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Comments to Yao and Zou on: "Hybrid Categorial Type Logics and the Formal Treatment of Chinese"

Sylvain Pogodalla[1,2,3]

[1] INRIA, Villers-lès-Nancy, F-54600, France
[2] Université de Lorraine, LORIA, UMR 7503, Vandœuvre-lès-Nancy, F-54500, France
[3] CNRS, LORIA, UMR 7503, Vandœuvre-lès-Nancy, F-54500, France
http://www.loria.fr/~pogodalla

1 Introduction

The paper "Hybrid Categorial Type Logics and the Formal Treatment of Chinese" presents the modeling of several linguistic phenomena occurring in Chinese. It relies on the formal framework of Hybrid Categorial Logics (HCL). This framework takes benefit from the ability to parametrize resource-sensitive logical systems with structural properties (such as associativity and commutativity), resulting in four systems:

NL: non-associative and non-commutative Lambek calculus [1];
NLP: non-associative and commutative Lambek calculus;
L: associative and non-commutative Lambek calculus [2];
LP: associative and commutative Lambek calculus, also known as (the intuitionistic fragment of) Linear Logic [3].

Each of the binary connectives of these systems can be indexed by a *composition mode* i to allow for the formulas[4] $\mathcal{F}$ where $\mathcal{A}$ is a set of atomic types:

$$\mathcal{F} ::= \mathcal{A}|\mathcal{F}\backslash_i\mathcal{F}|\mathcal{F}/_i\mathcal{F}|\mathcal{F}\bullet_i\mathcal{F}$$

The key point of hybrid systems is to offer a way to move from one deduction system to another with *inclusion* and *interaction postulates* [4] such as (1) or (2).

(1) $$\frac{\Gamma[(\Delta_1,\Delta_2)^{\circ_i}] \Rightarrow A}{\Gamma[(\Delta_2,\Delta_1)^{\circ_i}] \Rightarrow A}$$

(2) $$\frac{\Gamma[((\Delta_1,\Delta_2)^{\circ_i},\Delta_3)^{\circ_j}] \Rightarrow A}{\Gamma[(\Delta_1,(\Delta_2,\Delta_3)^{\circ_j})^{\circ_i}] \Rightarrow A}$$

which allow for interaction between structures and formulas lying in different systems.

[4] And the corresponding family of the structural connectives $(\cdot,\cdot)^{\circ_i}$ that describes the structured antecedent in the sequent formulation of the calculus.

The authors emphasize that their modeling consider multimodality restricted to *binary* connectives, and that they favor not considering *unary* connectives as MultiModal Categorial Grammar (MMCG) [4] usually does. They show how this hybrid system allows them to give interesting accounts of several phenomena in Chinese. They focus in particular on various ways to express topicalization and conjunction of non constituents.

The modeling they propose brings to my attention different questions. Some of them, discussed in Section 2, relate to the formal system itself and to the motivations of using a multimodal system with only binary connectives rather than unary ones. They also relate to the design chosen for the interaction postulates. Another set of questions that Section 3 points out relate to the modeling capacity of the approach, and to the possible over-generation of the system.

2 On Formal Properties of Hybrid Categorial Grammars

2.1 Unary and Binary Operations

The paper puts a strong emphasis on the advantages of systems that use multimodality and structural postulates for binary connectives over those using unary connectives: "extensive use of structural modalities tends to result on very complex analyses" (in the abstract), "where [structural modalities] are used extensively, unduly complicated accounts tend to result" (end of the first section). However, we would like to have a better characterization of the nature of the involved complexity. Does it relate to the number of postulates? To the design of lexical categories and grammar engineering? To some computational issues?

It would be of a great value that the authors discuss the formal properties of the framework of hybrid logics with respect to MMCG. In particular, it is worth mentioning that there exists embedding theorems [5,6,4] between the different logics by mean of $\Box$ and $\Diamond$ unary connectives. These theorems use translations $(\cdot)^\sharp$ from formulas of a strong logic $\mathcal{L}_1$ into formulas of some weaker logic $\mathcal{L}_1$[5]. They state that

$$\mathcal{L}_1 \vdash A \Rightarrow B \text{ iff } \mathcal{L}_0\Diamond + \mathcal{R}_\Diamond \vdash A^\sharp \Rightarrow B^\sharp$$

where $\mathcal{L}_0\Diamond$ is $\mathcal{L}_0$ augmented with the unary connectives and $\mathcal{R}_\Diamond$ the relevant structural postulates. Would it be possible that any lexical item whose category requires some constraint relaxation and is thus expressed in a strong logic is modeled in the weaker logic **L** using the unary connectives. For instance, the topicalization of noun phrases of example (3.5) is modeled with $s_T/(s \multimapinv np)$[6] using **LP**. Would it be possible to model this phenomenon using the unary connectives, possibly $s_T/(\Box s/np)$ and the adequate translation of the structured antecedent?

[5] Different kinks of translations are considered in the above mentioned papers, but it seems to me it is the ones that are relevant here.

[6] We follow the usual way to express the right implication of **L** with $/$ and the implication of **LP** with $\multimapinv$ rather than with indexed connectives.

2.2 Postulates

There also are some questions regarding the structural postulates and the interaction between the different composition modes. The paper should make them precise. The inclusion postulates are clearly stated. It is also clear which modes allow for permutation or associativity or combination of both. However, it should be explicitly stated that the associativity rule is bidirectional, as the examples show. That is both

$$\frac{\Gamma[((\Delta_1,\Delta_2)^{\circ},\Delta_3)^{\circ}] \Rightarrow A}{\Gamma[(\Delta_1,(\Delta_2,\Delta_3)^{\circ})^{\circ}] \Rightarrow A}\ [\mathrm{A}]$$

and

$$\frac{\Gamma[(\Delta_1,(\Delta_2,\Delta_3)^{\circ})^{\circ}] \Rightarrow A}{\Gamma[((\Delta_1,\Delta_2)^{\circ},\Delta_3)^{\circ}] \Rightarrow A}\ [\mathrm{A}]$$

stand, what is usually written

$$\frac{\Gamma[((\Delta_1,\Delta_2)^{\circ},\Delta_3)^{\circ}] \Rightarrow A}{\overline{\Gamma[(\Delta_1,(\Delta_2,\Delta_3)^{\circ})^{\circ}] \Rightarrow A}}\ [\mathrm{A}]$$

More importantly, the examples the paper provides don’t make any use of the interaction postulate (rule (2.5) of the paper). Does it mean that it is not useful for the given examples but are useful for other phenomena? Does it mean the authors prefer not to consider this postulate? It would be interesting to comment on the scope of this postulate, both from a cross-linguistic perspective and from a Chinese language perspective. Also note that the interaction postulate slightly differs from the one given in [5]:

$$\frac{\Gamma[(\Delta_1,(\Delta_2,\Delta_3)^{\circ_i})^{\circ_j}] \Rightarrow A}{\Gamma[((\Delta_1,\Delta_2)^{\circ_i},\Delta_3)^{\circ_j}] \Rightarrow A}\ \text{here vs.}\ \frac{\Gamma[(\Delta_1,(\Delta_2,\Delta_3)^{\circ_j})^{\circ_i}] \Rightarrow A}{\overline{\Gamma[((\Delta_1,\Delta_2)^{\circ_i},\Delta_3)^{\circ_j}] \Rightarrow A}}\ \text{in [5]}$$

3 Linguistic Modeling with Hybrid Categorial Grammars

The end of the paper is devoted to providing analysis of linguistic phenomena in Chinese. It focuses on topicalization and conjunction of non constituents.

3.1 Specificities of Chinese

While the modeling that are proposed here are convincing, it would help the reader to have a better exposition of the specificities of Chinese. Regarding topicalization, as far as I can see, only example (3.5) “topicalized complex head word of subject” really needs inclusion postulates.

For instance in example 3.3, we can associate the type $s_T/((np/np)\backslash s)$ to *Zhe-jian* instead of $s_T/((np/np) \multimap s)$ and still analyze *Zhe-jian yifu buliao bu-cuo* as the following derivation shows:

$$\dfrac{\dfrac{\dfrac{\dfrac{np \Rightarrow np \qquad \dfrac{np \Rightarrow np \qquad s \Rightarrow s}{(np, np\backslash s)^{\bullet} \Rightarrow s}[\backslash L]}{((np/np, np)^{\bullet}, np\backslash s)^{\bullet} \Rightarrow s}[/L]}{(np/np, (np, np\backslash s)^{\bullet})^{\bullet} \Rightarrow s}[A]}{(np, np\backslash s)^{\bullet} \Rightarrow (np/np)\backslash s}[\backslash R] \qquad s_t \Rightarrow s_T}{\underset{\text{Zhe-jian yifu}}{(s_T/((np/np)\backslash s),} \quad \underset{\text{buliao}}{(np,} \quad \underset{\text{bu-cuo}}{np\backslash s)^{\bullet})^{\bullet}} \Rightarrow s_T}[/L]$$

In order to require the commutative implication, the example should illustrate an extraction that is not peripheral, as in (4) where the cleft word relates to the object rather than to the subject, contrasting with (3). Note that with the type $s_T/((np/np) \multimap s)$ for *zhe-ge* would enforce the grammaticality of (4)[7] as the derivation (5) shows.[8] Such contrasts would help the reader without any knowledge of Chinese to grasp the insights of the modeling proposed here.

(3)

zhe-ge ban shang	*xuesheng*	*xihuan*	*zhuxi*
this class in	students	like	chairman
$s_T/((np/np) \multimap s)$	np	$(np\backslash s)/np$	np

'As to this class, the (its) students like the chairman'

(4)

zhe-ge ban shang	*zhuxi*	*xihuan*	*xuesheng*
this class in	chairman	likes	students
$s_T/((np/np) \multimap s)$	np	$(np\backslash s)/np$	np

'As to this class, the chairman likes its students'

(5)

$$\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{np \Rightarrow np \qquad \dfrac{\dfrac{\dfrac{np \Rightarrow np \qquad s \Rightarrow s}{(np, np\backslash s)^{\bullet} \Rightarrow s}[\backslash L] \qquad np \Rightarrow np}{(np, ((np\backslash s)/np, np)^{\bullet})^{\bullet} \Rightarrow s}[/L]}{((np, (np\backslash s)/np)^{\bullet}, np)^{\bullet} \Rightarrow s}[A]}{((np, (np\backslash s)/np)^{\bullet}, (np/np, np)^{\bullet})^{\bullet} \Rightarrow s}[/L]}{((np, (np\backslash s)/np)^{\bullet}, (np/np, np)^{\otimes})^{\bullet} \Rightarrow s}[<]}{((np, (np\backslash s)/np)^{\bullet}, (np, np/np)^{\otimes})^{\bullet} \Rightarrow s}[P]}{(((np, (np\backslash s)/np)^{\bullet}, np)^{\bullet}, np/np)^{\otimes} \Rightarrow s}[(2)]}{(np/np, ((np, (np\backslash s)/np)^{\bullet}, np)^{\bullet})^{\otimes} \Rightarrow s}[P]}{((np, (np\backslash s)/np)^{\bullet}, np)^{\bullet} \Rightarrow (np/np) \multimap s}[\multimap R] \qquad s_t \Rightarrow s_T}{\underset{\text{zhe-ge ban shang}}{(s_T/((np/np) \multimap s),} \quad \underset{\text{zhuxi}}{((np,} \quad \underset{\text{xihuan}}{(np\backslash s)/np)^{\bullet},} \quad \underset{\text{xuesheng}}{np)^{\bullet})^{\bullet}} \Rightarrow s_T}[/L]$$

A similar comment apply to example (3.4). The following derivation:

[7] To the best of my knowledge, this reading seems at least hard to get.

[8] Note that the derivation uses interaction postulate (2) . It's possible that other examples don't. I let it to Chinese speakers!

$$\dfrac{\dfrac{\dfrac{\dfrac{np\backslash s \Rightarrow np\backslash s \qquad \dfrac{np \Rightarrow np \qquad s \Rightarrow s}{(np, np\backslash s)^{\bullet} \Rightarrow s}[\backslash L]}{(np, (np\backslash s, (np\backslash s)\backslash(np\backslash s))^{\bullet})^{\bullet} \Rightarrow s}[\backslash L]}{((np, np\backslash s)^{\bullet}, (np\backslash s)\backslash(np\backslash s))^{\bullet} \Rightarrow s}[A]}{(np, np\backslash s)^{\bullet} \Rightarrow s/((np\backslash s)\backslash(np\backslash s))}[/R] \qquad s_T \Rightarrow s_T}{(s_T/(s/((np\backslash s)\backslash(np\backslash s))), (np, np\backslash s)^{\bullet})^{\bullet} \Rightarrow s_T}[/L]$$

shows that (6) is grammatical with this typing.[9]

(6)	*Ni-men-ban*	*we*	*shouxuan Yangfan*
	You-PL-class	I	first-pick Yangfan
	$s_T/(s/((np\backslash s)\backslash(np\backslash s)))$	np	$(np\backslash s)$

And (7) illustrates a similar remark for example (3.6)

(7)	*Jiu*	*wo*	*xihuan he*	*guizhou de*
	Alcool	I	like drink	Guizhou NOMI
	$s_T/(s/np)$	np	$(np\backslash s)/np$	np/np

$$(s_T/(s/np), ((np, (np\backslash s)/np)^{\bullet}, np/np)^{\bullet})^{\bullet} \Rightarrow s_T$$

None of these examples makes use of an inclusion or interaction postulate. So it is really important to provide relevant examples focusing on the requirement Chinese makes on peripheral or non-peripheral extraction. The examples for conjunction don't make clear either what the specificities for Chinese are. If there are none, related works to conjunction for other languages should be mentioned.

Finally, one could improve the understanding of the reader in providing glosses with a better alignment. It also seems that the examples include expressions that are provided with a single type, such as *Zhe-jian* : $s_T/((np/np) \multimap s)$ whereas it is itself a combination of words. It would be worth providing the very lexical types so that we can better understand the combination even if the derivations make use of partially evaluated expression. It amounts to ask: could $(s_T/((np/np) \multimap s))/n$ be a suitable type for *zhe* and n a suitable type for *jian*?

3.2 Parsing, Proof-Search, and Over-generation

My final comment has to do with choosing which sequent to prove. Indeed, as soon as several composition modes are available, one needs to specify the ones that are used in the structured antecedent of the sequent to prove. This choice is very important since choosing one composition mode or the other could prevent to use relevant structural postulates in the derivations and make them fail. So what are the strategies? Do we have to try all the possible composition modes? And what happens in case several structures would allow us to prove the sequent?

It is indeed striking that examples (3.3) and (3.6) only make use of the **L** composition mode, while (3.4) and (3.5) mix **L** and **LP** composition modes, and (3.7) uses only

[9] I don't quite understand why the authors call this case "object modifier" since its rather a verb phrase modifier that is hypothesized in the derivation.

LP composition mode. The latter is very surprising because it implies that the grammar will generate all the permutations: if

$(np$	$, ((np\backslash s)/np$	$, ((np\backslash s)\backslash(np\backslash s)$	$, np)^{\otimes})^{\otimes})^{\otimes} \Rightarrow s$	
Zhangsan	chi	le	fan	

is derivable, so are *Zhangsan chi fan le*, *Zhangsan le chi fan*, *Zhangsan le fan chi*, *Zhangsan fan chi le*, *Zhangsan fan le chi*, *chi Zhangsan le fan*, *chi Zhangsan fan le* etc. I really wonder if all of them are acceptable.

4 Conclusion

This paper provides an interesting use of hybrid systems to model Chinese. Defining more precisely the specificity the system should handle would improve the relevance of the approach. As such systems require fine-tuning to avoid under- and over-generation, automatic systems such as Grail [7] could be used.

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