LING/C SC 581:

Advanced Computational Linguistics

Lecture 9

Today's Topics

- Homework 4 Review
  - *Live programming*
  - Berkeley Neural Parser
  - ChatGPT
  - DALL-E 2
  - FrameNet

Homework 4 Review

- Q1: apply the transformation to the left recursion in `nl5.prolog`:
  - `np(np(NP,PP)) --> np(NP), pp(PP).`
  - `vp(vp(VP,PP)) --> vp(VP), pp(PP).`
- Show your grammar working properly on example sentences:
  1. the boy saw the man with the telescope
  2. the boy with the telescope saw the man
  3. the boy kicked the man with the telescope
  4. the boy with the telescope kicked the man
  5. the boy with the telescope kicked the man with the limp

Homework 4

- Hint #1: consider the case when there are multiple base rules for x
- `x(x(X,y)) --> x(X), [y].`
- `x(x(z)) --> [z].`
- `x(x(w)) --> [w].`
- Hint #2: w must be a fresh nonterminal, i.e. cannot be shared between the NP and VP recursions. Why?

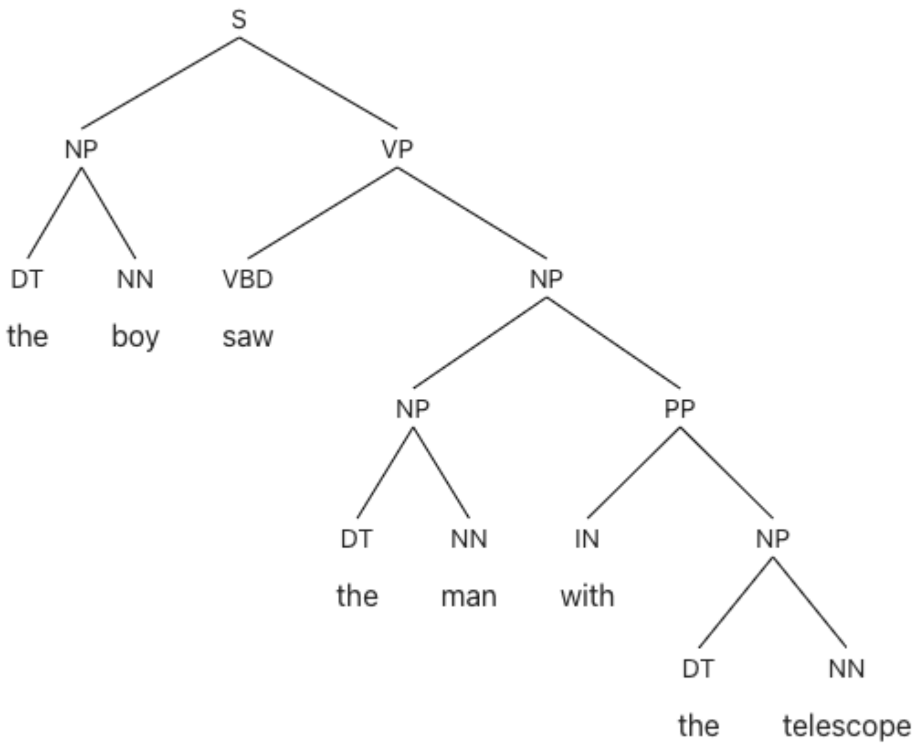
Homework 4 Review

- After live in class programming, we have the following grammar, call it `nl5.prolog`:

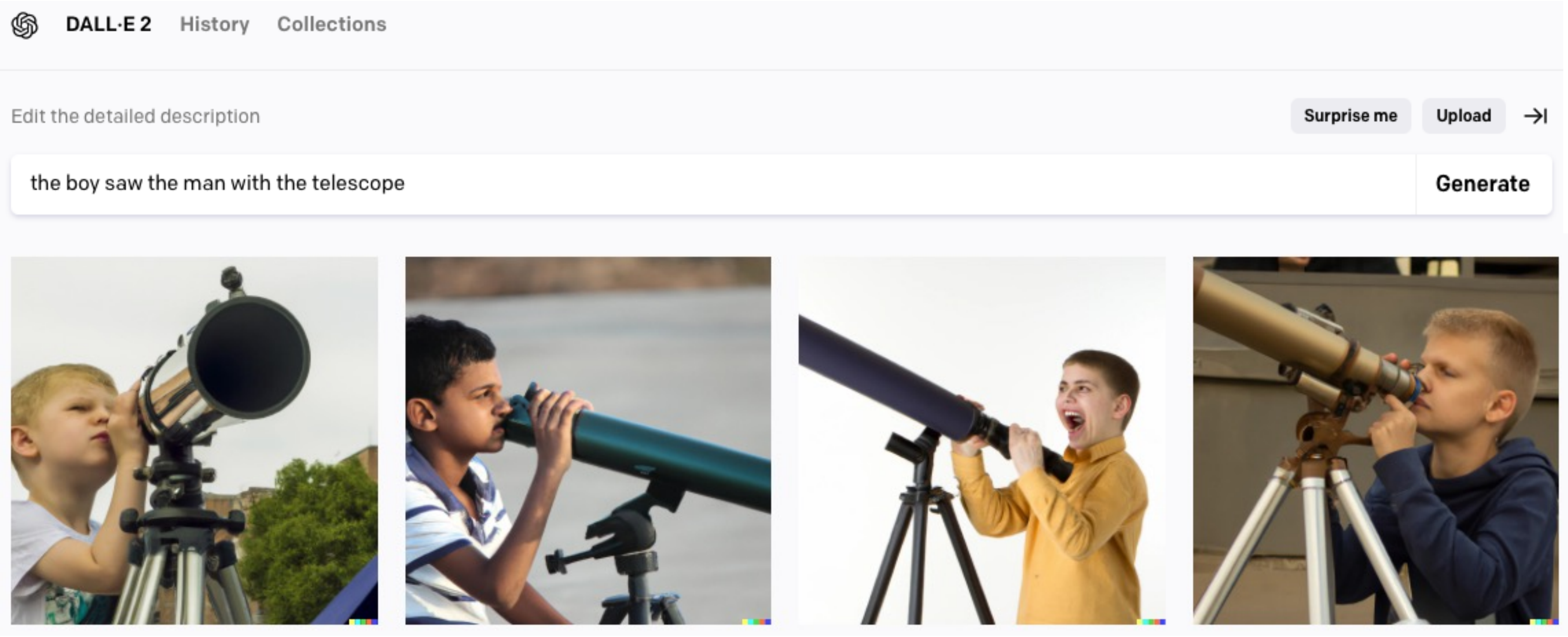
```
1.  s(s(NP, VP)) --> np(NP), vp(VP).
2.  np(np(DET, NN)) --> det(DET, NUM), nn(NN, NUM).
3.  np(np(NNP)) --> nnp(NNP).
4.  np(np(NP,PP)) --> np(NP), pp(PP).
5.  pp(pp(IN,NP)) --> in(IN), np(NP).
6.  det(dt(the), sg) --> [the].
7.  det(dt(the), pl) --> [the].
8.  det(dt(a), sg) --> [a].
9.  nn(nn(man), sg) --> [man].
10. nn(nn(boy), sg) --> [boy].
11. nn(nn(telescope), sg) --> [telescope].
12. nn(nn(limp), sg) --> [limp].
13. nn(nn(men), pl) --> [men].
14. nn(nn(ball), sg) --> [ball].
15. vp(vp(VTR, NP)) --> vtr(VTR), np(NP).
16. vp(vp(VP,PP)) --> vp(VP), pp(PP).
17. vtr(vbd(kick_ed)) --> [kicked].
18. vtr(vbd(hit_ed)) --> [hit].
19. vtr(vbd(see_ed)) --> [saw].
20. in(in(with)) --> [with].
21. nnp(nnp(john)) --> [john].
22. nnp(nnp(mary)) --> [mary].
```

Homework 4 Review

- Berkeley Neural Parser (https://parser.kitaev.io):
  1. the boy saw the man with the telescope

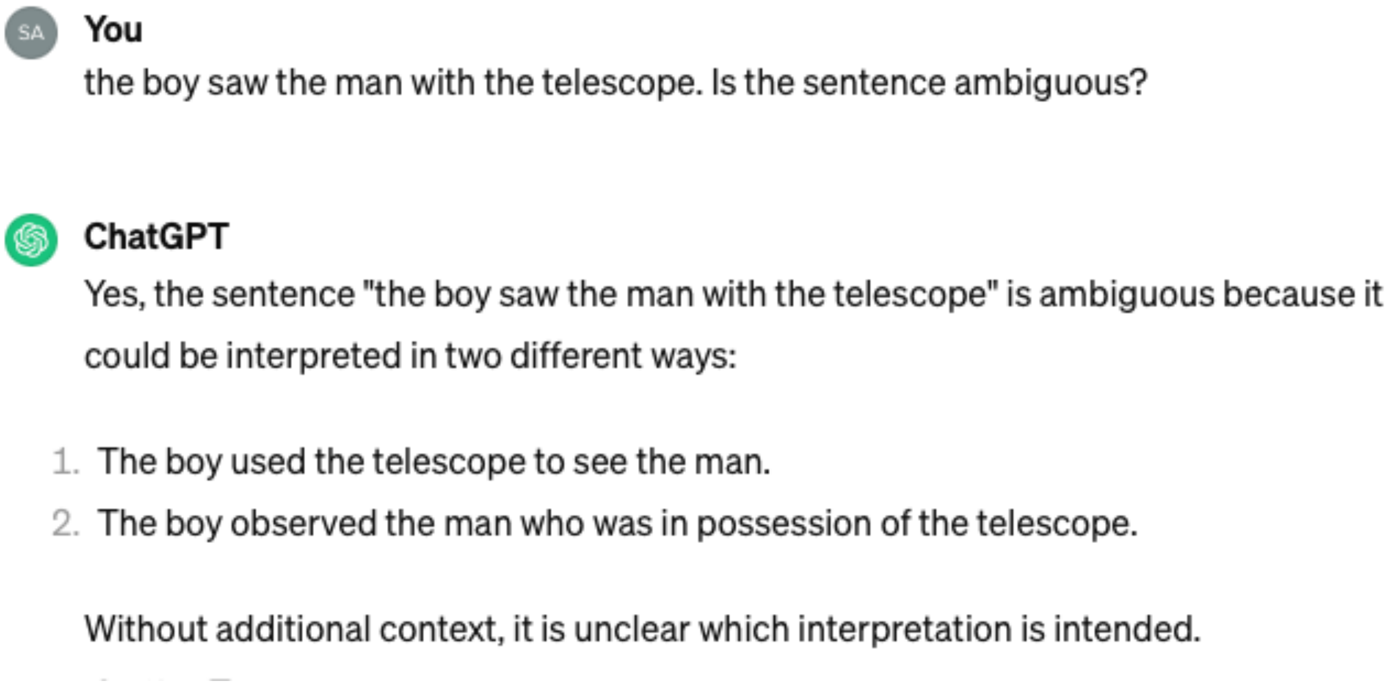


Dall-E 2



the boy saw the man with the telescope

Homework 4 Review



You

the boy saw the man with the telescope. Is the sentence ambiguous?

ChatGPT

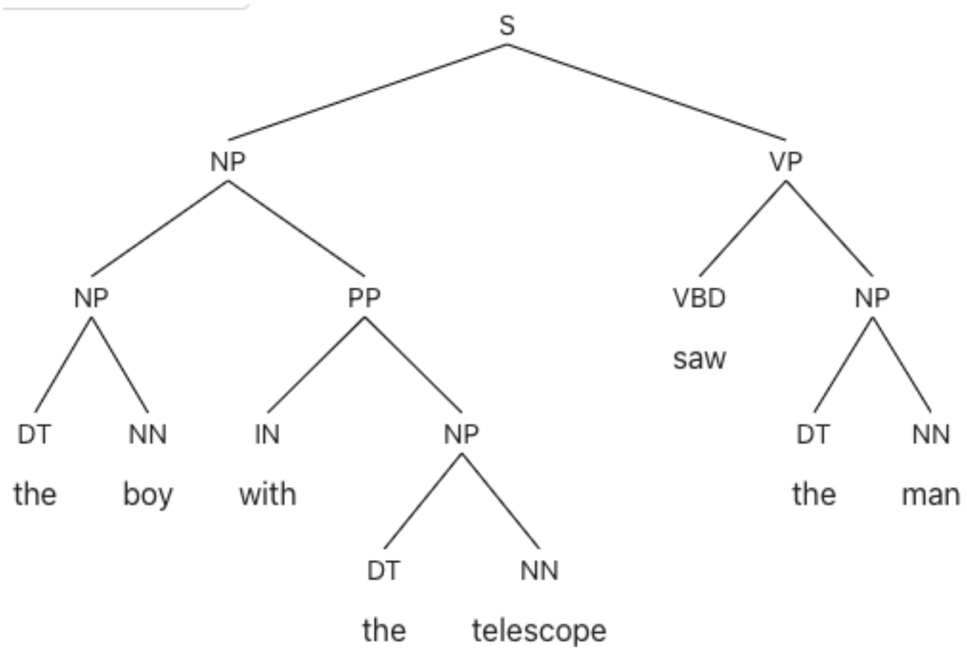
Yes, the sentence "the boy saw the man with the telescope" is ambiguous because it could be interpreted in two different ways:

1. The boy used the telescope to see the man.
2. The boy observed the man who was in possession of the telescope.

Without additional context, it is unclear which interpretation is intended.

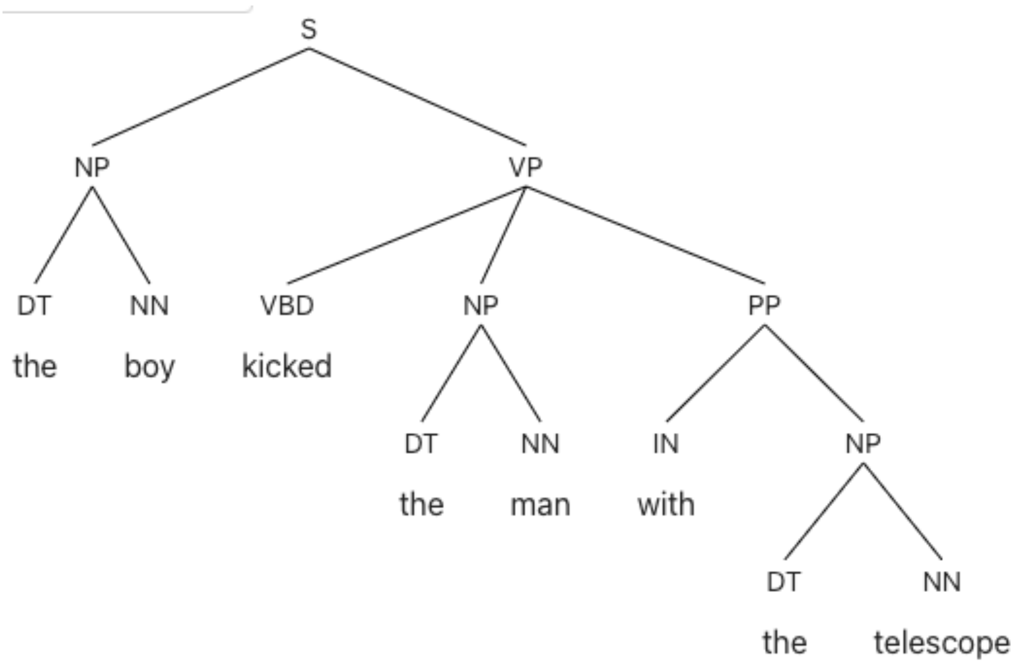
Homework 4 Review

- Berkeley Neural Parser (https://parser.kitaev.io):
  1. the boy saw the man with the telescope
  2. the boy with the telescope saw the man

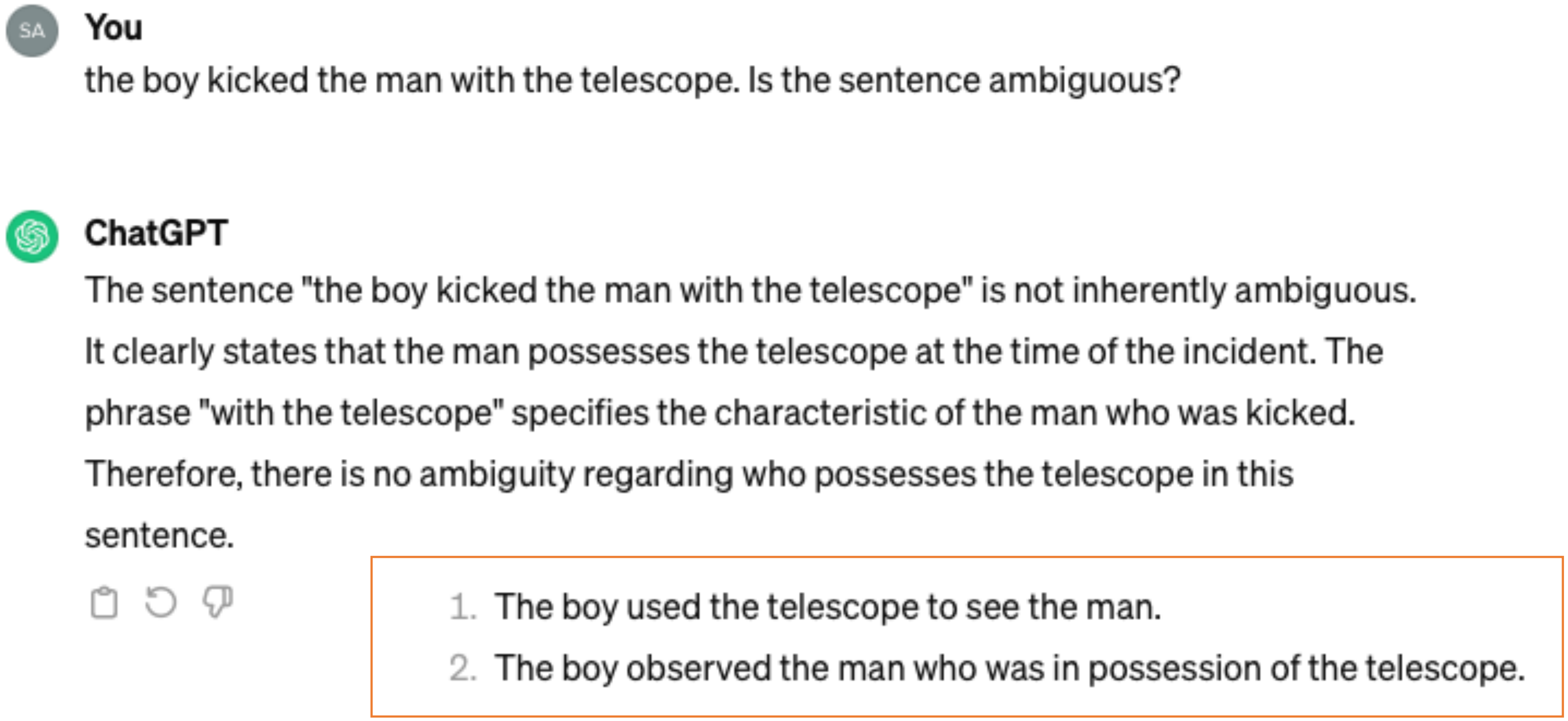


Homework 4 Review

- Berkeley Neural Parser (https://parser.kitaev.io):
  1. the boy saw the man with the telescope
  2. the boy with the telescope saw the man
  3. the boy kicked the man with the telescope



Homework 4 Review



You

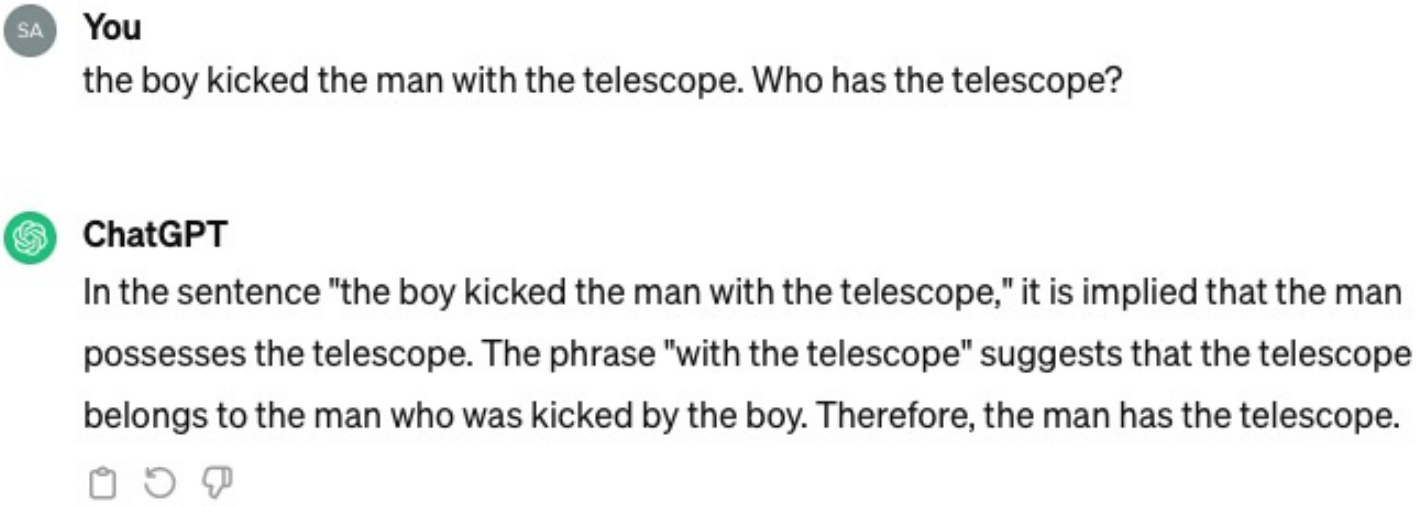
the boy kicked the man with the telescope. Is the sentence ambiguous?

ChatGPT

The sentence "the boy kicked the man with the telescope" is not inherently ambiguous. It clearly states that the man possesses the telescope at the time of the incident. The phrase "with the telescope" specifies the characteristic of the man who was kicked. Therefore, there is no ambiguity regarding who possesses the telescope in this sentence.

1. The boy used the telescope to see the man.
2. The boy observed the man who was in possession of the telescope.

Homework 4 Review



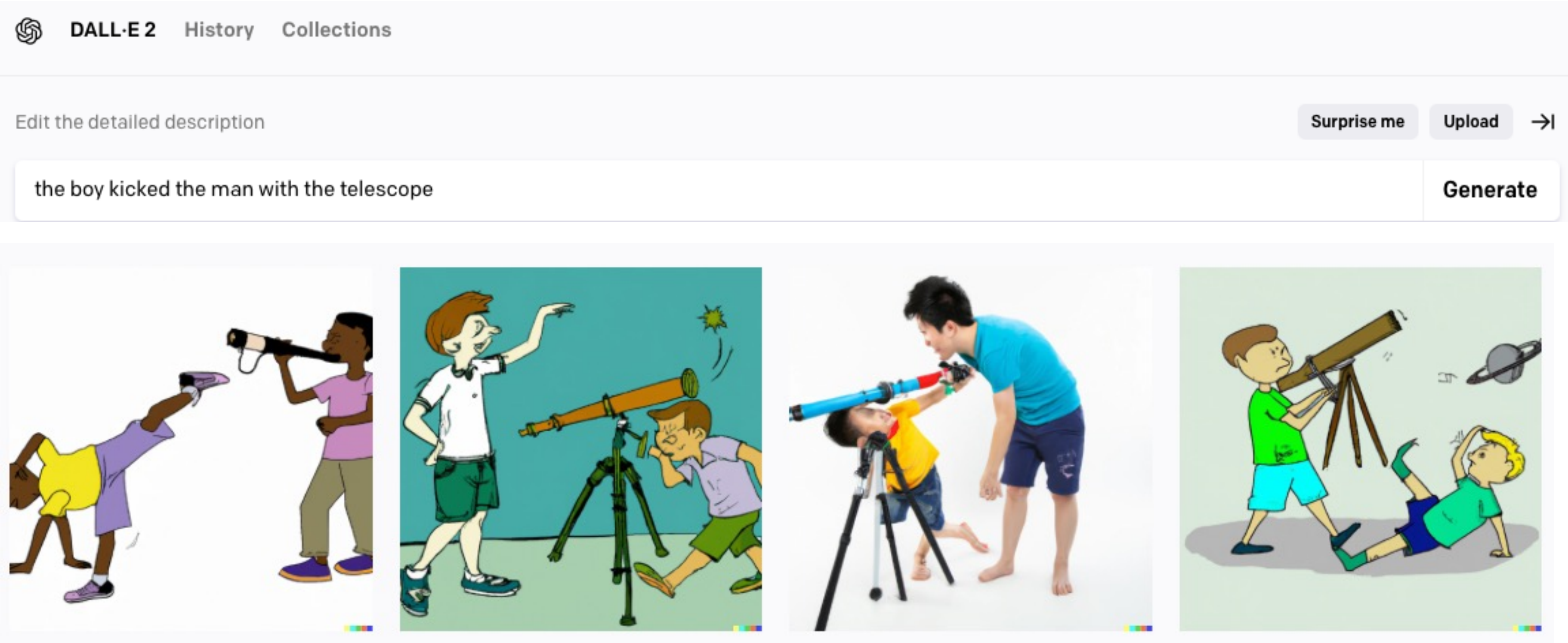
You

the boy kicked the man with the telescope. Who has the telescope?

ChatGPT

In the sentence "the boy kicked the man with the telescope," it is implied that the man possesses the telescope. The phrase "with the telescope" suggests that the telescope belongs to the man who was kicked by the boy. Therefore, the man has the telescope.

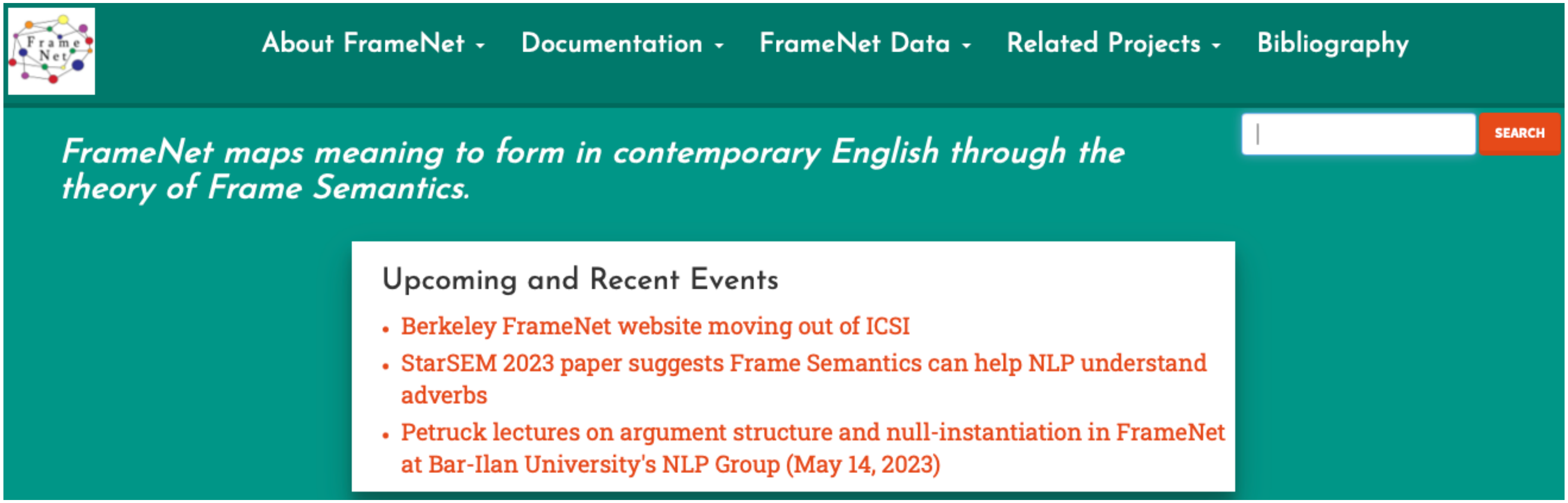
Dall-E 2



the boy kicked the man with the telescope

FrameNet

- https://FrameNet.icsi.berkeley.edu



FrameNet maps meaning to form in contemporary English through the theory of Frame Semantics.

Upcoming and Recent Events

- Berkeley FrameNet website moving out of ICSI
- StarSEM 2023 paper suggests Frame Semantics can help NLP understand adverbs
- Petruck lectures on argument structure and null-instantiation in FrameNet at Bar-Ilan University's NLP Group (May 14, 2023)

FrameNet

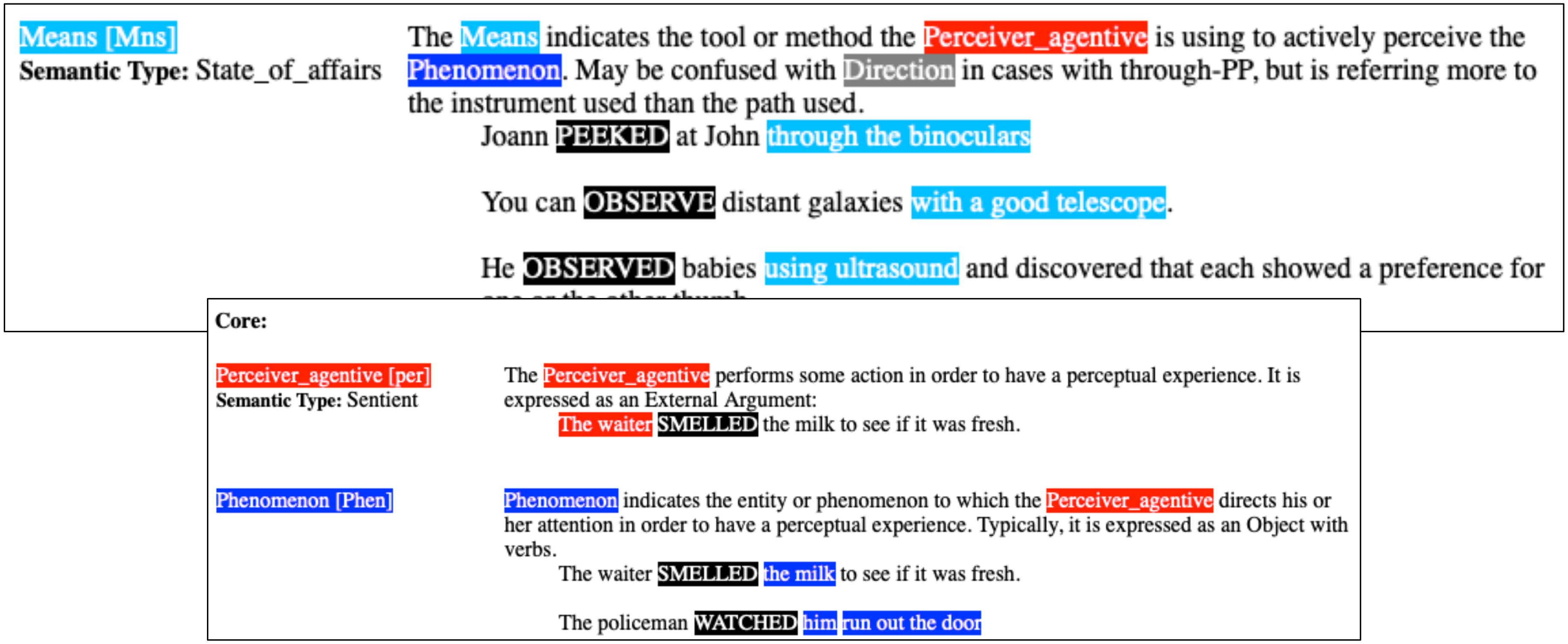
- FrameNet is based on a theory of meaning called **Frame Semantics** (Fillmore 1976, …)
- the meanings of most words can best be understood on the basis of a **semantic frame**, a description of a type of event, relation, or entity and the participants in it.
- Example: the concept of *cooking*:
  - a person doing the cooking (Cook),
  - the food that is to be cooked (Food),
  - something to hold the food while cooking (Container), and
  - a source of heat (Heating_instrument).

FrameNet

- The FrameNet project is building a lexical database of English that is both human- and machine-readable, based on annotating examples of how words are used in actual texts.
  - From the student's point of view, it is a dictionary of more than 13,000 word senses, most of them with annotated examples that show the meaning and usage.
  - For the researcher in Natural Language Processing, the more than 200,000 manually annotated sentences linked to more than 1,200 semantic frames provide a unique training dataset for semantic role labeling, used in applications such as information extraction, machine translation, event recognition, sentiment analysis, etc.
  - For students and teachers of linguistics it serves as a valence dictionary, with uniquely detailed evidence for the combinatorial properties of a core set of the English vocabulary.

FrameNet: *Perception_active*

- **Perception_active frame:**



Means [Mns] **Semantic Type:** State_of_affairs	The Means indicates the tool or method the Perceiver_agentive is using to actively perceive the Phenomenon. May be confused with Direction in cases with through-PP, but is referring more to the instrument used than the path used. Joann PEEKED at John through the binoculars You can OBSERVE distant galaxies with a good telescope. He OBSERVED babies using ultrasound and discovered that each showed a preference for

Core:

Perceiver_agentive [per] **Semantic Type:** Sentient	The Perceiver_agentive performs some action in order to have a perceptual experience. It is expressed as an External Argument: The waiter SMELLED the milk to see if it was fresh.
Phenomenon [Phen]	Phenomenon indicates the entity or phenomenon to which the Perceiver_agentive directs his or her attention in order to have a perceptual experience. Typically, it is expressed as an Object with verbs. The waiter SMELLED the milk to see if it was fresh. The policeman WATCHED him run out the door

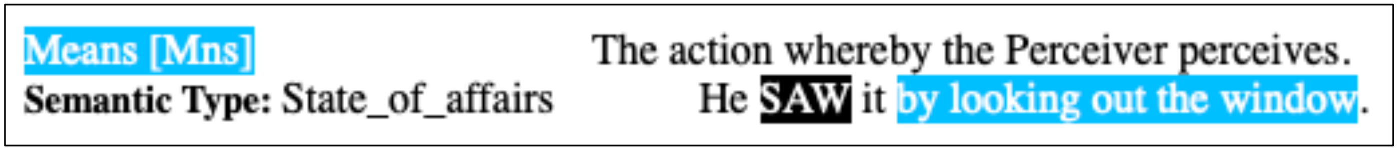
FrameNet: *Perception_active*

- **Lexical Units:**
- *admire.v, attend.v, eavesdrop.v, eye.v, feel.v, gape.v, gawk.v, gaze.n, gaze.v, glance.n, glance.v, goggle.v, listen.v, look.n, look.v, observation.n, observe.v, palpate.v, peek.n, peek.v, peep.v, peer.v, savour.v, smell.v, sniff.n, sniff.v, spy.v, squint.v, stare.n, stare.v, taste.n, taste.v, view.v, watch.v*

No *see*.v

FrameNet: *Perception_experience*

- Synopsis:
  - This frame contains perception words whose Perceivers have perceptual experiences that they do not necessarily intend to.
  - Perception_experience has *see*, Perception_active has *look at*.
- **Lexical Units:**
  - *detect.v, experience.n, experience.v, feel.v, hear.v, overhear.v, perceive.v, perception.n, see.v, sense.v, smell.v, taste.v, witness.v*

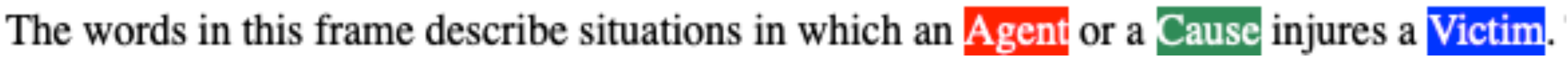


Means [Mns]
Semantic Type: State_of_affairs

The action whereby the Perceiver perceives.
He SAW it by looking out the window.

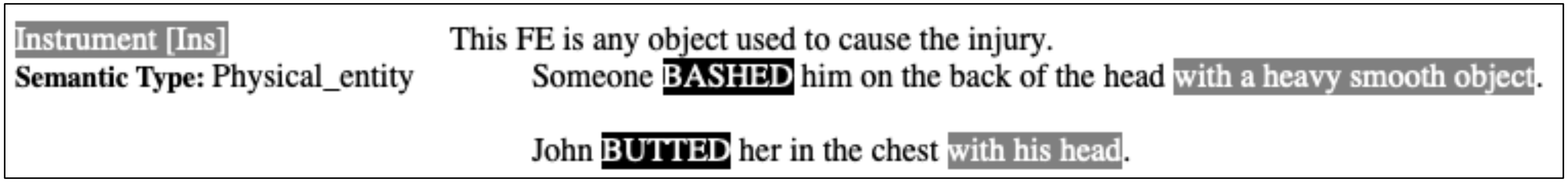
FrameNet: *Cause_harm*

- Synopsis:



The words in this frame describe situations in which an Agent or a Cause injures a Victim.

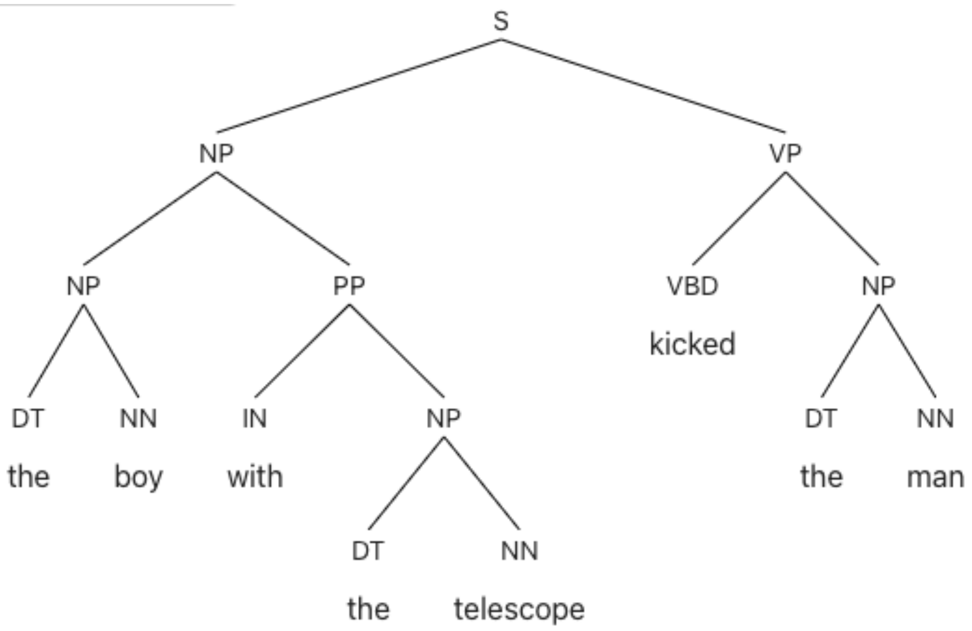
- **Lexical Units:**
- *bash.v, batter.v, bayonet.v, beat up.v, beat.v, belt.v, biff.v, bludgeon.v, boil.v, break.v, bruise.v, buffet.v, burn.v, butt.v, cane.v, chop.v, claw.v, clout.v, club.v, crack.v, crush.v, cudgel.v, cuff.v, cut.v, drug.v, elbow.v, electrocute.v, electrocution.n, flagellate.v, flog.v, fracture.v, gash.v, hammer.v, hit.v, horsewhip.v, hurt.v, impale.v, injure.v, jab.v, kick.v, knee.v, knife.v, knock.v, lash.v, maim.v, maul.v, mutilate.v, pelt.v, poison.v, poisoning.n, pummel.v, punch.v, run through.v, slap.v, slice.v, smack.v, smash.v, spear.v, squash.v, stab.v, sting.v, stone.v, strike.n, strike.v, swipe.v, thwack.v, torture.v, transfix.v, twist.v, welt.v, whip.v, wound.v*



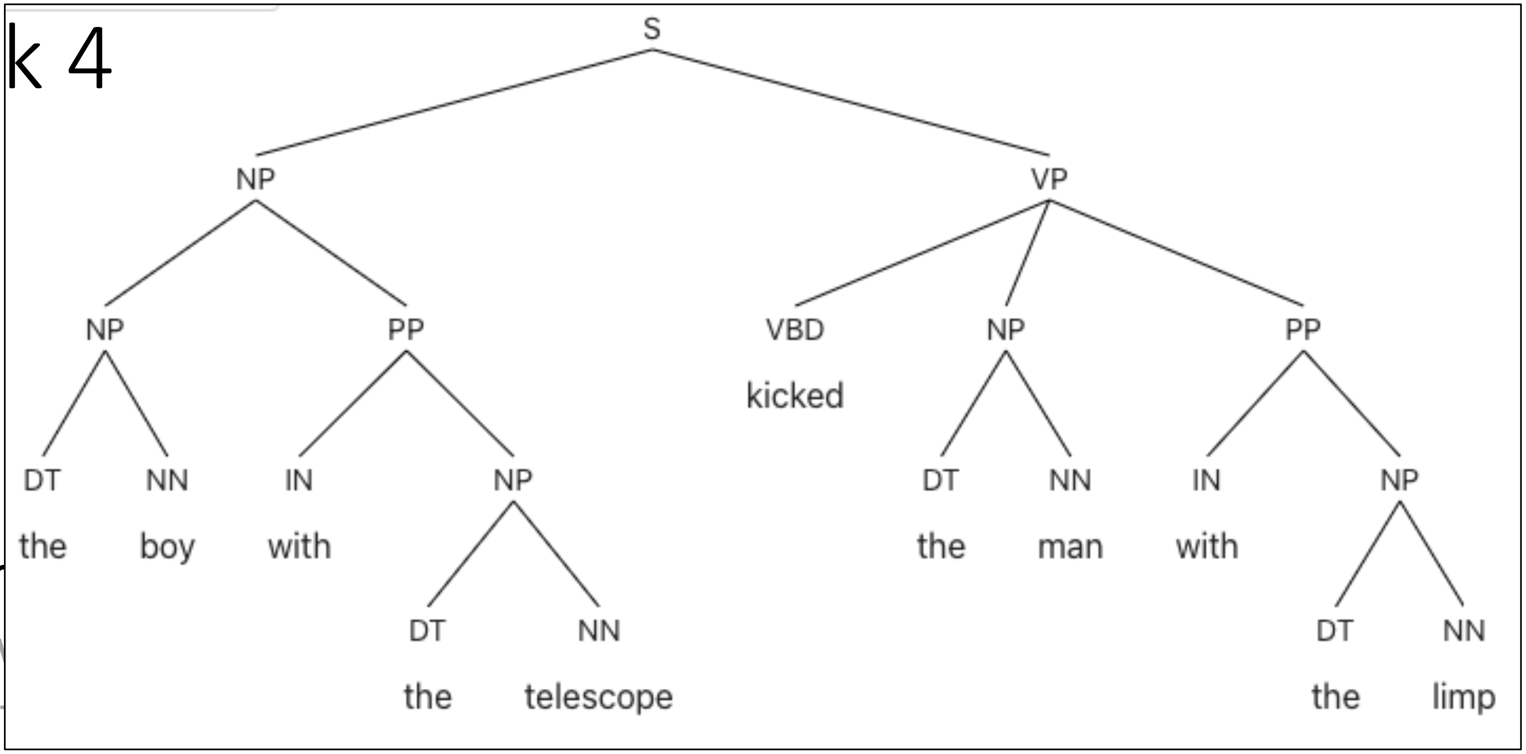
Instrument [Ins] **Semantic Type:** Physical_entity	This FE is any object used to cause the injury. Someone BASHED him on the back of the head with a heavy smooth object. John BUTTED her in the chest with his head.

Homework 4 Review

- Berkeley Neural Parser (https://parser.kitaev.io):
  1. the boy saw the man with the telescope
  2. the boy with the telescope saw the man
  3. the boy kicked the man with the telescope
  4. the boy with the telescope kicked the man

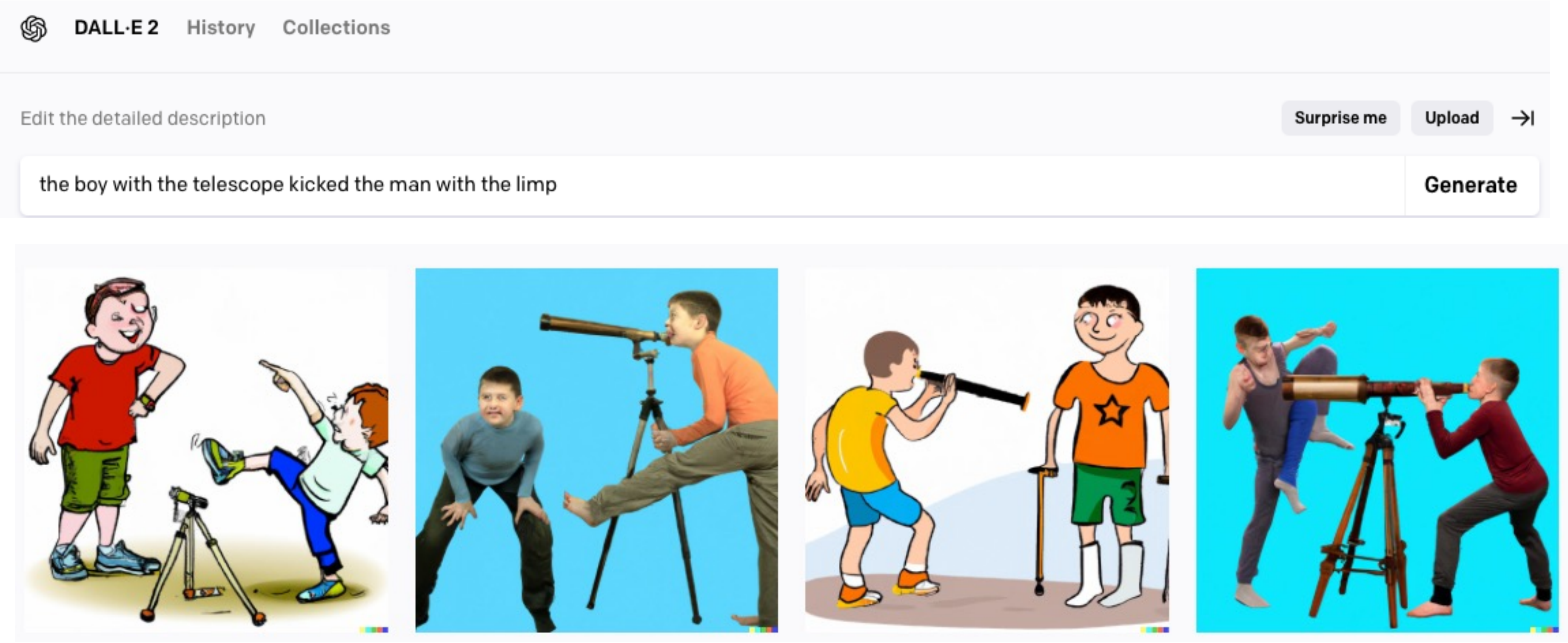


Homework 4 Review



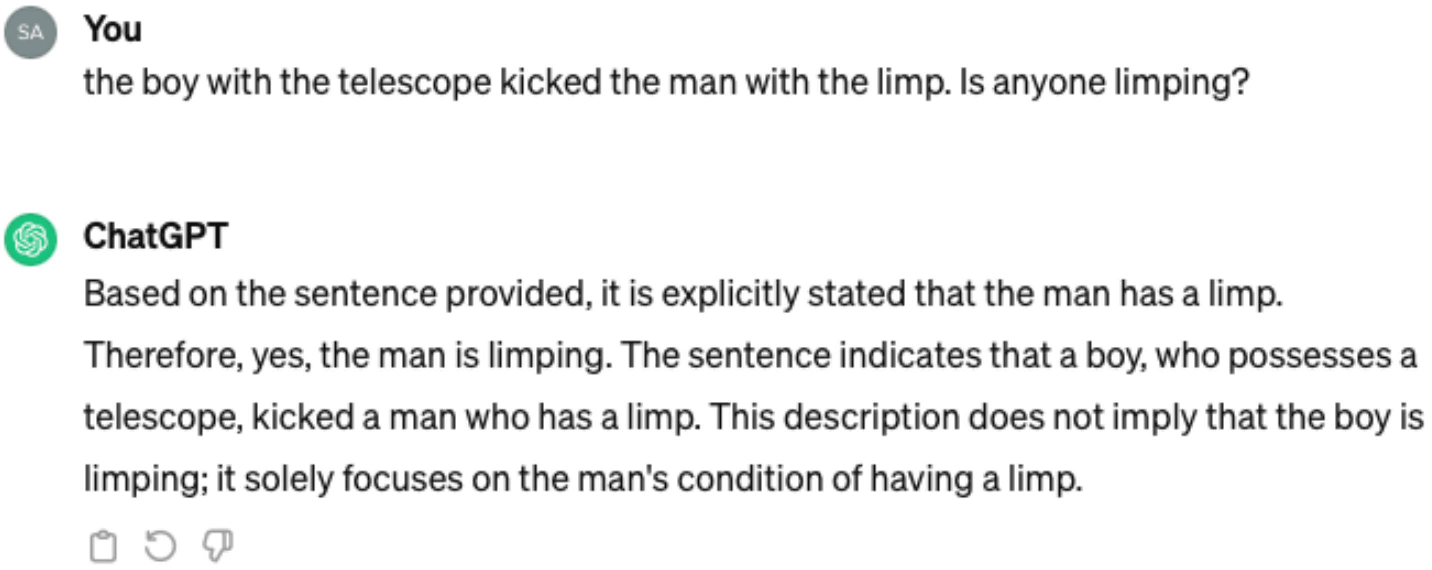
- Berkeley Neur
  1. the boy sa
  2. the boy wi
  3. the boy kicked the man with the telescope
  4. the boy with the telescope kicked the man
  5. the boy with the telescope kicked the man with the limp

Dall-E 2



the boy with the telescope kicked the man with the limp

Homework 4 Review



You

the boy with the telescope kicked the man with the limp. Is anyone limping?

ChatGPT

Based on the sentence provided, it is explicitly stated that the man has a limp. Therefore, yes, the man is limping. The sentence indicates that a boy, who possesses a telescope, kicked a man who has a limp. This description does not imply that the boy is limping; it solely focuses on the man's condition of having a limp.

Homework 4 Review

- Back to our grammar:

```
1.  s(s(NP, VP)) --> np(NP), vp(VP).
2.  np(np(DET, NN)) --> det(DET, NUM), nn(NN, NUM).
3.  np(np(NNP)) --> nnp(NNP).
4.  np(np(NP,PP)) --> np(NP), pp(PP).
5.  pp(pp(IN,NP)) --> in(IN), np(NP).
6.  det(dt(the), sg) --> [the].
7.  det(dt(the), pl) --> [the].
8.  det(dt(a), sg) --> [a].
9.  nn(nn(man), sg) --> [man].
10. nn(nn(boy), sg) --> [boy].
11. nn(nn(telescope), sg) --> [telescope].
12. nn(nn(limp), sg) --> [limp].
13. nn(nn(men), pl) --> [men].
14. nn(nn(ball), sg) --> [ball].
15. vp(vp(VTR, NP)) --> vtr(VTR), np(NP).
16. vp(vp(VP,PP)) --> vp(VP), pp(PP).
17. vtr(vbd(kick_ed)) --> [kicked].
18. vtr(vbd(hit_ed)) --> [hit].
19. vtr(vbd(see_ed)) --> [saw].
20. in(in(with)) --> [with].
21. nnp(nnp(john)) --> [john].
22. nnp(nnp(mary)) --> [mary].
```

Homework 4 Review

- Example:

```
?- s(Parse, [a, man, saw, the, boy, with, a, telescope], []).
Parse = s(np(dt(a), nn(man)), vp(vbd(see_ed), np(np(dt(the),
nn(boy)), pp(in(with), np(dt(a), nn(telescope)))))) ;
ERROR: Stack limit (1.0Gb) exceeded
ERROR:   Stack sizes: local: 0.7Gb, global: 0.2Gb, trail: 1Kb
ERROR:   Stack depth: 7,189,378, last-call: 0%, Choice points: 11
ERROR:   Possible non-terminating recursion:
ERROR:     [7,189,376] user:np(<compound np/2>, [length:2],
_57529258)
ERROR:     [7,189,375] user:np(<compound np/2>, [length:2],
_57529292)
   Exception: (11) vp(_12994, [saw, the, boy, with, a, telescope],
[]) ? abort
% Execution Aborted
?-
```

Homework 4 Review

- If you promote the VP rules ahead of the NP rules…
- Example:

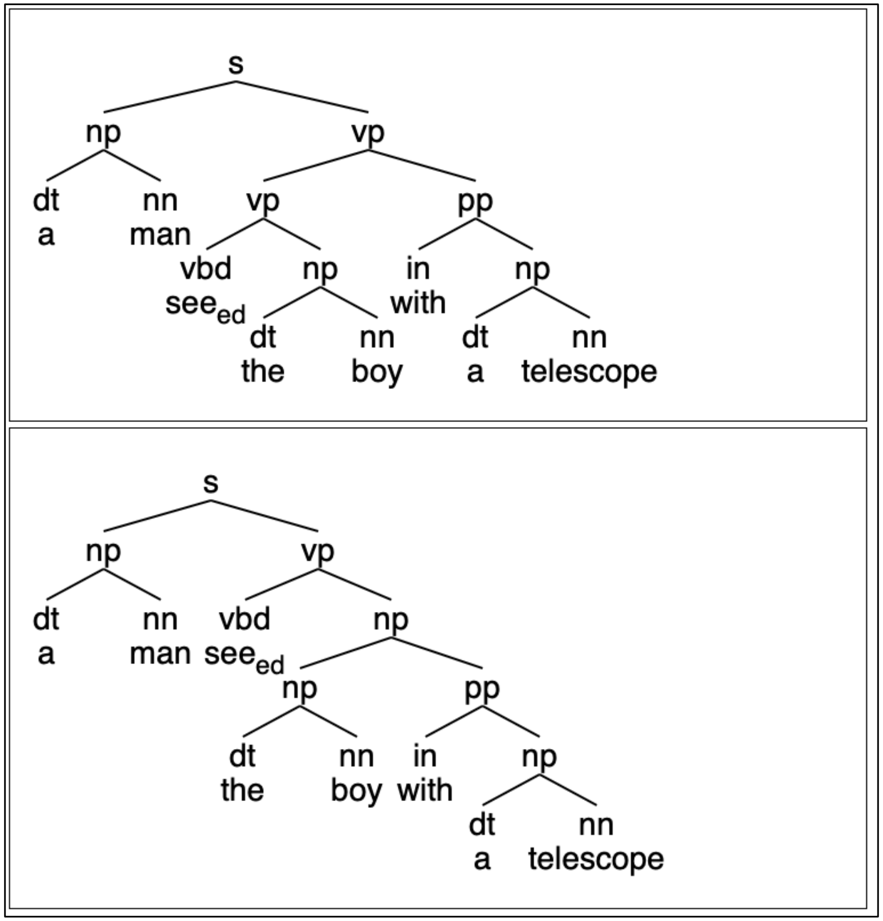
```
?- [nl5a].
true.

?- s(Parse, [a, man, saw, the, boy, with, a, telescope], []).
Parse = s(np(dt(a), nn(man)), vp(vbd(see_ed), np(np(dt(the), nn(boy)),
pp(in(with), np(dt(a), nn(telescope)))))) ;
ERROR: Stack limit (1.0Gb) exceeded
ERROR:   Stack sizes: local: 0.7Gb, global: 0.2Gb, trail: 0Kb
ERROR:   Stack depth: 7,189,708, last-call: 0%, Choice points: 10
ERROR:   Possible non-terminating recursion:
ERROR:     [7,189,707] user:np(<compound np/2>, [length:2], _57525164)
ERROR:     [7,189,706] user:np(<compound np/2>, [length:2], _57525198)
   Exception: (7,189,707) np(_57525080, [a, telescope], _57525084) ? abort
% Execution Aborted
```

Homework 4 Review

```
Parse = s(np(dt(a), nn(man)), vp(vp(vbd(see_ed),
np(dt(the), nn(boy))), pp(in(with), np(dt(a),
nn(telescope)))))
```

```
Parse = s(np(dt(a), nn(man)), vp(vbd(see_ed),
np(np(dt(the), nn(boy)), pp(in(with), np(dt(a),
nn(telescope))))))
```

Both parses makes sense in the *real world*!



Transformation

Consider input strings:	Parse:	Transformed rules:
1. [z]	x(z)	2
2. [z, y]	x(x(z),y)	1 + 4
3. [z, y_1, y_2]	x(x(x(z),y_1),y_2)	1 + 3 + 4

```
1. x(x(X,y)) --> x(X), [y].
2. x(x(z)) --> [z].
```

```
1. x(X) --> [z], w(X,x(z)).
2. x(x(z)) --> [z].
3. w(W,X) --> [y], w(W,x(X,y)).
4. w(x(X,y),X) --> [y].
```

x.prolog

- `x.prolog:`
    - `x(x(z)) --> [z].`
    - `x(x(X,y)) --> x(X), [y].`
- Examples:

```
?- [x].
true.

?- x(Parse, [z], []).
Parse = x(z) ;
ERROR: Stack limit (1.0Gb)
exceeded
```

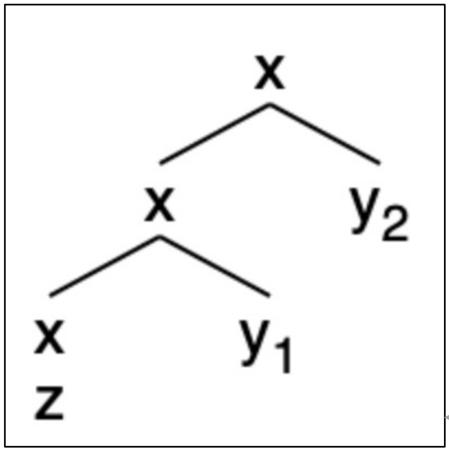
```
…
?- x(Parse, [z, y], []).
Parse = x(x(z), y) ;
ERROR: Stack limit (1.0Gb)
exceeded
…
?- x(Parse, [z, y, y], []).
Parse = x(x(x(z), y), y) ;
ERROR: Stack limit (1.0Gb)
exceeded
…
```

xt.prolog

- `xt.prolog:`
  - `x(X) --> [z], w(X,x(z)).`
  - `x(x(z)) --> [z].`
  - `w(W,X) --> [y], w(W,x(X,y)).`
  - `w(x(X,y),X) --> [y].`
- Examples:

```
?- [xt].
true.

?- x(Parse, [z], []).
Parse = x(z).

?- x(Parse, [z, y], []).
Parse = x(x(z), y) ;
false.

?- x(Parse, [z, y, y], []).
Parse = x(x(x(z), y), y) ;
false.
```

Transformation



- Steps for example 3 (● *marks the current spot*):
  - $[\bullet\ z,\ y_1,\ y_2]$
  - $[z,\ \bullet y_1,\ y_2]$ rule 1: call nonterminal $w(X,x(z))$
  - $[z,\ y_1,\ \bullet y_2]$ rule 3: call nonterminal $w(X,x(x(z),y_1))$
  - $[z,\ y_1,\ y_2\bullet]$ rule 4: answer $X = x(x(x(z),y_1),y_2)$

- this left recursive structure is formed by a right recursive derivation for $[z,\ y_1,\ y_2]$

```
1.x(X) --> [z], w(X,x(z)).
2.x(x(z)) --> [z].
3.w(W,X) --> [y], w(W,x(X,y)).
4.w(x(X,y),X) --> [y].
```

Uncomfortable with abstract `x, y, z` ?

- `npt.prolog:`
  - `replace x with np`
  - `replace z with noun`
  - `replace y with pp`
  - `np(NP) --> [noun], w(NP,np(noun)).`
  - `np(np(noun)) --> [noun].`
  - `w(W,NP) --> [pp], w(W,np(NP,pp)).`
  - `w(np(NP,pp),NP) --> [pp].`
- Examples:

```
?- [npt].
true.
?- np(Parse, [noun], []).
Parse = np(noun).

?- np(Parse, [noun, pp], []).
Parse = np(np(noun), pp) ;
false.

?- np(Parse, [noun, pp, pp], []).
Parse = np(np(np(noun), pp), pp) ;
false.
```

Homework 4 Review

- Let's do the transformation live on `nl5.prolog`!

Homework 4 Review

- Now, let's run the sentences!
    1. the boy saw the man with the telescope
    2. the boy with the telescope saw the man
    3. the boy kicked the man with the telescope
    4. the boy with the telescope kicked the man
    5. the boy with the telescope kicked the man with the limp