

# Extending TSL to Account for Interactions of Local and Non-Local Constraints

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## Introduction

Formal language theory can be used to describe the **complexity of linguistic processes**. Unbounded dependencies in phonotactics, morphology, and even syntax can all be captured by the class of **Tier-based Strictly Local languages (TSL)** [1]. However, some patterns have been **problematic** for this approach [2]. In this work:

- I review some of the limits of TSL
- I present extensions of TSL that can account for some problematic patterns

## Subregular Complexity

Regular languages are decomposed into a hierarchy of nested classes of decreasing complexity — the **subregular hierarchy** (Rogers et al. 2013; McNaughton and Papert 1971; i.a.).

Regular		Monadic Second-Order Logic
Locally Threshold Testable	$\cup$	Star Free
	$\subset$	
Locally Testable	$\cup$	Propositional Logic
	$\subset$	
Strictly Local	$\cup$	Conjunction of Negative Literals
	$\subset$	
TSL		
Strictly Piecewise		
$S/\triangleleft$		$< / \triangleleft^+$

## The Subregular Hypothesis

- Phonology is **subregular** [3]
- Local phonotactic dependencies are **strictly local** (SL)

### SL Example

Word-final devoicing in GERMAN:

- $G = \{*[+voice]\times\}$

\* $\times$  r a d  $\times$       ok  $\times$  r a t  $\times$

### TSL Example

Long-distance sibilant harmony in AARI:

- $G = \langle T = \{j, \zeta, s, z\}, S = \{*\zeta s, *\zeta z, *js, *jz, *sj, *zj, *s\zeta, *z\zeta\} \rangle$

\*  $\times$  j a e r s e  $\times$       ok  $\times$  j a e r j e  $\times$   
T: sibilant harmony      T: sibilant harmony

### Limits of TSL

Sibilant Harmony in SAMALA [5]:

- Unbounded sibilant harmony
  - /k-su-fojin/    kfufojin    “I darken it”
  - /s-ni?/        fni?        “his neck”
  - /s-nan?/        fnan?        “he goes”
- Sibilant harmony overrides palatalization
  - /s-net-us/        snetus        “he does it to him”

### SH in Samala is not TSL [2]

- $G = \langle T = \{j, \zeta, s, z, n, t, l\}, S = S_1 \cup S_2 \cup S_3 \rangle$
- $S_1 = \{*\zeta s, *\zeta z, *js, *jz, *sj, *zj, *s\zeta, *z\zeta\}$
- $S_2 = \{*sn, *st, *sl\}$
- $S_3 = ??$

ok  $\times$  j a e r j e  $\times$       \*  $\times$  s n i ?  $\times$   
T: sibilant harmony      T: sibilant harmony

ok  $\times$  j a e r j e  $\times$       ok  $\times$  s n e t u s  $\times$   
T: sibilant harmony      T: sibilant harmony

## Structure Sensitive TSL

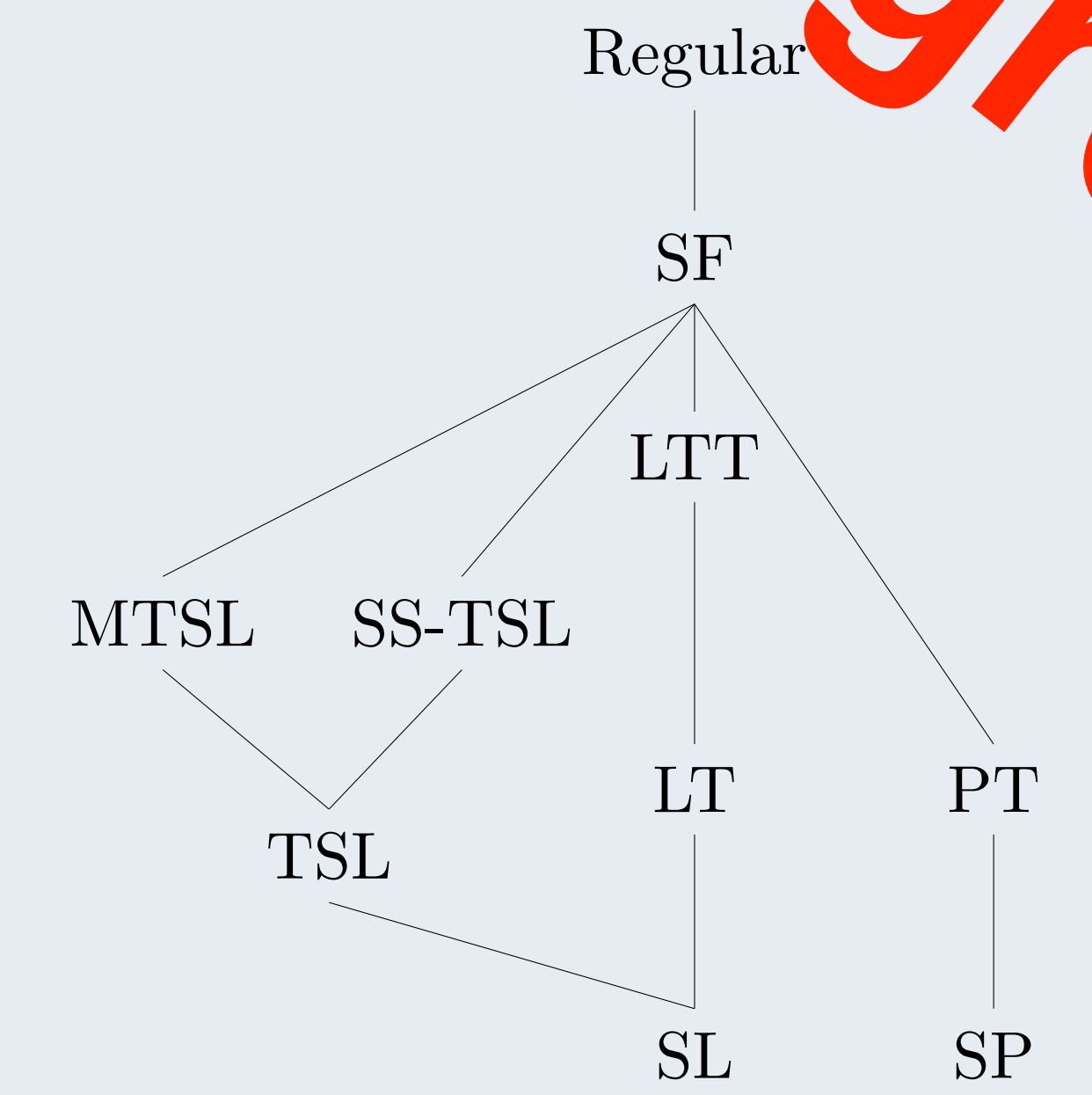
- Tier-projection** sensible to  $n$ -local properties

### SH in Samala is SS-TSL

ok  $\times$  j a e r j e  $\times$       \*  $\times$  s n i ?  $\times$   
T: sibilant harmony      T: sibilant harmony

ok  $\times$  s n e t u s  $\times$       ok  $\times$  j a e r j e  $\times$   
T: sibilant harmony      T: sibilant harmony

## The Subregular Hierarchy



## Conclusion

### Tracing Back Our Steps

- Subregular hypothesis is a strong computational theory of language complexity
- Phonology is SL + SP + TSL ...
- but there are patterns that are unaccounted for!

### In This Poster

- TSL is not **exactly** the right fit, but close!
- Minor changes lead to interesting new classes

### Future Work

- Further study of the TSL neighborhood
- Learning algorithms, AGL experiments ...

## References

[1] Heinz J., C. Rawal, and H. Tanner. 2011. Tier-based strictly local constraints for phonology. In ACL 49th 2011. [2] McMullin, K. J. 2016. Tier-based locality in long-distance phonotactics?: learnability and typology. PhD thesis, University of British Columbia. [3] Heinz J. 2015. The computational nature of phonological generalizations. Ms., U. of Delaware. [4] Hansson G. Ö. 2010. Consonant harmony: long-distance interaction in phonology. UC Publications in Linguistics. [5] Applegate R.B. 1972. Ineseno Chumash grammar. PhD thesis, UC Berkeley.

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- Unbounded dependencies are **not** SL
- Tier-based Strictly Local (TSL)**: select a subset of segments (a **tier**) and enforce local constraints only over it