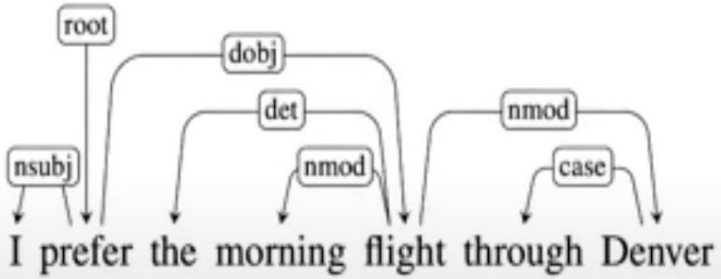
Dependency Parsing

Syntactical analysis

Dependency Parsing

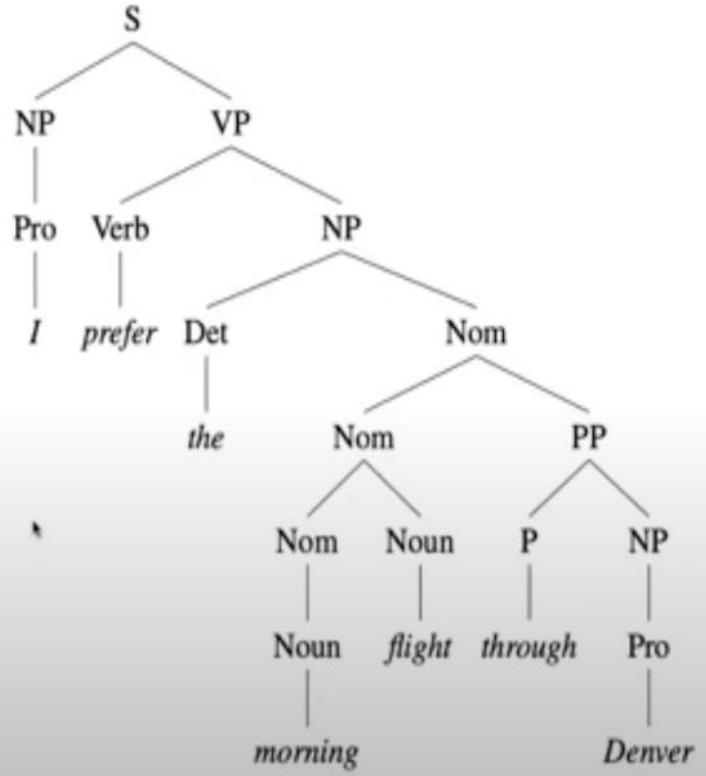
So far, we've thought about language statistically, or as a set of rules specified by a CFG; **Dependency grammars** provides a another representation of language as a graph: nodes are words, edges are dependencies.



heads and dependents

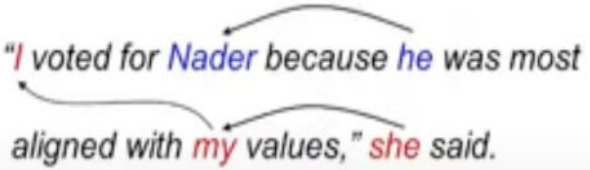
Dependency Parsing

In this way, a dependency grammar approach abstracts away from word-order information, representing only the information that is necessary for the parse.



Dependency Parsing

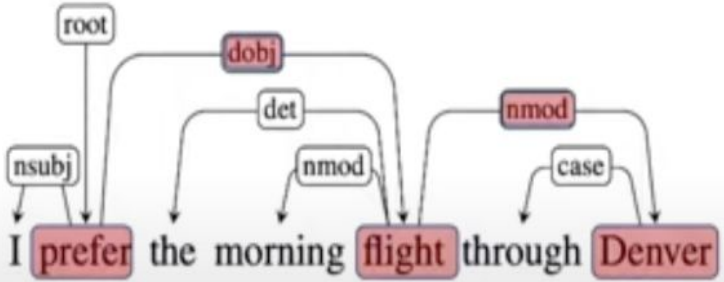
It is particularly important in contemporary speech and language processing systems for **coreference resolution**, question answering and information extraction.



Dependency Parsing

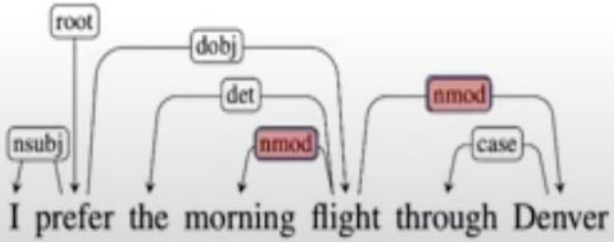
Dependency structures are represented by directed graphs that satisfy the following constraints:

1. There is a single designated root node that has no incoming arcs.
2. With the exception of the root node, each vertex has exactly one incoming arc.
3. There is a unique path from the root node to each vertex in V.



Dependency Parsing

Graphs may be represented by an adjacency **tensor** for analysis.



nmod	I	prefer	the	morning	flight	through	Denver
I							
prefer							
the							
morning							
flight				1			1
through							
Denver							

Dependency Parsing

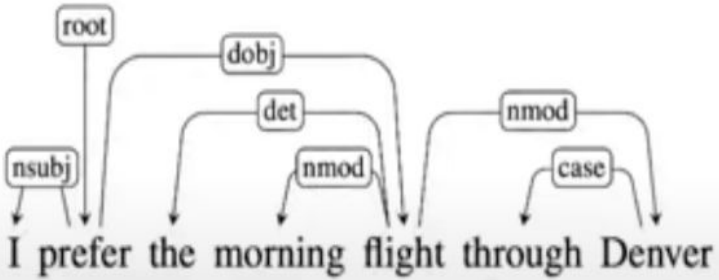
Peter Piper picked a peck of pickled peppers

Dependency tree?

Dependency Parsing

There are multiple algorithms that generate dependency trees from data:

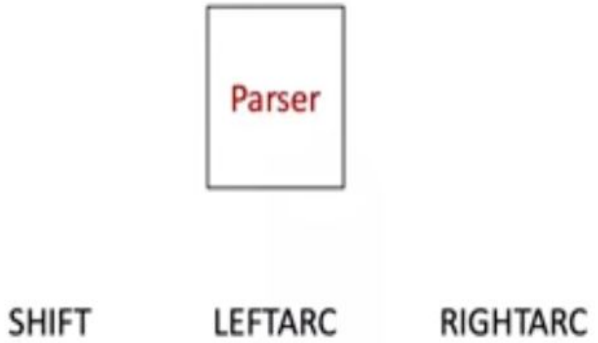
- **Transition-based Approaches**
  - Shift-reduce
- **Graph Algorithms**
  - Maximum Spanning Tree



Dependency Parsing

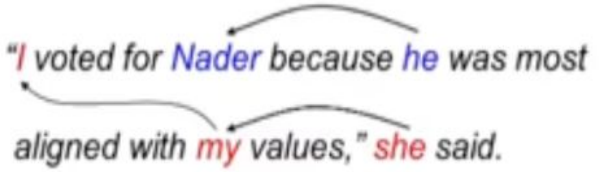
Arc-standard algo

State-of-the-art transition-based systems use supervised machine learning methods to train classifiers that perform the parsing. Given appropriate training data, these methods learn a function that maps from configurations to transition operators.



Dependency Parsing

The **Universal Dependencies project**, and other Treebanks provide an inventory of dependency relations generated by human annotators; these can be used as training data for models that automate graph generation.



Dependency Parsing

Note that some algorithms are **projective**: the edges in the graph are not allowed to cross. While most English sentences are projective, they're not in all cases:

Dependency Parsing

In arc-standard approaches we step across the *n* words in the **Input buffer** from left to right; and for each for word w_i, our **parser** can:

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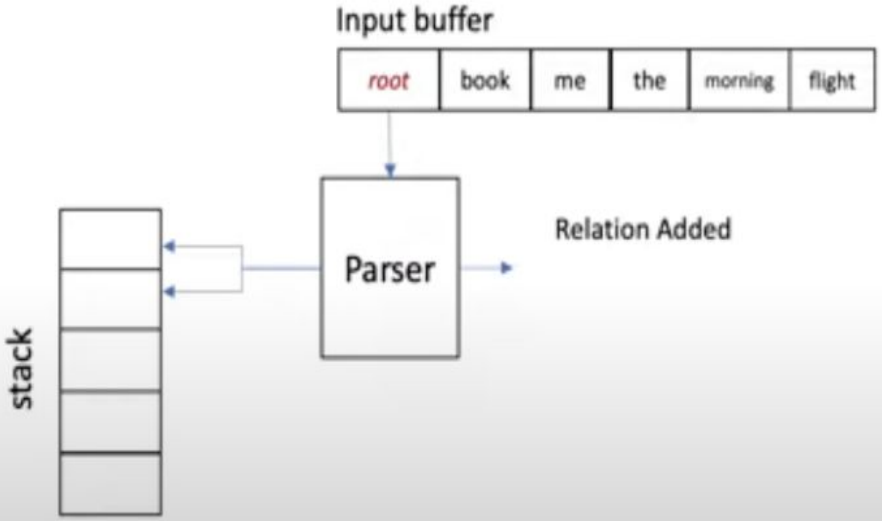

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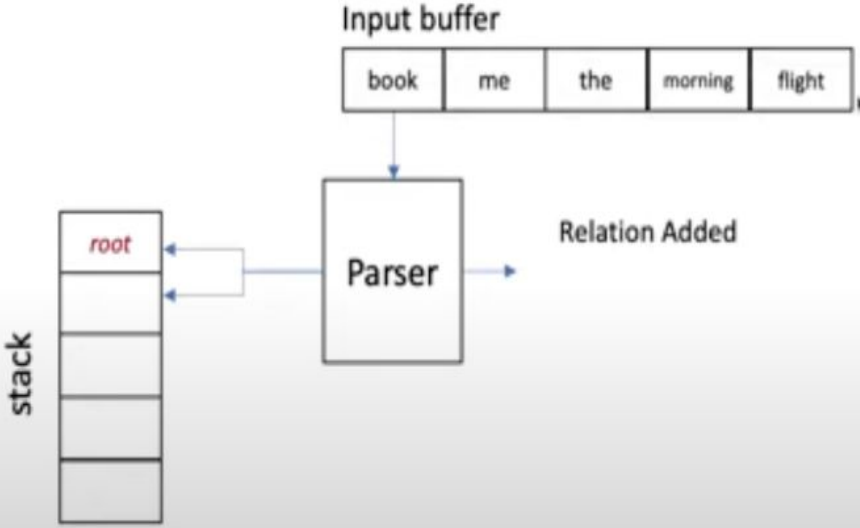

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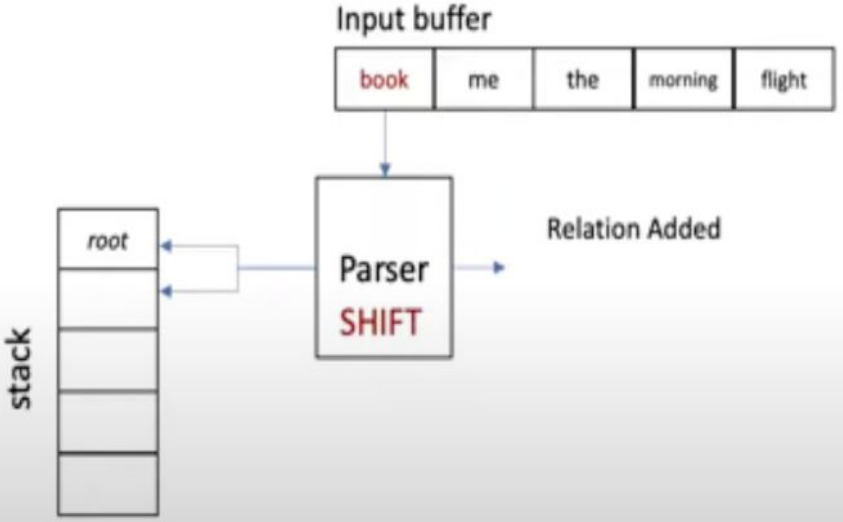

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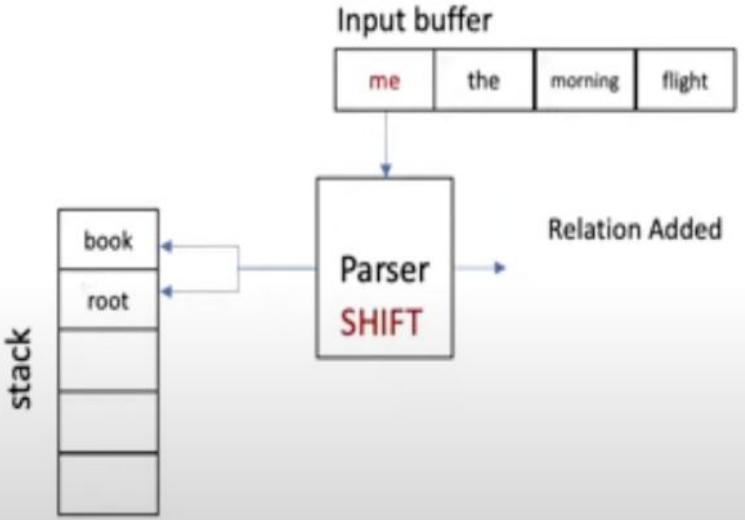

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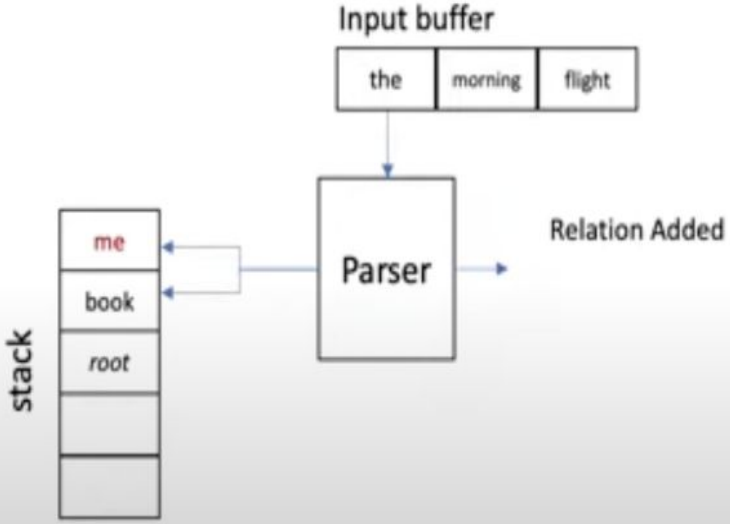

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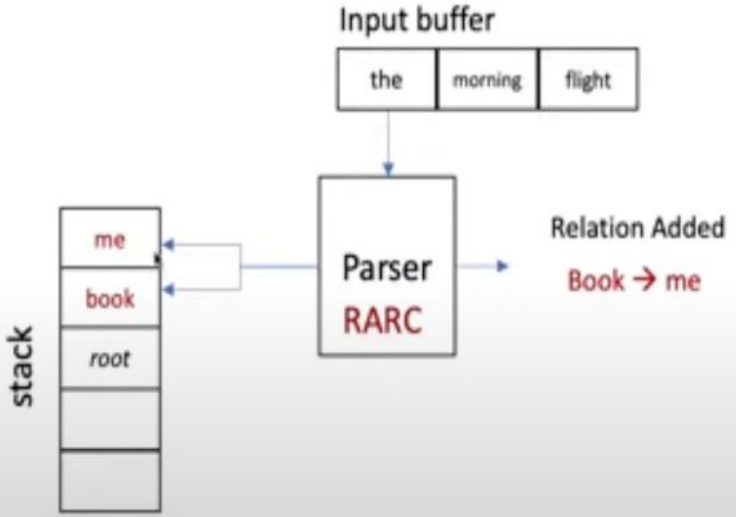

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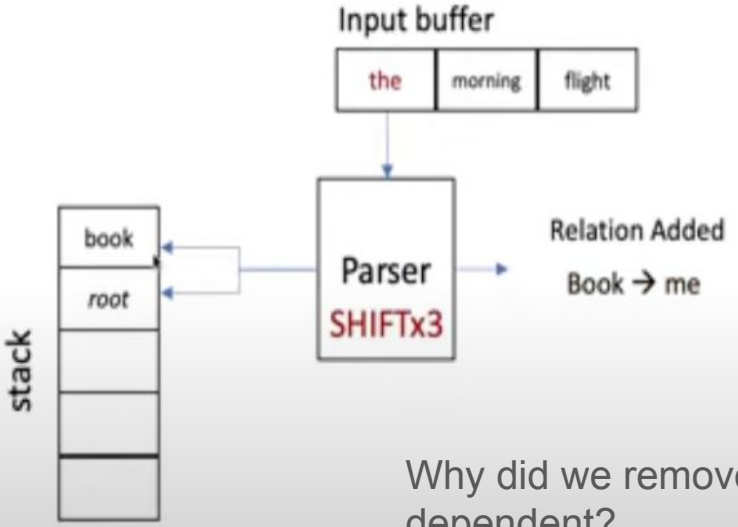

Why did we remove dependent?

Let's parse the entire string!

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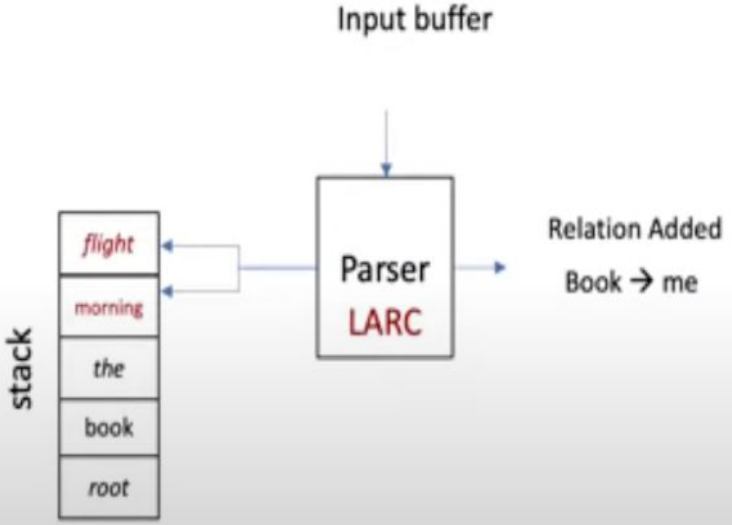

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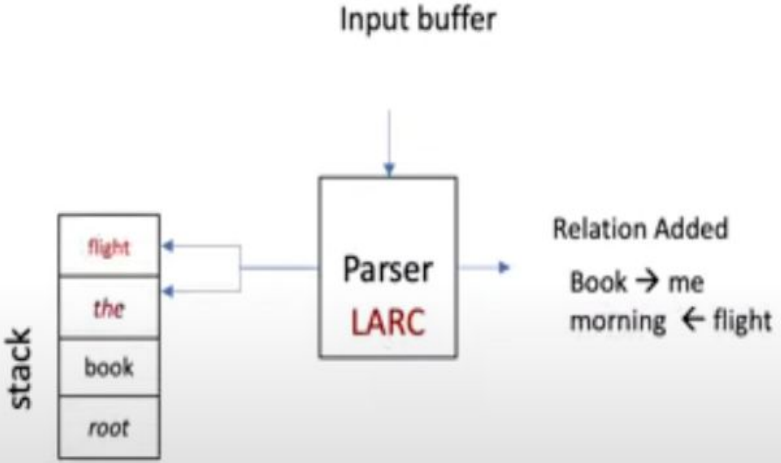

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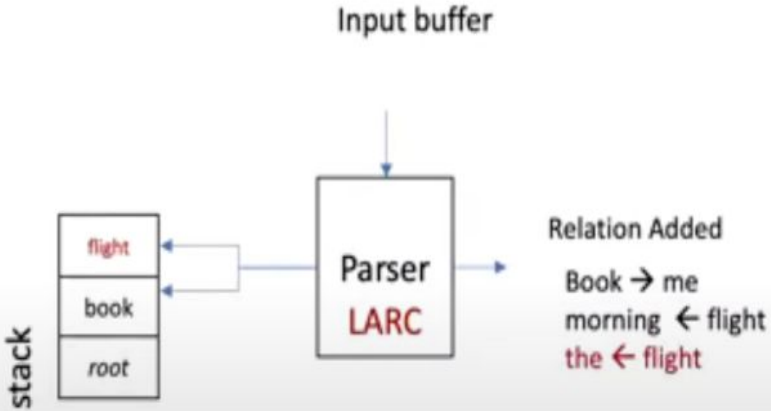

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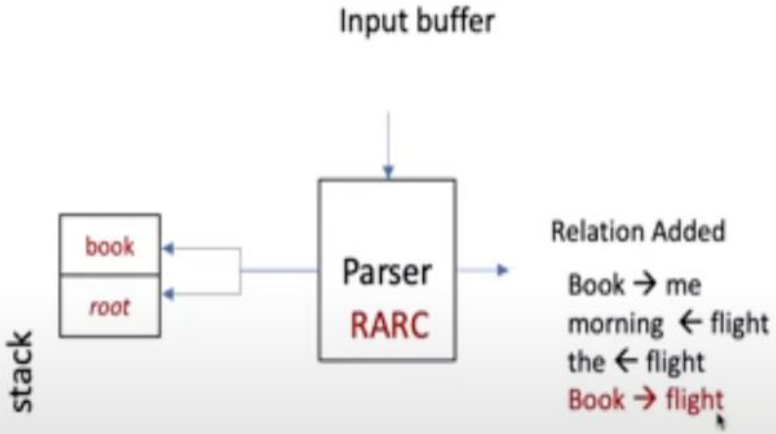

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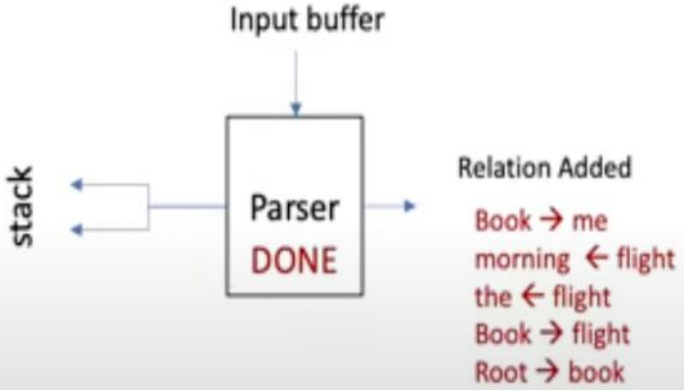


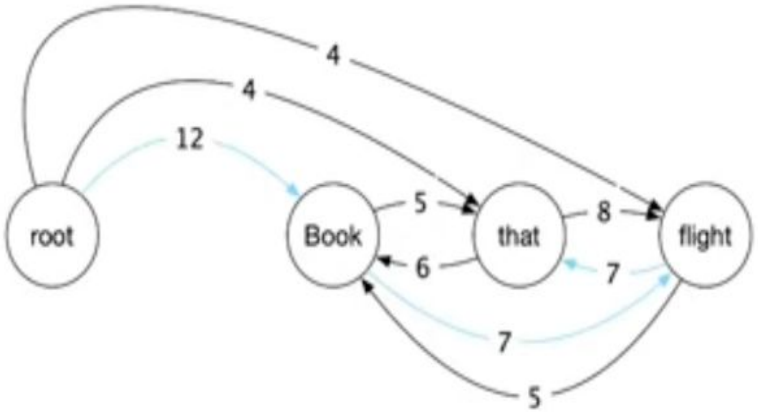
Dependency Parsing

Weights by ML algo

Do we have to maximize or mize the weights?

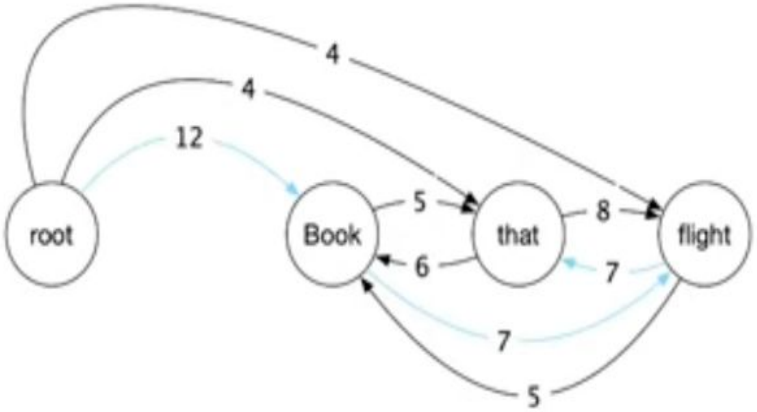
How to draw dependency tree?

How to remove ambiguity?



Dependency Parsing

Graph-based approaches to dependency parsing search through the space of possible trees for a given sentence for a tree (or trees) that maximize some score – this tree is called the **Maximum spanning tree**.



Focus on global optimal solution

Can capture non-projective dependencies (long dependencies)

Acknowledgements

Dr. Ghassemi at Michigan State University

Dr. Dan Jurafsky at Stanford University