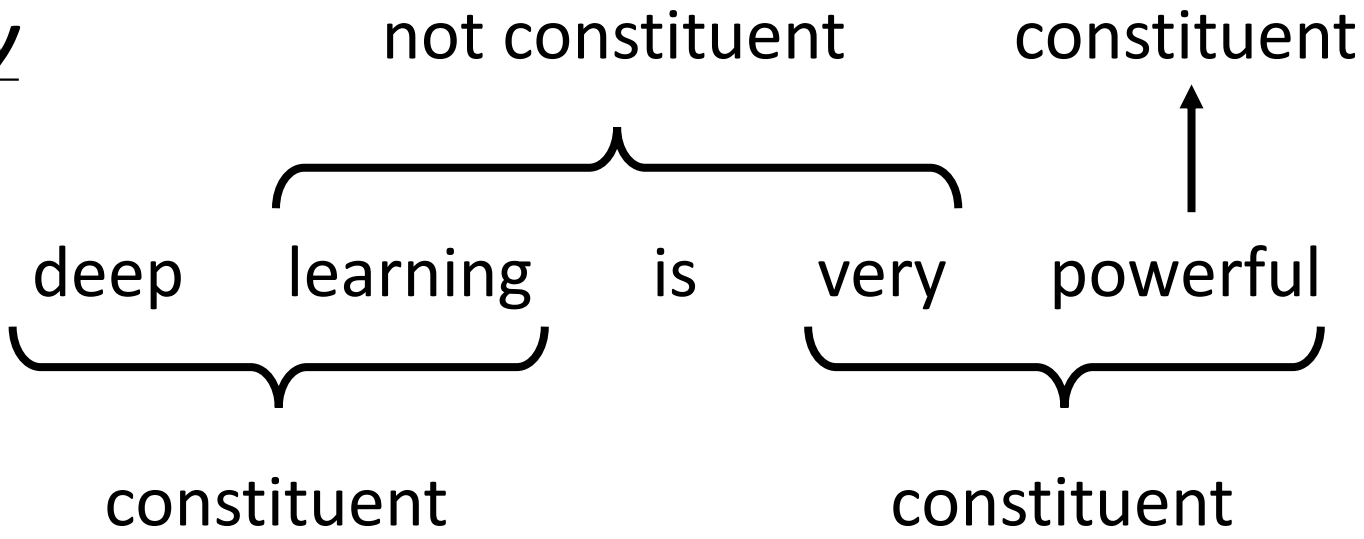
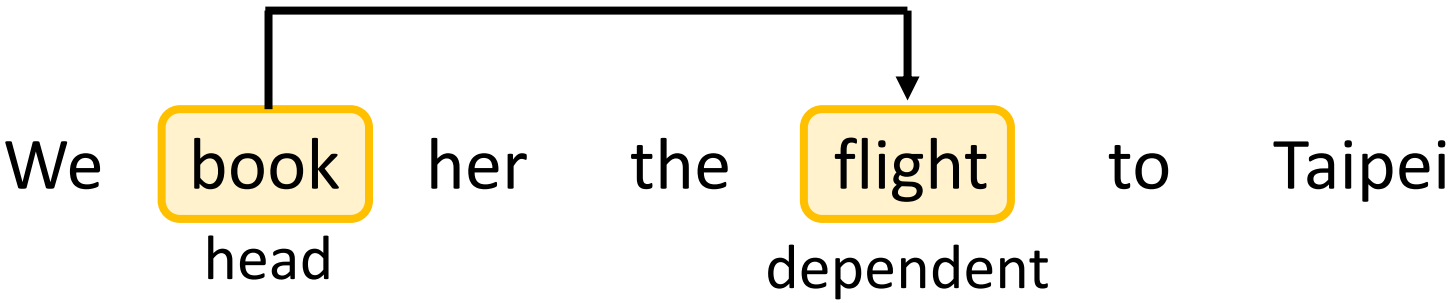

Dependency Parsing
Hung-yi Lee 李宏毅

	One Sequence	Multiple Sequences
One Class	Sentiment Classification Stance Detection Veracity Prediction Intent Classification Dialogue Policy	NLI Search Engine Relation Extraction
Class for each Token	POS tagging Word segmentation Extractive Summarization Slotting Filling NER	
Copy from Input		Extractive QA
General Sequence	Abstractive Summarization Translation Grammar Correction NLG	General QA Chatbot State Tracker Task Oriented Dialogue
Other?	Parsing, Coreference Resolution	

Constituency Parsing



Dependency Parsing



Clausal Argument Relations	Description
NSUBJ	Nominal subject
DOBJ	Direct object
IOBJ	Indirect object
CCOMP	Clausal complement
XCOMP	Open clausal complement
Nominal Modifier Relations	**Description**
NMOD	Nominal modifier
AMOD	Adjectival modifier
NUMMOD	Numeric modifier
APPOS	Appositional modifier
DET	Determiner
CASE	Prepositions, postpositions and other case marker
Other Notable Relations	**Description**
CONJ	Conjunct
CC	Coordinating conjunction

Figure 15.2 Selected dependency relations from the Universal Dependency set. (de Maeffe et al., 2014)

Dependency Parsing

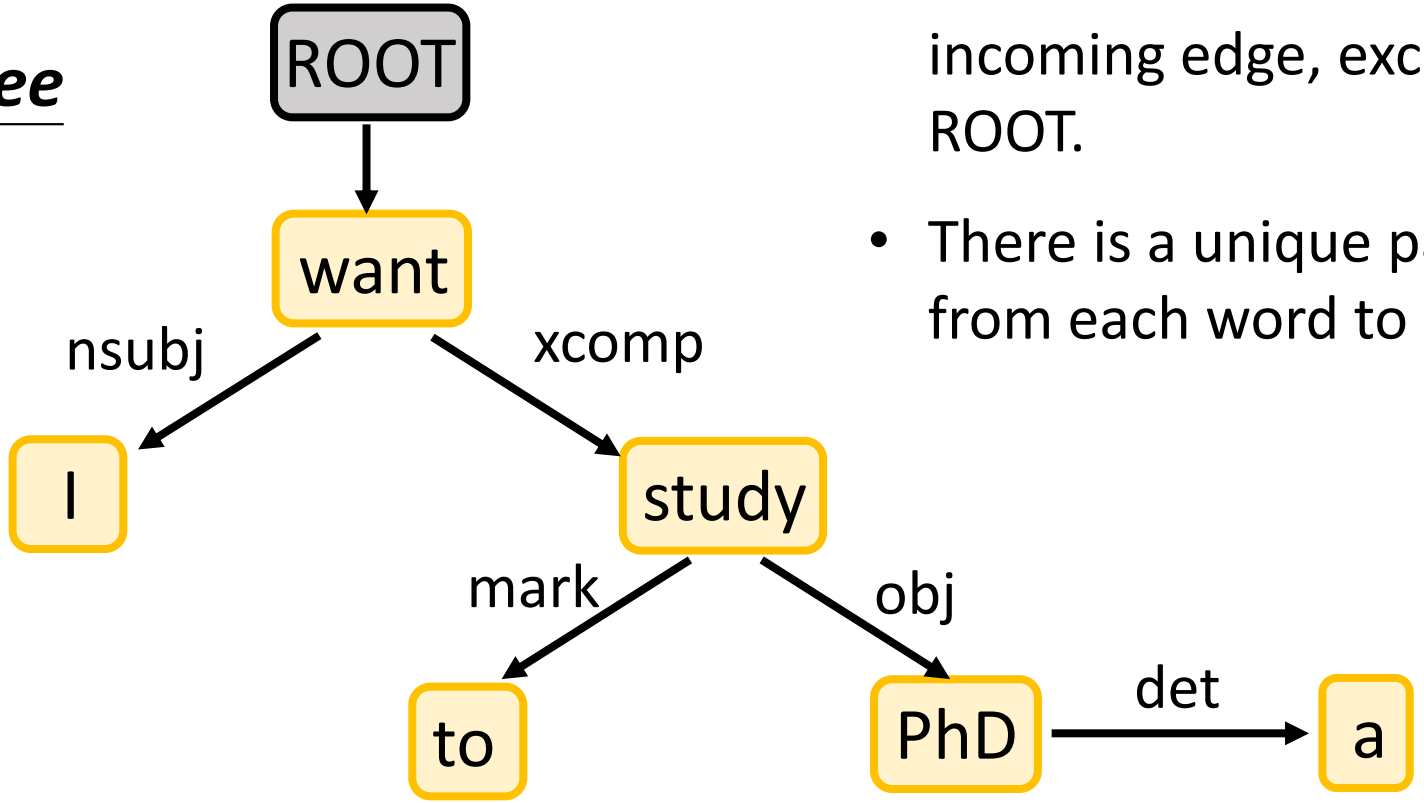
I want to study a PhD

Directed graph

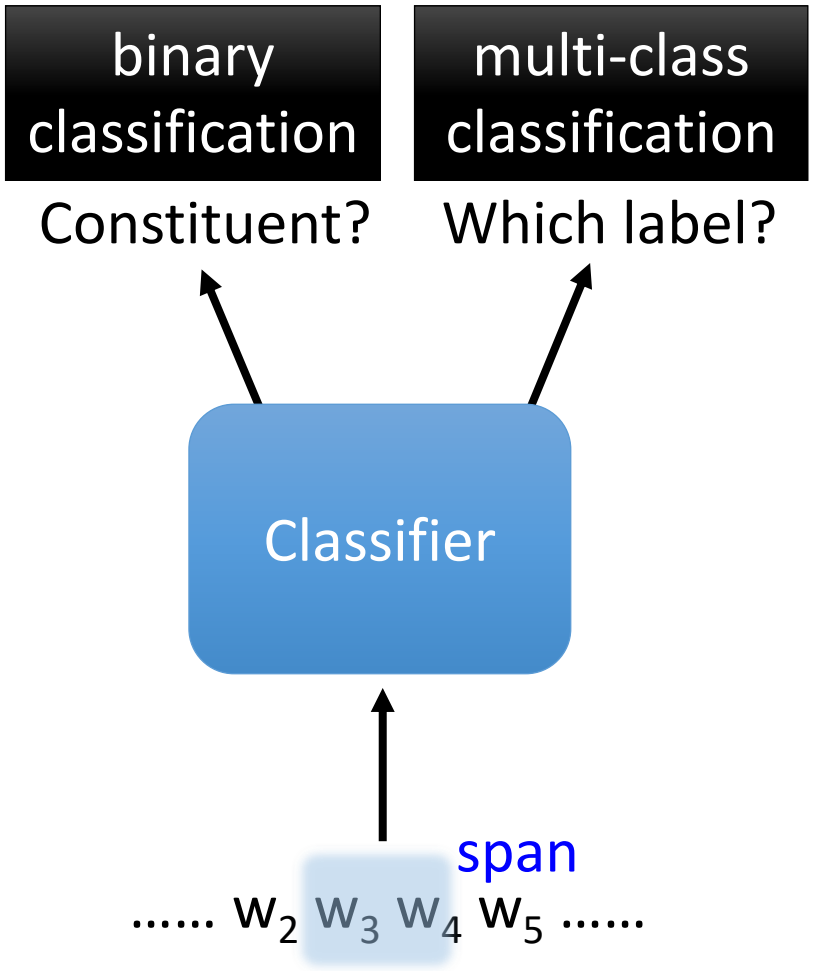
node → word

edge → relation

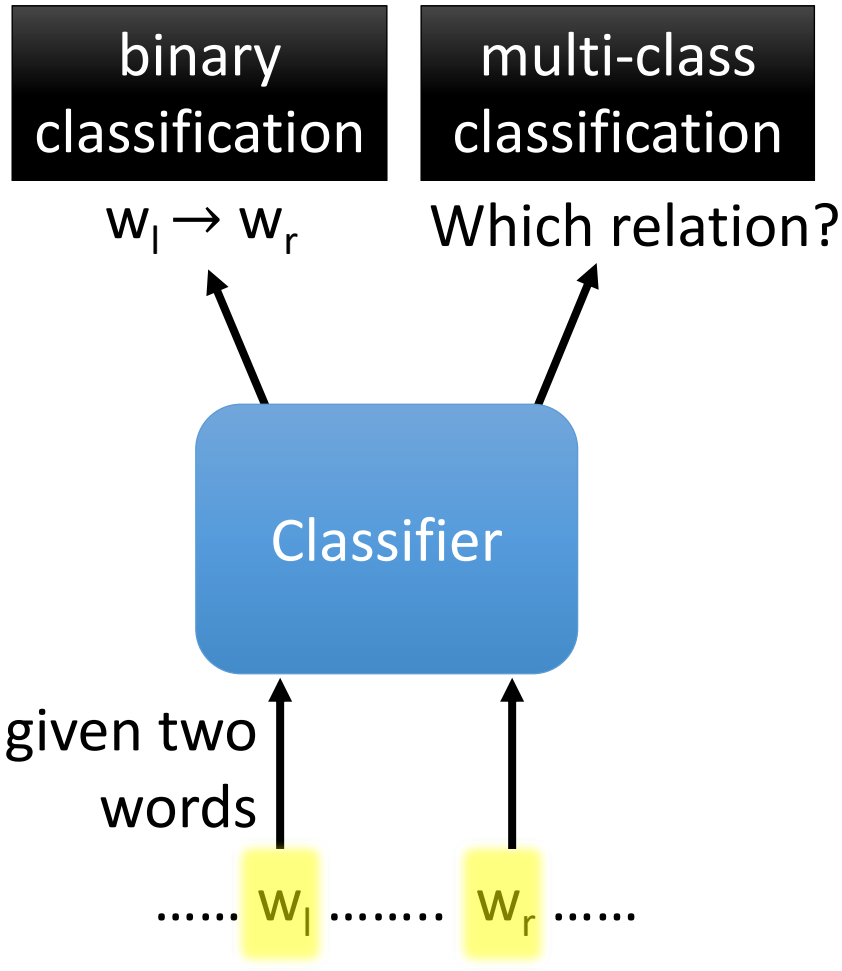
Tree



- All the words have one incoming edge, except ROOT.
- There is a unique path from each word to ROOT.



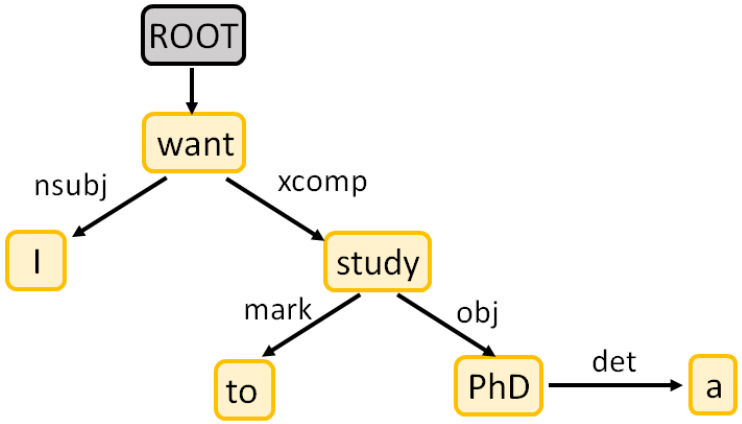
Constituency Parsing

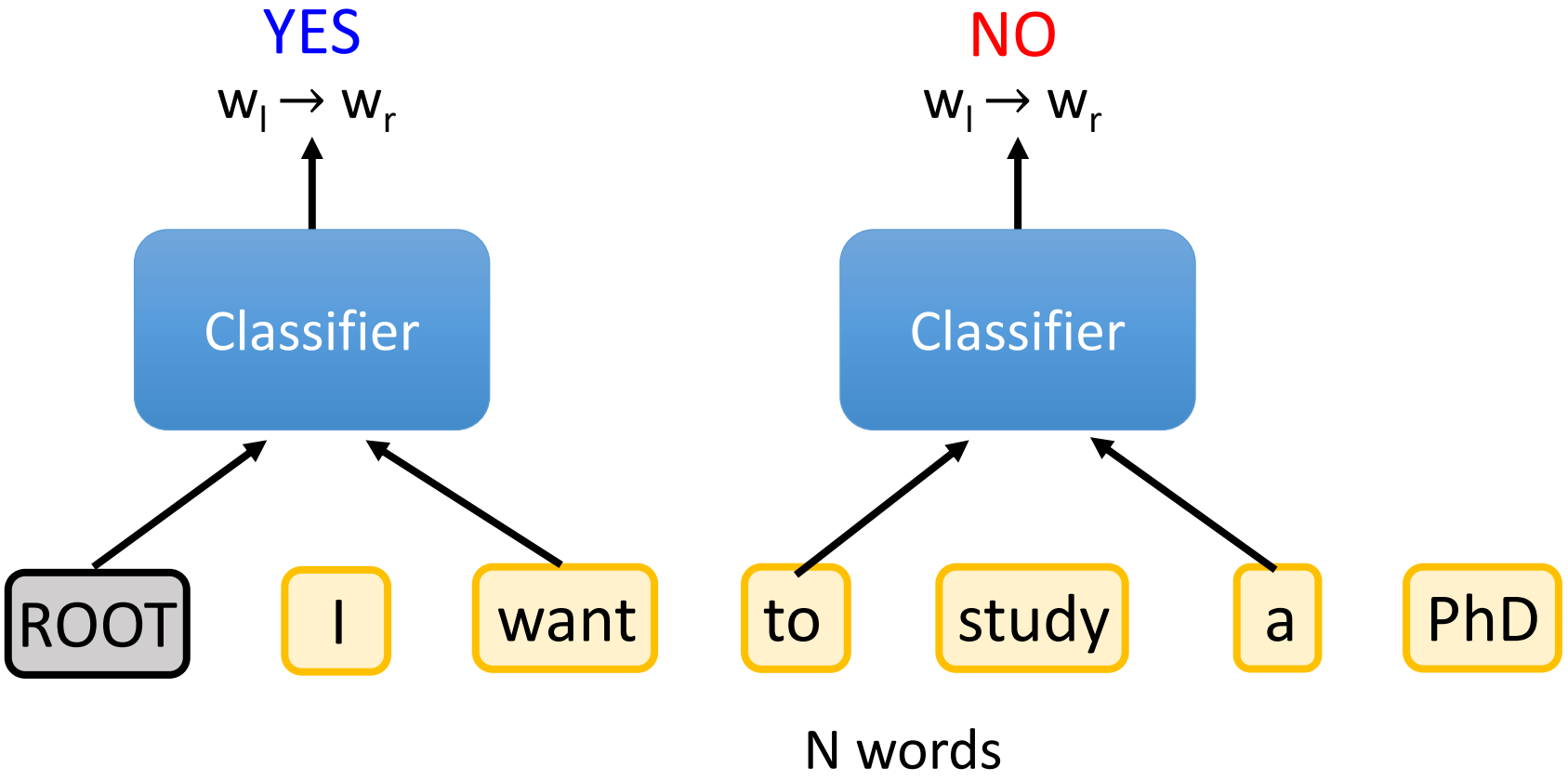


Dependency Parsing

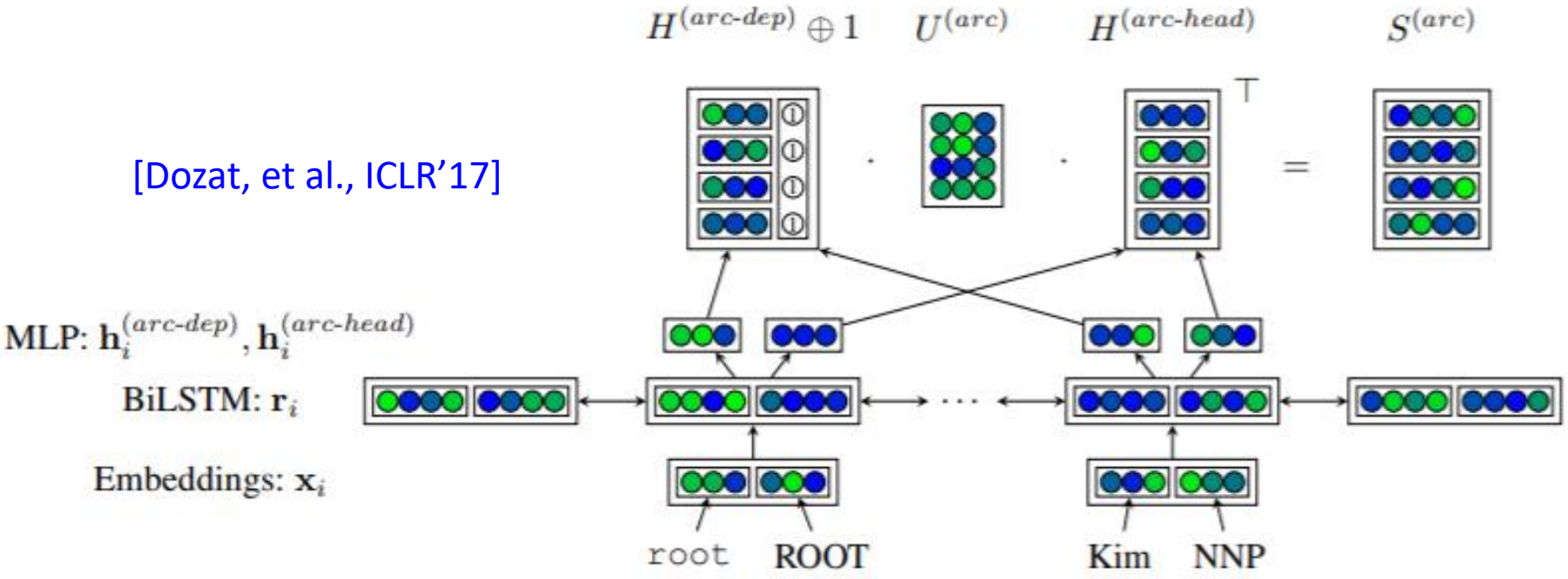
Graph-based

Run the classifier at most $(N+1)^2$ times

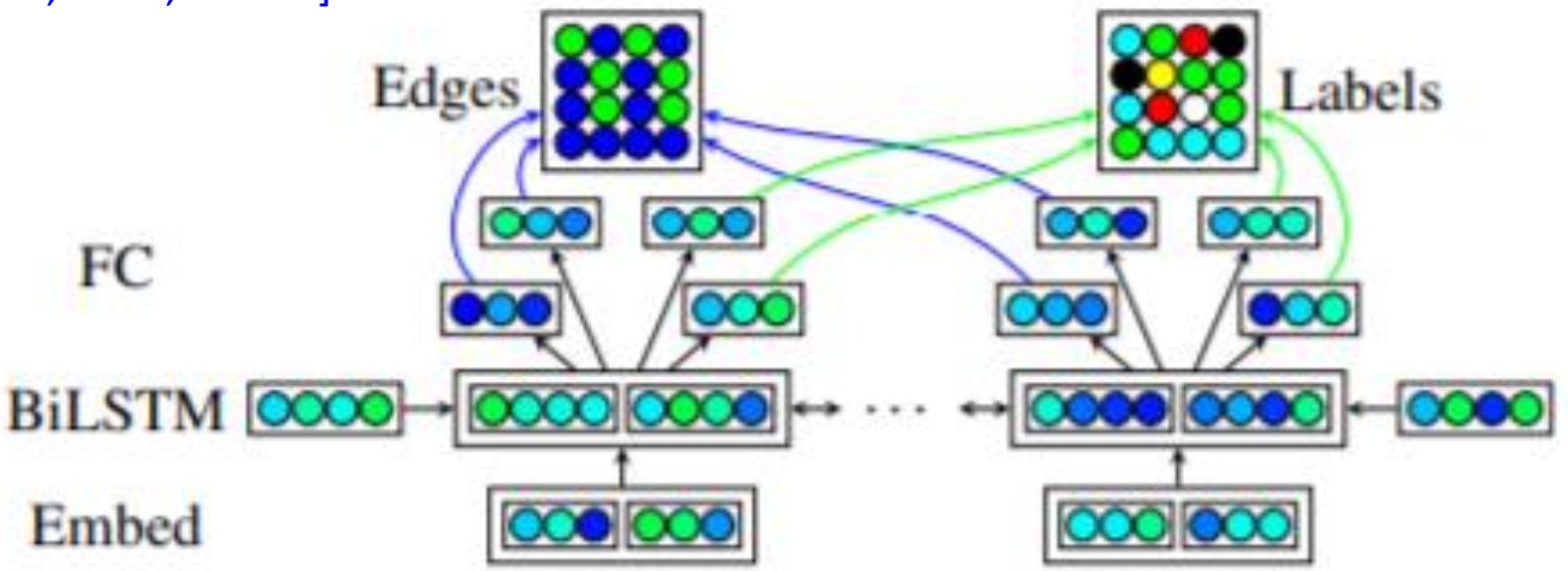




[Dozat, et al., ICLR'17]

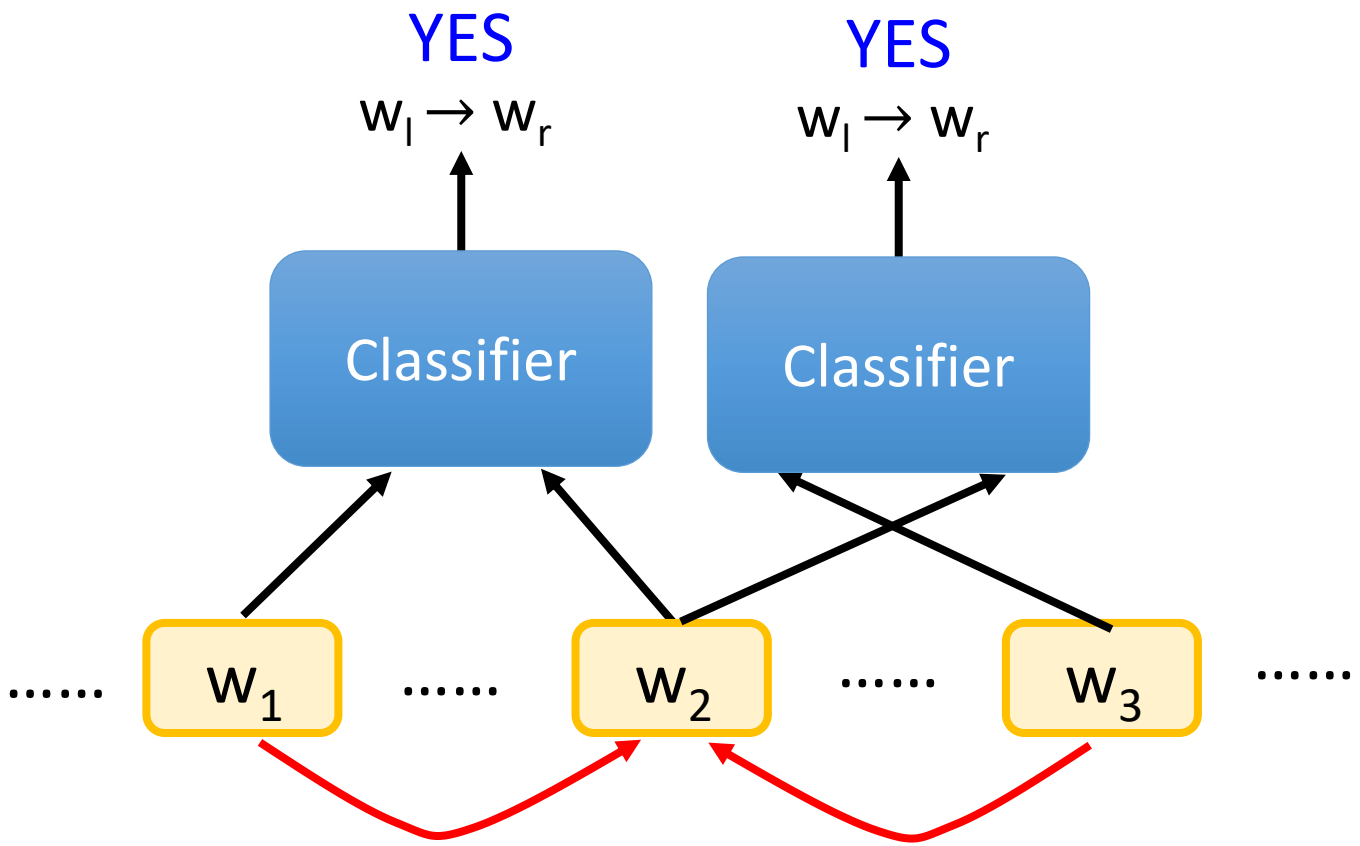


[Dozat, et al., ACL'18]

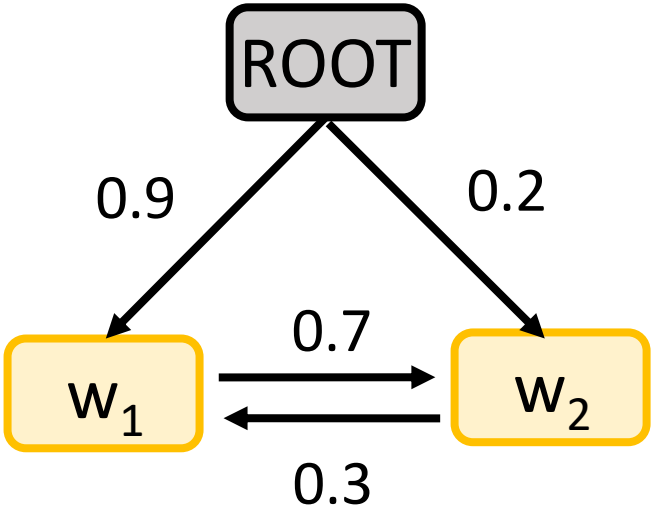


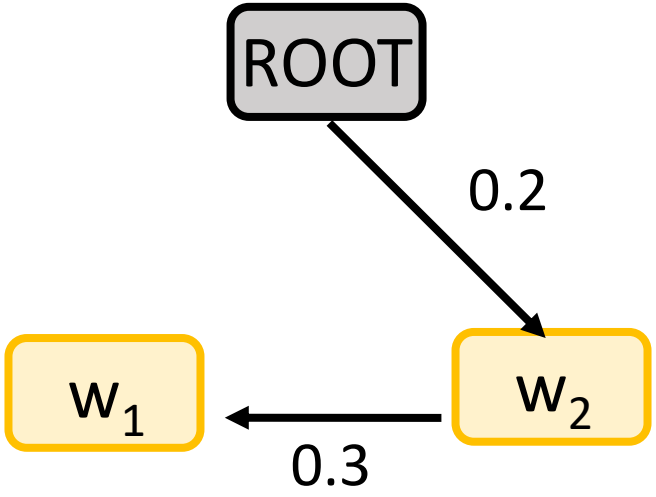
Graph-based

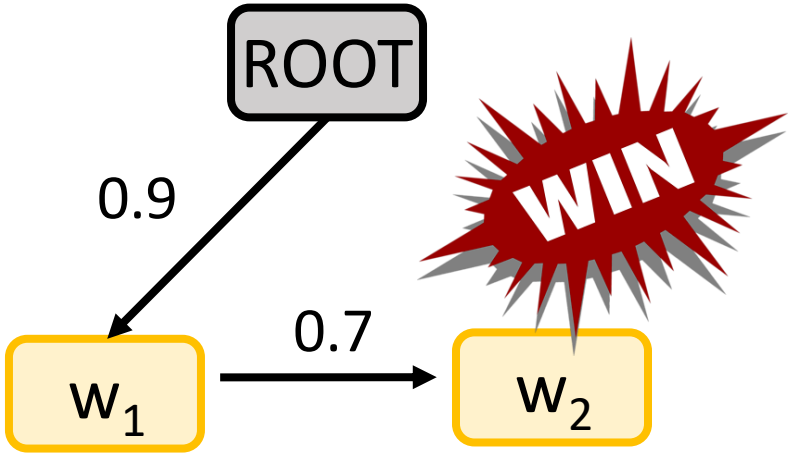
Contradiction!



Maximum Spanning Tree







Transition-based Approach

Step	Stack	Word List	Action	Relation Added
0	[root]	[book, me, the, morning, flight]	SHIFT	
1	[root, book]	[me, the, morning, flight]	SHIFT	
2	[root, book, me]	[the, morning, flight]	RIGHTARC	(book → me)
3	[root, book]	[the, morning, flight]	SHIFT	
4	[root, book, the]	[morning, flight]	SHIFT	
5	[root, book, the, morning]	[flight]	SHIFT	
6	[root, book, the, morning, flight]	[]	LEFTARC	(morning ← flight)
7	[root, book, the, flight]	[]	LEFTARC	(the ← flight)
8	[root, book, flight]	[]	RIGHTARC	(book → flight)
9	[root, book]	[]	RIGHTARC	(root → book)
10	[root]	[]	Done	

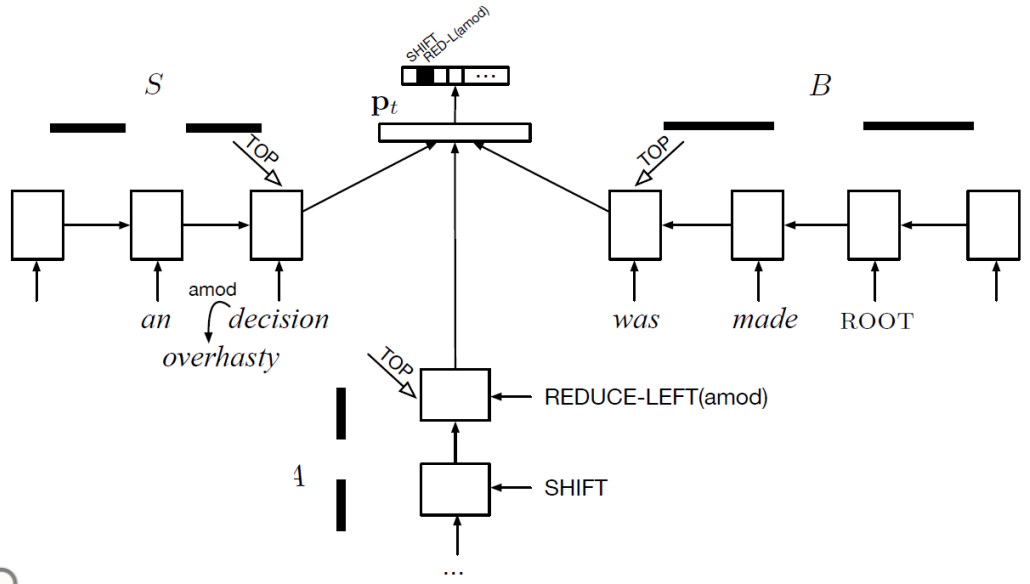
Figure 15.7 Trace of a transition-based parse.

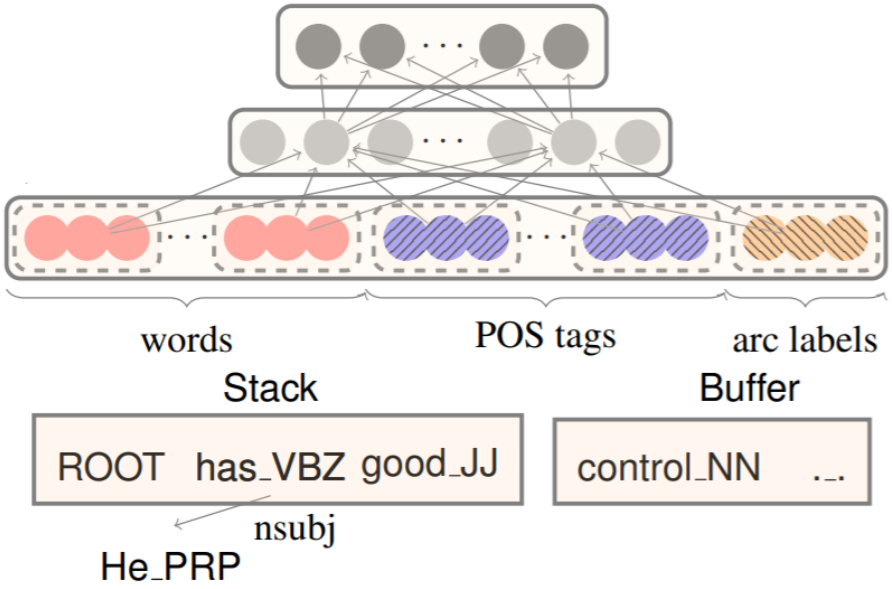
A stack, a buffer, some actions ……

We have learned similar approaches when talking about constituency parsing.

Transition-based Approach

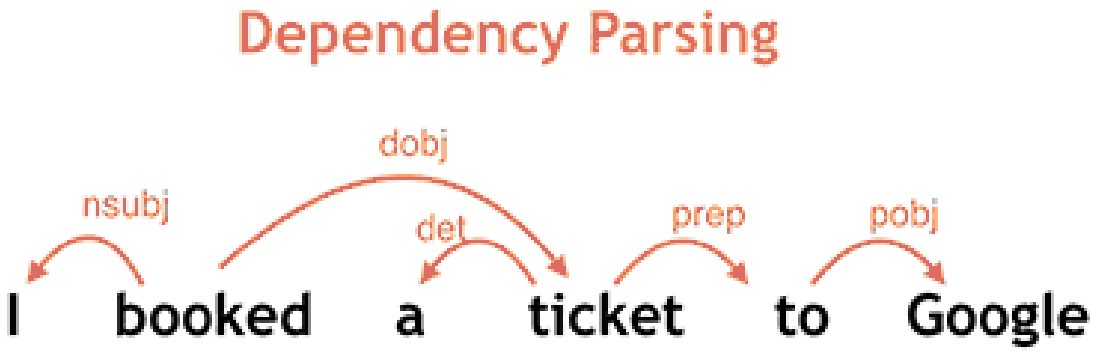
[Dyer, et al., ACL'15]





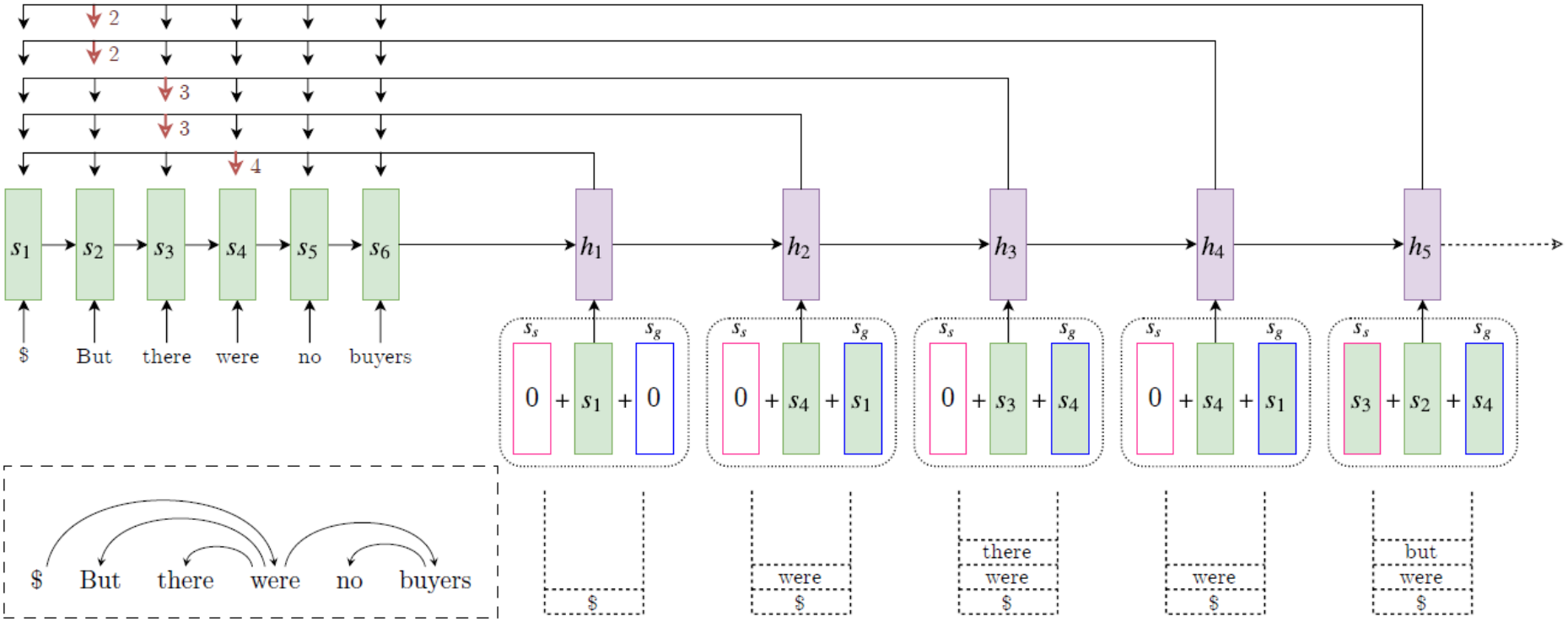
[Chen, et al., EMNLP'14]

SyntaxNet [Andor, et al., ACL'16]



https://ai.googleblog.com/2016/05/announcing-syntaxnet-worlds-most.html

Stack Pointer



[Ma, et al., ACL'18]

Reference

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