Interactive language learning from two extremes

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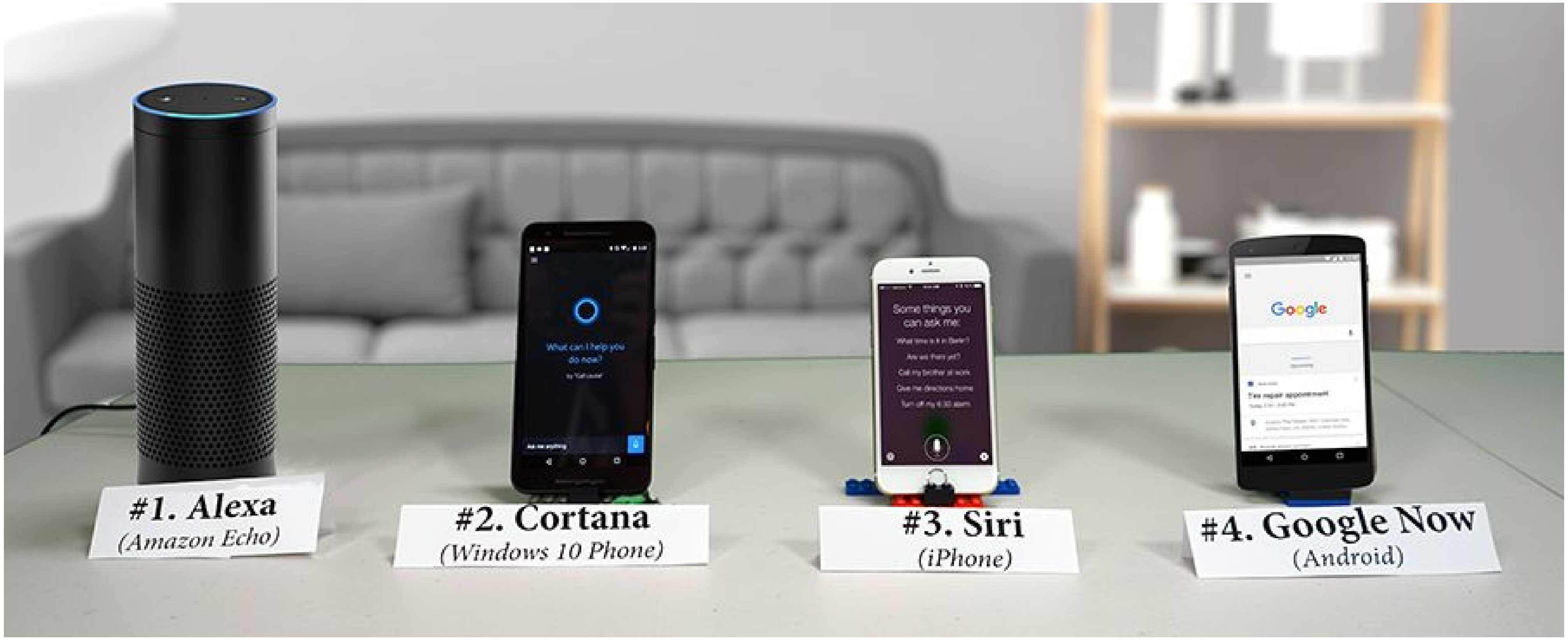
Natural language interfaces



Natural language interfaces

Stephen Colbert: write the show

SIRI: what would you like to search for?

...

Stephen Colbert: For the love of God, the cameras are on, give me something!

SIRI: What kind of place are you looking for, camera stores or churches?

Engineering goals

we are stuck when these systems misunderstand us

receive feedback from users, and improve through use

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  familiar words take on new meaning

  revert to commit 25ad3

  order buy red t5 2

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  revert to commit 25ad3

  order buy red t5 2

- **Perform complex actions**

  move my meeting with Percy to the same time as my meeting with Chris

  call Bob every hour until he picks up, stop after 8 tries

Research questions

- How to learn from scratch quickly?

- How to learn to perform complex, custom actions?

Main outline

- **Extreme 1: learning language games from scratch**
- Extreme 2: naturalizing a programming language

Learning language games

Wittgenstein. 1953. Philosophical Investigations:

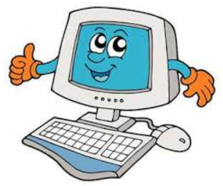
Language derives its meaning from use.

'block' 'pillar' 'slab' 'beam'.

Interactive language game

- Iterated, cooperative game between human and computer

- The human player
  - has a goal, cannot perform actions
  - can use language and provide feedback



- The computer player
  - does not know goal, can perform the actions
  - does not understand language

Interactive language game

- Iterated, cooperative game between human and computer

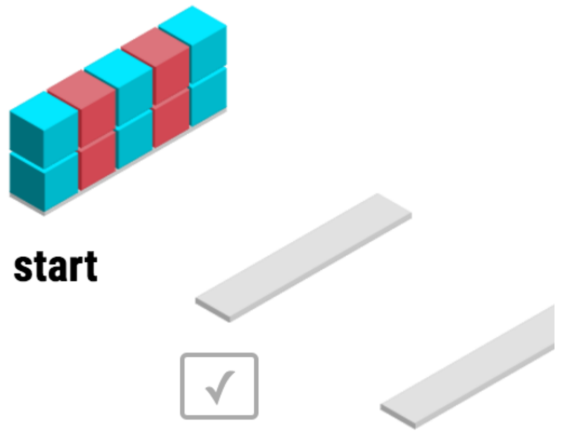
- The human player
  - has a goal, cannot perform actions
  - can use language and provide feedback

must teach the computer a suitable language, and adapt

- The computer player
  - does not know goal, can perform the actions
  - does not understand language

must learn language quickly through interaction

SHRDLURN



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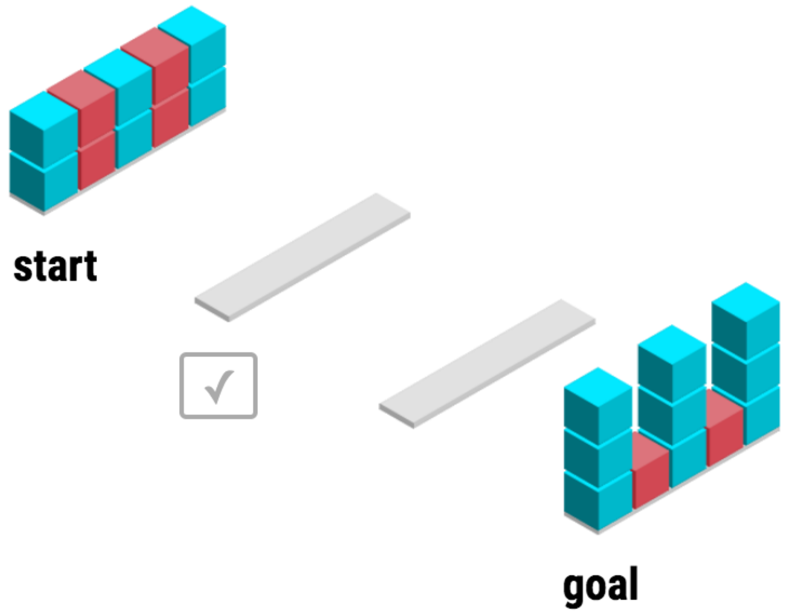

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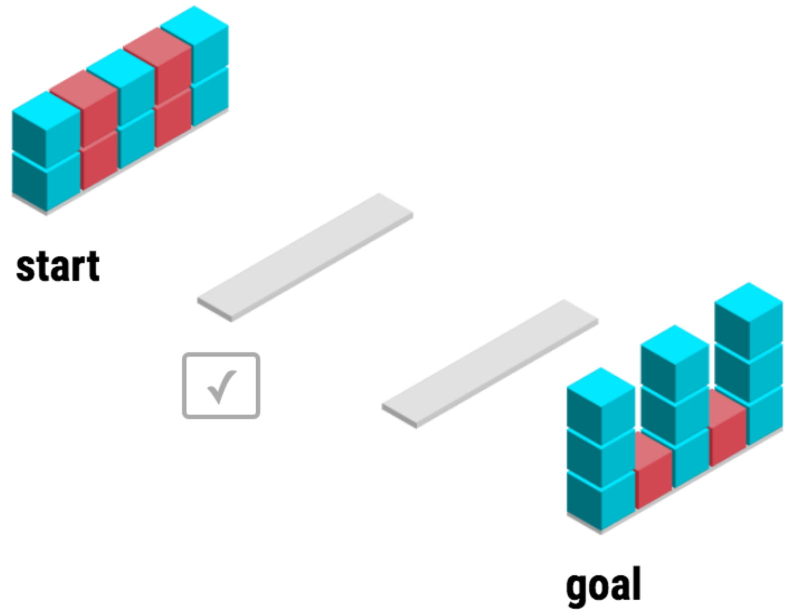
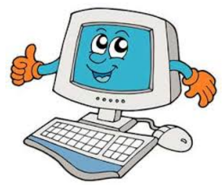


remove red



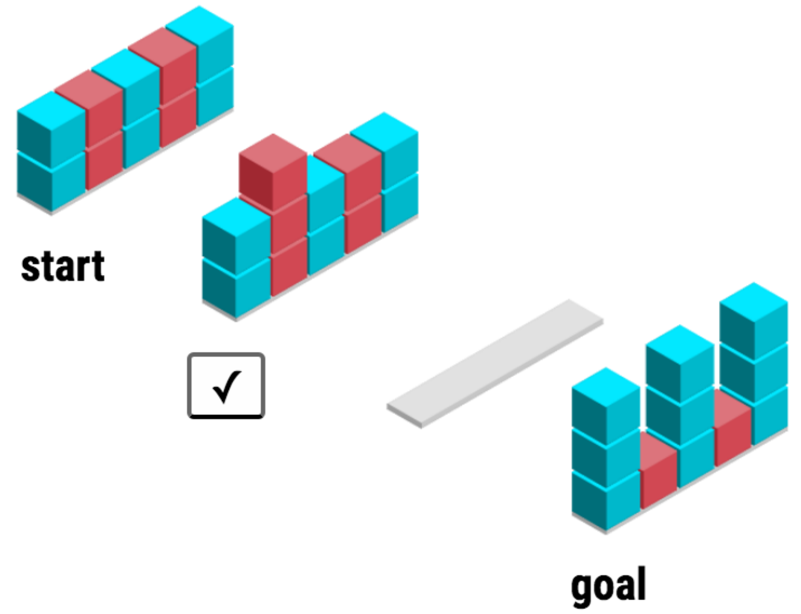
has a goal

has language

performs actions

does not talk

SHRDLURN



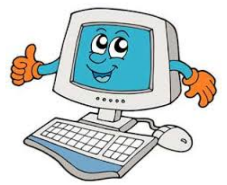
remove red

add(leftmost(hascolor(red)),red)

add(red, hascolor(cyan))

remove(hascolor(red))

remove(leftmost(hascolor(red)))



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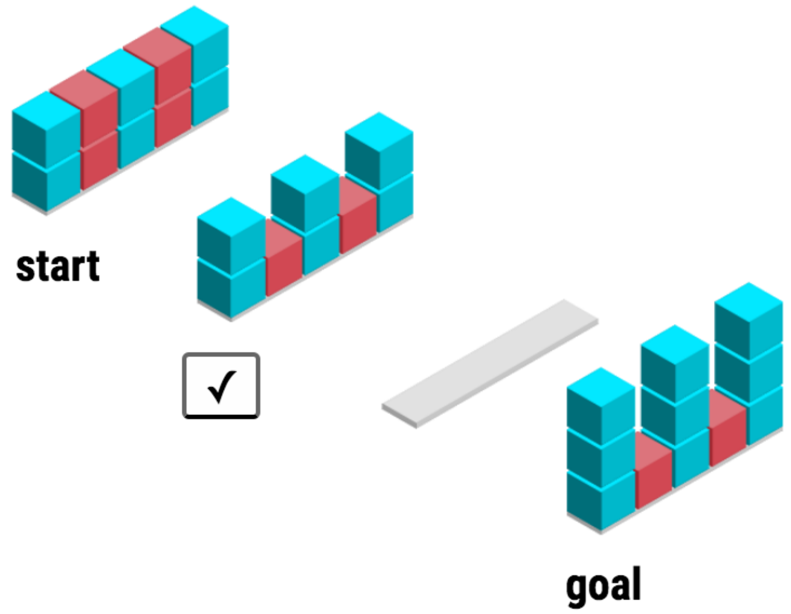

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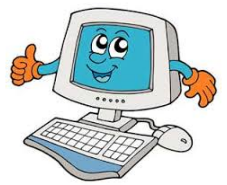

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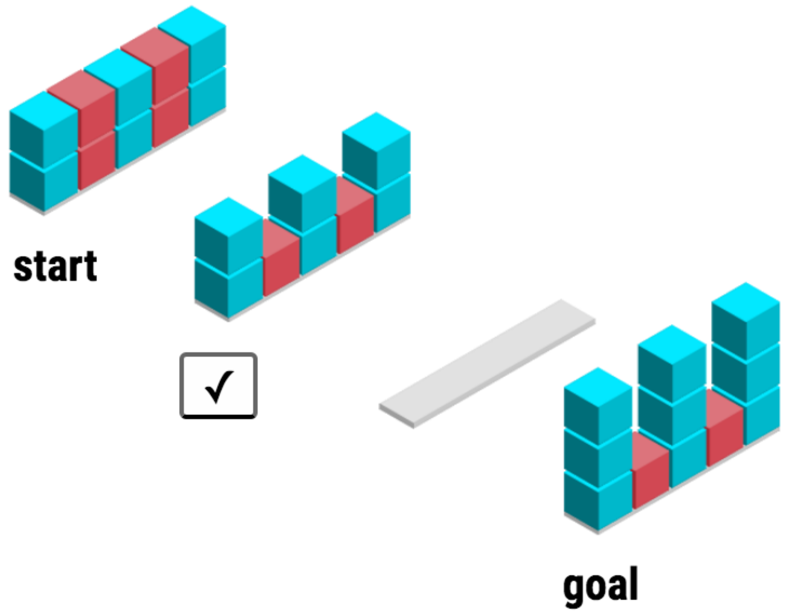

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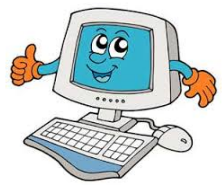

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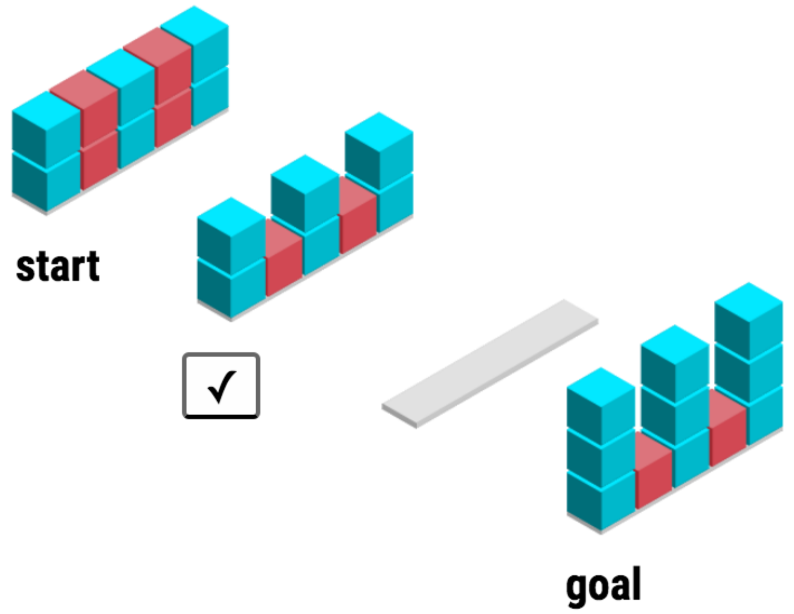

把 红的 拿走

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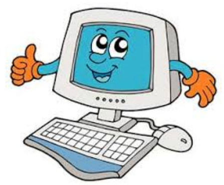
add(red, hascolor(cyan))
remove(hascolor(red))
remove(leftmost(hascolor(red)))



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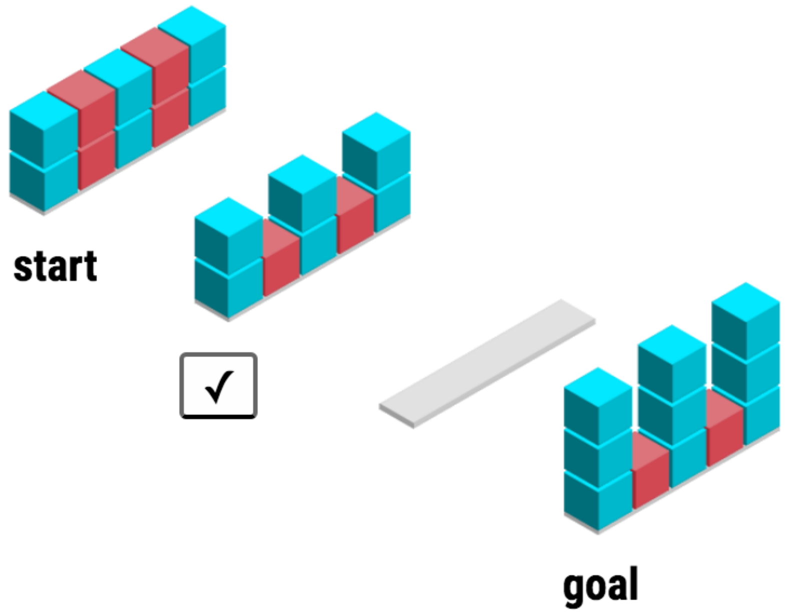

emoveray edray

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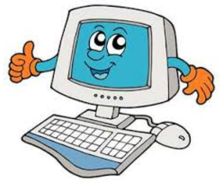

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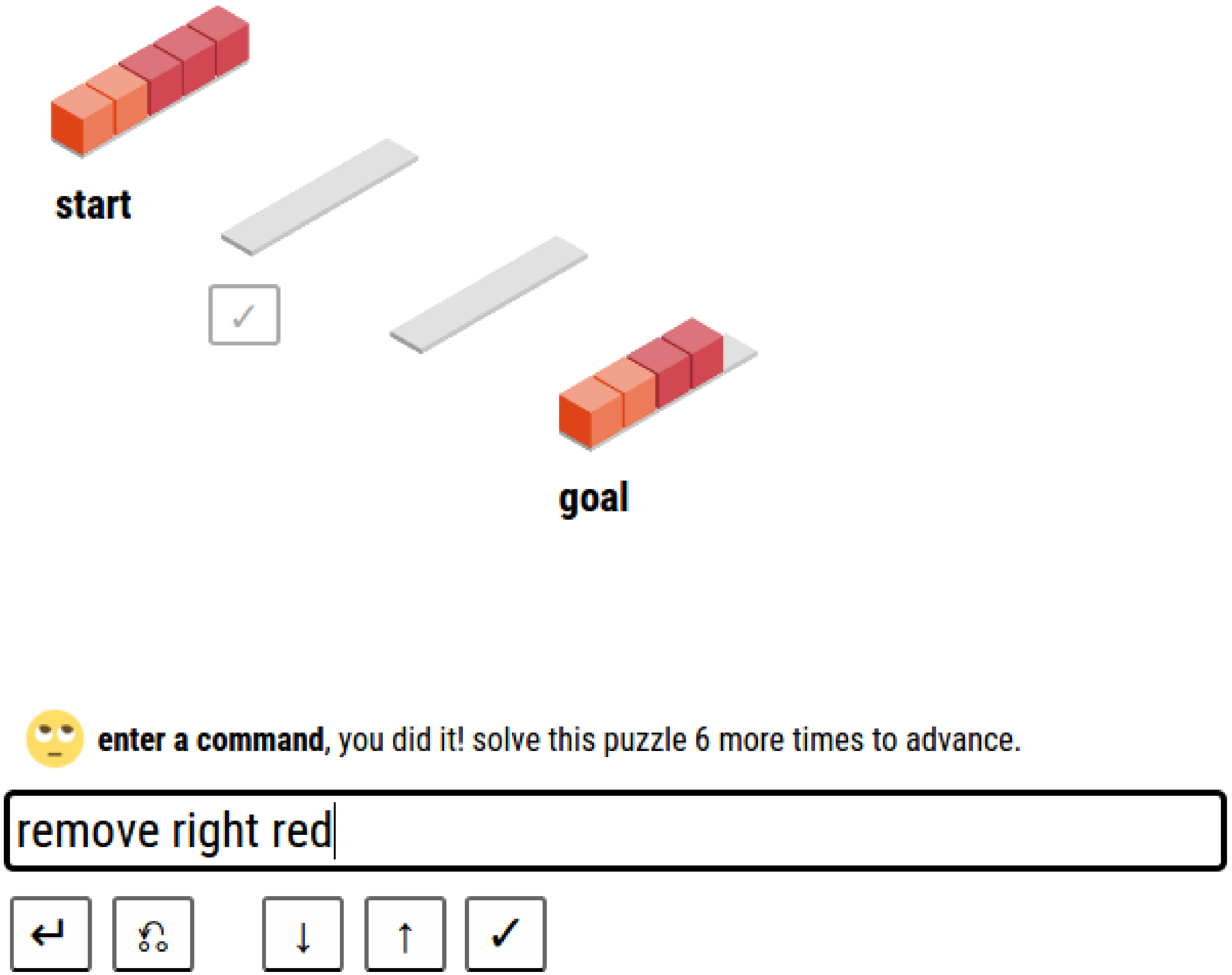


enter a command, you did it! solve this puzzle 6 more times to advance.

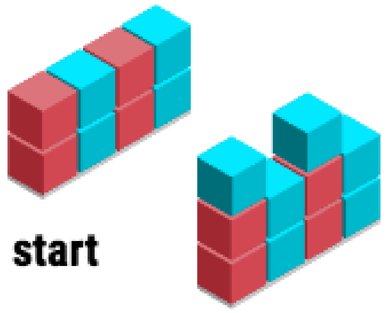
remove right red

Outline

- **Computer: semantic parsing**
- Human: 100 Turkers
- Pragmatics
- Updates

Semantic parsing

Actions as logical forms:



add(hascolor(red), cyan)

Semantic parsing

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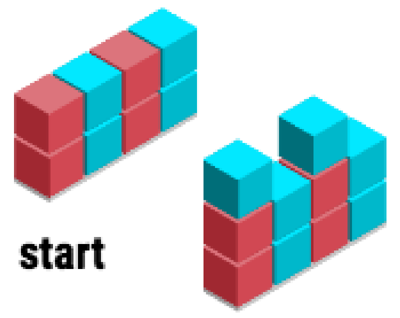

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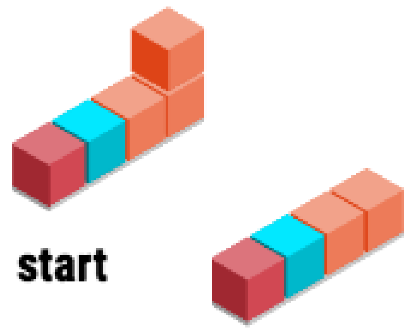


remove(rightmost(all()))
remove(rightmost(hascolor(orange)))

"Parsing" freely

- Generate logical forms
  - start from the smallest size
  - score them with a model
  - use beam search to find longer high-scoring logical forms
  - like the floating parser [Pasupat and Liang 2015]

brown

hascolor(brown)

leftmost(hascolor(brown))

diff(all(),leftmost(hascolor(brown))

remove(diff(all(),leftmost(hascolor(brown)))

Model

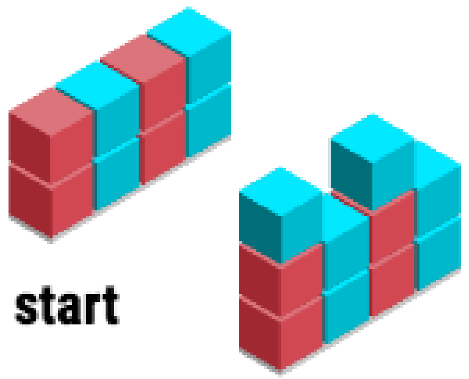
log-linear model with features $\phi(x, z)$:

$$p_\theta(z \mid x) \propto \exp(\phi(x, z) \cdot \theta)$$

x : *add a cyan block to red blocks*

z : add(hascolor(red), cyan)

y :



Learning from denotations

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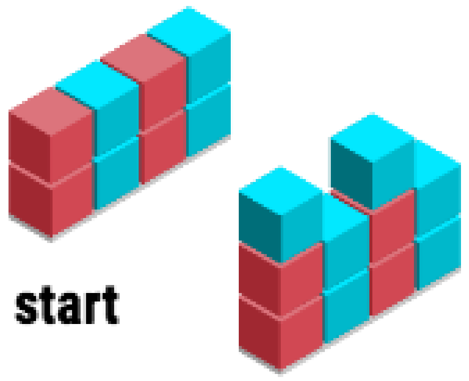

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$$p_\theta(z \mid x) \propto \exp(\phi(x, z) \cdot \theta)$$

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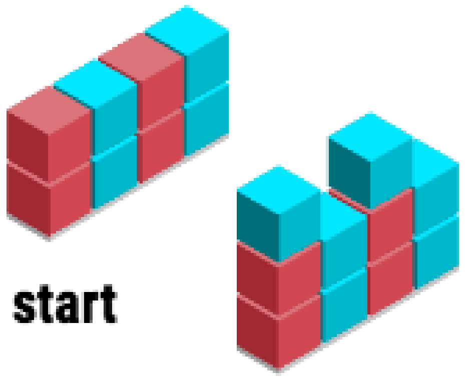

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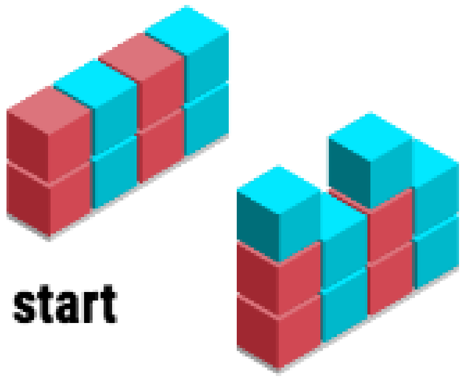


L1 penalty and update with AdaGrad

Background on features/model

Features $\phi(x, z)$: arbitrary mapping from x, z to strings

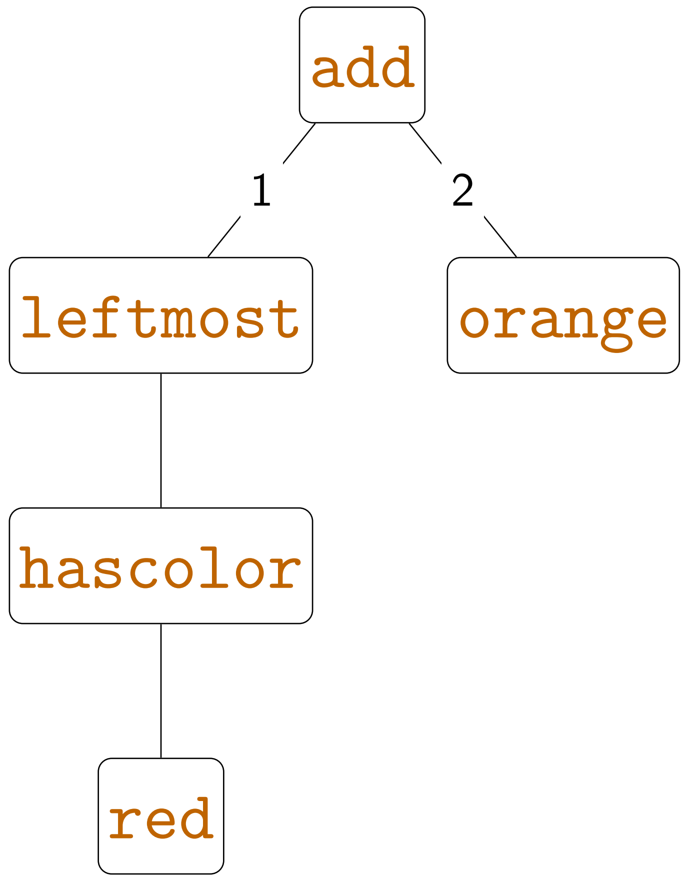
> feature: size(x),size(z)
>
> example: ”sizes: 10,5”
>
> weight: -2.5

> feature: x ¡=¿ z
>
> example: ”remove red ¡=¿ remove(red)”
>
> weight: 3.1

Parameters $\theta \cdot \phi(x, z)$: scores a mapping based on its features

$p_\theta(z \mid x) \propto \exp(\phi(x, z) \cdot \theta)$: assigns probabilities to possible mappings

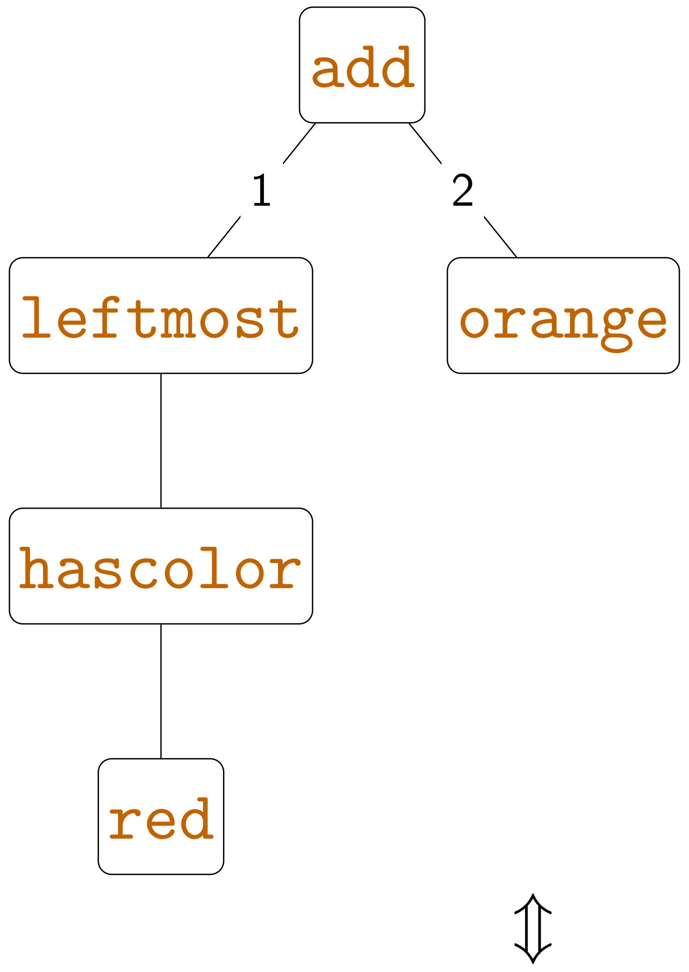
Features



⇕

put orange on the very left red block

Features



put orange on the very left red block

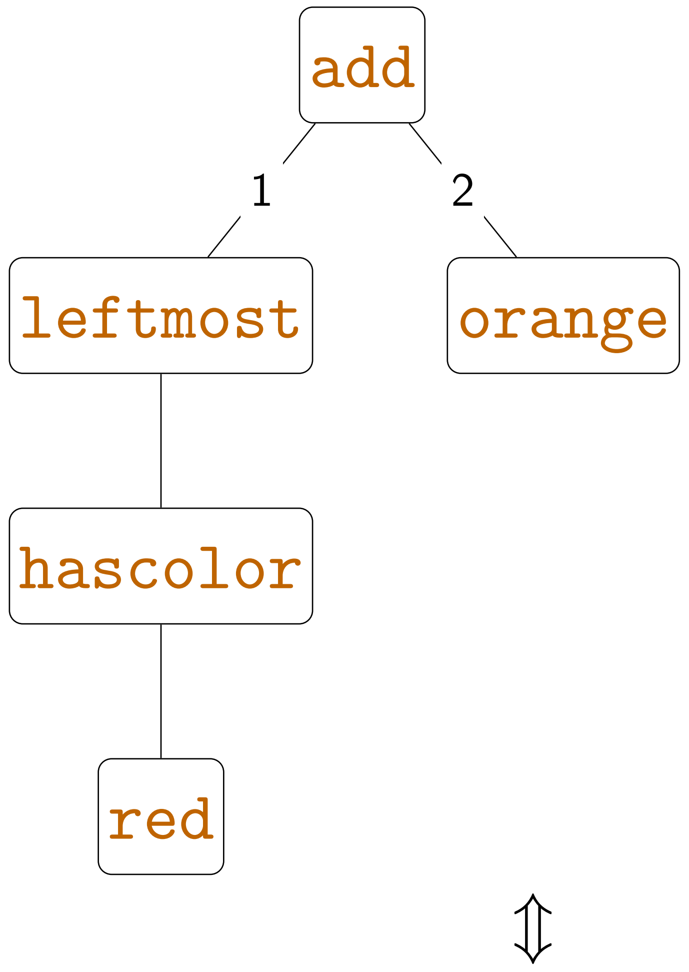
uni-, bi-, skip- grams

put, orange, on, the

put orange, orange on, ...,

*put * on, orange * the, ...,*

Features



put orange on the very left red block

uni-, bi-, skip- grams

put, orange, on, the

put orange, orange on, ...,

*put * on, orange * the, ...,*

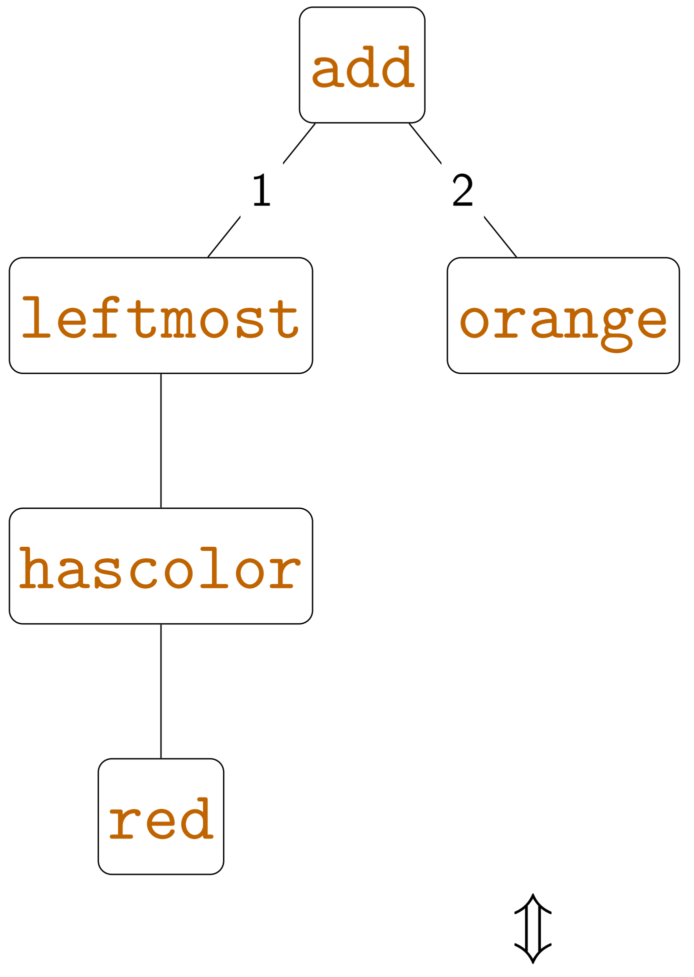
tree-grams

`add(leftmost(*), orange)`

`leftmost(hascolor(*))`

$\lambda c.$`(hascolor(c))`

Features



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cross product features

(*put*,`add(*,*)`)

(*put orange*,`add(*,orange)`)

(*put*,`orange`)

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Experiments

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- performance is measured by the amount of scrolling needed

Results: top players (rank 1-20)

precise and consistent:

(3.01)

rem cy pos 1
stack or blk pos 4
rem blk pos 2 thru 5
rem blk pos 2 thru 4
stack bn blk pos 1 thru 2
fill bn blk
stack or blk pos 2 thru 6
rem cy blk pos 2 fill rd blk

(2.72)

Remove the center block
Remove the red block
Remove all red blocks
Remove the first orange block
Put a brown block on the first brown block
Add blue block on first blue block

(2.78)

remove the brown block
remove all orange blocks
put brown block on orange blocks
put orange blocks on all blocks
put blue block on leftmost blue block in top row

Results: average players (rank 21-50)

inconsistent or mismatches computer capability:

(9.17)

reinsert pink
take brown
put in pink
remove two pink from second layer
Add two red to second layer in odd intervals
Add five pink to second layer
Remove one blue and one brown from bottom layer

(7.18)

move second cube
double red with blue
double first red with red
triple second and fourth with orange
add red
remove orange on row two
add blue to column two
add brown on first and third

(8.37)

remove red
remove 1 red
remove 2 4 orange
add 2 red
add 1 2 3 4 blue
emove 1 3 5 orange
add 2 4 orange
add 2 orange
remove 2 3 brown
add 1 2 3 4 5 red
remove 2 3 4 5 6
remove 2
add 1 2 3 4 6 red

Results: worst players (rank 51-100)

spammy, vague, did not tokenize:

(12.6)

'add red cubes on center left
center right
far left and far right'
'remove blue blocks on row two column two
row two column four'
remove red blocks in center left and center right on second row

(14.32)

laugh with me
red blocks with one aqua
aqua red alternate
brown red red orange aqua orange
red brown red brown red brown
space red orange red
second level red space red space red space

(14.15)

holdleftmost
holdbrown
holdleftmost
blueonblue
brownonblue1
blueonorange
holdblue
holdorange2
blueonred2
holdends1
holdrightend
hold2
orangeonorangerightmost

Results: interesting players

(Polish)

usuń brązowe klocki
usuń niebieski klocek
usuń pomarańczowe klocki
usuń czerwony klocek
postaw brązowy klocek na pierwszym klocku
postaw czerwony klocek na pierwszym klocku
postaw pomarańczowe klocki na brązowych
postaw czerwone klocki
usuń ostatni brązowy klocek
usuń wszystkie klocki oprócz ostatniego
postaw niebieski klocek na czerwonym
postaw brązowy klocek na pierwszym klocku

(Polish notation)

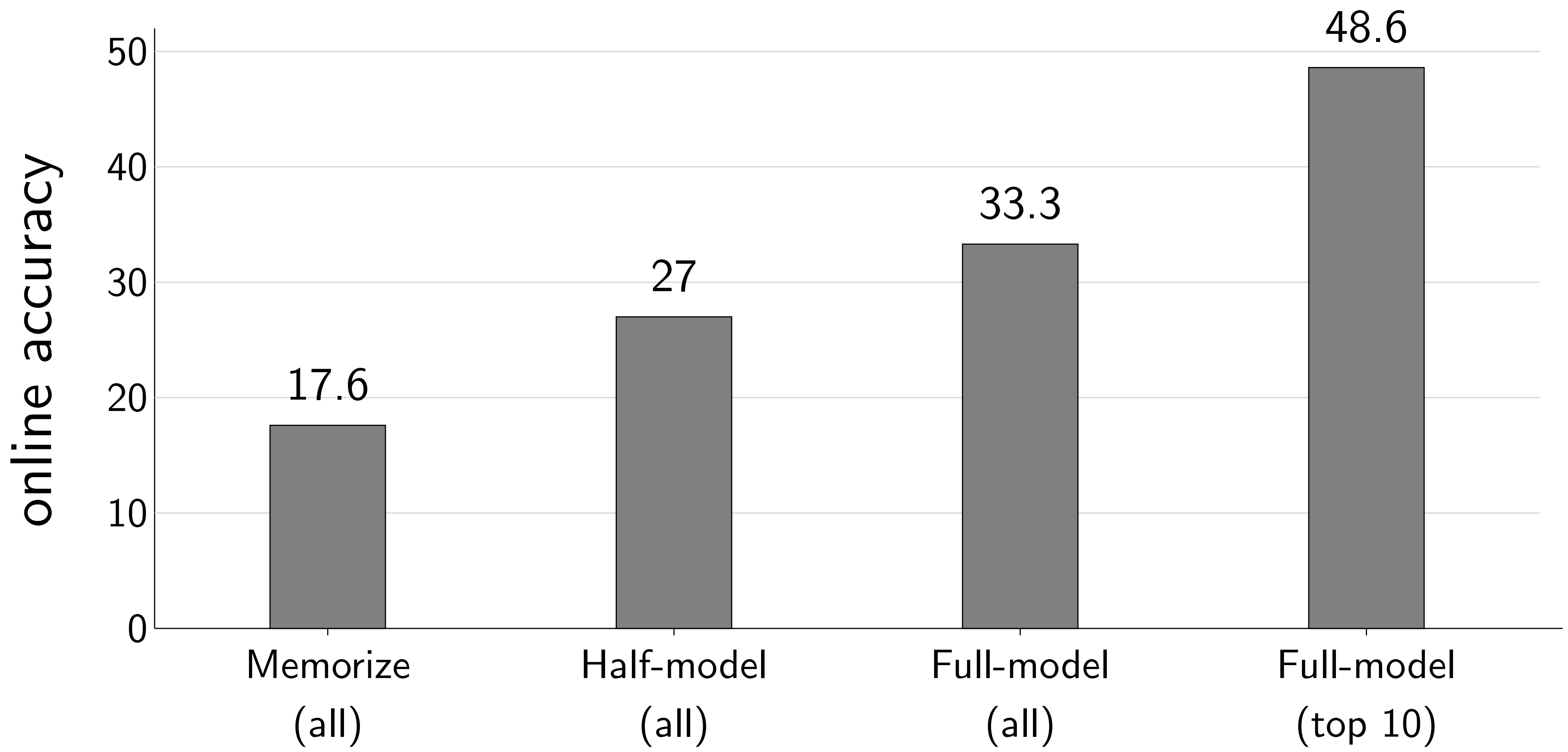
rm scat + 1 c
+ 1 c
rm sh
+ 1 2 4 sh
+ 1 c
- 4 o
rm 1 r
+ 1 3 o
full fill c
rm o
full fill sh
- 1 3
full fill sh
rm sh
rm r
+ 2 3 r
rm o
+ 3 sh
+ 2 3 sh

Players adapt

- More consistent
  - *remove, delete* $\rightarrow$ *remove*

- More concise
  - *Remove the red ones* $\rightarrow$ *Remove red*
  - *add brown on top of red* $\rightarrow$ *add orange on red*
  - *the, a* $\rightarrow \epsilon$

Quantitative results



Learning works fairly well, especially for top players

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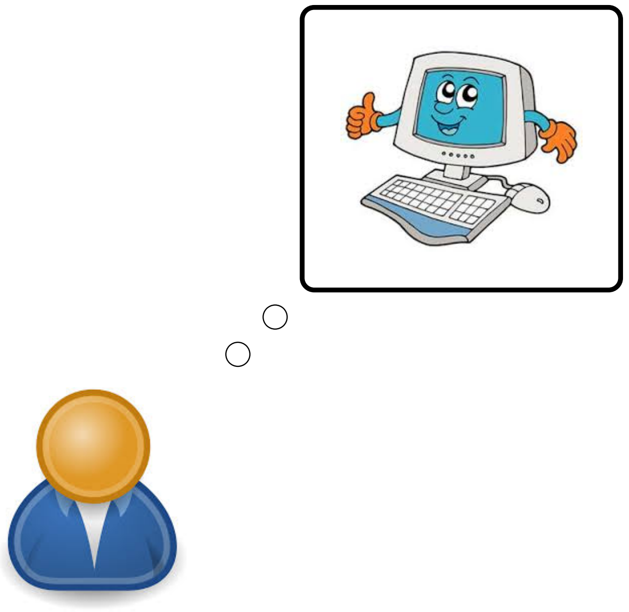

Pragmatics: motivation

delete cardinal

```
    remove(hascolor(red))
```

Pragmatics: motivation

delete cardinal

```
    remove(hascolor(red))
```

delete cyan

Pragmatics: motivation

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```
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remove(hascolor(red))

remove(hascolor(cyan))

remove(hascolor(brown))
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```
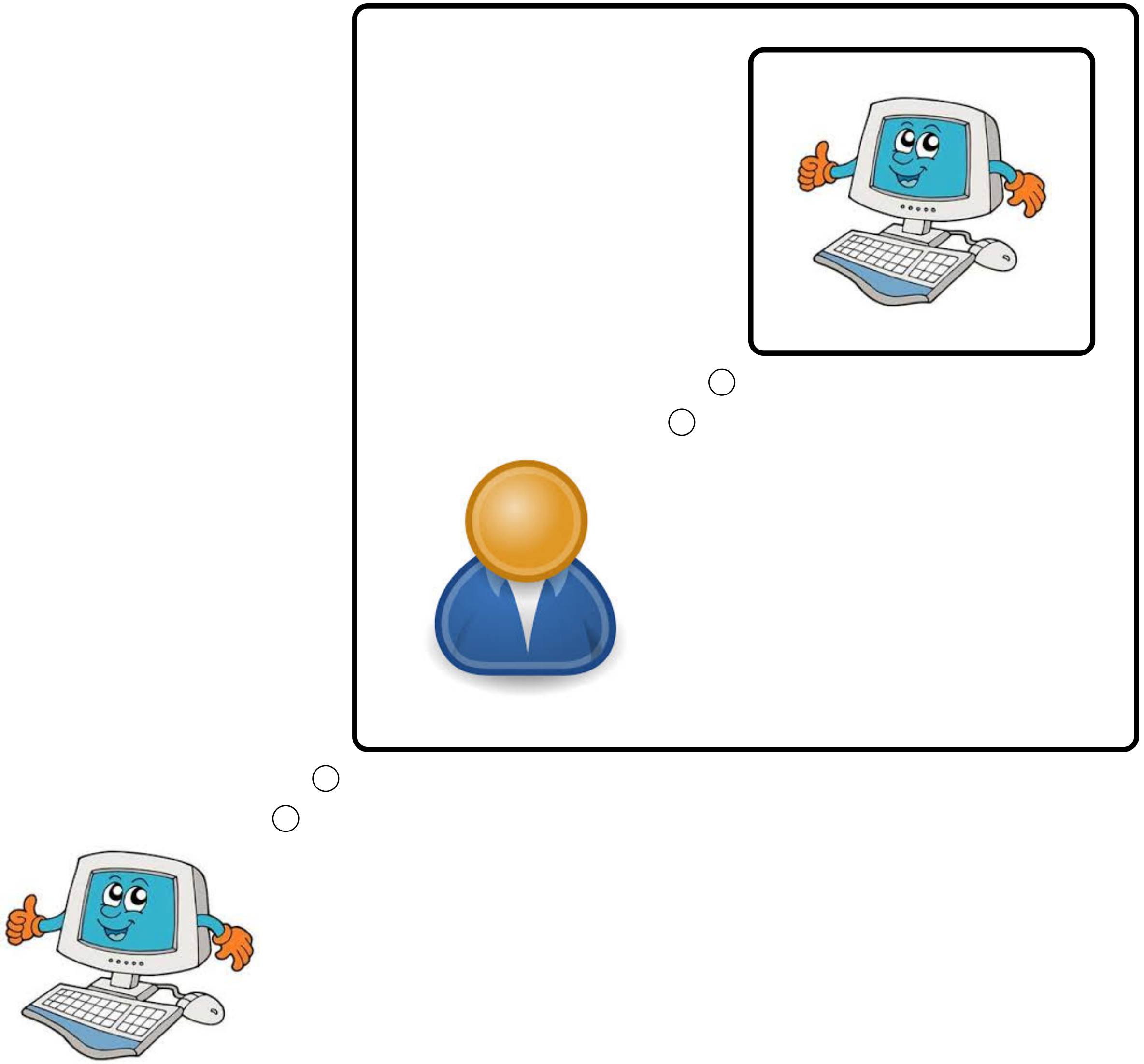

Intuition: cooperative communication

Paul Grice

[Golland et al. 2010; Frank/Goodman, 2012]

Pragmatics: model



Pragmatics: example

Listener (computer):

$p_\theta(z \mid x)$: semantic parsing model

	`remove(red)`	`remove(cyan)`	others
delete cardinal	0.8	0.1	0.1
delete cyan	$\boxed{\mathbf{0.6}}$	0.2	0.2

Pragmatics: example

Speaker (human):

$$S(x \mid z) \propto p_\theta(z \mid x)p(x)$$

(assume $p(x)$ uniform)

	`remove(red)`	`remove(cyan)`	others
delete cardinal	0.57	0.33	0.33
delete cyan	0.43	0.67	0.67

Pragmatics: example

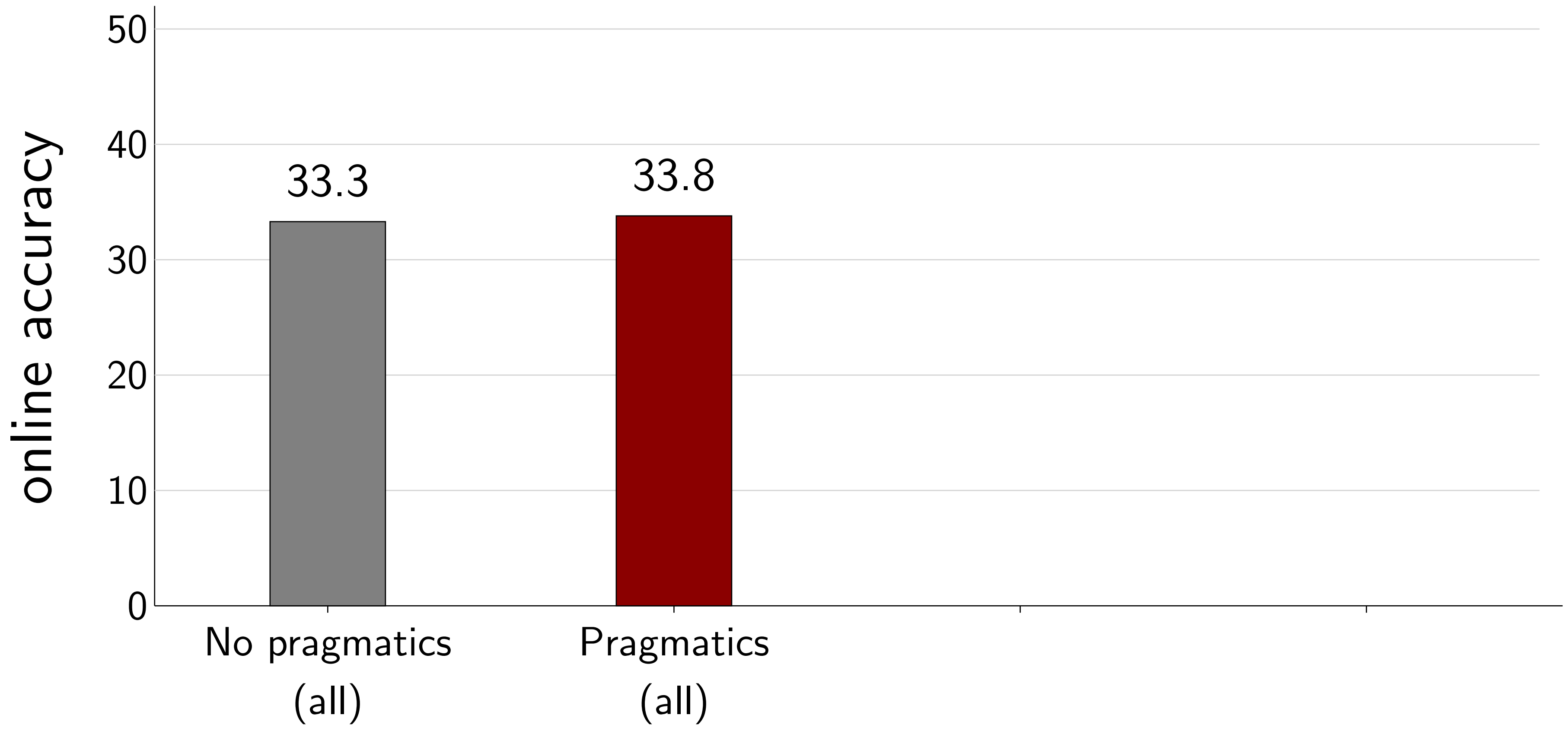
Listener (computer):

$$L(z \mid x) \propto S(x \mid z)p(z)$$

(assume $p(z)$ uniform)

	`remove(red)`	`remove(cyan)`	others
delete cardinal	0.46	0.27	0.27
delete cyan	0.24	$\boxed{\mathbf{0.38}}$	$\boxed{\mathbf{0.38}}$

Pragmatics: results



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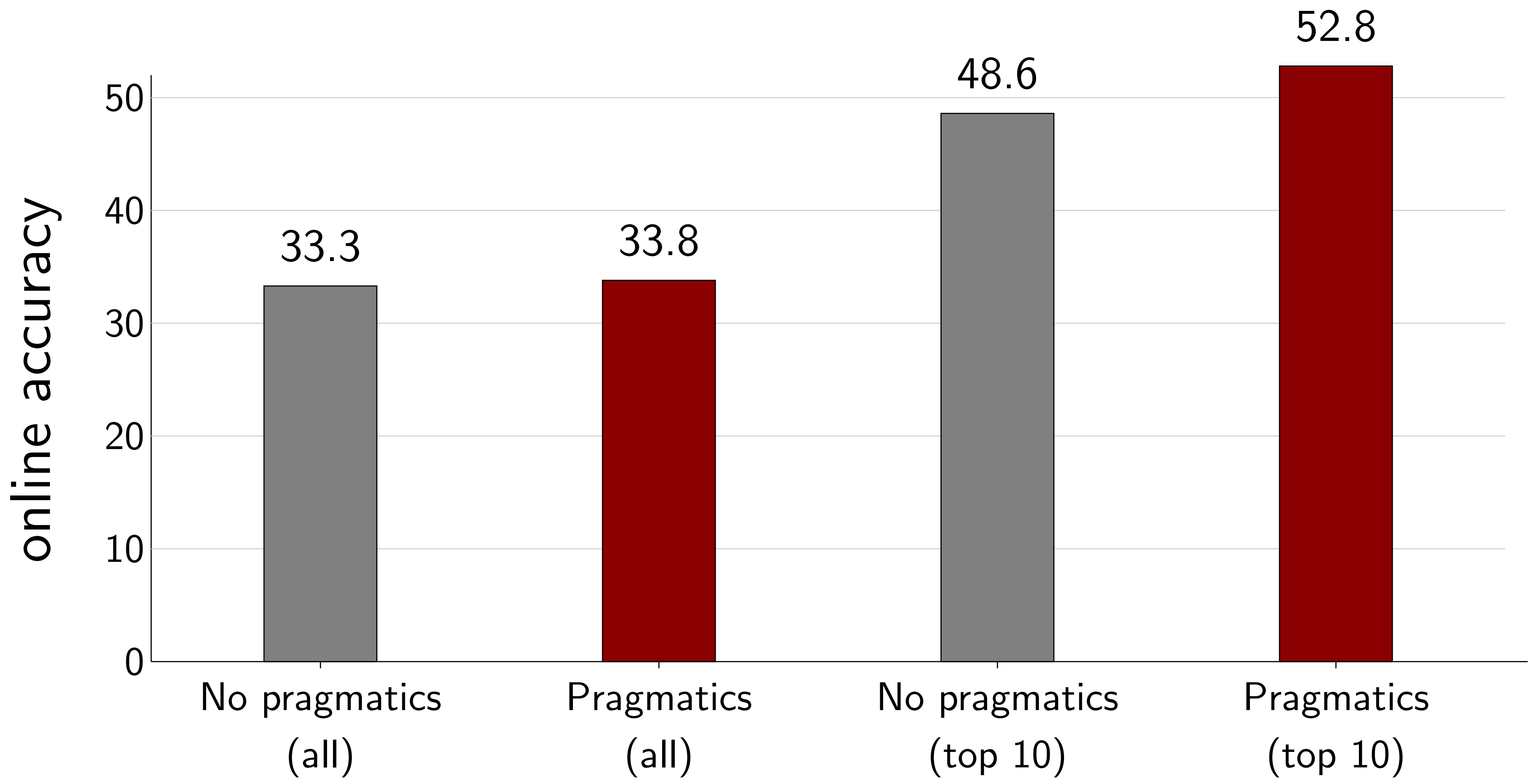

pragmatics helps top (cooperative, rational) players

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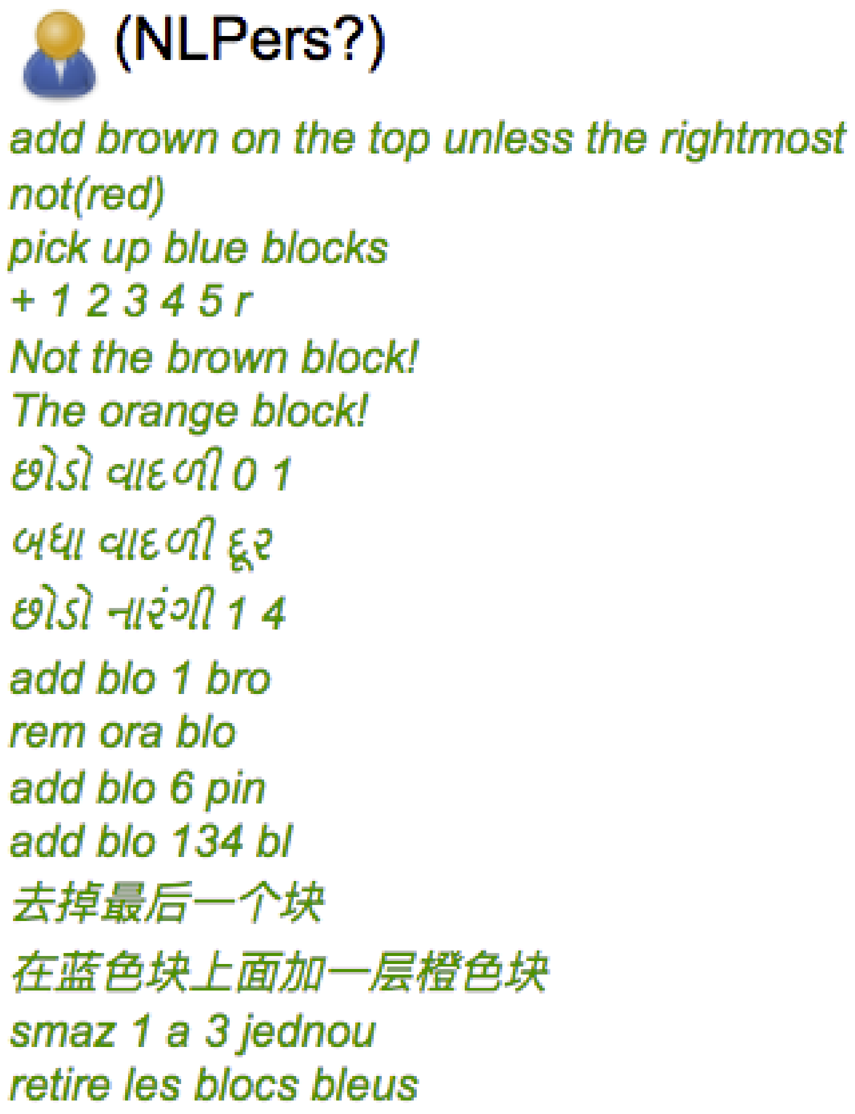
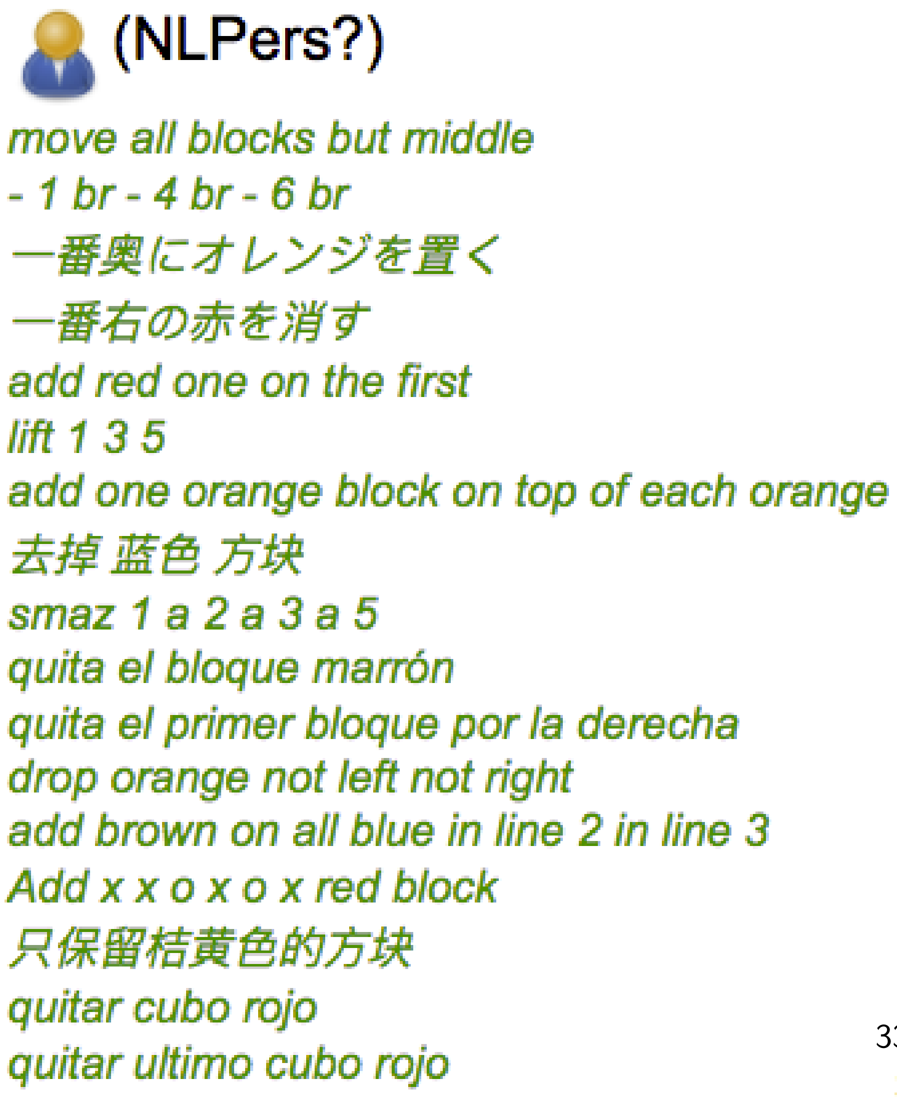
The real data

- Data from June 2016 - Feb 2017
  - 19k+ examples, 1.2k+ sessions



(NLPers?)

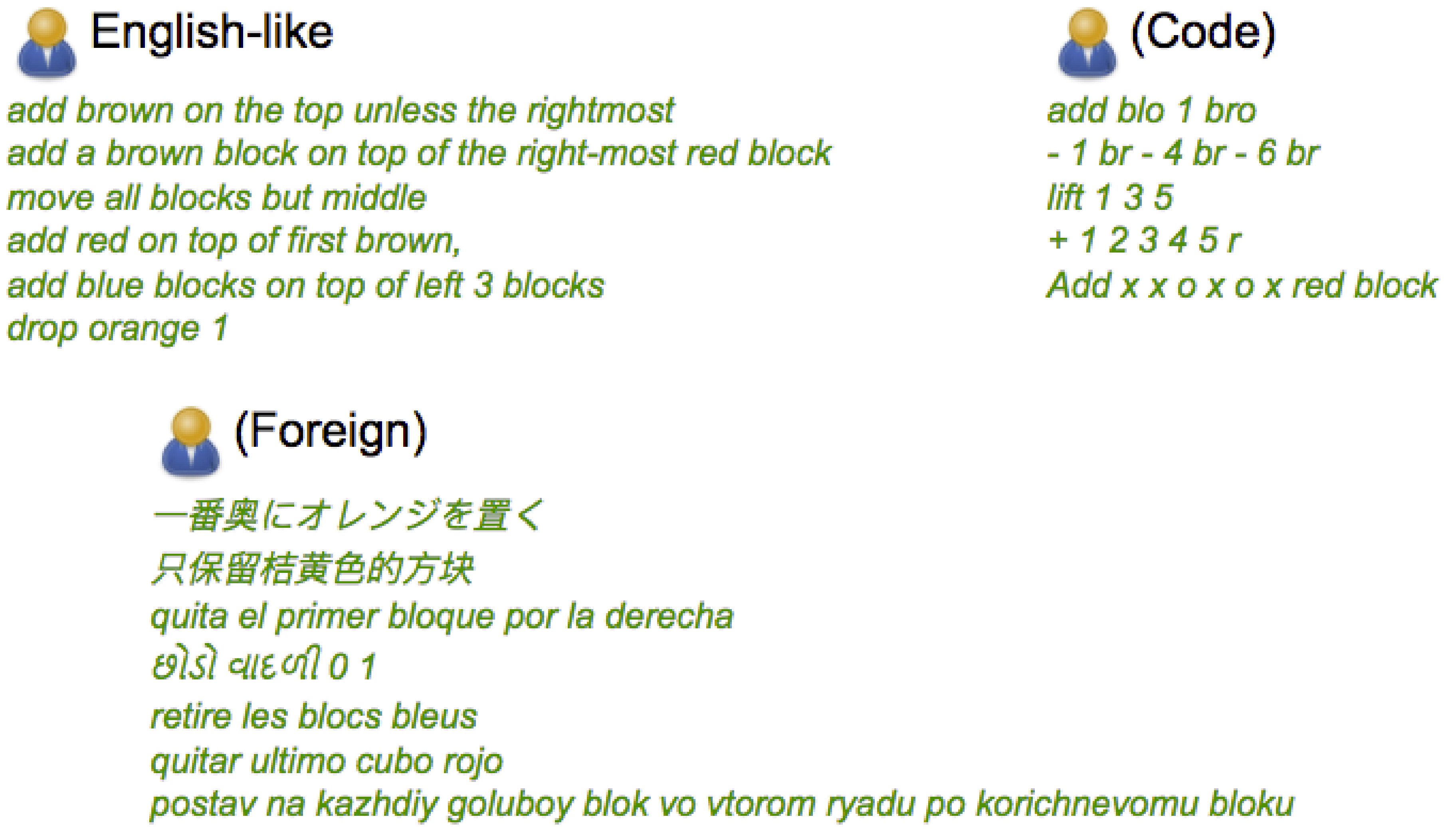
add brown on the top unless the rightmost
not(red)
pick up blue blocks
+ 1 2 3 4 5 r
Not the brown block!
The orange block!
છોડો વાદળી 0 1
બધા વાદળી દૂર
છોડો નારંગી 1 4
add blo 1 bro
rem ora blo
add blo 6 pin
add blo 134 bl
去掉最后一个块
在蓝色块上面加一层橙色块
smaz 1 a 3 jednou
retire les blocs bleus



(NLPers?)

move all blocks but middle
- 1 br - 4 br - 6 br
一番奥にオレンジを置く
一番右の赤を消す
add red one on the first
lift 1 3 5
add one orange block on top of each orange
去掉 蓝色 方块
smaz 1 a 2 a 3 a 5
quita el bloque marrón
quita el primer bloque por la derecha
drop orange not left not right
add brown on all blue in line 2 in line 3
Add x x o x o x red block
只保留桔黄色的方块
quitar cubo rojo
quitar ultimo cubo rojo

Diverse language in blocks world



English-like

add brown on the top unless the rightmost
add a brown block on top of the right-most red block
move all blocks but middle
add red on top of first brown,
add blue blocks on top of left 3 blocks
drop orange 1

(Code)

add blo 1 bro
- 1 br - 4 br - 6 br
lift 1 3 5
+ 1 2 3 4 5 r
Add x x o x o x red block

(Foreign)

一番奥にオレンジを置く
只保留桔黄色的方块
quita el primer bloque por la derecha
છોડો વાદળી 0 1
retire les blocs bleus
quitar ultimo cubo rojo
postav na kazhdiy goluboy blok vo vtorom ryadu po korichnevomu bloku

Learning language games findings

- our system learns from scratch, quickly
- modelling pragmatics is helpful
- people adapts to the computer
  - given the chance, people use very diverse language

Drawbacks

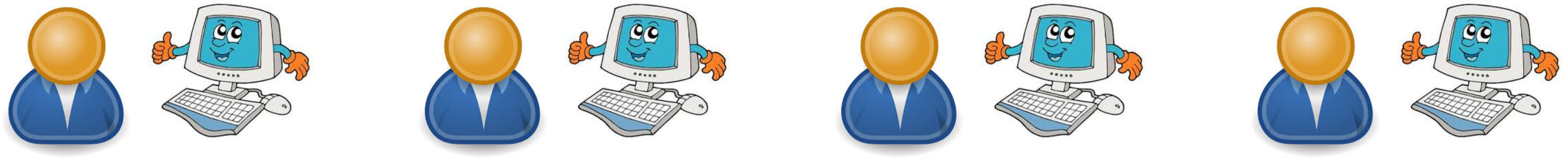
selection as supervision signal cannot scale very well

- number of logical forms is exponenential in length

```
(:blk (:loop 4 (:s (:blk (:loop 2 (:s (:blk (:loop
3(:s (:  add red here) (:for (call adj top) (:
select))))))(:for (call adj left) (:  select))))) (:for
(call adj back) (:  select)))))
```

each user has a private language – and no sharing

- the system does not continue to improve with more users



action space unclear, not communicated to users

- *Add x x o x o x red block* – *remove 2 4 6 8* – *lift 1 3 5*

Main outline

- Extreme 1: learning language games from scratch
- **Extreme 2: naturalizing a programming language**

Goal

- handle more complex actions / programs
  - *put cols B and D in a scatter plot against col A*
  - *lowercase the first letter of all my bullets*
  - *move all my future meetings with Bob ahead by 1 hour*
  - *street with palm trees 5 spaces apart*
- evolve the language through use in a community
  - system continues to improve through use
- define and accommodate the action space

Motivation

- formal language
  - unambiguous, compose tractably
- learning through definitions
  - 3 by 4 red square := 3 red columns of height 4
  - no need to infer from many examples
  - build up complex concepts hiearchically

. . . "There is in my opinion no important theoretical difference between natural languages and the artificial languages of logicians"

$\rightarrow$ language derives its meaning through definition

Naturalization

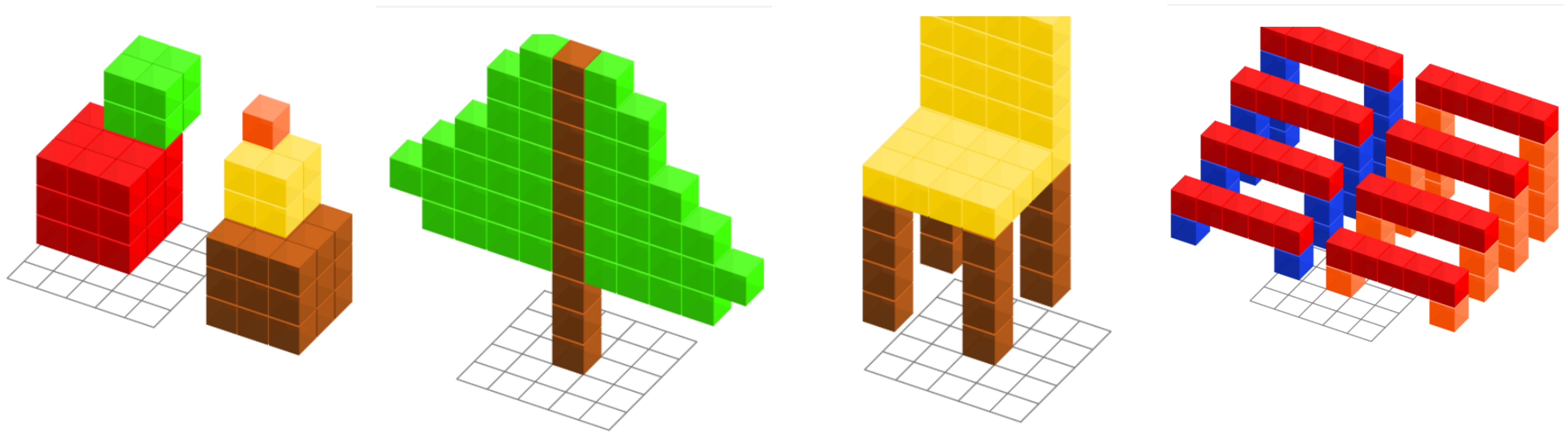
- seed the system with a core programming language
  - expressive and defines action space, but tedious to use
- user teach the system by defining new things
  - "X" means "Y"
- evolve the language to be more natural to people while accommodating the system action space

learn from how people try to program

Shared community learning

- all users teach one system
  - initial users need to know some of the core language
  - later users can use what initial users taught
- better for new users
  - after enough usage, most simple variations are covered
- easier to use for power users
  - allowing them to customize and share

Voxelurn



- world is a set of objects with relations
  - Voxels: $(x, y, z, \mathrm{color})$
  - domain specfic relation: [direction]: left, top, front, etc.
- domain specific actions: add, move

Core language

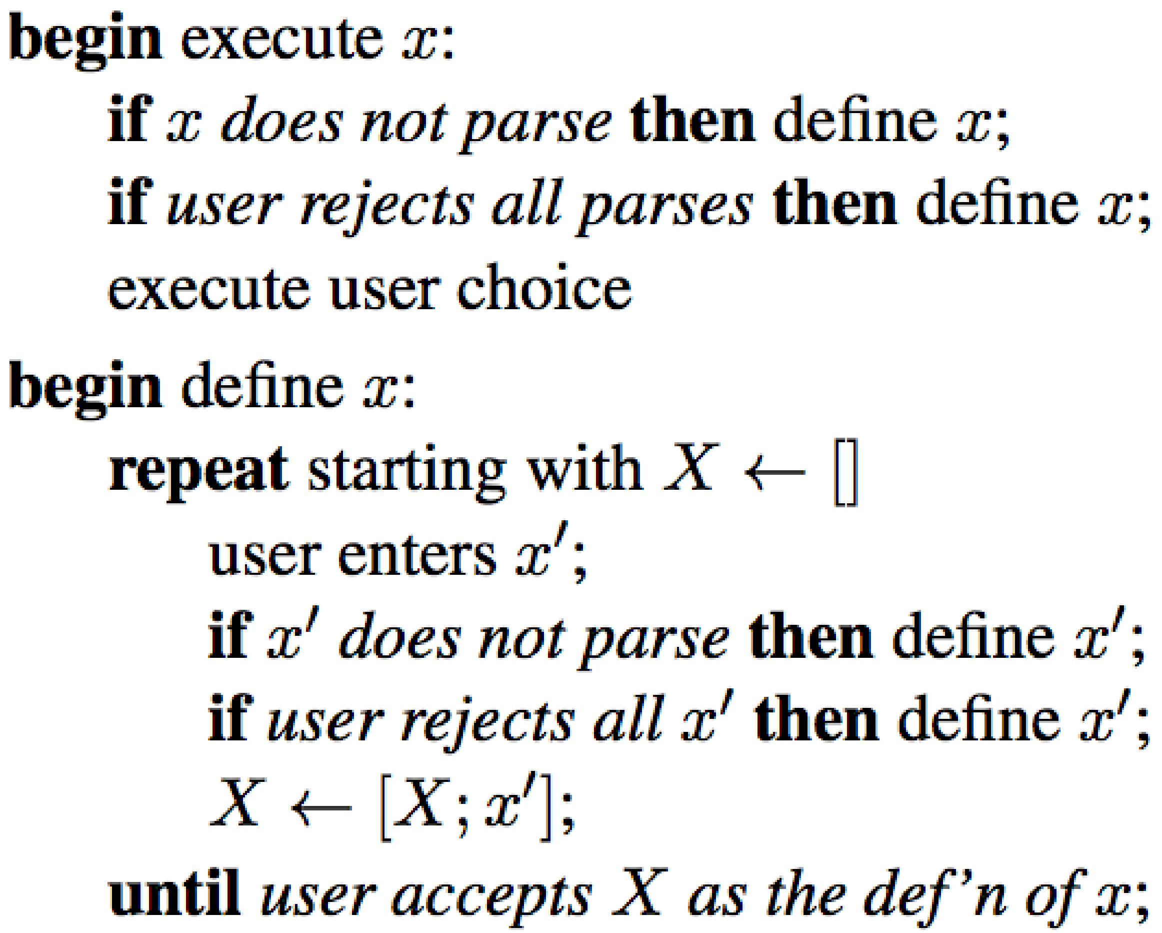
- programming language designed to interpolate with NL
- controls: if, foreach, repeat, while
- lambda DCS for variable-free joins, set ops, etc.
  - has color yellow or color of has row 1
- selection to avoid variables
  - select left of this
- block-structured scoping
  - , [], isolate

Core language (domain general)

Rule(s)	**Example(s)**
$A \rightarrow A;\ A$	select left; add red
$A \rightarrow$ repeat $N\ A$	repeat 3-1 add red top
$A \rightarrow$ if $S\ A$	if has color red [select origin]
$A \rightarrow$ while $S\ A$	while not has color red [select left of this]
$A \rightarrow$ foreach $S\ A$	foreach this [remove has row row of this]
$A \rightarrow [A\ ]$	[select left or right; add red; add red top]
$A \rightarrow \{A\ \}$	{select left; add red}
$A \rightarrow$ isolate A	isolate [add red top; select has color red]
$A \rightarrow$ select S	select all and not origin
$A \rightarrow$ remove S	remove has color red
$A \rightarrow$ update $R\ S$	update color [color of left of this]
S	this
S	all | none | origin
R of S | has $R\ S$	has color red or yellow | has row [col of this]
not S | S and S | S or S	this or left and not has color red
N | N+N | N-N	1,. . . ,10 | 1+2 | row of this + 1
argmax $R\ S$ | argmin $R\ S$	argmax col has color red

Demo

- explain the definition process
- do palm tree, and cube, add green monster



```
begin execute $x$:
    if $x$ does not parse then define $x$;
    if user rejects all parses then define $x$;
    execute user choice
begin define $x$:
    repeat starting with $X \leftarrow []$
        user enters $x'$;
        if $x'$ does not parse then define $x'$;
        if user rejects all $x'$ then define $x'$;
        $X \leftarrow [X; x']$;
    until user accepts $X$ as the def'n of $x$;
```

Palm tree example

- define new things in terms of what's already defined
- everything trace back to the core language

```
add palm tree:
    add brown trunk height 3:



    go to top:


    add leaves here:
```

Palm tree example

- define new things in terms of what's already defined
- everything trace back to the core language

```
add palm tree:
    add brown trunk height 3:
        add brown top 3 times:


    go to top:


    add leaves here:
```

Palm tree example

- define new things in terms of what's already defined
- everything trace back to the core language

```
add palm tree:
    add brown trunk height 3:
        add brown top 3 times:
            repeat 3 [add brown top]
    go to top:


    add leaves here:
```

Palm tree example

- define new things in terms of what's already defined
- everything trace back to the core language

```
add palm tree:
    add brown trunk height 3:
        add brown top 3 times:
            repeat 3 [add brown top]
    go to top:
        select very top of all
    add leaves here:
```

Palm tree example

- define new things in terms of what's already defined
- everything trace back to the core language

```
add palm tree:
    add brown trunk height 3:
        add brown top 3 times:
            repeat 3 [add brown top]
    go to top:
        select very top of all
    add leaves here:
        select left or right or front or back; add green
```

Model (now over derivations)

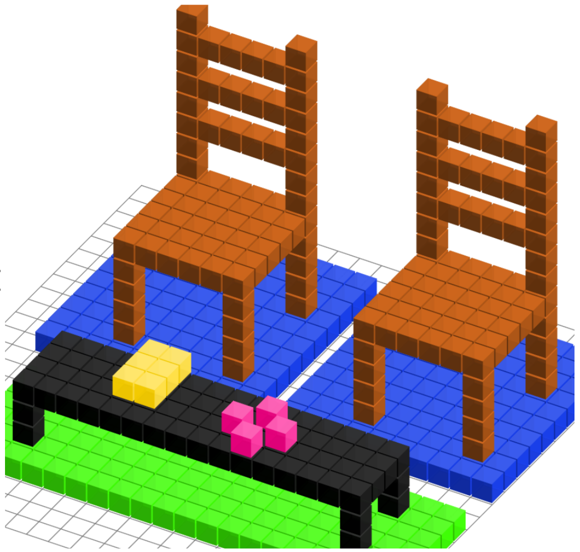
log-linear model with features $\phi(d, x, u)$:

$$p_\theta(d \mid x, u) \propto \exp(\phi(d, x, u) \cdot \theta)$$

x : *add two chairs 5 spaces apart*

z : (:blk (:loop ...))

y :



Learning from denotations

mainly for handling scoping automatically

$$p_\theta(d \mid x, u) \propto \exp(\phi(d, x, u) \cdot \theta)$$

x : *add two chairs 5 spaces apart*

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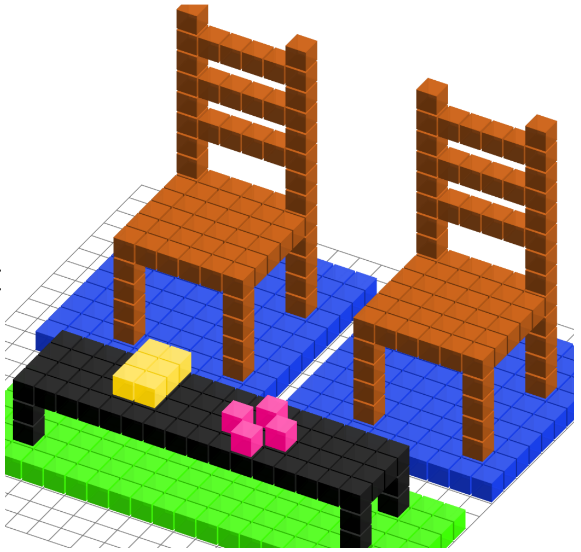


Learning from denotations

mainly for handling scoping automatically

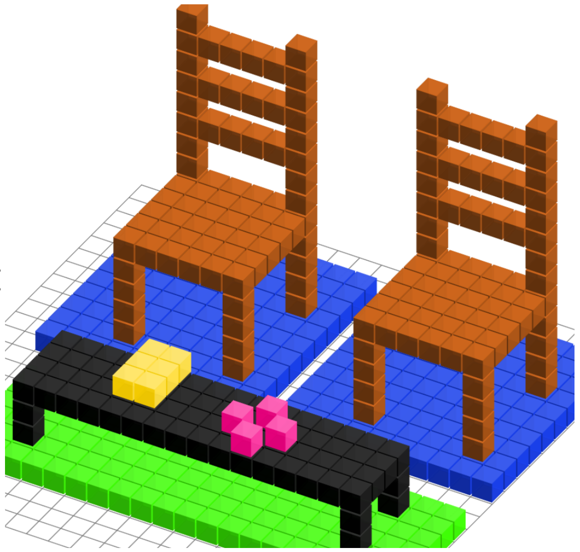
$$p_\theta(d \mid x, u) \propto \exp(\phi(d, x, u) \cdot \theta)$$

$$p_\theta(y \mid x, u) = \sum_{d:\mathrm{Exec}(d)=y} p_\theta(d \mid x, y)$$

x : *add two chairs 5 spaces apart*

z : *(: blk (: loop...))*

y :



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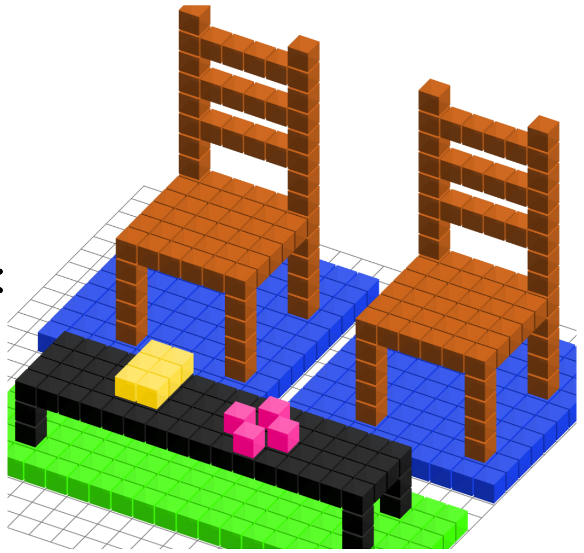
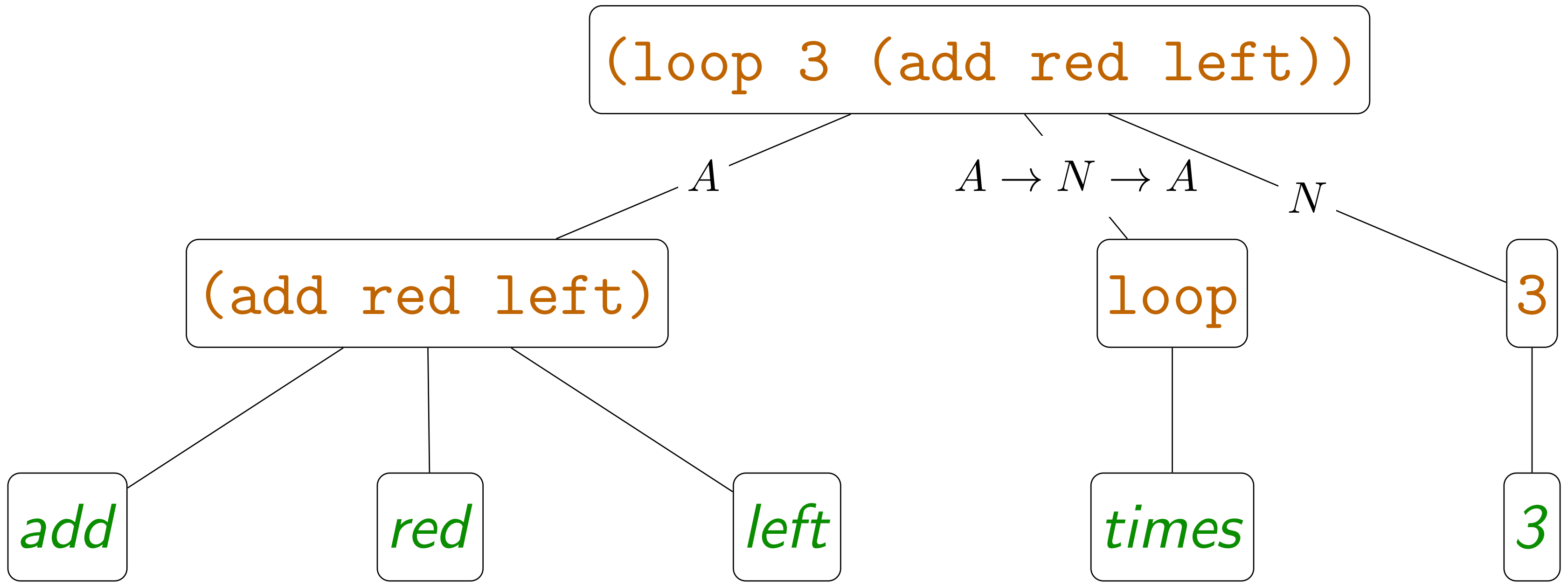


L1 penalty and update with AdaGrad

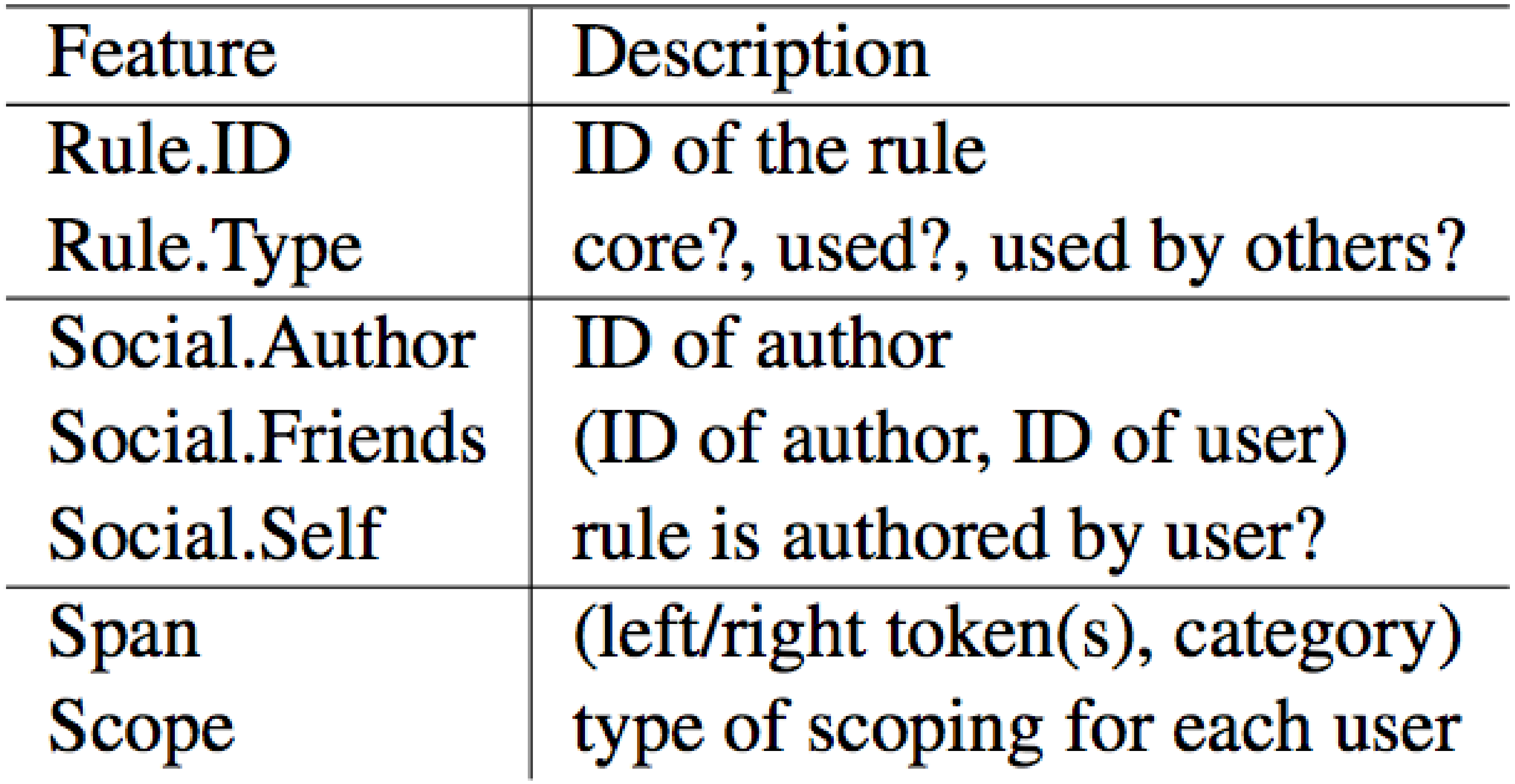
Derivation



Derivation: process of deriving the formula from the utterance

- which rules are used
- where each thing comes from
- categories, types, etc.

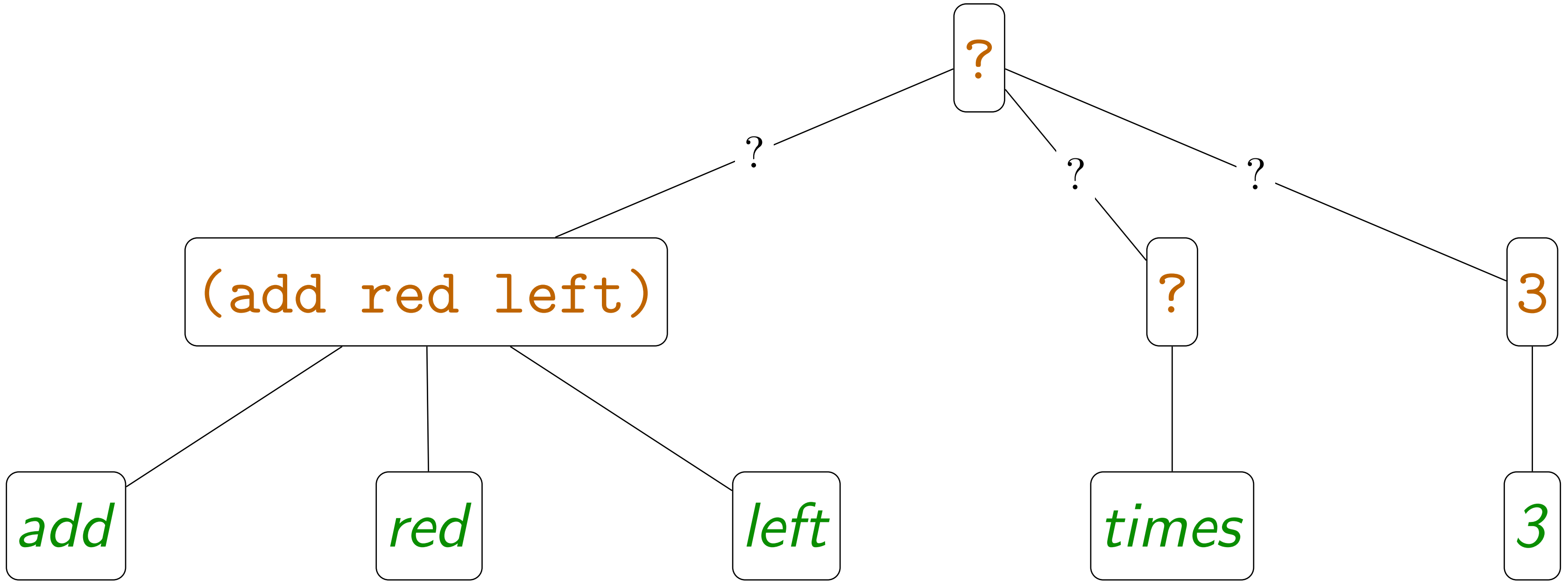
Features



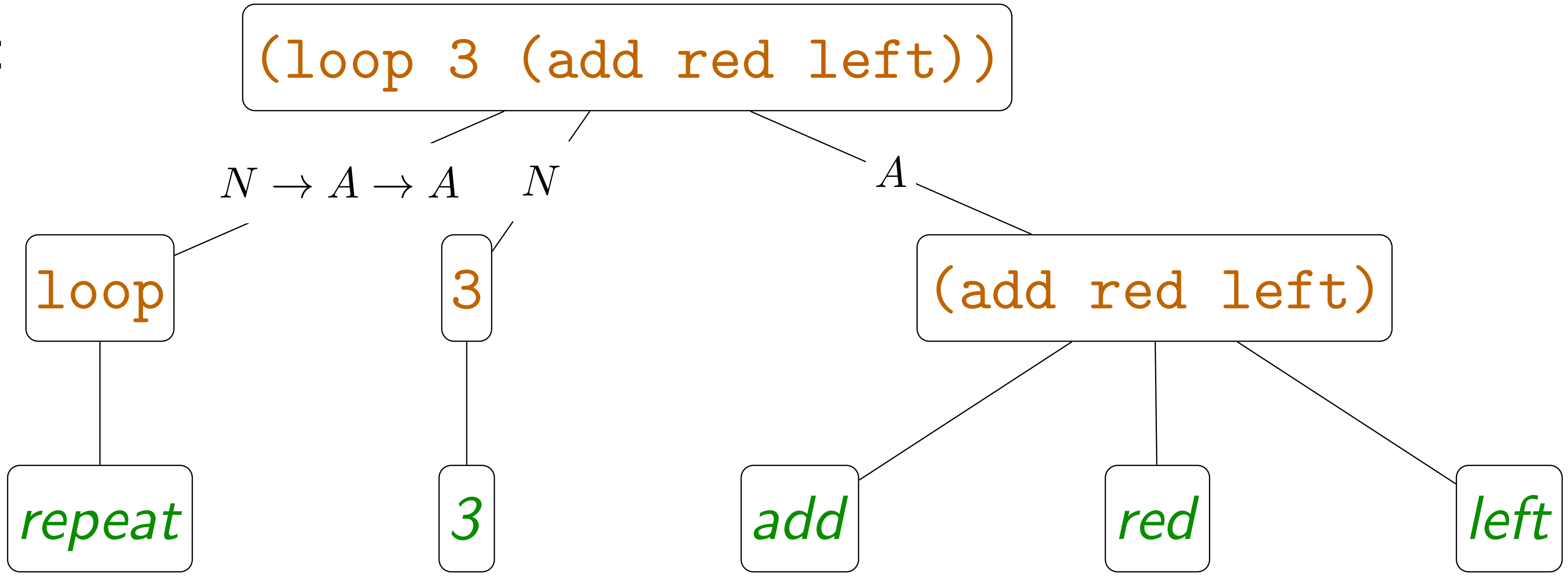
Feature	Description
Rule.ID	ID of the rule
Rule.Type	core?, used?, used by others?
Social.Author	ID of author
Social.Friends	(ID of author, ID of user)
Social.Self	rule is authored by user?
Span	(left/right token(s), category)
Scope	type of scoping for each user

Definition

head:



body X:



Grammar induction

- Want high precision rules
  - low precision: all users see more junk candidates
  - low recall: need more definitions
- Use the tree structure of derivation
  - instead of just the program
- Use both the derivation AND the utterance of the body

Grammar induction

Inputs: x, X, d, $\text{chart}(x)$

- x : add red top times 3
- X : repeat 3 [add red top] (often a sequence)
- d: (loop 3 (add red top)), and how it is derived
- $\text{chart}(x)$: 3, (add red top) and their derivations

Outputs:

- $A \rightarrow \textit{add}\ C\ \ D\ \textit{times}\ N$: λCDN.repeat N add C D
- $A \rightarrow A\ \textit{times}\ N$: λAN.repeat N [A]

Grammar induction

Inputs: x, X, d, $\mathrm{chart}(x)$

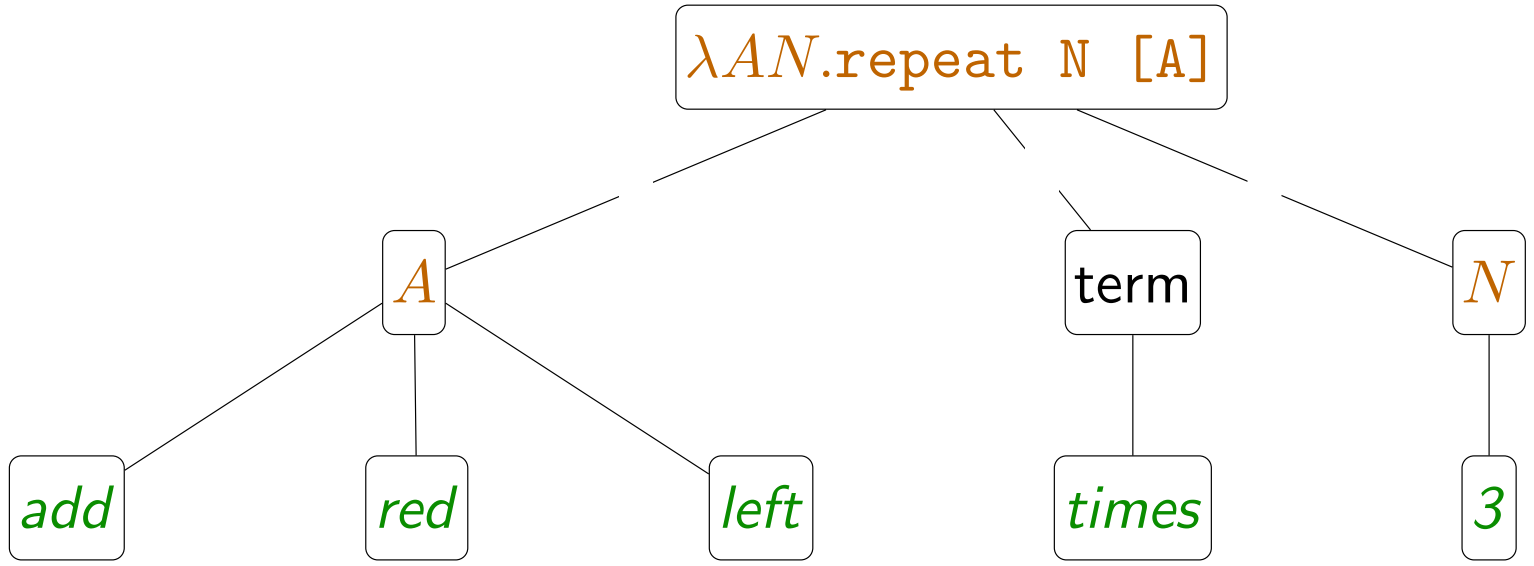
- x : add red top times 3
- X : repeat 3 [add red top] (often a sequence)
- d: (loop 3 (add red top)), and how it is derived
- $\mathrm{chart}(x)$: 3, (add red top) and their derivations

Outputs:

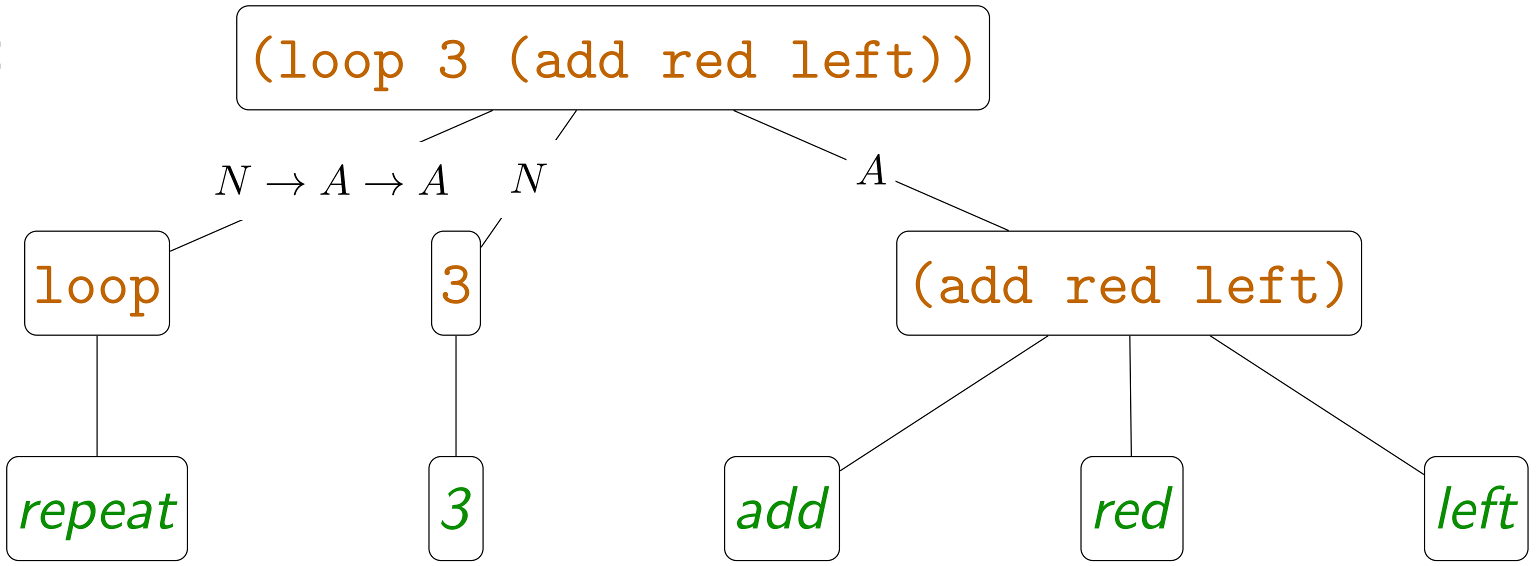
- $A \rightarrow \mathit{add}\ C\ D\ \mathit{times}\ N\ \ : \lambda CDN$.repeat N add C D
- $A \rightarrow A\ \mathit{times}\ N\ \ : \lambda AN$.repeat N [A]
  - can be wrong: add red to row 2 times 2

Grammar induction

substitute matching derivations by their categories:



body:



Considerations

Simple heuristic would not always work:

$$\underbrace{\overbrace{\text{add red}}^{A_1}\text{ left}}_{A_2}\text{ and here} = \underbrace{\overbrace{\text{add red}}^{A_1}\text{ left}}_{A_2};\ \overbrace{\text{add red}}^{A_1}$$

- A1: highest coverage of 4 tokens
- A2: largest match
- we extract the best scoring matches instead, inspired by GENLEX (Zettlemoyer and Collins, 2005)

Derivation scoping

put a chair leg

$:=$ *brown column of height 3*

put 4 chair legs 3 spaces apart

$:=$ *put a chair leg; move back 3 spaces; put a chair leg; move right 3 spaces; put a chair leg; move front 3 spaces; put a chair leg*

Highest scoring packing

- a span is a set of consecutive tokens
  - matching if the chart element is in definition
- a packing is a set of non-overlapping matching spans
  - maximal packing – no span to be added
- abstract away the highest scoring maximal packing

$$P_l^* = \operatorname*{argmax}_{P \in \text{packing}(M);} \sum_{d \in P} \text{score}(d).$$

- solve with a dynamic program

Can people do this?

- *chair legs of height 3*

```
(:s (:s (:blkr (:s (:loop (number 3) (:s (:  add brown
here) (:for (call adj top this) (:  select)))) (:loop
(number 3) (:for (call adj bot this) (:  select)))))
(:loop (number 3) (:for (call adj left this) (:
select)))) (:s (:s (:s (:s (:blkr (:s (:loop (number
3) (:s (:  add brown here) (:for (call adj top this)
(:  select)))) (:loop (number 3) (:for (call adj bot
this) (:  select))))) (:loop (number 3) (:for (call
adj back this) (:  select)))) (:blkr (:s (:loop (number
3) (:s (:  add brown here) (:for (call adj top this)
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this) (:  select)))))) (:loop (number 3) (:for (call
adj right this) (:  select)))) (:blkr (:s (:loop (number
3) (:s (:  add brown here) (:for (call adj top this) (:
select)))) (:loop (number 3) (:for (call adj bot this)
(:  select)))))))
```
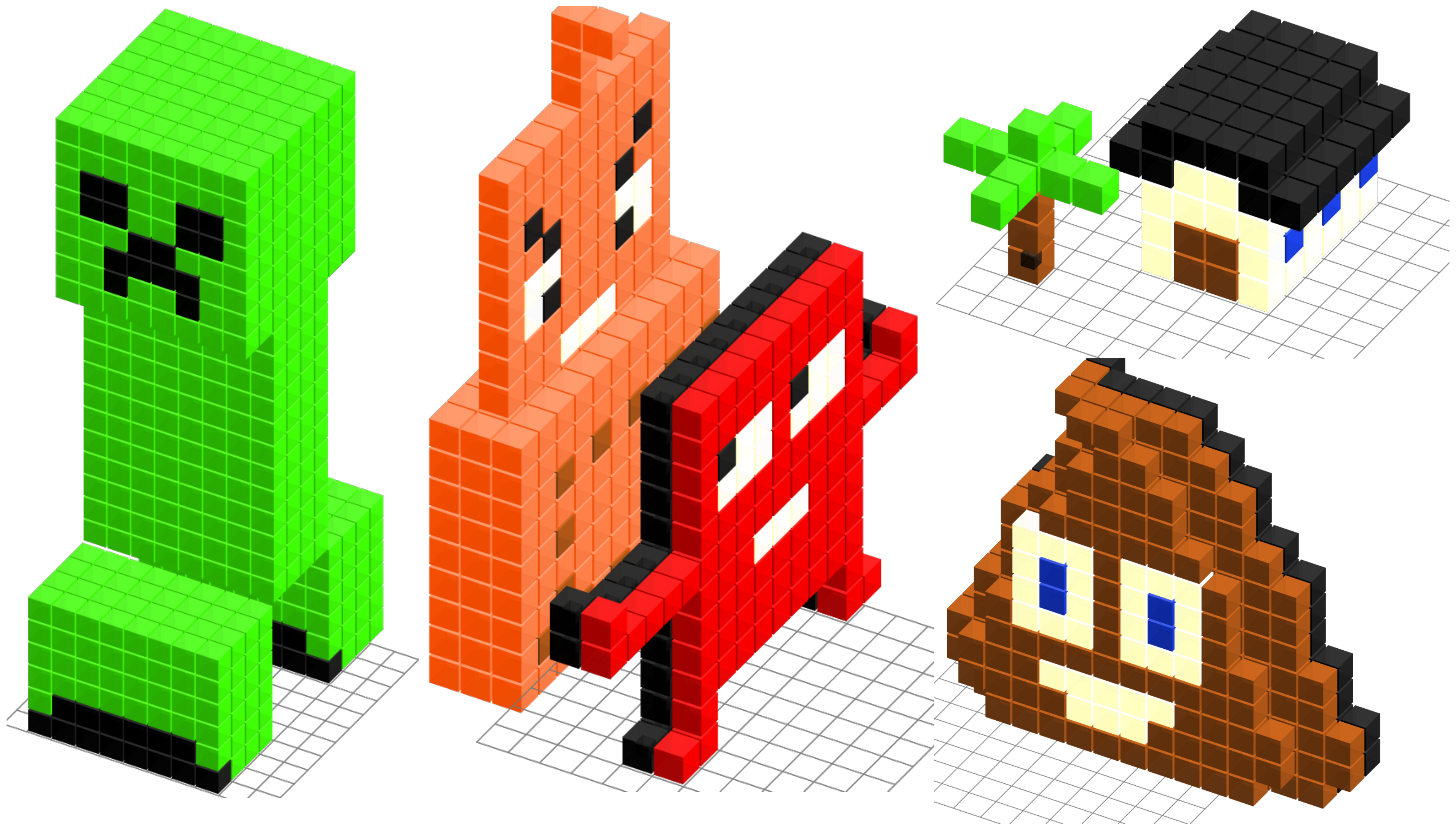
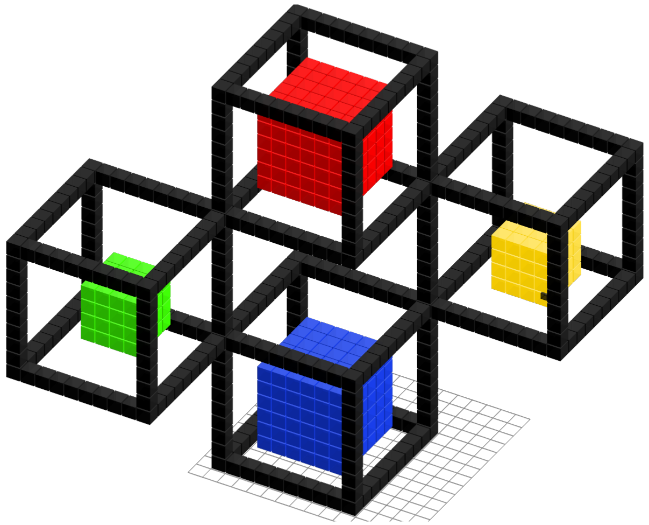
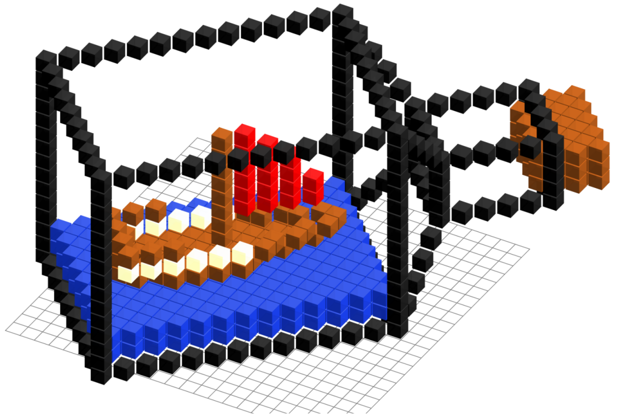
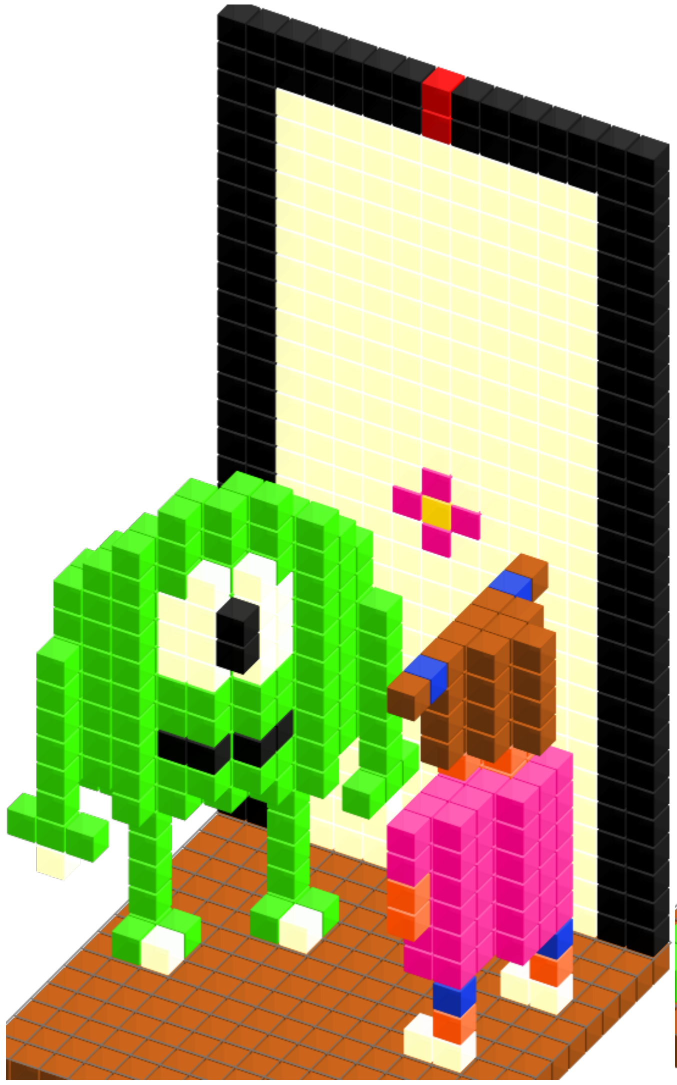
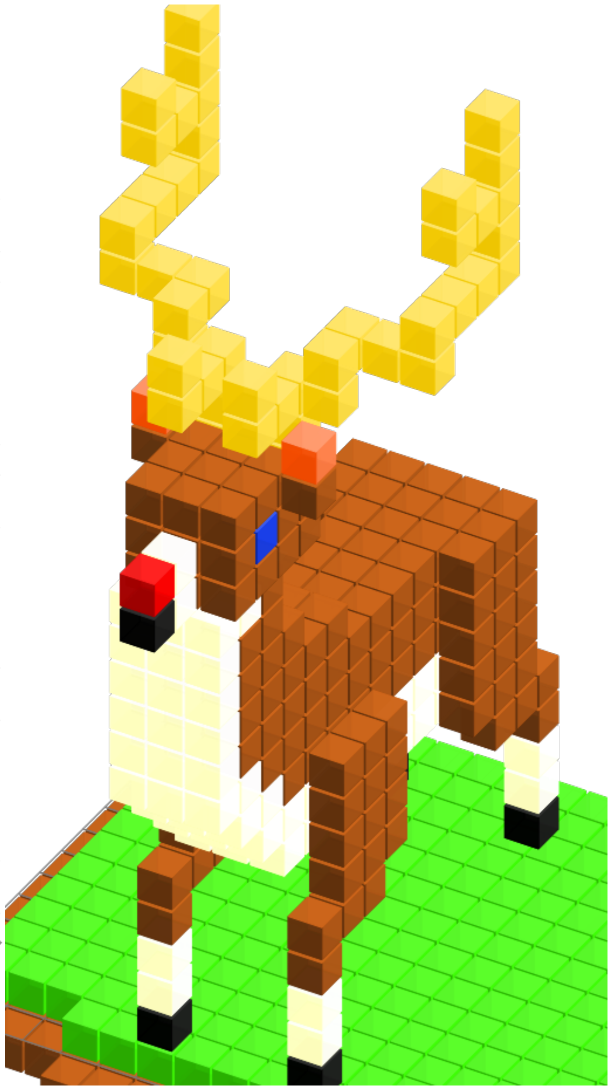

Experiments

- users built great structures?



Experiments

- users built great structures! (show leaderboard)

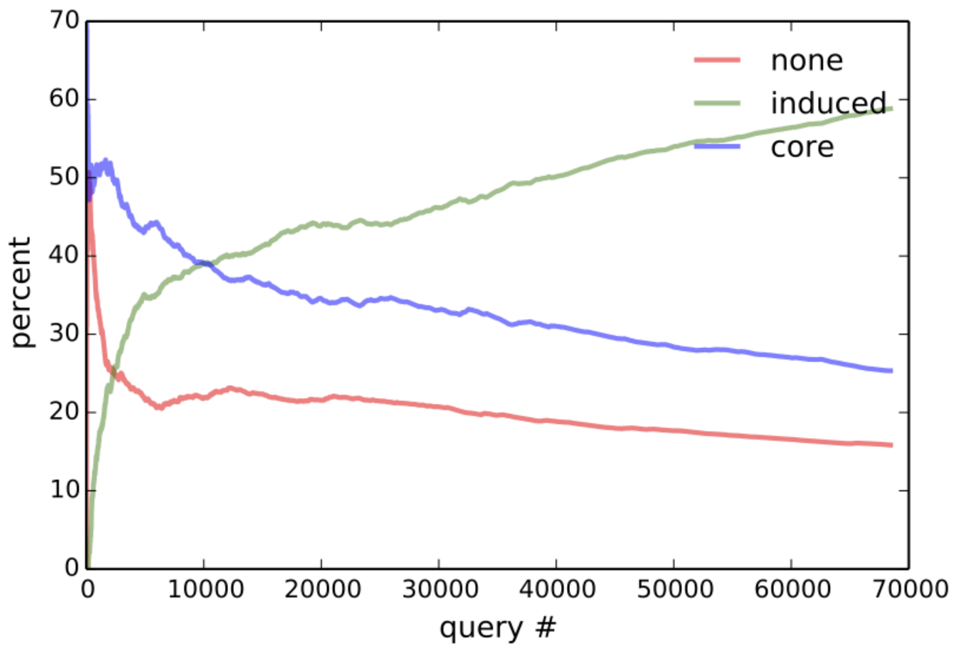
Setup

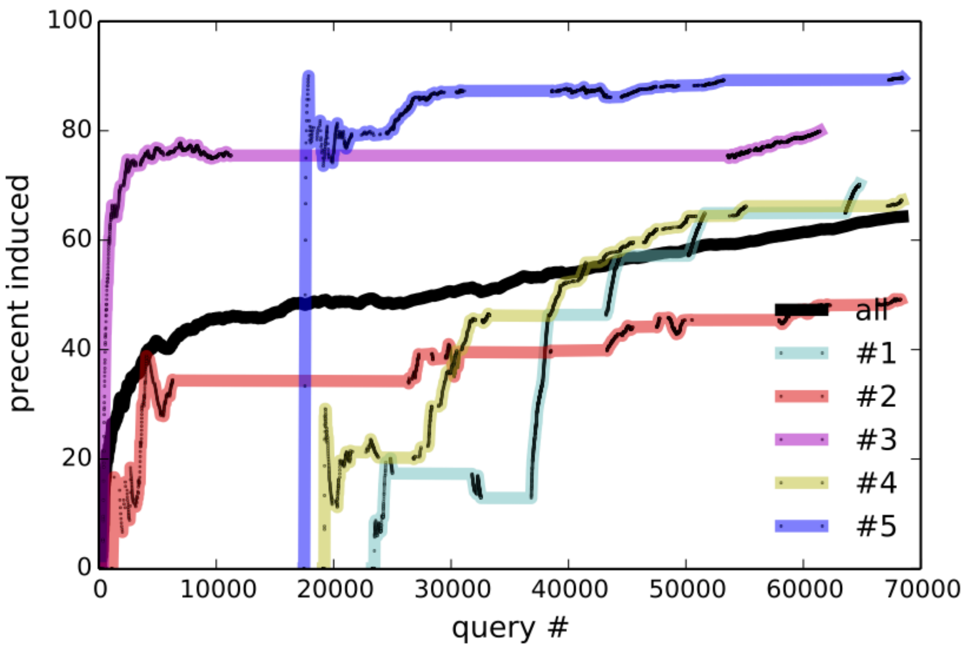
- qualifier: build a fixed structure
- post-qual: over 3 days build whatever they want
- prizes for best structures
  - day 1: bridge, house, animal
  - day 2: tower, monster(s), flower(s)
  - day 3: ship(s), dancer(s), and castle
- prize for top h-index
  - a rule (and its author) gets a citation whenever it is used

Basic statistics

- 70 workers qualified, 42 participated, 230 structures
- 64075 utterances, 36589 accepts
  - each accept leads to a datapoint labeled by derivation(s)
- 2495 definitions, 2817 induced rules (¡100 core)

Is naturalization happening

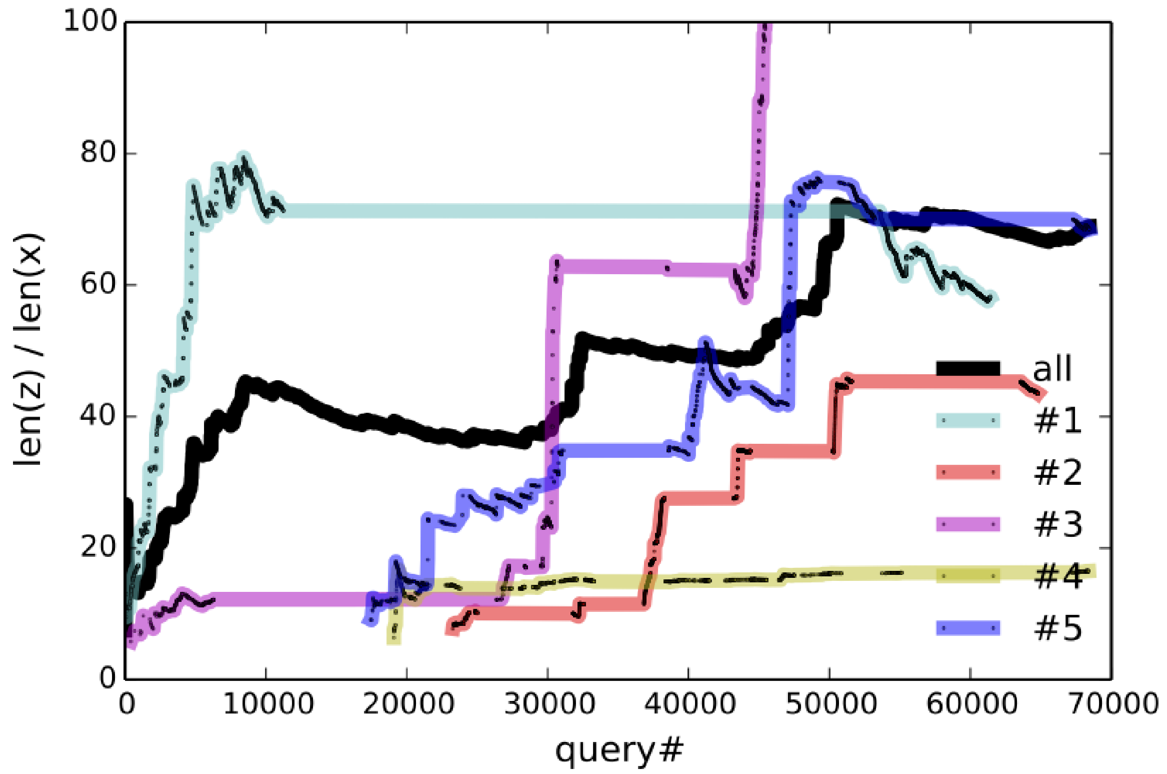




percent utterances using induced rules:

- 58% of all at the end (up from 0 in the beginning)
- 64.3% of all accepted, and 77.9% of the last 10k accepted
- top users naturalized to different extends, but all increasing

Expressive power



- cumulative average of string.length in program / # tokens in utterance
- len(z)/len(z) is very stable at 10 for core language
- varies greatly by user

Modes of naturalization

short forms:

left, l, mov left, go left, ¡, sel left

br, blk, blu, brn, orangeright, left3

add row brn left 5

$:=$ *add row brown left 5*

Modes of naturalization

syntactic:

go down and right	*l white*
:= *go down; go right*	:= *go left and add white*
select orange	*mov up 2*
:= *select has color orange*	:= *repeat 2 [select up]*
add red top 4 times	*go up 3*
:= *repeat 4 [add red top]*	:= *go up 2; go up*

Modes of naturalization

higher level:

add black block width 2 length 2 height 3

$:=$ {*repeat 3 [add black platform width 2...*

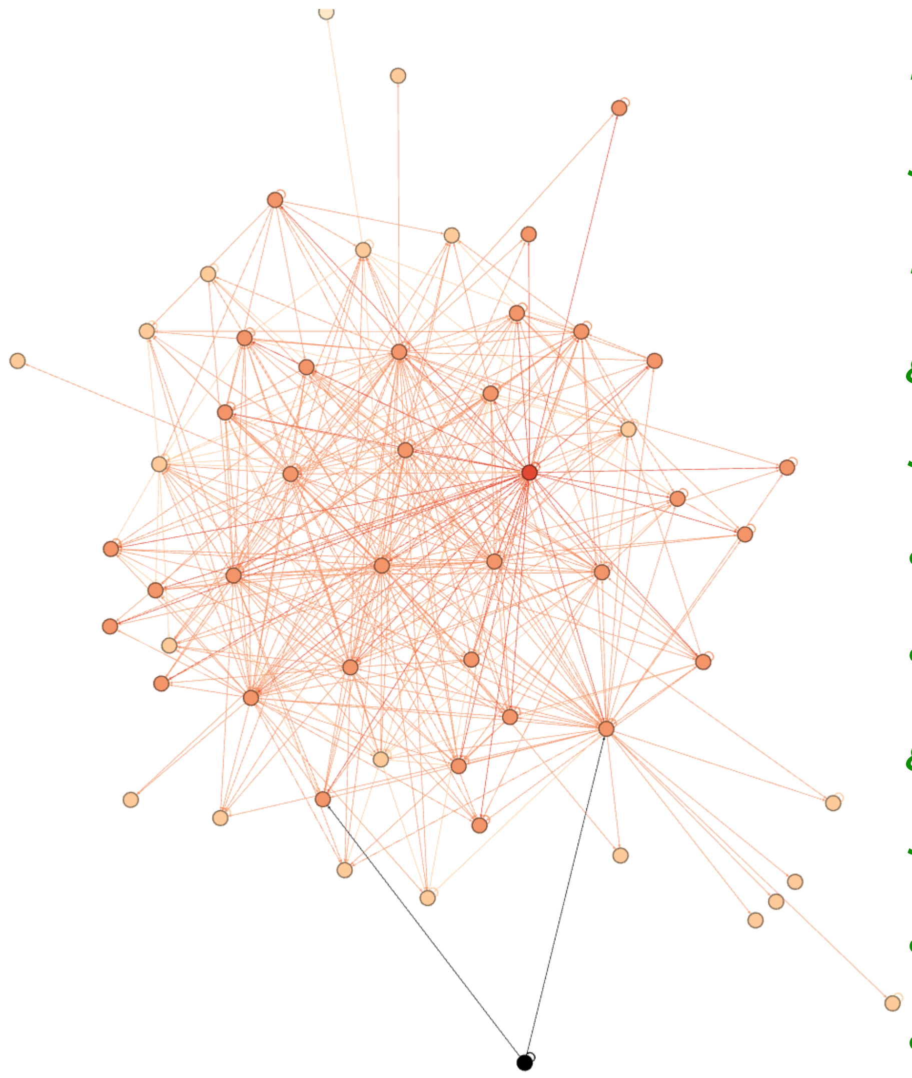
flower petals

$:=$ *flower petal; back; flower petals*

cube size 5, get into position start, 5 x 5 open green square, brownbase

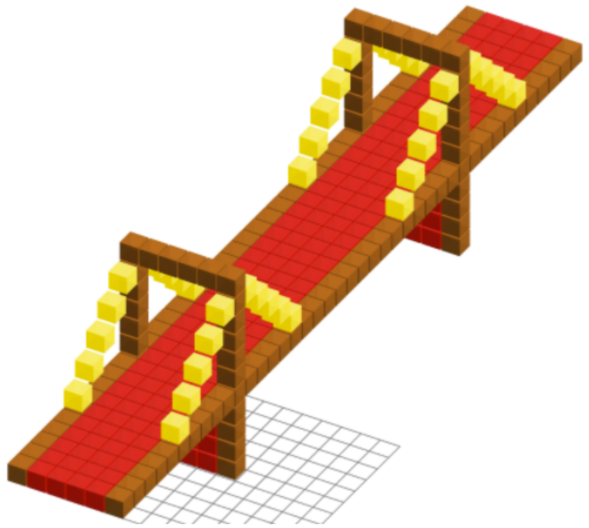
Citations

basic statistics: 1113 cited rules, median 3, mean 46



left 3	5820
select up	4591
right, ...	2888
go left	1438
select right 2	1268
add b	975
add red top 4 times	309
go back and right	272
select orange	256
add white plate 6 x 7	232
add brown row 3	203
mov right 3	178

Bridge the gap in power

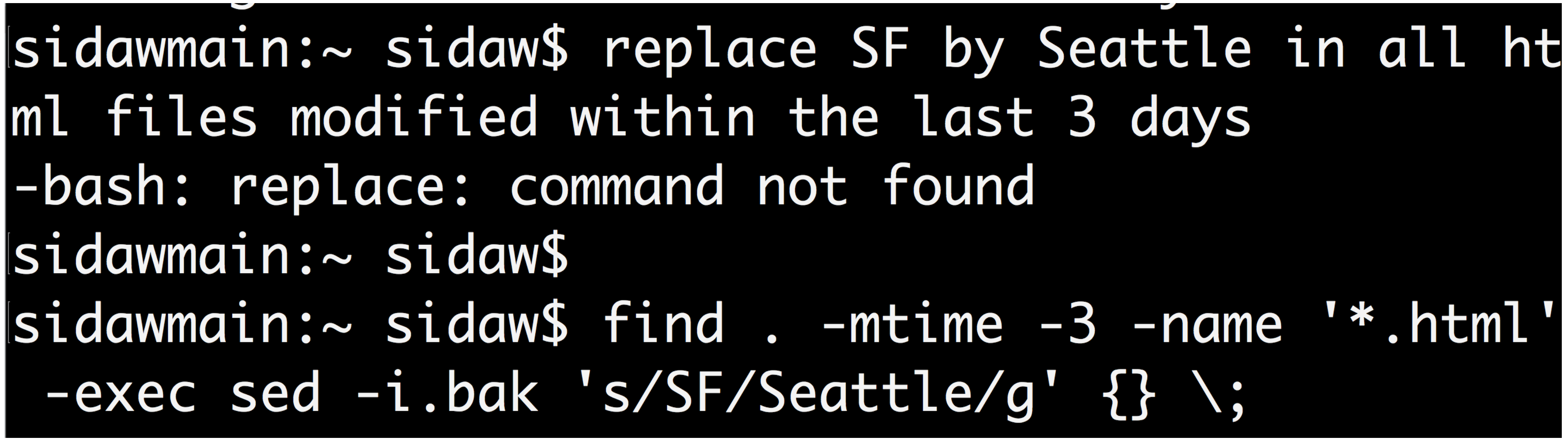


naturalizing a programming language:

- handle complex actions
- shared community learning

to cover more variations

- better for beginners and experts alike?



```
sidawmain:~ sidaw$ replace SF by Seattle in all ht
ml files modified within the last 3 days
-bash: replace: command not found
sidawmain:~ sidaw$
sidawmain:~ sidaw$ find . -mtime -3 -name '*.html'
 -exec sed -i.bak 's/SF/Seattle/g' {} \;
```

The two extremes

LLG: start from scratch, understands nothing, anything goes

NPL: start with a programming language and its power

The two extremes

LLG: start from scratch, understands nothing, anything goes

NPL: start with a programming language and its power

LLG: each user has a private language

NPL: user community has one shared language

- with some user modelling

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LLG: selection is the supervision

NPL: definition is the supervision

- possible to build up complex actions/concepts

The two extremes

LLG: start from scratch, understands nothing, anything goes

NPL: start with a programming language and its power

LLG: each user has a private language

NPL: user community has one shared language

- with some user modelling

LLG: selection is the supervision

NPL: definition is the supervision

- possible to build up complex actions/concepts

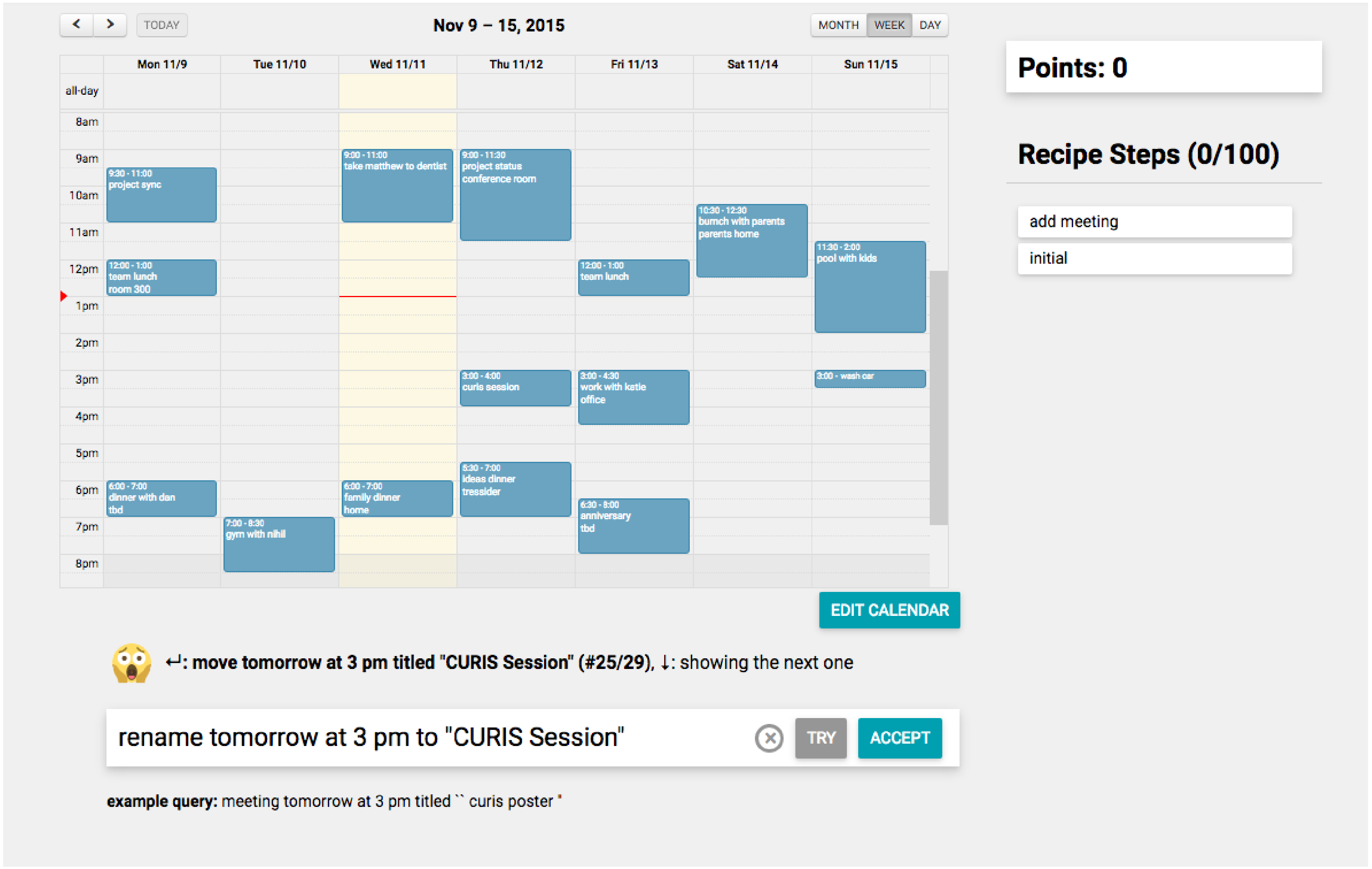
LLG: features, learning from denotations do the heavy lifting

- guess any action, language agnostic

NPL: grammar induction do the heavy lifting

- no parse unless well-supported

Calendar (with Nadav Lidor)



TODAY
Nov 9 – 15, 2015
MONTH WEEK DAY
Mon 11/9 Tue 11/10 Wed 11/11 Thu 11/12 Fri 11/13 Sat 11/14 Sun 11/15
all-day
8am 9am 10am 11am 12pm 1pm 2pm 3pm 4pm 5pm 6pm 7pm 8pm
9:30 - 11:00 project sync
12:00 - 1:00 team lunch room 300
6:00 - 7:00 dinner with dan tbd
7:00 - 8:30 gym with nihil
9:00 - 11:00 take matthew to dentist
6:00 - 7:00 family dinner home
9:00 - 11:30 project status conference room
3:00 - 4:00 curis session
5:30 - 7:00 ideas dinner tressider
12:00 - 1:00 team lunch
3:00 - 4:30 work with katie office
6:30 - 8:00 anniversary tbd
10:30 - 12:30 brunch with parents parents home
11:30 - 2:00 pool with kids
3:00 - wash car
EDIT CALENDAR
Points: 0
Recipe Steps (0/100)
add meeting
initial
TRY
ACCEPT

↵: move tomorrow at 3 pm titled "CURIS Session" (#25/29), ↓: showing the next one

rename tomorrow at 3 pm to "CURIS Session"

example query: meeting tomorrow at 3 pm titled `` curis poster '

http://nlp.stanford.edu/blog/interactive-language-learning/

We use the same logical language

- *delete Thursday's events*

```
(:foreach (start_date (date 2015 11 12)) (:  remove))
```

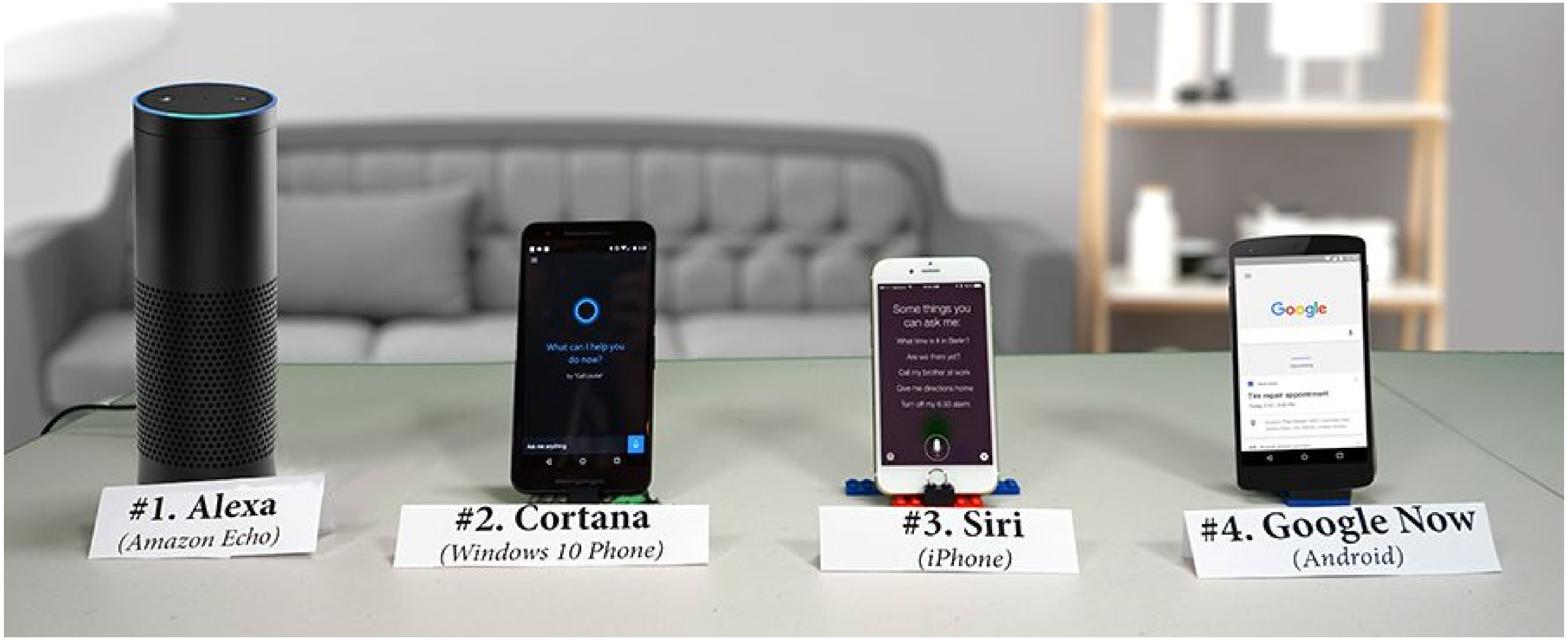
- *change my 3pm meeting to be 30 minutes after my 10:15am meeting*

```
(:s foreach (start_time (time 15 00)) (:  move
start_datetime (call addtime ((reverse end_datetime)
(start_time (time 10 15))) (number 30 minutes)))
```

- *rename next meeting "Boring Family Dinner"*

```
(:foreach (call pick_first start_datetime (call after
start_datetime (call now))) (:  update title (string
"boring family dinner")))
```

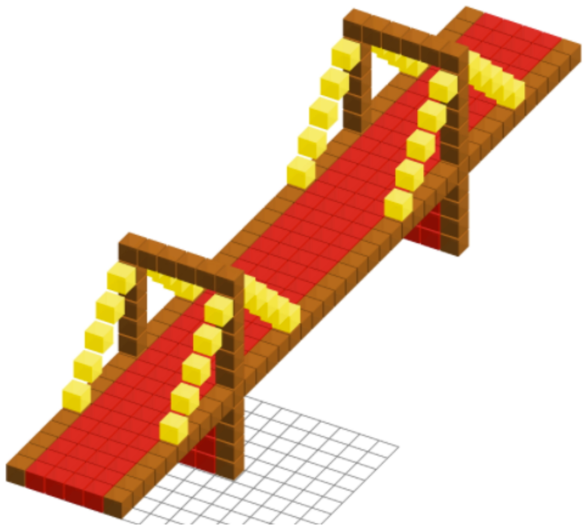
Better communication with computers



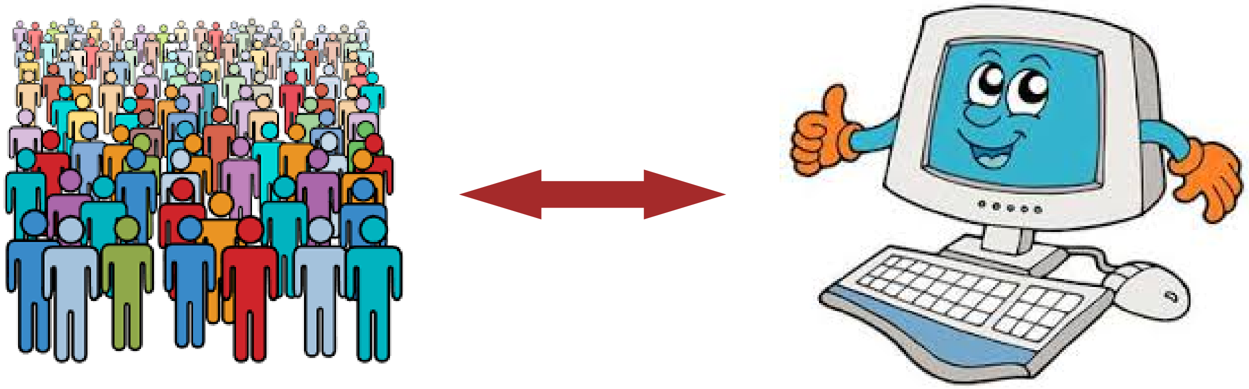
Extremes of the solution space

- LLG: we can build a system that learn from scratch quickly through interaction

- NPL: a community of untrained users can use definitions to naturalize a PL



Learn from users interactively



Wittgenstein: language derives its meaning through use

Montague: language derives its meaning through definition?

Code, experiments, demo of LLG: shrdlurn.sidaw.xyz

CodaLab

Hmm, wait for us to release the NPL stuff