A Study of a Simple Generalized Transition Network Parser for the Japanese Language (II)

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Abstract
This paper presents a parsing system for the Japanese language. The JPARS system applys a Generalized Transition Network parser to a portion of the grammar of the Japanese language. Its grammatical description is focused on syntactic concepts. It is hoped that the JPARS can be elaborated by further research and used by learners of the Japanese language to test the accuracy of their syntactic knowledge.

The following sections of this paper were already presented: 1.0 an introduction, 2.0 an overview of natural language processing, 3.0 the features of Generalized Transition Networks [GTNs], 4.0 the Japanese Language Parsing System, and 5.0 a discussion of Japanese grammar structure which is relevant to the program. This paper will deal with 5.2 new functions, 6.0 a general summary and conclusion, and 7.0 further research.

5.2. New Functions

Several new functions have been added to the original Parlisp. Like Parlisp, these functions are written in TLC lisp. These functions enable either the parser to work quickly or the author to code easily. The functions are as follows;

```
(de NEWCAT (feat)
    (equal (getfeature * 'pos) feat)
))   )))))))

(de GETFEATURE (word feat)
    (cadar (assoc feat (getprop word 'features)))
)   )))))))

(de CHECKAGREE ( )
    (formcheck * 'form (getr 'agree) )
)))))))
```

Listing 5.2.1. New JPARS functions

```
(de CHECK_FEAT (word1 word2 feat1 feat2)
    (equal (getfeature word1 feat1)
           (getfeature word2 feat2))
)))))))))

(de GET (word feat cl)
   (if (atom (getfeature word feat))
       (getfeature word feat)
       (cadar (assoc cl (getfeature word feat) )
))))))))))

(de FORMCHECK (word feat cl
  &opt(listinhere (assoc feat (getprop word 'features))))
       (setq form (cadar listinhere))
       (setq listinhere (cdr (assoc feat listinhere)))
       (or  (equal form cl)
            (if (listp listinhere)
                (formcheck word feat cl listinhere)
                 nil)      )
))))))))))
```

Listing 5.2.1. New JPARS functions (continued)

6.0. Results

The followings are the sentences which are parsed as grammatically correct. Below each sentence, there is an English gloss and a parse tree which is modified for simplification.

1) inu wo kau
(dog obj-p buy)

Parse Tree
(tailnt np/4) (patient inu) (head inu) (part wo)
(tail kau) (wf t) (constwn 2) (const s/)

Th first sentence (1) means "(I) buy a dog." The subject is omitted if there is no possibility of being mistaken.

The meaning of the word "kau" is ambiguous, because there are two "kau" verbs in Japanese, "buy" and "keep" [as in "keep a dog"]. These two verbs are distinguishable if they are written in Japanese, or spoken by a native speaker. Sentence (7) becomes an ungrammatical sentence if the latter meaning is applied. In this paper the word "kau" only has the meaning "buy."

The verb takes only one object. The sentence "neko wo inu wo kau" [buy a cat

a dog] is not parsed successfully.

2) inu wo kat ta
(dog obj-p buy past)

Parse Tree
(tailnt np/6) (patient inu) (head inu) (part wo)
(tail kat) (aux ta) (agree y) (wf t) (constwn 2) (const s/)

Compare sentence (2) with sentence (1). The past tense is created by adding a past tense auxiliary verb, "ta."

3) inu wo kawa nai
(dog obj-p buy not-aux)

Parse Tree
(tailnt np/6) (patient inu) (head inu) (part wo)
(tail kawa) (aux nai) (agree m) (stypexng ng)
(wf t) (constwn 2) (const s/)

Sentence (3) is a present negative sentence. The negative sentence is created by adding a negative auxiliary verb, "nai." Sentences (3) and (4) show the difference of inflected forms of the verb "kau" or "buy." (AGREE) information of those sentences show that the form Y, and M are used respectively to meet the requirement of the following auxiliary verbs.

4) inu wo kau ka
(dog obj-p buy question-p)

Parse Tree
(tailnt np/6) (patient inu) (head inu) (part wo)
(tail kau) (part ka) (stypexqu qu) (wf t) (constwn 2) (const s/)

An interrogative sentence is formed by adding an interrogative particle, "ka" at the end. Almost all particles follow the ending form of verbs. Therefore no information of (AGREE) is available here.

5) inu wo kat ta ka
(dog obj-p buy past question-p)

Parse Tree
(tailnt np/8) (patient inu) (head inu) (part wo)
(tail kat) (aux ta) (agree y) (part ka) (stypexqu qu)
(wf t) (constwn 2) (const s/)

Sentence (5) is an example of a past tense interrogative sentence.

6) dare ga inu wo kau ka
(who sup-p dog obj-p buy question-p)

Parse Tree
(tailnt np/10) (agent dare) (stypenqu qu) (head dare) (part ga)
(tailnt np/6) (patient inu) (head inu) (part wo)
(tail kau) (part ka) (stypexqu qu) (wf t) (constwn 2) (const s/)

An interrogative sentence does not change its order from a declarative sentence. In colloquial Japanese, when interrogatives are used, the final interrogative particle can be abbreviated. Since this parser is intended for use by learners of standard Japanese, this parser does not allow the abbreviated form. The sentence "dare ga inu wo kau" is not parsed successfully.

7) sanzi ni inu wo kau
(3-o'clock adv-p dog obj-p buy)

Parse Tree
(tailnt np/8) (adv sanzi) (head sanzi) (par ni)
(tailnt np/4) (patient inu) (head inu) (part wo)
(tail kau) (wf t) (constwn 2) (const s/)

The adverbial phrase is added in sentence (7). The particle "ni" has several functions; all of these are taken into consideration.

8) georgetown de inu wo kau
(georgetown loc-p dog obj-p buy)

(For ease of reading, English spelling of "georgetown" is used. True Japanese romanized spelling may be "zyoozitaun.")
Parse Tree
(tailnt np/8) (adv georgetown) (head georgetown) (part de)
(tailnt np/4) (patient inu) (head inu) (part wo)

(tail kau) (wf t) (constwn 2) (const s/)

The adverbial phrase indicating a place is included in sentence (8).

9) georgetown ni iku
(georgetown adv-p go)

Parse Tree
(tailnt np/4) (loc georgetown) (head georgetown) (part ni)
(tail iku) (wf t) (constwn 2) (const s/)

Sentence (9) has the sense of location, but this time the verb "go" takes the destination. The locative is coded in the lexicon of the word "go."

10) watasi ha georgetown ni iku
(I topic-p georgetown adv-p go)

Parse Tree
(agent watasi) (tailnt np/8) ((topic watasi) (head watasi) (part ha)
(tailnt np/4) (loc georgetown) (head georgetown) (part ni)
(tail iku) (wf t) (constwn 2) (const s/)

11) ano inu wo kau
(that dog obj-p buy)

Parse Tree
(tailnt np/4) (patient inu) (dem ano) (head inu) (part wo)
(tail kau) (wf t) (constwn 2) (const s/)

A noun can take a demonstrative adjective. The demonstrative adjective is interpreted as "that" here although the word indicates the distance of the referent from the speaker. The demonstrative adjective "sono" is usually translated into "the" although the grammatical function is sometimes different. Because of their contradictory meanings, two demonstrative adjectives are not allowed for a noun. The sentence "sono ano inu wo kau" is not parsed successfully.

12) kawaii inu wo kau
(cute dog obj-p buy)

Parse Tree
(tailnt np/4) (patient inu) (adj kawaii) (head inu) (part wo)

(tail kau) (wf t) (constwn 2) (const s/)

A noun can take one or more adjectives. Sentence (12) is an example taking an adjective, and sentence (13) is an example taking two adjectives.

13) kawaii tiisai inu wo kau
(cute little dog obj-p buy)

Parse Tree
(tailnt np/4) (patient inu) (adj kawaii) (head inu) (part wo)
(tail kau) (wf t) (constwn 2) (const s/)

14) ano kawaii inu wo kau
(that cute dog obj-p buy)

Parse Tree
(tailnt np/4) (patient inu) (dem ano) (adj kawaii) (head inu) (part wo)
(tail kau) (wf t) (constwn 2) (const s/)

15) kawaii ano inu wo kau
(cuet that dog obj-p buy)

Parse Tree
(tailnt np/4) (patient inu) (dem ano) (adj kawaii) (head inu) (part wo)
(tail kau) (wf t) (constwn 2) (const s/)

Compae sentence (14) and (15); the positions of demonstrative adjectives and adjectives are not fixed. "kawaii ano tiisai inu" is also permissible.

16) watasi no inu ha hoeru
(I possess-p dog topic-p bark)

Parse Tree
(agent inu) (tailnt np/4) (topic inu) (poss watasi) (head inu) (part ha)
(tail hoeru) (wf t) (constwn 2) (const s/)

The sentences from (17) to (20) are examples of flexibility of word order and the use of particles in the Japanese language. The possessive phrase "watasi no" is placed before the modified noun. This differentiates sentence (20) from (21).

17) watasi no inu ga kodomo wo hoeru
(I possess-p dog sub-p child obj-p bark)

Parse Tree
(tailnt np/8) (agent inu) (poss watasi) (head inu) (part ga)
(tailnt np/4) (patient kodomo) (head kodomo) (part wo)
(tail hoeru) (wf t) (constwn 2) (const s/)

18) watasi no inu ga kodomo ni hoeru
(I possess-p dog sub-p child adv-p bark)

Parse Tree
(tailnt np/8) (agent inu) (poss watasi) (head inu) (part ga)
(tailnt np/4) (patient kodomo) (head kodomo) (part ni)
(tail hoeru) (wf t) (constwn 2) (const s/)

19) watasi no inu ha kodomo wo hoeru
(I possess-p dog topic-p child obj-p bark)

Parse Tree
(agent inu) (tailnt np/8) (topic inu) (poss watasi) (head inu) (part ha)
(tailnt np/4) (patient kodomo) (head kodomo) (part wo)
(tail hoeru) (wf t) (constwn 2) (const s/)

20) kodomo wo watasi no inu ga hoeru
(child obj-p I possess-p dog sub-p bark)

Parse Tree
(tailnt np/12) (patient kodomo) (head kodomo) (part wo)
(tailnt np/4) (agent inu) (poss watasi) (head inu) (part ga)
(tail hoeru) (wf t) (constwn 2) (const s/)

21) watasi no kodomo wo inu ga hoeru
(I possess-p child obj-p dog sub-p bark)

Parse Tree
(tailnt np/8) (patient kodomo) (poss watasi) (head kodomo) (part wo)
(tailnt np/4) (agent inu) (head inu) (part ga)
(tail hoeru) (wf t) (constwn 2) (const s/)

Sentence (20) means "my dog barks at a [the] child," whereas sentence (21) means "a [the] dog barks at my child."

22) anata ni kare no hoe rare ta inu wo ageru
(you adv-p he possess-p bark passive-aux past dog obj-p give)

Relative Clause Tree
(tailnt np/18) (agent anata) (head anata) (part ni)
(tailnt np/14) (patient kare) (head kare) (part no)
(tail hoe) (aux rare) (agree m) (stypexpv pvs) (aux ta) (agree y)
(wf t) (constwn 8) (const relc/)

Parse Tree
(tailnt np/4) (patient inu) (head inu) (part wo)
(tail ageru) (wf t) (constwn 2) (const s/)

The verb "ageru" has three slots; an agent, a patient and a recipient. The position of "anata ni" is far from the verb. Thus the parser takes "anata ni" as an agent of the verb "hoe rare ta," rather than as a recipient of the verb "ageru." For that reason, this sentence was not parsed correctly. Not only this parser but also native speakers may mistake the meaning if they are not careful. This sentence has to have the same parse tree as sentence (24). Th only way to parse this sentence correctly is to add semantic constraints to the parser. The structure of this sentence is similar to that of sentence (26). Except for the first noun phrase there is no difference in the relative clause. The semantic difference between "inu" [dog] and "koto" [incident] should be used by the parser to recognize the difference in the structures of these sentences. If the "anata ni kare no hoe rare ta" is one phrase, the verb "hoeru" already has an agent and a patient; therefore, the relative clause modifies a noun which does not function as an agent or a patient of the verb. In other words, the slot of the verb in the relative clause has to be empty. Semantically it is obvious that "anata" doesn't bark at "kare." It must be "inu" that barks at "kare." Without this constraint, the Japanese sentences, which allow empty slots for verbs, will not be parsed successfully. JPARS needs more elaboration in this area.

23) anata ni kare ga hoe rare ta inu wo ageru
(you adv-p he sub-p bark passive-aux past dog obj-p give)

Relative Clause Tree
(tailnt np/18) (agent anata) (head anata) (part ni)
(tailnt np/14) (patient kare) (head kare) (part ga)

(tail hoe) (aux rare) (agree m) (stypexpv pvs) (aux ta) (agree y)
(wf t) (constwn 8) (const relc/)

Parse Tree
(tailnt np/4) (patient inu) (head inu) (part wo)
(tail ageru) (wf t) (constwn 2) (const s/)

24) kare no hoe rare ta inu wo anata ni ageru
(he possess-p bark passive-aux past dog obj-p you adv-p give)

Relative Clause Tree
(tailnt np/18) (patient kare) (head kare) (part no)
(tail hoe) (aux rare) (agree m) (stypexpv pvs) (aux ta) (agree y)
(wf t) (constwn 12) (const relc/)

Parse Tree
(tailnt np/8) (patient inu) (head inu) (part wo)
(tailnt np/4) (rcp anata) (head anata) (part ni)
(tail ageru) (wf t) (constwn 2) (const s/)

This sentence is clear in meaning. No native speaker will mistake the meaning.

25) sono inu ni watasi ga hoe rare ta koto ga aru
(the dog adv-p I sub-p bark passive-aux past incident sub-p exist)

Relative Clause Tree
(tailnt np/18) (agent inu) (dem sono) (head inu) (part ni)
(tailnt np/14) (patient watasi) (head watasi) (part ga)
(tail hoe) (aux rare) (agree m) (stypexpv pvs) (aux ta) (agree y)
(wf t) (constwn 8) (const relc/)

Parse Tree
(tailnt np/4) (agent koto) (head koto) (part ga)
(tail aru) (wf t) (constwn 2) (const s/)

26) *sono inu ni watasi no hoe rare ta koto ga aru
(the dog adv-p I possess-p bark passive-aux past incident sub-p exist)

Relative Clause Tree
(tailnt np/18) (agent inu) (dem sono) (head inu) (part ni)
(tailnt np/14) (patient watasi) (head watasi) (part no)
(tail hoe) (aux rare) (agree m) (stypexpv pvs) (aux ta) (agree y)
(wf t) (constwn 8) (const relc/)

Parse Tree
(tailnt np/4) (agent koto) (head koto) (part ga)
(tail aru) (wf t) (constwn 2) (const s/)

Setence (26) is not grammatically correct, although a very similar sentence (25) is correct. This sentence (25) is grammatically correct, but native speakers seldom use it. They prefer to use "ha" instead of "ga" or "no." This needs further research.

27) anata ni hoe ta inu wo ageru
(you adv-p bark past dog obj-p give)

Relative Clause Tree
(tailnt np/12) (patient anata) (head anata) (part ni)
(tail hoe) (aux ta) (agree y) (wf t) (constwn 8) (const relc/)

Parse Tree
(tailnt np/4) (patient inu) (head inu) (part wo)
(tail ageru) (wf t) (constwn 2) (const s/)

(27) is an ambiguous sentence. This sentence means either "(I will) give you the dog that barked (at somebody)" or "(I will) give (somebody) the dog that barked at you." The parser does not trace two possibilities. It takes the latter, because the phrase "anata ni" is closer to the verb "hoe" [bark] than the verb "ageru."

28) anata ni hon wo ageru
(you adv-p book obj-p give)

Parse Tree
(tailnt np/8) (rcp anata) (head anata) (part ni)
(tailnt np/4) (patient hon) (head hon) (part wo)
(tail ageru) (wf t) (constwn 2) (const s/)

Sentence (28) does not have the ambiguity of sentence (27) because it does not have a relative clause.

29) georgetown de watasi ga kat ta inu wo anata ni ageru
(georgetown loc-p I sub-p buy past dog obj-p you adv-p give)

Relative Clause Tree

(tailnt np/20) (adv georgetown) (head georgetown) (part de)
(tailnt np/16) (agent watasi) (head watasi) (part ga)
(tail kat) (aux ta) (agree y) (wf t) (constwn 12) (const relc/)

Parse Tree
(tailnt np/8) (patient inu) (head inu) (pat wo)
(tailnt np/4) (rcp anata) (head anata) (part ni)
(tail ageru) (wf t) (constwn 2) (const s/)

Sentence (29) is another ambiguous sentence. "georgetown de" can modify either the verb "kat ta" [bought] or the verb "ageru" [give]. The parser again takes the "kat ta" for the modifiee, because it is closer to the phrase.

30) anata ni sanzi ni hon wo kau
(you adv-p 3-o'clock adv-p book obj-p buy)

Parse Tree
(tailnt np/12) (rcp anata) (head anata) (part ni)
(tailnt np/8) (adv sanzi) (head sanzi) (part ni)
(tailnt np/4) (patient hon) (head hon) (part wo)
(tail kau) (wf t) (constwn 2) (const s/)

This sentence is successfully parsed and the parse tree is just as expected. This parsing, however, shows a defect of the lexicon. The JPARS does not analyze morphology. A number plus "zi" [o'clock] should be treated separately in the parser. Since this parser lacks morphological analysis, the phrase "3 o'clock" has to be entered as a word. The Japanese language has two ways of counting. The first one goes with "zi" with the exception of "yo zi." [4 o'clock; this becomes "yon zi" if they are simply combined.] The second one does not go with "zi," although in old Japanese, it was just the opposite.

31) sanzi ni georgetown ni iku
(3-o'clock adv-p georgetown adv-p go)

Parse Tree
(tailnt np/8) (adv sanzi) (head sanzi) (part ni)
(tailnt np/4) (loc georgetown) (head georgetown) (part ni)
(tail iku) (wf t) (constwn 2) (const s/)

32) hon wo kau node sanzi ni georgetown ni iku
(book obj-p buy because 3-o'clock adv-p georgetown adv-p go)

Parse Tree
(tailnt np/16) (patient hon) (head hon) (part wo)
(tail kau) (agree t)
(conjn node) (aux node)
(tailnt np/8) (adv sanzi) (head sanzi) (part ni)
(tailnt np/4) (loc georgetown) (head georgetown) (part ni)
(tail iku) (wf t) (constwn 2) (const s/)

Now the conjunction is introduced. In this parser only conjunctive particles are taken into consideration. The word "keredomo," however, is used both as a conjunctive particle and a conjunction.

33) hon wo kau node watasi no sukina georgetown ni iku
(book obj-p buy because I possess-p likable georgetown adv-p go)

Relative Clause Tree
(tailnt np/10) (agent watasi) (head watasi) (part no)
(tail sukina) (wf t) (constwn 8) (const relc/)

Parse Tree
(tailnt np/18) (patient hon) (head hon) (part wo)
(tail kau) (agree t)
(conjn node) (aux node)
(tailnt np/4) (loc georgetown) (head georgetown) (part ni)
(tail iku) (wf t) (constwn 2) (const s/)

34) hoeru keredomo sono inu ha sukida
(bark although the dog topic-p likable)

Parse Tree
(tail hoeru) (agree e)
(conjn keredomo) (aux t)
(agent inu) (tailnt np/4) (topic inu) (dem sono) (head inu) (part ha)
(tail sukida) (wf t) (constwn 2) (const s/)

35) watasi ga sukina hon wo kau node
(I possess-p likable book obj-p buy because

watasi ga sukina georgetown ni iku
I sub-p likable georgetown adv-p go)

Relative Clause Tree 1
(tailnt np/24) (agnt watasi) (had watasi) (part ga)
(tail sukina) (wf t) (constwn 22) (const relc/)

Relative Clause Tree 2
(tailnt np/10) (agent watasi) (head watasi) (part ga)
(tail sukina) (wf t) (constwn 8) (const relc/)

Parse Tree
(tailnt np/18) (patient hon) (head hon) (part wo)
(tail kau) (agree t)
(conjn node) (aux node)
(tailnt np/4) (loc georgetown) (head georgetown) (part ni)
(tail iku) (wf t) (constwn 2) (const s/)

36) hon wo kau node georgetown ni iku keredo iku ka
(book obj-p buy because georgetown adv-p go although go question-p)

Parse Tree
(tailnt np/18) (patient hon) (head hon) (part wo)
(tail kau) (agree t)
(conjn node) (aux node)
(tailnt np/10) (loc georgetown) (head georgetown) (part ni)
(tail iku) (agree e)
(conjn keredo) (aux keredo)
(tail iku) (part ka) (stypexqu qu) (wf t) (constwn 2) (const s/)

37) watasi no kat ta anata no sukina hon wo ageru
(I possess-p buy past you possess-p likable book obj-p give)

Relative Clause Tree 1
(tailnt np/10) (agent anata) (head anata) (part no)
(tail sukina) (wf t) (constwn 8) (const relc/)

Relative Clause Tree 2
(tailnt np/18) (agent watasi) (head watasi) (part no)
(tail kat) (aux ta) (agree y) (wf t) (constwn 14) (const relc/)

Parse Tree
(tailnt np/4) (patient hon) (head hon) (part no)
(tail ageru) (wf t) (constwn 2) (const s/)

A sentence can take several auxiliary verbs, but this parser only checks the grammatical forms of connections. As a result, if the auxiliary verbs are connected grammatically, the parser parses the sentence successfully even if the order of the auxiliary verbs is wrong. An example is sentence (38).

38) *watasi ga it taro nai
(I sub-p say past neg-aux)

Parse Tree
(tailnt np/8) (agent watasi) (head watasi) (part ga)
(tail it) (aux taro) (agree y) (aux nai) (agree m) (stypexng ng)
(wf t) (constwn 2) (const s/)

39) watasi ga it taro u
(I sub-p say past may)

Parse Tree
(tailnt np/8) (agent watasi) (head watasi) (part ga)
(tail it) (aux taro) (agree y) (aux u) (agree s) (wf t) (constwn 2) (const s/)

Conventional grammars of the Japanese language do not have a copular verb. In order to parse the sentence like (40), the auxiliary verb "da" is coded as a verb, and the parser inserts the object particle "wo" between the last noun and the verb. The parse tree of (40) shows the particle "wo," but it is added by the parser, not in the original sentence.

40) anata ha kodomo da
(you topic-p child be)

Parse Tree
(agent anata) (tailnt np/6) (topic anata) (head anata) (part ha)
(tailnt np/4) (patient kodomo) (head kodomo) (part wo)
(tail da) (wf t) (constwn 2) (const s/)

7.0. Further research

The result of parsing several sentences has revealed this parser has several

limitations. The analysis of the grammar of this parser does not cover the entire language. Morphological analysis and semantic analysis are not dispensable. To use this parser for assisting learners of the Japanese language, a pre-editor should be included in this system. Th pre-editor must be able to split a Japanese sentence into a series of words, although even native speakers of the Japanese language will make mistakes in dividing a sentence into words. Then the parser will determine if the sentence is grammatical or not. The current system only parses sentences which are already divided into words.

In order to construct a large lexicon, a lexicon editor will be needed. Including the lexicon in the parser program file is not a good way to build a large lexicon. A program which systematically build a lexicon is necessary. Further research will add such a program to the current system.

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