[Coronal] is Never Underspecified in English: a Computational View

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MidPhon 29

October 6, 2024

Motivation

"At the heart of debates on underspecification are assumptions about the nature of the representations and the nature of the rule system."

Mohanan (1991, p. 323)

Motivation

"…rules and input underspecification are interdependent in such a way that the function of each at best largely duplicates the function of the other."

Baković (2000, p. 301)

Underspecification

- Given a set of features Φ, a phonological element x is said to be underspecified if there exists a feature $\varphi \in \Phi$ such that x is not valued for φ.

- Typically, features are valued using $\{+, -\}$, indicating the presence vs. absence of some property.

- An element x is typically unvalued for a given feature either because the property it corresponds to is not relevant to a higher-order class of sounds to which x belongs, or because the property is not contrastive within the higher-order class of sounds.

/s/-voicing

- A number of *lexical* processes/constraints in English require direct reference to the feature [Coronal].
- E.g. - /s/-voicing requires [Coronal] specification in the structural description.
  - *preci*[s]*e* ∼ *preci*[z]*ion*
  - *moti*[f] ∼ *moti*[f]*ic*

Rubach (1984); Halle and Mohanan (1985); Mohanan (1991)

Nasal-place assimilation

- In English, coronal nasals assimilate in place to a following obstruent *post-lexically*.
- The status of non-coronal nasal assimilation is contested, but it has been argued to be absent in certain dialects.
- One way to account for this behavior is [Coronal] underspecification

- *i*[m] [p]*ort Jefferson*
- *i*[ŋ] [k]*anada*
- *i*[n] [t]*acoma*

- *fro*[m] [p]*ort Jefferson*
- *fro*[m] [k]*anada*
- *fro*[m] [t]*acoma*

Borowsky (1986); Avery and Rice (1989); Coleman et al. (2016)

Focus of Today's Talk

The puzzle and how to solve it

- Late (*postlexical*) nasal place assimilation requires [Coronal] underspecification, but early (*lexical*) /s/-voicing requires [Coronal] specification.
- **How do we reconcile this contradiction?**
- Today I will argue that underspecification can be thought of as an emergent property of certain computational structures. The corollary of this is that [Coronal] can be viewed as always being fully specified, thus eliminating the contradiction.

Underspecification as Computation

How should we think about Underspecification?

- **What**: Underspecification is the idea that a linguistic representation can have missing information: some elements of the representation that could be specified, but aren't.

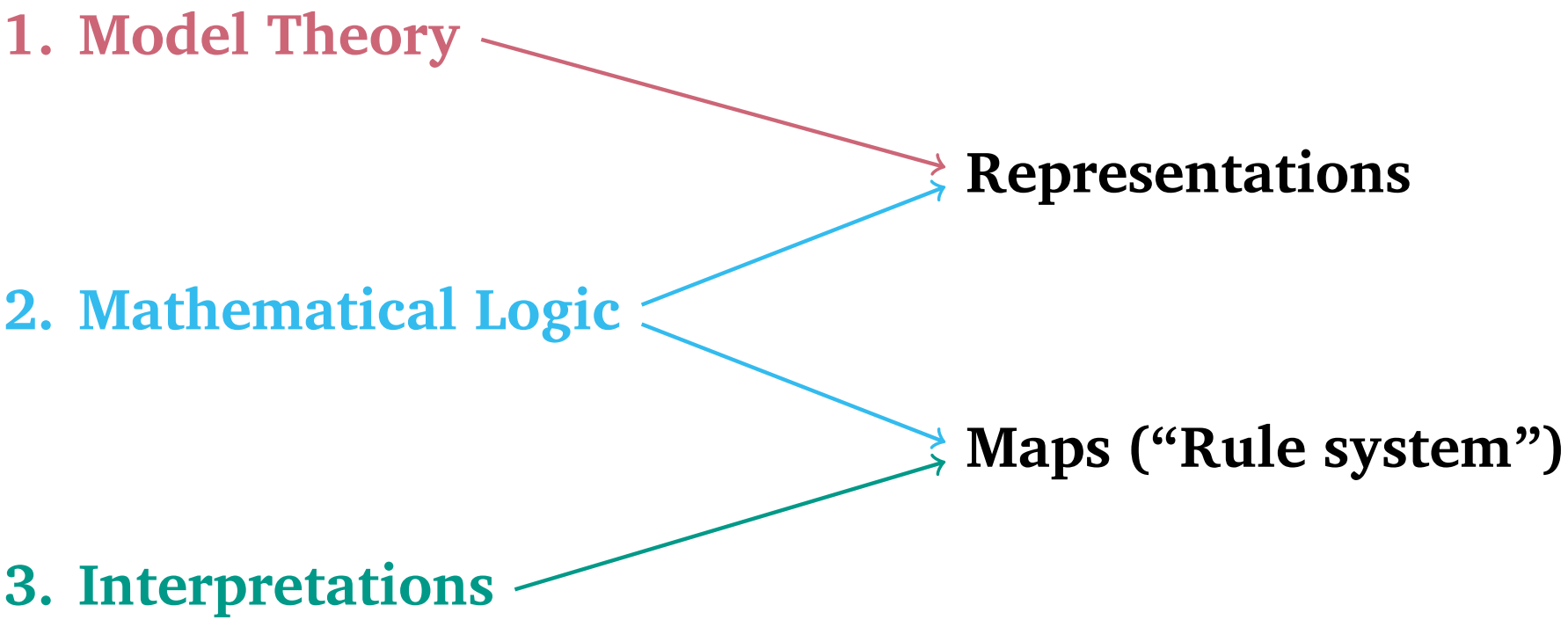
How should we think about Underspecification?

- **Why**: Underspecification is used to explain why certain phonological elements are not a target or trigger for a phonological process.

How should we think about Underspecification?

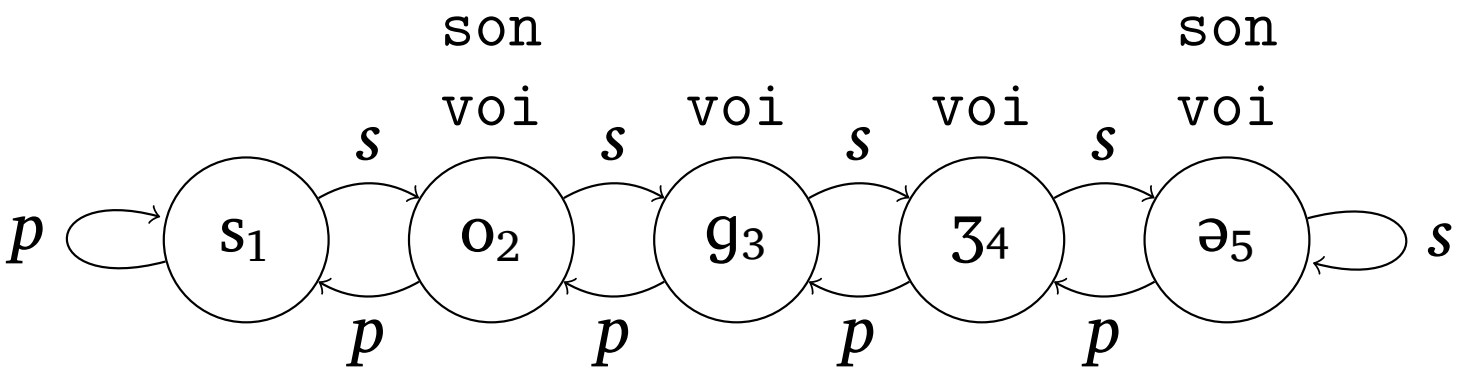
- In the former case, underspecification is clearly a representational property.
- In the latter case, representation is used as an *intensional* explanation for certain phonological maps.
- But these maps exist *extensionally* and therefore can be described without underspecified representations.

Computation and Phonological Theory



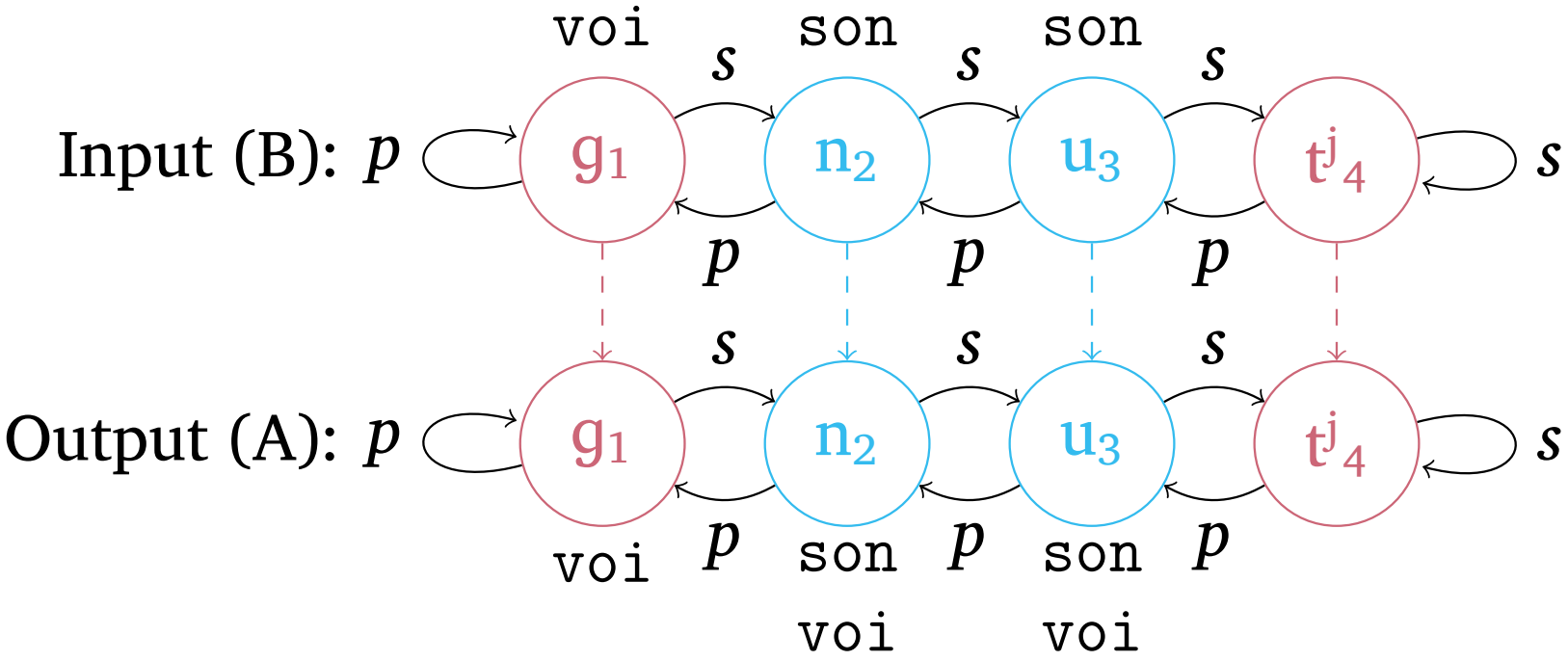
- The model-theoretic approach to phonological theory allows us to study the computational properties of both the representations and the rules in the same description language: mathematical logic.

Model-Theoretic Phonological Structure



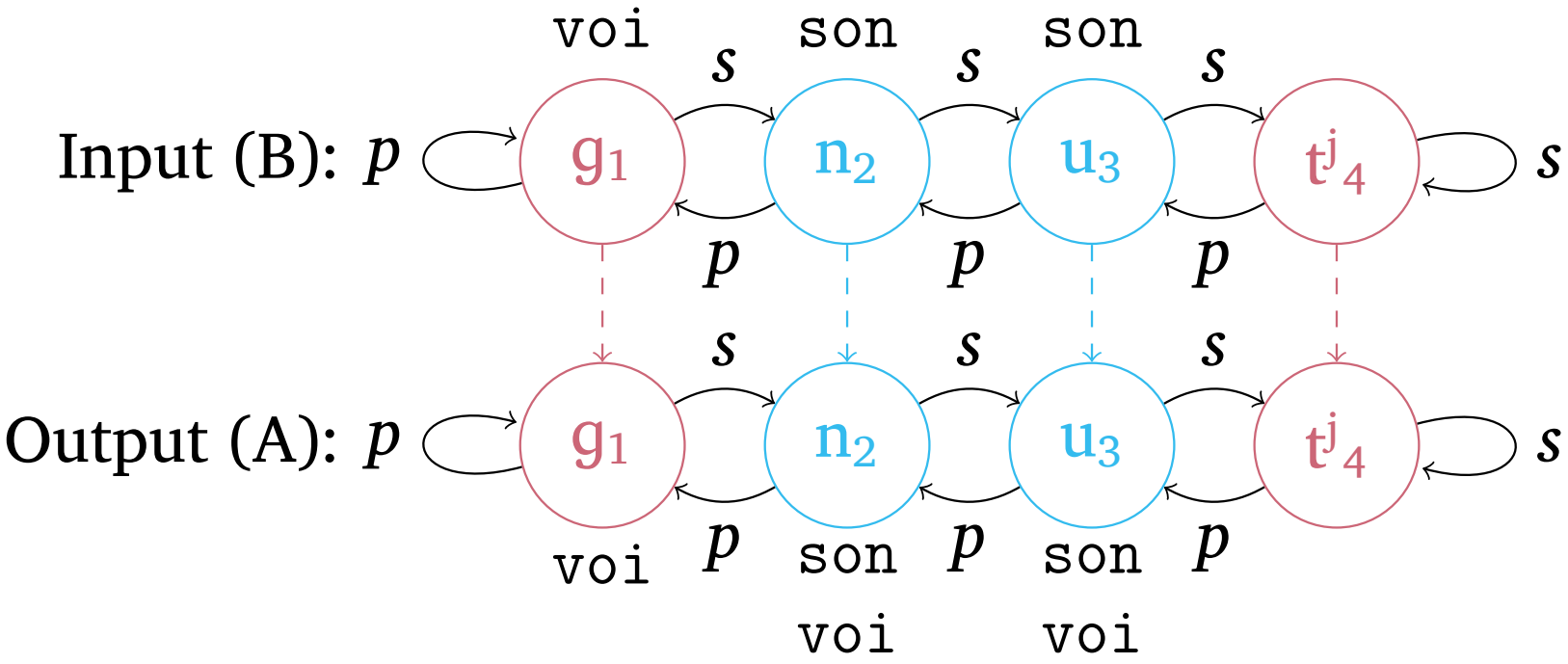
- A structure/model for a string $\mathbf{S} = \langle D, \sigma_i \mid \sigma \in \Sigma, \mathtt{p}(), \mathtt{s}() \rangle$ contains:
  - a set of indices D.
  - unary labeling relations $\sigma_i \subseteq D$.
  - predecessor $\mathtt{p}()$ and successor $\mathtt{s}()$ ordering functions.

Transforming Phonological Structure



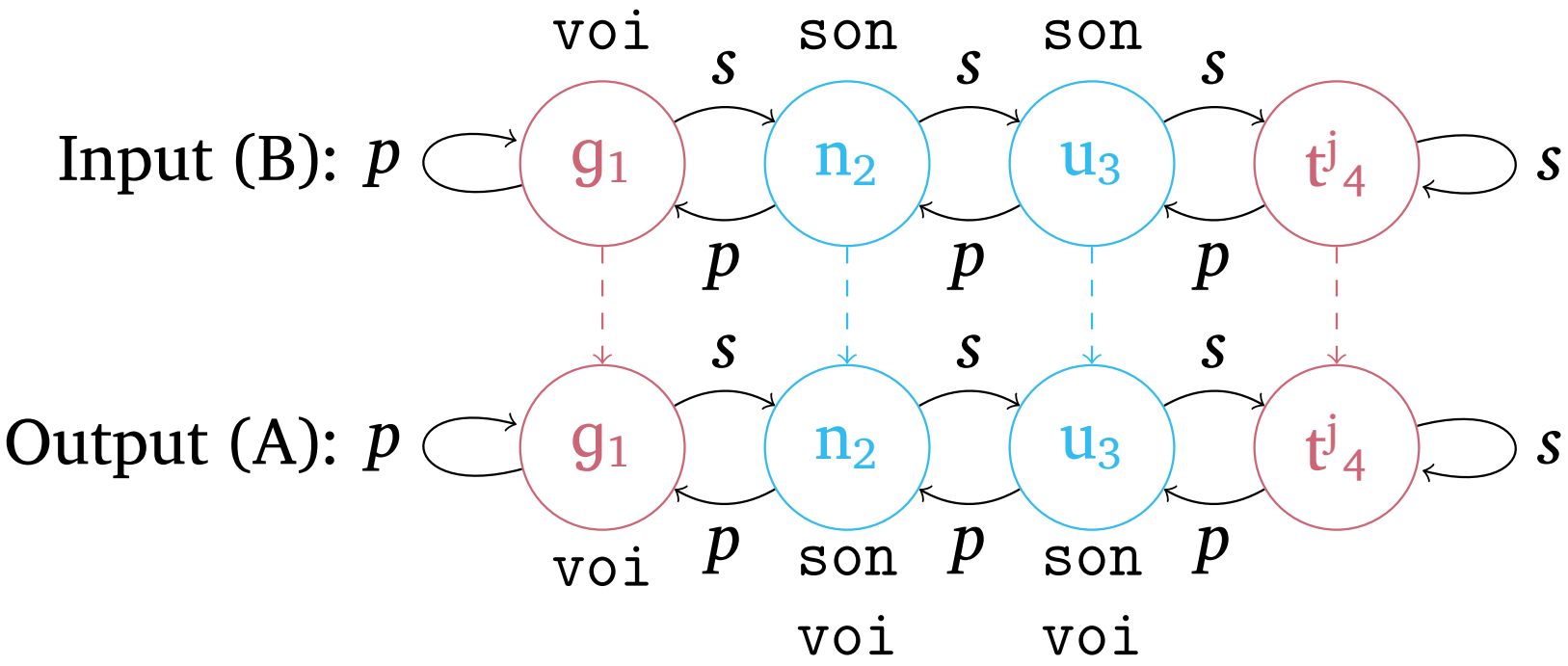
- An interpretation of structure A in terms of structure B is a function denoted by a a set of n formulas $\{\phi_i, \ldots, \phi_n\}$.

Transforming Phonological Structure



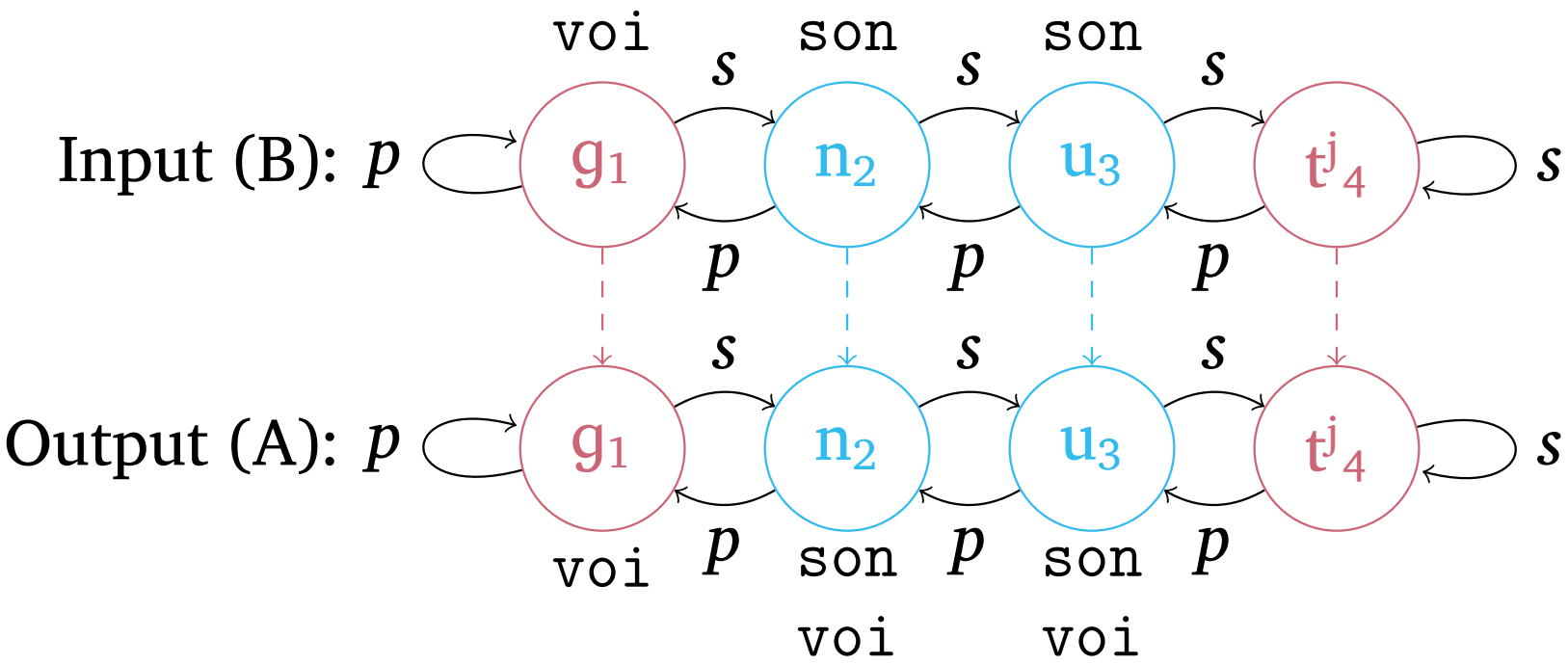
- A formula $\phi_P(x) \stackrel{\text{def}}{=} Q(x)$ denotes that domain element x has property P in the output structure (A) only if it has property Q in the input structure (B).

Transforming Phonological Structure



- $\phi_{\texttt{voi}}(x) \stackrel{\text{def}}{=} \texttt{son}(x) \vee \texttt{voi}(x)$

Boolean Monadic Recursive Schemes



- A BMRS term T is given by the grammar
  $T \to x \mid T_1 = T_2 \mid \top \mid \bot \mid \mathbf{f}(T_1, \ldots, T_k) \mid \mathtt{s}(T_1) \mid \mathtt{p}(T_1) \mid \sigma(T_1) \mid$
  $\mathtt{IF}\ T_1\ \mathtt{THEN}\ T_2\ \mathtt{ELSE}\ T_3.$

Bhaskar et al. (2020); Chandlee and Jardine (2021); Bhaskar et al. (2023)

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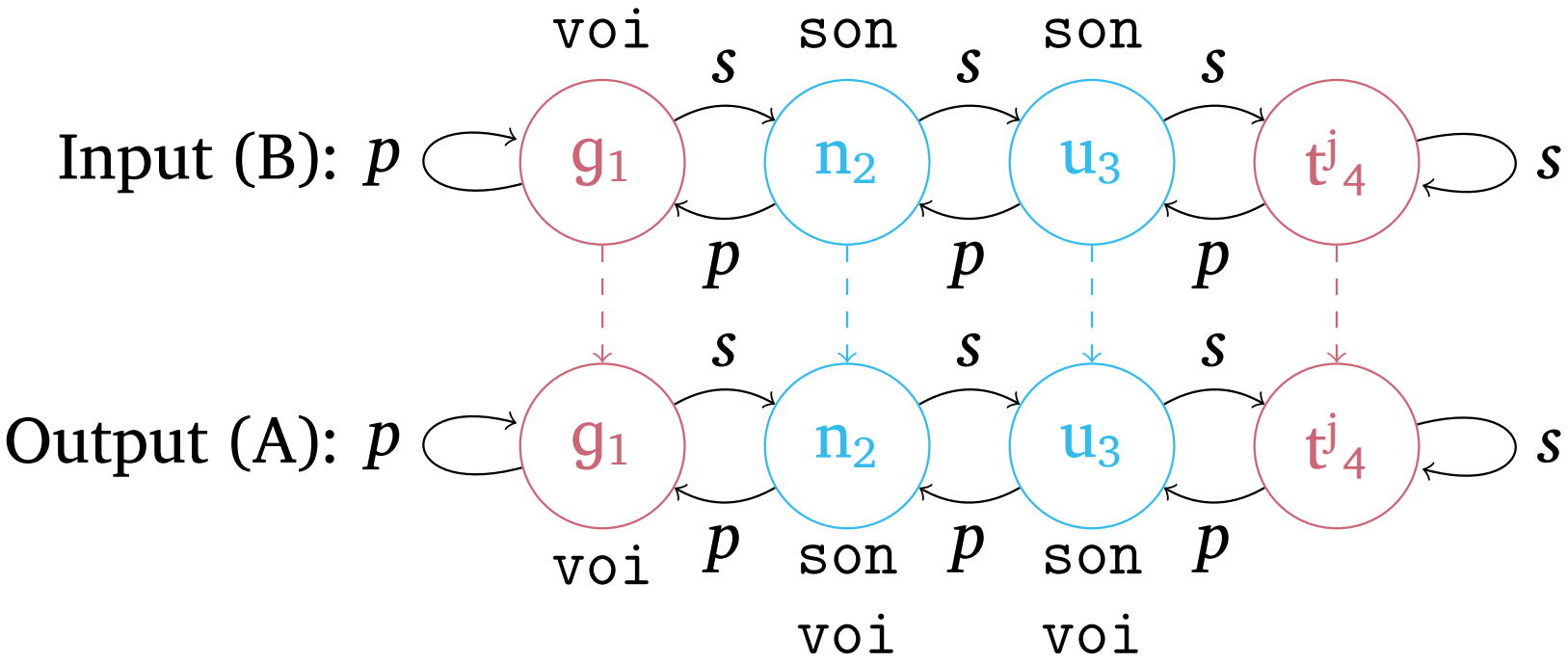

- $\phi_{\texttt{voi}}(x) \stackrel{\text{def}}{=} \texttt{IF son}(x) \texttt{ THEN } \top \texttt{ ELSE voi}(x)$

Bhaskar et al. (2020); Chandlee and Jardine (2021); Bhaskar et al. (2023)

Problems Formalizing Underspecification

- Logical approaches to phonological feature systems result in three problems for natural class formation:

Nelson (2022)

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  2. A logical language with conjunction, atomic negation and privative feature relations overgenerates classes in feature systems that mix $\{+, -, 0\}$.

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2. A logical language with conjunction, atomic negation and privative feature relations overgenerates classes in feature systems that mix $\{+, -, 0\}$.

3. A logical language with only conjunction and valued feature relations allows for 0 to be used as a third value in feature systems that mix $\{+, -, 0\}$.

Nelson (2022)

Against 0 as a Third Value

The correctness of any empirical claim that distinctive features are binary is, of course, not at issue here. The point is simply that, once we decide to use a binary system, we must be formally consistent. Unfortunately, it is all too easy to be formally inconsistent by letting '0' function as a third feature value, and this has often been done unknowingly in the writing of generative grammars. What is important is that we keep the meaning of '0' clearly in mind. It is not a feature value, but merely a mark which indicates that the feature value of the entry in which it appears has not yet been filled in.

Stanley (1967, p. 410)

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Russian Voicing Assimilation

Descriptive Generalization

- In Russian, obstruents contrast in voicing and also participate as both triggers and targets for a voicing assimilation process.
- Sonorants, on the other hand, neither contrast nor participate as either a trigger or target in the process.

One way to write the rule is:

$$[-\texttt{son}] \rightarrow [\alpha\texttt{voi}] \; / \; \_ \; \begin{bmatrix} \alpha\texttt{voi} \\ -\texttt{son} \end{bmatrix}$$

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Capitalizing on sonorants not being contrastive for voicing in the language, a simpler analysis can be head if we say that sonorants are not specified for the [voice] feature and have the following rule:

$$[-\texttt{son}] \rightarrow [\alpha\texttt{voi}] \;/\; \_\; [\alpha\texttt{voi}]$$

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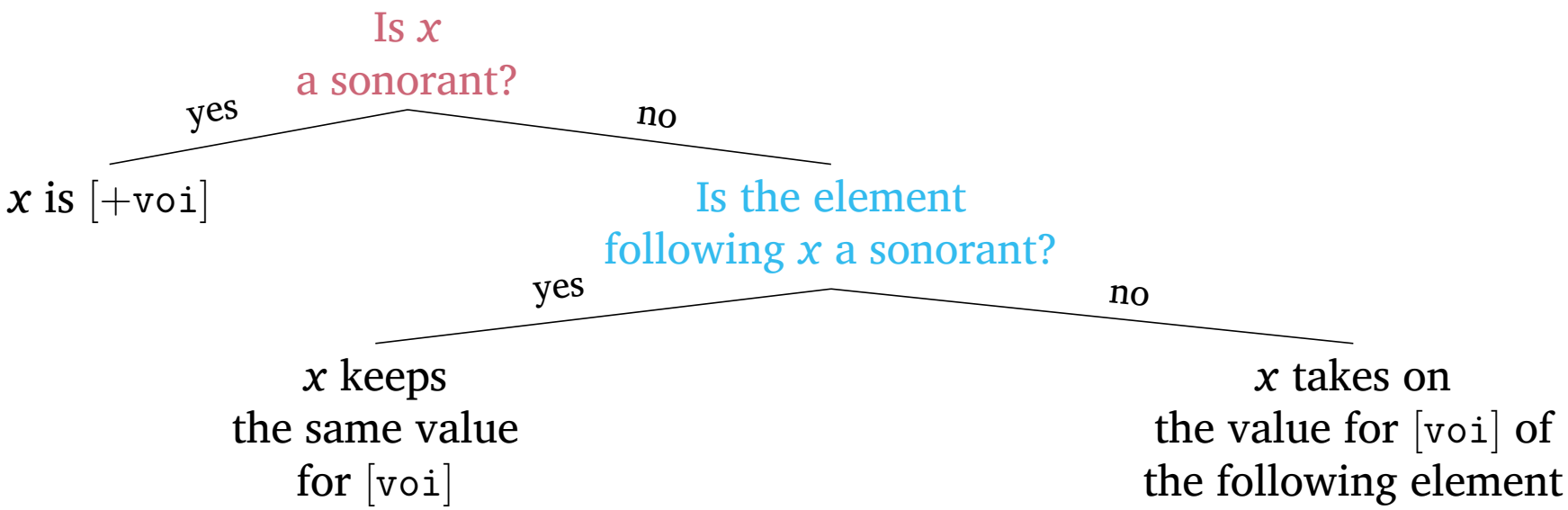
This of course would also then require the redundancy rule:

$$[+\texttt{son}] \rightarrow [+\texttt{voi}]$$

Russian Voicing as a Decision Tree



- The first query removes sonorants from the set of targets and the second query removes them from the set of triggers.
- At no point is the [voi] value for sonorants queried!

Nelson and Baković (2024)

Russian Voicing as a BMRS Program

(1) $\phi_{\texttt{voi}}(x) :=$

$\texttt{IF son}(x)\ \texttt{THEN}\ \top$

$\texttt{ELSE IF son}(\texttt{s}(x))\ \texttt{THEN voi}(x)$

$\texttt{ELSE voi}(\texttt{s}(x))$

- The first conditional removes sonorants from the set of targets and the second conditional removes them from the set of triggers.
- At no point is the [voi] designation for a sonorant called!

Nelson and Baković (2024)

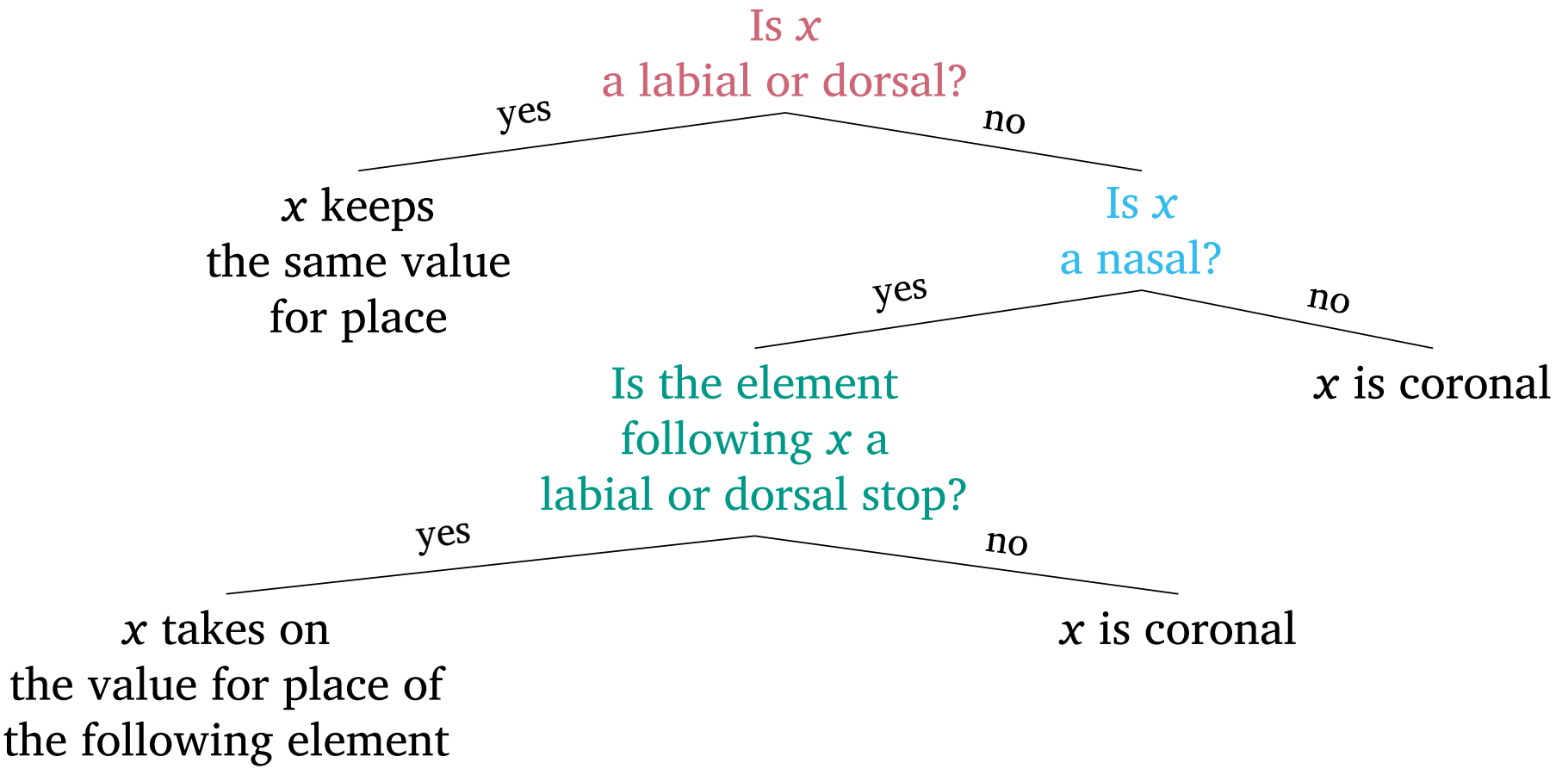
Underspecification Maps

1. The map will define input-output conditions for the "underspecified feature".
2. Any underspecification map will include a nested conditional BMRS term.
3. Both the upper conditional P and lower conditional Q will determine a truth value based on the antecedent of the redundancy rule that fills in the "underspecified feature".
4. P partitions the set of targets while Q partitions the set of triggers.

Nelson and Baković (2024)

English [Coronal] and Underspecification Maps

Nasal Place Assimilation as a Decision Tree



- At no point does input [Coronal] play a role in determining the output place property!

Nasal Place Assimilation as a BMRS Program

(2) $\phi_{\texttt{place}}(x) :=$

$\texttt{IF place}(x) \in \{\texttt{lab}, \texttt{dor}\}$
$\texttt{THEN place}(x)$
$\texttt{ELSE}$
$\texttt{IF nas}(x)$
$\texttt{THEN}$
$\texttt{IF stop}(\texttt{s}(x)) \wedge \texttt{place}(\texttt{s}(x)) \in \{\texttt{lab}, \texttt{dor}\}$
$\texttt{THEN place}(\texttt{s}(x))$
$\texttt{ELSE cor}$
$\texttt{ELSE cor}$

- At no point does input [Coronal] play a role in determining the output place property!

Is Nasal Place Assimilation an Underspecification Map?

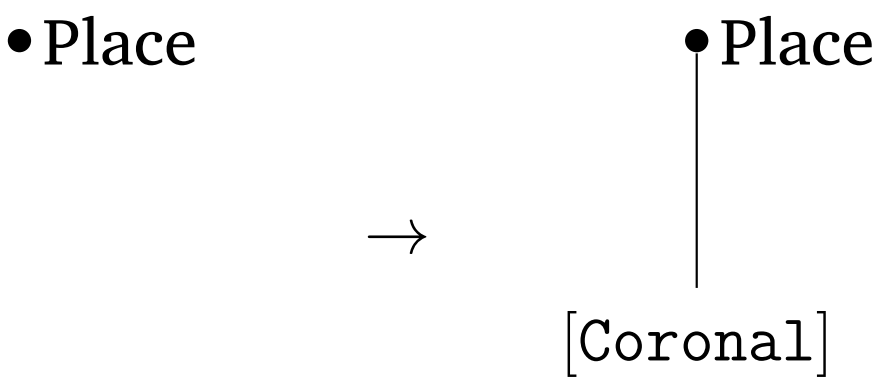
(1)	underspecified feature?	✓
(2)	nested conditional?	✓
(3)	antecedent of redundancy rule?	✓
(4a)	P partitions targets	✓
(4b)	Q partitions triggers	✓

- If [cor] is underspecified the redundancy rule is something like $[-\,\texttt{lab}, -\,\texttt{dor}] \rightarrow [+\texttt{cor}]$.

Is Nasal Place Assimilation an Underspecification Map?

(1)	underspecified feature?	✓
(2)	nested conditional?	✓
(3)	antecedent of redundancy rule?	✓
(4a)	P partitions targets	✓
(4b)	Q partitions triggers	✓

- Or, autosegmentally:



Reconciliation

- The view sketched so far suggests that the actual underlying feature encoding for an "underspecified" feature is arbitrary. The declarative computation itself is based off of redundant dependencies.

- While the computational structure of the nasal assimilation BMRS program makes the input specification of [Coronal] arbitrary, recall that the contradictory case of /s/-voicing requires full specification early in the derivation.

- So, as it turns out, there is no contradiction at all: the arbitrariness of [Coronal] specification equally supports full specification on the input.

Summary

- Examining the computational properties of phonological generalizations provides unified insights into the core questions of phonological theory:

  1. *What is the data structure for phonological elements?* (Representational Knowledge)
  2. *What types of operations are computed over phonological elements?* (Computational Knowledge)

Summary

- In the approach presented here, underspecification emerges as a specific type of computational knowledge contra standard views of it being a type of representational knowledge.

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Summary

- In the approach presented here, underspecification emerges as a specific type of computational knowledge contra standard views of it being a type of representational knowledge.

- The computational structure implicit in UNDERSPECIFICATION MAPS suggests the representational encoding of "underspecified" features is arbitrary.

- BUT the data from English segmental phonology suggest that "underspecified" features like [Coronal] in English are in fact always fully specified.

THANK YOU!

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Appendix

Catalan Assimilation is not an Underspecification Map

(3) $\phi_{\texttt{voi}}(x) :=$

$\texttt{IF son}(x)\ \texttt{THEN}\ \top$

$\texttt{ELSE IF syll}(\texttt{s}(x))\ \texttt{THEN voi}(x)$

$\texttt{ELSE voi}(\texttt{s}(x))$

- Sonorants trigger assimilation but are not targets.

Turkish 3-way Behavior Voicing Alternations

(4) a. [−voice]: [devlet] ~ [devleti] ‘state ~ ACC’
b. [+voice]: [etyd] ~ [etydy] ‘study ~ ACC’
c. [0 voice]: [kanat] ~ [kanadɯ] ‘wing ~ ACC’

- The clearly exceptional [+voice] class (b) consists mostly of loans like [etyd] ‘study’ and [katalog] ‘catalog’.

- Alternate represenations:
  a. [−voice]
  b. [+voice ∧ +*f*]
  c. [+voice]

Turkish 3-Way Behavior Voicing Alternations

(5) $\phi_{\texttt{voi}}(x) :=$

$\texttt{IF } f(x) \vee \texttt{son}(x) \texttt{ THEN } \top$

$\texttt{ELSE IF coda}(x) \wedge \texttt{stop}(x) \texttt{ THEN } \bot$

$\texttt{ELSE voi}(x)$

- $+f$ removes the non-alternating class of voiced stops via the high "redundancy rule" condition.
- The rest is just a standard devoicing grammar.

Structuring Target & Trigger Removal

target & trigger /tn/ ↦ [dn] /nt/ ↦ [n̥t]	*target only* /tn/ ↦ [tn] /nt/ ↦ [n̥t]	*trigger only* /tn/ ↦ [dn] /nt/ ↦ [nt]	*neither* /tn/ ↦ [tn] /nt/ ↦ [nt]	
$\varphi_{\texttt{voi}}(x) :=$	$\varphi_{\texttt{voi}}(x) :=$	$\varphi_{\texttt{voi}}(x) :=$	$\varphi_{\texttt{voi}}(x) :=$	
IF final(x)	IF final(x)	IF final(x)	IF final(x)	specify potential trigger
THEN	THEN	THEN	THEN	
IF son(x)	IF son(x)	IF son(x)	IF son(x)	redundancy rule
THEN ⊤	THEN ⊤	THEN ⊤	THEN ⊤	
ELSE voi(x)	ELSE voi(x)	ELSE voi(x)	ELSE voi(x)	faithful
	ELSE	ELSE	ELSE	
		IF son(x)	IF son(x)	
		THEN ⊤	THEN ⊤	redundancy rule
			ELSE	
	IF son(s(x))		IF son(s(x))	faithful
	THEN voi(x)		THEN voi(x)	
ELSE $\varphi_{\texttt{voi}}$(s(x))	ELSE $\varphi_{\texttt{voi}}$(s(x))	ELSE $\varphi_{\texttt{voi}}$(s(x))	ELSE $\varphi_{\texttt{voi}}$(s(x))	spreading