BDA 2026
DIJON
19-22 octobre 2026
Gestion de Données - Principes, Technologies et Applications

Expressive Power of Property Graph Constraint Languages

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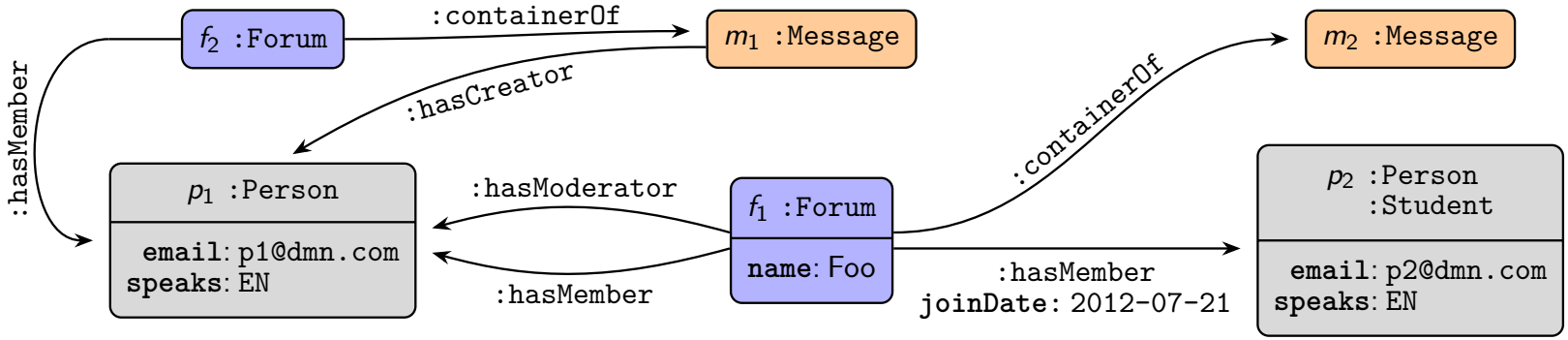
2026-10-21

Property Graph



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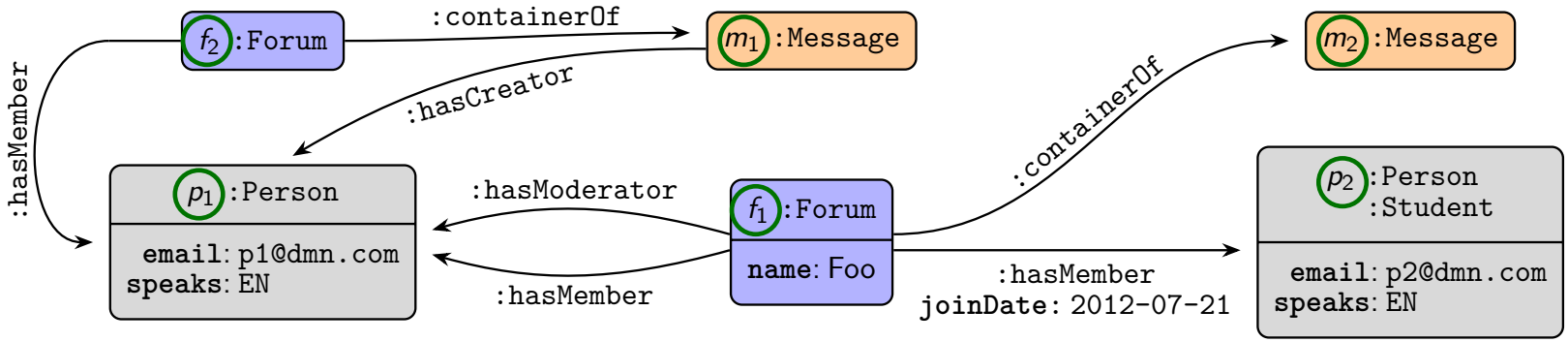
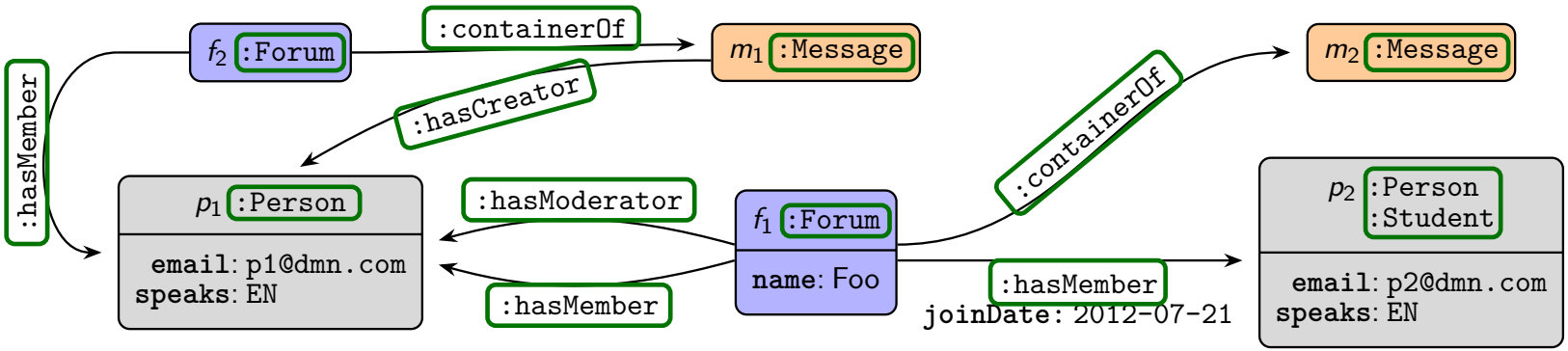


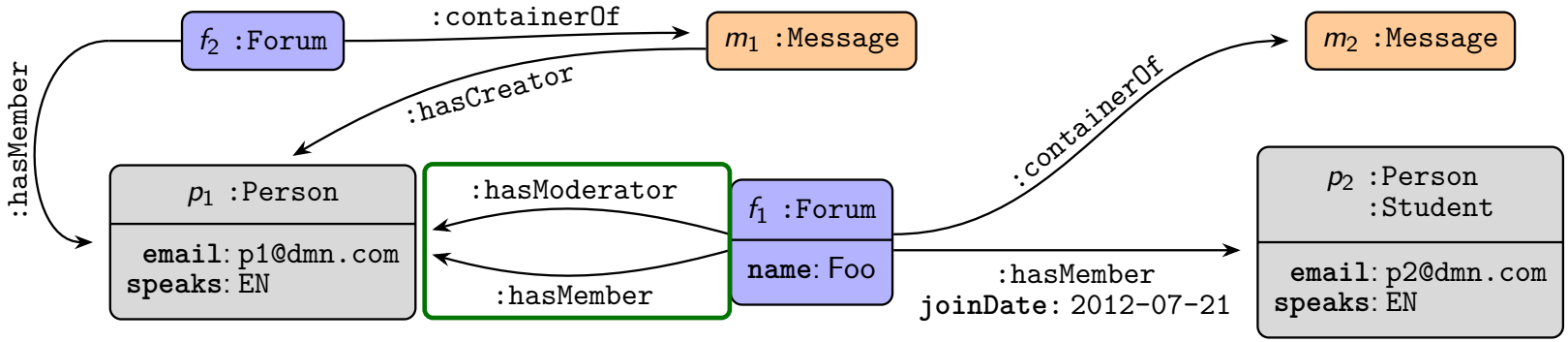
- Identifiers

Property Graph



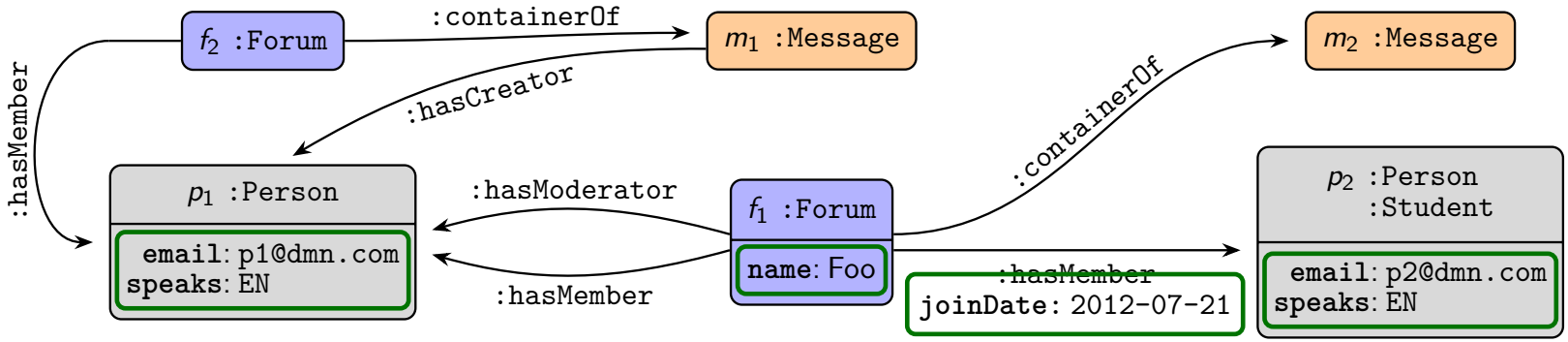
- Identifiers
- Labels

Property Graph



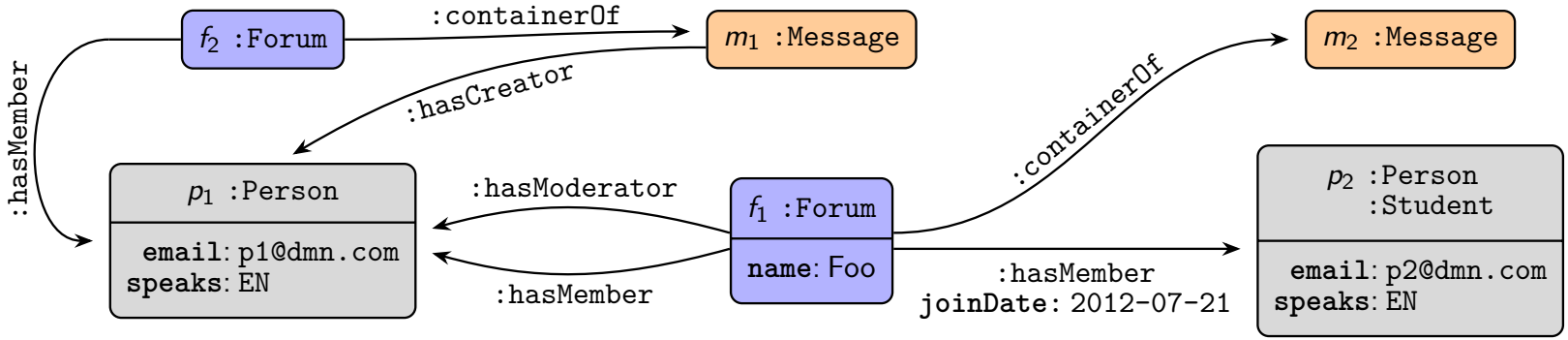
- Identifiers
- Labels
- Parallel edges

Property Graph



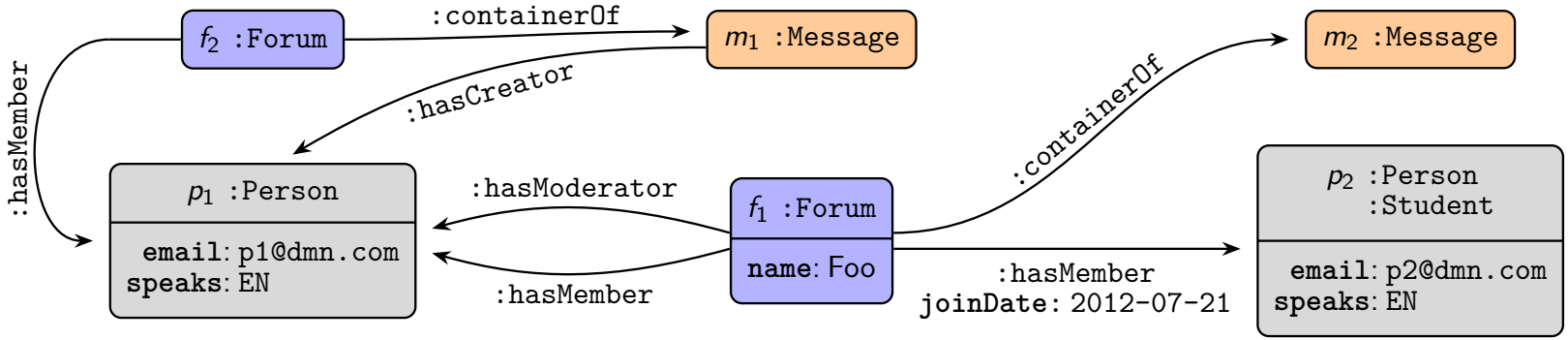
- Identifiers
- Labels
- Parallel edges
- Properties

Property Graph



- A student cannot moderate a forum
- All members of a forum must speak the same language
- The creator of a message must be a member of the forum where the message is posted

Property Graph



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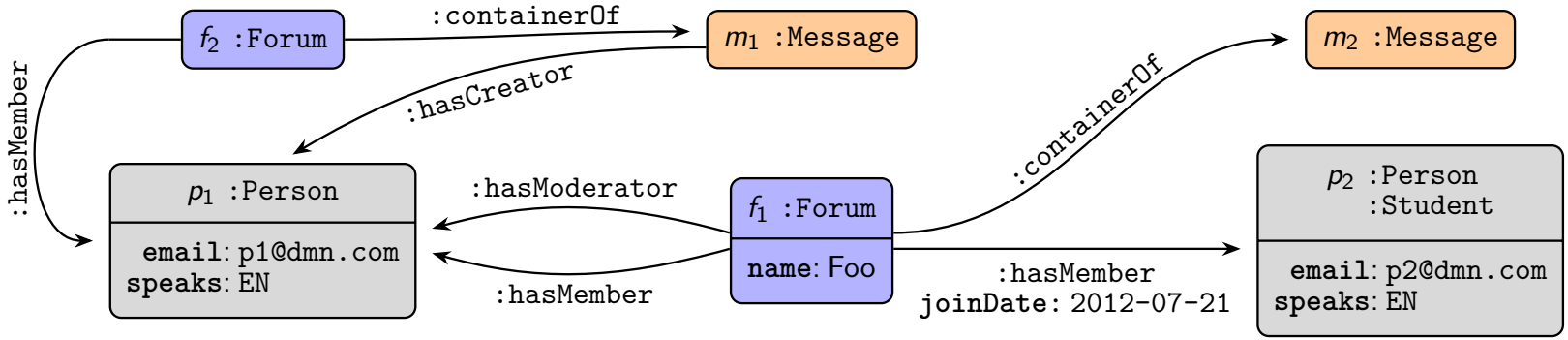

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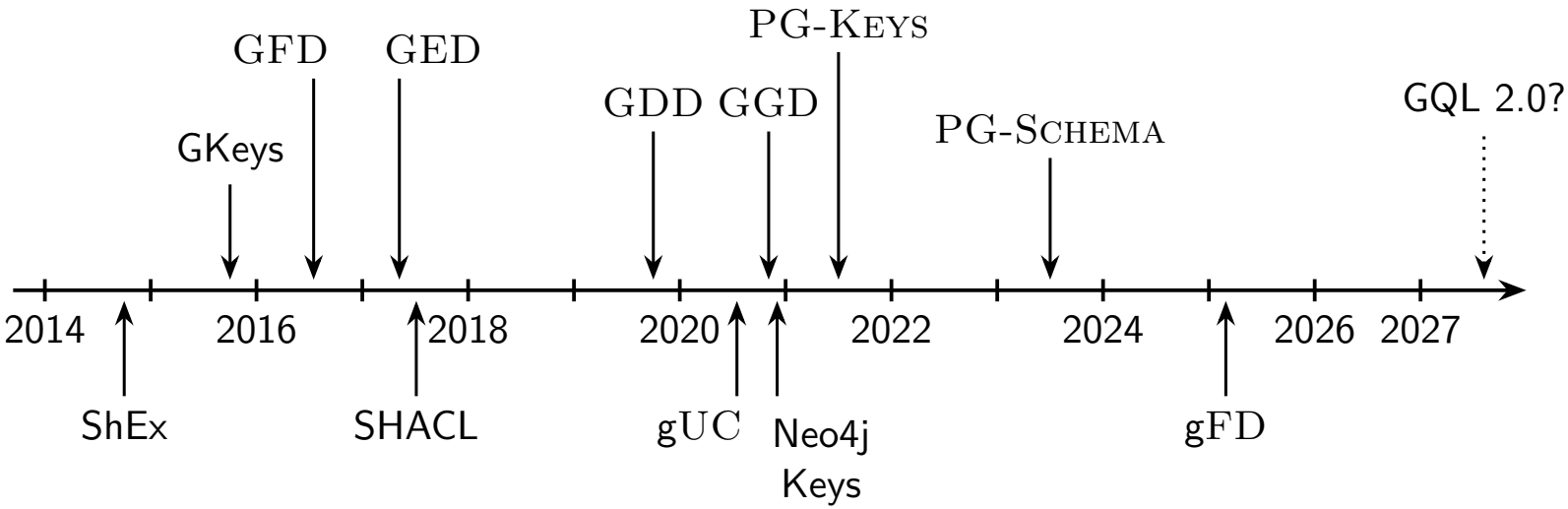
Constraint Languages for Graph Data

A History



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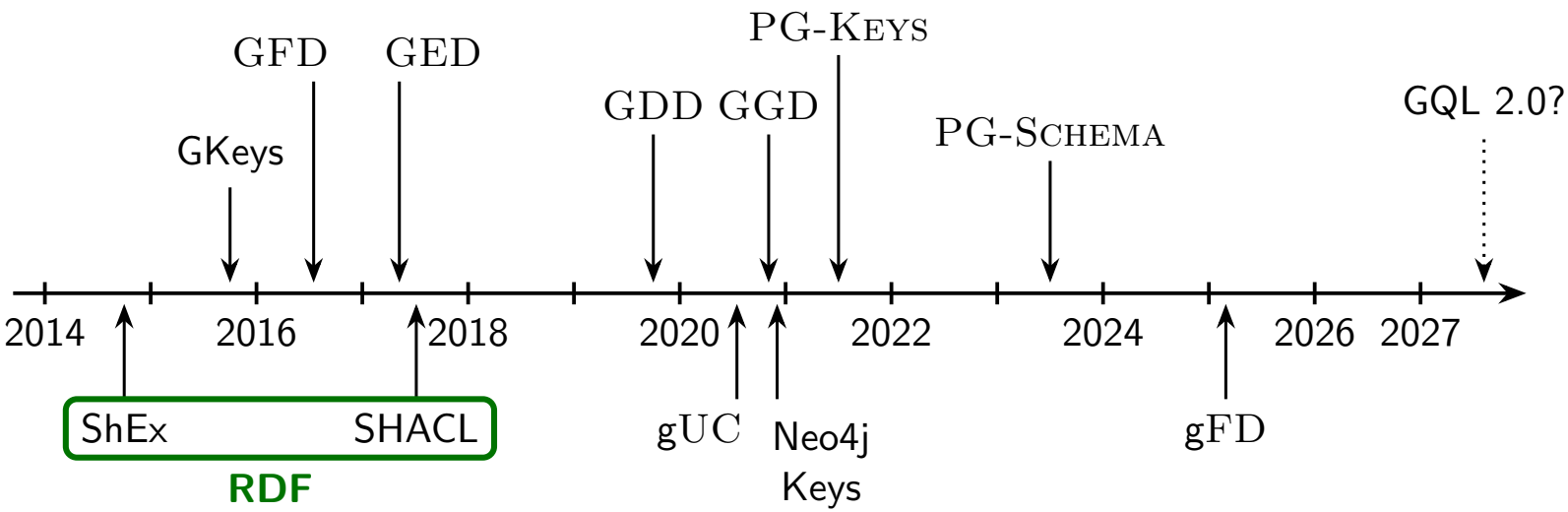

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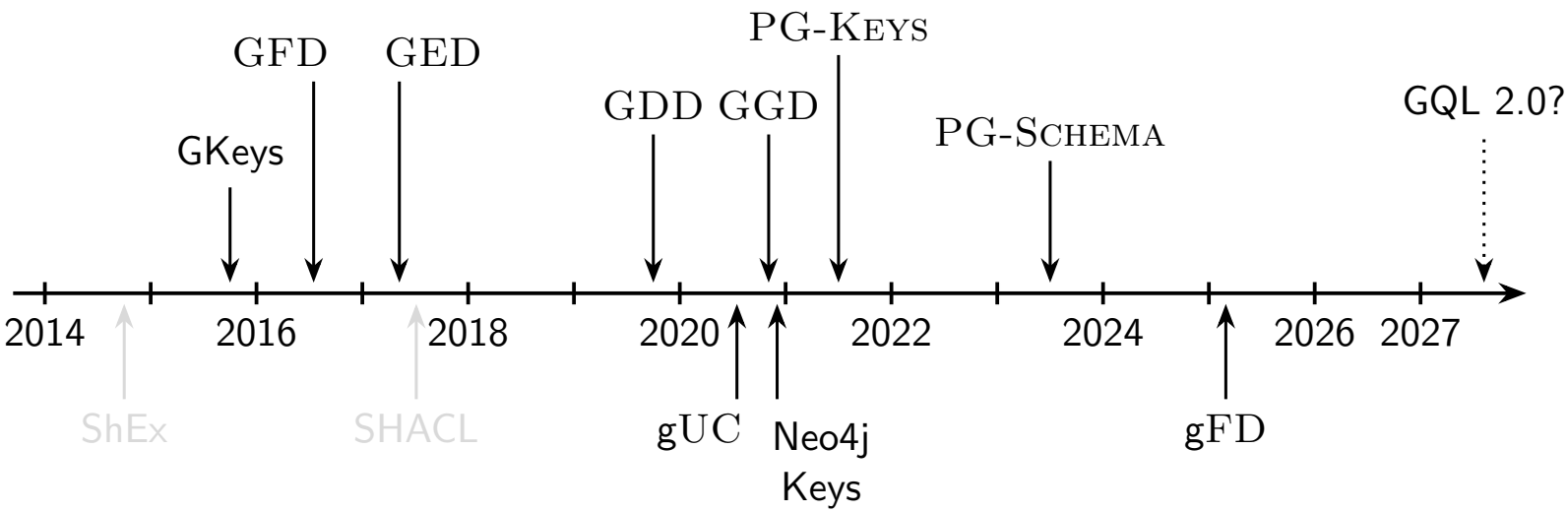

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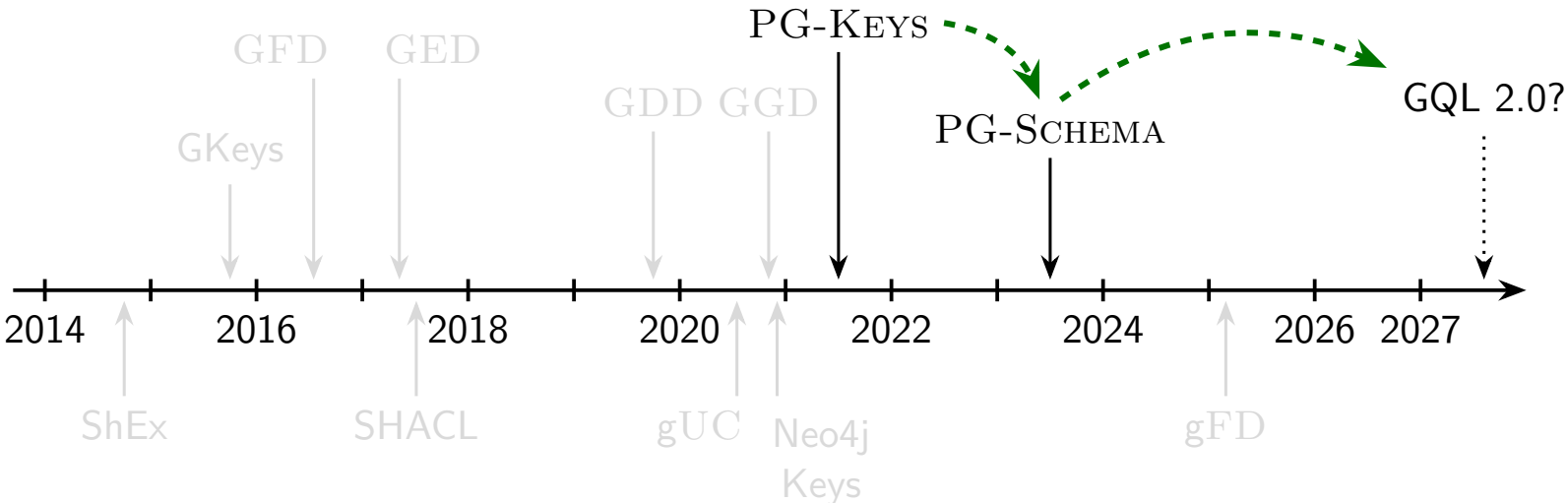

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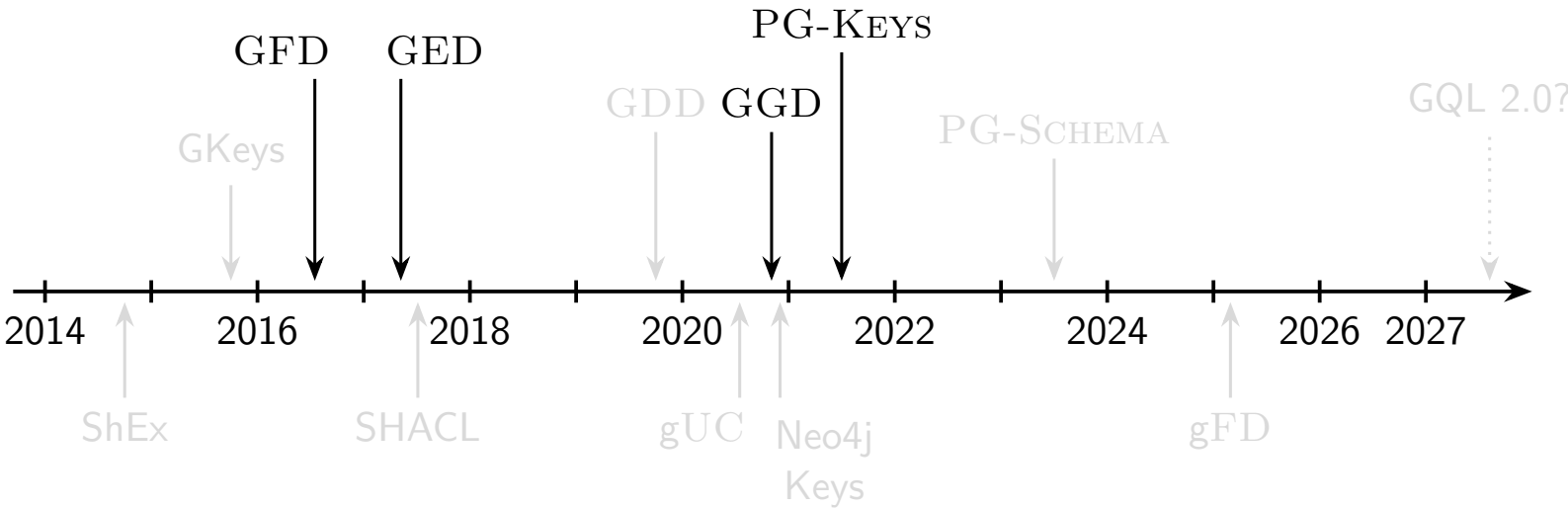


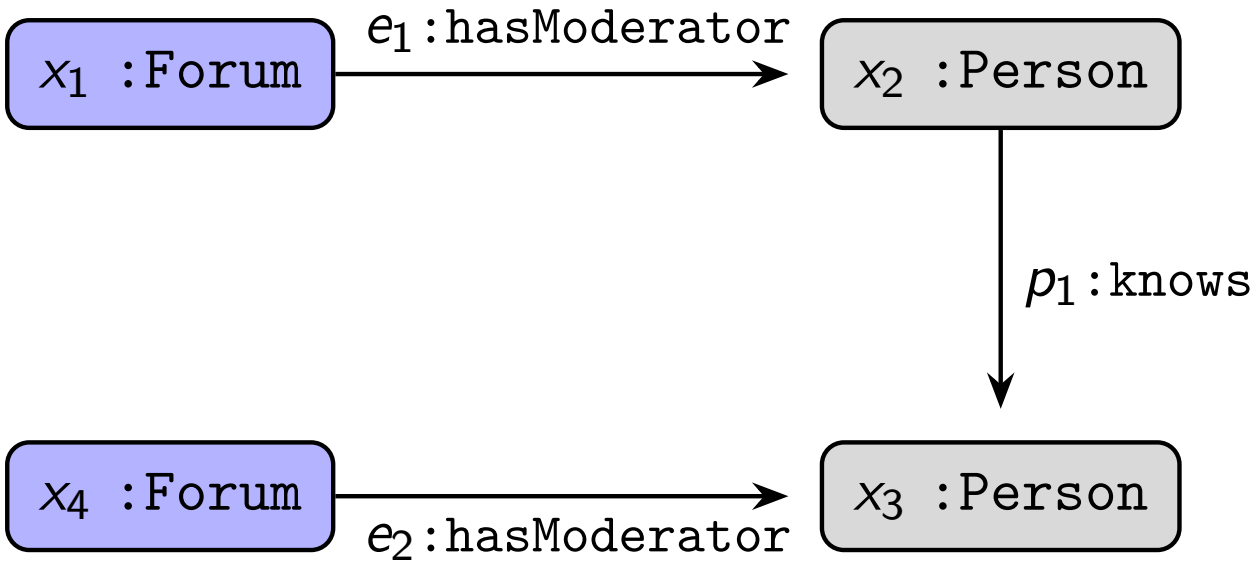
R. Angles et al. "PG-Keys: Keys for Property Graphs". In: *SIGMOD*. 2021.

W. Fan et al. "Functional Dependencies for Graphs". In: *SIGMOD*. 2016.

W. Fan et al. "Dependencies for Graphs". In: *PODS*. 2017.

L. C. Shimomura et al. "GGDs: Graph Generating Dependencies". In: *CIKM*. 2020.

Patterns: CQ, CRPQ



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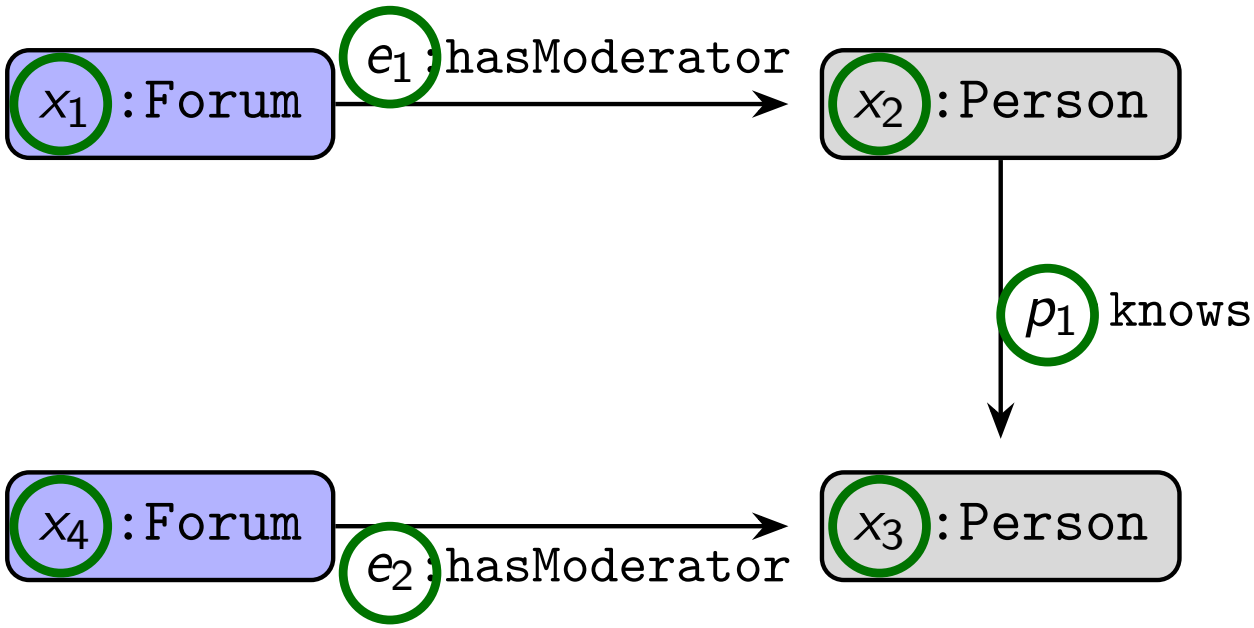

Variables

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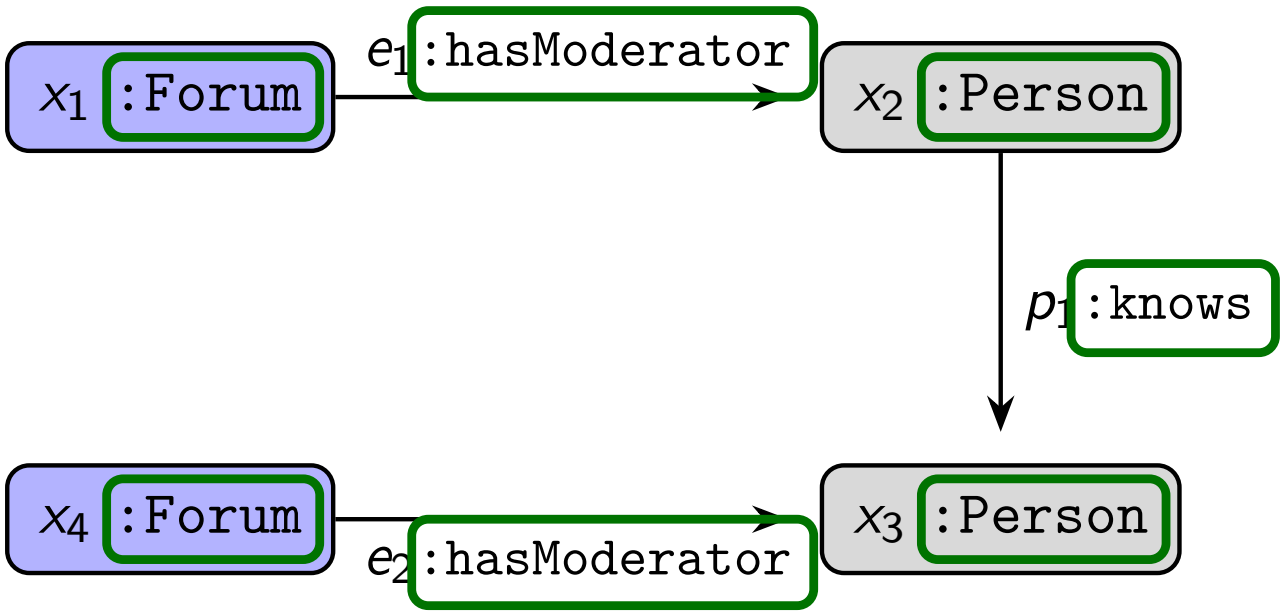

Labels

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Regular Expression

Constraint Languages for Property Graphs

General constraints: $\forall \overline{x}, \overline{y}\ \mathtt{body}(\overline{x}, \overline{y}) \Rightarrow \exists \overline{z}\ \mathtt{head}(\overline{x}, \overline{z})$

- GGD: $x{:}\mathtt{Forum} \xrightarrow{:\mathtt{hasMember}} y \Rightarrow x \xrightarrow{:\mathtt{hasModerator}} z, y \neq z$
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PG-Keys: $\texttt{FOR}\ x\ \texttt{WITHIN}\ \texttt{body}(x, \overline{y})\ \alpha(\texttt{keys})\ \texttt{WITHIN}\ \texttt{head}(x, \overline{z})$

- $\texttt{FOR}\ x\ \texttt{WITHIN}\ x\texttt{:Forum}\ \texttt{MANDATORY}\ (y\texttt{.email})$
  $\texttt{WITHIN}\ x \rightarrow y, y\texttt{.speaks} = \texttt{FR}$
- $\texttt{FOR}\ x\ \texttt{SINGLETON}\ (y)\ \texttt{WITHIN}\ x \xrightarrow{\texttt{:hasModerator}} y$
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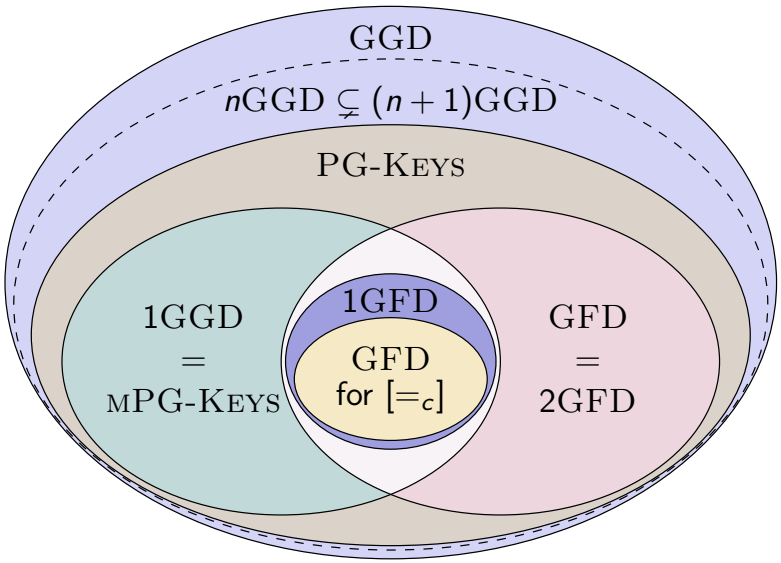
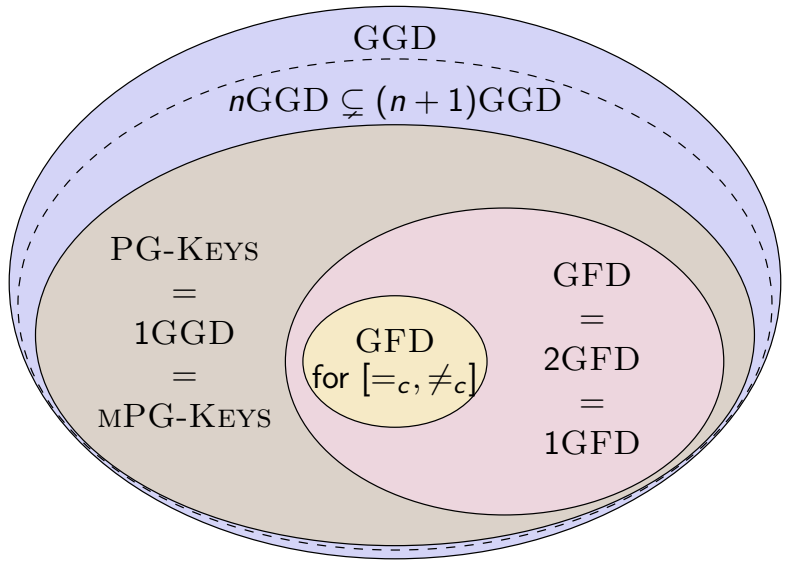
- nGFD, nGGD: $|\overline{x}| \leq n$
- mPG-Keys: MANDATORY only

Main Results: A Complete Hierarchy of Expressivity



(a) With $=$



(b) With $=$ and $\neq$

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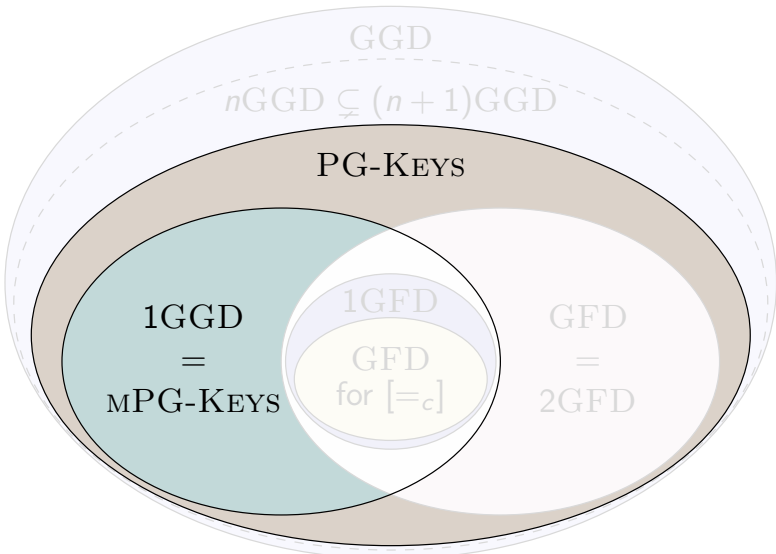

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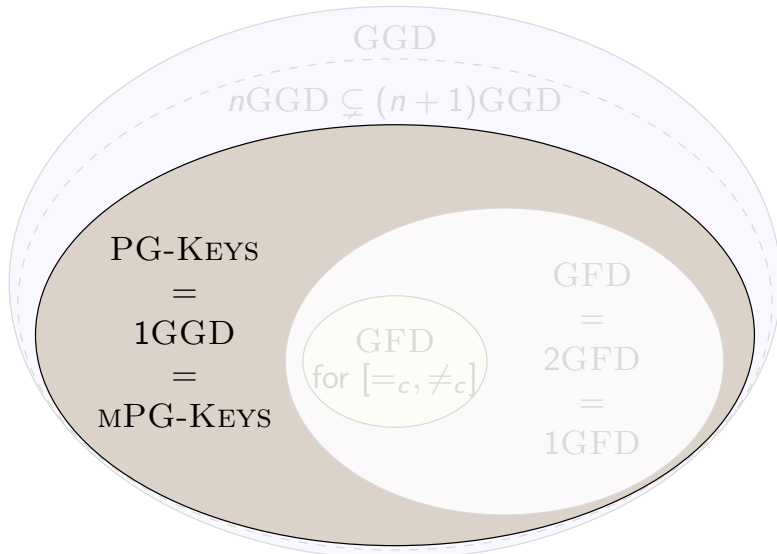

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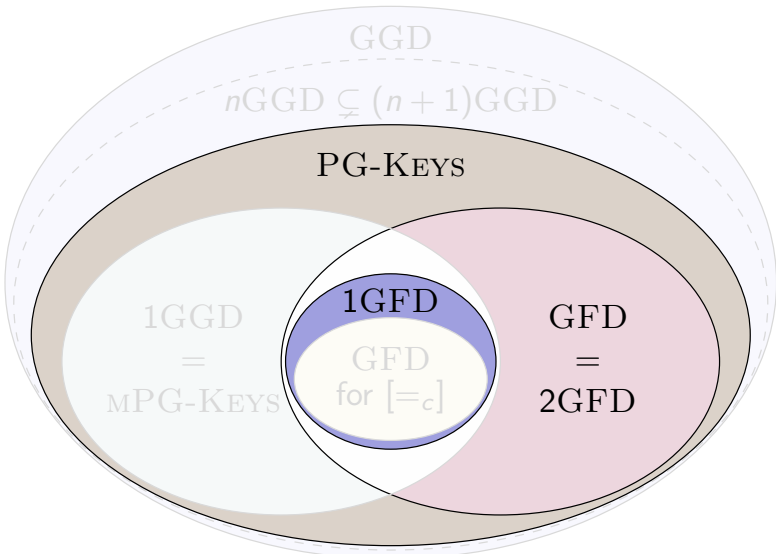

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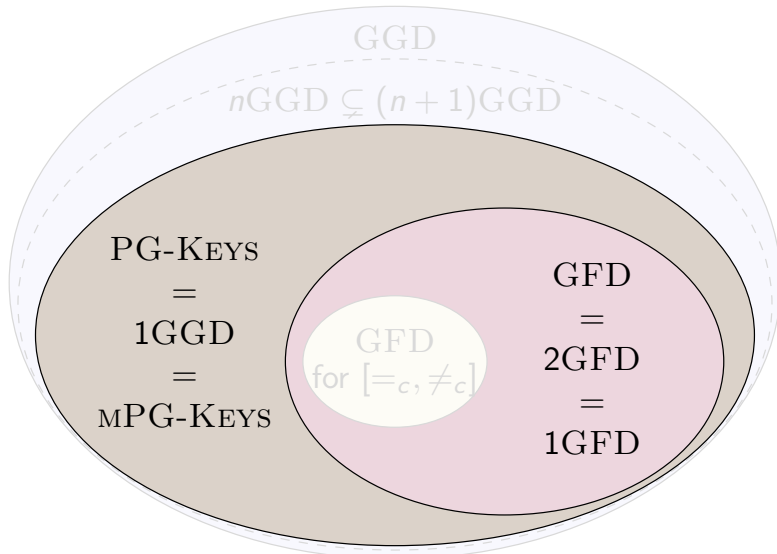

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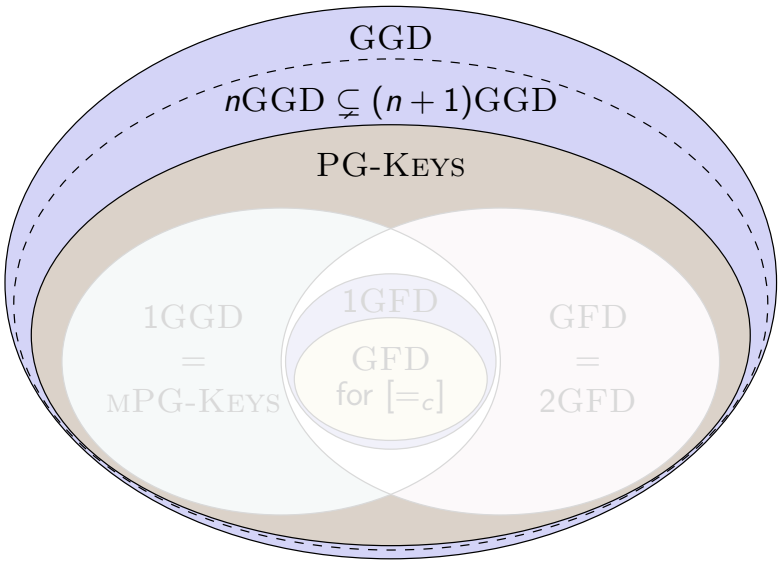

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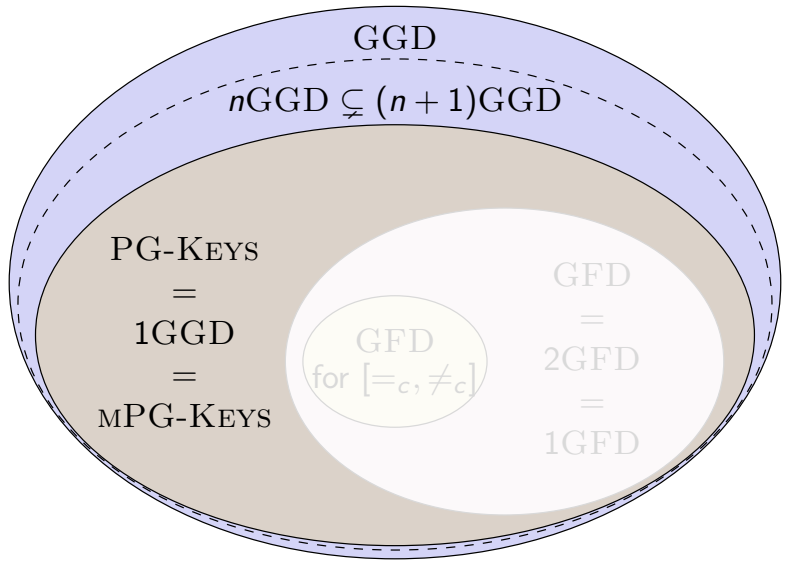

(b) With $=$ and $\neq$

(PG-Keys with $\neq$) $\subseteq$ (mPG-Keys with $\neq$)

FOR x WITHIN $\mathtt{body}(x, \overline{y})$
EXCLUSIVE $(\mathtt{keys})$ WITHIN $\mathtt{head}(x, \overline{z})$

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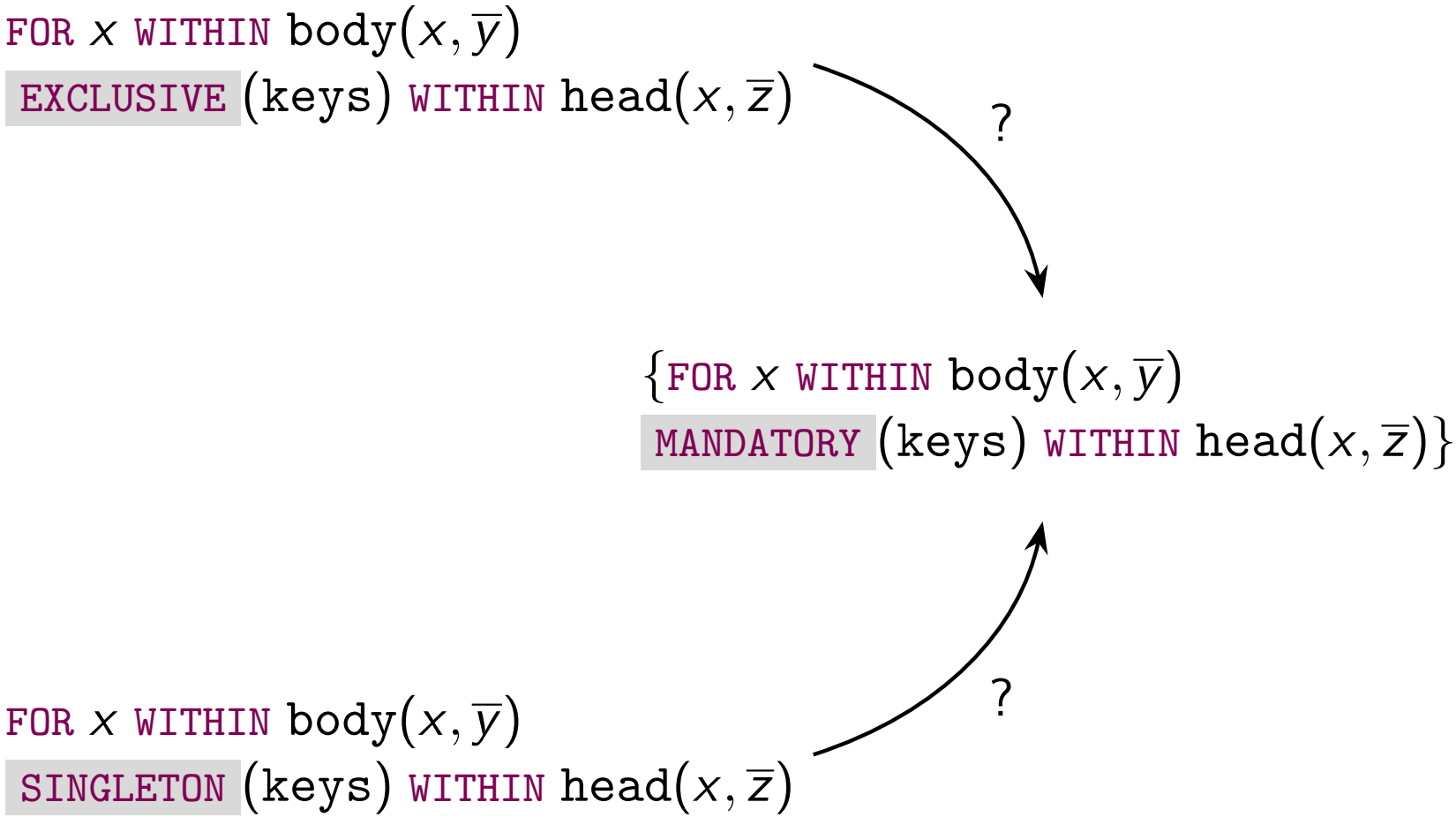

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"If two different values for x share the same keys, we must reject."

FOR x WITHIN $\mathtt{body}(x_1, \overline{y_1}) \wedge \mathtt{head}(x_1, \overline{z_1}) \wedge$
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SINGLETON $\rightarrow$ MANDATORY

FOR x WITHIN $\mathtt{body}(x, \overline{y})$ SINGLETON $(\mathtt{keys})$ WITHIN $\mathtt{head}(x, \overline{z})$

"For a given value of x, if all keys exist and there exists an element of keys that admits two values, we must reject.

FOR x WITHIN $\mathtt{body}(x, \overline{y}) \wedge \mathtt{head}(x, \overline{z_1}) \wedge \mathtt{head}(x, \overline{z_2}) \wedge$
$\mathtt{elt}_1 \neq \mathtt{elt}_2 \wedge \mathtt{exists}(\mathtt{keys}_1, \mathtt{keys}_2)$
MANDATORY (x) WITHIN $x \neq x$

(PG-Keys with $\neq$) $\subseteq$ (mPG-Keys with $\neq$)

SINGLETON $\rightarrow$ MANDATORY

FOR x WITHIN $\mathtt{body}(x, \overline{y})$ SINGLETON $(\mathtt{keys})$ WITHIN $\mathtt{head}(x, \overline{z})$

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One mPG-Key per element of keys

Conclusion

Key Takeaways

- A different landscape depending on tests
- Frontier size matters
- Keywords enable to bypass frontier restrictions

Future work

- Restrict to constraints using connected patterns only
- Study the impact of other RPQ semantics

References

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