Toward the construction of A linguistically valid Japanese CCG treebank

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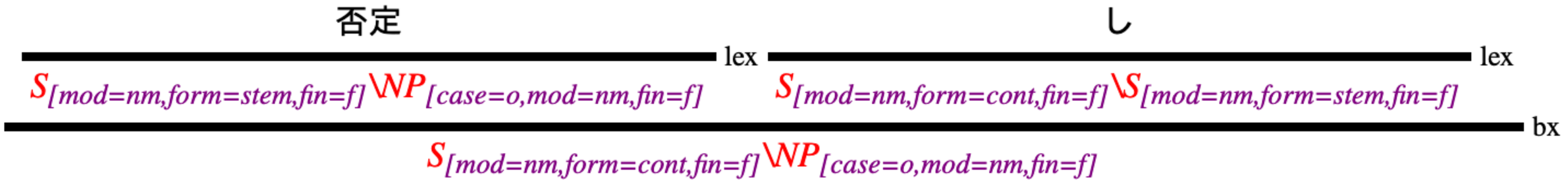
Treebank:

a corpus that annotates the syntactic structures of sentences

ex: Japanese CCGbank [Uematsu et al. 2013]



Combinatory categorial grammar (CCG)
[Steedman 1996, 2001]

Lexicon

Contains words:
their phonological, syntactic and semantic information

Keats $\vdash NP : k$
eats $\vdash (S \setminus NP) / NP : eat$
apples $\vdash NP : apple$

+

Combinatory Rules

ex:
function application rules
function composition rules

Background

Japanese CCG parsers (ex: **depccg** [Yoshikawa et al. 2017], **jigg** [Noji & Miyao 2016])

- Take Japanese sentences as input and then output CCG trees
- Use **CCG treebanks** as training/evaluation data
- Rely on CCG treebanks for their **linguistic validity**

→ We constructed a **linguistically valid** CCG treebank based on Bekki (2010), which we regard as the standard Japanese CCG

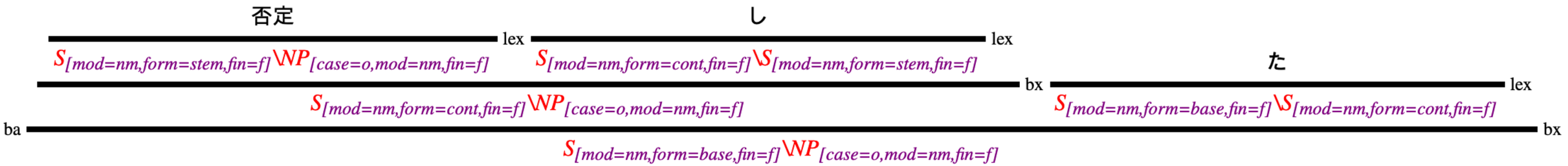
Japanese CCGbank [Uematsu et al. 2013]

Kyoto corpus [Kawahara et al. 2002]

NAIST text corpus [Iida et al. 2007]

Japanese particle corpus [Hanaoka et al. 2010]

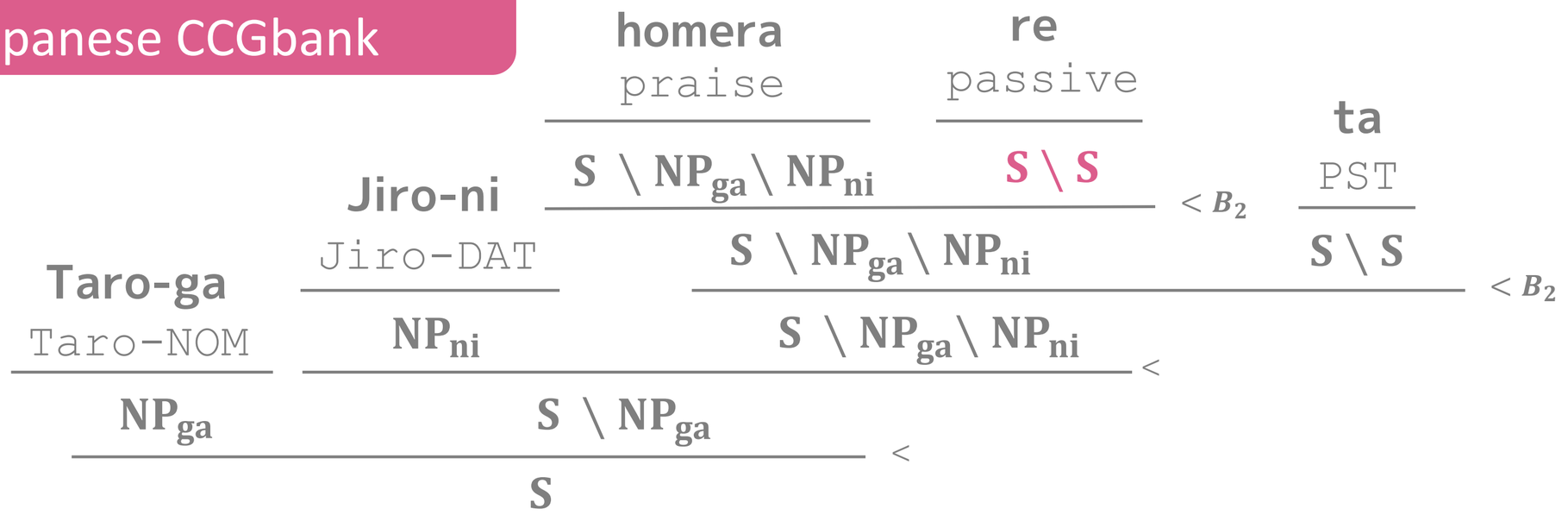
Japanese CCGbank was obtained through automatic conversion of these corpora.



Japanese CCGbank [Uematsu et al. 2013]

Problem: produces false predictions on passive and causative nestings [Bekki & Yanaka 2023]

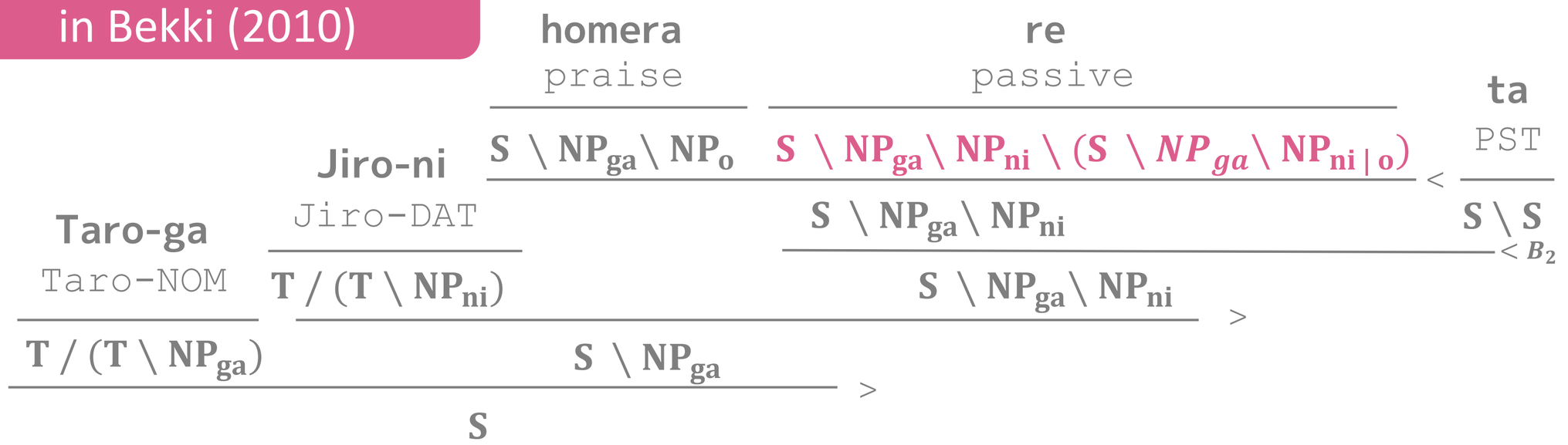
Syntactic structure in Japanese CCGbank



Japanese CCGbank [Uematsu et al. 2013]

Problem: produces false predictions on passive and causative nestings [Bekki & Yanaka 2023]

Syntactic structure in Bekki (2010)



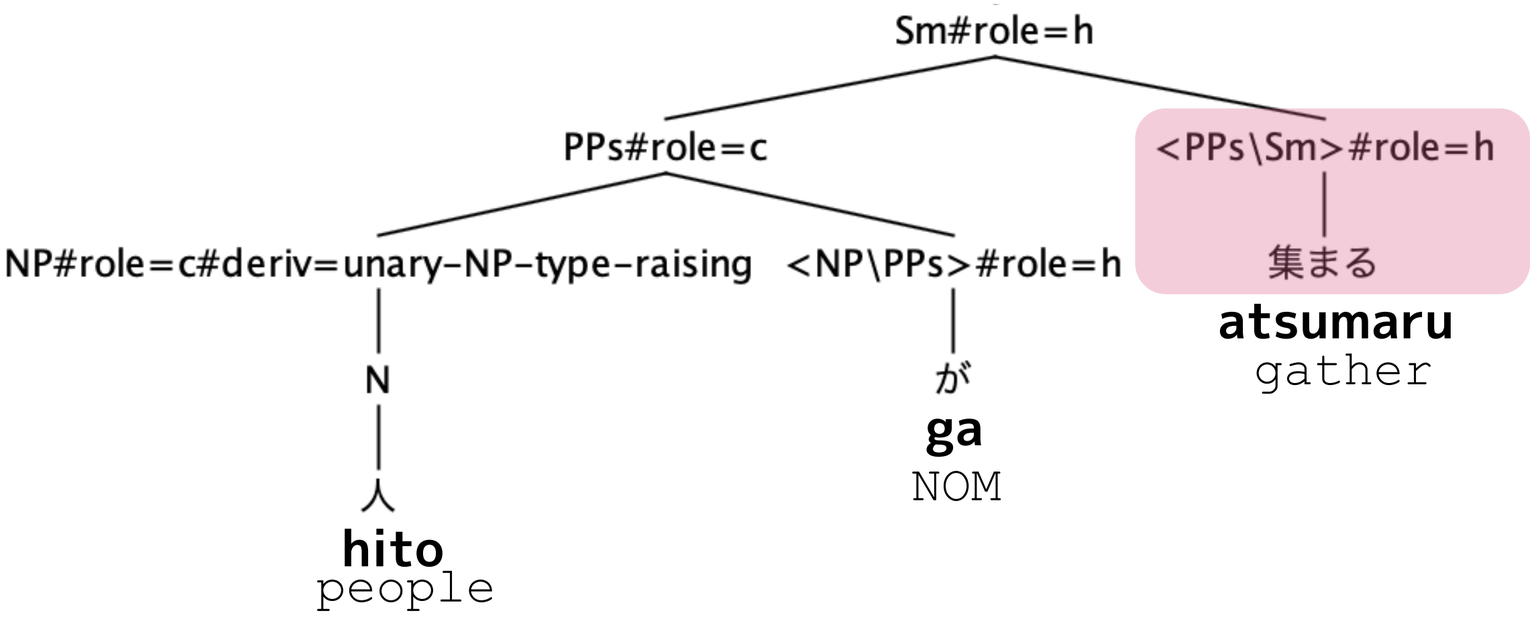
ABCTreebank [Kubota et al. 2019]

- Constructed by converting the Keyaki Treebank [Butler 2012] to **ABC grammar** trees
  (ABC grammar: function application rules + function composition rules)

- Can be easily converted to a CCG or type-logical grammar (TLG) [Morrill 1994; Moortgat 1997] treebank

ABCTreebank [Kubota et al. 2019]

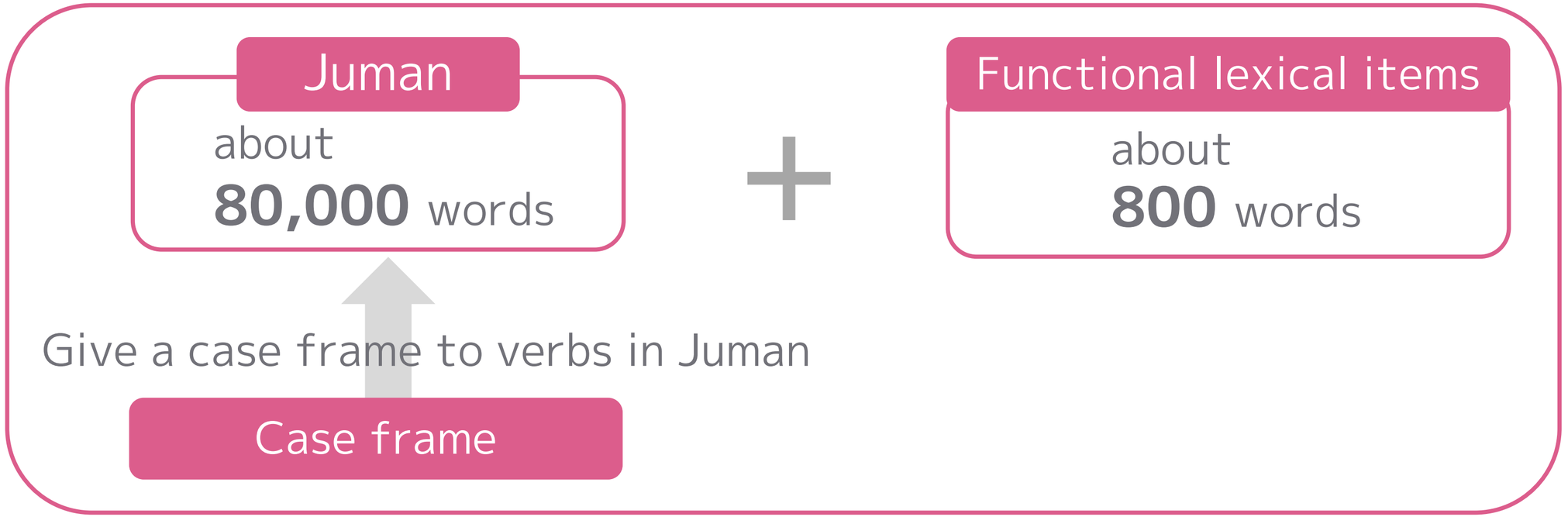
Pros: Argument structures are manually annotated
Cons: Syntactic information such as the part of speech is not included



Ra-column five row conjugation form

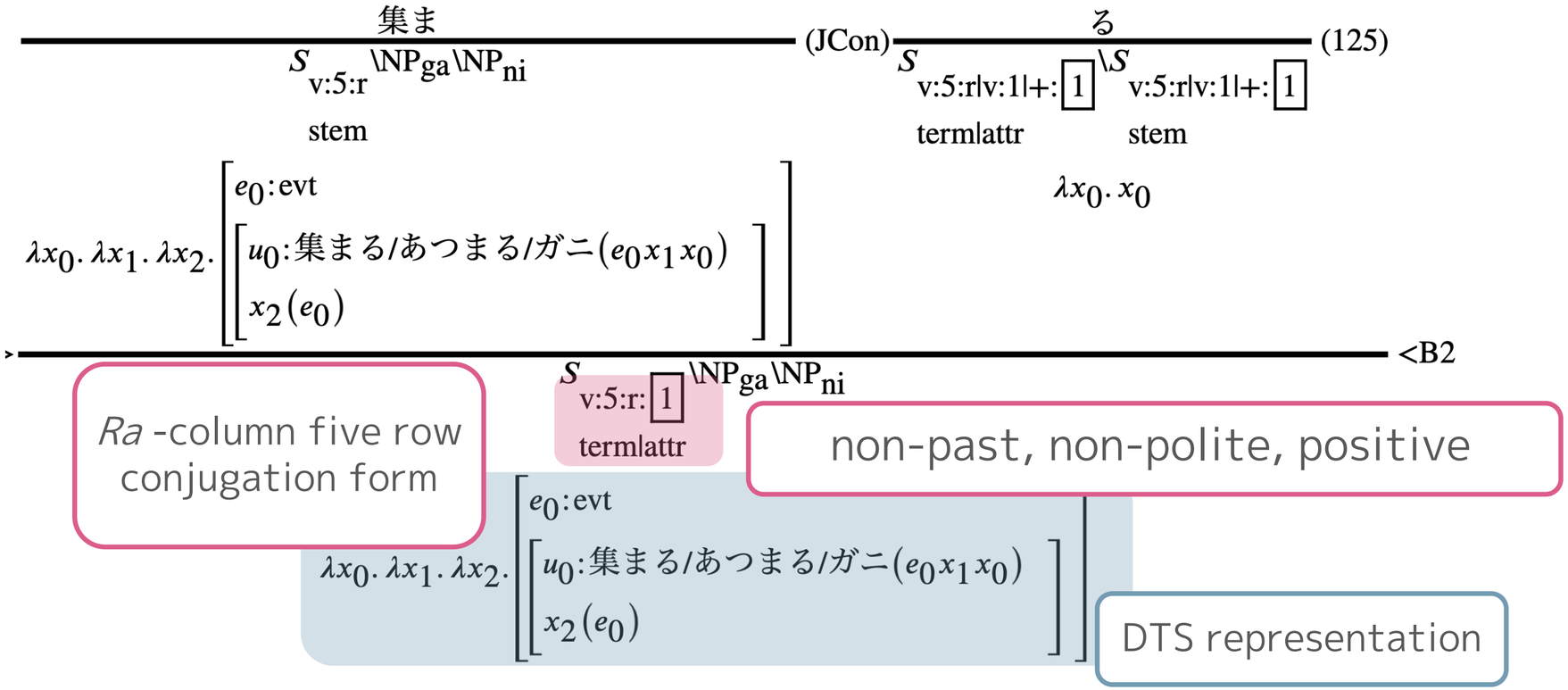
lightblue [Bekki & Kawazoe 2016]

- Japanese CCG parser that utilizes a **lexicon** consisting of 80,000 Juman words with case frames



lightblue [Bekki & Kawazoe 2016]

Pros: provides CCG trees with detailed syntactic features and semantic representations in DTS



lightblue [Bekki & Kawazoe 2016]

Pros: provides CCG trees with detailed syntactic features and semantic representations in DTS

Cons: contains errors in argument structure
→ sometimes gives an unnatural disambiguation in some contexts

Research aim and proposal

Research aim

Construction of a **linguistically valid** Japanese CCG treebank with **detailed syntactic features**

Research aim and proposal

Research aim

Construction of a **linguistically valid** Japanese CCG treebank with **detailed syntactic features**

Proposed Method

ABCTreebank

argument structures are manually annotated

+

lightblue

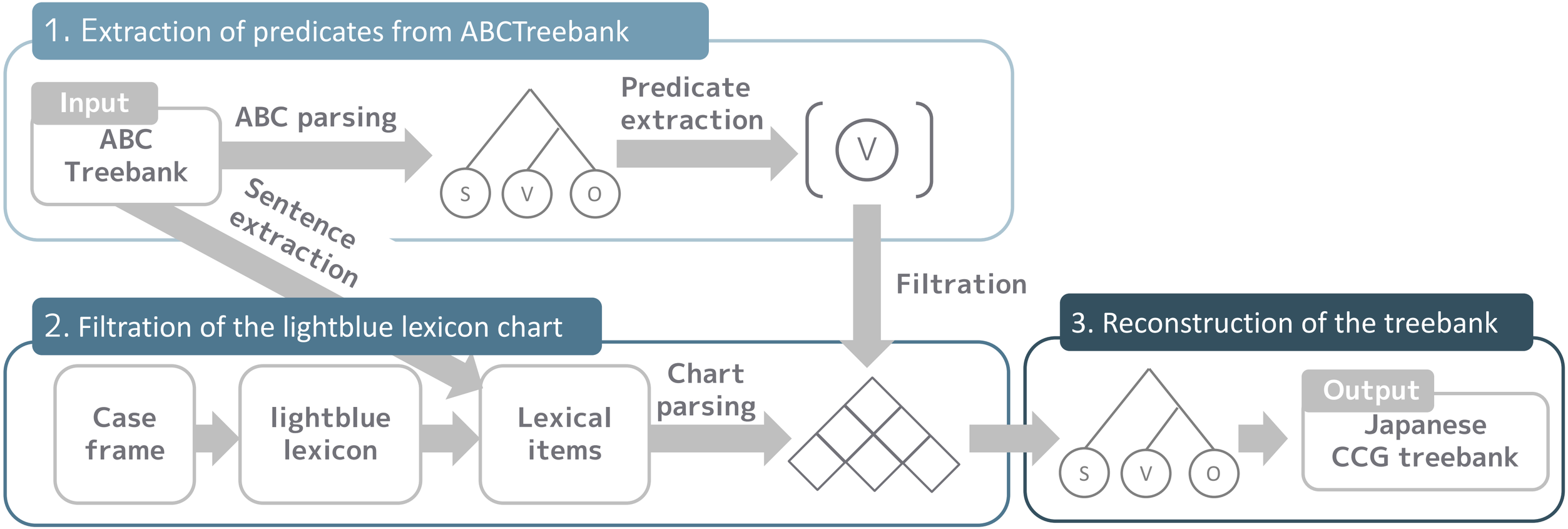
provides CCG trees with **detailed syntactic features and DTS representations**

ABCTreebank reforging

Reforging: a method of **decomposing** and **reconstructing** a treebank

1. Extraction of predicates from ABCTreebank
2. Filtration of the lightblue lexicon chart
3. Reconstruction of the treebank

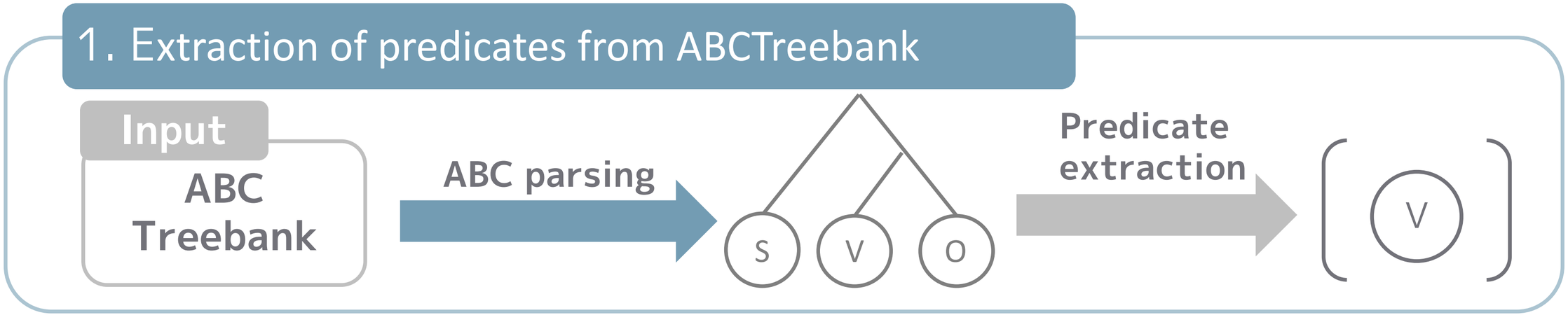
ABCTreebank reforging



Reforging – extraction of predicates from ABCTreebank

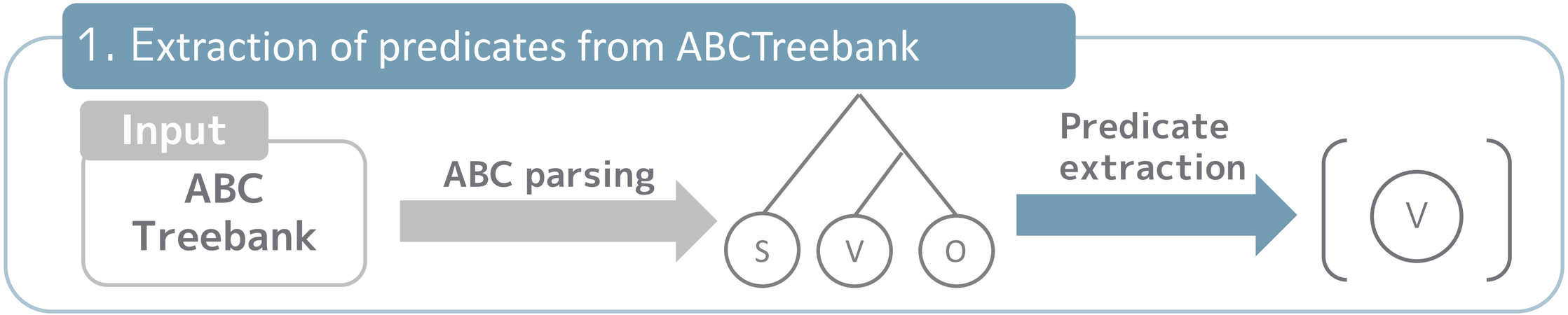
1. Extraction of predicates from ABCTreebank
2. Filtration of the lightblue lexicon chart
3. Reconstruction of the treebank

Reforging – extraction of predicates from ABCTreebank



Step 1-1:
Obtain tree-structured data from ABCTreebank by parsing the ABCTreebank

Reforging – extraction of predicates from ABCTreebank



Step 1-2:

Extract the syntactic information of predicates from ABCTreebank as a list of tuples with **four elements**

Four elements of the tuple:

phonetic form, category, starting position, ending position

Reforging – extraction of predicates from ABCTreebank

example:

Input

「 嫌いな 人 も いる 」

don't like / people / also / exist

(Some people don't like it.)

Output

[("嫌い", PPs \ SreI , 0 , 1),

phonetic form / category / start / end

(“いる”, PPs \ Sm , 5 , 6)]

Step 1-2:

Extract the syntactic information of predicates from the ABCTreebank as a list of tuples with **four elements**

Four elements of the tuple:

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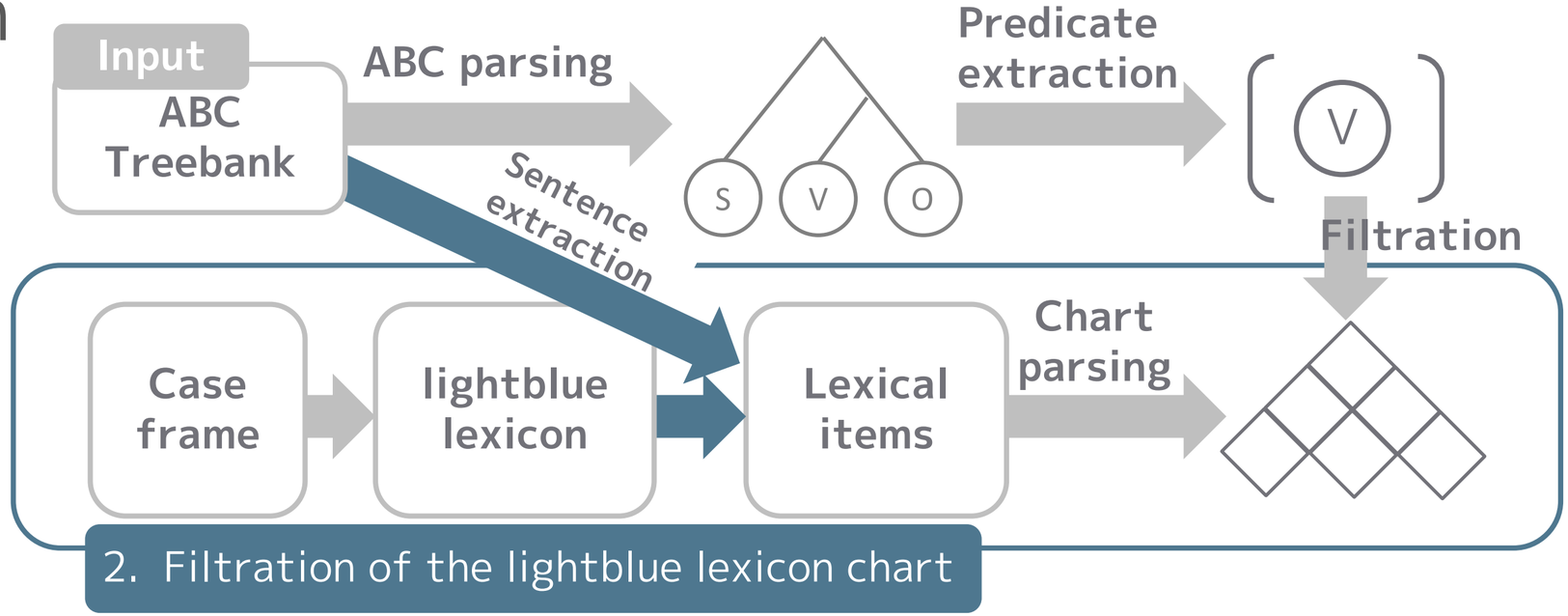
Reforging – filtration of the lightblue lexicon chart

1. Extraction of predicates from ABCTreebank
2. Filtration of the lightblue lexicon chart
3. Reconstruction of the treebank

Reforging – filtration of the lightblue lexicon chart

Step 2-1:

Extract the lexical items of all combinations of the substrings in the ABCTreebank sentence from the lightblue lexicon



Reforging – filtration of the lightblue lexicon chart

Step 2-1:
Extract the lexical items of all combinations of the substrings in the ABCTreebank sentence from the lightblue lexicon

Example:

Input

「 嫌いな 人 も いる 」
don’t like　people　also　exist

(Some people don't like it.)

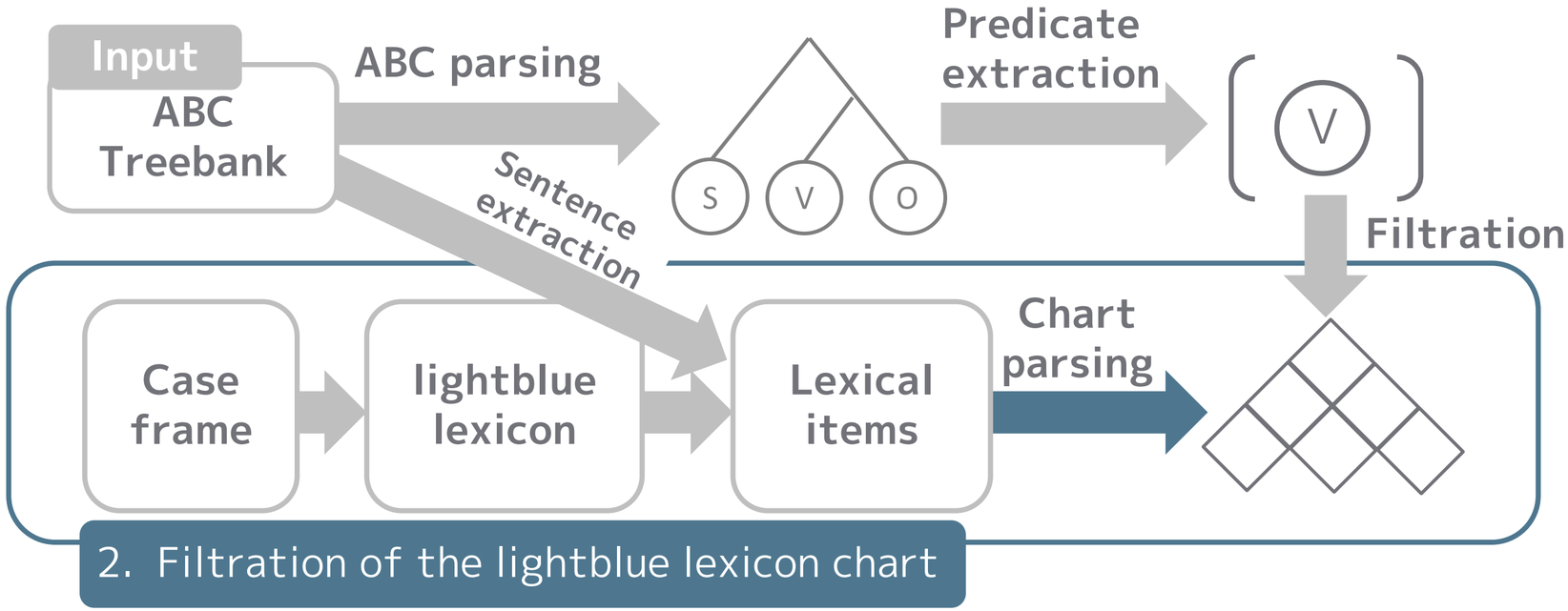
Output

Lexical items of words such as
嫌、い、な、人、も、い、る、嫌い、いな、いる、嫌いな

Reforging – filtration of the lightblue lexicon chart

Step 2-2:

Perform chart parsing for the sentence, using the lexical items extracted in Step2-1

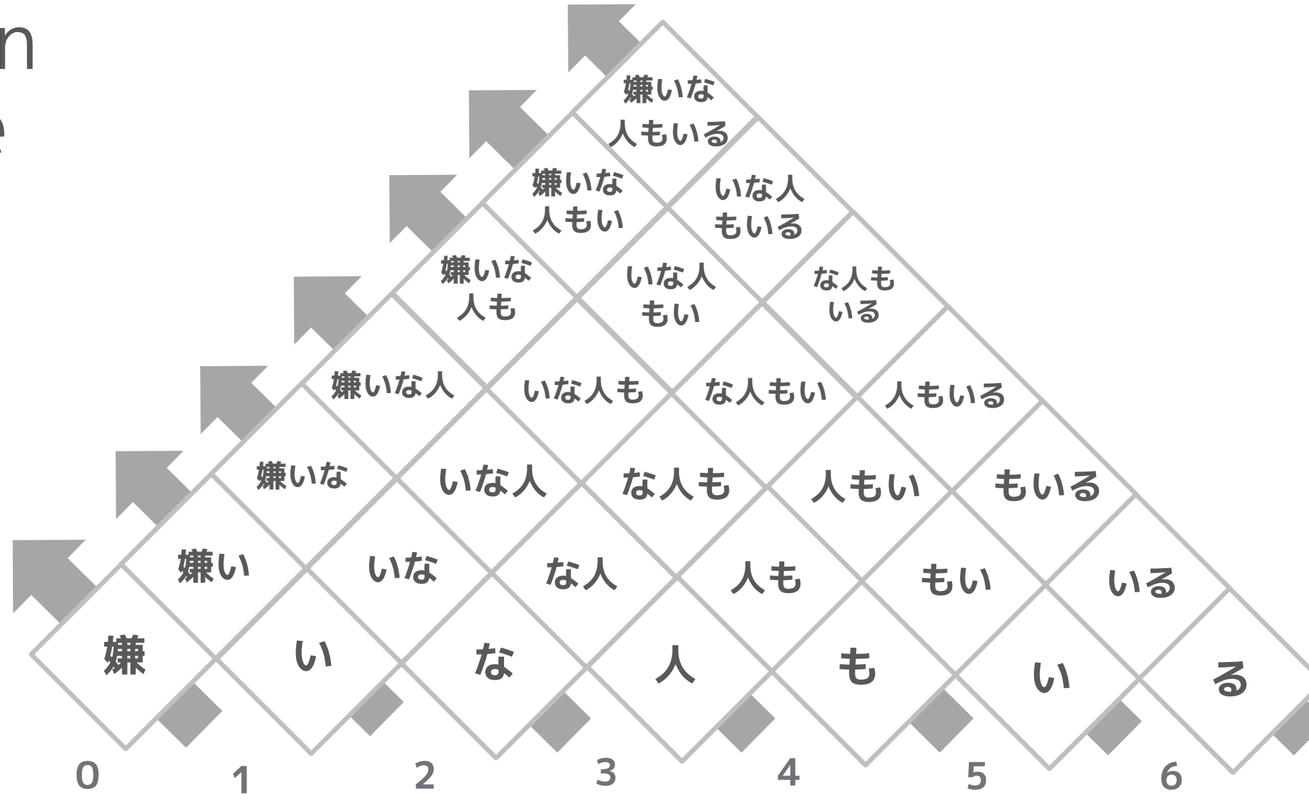


Left-corner chart parsing

Node data are calculated when building a syntactic structure of the word by compositing daughter nodes.

Node data include:

- syntactic category
- semantic representation
- score
- and so on ...



Left-corner chart parsing

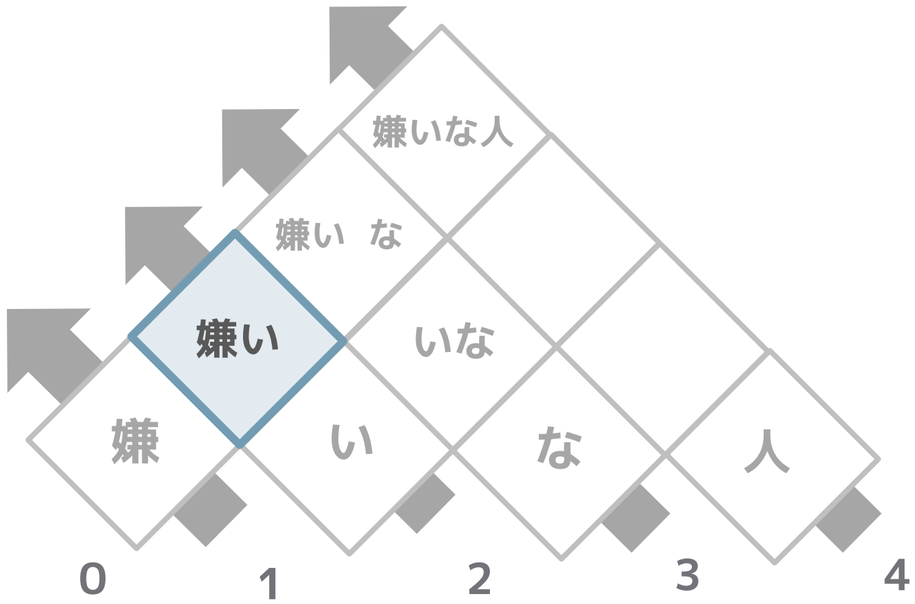
Node data of 「嫌い (don't like)」 cell (0,2) are

1. **Syntactic information of 「嫌い」 (nominal predicate)**
2. Syntactic information composited from 「嫌」 and 「い」 (continuous form of the verb)

Lexical items of (0,2)

("嫌い/きらい", $S_{[n:da|n:na|n:ni|+][nstem]} \setminus NP_{ga}$)

("嫌う/きらう/ガオ", $S_{[v:5:w<1>][cont|mod:m]} \setminus NP_{ga} \setminus NP_{o}$)



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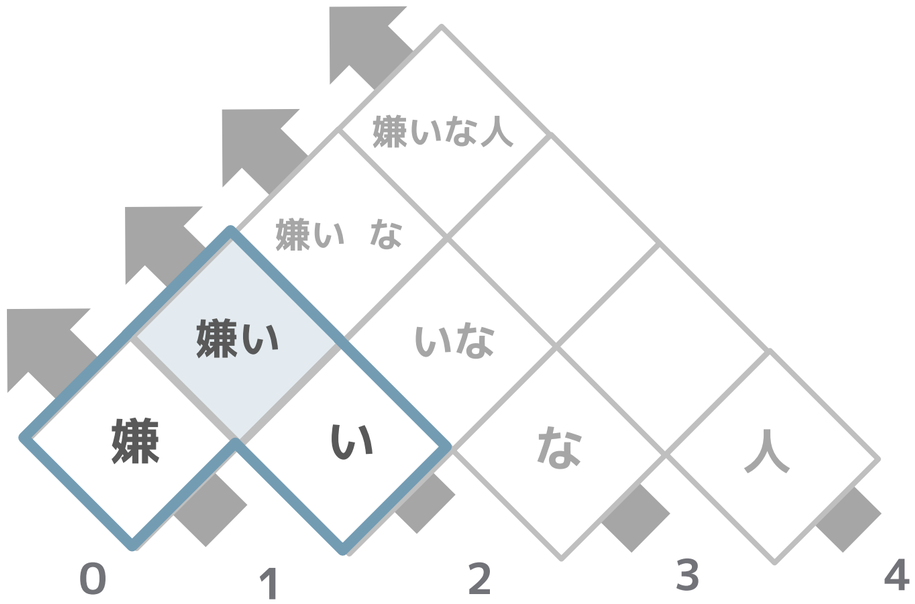
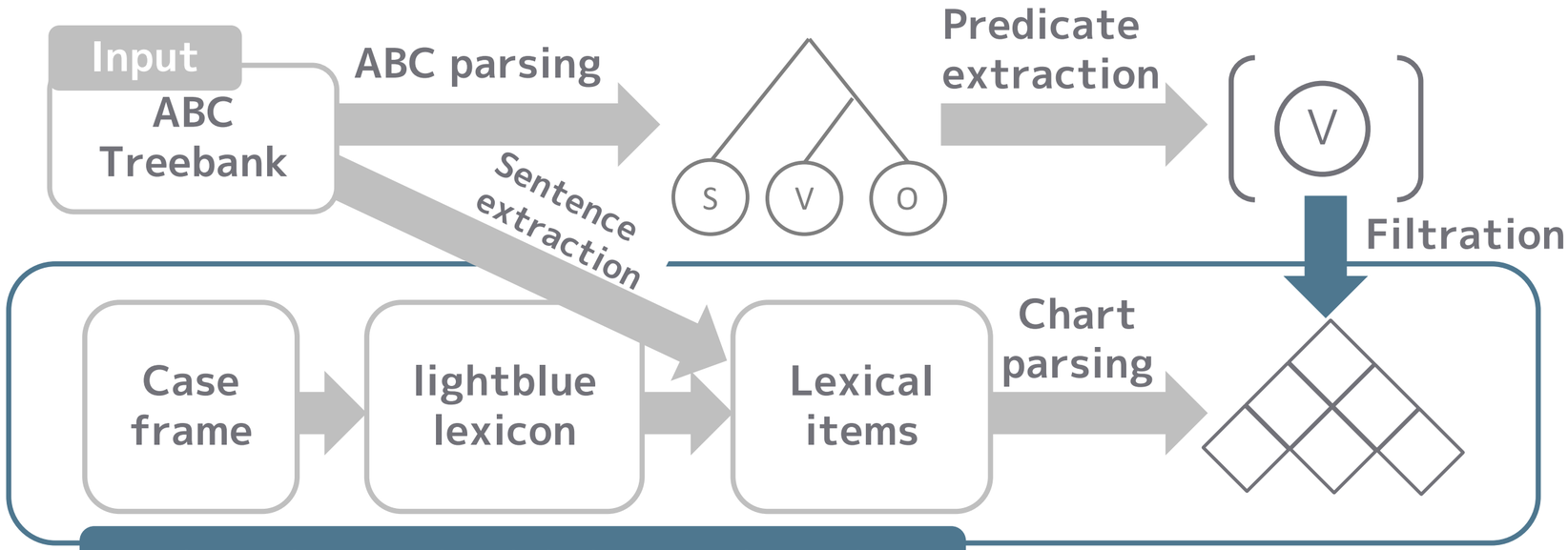
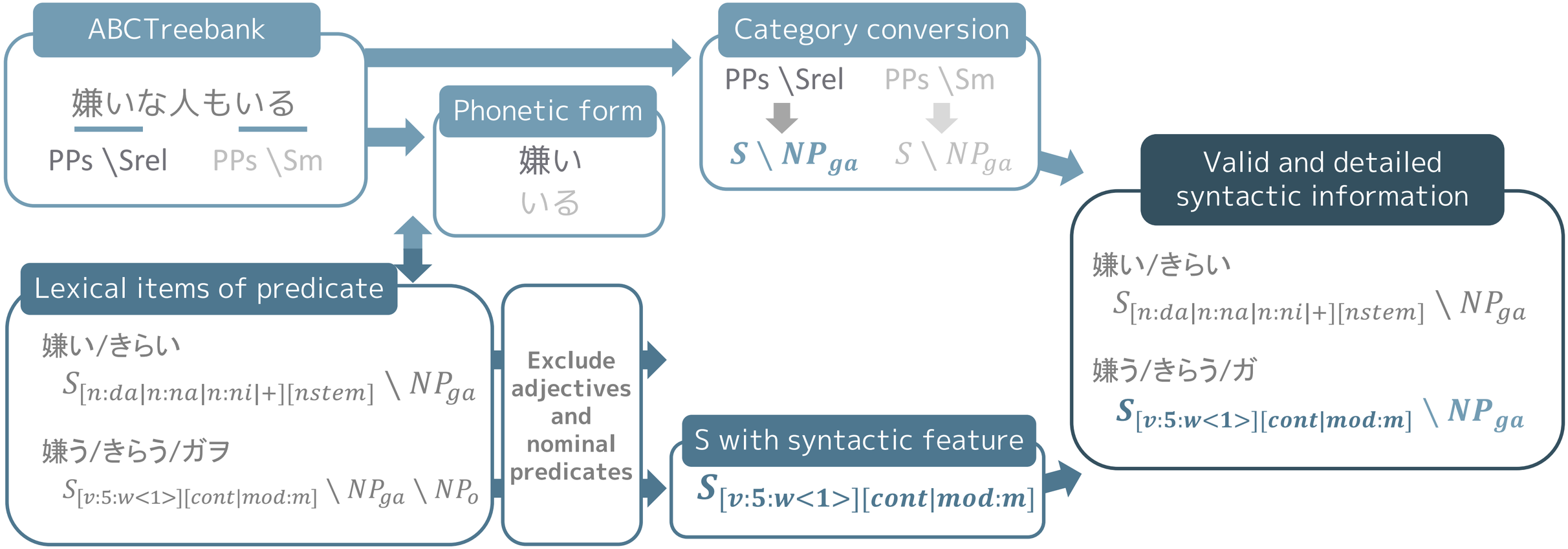


Reforging – filtration of the lightblue lexicon chart

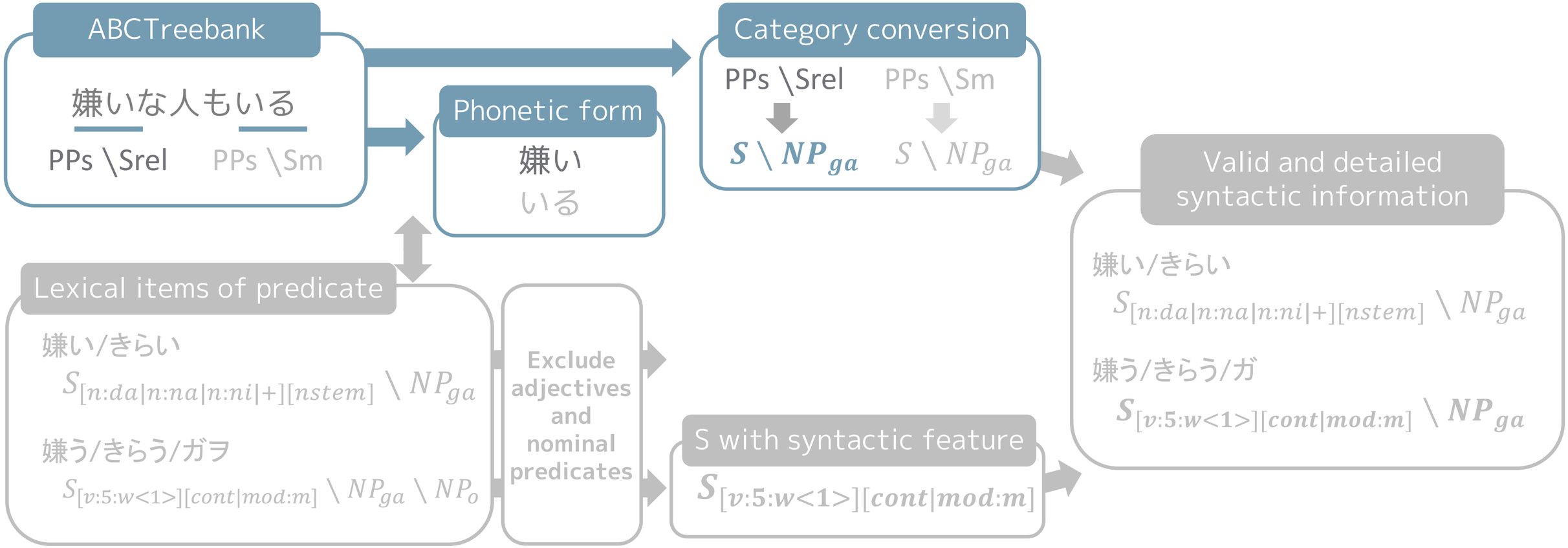
Step 2-3:
Filter the chart with the argument-structure information of the verb extracted from ABCTreebank



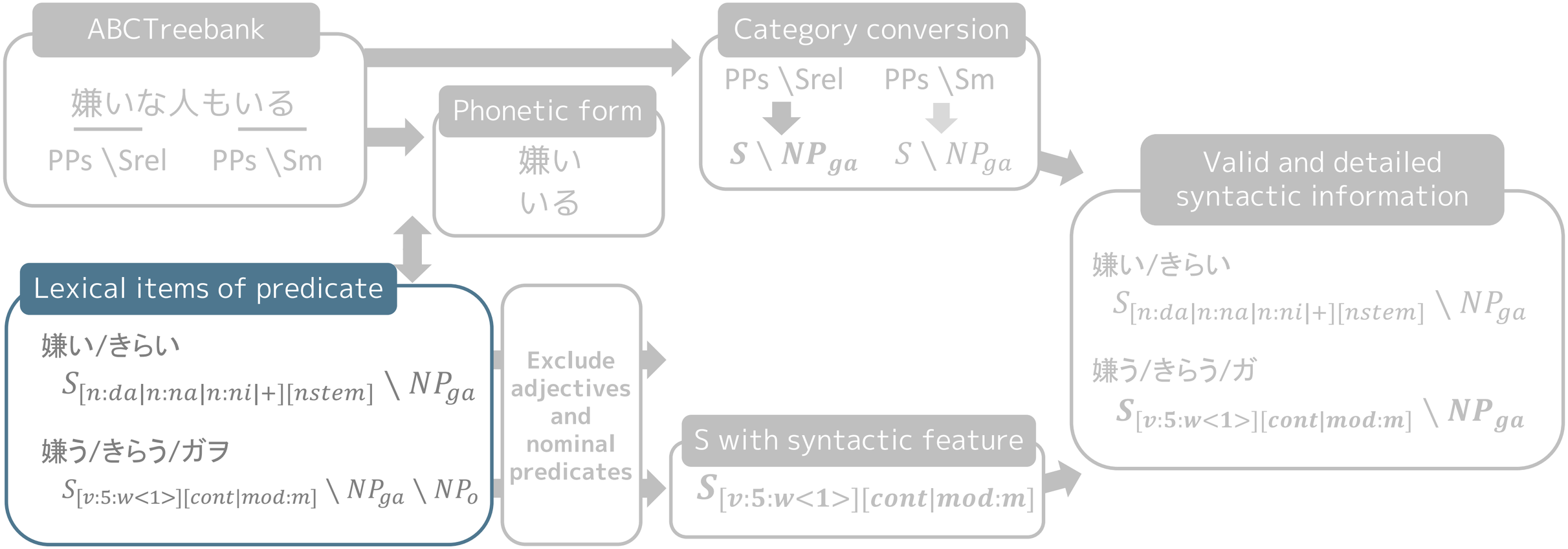
Filtering algorithm



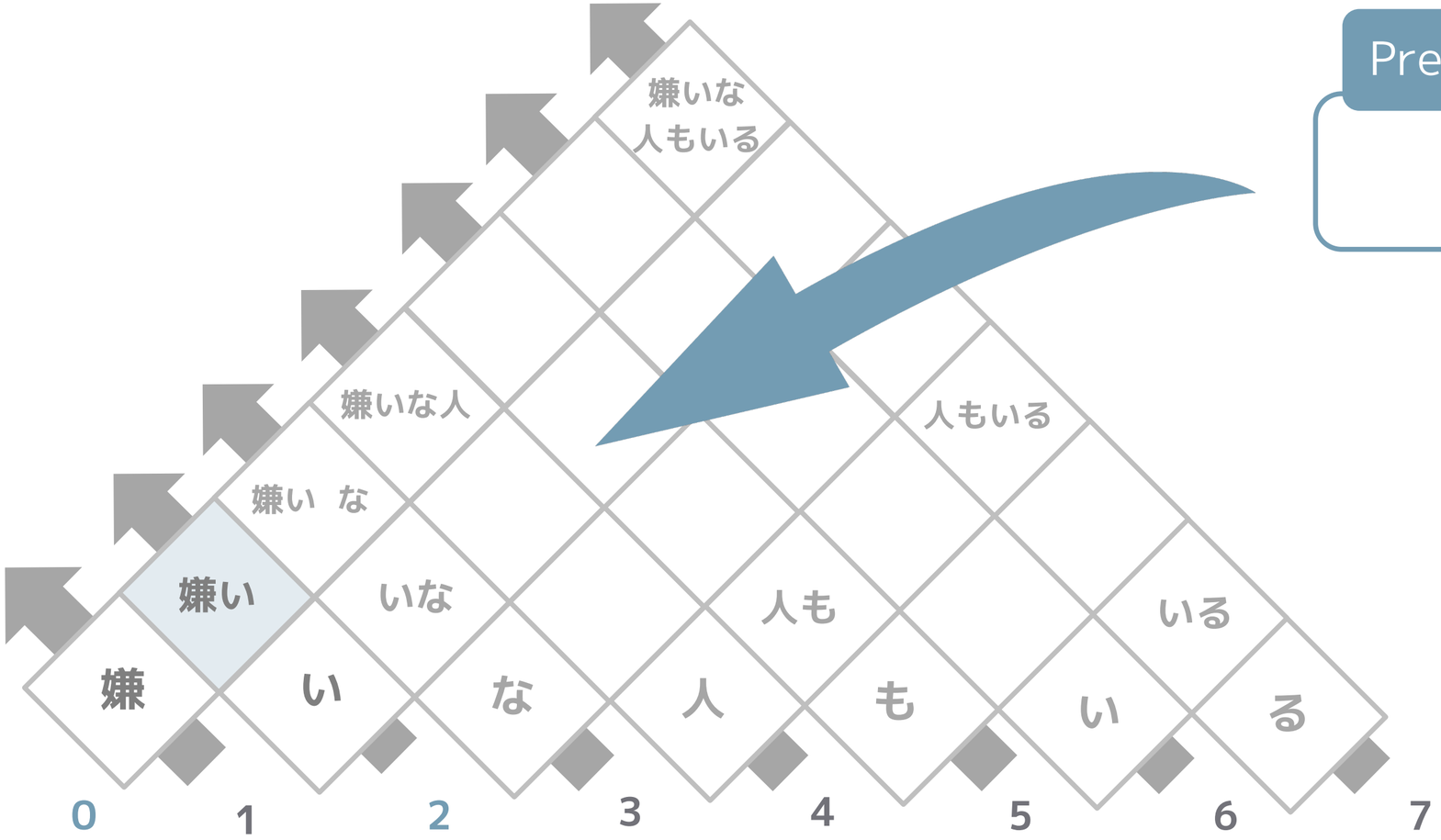
Filtering algorithm



Filtering algorithm



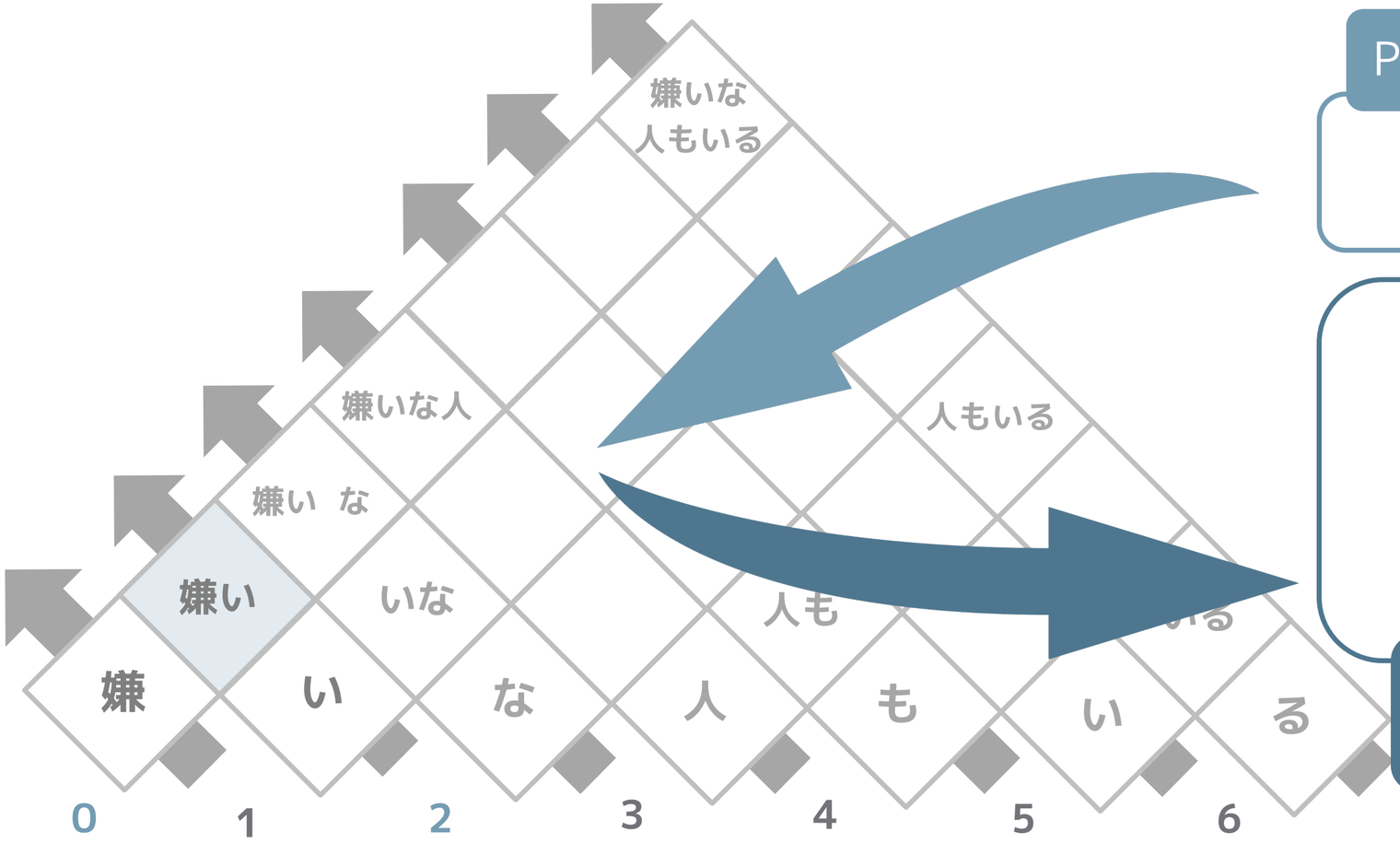
Filtering algorithm – obtaining lexical items



Predicate data from ABCTreebank

("嫌い", PPs \ SreI ,0,1)

Filtering algorithm – obtaining lexical items



Predicate data from ABCTreebank

("嫌い", PPs \ SreI ,0,1)

嫌い/きらい

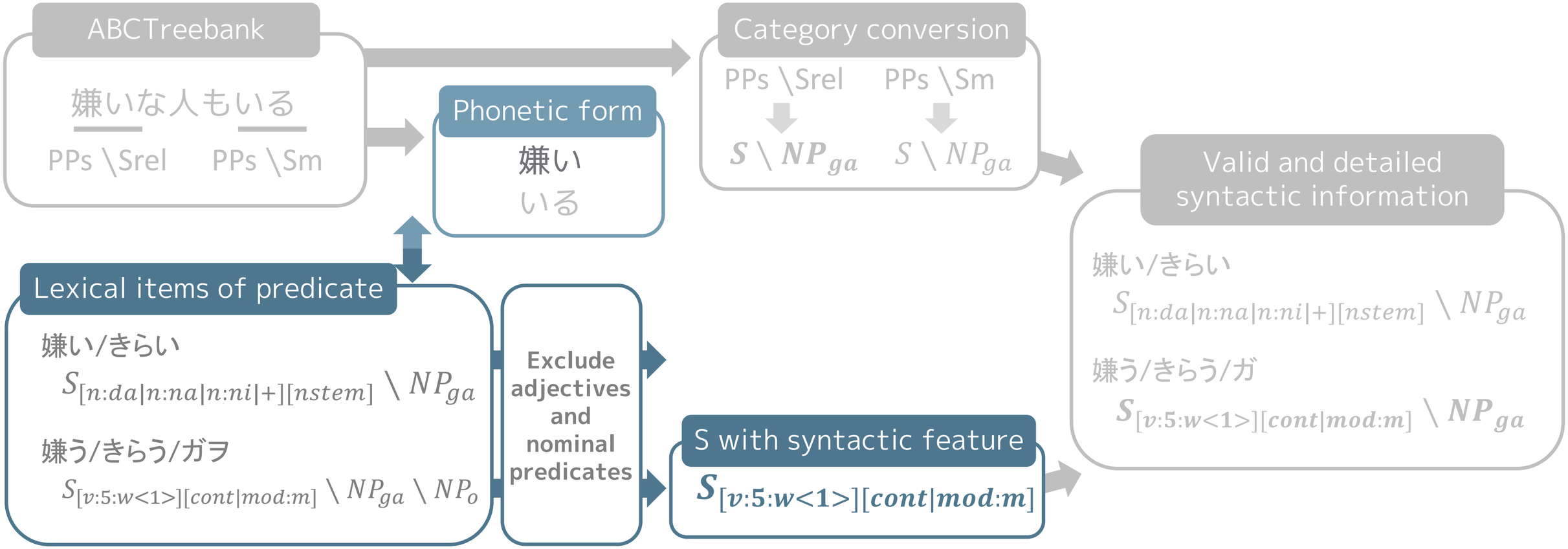
$S_{[n:da|n:na|n:ni|+][nstem]} \setminus NP_{ga}$

嫌う/きらう/ガヲ

$S_{[v:5:w<1>][cont|mod:m]} \setminus NP_{ga} \setminus NP_{o}$

Syntactic information of lexical items in the lightblue lexicon

Filtering algorithm



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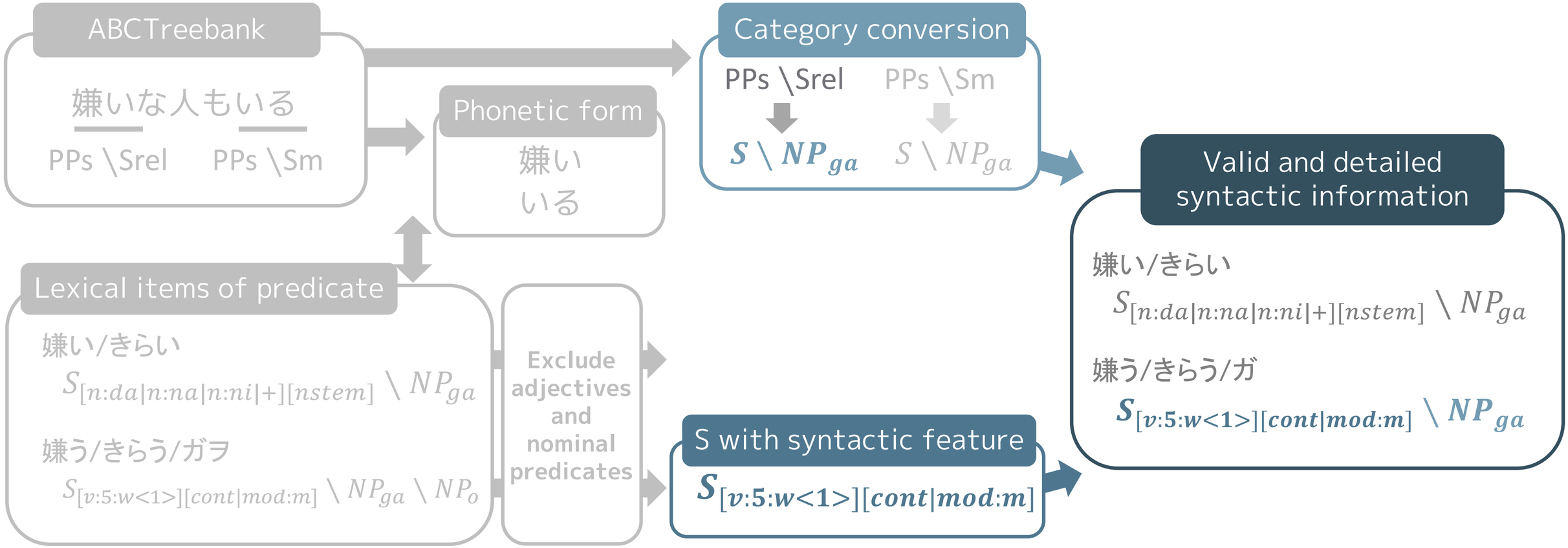
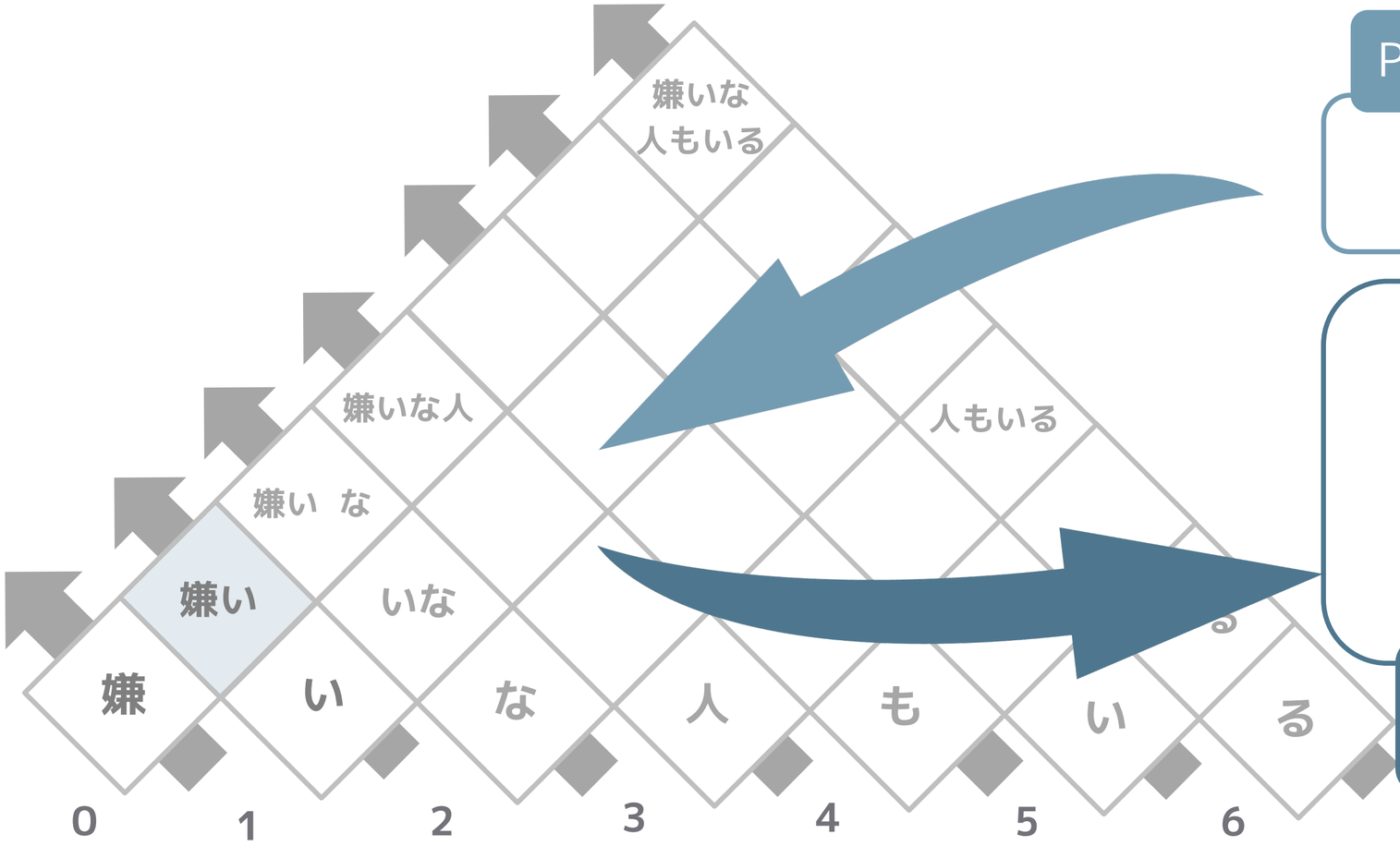


Reforging – filtration of the lightblue lexicon chart



Predicate data from ABCTreebank

[("嫌い", PPs \ SreI ,0,1)]

嫌い/きらい

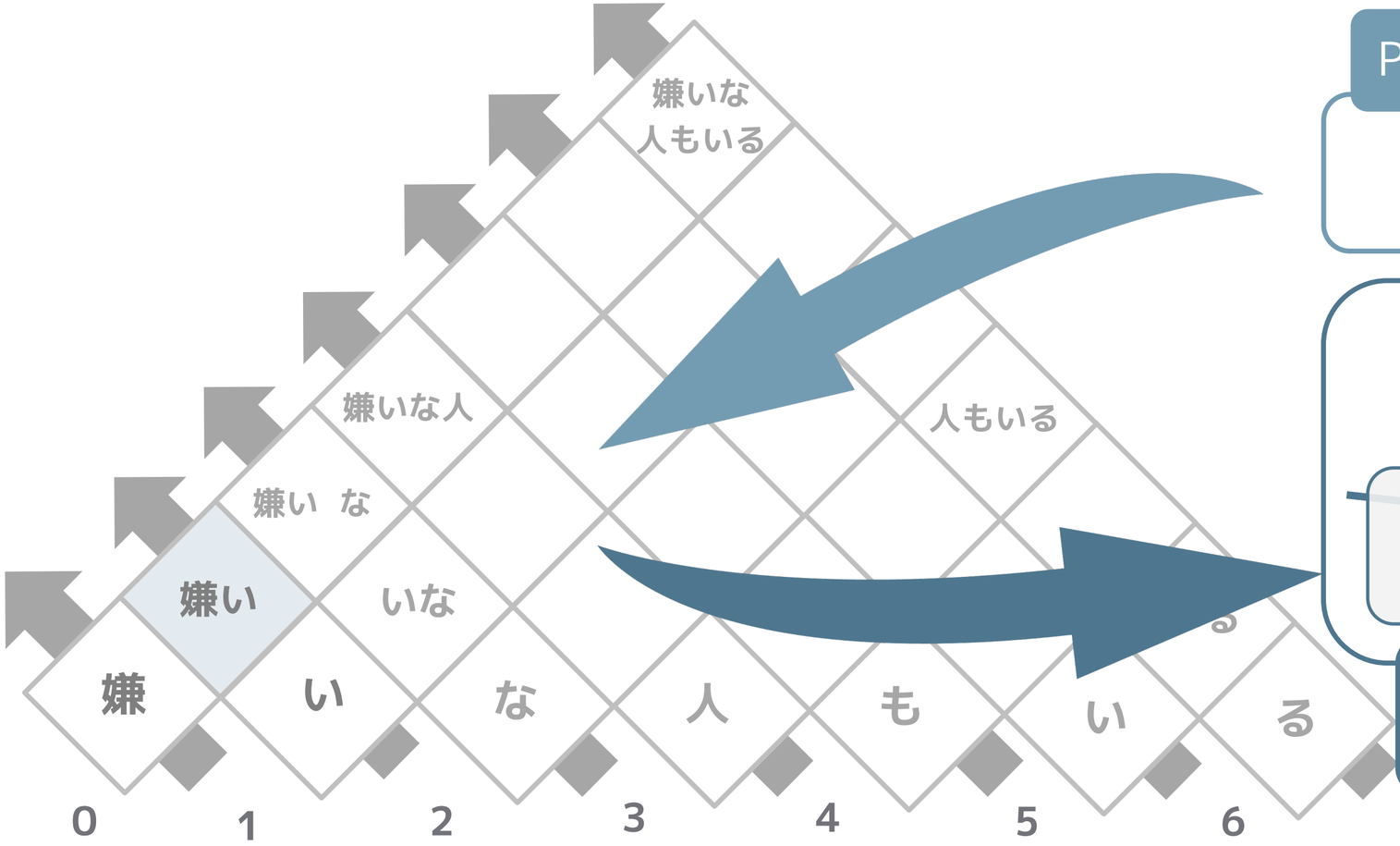
$S_{[n:da|n:na|n:ni|+][nstem]} \setminus NP_{ga}$

嫌う/きらう/ガヲ

$S_{[v:5:w<1>][cont|mod:m]} \setminus NP_{ga} \setminus NP_{o}$

Syntactic information of lexical items in lightblue lexicon

Reforging – filtration of the lightblue lexicon chart



Predicate data from ABCTreebank

[("嫌い", PPs \ SreI ,0,1)]

嫌い/きらい

$S_{[n:da|n:na|n:ni|+][nstem]} \setminus NP_{ga}$

嫌う/きらう/ガ

$S_{[v:5:w<1>][cont|mod:m]} \setminus NP_{ga}$

Syntactic information of lexical items in lightblue lexicon

Reforging – reconstruction of the treebank

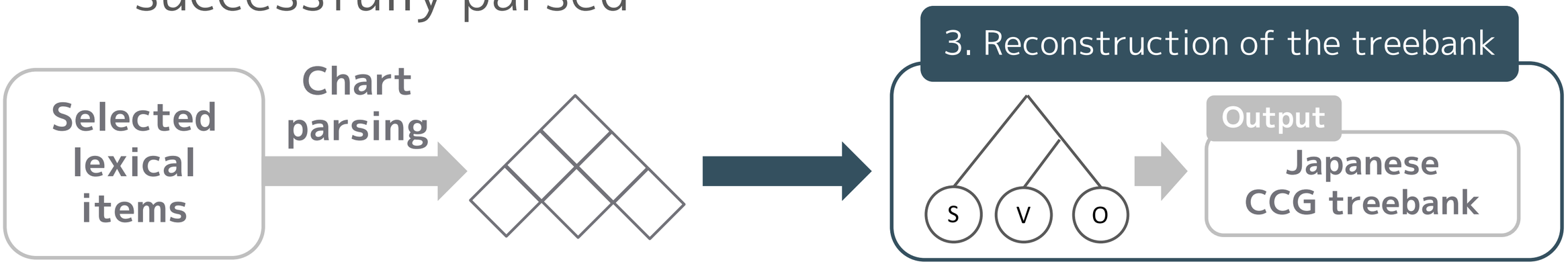
1. Extraction of predicates from ABCTreebank
2. Filtration of the lightblue lexicon chart
3. Reconstruction of the treebank

Reforging – reconstruction of the treebank

Step 3-1:

Parse the sentence in ABCTreebank, using the filtered chart

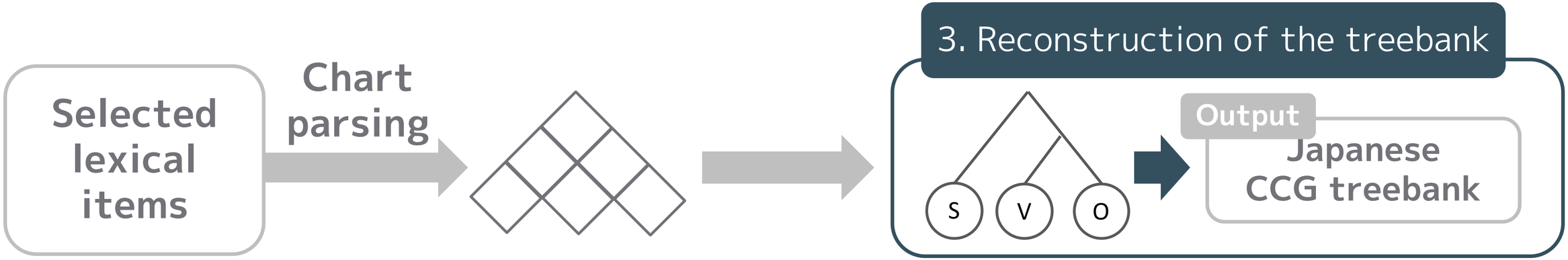
- The CCG syntactic structure is output when successfully parsed



Reforging – reconstruction of the treebank

Step 3-2:

Parse all sentences in ABCTreebank and convert them to a treebank format



Example of successful reforging

Input: 会議が始まった

(The meeting began)

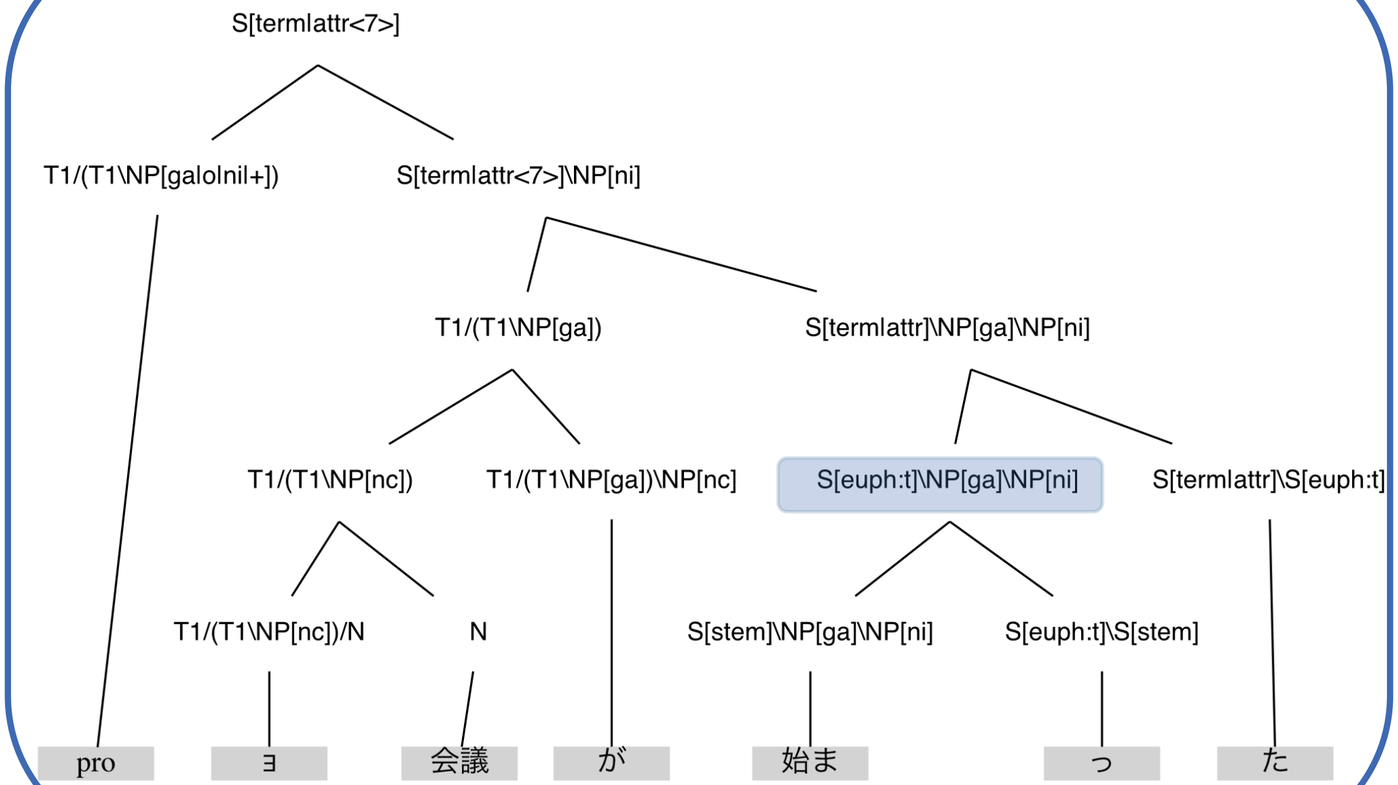
- lightblue analyzes **Ga-case and Ni-case NPs** as arguments

Syntactic information of lexical items in the lightblue lexicon

$S_{[v:5:r<1>][euph:t]} \setminus NP_{ga} \setminus NP_{ni}$

$S_{[v:5:r<1>][euph:t]} \setminus NP_{ga}$

Before reforging



Example of successful reforging

Input: 会議が始まった

(The meeting began)

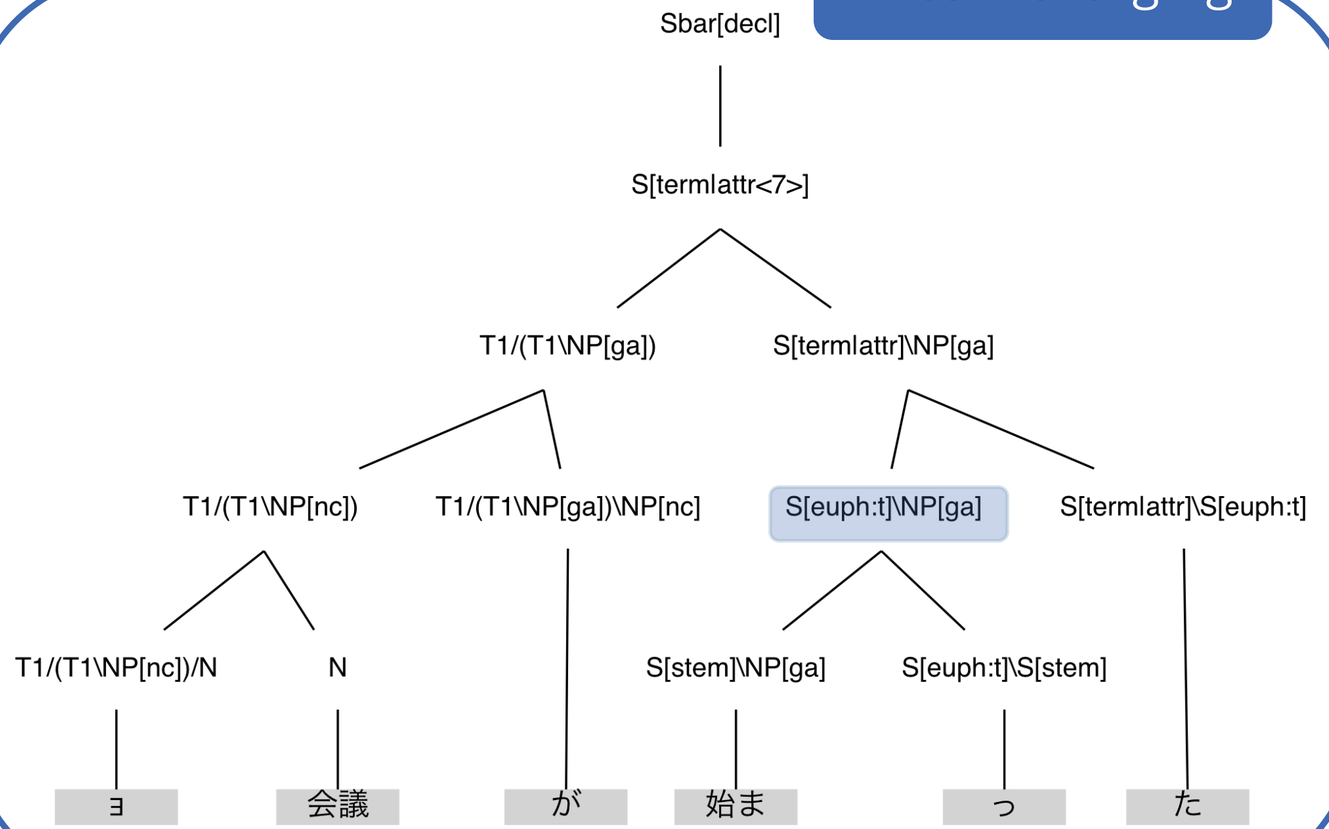
- An argument was changed to **Ga-case NP**
- One “pro” was removed

Syntactic information of lexical items in the lightblue lexicon

$S_{[v:5:r<1>][euph:t]} \setminus NP_{ga}$

$S_{[v:5:r<1>][euph:t]} \setminus NP_{ga}$

After reforging



Error analysis

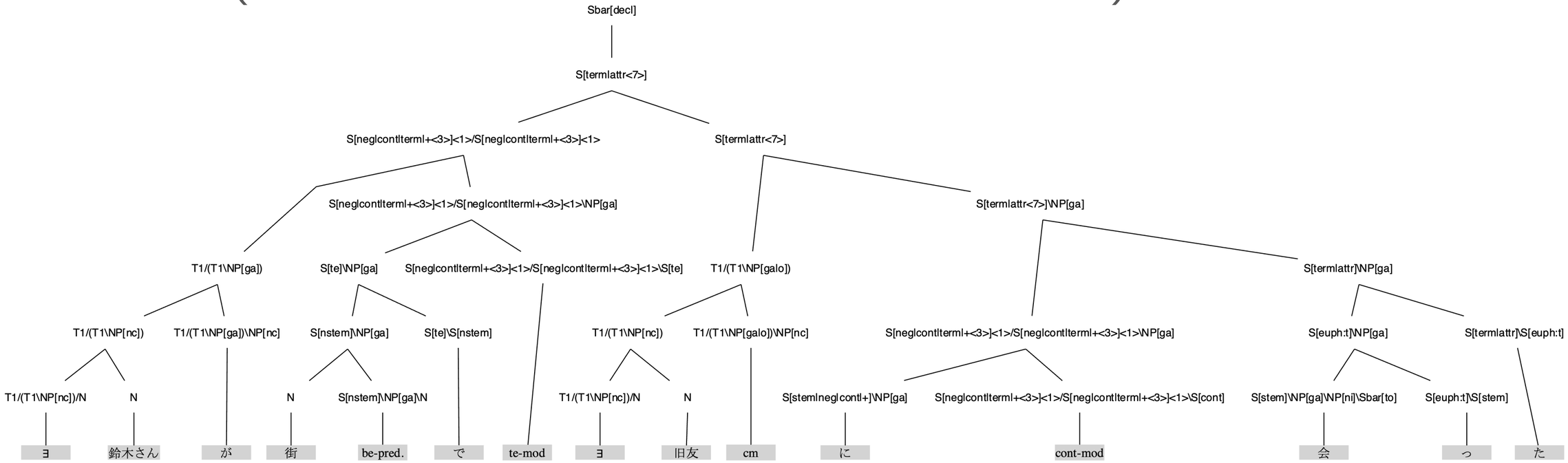
Possible causes of error:

1. Errors caused by **incorrect argument structures** in ABCTreebank
2. Errors caused by **missing entries** in the lightblue lexicon
3. Errors caused by incorrect analysis of adnominal clause in lightblue

Error analysis
– Incorrect argument structure in ABCTreebank

Input: 鈴木さんが街で旧友に会った

(Mr. Suzuki met an old friend in town)



Error analysis
– Incorrect argument structure in ABCTreebank

Input: 鈴木さんが街で旧友に会った

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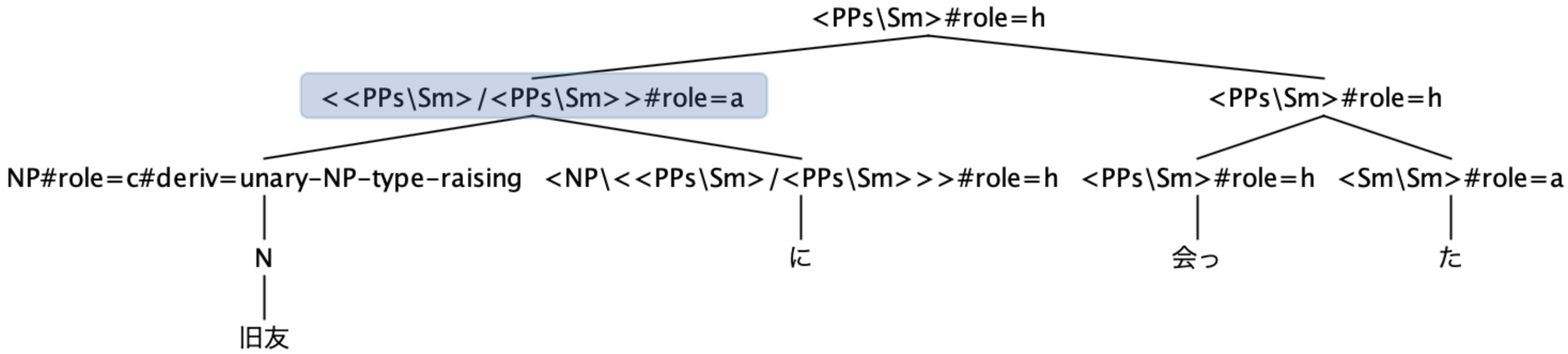
Argument structure in ABCTreebank



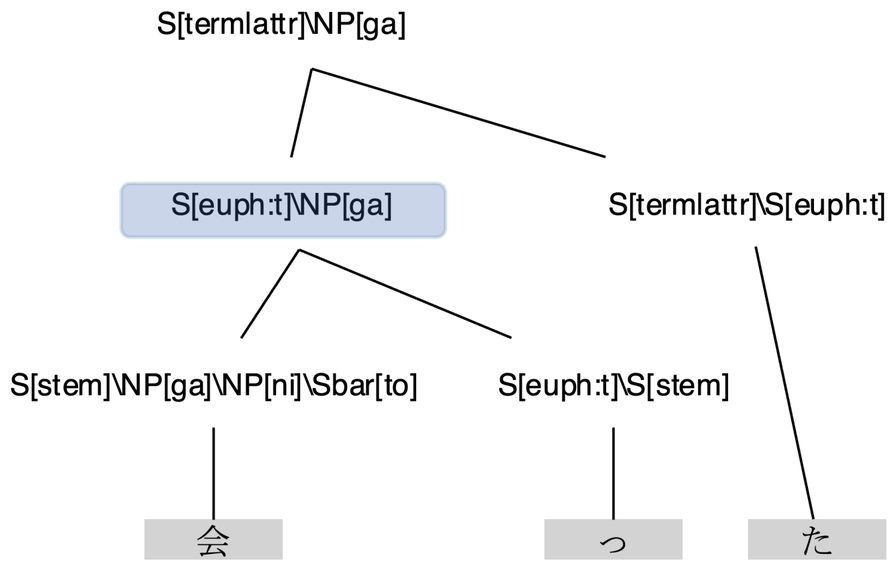
- ABCTreebank analyzed「旧友に」as an **adverb phrase**, but it should be analyzed as a **Ni-case noun phrase (PPo2)**

Error analysis
– Incorrect argument structure in ABCTreebank

Input: 鈴木さんが街で旧友に会った

(Mr. Suzuki met an old friend in town)

Output of lightblue



lightblue analyzed **Ga-case NP** as the argument.

However,
the argument should be **Ga-case and Ni-case NPs.**

Conclusion

- We proposed a **"reforging"** method for constructing a linguistically valid Japanese CCG treebank with detailed syntactic features
- Using this method, we succeeded in outputting some correct Japanese CCG syntactic structures
- This study started with the assumption that argument structures of ABCTreebank are valid
  - However, the validity of argument structures of ABCTreebank is an upper bound

Conclusion

Future work

- Output a greater number of valid CCG syntactic structures
  → improve the filtering algorithm
- Obtain linguistically valid argument structures
  → investigate sources other than ABCTreebank

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