# Strict Locality in Syntax

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# Introduction (1)

Linguistic patterns belong to very simple classes of formal languages, known as subregular languages (Heinz 2018; Graf 2022a).

The strictly local (SL) languages are used to model finitely bounded dependencies.

- In phonology: local phonotactics
- In syntax: lexical (category) selection

# Introduction (2)

This presentation: syntax contains more SL patterns than is usually thought, covering essentially the full range of what is possible.

I use a formalism based on command strings (c-strings) in order to enable direct comparisons with phonology, and visualizations using finite state automata.

- Lexical selection – branching and looping paths
- Functional hierarchies – linear order, optionality
- Adjunct ordering – linear order, optionality, iteration

Proposal: SL computations are the basis for linguistic structure building across domains.

# Overview

1. Introduction to SL
    - Examples from phonology
2. Generalizing SL to trees using c-strings
    - Dependency trees
    - C-string
3. SL in syntax:
    - Lexical selection
    - Functional hierarchies
    - Adjunct ordering
4. Beyond local dependencies

# Strictly Local Languages (1)

**Defining characteristic:** a string is well-formed if all of its substrings (of some fixed length) are well-formed

**SL-k:** SL for substrings of length *k*

**Example: CV Alternation (SL-2)**

Σ = {C, V}     k = 2     G = {$C, $V, CV, VC, C$, V$}

| | Word | Substrings (k=2) |
|---|---|---|
| ✓ | $CVCVC$ | $C, CV, VC, CV, VC, C$ |
| ✓ | $VCV$ | $V, VC, CV, V$ |
| ✗ | $CVCCV$ | $C, CV, VC, **CC**, CV, V$ |
| ✗ | $VCVV$ | $V, VC, CV, **VV**, V$ |

# Strictly Local Languages (2)

## Example: Japanese phonotactics (SL-2)

Syllable template: (C) (j) V (N)

Example words: aoi, kotowaza, sjunkan

$$\Sigma = \{C, j, V, N\} \qquad k = 2$$

$$G = \left\{ \begin{array}{lllll} \$C & & & VC & NC \\ \$j & Cj & & Vj & Nj \\ \$V & CV & jV & VV & NV \\ & & & VN & \\ & & & V\$ & N\$ \end{array} \right\}$$

Note: geminates are omitted. The grammar with geminates is also SL-2.

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| \$ | $\boxed{\text{s} \quad \text{j}}$ | | u | n | k | a | n | \$ |

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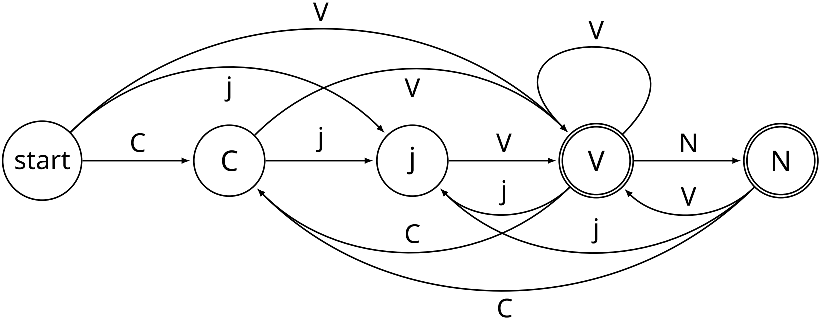
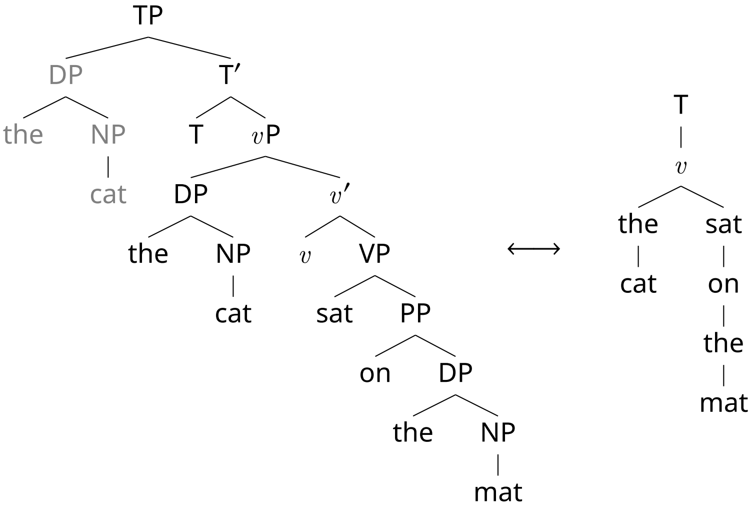
# Strictly Local Languages (3)

We can represent an SL grammar visually using a finite-state automaton (FSA).




SL is a subclass of the languages expressible by FSAs.

# Dependency Trees



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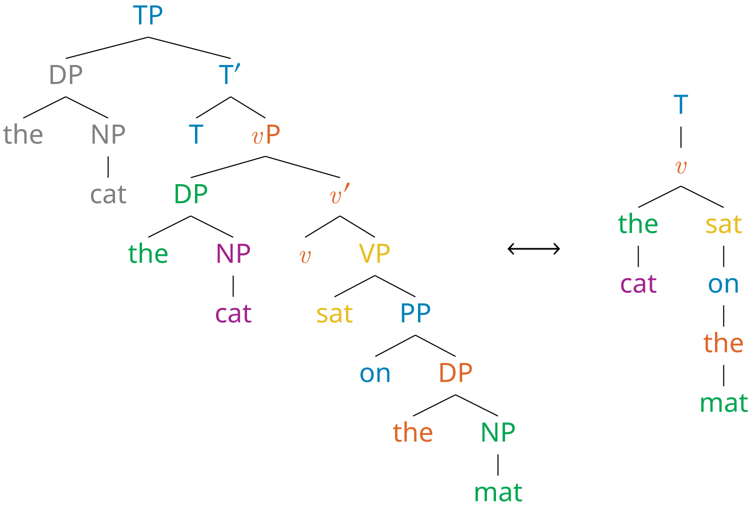

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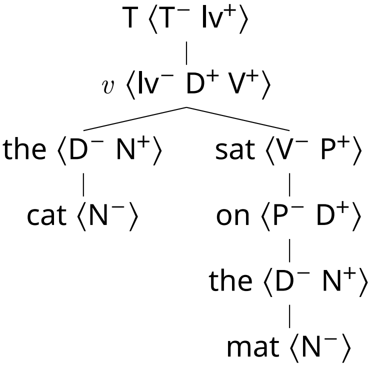
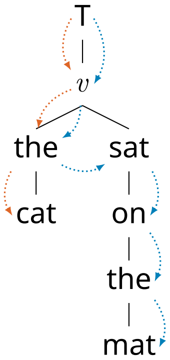



Note: the feature system is based on Minimalist Grammar (Stabler 1997).

# C-Strings



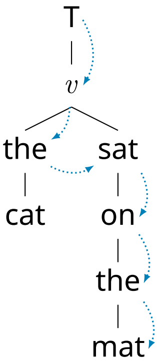

$\longrightarrow$

T $\cdot\, v \,\cdot$ the $\cdot$ sat $\cdot$ on $\cdot$ the $\cdot$ mat

T $\cdot\, v \,\cdot$ the $\cdot$ cat

See Graf and Shafiei (2019) for details.

# Lexical Selection (1)




$\longrightarrow$

$\mathrm{T} \cdot v \cdot \mathrm{the} \cdot \mathrm{sat} \cdot \mathrm{on} \cdot \mathrm{the} \cdot \mathrm{mat}$

| | |
|---|---|
| T | $\langle \mathrm{T}^- \ \mathrm{lv}^+ \rangle$ |
| $v$ | $\langle \mathrm{lv}^- \ \mathrm{D}^+ \ \mathrm{V}^+ \rangle$ |
| the | $\langle \mathrm{D}^- \ \mathrm{N}^+ \rangle$ |
| sat | $\langle \mathrm{V}^- \ \mathrm{P}^+ \rangle$ |
| on | $\langle \mathrm{P}^- \ \mathrm{D}^+ \rangle$ |
| the | $\langle \mathrm{D}^- \ \mathrm{N}^+ \rangle$ |
| mat | $\langle \mathrm{N}^- \rangle$ |

# Lexical Selection (2)

## What the SL grammar looks like

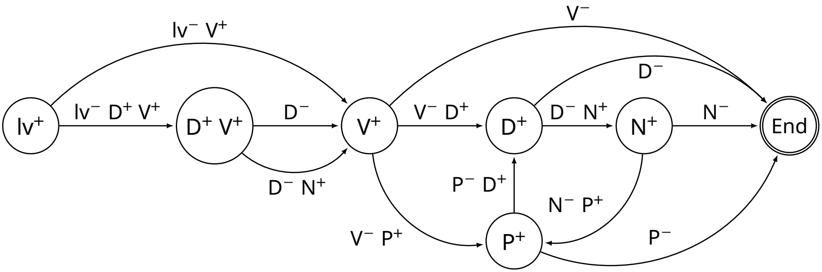
$\Sigma = \{\langle \mathrm{T}^- \ \mathrm{lv}^+\rangle, \langle \mathrm{lv}^- \ \mathrm{V}^+\rangle, \langle \mathrm{lv}^- \ \mathrm{D}^+ \ \mathrm{V}^+\rangle, \langle \mathrm{V}^-\rangle, \langle \mathrm{V}^- \ \mathrm{D}^+\rangle, \langle \mathrm{V}^- \ \mathrm{P}^+\rangle, \ldots\}$

$k = 3$

$$G = \left\{\begin{array}{ccc}
\cdots & \langle \mathrm{V}^- \ \mathrm{D}^+\rangle & \langle \mathrm{D}^-\rangle \\
\cdots & \langle \mathrm{V}^- \ \mathrm{D}^+\rangle & \langle \mathrm{D}^- \ \mathrm{N}^+\rangle \\
\cdots & \langle \mathrm{D}^- \ \mathrm{N}^+\rangle & \langle \mathrm{N}^-\rangle \\
\cdots & \langle \mathrm{D}^- \ \mathrm{N}^+\rangle & \langle \mathrm{N}^- \ \mathrm{P}^+\rangle \\
\cdots & \langle \mathrm{lv}^- \ \mathrm{D}^+ \ \mathrm{V}^+\rangle & \langle \mathrm{D}^- \ \mathrm{N}^+\rangle \\
\langle \mathrm{lv}^- \ \mathrm{D}^+ \ \mathrm{V}^+\rangle & \langle \mathrm{D}^- \ \mathrm{N}^+\rangle & \langle \mathrm{V}^- \ \mathrm{D}^+\rangle \\
\vdots & \vdots & \vdots
\end{array}\right\}$$

# Lexical Selection (3)

## FSA Representation



# Functional Hierarchies (1)

**Example: English clausal hierarchy**

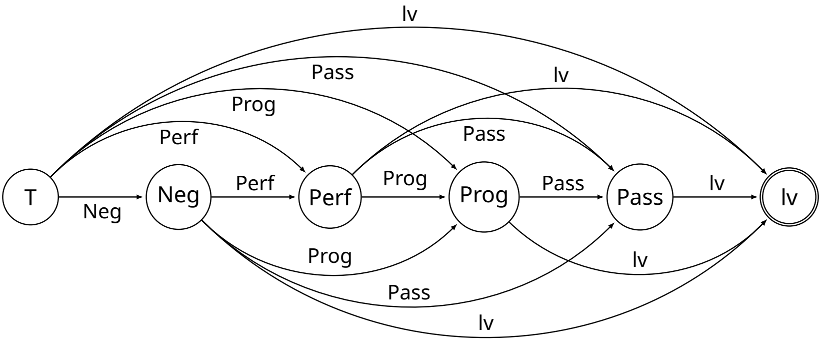
T < (Neg) < (Perf) < (Prog) < (Pass) < $v$ < V

Ex. "He might$_{\text{T}}$ not$_{\text{Neg}}$ have$_{\text{Perf}}$ been$_{\text{Prog}}$ being$_{\text{Pass}}$ watched."

This is also SL-2!

$$G = \left\{ \begin{array}{lllll} \text{T Neg} & & & & \\ \text{T Perf} & \text{Neg Perf} & & & \\ \text{T Prog} & \text{Neg Prog} & \text{Perf Prog} & & \\ \text{T Pass} & \text{Neg Pass} & \text{Perf Pass} & \text{Prog Pass} & \\ \text{T lv} & \text{Neg lv} & \text{Perf lv} & \text{Prog lv} & \text{Pass lv} \end{array} \right\}$$

# Functional Hierarchies (2)



# Adjunct Ordering (1)

Adjectives and adverbs often have a preferred order.

1. opinion
2. size
3. shape
4. age
5. color
6. origin
7. material
8. purpose

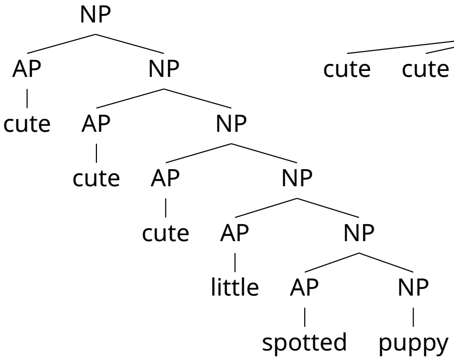
✓ *cute little spotted puppy*
? *little cute spotted puppy*
? *cute spotted little puppy*
?? *little spotted cute puppy*

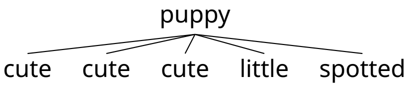
Items in the same group can be iterated.

✓ *cute cute cute little spotted puppy*

# Adjunct Ordering (2)

**PS tree and dependency tree for "cute cute cute little spotted puppy"**



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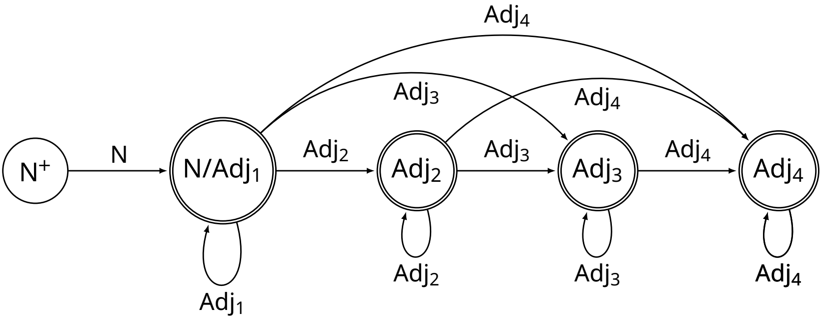
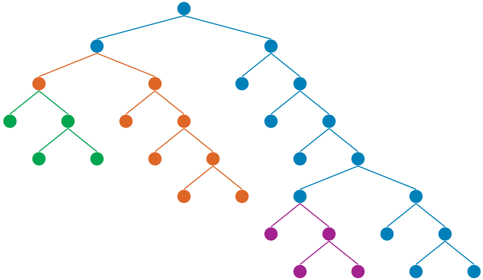


# Which c-strings do we use?

Answer: those that trace the complement spine of the tree, or of a subtree. See Graf and De Santo (2019) for details.



# What about long-distance phenomena?

Most long-distance phonological dependencies are in the class tier-based strictly local (TSL), a generalization of SL in which non-salient items are ignored (Heinz 2018).

Most long-distance syntactic phenomena are TSL (or a close variant of TSL) over trees.

- Movement (Graf 2022b)
- Case (Vu et al. 2019)
- Anaphora and NPI licensing (Graf and Shafiei 2019)
- Agreement (work in progress)

# Conclusion

Functional hierarchies and adjunct hierarchies are unsurprising from a computational perspective — they are just further examples of SL patterns.

Syntax and phonology are very similar in their computational properties, as highlighted by the c-string perspective.

SL computations are a good candidate for the basis of linguistic structure building.

# Thank you!

Acknowledgments:

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- Thanks to Thomas Graf and the Stony Brook Mathematical Linguistics Reading Group for comments and discussion.

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