing Layer

JanusGraph

Reciprocal Consistency

An edge is represented by two physical objects that must remain **reciprocally consistent**



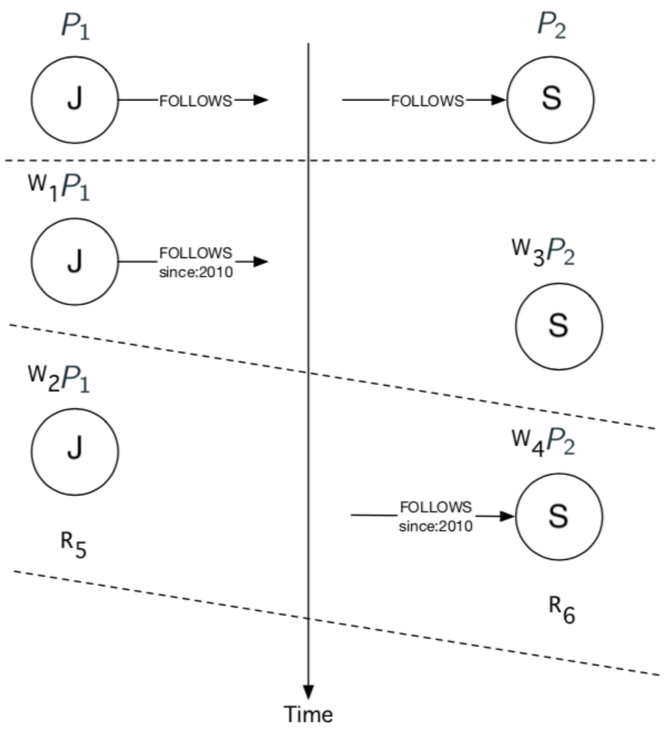
This allows bi-directional edge traversal

Edge Half-Corruption

Maintaining reciprocal consistency is a challenge for distributed edges

NoSQL storage backends do not provide ACID transactions

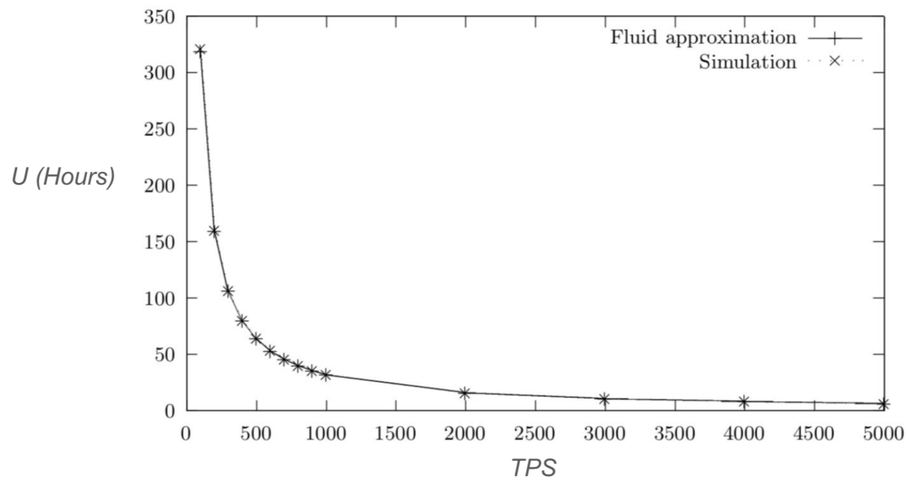
Concurrent updates can interleave and edges become **half-corrupted**



Database Corruption

Simulated the rate of corruption:

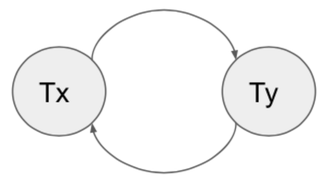
- Scale-free Graph Database with 1 billion nodes, 11 billion edges (30% distributed)
- 10% queries read-write transactions
- Reads-per-query geometrically distributed (mean 15)



Solution

Three-step approach:

1. Identified baseline isolation requirement for distributed graph databases
   (a) Half-corruption of distributed edge occurs due to write cycles between transactions



2. Developed lightweight edge concurrency control mechanism: Interference free updates on a single edge
   (a) Optimistic, non-blocking approach
   (b) Transactions aborted when possibility of half-corruption detected
   (c) Some transactions can be "innocently" aborted
3. Performance evaluation of mechanism via simulation