Open Problems in Consistent Query Answering
Open Problems in Database Theory, ICDT 2017

Benny Kimelfeld  Paris Koutris
Inconsistent database: database $D$, violates set $\Sigma$ of constraints

Database Repairs [ABC99]
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Repair of $D$: database $D'$ that
- satisfies $\Sigma$
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  - *(minimal w.r.t. set inclusion)*
Database Repairs [ABC99]

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- **Repair** of $D$: database $D'$ that
  - satisfies $\Sigma$
  - obtained from $D$ via a *minimal* set of tuple deletions/additions
    - (minimal w.r.t. set inclusion)

- **Special case**: $\Sigma$ is a set of *primary-key constraints*
  - Then, a repair selects one tuple for each key value
Consistent Query Answering (CQA)

Let $\Sigma$ be a finite set of constraints, and $Q$ a boolean query. **CQA** is the following decision problem:

Given an inconsistent $D$, is $Q(D')$ true for every repair $D'$?
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- **Dichotomy** for such classes of $\Sigma$ and $Q$ refers to the conjecture that for every $\Sigma$ and $Q$, CQA is either in PTime or coNP-complete
  - Ideally, we would also like to have an algorithm that determines the complexity of CQA for given $\Sigma$ and $Q$
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  - Ideally, we would also like to have an algorithm that determines the complexity of CQA for given $\Sigma$ and $Q$
- **FO rewritability**: Can CQA for $Q$ and $\Sigma$ be expressed as an ordinary query $Q'$ in FO (hence, PTime)?
History on CQA Research for Primary-Key Constraints

- **2005**: First attempt to establish a dichotomy for *acyclic simple CQs* [FM05]
  - *simple* = no self joins

- **2010**: Characterization of FO rewritability for *acyclic simple CQs* [Wij10]

- **2012**: Dichotomy (PTime vs coNP-complete) for simple CQs with two atoms [KP12]

- **2014**: Dichotomy for simple CQs over binary relations [KS14]

- **2015**: Dichotomy for all simple CQs [KW15]
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CSP vs. CQA

- The *Constraint Satisfaction Problem* (CSP) dichotomy conjecture: Every CSP instance (set of allowed constraints) is either in PTime or NP-complete.
- Posed by Feder and Vardi in 1993 [FV93], generalizes Schaefer’s 1978 dichotomy theorem [Sch78].
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**Theorem [Fon13]**

Dichotomy for CQA with GAV constraints and UCQs

⇒ Dichotomy for CSP
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**Theorem [Fon13]**

- Dichotomy for CQA with GAV constraints and UCQs
  \[ \implies \text{Dichotomy for CSP} \]

- Twist: recent claims that CSP conjecture has been **proved valid** [RKF17]
  - Does it imply CQA dichotomy? Unknown [Fon13]
Counting Repairs

Let $\Sigma$ be a finite set of constraints.

- how many repairs does $D$ have?
- how many repairs of $D$ satisfy a query $Q$?
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Closely connected to query evaluation over BID probabilistic databases:

- set the probability of a tuple in a block of size $k$ to $1/k$
- **difference**: in BIDs, tuples in the same block (a) can have non-uniform probabilities (b) their probabilities may not sum to 1
Counting Repairs: Dichotomies

**Dichotomy** here refers to that *for every* $\Sigma$ *and* $Q$, *counting is either in PTime (FP) or \#P-complete*

**Known:**
- a dichotomy for counting the number of repairs for FDs [LK17]
- a dichotomy for counting repairs that satisfy CQs with primary keys [MW14]
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**Unknown:** Everything else: e.g., CQs and FDs
Questions?
References


References II


References
