

1. Review of Current Framework (Simple Categorical Grammar)

1. Basic Principles

The following are the fundamental principles of **Basic (Simple) Categorical Grammar**.

- (1) Every significant-phrasal-unit (*constituent*) is assigned a **type**.
- (2) Types include **primitive types** and **derivative types**.
 - (a) primitive-type phrases are complete, and accordingly do not take input.
 - (b) derivative-type phrases (a.k.a. **functors**) are incomplete; they take input.
- (3) Functors are categorized according to what types of phrases they take as input and what types of phrases they produce as output.
- (4) (**simplified**) Every syntactic composition is achieved by applying a **unary functor** to an argument. In particular, a phrase of type \mathfrak{J}_2 is obtained by combining a functor of type $\mathfrak{J}_1 \rightarrow \mathfrak{J}_2$ with a phrase of types \mathfrak{J}_1 .
- (5) Further syntactic formatting restrictions apply to composition.

2. Current Type Assignments

1. Primitive Types

- (1) D definite-noun-phrase (DNP) ["name"]
- (2) C common-noun-phrase (CNP)
- (3) S sentence

2. Derivative Types

- (4) if \mathfrak{J}_1 and \mathfrak{J}_2 are types, then so is $(\mathfrak{J}_1 \rightarrow \mathfrak{J}_2)$;
- (5) nothing else is a type.

3. Examples

(1)	one-place connective	$S \rightarrow S$
(2)	two-place connective	$S \rightarrow (S \rightarrow S)$
(3)	verb phrase	$D \rightarrow S$
(4)	transitive verb	$D \rightarrow (D \rightarrow S)$
(5)	CNP-modifier	$C \rightarrow C$
(6)	definite determiner	$C \rightarrow D$
(7)	quantifier	$C \rightarrow [(D \rightarrow S) \rightarrow S]$
(8)	quantifier phrase	$(D \rightarrow S) \rightarrow S$
(9)	restrictive relative pronoun	$(D \rightarrow S) \rightarrow (C \rightarrow C)$
(10)	adjectival preposition	$D \rightarrow (C \rightarrow C)$

2. Shortcomings of Basic (Simple) Categorical Grammar

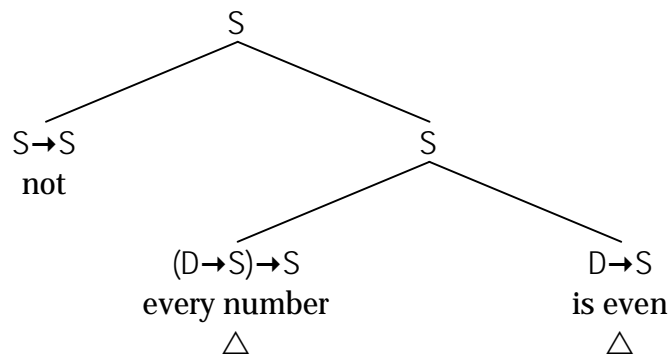
1. Negation

In logic at least, the negation-operator ('not') is officially characterized as a one-place connective, which is to say:

$$\text{type(not)} = S \rightarrow S$$

In the following example, this analysis works flawlessly.

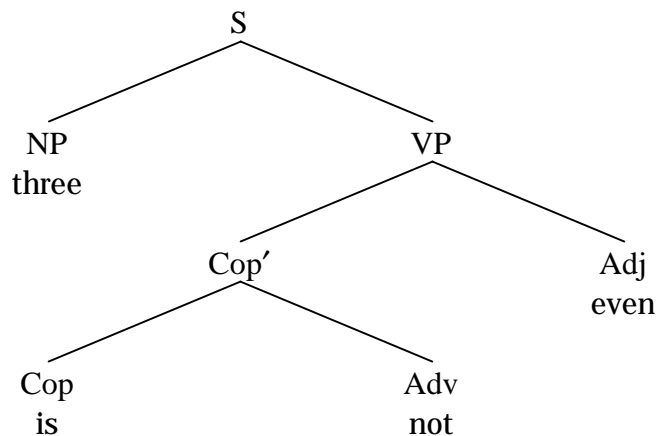
not every number is even



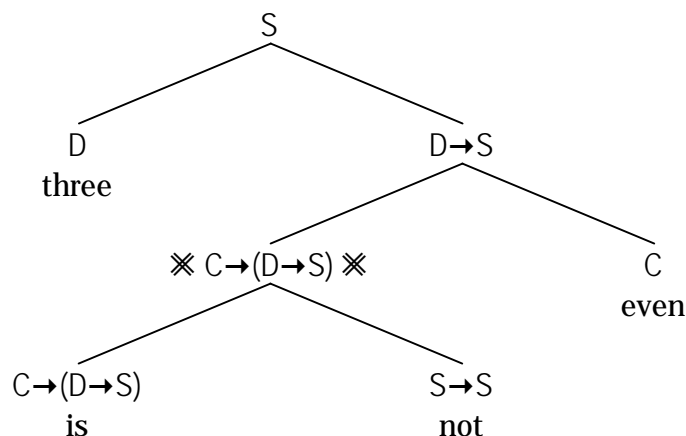
But this is the exception, not the rule. More commonly we have the following sort of example.

three is not even

First, the following is a fairly plausible analysis using traditional categories.



On the other hand, the associated type-analysis looks thus.



The problem is that 'is' and 'not' do not combine properly by the categorial rules, since neither serves as an argument for the other.

2. QPs as Direct-Objects

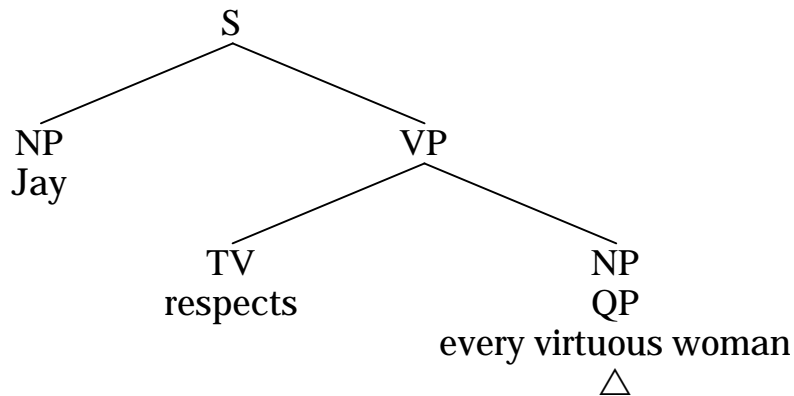
So far, every QP we have considered has been a subject, as in the following example.

every woman is virtuous

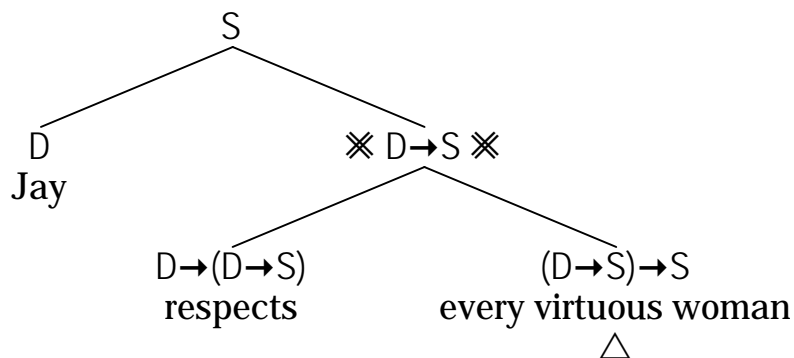
But a QP can also serve as a direct-object, as in the following example.

Jay respects every virtuous woman

How do we grammatically analyze such a sentence? The traditional syntactic-analysis goes as follows.



When we translate this into categorial grammar, with the usual type-assignments, we obtain the following tree.



The problem occurs when combining ‘respects’ with ‘every virtuous woman’; in particular, neither takes the other as argument, so the expected output – $D \rightarrow S$ – is not properly achieved by standard categorial means.

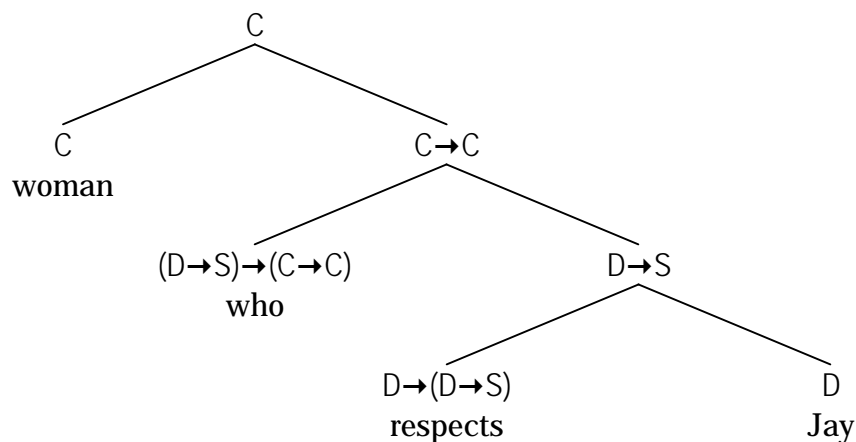
3. Accusative Relative Pronouns

Recall that a restrictive-relative-pronoun – e.g., ‘who’ – is categorially rendered as follows.

$$\begin{aligned} \text{type}(\text{who}) &= \text{VP} \rightarrow \text{Adj} \\ &= (\text{D} \rightarrow \text{S}) \rightarrow (\text{C} \rightarrow \text{C}) \end{aligned}$$

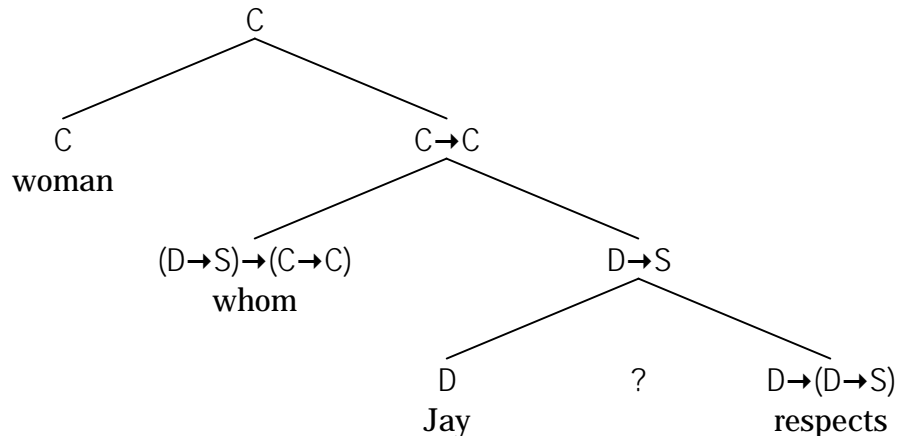
This works perfectly when ‘who’ is nominative, as in the following phrase structure.

woman **who** respects Jay



But what happens if ‘who’ is accusative, in which case it is (optionally) pronounced ‘whom’, as in the following phrase structure.

woman **whom** Jay respects



The syntax *seems* to work in accordance with the categorial rules. The problem is that ‘respects’ is supposed to precede its argument, not follow it. Another problem is that the phrase ‘Jay respects’ is not a VP in the *usual* sense, since it cannot be *appended* to an NP to form a sentence. For example, the following is ill-formed in standard English.¹

⊖ Kay Jay respects

¹ There are non-standard dialects of English, such as spoken by Yoda in *Star Wars*, that allow "fronting", according to which this is well-formed. Other phrases Yoda utters are completely wacky, as in:

begun the clone wars have

3. Revised Categorical Grammar

In order to overcome the above difficulties, and numerous other difficulties, we propose to revise and expand categorial grammar in the following ways.

- (1) we add **case-markers**, which include the usual thematic cases as well as anaphoric cases;
- (2) we significantly **expand the rules** for categorial-composition;
- (3) we add **category-multiplication** (\times) as a (**full-fledged**) **category operation**.

We consider each of these in turn.

4. Case-Marking

Cases mark *roles* of noun-phrases² in respect to verbs, where the marking is usually accomplished by one of three syntactic devices –

word-order
inflection
adposition

the latter of which includes pre-position and post-position. For example, English *mostly* uses word-order to distinguish subjects of verbs from objects of verbs, but it also uses inflection and prepositions to mark cases.

On the other hand, Korean and Japanese use post-positions. For example, in the Japanese sentence³

John ga Mary ni hon o yatta

the postposition ‘ga’ indicates that ‘John’ is the subject of the verb ‘yatta’ [= ‘gave’], whereas the postposition ‘ni’ indicates that ‘Mary’ is the indirect object, and the postposition ‘o’ indicates that ‘hon’ [= ‘book’] is the direct object.

By contrast, the following sentence employs the other three case-marking methods.

Jay recommended his mother to Kay

First, the preposition ‘to’ indicates that ‘Kay’ is the indirect object of the verb ‘recommended’. The subject of the verb is ‘Jay’, which is so marked by preceding the verb, and the direct object is ‘his mother’, which is so marked by following the verb. Finally, the word ‘his’ is an inflected form of ‘he’ used to mark a genitive role.

Note that, since it makes no difference to semantics, we do not distinguish inflection, which is part of word-structure (morphology), from other case-marking methods, including word-order and adposition. In particular, for the sake of simplifying our terminology, we will loosely call all these devices “case-inflection”. Also, we will concentrate on case-inflection, so when we use the word ‘inflection’ without modification, we *usually* mean case-inflection.

In English, the prominent cases include the following.

² **Noun-phrase** is a syntactic category that includes names [D] and quantifier phrases [D→S.→S].

³ This example is borrowed from www.sil.org.

nominative	usually the <i>subject</i> of a verb phrase, marked by preceding the verb { Jay he she } respects everyone
accusative	usually the <i>direct object</i> of a transitive verb phrase, marked by following the verb everyone respects { Jay him her }
dative	usually the <i>indirect object</i> of a di-transitive verb, usually marked by ‘ to ’ Jay wrote a letter to { Jay him her }
ablative	usually the <i>indirect object</i> of a di-transitive verb, usually marked by ‘ from ’ Kay received a letter from { Jay him her }
bylative	usually the agent in a passive construction, usually marked by ‘ by ’ Jay is respected by { Jay him her }
genitive⁴	associated with certain <i>inherently-relational</i> common nouns, including: mother, brother, friend, capital, premise marked by ‘ of ’ and also by the suffix apostrophe-‘s’ (plus irregular forms)

5. Case-Inflected Types

For the purpose of categorially rendering cases, we propose case-inflected types, including the following.⁵

D ₁	nominative-inflected	names
D ₂	accusative-inflected	
D ₃	dative-inflected	
D ₄	ablative-inflected	
D ₅	bylative-inflected	
D ₆	genitive-inflected	

The inflectional morphemes themselves are notated, and categorized, as follows.⁶

[+ 1]	nominative inflection	D→D ₁	
[+ 2]	accusative inflection	D→D ₂	
[+ 3]	dative inflection	D→D ₃	D ₂ →D ₃
[+ 4]	ablative inflection	D→D ₄	D ₂ →D ₄
[+ 5]	bylative inflection	D→D ₅	D ₂ →D ₅
[+ 6]	genitive inflection	D→D ₆	D ₂ →D ₆

⁴ Genitive case and possessive "case" are syntactically very similar, but semantically quite different. We do not include possessive "case", since we prefer to treat possessive forms as adjunctive-prepositions, not as case-markers. See later chapter.

⁵ More generally, we propose to case-inflect all types, and we propose an infinite sequence of case-markers.

⁶ Note carefully that the last four case-markers are presented with two types. The secondary type is proposed in order to render case-marking prepositions syntactically similar to adjunctive-prepositions.

More generally, we propose to use the full set of integers to encode cases. In addition to the "positive" cases, which correspond to thematic roles, we also propose a "nullative" case, encoded by 0, and infinitely-many "negative" cases, encoded by negative integers. The latter are used for anaphoric cross-referencing and binding.

6. Re-Categorizing Verbs

Next, we propose to categorize all verbs according to what inflected-types they take as arguments. For example, an ordinary transitive verb like 'respect' takes both a nominative argument and an accusative argument, and is categorized as follows.

$$\text{type}(\text{respect}) = D_2 \rightarrow (D_1 \rightarrow S)$$

On the other hand, di-transitive verbs come in at least two varieties, illustrated as follows.

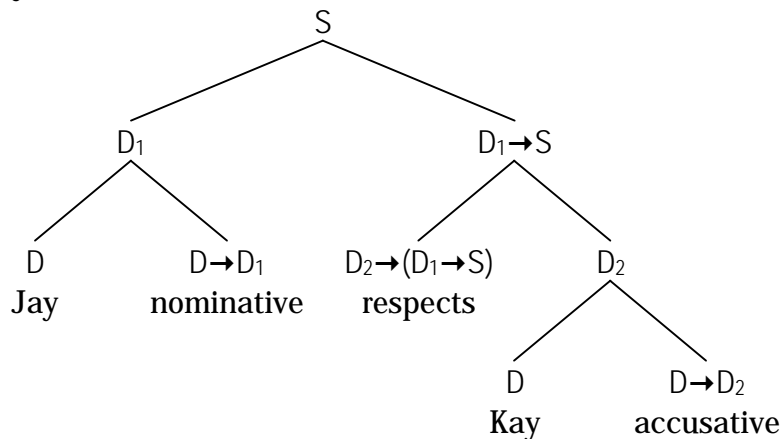
$$\text{type}(\text{sell}) = D_2 \rightarrow [D_3 \rightarrow (D_1 \rightarrow S)]$$

$$\text{type}(\text{buy}) = D_2 \rightarrow [D_4 \rightarrow (D_1 \rightarrow S)]$$

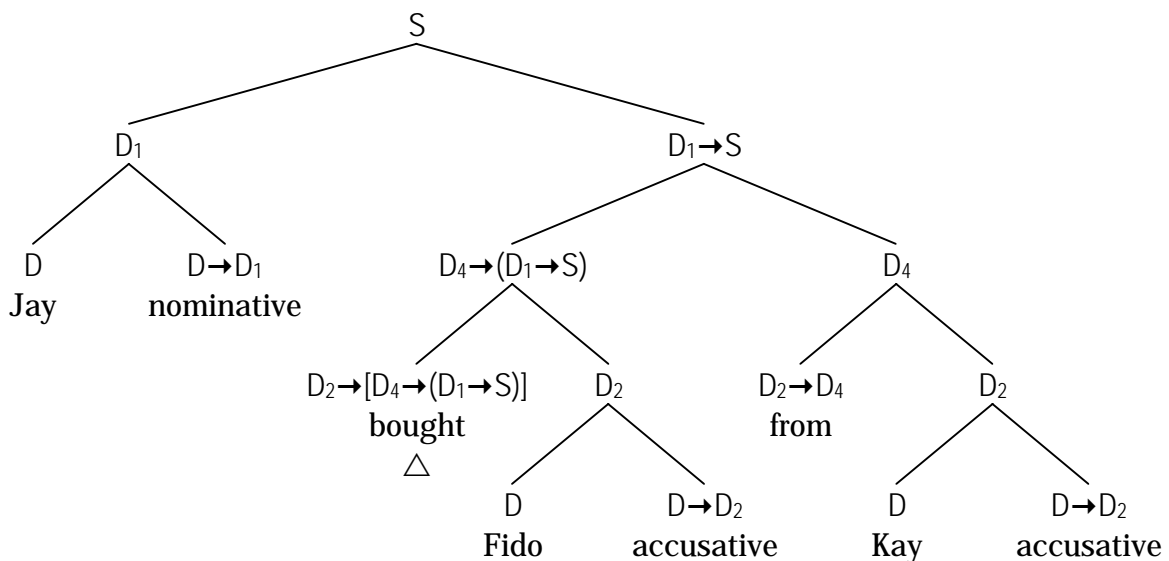
For example 'sell' takes an accusative argument, and delivers a functor that takes a dative argument, and delivers a functor that takes a nominative argument and delivers a sentence.

7. Simple Examples

1. Jay respects Kay

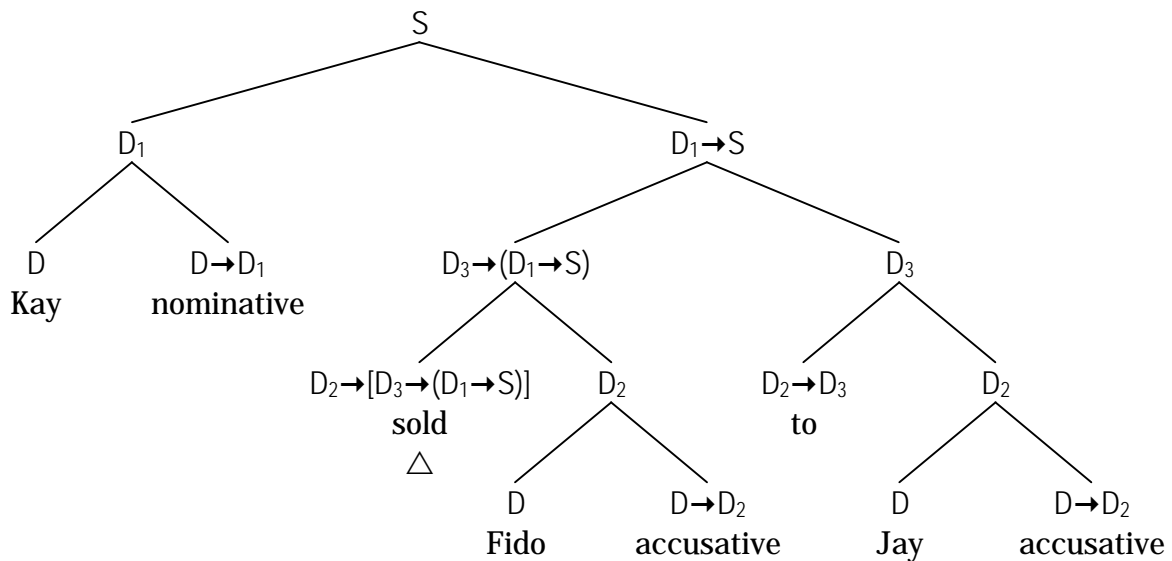


2. Jay bought Fido from Kay



We propose to treat 'from' as a case-marking pre-position, which in particular takes an accusative input and delivers an ablative output. The following is a similar example.

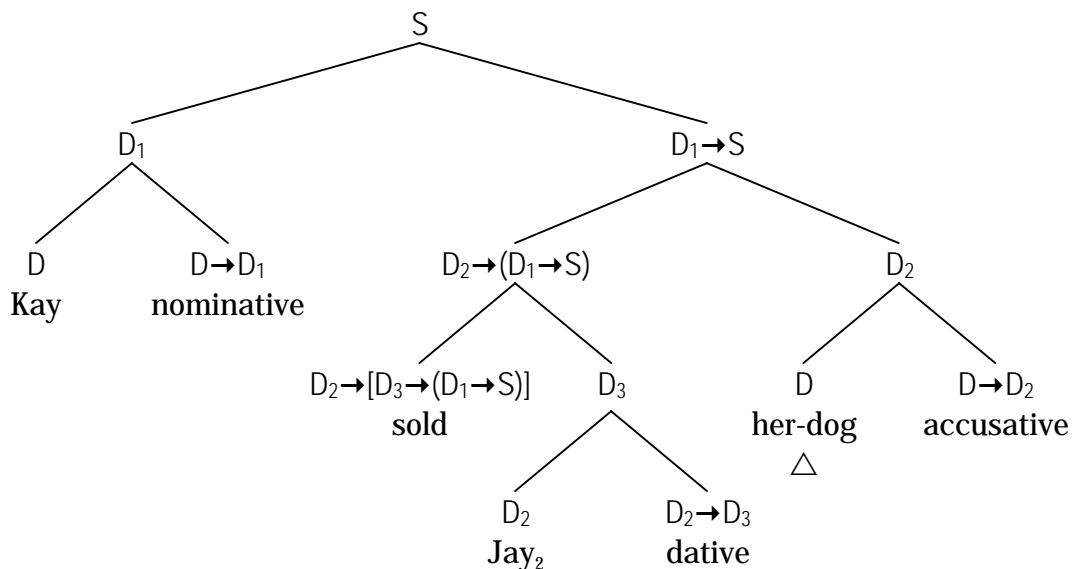
3. Kay sold Fido to Jay



We similarly propose to treat ‘to’ as a case-marking preposition, which in particular takes an accusative input and delivers a dative output.

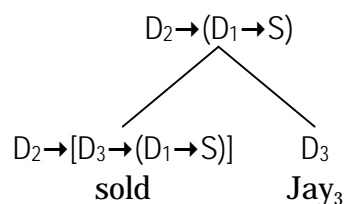
We next observe that English offers an alternative dative construction, illustrated in the following example.

4. Kay sold Jay her-dog



8. Type Mismatch!

We now face an immediate and serious categorial problem. In particular, in the previous example, notice the following sub-tree.



Notice in particular that ‘sell’ officially takes an accusative argument, but ‘Jay₃’ is dative. Thus, we have a type mismatch.

We propose to solve this problem by expanding grammatical-composition.