

## Generating CoLAG Languages Using the ‘Supergrammar’

This is a technical report describing the grammar and procedure that was used to generate the CoLAG 2011 Domain. The original CoLAG domain (circa 2003) was generated by a grammar written by Janet Dean Fodor, Yana Melnikova, Erika Troseth, William Gregory Sakas & Eiji Nishimoto. This updated technical report, which includes much of the original grammar, was written by William Gregory Sakas and Janet Dean Fodor<sup>1</sup>.

The grammar below contains a core of universal feature assignments, with modulations (e.g., for word order and morphological marking) dependent on particular syntactic parameter values. It takes the form of an enriched phrase structure grammar which can be implemented in a computer program; the CoLAG 2011 Domain (available at <http://www.colag.cs.hunter.cuny.edu/projects.html>) was generated by a C++ implementation of the grammar. The grammar rules are organized subtree by subtree (e.g., CP, CBAR, etc.); the subtrees are intended to be unified into complete sentential trees. All relevant definitions are given below.

The syntactic parameters and their values are shown in the table below. There are 13 binary parameters each with values 0 and 1; for purposes of generating languages with the supergrammar, the assignment of 0 or 1 is arbitrary (e.g., 0 does not signify a default value). In later work, these same parameters were in some cases renamed and some default values were reassigned, as in Table 1 in Sakas & Fodor (2012) available at: [http://www.colag.cs.hunter.cuny.edu/pub/Sakas\\_Fodor\\_Disambiguating\\_prepub.pdf](http://www.colag.cs.hunter.cuny.edu/pub/Sakas_Fodor_Disambiguating_prepub.pdf). The reasons for these adjustments are discussed in that paper. Either characterization generates exactly the same set of languages and sentence structures. The table below shows the parameters and their values in the format pertinent to the supergrammar as presented in this document.

Parameter Name	Parameter Abbreviation	Parameter Value	Name for the Value
Subject Initial	SI	0	Subject Initial
		1	Subject Final
Object Final	OF	0	Object Final
		1	Object Initial
Complementizer Initial	CI	0	Complementizer Initial
		1	Complementizer Final
Obligatory Topic	ObT	0	Obligatory Topic
		1	Optional Topic
Null Subject	NS	0	No Null Subject
		1	Optional Null Subject
Null Topic	NT	0	No Null Topic
		1	Optional Null Topic
WH-Movement obligatory	WH-M	0	No WH-Movement
		1	Obligatory WH-Movement
Pied Piping	PI	0	Pied Piping
		1	Preposition Stranding
Topic Marking	TM	0	No Topic Marking
		1	Obligatory Topic Marking
V to I Movement	VtoI	0	No V to I Movement
		1	Obligatory V to I Movement
I to C Movement	ItoC	0	No I to C Movement
		1	Obligatory I to C Movement
Affix Hopping	AH	0	No Affix Hopping
		1	Affix Hopping
Question Inversion	Qinv	0	No Question Inversion
		1	Obligatory Question Inversion

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## Notation and definitions

“ftr” is an abbreviation for “feature”.  
“dtr” is an abbreviation for “daughter”.  
“prp” is an abbreviation for “parameter”.  
“lg” is an abbreviation for “language”.

Square brackets are used for feature-value specifications, e.g., [+FIN] indicates the finiteness of an auxiliary or a verb.

Also, as shorthand for parameter-value specifications, the supergrammar uses square brackets and the parameter name abbreviations, e.g., [0 VtoI] indicates the negative value of the V to I Movement parameter. (In past and current CoLAG research, the values of parameters are taken to be ‘treelets’, i.e., underspecified fragments of tree structure. In the supergrammar, designed to feed computer implementations, the feature-style notation is more practical.)

## Features

[+H] is a feature on the head dtr, used for ordering sibling nodes; it does not appear in the tree structures in the CoLAG 2011 Domain.

ILLOC is a category-valued ftr indicating illocutionary force, with values: Q, DEC and IMP; its default is absence.

SLASH is a category-valued ftr used to relate moved items with their traces in the style of GPSG. Its possible values are an auxiliary or a lexical verb, the subject, and complements of the verb. For the purposes of this grammar, argument-valued SLASH is distinguished from verbal-valued SLASH (to permit imposition of the constraint that a node may have both, but no more than one of each type). Note that this distinction between SLASH-value types is present in the supergrammar, but is suppressed in the CoLAG 2011 Domain tree structures.

[+FIN] marks finiteness on an auxiliary or a verb.

[+TOPIC] marks a topicalized element (left dtr of CP).

[+NULL] marks lexical elements in the tree structure that are not overtly realized in the terminal string. Some [+NULL] items are traces, others are null subjects or null topics.

[+WH] marks a wh-interrogative clause; the feature is passed down from CP to the interrogative item either in situ or fronted.

[+WA] marks a topicalized item in languages with overt morphological topic marking.

? is a variable over possible values of the ftr in question. E.g., [? FIN] is compatible with either [+FIN] or [-FIN].

## Notes on features

1) Minus ftr specifications need not appear in the generated subtrees (and do not appear in the 2011 CoLAG Domain). Minus values can be assumed whenever a plus value is not specified. Also, in the supergrammar, minus values are overtly specified only where necessary. For non-Boolean features (category-valued features SLASH, and ILLOC), there is no default value; the default is absence of the feature.

2) For simplicity, the value of a SLASH feature does not carry any features (e.g., [SLASH Verb], but not [SLASH Verb[+FIN]]). For purposes of trace creation, [SLASH Verb] on Verb[+FIN] qualifies as a match, permitting [+NULL] to be added to Verb[+FIN]. It so happens, in the current version of the supergrammar, that none of the features need to percolate inside a SLASH feature (e.g., no agreement features on extracted elements) though richer versions could readily be created.

**Note:** There are also “parameter relevance tags” (listed as PRR-REL) which are not functional features in the supergrammar. They are present in the supergrammar as a convenient summary of which parameters are relevant to the generation of a given subtree. These are of interest for some applications (e.g., acquisition) but are not needed for subtree generation since they play no role in unification. These relevance tags are suppressed in the CoLAG 2011 Domain tree structures.

## Lexicon

The supergrammar does not contain a separate lexicon component. Instead, some subtrees specify that a nonterminal node dominates a certain lexical item. The set of universally available lexical items is as follows: *S*, *O1*, *O2*, *O3*, *P*, *Adv*, *Aux*, *Verb*, *not*, *never*, *that*, *ka*, and suffix *-wa*.

*S* is a subject;  
*O1* is a direct object;  
*O2* is an indirect object;  
*O3* is the object of a preposition (or postposition, thus technically an adposition);  
*not* is the head of NegP above VP;  
*never* is an adverb located in specifier position (non-head daughter) of NegP.  
*that* is a declarative complementizer which is always phonologically null in main clauses;  
*ka* is an interrogative complementizer;  
*-wa* is a topic-marking suffix (which appears on items with the feature [+WA]);

### Notes on lexical insertion

- 1) *O2* can be present only if *O1* is.
- 2) No type of complement of the verb is permitted to appear more than once in the same VBAR, with or without the same ftrs, e.g., there can't be both PP and PP[SLASH PP][+NULL].
- 3) In the rules for VBAR subtrees, an obliqueness ranking is defined over the complements of the verb (*O1*, *O2*, PP, Adv). This is used to control their order under VBAR such that less oblique complements are closer to the head.

### Miscellaneous notes

1a) A ftr tagged as "COPIED DOWN" means the ftr value is identical to the one on its mother. The supergrammar assumes top-down generation within subtrees. (Though the subtrees could be constructed in any order.)

1b) A ftr tagged as "NEW" means the ftr value is freshly assigned by a rule for that subtree; if it is identical to the mother's value, that's just coincidental.

2) Rules applying within a single subtree should be applied in the order presented (rule-ordering is often critical). At the end of generating a subtree, all OBLIGATORY FTRS which have not been assigned a value by the rules should be assigned their default value.

3) The Nonterminal Filter: After maximal unification, discard any tree which has a nonterminal node that does not dominate a terminal item. Any node with the ftr [+NULL], even if it is normally a nonterminal when not null, counts as a terminal item for purposes of the Nonterminal Filter. This acts as a safety net to catch incomplete trees.

4) The CoLAG domain has some universal constraints between parameters which rule out certain combinations of parameter values:

[1 NT] is incompatible with [1 NS] and also incompatible with [1 ObT].

[1 AH] is incompatible with [1 Vtol].

E.g., a language could not have both positive Null Subject and Null Topic values. These constraints are intended to be used in conjunction with the rules in the supergrammar; they limit the set of possible grammars used to generate languages in the domain.

## How to apply the supergrammar

The supergrammar is designed to generate subtrees language by language i.e., with a value fixed for each parameter before generation begins.

### To generate a forest of subtrees, for one language in the domain:

For a given (permissible) combination of prr values, do the following to generate all the subtrees of one language in the domain:

1. For each subtree level, create one or more structural skeletons in accord with the specifications for mother and daughter nodes and the OBLIGATORY FTRS and POSSIBLE FTRS on them.
2. Any ftr which is shown in the skeleton with “?” value represents an option. Generate a maximal set of subtrees by exhausting all specified options. A value must be inserted in place of the “?” by the time a subtree is finished. If the subtree rules do not supply a value the default value is inserted.

### To generate a complete tree structure for a sentence in a particular language, combine subtrees from that language as follows:

1. Exactly one of those subtrees must have a CP mother.
2. Two subtrees can be combined if they unify on a node (i.e., two subtrees can be combined if the values of all ftrs on a node-type, e.g., IBAR, are the same for a subtree in which that node-type is a dtr, as for a subtree in which it is the mother).
3. Continue step 2) until no more unification is possible.
4. A sentential tree structure is complete if it satisfies the Non-Terminal Filter condition.

### To generate a complete language:

For a given (permissible) combination of prr values:

- Assemble the maximal set of complete sentence structures that can be created by exhaustive unification of subtrees as above.

### To generate the domain of languages:

- Assemble all complete languages, each resulting from one (permissible) distinct combination of prr values.

I. CP Subtrees.

MOTHER: CP  
OBLIGATORY FTRS: [ILLOC ?] [ ? FIN] [ ? WH] (See rule under a. below.)  
POSSIBLE OTHER FTRS: none  
PRR-REL: ObT, NT, WH-M, TM

HEAD DAUGHTER: CBAR[+H]  
OBLIG FTRS: COPIED DOWN: [ILLOC ?] [ ? FIN] [ ? WH] (see rules under d. below)  
POSSIBLE FTRS: [argument-SLASH ?] (see rules under d. below)

NONHEAD DTR: THIS DTR IS NOT ALWAYS PRESENT. (See rules b. below.)

Category is variable. (See rules b. below)

OBLIG FTRS on nonhead, if it is present: [+TOPIC] [ ? WH] [ ? NULL]. (See rules c. below.)

POSSIBLE FTRS on nonhead: [+WA]. (See rules under c. below.)

ORDER OF OPERATIONS:

FIRST order the dtrs:

- [+H] is final.

THEN assign ftrs:

a) Add syntactic ftrs to mother:

- Assign a value for [ILLOC ?].
- If CP has [ILLOC Q], then optionally assign to CP the value [+WH].
- If CP has [ILLOC DEC] or [ILLOC Q], give CP [+FIN].

b) Create (in some cases) a non-head dtr for the CP subtree, as follows:

- If CP has [ILLOC DEC], or if CP has [ILLOC Q] & [+WH], then insert a non-head daughter of CP, optionally if the lg is [1 ObT] and obligatorily if the lg is [0 ObT] or if the lg is [1 WH-M] and CP has [+WH].
- The category of the nonhead dtr can be S or O1 or O2 or Adv. Or O3 if [1 PI]. Or PP if [0 PI].

c) Add ftr values to the non-head dtr (if one has been created):

- In all cases, add [+TOPIC].
- If [1 WH-M] and CP has [+WH], then copy the [+WH] from CP to the non-head dtr.
- If [0 WH-M] and CP has [+WH], then optionally copy [+WH] to the non-head dtr.
- If [1 NT], optionally add the ftr [+NULL] to the non-head dtr of CP, unless the non-head dtr has [+WH].
- If the lg is [1 TM] and the non-head dtr does not have the ftr [+NULL], add the ftr [+WA] to the non-head dtr.

d) Add ftr values to the head dtr CBAR (after applying rules b. and c.).

- Copy the value of [ILLOC ?] and of [ ? FIN] to CBAR.
- Add the ftr [argument-SLASH X] to the head dtr (CBAR) if a non-head dtr of category X is now under CP (for X = S, O1, O2, O3, PP or Adv).
- If [0 WH-M] and CP has the ftr [+WH], and there is no non-head dtr, copy [+WH] to CBAR.
- If [0 WH-M] and CP has the ftr [+WH], and a non-head dtr exists but does not have the ftr [+WH], then copy [+WH] to CBAR.

## II. CBAR Subtrees.

MOTHER: CBAR  
OBLIGATORY FTRS: [ILLOC ?] [? FIN] [? WH] (See rules under a. below)  
POSSIBLE FTRS: [argument-SLASH ?] (See rules under a. below.)  
PRR-REL: CI

HEAD DAUGHTER: C[+H]  
OBLIG FTRS: COPIED DOWN: [ILLOC ?]  
POSSIBLE FTRS:  
PRR-REL: Qinv, ItoC

POSSIBLE LEXICAL DTR OF HEAD DTR: ka, Aux[+FIN], Verb[+FIN], Please[+NULL], That[+NULL]  
(see rules under c. below)

NONHEAD DTR: IP  
OBLIG FTRS: COPIED DOWN: [ILLOC ?] [? FIN] [? WH]  
POSSIBLE FTRS: COPIED DOWN: [argument-SLASH ?] [verbal-SLASH ?] (see rules d. below)

### ORDER OF OPERATIONS:

FIRST order the dtrs:

- If [0 CI], [+H] is initial; if [1 CI], [+H] is final.

THEN assign ftrs:

a) Add ftrs to the mother (CBAR):

- Assign a value to [ILLOC ?].
- If CBAR has [ILLOC Q], and if the lg is [0 WH-M], optionally assign to CBAR the value [+WH].
- If CBAR has [ILLOC DEC] or [ILLOC Q], assign [+FIN] to CBAR.
- Optionally add an argument-SLASH ftr to CBAR, with any one of the 6 possible values (S, O1, O2, O3, PP, Adv).

b) Add ftrs to the head dtr (C).

- Copy the value of [ILLOC ?] from CBAR to C.

c) Add a lexical daughter under the head dtr (C) as follows.

- If C has [ILLOC Q] and [0 QInv] and [0 ItoC], insert as the dtr of C [ILLOC Q] the lexical item ka.
- If [1 ItoC], and if C has [ILLOC DEC] or [ILLOC Q], insert the lexical item Aux[+FIN] or Verb[+FIN] as the dtr of C.
- If [1 QInv] and C has [ILLOC Q], insert the lexical item Aux[+FIN] or Verb[+FIN] as the dtr of C.
- If C has [ILLOC IMP], insert as the dtr of C the lexical item Please[+NULL].
- If [0 ItoC] and C has [ILLOC DEC], insert as the dtr of C the lexical item That[+NULL].

d) Add ftrs to the non-head dtr (IP) as follows (after applying rule c).

- Copy the values of [ILLOC ?] [? FIN] [? WH] from CBAR to IP.
- If CBAR has a argument-SLASH ftr on it, copy the argument-SLASH ftr to the IP node.
- If C has the dtr Aux[+FIN] or Verb[+FIN], add to IP a verbal-SLASH ftr whose value is Aux or Verb (without features), respectively.

### III. IP Subtrees.

MOTHER:	IP
OBLIGATORY FTRS:	[? FIN] [ILLOC ?] [? WH] (see rules a.)
POSSIBLE FTRS:	[argument-SLASH ?] [verbal-SLASH ?] (see rules a.)
PRR-REL:	SI, NS
HEAD DTR:	IBAR[+H]
OBLIG FTRS:	COPIED DOWN: [? FIN] [ILLOC ?] NEW [? WH]
POSSIBLE FTRS:	COPIED DOWN: [argument-SLASH ?] [verbal-SLASH ?] (See rules under c. below)
NONHEAD DTR:	S
OBLIG FTRS:	none
POSSIBLE FTRS:	COPIED DOWN: [SLASH S] (See rule under b. below.) NEW: [? NULL] [? WH] (See rules under b. below)

#### ORDER OF OPERATIONS:

FIRST impose word order.

- If [0 SI], [+H] is final; if [1 SI], [+H] is initial.

THEN assign ftrs:

a) Add ftr values to the mother (IP) as follows:

- Assign a value to [? ILLOC].
- If IP has [ILLOC Q] or [ILLOC DEC] assign [+FIN] to the IP node.
- If IP has [ILLOC Q], optionally assign [+WH] to the IP node.
- Optionally assign an argument-valued SLASH ftr to IP.
- Optionally assign a verbal-valued SLASH ftr to IP.

b) Add ftr values to the nonhead dtr (S), after applying rules a.

- If IP has the ftr [SLASH S] on it, then copy the SLASH ftr to the S node, and add [+NULL] to the S[SLASH S].
- If IP has the ftr [ILLOC IMP], add the ftr [+NULL] to the S node.
- If [1 NS] and IP does not have [ILLOC IMP] or [SLASH S], optionally add [+NULL] to S.<sup>2</sup>
- Following the three other rules in this block: If IP has the ftr [+WH] and S does not have [+NULL], then optionally copy [+WH] from the IP to S. (Thus a null subject never has [+WH].)

c) Add ftr values to the head dtr (IBAR) as follows, after applying rules b.

- Copy down the ftrs [? FIN] [ILLOC ?] to IBAR.
- If IP has [+WH], and the non-head dtr S does not have [+WH], then obligatorily copy [+WH] down to IBAR. (Else, by convention IBAR has the default [-WH].)
- If IP has one or more SLASH ftrs on it other than [SLASH S], add copies of those SLASH ftrs to the IBAR node.

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<sup>2</sup> Thus, S can get [+NULL] from 3 sources: S[+NULL] is *pro*, or a trace, or is an implicit “you” in imperatives. It cannot be more than one of these at the same time. If S has a [SLASH S] ftr, it is a trace; if its mother has the ftr [ILLOC IMP], it is an imperative subject; otherwise, it is *pro*.

IV. IBAR Subtrees. There are two ‘skeletons’, one for non-negative sentences, and one for negative sentences.

IBAR NON-NEGATIVE:

MOTHER: IBAR  
OBLIGATORY FTRS: [? FIN] [ILLOC ?] [? WH] (See rules a.)  
POSSIBLE FTRS: [argument-SLASH ?] [verbal-SLASH ?]  
PRR-REL: OF, AH

HEAD DTR: [+H], but not always present. (See rules b.)  
OBLIG FTRS: COPIED DOWN: [ILLOC ?] [? FIN] (See rules c.)

POSSIBLE FTRS: COPIED DOWN: [verbal-SLASH ?]  
PRR-REL: Vtol

OBLIGATORY LEXICAL DTR TO THE HEAD DTR (IF HEAD DTR EXISTS): Aux or Verb (See rules d.)

OBLIG FTRS OF THE LEXICAL DTR TO THE HEAD DTR: COPIED DOWN: [? FIN]  
NEW: [? NULL] (See rules d.)

POSSIBLE FTRS OF THE LEXICAL DTR: [verbal-SLASH ?]

NONHEAD DTR: VP  
OBLIG FTRS: COPIED DOWN: [? WH]  
NEW: [? FIN] (See rules e.)  
POSSIBLE FTRS: COPIED DOWN: [argument-SLASH ?]  
NEW: [SLASH Verb] (See rules e.)

ORDER OF OPERATIONS:

FIRST impose word order:

- If [0 OF], [+H] is initial; if [1 OF], [+H] is final.

THEN assign ftrs:

a) Assign ftrs to the mother IBAR, as follows:

- Assign a value to [? ILLOC]. Then:
- If IBAR has [ILLOC Q] or [ILLOC DEC] assign [+FIN] to the IBAR node.
- If IBAR has [ILLOC Q], optionally assign [+WH] to the IBAR node.
- Optionally assign a verbal-SLASH ftr to IBAR, and/or optionally assign an argument-SLASH ftr to IBAR, except not [SLASH S].

b) Create a head dtr, in some cases, as follows:

- If [0 AH], then create a head dtr I.
- If IBAR has a verbal-SLASH ftr then create a head dtr I.
- If [1 AH], then optionally create a head dtr I.

c) Add ftr values to the head dtr (I), if one has been created, as follows:

- Copy the values of [ILLOC ?] and [? FIN] from IBAR to I.
- If IBAR has a verbal-SLASH ftr, copy that SLASH ftr to I.

d) Assign a lexical daughter (Aux or Verb) to the head daughter (I), if the latter exists, as follows.



- If I has [ILLOC IMP], then add Aux[+NULL] as dtr to I.
- If [1 Vtol] and I has [ILLOC DEC] or [ILLOC Q], then add either Aux or Verb as dtr to I: obligatorily Aux if I has [SLASH Aux] and obligatorily Verb if I has [SLASH Verb].
- If [0 Vtol] and I has [ILLOC DEC] or [ILLOC Q], then add Aux as dtr to I.

Assign ftrs to the lexical daughter of the head daughter (I), if there is one:

- Copy the value of [? FIN] from I to its lexical dtr.
- If I has [SLASH Aux], copy this SLASH ftr to the lexical dtr of I and add [+NULL] to the Aux[SLASH Aux].
- If I has [SLASH Verb], copy this SLASH ftr to the lexical dtr of I, and add [+NULL] to the Verb[SLASH Verb].

e) Add ftr values to the nonhead dtr (VP), as follows:

- Copy the value of [? WH] from IBAR to VP.
- If [1 AH] and there is no head dtr I, then add [+FIN] to VP. (Otherwise, VP will have the default value [-FIN].)
- If IBAR has an argument-SLASH ftr, copy it to VP.
- If I has Verb as its dtr, add [SLASH Verb] to VP.

IBAR NEGATIVE: (All is identical to the non-negative IBAR subtree except for the NegP dtr rules in e. below.)

MOTHER: IBAR  
OBLIGATORY FTRS: [? FIN] [ILLOC ?] [? WH] (See rules a.)  
POSSIBLE FTRS: [argument-SLASH ?] [verbal-SLASH ?]  
PRR-REL: OF, AH

HEAD DTR: I[+H], but not always present. (See rules b.)  
OBLIG FTRS: COPIED DOWN: [ILLOC ?] [? FIN] (See rules c.)

POSSIBLE FTRS: COPIED DOWN: [verbal-SLASH ?]  
PRR-REL: Vtol

OBLIGATORY LEXICAL DTR TO THE HEAD DTR (IF HEAD DTR EXISTS): Aux or Verb (See rules d.)

OBLIG FTRS OF THE LEXICAL DTR TO THE HEAD DTR: COPIED DOWN: [? FIN]  
NEW: [? NULL] (See rules d.)

POSSIBLE FTRS OF THE LEXICAL DTR: [verbal-SLASH ?]

NONHEAD DTR: NegP  
OBLIG FTRS: COPIED DOWN: [? WH]  
NEW: [? FIN] (See rules e.)  
POSSIBLE FTRS: COPIED DOWN: [arg-SLASH]  
(Note: Other rules entail that an [arg-SLASH] here cannot be [SLASH S].)  
NEW: [verbal SLASH] (see special rule under e.)

ORDER OF OPERATIONS:

FIRST impose word order:

- If [0 OF], [+H] is initial; if [1 OF], [+H] is final.

THEN assign ftrs:

a) Assign ftrs to the mother IBAR, as follows:

- Assign a value to [? ILLOC]. Then:
- If IBAR has [ILLOC Q] or [ILLOC DEC] assign [+FIN] to the IBAR node.
- If IBAR has [ILLOC Q], optionally assign [+WH] to the IBAR node.
- Optionally assign a verbal-SLASH ftr to IBAR, and/or optionally assign an argument-SLASH ftr to IBAR, except not [SLASH S].

b) Create a head dtr, in some cases, as follows:

- If [0 AH], then create a head dtr I.
- If IBAR has a verbal-SLASH ftr then create a head dtr I.
- If [1 AH], then optionally create a head dtr I.

c) Add ftr values to the head dtr (I), if one has been created, as follows:

- Copy the values of [ILLOC ?] and [? FIN] from IBAR to I.
- If IBAR has a verbal-SLASH ftr, copy that SLASH ftr to I.

d) Assign a lexical daughter (Aux or Verb) to the head daughter (I), if the latter exists, as follows.

- If I has [ILLOC IMP], then add Aux[+NULL] as dtr to I.
- If [1 Vtol] and I has [ILLOC DEC] or [ILLOC Q], then add either Aux or Verb as dtr to I: obligatorily Aux if I has

[SLASH Aux] and obligatorily Verb if I has [SLASH Verb].

- If [0 Vtol] and I has [ILLOC DEC] or [ILLOC Q], then add Aux as dtr to I.

Assign ftrs to the lexical daughter of the head daughter (I), if there is one:

- Copy the value of [? FIN] from I to its lexical dtr.
- If I has [SLASH Aux], copy this SLASH ftr to the lexical dtr of I and add [+NULL] to the Aux[SLASH Aux].
- If I has [SLASH Verb], copy this SLASH ftr to the lexical dtr of I, and add [+NULL] to the Verb[SLASH Verb].

e) Add ftr values to the nonhead dtr (NegP), as follows:

- Copy the value of [? WH] from IBAR to NegP.
- If [1 AH] and there is no head dtr I, then add [+FIN] to NegP. (Otherwise, NegP will have the default value [-FIN].)
- If IBAR has an argument-SLASH ftr, copy it to NegP.
- If I has Verb as its dtr, add [SLASH Verb] to NegP.

## V. NegP Subtrees.

MOTHER: NegP  
OBLIGATORY FTRS: [? FIN] [? WH]  
POSSIBLE FTRS: [argument-SLASH ?] [SLASH Verb]

HEAD DAUGHTER: NegBAR[+H]  
OBLIG FTRS: COPIED DOWN: [? FIN] [? WH]

POSSIBLE FTRS: COPIED DOWN: [argument-SLASH ?] [SLASH Verb]

NONHEAD DTR: The lexical item "Never". This daughter is not always present.

### ORDER OF OPERATIONS:

FIRST impose word order:

- If [0 OF], [+H] is initial; if [1 OF], [+H] is final.

THEN assign ftrs:

a) Assign ftrs to the mother NegP, as follows:

- Assign any value of [? WH] and of [? FIN] to NegP.
- Optionally add to NegP one argument-valued SLASH ftr, and/or [SLASH Verb].

b) Assign properties to the head daughter (NegBAR):

- Copy the value of [? WH] and of [? FIN] from NegP to NegBAR.
- If NegP has any [SLASH] ftrs, copy them to NegBAR.

c) Optionally create a non-head daughter Never, with no features.

## VI. NegBAR Subtrees.

MOTHER: NegBAR  
OBLIG FTRS: [? FIN] [? WH]. See rule yyy.  
POSSIBLE FTRS: [argument-SLASH ?] [SLASH Verb] (Note: verb raising in +VtoI languages is not blocked by NegP.)  
PRR-REL: OF

HEAD DAUGHTER: Not always present. When present its category is Neg[+H]. See rules xxx.  
OBLIG FTRS: (none)  
POSSIBLE FTRS: (none)

LEXICAL DTR OF HEAD DTR: "Not"  
FTRS OF LEXICAL DTR OF HEAD DTR: (none)

NONHEAD DTR: VP  
OBLIG FTRS: COPIED DOWN: [? FIN] [? WH]  
POSSIBLE FTRS: COPIED DOWN: [argument-SLASH ?] [SLASH Verb]

### ORDER OF OPERATIONS:

FIRST impose word order:

- If [0 OF], [+H] is initial; if [1 OF], [+H] is final.

THEN Assign ftrs:

a) Assign ftrs to the mother NegBAR, as follows:

- Assign any value of [? WH] to NegBAR.
- Assign any value of [? FIN] to NegBAR.
- Optionally assign an argument-SLASH ftr and/or the ftr [SLASH Verb].

b) If the mother NegBar is [-FIN],<sup>3</sup> and if there is no non-head dtr at the NegP level,<sup>4</sup> optionally create a head-dtr (Neg) with no features.

c) If there is a head-dtr, insert "Not" as its lexical dtr, with no features.

d) Assign ftrs to the non-head dtr (VP):

- Copy the value of [? WH] and of [? FIN] down from NegBAR to VP.
- If NegBAR has any SLASH ftrs, copy them to VP.

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<sup>3</sup> This makes a headed NegP incompatible with affix hopping.

<sup>4</sup> This is an ad-hoc constraint preventing double negation in CoLAG sentences. It was not formally integrated into the localist feature unification implementation of the grammar.

## VII. VP Subtrees.

MOTHER: VP  
OBLIGATORY FTRS: [? FIN] [? WH]  
POSSIBLE FTRS: [argument-SLASH ?] [SLASH Verb]

HEAD DAUGHTER: VBAR[+H]  
OBLIG FTRS: COPIED DOWN: [? FIN] [? WH]  
POSSIBLE FTRS: COPIED DOWN: [argument-SLASH ?] [SLASH Verb]

NONHEAD DTR: (NONE)

### ORDER OF OPERATIONS:

a) Assign ftrs to the mother VP, as follows:

- Assign any value of [? WH] and of [? FIN] to VP.
- Optionally add to VP one argument-valued SLASH ftr and/or [SLASH Verb].

b) Assign properties to the head daughter (VBAR):

- Copy down the value of FIN from VP to VBAR.
- Copy down the value of WH from VP to VBAR.
- If VP has any [SLASH] ftrs, copy them to VBAR.

### VIII. VBAR Subtrees.

MOTHER: VBAR  
OBLIGATORY FTRS: [? FIN] [? WH]  
POSSIBLE FTRS: [argument-SLASH] [SLASH Verb]  
PRR-REL: OF

HEAD DAUGHTER: V[+H]  
OBLIG FTRS: COPIED DOWN: [? FIN]  
POSSIBLE FTRS: [SLASH Verb]

LEXICAL DTR OF HEAD DTR: Verb  
OBLIG FTRS OF LEXICAL DTR OF HEAD DTR: [? FIN]  
POSSIBLE FTRS OF LEXICAL DTR: [SLASH Verb] [+NULL]

NONHEAD DTRS: VARIOUS CATEGORIES, see notes below.  
OBLIG FTRS: [? WH] [? NULL]  
POSSIBLE FTRS: [argument-SLASH]

#### ORDER OF OPERATIONS:

FIRST impose word order:

- If [0 OF], [+H] is initial; if [1 OF], [+H] is final.

The order of non-head dtrs, if any, follows from (i) the initial/final status of the head, and (ii) the universal obliqueness hierarchy in the CoLAG domain which requires that less oblique complements are closer to the head. Thus: O1 is closest to V; O2 is next closest to V; PP is next closest; Adv is furthest from V. O2 can be present only if O1 is. There can be no more than one complement of each type within VBAR.

THEN assign ftrs:

a) Assign ftrs to the mother VBAR, as follows:

- Assign a value to [? WH] and [? FIN].
- Optionally add one argument-SLASH ftr and/or [SLASH Verb].

b) Add non-head dtrs, in some cases.

- If VBAR has [SLASH O1], add O1 as a nonhead dtr of VBAR, copy the SLASH ftr onto O1, and add [+NULL] to the O1[SLASH O1].
- If VBAR has [SLASH O2], add O2 and O1 as nonhead dtrs of VBAR, copy the SLASH ftr onto O2, and add [+NULL] to the O2[SLASH O2].
- If VBAR has [SLASH Adv], add Adv as a nonhead dtr of VBAR, copy the SLASH ftr onto Adv, and add [+NULL] to the Adv[SLASH Adv].
- If VBAR has [SLASH PP], add PP as a nonhead dtr of VBAR, copy the SLASH ftr onto PP, and add [+NULL] to the PP[SLASH PP].
- If VBAR has [SLASH O3], add PP as a nonhead dtr of VBAR, and copy the SLASH ftr onto the PP.
- If VBAR has [+WH], insert one non-head dtr in addition to any daughter with an argument-SLASH feature and assign the [+WH] feature to it.
- Optionally add any one or more of O1, O2, PP or Adv as dtrs of VBAR (without any features), if they have not already been added by the rules above, except add O1 obligatorily if O2 is added or is already present.

c) Assign properties to the head daughter (V):

- Copy the value of FIN from VBAR to V.
- If VBAR has a [SLASH Verb] ftr, copy it to V.

d) Assign a lexical dtr to the V dtr of VBAR:

- Insert Verb as the sole dtr of V.
- Copy the value of FIN to Verb.
- If V has [SLASH Verb], copy it to Verb, and add the ftr [+NULL] to the Verb[SLASH Verb].

e) Assign obliqueness order to the non-head dtrs.



IX. PP Subtrees.

MOTHER: PP  
OBLIGATORY FTRS: [? TOPIC] [? WH] [? WA] [-NULL]  
(Note: +NULL PPs do not have daughters; their ftrs have been assigned in the CP and the VBAR subtrees.)

POSSIBLE FTRS: [SLASH O3]  
PRR-REL: OF, PI

HEAD DAUGHTER: P[+H]  
OBLIG FTRS: COPIED DOWN: [? WA]

NONHEAD DTR: O3  
OBLIG FTRS: COPIED DOWN: [? WH]  
POSSIBLE FTRS: [SLASH O3][+NULL]

ORDER OF OPERATIONS:

FIRST impose word order:

If [0 OF], [+H] is initial; if [1 OF], [+H] is final.

THEN assign ftrs:

a) Add ftrs to the mother PP: (Apply all rules in the order given.)

- If [0 PI], optionally assign to PP the ftr [+TOPIC].
- If [1 TM] and PP is [+TOPIC] assign [+WA] to PP.
- If [1 PI] then PP is [-TOPIC] under VBAR; assign optionally to PP the ftr [SLASH O3].
- If PP does not have a SLASH ftr, optionally assign it [+WH].

b) Add ftrs to the head dtr P.

- Copy down [? WA] from the PP to the head-dtr P.

c) Add ftrs to the nonhead dtr O3:

- Copy the [? WH] ftr from PP to O3.
- If PP has the ftr [SLASH O3], copy the SLASH ftr from PP to O3, and put [+NULL] on the O3[SLASH O3].

===== END OF SUPERGRAMMAR =====