Ling 151/Psych 156A: Acquisition of Language II

Lecture 23

Structure IV

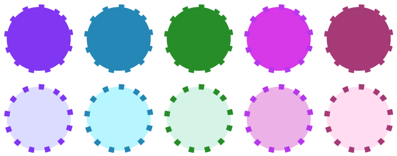
Announcements

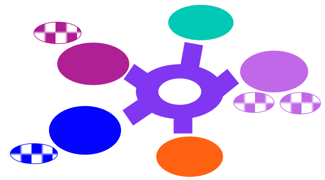
Be working on HW8 and the structure review questions

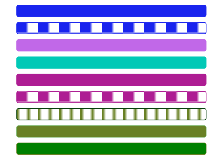
Final review this Friday 3/16/18

Final exam next Friday 3/23/18 between 1:30 and 3:30pm (taken online through Canvas EEE).

Consider taking more language science classes in the future!

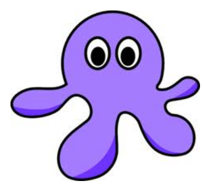






Learning with parameters vs. constraints

metrical phonology



Learning with parameters vs. constraints

metrical phonology

✓ KI tty

✗ ki TTY

Learning with parameters vs. constraints

metrical phonology

✓ a DO ra ble

✗ A do RA ble

✗ a DO ra BLE

✓ KI tty

✗ ki TTY

Learning with parameters vs. constraints

metrical phonology

✓ a DO ra ble

✗ A do RA ble

✗ a DO ra BLE

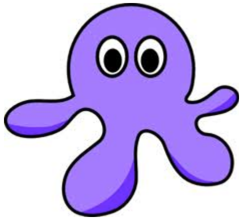
✓ KI tty

✗ ki TTY

✓ OC to pus

✗ oc TO PUS

✗ oc to PUS



Learning with parameters vs. constraints

metrical phonology

✓ a DO ra ble

✗ A do RA ble

✗ a DO ra BLE

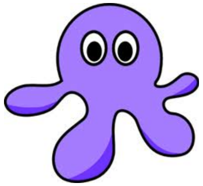
✓ KI tty

✗ ki TTY

✓ OC to pus

✗ oc TO PUS

✗ oc to PUS



Our underlying knowledge representation of the metrical phonology system allows us to generate these metrical stress preferences.

Learning with parameters vs. constraints

Our underlying knowledge representation of the metrical phonology system allows us to generate these metrical stress preferences.

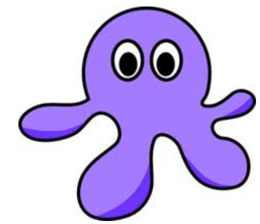
https://www.youtube.com/watch?v=MdId9wnMNg8&feature=youtu.be
2:03 - 3:00: Metrical stress

Underlying knowledge representations

metrical phonology

Account for word-level stress patterns

Observable data: stress contour   OCtopus



Underlying representation?

Points of agreement:

Use **metrical feet**:
Units ≥ syllables
but (often) smaller than words

Look only at syllable **rimes** (the "rhyming" part, after the onset)

Divide word into **syllables**

(...) (.........)

VC V VC
ɑk ə ʊs ← intake
ɑk tə pʊs ← IPA
oc to pus

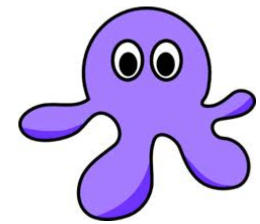
Pearl 2016, Pearl, Ho, & Detrano 2016

Underlying knowledge representations

metrical phonology

Account for word-level stress patterns

Observable data: stress contour   OCtopus



Underlying representation?

Points of cross-linguistic variation:

?

How to classify syllables

What metrical feet are allowed

How stress interacts with metrical feet

(H L) H	(H L L)	(S S) S	(S S S)

VC	V	VC
ɑk	ə	ʊs
ɑk	tə	pʊs
oc	to	pus

Pearl 2016, Pearl, Ho, & Detrano 2016

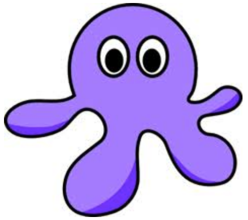
Underlying knowledge representations

metrical phonology

Account for word-level stress patterns

Observable data: stress contour

OCtopus

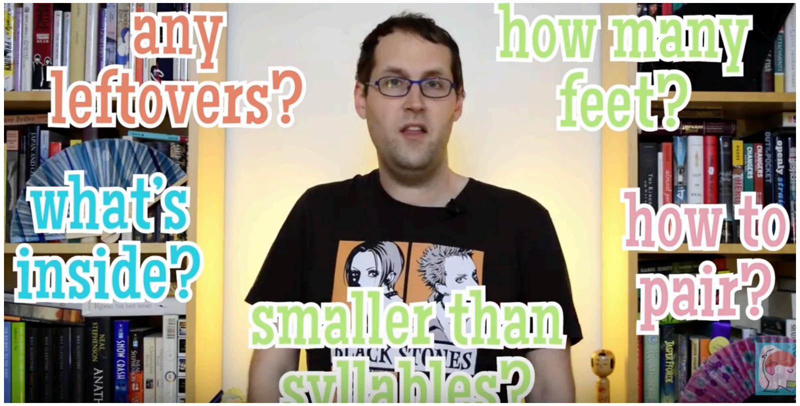


Underlying representation?

Points of cross-linguistic variation:

https://www.youtube.com/watch?v=MdId9wnMNg8&feature=youtu.be

5:20 - 6:04: Points of variation



Pearl 2016, Pearl, Ho, & Detrano 2016

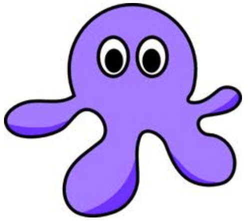
Underlying knowledge representations

metrical phonology

Account for word-level stress patterns

Observable data: stress contour

OCtopus



Points of disagreement:

Underlying grammar = ….?

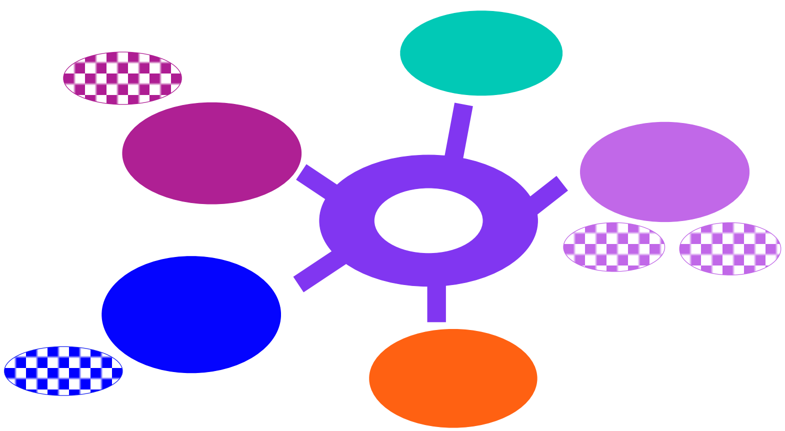
Pearl 2016, Pearl, Ho, & Detrano 2016

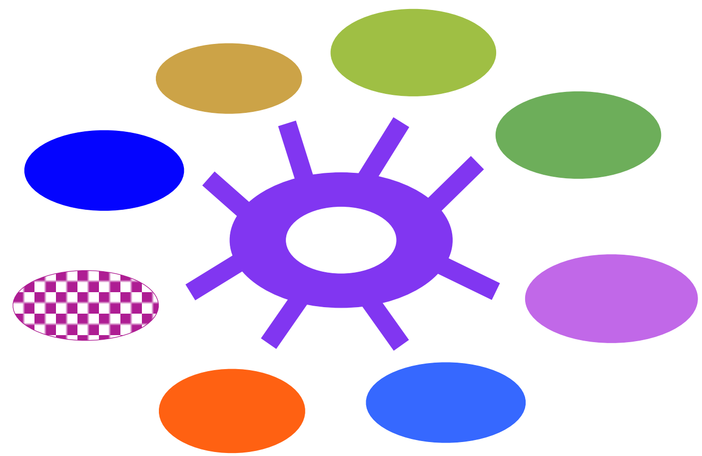
Underlying knowledge representations

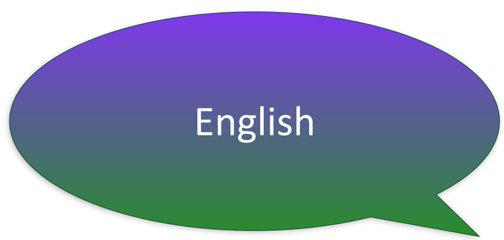
metrical phonology

Knowledge representation options

Parameters whose values must be set







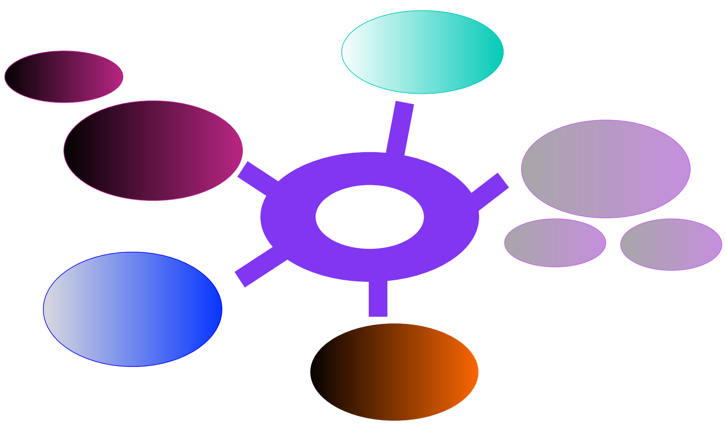
Pearl 2016, Pearl, Ho, & Detrano 2016

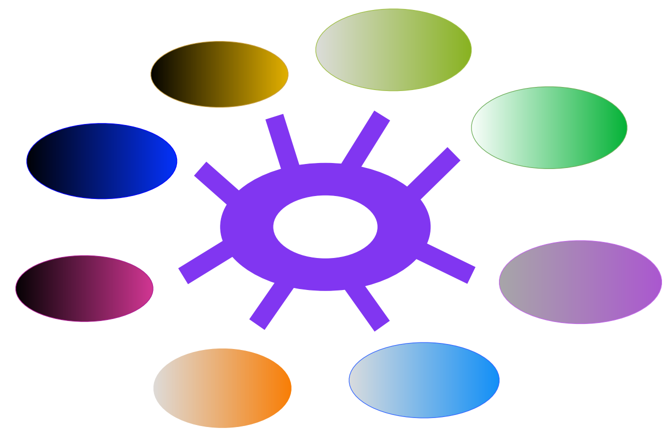
Underlying knowledge representations

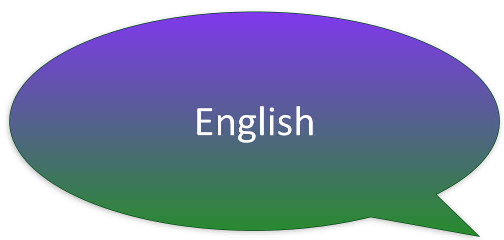
metrical phonology

Knowledge representation options

Parameters whose values must be set







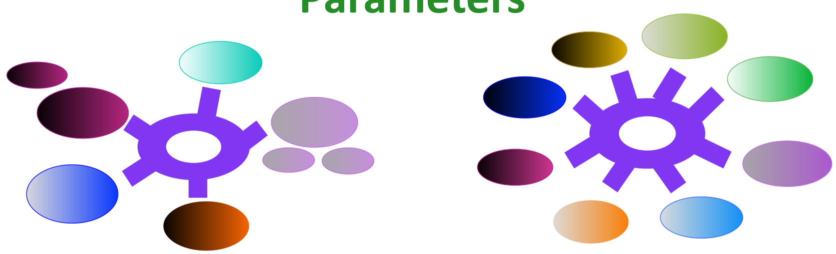
Pearl 2016, Pearl, Ho, & Detrano 2016

Underlying knowledge representations

metrical phonology

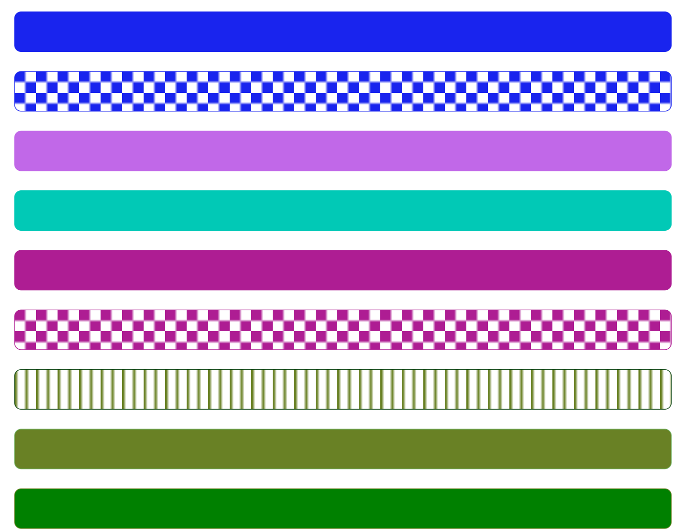
Knowledge representation options

Parameters



English

Violable constraints that must be ranked



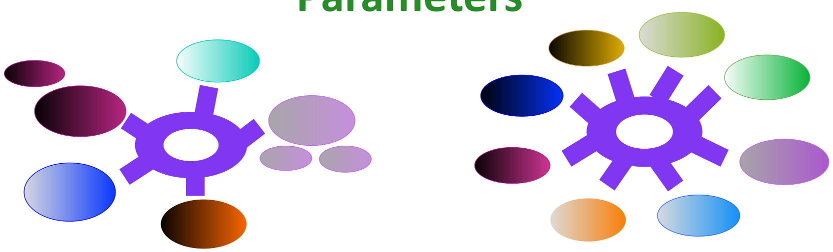
Pearl 2016, Pearl, Ho, & Detrano 2016

Underlying knowledge representations

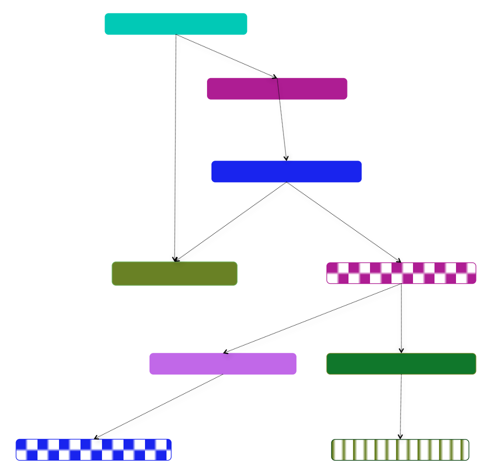
metrical phonology

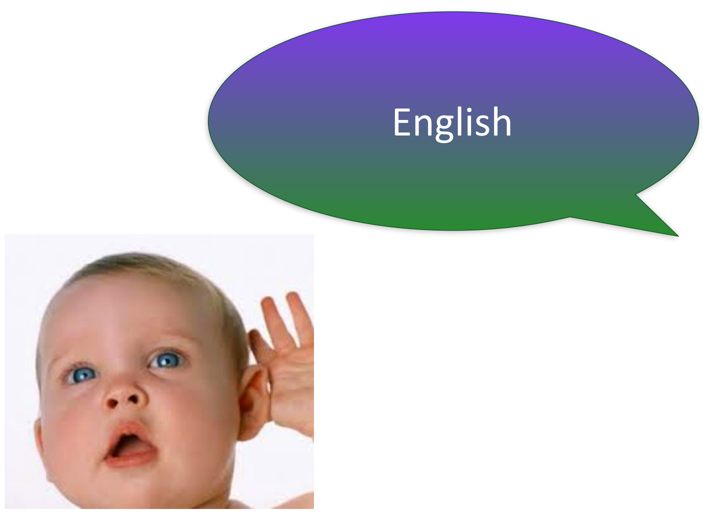
Knowledge representation options

Parameters



Violable constraints that must be ranked





Pearl 2016, Pearl, Ho, & Detrano 2016

Underlying knowledge representations

metrical phonology

Parameters

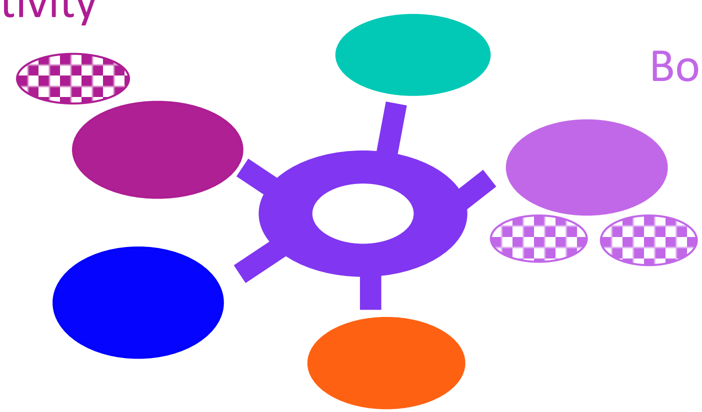
HV: Halle & Vergnaud 1987, Dresher 1999, Pearl 2011

5 parameters & 3 sub-parameters

Hypothesis space: 156 grammars

Correct grammar builds compatible contour

OCtopus



Grammar = Set of parameter & sub-parameter values

Pearl 2016, Pearl, Ho, & Detrano 2016

Underlying knowledge representations

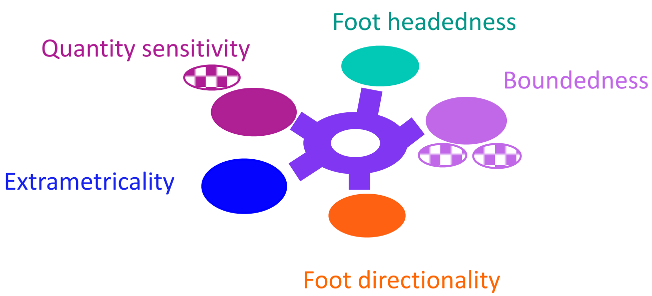
metrical phonology

Parameters

HV: Halle & Vergnaud 1987, Dresher 1999, Pearl 2011

5 parameters & 3 sub-parameters

Hypothesis space: 156 grammars



Correct grammar builds compatible contour

OCtopus

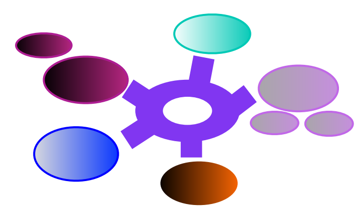
This grammar, comprised of particular parameter values, generates the correct stress contour.

(H L) H

OC to pus

Parameter values used:

QS-VC-H, Em-Rt, FtDir-Rt, B-2-Syl, FtHd-Left



…which are the values of the English grammar.

Pearl 2016, Pearl, Ho, & Detrano 2016

Underlying knowledge representations

metrical phonology

Parameters

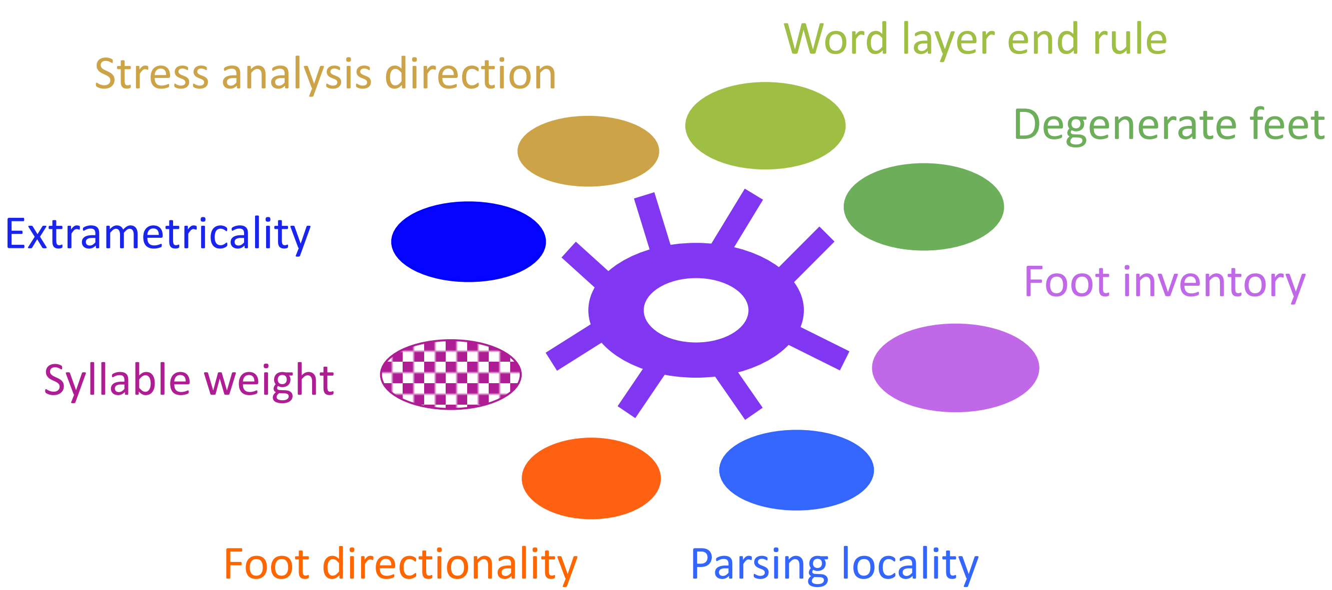
Hayes: Hayes 1995

8 parameters

Hypothesis space: 768 grammars

Correct grammar builds compatible contour

OCtopus



Pearl 2016, Pearl, Ho, & Detrano 2016

Underlying knowledge representations

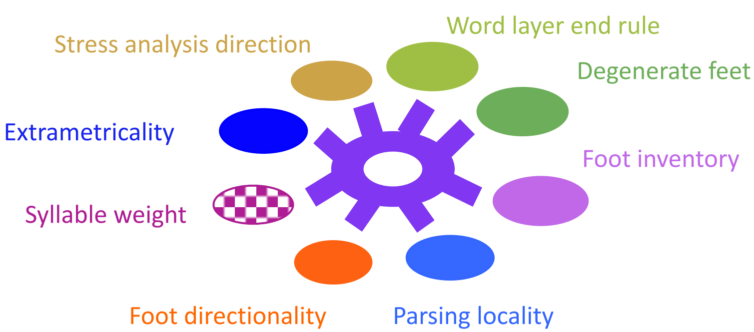
metrical phonology

Parameters

Hayes: Hayes 1995

8 parameters

Hypothesis space: 768 grammars



Parameter values used:

Bot, Em-RtCons, VC-H, FtDir-Rt,
PL-Strong, MorTro, DF-Strong, WLER-Rt

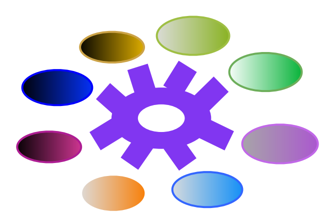
Correct grammar builds compatible contour

OCtopus

This grammar, comprised of particular parameter values, generates an incorrect stress contour.

H L L

OC TÓ pus



...which are the values of the English grammar.

Pearl 2016, Pearl, Ho, & Detrano 2016

Underlying knowledge representations

metrical phonology

Best candidate for the correct grammar has a compatible contour

OCtopus

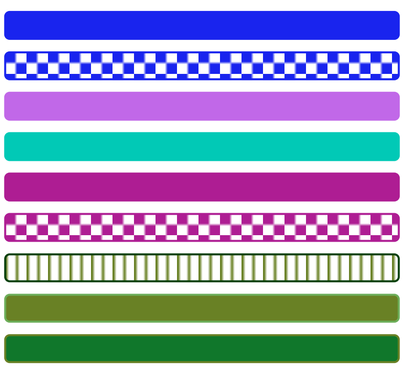
Constraints

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

Premise: Many different candidates for a word's stress representation and contour are generated and then ranked according to which constraints are violated. Violating higher-ranked constraints is worse than violating lower-ranked constraints.



Higher **Lower**

	C1	C2	C3	C4
(OC to) pus			*	*
oc (TO pus)	*		*	
(oc TO) pus		*	*	

Pearl 2016, Pearl, Ho, & Detrano 2016

Underlying knowledge representations

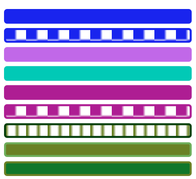
metrical phonology

Constraints

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars



Best candidate for the correct grammar has a compatible contour

OCtopus

https://www.youtube.com/watch?v=MdId9wnMNg8&feature=youtu.be

1:29 - 2:40: Intro to constraint ranking

Pearl 2016, Pearl, Ho, & Detrano 2016

Underlying knowledge representations

metrical phonology

Constraints

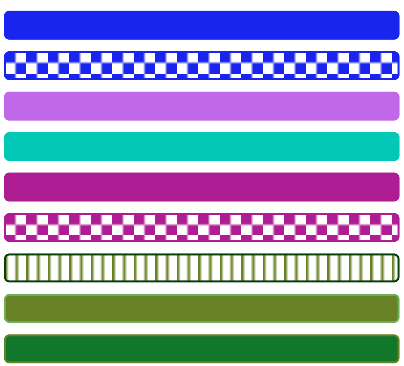
OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

Best candidate for the correct grammar has a compatible contour

OCtopus



Grammar = ranked ordering of all constraints

Pearl 2016, Pearl, Ho, & Detrano 2016

Underlying knowledge representations

metrical phonology

Best candidate for the correct grammar has a compatible contour

OCtopus

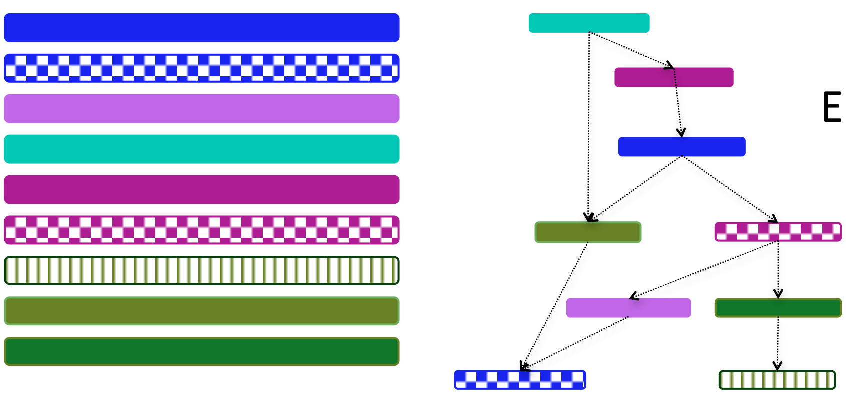
Constraints

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

Official grammars for languages are often described as partial orderings of constraints.



English grammar

Pearl 2016, Pearl, Ho, & Detrano 2016

Underlying knowledge representations

metrical phonology

Constraints

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

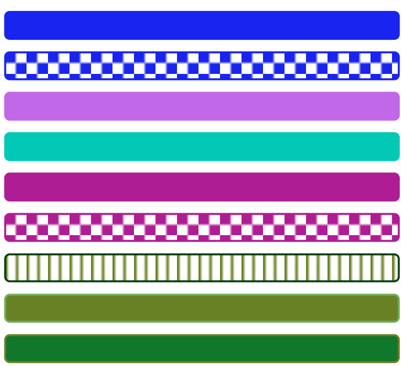
9 violable constraints

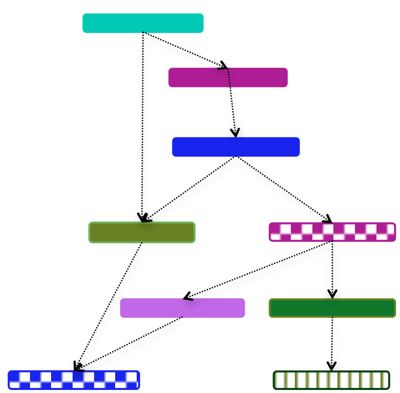
Hypothesis space: 9! rankings = 362,880 grammars

Best candidate for the correct grammar has a compatible contour

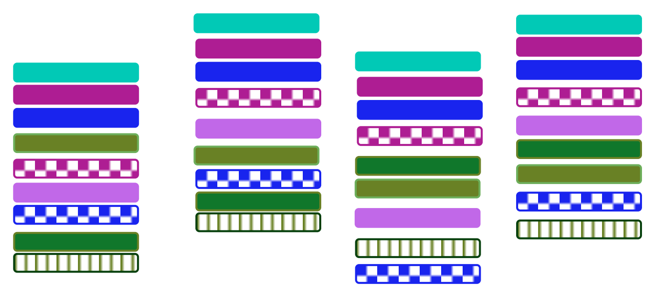
OCtopus

This means the "grammar" for a language is often a set of the possible rankings (grammars) that obey those orderings.





Ex: The English "grammar" is compatible with 26 rankings.



Pearl 2016, Pearl, Ho, & Detrano 2016

Underlying knowledge representations

metrical phonology

Best candidate for the correct grammar has a compatible contour

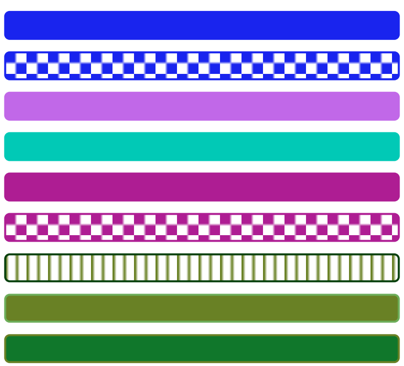
OCtopus

Constraints

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars



Nonfinality, Parse-σ

Foot binarity

Trochaic

Weight-to-Stress

Align left, Align right

*Sonorant nucleus

Pearl 2016, Pearl, Ho, & Detrano 2016

Underlying knowledge representations

metrical phonology

Constraints

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

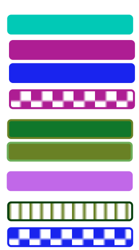
Hypothesis space: 9! rankings = 362,880 grammars

Best candidate for the correct grammar has a compatible contour

OCtopus

Principle (Rooting): All words must have stress

A sample grammar that is a version of the English "grammar":



Sample candidates

(OC to) (PUS)	(OC to) pus
(oc TO) (PUS)	oc (TO pus)

Pearl 2016, Pearl, Ho, & Detrano 2016

Underlying knowledge representations

metrical phonology

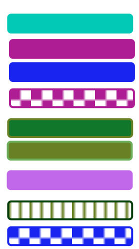
Constraints

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

A sample grammar that is a version of the English "grammar":



Best candidate for the correct grammar has a compatible contour

OCtopus

Only one candidate left, and it has a compatible contour.

Sample candidates

(OC to) (PUS)

(OC to) pus

(oc TO) (PUS)

oc (TO pus)

Pearl 2016, Pearl, Ho, & Detrano 2016

Underlying knowledge representations

metrical phonology

Constraints

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

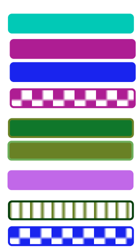
9 violable constraints

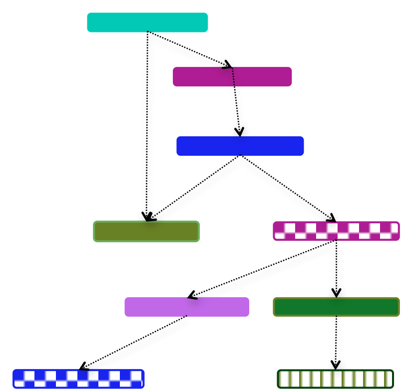
Hypothesis space: 9! rankings = 362,880 grammars

Best candidate for the correct grammar has a compatible contour

OCtopus

A sample grammar that is a version of the English "grammar":



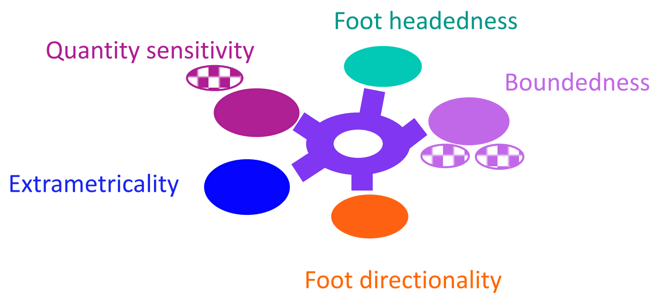


English "grammar"

Pearl 2016, Pearl, Ho, & Detrano 2016

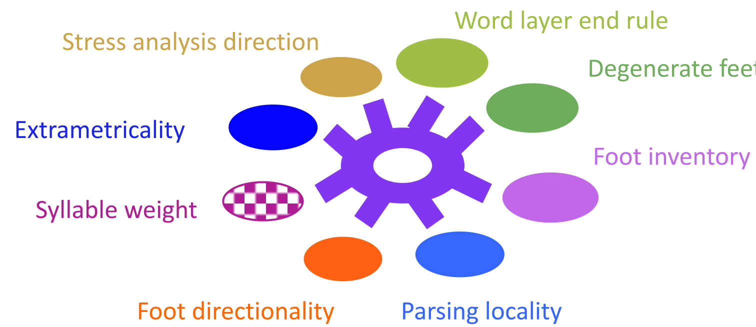
Knowledge representation comparison

metrical phonology



HV: 5 parameters & 3 sub-parameters

Hypothesis space: 156 grammars

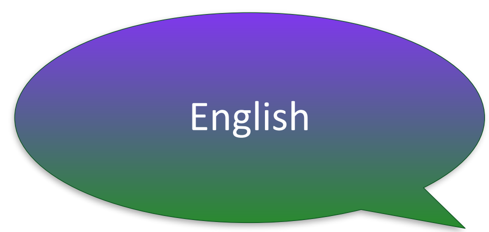


Hayes: 8 parameters

Hypothesis space: 768 grammars

OT: 9 violable constraints

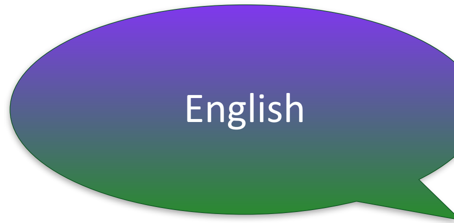
Hypothesis space: 362,880 grammars



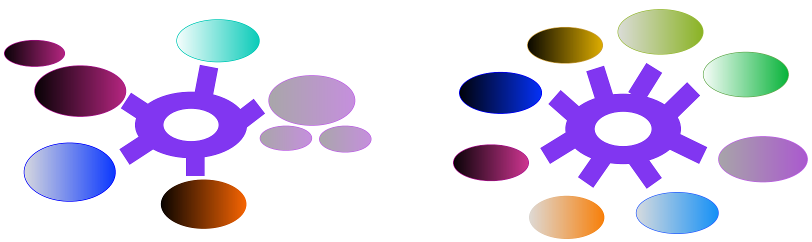
Pearl 2016, Pearl, Ho, & Detrano 2016

Knowledge representation comparison

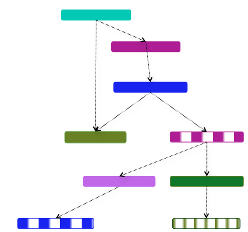
metrical phonology



parameters



constraints



These representations have some similarities, but aren't obviously using identical variables.

How do we choose among these representations and their English versions?

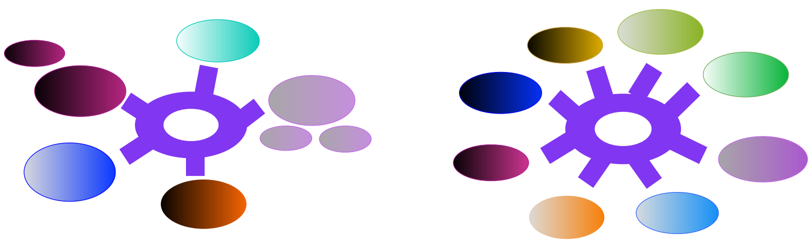
Pearl 2016, Pearl, Ho, & Detrano 2016

Knowledge representation comparison

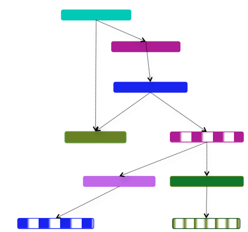
metrical phonology

English

parameters



constraints

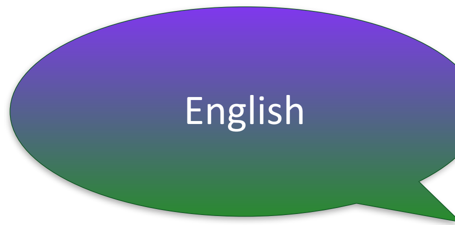


Answer: Let's see how learnable they are from the English data children typically encounter!

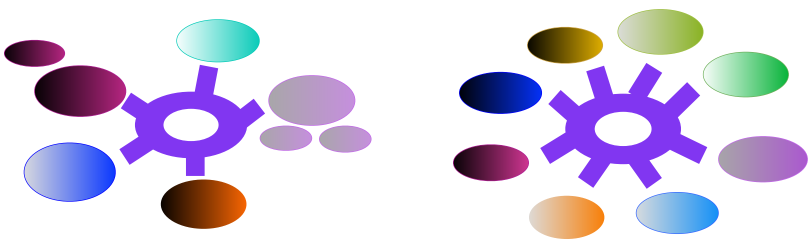
Pearl 2016, Pearl, Ho, & Detrano 2016

Knowledge representation comparison

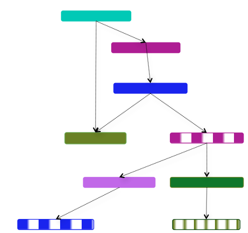
metrical phonology



parameters



constraints



Acquisition goal: Identify the grammar that can account for the word-level stress patterns in the language

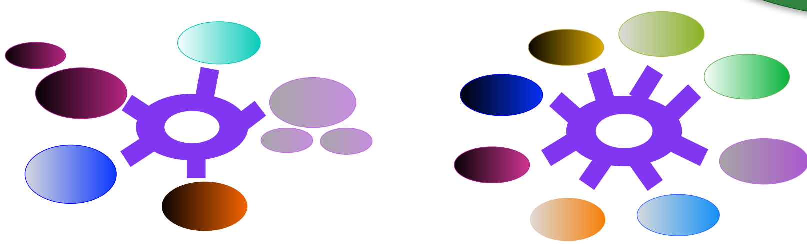
Pearl 2016, Pearl, Ho, & Detrano 2016

Knowledge representation comparison

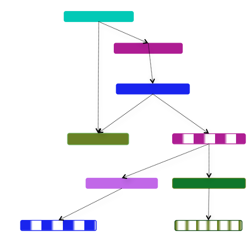
metrical phonology

English

parameters

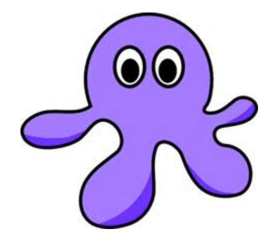


constraints



Observable data: stress contour

OCtopus



All representations: use metrical feet based on syllable rimes

ɑk ə ʊs

VC V VC

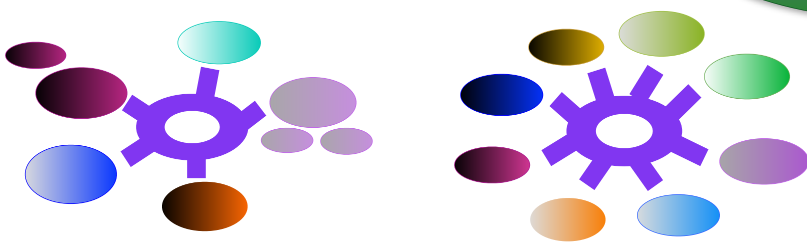
Pearl 2016, Pearl, Ho, & Detrano 2016

Knowledge representation comparison

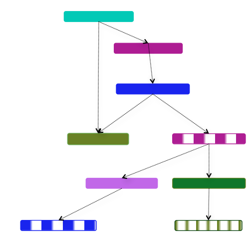
metrical phonology

English

parameters



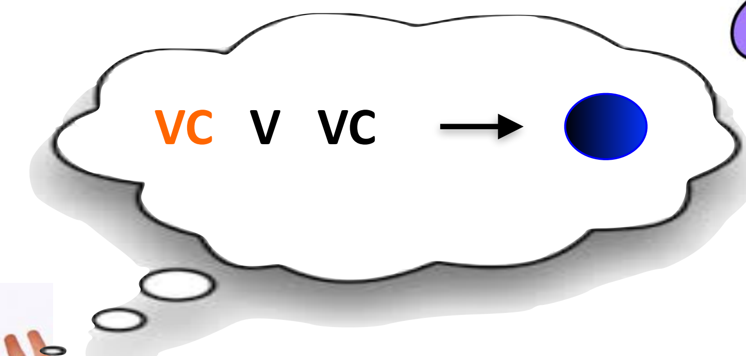
constraints



Observable data: stress contour

OCtopus

All representations: use metrical feet based on syllable rimes



Parametric inference:
Does this set any values?

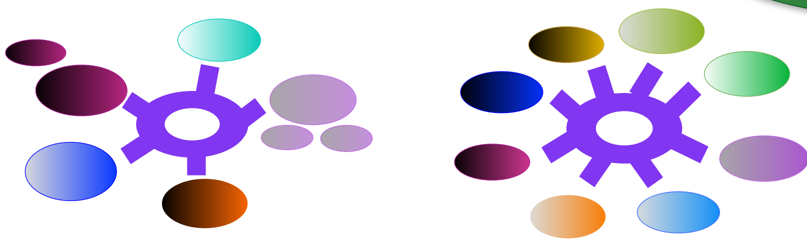
Pearl 2016, Pearl, Ho, & Detrano 2016

Knowledge representation comparison

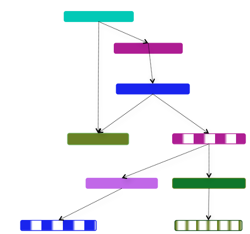
metrical phonology

English

parameters



constraints

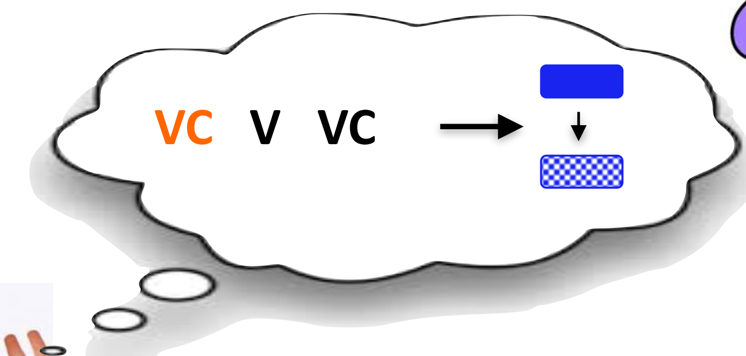


Observable data: stress contour

OCtopus

All representations: use metrical feet based on syllable rimes

OT inference:
Does this implicate any constraint rankings?

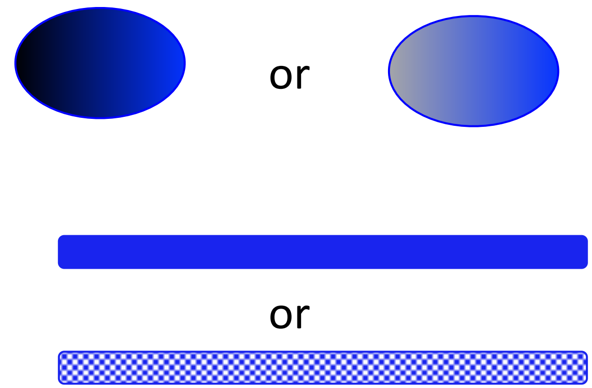


Pearl 2016, Pearl, Ho, & Detrano 2016

Learning English

metrical phonology

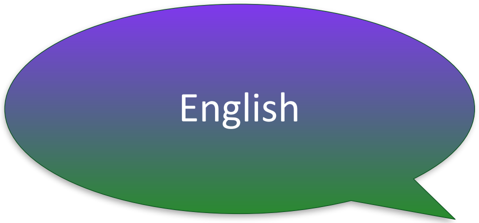
English metrical phonology is non-trivial to learn because there are many data that are ambiguous for which parameter value or constraint ranking they implicate.



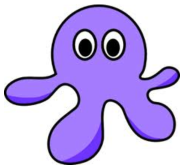
This is generally a problem for acquisition (poverty of the stimulus = the data are compatible with many hypotheses).

Pearl 2016, Pearl, Ho, & Detrano 2016

Learning English



metrical phonology



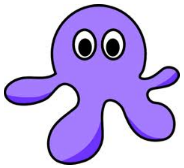
Non-trivial because there are many irregularities. This is less common for acquisition – usually there aren't a lot of exceptions to the system being acquired.

Pearl 2016, Pearl, Ho, & Detrano 2016

Learning English

English

metrical phonology



irregularities

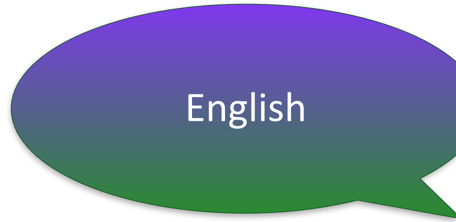
Interactions with morphology (Chomsky & Halle 1968, Hayes 1982, Kiparsky 1979)

Example: Adding productive morphology doesn't change the stress pattern, even though all grammars base their stress patterns on the syllables present in the word.

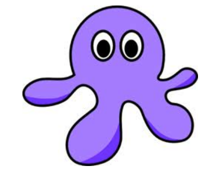
EARly	PREtty	senSAtion
EARlier	PREttiest	senSAtional
		senSAtionally

Pearl 2016, Pearl, Ho, & Detrano 2016

Learning English



metrical phonology



irregularities

Interactions with syntactic category (Hammond 1999, Hayes 1982, Cassidy & Kelly 2001, Christiansen & Monaghan 2006)

Stress contours may be different across syntactic categories, even though the syllabic word form doesn't change.

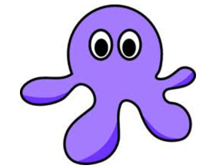
NOUNS	VERBS	Syllabic word form
CONduct	conDUCT	VC VCC
DEsert	deSERT	V VCC
SUspect	suSPECT	V VCC

Pearl 2016, Pearl, Ho, & Detrano 2016

Learning English

English

metrical phonology



These irregularities can cause multiple stress contours to be associated with a syllabic word form. This is problematic for the grammars in these knowledge representations…

Syllabic word form: V VV

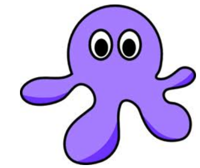
KI tty	a WAY	UH OH
V vv	v VV	V VV

Pearl 2016, Pearl, Ho, & Detrano 2016

Learning English

English

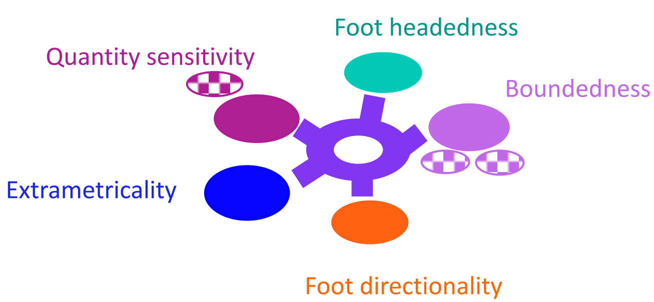
metrical phonology

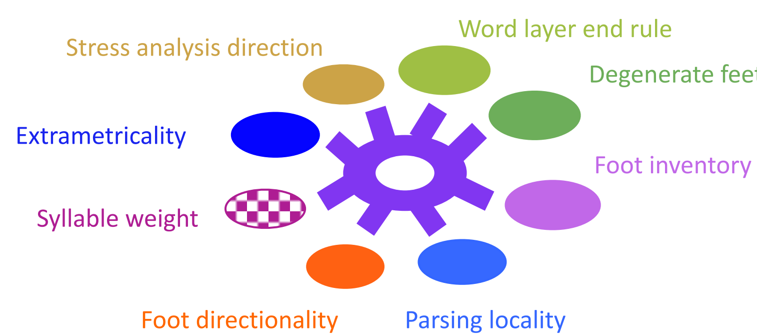


These irregularities can cause multiple stress contours to be associated with a syllabic word form. This is problematic for the grammars in these knowledge representations, since a grammar can only generate a single stress contour per syllabic word form…

Syllabic word form: V VV

Generate one of these…	KI tty	a WAY	UH OH
	V vv	v VV	V VV



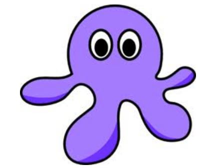


Pearl 2016, Pearl, Ho, & Detrano 2016

Learning English

English

metrical phonology



These irregularities can cause multiple stress contours to be associated with a syllabic word form. This is problematic for the grammars in these knowledge representations, since a grammar can only generate a single stress contour per syllabic word form or select a single stressed syllabic word form as the best candidate.

Syllabic word form: V VV

Select one of these…

KI tty	a WAY	UH OH
V vv	v VV	V VV

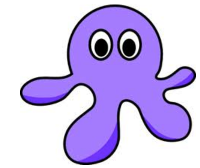
Nonfinality, Parse-σ
Foot binarity
Trochaic
Weight-to-Stress
Align left, Align right
*Sonorant nucleus

Pearl 2016, Pearl, Ho, & Detrano 2016

Learning English

English

metrical phonology



Upshot of multiple stress contours: No one grammar can account for all the stressed words in the input.

Syllabic word form: V VV

KI tty	a WAY	UH OH
V vv	v VV	V VV

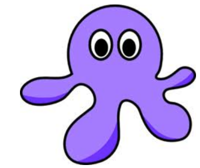
But how big of a problem is this in English child-directed speech?

Pearl 2016, Pearl, Ho, & Detrano 2016

Learning English

English

metrical phonology



multiple stress contours = pretty big problem

Analysis of Brent corpus (CHILDES database): 4780 word types (99,968 tokens) of American English speech directed at children between the ages of 6 and 12 months

Syllabic word form: V VV

KI tty	a WAY	UH OH
V vv	v VV	V VV

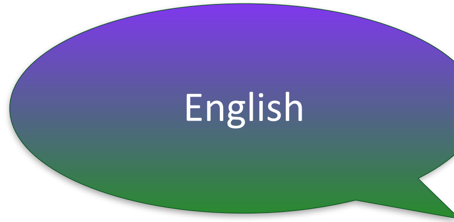
Multiple stress contours

HV:	73 of 123 syllabic word forms
Hayes:	86 of 149 syllabic word forms
OT:	166 of 452 syllabic word forms

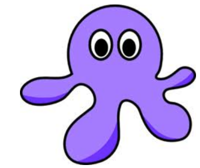
This occurs a lot!

Pearl 2016, Pearl, Ho, & Detrano 2016

Learning English



metrical phonology



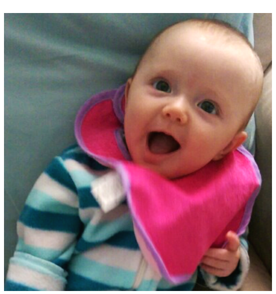
multiple stress contours = pretty big problem

Syllabic word form: V VV

KI tty	a WAY	UH OH
V vv	v VV	V VV

Acquisition success: Identify the grammar that can account for ^ the word-level stress patterns in the language

a good portion of

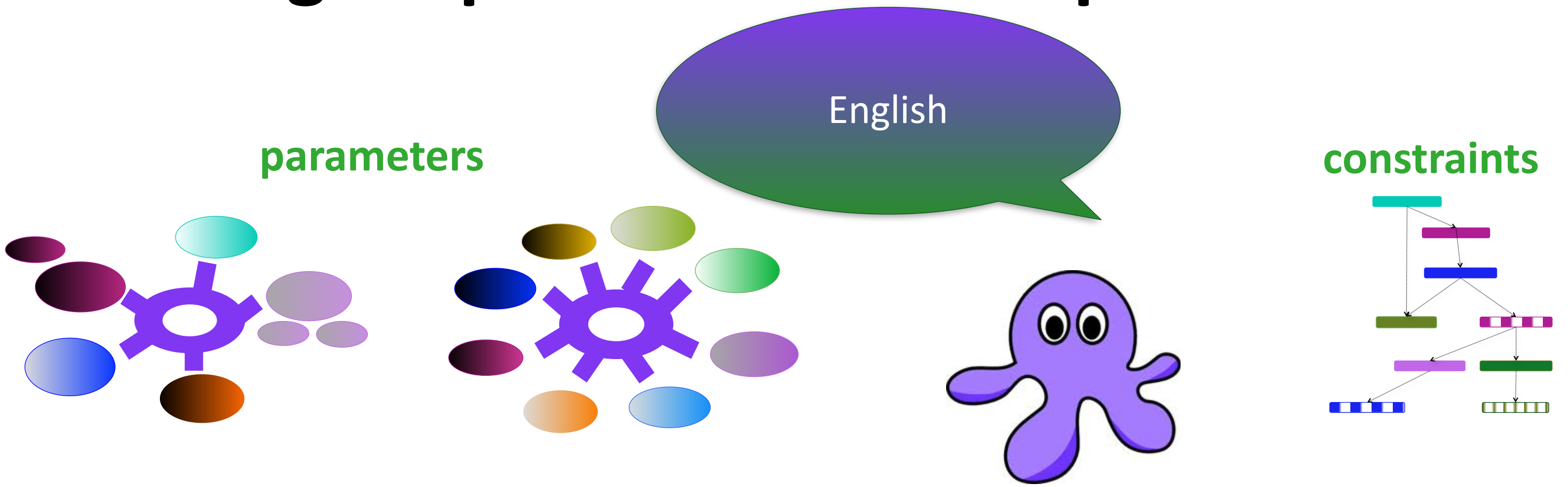


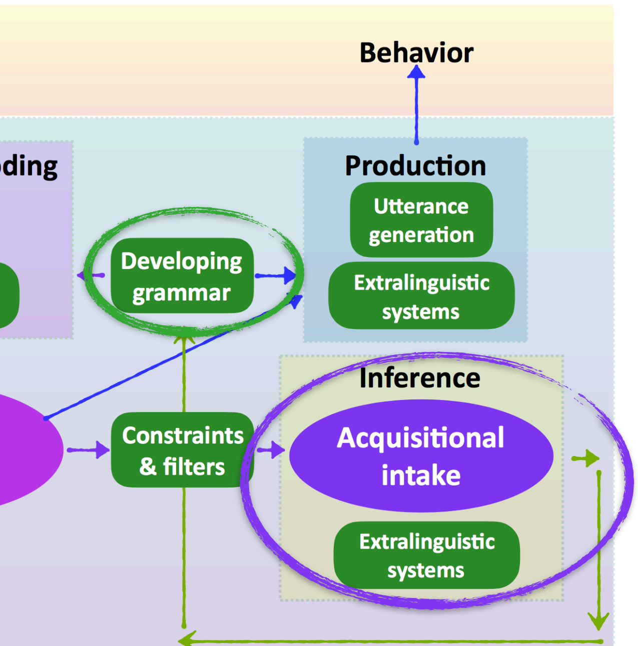
This isn't unreasonable: A grammar is useful because it provides a compact representation of some aspect of the data. Even if it doesn't cover all the data, covering some is helpful.

Pearl 2016, Pearl, Ho, & Detrano 2016

Knowledge representation comparison

metrical phonology





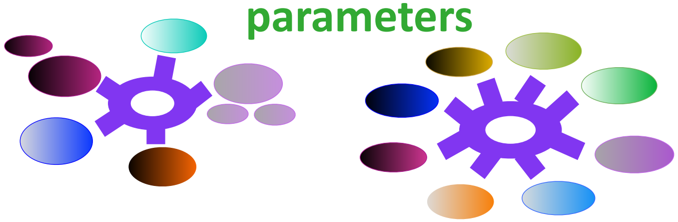
Computational-level analysis

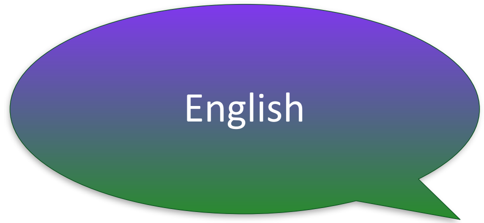
Pearl 2016, Pearl, Ho, & Detrano 2016

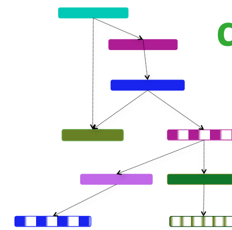
Knowledge representation comparison

metrical phonology

parameters







constraints

Working premise: Rational learners

A learner trying to learn which grammar is the right one for the language will choose the grammar perceived to be the best.

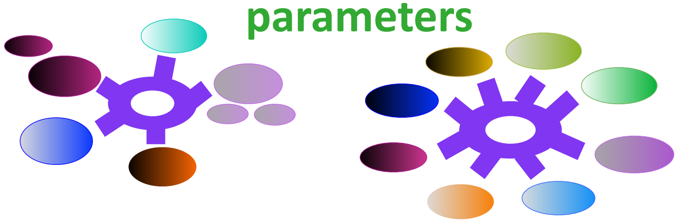
able to account for the most data in the acquisitional intake = most useful to have

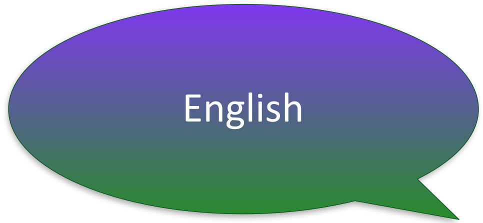
Pearl 2016, Pearl, Ho, & Detrano 2016

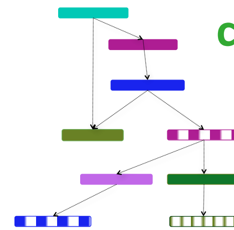
Knowledge representation comparison

metrical phonology

parameters

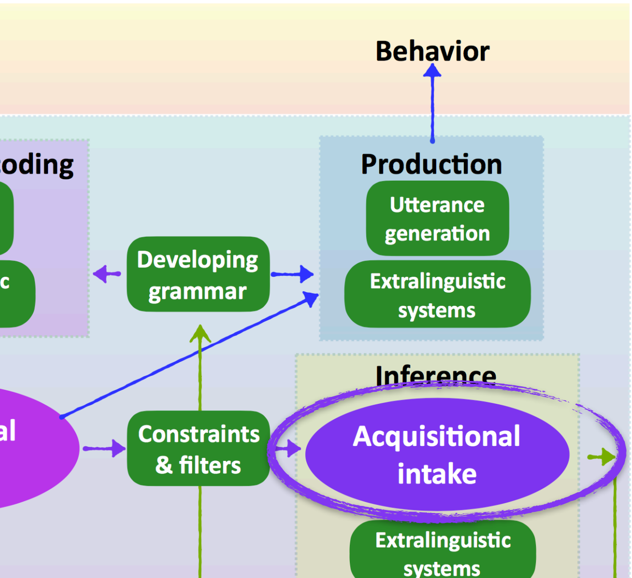






constraints

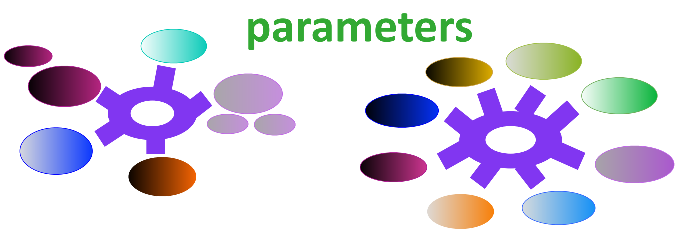
Once we define the acquisitional intake, we can then ask which grammar in the hypothesis space defined by the knowledge representation is best, assuming a rational learner that will choose the grammar compatible with the most data.

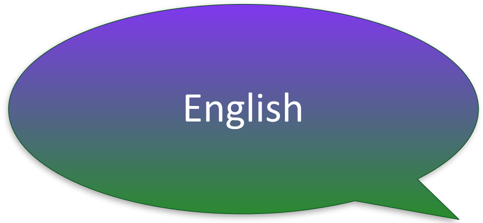


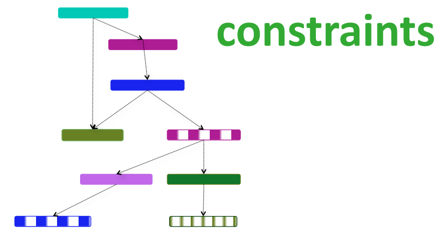
Pearl 2016, Pearl, Ho, & Detrano 2016

Knowledge representation comparison

metrical phonology







It turns out that all three English grammars are compatible with 49-59% of the data in English child-directed speech.

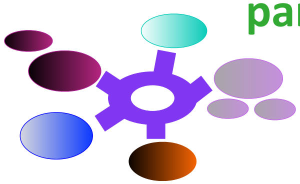
Not too bad!

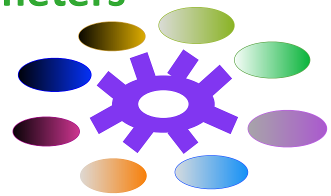
Pearl 2016, Pearl, Ho, & Detrano 2016

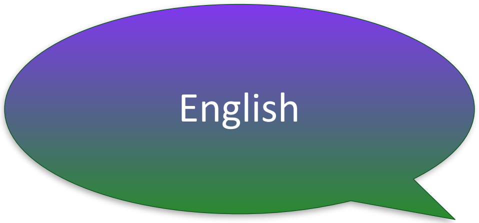
Knowledge representation comparison

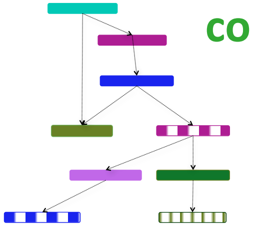
metrical phonology

parameters









constraints

It turns out that all three English grammars are compatible with 49-59% of the data in English child-directed speech.

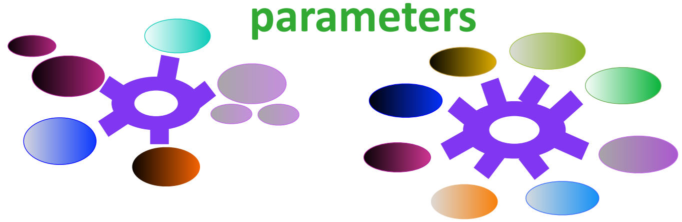
Not too bad…but can we do better?

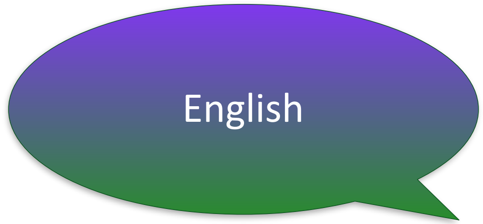
Pearl 2016, Pearl, Ho, & Detrano 2016

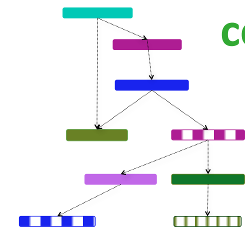
Knowledge representation comparison

metrical phonology

parameters

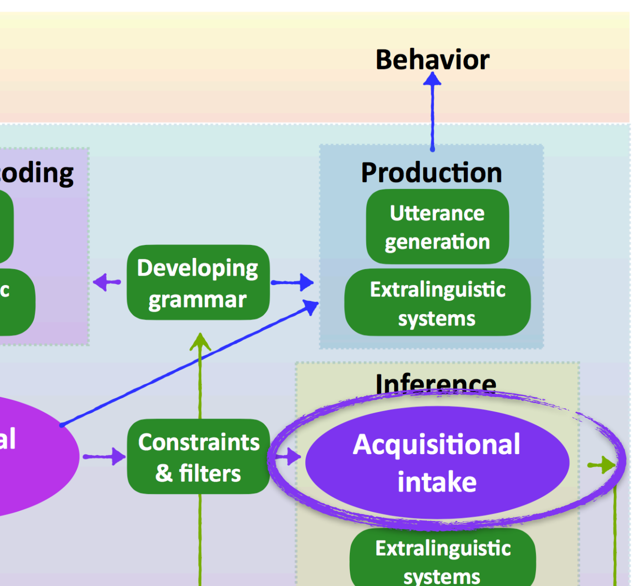






constraints

It turns out that all three English grammars are compatible with 49-59% of the data in English child-directed speech.



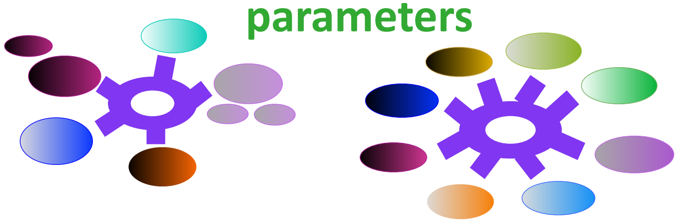
Let's look more closely at the acquisitional intake.

Pearl 2016, Pearl, Ho, & Detrano 2016

Knowledge representation comparison

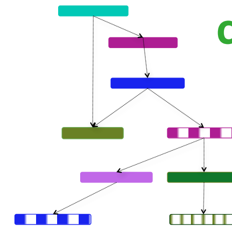
metrical phonology

parameters



English

constraints



Previous working assumption: The learner will try to learn a grammar that can account for all the data encountered.

all data

But we know that's impossible, because of the multiple stress contours!

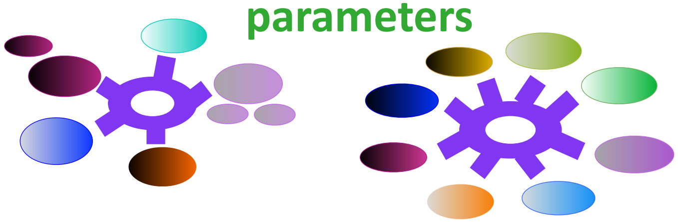
KI tty	a WAY	UH OH
V vv	v VV	V VV

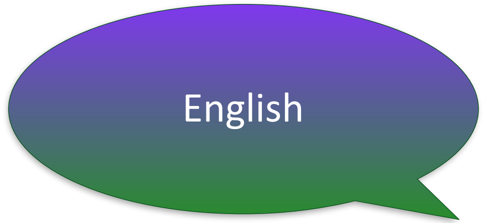
Pearl 2016, Pearl, Ho, & Detrano 2016

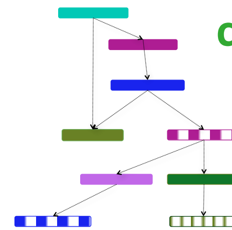
Knowledge representation comparison

metrical phonology

parameters

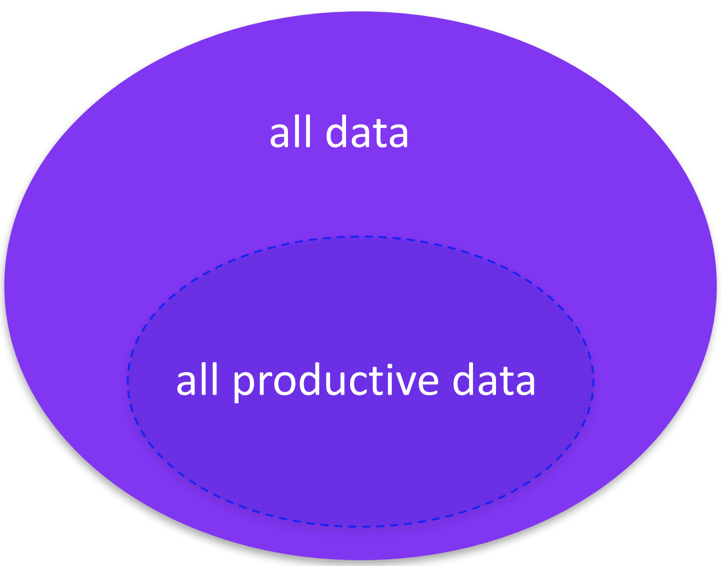






constraints

Updated working assumption: The learner will try to learn a grammar that can account for all the productive data encountered (Legate & Yang 2012).



Productive = the one you use when producing a novel word form

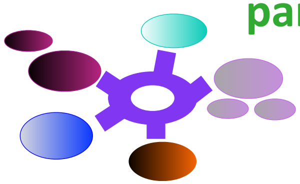
Acquisitional intake = only productive data because those are the predictable, rule-based data.

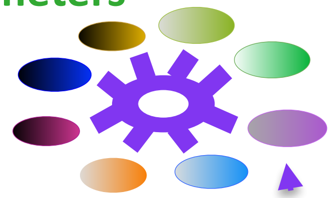
Pearl 2016, Pearl, Ho, & Detrano 2016

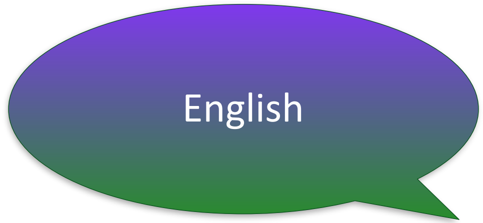
Knowledge representation comparison

metrical phonology

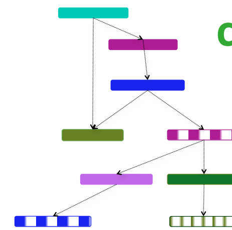
parameters







constraints



Updated working assumption: The learner will try to learn a grammar that can account for all the productive data encountered (Legate & Yang 2012).

Principled way to implement this = Tolerance Principle

Productive data filter

✓
COO kie
DA ddy
FU nny

✗
a WAY
be LOW
to DAY

Syllabic word form:

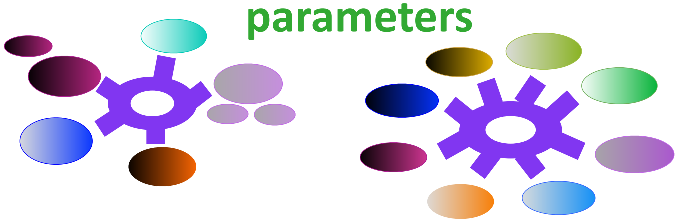
V VV

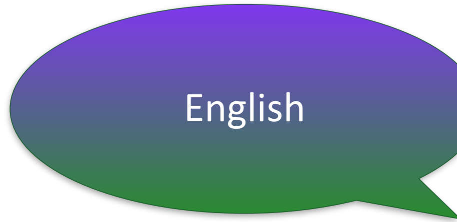
Pearl 2016, Pearl, Ho, & Detrano 2016

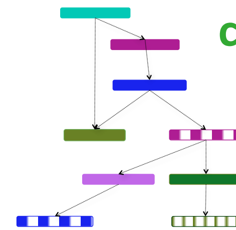
Tolerance Principle

metrical phonology

parameters







constraints

A formal way for identifying if there is a dominant rule for a set of items is the Tolerance Principle (Yang 2005, Legate & Yang 2012). This is used to estimate how many exceptions a rule can tolerate in a set before it's no longer useful for the learner to have the rule.

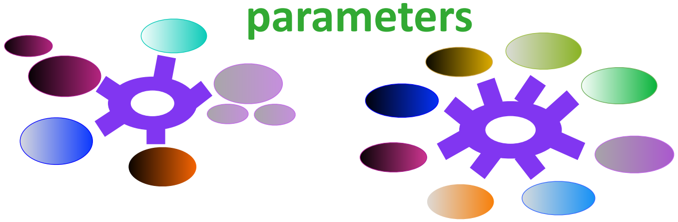
If there are too many exceptions, it's better not to have a rule and learn patterns on an individual item basis instead of having a rule that keeps getting violated.

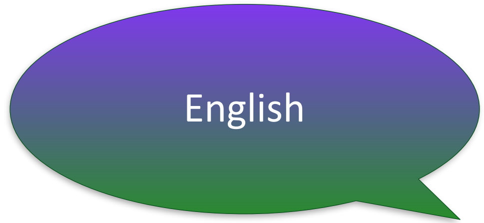
Pearl 2016, Pearl, Ho, & Detrano 2016

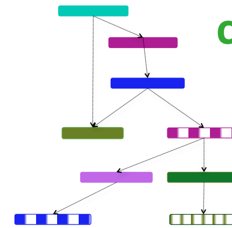
Tolerance Principle

metrical phonology

parameters







constraints

The number of exceptions a rule can tolerate for a set of N items is

$$\frac{N}{ln(N)}$$

(Yang 2005, Legate & Yang 2012)

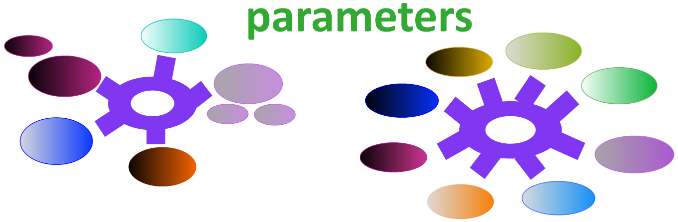
Pearl 2016, Pearl, Ho, & Detrano 2016

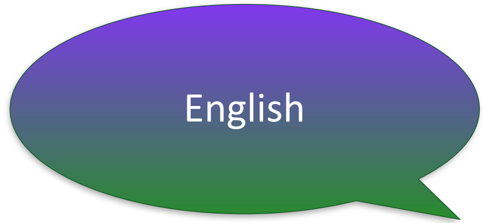
$$\frac{N}{ln(N)}$$

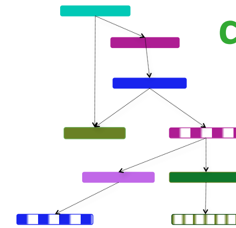
Tolerance Principle

metrical phonology

parameters







constraints

For every syllable word form with multiple stress contours, the learner could assess whether any of those contours is the dominant one (the “rule” for that syllable word form), using the Tolerance Principle.

V VV

a WAY

KI tty

UH OH

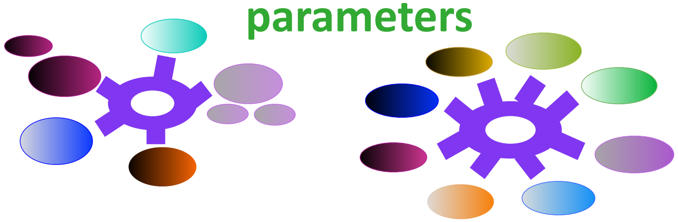
Pearl 2016, Pearl, Ho, & Detrano 2016

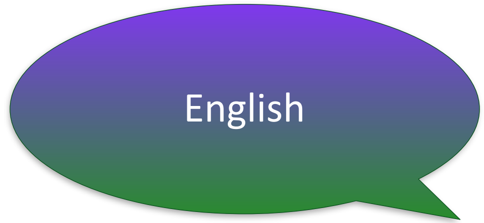
$$\frac{N}{ln(N)}$$

Tolerance Principle

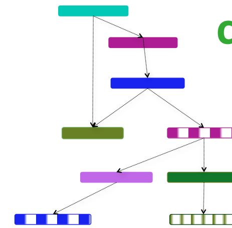
metrical phonology

parameters

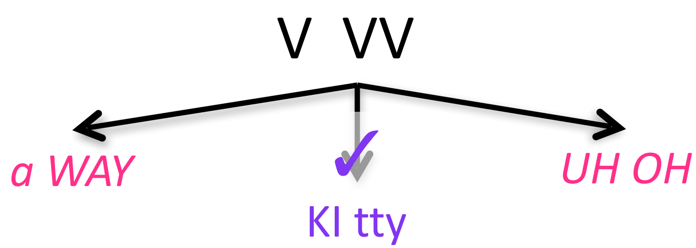




constraints



If one contour is dominant, the learner should focus on accounting for that pattern, since it's regular and productive. The grammar should be able to generate it. The other contours can be ignored for purposes of learning the grammar.



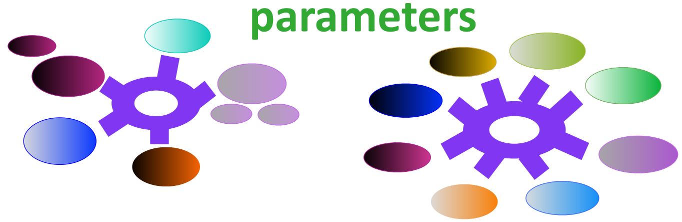
Pearl 2016, Pearl, Ho, & Detrano 2016

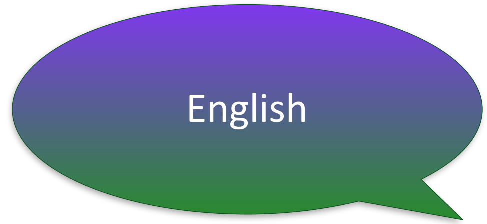
$$\frac{N}{ln(N)}$$

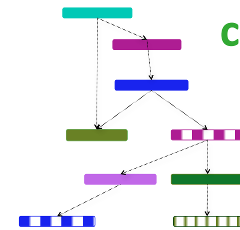
Tolerance Principle

metrical phonology

parameters

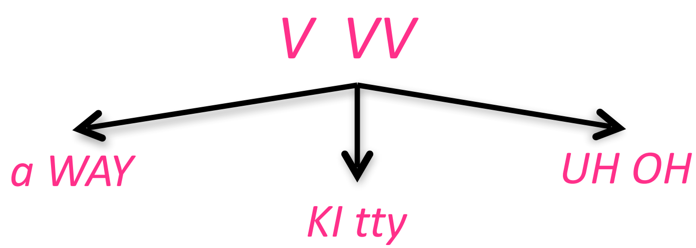






constraints

If no contour is dominant, the learner should ignore this syllable word form for the purposes of learning the grammar since there is no obvious regularity to account for.



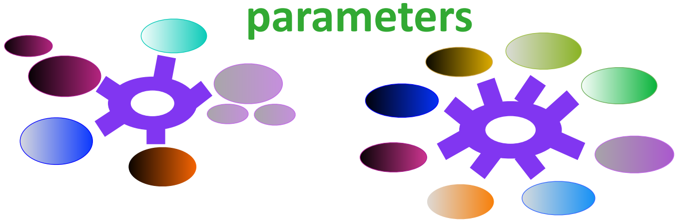
Pearl 2016, Pearl, Ho, & Detrano 2016

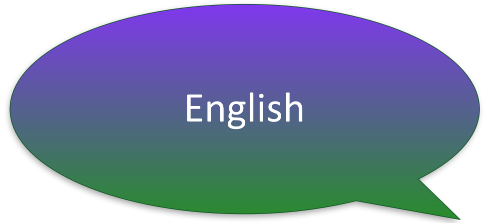
$$\frac{N}{ln(N)}$$

Tolerance Principle

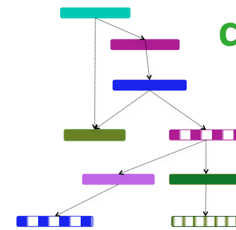
metrical phonology

parameters

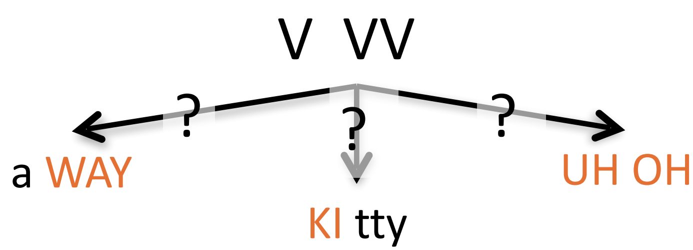




constraints



Productive data filter in action

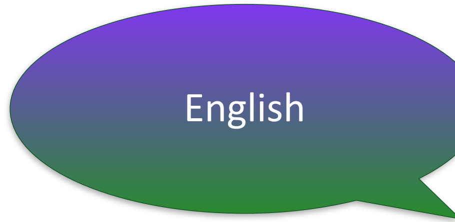


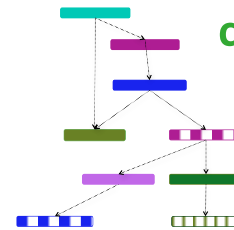
Pearl 2016, Pearl, Ho, & Detrano 2016

$$\frac{N}{ln(N)}$$

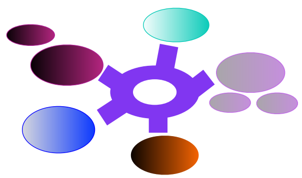
Tolerance Principle

metrical phonology

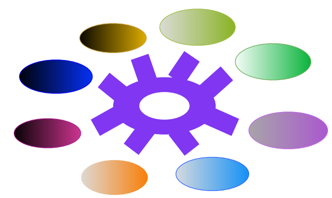




constraints



parameters



HV

Hayes

V VV

? ? ?

a WAY

162 types
3713 tokens

KI tty

325 types
12709 tokens

UH OH

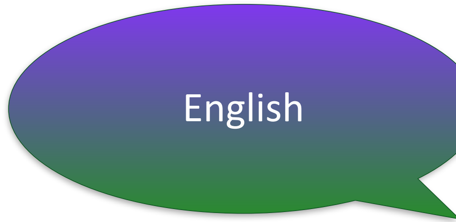
19 types
1509 tokens

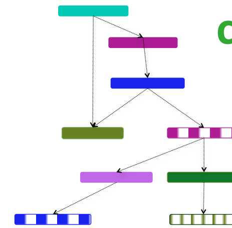
Pearl 2016, Pearl, Ho, & Detrano 2016

$\frac{N}{ln(N)}$

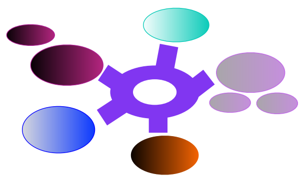
Tolerance Principle

metrical phonology

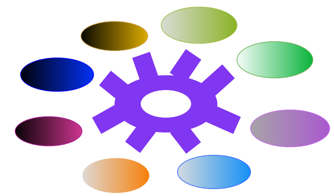




constraints



parameters



HV

Hayes

V VV

? ? ?

a WAY

162 types
3713 tokens

KI tty

325 types
12709 tokens

UH OH

19 types
1509 tokens

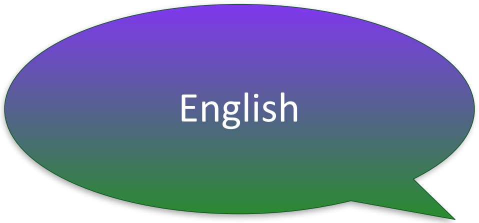
These items are good for the HV English grammar.

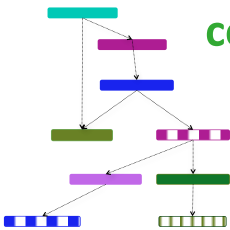
Pearl 2016, Pearl, Ho, & Detrano 2016

$$\frac{N}{ln(N)}$$

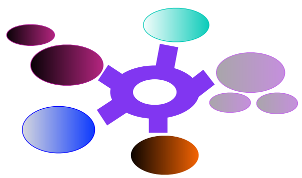
Tolerance Principle

metrical phonology

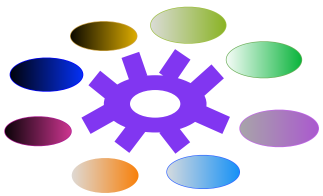




constraints



parameters



HV

Hayes

V VV

? ? ?

a WAY

162 types
3713 tokens

KI tty

325 types
12709 tokens

✓ ✗

UH OH

19 types
1509 tokens

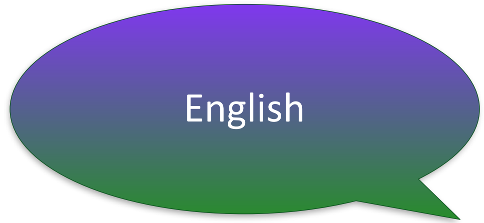
but bad for the Hayes English grammar

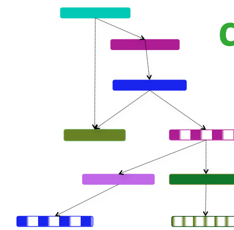
Pearl 2016, Pearl, Ho, & Detrano 2016

$$\frac{N}{ln(N)}$$

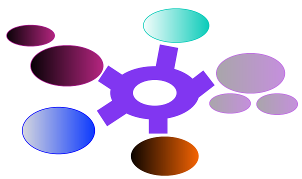
Tolerance Principle

metrical phonology

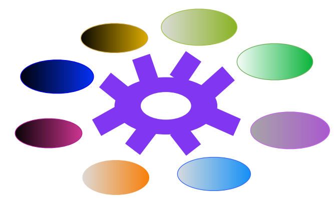




constraints



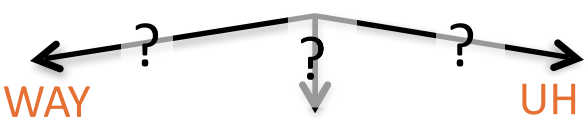
parameters



HV

Hayes

V VV



a WAY

162 types
3713 tokens

✗

KI tty

325 types
12709 tokens

✓ ✗

UH OH

19 types
1509 tokens

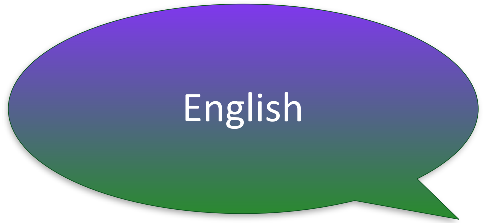
These items are bad for the HV English grammar.

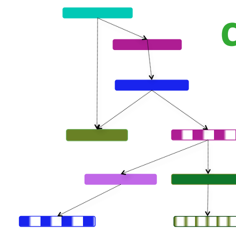
Pearl 2016, Pearl, Ho, & Detrano 2016

$$\frac{N}{ln(N)}$$

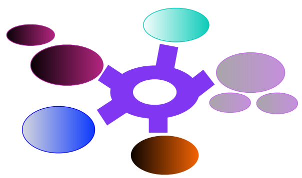
Tolerance Principle

metrical phonology

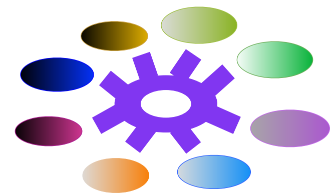




constraints



parameters



HV

Hayes

V VV

? ? ?

a WAY

162 types
3713 tokens

✗ ✓

but good for the Hayes grammar.

KI tty

325 types
12709 tokens

✓ ✗

UH OH

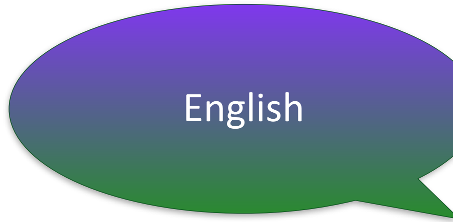
19 types
1509 tokens

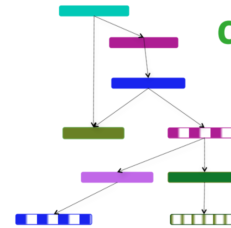
Pearl 2016, Pearl, Ho, & Detrano 2016

$$\frac{N}{ln(N)}$$

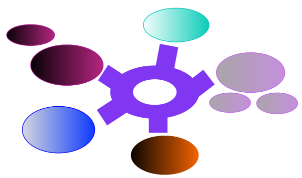
Tolerance Principle

metrical phonology

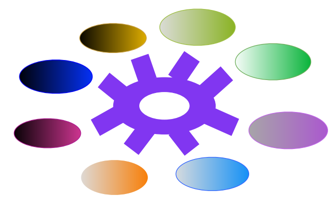




constraints



parameters



HV

Hayes

V VV

? ? ?

a WAY	KI tty	UH OH
162 types *3713 tokens*	**325 types** *12709 tokens*	**19 types** *1509 tokens*
✗ ✓	✓ ✗	✗ ✗

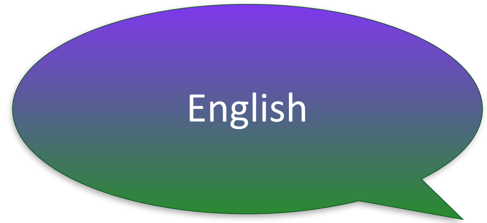
These are bad for both grammars.

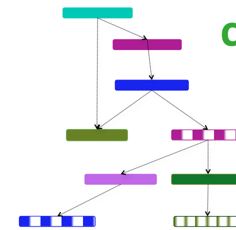
Pearl 2016, Pearl, Ho, & Detrano 2016

$$\frac{N}{ln(N)}$$

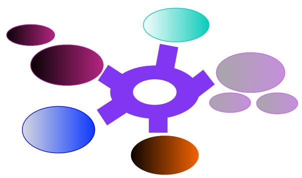
Tolerance Principle

metrical phonology

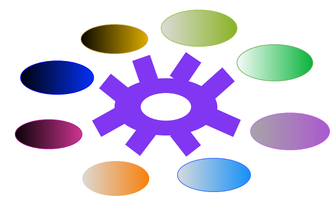




constraints



parameters



HV

Hayes

V VV

? ? ?

a WAY

162 types
3713 tokens

✗ ✓

KI tty

325 types
12709 tokens

✓ ✗

UH OH

19 types
1509 tokens

✗ ✗

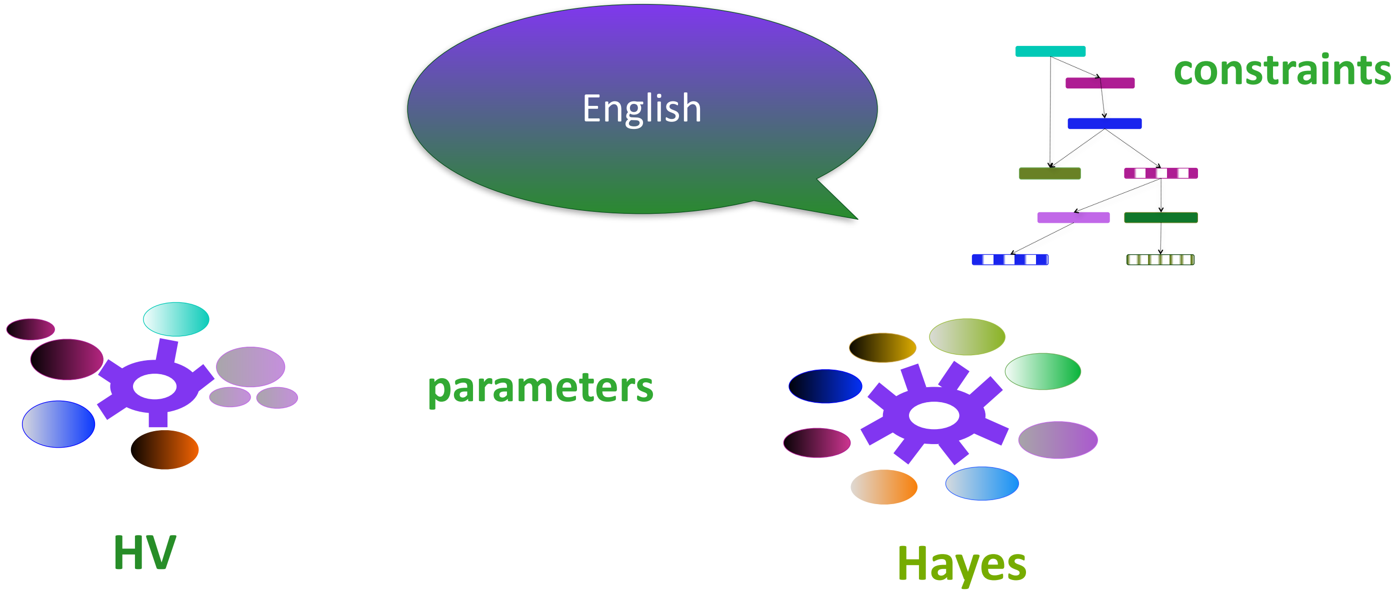
The Tolerance Principle looks at the **word types** for each stress pattern. Each type represents an individual item that might follow the regular stress pattern rule (if there is one).

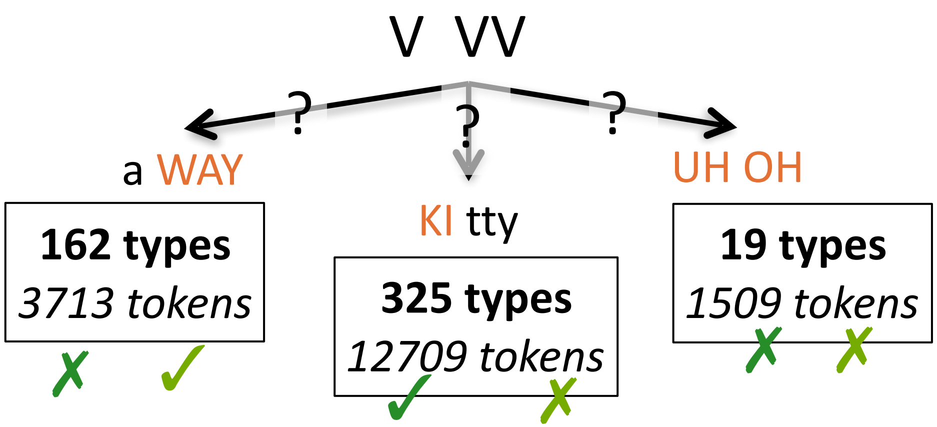
Pearl 2016, Pearl, Ho, & Detrano 2016

$$\frac{N}{ln(N)}$$

Tolerance Principle

metrical phonology



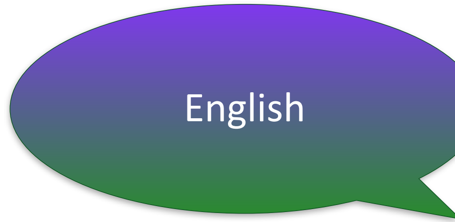


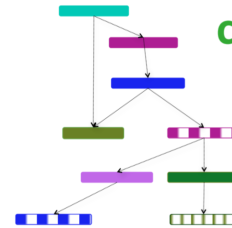
It doesn't matter how frequently a type appears (which is what "tokens" indicates).

Pearl 2016, Pearl, Ho, & Detrano 2016

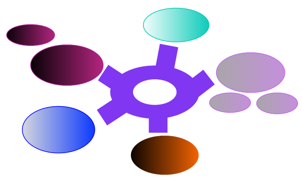
Tolerance Principle

metrical phonology

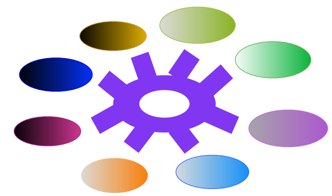




constraints

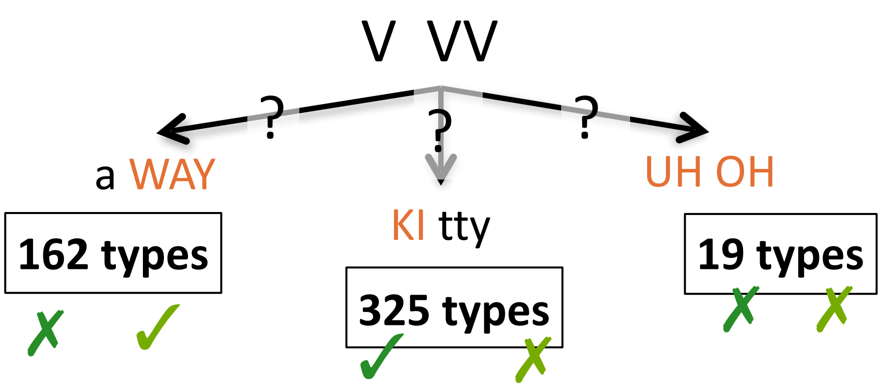


parameters



HV

Hayes



How many items should the stress "rule" apply to?

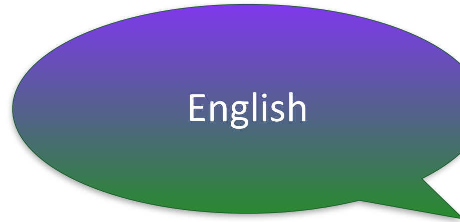
N = 162 + 325 + 19 = 506

$$\frac{N}{ln(N)}$$

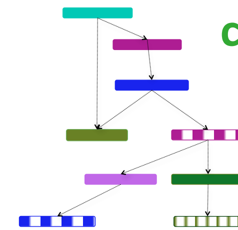
Pearl 2016, Pearl, Ho, & Detrano 2016

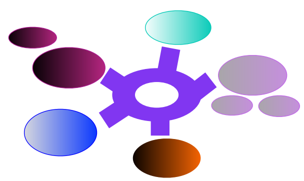
Tolerance Principle

metrical phonology

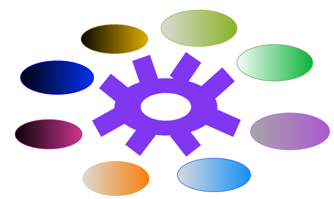


constraints





parameters



HV

Hayes

V VV

? ? ?

a WAY

162 types

✗ ✓

KI tty

325 types

✓ ✗

UH OH

19 types

✗ ✗

How many exceptions are allowed?

506 / ln(506) = **81** $\frac{N}{ln(N)}$

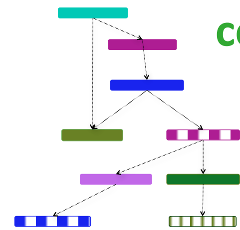
Pearl 2016, Pearl, Ho, & Detrano 2016

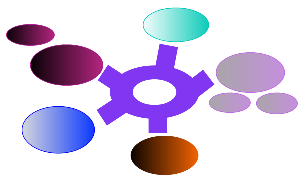
Tolerance Principle

metrical phonology

English

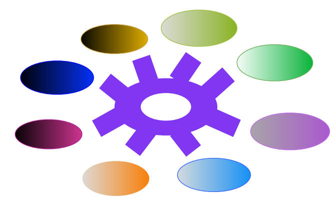
constraints





HV

parameters



Hayes

V VV

? ? ?

a WAY

162 types

✗ ✓

KI tty

325 types

✓ ✗

UH OH

19 types

✗ ✗

If this is the dominant pattern,
too many exceptions:
325 + 19 > 81

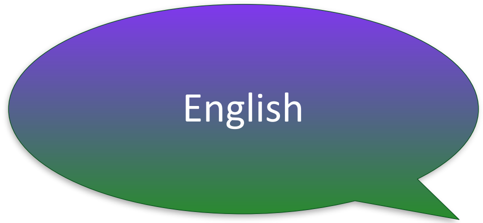
How many exceptions
are allowed?
506 / ln(506) = **81**

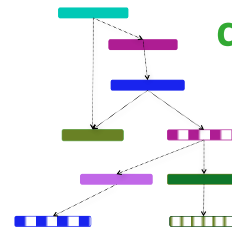
$$\frac{N}{ln(N)}$$

Pearl 2016, Pearl, Ho, & Detrano 2016

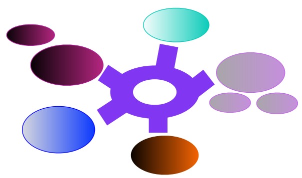
Tolerance Principle

metrical phonology

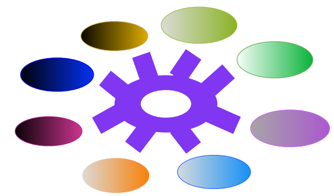




constraints



parameters



HV

Hayes

V VV

? ? ?

a WAY

162 types

✗ ✓

KI tty

325 types

✓ ✗

UH OH

19 types

✗ ✗

If this is the dominant pattern,
too many exceptions:
162 + 19 > 81

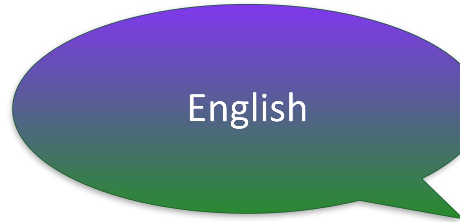
How many exceptions
are allowed?
506 / ln(506) = **81**

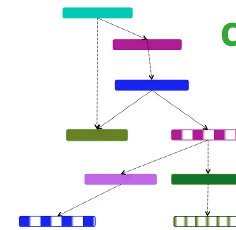
$$\frac{N}{ln(N)}$$

Pearl 2016, Pearl, Ho, & Detrano 2016

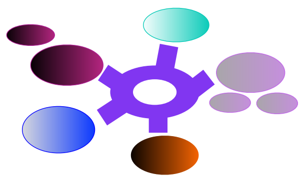
Tolerance Principle

metrical phonology

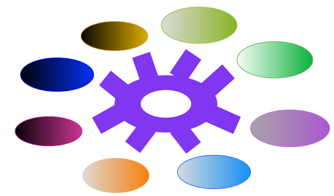




constraints



parameters



HV

Hayes

V VV

? ? ?

a WAY

162 types

✗ ✓

KI tty

325 types

✓ ✗

UH OH

19 types

✗ ✗

If this is the dominant pattern,
way too many exceptions:
162 + 325 > 81

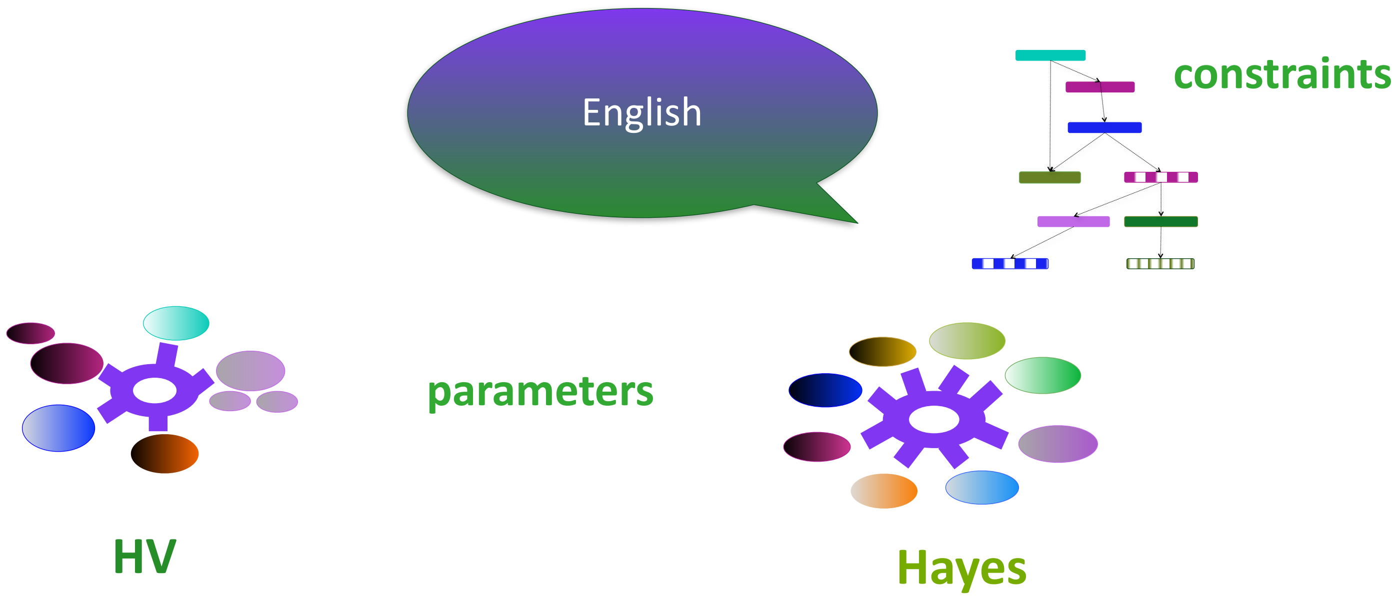
How many exceptions
are allowed?
506 / ln(506) = **81**

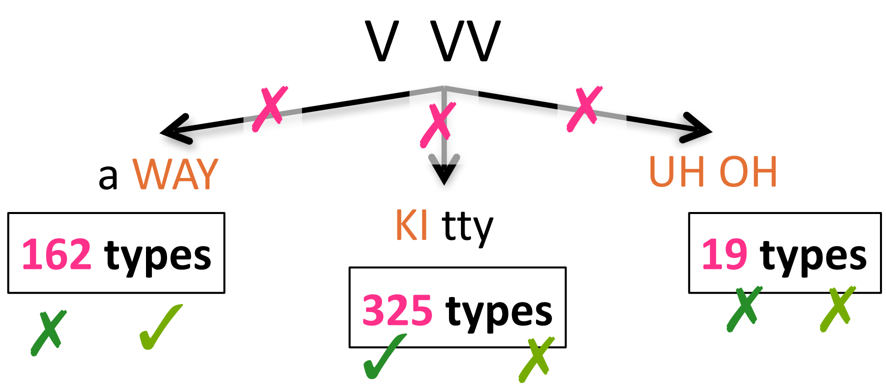
$$\frac{N}{ln(N)}$$

Pearl 2016, Pearl, Ho, & Detrano 2016

Tolerance Principle

metrical phonology





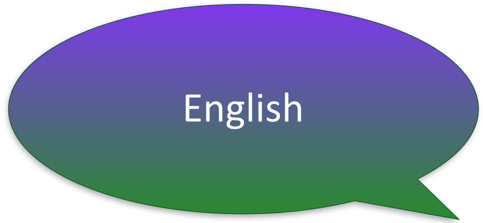
Learner conclusion: No dominant stress pattern, so none of these syllable word form data should be used to learn the English grammar.

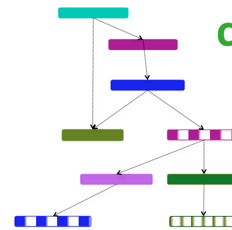
$$\frac{N}{ln(N)}$$

Pearl 2016, Pearl, Ho, & Detrano 2016

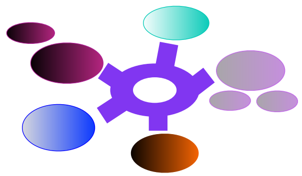
Tolerance Principle

metrical phonology

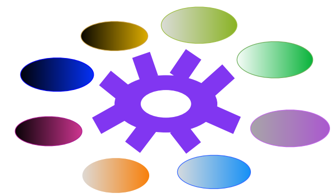




constraints

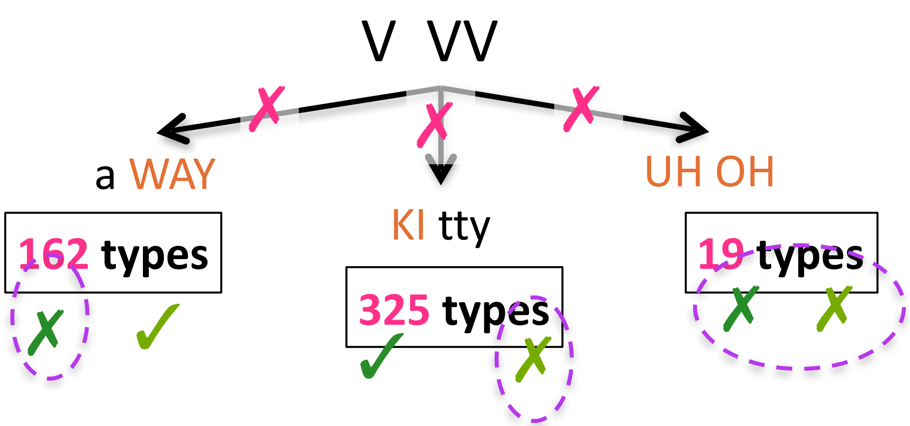


parameters



HV

Hayes



This will end up helping both grammars, since they won't be penalized for the patterns they can't account for.

$$\frac{N}{ln(N)}$$

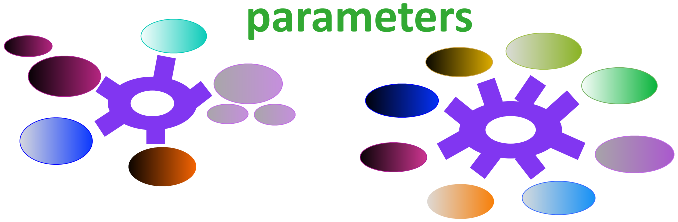
Pearl 2016, Pearl, Ho, & Detrano 2016

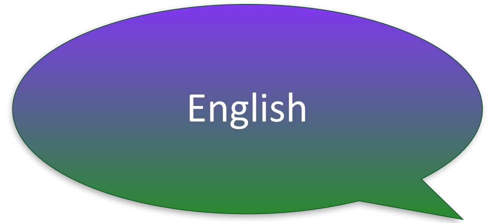
$$\frac{N}{ln(N)}$$

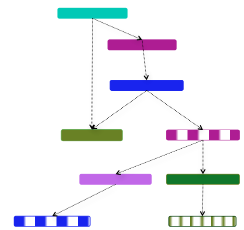
Tolerance Principle

metrical phonology

parameters

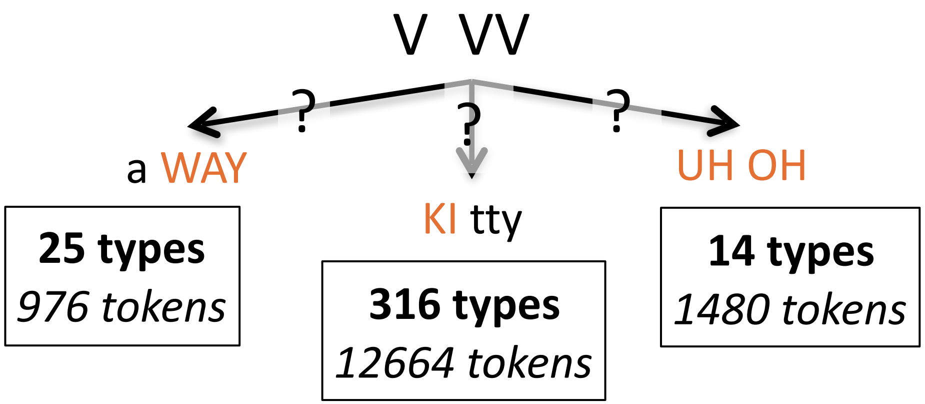






constraints

OT



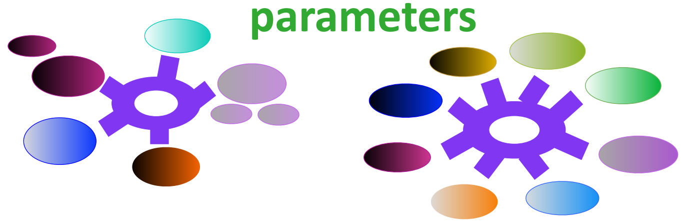
Pearl 2016, Pearl, Ho, & Detrano 2016

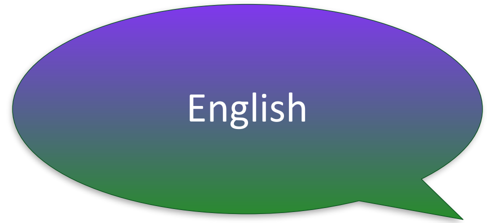
$$\frac{N}{ln(N)}$$

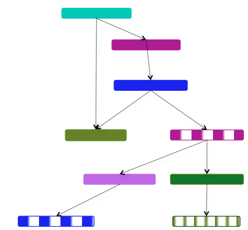
Tolerance Principle

metrical phonology

parameters







constraints

OT

V VV

? ? ?

a WAY

25 types
976 tokens

KI tty

316 types
12664 tokens
✗

UH OH

14 types
1480 tokens

These items are bad for all English grammars.

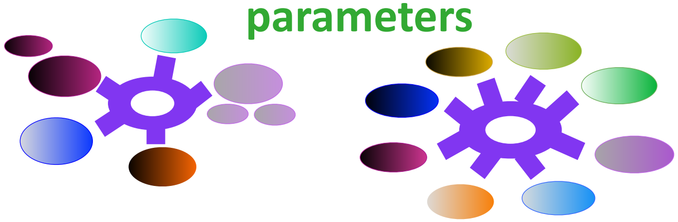
Pearl 2016, Pearl, Ho, & Detrano 2016

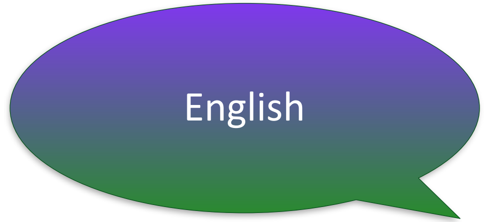
$$\frac{N}{ln(N)}$$

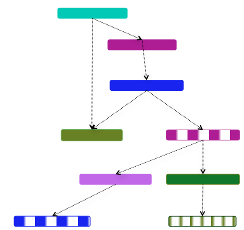
Tolerance Principle

metrical phonology

parameters



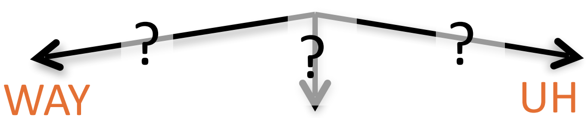




constraints

OT

V VV



a WAY

25 types

976 tokens

✓

KI tty

316 types

12664 tokens

✗

UH OH

14 types

1480 tokens

These items are good for most English grammars (21/26).

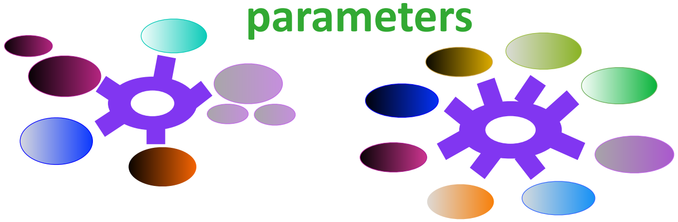
Pearl 2016, Pearl, Ho, & Detrano 2016

$$\frac{N}{ln(N)}$$

Tolerance Principle

metrical phonology

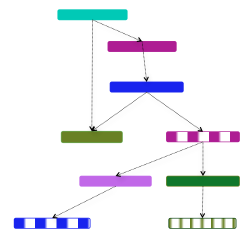
parameters



English

constraints

OT



V VV

? ? ?

a WAY

KI tty

UH OH

25 types	316 types	14 types
976 tokens	*12664 tokens*	*1480 tokens*
✓	✗	✗✓

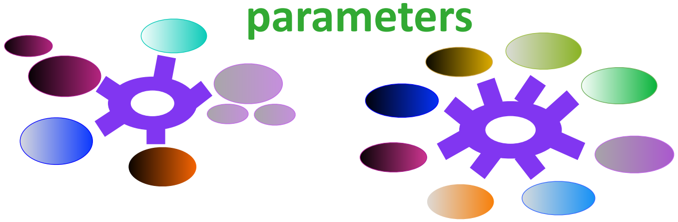
These items are good for a few English grammars (5/26).

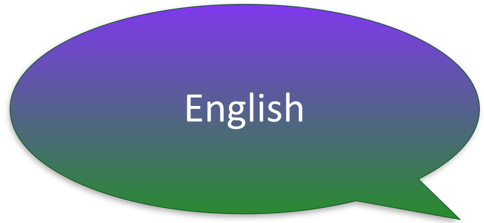
Pearl 2016, Pearl, Ho, & Detrano 2016

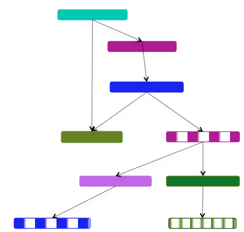
Tolerance Principle

metrical phonology

parameters







constraints

OT

V VV

? ? ?

a WAY

25 types

✓

KI tty

316 types

✗

UH OH

14 types

✗✓

How many items should the stress "rule" apply to?

N = 25 + 316 + 14 = 355

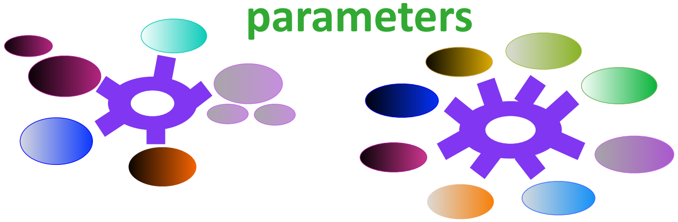
$$\frac{N}{ln(N)}$$

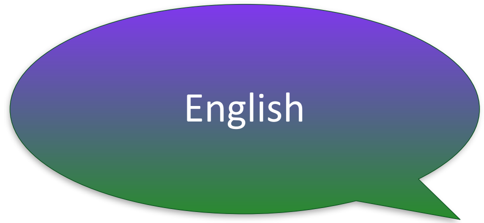
Pearl 2016, Pearl, Ho, & Detrano 2016

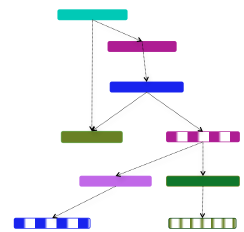
Tolerance Principle

metrical phonology

parameters



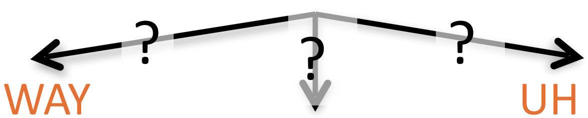




constraints

OT

V VV



a WAY

25 types ✓

KI tty

316 types ✗

UH OH

14 types ✗✓

How many exceptions are allowed?

355 / ln(355) = **60**

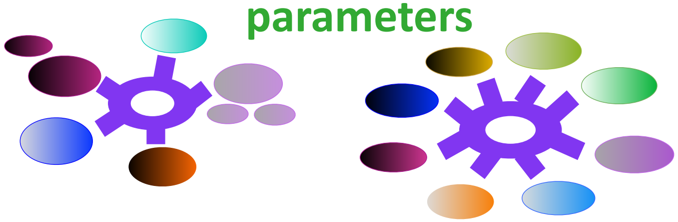
$$\frac{N}{ln(N)}$$

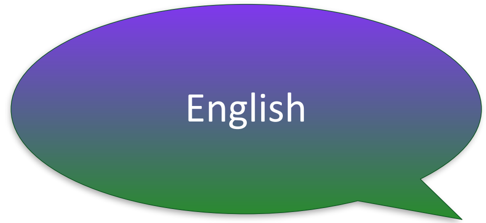
Pearl 2016, Pearl, Ho, & Detrano 2016

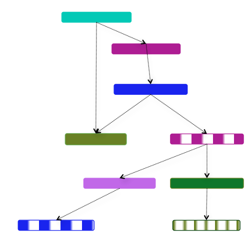
Tolerance Principle

metrical phonology

parameters



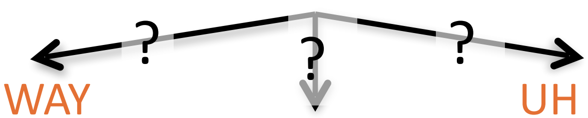




constraints

OT

V VV



a WAY

25 types ✓

KI tty

316 types ✗

UH OH

14 types ✗✓

How many exceptions are allowed?

355 / ln(355) = **60**

$$\frac{N}{ln(N)}$$

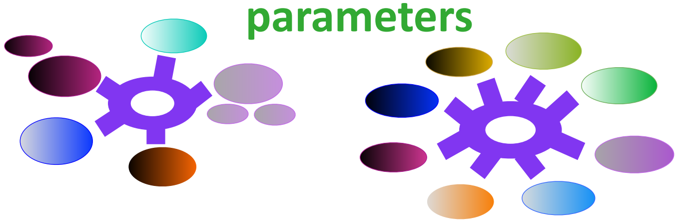
If this is the dominant pattern, too many exceptions:
316 + 14 > 60

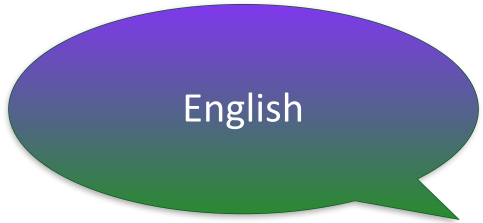
Pearl 2016, Pearl, Ho, & Detrano 2016

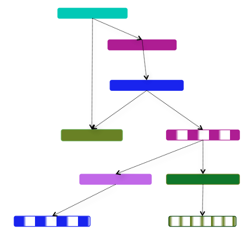
Tolerance Principle

metrical phonology

parameters



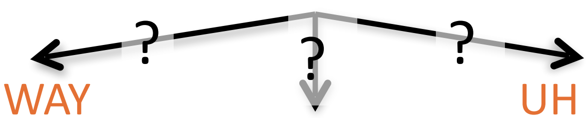




constraints

OT

V VV



a WAY

25 types ✓

KI tty

316 types ✗

UH OH

14 types ✗✓

How many exceptions are allowed?

355 / ln(355) = **60**

$$\frac{N}{ln(N)}$$

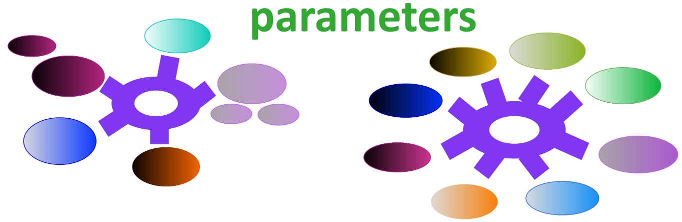
If this is the dominant pattern, NOT too many exceptions:
25 + 14 < 60

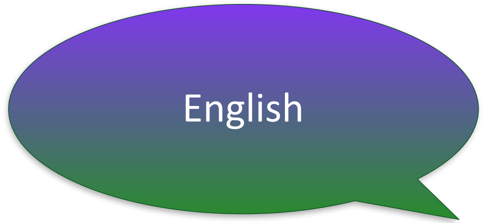
Pearl 2016, Pearl, Ho, & Detrano 2016

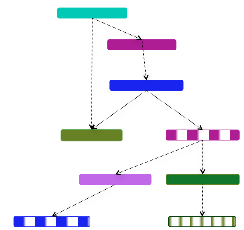
Tolerance Principle

metrical phonology

parameters



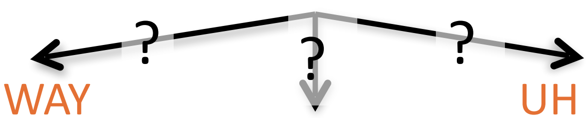




constraints

OT

V VV



a WAY

25 types ✓

KI tty

316 types ✗

UH OH

14 types ✗✓

If this is the dominant pattern, too many exceptions:
25 + 316 > 60

How many exceptions are allowed?

355 / ln(355) = **60**

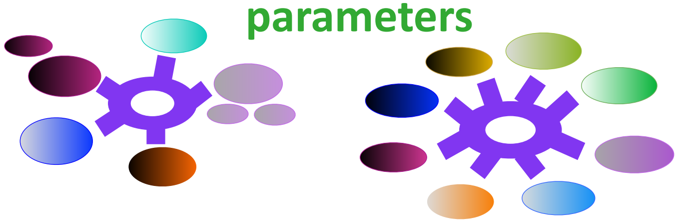
$$\frac{N}{ln(N)}$$

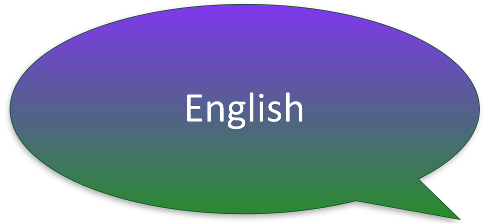
Pearl 2016, Pearl, Ho, & Detrano 2016

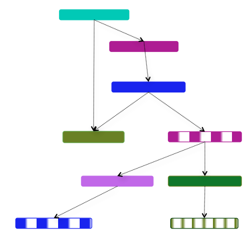
Tolerance Principle

metrical phonology

parameters

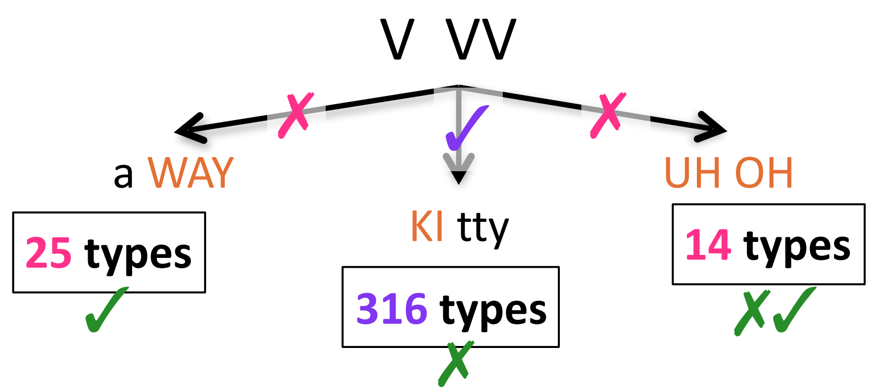






constraints

OT



How many exceptions are allowed?

355 / ln(355) = **60**

$$\frac{N}{ln(N)}$$

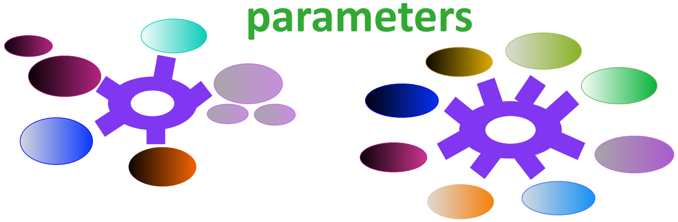
Pearl 2016, Pearl, Ho, & Detrano 2016

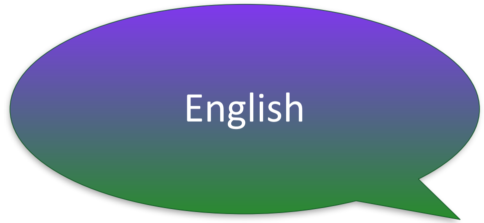
$$\frac{N}{ln(N)}$$

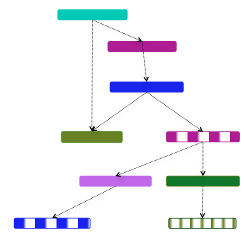
Tolerance Principle

metrical phonology

parameters



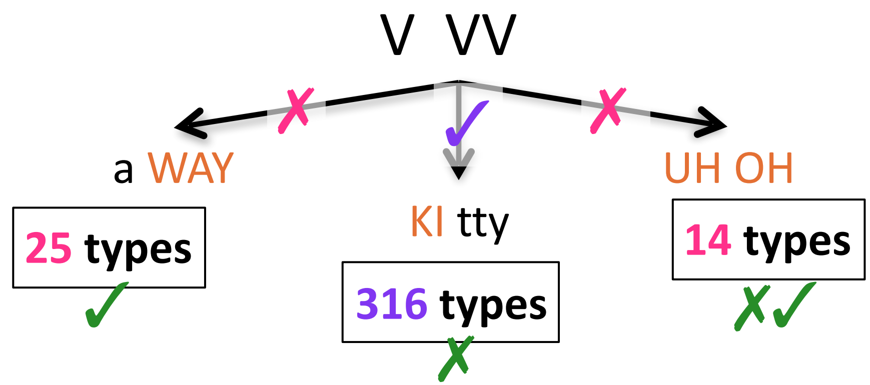




constraints

OT

Under the OT syllable representation, there is a dominant stress pattern for this word form. Therefore, this pattern should be accounted for by the English grammar and included in the acquisitional intake.



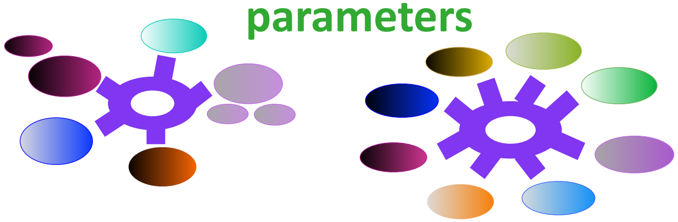
Pearl 2016, Pearl, Ho, & Detrano 2016

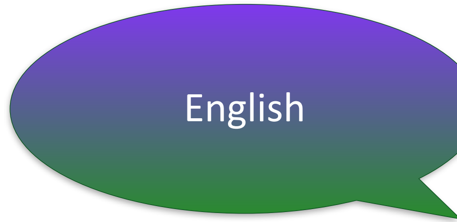
$$\frac{N}{ln(N)}$$

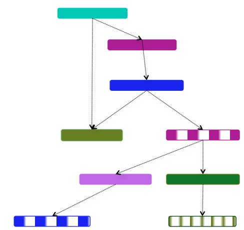
Tolerance Principle

metrical phonology

parameters



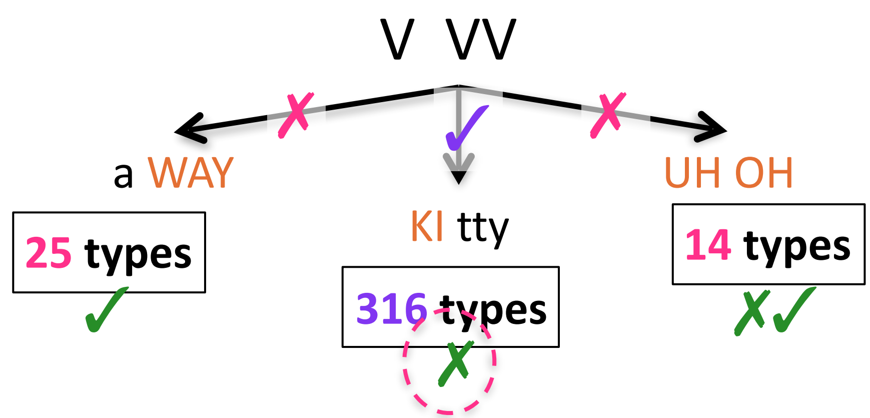




constraints

OT

Unfortunately, for the OT English constraint ranking, this is the only pattern the English grammars can't account for….this means a learner using the productivity filter would have even more trouble learning.

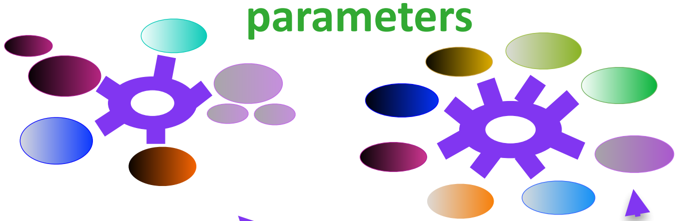


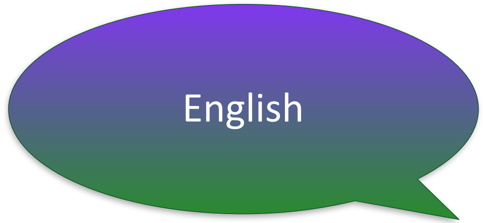
Pearl 2016, Pearl, Ho, & Detrano 2016

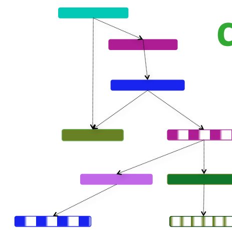
Knowledge representation comparison

metrical phonology

parameters







constraints

Updated working assumption: The learner will try to learn a grammar that can account for all the productive data encountered (Legate & Yang 2012).

Principled way to implement this = Tolerance Principle

Productive data filter

COO kie

DA ddy

FU nny

a WAY

be LOW

to DAY

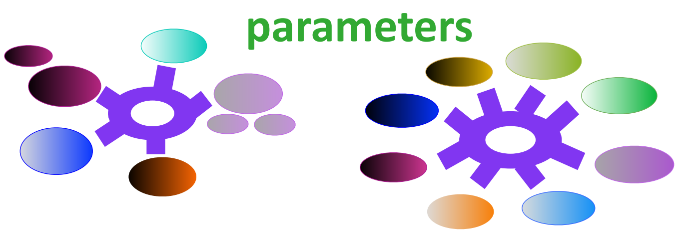
Syllabic word form:

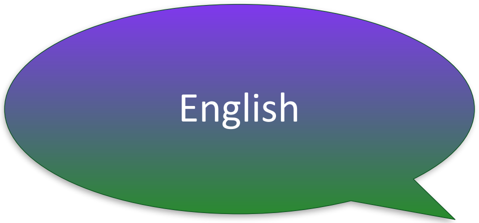
V VV

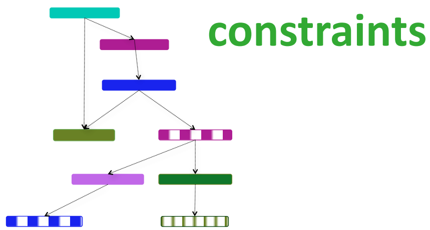
Pearl 2016, Pearl, Ho, & Detrano 2016

Knowledge representation comparison

metrical phonology







Now it turns out that all three English grammars are compatible with 63-87% of the data in productive English child-directed speech.

Not too bad!

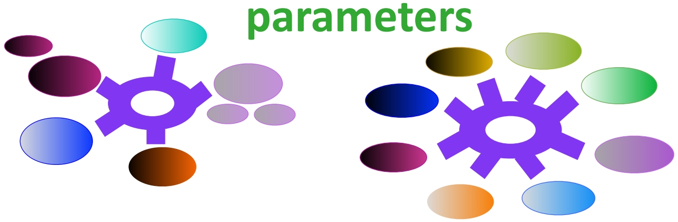
And definitely an improvement over 49-59%!

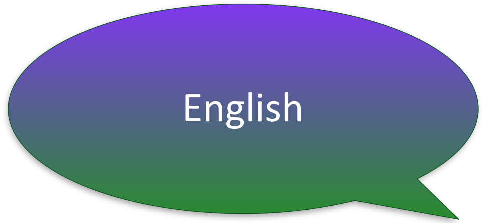
Pearl 2016, Pearl, Ho, & Detrano 2016

Knowledge representation comparison

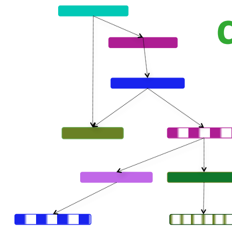
metrical phonology

parameters





constraints



Now it turns out that all three English grammars are compatible with 63-87% of the data in productive English child-directed speech.

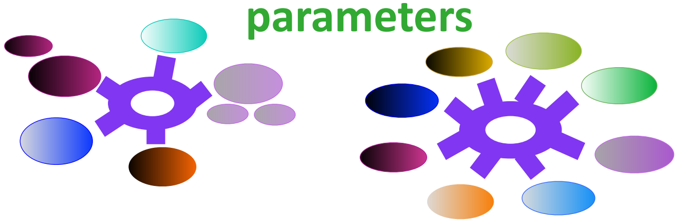
But how does this compare to other possible grammars in the hypothesis space?

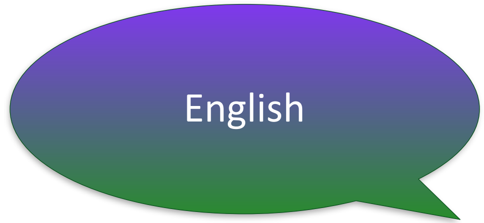
Pearl 2016, Pearl, Ho, & Detrano 2016

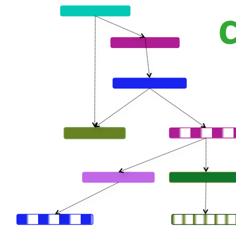
Knowledge representation comparison

metrical phonology

parameters







constraints

Now it turns out that all three English grammars are compatible with 63-87% of the data in productive English child-directed speech.

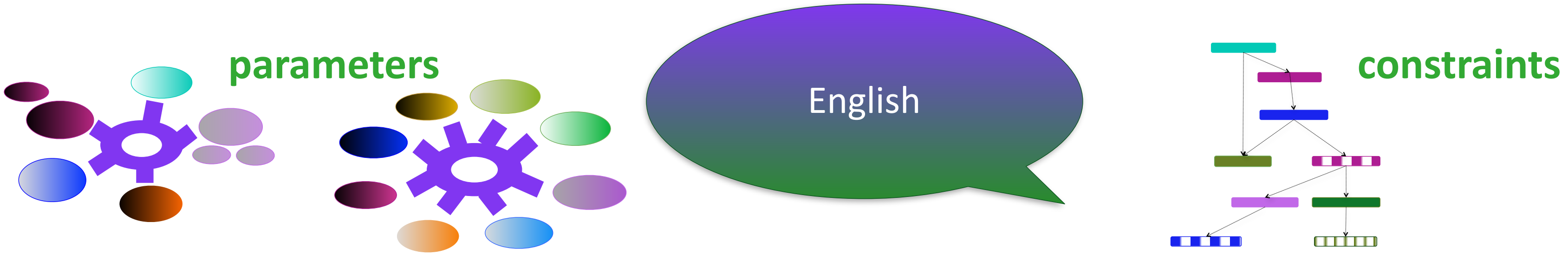
It turns out that this is worse compatibility than tens (HV), hundreds (Hayes), or tens of thousands (OT) of other possible grammars.

Uh oh!!

Pearl 2016, Pearl, Ho, & Detrano 2016

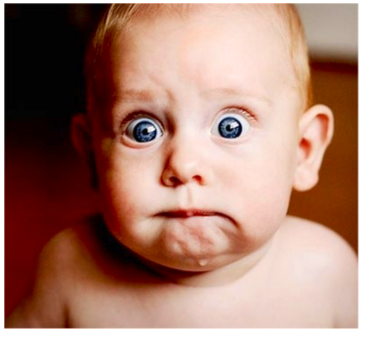
Knowledge representation comparison

metrical phonology



Now it turns out that all three English grammars are compatible with 63-87% of the data in productive English child-directed speech.

This means the best grammar options for English data aren't the ones currently proposed for English.



Which ones do better?

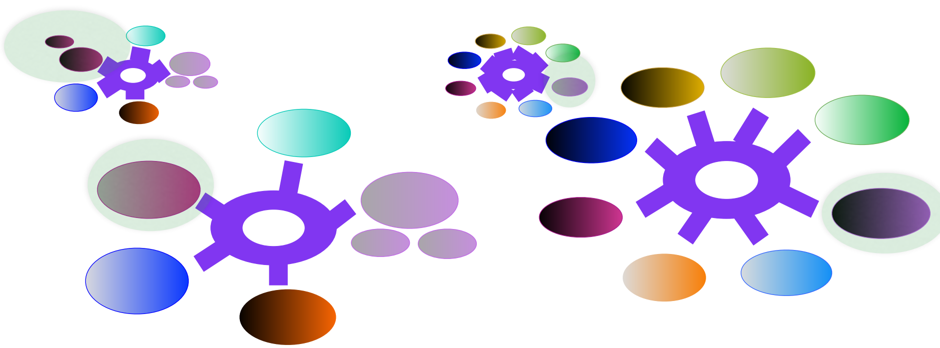
Pearl 2016, Pearl, Ho, & Detrano 2016

Knowledge representation comparison

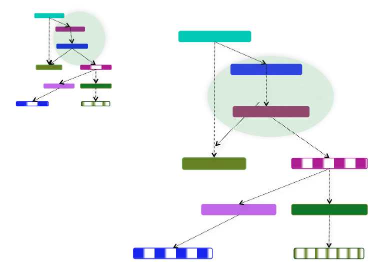
metrical phonology

English

parameters



constraints

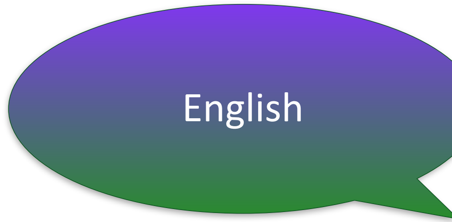


Other options (differing very slightly) are much more easily learnable - these grammars have much higher English child-directed speech data coverage when a productive data filter is in place: **84-93%**.

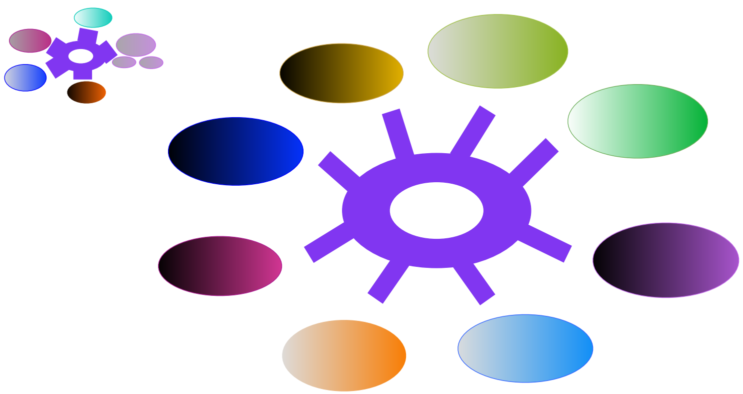
Pearl 2016, Pearl, Ho, & Detrano 2016

Knowledge representation comparison

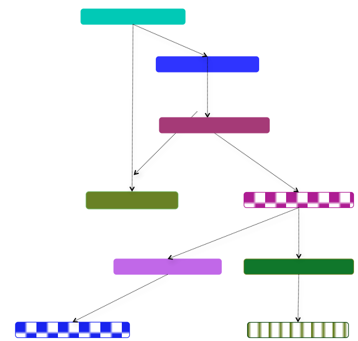
metrical phonology



parameters



constraints



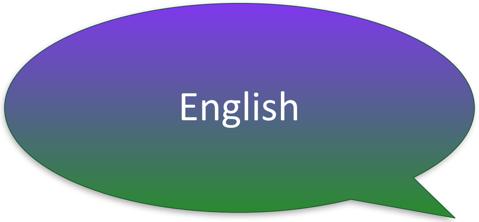
And two of these other options are better than 96-99% of all the other grammars available! This makes them much more easily learnable.

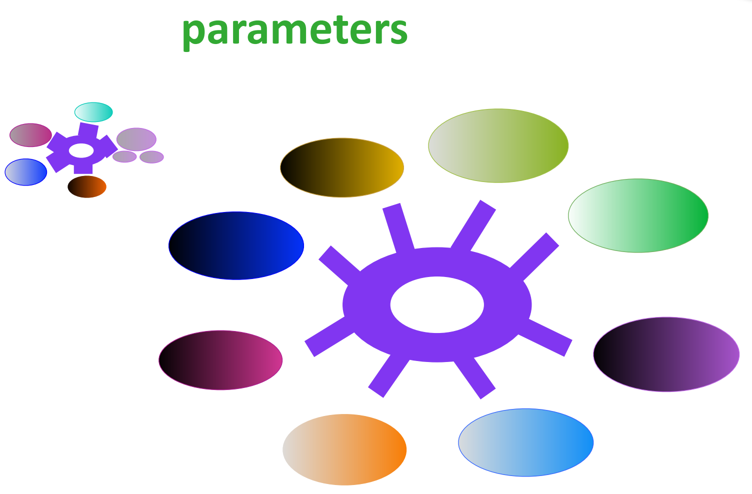
Implication: Maybe these are a better description of the knowledge representation for the English metrical phonology grammar.

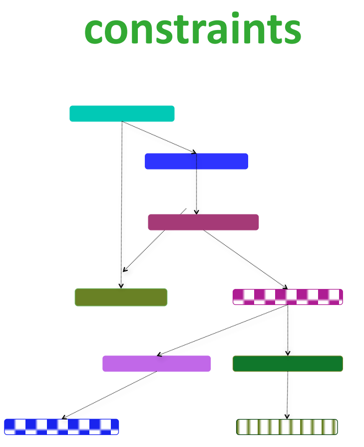
Pearl 2016, Pearl, Ho, & Detrano 2016

Knowledge representation comparison

metrical phonology







By modeling acquisition, we provide support for these two theories of English representation in metrical phonology.

Pearl 2016, Pearl, Ho, & Detrano 2016

Recap

Linguistic knowledge can be represented by different types of abstract knowledge, such as linguistic parameters or linguistic constraints.

There are many cases where multiple options have been proposed for a knowledge representation, and acquisition modeling can be used to evaluate the options.

For learning English metrical phonology, one important aspect is a productive data filter, because there are so many exceptions.

One principled way to implement a productive data filter is with the Tolerance Principle.

Questions?

You should be able to do all the questions on the structure review questions and all of HW8.

Three knowledge representations

Parametric systems

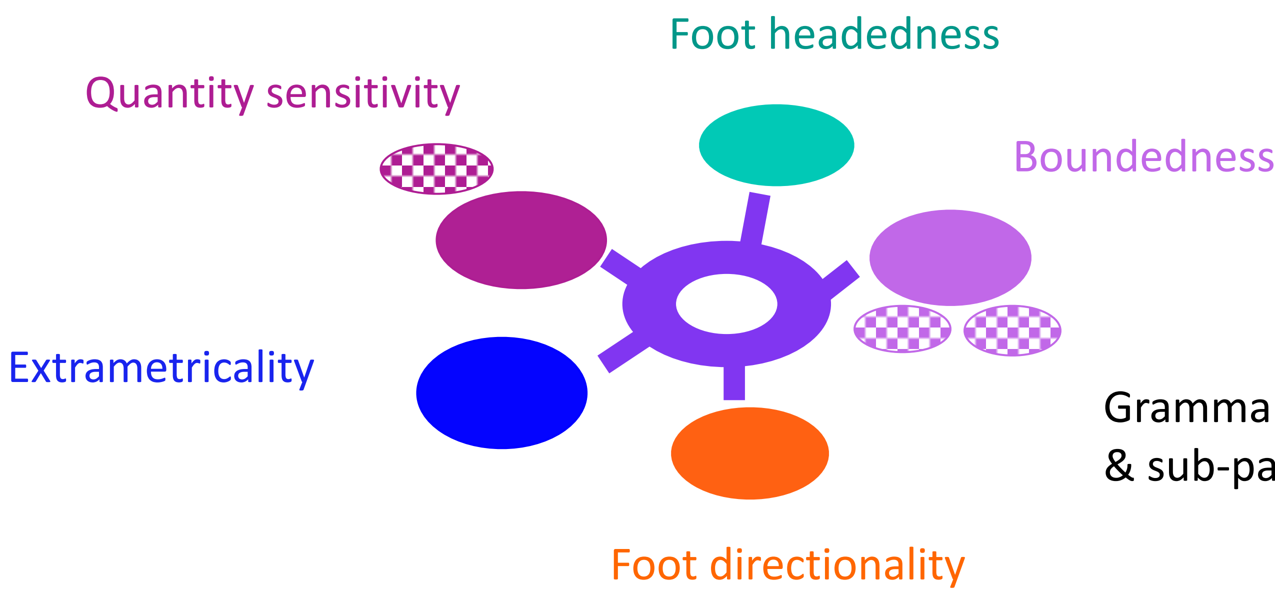
Correct grammar builds compatible contour

OCtopus

HV: Halle & Vergnaud 1987, Dresher 1999, Pearl 2011

5 parameters & 3 sub-parameters

Hypothesis space: 156 grammars



Grammar = Set of parameter & sub-parameter values

Three knowledge representations

Parametric systems

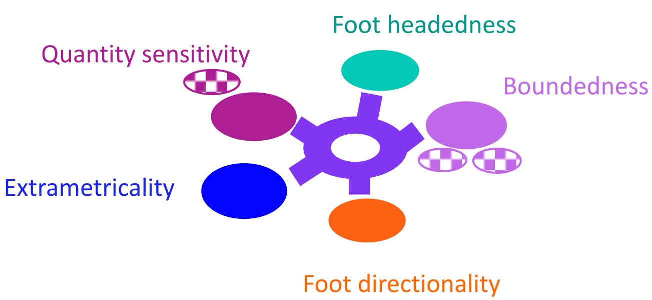
Correct grammar builds compatible contour

HV: Halle & Vergnaud 1987, Dresher 1999, Pearl 2011

5 parameters & 3 sub-parameters

Hypothesis space: 156 grammars

OCtopus



oc to pus

Three knowledge representations

Parametric systems

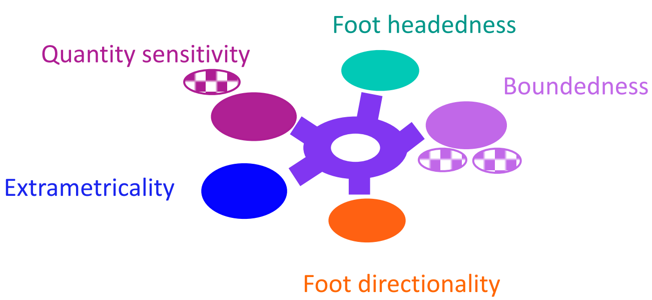
Correct grammar builds compatible contour

OCtopus

HV: Halle & Vergnaud 1987, Dresher 1999, Pearl 2011

5 parameters & 3 sub-parameters

Hypothesis space: 156 grammars



H L H
oc to pus

Quantity sensitivity
Are syllables all identical, or are they differentiated by syllable weight (into Heavy and Light syllables)?

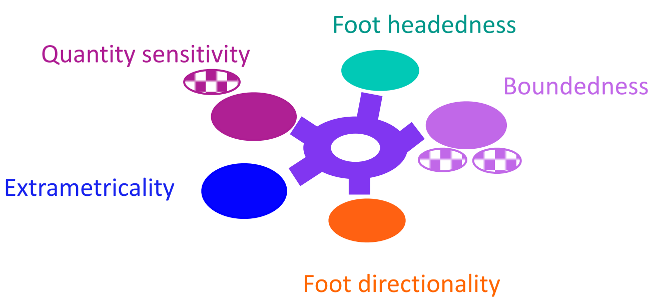
Three knowledge representations

Parametric systems

HV: Halle & Vergnaud 1987, Dresher 1999, Pearl 2011

5 parameters & 3 sub-parameters

Hypothesis space: 156 grammars



Correct grammar builds compatible contour

OCtopus

H L ~~H~~

oc to pus

Extrametricality

Are all syllables included in the larger units of metrical feet, or are some excluded?

Three knowledge representations

Parametric systems

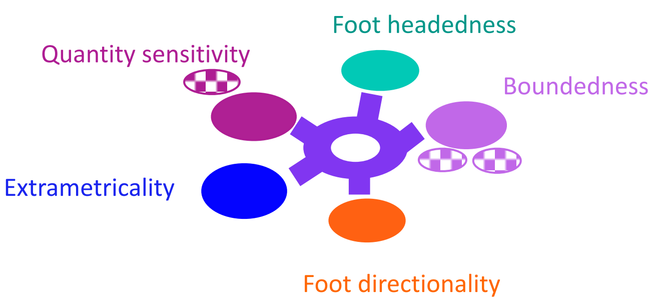
Correct grammar builds compatible contour

OCtopus

HV: Halle & Vergnaud 1987, Dresher 1999, Pearl 2011

5 parameters & 3 sub-parameters

Hypothesis space: 156 grammars



H L) ~~H~~
oc to pus

Foot directionality
Are feet constructed from the left or from the right?

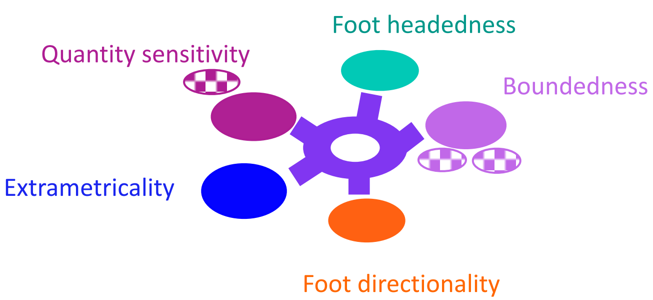
Three knowledge representations

Parametric systems

HV: Halle & Vergnaud 1987, Dresher 1999, Pearl 2011

5 parameters & 3 sub-parameters

Hypothesis space: 156 grammars



Boundedness
How big are metrical feet?

Correct grammar builds compatible contour

OCtopus

(H L) ~~H~~

oc to pus

Three knowledge representations

Parametric systems

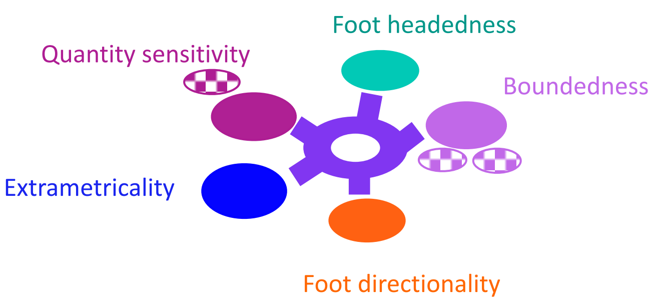
Correct grammar builds compatible contour

OCtopus

HV: Halle & Vergnaud 1987, Dresher 1999, Pearl 2011

5 parameters & 3 sub-parameters

Hypothesis space: 156 grammars



(H L) H
oc to pus

Foot headedness
Which syllable in a foot is stressed?

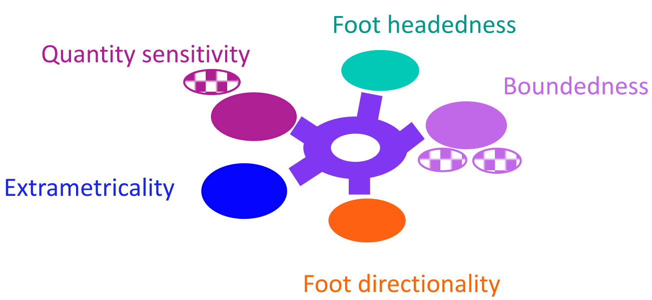
Three knowledge representations

Parametric systems

HV: Halle & Vergnaud 1987, Dresher 1999, Pearl 2011

5 parameters & 3 sub-parameters

Hypothesis space: 156 grammars



Correct grammar builds compatible contour

OCtopus

This grammar, comprised of particular parameter values, generates the correct stress contour.

(H L) H
OC to pus

Parameter values used:
Quantity sensitive, VC syllables = Heavy, Extrametricality on rightmost syllable, Feet built from the right, Foot = 2 syllables, Leftmost syllable in foot stressed

Three knowledge representations

Parametric systems

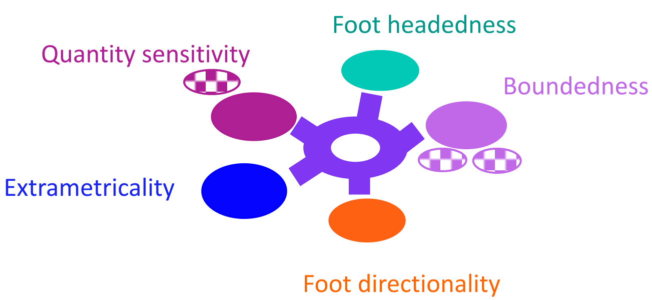
Correct grammar builds compatible contour

OCtopus

HV: Halle & Vergnaud 1987, Dresher 1999, Pearl 2011

5 parameters & 3 sub-parameters

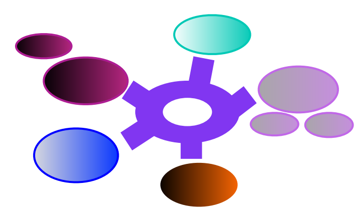
Hypothesis space: 156 grammars



This grammar, comprised of particular parameter values, generates the correct stress contour.

(H L) H
OC to pus

Parameter values used:
QS-VC-H, Em-Rt, FtDir-Rt, B-2-Syl, FtHd-Left



...which are the values of the English grammar.

Three knowledge representations

Parametric systems

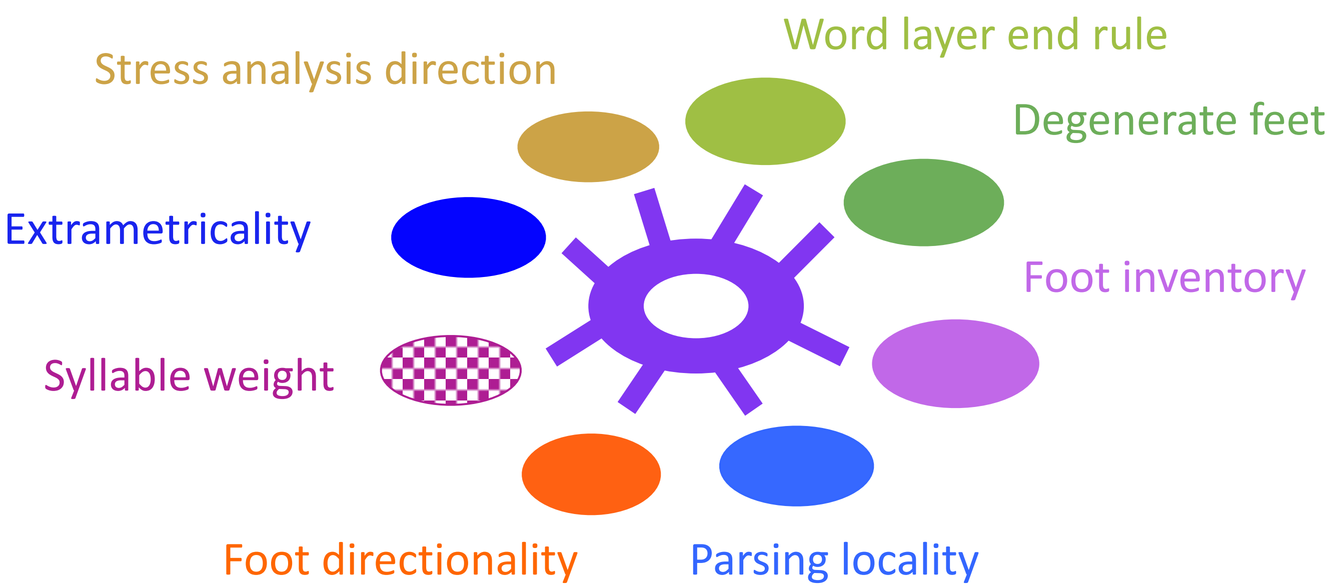
Correct grammar builds
compatible contour

OCtopus

Hayes: Hayes 1995

8 parameters

Hypothesis space: 768 grammars



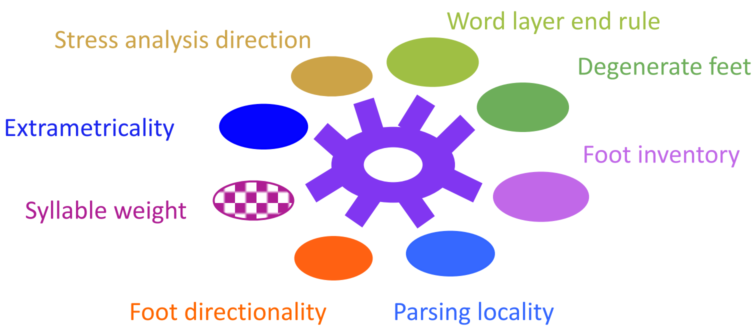
Three knowledge representations

Parametric systems

Hayes: Hayes 1995

8 parameters

Hypothesis space: 768 grammars



Correct grammar builds compatible contour

OCtopus

oc to pus

Three knowledge representations

Parametric systems

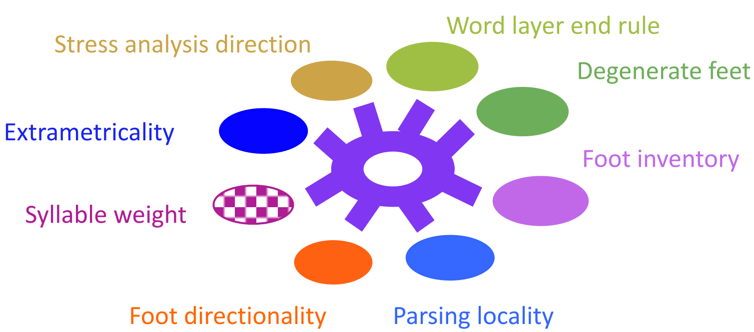
Correct grammar **builds** compatible contour

OCtopus

Hayes: Hayes 1995

8 parameters

Hypothesis space: 768 grammars



(...feet first...)

oc to pus

Stress analysis direction

Are metrical feet created before word-level stress is assigned to the edge syllables or after?

Three knowledge representations

Parametric systems

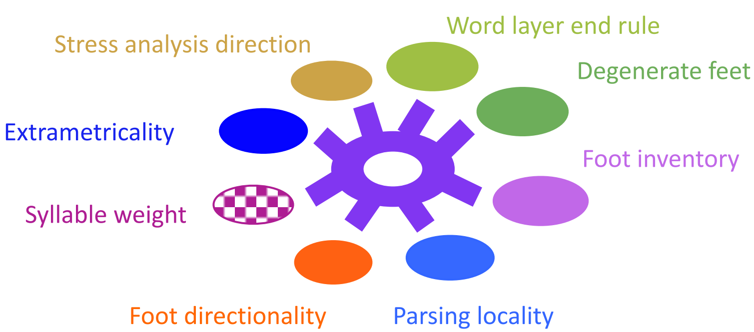
Correct grammar builds compatible contour

OCtopus

Hayes: Hayes 1995

8 parameters

Hypothesis space: 768 grammars



oc to pus

Extrametricality

Are syllables on the edge (or parts of syllables) excluded from metrical feet?

Three knowledge representations

Parametric systems

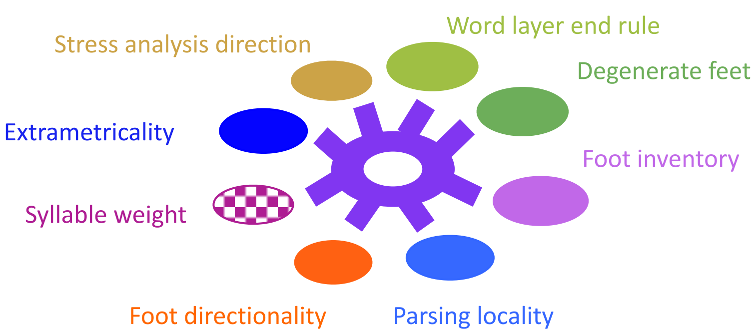
Correct grammar **builds** compatible contour

OCtopus

Hayes: Hayes 1995

8 parameters

Hypothesis space: 768 grammars



H L L

oc to pus

Syllable weight

Syllables are distinguished into Heavy and Light. Are syllables ending in VC (like *oc*) Heavy or Light?

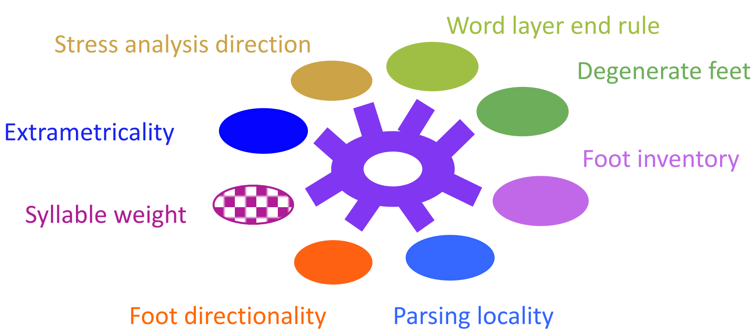
Three knowledge representations

Parametric systems

Hayes: Hayes 1995

8 parameters

Hypothesis space: 768 grammars



Foot directionality
Are metrical feet constructed from the left or the right?

Correct grammar builds compatible contour

OCtopus

H L L)

oc to pus

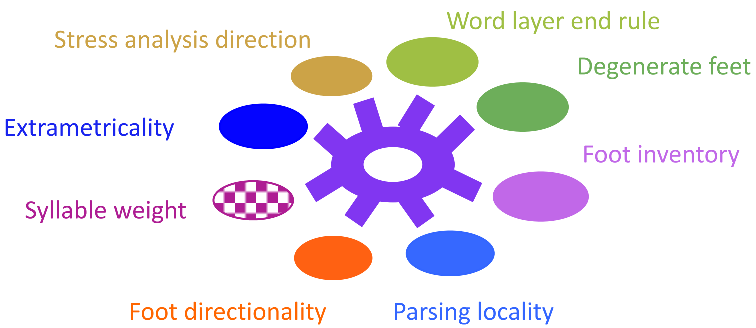
Three knowledge representations

Parametric systems

Hayes: Hayes 1995

8 parameters

Hypothesis space: 768 grammars



Parsing locality
Is one Light syllable skipped between metrical feet?

Correct grammar builds compatible contour

OCtopus

?

H L L

oc to pus

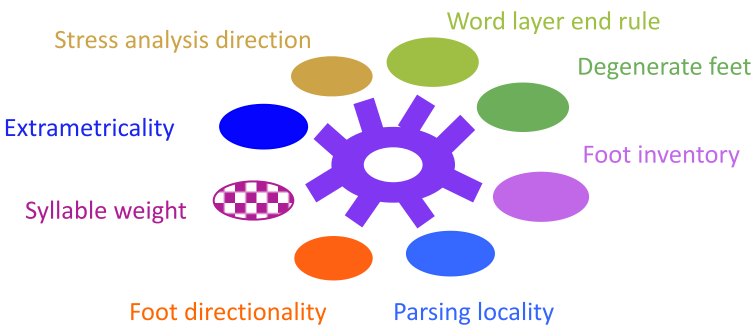
Three knowledge representations

Parametric systems

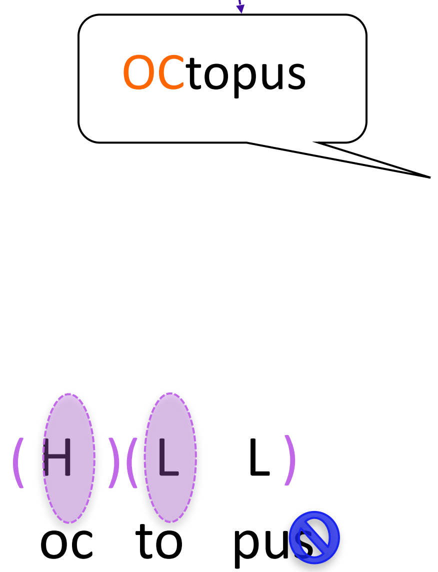
Hayes: Hayes 1995

8 parameters

Hypothesis space: 768 grammars



Correct grammar builds compatible contour



Foot inventory

How big are metrical feet?

Where does the stress fall within them?

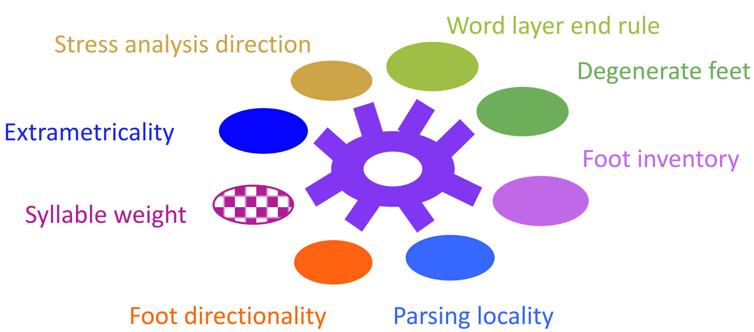
Three knowledge representations

Parametric systems

Hayes: Hayes 1995

8 parameters

Hypothesis space: 768 grammars



Degenerate feet
What do you do with leftover Light syllables if you have any?

Correct grammar builds compatible contour

OCtopus

(H)(L L)
oc to pus

Three knowledge representations

Parametric systems

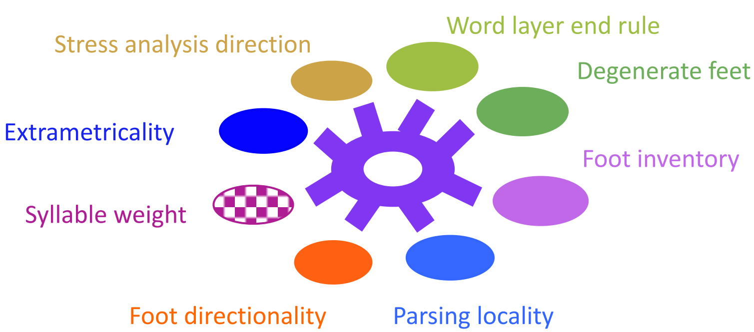
Correct grammar builds compatible contour

OCtopus

Hayes: Hayes 1995

8 parameters

Hypothesis space: 768 grammars



(H)(L L)

oc to pus

Word layer end rule

Where does word-level stress go if there are multiple stressed syllables? Can leftover Light syllables have word-level stress?

Three knowledge representations

Parametric systems

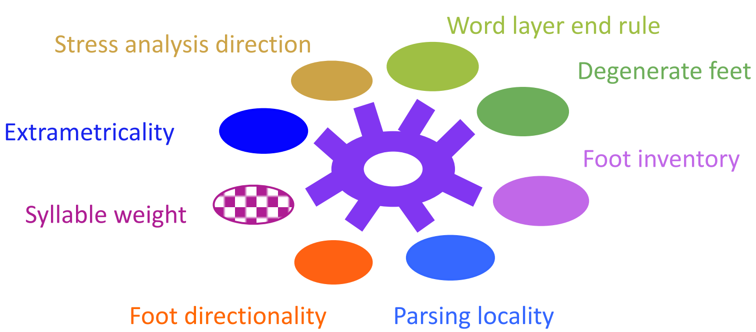
Correct grammar builds compatible contour

OCtopus

Hayes: Hayes 1995

8 parameters

Hypothesis space: 768 grammars



This grammar, comprised of particular parameter values, generates an incorrect stress contour.

(H)(L L)

OC TÓ pus

Parameter values used:

Bottom-up, Extrametricality on rightmost consonant, VC syllables = Heavy, Feet built from the right, Light syllables not skipped in between feet, Foot = Moraic trochee (2 moras with stress on leftmost), Single Light edge syllables not allowed to have stress, Rightmost syllable gets main stress

Three knowledge representations

Parametric systems

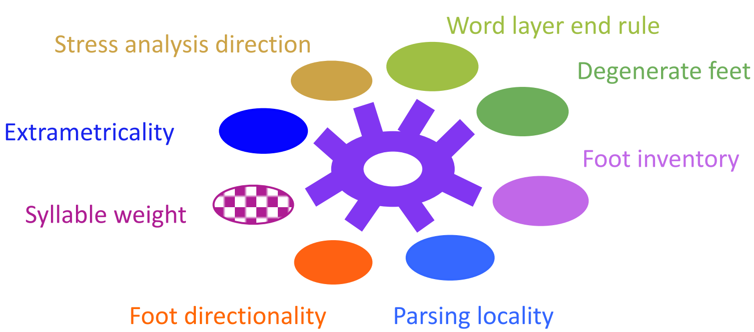
Correct grammar builds compatible contour

OCtopus

Hayes: Hayes 1995

8 parameters

Hypothesis space: 768 grammars



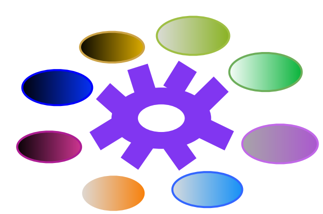
This grammar, comprised of particular parameter values, generates an incorrect stress contour.

(H)(L L)

OC TÓ pus

Parameter values used:

Bot, Em-RtCons, VC-H, FtDir-Rt,
PL-Strong, MorTro, DF-Strong, WLER-Rt



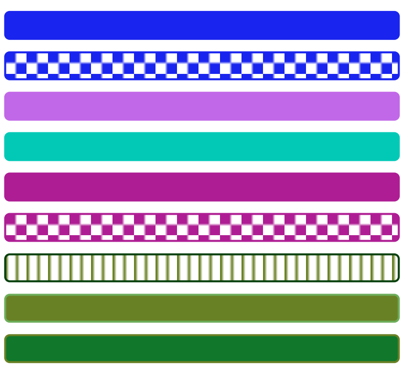
…which are the values of the English grammar.

Three knowledge representations

Constraint-ranking systems

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints



Three knowledge representations

Constraint-ranking systems

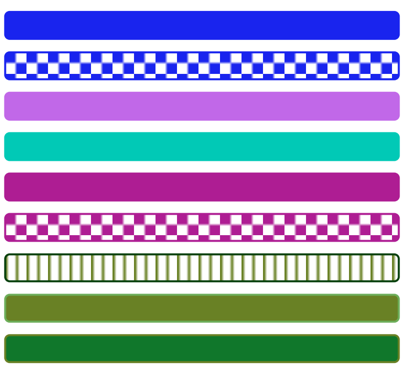
Best candidate for the correct grammar has a compatible contour

OCtopus

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Premise: Many different candidates for a word's stress representation and contour are generated and then ranked according to which constraints are violated. Violating higher-ranked constraints is worse than violating lower-ranked constraints.



	C1	C2	C3	C4
(OC to) pus			*	*
oc (TO pus)	*		*	
(oc TO) pus		*	*	

Three knowledge representations

Constraint-ranking systems

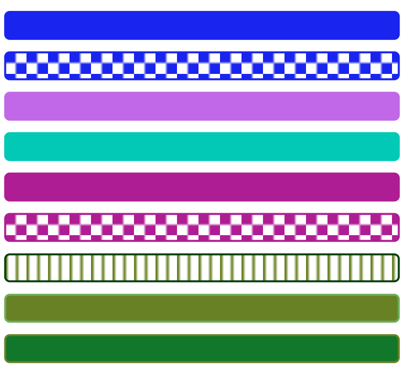
Best candidate for the correct grammar has a compatible contour

OCtopus

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars



Grammar = ranked ordering of all constraints

Three knowledge representations

Constraint-ranking systems

Best candidate for the correct grammar has a compatible contour

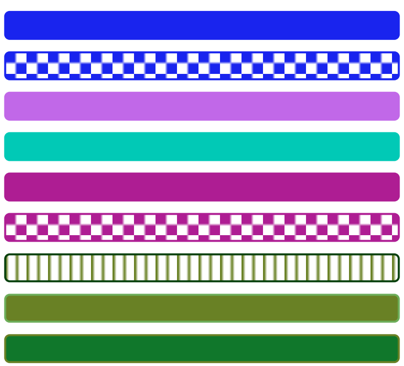
OCtopus

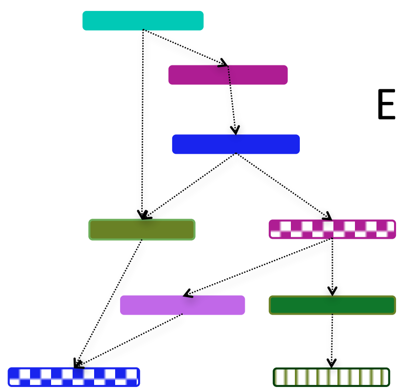
OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

Official grammars for languages are often described as partial orderings of constraints.





English grammar

Three knowledge representations

Best candidate for the correct grammar has a compatible contour

OCtopus

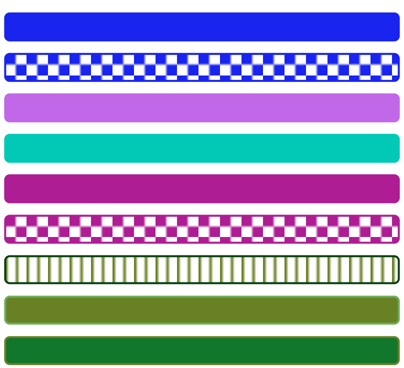
Constraint-ranking systems

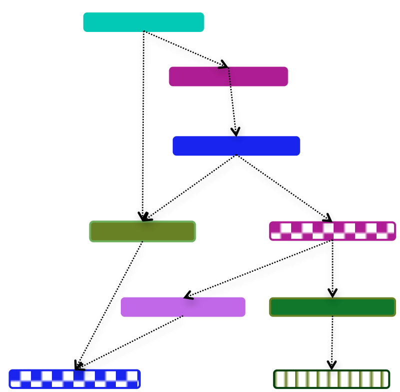
OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

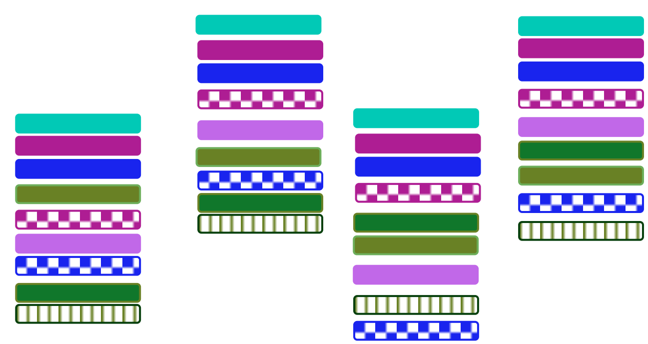
Hypothesis space: 9! rankings = 362,880 grammars

This means the “grammar” for a language is often a set of the possible rankings (grammars) that obey those orderings.





Ex: The English “grammar” is compatible with 26 rankings.



Three knowledge representations

Constraint-ranking systems

Best candidate for the correct grammar has a compatible contour

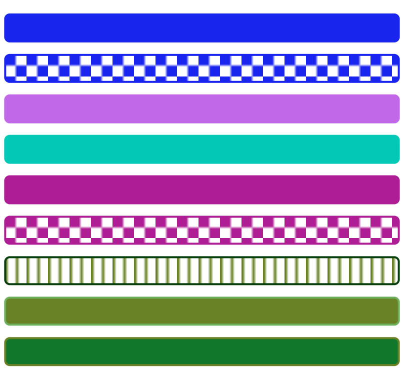
OCtopus

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

Principle (Rooting): All words must have stress



Nonfinality, Parse-σ

Foot binarity

Trochaic

Weight-to-Stress

Align left, Align right

*Sonorant nucleus

Three knowledge representations

Best candidate for the correct grammar has a compatible contour

OCtopus

Constraint-ranking systems

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

Principle (Rooting): All words must have stress

Nonfinality, Parse-σ

Foot binarity

Trochaic

Weight-to-Stress

Align left, Align right

*Sonorant nucleus

Nonfinality

Should the final syllable not be in a metrical foot?

(OC to) (PUS)	✓ (OC to) pus
(oc TO) (PUS)	oc (TO pus)

Three knowledge representations

Constraint-ranking systems

Best candidate for the correct grammar has a compatible contour

OCtopus

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

Principle (Rooting): All words must have stress

Parse-σ
Should all syllables be in metrical feet?

✓ (OC to) (PUS) | (OC to) pus

✓ (oc TO) (PUS) | oc (TO pus)

Three knowledge representations

Constraint-ranking systems

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

Principle (Rooting): All words must have stress

Best candidate for the correct grammar has a compatible contour

OCtopus

Foot binarity

Should all metrical feet consist of two units?

(OC to) (PUS)	✓ (OC to) pus
(oc TO) (PUS)	✓ oc (TO pus)

Three knowledge representations

Constraint-ranking systems

Best candidate for the correct grammar has a compatible contour

OCtopus

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

Principle (Rooting): All words must have stress

Nonfinality, Parse-σ
Foot binarity
Trochaic
Weight-to-Stress
Align left, Align right
*Sonorant nucleus

Trochaic
Should metrical feet have stress on the leftmost syllable?

✓ (OC to) (PUS)

✓ (OC to) pus

(oc TO) (PUS)

✓ oc (TO pus)

Three knowledge representations

Constraint-ranking systems

Best candidate for the correct grammar has a compatible contour

BAby

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

Principle (Rooting): All words must have stress

Weight-to-Stress (VV)

Should all VV syllables be stressed?

✓

(ba BY)	(BA) (BY)
(BA) by	(BA by)

Three knowledge representations

Best candidate for the correct grammar has a compatible contour

OCtopus

Constraint-ranking systems

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

Principle (Rooting): All words must have stress

Weight-to-Stress (VC)

Should all VC syllables be stressed?

✓ (OC to) (PUS)

(OC to) pus

(oc TO) (PUS)

oc (TO pus)

Three knowledge representations

Constraint-ranking systems

Best candidate for the correct grammar has a compatible contour

OCtopus

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

Principle (Rooting): All words must have stress

Nonfinality, Parse-σ
Foot binarity
Trochaic
Weight-to-Stress
Align left, Align right
*Sonorant nucleus

Align left
≈ Should metrical feet include the leftmost syllable?

✓ (OC to) (PUS)	✓ (OC to) pus
✓ (oc TO) (PUS)	oc (TO pus)

Three knowledge representations

Best candidate for the correct grammar has a compatible contour

OCtopus

Constraint-ranking systems

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

Principle (Rooting): All words must have stress

Nonfinality, Parse-σ
Foot binarity
Trochaic
Weight-to-Stress
Align left, Align right
*Sonorant nucleus

Align right
≈ Should metrical feet include the rightmost syllable?

✓ (OC to) (PUS)

(OC to) pus

✓ (oc TO) (PUS)

✓ oc (TO pus)

Three knowledge representations

Constraint-ranking systems

Best candidate for the correct grammar has a compatible contour

yourSELF

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

Principle (Rooting): All words must have stress

***Sonorant nucleus**

Should syllables not have sonorants (m, n, ŋ, l, r) as the nucleus?

✓ your (SELF) | (yr SELF)

✓ (YOUR) (SELF) | (YOUR slf)

Three knowledge representations

Constraint-ranking systems

Best candidate for the correct grammar has a compatible contour

OCtopus

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

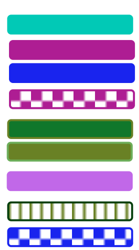
9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

Principle (Rooting): All words must have stress

Sample candidates

A sample grammar that is a version of the English "grammar":



(OC to) (PUS)	(OC to) pus
(oc TO) (PUS)	oc (TO pus)

Three knowledge representations

Best candidate for the correct grammar has a compatible contour

OCtopus

Constraint-ranking systems

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

Principle (Rooting): All words must have stress

Most important: Metrical feet have stress on the leftmost syllable.

Sample candidates

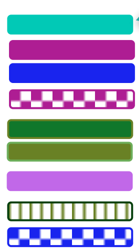
(OC to) (PUS)

(OC to) pus

(oc TO) (PUS)

oc (TO pus)

A sample grammar that is a version of the English “grammar”:



Three knowledge representations

Constraint-ranking systems

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

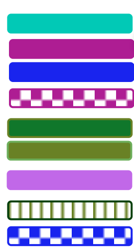
Principle (Rooting): All words must have stress

Best candidate for the correct grammar has a compatible contour

OCtopus

Next important: VV syllables are stressed.

A sample grammar that is a version of the English “grammar”:



Sample candidates

(OC to) (PUS)

(OC to) pus

~~(oc TO) (PUS)~~

oc (TO pus)

Three knowledge representations

Constraint-ranking systems

Best candidate for the correct grammar has a compatible contour

OCtopus

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

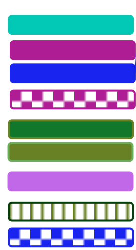
Hypothesis space: 9! rankings = 362,880 grammars

Principle (Rooting): All words must have stress

Nonfinality, Parse-σ
Foot binarity
Trochaic
Weight-to-Stress
Align left, Align right
*Sonorant nucleus

Next important: The final syllable is not included in a foot.

A sample grammar that is a version of the English “grammar”:



Sample candidates

~~(OC to) (PUS)~~

(OC to) pus

~~(oc TO) (PUS)~~

~~oc (TO pus)~~

Three knowledge representations

Constraint-ranking systems

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

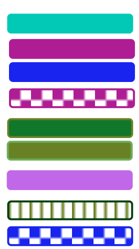
9 violable constraints

Hypothesis space: 9! rankings = 362,880 grammars

Principle (Rooting): All words must have stress

Nonfinality, Parse-σ
Foot binarity
Trochaic
Weight-to-Stress
Align left, Align right
*Sonorant nucleus

A sample grammar that is a version of the English “grammar”:



Best candidate for the correct grammar has a compatible contour

OCtopus

Only one candidate left, and it has a compatible contour.

Sample candidates

~~(OC to) (PUS)~~

(OC to) pus

~~(oc TO) (PUS)~~

~~oc (TO pus)~~

Three knowledge representations

Constraint-ranking systems

OT: Hammond 1999, Pater 2000, Tesar & Smolensky 2000

9 violable constraints

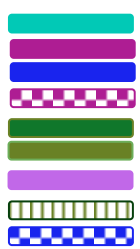
Hypothesis space: 9! rankings = 362,880 grammars

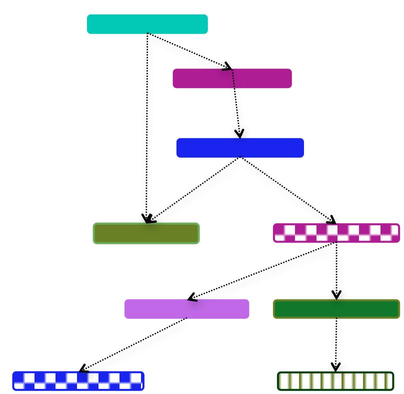
Principle (Rooting): All words must have stress

Best candidate for the correct grammar has a compatible contour

OCtopus

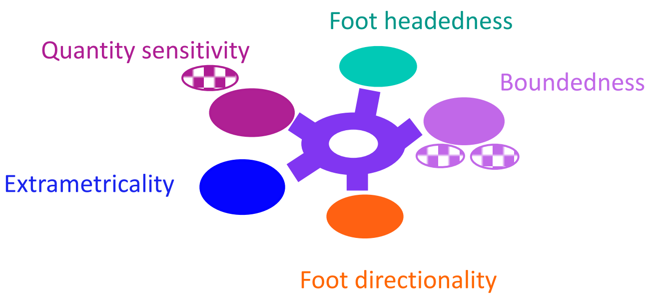
A sample grammar that is a version of the English "grammar":





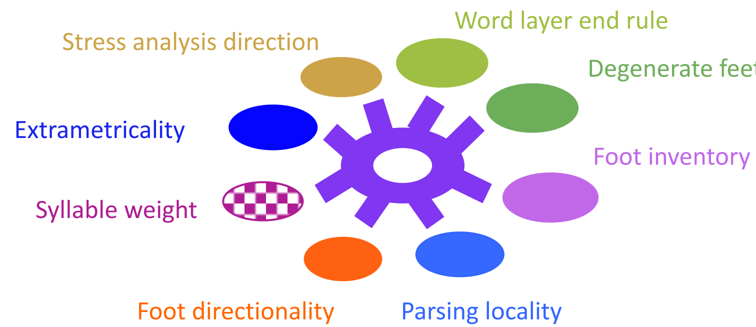
English "grammar"

Knowledge representation comparison



HV: 5 parameters & 3 sub-parameters

Hypothesis space: 156 grammars



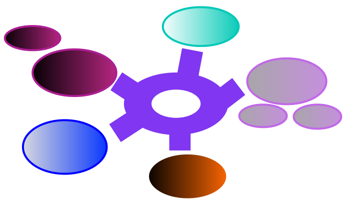
Hayes: 8 parameters

Hypothesis space: 768 grammars

OT: 9 violable constraints

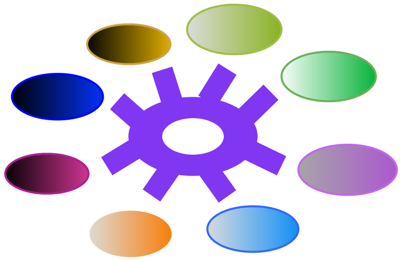
Hypothesis space: 362,880 grammars

English instantiations



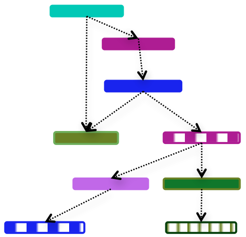
HV: 5 parameters & 4 sub-parameters

Hypothesis space: 156 grammars



Hayes: 8 parameters

Hypothesis space: 768 grammars

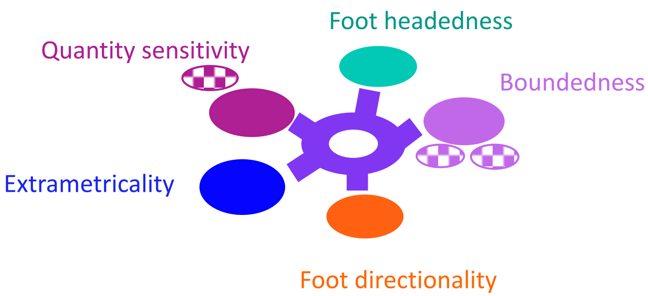


OT: 9 violable constraints

Hypothesis space: 362,880 grammars

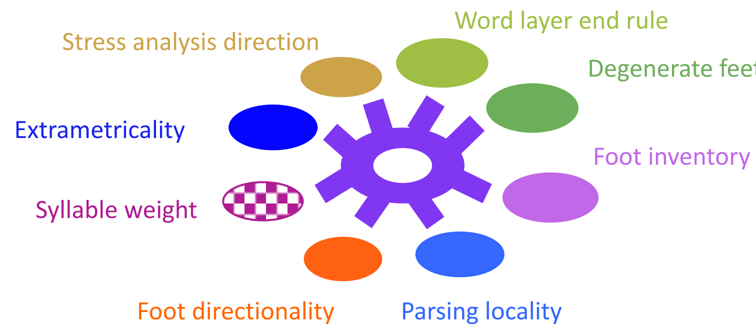
(English = 26 grammars)

Knowledge representation comparison



HV: 5 parameters & 3 sub-parameters

Hypothesis space: 156 grammars



Hayes: 8 parameters

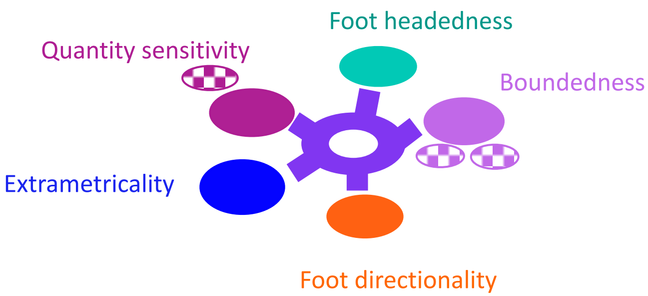
Hypothesis space: 768 grammars

Each representation assumes certain syllabic distinctions.

OT: 9 violable constraints

Hypothesis space: 362,880 grammars

Knowledge representation comparison

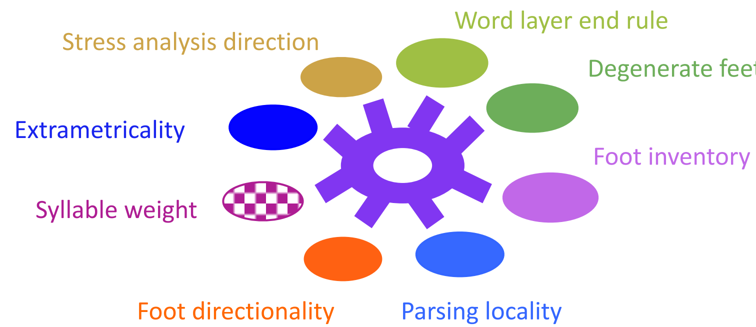


HV: 5 parameters & 3 sub-parameters

Hypothesis space: 156 grammars

Syllabic distinctions: 3

(short, closed, long)



Hayes: 8 parameters

Hypothesis space: 768 grammars

Syllabic distinctions: 4

(short, potentially short, closed, long)

OT: 9 violable constraints

Hypothesis space: 362,880 grammars

Syllabic distinctions: 8

(short, sonorant, 4 closed variants, long, super-long)