Deduction and Analysis in the Presence of Uncertainty, Contradictions and Distribution

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I will describe our ongoing research on datalog-style deduction, in the presence of uncertainty, Functional Dependency constraints that capture contradictions, and a distributed setting .

We start with a simple semantics for datalog in the presence of functional dependencies that is based on inferring facts one at a time, never violating the FDs, until no further facts can be added. This is a non-deterministic semantics, which may lead to several possible worlds. We present a proof theory for this semantics and compare it to previous work on datalog with negation. We also discuss a set-at-a-time semantics, where in each iteration, all facts that can be inferred are added to the database, and then choices are made between contradicting facts. We then proceed to defining semantics for the distributed setting. Note that contradictions naturally arise in a distributed setting since different peers may have conflicting information, opinions or recommendations. In the distributed case, we propose and study a concrete semantics for (an important fragment of) Webdamlog, that we enrich to account for FDs. Here again, we compare the semantics with previously studied semantics and in particular Webdamlog with negation in the absence of FDs .

Then, we note that in a distributed environment, it is natural to settle contradictions by introducing probabilities. We consider a simple adaptation of the distributed semantics to a probabilistic setting and show that it captures an intuitive way of resolving contradictions. We propose a sampling algorithm for evaluating queries under this semantics.

Finally, based on our probabilistic model and proof theory, we introduce the problem of identifying the top-k most likely proofs that have led to the derivation of a given fact. We show the usefulness of such an analysis in both the centralized and distributed settings, and study its complexity.

Joint work (in progress) with Serge Abiteboul and Meghyn Bienvenu