

Selected Topics in Communication and Action

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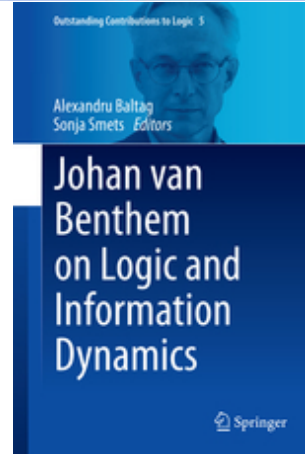
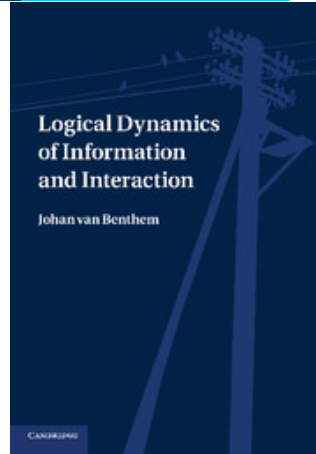
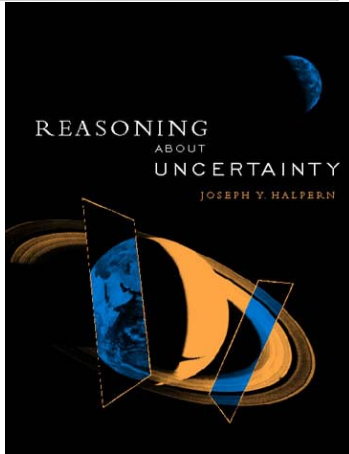
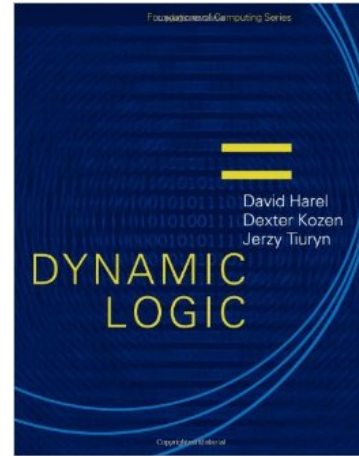
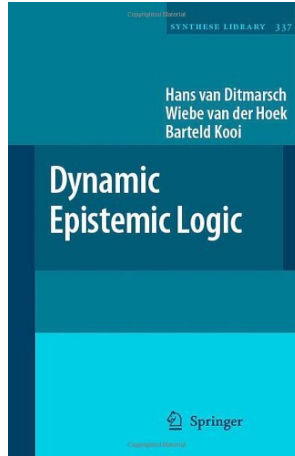
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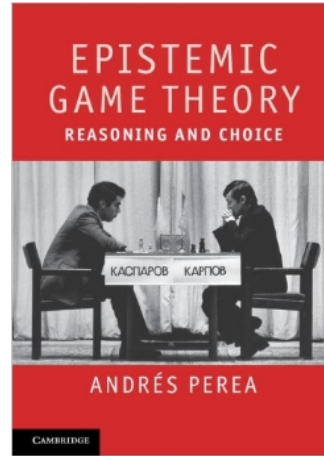
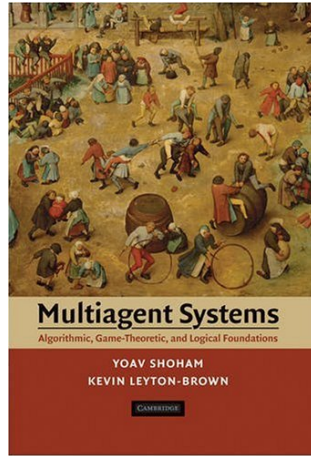
Abstract

The talk provides a taste of what is to be covered in our textbook "Reasoning about Communication and Action" (a joint enterprise, in progress, with Alexandru Baltag, Johan van Benthem and Sonja Smets) [[BvBvES14](#)].

Overview

- Position of the textbook, intended audience
- Open issues about how to structure the text
- Some samples from the existing draft
- Establishment of reading/support group





New Textbook Enterprise: Reasoning about Communication and Action

“The book is geared to graduate students in logic, artificial intelligence, computer science and (formal) philosophy. It does not assume computational skills, but it will offer training in (functional) programming as part of the course.” [BvBvES14]

Preliminary set-up:

- Statics
- Dynamics
- Applications
- Computational Aspects

Where we seem to agree

- Audience: addressed to students and researchers with a formal background: mostly in Computer Science and Logic, but also Mathematics, possibly also Game Theory. Philosophers: only if they are willing to enter through the gate of Plato's Academy (“ageometretos medeis eisito”).
- Structure: needs to reflect our various perspectives in a balanced way.
- Structure: follow a progressive development, from simple to complex.
- Distinguish between monotonic and non-monotonic DEL. Maybe also: probabilistic DEL, preferential DEL, temporal DEL.

Where we can agree to disagree

- Alexandru: “The problem starts when trying to formally connect the probability and (qualitative) beliefs, in ways that go beyond mere analogy: this is when things stop being clear and canonical, and when controversial choices need to be made. Finding the formal connections between belief and probabilities is still an ongoing effort, and there are several influential lines of thought and no canonical option, thus large potential for disagreement.”

- Johan: “As for adding probability, I should emphasize that I am in favor of this! I just wanted to point out the risk of seeing DEL’s main novel contribution drown in such a powerful entrenched paradigm, and another consideration is this: a textbook should not take tentative recent views of the authors in a fast-changing area, but represent perspectives that have stood the test of time in a way that is neutral between major controversies. Otherwise we run the risk of being obsolete very fast.”
- Johan: “Do we really want to take the line that validating the AGM postulates, and using Grove models, is our guiding criterion – rather than taking the more general stance that we are offering a dynamic perspective on a much broader area where roughly similar ideas have played for a long time: belief revision theory, conditional logic, default logic?”

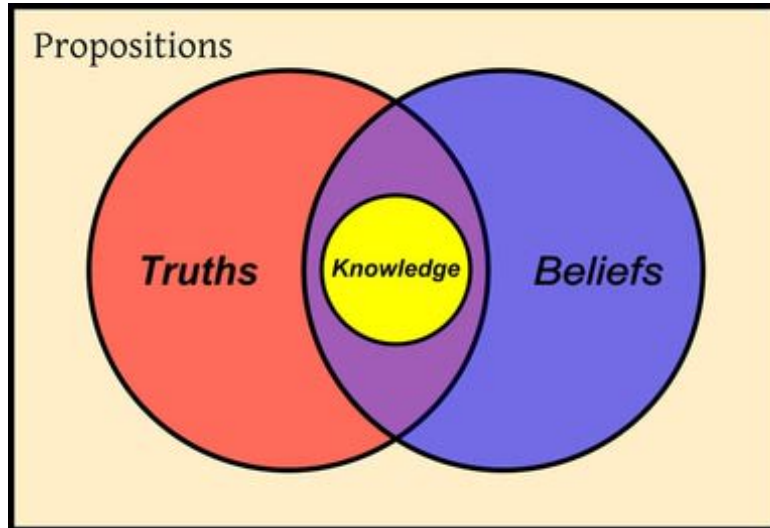
- My conclusion: We will work on the formal connections between belief and probabilities anyway, and we can decide later about what should end up in the textbook. And we can and should look at AGM style belief revision from the perspective of DEL, and not vice-versa.

How to Arrange?

- By function: see above.
- By structure: simplest structures first.
- Mix: first give a mini-treatment of the whole DEL picture in a simplified setting, next proceed by structure.
- Sonja: “It might be a good idea to split the material up in smaller chapters (about the size of chapters that Jan has indicated in his draft, looking at Ch2 now). Concretely this comes down to covering the 'statics' and the 'dynamics' separately in different chapters. We can then still decide on the order we put on this.”

- Sonja: “In addition to the statics/dynamics distinction, we can also add a third component which are the 'computational aspects' for every theme (in which case we have to think carefully about where to place the necessary background on programming needed for the computational chapters).”

Starting from a simple picture ...



Role of computational tools?

- Do we need them? Advantages and disadvantages. Threat to accessibility? Danger of becoming obsolete too fast?
- Should computational training be one of the book aims? Or maybe better in a separate volume?
- Put the computational stuff at the end, or throughout the book?
- Compare modern computer science textbooks, with an implementation section at the end of every chapter. But what works for computer scientists may not work for our broader audience.

Perspectives on Knowledge and Belief

- Epistemic logic: Kripke semantics.
- Belief Revision Theory, AGM. Here, DEL seems to provide a generic perspective.
- Probability theory: objective and subjective perspectives.
- Bayesian learning/updating, Bayesian “philosophy”: belief in φ = willingness to take an even bet on φ .
- Economy: uncertainty = having subjective probability less than 1.
- Epistemic game theory: Knowledge = Aumann knowledge = truth in all worlds in current information cell. Belief = being assigned subjective probability 1.

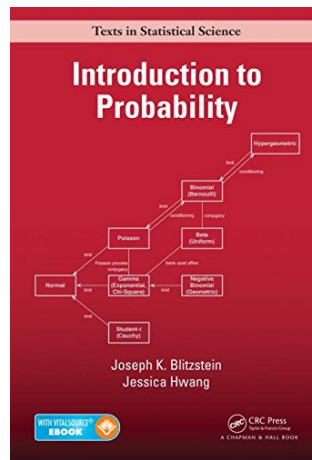
How to relate to probability?

- Alexandru: “In itself, probability is not really controversial, and applying logical methods to probability “by analogy” works perfectly (see e.g. Probabilistic DEL). For instance, Bayesian conditioning works analogous to updates, Jeffrey conditioning resembles radical upgrades etc.”
- Alexandru: “it’d be no problem whatsoever in directly connecting classical epistemic/doxastic logic and AGM revision theory to the standard terminology and methods in Epistemic Game Theory! Extending these connections to dynamics and thus to DEL can be done easily (though there are lots of open questions): there are even probabilistic analogues of radical and conservative upgrades...”

- Alexandru: “[The perspective on belief as willingness to bet] connects well with the approach to belief taken by some Bayesian philosophers (including our visitor Branden Fittelson), who reject the validity of the KD45 axioms (and in particular K). Connecting this approach to the usual developments in DEL would be very challenging, in both positive sense (definitely interesting to pursue as a line of research) and in a negative sense (the final picture according to this approach is likely to look very different from the simple picture of traditional doxastic logic).”

Possible Unifying Theme

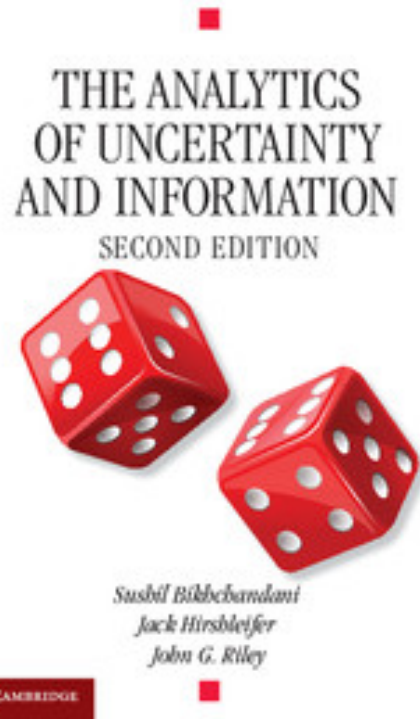
- Johan: “I also liked Jan’s earlier emphasis on PDL and dynamic logic as a sort of running side-theme through many of our topics (both for statics and dynamics): is it still there, or has this dropped out?”
- Epistemic PDL gives a perspective on (relativized) common knowledge
- PDL valuation change gives a perspective on factual change, PDL relation change gives a perspective on belief revision.
- Epistemic PDL combined with network relations can be used to model communication in networks.
- PDL can also be used to model game playing, in various ways, and it can be developed into a tool for epistemic game theory.



Quote from [BH15]:

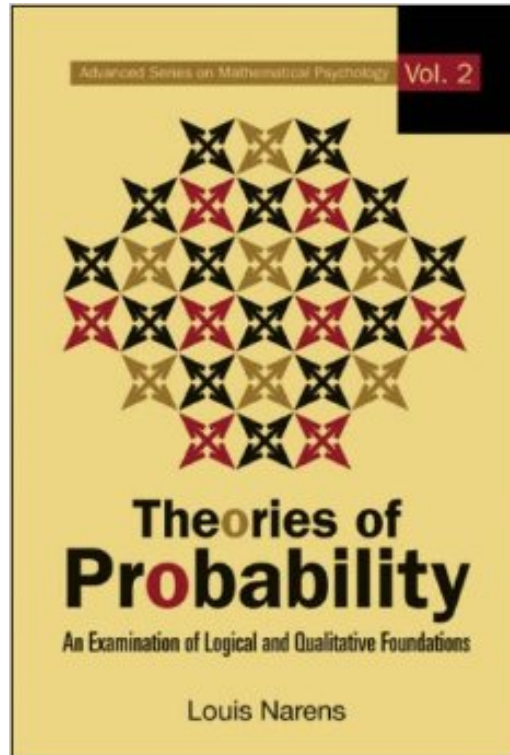
“Life: Life is uncertain, and probability is the logic of uncertainty. While it isn’t practical to carry out a formal probability calculation for every decision made in life, thinking hard about probability can help us avert some common fallacies, shed light on coincidences, and make better predictions.”

Risk and Uncertainty



“A number of economists have attempted to distinguish between risk and uncertainty [...] For our purposes, risk and uncertainty mean the same thing [...] probability is simply **degree of belief**. In fact, even in cases of a toss of a die where assigning “objective” probabilities appears possible, such an appearance is really illusory. That the chance of any single face turning up is one-sixth is a valid inference **only if the die is a fair one** – a condition about which no one could ever be “objectively” certain. Decision makers are therefore never in Knight’s world of risk but instead always in his world of uncertainty. That this approach, assigning probabilities on the basis of subjective degree of belief, is a workable and fruitful procedure will be shown constructively throughout the book.”

Preferences and Probability Representations



Scott's Theorem

Let \succsim be a reflexive relation and let \sim denote \succsim equivalence, and \prec the irreflexive part of \succsim .

[Sco64]: Let X be a finite set. If E is a boolean algebra of subsets of X , and if \succsim is a binary reflexive preference relation on E with $\emptyset \prec X$. If the structure satisfies the cancellation axioms (see below) then it has a probability representation.

Cancellation axioms: let Γ be a finite indexed family of \simeq equivalences of elements of E or \succsim strict inequalities of elements of E . For $x \in X$, let $\Gamma_l(x)$ be the number of $\gamma \in \Gamma$ with x an element of the left side of γ , and let $\Gamma_r(x)$ be the number of $\gamma \in \Gamma$ with x an element of the right side of γ .

Then the structure satisfies the k -th cancellation law if for each Γ of length k and for each $x \in X$ with $\Gamma_l(x) = \Gamma_r(x)$ it holds that each $\gamma \in \Gamma$ is an equivalence.

This requirement can be expressed as a modal formula, for each k .

Fact: Neighbourhood semantics for belief as willingness to bet is more general than probabilistic semantics.

Program: investigate plausible cases where Scott's cancellation axioms fail.

The Importance of Modelling

- Modelling is an art rather than a science
- To learn an art, study the work of artists and learn by doing
- Modelling in the field of communication and action: we have many tools, but the tools can be applied in various ways.
- PDL, e.g., is a multi-purpose tool.
- We seem to miss in practice and application: there are probably more ways of employing PDL than we have thought of.
- This is also an argument for developing the computational component of the book ...

The current state of the book ...

Draft chapters available on:

- Overview, Motivating Examples
- Epistemic Logic
- Doxastic Logic (and Probability)
- Computational Aspects

Setting up a Reading and Feedback Group

- Has worked wonders in an earlier enterprise . . .
- Method: set deadlines for chapters, provide drafts, give readers a few days to digest, discuss, improve.
- Regular meetings: maybe once every month. This provides much-needed deadlines.
- Try out sample chapters in courses and lectures asap.

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