Dependency Parsing:
Parsing with the Eisner Algorithm

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Deadline: 05.07.2021. Please send completed solutions to evang@hhu.de with subject "dependency homework" and attachment ex12_lastname(s).pdf.

1 Example

Consider the sentence $x = w_0 w_1 w_2 w_3 = ROOT\ John\ eats\ pizza$ ($n = 3$). Assume the following edge weights:

$$w(ROOT, John) = 1$$
$$w(ROOT, eats) = 2$$
$$w(ROOT, pizza) = 1$$

$$w(John, eats) = 1$$
$$w(John, pizza) = 1$$

$$w(eats, John) = 2$$
$$w(eats, pizza) = 2$$

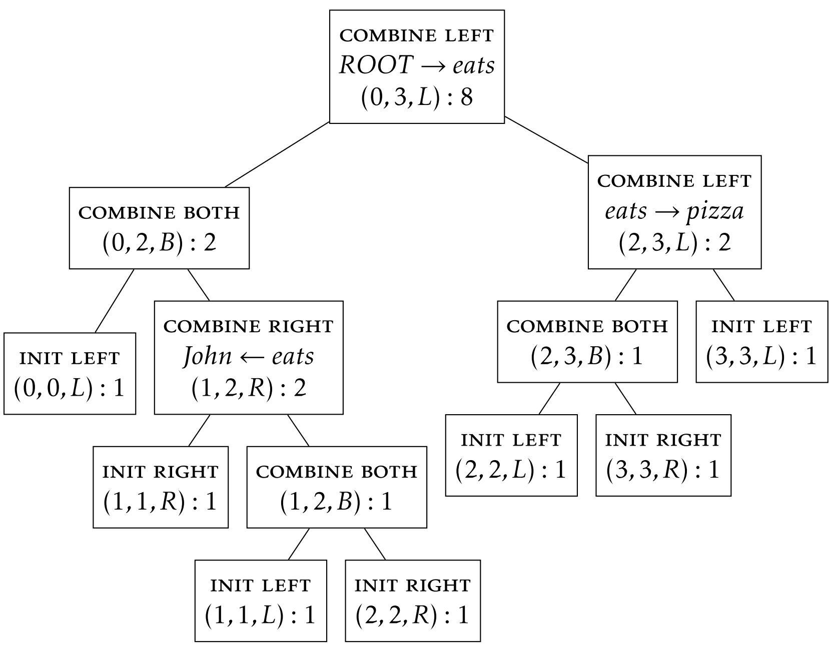
$$w(pizza, John) = 1$$
$$w(pizza, eats) = 1$$

The Eisner algorithm then builds the following chart. Items are organized into rows by length, with row 1 containing items spanning only a single word, and row $n = 4$ containing items spanning the whole sentence. Column i contains the items starting at word i. The algorithm fills the rows from 1 to n, in each row first applying all possible COMBINE BOTH rules (in row 1: INIT LEFT and INIT RIGHT) and then all possible COMBINE LEFT and COMBINE RIGHT rules. It happens that the same item is generated more than once with different weights; only the item with the highest weight is stored in the chart.

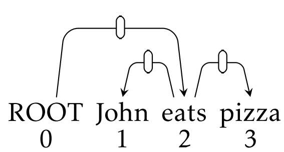
	0	1	2	3
4	$(0,3,B):4$ $(0,3,L):8$ $(0,3,R):2$			
3	$(0,2,B):2$ $(0,2,L):4$ $(0,2,R):2$	$(1,3,B):1$ $(1,3,L):2$ $(1,3,R):2$		
2	$(0,1,B):1$ $(0,1,L):1$ $(0,1,R):0$	$(1,2,B):1$ $(1,2,L):1$ $(1,2,R):2$	$(2,3,B):1$ $(2,3,L):2$ $(2,3,R):1$	
1	$(0,0,R):1$ $(0,0,L):1$	$(1,1,R):1$ $(1,1,L):1$	$(2,2,R):1$ $(2,2,L):1$	$(3,3,R):1$ $(3,3,L):1$

Since the *ROOT* is at the left edge of the sentence, an L item in the top row is our goal item. If we trace back which items we used to create it (and which items were used to create these, and so on), we will find the items that are highlighted in yellow in the chart. From those that were created using a COMBINE LEFT and COMBINE RIGHT rule, we can construct the dependency tree (recall that each application of such a rule creates an edge).

The following tree diagram shows the rule applications that led to the highlighted items. Each node represents an item and is also labeled with the rule used to create it and, in the case of COMBINE LEFT and COMBINE RIGHT, the edge created. The children of an item are the items used to create it.



This is the resulting dependency tree:



Exercise

a) Use the example sentence x = *ROOT Cats like to sleep* and the edge weights from exercise sheet 11. Apply the Eisner algorithm to it and draw the chart and a tree diagram for the successful items as in the example. Also draw the resulting dependency tree. Is it the same tree that the Chu-Liu-Edmonds algorithm finds?

b) More generally, in which cases does the Eisner algorithm find the same dependency tree as the Chu-Liu-Edmonds algorithm? Answer briefly in 1-2 sentences.