

# **A Note on Interpretations for Federated Languages and the Use of Disquotation**

Steven O. Kimbrough  
University of Pennsylvania  
565 Jon M. Huntsman Hall  
Philadelphia, PA 19104 USA  
kimbrough@wharton.upenn.edu  
215-898-5133

ICAIL, Bologna, 7 June 2005

<http://opim-sun.wharton.upenn.edu/~sok/sokpapers/2005/icail2005/flbc-disquotation-foils.pdf>

## Wha? ICAIL? . . . We need to review. . .

- ICAIL '01 paper: “Reasoning about the Objects of Attitudes and Operators: Towards a Disquotation Theory for Representation of Propositional Content”
- ‘Disquotation’ move offered as a way of augmenting event semantics in order to handle complex sentences, sentences with embedded sentences.
- Lingering worry: languages with quotation/disquotation are inconsistent. Purpose of the present paper is to address this. Purpose of the talk: overview.
- Begin with background and motivation. So what?

# Background

- Needed: A representation and formalization policy/approach for sentences of legal—i.e., AI and law, IAAIL—interest. A generally accepted point, to which there has been much useful contribution.
- Nice if you can get it: A formalization in logic.  
Formulas in logic are more than data structures. Semantics and support for inferencing.
- Impediment: Existing logics are not, it is widely agreed, fully up to the representation task.
- Impediment: Implementation of the most promising logics is problematic.

## Positive reasons, too. Compare with speech acts.

- Q: Why so much attention paid to speech acts (assertions, promises, requests, etc.)?

(Or to obligations, permissions, institutional power, etc.)

- A: Because it is plain that we use them.

It is obvious that assertions, promises, requests, etc. will be needed in any accurate description of legal discourse.

Whether Searle's or any other particular theory is correct is another matter.

## Event semantics

- Q: Why (say in FLBC) organize a formal language around event semantics?
- A: Because it seems plain that verbs are 'about' events.  
And recognizing this fact generally leads to felicitous representations.
- Long history of the idea: Panini, Donald Davidson, Terrance Parsons, etc.

## Not to be confused with Panino

Panino From Wikipedia, the free encyclopedia. (Redirected from Panini (sandwich))

A panino (plural panini, although panini is often used in a singular sense outside Italy) is a toasted sandwich made from a small loaf of bread, typically ciabatta. The loaf is often cut horizontally and filled with salami, ham, meat, cheese or other food, and served hot.

“Panini” is also a brand of grill made specifically for grilling these sandwiches.

In Italian, panino can variously refer to a bread roll or a sandwich. Retrieved from "<http://en.wikipedia.org/wiki/Panino>"

Categories: Italian cuisine

# Event Semantics

URLs for Panini:

<http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Panini.html>

<http://www.encyclopedia.com/html/P/Panini.asp>

[http://en.wikipedia.org/wiki/Panini\\_%28scholar%29](http://en.wikipedia.org/wiki/Panini_%28scholar%29)

## Event semantics (con't.)

- Roughly, verbs in use are indexed by *eventualities* (or *events*, risking confusion)
- E.g., instead of “Bush lied” as  $lied(Bush)$  or  $P(lie(Bush))$  we have  
 $\exists e, t(lie(e) \wedge Agent(e, Bush) \wedge Cul(e, t) \wedge t < now)$ .  
(Simplifying for the discussion. Main point: a technique with many virtues.)
- Eventualities (events): events (point in time happenings), processes (happenings extended in time), states (beings, extended in time)

## Background (con't.), . . . 3 types of sentences

- Simple, a clause

“The American military has killed very many non-combatants in Iraq.”

- Compound, combining two or more simple sentences

“The American military has killed very many non-combatants in Iraq, and it seems to be quite trigger-happy and unapologetic.”

- Complex, with one or more embedded sentences

“The American public finds it hard to admit that the behavior of the American government may at times be legitimately challenged on moral grounds.”

## Complex Sentences

Examples (with content  $P$ ):  $S$  believes that  $P$ ,  $S$  promises that  $P$ ,  $S$  says that  $P$ , etc.

- Saying that (indirect discourse):
  - *Galileo said that the earth moves*
  - *Bush said that the U.S. economy was in deep trouble and only massive tax reductions, especially for the wealthy, could save the day.*

- Propositional attitude descriptions (aka: clausal complements) such as:
  - *Jane believes that Tom loves Mary*
  - *Jane desires that Tom does not love Mary*
  - *Jane intends that Tom will marry Susan*

and their stylistic equivalents. For example, *Tom intends to marry Mary* is arguably a variant of the more stilted *Tom intends that he (Tom) will marry Mary*.

- Speech act descriptions, such as:
  - *Tom promised that he will marry Mary.*
  - *Sam promised Sue a diamond.*<sup>1</sup>
  - *Bush asserted that his administration would operate on a bipartisan basis.*

---

<sup>1</sup>I take this kind of construction as shorthand for, here, something akin to *Sam promised Sue that she (Sue) will get a diamond.*

- *The Supreme Court declared that the ballots will not be counted.*
- Modal descriptions, such as:
  - *It is impossible that Gore can appeal a Supreme Court decision.*
  - *Necessarily, it is raining or not*
- Deontic descriptions, such as:
  - *Jake is obliged to Tom that Jake read(s) the letter.*
  - *Parking is not permitted here.*
- Perceiving-that descriptions, such as:
  - *Jane saw that Tom kissed Mary*  
(as distinguished from *Jane saw Tom kiss Mary.*)
- Others, e.g., *...needs it to be the case that...*

## Comments

1. Most of these examples and other cases involve some degree of inten[st]ionality.

Here: focus on intensionality (“s-ality”). Roughly: linguistic description of intentionality. Diagnostic: failure of substitution of equivalents (identicals) can fail to preserve truth. “S believes that P, P if and only if Q, therefore S believes that Q” is surely invalid, as is “S knows that a robbed the bank,  $a = b$ , therefore S knows that b robbed the bank.” Aside: degrees or levels of inten[st]ionality.

2. Here: a sketch of a theory (or approach)
3. Definition versus description. Here: description. (Baseball)

## More on inten[st]ionality

Puzzling. Thought to challenge naturalism, materialism. The “mark of the mental”? Intentionality: directed, aspectual.

$$f(x) = z, x = y \models f(y) = z$$

$$P, P \leftrightarrow Q \models Q$$

$$P \rightarrow R, P \leftrightarrow Q \models Q \rightarrow R$$

Examples of intentionality: Oedipus, Juliet, police knowing the bank robber, BDI, etc.

Levels of inten[st]ionality, include: equivalences: extensional (Batman and Bruce Wayne), nomic (laws of nature), alethic (ordinary necessity), analytic (triangles, bachelors), synonymy (?)

## Modal approaches (to intensionality)

Standardly:

Modal logic, e.g.,  $\Box P, P \leftrightarrow Q \not\models \Box Q$  but  $\Box P, \Box(P \leftrightarrow Q) \models \Box Q$

Logics of belief, of knowledge, etc.

Speech act analysis pushed by sok:

$$\textit{promise}(P) \approx \exists e(\textit{promise}(e) \wedge \Box(K(e) \leftrightarrow P))$$

What's wrong with this? (a) Does there have to be something wrong to consider an alternative? (b) In my own case, I've been bothered by the lack of principled motivation for a modal approach. It's there for intensionality (only?).

## Another motivation

- Event semantics (Davidson, Parsons, et al.) has not really addressed complex sentences, sentences with embedded propositional content.
- The disquotation move is an attempt to provide event semantics (with its considerable virtues) with a general and principled approach to handling propositional content.

## **Disquotation theory/approach: core idea**

Propositional content has (at least) two important aspects. First, it is about something, that is to say it is true-or-false or rather it is a description, accurate or not, of something. Second, it is itself something about which we attribute certain properties, e.g., that Mary believes it or hopes it or asserts it or promises it. Summarizing (perhaps sloganizing), we might put the point by saying that the sentences of interest here large have the structure: content + comment (on the content). The core idea I wish to develop involves directly recognizing and representing these two aspects (content, comment) of sentences with propositional content.

## Disquotation theory: alternative to the modal theory ( $\square$ )

Consider the simple propositional content (and speech act) sentence:

**Expression 1.** *Mary asserts that Sam arrived yesterday.*

My idea is to represent this (and similar) sentence(s) with two kinds of expression: (a) a fundamental expression and (b) one or more axiom schemas, used to articulate meaning for the fundamental expressions. First, we can represent *Sam arrived yesterday* in what is more or less standard event semantics:

**Expression 2.**  $\exists e'(\text{arrive}(e') \wedge \text{Subject}(e', \text{Sam}) \wedge \text{Cul}(e', \text{yesterday}))$

Let  $\phi$  represent Expression 2.

The fundamental expression for the sentence (in Expression 1) becomes, in shorthand:

**Expression 3.**  $\exists e(\text{assert}(e) \wedge \text{Subject}(e, \text{Mary}) \wedge \text{Obj}(e, [\phi]))$

or fully written out:

**Expression 4.**  $\exists e(\text{assert}(e) \wedge \text{Subject}(e, \text{Mary}) \wedge \text{Obj}(e, [\exists e'(\text{arrive}(e') \wedge \text{Subject}(e', \text{Sam}) \wedge \text{Cul}(e', \text{yesterday}))]))$

Thus, the main idea in the fundamental expressions is to treat a quoted sentence (the propositional content) as an object or individual about which a comment is made. In particular, the quoted sentence is the direct object of an event (or eventuality). Moreover, a special form of quotation is used:  $[\cdot]$ . By quoting an expression in this way—as in 3 and 4—we treat it as an individual and so capture (I argue) the second aspect noted about it.

## Disquotation theory: alternative to the modal theory ( $\Box$ )

Formally we have the following rule:

**Axiom Schema 1. [Assert Rule]**  $\forall e((assert(e) \wedge Obj(e, [\phi]))) \rightarrow (Veridical(e) \leftrightarrow \phi))$

Axiom Schema 1 should be thought of as a rule into which we may substitute uniformly for  $\phi$  any well-formed formula in the current language.

Note: This generalizes to all the speech acts. And to complex sentences generally.

## End of background: Lingerin<sup>g</sup> worries

- What does it mean? The expressions are not wffs in ordinary first order logic, so what gives?
- And didn't Richard Montague investigate languages with quotation and prove that they are all inconsistent?

Short answer: Yes, he did some investigation here; no, he didn't prove they are all inconsistent, just some of them.

We'll focus on the first question/lingerin<sup>g</sup> worry.

## Federated (logical) language

- Key notion in the paper. A language composed of other languages.

Idea: if you do this right, you can get and understand disquotation. Quickly, the elements.

- Language *tokens*: syntactically distinct instances of a common language/logic. Think: propositional logic.
- *Atomically disjoint languages*: Two language tokens,  $\mathcal{L}^1$  and  $\mathcal{L}^2$ , are said to be atomically disjoint if they have no logical terms in common

## Federated (logical) language (con't.)

- Federated language: composed from two or more federating languages.
- Let  $\mathcal{L}^1$  and  $\mathcal{L}^2$  be two atomically disjoint tokens of propositional logic. These will be our federating languages.
- Form  $\mathcal{L}^3$  as a federated language from  $\mathcal{L}^1$  and  $\mathcal{L}^2$ .

Use obvious extensions of the usual rules. E.g. if  $S \in \mathcal{L}^1 \cup \mathcal{L}^2$  then  $S \in \mathcal{L}^3$ , if  $S, T \in \mathcal{L}^3$ , then  $(S \wedge T) \in \mathcal{L}^3$ .

Semantics easily follows, too.

## Observations

- By a relabeling argument we see that  $\mathcal{L}^3$  is just another token of propositional logic.
- Because of atomic disjointness, if  $\Gamma^1$  is a consistent set of  $\mathcal{L}^1$  sentences and  $\Gamma^2$  consistent  $\mathcal{L}^2$ , then  $\Gamma^1 \cup \Gamma^2$  is consistent in  $\mathcal{L}^3$ .
- It is entirely possible to have intended interpretations of  $\mathcal{L}^1$  and  $\mathcal{L}^2$  that produce nominal but not formal contradictions in  $\mathcal{L}^3$ .

## Example of nominal contradiction

By way of illustrating this last observation, let us have the following intended interpretations:

$P_1^1$  It is Tuesday.

$P_2^1$  It is raining.

$P_1^2$  It is Tuesday.

$P_2^2$  It is raining.

The the following sequent is valid in  $\mathcal{L}^3$ :

$$P_1^1, (P_1^1 \rightarrow P_2^1), P_1^2, (P_1^2 \rightarrow \neg P_2^2) \models (P_2^1 \wedge \neg P_2^2) \quad (1)$$

While this seeming failure to detect contraction may seem odd, it is not an anomaly.  $\mathcal{L}^3$  is simply an instance of sentence logic. The behavior on display here is quite available in any instance of sentence logic.

## On now to FOL and disquotation

- Proceed in the (now) obvious way to define  $\mathcal{L}^3$ , a FOL federation of two FOL, syntactically disjoint languages,  $\mathcal{L}^1$  and  $\mathcal{L}^2$ .

Now we need syntactically distinct variables, names, functions, etc.

- Some subtleties and restrictions. Principally: predicates in one language cannot take as arguments terms in another language. E.g.,  $P_4^1(a_3^2)$  is ill-formed.
- So how do we get quotation? (Be patient. Almost there.)

## Correspondence table

- Between certain *names* in  $\mathcal{L}^2$  and elements in  $\mathcal{L}^1$ .

E.g.  $o_3^2 \Rightarrow P_{233}^1$

- Now, e.g.,

$$\text{assert}(e) \wedge \text{Speaker}(e, \text{Bob}) \wedge \text{Content}(e, o_3) \quad (2)$$

with everything superscripted with a 2. Everything here is standard FOL.

## Axiom schema

$$(\text{assert}(e) \wedge \text{Content}(e, o_3)) \rightarrow (\text{Veridical}(e) \leftrightarrow P_{233}^1) \quad (3)$$

This works, is a wff in  $\mathcal{L}^3$ , but is very cumbersome.

Since every  $\mathcal{L}^1$  expression,  $\phi$  is uniquely readable, so is  $[\phi]$ . So, if  $\phi$  is a wff in  $\mathcal{L}^1$ , then we let  $[\phi]$  be a wff in  $\mathcal{L}^2$ .

And this leads to just what we want.

## In summary

If  $\phi$  is a wff in  $\mathcal{L}^1$ , then  $\lceil\phi\rceil$  is a wff in  $\mathcal{L}^2$ . (But not vice versa.)

Form  $\mathcal{L}^3$  as the federation of  $\mathcal{L}^1$  and  $\mathcal{L}^2$ .

Add as axiom schemas to  $\mathcal{L}^3$  such expressions as

$$(\textit{assert}(e) \wedge \textit{Content}(e, \lceil\phi\rceil)) \rightarrow (\textit{Veridical}(e) \leftrightarrow \phi) \quad (4)$$

(all with proper superscripting).

## There's more in the paper

- Further details
- Consistency assurance
- Broader uses and applications, e.g., paraconsistent logic

In sum, more to be done, but this basic approach secures us from worries about inherent inconsistency and demonstrates much generality and expressive power.

`$Id: flbc-disquotation-foils.tex,v 1.4 2005/06/02 12:49:40 sok Exp $`