Causatives as Complex Predicates without the Restriction Operator

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Alsina's (1996) concept of complex predicates has been, within LFG, applied to a number of phenomena and languages including, for example, Turkish causatives (Çetinoğlu et al., 2008). These approaches are comparable insofar as they use the so-called restriction operator introduced by Kaplan and Wedekind (1993). The reason for the use of this ad-hoc workaround is the fact that standard LFG does not allow for modification of the PRED attribute in f-structures. The "restriction operator" solves this problem but it breaks the monotonicity[1] of the LFG architecture which has been one of the biggest advantages of the formalism according to Bresnan (2001). We propose a solution to this problem that preserves the monotonicity of LFG using equational unification.

For the Catalan example in (1), the PRED of the main f-structure is given in (2).

(1) *El* *vaig* *fer* *riure.*
him go-1SG do-INF laugh-INF
"I made him laugh."

(2) $\text{cause}\langle(\uparrow \text{SUBJ}), \text{riure}\langle(\uparrow \text{OBJ})\rangle\rangle$

Unlike in languages with morphologically formed causatives, such as Turkish, Catalan causatives are formed syntactically, i.e. the complex PRED value is not created in the lexicon. We will show that the creation of complex predicates can be formalized as unification. Thus monotonicity, with all its corollaries, is preserved.

The process of the composition of f-structures is based on unification. In standard LFG, PRED values were treated as atomic in the syntactic component, making it impossible to alter them. However it is possible to use equational unification, a concept used in logical programming for deduction and reasoning, to get rid of the restriction operator and use only standard functional descriptions.

For Catalan causatives, we assume the following PRED values of the verbs in (1):

(3) *fer* $\text{cause}\langle(\uparrow \text{SUBJ}), f\langle(\uparrow \text{OBJ})\rangle\rangle$
riure $\text{laugh}\langle(\uparrow \text{SUBJ})\rangle$

The symbol f represents a higher-order variable that can be instantiated with a function symbol. To form a complex causative predicate in the syntax, we define an equational theory ($\doteq_E$) based on the following term identity:

(4) $E = \{\text{cause}\langle(\uparrow \text{SUBJ}), f\langle(\uparrow \text{OBJ})\rangle\rangle \approx f\langle(\uparrow \text{SUBJ})\rangle\}$

Now if we unify the f-structures of *fer* and *riure* modulo $\doteq_E$ we get the complex PRED value given in (2).

Formal definition: Let $\mathcal{T}(\mathcal{F},\mathcal{V})$ be a term algebra with a signature (set of function symbols) $\mathcal{F}$ and a set of variables $\mathcal{V}$. Let E be a set of equations over $\mathcal{T}(\mathcal{F},\mathcal{V})$ (called identities). We define equational theory $\doteq_E$ as the least congruence relation on $\mathcal{T}(\mathcal{F},\mathcal{V})$ closed under substitution and containing E. More formally, $\doteq_E$ is the least binary relation on $\mathcal{T}(\mathcal{F},\mathcal{V})$ with the following properties:

1. $E \subseteq \doteq_E$
2. $s \doteq_E s$ for all s
3. if $s \doteq_E t$ then $t \doteq_E s$ for all s, t
4. if $s \doteq_E t$ and $t \doteq_E r$ then $s \doteq_E r$ for all s, t, r

[1] It is trivial to see that if d_1 and d_2 are functional descriptions, ϕ is the function that maps functional descriptions to f-structures and d_2 contains a description with a restriction operator then $d_1 \subseteq d_2 \Rightarrow \phi(d_1) \sqsubseteq \phi(d_2)$ may not be true.

5. if $s_1 \doteq_E t_1, \ldots, s_n \doteq_E t_n$ then $f(s_1, \ldots, s_n) \doteq_E f(t_1, \ldots, t_n)$ for all s, t, n, f
6. if $s \doteq_E t$ then $s\sigma \doteq_E t\sigma$ for all s, t, σ

An E-unification problem over $\mathcal{F}$ is a finite set of equations $\Gamma = \{s_1^? \doteq_E t_1^?, \ldots, s_n^? \doteq_E t_n^?\}$ where $s_i, t_i \in \mathcal{T}(\mathcal{F}, \mathcal{V})$. An E-unifier of Γ is a substitution σ such that $s_1\sigma \doteq_E t_1\sigma, \ldots, s_n\sigma \doteq_E t_n\sigma$. $u_E(\Gamma)$ is the set of E-unifiers of Γ and Γ is E-unifiable iff $u_E(\Gamma) \neq \emptyset$. Unlike syntactic unification, a most general unifier may not exist. Typically, one can compute a minimal complete set of E-unifiers (i.e., a set of unifiers that are not comparable to each other with respect to the relation of being a more general modulo E).

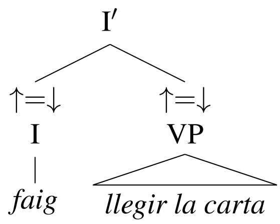
It is obvious that equational unification is a simple generalization of syntactic unification. For the example given above, we unify the PRED values of *fer* and *riure* modulo E as defined in (4) using the substitution $\sigma = \{f \mapsto \text{riure}\}$.

We have shown how the f-structures of *fer* and *riure* can be combined to an f-structure with a complex PRED value using only unification, i.e. using ↑=↓ for both these words. The solution is the use of equational theory $\doteq_E$ defined over a set of identities E ((4) is a simple example for causatives of intransitive verbs) that allows for a generalized (equational) unification of f-structures with all the advantages of syntactic unification. E can be understood as a linguistically motivated transparent description of syntactically formed PRED altering constructions. It is obvious that E is language specific while the unification mechanism is universal.

Example for a transitive verb:[2]

(5) *Li faig llegir la carta.*
him do-1SG read-INF the letter
"I make him read the letter."

(6)



(7) PRED of the f-structure of the sentence: cause⟨(↑ SUBJ), llegir⟨(↑ OBJ$_\theta$)(↑ OBJ)⟩⟩

(8) $E = \{\text{cause}\langle(\uparrow \text{SUBJ}), f\langle(\uparrow \text{OBJ}_\theta)(\uparrow \text{OBJ})\rangle\rangle \approx f\langle(\uparrow \text{SUBJ})(\uparrow \text{OBJ})\rangle\}$

The presented machinery of complex predicate formation is an attempt to keep the LFG architecture formally and computationally sound. Further research is needed to elaborate analogue solutions for other languages and constructions. Since equational unification and complex predicates are general concepts, the presented method can also be used in other unification-based linguistic formalisms.

References

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[2] It is clear that verbs with different valency frames need to be treated by different equations. To make the declarations more transparent to traditional linguists, one could use equation templates to express more equations with merely one expression (much like $S \to \mathcal{C}^+$ is a rule template which represents an infinite set of context-free rules).