EYWA: Building a Distributed Graph Engine on Huawei Cloud

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09/01/2017
About Huawei

170,000 employees

170 countries

$75B revenue

14 regional HQ

16 R&D centers

32% YoY growth
About Huawei - 2

8/28/2017
The Na'vi believe that Eywa acts to keep the ecosystem of Pandora in perfect equilibrium. Eywa emphasizes connection, the connections among the creatures on Pandora and the connections between Na’vi and their ancestors.
Graphs in AI: Intelligent Service

Use Case:
AI assists Technical Services

Private Knowledge Graph

Chat conversation

Knowledge Base

- Greater scope
- Fewer errors

KBAI Virtuous Circle

- More features
- More precision

Artificial Intelligence

Inference & Reasoning

Human-Machine Collaboration
Eywa Graph Engine Service
From Product to Techniques

Import graph data

High usability through clicks

Usability - Easy to use

Display result in JSON and visualize it

Usability - Flexible to use

Perform user queries through query language

Graph metrics
- Degree Dist.
- Betweenness
- Diameter
- Betweenness
- Triangle Cnt.
- Triangle Cnt.
- Betweenness

Algorithms
- Max CC
- Top-k TKSP
- MST
- PageRank
- Clustering
- Link Pred.

Queries
- k-Core query
- Top-k TKSP
- MST
- PageRank
- Clustering
- Link Pred.

Results

Visualizer
Eywa on Cloud - the Architecture

Data in & out
- Graph data import/export agent
- Run-time Monitor
- DB interfaces
- Configurations

Query & Analysis
- Graph metrics
- Graph algorithms
- Gremlin / (Cypher)
- Multi-lingal adaptor

Query & Analysis (continued)
- GAS
- RESTful APIs
- Eway Kernel for Graph Computing and Query

Sys Mgmt
- Management front-end
- Anomaly detector
- Load balancer
- User management

Cloud Infrastructure/Platforms

Legend:
- End User
- Developers
- Kernel
- Platform
Trade-off Between Analytics and Query

Physical edge-sets

Flow direction

Observation on PSIV data access patterns implies efficient sharing representation.

Iteration /
Labeled Property Graph Model

• Definition
  • graph + property + label

• Industry adoption
  • de facto model for GraphDB
  • Noe4j, Titan, DSE Graph etc.

  • each vertex has a collection of properties defined by a map from key to value.
  • each edge has a collection of properties defined by a map from key to value.
Challenges - Label Ambiguity

Books, authors, and readers
Managers, likes, and collaborators

A person can be an author, or a reader, or both
Graph-based Property Management

- Schema graph of a property graph
  - Vertex — a label representing a vertex type
  - Edge — a label representing an edge type
- Schema graph ontology
  - Relevant labels are connected using directed edge
Graph-based DevOps for Eywa

Use a graph to link algorithms, datasets, and users, which DevOps by grouping users, predicting algorithm usage, and offer helps.

Utilize ML and graph algorithms to analyze the above graphs, Eywa enjoys some basic AI capability in its DevOps.
Experiments

- **Infrastructure**
  - 9 VMs from data center
  - each with 22-core CPU, 125 GB memory

- **Dataset**
  - Orkut: $|V|=3.07M$, $|E|=117M$
  - Friendster: $|V|=65M$, $|E|=1.8B$
  - Kronecker: $|V|=984M$, $|E|=106.5B$

- **Query evaluation**
  - Given a set of vertices, perform 3-hop local traversal
Experiments - 1

- Dataset: Orkut
- Platform: Eywa vs Titan
- Infrastructure: a single machine
- Test bench: local traversal
- Concurrency: 100 queries
Experiments - 2

- Dataset: Orkut
- Platform: Eywa vs Titan
- Infrastructure: a single machine
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Experiments - 3

Eywa VS. Titan (\(|V|: 3072441, |E|:117185083\))

- Eywa outperformed the baseline method
- Eywa shows consistent running time
Experiment - 4

Eywa (|V|: 984,125,490, |E|: 106,579,558,164)

100 Concurrent Queries, each executing consecutive 3-hop traversals with random roots

- Dataset: Kronecker
- Platform: Eywa
- Infrastructure: 9 VMs
- Test bench: local traversal
- Concurrency: 100 queries
Experiment - 5

- Consistent performance observed across graphs of different scales
Experiment - 6

- Consistent performance observed across graphs of different scales
- Better overall throughput for higher concurrency
- For bigger graph, the throughput increases to some extent as the number of VMs increases
Experiment - 7

CPU Usage: friendster

- CPU usages seems not high
- Further concurrent queries can be supported
- Each query may incur multiple threads (workers) for distributed communication reasons, which consumes little CPU resources, but occupy a core (OS can swap them out)