Graph queries, schemas and standards

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Author of The GQL Manifesto (Lead at Neo4j for query language/research group 2017-9)
A new International Standard, GQL (Graph Query Language)

**September 2019** ISO/IEC Joint Technical Committee 1 [IT standards] agrees to start a new project for the SC 32 [Data Management] Working Group 3 [Database Languages]

WG3 is the SQL standard committee.

The new project is GQL.

A query and schema language for mutable property graph databases.

The read-only pattern matching part of GQL is also part of SQL/PGQ.

WG3 has not worked on any language other than SQL in the past 35 years

**This could be a big deal.** I think it's the tip of an iceberg
What is a property graph?

A graph where the nodes and edges are data records.

Sometimes, a field can be a tags, with no value (a “label”)

Sometimes, the graph can have its own attributes

Usually, the field values are not graphs or graph elements

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Box 3: Our definition of “graph”

Here we use “graph” to mean a directed, attributed multi-graph with a global attribute. In our terminology, a node is denoted as \( v_i \), an edge as \( e_k \), and the global attributes as \( u \). We also use \( s_k \) and \( r_k \) to indicate the indices of the sender and receiver nodes (see below), respectively, for edge \( k \). To be more precise, we define these terms as:

- **Directed**: one-way edges, from a “sender” node to a “receiver” node.
- **Attribute**: properties that can be encoded as a vector, set, or even another graph.
- **Attributed**: edges and vertices have attributes associated with them.
- **Global attribute**: a graph-level attribute.
- **Multi-graph**: there can be more than one edge between vertices, including self-edges.
Is graph data important?

Late 2020 DeepMind’s Alphafold: a solution to a 50-year-old grand challenge in biology

‘A folded protein can be thought of as a “spatial graph”... [our] neural network system ... interpret[s] the structure of this graph, while reasoning over the implicit graph that it’s building’.

Late 2018, in the Battaglia et al. paper, Deep Mind and other scientists advocated graph networks as a paradigm of deep learning, using the property graph data model.
Are graph databases important?

The **2018 Seattle Report** on database research directions does not mention graphs.

~50 papers and multiple sessions at VLDB 2020 focussed on graphs.

**February 2021** a small graph database/analytics company called **TigerGraph** received third-round venture funding of $105m.

**Databricks**, a large SQL data/analytics company, received $1bn the same month.

There are numerous other fundings and acquisitions (Bitnine in Korea first graph IPO).

**Oracle** are a big force behind SQL/PGQ.

**Ant Group** has multiple graph databases.

**Amazon Neptune** is the leading graph cloud service.
WG3 and LDBC liaison

Birkbeck has just joined Linked Data Benchmark Council

Jan Hidders in the CS department co-leads an LDBC community working group on PGS

CWI/VU in Amsterdam, ENS-Paris, Edinburgh, Lyon, INRIA Lille, Warsaw, UPC ... lots of academic partners

Another LDBC project (Leonid Libkin ENS/Edinburgh) in is a GQL Formal Semantics working group

Cypher to GQL is a likely direction for future community efforts

Petra Selmer (Birkbeck alumna and visiting lecturer) at Neo4j heads a working group on Existing Languages analysis
Queries

Graph queries using the pattern-matching paradigm of Cypher (originally from Neo4j) are not schema-aware: they search for topological patterns (sub-graphs) and data structures and values.

<table>
<thead>
<tr>
<th>Cypher 9</th>
<th>PGQL 1.1</th>
</tr>
</thead>
</table>
| FROM languageGraph  
MATCH (a:Engineer)-[:LIKES]->(l:Language)  
WHERE (l)-[:SUPPORTS]->(:Feature {name: "Pattern Matching"})  
RETURN a.name, l.name | SELECT a.name, l.name FROM languageGraph  
MATCH (a:Engineer)-[:LIKES]->(l:Language)  
WHERE EXISTS (  
    SELECT *  
    MATCH (l)-[:SUPPORTS]->(:Feature {name: "Pattern Matching"})  
) |
Queries and Schemas

SQL/PGQ is about adding (conjunctive) regular path queries to sophisticate this approach.

You don’t have to have a schema to have a graph database (unlike SQL).

But there is great interest in property graph schema: one of the motivations for GQL.

Water to Ice
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Input languages and output timescales

Working towards a New Work Item for GQL, to complement SQL PGQ

Cypher, PGQL, G-CORE, GSQL, SQL-PGQ, Cypher for Apache Spark, GXPath

US, UK, China, Sweden, NL, S. Korea, Finland, Denmark, Japan

SQL-PGQ CD Q4 2021
GQL CD Q3 2022
What’s (not) coming when?

In 2022
DQL returns table from **path pattern match**
DML to **mutate graph** (including merge)
DDL to create **graph types and typed graphs**

Not yet (not 2022)
G-CORE
Graph query language closed over graphs
Extensible schema, keys, participation constraints