Lifting Queries for Lifted Inference
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**Lifted Inference**

Model $G$: $P_G = \frac{1}{Z} \prod_{f \in gr(G)} f$ (grounding semantics$^2$)

\[ \text{AttendsConfOnAI}(X) \rightarrow g_1 \rightarrow \text{DoesResearchInAI}(X) \]

- Query answering: Lifted variable elimination (LVE)$^1$
  - Query for probability distributions, e.g., $P(\text{AttendsConfOnAI(eve)})$
  - Shattering: Split off constants occurring in query, e.g., $\text{eve}$
  - Elimination: $\sum$ over range values of random variables not in query
  - Lifting: Eliminate once and account for interchangeable instances

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$^1$Poole (2003); de Salvo Braz et al. (2005); Milch et al. (2008); Apsel and Brafman (2011); Taghipour et al. (2013)

$^2$Sato (1995); Fuhr (1995)
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\[ P(A(alice), A(eve), A(bob)) \]

Problem: Grounding Queries

- Large query size
  - Interchangeable query terms
- Inefficiencies in query answering
  - Identical computations, large intermediate results
- Large result representation
  - Exponential in number of query terms

A = AttendsConfOnAI
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\[ P(A(\text{alice}), A(\text{eve}), A(\text{bob})) \]

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**Solution: Lifted Queries**

- Compact query representation
  - Using logical variables
- Lifted query answering with LVE
  - Exploiting count conversions from LVE
- Compact result representation
  - Using counting random variables (polynomial in size)

\[ P(A(X'))_{X' \in \{\text{alice, eve, bob}\}} \]

\[ A = \text{AttendsConfOnAI} \]