# Modeling morphological epenthesis

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# Classical epenthesis

- Spanish

/stop/ > [estop]

# Classical vs. morphological epenthesis

- Northwestern Catalan (Artés 2013)

/l#ma$_{r}$/ > [əlmár] ‘the sea’ (f.)

# Classical vs. morphological epenthesis

- Northwestern Catalan (Artés 2013)

| | | | |
|---|---|---|---|
| /l#ma$_{ɾ}$/ | > | [əlmár] | ‘the sea’ (f.) |
| /l#a$_{ɾ}$b$_{ɾ}$e/ | > | [larβ$_{ɾ}$e] | ‘the tree’ (m.) |

# Classical vs. morphological epenthesis

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| /l#ma$_{ɾ}$/ | > | [əlmár] | ‘the sea’ (f.) |
| /l#a$_{ɾ}$b$_{ɾ}$e/ | > | [larβ$_{ɾ}$e] | ‘the tree’ (m.) |
| /l#pa$_{ɾ}$e/ | > | [lopá$_{ɾ}$e] | ‘the father’ (m.) |

# Classical vs. morphological epenthesis

- Valencian hypocoristics (Artés 2014)

| **Name** | **Central Catalan** | **Valencian** |
|---|---|---|
| Agustina | Tina | Tina |
| Francisco | Cisco | Cisco |
| Isabel | Bel | Bela |
| Miquel | Quel | Quelo |
| Manel | Nel | Nelo |
| Rosario | Sari | Sari |

# Classical vs. morphological epenthesis

- Brazilian Portuguese (Bachrach & Wagner 2007)

/korea/ > [koreja] ‘Korea’

# Classical vs. morphological epenthesis

- Brazilian Portuguese (Bachrach & Wagner 2007)

| | | | |
|---|---|---|---|
| /korea/ | > | [koreja] | ‘Korea’ |
| sofá + inho | > | sofazinho | ‘little sofa’ |
| café + al | > | cafezal | ‘coffee grove’ |

# Classical vs. morphological epenthesis

- Spanish diminutives (Crowhurst 1992, Norrmann-Vigil 2012)

| | | | | | |
|---|---|---|---|---|---|
| gato | > | gatito | | | |
| bacalao | > | bacalaíto | | | |
| cable | > | cablecito | madre | > | madrecita |
| sofá | > | sofacito | comadre | > | comadrita |
| camión | > | camioncito | | | |
| lápiz | > | lapicito | | | |
| pez | > | pececito | | | |

# Classical vs. morphological epenthesis

- Classical epenthesis: motivated by phonology
- Non-canonical epenthesis: morphologically influenced

| Inserted Elements | classical epenthesis | non-canonical epenthesis |
|---|---|---|
| semantic function | - | - |
| presence is phonologically motivated | + | + |
| distribution is influenced by morphology | - | + |
| quality is influenced by morphology | - | + |

(Repetti, Moradi & Aronoff 2018)

# The nature of morphological processes

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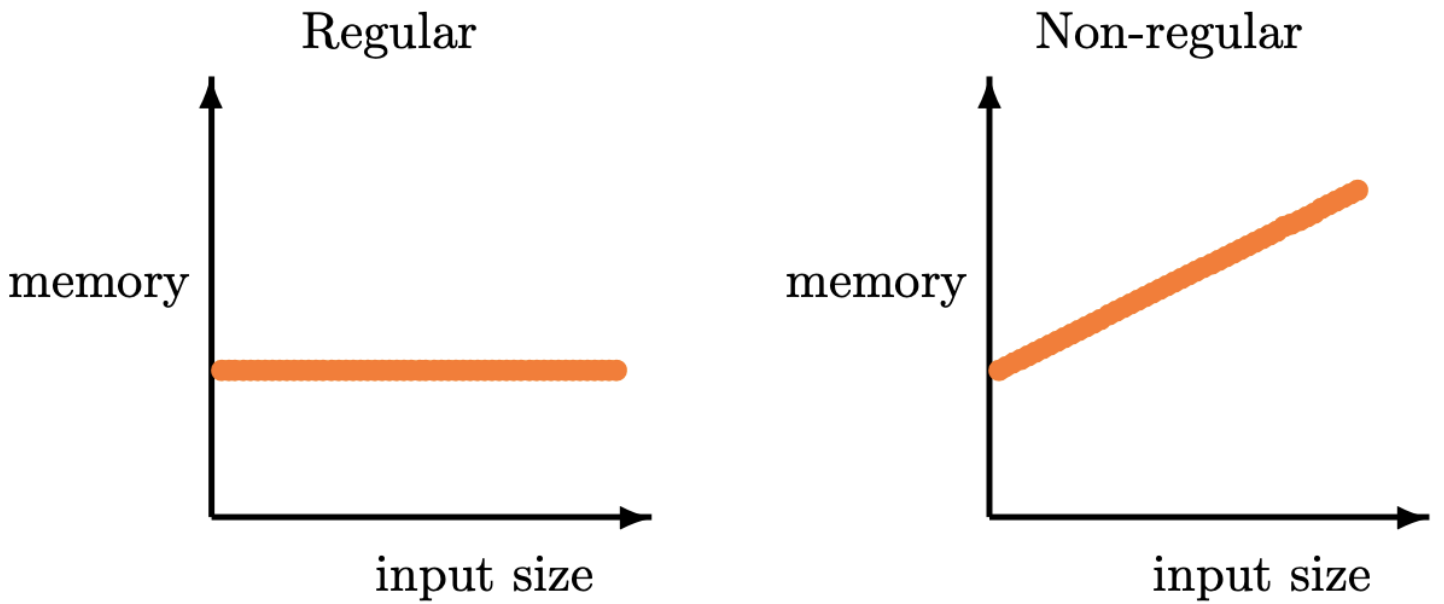
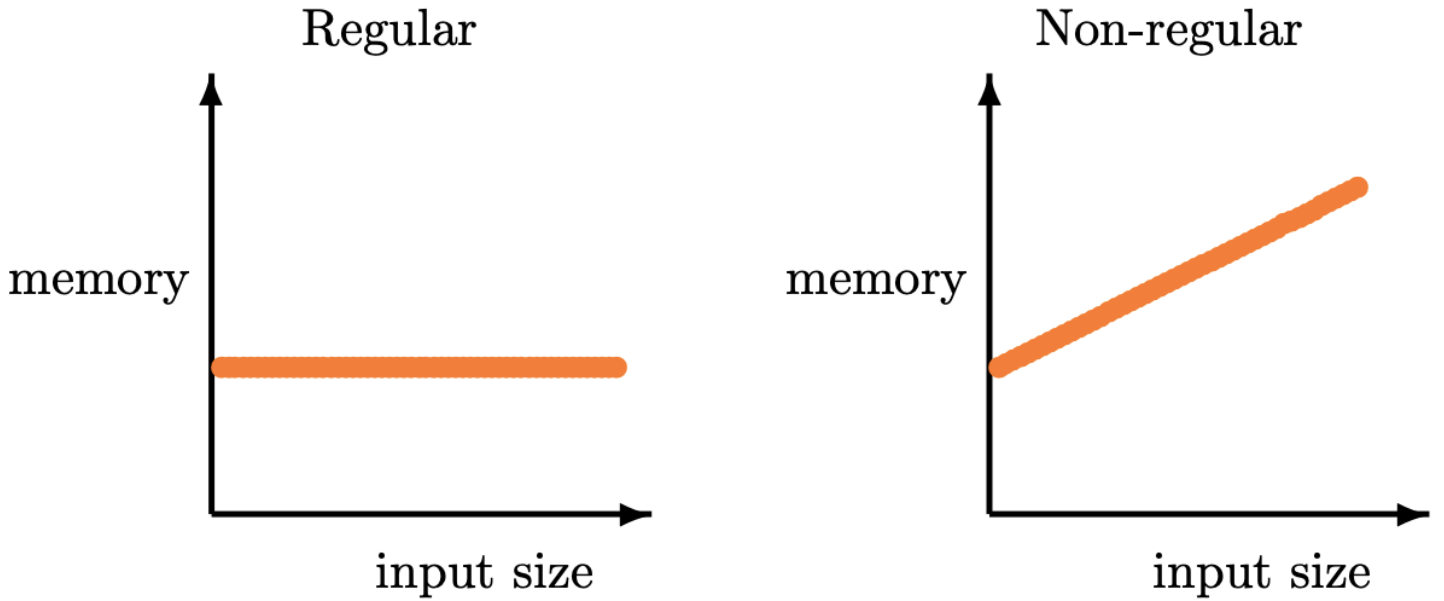



(Heinz 2018)

# The nature of morphological processes

- A function is regular provided the memory required for the computation is bounded by a constant, regardless of the size of the input.




(Heinz 2018)

# The nature of morphological processes

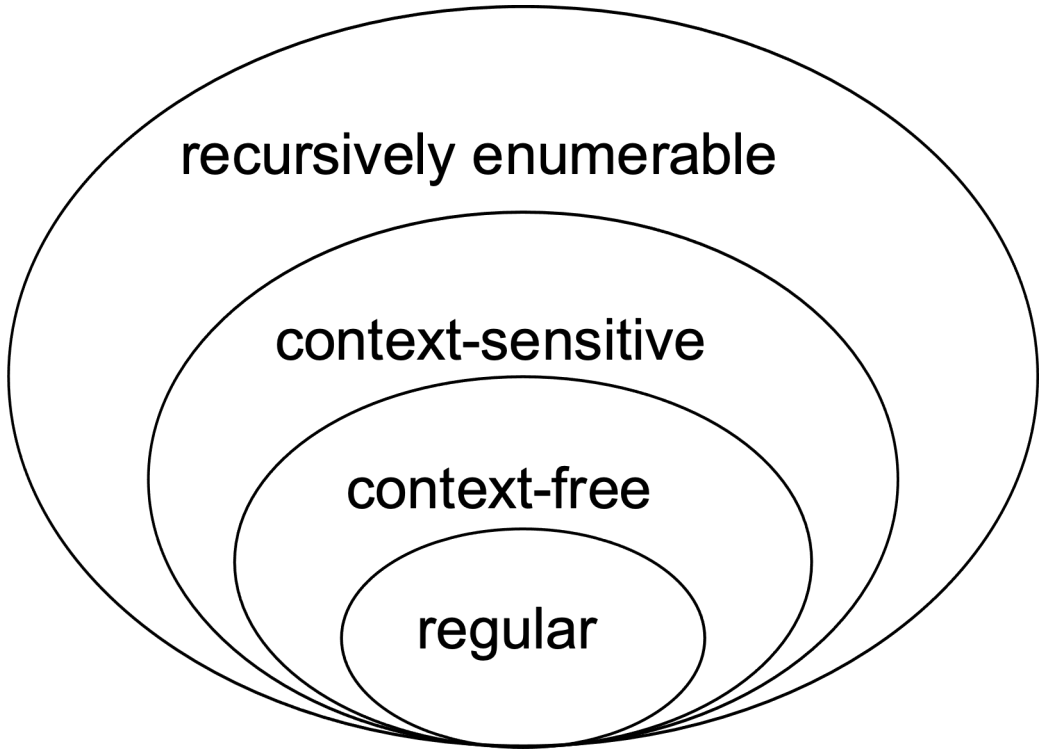
- Regular relations can be specified using (ordered sets of) *rewrite rules* (SPE-style)

In phonology and morphology:

- non-regular patterns are unattested (e.g. ‘majority rule’ in Bakovic 2000)
- human subjects fail to learn non-regular patterns in artificial grammar learning experiments (e.g. Finley 2008)

# The nature of morphological processes

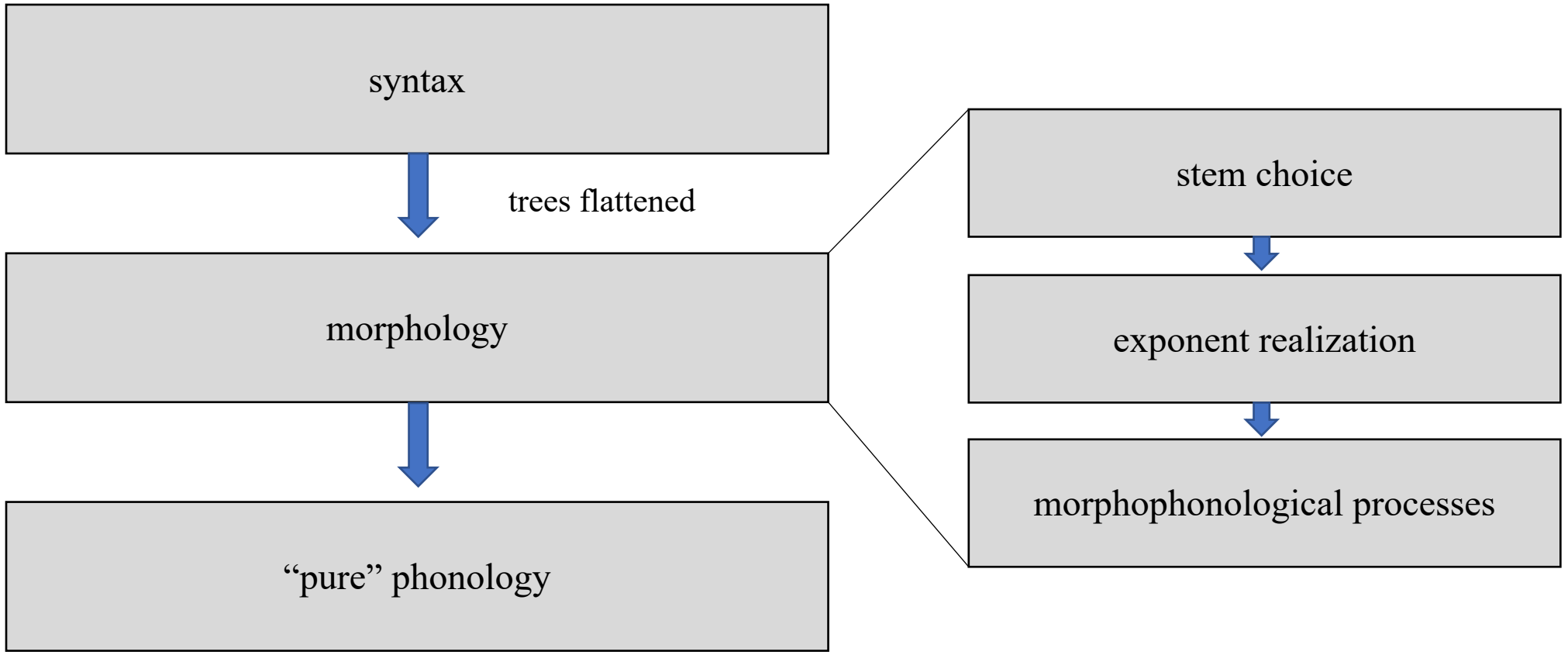
- The Chomsky hierarchy



# The nature of morphological processes

- Syntax is context-free ☹
- DM is a tree-based theory, but can be formalized over strings (Ermolaeva & Edmiston 2018)
  - yield function flattens trees, retaining necessary boundary symbols
- In terms of computational power, W&P morphology is equivalent to a collection of regular relations (Karttunen 2003)

# Proposed model



# Analysis

- *Boolean Monadic Recursive Schemes* (BMRS)
  - incorporates the observation that morphology is regular (Karttunen et al. 1992, Chandlee 2017)
  - unlike FSTs, captures linguistically significant generalizations – we can use representations that are common in linguistics (Chandlee & Jardine 2020)
    - phonological, morphosyntactic features
    - Pāṇini's Principle (= Elsewhere condition) has no obvious finite-state implementation (Karttunen 2003), whereas it is directly captured with BMRS's 'if...then...else' syntax

# Analysis

- primitives:
  - *boolean values* ⊤ and ⊥
  - *monadic predicates* $P(t)$ – take a *single* argument *t,* and return ⊤ or ⊥

$\mathbb{V}$ = {a, e, i, o, u, …}
$\mathbb{C}$ = {b, c, d, …}
$\mathbb{M}$ = {[hyp]…}

$\Sigma = \mathbb{V} \cup \mathbb{C} \cup \mathbb{M}$ $\quad\quad$ $\Sigma_{\bowtie} = \Sigma \cup \{\rtimes, \ltimes, +, \#\ldots\}$

# Analysis

- primitives:
  - *boolean values* $\top$ and $\bot$
  - *monadic predicates* $P(t)$ – take a *single* argument $t$, and return $\top$ or $\bot$

$\mathbb{V} = \{\texttt{a}, \texttt{e}, \texttt{i}, \texttt{o}, \texttt{u}, \ldots\}$
$\mathbb{C} = \{\texttt{b}, \texttt{c}, \texttt{d}, \ldots\}$
$\mathbb{M} = \{\texttt{[hyp]}\ldots\}$

$\Sigma = \mathbb{V} \cup \mathbb{C} \cup \mathbb{M} \qquad \Sigma_{\bowtie} = \Sigma \cup \{\rtimes, \ltimes, \texttt{+}, \texttt{\#}\ldots\}$

$\mathcal{I} = \{\texttt{a}(t), \ldots, \texttt{z}(t), \texttt{[hyp]}(t), \ldots, \rtimes(t), \ltimes(t), \texttt{+}(t)\ldots\}$
$O = \{\texttt{a}_o(t), \ldots, \texttt{z}_o(t), \texttt{[hyp]}_o(t), \ldots, \rtimes_o(t), \ltimes_o(t), \texttt{+}_o(t)\ldots\}$

# Analysis

$\mathcal{I}$ = {a(*t*), …, z(*t*), [hyp](*t*), ⋊(*t*), ⋉(*t*), +(*t*)…}

| | 1 | 2 | 3 | 4 | 5 | 6 | … |
|---|---|---|---|---|---|---|---|
| | ⋊ | t | e | l | e | + | … |
| e(*x*) | ⊥ | ⊥ | ⊤ | ⊥ | ⊤ | ⊥ | |
| ⋊(*x*) | ⊤ | ⊥ | ⊥ | ⊥ | ⊥ | ⊥ | |
| l(*p*(*x*)) | ⊥ | ⊥ | ⊥ | ⊥ | ⊤ | ⊥ | |
| l(*s*(*s*(*x*))) | ⊥ | ⊤ | ⊥ | ⊥ | ⊥ | ⊥ | |

# Analysis

- Northwestern Catalan:

`l#pare[m]` → `lopare`

$\circ_{\circ}(x)$ = if `#`($x$) then
if `C`(p($x$)) then `C`(s($x$)) else ⊥
else $\circ(x)$

`out`($x$) = if `#`($x$) then ⊥ else
if `feat`($x$) then ⊥ else ⊤

# Analysis

- Valencian:

`(agus)tina[f]+[hyp]` → `tina`  `(isa)bel[f]+[hyp]` → `bela`

$a_{\circ}(x)$ = if +($x$) then
if `[hyp]`(s($x$)) then
if `[f]`(p($x$)) then `NOTa`(p(p($x$))) else ⊥
else ⊥
else `a`($x$)

`out`($x$) = if #($x$) then ⊥ else
if `feat`($x$) then ⊥ else ⊤

# Analysis

- Valencian:

`(ma)nel[m]+[hyp]` → `nelo`

$\circ_{\circ}(x)$ = if $+(x)$ then
if `[hyp]`(s($x$)) then
if `[m]`(p($x$)) then `NOT`$\circ$(p(p($x$))) else $\bot$
else $\bot$
else $\circ(x)$

`out`($x$) = if `#`($x$) then $\bot$ else
if `feat`($x$) then $\bot$ else $\top$

# Analysis

- Brazilian Portuguese:

`sofa+inho[dim]` → `sofazinho`

`[dim]`(*x*) = if `seg`(*x*) then `[dim]`(s(*x*)) else ⊥

$z_{\circ}$(*x*) = if +(*x*) then
if `[dim]`(s(*x*)) then
if `V`(s(*x*)) then `V`(p(*x*)) else ⊥
else ⊥
else `z`(*x*)

# Analysis

- Spanish:

`#sofa#+ito[dim]` → `sofasito` `#pes#+ito[dim]` → `pesesito`

$s_{o}(x)$ = if +($x$) then
if o(p(p($x$))) then ⊥ else
if a(p(p($x$))) then ⊥ else
if C-n,r(p(p($x$))) then ⊥ else ⊤
else s($x$)

$e_{o}(x)$ = if #($x$) then MONO(p($x$))

out($x$) = if TERM($x$) then ⊥ else
if feat($x$) then ⊥ else
if symb($x$) then ⊥ else ⊤

# Conclusions

- Assuming morphological epenthesis enables us to express the generalizations explicitly and overtly
- A means to avoid stipulating listed allomorphy

- BMRSs can directly capture morphological and phonological generalizations, retaining the computationally restrictive nature of such processes
- Intuitive (? ☺), easily implementable, extendable to a wider range of phenomena
- We can account for the data in a very direct and parsimonious way

# Team Epenthesis

Lori Repetti

Mark Aronoff

Ji Yea Kim

Veronica Miatto

Sedigheh Moradi

Thank you!

# References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