

中文名词性谓词语义角色标注*

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Semantic Role Labeling in Chinese Language for Nominal Predicates

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Abstract: This paper explores semantic role labeling (SRL) in the Chinese language for nominal predicates. In addition to the widely adopted features of verbal SRL, various nominal predicate-specific features are also explored. Moreover, the nominal SRL performance has been improved by properly integrating features that were derived from a state-of-the-art verbal SRL system. Finally, the paper explains in detail the nominal predicate recognition, which is essential in a fully automatic nominal SRL system. Evaluations on Chinese NomBank show that proper integration of a verbal SRL system significantly improves the performance of a nominal SRL. It also shows that this nominal SRL system achieves the performance of 72.67 in *F1*-measure on golden parse trees and golden predicates, and outperforms the state-of-the-art nominal SRL systems in the Chinese language; however, the performance drops to 55.14 in *F1*-measure on automatic parse trees and automatic predicates.

Key words: semantic role labeling; nominal predicate-specific feature; verbal SRL feature; nominal predicate recognition

摘要: 研究了中文名词性谓词的语义角色标注(semantic role labeling, 简称 SRL)。在使用传统动词性谓词 SRL 相关特征的基础上, 进一步提出了名词性谓词 SRL 相关的特征集。此外, 探索了中文动词性谓词 SRL 对中文名词性谓词 SRL 的影响, 并且联合谓词自动识别实现了全自动的中文名词性谓词 SRL。在中文 NomBank 上的实验结果表明, 中文动词性谓词的 SRL 合理使用能够大幅度提高中文名词性谓词的 SRL 性能; 基于正确句法树和正确谓词识别, 中文名词性谓词的 SRL 性能 *F1* 值达到了 72.67, 大大优于目前国内外的同类系统; 基于自动句法树和自动谓词识别, 性能 *F1* 值为 55.14。

关键词: 语义角色标注; 名词性谓词相关特征; 动词性语义角色标注特征; 名词性谓词识别

中图法分类号: TP391 文献标识码: A

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: 2009-05-13; : 2009-10-14; : 2010-03-29

(semantic role labeling, SRL)

() () .SRL

5W (who,what,when,where,why)

[1] [2] [3] [4] SRL

SRL SRL

FrameNet^[5],PropBank^[6] ,CoNLL-2004^[7] 2005^[8]

SRL [9-13] [9-11]

SRL^[12] [13]

PropBank Penn TreeBank^[14] ,NomBank^[15] PropBank

Penn TreeBank .Jiang Ng^[16] NomBank

SRL SRL,

PropBank^[17] NomBank^[18] SRL

.Sun Pradhan [19,20]

.Xue [21-23] PropBank NomBank

SRL. ,Xue Palmer^[21] SRL,

F1 91.3 61.3.Xue^[22] SRL. [22]

SRL SRL

.Xue^[23]

SRL .Ding Chang^[24]

94.68%.Chen [25]

SRL, .Che^[26]

SRL, [26]

2008 [27] SRL SRL .CoNLL-

SRL SRL

2009 [28] CoNLL-2008 Pipeline SRL .CoNLL-

,CoNLL-2008 7

SRL 3 :

;

2

:(1) SRL :(2)

SRL SRL ;(3)

SRL

NomBank : SRL F1

72.67, ; SRL F1

55.14.

SRL

1 中文 NomBank 介绍

NomBank NomBank TreeBank^[29]
 (core argument) Arg0~Arg5 6 .Arg0
 ,Arg1 ,Arg2~Arg5
 , ArgM , ArgM-LOC
 ,ArgM-TMP . 1 NomBank
 “ ” “ /Arg0”
 “ /Arg1”; “ ” “ /Arg1” “ /Arg0”.
 “ /ArgM-MNR”, “ ” Arg1
 “ ” “Sup”,
 (support verb). 1
 [18], 1, NP() PP()
 “ ” “ ” “ ” “ ”

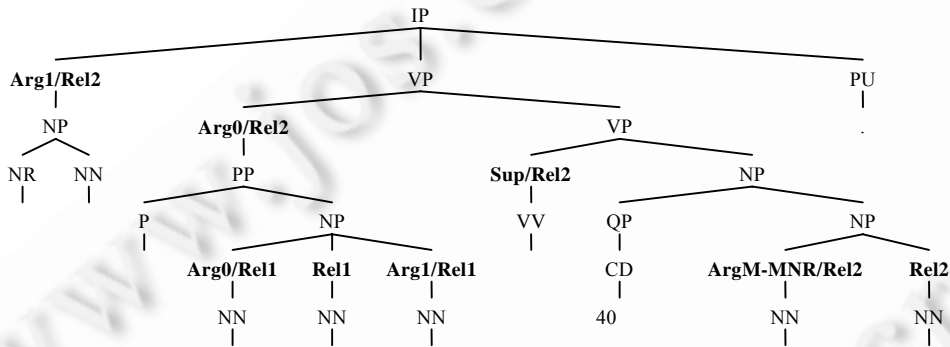


Fig.1 Nominal predicates “ ” and “ ”, and their semantic arguments

2 中文名词性谓词语义角色标注

1 , ()
 : (i) , 1 “ ” Arg0 Arg1 “ ” ArgM-MNR
 . (ii) , VP
 , 1 “ ” Arg1 Arg0
 ; (traditional feature);
 (nominal predicate-specific feature).

2.1 系统流程

[9,10,21-23] , 3 :

1. ... ; ... 2 ...

1. ... ; ... Xue^[22] ...

3 ... **:

- CP DNP ;
- C ; C 1
- NP C ;

1 “NP()” “PP()” “ ”

“ ” M M

(intervening verb)^{***}, [21]

2. ... (NULL Non-NULL)

Pradhan^[10] ...

NULL (0.90),

3 ... 0.90

Non-NULL

3. ... (NULL)

2.2 传统特征

Xue Palmer^[9] ; SRL^[16,21,22]

1. 3 1

NP() NN()

1 b2^[21] ;

Palmer^[21] 3 ; .Xue

“ ” “ ” “ ” [21].

** ,VP ,NP ,PP ,IP ,CP

IP+“ ”;DNP NP+“ ”

*** VV<VP>NP⁺>NN ,NP⁺ 1 NP.

Table 1 Traditional features for argument identification and argument classification
表 1

Traditional features for argument identification: b1~b5, b11~b14		
b1	Predicate: the predicate itself	
b2	Predicate class: the verb class that the predicate belongs to	C4a
b3	Head word (b3H) and its part-of-speech (POS) tag (b3P)	,NN
b4	Phrase type: the syntactic category of the constituent	NP
b5	Path: the syntactic path from the constituent to the predicate	(NP<IP>VP>VP>NP>VP>NN)
Combined features (b11~b14): b1&b4; b1&b3H; b2&b4; b2&b3H		
Traditional features for argument classification: besides features b1~b5, b11~b14, they also include b6~b7, b15		
b6	Position: the positional relationship of the constituent with the predicate. "left" or "right"	left
b7	The first word (b7F) and the last word (b7L) of the constituent	,
Combined features (b15): b5&b6		

2.3 名词性谓词相关特征

2.2

[21,23]

SRL

2.3.1

NomBank

40%

{ai1~ai7, ai11~ai12}.

(ai6); ai6 ai7, 2, 3
1, "NN()" "NN()",

Table 2 Nominal predicate-specific features for inside arguments
表 2

ai1	Whether the constituent is adjacent to the predicate? Yes or No	Yes
ai2	Headword (ai2H) and its POS (ai2P) of the predicate's nearest right sibling	,NN
ai3	Whether the predicate has right siblings? Yes or No	Yes
ai4	Compressed path of b5: compressing sequences of identical labels into one	NN<NP>NN
ai5	Whether the predicate has sibling? Yes or No	Yes
ai6	For each sibling of the constituent, combine b4&b3H&b5&b6	&NN&NN<NP>NN&right
ai7	For each sibling of the constituent, combine b4&b6	NN&right
Combined features (ai1~ai12): b11&ai3; ai4&b1		

2.3.2

NomBank

20% 22%

{ao1~ao4, ao11~ao14}(ao11 ao13 [20]), 3, 3 1,
"NN()" "NP()",

Table 3 Nominal predicate-specific features for outside arguments
表 3

ao1	Intervening verb: the intervening verb itself	
ao2	Intervening verb class: the verb class that the intervening verb belongs to	C3b
ao3	Intervening path: the syntactic path from the constituent to the intervening verb	NP<IP>VP>VP>VV
ao4	Intervening compressed path: compressing sequences of identical labels into one	NP<IP>VP>VV
Combined features (ao11~ao14): ao1&ao3; ao1&ao4; ao2&ao3; ao2&ao4		

2.3.3

[16]. () ,
 :(1) {b1~b5,b11~b14}
 , {ai1~ai7,ai11~ai12,ao1~ao4,ao11~ao14} ;(2)
 , {b1~b7;b11~b15}
 , {ai1~ai7,ai11~ai12,ao1~ao4,ao11~ao14}

3 中文动词性谓词 SRL 在中文名词性谓词 SRL 中的应用

NomBank PropBank
 , “ ”
 Arg0, Arg1. , “ ” “ ”
 :
 1. [Arg1] [Arg0] [Rel].
 2. [Arg0] [Arg1] [Rel].
 “ ” 1 2
 SRL [22]
 SRL PropBank NomBank
 , PropBank NomBank
 , 1 2
 , 2 1 , “ ” 2 Arg0,
 1 Arg1.
 2.3 SRL
 ? , 1 , “VV()” “NP()”
 “NN()” “NP()” ? , NN,
 VV, NP. , SRL ,NN NP VV ,
 NP VV NN ,NP()VV() (NN),
 NP VV , VV VV
 NP NN , 1 “ ” “ ” “ ” “ ”
 ” “ ” , “ ”
 4 SRL {ao5~ao8,ao21~ao27}(SRL
 [21]).

Table 4 Features derived from a verbal SRL system

表 4 SRL

ao5	Whether the constituent is an argument of the intervening verb? Yes or No
ao6	The semantic role of the constituent for the intervening verb
ao7	Whether the highest none phrase (NP) dominated by the predicate is an argument of the intervning verb? Yes or No
ao8	The semantic role of the highest NP dominated by the predicate for the intervening verb
Combined features (ao21~ao27): ao1&ao5; ao1&ao6; ao1&ao5&b1; ao1&ao6&b1; ao1&ao7; ao1&ao8; ao5&ao7	

4 中文名词性谓词自动识别

SRL

PropBank 99%
 : NomBank 82 982 (11 386),
 14 525 (1 421), 17.5%(12.5%); 5 743 , 675
 , 11.8%.
 ,CoNLL-2008^[27]
 ,CoNLL-2008
 (Predicate Non-Predicate)
 NN , 1 , { , , ,
 } ; (1) ;
 规则 1. w, w w
 1
 1 , 1 { , } .
 , POS-Item ,Parent-Item Grand- Item
 POS-Item ,InteVerb-Item (). 1 ,
 “ ” POS-Item,Parent-Item,Grand-Item “(NN)” “(NP)” “(NP 40
)”,InteVerb-Item “(VV)”. 5 (f1~f15),

Table 5 Local features for nominal predicate recognition
 表 5

f1	The predicate candidate itself	
f2	The left word (f2W) and its POS (f2P)	NN
f3	The right word (f3W) and its POS (f3P)	.PU
f4	The first character (f4F) and the last character (f4L) of the candidate	
f5	The discriminial subcategory of Parent-Item	NP→NN+NN*
f6	Whether POS-Item is the head child of Parent-Item? Yes or No	Yes
f7	For each left siblings of POS-Item, its headword	
f8	For each right siblings of POS-Item, its headword	NULL
f9	The discriminial subcategory of Grand-Item	NP→QP+NP*
f10	Whether Parent-Item is the head child of Grand-Item? Yes or No	Yes
f11	Whether the candidate is the headword of Grand-Item? Yes or No	Yes
f12	The headword of Parent-Item's nearest left sibling	40
f13	The headword of Parent-Item's nearest right sibling	NULL
f14	The intervening verb itself	
f15	The syntactic path from InteVerb-Item to POS-Item	VV<VP>NP>NP>NN

(f1~f15) 4 : 1 (f1~f4) . 2 (f5~f8)
 Parent-Item , f5 , TreeBank
 , NN , NP , NN , Parent-Item
 , NN ,
 (,NP→NN*+NN NP→NN+NN*) . 3 (f9~f13)
 Grand-Item , Grand-Parent NP , NomBank ,
 , Parent-Item
 , f9~f13 , 4 (f14~f15) InteVerb-
 Item , SRL ,

(global features). , 6 (g1~g5),
 ,g3~g5 4 :
 (1) Predicate
 (2) NOTPredicate
 (3) Predicate_NOTPredicate
 (4) NULL ,g3 NULL “ ”
 ;g4 Predicate “ ” ;“ ” Predicate.

Table 6 Global features for nominal predicate recognition
 表 6

g1	Whether the candidate is ever tagged as a verb in the training data? Yes/No	Yes
g2	Whether the candidate is ever tagged as predicate in the training data? Yes/No	Yes
g3	The most likely label when the candidate co-occurs with its both left and right words	NULL
g4	The most likely label when the candidate co-occurs with its left word	Predicate
g5	The most likely label when the candidate co-occurs with its right word	Predicate

5 实验结果与分析

NomBank , NomBank PropBank TreeBank
 5.1(CTB5.1)
 SRL , ; SRL ,
 SRL SRL(SRL SRL)
 ;
 SRL ,
 SRL

5.1 实验设置

Xue^[23] , NomBank 648 (chtb_081.fid-chtb_899.fid) ,40
 (chtb_041.fid-chtb_080.fid) ,72 (chtb_001.fid-chtb_040.fid chtb_900.fid-chtb_931.fid)
 8 642,731 1 124.
 ;
 (1) (word-based) :
 (2) (character-based) :
 (http://nlp.suda.edu.cn)
 B,I E, S; Berkeley parser(http://code.
 google.com/p/berkeleyparser/).Berkeley parser Berkeley
^[30] , CTB5.1 ,
 F1 96.5, F1 82.1,
 F1 85.6****.
 , SVM Light (http://dit.unitn.it/~moschitt)
 , SVM Light (one vs. others)

F1

F1

Table 8 Effect of features derived from verbal SRL on nominal SRL on the test data

表 8		SRL		SRL
Parse	Feature	<i>R</i> (%)	<i>P</i> (%)	<i>F1</i>
Golden	baseline	67.86	73.63	70.63
	+ao5	68.15	73.60	70.77 (+0.14)
	+ao6	67.66	72.80	70.14 (-0.49)
	+ao7	68.20	75.41	71.62 (+0.99)
	+ao8	68.30	75.39	71.67 (+1.04)
	+ao21	67.91	74.40	71.00 (+0.37)
	+ao22	67.76	74.20	70.83 (+0.20)
	+ao23	67.96	74.69	71.16 (+0.53)
	+ao24	68.01	74.18	70.96 (+0.33)
	+ao25	68.01	75.01	71.39 (+0.76)
	+ao26	68.20	75.12	71.49 (+0.86)
	+ao27	68.40	75.70	71.87 (+1.24)
Word-Based	+features derived from verbal SRL	68.40	77.51	72.67
	Ref.[23]	66.1	73.4	69.6
Character-Based	+features derived from verbal SRL	55.95	66.74	60.87
	Ref.[23]	53.1	62.9	57.6
Golden	+features derived from verbal SRL	53.55	66.69	59.40
	Ref.[23]	52.9	62.3	57.3

5.4 基于自动谓词识别的名词性谓词SRL

SRL

5.4.1

NN, NN 9
 F1 (81.04) F1 (91.64)
 (1) F1 1.42,
 (2)
 (3) 1.6%, 1.6%

Table 9 Performance of nominal predicate recognition on the test data

表 9

Parse	g1~g5	<i>R</i> (%)	<i>P</i> (%)	<i>F1</i>
Golden	No	91.46	89.00	90.22
	Yes	92.70	90.61	91.64
Word-Based	Yes	86.57	82.95	84.72
Character-Based	Yes	84.96	82.83	83.88

5.4.2

SRL

10

10 , SRL F1 55.14, SRL

Table 10 Performance of SRL on the test data, with golden/automatic parse trees and golden/automatic predicates

表 10 SRL : / /

Parse	Predicate	R (%)	P (%)	F1
Golden	Golden	68.40	77.51	72.67
	Automatic	65.36	74.69	69.72
Word-Based	Golden	55.95	66.74	60.87
	Automatic	53.06	59.70	56.19
Character-Based	Golden	53.55	66.69	59.40
	Automatic	51.10	59.87	55.14

11 / / 2/6
 F1 ; 3/7 ()
 F1; 4/8 11
 Arg0,Arg1,ArgM-MNR ArgM-LOC

Table 11 Performance on the test data for each role type

表 11

Type/Description	Golden	Automatic	Ratio (%)	Type/Description	Golden	Automatic	Ratio (%)
Arg0/Agent	71.32	55.44	28.17	ArgM-DIS/Discourse marker	72.73	65.12	1.22
Arg1/Patient, recipient	77.73	55.30	36.26	ArgM-EXT/Extent	0.00	0.00	0.05
Arg2/Predicate-specific	77.14	70.59	3.92	ArgM-FRQ/Frequency	0.00	0.00	0.20
Arg3/Predicate-specific	0.00	0.00	0.39	ArgM-LOC/Locative	70.23	55.56	7.06
Arg4/Predicate-specific	0.00	0.00	0.10	ArgM-MNR/Manner	70.21	57.27	11.86
ArgM-ADV/Adverbial	59.26	53.12	3.43	ArgM-NEG/Negation	75.00	66.67	0.20
ArgM-CND/Condition	0.00	0.00	0.15	ArgM-PRP/Purpose	25.00	25.00	0.24
ArgM-DGR/Degree	50.00	28.57	0.59	ArgM-TMP/Temporal	68.82	42.46	5.34
ArgM-DIR/Direction	66.67	52.94	0.73	ArgM-TPC/Topic	50.00	50.00	0.10
Overball	72.67	55.14	100.00	-	-	-	-

5.5 与已有系统的结果比较分析

SRL SRL
 F1 SRL 20(e.g. 72.67 vs. 92.0). : (1)
 TreeBank 5.1 [18]
 1/5.(2)
 ,96% ; 40%
 .(3) [14]
 , 4 :(a) ;(b)
 (c) ;(d)
 SRL ;(4)
 SRL .Jiang Ng^[16] SRL,
 F1 72.73 69.14, 3.6.
 SRL
 Arg2~Arg5

, SRL F1 13; SRL F1
 3.5. F1 91~92,
 ; 97%
 , 96%

6 结束语

, SRL SRL ;
 / SRL SRL ;

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李军辉(1983), , , ,



朱巧明(1963), , , ,



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钱培德(1947), , , , ,