6. Tree-Adjoining Grammar (TAG)

1 Reminder: stack-based memory and "working in the middle"

We saw that an unbounded stack-based memory can allow for nesting dependencies in a string that is constructed left-to-right (i.e. categorizing only prefixes).

(1)

	Transition	String	Stack Contents
Step 0	—	ε	X
Step 1	(X, `flip`, FX)	`flip`	FX
Step 2	(X, `tick`, TX)	`flip tick`	FTX
Step 3	(X, `flip`, FX)	`flip tick flip`	FTFX
Step 4	(X, `flip`, FX)	`flip tick flip flip`	FTFFX
Step 5	(X, ε, Y)	`flip tick flip flip`	FTFFY
Step 6	(FY, `flop`, Y)	`flip tick flip flip flop`	FTFY
Step 7	(FY, `flop`, Y)	`flip tick flip flip flop flop`	FTY
Step 8	(TY, `tock`, Y)	`flip tick flip flip flop flop tock`	FY
Step 9	(FY, `flop`, Y)	`flip tick flip flip flop flop tock flop`	Y

We can get the same effect with bounded memory if we can "work in the middle" as we construct a string (i.e. categorizing infixes).

(2)

S → `flip` F	S
F → (S) `flop`	`flip` F
S → `tick` T	`flip` S `flop`
T → (S) `tock`	`flip tick` T `flop`
	`flip tick` S `tock flop`
	`flip tick flip` F `tock flop`
	`flip tick flip` S `flop tock flop`
	`flip tick flip flip` F `flop tock flop`
	`flip tick flip flip flop flop tock flop`

This relationship between a PDA and a CFG is analogous to the relationship between an LIG and a TAG.

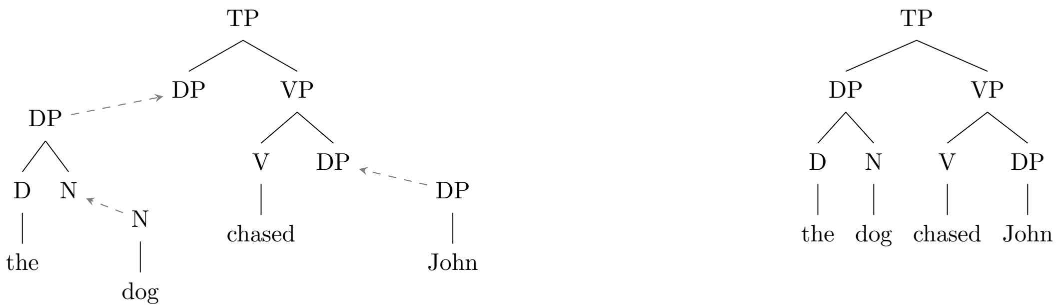
(3)

	Strings	Trees
Unbounded stack-based memory, working "end to end"	PDA (1)	LIG
Bounded memory, working "in the middle"	CFG (2)	TAG

2 TAG basics

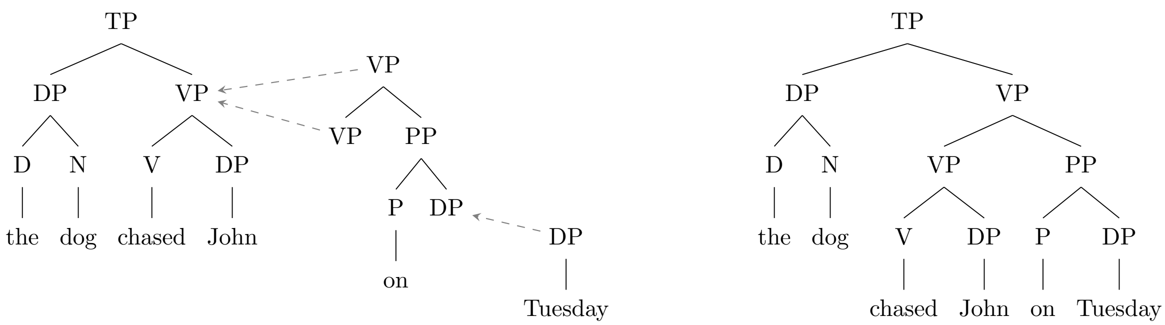
One of the two basic tree-building operations in TAG is **substitution**. This does the boring stuff.

(4)



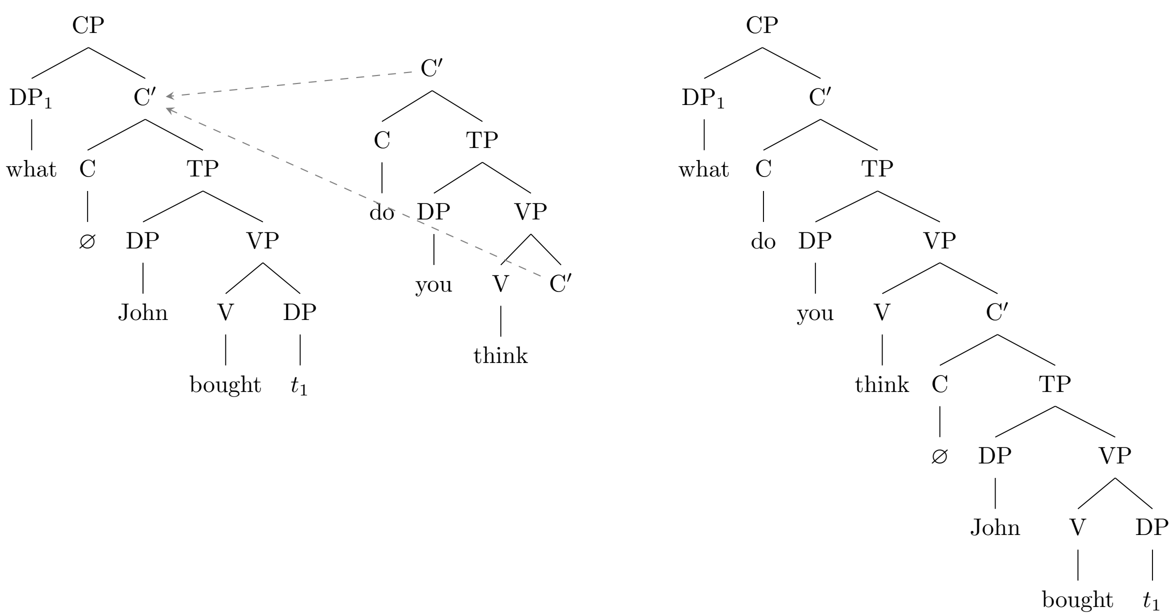
The other, more distinctive operation is **adjunction**. As you might expect, this is used for introducing optional modifiers.

(5)



But this same adjunction operation is also used for "stretching" long-distance dependencies.

(6)



See Kroch and Joshi 1985 or Frank 2004 for broader introductions to the use of TAG as a linguistic formalism. Chapter 1 of Frank 2002 gives a fascinating account of how TAG relates to the various changes in the architectures of pre-*Aspects*, post-*Aspects* and minimalist generative theories. (Spoiler: The clausal trees that get combined via adjunction are kind of like kernel sentences!)

3 Non-context-free string languages

The TAG for $\mathtt{a}^n\mathtt{b}^n\mathtt{c}^n$ is a lexicon of just two elementary trees. The NA subscripts indicate that adjoining is not allowed at those nodes.

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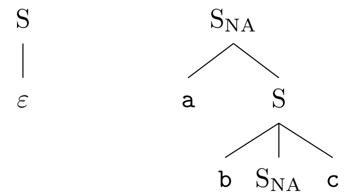
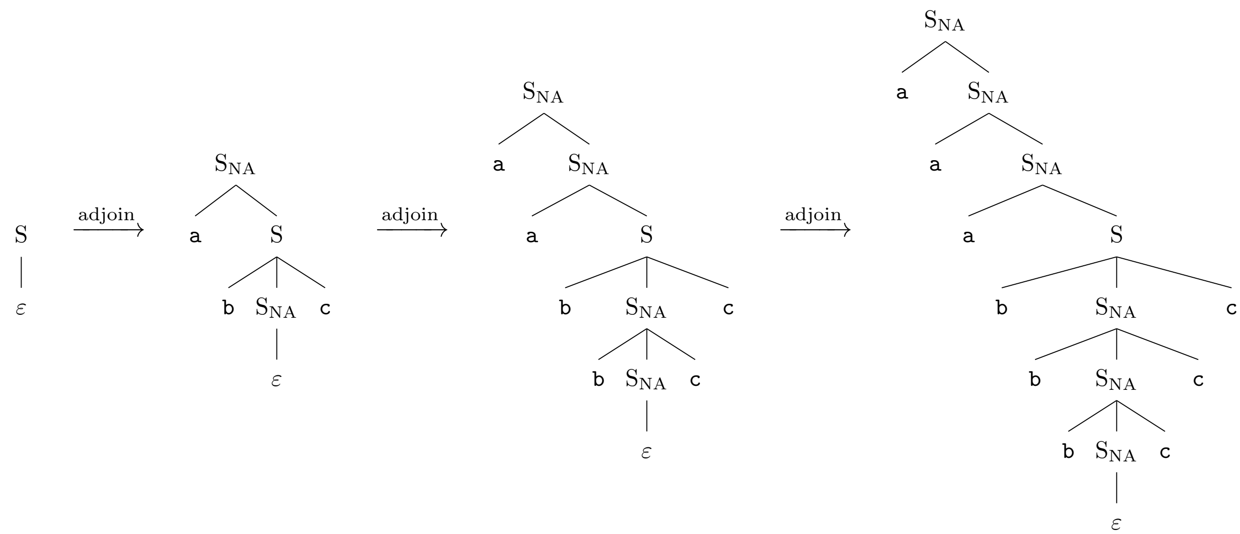
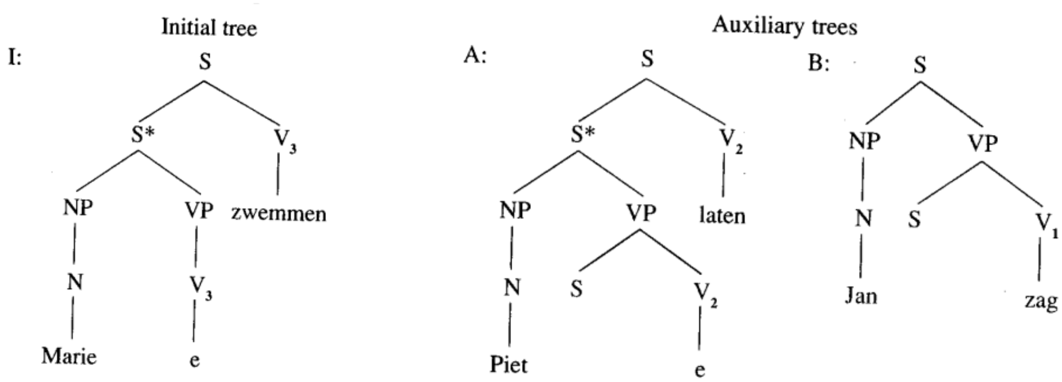


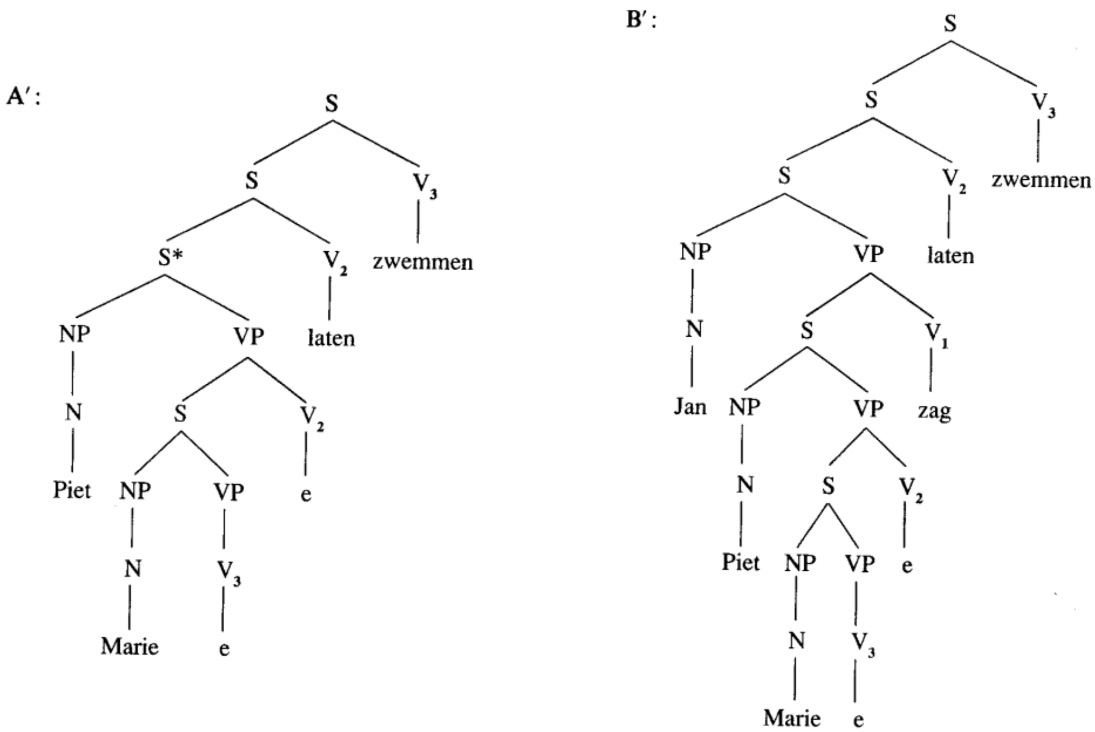
A derivation using this grammar proceeds by repeatedly adjoining the tree with the three terminal nodes into the middle S node.

(8)


Kroch and Santorini (1991, pp.310–312) use this kind of "vertical nesting" derivation to generate the Dutch crossing-dependency construction.

(9)


(10)

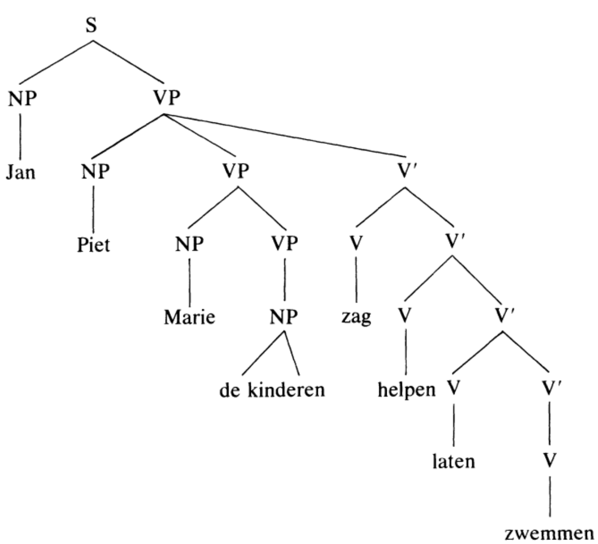


4 Non-finite-state tree languages

Are those the “right” tree structures for the Dutch crossing dependencies?

This is a somewhat thorny question. Many others have instead analyzed these sentences using a “double right-branching” structure, following Bresnan et al. (1982).

(11)



This kind of structure *cannot* be generated by a TAG (Joshi, 1985, pp.245–249) — one easy way to see why is to think about it in terms of an LIG.

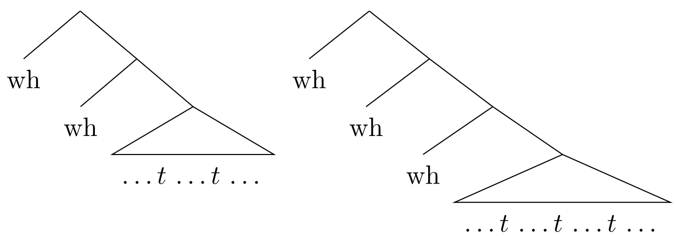
Are there analogous constructions where we might be more confident that the TAG-style structure is what we want?

Perhaps examples like the following, in languages like Bulgarian where embedded questions are not islands? As long as the pattern extends unboundedly? (Frank and Hunter, 2021)

(12) Koja kniga$_1$ te popita učitelja kogo$_2$ [ubedi Ivan t_2 da publikiva t_1]
which book you asked teacher who convinced Ivan to publish
"Which book did the teacher ask you who Ivan convinced to publish?"

(13) Koj kontinent$_1$ te popita učitelja koj$_2$ [t_2 e otkril t_1]?
which continent you asked teacher who has discovered
"Which continent did the teacher ask you who discovered?"

(14)



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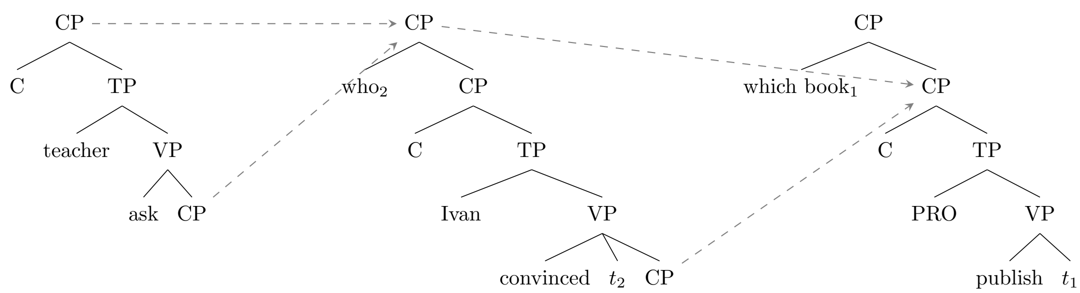

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