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Representing Confidence in Assurance Case Evidence

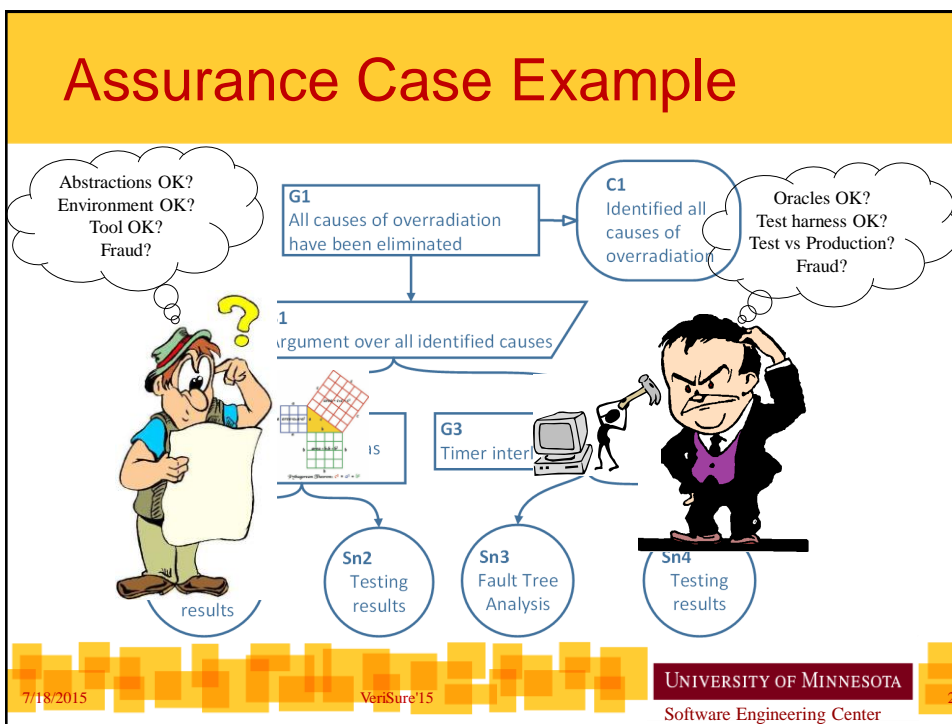
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PRECISE



Confidence

- Need to have confidence in the claims made in the assurance case
 - Does not matter what approach to the case we take
- Approving a system is ***always*** a judgement call
- Can model it qualitatively or quantitatively
 - Qualitatively:
 - Separate confidence case, acceptance criteria, ...
 - Quantitatively:
 - Use a single number, a range, or a distribution



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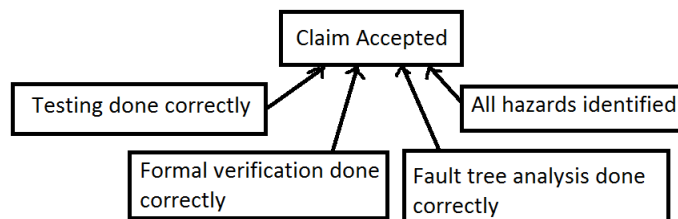
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Previous Work: Bayesian Networks

- Evidence nodes (quantitative information)
- Links (qualitative information)



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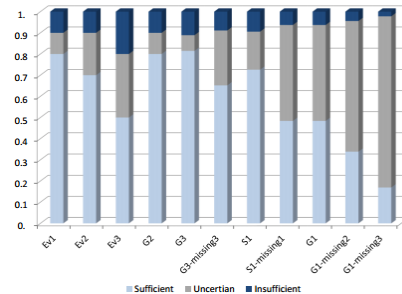
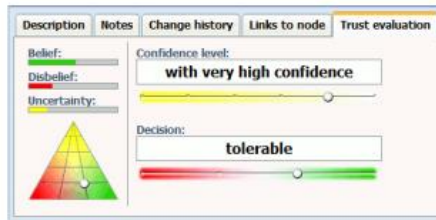
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Previous work: Dempster-Shafer Theory

- Separate out uncertainty
- Belief, Disbelief, Uncertainty



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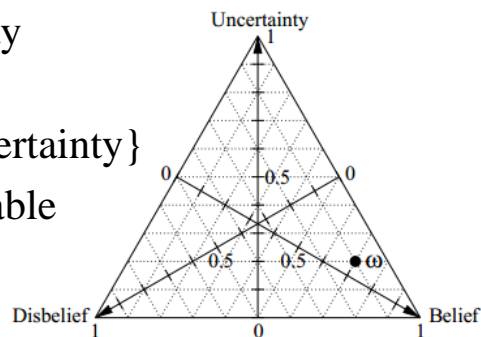
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Jøsang's Opinion Triangle

- Standard logic: bottom part (disbelief to belief) of triangle
- Top vertex: uncertainty
- An opinion is {belief, disbelief, uncertainty}
- Base rate: fourth variable (prior belief)



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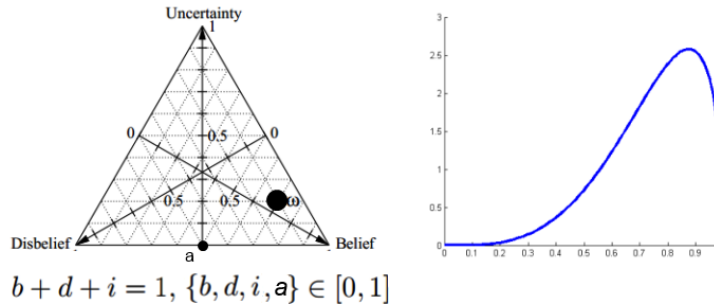
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Our Proposal

- Use the beta distribution to represent confidence
- Mapping to Jøsang's opinion triangle



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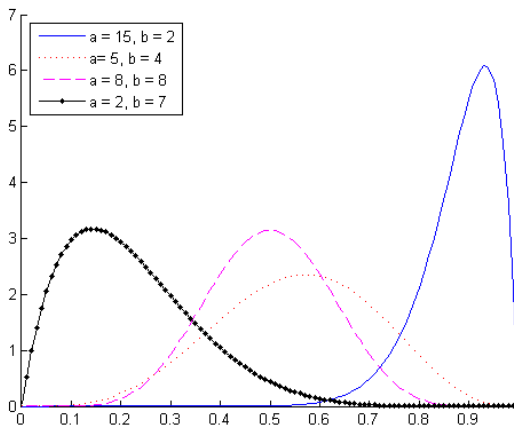
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Beta Distribution

- Continuous version of binomial distribution
- Finite range
- Versatile
- 2nd order distribution: probability of probabilities



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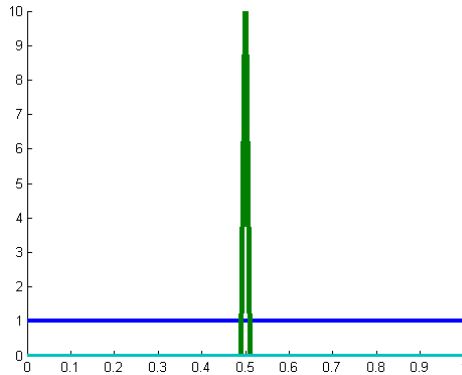
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Uncertainty vs. Split Opinion

- $\{0.0, 0.0, 1.0\}$ – Full uncertainty
- $\{0.5, 0.5, 0.0\}$ – Split opinion



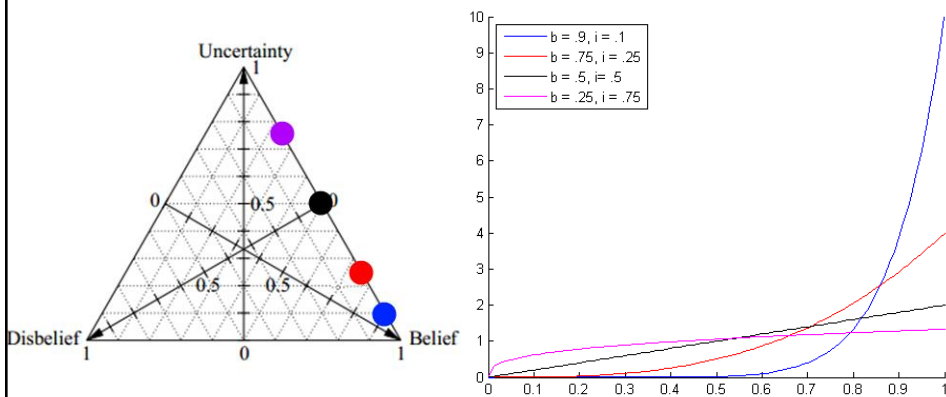
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More Beta/Opinion Triangle:

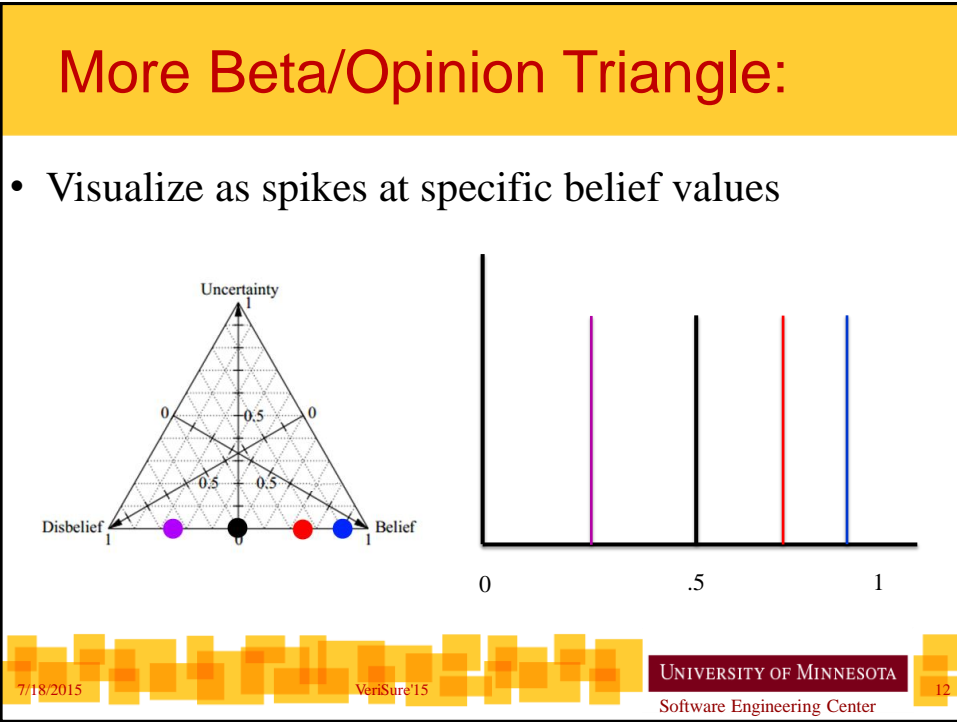
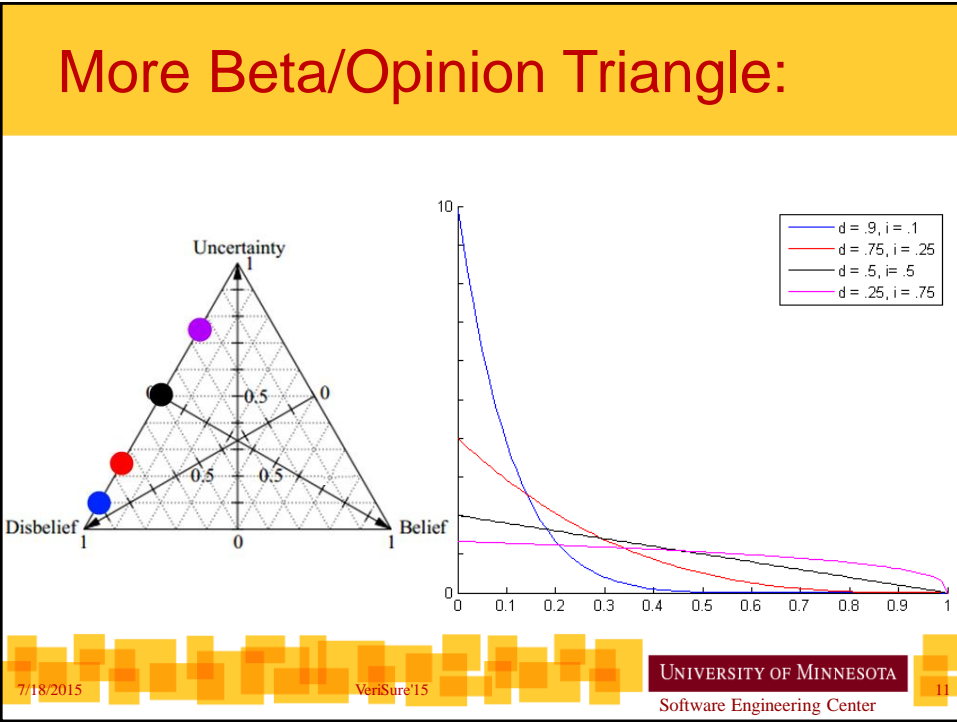


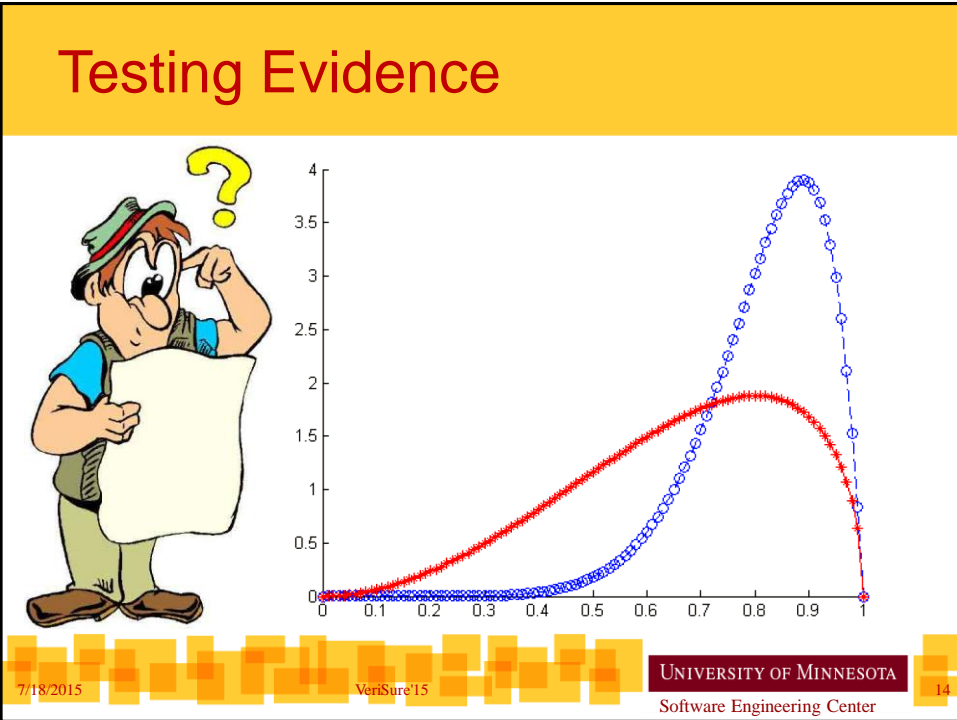
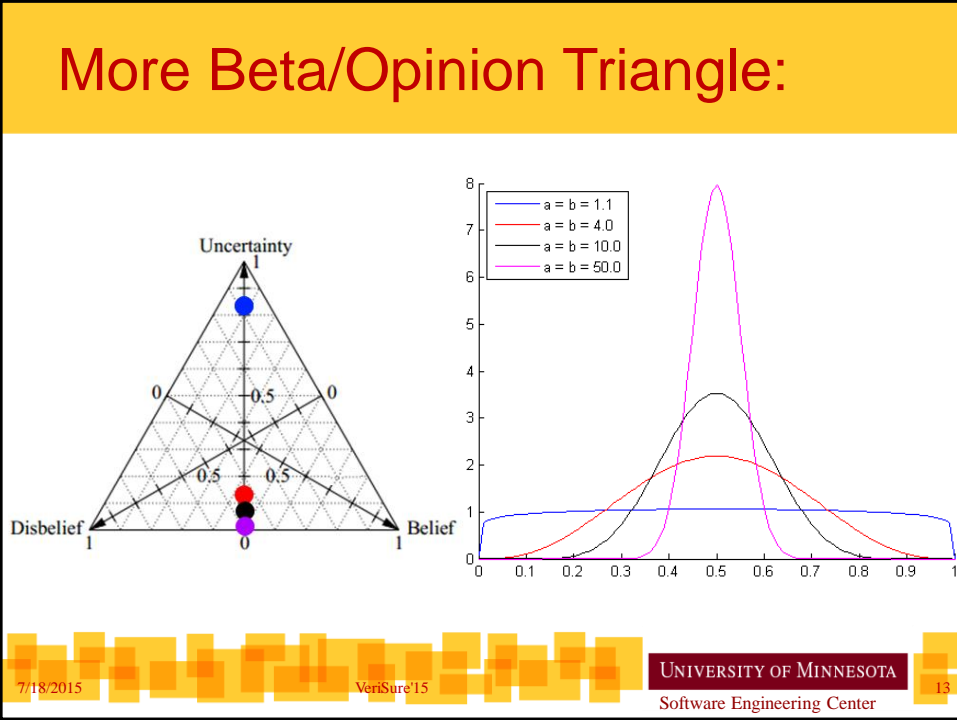
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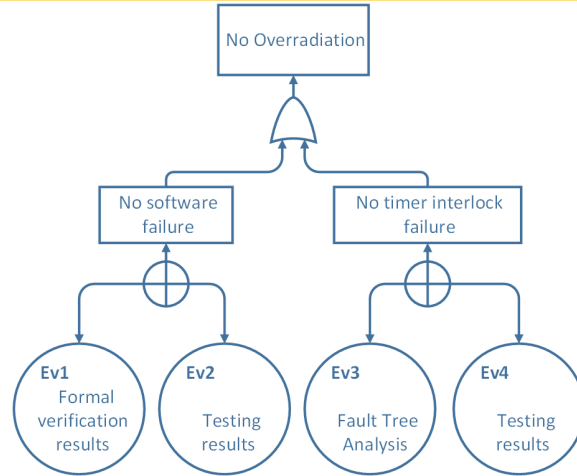
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Logical Argument Example



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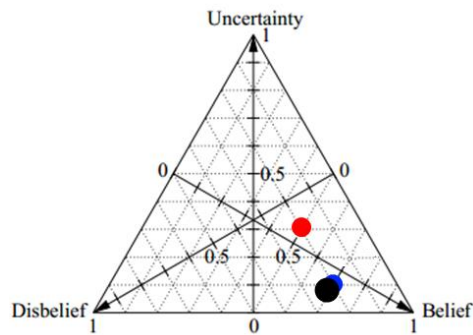
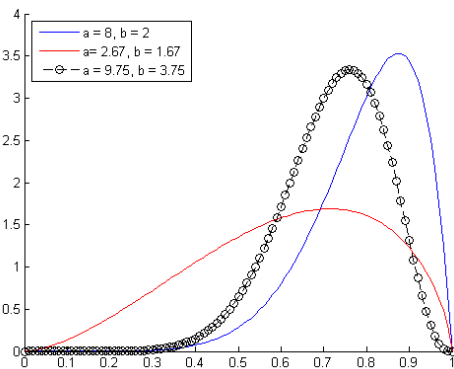
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Software Node: $Ev1 \oplus Ev2$

- Consensus operator:

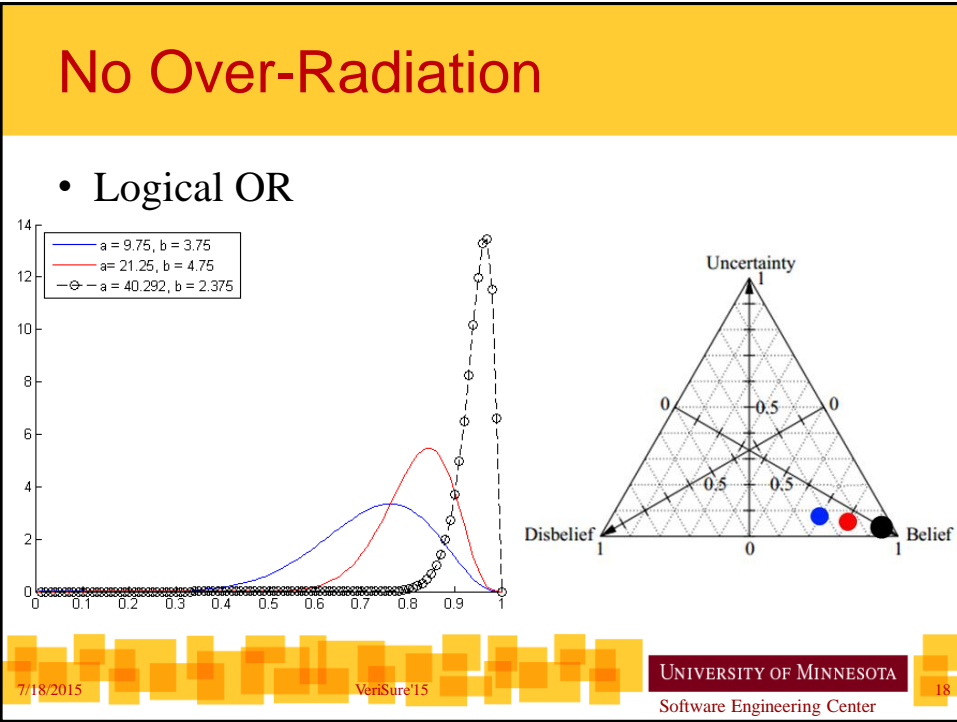
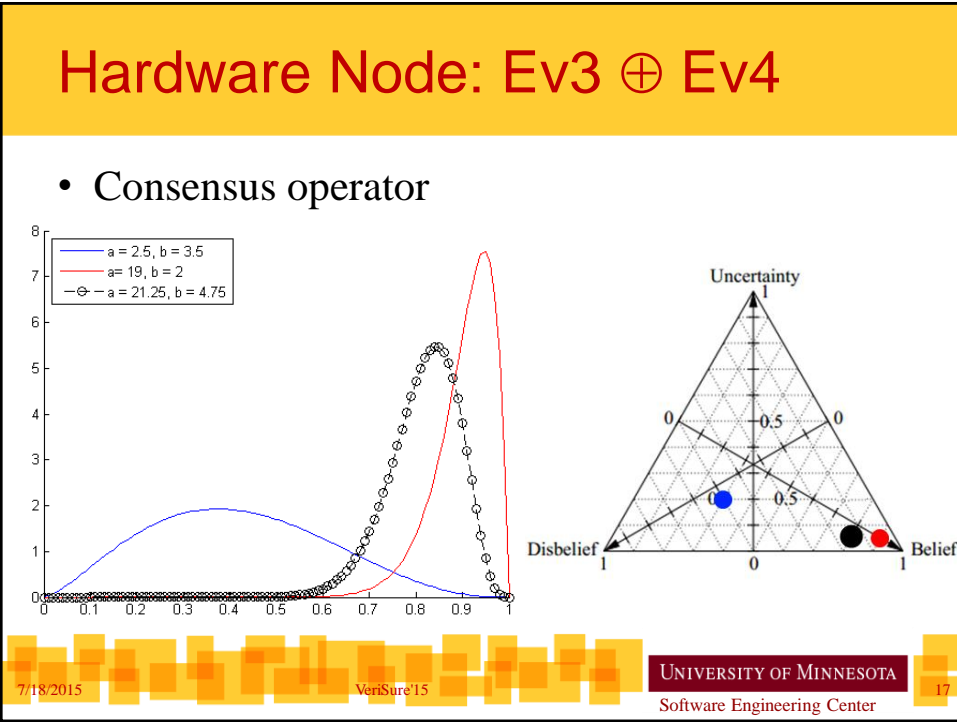


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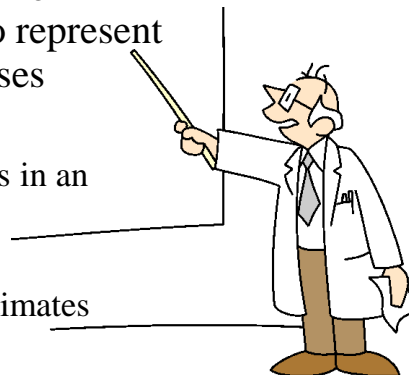
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Work in Progress

- Propose the use of the Beta distribution, and its duality with the opinion triangle/subjective logic, to represent confidence in assurance cases
- **Work in progress**
 - Combination of distributions in an assurance case
 - Weighing evidence
 - Elicitation of confidence estimates
 - Sensitivity analysis



Summary

Assurance Case Example



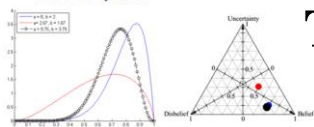
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Software Node: Ev1 @ Ev2

Consensus operator:



Work in Progress

- Propose the use of the Beta distribution, with its duality with the opinion triangle/subjective logic, to represent confidence in assurance cases
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 - Combination of distributions in an assurance case
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Thank You

Summary

Assurance Case Example

Previous work:
Dempster-Shafer Theory

- Separate out uncertainty

Questions:

- Should we quantify confidence/trust?
- Can we elicit belief in any reliable manner?
- Is Beta the answer?
- Can we have “belief templates” for various types of evidence?
- Will this ever be better than educated guesses?

Software

- Consensus

Thank You

Triangle: subjective logic, to represent confidence in assurance cases

Work in progress

- Combination of distributions in an assurance case
- Elicitation of confidence estimates
- Sensitivity analysis



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