1. Strongest, best option:

Data → Discovery device ⟹ Correct grammar of data

2. Next best option:

Data
Grammar → Verification device ⟹ Yes, *or*, No

3. Fallback position:

Data
Grammar 1
Grammar 2 → Evaluation metric ⟹ G_1 is better; *or*, G_2 is better.
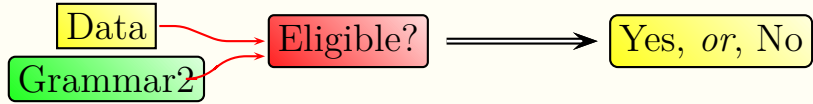
Generative position: a special case of Option 3

First, test grammars' eligibility:

Data — Grammar1 → Eligible? ⟹ Yes, *or*, No

Data — Grammar2 → Eligible? ⟹ Yes, *or*, No
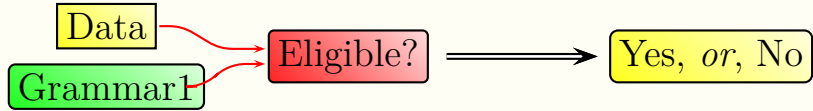
If both grammars are eligible:

Grammar 1 — Grammar 2 → Evaluation metric ⟹ G_1 is better; *or*, G_2 is better.
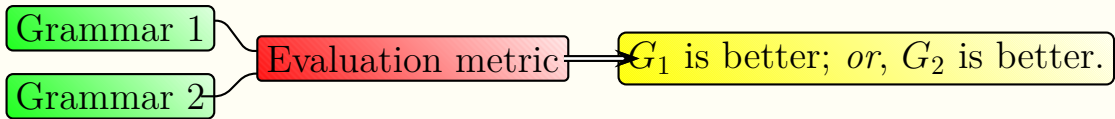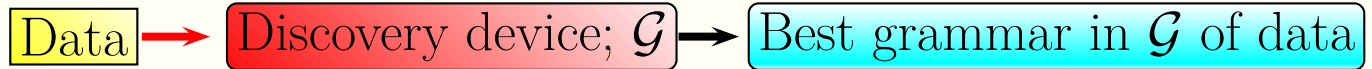
Three central questions:

1. **Where do hypotheses come from?** Answer: As far as Linguistic Theory goes, that's none of your business. Ideas come from wherever they come from. As far as individual grammars go, hypotheses may come from anywhere, but mostly they come from looking at what linguists have said about other languages.

2. **How do we determine the extent to which data support a hypothesis?** Generative theory has no answer to this.

3. **How do we determine the goodness of a theory, independent of data?** Formal simplicity, but we have not yet found the right way to calculate this.

Machine learning:
Back to Option 1

$$\boxed{\text{Data}} \xrightarrow{\hspace{1cm}} \boxed{\text{Discovery device; } \mathcal{G}} \xrightarrow{\hspace{1cm}} \boxed{\text{Best grammar in } \mathcal{G} \text{ of data}}$$
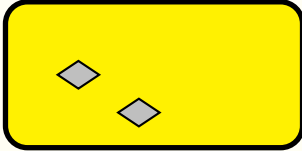
Generative grammar and Machine learning agree:

- Growing the space of grammars when needed is a good thing.

- Shrinking the space of grammars when we jettison unnecessary possibilities is a good thing.
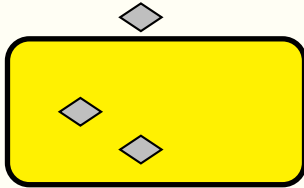
Machine learning:

- A linguistic theory requires a method to *find* the grammar (within the given hypothesis space) that best accounts for the data.

5

Two languages, two grammars, and a Universal Grammar

The expected evolution of generative theory

A grammar is found that lies outside of Universal Grammar.

The expected evolution of generative theory

A grammar is found that lies outside of Universal Grammar.
Univeral Grammar is expanded, on empirical grounds.

The expected evolution of generative theory

Revised Universal Grammar.

The expected evolution of generative theory

Unused space in Universal Grammar is noticed.

The expected evolution of generative theory
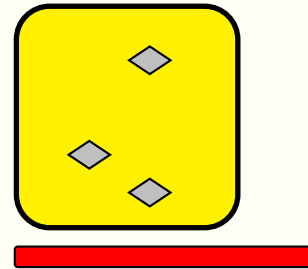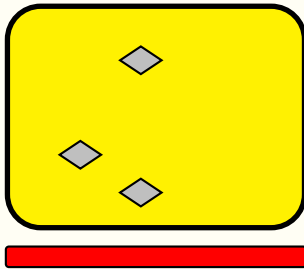
Universal Grammar
is shrunk.

The expected evolution of generative theory
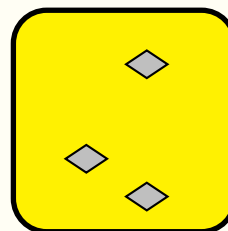
Revised
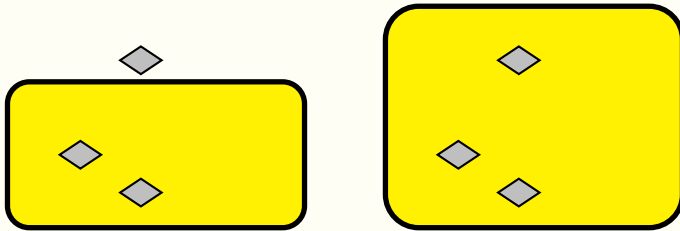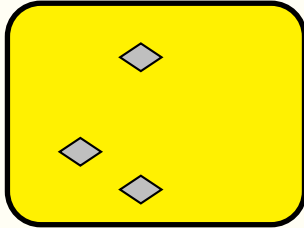Universal Grammar.

The expected evolution of generative theory
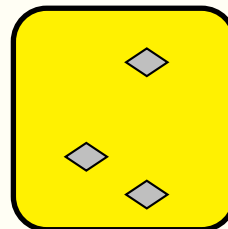
A grammar is found that
lies outside of
Universal Grammar.
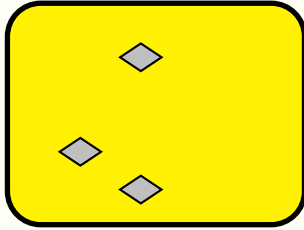
The expected evolution of generative theory
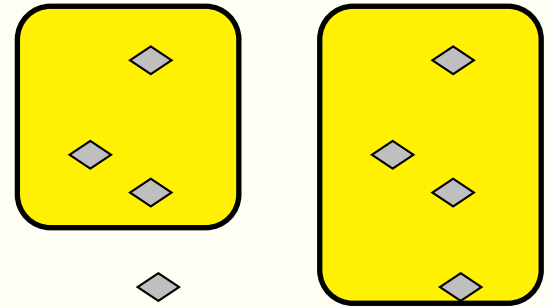
Univeral Grammar is
expanded, on
empirical grounds.

The expected evolution of generative theory
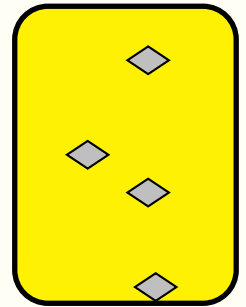
Revised
Universal
Grammar.

The expected evolution of generative theory
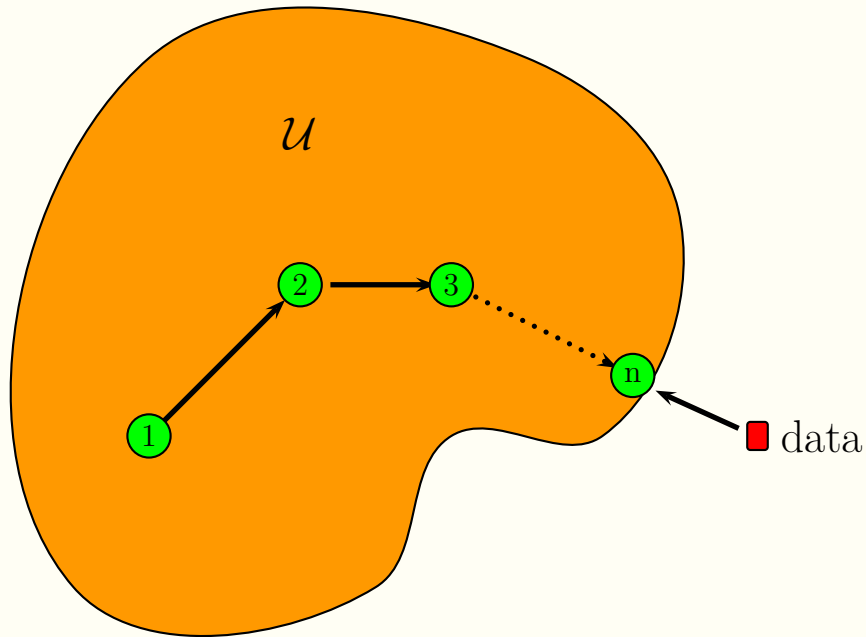
Find the grammar within the Universe $\mathcal{U}$ of Universal Grammar which best models the data.

Machine learning world

Example 1: Word learning

TheFultonCountyGrandJurysaidFridayaninvestigationo fAtlanta'srecentprimaryelectionproducednoevidenceth...

Desired output:

The Fulton County Grand Jury said Friday an investigation of Atlanta's recent primary election produced no evidence that any irregularities took place.

Actual output:

The F ult on County Gr and Ju ry said Fri day an investig ationof Atlan ta 's recent primary election produc ed no evidence that any ir regular ities took place.

Iteration number 1

piece	count	piece	count
th	127,717		
he	119,592	to	48,233
in	86,893	or	47,391
er	81,899	te	44,280
an	72,154	is	41,159
re	67,753	ea	41,913
on	61,275	is	41,159
es	59,943	ar	40,402
en	55,763	of	40,296
at	54,216	ha	39,922
ed	52,893	it	39,304
nt	52,761	ng	39,018
st	52,307		
nd	50,504		
ti	50,253		

Iteration number 1

piece	count
th	127,717
he	119,592
in	86,893
er	81,899
an	72,154
re	67,753
on	61,275
es	59,943
en	55,763
at	54,216
ed	52,893
nt	52,761
st	52,307
nd	50,504
ti	50,253

Iteration number 10

piece	count	piece	count
In	2,355		
vi	2,247		
some	2,169		
who	2,155		
ical	2,130		
He	2,119		
ure	2,102		
ance	2,085		
ty	2,061	now	1,962
edthe	2,061	gre	1,951
sel	2,053	ated	1,951
its	2,053	son	1,940
more	2,034	off	1,922
form	2,023	edin	1,890
fac	2,009	edby	1,873

Iteration number 1

piece	count
th	127,717
he	119,592
in	86,893
er	81,899
an	72,154
re	67,753
on	
es	59,943
en	55,763
at	54,216
ed	52,893
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Iteration number 10

piece	count		
In	2,355		
vi	2,247		
some	2,169		
who	2,155		
ical	2,130		
He	2,119		
ure	2,102		
ance	2,085		
ty	2,061	**now**	1,962
edthe	2,061	gre	1,951
sel	2,053	ated	1,951
its	2,053	**son**	1,940
more	2,034	**off**	1,922
form	2,023	edin	1,890
fac	2,009	edby	1,873

20

Iteration number 1		Iteration number 10		Iteration number 399	
piece	count	piece	count	piece	count
th	127,717	**In**	2,355	**divided**	22
he	119,592	vi	2,247	**minimal**	21
in	86,893	**some**	2,169	ender	21
er	81,899	**who**	2,155	**Baltimore**	21
an	72,154	ical	2,130	Memor	21
re	67,753	**He**	2,119	**fever**	21
on		ure	2,102	WestBerlin	21
es	59,943	ance	2,085	**thickness**	21
en	55,763	ty	2,061	**contains**	21
at	54,216	edthe	2,061	backin	21
ed	52,893	sel	2,053	choiceof	21
nt	52,761	**its**	2,053	attentiontothe	21
st	52,307	**more**	2,034	itthe	21
nd	50,504	**form**	2,023	**sophisticated**	21
ti	50,253	fac	2,009	**sector**	21

Iteration number 399

piece	count
th	127,717
he	119,592
in	86,893
er	81,899
an	72,154
re	67,753
on	
es	59,943
en	55,763
at	54,216
ed	52,893
nt	52,761
st	52,307
nd	50,504
ti	50,253

Iteration number 10

piece	count
In	2,355
vi	2,247
some	2,169
who	2,155
ical	2,130
He	2,119
ure	2,102
ance	2,085
ty	2,061
edthe	2,061
sel	2,053
its	2,053
more	2,034
form	2,023
fac	2,009

22

Iteration number 399

piece	count
divided	22
minimal	21
ender	21
Baltimore	21
Memor	21
fever	21
WestBerlin	21
thickness	21
contains	21
backin	21
choiceof	21
attentiontothe	21
itthe	21
sophisticated	21
sector	21