Psych 156A/ Ling 150: Psychology of Language Learning

Lecture 1

Introduction

Administrivia

Instructor:

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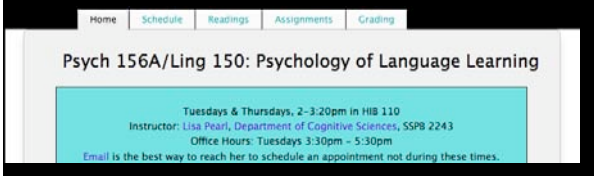
Administrivia

Class web page:

http://www.socsci.uci.edu/~lpearl/courses/psych156A_2009win/index.html

Accessible from EEE, as well. Contains overview (including office hours), schedule, readings, course assignments, and grading policies.



Administrivia

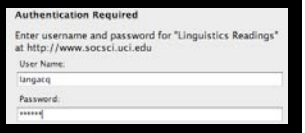
Important to access readings

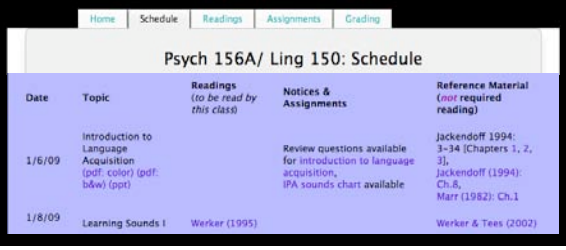
Click on readings in schedule page

user name = langacq

user password = models

Lecture notes do not require a password





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Assignments

Homework:

Three throughout the quarter, usually due just after we finish discussing the relevant topics in class. Collaboration is allowed and encouraged. However…

You may discuss the homework together, but you must write up your answers separately, and you must write the names of your collaborators on your assignment when you turn it in.

If you do not do both these things, it will be considered academic dishonesty and you will receive a 0 for that assignment.

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Midterm Exam

There will be a midterm exam on 2/5/09. It will cover the material in weeks 1-4. Review questions will be available for each topic covered in class, and there will be a midterm review in class 2/3/09.

The midterm exam will be open-note, but non-collaborative.

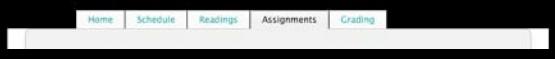
If you are found collaborating with other classmates during the midterm exam, you will receive a 0.

Administrivia

Final Exam/Assignment

Final assignment:

If you have an A in the class by week 10, you may choose to either take the final exam or submit a final paper. Details are on the class webpage, under the "assignments" section.



If you do not have an A in the class by week 10, you must take the final exam.

The final exam will be held 3/12/09 during class. If you are submitting a final paper, it must be turned in by 3:20pm 3/12/09.

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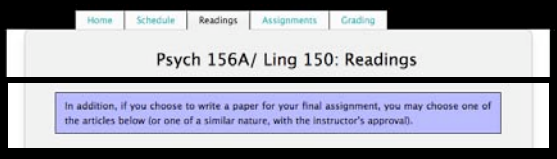
Final Paper

If you choose to do a final paper in place of a final exam, you will write a short review paper on one of the articles we discuss in class. You must indicate by 3/10/09 that you will be writing a final paper, and which article you will be reviewing. Articles available for review are listed under the "readings" section of the webpage.



Administrivia

Final Exam

The final exam will focus on the material in weeks 6-10, though there will be some questions from the material in weeks 1-4. There will be a final review in class 3/10/09.

The final exam will be open-note, but non-collaborative.

If you are found collaborating with other classmates during the final exam, you will receive a 0.

Administrivia

Grades

Homework: 50%

Midterm: 25%

Final Assignment (Exam or Paper): 25%

Your grades will be determined by *approximately* this scale (available on the webpage):

96-100: A+	84-88: B+	72-76: C+	…
92-96: A	80-84: B	68-72: C	
88-92: A-	76-80: B-	64-68: C-	

Administrivia

Schedule

"This is our wonderfully ambitious schedule. We'll attempt to keep with it, but it is subject to modification."

Topics:

Introduction	(1/6)
Sounds & Sounds of Words	(1/8-1/13)
Words & Morphology	(1/15-1/29)
MIDTERM	(2/5)
Phrases	(2/10)
Poverty of the Stimulus & Learning Biases	(2/12-2/19)
Sentences & Language Structure	(2/24-2/26)
FINAL	(3/12)

Knowledge of Language

It's so natural for us to produce and comprehend language that we often don't think about what an accomplishment this is.

Or how we learned language in the first place.

Jackendoff (1994)

"For the moment, the main thing is to appreciate how hard a problem this is. The fact that we can talk (and cats can't) seems so obvious that it hardly bears mention. But just because it's obvious doesn't mean it's easy to explain. Think of another perfectly obvious, well-known phenomenon: the fact that metals turn red when you heat them. Why does this happen? It could be otherwise - they might just as well turn green or not change color at all. It's a simple phenomenon, easily observable, but the explanation isn't simple at all. It turns out to involve at the very least the theories of electromagnetic radiation and quantum mechanics, two of the more amazing intellectual advances in the past century. So it is, I want to suggest, with the human ability to use language."

About Language

Language is a complex system of knowledge that all children learn by listening to native speakers in their surrounding environment.

It includes sound structure, word structure, word meaning, sentence structure, mapping from sentence structure to meaning, unspoken rules of conversation…

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Stress pattern → gob lins

Individual sounds (in IPA) → g a b l ɪ n z

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goblin (plural) = goblin + s

gob lins

g a b l ɪ n z

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goblins

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Goblins like children.

goblins

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About Language

Language is a complex system of knowledge that all children learn by listening to native speakers in their surrounding environment.

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Don't goblins like children?

Goblins like children.

goblins

goblin (plural) = goblin + s

gob lins

g a b l ɪ n z

Some Terminology

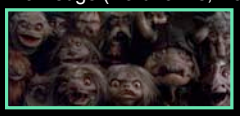
Phonology: sounds and sound system of the language

g a b l ɪ n z gob lins

Lexicon: Words and associated knowledge (word forms, word meanings, etc.)

goblins =

(not koblins)



Morphology: system for combining units of meaning together (goblin + [plural] = goblins)

Some Terminology

Syntax: system for combining words into sentences

Goblins like children.

Pragmatics: knowledge of language use

Don't goblins like children?
(expresses prior belief that goblins do like children)
Use this question form if you have this prior belief

Kids Do Amazing Things

Much of the linguistic system is already known by age 3.

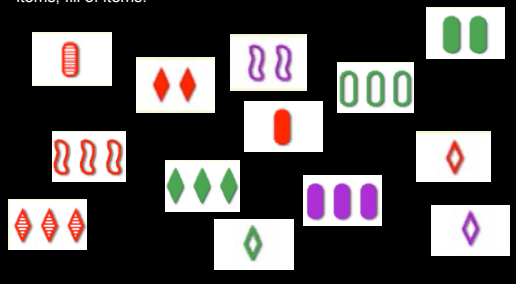
…when kids can't tie their own shoes or reliably recognize "4".

What kids are doing: extracting patterns and making generalizations from the surrounding data mostly without explicit instruction.

"Rules" of language = grammar

A learning analogy: Set

Here are some cards - they have some salient properties associated with them: number of items, shape of items, color of items, fill of items.



A learning analogy: Set

Task: Find Sets.

Here's one:

What generalizations might you make about Sets?

A learning analogy: Set

Task: Find Sets.

Here's one:

What generalizations might you make about Sets?

Set = all shapes, fills, and number of items the same?

A learning analogy: Set

Task: Find Sets.

Here's another one:

Does this fit the generalization?

Set = all shapes, fills, and number of items the same?

A learning analogy: Set

Task: Find Sets.

Here's another one:

Does this fit the generalization?

~~Set = all shapes, fills, and number of items the same?~~
Set = all shapes and fills the same?

A learning analogy: Set

Task: Find Sets.

Here's another one:

What about this one?

~~Set = all shapes, fills, and number of items the same?~~
Set = all shapes and fills the same?

A learning analogy: Set

Task: Find Sets.

Here's another one:

What about this one?

~~Set = all shapes, fills, and number of items the same?~~

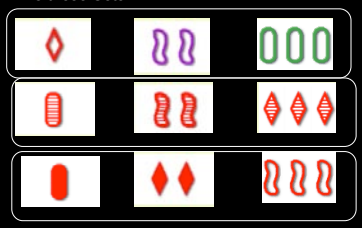
~~Set = all shapes and fills the same?~~

Set = all fills the same?

A learning analogy: Set

Task: Find Sets.

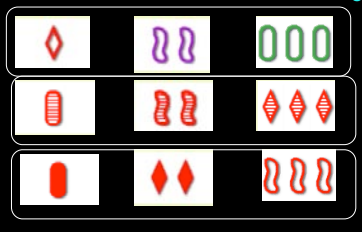
Are these Sets?



A learning analogy: Set

Task: Find Sets.

Are these Sets?



Set = all fills the same?

Yes

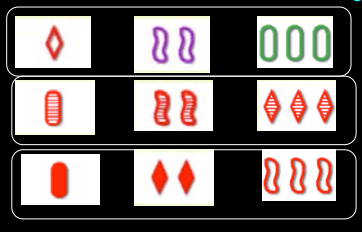
Yes

No

A learning analogy: Set

Task: Find Sets.

Are these Sets?



Set = all fills the same?

Yes √ Yes

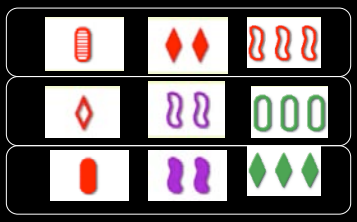
Yes √ Yes

No √ No

A learning analogy: Set

Task: Find Sets.

Here are some more examples of sets:

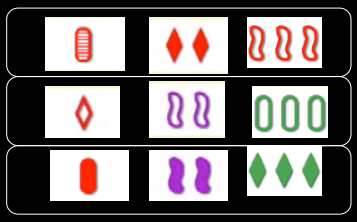


A learning analogy: Set

Task: Find Sets.

Here are some more examples of sets:

Set = all fills the same?



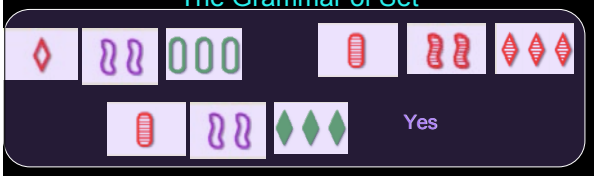
X Uh oh…

√

√

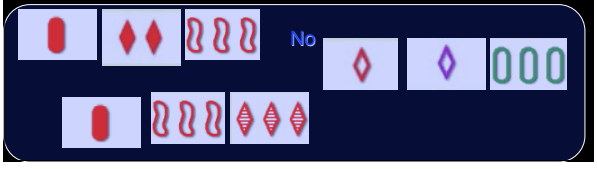
We need a different generalization…

The Grammar of Set



Yes

A 'Set' consists of three cards in which each feature is EITHER the same on each card OR is different on each card. That is to say, any feature in the 'Set' of three cards is either common to all three cards or is different on each card.



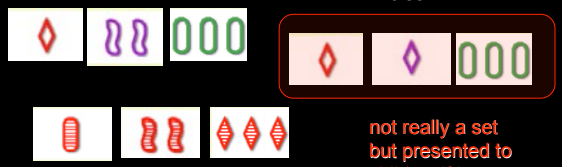
No

Back to Kids & Language

Children infer rules with this amount of complexity (and more!) from examples of language. And sometimes, even when there's noise (misleading examples in the input).

Noise Analogy: "All these are Sets."

noise



not really a set but presented to child as if it were

Knowledge of Language & Hidden Rules

Some examples from language:

You know that…

…*strop* is a possible word of English, while *stvop* isn't.

Knowledge of Language & Hidden Rules

Some examples from language:

You know that…

…"Who did you see who did that?" is not a grammatical question in English

(Instead: "Who did you see do that?")

Knowledge of Language & Hidden Rules

Some examples from language:

You know that…

…In "She ate the peach while Sarah was reading", *she* ≠ *Sarah*

but *she* can be *Sarah* in all of these:

Sarah ate the peach while she was reading.
While she was reading, Sarah ate the peach.
While Sarah was reading, she ate the peach.

Knowledge of Language & Hidden Rules

Some examples from language:

You know that…

…the 's' in 'cats' sounds different from the 's' in goblins

cats: 's' = /s/

goblins: 's' = /z/

Why rules?

"The expressive variety of language use implies that a language user's brain contains unconscious grammatical principles" - Jackendoff (1994)

Example: Most sentences we have never seen or used before, but we can still understand them.

Question: Can speakers simply memorize all the possible sentences of a language the way they learn the vocabulary of their language? Not if there are an infinite number of them…

Linguistic Infinity

Hoggle has two jewels.
Hoggle has three jewels.
Hoggle has four jewels.
…
Hoggle has forty-three million and five jewels.
…

One (dumb) way to get infinity

Linguistic Infinity

An aardvark is not an antelope.
…
An aardvark is not a zenith.
…
A penguin is not a goblin.
…

Another way to get a really large number of sentences…

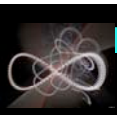
Linguistic Infinity

An aardvark is not an antelope.
…
An aardvark is not a zenith.
…
A penguin is not a goblin.
…

Another way to get a really large number of sentences…

And another…

If an aardvark is not an antelope, then an aardvark is not an ant.
…
If an aardvark is not a zenith, then a peach is not an idea.
…
If a penguin is not a goblin, then a fruit is not a fairy.
…



Linguistic Creativity

What lists include this sentence?

Through dangers untold and hardships unnumbered, I have fought my way here to the castle beyond the goblin city to take back the child you have stolen, for my will is as strong as yours and my kingdom is as great.

Or this one?

In the purple powder room, there lived a grumpy dollop of cream that slept lazily and yelled silently by turns, often scaring the silverware with its fierce pacific nature.

Linguistic Infinity

The point: our minds store words and meanings and the patterns into which they can be placed (grammar).

Sentence Patterns:

Hoggle has *n* jewels.

An X is not a Y.

Since an X is not a Y, a Z is not a W.

The argument for mental grammar

"In short, in order for us to be able to speak and understand novel sentences, we have to store in our heads not just the words of our language but also the patterns of sentences possible in our language. These patterns, in turn, describe not just patterns of *words* but also patterns of *patterns*. Linguists refer to these patterns as the *rules* of language stored in memory; they refer to the rules as the *mental grammar* of the language, or *grammar* for short." - Jackendoff (1994)

Possible objections to a mental rule set

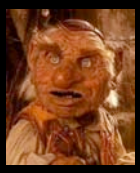
"Why should I believe I store a set of rules unconsciously in my mind? I just understand sentences because they make sense."

Possible objections to a mental rule set

"Why should I believe I store a set of rules unconsciously in my mind? I just understand sentences because they make sense."

But why do some sentences make sense and others don't?

Hoggle has two jewels.
*Two Hoggle jewels has.



Possible objections to a mental rule set

Why can we recognize patterns even when some of the words are unknown?

'Twas brillig, and the slithy toves
did gyre and gimble in the wabe...

Possible objections to a mental grammar

"What about people who speak ungrammatically, who say things like 'We ain't got no bananas'? They obviously don't have grammars in their heads."

Possible objections to a mental grammar

"What about people who speak ungrammatically, who say things like 'We ain't got no bananas'? They obviously don't have grammars in their heads."

Prescriptive vs. Descriptive Grammar

Prescriptive: what you have to be taught in school, what is prescribed by some higher "authority"

"Don't end a sentence with a preposition."
" 'Ain't' is not a word."

Possible objections to a mental grammar

"What about people who speak ungrammatically, who say things like 'We ain't got no bananas'? They obviously don't have grammars in their heads."

Prescriptive vs. Descriptive Grammar

Descriptive: what you pick up from being a native speaker of the language, how people actually speak in their day-to-day interactions

Who does Sarah first talk **with**?

"You're horrible!" "No, I **ain't** - I'm Hoggle!"

Possible objections to an unconscious rule set

"When I talk, the talk just comes out - I'm not consulting any rule set."

Possible objections to an unconscious rule set

"When I talk, the talk just comes out - I'm not consulting any rule set."

Analogy: wiggling your fingers

When you want to wiggle your fingers, you "just wiggle them".

But your finger-wiggling intention was turned into commands sent by your brain to your muscles, and you're never conscious of the process unless something interferes with it.
Nonetheless, there *is* a process, even if you're not aware of it.

Learning hard things

Suppose we have mental grammars in our heads - how did they get there?

"Many people immediately assume that the parents taught it. To be sure, parents often engage in teaching *words* to their kids: "What this, Amy? It's a *BIRDIE*! Say 'birdie,' Amy!" But language learning can't entirely be the result of teaching words. For one thing, there are lots of words that it is hard to imagine parents teaching, notably those one can't point to: "Say 'from', Amy!" "This is *ANY*, Amy!" - Jackendoff (1994)

Learning hard things

Some other things that are hard to teach: interpretations

Moira

Joan

Joan appeared to Moira to like herself.	M thinks J likes J
Joan appeared to Moira to like her.	M thinks J likes M
Joan appealed to Moira to like herself.	J wants M to like M
Joan appealed to Moira to like her.	J wants M to like J

Learning hard things

Some other things that are hard to teach: interpretations

Moira

Joan

"How do we come to understand these sentences this way? It obviously depends somehow on the difference between ordinary pronouns such as "her" and reflexive pronouns such as "herself," and also on the differences between the verbs "appear" and "appeal." But how?…sure no one is ever taught contrasts like this by parents or teachers…" - Jackendoff (1994)

Learning patterns

Not so clear that children learn grammatical patterns from their parents

(From Martin Braine)

Child: Want other one spoon, Daddy.
Father: You mean, you want the other spoon.
Child: Yes, I want other one spoon, please Daddy.
Father: Can you say "the other spoon"?
Child: Other…one…spoon.
Father: Say "other".
Child: Other.
Father: "Spoon."
Child: Spoon.
Father: "Other spoon."
Child: Other…spoon. Now give me other one spoon?

Children don't just imitate what they've heard

From Edward Klima & Ursula Bellugi

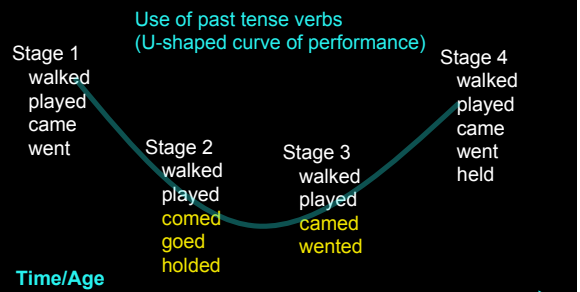
Use of past tense verbs
(U-shaped curve of performance)

Stage 1	Stage 2	Stage 3	Stage 4
walked	walked	walked	walked
played	played	played	played
came	comed	camed	came
went	goed	wented	went
	holded		held

Time/Age →

Children don't just imitate what they've heard

From Edward Klima & Ursula Bellugi



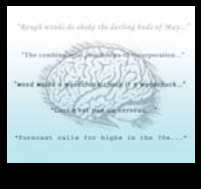
Main points

Children learn (hard) things about language that are not easy to explain.

The patterns they produce during learning are often stripped-down versions of the adult pattern, but they make mistakes that cannot be attributed directly to the input.

Children don't just imitate what they've heard - they're trying to figure out the patterns of their native language. Also, they may not notice or respond to explicit correction.

Levels of Representation
Marr (1982)



Describing vs. Explaining in Vision

"…it gradually became clear that something important was missing …neurophysiology and psychophysics have as their business to *describe* the behavior of cells or of subjects but not to *explain* such behavior….What are the problems in doing it that need explaining, and what level of description should such explanations be sought?" - Marr (1982)

On Explaining (Marr 1982)

"But the important point is that if the notion of different types of understanding is taken very seriously, it allows the study of the information-processing basis of perception to be made *rigorous*. It becomes possible, by separating explanations into different levels, to make explicit statements about what is being computed and why…"

On Explaining (Marr 1982)

"But the important point is that if the notion of different types of understanding is taken very seriously, it allows the study of the information-processing basis of perception to be made *rigorous*. It becomes possible, by separating explanations into different levels, to make explicit statements about what is being computed and why…"

Our goal: Substitute "language learning" for "perception".

The three levels

Computational
What is the goal of the computation? What is the logic of the strategy by which is can be carried out?

Algorithmic
How can this computational theory be implemented? What is the representation for the input and output, and what is the algorithm for the transformation?

Implementational
How can the representation and algorithm be realized physically?

The three levels: An example with the cash register

Computational
What does this device do?
Arithmetic (ex: addition).
Addition: Mapping of a pair of numbers to another number.

(3,4) ⟶ 7 (often written (3+4=7))
Properties: (3+4) = (4+3) [commutative], (3+4)+5 = 3+(4+5) [associative], (3+0) = 3 [identity element], (3+ -3) = 0 [inverse element]

True no matter how numbers are represented: this is what is being computed

The three levels: An example with the cash register

Computational
What does this device do?
Arithmetic (ex: addition).
Addition: Mapping of a pair of numbers to another number.

Algorithmic
What is the input, output, and method of transformation?
Input: arabic numerals (0,1,2,3,4…)
Output: arabic numerals (0,1,2,3,4…)
Method of transformation: rules of addition, where least significant digits are added first and sums over 9 have their next digit carried over to the next column

```
 99
+ 5
```

The three levels: An example with the cash register

Computational
What does this device do?
Arithmetic (ex: addition).
Addition: Mapping of a pair of numbers to another number.

Algorithmic
What is the input, output, and method of transformation?
Input: arabic numerals (0,1,2,3,4…)
Output: arabic numerals (0,1,2,3,4…)
Method of transformation: rules of addition, where least significant digits are added first and sums over 9 have their next digit carried over to the next column

```
 99
+ 5
 14
```

The three levels: An example with the cash register

Computational
What does this device do?
Arithmetic (ex: addition).
Addition: Mapping of a pair of numbers to another number.

Algorithmic
What is the input, output, and method of transformation?
Input: arabic numerals (0,1,2,3,4…)
Output: arabic numerals (0,1,2,3,4…)
Method of transformation: rules of addition, where least significant digits are added first and sums over 9 have their next digit carried over to the next column

```
 1
 99
+ 5
 4
```

The three levels: An example with the cash register

Computational
What does this device do?
Arithmetic (ex: addition).
Addition: Mapping of a pair of numbers to another number.

Algorithmic
What is the input, output, and method of transformation?
Input: arabic numerals (0,1,2,3,4…)
Output: arabic numerals (0,1,2,3,4…)
Method of transformation: rules of addition, where least significant digits are added first and sums over 9 have their next digit carried over to the next column

```
 1
 99
+ 5
 104
```

The three levels: An example with the cash register

Computational
What does this device do?
Arithmetic (ex: addition).
Addition: Mapping of a pair of numbers to another number.

Algorithmic
What is the input, output, and method of transformation?
Input: arabic numerals (0,1,2,3,4…)
Output: arabic numerals (0,1,2,3,4…)
Method of transformation: rules of addition

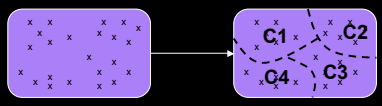
Implementational
How can the representation and algorithm be realized physically?
A series of electrical and mechanical components inside the cash register.

Mapping the Framework: Algorithmic Theory of Language Learning

Goal: Understanding the "how" of language learning

First, we need a computational-level description of the learning problem.

Computational Problem: Divide sounds into contrastive categories



Mapping the Framework: Algorithmic Theory of Language Learning

Goal: Understanding the "how" of language learning

First, we need a computational-level description of the learning problem.

Computational Problem: Divide spoken speech into words

húwzəfréjdəvðəbígbǽdwʊ́lf

húwz əfɹéjd əv ðə bíg bǽd wʊ́lf
who's afraid of the big bad wolf

Mapping the Framework: Algorithmic Theory of Language Learning

Goal: Understanding the "how" of language learning

First, we need a computational-level description of the learning problem.

Computational Problem: Map word forms to speaker-invariant forms

Mapping the Framework: Algorithmic Theory of Language Learning

Goal: Understanding the "how" of language learning

First, we need a computational-level description of the learning problem.

Computational Problem: Identify grammatical categories

"This is *a* DAX." 

DAX = noun

Mapping the Framework: Algorithmic Theory of Language Learning

Goal: Understanding the "how" of language learning

First, we need a computational-level description of the learning problem.

Computational Problem: Identify word affixes that signal meaning.

What do you have to change about the verb to signal the past tense in English? (There are both regular and irregular patterns.)

blink~blinked confide~confided
blɪŋk blɪŋkt kənfajd kənfajdəd

drink~drank
dɹɪŋk dɹejŋk

Mapping the Framework: Algorithmic Theory of Language Learning

Goal: Understanding the "how" of language learning

First, we need a computational-level description of the learning problem.

Computational Problem: Identify the rules of word order for sentences.

Kannada
Subject t_{Object} Verb Object

Jareth juggles crystals
Subject Verb Object

German
Subject Verb $t_{Subject}$ Object t_{Verb}

English
Subject Verb Object

Mapping the Framework: Algorithmic Theory of Language Learning

Goal: Understanding the "how" of language learning

Second, we need to be able to identify the algorithmic-level description:

Input = sounds, syllables, words, phrases, …
Output = sound categories, words, words with affixes, grammatical categories, sentences, …
Method = statistical learning, algebraic learning, prior knowledge about how human languages work, …

Recap: Levels of Representation

Language acquisition can be viewed as an information-processing task where the child takes the native language input encountered and uses it to construct the adult rule system (grammar) for the language.

Main idea: The point is not just to describe what children know about their native language and when they know it, but also how they learned it.

Three levels:

- computational: what is the problem to be solved
- algorithmic: what procedure will solve the problem, transforming input to desired output form
- implementational: how is that procedure implemented/instantiated in the available medium

Questions?