PGX.D aDFS: An Almost Depth-First-Search Distributed Graph-Querying System

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Complexities in Graph-Query Execution

- **Limited locality** (especially in a distributed system)
- Intermediate (and final) result explosion

### 1 hop

```sql
SELECT COUNT(*) MATCH (a)->()
+---------------------------+
| COUNT(*)           | 1,468,365,182 |
|---------------------------+
```

### 2 hops

```sql
SELECT COUNT(*) MATCH (a)->()->()
+---------------------------+
| COUNT(*)           | 9,324,563,362,739 |
|---------------------------+
```

-- Info of authors who like each other and have < 10 years of age difference

```sql
SELECT a1.name, a2.name, a1.country = a2.country,
    ABS(a1.salary - a2.salary) AS salary_diff
MATCH (a1:author) -[:likes]-> (a2:author) -[:likes]-> (a1)
WHERE ABS(a1.age - a2.age) < 10
ORDER BY salary_diff DESC
```

**Need a distributed solution that is flexible and can handle the scale**

- **Twitter graph**
- **PGX.D aDFS**
- 8 machines
- ~20 minutes
- ~8B matches/s

**Any user expression** in projections and filters

Requires **homomorphic matching** and returns **all result permutations**
Agenda

1. Introduction / Motivation
2. aDFS Design
3. Evaluation
4. Conclusions
aDFS Design Principles

1. Asynchronous operation
   • Workers operate independently
     - on traversals where there is work
   • Workers buffer and forget remote traversals
     → Workers do not block due to remote communication

2. (Almost) Depth-first traversal
   • Eager completion of matches
   • Fine-grained flow control
     → Control memory consumption

In-memory distributed execution with controllable memory usage
From a PGQL Query to an aDFS Execution Plan

SELECT ...
MATCH
  (a) -> (b),
  (b) -> (c),
  (c) -> (d)
WHERE ...

A list of stages that “know” how to
1. match a vertex
2. move to next stage
Asynchronous DFS/BFS Traversals

MATCH (a) → (b) → (c) → (d)

Is “strict” DFS the best approach? No!
Experimental Evaluation
Schemaless Graphs and Queries

- **Q1**: cycle (a)→(b)→(a)
- **Q2**: 2-hops (a)→(b)→(c)
- aDFS and GraphFrames with 8 machines / others single machine
- aDFS configured with 1GB memory per machine / others have access to whole machine memory (768 GB)
- Did not complete in 8 hours / Hang due to out of memory

Only aDFS can handle the scale
Conclusions

• **aDFS is a fast and scalable distributed graph querying engine**
  • Provides flexible PGQL querying
  • Combines BFS / DFS
  • Limits max memory usage

• **Also in the paper:** Experiments with the LDBC graph and queries

• **Since the experiments for ATC paper, PGX.D**
  • supports graphs with schema → lower memory and better performance
  • has significantly faster PGQL query execution
  • supports bigger subset of PGQL

Thank you!