Motivation
- Graphs are ubiquitous (e.g., road networks, social networks, biological networks, data-center networks)
- Specialized graph systems are not as mature as RDBMSs
- Graph-Relational queries are pervasive in many applications
  - Queries containing graph operations, (e.g., shortest-paths) and relational predicates
  - E.g., select specific users from relational tables, then find their nearest hospitals using shortest-path over a road-network
- Vanilla RDBMSs cannot evaluate deep-traversal queries efficiently
  - Large intermediate results of the join operations
  - Inaccurate cardinality estimation

Existing Approaches
- Native Relational-Core
  - Deep-traversal queries are inefficient to evaluate
  - Graphs are encoded in complex schemata
- Native Graph-Core
  - Graphs are extracted from RDBMS into graph-core
  - Graph updates require graph re-extraction
  - Queries cannot reference non-extracted relational data

Proposed Approach: Native G+R Core
- Represent graphs as native graph structures
- Extend SQL to reference graphs in queries
- Support cross-data-model QEPs
- GRFusion realizes the Native G+R approach

Creating Graph Views in GRFusion
CREATE UNDIRECTED GRAPH VIEW SocialNetwork
VERTESES (ID = uId, lstName = lName, birthdate = dob)
FROM Users
EDGES (ID = relId, FROM = uId1, TO = uId2, startdate = sDATE, relative = isRelative)
FROM Relationships

Lightweight Graph Views in GRFusion

The PATHS Construct and Cross-Model QEPs
SELECT PS.EndVertex.lstName
FROM SocialNetwork.PS
WHERE U.Job = 'Lawyer' AND PS.StartVertex.id = U.UserID AND PS.PathLength = 2 AND PS.Start = 1
ORDER BY PS.EndVertex.lstName

Graph-Traversal Query Examples
SELECT PS.EndVertex.lstName
FROM SocialNetwork.PS
WHERE U.Job = 'Lawyer' AND PS.StartVertex.id = U.UserID AND PS.PathLength = 2 AND PS.Start = 1
ORDER BY PS.EndVertex.lstName

Experimental Results

Extend In-Memory Relational Database Engines with Native Graph Support
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