Argument Analysis Using Bayesian Networks

Kevin B. Korb and Erik Nyberg
Clayton School of IT
Monash University

kbkorb@gmail.com
Argument Analysis
Seven Step Program

Michael Scriven in *Reasoning* (1980):

1. Clarify meanings
2. Identify premises and conclusions
3. Graph the argument structure
4. Make it valid: counterexample, find missing premises
5. Counterargue: criticize premises
6. Introduce alternative arguments
7. Evaluate
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In the meantime, argument mapping software has become popular and is reasonably effective. E.g., Tim van Gelder’s Rationale (http://rationale.austhink.com):
Argument Mapping Problems

- All relations are qualitative
  - Qualitative relations can be represented quantitatively, but not vice versa
  - In particular, there is no concept of “strength of belief”, imposing cognitive load on the user

- No possibility of representing interaction effects. E.g., consider a defective car:
  - You can get away with faulty electrics (e.g., some sparks flying)
  - You can get away with a leaky fuel line
  - You can’t get away with both!
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Recently, Peter Sturrock has championed Naive Bayes models in his “scientific approach to reasoning” (see http://aka-shakespeare.com):
A Naive Bayes Approach

Some problems:

- Dependencies between evidence items go missing
- These are multiplied by virtual duplications of evidence
- Result: Sturrock endorses estimates that Shakespeare was from Stratford from about $10^{-15}$ to $10^{-21}$ . . .

⇒ Neil Thomason: “If you chose a random human at the time, she or he’d be more far likely to be the author than the guy from Stratford!!”
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A Naive Bayes Approach

Inspired by Sturrock’s work, Tim van Gelder is working on a GUI for interactive argument analysis. Here’s screenshot from his prototype:
A Bayesian Net Approach

Advantages

- Can represent degrees of argument strength
- Provides graphical representation for: premises, missing premises, conclusions
- Supports interactions, dependencies
- BN tools allow for sensitivity analysis, hypothetical reasoning
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We propose using Bayesian nets to model arguments, instead. Here’s a possible model of the breast cancer argument:
A Bayesian Net Approach

The argument from background only runs against cancer:
The argument from positive self-examination also runs against cancer:
A Bayesian Net Approach

To get an argument for cancer, we have to go all the way:
A Bayesian Net Approach

Disadvantages

- Many people are allergic to numbers
  - The point isn’t to find exact numbers, but numbers that convey appropriate strengths. Use sensitivity analysis to find reasonable ranges.

- Nodes need to express simple propositions. Avoid internal quantifiers, probability qualifiers.
  - “Abbott will lose the next election”
  - Not: “Abbott will likely lose the next election”

- Dense networks lead to parameter explosion. KISS.

- Best starting point likely to be a causal model. The best argument may look different.
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To suppress many of the complexities, we propose adapting the van Gelder’s GUI. Instead of a one-size fits all GUI (possible with naive Bayes), we can tailor GUIs to arguments and decision problems.
BayesianWatch  https://bayesianwatch.wordpress.com/