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Intensionality and Circumscription

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Strategy

A **Question**: How does our vocabulary affect our reasoning?

Answers:

1. from philosophy
2. from mathematics

An **Example** showing the problems with circumscription

Some **Metatheory** showing what happens in general

Comments

- McCain and Turner
- Applications to reasoning about actions

The Problem

- when we formalize a particular domain, we do so starting from a particular language
- and the terms in our theory reflect the vocabulary we start with
- ought this to matter?

Answer 1: Philosophy

- Quine says no:

Quine: “What makes sense is to say not what the objects of a theory are, absolutely speaking, but how one theory of objects is interpretable or reinterpretable in another.”¹

- so we have two vocabularies, we out to be able to “interpret or reinterpret” the theory of one in the theory of another

¹Quine, *Ontological Relativity* (Columbia 1969), p. 50.

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Answer 2: Mathematics

- mathematicians often reformulate things in different ways
- it doesn't matter whether $\langle x, y \rangle$ is $\{\{x\}, \{x, y\}\}$ or $\{\{y\}, \{x, y\}\}$
- and mathematicians recognise this by not caring
- and by being willing to reinterpret
- we are talking about what mathematicians *do*, rather than the philosophy of mathematics
- examples like these cause rather severe problems for the philosophy of mathematics
see Paul Benacerraf, "What Numbers Cannot Be"
which are still not satisfactorily solved

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Coordinates

- an extremely common instance of this is the use of *coordinate systems* in geometry and mechanics
- there is no unique choice; we go with what's convenient
- the fact that we can always reinterpret the results means we don't have to worry
- *all* that we need to worry about is correctness:
 - given* a particular coordinate system, does our formulation of the problem fit the way the world is?
- and we don't have to worry about finding the magic, correct coordinate system

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Why Does this Matter?

two reasons:

Convenience

- some representations (or coordinate systems) are better at solving certain problems than others
- and we might want to promiscuously combine results from several different representations
- a surprising amount of mathematical reasoning is like this
- so it's a good thing if the results don't depend on the choice of representation

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That's Where the Ontology Is

- in order to do this sort of retranslation, we must be able to tell when two things are the same or not
- This ability is crucial:

“To learn ‘apple’ it is not sufficient to learn how much of what goes on counts as an apple; we must learn how much counts as *an* apple, and how much as another.” (Quine, “Speaking of Objects”)

Individuative language gives us our grasp of the world:

“[the child] can never fully master ‘apple’ in its individuative use, except as he gets on with the scheme of enduring and recurrent physical objects.” (Quine, “Speaking of Objects”)

Thus:

“Words like ‘apple’, and not words like ‘mama’ or ‘water’ or ‘red’, are the terms whose ontological involvement runs deep.” (Quine, “Speaking of Objects”)

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The Example

Two balls are linked by a string of length 1. Initially (at $t = 0$) they are lying next to one another on a table, with the string slack. At $t = 1$, one ball is raised to height 2; this tightens the string and raises the other ball to height 1.

- We want to work out, using circumscriptive techniques, the position of the ball at $t = 1$.
- Because of the constraints, there are only 3 situations to consider (the ball can end up at height 1, 2, or 3)
- We try formalizing this with various combinations of these fluents:

$\text{at}(\cdot, \cdot)$	whether a ball is at a particular height
$\text{above}(\cdot, \cdot)$	whether a ball is above another or above a particular height
taut	whether the string is taut or not

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- We will consider *vocabularies*, which are collections of fluents from the above list
- Given any particular vocabulary (if it's sufficiently expressive) one can write down the theory expressing the constraints
- Given any pair of vocabularies, we can translate from one to the other
We simply take each fluent in one vocabulary, and express it as a combination of fluents in the other
- We can also, given a vocabulary, work out the order it induces on worlds (in terms of minimal change from $t = 0$).

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Vocabulary	Fluents	Order
A	$\text{at}(b_i, j) \Big _{i=1}^2 \Big _{j=0}^3$ taut	$m_1 \quad m_2 \quad m_3$
B	$\text{above}(b_i, j) \Big _{i=1}^2 \Big _{j=0}^3$ taut	m_3 $m_1 \quad m_2$
C	$\text{above}(b_i, j) \Big _{i=1}^2 \Big _{j=0}^3$	m_3 m_2 m_1
D	$\text{above}(b_1, j) \Big _{j=0}^2$ $\text{above}(b_1, b_2), \text{above}(b_2, b_1)$	$m_1 \quad m_3$ \ m_2 /
E	$\text{above}(b_1, j) \Big _{j=0}^2$ $\text{above}(b_2, b_1)$ taut	m_3 m_1 m_2

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Vocabulary	Fluents	Order
F	$\text{above}(b_1, j) \Big _{j=0}^2$ $\text{above}(b_1, b_2)$ taut	m_1 m_3 m_2
G	$\text{above}(b_1, j) \Big _{j=0}^2$ $\text{at}(b_2, 2), \text{at}(b_2, 3)$	m_2 m_3 \ / m_1
H	$\text{above}(b_1, j) \Big _{j=0}^2$ $\text{at}(b_2, 1), \text{at}(b_2, 2)$	m_1 m_2 \ / m_3
I	$\text{above}(b_1, j) \Big _{j=0}^2$ $\text{above}(b_2, 1)$ $\text{at}(b_2, 2)$	m_2 m_3 m_1

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Some Metatheory

- we got this example by writing down all a few vocabularies that came to mind
- and got 9 different orders (there are 24 in all)
- what are the theoretical limits?
- in this sort of case (finite number of models, essentially propositional fluents) we can attain *any order we want* by a suitable choice of vocabulary
- given a particular vocabulary, if we enlarge it we make the order more discrete
- and, if we start with a particular vocabulary, we can get any order we want that is more discrete than it

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Responses

We can think of two kinds of responses to this:

- things look bad for circumscription
- things are just fine for circumscription:
 - the choice of vocabulary does indeed matter
 - the crucial thing is to choose the right vocabulary
 - this magic vocabulary expresses an essential part of our grasp of the world
 - and (whatever mathematicians do or Quine says) people always use the same vocabulary in reasoning about change

McCain and Turner

Remember McCain and Turner's proposal (McCain and Turner, "Causal Theories of Action and Change", AAAI97)

- they have a new connective, which I'll write \triangleright .
 - they say $\phi \triangleright \psi$ means "necessarily, if ϕ then the fact that ψ is caused"
 - Lifschitz formulates it in terms of explanation (V. Lifschitz, "On the Logic of Causal Explanation", *Artificial Intelligence* 96)
- Given \mathcal{T} , a collection of such things (in a particular language, and given a theory expressing the constraints) we define, for a particular model M ,
$$\mathcal{T}^M = \{\psi \mid \text{for some } \phi, \phi \triangleright \psi \text{ and } M \models \phi\}$$
- Say a model M is *causally explained* (according to \mathcal{T}) if it is the only model of \mathcal{T}^M .
- Finally, we say that ϕ is a *consequence* of \mathcal{T} if ϕ is true in every \mathcal{T} -causally explained model.

Interesting Fact McCain and Turner's theory doesn't depend on the choice of a particular vocabulary: that is,

- if you have two different vocabularies, and you have corresponding sets of causal laws in both vocabularies
- then the results are the same in either vocabulary
- this is almost completely obvious:
 - the whole thing is formulated in terms of models
 - the idea of a model is vocabulary-independent
 - the only thing which needs a bit of thought is the definition

$$\mathcal{T}^M = \{\psi \mid \text{for some } \phi, \phi \triangleright \psi \text{ and } M \models \phi\}$$

- Lifschitz manages to produce circumscriptions out of McCain and Turner, but only by introducing what he calls "observable symbols", which introduce vocabulary-dependence into the formalism

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so:

- if you think that circumscription has problems, you will like McCain and Turner, because it avoids those problems
- but if you think that circumscription is fine, then you will think that our vocabulary choice is essential to our grasp of the world
- and so you will not like McCain and Turner, because their formalism is insensitive to vocabulary choice

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- This is all very well, but it would be nice to know some concrete examples of argumentation which depended on being able to translate between vocabularies
- here's one, by Davidson:

'I didn't know that it was loaded' belongs to one standard pattern of excuse. I do not deny that I pointed the gun and pulled the trigger, nor that I shot the victim. My ignorance explains how it happens that I pointed the gun and pulled the trigger intentionally, but did not shoot the victim intentionally. . . . What is the relation between my pointing the gun and pulling the trigger, and my shooting the victim? The natural and, I think, correct answer is that the relation is that of identity. The logic of this sort of excuse includes, it seems, at least this much structure: I am accused of doing *b*, which is deplorable. I admit I did *a*, which is excusable. My excuse for doing *b* rests upon my claim that I did not know that $a = b$. (Davidson, "The Logical Form of Action Statements")

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- So, here we have some reasoning about actions which relies on
 - being able to describe the *same* action in two different vocabularies
 - there is an interesting epistemic dimension here (if the same thing can be described in two different ways, then someone is capable of not seeing that they are the same). This could be worth investigation.