Provenance Analysis for First-Order Model Checking

Model-checking for first-order logic is the computational problem
of deciding whether a given finite structure is a model of
a given first-order sentence. Its provenance analysis determine
how that answer depends on the atomic facts that determine the structure.
Provenance questions like this one have emerged in databases, scientific
workflows, networks, formal verification, and other areas.

We extend the semiring provenance framework to the the first-order model
checking problem.
This provides a non-standard semantics for first-order logic that refines logical
truth to values in commutative semirings: a semiring of provenance
polynomials, the Viterbi semiring of confidence scores, access control
semirings, etc. The semantics can be used to synthesize models based on
criteria like maximum confidence or public access. Our uniform treatment of
logical negation can be used to explain absent answers for queries, and
failures of integrity constraints, as well to compute corresponding "repairs" to
a model to fix these issues.

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The work on repairs is also joint with Abdu Alawini, Jane Xu, and Waley
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