Dependency Structure of Coordination in Head-final Languages: a Dependency-Length-Minimization-Based Study

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The study on the UD corpora

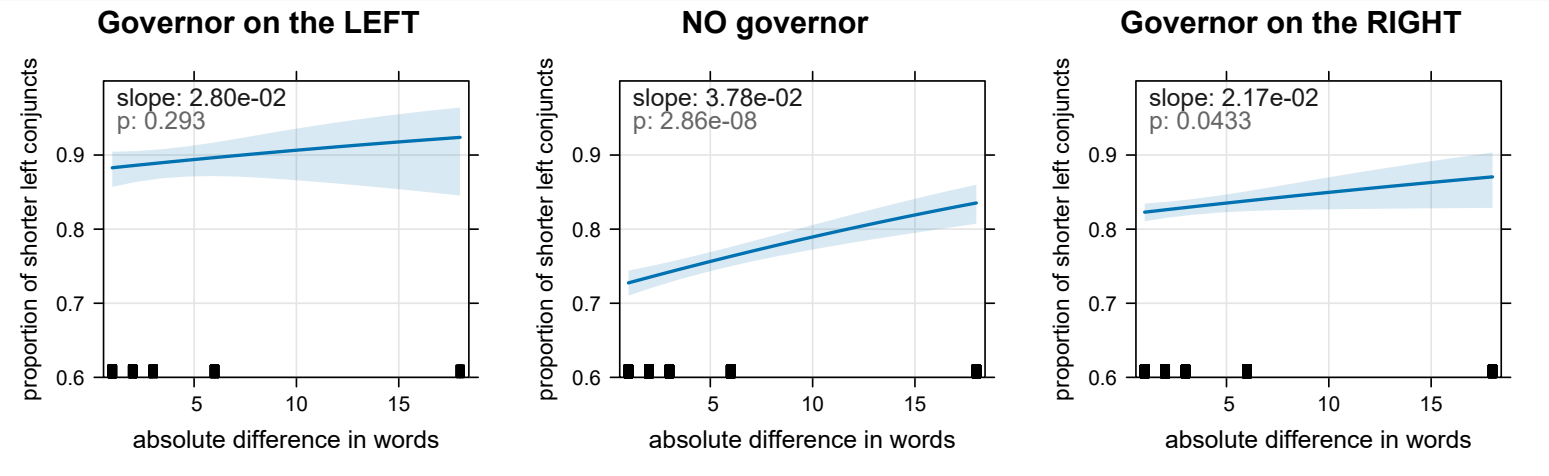
	tokens	coords	L/–	–/R	L/R	R
it	864K	25,426	$+^{***}$	+	$+^{*}$	$+^{**}$
la	983K	39,510	$+^{*}$	$+^{***}$	$+^{***}$	–
pt	1,361K	29,255	$+^{***}$	+	$+^{**}$	$+^{**}$
ro	938K	37,247	+	$+^{***}$	$+^{***}$	+
es	1,002K	28,666	$+^{***}$	+	$+^{*}$	$+^{**}$
en	718K	21,013	–	$+^{**}$	$+^{**}$	–
is	1,183K	43,852	$+^{***}$	–	$+^{*}$	$+^{*}$
cs	2,249K	90,566	$-^{***}$	$+^{***}$	$+^{***}$	$-^{*}$
pl	497K	16,684	–	$+^{*}$	+	+
ru	1,896K	61,004	+	$+^{***}$	$+^{***}$	–

(Przepiórkowski et al. 2024)

The study on the UD corpora – head-final languages

- Korean

- Turkish



The study on the UD corpora – head-final languages

	tokens	coords	L/–	–/R	L/R	R
ko	447K	21.5K	+	+	+	+**
tr	730K	19.6K	–	+	+	+*

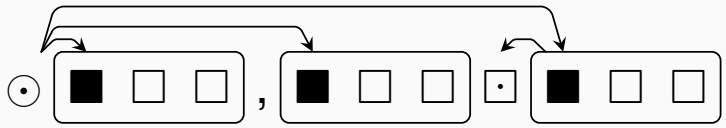
Question: How do we interpret them?

Intuition: Coordinations in head final languages “should” have “opposite” tendencies to those in head-initial languages.

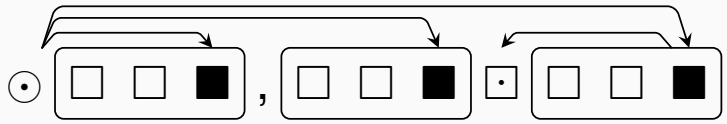
Coordination in head-final languages

Assumption 1. The head has more dependents on its left side than on its right side.

Head-initial languages:



Head-final languages:



Coordination in head-final languages

Assumption 1 was checked using the average relative head position defined by the formula

$$P = \frac{H - 1}{N - 1} \text{ for } N \geq 2,$$

where:

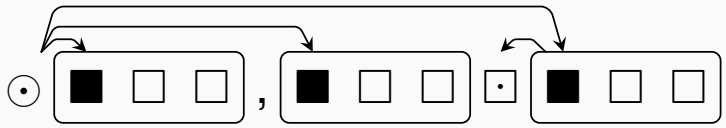
- P – the relative position of the head;
- H – the absolute position of the head within the conjunct;
- N – the conjunct length.

	left conjunct		right conjunct	
	N	mean	N	mean
ko	6801	**0.78**	12951	**0.65**
tr	7994	**0.64**	12763	**0.69**

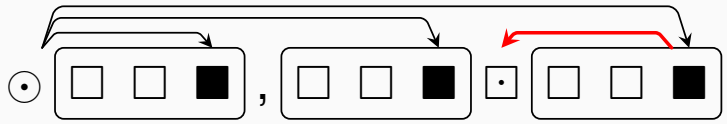
Coordination in head-final languages

Assumption 1. The conjunct head has more dependents on its left side than on its right side.

Head-initial languages:

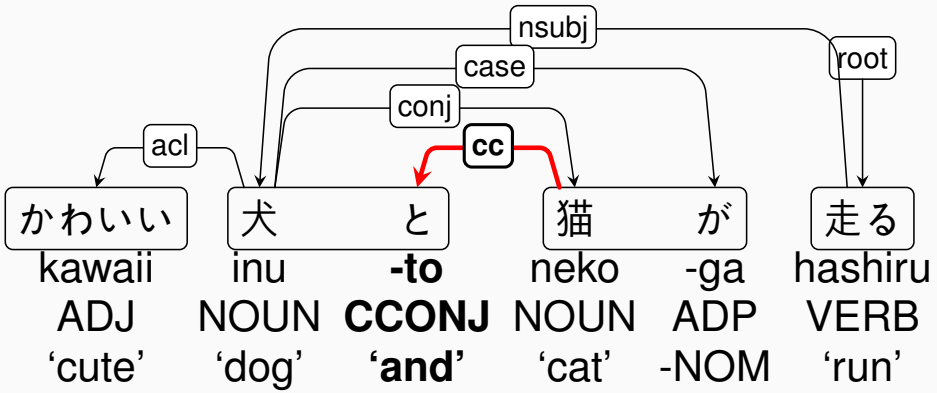


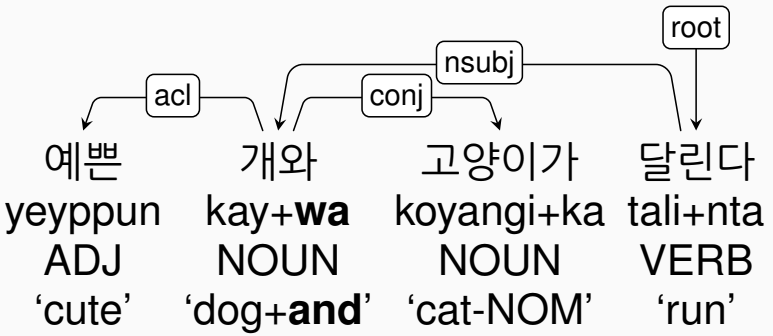
Head-final languages:



Coordination in head-final languages

Problem: Conjunctions in head-final languages do not work like that: (Kanayama et al. 2018)

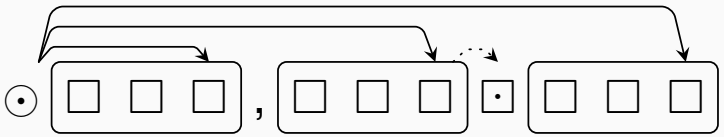




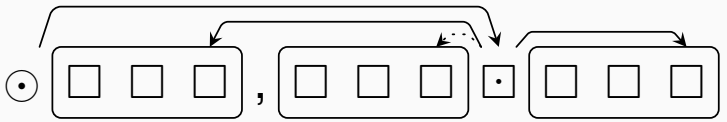
Coordination in head-final languages

Assumption 2. The conjunction is a dependent of the *closest* token head.

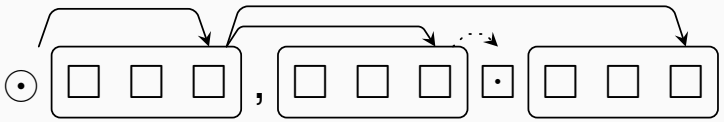
London (Multi-headed):



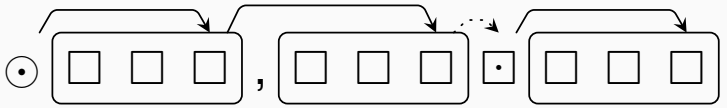
Prague (Conjunction-headed):



Stanford (Bouquet):



Moscow (Chain):



(Popel et al. 2013, Przepiórkowski and Woźniak 2023)

Coordination in head-final languages

Assumption 3. We must consider different approaches.

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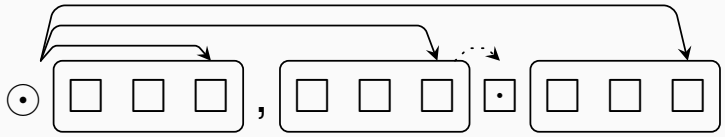

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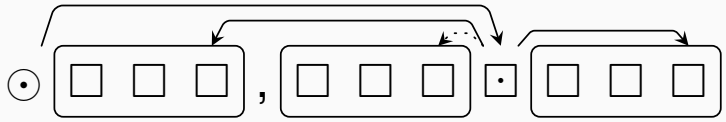

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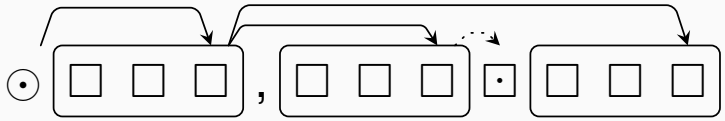

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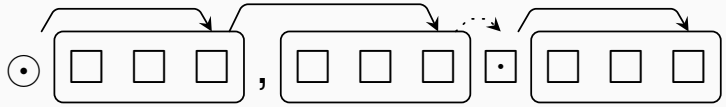

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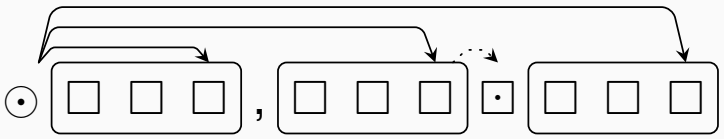

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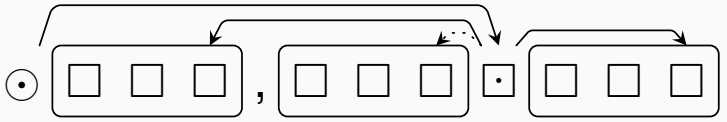

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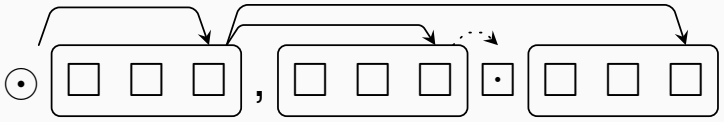

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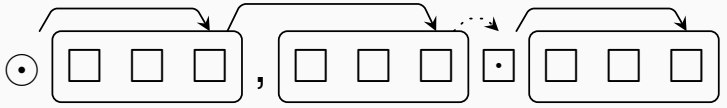
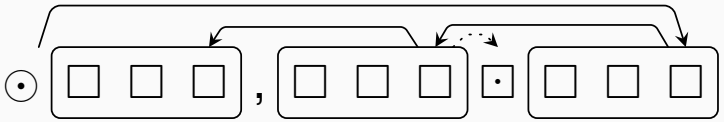


Inverted Moscow (Right-headed):

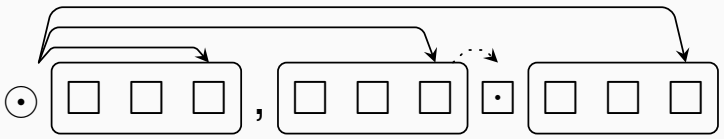


(Choi and Palmer, 2011)

Coordination in head-final languages

The analysis covers only binary coordinations.

London (Multi-headed):



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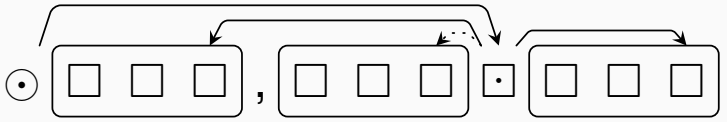

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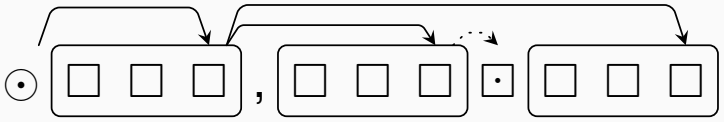

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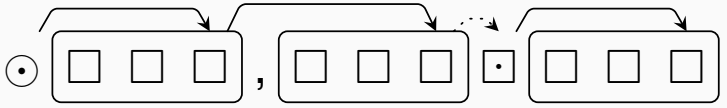

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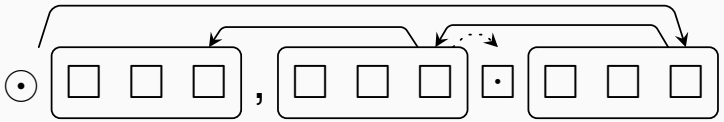

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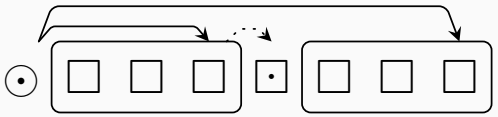

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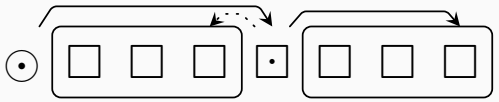

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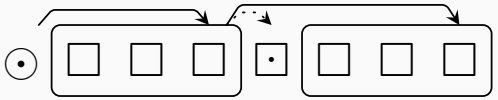

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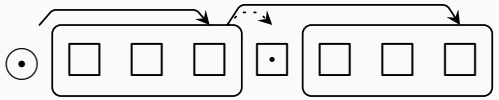

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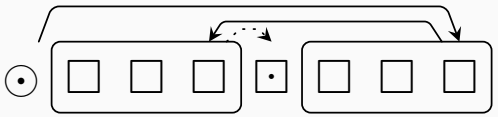

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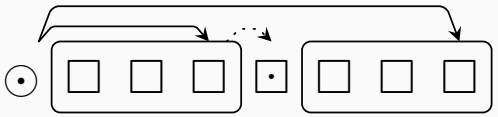

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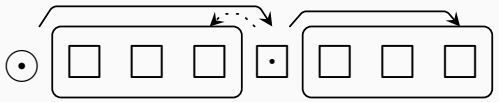

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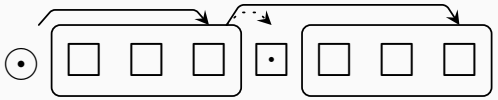

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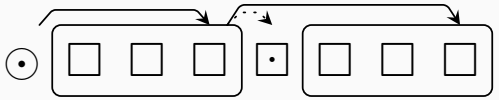

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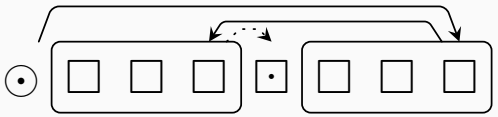
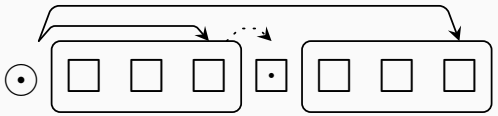


(Choi and Palmer, 2011)

Coordination in head-final languages

Considered approaches:

London (Multi-headed):



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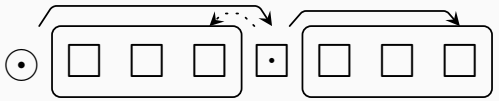
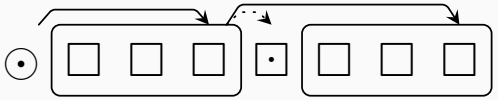


Stanford (Bouquet):



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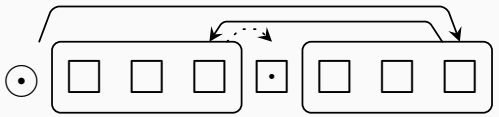
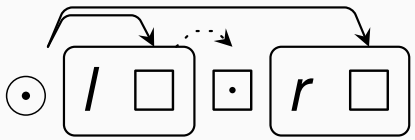


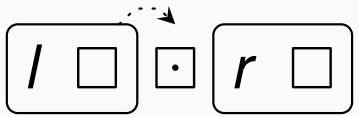
Computing the tendencies

For a given approach (here – London), we consider three types of coordinations:

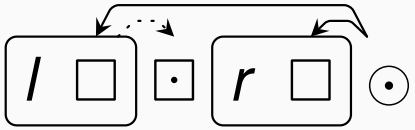
with governor on the left:



with no governor:



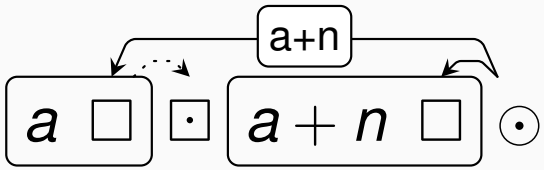
with governor on the right:



Computing the tendencies

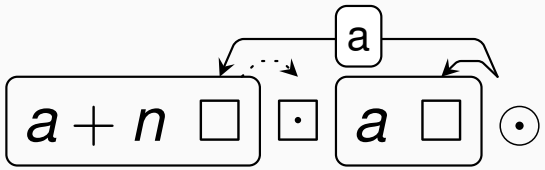
For every type of coordination, we compare the sum of total *relevant* dependencies:

shorter conjunct on the left



$S = a + n$

shorter conjunct on the right

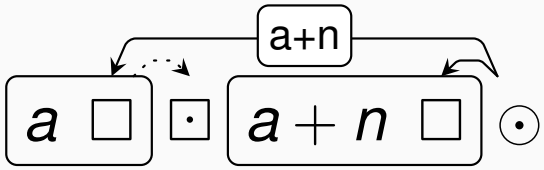


$S = a$

$n \geq 0$ is the absolute difference of the conjuncts length.

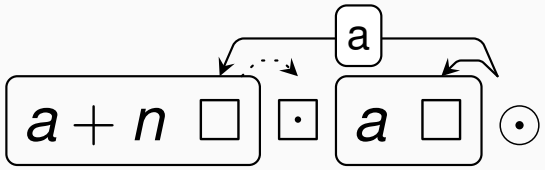
Computing the tendencies

shorter conjunct on the left



$S_R = a + n$

shorter conjunct on the right



$S'_R = a$

For a coordination with the governor position $* \in \{L, -, R\}$, the change in the tendency to put shorter conjunct at the beginning of coordination with the growth of the absolute difference of the conjuncts length $p_*(n)$ is predicted by the sign of the function $e_* = S'_* - S_*$.

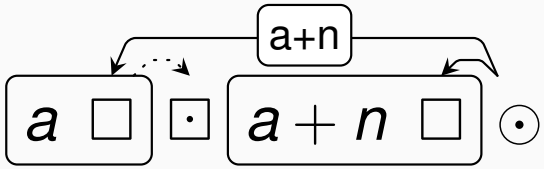
E.g. the London approach predicts that the $p_R(n)$ tendency is decreasing:

$$e_R(n) = S'_R - S_R = a - (a + n) = -n < 0$$

Computing the $p_*(n)$ tendencies

Let $\overline{l_*}$ ($\overline{r_*}$) be the number of relations going *over* the body of the left (right) conjunct.

shorter conjunct on the left



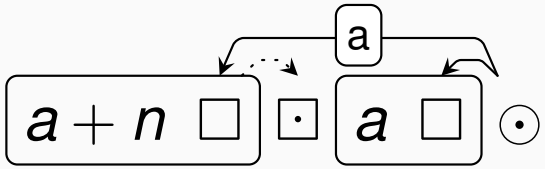
$$S_R = a + n$$

$$S_R = 0a + 1(a + n)$$

$$S_R = \overline{l_R}a + \overline{r_R}(a + n)$$

$$S_* = \overline{l_*}a + \overline{r_*}(a + n)$$

shorter conjunct on the right



$$S'_R = a$$

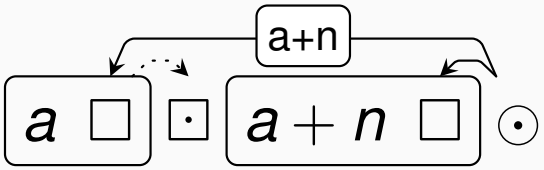
$$S'_R = 1a + 0(a + n)$$

$$S'_R = \overline{l_R}(a + n) + \overline{r_R}a$$

$$S'_* = \overline{l_*}(a + n) + \overline{r_*}a$$

Computing the p_* tendencies

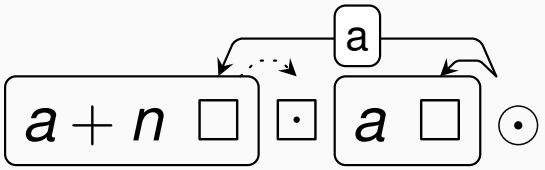
shorter conjunct on the left



$$S_R = a + n$$

$$S_* = \overline{l_*}a + \overline{r_*}(a + n)$$

shorter conjunct on the right



$$S'_R = a$$

$$S'_* = \overline{l_*}(a + n) + \overline{r_*}a$$

$$e_*(n) = S'_* - S_*$$

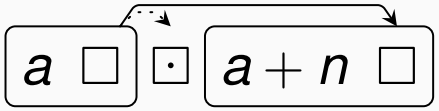
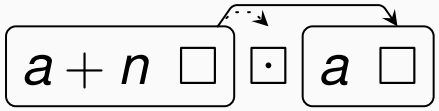
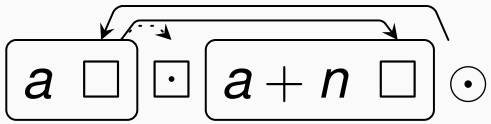
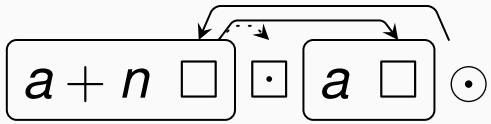
$$e_*(n) = \overline{l_*}(a + n) + \overline{r_*}a - (\overline{l_*}a + \overline{r_*}(a + n))$$

$$e_*(n) = (\overline{l_*} - \overline{r_*})((a + n) - a)$$

$$e_*(n) = (\overline{l_*} - \overline{r_*}) \cdot n$$

Since $n \geq 0$, the prediction of the model of the direction of $p_*(n)$ slope is equal to sign of $\overline{l_*} - \overline{r_*}$

Computing the contrasts between $p_*(n)$ tendencies

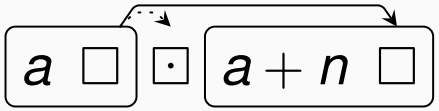
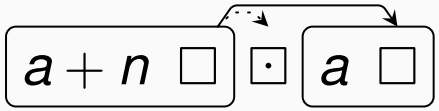
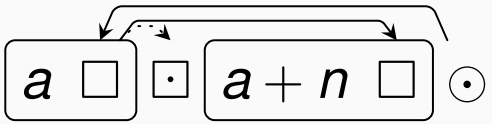
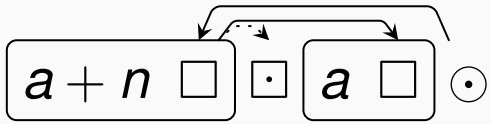
governor	shorter conjunct on the left	shorter conjunct on the right
absent		
right		

$$e_{-}(n) = a - (a + n) = -n$$

$$e_{R}(n) = 2a - 2(a + n) = -2n$$

The slope of $p_R(n)$ is expected to be *more* negative than the slope of $p_{-}(n)$ (assuming DLM's monotonicity).

Computing the contrasts between p_* tendencies

governor	shorter conjunct on the left	shorter conjunct on the right
absent		
right		

Generalize this using function:

$$e_{*/\dagger}(n) = e_*(n) - e_\dagger(n)$$

$$e_{*/\dagger}(n) = (\overline{l_*} - \overline{r_*} - (\overline{l_\dagger} - \overline{r_\dagger})) \cdot n \text{ (for } *, \dagger \in \{L, -, R\} \text{ and } n > 0)$$

Predictions of the approaches

- Head initial-languages

Model	$e_L(n)$	$e_-(n)$	$e_R(n)$	$e_{-/R}(n)$	$e_{L/-}(n)$
Prague	$2n$	n	0	$-n$	$-n$
London	n	0	$-n$	$-n$	$-n$
Stanford	n	n	n	0	0
Inverted	$2n$	n	0	$-n$	$-n$

- Head final-languages

Model	$e_L(n)$	$e_-(n)$	$e_R(n)$	$e_{-/R}(n)$	$e_{L/-}(n)$
Prague	0	$-n$	$-2n$	$-n$	$-n$
London	n	0	$-n$	$-n$	$-n$
Stanford	0	$-n$	$-2n$	$-n$	$-n$
Inverted	$-n$	$-n$	$-n$	0	0

The study on the UD corpora – head-final languages

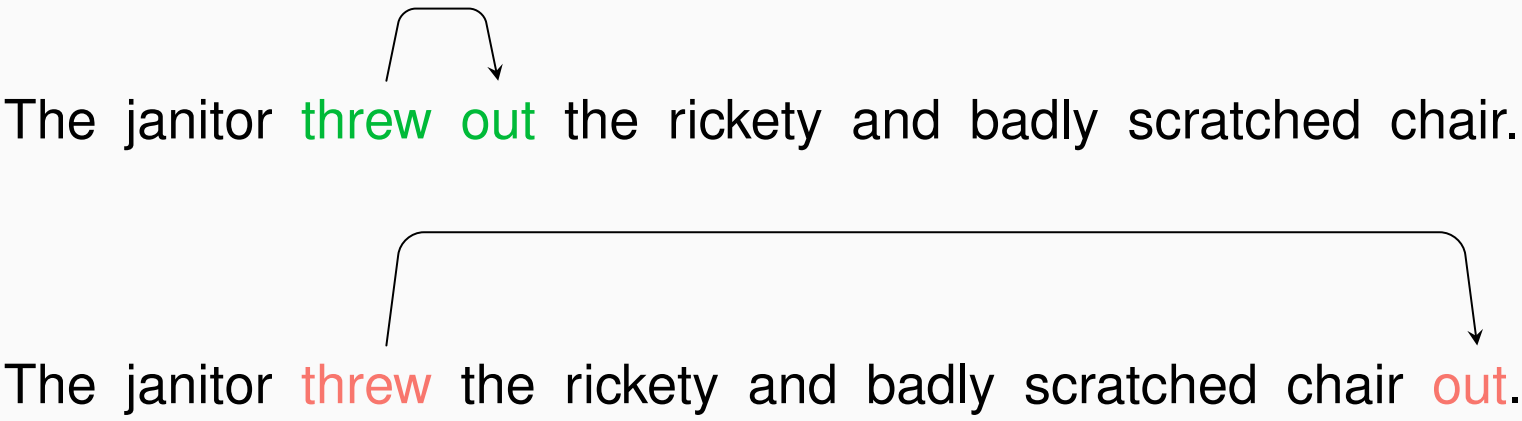
	tokens	coords	L/–	–/R	L/R	R
ko	447K	21.5K	+	+	+	+**
tr	730K	19.6K	–	+	+	+*

Model	$e_L(n)$	$e_-(n)$	$e_R(n)$	$e_{-/R}(n)$	$e_{L/-}(n)$
Prague	0	$-n$	$-2n$	$-n$	$-n$
London	n	0	$-n$	$-n$	$-n$
Stanford	0	$-n$	$-2n$	$-n$	$-n$
Inverted	$-n$	$-n$	$-n$	0	0

Dependency Length Minimization

We prefer sentences with shorter dependencies, because they are easier to process.

- The at-use DLM (Hunter and Prideaux, 1983):



- The at-grammar DLM (Hawkins, 1994):
  * Did $_{S}$[that John failed his exam] surprise Mary?

    Did $_{NP}$[that fact] surprise Mary?

Predictions of the approaches

- Head initial-languages

Model	$e_L(n)$	$e_-(n)$	$e_R(n)$	$e_{-/R}(n)$	$e_{L/-}(n)$
Prague	$2n$	n	0	$-n$	$-n$
London	n	0	$-n$	$-n$	$-n$
Stanford	n	n	n	0	0
Inverted	$2n$	n	0	$-n$	$-n$

- Head final-languages

Model	$e_L(n)$	$e_-(n)$	$e_R(n)$	$e_{-/R}(n)$	$e_{L/-}(n)$
Prague	0	$-n$	$-2n$	$-n$	$-n$
London	n	0	$-n$	$-n$	$-n$
Stanford	0	$-n$	$-2n$	$-n$	$-n$
Inverted	$-n$	$-n$	$-n$	0	0

Summary and Limitations

- The experimental part of the study remains negative
- The algorithm used for the extraction is inaccurate and based on heuristics
  - Only 58% of all Turkish coordinations were extracted correctly.
  - Recurring issue: two unrelated simple sentences are treated as one coordination without a governor
- Problems with UD corpora (Kanayama et al. 2018)
  - No coordinations in Japanese corpora made analysis of tis language impossible

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