

**NLP**

# Parsing

## *Prepositional Phrase Attachment (1)*

# Penn Treebank Representation

```
( (S
  (NP-SBJ
    (NP (NNP Pierre) (NNP Vinken) )
    (, ,)
    (ADJP
      (NP (CD 61) (NNS years) )
      (JJ old) )
    (, ,) )
  (VP (MD will)
    (VP (VB join)
      (NP (DT the) (NN board) )
      (PP-CLR (IN as)
        (NP (DT a) (JJ nonexecutive) (NN director) ))
      (NP-TMP (NNP Nov.) (CD 29) )))
    (. .) ))
```


# Penn Treebank Representation

```
( (S
  (NP-SBJ (NNP Mr.) (NNP Vinken) )
  (VP (VBZ is)
    (NP-PRD
      (NP (NN chairman) )
      (PP (IN of)
        (NP
          (NP (NNP Elsevier) (NNP N.V.) )
          ( , , )
          (NP (DT the) (NNP Dutch) (VBG publishing) (NN group) ))))
    (. .) ))
```

# Prepositional Phrase Attachment

- High (verbal):

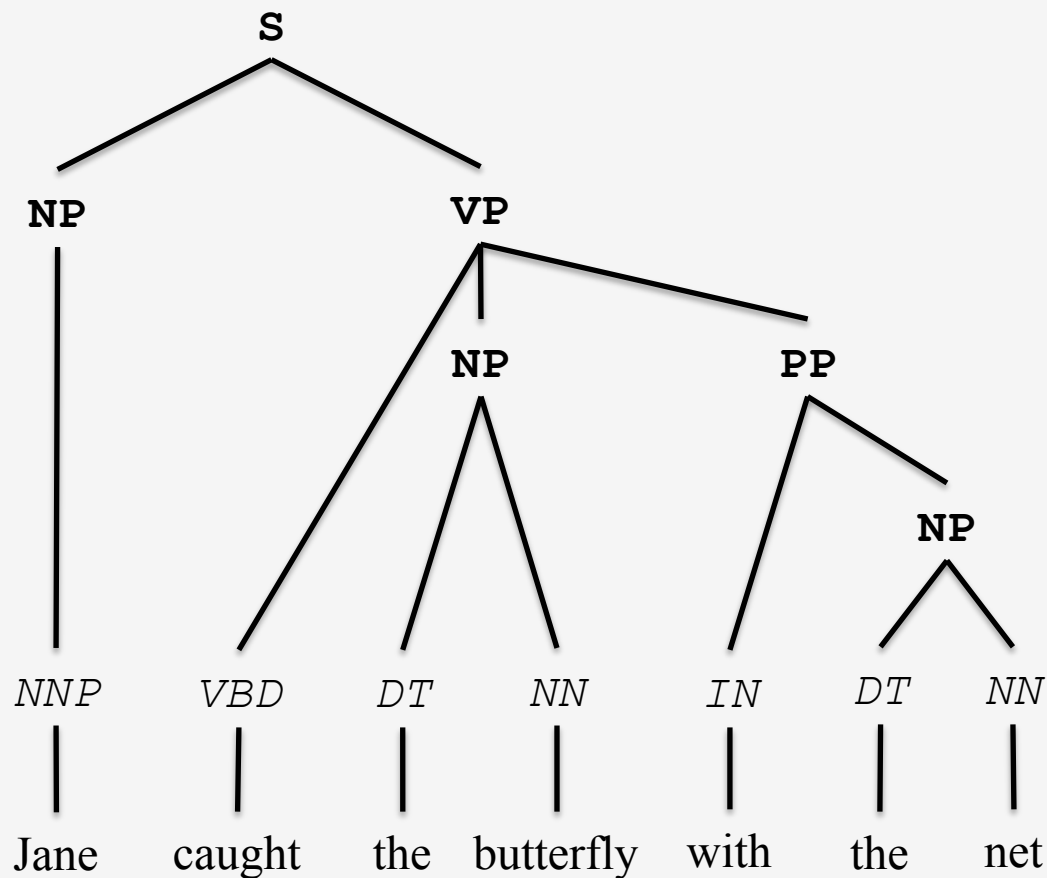
join board as director



- Low (nominal):

is chairman of Elsevier





## Examples

- Examples:
  - Lucy's plane leaves Detroit **on Monday**. – high
  - Jenna met Mike **at the concert**. – high
  - This painting must cost millions **of dollars**. – low
- High or low attachment?
  - Alicia ate spaghetti **from Italy**.
  - Alicia ate spaghetti **with meatballs**.
  - Alicia ate spaghetti **with a fork**.
  - Alicia ate spaghetti **with Justin**.
  - Alicia ate spaghetti **with delight**.
  - Alicia ate spaghetti **on Friday**.

# Solution

- High or low attachment?
  - Alicia ate spaghetti **from Italy**. – low
  - Alicia ate spaghetti **with meatballs**. – low
  - Alicia ate spaghetti **with a fork**. – high
  - Alicia ate spaghetti **with Justin**. – high
  - Alicia ate spaghetti **with delight**. – high
  - Alicia ate spaghetti **on Friday**. – high

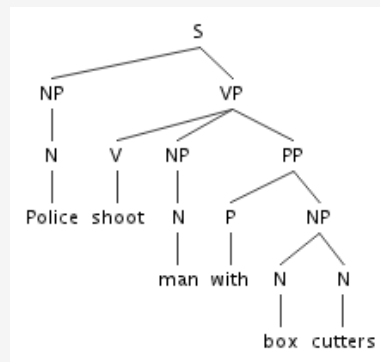
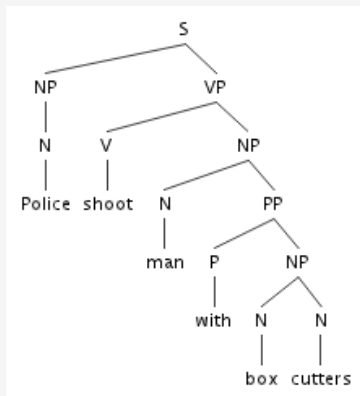


# Actual Headline

- Police shoot man with box cutters.

(S (NP (N Police)) (VP (V shoot) (NP (N man) (PP (P with) (NP (N box) (N cutters))))))

(?) (S (NP (N Police)) (VP (V shoot) (NP (N man)) (PP (P with) (NP (N box) (N cutters))))))



# Prepositional Phrase Attachment

- Input: a prepositional phrase and the surrounding context
- Output: a binary label: 0(high) or 1(low)
- In practice: the context consists only of four words: the preposition, the verb before the preposition, the noun before the preposition, and the noun after the preposition
- Example: *join board as director*
- Why?

## Answer

- Because almost all the information needed to classify a prepositional phrase's attachment as high or low is contained in these four features.
- Furthermore, using only these *tuples* of four features allows for a consistent and scaleable approach.

# Sample Tuples

Sent #	Verb	Noun <sub>1</sub>	Preposition	Noun <sub>2</sub>	Class
0	join	board	as	director	V
2	named	director	of	conglomerate	N
3	caused	percentage	of	deaths	N
6	bring	attention	to	problem	V
12	led	team	of	researchers	N
16	including	three	with	cancer	N
24	imposed	ban	on	uses	N
26	made	paper	for	filters	N
28	dumped	sacks	of	material	N
28	dumped	sacks	into	bin	V

## Sidebar (1/2)

- The linguistics (and psycholinguistics) literature offers competitive explanations for attachment.
- One theory (Kimball 1973) favors the so-called *right association* rule. It says that, given a new phrase and two choices for attachment, people tend to attach the new phrase with the more recent (“rightmost” within the sentence) of the candidate nodes, resulting in low attachment.
- Alternatively, the *minimal attachment* principle (Frazier 1978) favors an attachment that results in the syntax tree having fewer additional syntactic nodes (in this case, favoring high attachment).
- As one can see from the statistics, none of these methods alone can explain the high prevalence of both types of attachment.

## Sidebar (2/2)

- Some other observations can be made by performing statistical analysis of a training set.
- The standard corpus used for this sort of analyses comes from (RRR 1994) and includes 27,937 prepositional phrases extracted from the Penn Treebank (Marcus et al. 1993), divided into three groups (20,801 training, 4039 development, and 3097 test).
- This data representation makes the assumption that additional context is only marginally more useful for classification purposes compared to the four features in the table (verb, noun1, preposition, and noun2).
- For comparison, the sentence matching the data point “bring attention to problem” is actually “Although preliminary findings were reported more than a year ago, the latest results appear in today's New England Journal of Medicine, a forum likely to bring new attention to the problem.” It is unlikely that the information in the first  $\frac{3}{4}$  of the sentence will affect the classification of the prepositional phrase “to the problem”.

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