Computing Inferences for Credal $\mathcal{ALC}$ Terminologies

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Quick overview

- Goal: to build a package that performs inferences in terminologies that combine probabilities with $ALC$-style constructs.
- Language is called Credal $ALC$ (Cr$ALC$).
- Short paper reports on initial development (mostly by first author).
- Current effort: to implement lifted inference algorithms (mostly by third author).
Cr\textit{ALC} - Example

- Individuals, concepts, roles.
- \textit{Extends} \textit{ALC} constructors with \textit{probabilistic inclusions}
  - \(P(C/D)=\alpha\), interpreted as: for every element \(x\) of domain, \(P(C(x)/D(x))=\alpha\).
  - \(P(r)=\beta\), interpreted as: for every pair \((x,y)\) of elements of the domain, \(P(r(x,y))=\beta\).
- Acyclic terminology

\[
\begin{align*}
B \subseteq A \\
C \subseteq B \cup \exists r. D \\
P(A)=0.9, \\
P(B|A)=0.4 \\
P(C | B \cup \exists r. D)=0.6 \\
P(D|\forall r. A)=0.3
\end{align*}
\]
The challenge is to compute the probability of an assertion, conditional on other assertions.

\[ P(D(a)|B(b)) = ? \]

One solution: generate propositional Bayesian network, solve it.
Inference in CrALC - Example

- **Domain**={a,b}

- Markov condition guarantees interpretation as relational Bayesian network.
- $P(D(a)|B(b)) = 0.232$
CrALC - Inference

- The challenge is to compute the probability of an assertion, conditional on other assertions.
  \[ P(D(a)|B(b)) = ? \]
  - One solution: generate propositional Bayesian network, solve it.
    - too hard...
  - Another solution: variational approximation method by Polastro.
    - approximate, and still not very easy....
  - Yet another solution: lifted inference (under implementation...).

- But the problem is that there is no available package to easily run these algorithms.
A Package

- Adopts specification by enhanced KRSS (Knowledge Representation System Specification).
- Preliminary (free) implementation with variational inference.
- Lifted inference is next step.

http://sites.poli.usp.br/pmr/ltd/Software/CRALC/index.html
Questions?