Database Technology Evolution II: Graph Database Language

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Malcolm Crowe

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- Malcolm Crowe is an Emeritus Professor at the University of the West of Scotland, where he worked from 1972 (when it was Paisley College of Technology) until 2018.
- He gained a D.Phil. in Mathematics at the University of Oxford in 1979.
- He was appointed head of the Department of Computing in 1985. His funded research projects before 2001 were on Programming Languages and Cooperative Work.
- Since 2001 he has worked steadily on PyrrhoDBMS to explore optimistic technologies for relational databases and this work led to involvement in DBTech, and a series of papers and other contributions at IARIA conferences with Fritz Laux, Martti Laiho, and others.
- Prof. Crowe has recently been appointed an IARIA Fellow.

Prof. Dr. Fritz Laux

(Retired), Reutlingen University
Email: fritz.laux@reutlingen-university.de

- Prof. Dr. Fritz Laux was professor (now emeritus) for Database and Information Systems at Reutlingen University from 1986 - 2015. He holds an MSc (Diplom) and PhD (Dr. rer. nat.) in Mathematics.
- His current research interests include
  - Information modeling and data integration
  - Transaction management and optimistic concurrency control
  - Business intelligence and knowledge discovery
- He contributed papers to DBKDA and PATTERNS conferences that received DBKDA 2009 and DBKDA 2010 Best Paper Awards. He is a panellist, keynote speaker, and member of the DBKDA advisory board.
- Prof. Laux is a founding member of DBTech.net (http://www.dbtechnet.org/), an initiative of European universities and IT-companies to set up a transnational collaboration scheme for Database teaching. Together with colleagues from 5 European countries he has conducted projects supported by the European Union on state-of-the-art database teaching.
- He is a member of the ACM and the German Computer Society (Gesellschaft für Informatik).

Property graphs are useful

- Graph database products help in conceptual modeling
  - Mostly (e.g.,Neo4j) node properties are not strongly typed
  - Model does not result in a corresponding relational database
  - A standard Graph Query Language is forthcoming
- We construct the relational database at the same time
  - Helps bridge the conceptual gap for app development
  - If models are in the database, all developers can agree
- Creating a Typed Graph Model by instances
    - Design by example: create the concepts incrementally
  - Repeating Patterns
- We believe it is useful to add the graphical support directly to the relational database management system

Property Graphs vs SQL

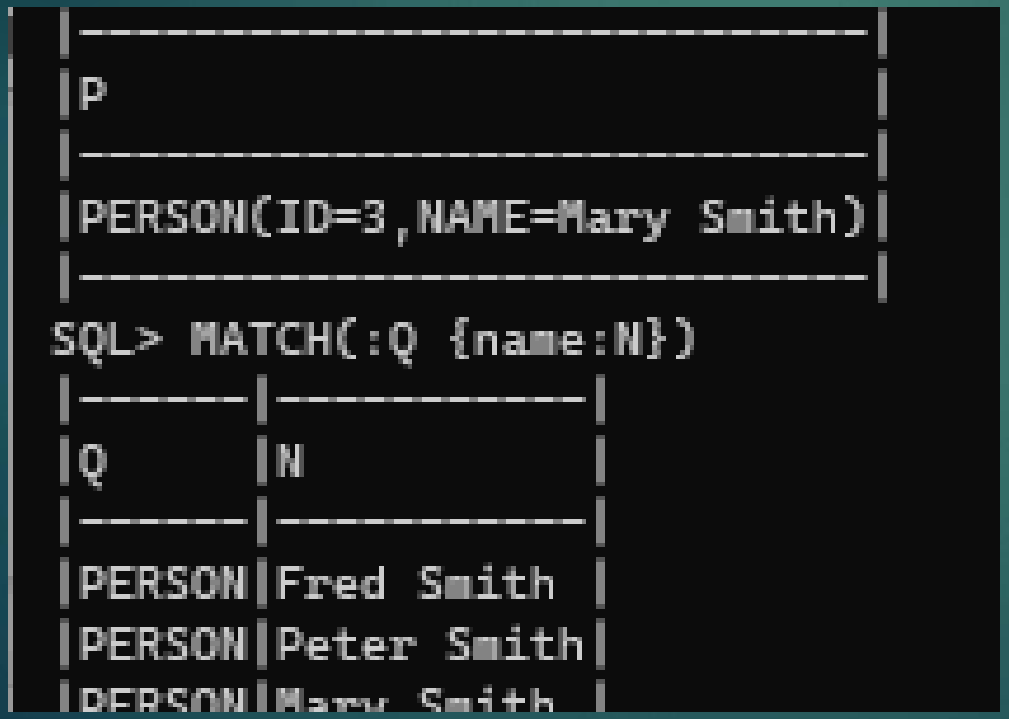
- The SQL programming model is well known
- Most organisations have an RDBMS so it avoids having a separate product and support team
- Enable SQL queries to process graph data
- Graph matching is often a useful shortcut
- The forthcoming GQL standard will be compatible with SQL/PGQ
- With a lot of work, we can do graphical things in SQL, but let's make it easier..
  - An example

An example: graph creation

```
[CREATE
(:Person {name:'Fred Smith'})
<-[:Child]-
(a:Person {name:'Pete Smith'}),
(a)-[:Child]->
(b:Person {name:'Mary Smith'})
-[:Child]->
(:Person {name:'Lee Smith'})]
```

Using MATCH on existing data

```
[MATCH (P {name:'Pete Smith'})
   P.name='Peter Smith']
MATCH (P {name:'Mary Smith'})
```



- MATCH and CREATE

MATCH and CREATE

- This combination is used a lot!

```
[MATCH
(a:Person {name:'Mary Smith'})
CREATE (a)-[:Child]->
(:Person {name:'Bill Smith'})]
```

```
SQL> table Person
|--|-----------|
|ID|NAME       |
|--|-----------|
|1 |Fred Smith |
|2 |Peter Smith|
|3 |Mary Smith |
|4 |Lee Smith  |
|5 |Bill Smith |
|--|-----------|
```

```
SQL> table Child
|--|-------|--------|
|ID|LEAVING|ARRIVING|
|--|-------|--------|
|1 |2      |1       |
|2 |2      |3       |
|3 |3      |4       |
|4 |3      |5       |
|--|-------|--------|
SQL>
```

- Repeating patterns

Repeating patterns

- We can get all descendants of Peter Smith by allowing iteration on the Child edge

```
[MATCH ({name:'Peter Smith'}) [()-[:Child]->()]+
({name:D})]
```

```
|-----------|
|D          |
|-----------|
|Fred Smith |
|Lee Smith  |
|Bill Smith |
|Mary Smith |
|-----------|
SQL>
```


- Visualizing the graph

Altering the Graph Schema

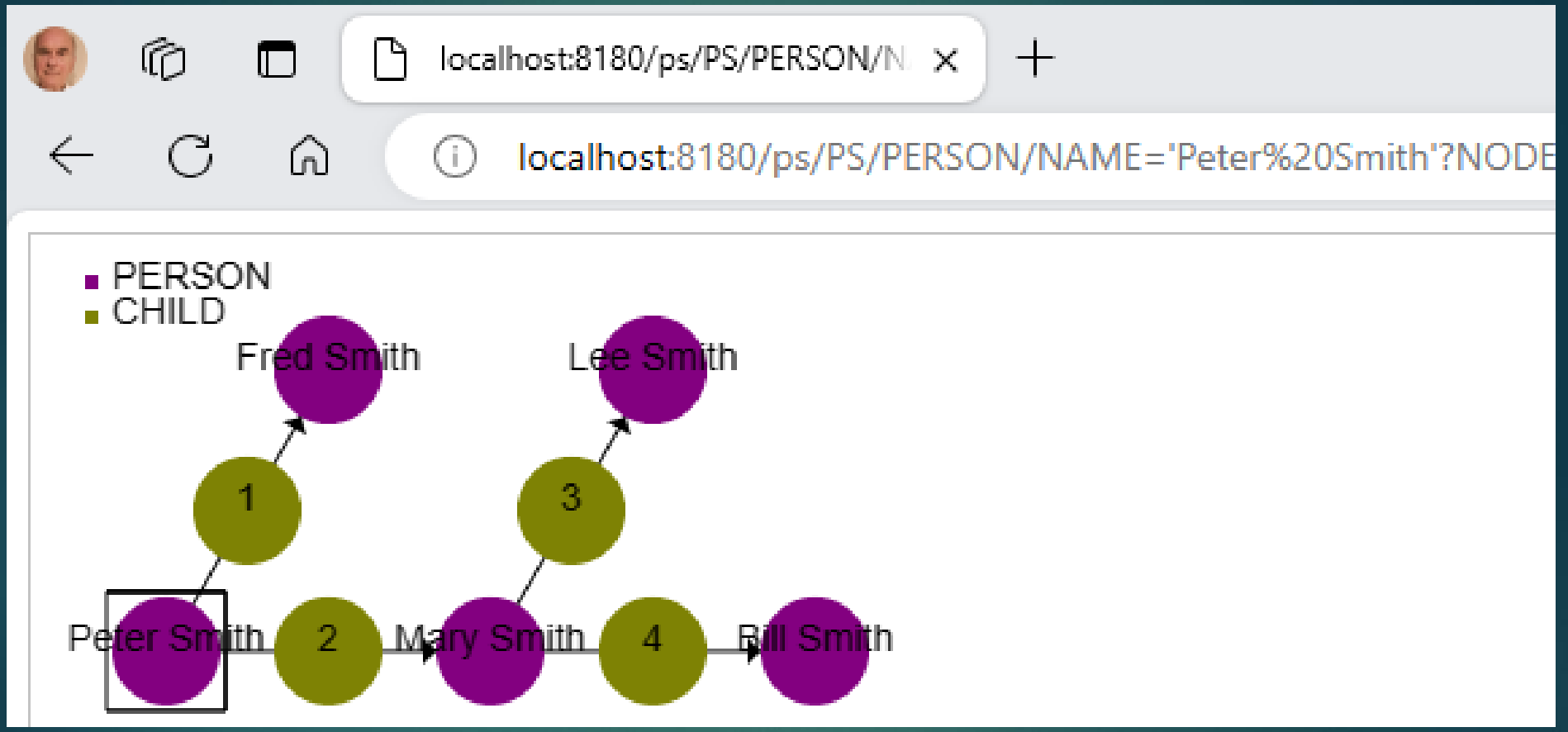
- Improving the Child relation

```
SET ROLE PS
ALTER TABLE Child TO ChildOf
ALTER TABLE ChildOf ALTER LEAVING TO Parent
ALTER TABLE ChildOf ALTER ARRIVING TO Child
ALTER TABLE Person ADD PRIMARY KEY (name)
```

```
SQL> table childof
|--|-----------|-----------|
|ID|PARENT     |CHILD      |
|--|-----------|-----------|
|1 |Pete Smith|Fred Smith|
|2 |Pete Smith|Mary Smith|
```

- Visualizing the graph

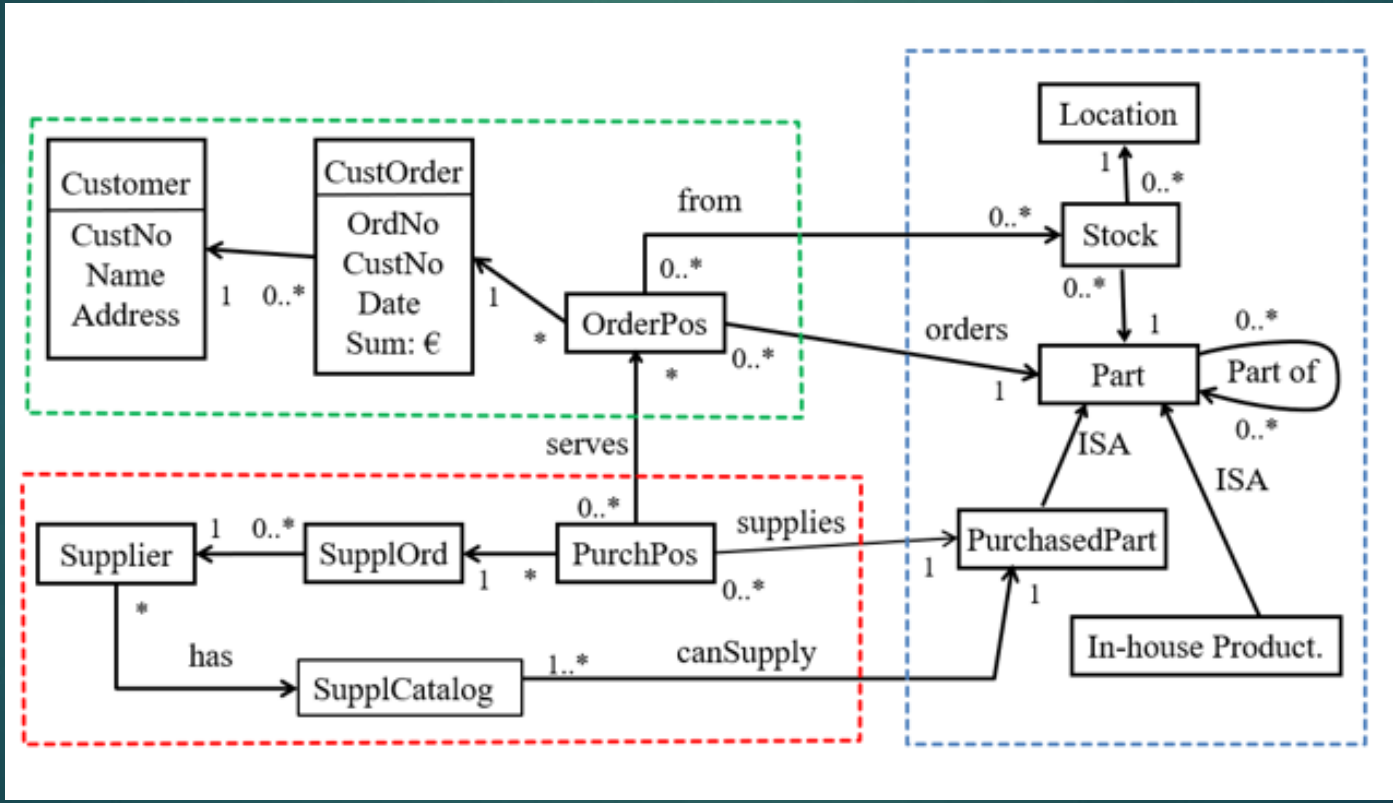
Visualizing the graph



- A more real-life design

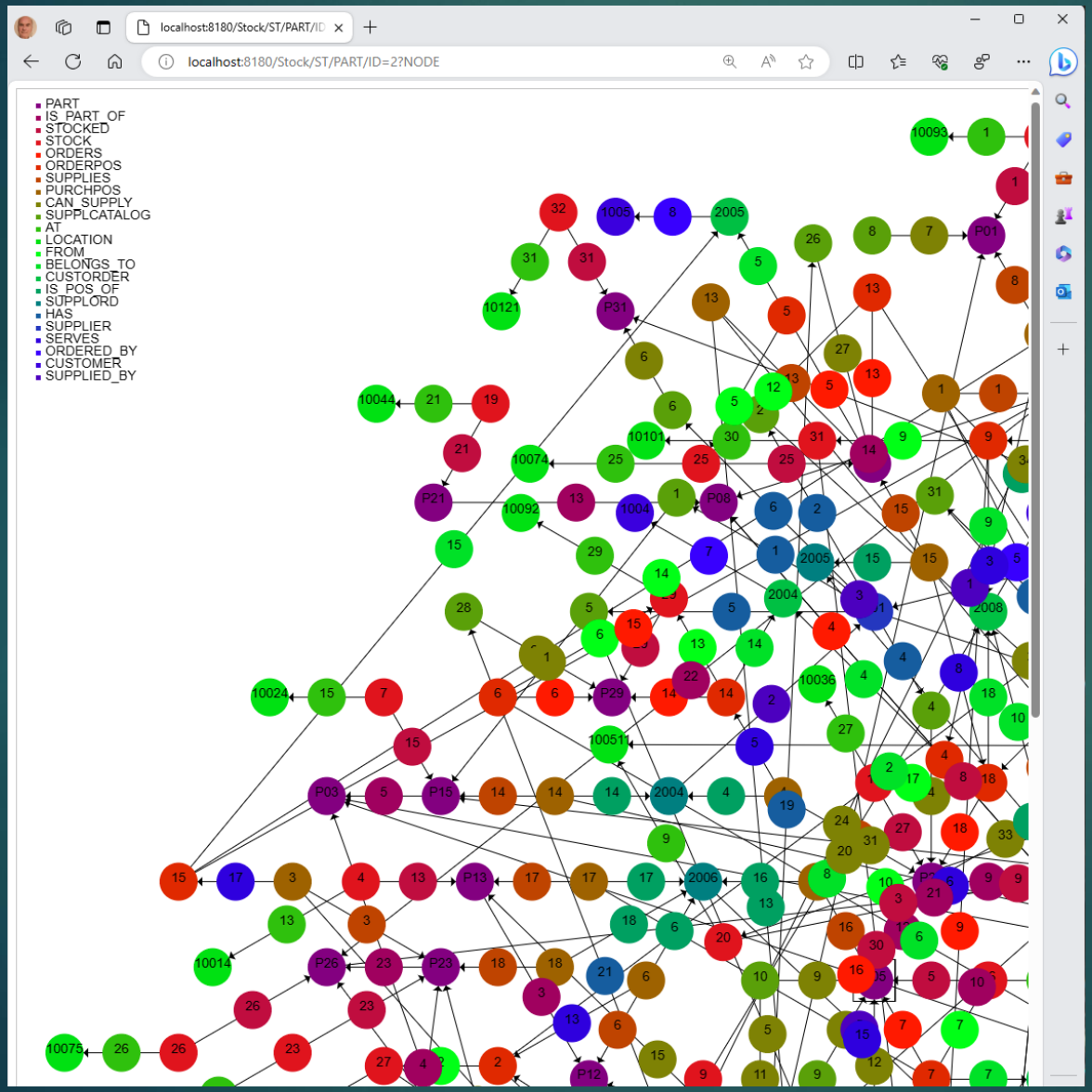
An Example ERP database

- A commercial enterprise buys parts and products
- Resells and/or creates products from parts (not working from raw materials)



- Example ERP database

Graph visualization



- Conclusions

Conclusions

- This merging of TGM with relational technology allows graph-oriented data manipulation and queries
- The forthcoming Graph Query Language standard GQL (ISO 39075) should be compatible with the ideas presented here.

- References

References

1. F. Laux and M. Crowe, Information Integration using the Typed Graph Model. DBKDA 2021: The Thirteenth International Conference on Advances in Databases, Knowledge, and Data Applications, IARIA, May 2021, pp 7-14, ISSN 2308-4332, ISBN 978-1-61208-857-0
2. F. Laux, "The Typed Graph Model", DBKDA 2020 : The Twelfth International Conference on Advances in Databases, Knowledge, and Data Applications, IARIA, Sept 2020, pp. 13-19, ISSN: 2308-4332, ISBN: 978-1-61208-790-0
3. M. Crowe, and F. Laux, "Database Technology Evolution", IARIA International Journal on Advanced is Software, vol 15 (3-4) 2022, pp. 224-234, ISSN: 1942-2628
4. N. Francis, A. Gheerbrant, P. Guagliardo, L. Leonid, V. Marsault, et al.. A Researcher's Digest of GQL. 26th International Conference on Database Theory (ICDT 2023), Mar 2023, Ioannina, Greece. doi:10.4230/LIPIcs.ICDT.2023.1. https://hal.science/hal-04094449 [retrieved: Aug 2023]