File Cards, Discourse Referents and the Objects of Belief

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Egli and Bäuerle 1985:

discourse referents are the result of skolemisation

alternative DRT based on skolemised Beth-tableaux

application to quantifier modification

This paper:

playdoyer for revival in combination with Karttunen's file cards as explanations of DRs using new approaches to dependency

FCD (File Cards with Dependencies): essentially skolem normal forms for predicate logic

FCD: promising logical interpretation of traditional mental representation

FCD: a big improvement for formal semantics of natural language

FCD: a natural approach for belief semantics

FCD

a set of file cards labeled by object names and containing information about the object with pointers to other cards with

a dependency relation over those cards (a partial order)

later bells and whistles:

plural objects
an inheritance relation over cards

Truth for FCD

find witnesses for each card that meet the information on the card

independent objects: they should just meet the information

dependent objects are witnessed by functions from the objects they depend on to the kind of things that would witness them if they were independent: the functions supply a witness for each object in the domain of the function

plural objects: each element meets all information on their card

Plan

0. FCD gives logical representations related to theorem proving

1. argue that FCD is radical Discourse Representation Theory (Kamp) or File Card Semantics (Heim)

2. (beyond 1) FCD give a solution to cumulative and branching quantification, allow languages without proper quantification and allow one single conjunction and disjunction

3. FCD can be interpreted as a formalisation of traditional philosophical psychology (Vorstellung, mental representation)

4. reject an argument against FCD based on negation (Twardovski)

5. show that FCD give an intuitive logic of belief

FCD is a logical formalism

FCD captures FOL

Conjunctive Skolem Normal Forms are the basis of resolution theorem proving which is the origin of unification and prolog.

Theorem

any FOL sentence φ can be represented by a conjunction of disjunctions of literals ψ such that for all M $M \models \varphi$ iff $M \models \exists f_1 \dots f_n \; \forall x_1 \dots x_k \psi$, where $f_1 \dots f_n$ are the skolem functions and $x_1 \dots x_k$ the free variables of ψ

Resolution rule

If there is a unification θ such that $A \vee \psi$ and $B \vee \neg\psi$ are conjuncts in θX, then replace the two disjuncts by $A \vee B$ in θX

CSNFs are essentially FCDs

make a card for each term of the CSNF and label it by the term

write all disjuncts with the term on its card (1-place disjuncts)

define the dependency relation: the card labeled t depends on cards labeled s iff s occurs in t

Semantics on a model $M =< D, F >$

variable cards are witnessed by the plural object given by the whole domain D

dependent cards are witnessed by functions in D^{D^n}

independent cards are witnessed by elements of D

witnesses (pointwise) fulfill the conditions on the card they witness (should be spelled out in detail)

a file card system A is true iff A has witnesses for each card

f witnesses $x \in A$ pointwise iff $\forall d \in dom(f)\ f(d)$ witnesses x

an algebraic consideration

FCDs are different from standard logical formulas because they are not constructed from logical operations over some base (with -arguably- the exception of conjunction)

FCD can be constructed from disjunctions of literals by union and unification (roughly DRT merge)

abstractly they are however closed under all logical operations: for every n-place sequence $< s_1, \ldots s_n >$ of FCDs and n-place logical operator O, there is an FCD t that is equivalent to $Os_1 \ldots s_n$

Conclusion: FCD belongs to logic, especially to proof theory

their importance can be motivated from natural language semantics and philosophical psychology (while FOL can be motivated from semantics and algebra)

Discourse Referents

FCD are a radical Discourse Representation Theory (Kamp) or proper File Card Semantics (Heim) or Karttunen file cards.

In this interpretation, they are plural cards that will inherit from concepts and can have cardinality and proportionality properties as well as anaphoric and deictic properties

The technical improvement is the dependency relation

This allows doing without the special treatment of negation, implication and quantification in DRT and File Change Semantics

Counterargument: the uniformity between discourse referents at different levels of embedding is lost as are the restrictions on anaphora to embedded discourse referents

Reply:

all DRs are the same in FCD. These restrictions have too many exceptions while DRT anaphora restrictions are far too weak

FCD in NL Semantics

1. all objects are plural

2. all objects inherit from given concept objects

3. event semantics as in DRT

4. $\theta(X) = A$ iff $A = \{\theta(x) : x \in X\}$ for thematic roles θ (projection semantics)

concepts are given by mental lexicon/semantic memory

three boys from Amsterdam inherits from *boys from Amsterdam* inherits from *boys*

example: every man loves a woman
w an assignment of witnesses

given conceptual objects for *man*, *woman*, *love*

$w(\textit{every man}) = w(\textit{the men}) = w(\textit{man})$

$w(\textit{a woman})$ depends on $w(\textit{every man})$:
$w(\textit{a woman})(m) \in w(\textit{woman})$ for each $m \in w(\textit{every man})$

($\in$ is $\subseteq$ and cardinality =1)

$w(\textit{loves}) \subseteq w(\textit{love})$

the experiencers of $w(\textit{loves})$ are $w(\textit{every man})$

if $x \in w(\textit{every man})$ is the experiencer of $e \in w(\textit{loves})$ the theme of e is $w(\textit{a woman})(x)$
without the dependency or with the other dependency: the

12 men love 7 women (3 readings)

7 women depend on 12 men (may involve 84 women)

12 men depend on 7 women (may involve 84 men)

no dependencies: the cumulative reading (involves 12 men, 7 women)

12 men from 5 cities love 7 women from 3 villages (branches 3, 7 and 5, 12 unordered with respect to each other)

branching

5 cities $>$ 12 men $>$ love
3 villages $>$ 7 women $>$

Linguistic evidence

dependency is a new thing in language evolution

Stat'imc'ets seems to lack for standard NPs scoping readings for sentences with two generalised quantifiers

Typology: if a language has scoping readings, it has cumulative readings

X bar syntax is semantic

N and V are concepts witnessed by their denotations

N' and V' may have extra arguments and are witnessed by non-empty subsets of the concept denotation

N'' and V'' can have cardinality and proportionality predicates on their witnesses

application to quantifier modification
rarely
often
probably

uniform conjunction (union of witnesses with a disjointness default)

restricted quantification as basic

the extension to generalised quantifiers is natural, while it is a leap in FOL extensions, DRT and Heim's File Card Semantics

logical form and syntactic structure can be unified

inheritance generalises over three relations neset/concept concept/concept neset/neset

A neset inherits from a concept iff it is the denotation of that concept

A neset A inherits from another neset B if $A \subseteq B$

A concept A inherits from another concept B iff $\forall x(Ax \rightarrow Bx)$

Mental representation and philosophical psychology

Aristotle, ..., Kant, ..., Brentano, ..., Twardovski

Brentano's principle: intentionality of representations

Meinong: different kinds of objects

Frege: equivocation of proposition, predicate and judgment

claims:

Frege's criticism can be handled by FCD

Meinong:

arbitrary objects of different kinds
objects of belief
dependent objects
Brentano

with a difference: witnesses can be complex

card and witness: internal and external objects of a representation

strong point of the traditional concept of representation over standard logical formalisms

knowledge from visual perception is basic

mental representation as the interface between perception, thought, action

simulation and imagery

Twardovski's argument for negative states of affairs

1. repair of the Brentano view that negation is rejection of a representation: negative propositions are true and give information

2. starting from the obvious:
there are no witnesses for negative judgments

weaker version of Brentano's principle in FCD:
the intentionality for many thoughts involves multiple objects and not just one object

there are no negative FCDs apart from atomic ones and they can be brought into subject predicate form such that the subject witnesses the non application of the predicate

unity of representations: connections between the cards as indicated on the cards

the other proper ones come about by normal form computation

conclusion should be that true negative thoughts can have complex external objects and are otherwise not uniform

FCD as models of belief

An FCD can model the belief system

Let A and B be complete FCDs
complete: xRy on $x \in A$ then $y \in A$

$B \models A$ iff there is an embedding f $B \models A[f]$

f is an embedding for A on B iff
1. $f : A \to B$
2. $x \leq_f f(x)$

$x \leq_f y$ iff

1. the predicates on x are present in y (y can have more)
2. $\theta = z$ on $x \Rightarrow \theta(y) = f(z)$ (y can have more defined theta arguments)
3. $dep = z$ on $x \Rightarrow dep = f(z)$ on y and $f(z) \leq_f z$
4. $inherit = z$ on $x \Rightarrow inherit = f(z)$ on y

If B is the information state of somebody b, $B \models A$ can be used to describe b's beliefs.

But the same relation can also be taken as giving model theory. B can be taken as determining a partial model by fixing which objects there are minimally and what atomic relations are true of them. For dealing with belief sentences, belief subject a's card in C will have a FCD B_a on it.

$B \models a$ believes that A iff $B_a \models A$

The objects occurring in A can however also be an informational part of objects in C so that the belief will be from the perspective of C about existing objects.

The same can happen with respect to the belief state B_b of subject b in C, so that b and c can have a belief about the same object of A.

The various puzzles about quantifying in, intentional identity and asymmetries can be handled more or less straightforwardly by treating objects as the objects of an FCD.

Pierre does not believe that Paderewski the politician is the same as Paderewski the pianist. In C this is the same person, as indeed is the case. Pierre must have two objects here that are both about the same object in C

Arski and Barski are independently doing murder investigations of Smith and Jones, who however died of natural causes. Arski but not Barski believes that the same murderer was responsible. Barski believes that the murderer of Jones left town.

Barski believes that someone murdered Jones and Arski believes that he killed Smith.

but not

Arski believes that someone murdered Smith and Barski believes that he left town.

Tentative conclusions

standard logical systems are not necessarily the best for all purposes not even in logic

it is plausible that mental representation is optimised for inferencing. using such representations helps natural language semantics and leads to semantic generalisations

mental representation in the classical tradition may have an important role in understanding the functioning of verbal communication in cognition