Approximation and Semantic tree-width of Conjunctive Regular Path Queries.

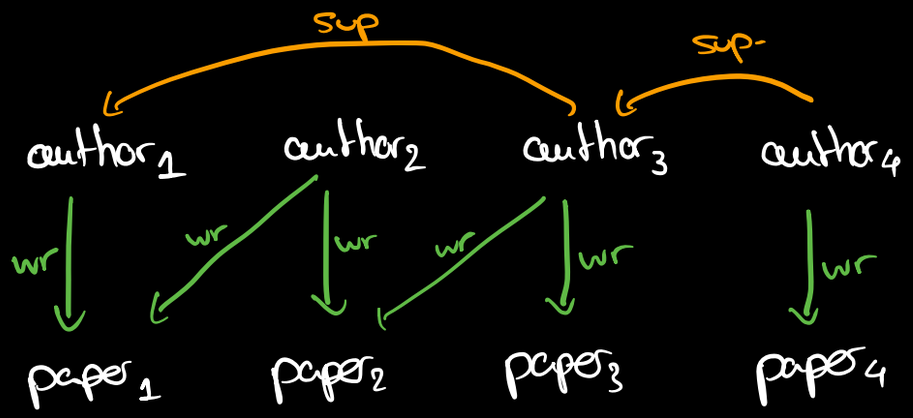
Rémi Morvan

joint work w/
Diego Figueira

7 October 2022

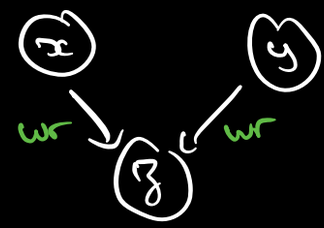
Journée M2F - Bordeaux

Graph databases



Conjunctive queries (CQs)

$$q(x,y) = \exists z.\ x \xrightarrow{wr} z \wedge y \xrightarrow{wr} z$$



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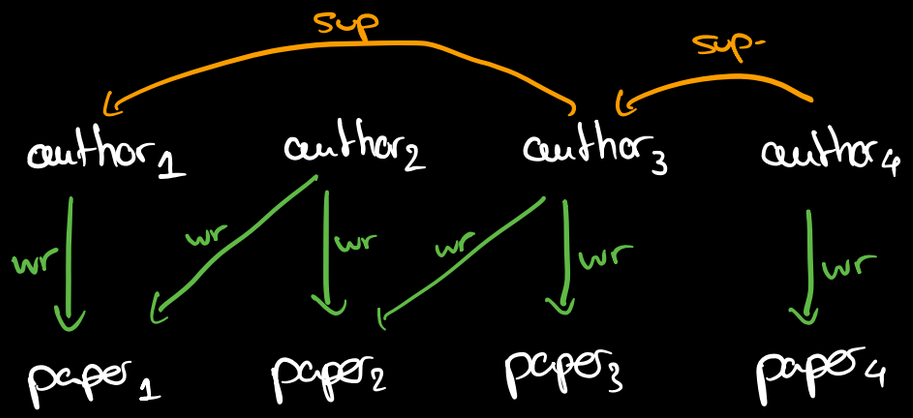

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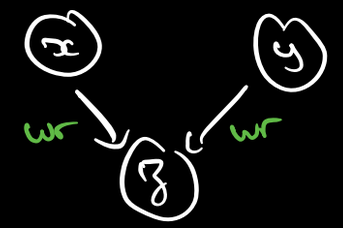
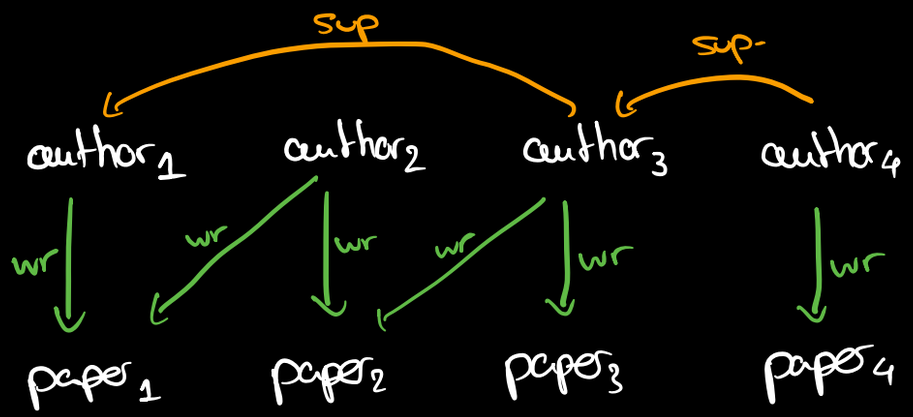


Evaluation:

(author1, author2),
(author1, author1),
etc...

Evaluation of CQs is NP-complete. (Combined complexity)

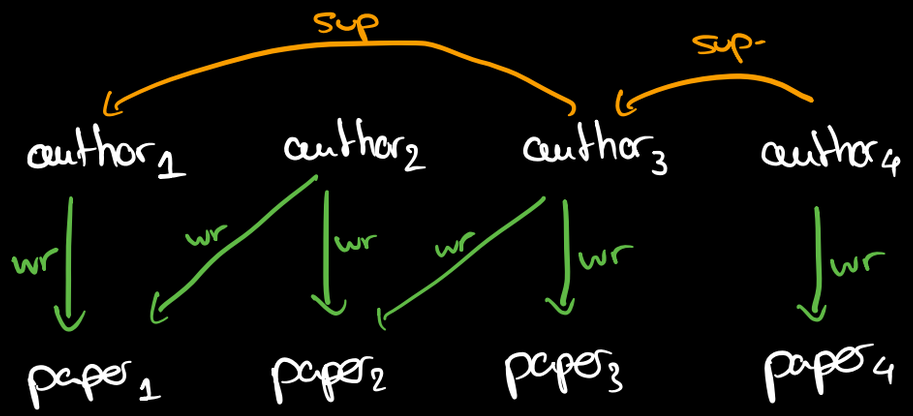
Path queries



Conjunctive regular path queries (CRPQs)

Atoms: $x \xrightarrow{L} y$ ← regular lang. on {wr, sup}

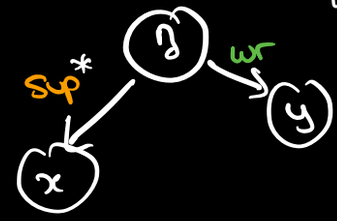
Path queries



Conjunctive regular path queries (CRPQs)

Atoms: $x \xrightarrow{L} y$ ← regular lang. on {wr, sup}

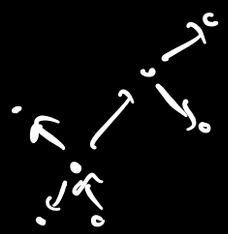
$$\varphi(x,y) = \exists z.\ z \xrightarrow{sup^*} x \wedge z \xrightarrow{wr} y$$



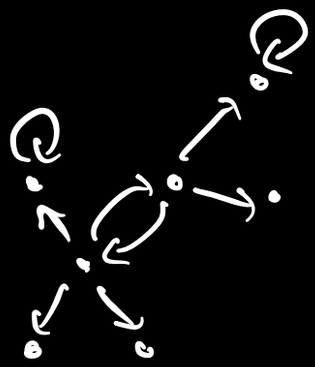
Evaluation:
ex: (author1, paper4)

Prop Evaluation of CRPQs is NP-complete. (Combined complexity)

Tree-width



tw = 1



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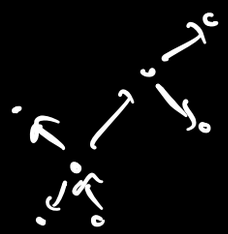
("Maximal") graph of free-width k

$\simeq$

graph obtained by substituting a k-simplex ($= (k+1)$-clique) for each node of a tree

Tree-width



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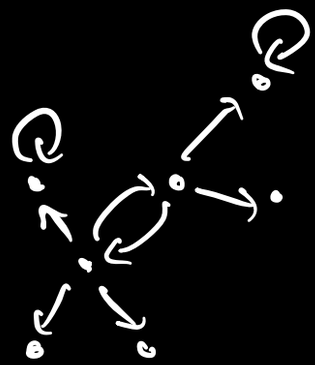

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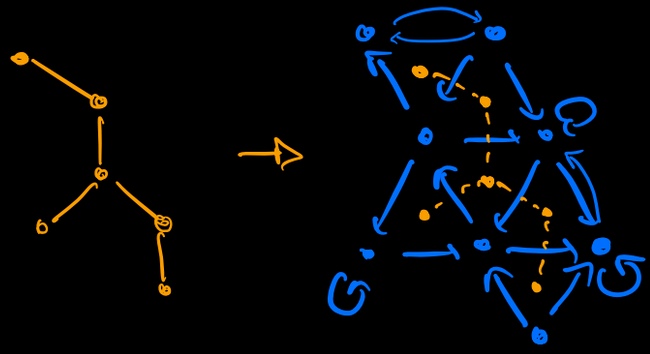
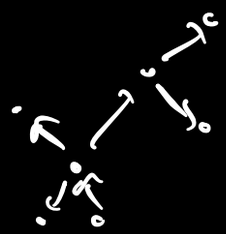


tw = 2

Tree-width



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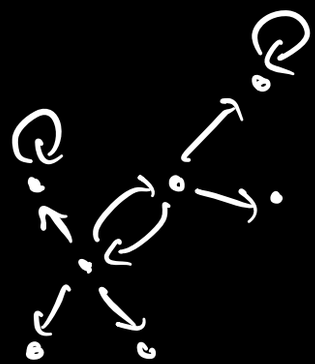

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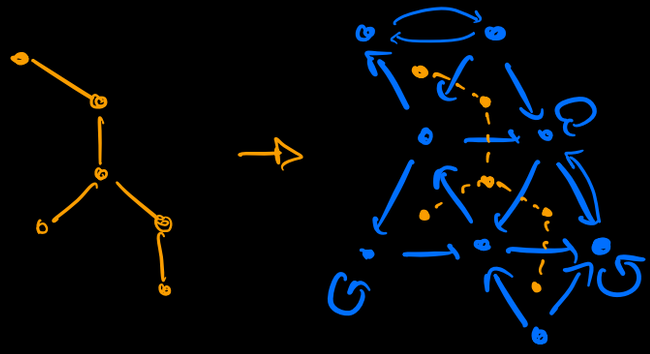

tw = 2

Prop For each $k \geq 1$, evaluation of CRPQs of free-width $\leq k$ is PTIME.

Semantic tree-width

Question

Given a conjunctive regular path query, can we decide if it is semantically equivalent to a union of queries of tree-width $\leq k$?

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Thm [Figueira & M, '22]

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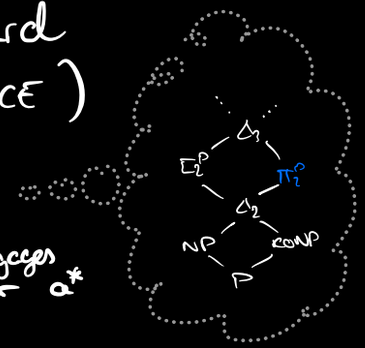
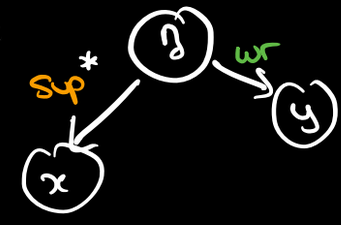
(ExpSpace-hard and 2ExpSpace)

drops to Π_2^P if all regular languages are either a or a^*



ex:



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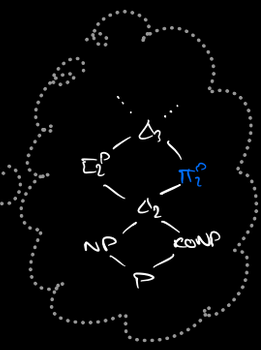
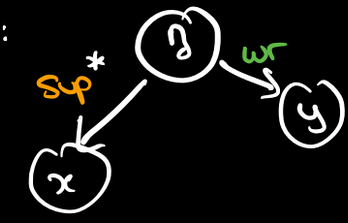


ex:



Technique: Maximal under-approximation by unions of queries of tw $\leq k$. (computable!)

13 December: RATIO seminar!