Syntactic tiers: Empirical applications and challenges

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NYU Syntax Brown Bag
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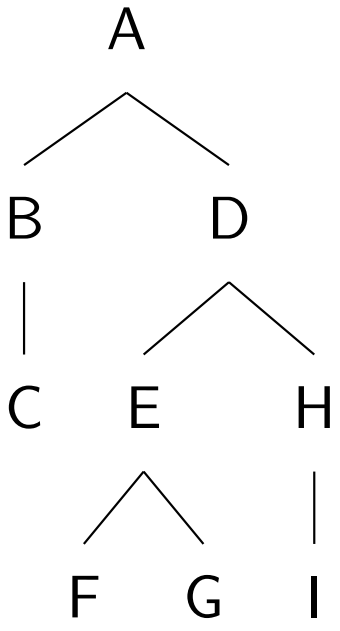
The talk in a nutshell

- Tiers, in syntax



- Can we use this for anything?
  Way more than you'd think. . . !

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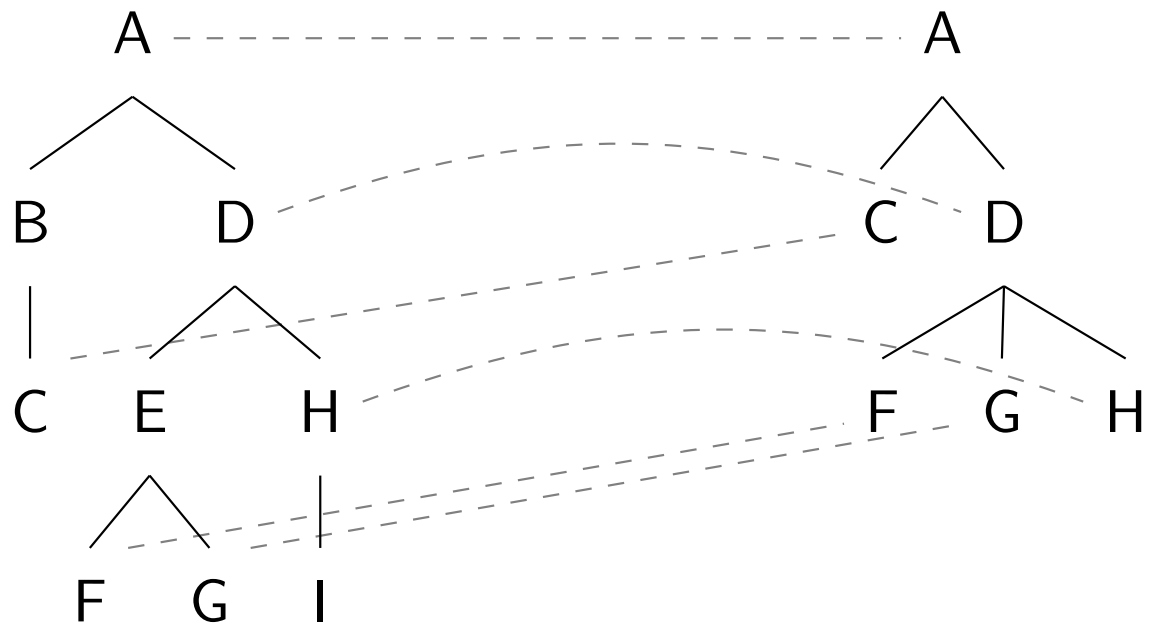

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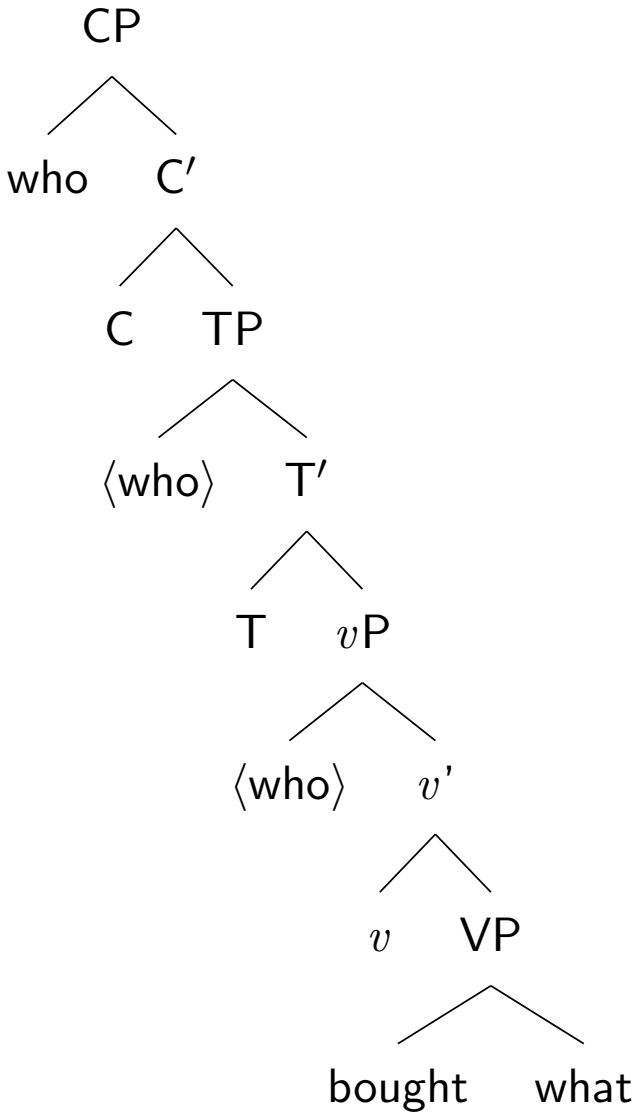
Applications

- Movement
- Multiple wh-movement
- Grafts/amalgams/reprojection
- Island effects (with exceptions and gradience)
- Extraction morphology
- complementizer alternations in Lio
- German wh-copying

Outline

Derivations as dependency trees



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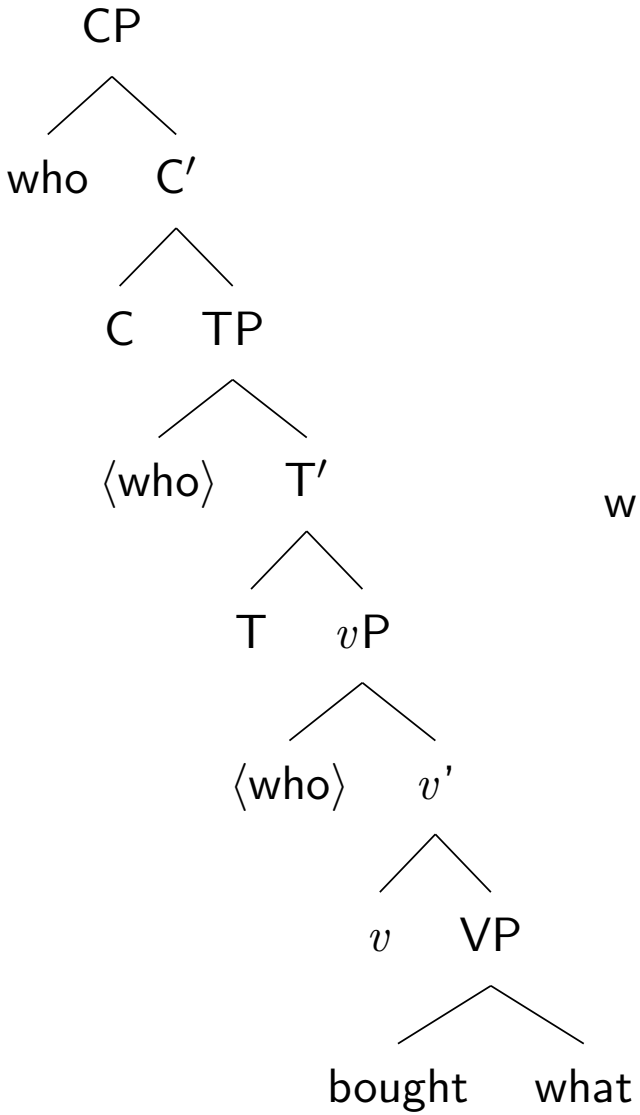
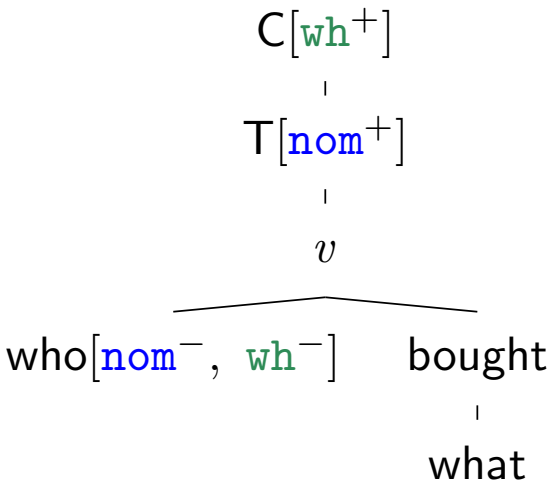
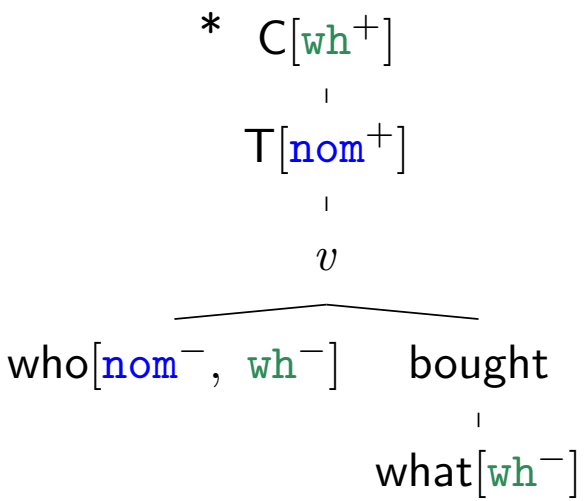


Derivation



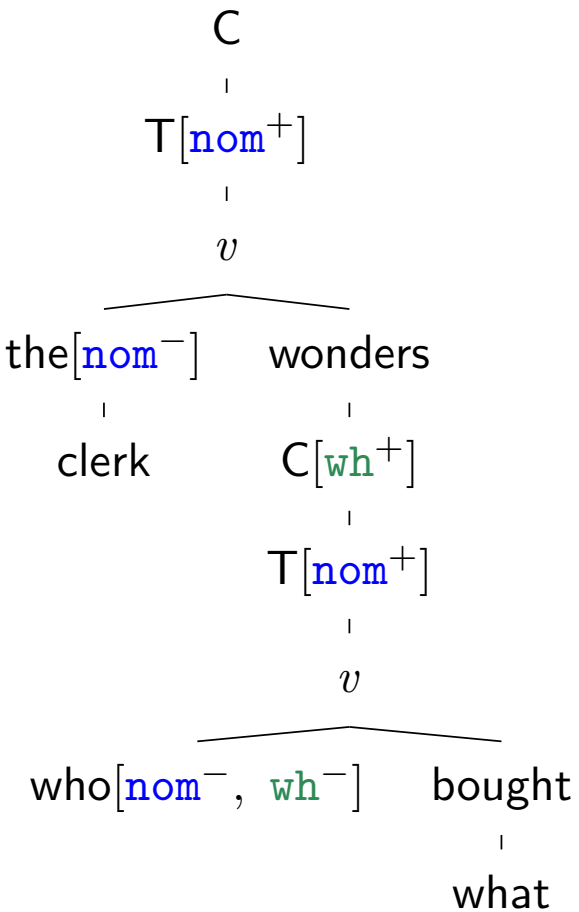
Some basic assumptions about movement

- $\texttt{wh}^-$ = "you must wh-move"
- $\texttt{wh}^+$ = "something must wh-move to you"
- **Empirical fact**
  Mover targets closest landing site of suitable type
- **Convenient assumption**
  One-to-one match of movers and landing sites



A cognitive/computational question about movement

- How hard is it to verify that all movement steps in a derivation meet these conditions?
- One particularly simple solution: tree tiers



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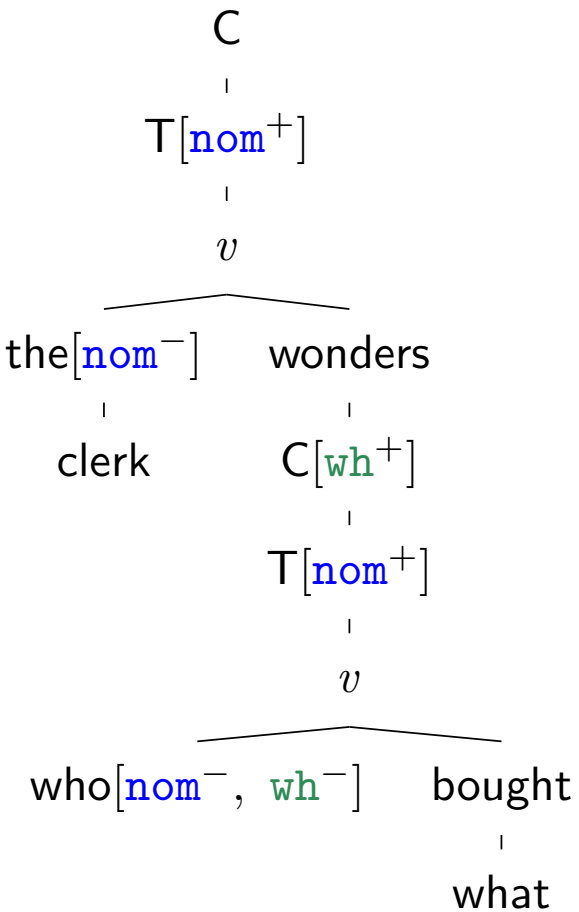

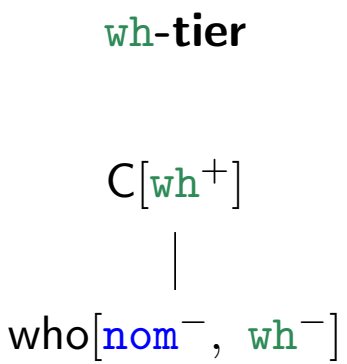

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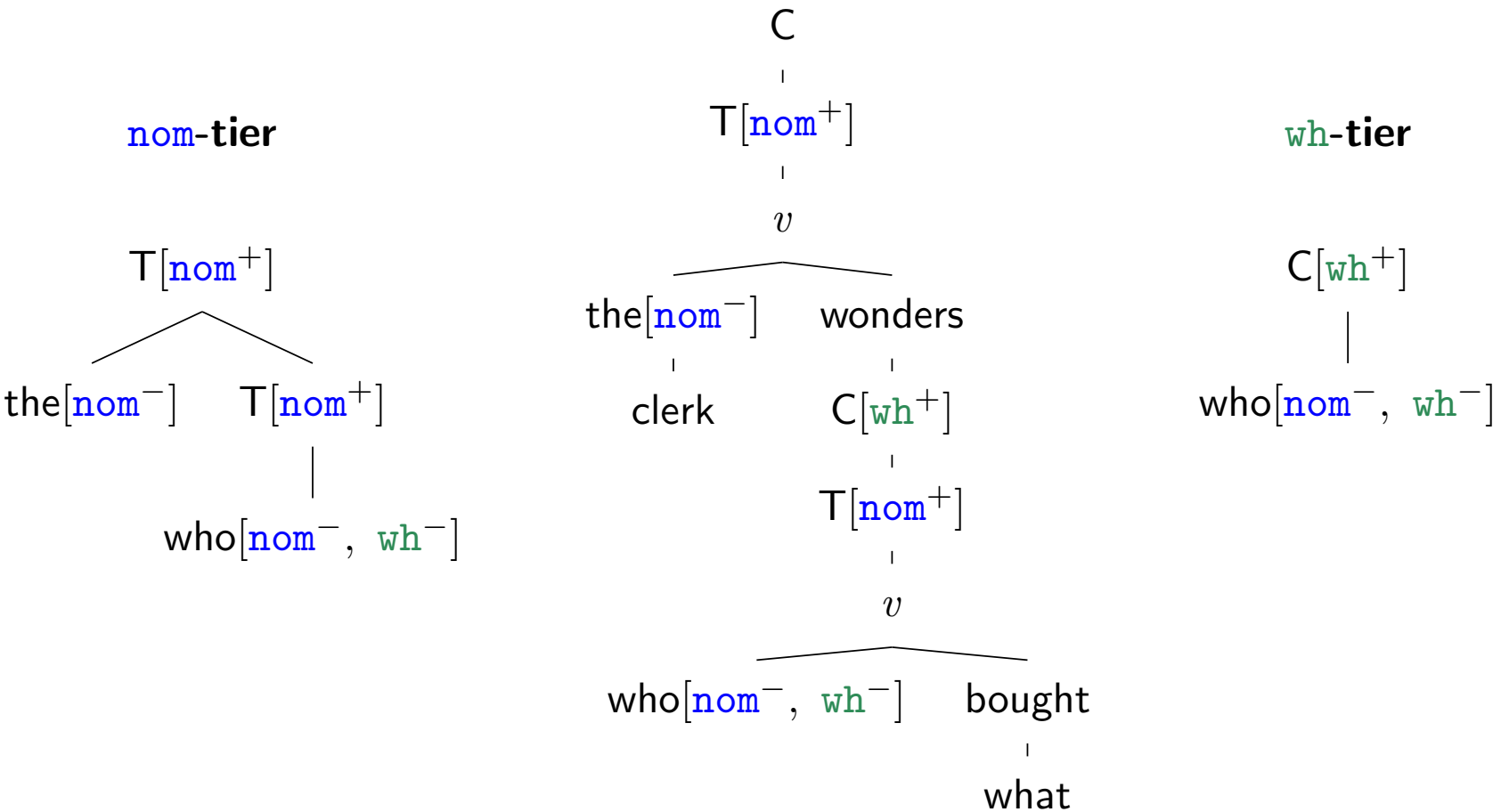


How tree tiers work

- finite number of tiers
- for each tier **T**:
  - whether node **N** projects to **T** depends only on **N** itself
    features, phonetic exponent, ...
  - finite number of constraints on mother-daughter configurations

Example: Tiers for movement

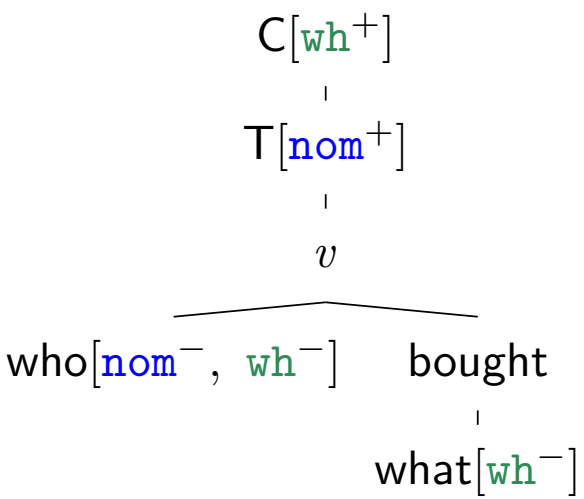
- for every movement type `f`, construct an `f`-**tier**
- on each `f`-tier:
  - $\texttt{f}^-$ must have $\texttt{f}^+$ mother
  - $\texttt{f}^+$ must have exactly one daughter with $\texttt{f}^-$

Um, why would we do this?

- **Philosophical answer**
  We're not doing anything, this is just an inherent property of the computational nature of movement.
- **Computational answer**
  This is a generalization of the formal class TSL from strings to trees, and TSL is awesome:
  - very restricted typology
  - easy to study
  - efficient learning algorithms
- **Linguistic answer**
  Tree tiers provide a **unified perspective** on many phenomena.

Multiple wh-movement

- Existence of multiple wh-movement unsurprising
- **Reason:** a computational device that can enforce "exactly 1" can also enforce "at least 1"



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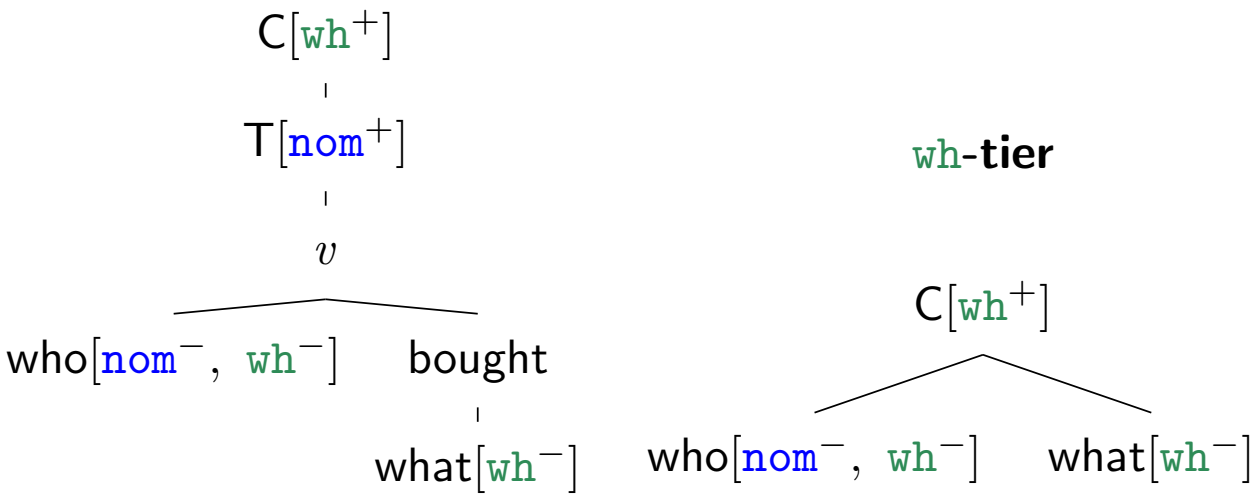

But that's barely an analysis...

That's a nice starting point, but we need to account for...

- why there is no multiple nom-movement
- linearization,
- superiority effects/c-command,
- multiple movers with distinct targets,
- the 2-by-2 typology of wh-movement

Multiple wh	**Superiority**	**Example language**
-	-	Spanish
-	+	English
+	-	Russian
+	+	Bulgarian

Grafts as long-distance selection (Van Riemsdijk)

(1) John went to I believe it was Chicago.

(2) I like [what you bought].

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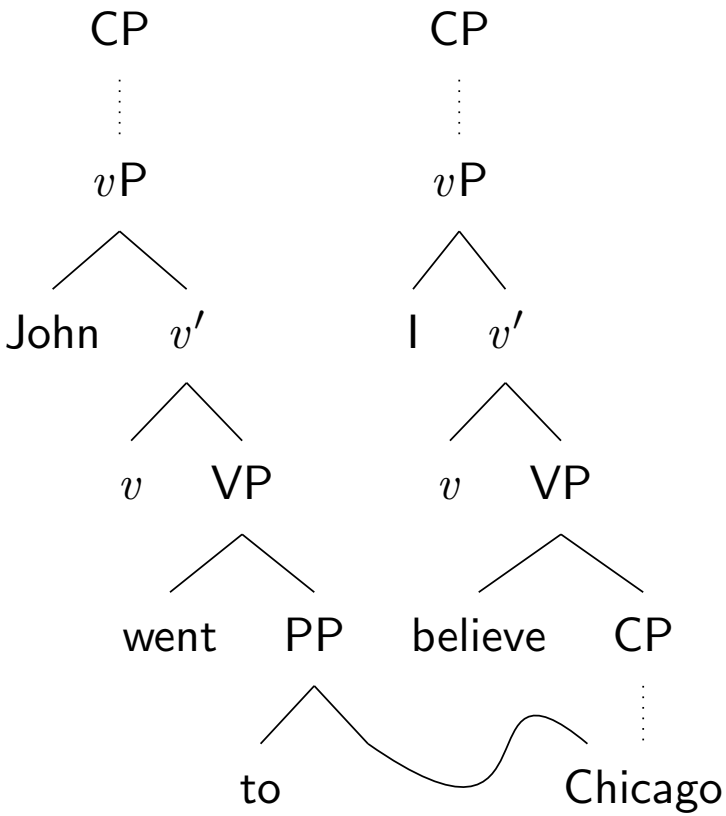

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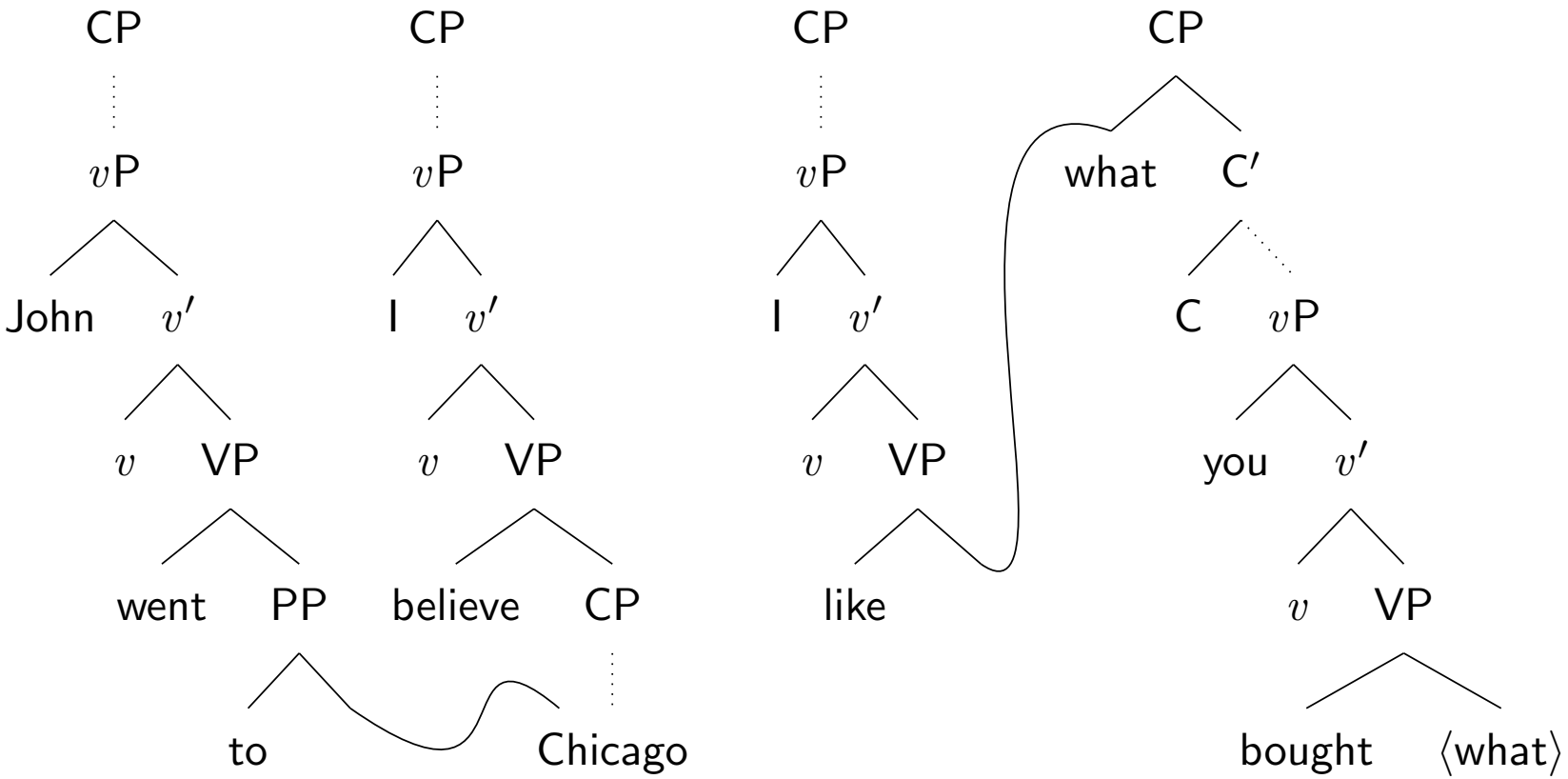

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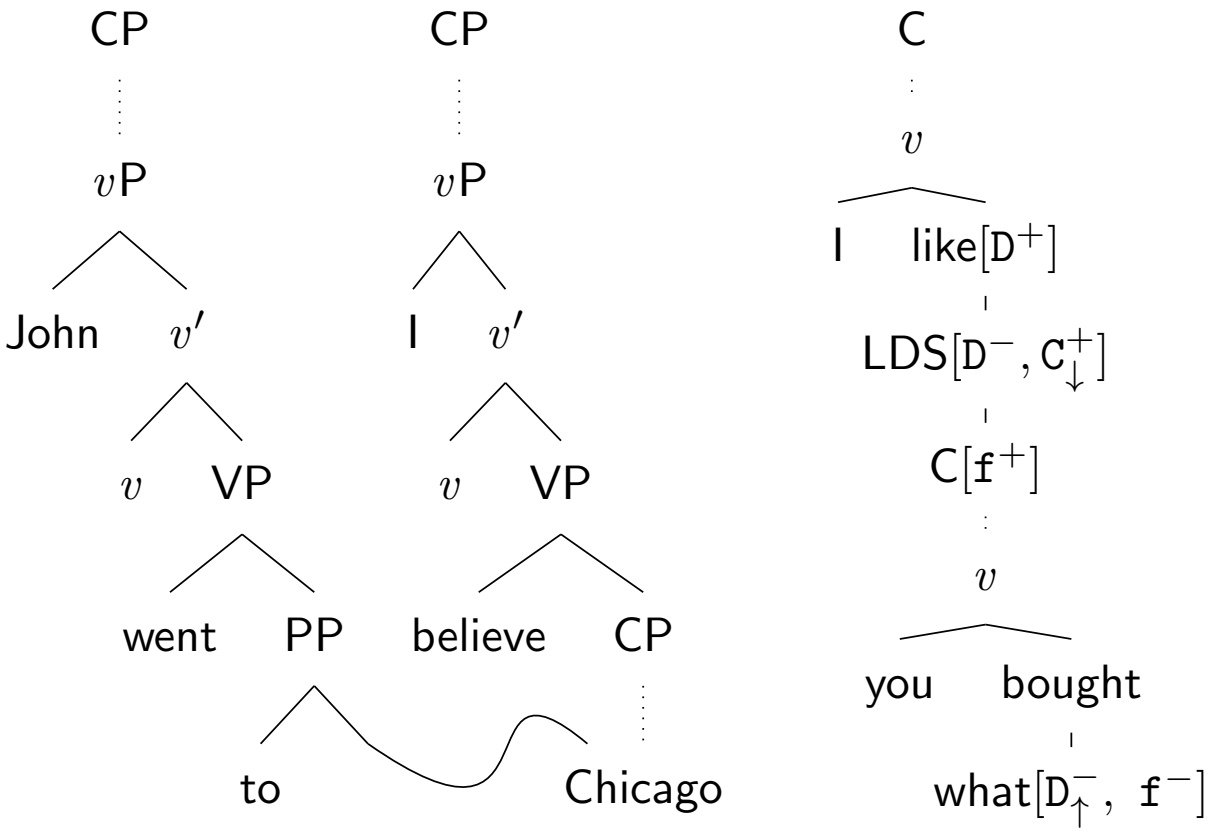

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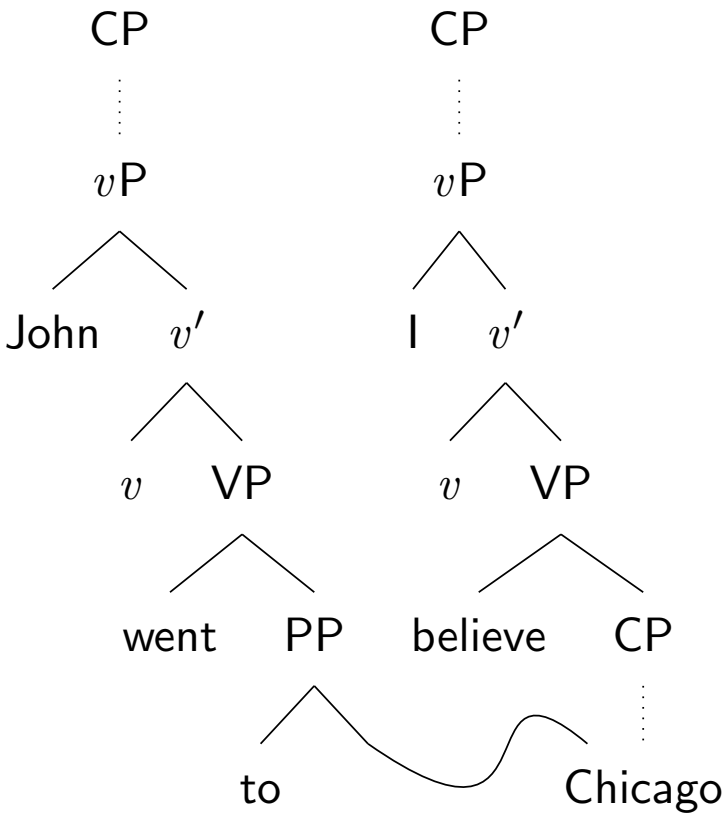
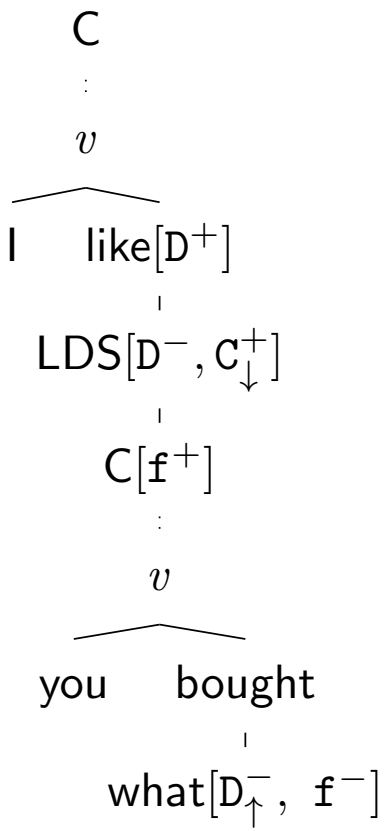
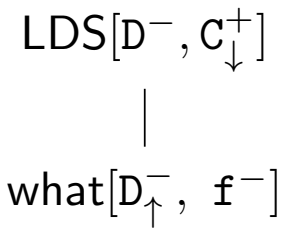




LDS-tier



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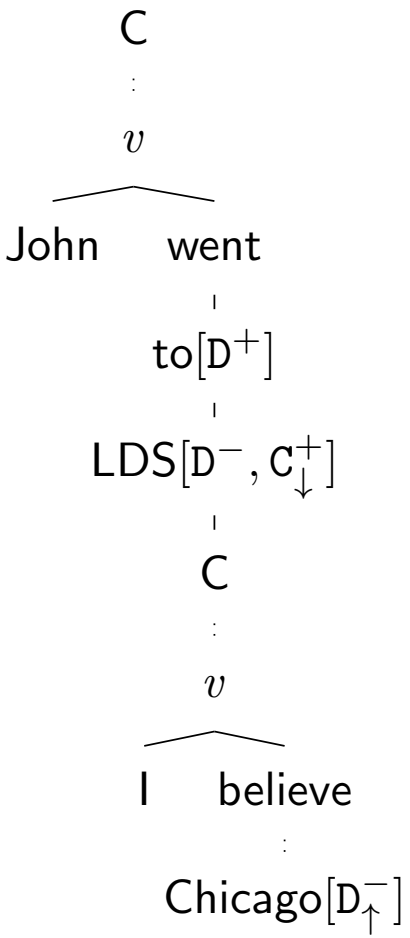

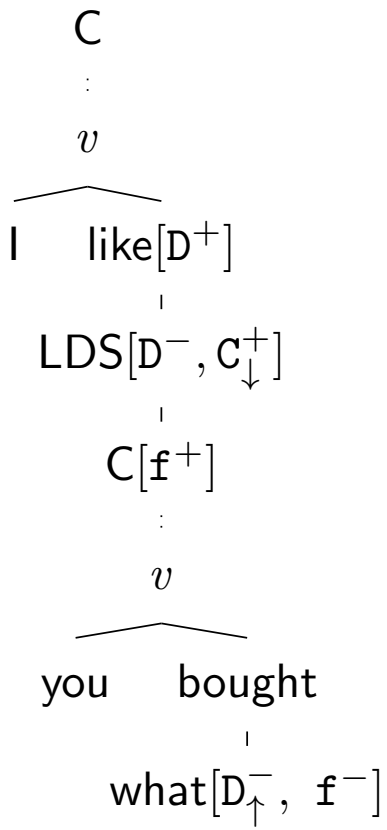

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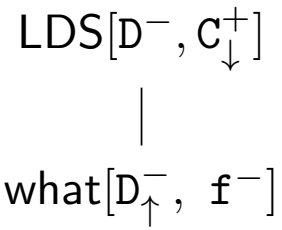

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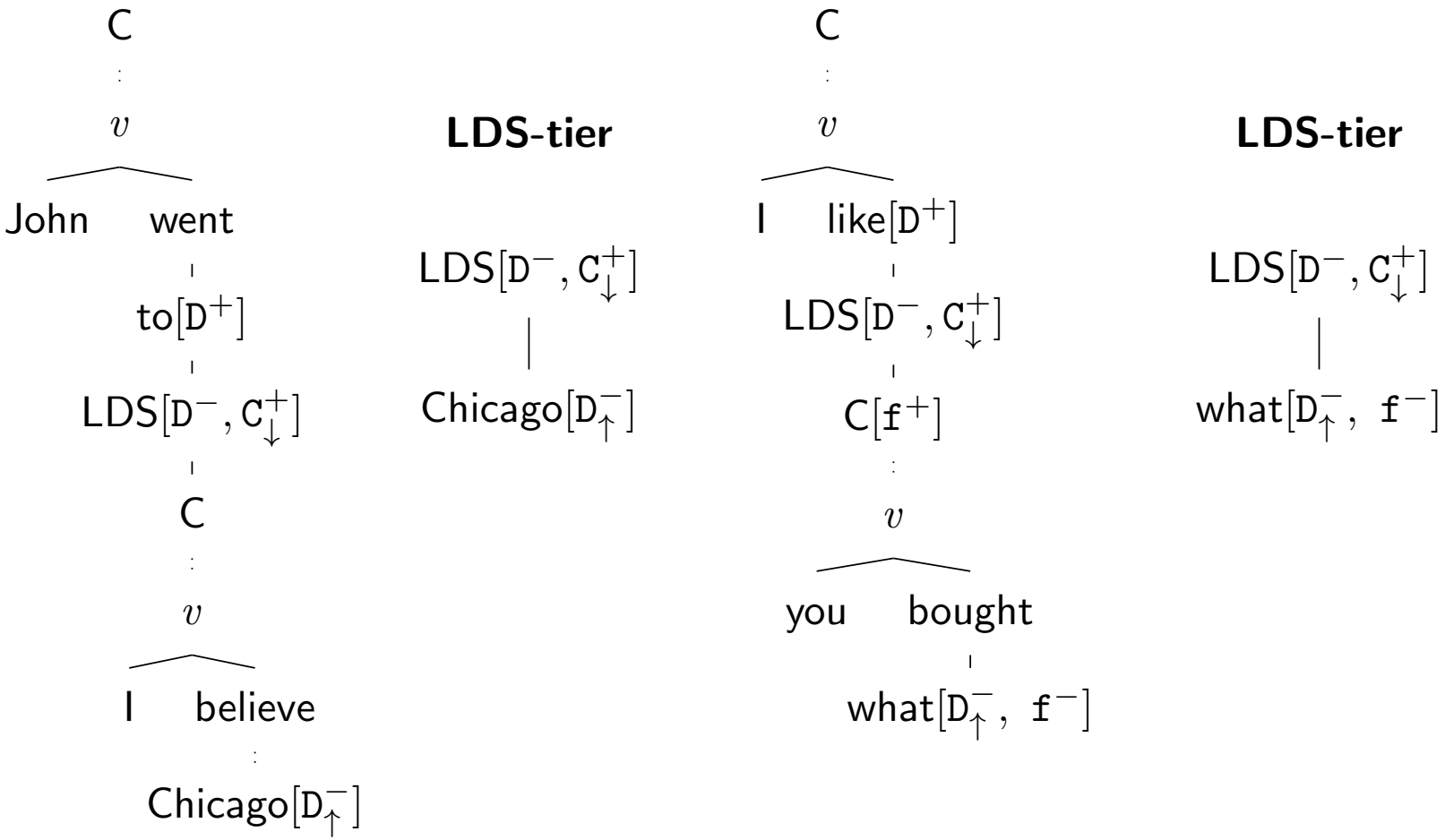


But that's barely an analysis. . . again

- only select few CPs can be grafted

(3) a. * John went to Al Capone ruled Chicago.

b. ?? John went to I established it was Chicago.

- only select few DPs can be LDS-ed within a graft

(4) a. * I like you bought what.
(meaning *what you bought*)

b. * I like you slept.
(meaning *I like you & you slept*)

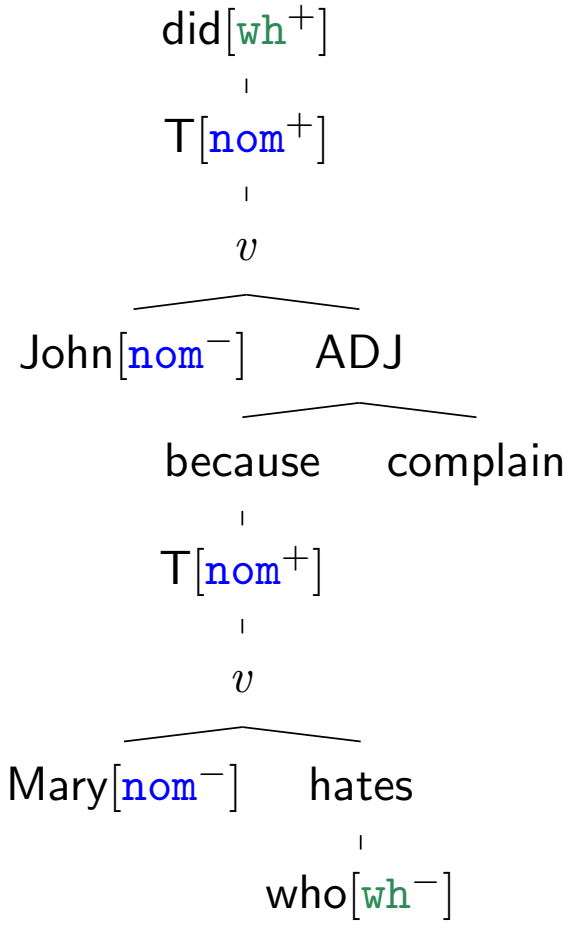
- grafts bridge locality domains

(5) John nominated [$_{CP}$ I believe [$_{CP}$ it was himself]].

- grafts have other applications (Meinunger on numerals)

Islands

- (Strong) islands are easy to capture with tiers
- island = node that disrupts licensing on movement tier



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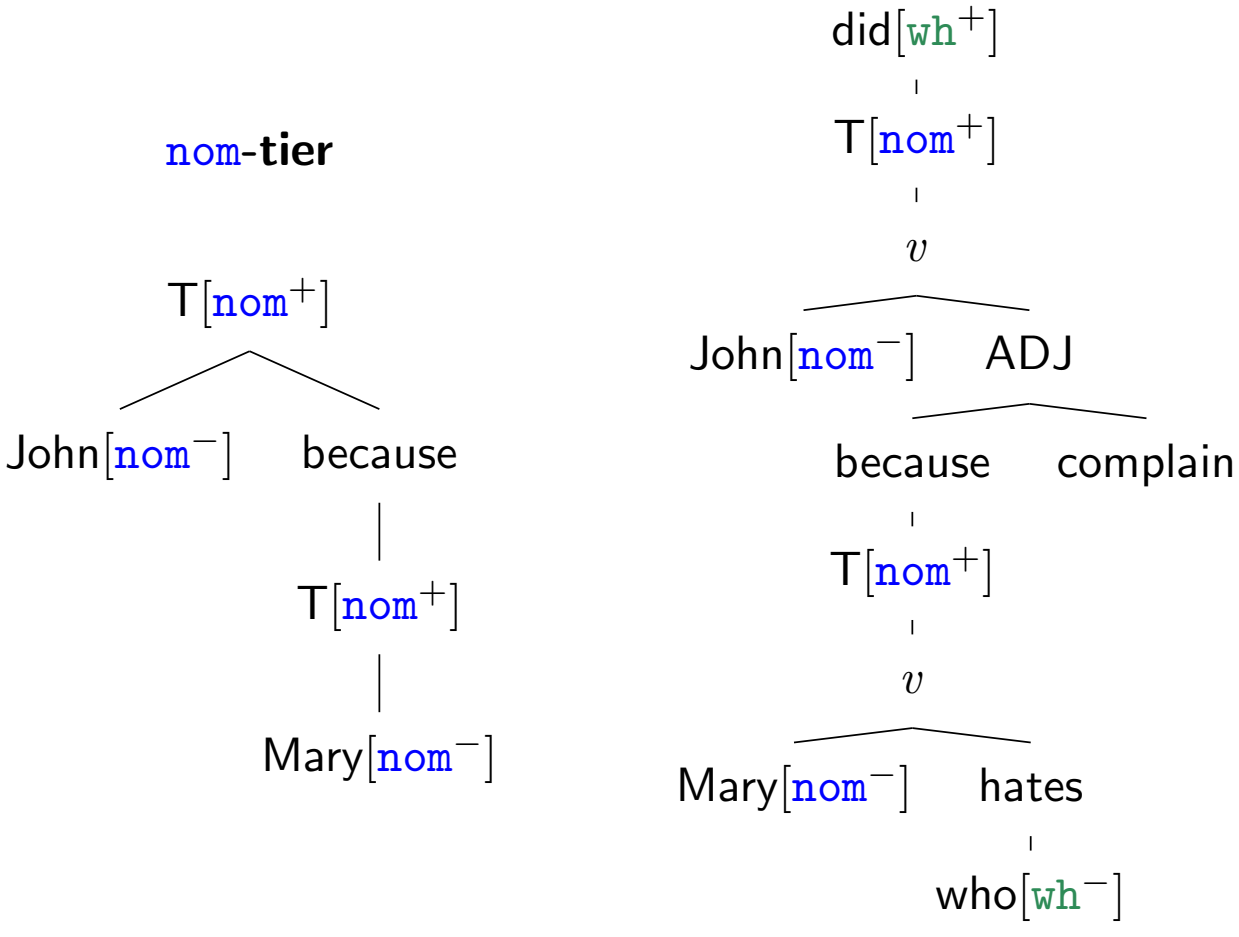

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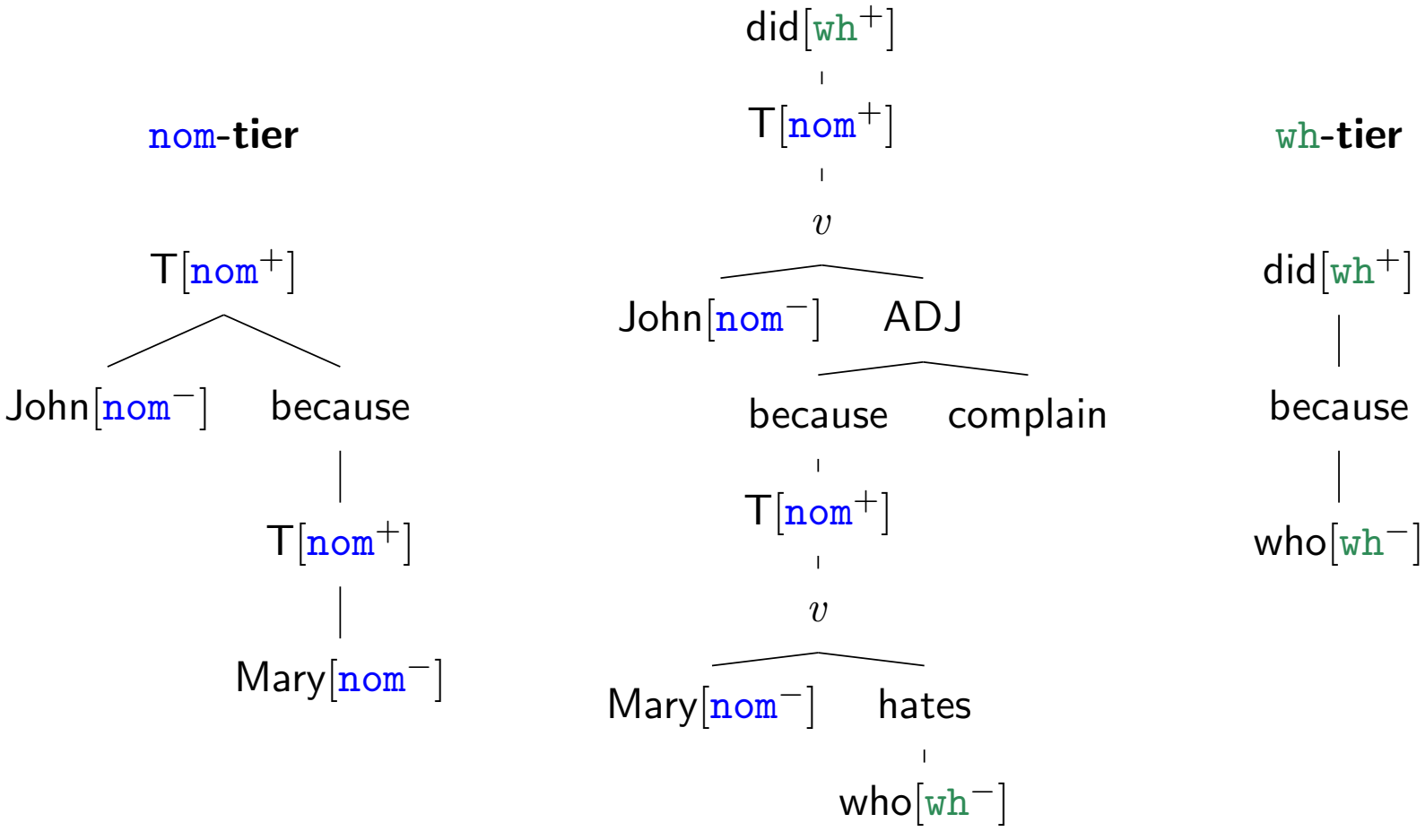
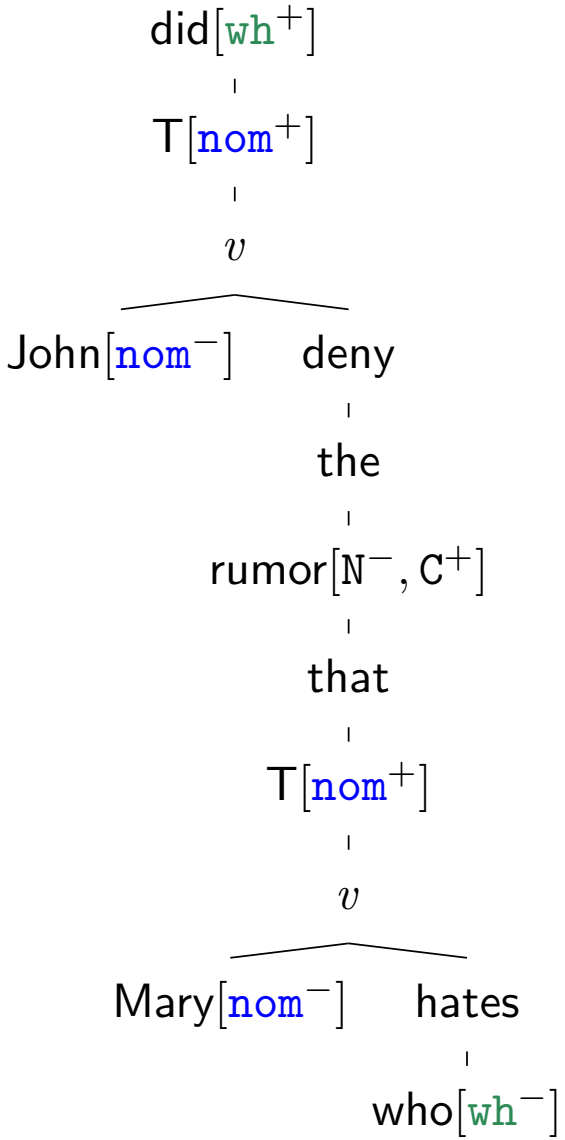


Another example: Complex NP constraint



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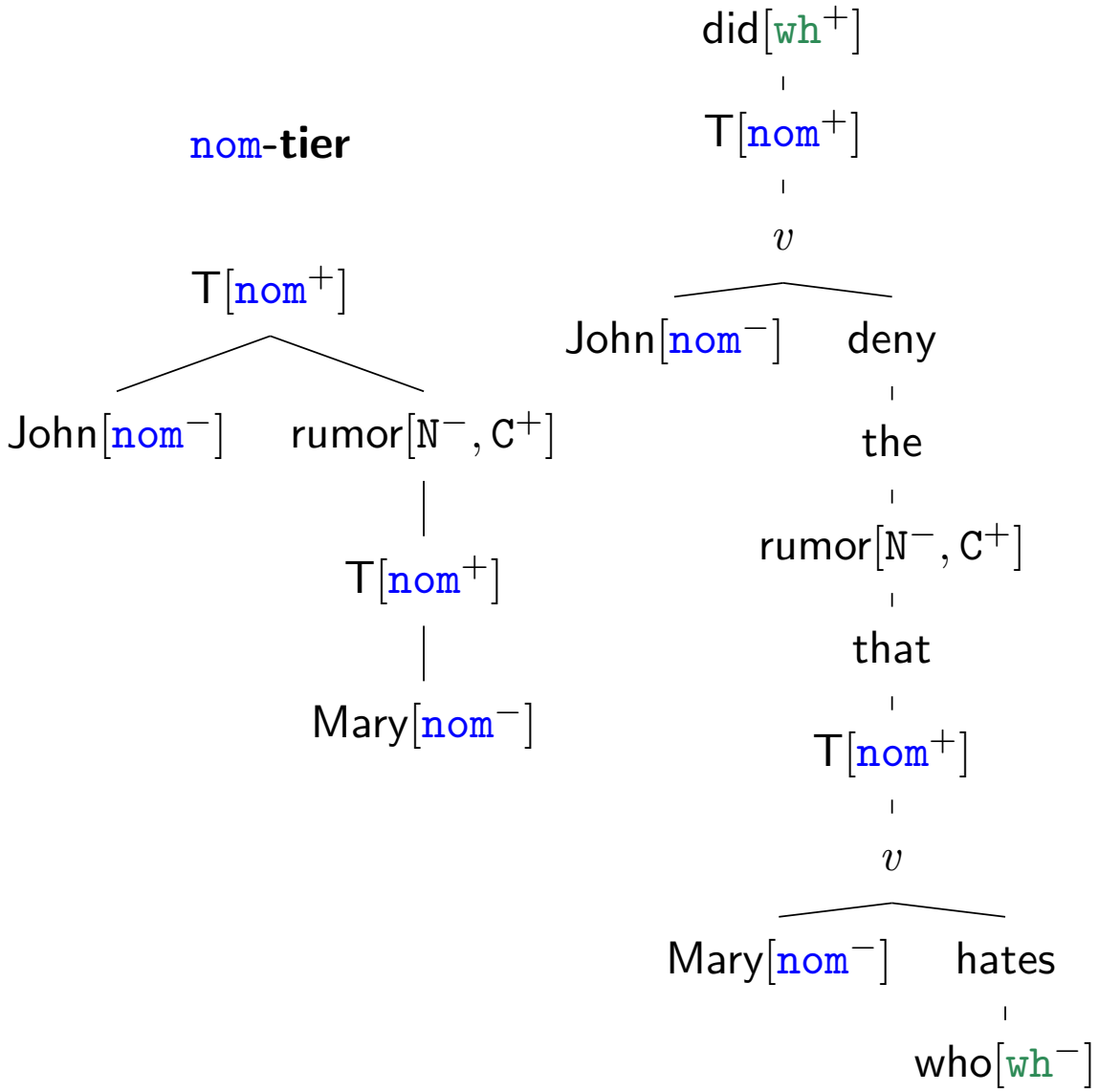

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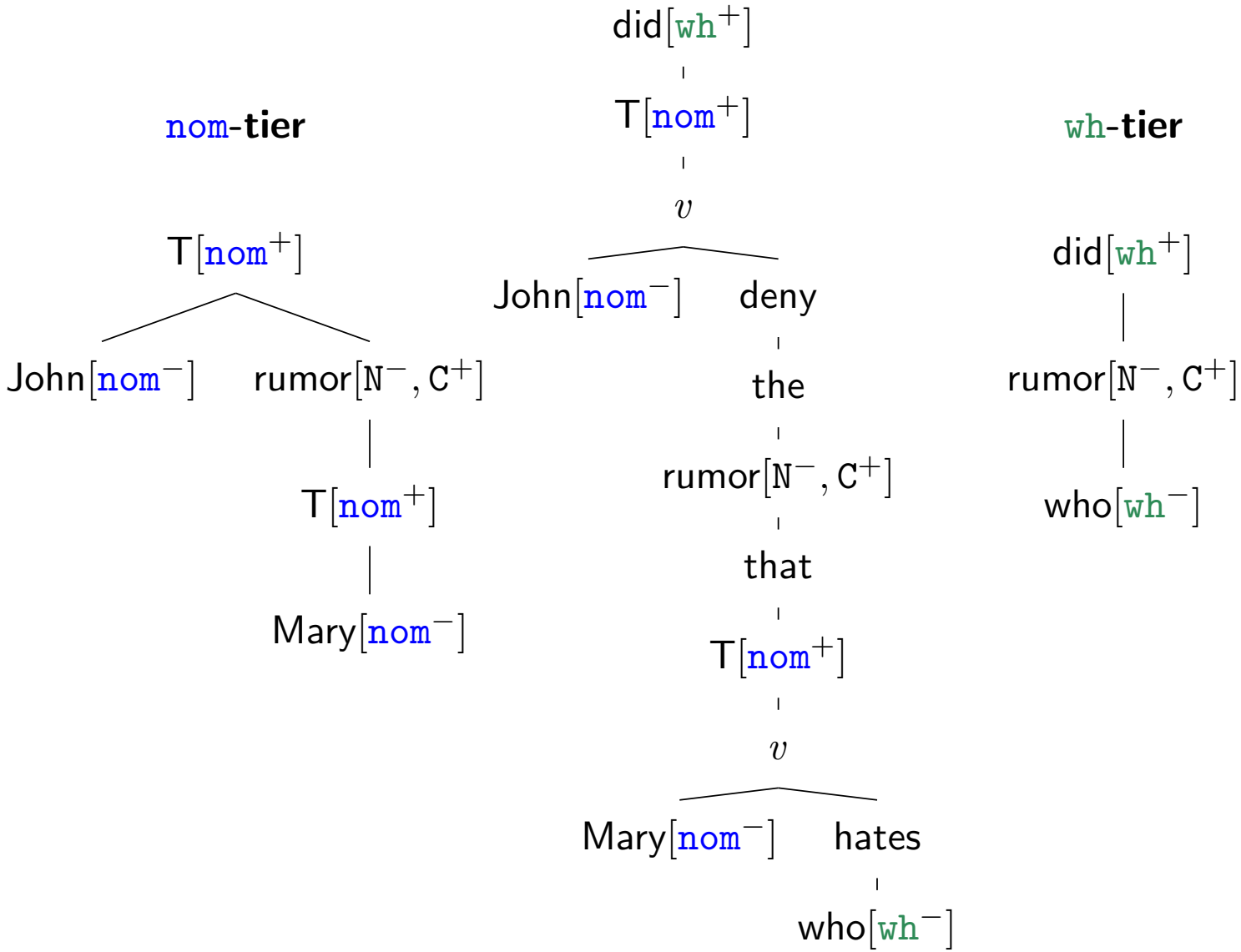

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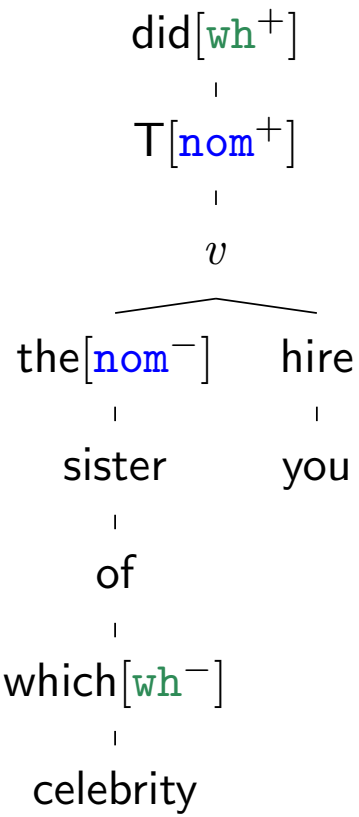

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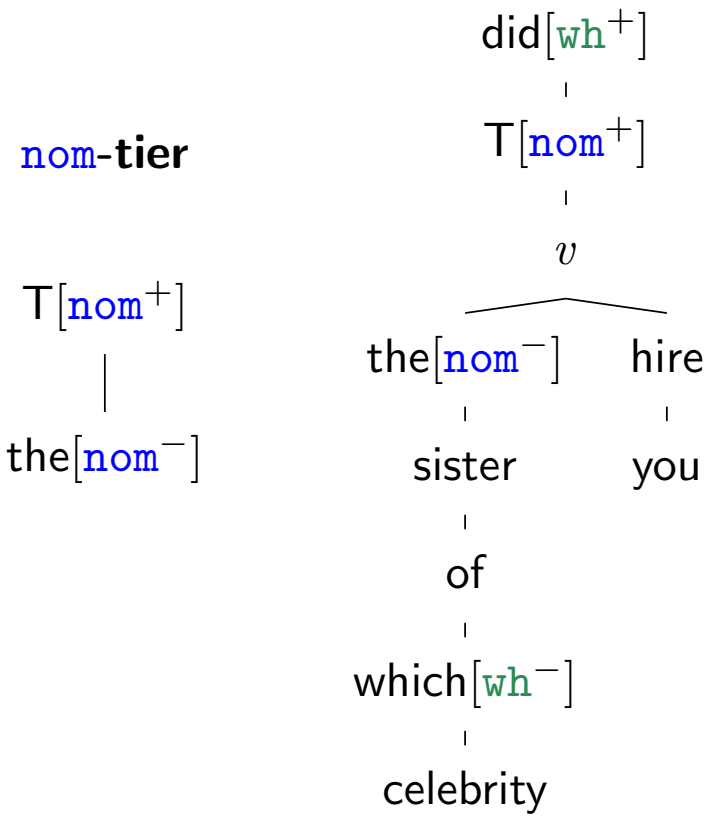

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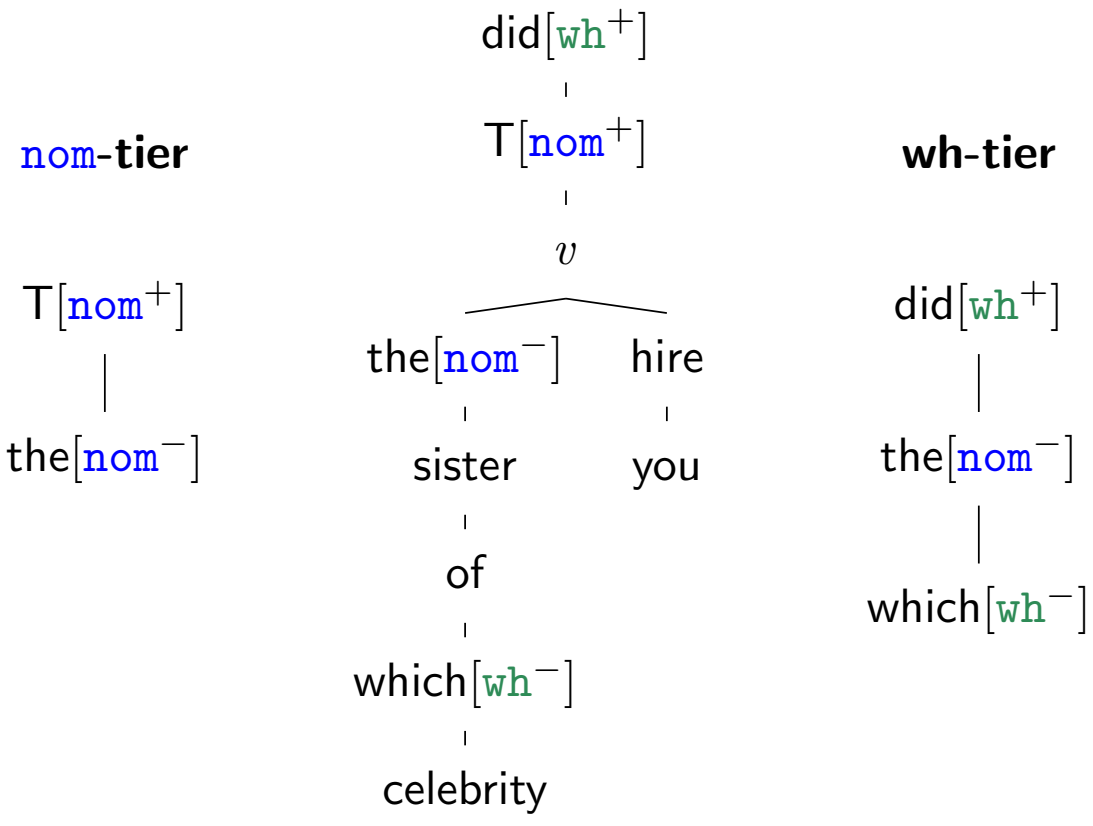


Disclaimer

- Yes, there's tons of **exceptions**!
  (Chaves and Dery 2019) and references therein

(6) Which president would [the impeachment of _] cause outrage?

(7) What did [the attempt to find _] end in failure?
(sounds awful to me)

(8) This is the man who [friends of _] think that [enemies of _] are everywhere.

- Tiers have some ways of dealing with exceptions,
  not clear yet if it works with these.

Constraints I've looked at so far

1. Adjunct islands: project adjuncts
2. Complex NP constraint: project items with $\texttt{N}^-$ and $\texttt{C}^+$
3. Relative clause islands: project items with $\texttt{rel}^+$
4. Subject island constraint: project items with $\texttt{nom}^-$
5. *that*-trace and anti-*that*-trace: works, but it's complicated

Gradience

- Tier projection can be made probabilistic to capture gradience (Mayer 2021)

Calculating gradience with probabilistic wh-tier

1. construct all possible versions of the wh-tier
2. filter out illicit tiers
3. sum up probabilities of remaining tiers

Example calculation

(9) * Who did Bill complain after having a meeting with ⟨who⟩ because he's always angry.

Item	Probability
any $\texttt{wh}^+$	1
any $\texttt{wh}^-$	1
because	.9
after	.8

- **Possible tiers**
  1. Project $\texttt{wh}^+$, $\texttt{wh}^-$, because, after: .72, illicit
  2. Project $\texttt{wh}^+$, $\texttt{wh}^-$, because: .18, licit
  3. Project $\texttt{wh}^+$, $\texttt{wh}^-$, after: .08, illicit
  4. Project $\texttt{wh}^+$, $\texttt{wh}^-$: .02, licit
- Overall probability: .2

Ongoing project

Charlie Torres
UCI

Connor Mayer
UCI

Kenneth Hanson
SBU

(Too) Many degrees of freedom

- **Three predictions**
  1. Island constraints can vary across languages.
  2. Islands may appear on some but not all movement tiers.
  3. There may be lexical exceptions to what projects on what tier.
- This is a **boon**!
  Consider recent data from Norwegian (Bondevik et al. 2021), where extraction is
  - allowed from finite adjunct clauses with *om* 'if'
  - forbidden from finite adjunct clauses with *når* 'when' or *fordi* 'because'
- This is a **bane**!
  - Typological overgeneration
  - Why are island effects very systematic overall?

Summary: Islands

- Computational mechanisms behind movement
  also allow for islands
- **Flexible**
  - covers many common island phenomena
  - gradience easy to add if desired
  - allows for lexical exceptions
- **Too flexible**
  needs to be combined with some other theory of islandhood

Extraction morphology: An example from Wolof u-chains

Extraction morphology morphology conditioned by the presence of movement

- Consider **Wolof u-chains** (Niger-Congo)
  - (covert) wh-phrase moves to matrix Spec,CP
  - highest C-head *u* along the movement path must agree with wh-phrase in Class
  - intermediate C-heads may agree with wh-phrase in Class

(10) [ε **k**-u Kumba wax [ne **k**/**l**-u Isaa defe [
Q CL-u Kumba say FRC CL/EXPL-u Isaa think
ne **k**/**l**-u Maryam dóór *t*]]]
FRC CL/EXPL-u Maryam hit

'Who did Kumba say that Isaa thought that Maryam hit?'
(Torrence 2012:1171)

A typology of extraction morphology

based on Georgi (2017), a terrific paper

1. What is agreeing?
   - L landing site (Wolof u-chains)
   - X some other head X in the clause of the landing site (Duala *no*-marking on T)
2. What clauses display agreement?
   - F the clause of the **F**inal landing site (Chamorro complementizer agreement)
   - N clauses with **N**on-final landing sites (Kiitharaka focus marking on verb)
3. agreement is. . .
   - M **M**andatory
   - O **O**ptional

Example

Wolof u-chains are $\text{L-F}_{\text{M}}\text{-N}_{\text{O}}$

Extraction morphology and tiers

- Tiers work well for extraction morphology.
- the various options fall out nicely for L-patterns
- X-patterns are harder

Central idea

- treat it as a distribution problem (not mapping/spell-out)
- use tiers to ensure correct distribution of agreeing forms

Two simplifications due to data gaps

- exactly one A′-mover per sentence
- only one type of A′-movement per sentence
  (no *which car that John bought did we trash*)

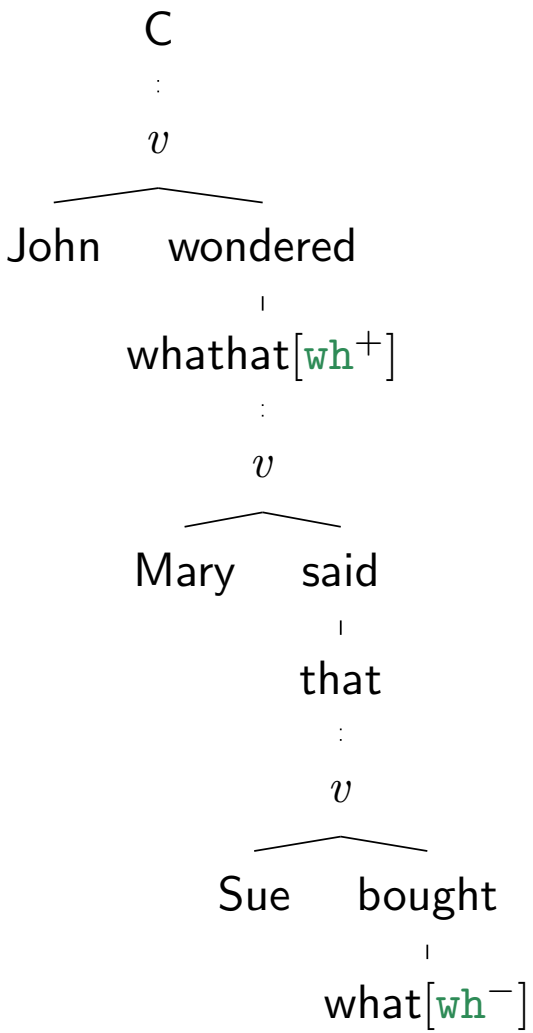
Toy example 1: F_M English *whathat*

- Suppose English had a special C-head *whathat*, which has to be the final landing site of some wh-mover.

Analysis: Lexical accident

The lexicon happens to be such that

- *whathat* must carry $\texttt{wh}^+$,
- *that* must not carry $\texttt{wh}^+$,
- empty C must not carry $\texttt{wh}^+$.

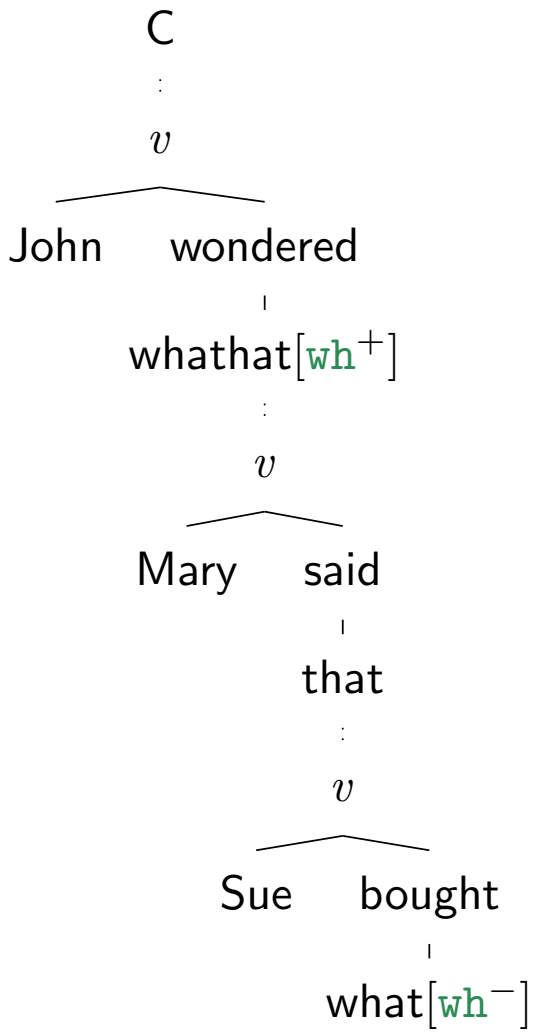


Toy example 2: F_M English *whathat*/*whothat*

- Suppose English also had *whothat*,
  and *Xthat* must agree in animacy with the wh-mover.

Lexical accident + tier match

- $\texttt{wh}^+$ only on *whathat* and *whothat*
- on wh-tier, $\texttt{wh}^+$-head must match animacy of $\texttt{wh}^-$-daughter



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wh-tier

whathat[wh$^+$]

|

what[wh$^-$]

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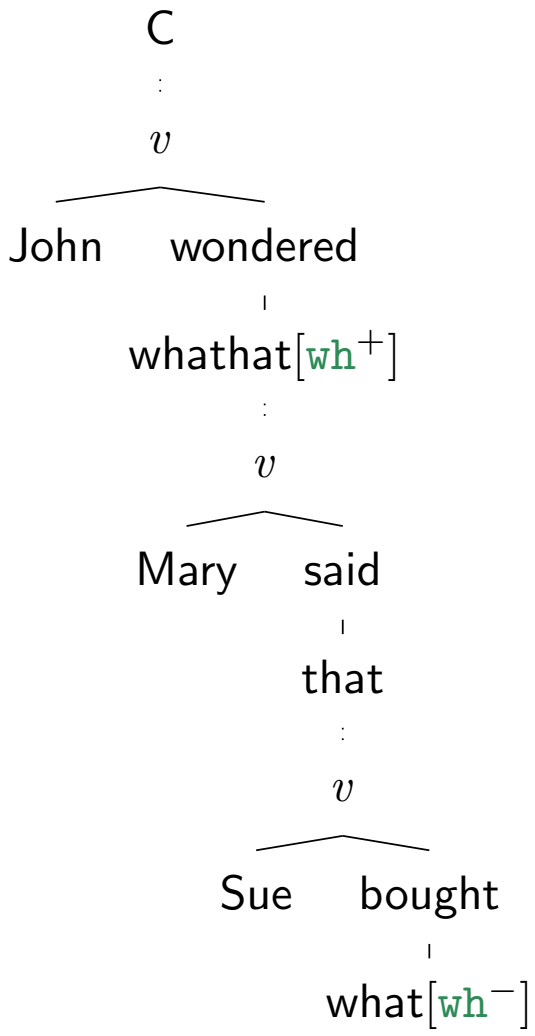
Toy example 3: F_M-N_M English *whathat*/*whothat*

- Suppose every C-head along a wh-movement path has to be *whathat*/*whothat*

Lexical accident + tier match + N-tier

- wh^+ only on *whathat* and *whothat*
- on wh-tier, wh^+-head must match animacy of wh^--daughter
- **N-tier**
  - project all wh^+, all wh^-, and all C-heads
  - every *Xthat* must have daughter that is *Xthat* (same X) or wh^-
  - non-*Xthat* with *Xthat* daughter, daughter must carry wh^+



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N-tier

C

|

whathat[wh^+]

|

that

|

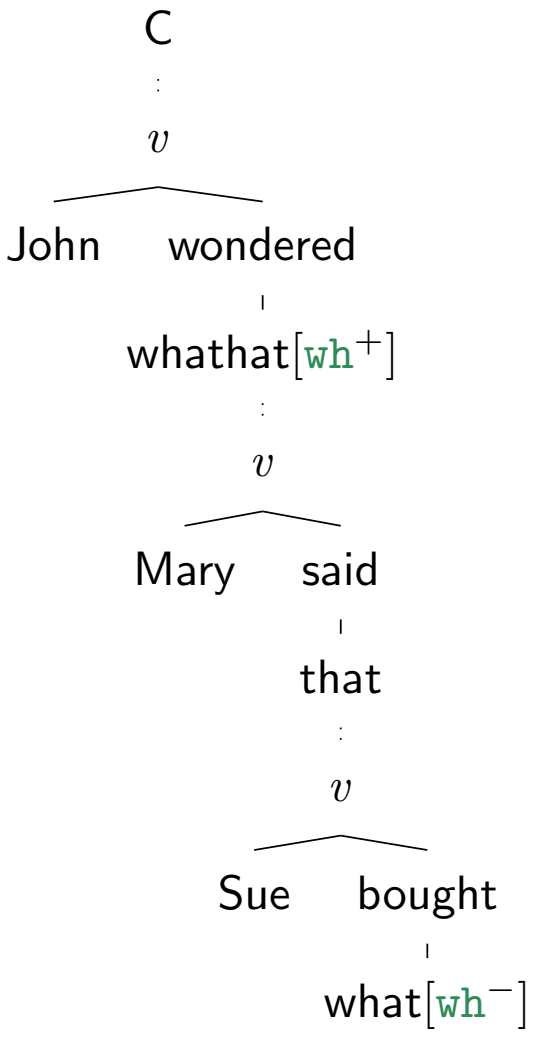
what[wh^-]

Toy example 4: F_O-N_O English *whathat/whothat*

- Suppose as before, except that *Xthat* is optional

No accident + fused(tier match, N-tier)

- $\texttt{wh}^+$ on *Xthat* **or that**
- **N-tier**
  - project all $\texttt{wh}^+$, all $\texttt{wh}^-$, and all C-heads **that are Xthat**
  - every *Xthat* must have daughter that is *Xthat* or **matching** $\texttt{wh}^-$
  - non-*Xthat* with *Xthat* daughter, daughter must carry $\texttt{wh}^+$



Toy example 4: F_O-N_O English *whathat/whothat*

- Suppose as before, except that *Xthat* is optional

N-tier

whathat[wh$^+$]

|

what[wh$^-$]

No accident + fused(tier match, N-tier)

- wh$^+$ on *Xthat* **or that**
- **N-tier**
  - project all wh$^+$, all wh$^-$, and all C-heads **that are Xthat**
  - every *Xthat* must have daughter that is *Xthat* or **matching** wh$^-$
  - non-*Xthat* with *Xthat* daughter, daughter must carry wh$^+$

Summary of analytical tricks for L-patterns

- **F-patterns arise from lexicon**
  - no F: $\texttt{wh}^{+}$ only on default C
  - F_{M}: $\texttt{wh}^{+}$ only on agreeing C
  - F_{O}: $\texttt{wh}^{+}$ on either one
- **N-patterns captured via tiers**
  - construct "daisy chain" of agreeing mother-daughter configurations
  - top of daisy chain: $\texttt{f}^{+}$
  - bottom of daisy chain: $\texttt{f}^{-}$
- If we need agreement with some feature of the mover, find a suitable tier to enforce the match condition on.

X patterns

- X patterns are more convoluted, even in simple cases.
- L-F_M is trivial, X-F_M is challenging

Example: X-F_M on verb with wh-movement

- Project all $\texttt{wh}^+$, all $\texttt{wh}^-$, and all V
- inflected V must have $\texttt{wh}^+$ mother

Example: agreeing X-F_M on verb with wh-movement

- everything as before, plus a new tier
- Project all $\texttt{wh}^+$, all $\texttt{wh}^-$, and all inflected V
- inflected V must have matching $\texttt{wh}^-$ daughter

X patterns [cont.]

Example: agreeing X-F_M-N_O on verb with `wh`-movement

- **Tier 1**: F_M
  - Project all $\texttt{wh}^+$, all $\texttt{wh}^-$, and all V
  - $\texttt{wh}^+$ must have inflected V daughter
- **Tier 2**: N_O
  - Project all $\texttt{wh}^+$, all $\texttt{wh}^-$, and all inflected V
  - inflected V must have matching daughter that is $\texttt{wh}^-$ or inflected V

Problems

- Some patterns not doable without extensions (X-F_O-N_M)
- Sometimes target of extraction morphology does not sit above the mover (e.g. V with moving subject)

Summary: Extraction morphology

- rich, varied typology
- L-patterns work very well and require no extra machinery
- X-patterns get tricky, some require more than just mother-daughter over tiers (X-F_O-N_M,X-N_M)
- But there's a clear path forward to capturing the full typology.

Speaking of problems...

- There is a lot of movement stuff that does not work.
  smuggling, freezing, ATB, CSC, ...

Example: Smuggling

- We always calculate locality from a mover's base position.
- Being contained inside another mover does not alter locality.

- Ideally, the things that don't work are **productive failures**.

Example: Ban on Improper Movement (BoIM)

BoIM Once you A′-move, you cannot A-move anymore

(11) * John seems [$_{CP}$ ⟨John⟩ [$_{TP}$ ⟨John⟩ snores a lot]].

- We cannot use tiers to correctly enforce BoIM.
- **But**: tiers can handle an alternative, **probe horizons** (Keine 2016)

Modeling probe horizons with tiers

Probe horizon	**Tier counterpart**
[uEPP] cannot probe past C	all C-heads on `nom`-tier
[uF] cannot probe past T	all T-heads on `f`-tier
[uwh] can probe into anything	normal `wh`-tier

A cute observation

- A version of BoIM is needed for tier-based linearization.
- Perhaps a lot of tier-based stuff is the low-level implementation of more general principles.

High-level principles VS grammar implementation

- **PF interface** says: "Syntax, the PF interface congress just passed the BoIM bill to boost efficient linearization."
- **Syntax** sighs: "Oh god, another set of super abstract regulations. But whatever, I'll put in place a few simple procedures that ensure we're in compliance. Hmm, probe horizons should do the trick."

Conclusion

- Movement recently analyzed as local dependency over tiers (Graf 2018; Graf and Kostyszyn 2021)
- In fact, tiers provide a unified mechanism for
  1. multiple wh-movement (preliminary),
  2. grafts/long-distance selection (preliminary)
  3. islands (adjuncts, complex NPs, relative clauses, . . .)
  4. *that*-trace effect and its exceptions
  5. anti-*that*-trace effect
  6. extraction morphology (some X-patterns are tricky)
  7. complementizer alternations in Lio (preliminary)
  8. German wh-copying (preliminary)

Take-Home Message

Tiers aren't just for phonologists anymore!

Acknowledgments

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References I

Bondevik, Ingrid, Dave Kush, and Terje Lohndal. 2021. Variation in adjunct islands: The case of Norwegian. *Nordic Journal of Linguistics* 44:223–254.

Chaves, Rui P., and Jeruen E. Dery. 2019. Frequency effects in subject islands. *Journal of Linguistics* 55:475–521.

Georgi, Doreen. 2017. Patterns of movement reflexes as the result of the order of merge and agree. *Linguistic Inquiry* 48:585–626.

Graf, Thomas. 2018. Why movement comes for free once you have adjunction. In *Proceedings of CLS 53*, ed. Daniel Edmiston, Marina Ermolaeva, Emre Hakgüder, Jackie Lai, Kathryn Montemurro, Brandon Rhodes, Amara Sankhagowit, and Miachel Tabatowski, 117–136.

Graf, Thomas, and Kalina Kostyszyn. 2021. Multiple wh-movement is not special: The subregular complexity of persistent features in Minimalist grammars. In *Proceedings of the Society for Computation in Linguistics (SCiL) 2021*, 275–285.

Keine, Stefan. 2016. *Probes and their horizons*. Doctoral Dissertation, University of Massachusetts, Amherst.

Mayer, Connor. 2021. Capturing gradience in long-distance phonology using probabilistic tier-based strictly local grammars. In *Proceedings of the Society for Computation in Linguistics (SCiL) 2021*, 39–50.

Torrence, Harold. 2012. The morpho-syntax of silent *wh*-expressions in wolof. *Natural Language and Linguistic Theory* 30:1147–1184.