TITLE: Type logical grammar and classical Sanskrit

ABSTRACT:

For semanticists interested in treating natural language semantics with model theory, the syntax of choice is so-called type logical syntax (Kubota and Levine 2020). This syntax, which is based on the Lambek Calculus (Lambek 1958), itself a generalization of categorial grammar (Ajdukiewicz 1935), has the advantage that each of its syntactic types determines its corresponding semantic type. Unfortunately, type logical syntax, taken off the shelf as it were, is ill-suited to being applied to Sanskrit. The most obvious problem is that the constituents of a type logical grammar are linearly ordered. Yet, as is well known, word order in classical Sanskrit is relatively free (Staal 1967).

However, through a few rather modest modifications of type logical grammar one can arrive at a version which can easily accommodate a number of features of Sanskrit, including its relatively free word order. One modification, not immediately pertinent to word order, is the replacement of the basic syntactic categories of t and e with a richer set of categories based on noun, verb, preposition, adjective and clause. The second, directly pertinent to word order, is the replacement the linear order of lexical complement specification with a set of indices. The basic idea is to use case in place of linear order to establish the connection between a word's specification of its complements and the complements themselves. This replacement is based on a well-known mathematical fact where each finite sequence of length n maps bijectively to the set of positive integers up and including n. For example, the sequence of letters ABACD can be recast as a set of ordered pairs $\{(1, \mathrm{A}), (2, \mathrm{B}), (3, \mathrm{A}), (4, \mathrm{C}), (5, \mathrm{D})\}$. Notice that the letters in the expression ABACD are linearly ordered, but there is no order among the ordered pairs in the set. Here, positive integers serve as indices, or pointers, to the letters in the sequence in the position in which they occur. But nothing requires that the indices be positive integers. Any suitably chosen set can be used as indices, including the set of Sanskrit cases.

The familiar cancellation rule for constituent formation is stated in terms of a match between the indices used to specify the complements of a word and the indices of the expressions which are the word's complements. For example, the verb *traitum* (*to save*) takes two complements, one in the second case (NP_2), the other in the fifth case (NP_5). The words *duḥśāsanam* and *bhīmāt* are in the second and fifth case respectively. The cancellation rule applies to form the verb phrase *bhīmād duḥśāsanaṃ trātuṃ* (*to save Duḥśāsana from Bhīma*, cited in Apte 1885 §78: Ve 3). The cancellation rule works for any of the six distinct linear orders of the three words constituting the verb phrase. All that is required for the verb phrase to be well formed is that the indices in the angle brackets have indexed expressions, here words, with matching indices. (The technical formulation has been omitted for reasons of space.)

DERIVATION 1:

traitum	*bhīmād*	*duḥśāsanaṃ*
V:$\langle \mathrm{NP}_2, \mathrm{NP}_5 \rangle$	NP_5	NP_2
	VP	

DERIVATION 2:

duḥśāsanaṃ	*traitum*	*bhīmād*
NP_2	V:$\langle \mathrm{NP}_2, \mathrm{NP}_5 \rangle$	NP_5
	VP	

Each of the four other linear orders abide by the same cancellation rule.

REFERENCES:

Ajdukiewicz, Kazimierz 1935 Die syntaktische Konnexität. *Studia Logica*: v. 1, pp. 1-27. English Translation: McCall (ed) 1967 *Polish Logic*, pp. 207–231.

Buszkowski, Wojciech; Marciszewski, Witold; van Benthem, Johan (eds) 1988 *Categorial Grammar*. Amsterdam, The Netherlands: John Benjamins.

Kubota and Levine 2020 *Type-logical syntax*. Cambridge, Massachusetts: MIT Press.

Lambek, Joachim 1958 The mathematics of sentence structure. *American Mathematical Monthly*: v. 65, pp. 154–170. Reprinted in: Buszkowski, Wojciech *et al.* (eds) 1988 pp. 57–84.

McCall, Storrs (ed) 1967 *Polish Logic*. Oxford, England: Oxford University Press.

Staal, J. F. 1967 *Word Order in Sanskrit and Universal Grammar*. Dordrecht, Holland: D. Reidel Publishing Co. (Foundations of Language, Supplementary Series: v. 5).