Reintroducing Credal Networks under Epistemic Irrelevance

Jasper De Bock

Ghent University
Belgium
Jasper De Bock

Ghent University
Belgium
Jasper De Bock
IPG group of IDSIA
Switzerland
Bayesian network

\[ P(x_G) = \prod_{s \in G} P(x_s \mid x_{\Pi(s)}) \]

\[ P(X_s \mid x_{\Pi(s)}) = P(X_s \mid x_{\Pi N(s)}) \]

extreme sensitivity analysis?
Bayesian network

\[ P(x_G) = \prod_{s \in G} P(x_s \mid x_{\Pi(s)}) \]

**Extreme sensitivity analysis?**
Credal network...

\[
P(X_s \mid x_{\Pi(s)}) \cap M_s | x_{\Pi(s)} = \text{ ???}
\]
Credal network...

\[ P(x_G) = \prod_{s \in G} P(x_s \mid x_{\Pi(s)}) \]

...under complete independence
Credal network...

$$P(x_G) = \prod_{s \in G} P(x_s \mid x_{\Pi(s)})$$

...under complete independence
Credal network...

...under epistemic irrelevance
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Cozman 2000

Cozman 1998

de Campos & Cozman 2007
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Abstract

This paper presents a complete theory of credal networks, which are graphical models of inference with imprecise probabilities. The main contributions are: (1) a unifying theory that combines the concepts of epistemic irrelevance and epistemic independence; (2) characterization results that connect these concepts to the notion of d-separation; (3) efficient algorithms for computing lower and upper expectations under epistemic independence; (4) novel results for natural extensions, and (5) linear fractional programming methods for computing lower and upper expectations. The paper also investigates credal networks that are defined globally or locally. Two types of extensions are presented: (1) a linear fractional programming approach for computing lower and upper expectations, and (2) an algebraic approach that generalizes the concept of d-separation.

Keywords: Credal networks; Epistemic irrelevance; Epistemic independence; D-separation; Convex sets of probability measures; Bayesian networks; Lower and upper expectations; Linear fractional programming.
Before
PGM 2016
Lugano

Reintroducing Credal Networks under Epistemic Irrelevance

de Cooman, Hermans, Antonucci & Zaffalon 2010

Benavoli, Zaffalon & Miranda 2011

De Bock & de Cooman 2015

De Bock & de Cooman 2014

De Bock 2015

\[ P(x_G) = \prod_{s \in G} P(x_s | x_{\Pi(s)}) \]

AD-separation

efficient computations
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Graphoid properties

Probability zero?
- full conditional probabilities
- epistemic h-irrelevance

Strong independence?

AD-separation

Efficient computations

In terms of probabilities!

More details + algorithms?

De Bock 2015