Exploiting Semantic Treewidth for Graph Queries
Evaluation
FPT approach

Cristina Feier, Tomasz Gogacz, Filip Murlak
University of Warsaw

May 25, 2023
 Conjunctive Regular Path Queries (CRPQs)
Conjunctive Regular Path Queries (CRPQs)
Conjunctive Regular Path Queries (CRPQs)
Syntactic treewidth
Syntactic treewidth
Syntactic treewidth
Syntactic treewidth
Syntactic treewidth
Syntactic treewidth
Syntactic treewidth
Syntactic treewidth
Syntactic treewidth
Semantic treewidth

Easy for CQs (core is the solution)

For CRPQs we can get a UCRPQ
Semantic treewidth

Easy for CQs (core is the solution)
Semantic treewidth

*Easy for CQs (core is the solution)*
Easy for CQs (core is the solution)

*For CRPQs we can get a UCRPQ
Previous work

Theorem (Miguel Romero, Pablo Barcelo, Moshe Y. Vardi)
2-approximation of semantic treewidth is computable. Rewritten query is a UCRPQ of exponential size.

Theorem (Diego Figueira, Rémi Morvan)
Semantic treewidth is computable. Rewritten query is a UCRPQ of doubly exponential size.
Previous work

Theorem (Miguel Romero, Pablo Barcelo, Moshe Y. Vardi)

2-approximation of semantic treewidth is computable. Rewritten query is a UCRPQ of exponential size.
Leads to an evaluation algorithm running in time: $O(2^{|Q|}|D|^{2k+2})$

Theorem (Diego Figueira, Rémi Morvan)

Semantic treewidth is computable. Rewritten query is a UCRPQ of doubly exponential size.
Leads to an evaluation algorithm running in time: $O(2^{2|Q|}|D|^{k+1})$
Previous work

Theorem (Miguel Romero, Pablo Barcelo, Moshe Y. Vardi)

2-approximation of semantic treewidth is computable. Rewritten query is a UCRPQ of exponential size.
Leads to an evaluation algorithm running in time: $O(2^{|Q|}|D|^{2k+2})$

Theorem (Diego Figueira, Rémi Morvan)

Semantic treewidth is computable. Rewritten query is a UCRPQ of doubly exponential size.
Leads to an evaluation algorithm running in time: $O(2^{2^{|Q|}}|D|^{k+1})$

We get the best of both worlds: $O(2^{|Q|}|D|^{k+1})$
Methods

- Consider doubly exponential UCRPQ of Figueira-Morvan
Methods

- Consider doubly exponential UCRPQ of Figueira-Morvan
- Disjuncts there have very similar structure
Methods

- Consider doubly exponential UCRPQ of Figueira-Morvan
- Disjuncts there have very similar structure
- Instead of evaluating them one by one, evaluate them in parallel
Methods

- Consider doubly exponential UCRPQ of Figueira-Morvan
- Disjuncts there have very similar structure
- Instead of evaluating them one by one, evaluate them in parallel
- Dynamic algorithm (Datalog rewriting)
Future work

- Complexity of computing the semantic treewidth
  - ExpSpace-hard (even for $k = 1$)
  - In 2EXPSpace (cost of containment of doubly exponential query)

- Parametrized lower bounds:
  **Conjecture.** *There exists an FPT evaluation algorithm for a class $C$ of CRPQs iff $C$ has bounded semantic treewidth.*