

The Vagueness of Beliefs: A Framework for Regularizing the Structure of Stories

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Introduction

The computational modeling of Beliefs presents many interesting conceptual challenges. In this poster, I want to highlight one particular feature of beliefs, their **Vagueness**, that's particularly immune to computational inquiry. By vagueness, I mean the following three properties:

- (a) Beliefs are context dependent. A tall Pygmy is likely to be a short Masai, so our beliefs about the height of a person in the two communities is relative to their context.
- (b) They have flexible boundaries – for example, consider our beliefs about who counts as Christian or Hindu or Buddhist.
- (c) They can be interpreted in an infinite number of ways – think of the diverse interpretations of religious texts.

So how can we model vagueness computationally? Note that replacing vagueness by probabilistic or statistical interpretations, while valid for certain predictive purposes, does not do justice to the vagueness of the beliefs themselves.

Representing Beliefs as Stories

Stories are useful for framing beliefs because they are often used in answers for "why questions". Furthermore:

- They explicitly encode context – "Once upon a time in a galaxy far far away".
- They are comfortable with shifting category boundaries – think of the stories where the main character has a change of heart or transformation of identity.
- They are ideal for fleshing out the same event or set of events in different ways

Modeling Stories

Consider a typical story, like a "hero's journey", which can be caricatured as: "The hero is sitting comfortably in his village smoking a cigar, when a demon comes threatening to kill everybody. The hero takes up arms, kills the demon and comes home to a heroic welcome. End." Or you have the "romantic tragedy" where "Boy meets girl, they fall in love, their families object, they commit suicide". From a structural perspective we can model the story logic as follows;

Story begins → Protagonist 1 in Context 1, Protagonist 2 in Context 2 → Conflict between the two protagonists forces Context 3 → Conflict resolved in Context 3, story descends back to Contexts 1 and 2 (possibly to a different state)→ End

In other words, stories are about moving in and out of nested contexts. Category Theory offers a useful formal tool for modeling context movement.

Definition: Let C_1 and C_2 be two partially ordered contexts (formally they are categories). Then the *mapped* context, $C_1 \bullet C_2$, is the *minimal* subcategory C_3 that includes both C_1 and C_2 .

The simplest model of a story is a linear sequence that moves forward to a higher context by mapping two contexts together. We can model the linear story as follows:

Definition: Let Γ_1 and Γ_2 be two partial orderings of closed directed line segments. A Story is a sequence of inclusions and projections $\Gamma_1, \Gamma_2 \rightarrow \Gamma_3 \bullet \Gamma_2 \rightarrow \Gamma_1, \Gamma_2$.

Note that there is no unique partial order that contains the two partial orders that we start with. The minimal partial order is *uniquely* determined only if the context is fully defined, which it rarely is. In general there are multiple minimal mappings, which is not a problem really, since beliefs are underdetermined, and therefore, we want the formal framework to accept underdetermined solutions as well.

Stories Continued

Suppose I am working on my laptop in the bedroom. You come in and ask me "why is the computer here" to which I reply "I like working on the laptop in the bedroom". So far, there is nothing new. A default context has been set up, of answering the question in the proximate spatio-temporal context. But if you say "but why the PC?" there is a conflict, which cannot be resolved in the default context. What do I do? I can say: "Because my Mac is being repaired" or "I have switched to PC's" or "It is my brother's laptop, I am loading some music in it for him". There is no *correct* answer, but I cannot say: "Because computers have been invented" except as a wisecrack, since it is not a minimal answer.

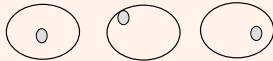


Grounding Beliefs in the World

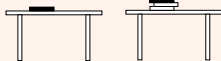
The problem of mapping beliefs on to states of the world is underdetermined in a radical manner – it is infinitely underdetermined. For example, consider the belief "He is from Chicago". There is an infinite dimensional space of possibilities that's consistent with a person being from Chicago. So how does a person evaluate a belief?

To be more precise, beliefs are:

- (a) Selective and Schematic: The grey dot is in the ellipse in all three cases



- (b) Beliefs make reference to the world in ways that are appropriate to the context: The belief, "the black book is on the table", refers to different world situations in the two cases below



Category theory is a useful tool to address these computational issues

Category Theory

The Mapping Problem: : Suppose R_1 is an abstract model of space and R_2 is a grounded model of space. Then,

- What are the computationally plausible maps $F: R_1 \rightarrow R_2$ from R_1 to R_2 ?

- What are the rules governing these maps from R_1 to R_2 ?

Category Theory is the appropriate formal tools for answering these questions.

Why Category Theory? We need a formal tool for mapping qualitatively different kinds of representation, such as the equations and geometric shapes in the figure below

Category	Equation	Shape
Token	$x^2 + y^2 = 1$	

Beliefs and States of the world are qualitatively different as well, which is why we need a tool such as category theory in order to model beliefs

Conclusions

The fundamental lesson for modeling beliefs is the following: new beliefs come from mapping old beliefs on to each other, which is represented in the old idea that stories have a conflict as the driving force. From a structural perspective, we could say belief change occurs when a new context is induced by two old contexts.

Acknowledgments

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