Order-Preserving DAG Grammars: Parsing, Complexity and Learning

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Motivation: Semantic graphs

One type of semantic graphs: Abstract Meaning Representations

AMR for "the boy thinks that the girl likes him"
Abstract Meaning Representations

Properties of AMRs:
- Directed and acyclic
- Reentrancies (not trees)
- Any number of modifiers (i.e. no fixed rank)
- No formalized grammar
Long term goals

Parallel parsing of natural language sentences, building both syntax trees and semantic graphs.
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Transformation of semantic graphs into natural language sentences.
Hyperedge replacement grammars
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A → B

C → a
Uniform vs. non-uniform parsing

For database theoreticians: Think data complexity vs. combined complexity

For verification people: Think model complexity vs. combined complexity
Uniform vs. non-uniform parsing

For database theoreticians: Think data complexity vs. combined complexity

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Consider a grammar where we only have rules of the following forms:

\[
A \rightarrow a \\
A \rightarrow B \quad C
\]
Order-preserving DAG grammars

Graph parsing is hard.
Order-preserving DAG grammars

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To achieve uniform polynomial parsing, we need to heavily restrict the right-hand sides.
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To achieve uniform polynomial parsing, we need to heavily restrict the right-hand sides.
We develop an algorithm for learning OPDGs from a **Minimally Adequate Teacher** (Angluin).

The teacher can answer

- **equivalence queries** (Is this the correct grammar?)
- **membership queries** (Does this graph belong to the language of the grammar?)
Concatenation
A Myhill-Nerode theorem

**Theorem.** A DAG language $L$ can be generated by an OPDG if and only if $\equiv_L$ has finite index. If $\equiv_L$ has finite index, there is a unique minimal unambiguous OPDG for $L$. 
**Theorem.** An OPDG $G$ can be learned from a MAT in time polynomial in $|G|$ and the combined sizes of the counterexamples provided by the teacher.
The end

Thank you for listening!