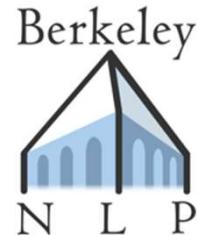


Natural Language Processing



Instructors: Dan Klein, Alane Suhr
GSIs: Kaylo Littlejohn, Kayo Yin
UC Berkeley

Logistics



Logistics

- **Enrollment**

- Class is full
- We will fit as much of the waitlist as we can
- We will not be able to fit more than that
- Access to materials doesn't require enrollment
- <https://edstem.org/us/join/RZpSp9>

- **Requirements**

ML: A-level mastery,
eg CS189

NL: Care a lot about
natural language

PL: Ready to work in
PyTorch (Kaggle)

- **Course expectations**

- Readings, lectures, ~5 projects
- No sections, no exams
- Engagement with the course
- Workload will be high, autonomy required
- Patience: class is under construction!

- **COVID/Attendance Policies**

- Webcasts posted (Berkeley-local)
- Expanded late day policy (14 day, 5 max/project)
- Please do not come to lecture sick



Resources and Readings

- Resources

- Webpage (syllabus, readings, slides, links)
- EdStem Discussion (course communication)
- Gradescope (submission and grades)
- Compute via Kaggle notebooks
- Berkeley-internal recordings for main lectures

- Readings (see webpage)

- Individual papers will be linked
- Optional text: Jurafsky & Martin, 3rd (more NL)
- Optional text: Eisenstein (more ML)

CS 288	Schedule <table><tbody><tr><td>August 29:</td><td>Introduction</td></tr><tr><td colspan="2">PROJECT 1 RELEASED BY EOD FRIDAY, AUGUST 30</td></tr><tr><td>Sept 3:</td><td>LANGUAGE MODELING Statistical models</td></tr><tr><td>Sept 5:</td><td>LANGUAGE MODELING Representation learning and early neural models</td></tr><tr><td>Sept 10:</td><td>LANGUAGE MODELING Neural models</td></tr><tr><td>Sept 12:</td><td>LANGUAGE MODELING Recurrence</td></tr><tr><td colspan="2">PROJECT 1 DUE EOD MONDAY, SEPTEMBER 16</td></tr></tbody></table>	August 29:	Introduction	PROJECT 1 RELEASED BY EOD FRIDAY, AUGUST 30		Sept 3:	LANGUAGE MODELING Statistical models	Sept 5:	LANGUAGE MODELING Representation learning and early neural models	Sept 10:	LANGUAGE MODELING Neural models	Sept 12:	LANGUAGE MODELING Recurrence	PROJECT 1 DUE EOD MONDAY, SEPTEMBER 16	
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PROJECT 1 DUE EOD MONDAY, SEPTEMBER 16															
Home															
Course Info															
Staff															

ed CS 288 – Ed Discussion

New Thread	<input type="text"/> Search
COURSES	+
CS 288	
CATEGORIES	
General	
Lectures	
Assignments	

No threads
Be the first to create a thread!



Projects and Infrastructure

▪ Projects

- P1: Language Models
- P2: Machine Translation
- P3: Syntax and Parsing
- P4: LLMs and Structured Prediction
- P5: Multimodal Language Understanding

▪ Infrastructure

- Python / PyTorch
- Compute via Kaggle notebooks
- Grading via Gradescope

The screenshot shows a Kaggle notebook interface. On the left, there's a sidebar with links for Create, Home, Competitions, Datasets, Code, Discussions, Learn, and More. Under 'RECENTLY EDITED', there's a link to 'notebook797e85a997'. The main area is titled 'Project 1 Draft saved' and contains a text block with instructions for a write-up. Below that is a code cell with a prompt to run it to train an LSTM model and evaluate it. The code cell contains Python code for initializing an LSTM model and training it on validation data.

```
## Feel free to copy your original LSTM solution down here to modify for your report if you'd like.  
# YOUR CODE [optionally] HERE  
##  
  
#lstm_model = LSTMModel()  
#lstm_model.train()  
  
print('lstm validation perplexity:', lstm_model.dataset_perplexity(validation_dataset))  
save_truncated_distribution(lstm_model, 'lstm_predictions.npy', short=False)
```

What is NLP?



Natural Language Processing



NLP



grep

Goal: Deep Understanding

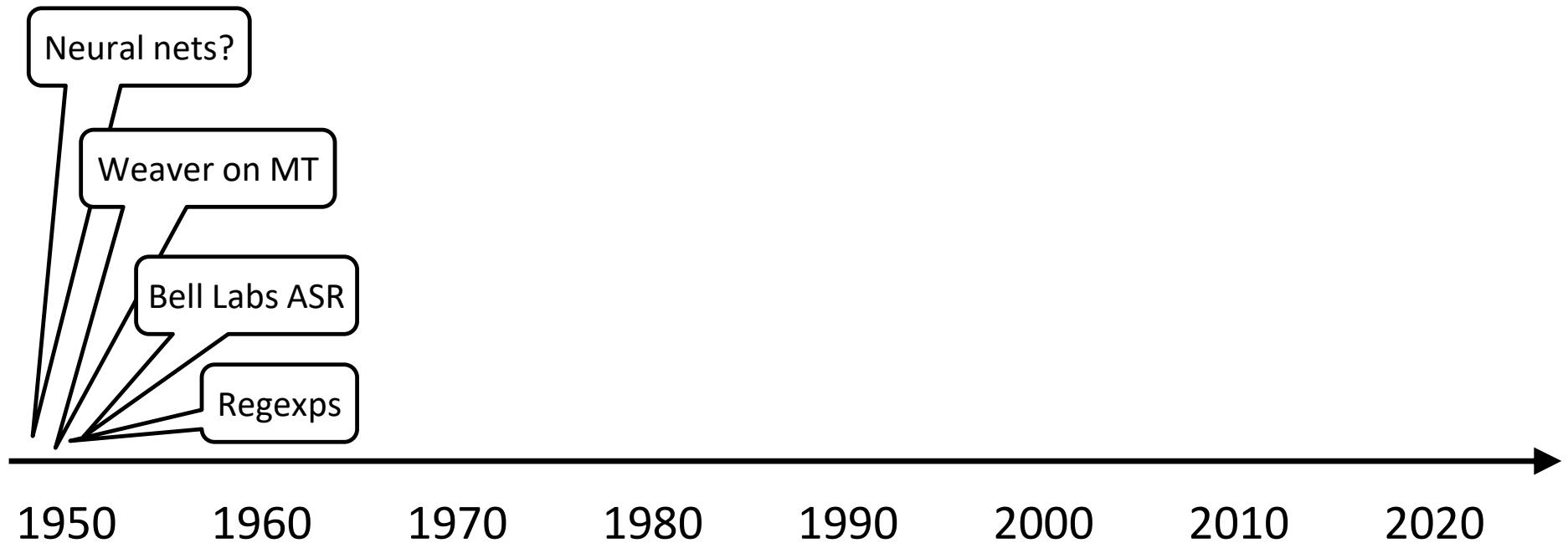
- Requires knowledge, context, and grounding
- Traditionally out of reach, but huge recent advances

Classic Systems: Shallow Matching

- Focus on robustness, scale, and predictability
- Very useful, scalable, but fundamental limitations



NLP History



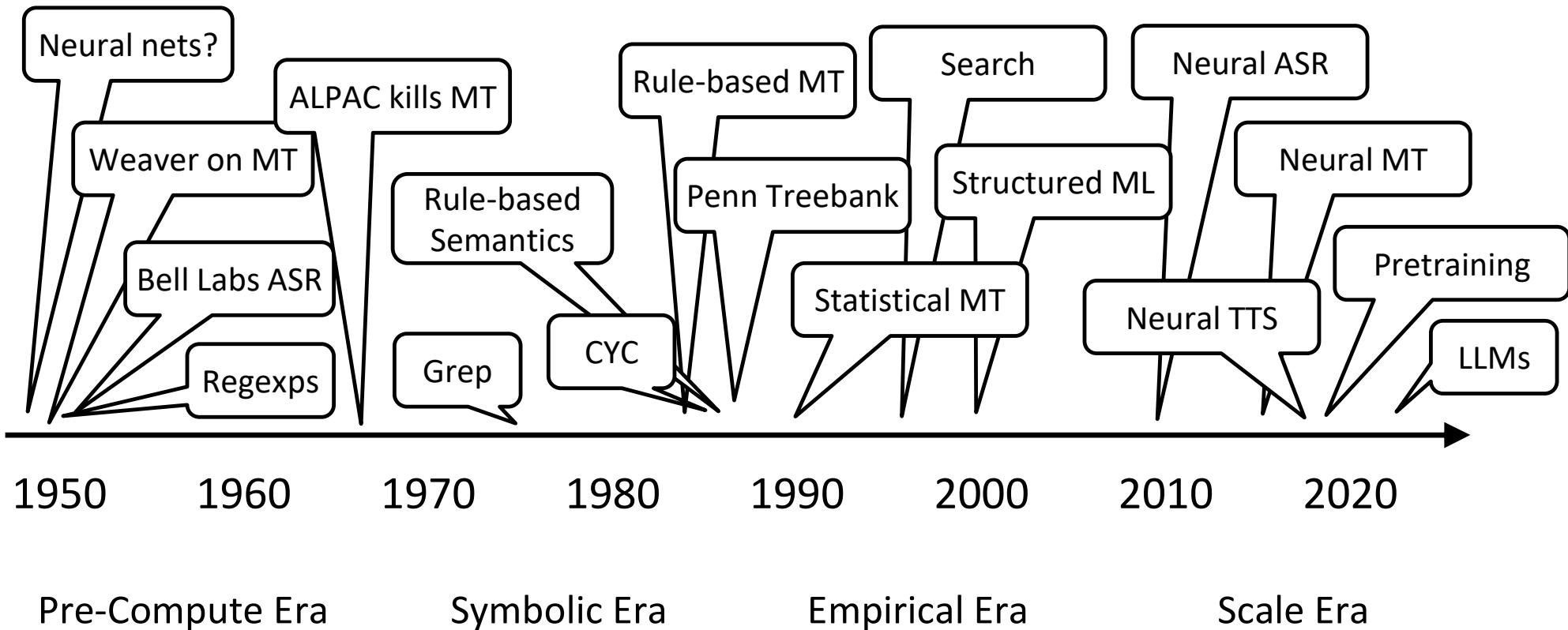
Pre-Compute Era



NLP History



NLP History



Designing NLP Systems



Role of Language Technologies

- What is their *intended* use?
 - Keeping users engaged?
 - Interacting with users as little as possible?
 - What kind of users?
- How does this influence their design?
 - The user interface
 - The underlying structure / model
 - The assumptions they are making
- How are they *actually* used?
 - Where do they fail?
 - How do users adapt?
- What other considerations should we make?
 - Resource efficiency
 - Fairness, ethics, social impact



Speech Systems

▪ Text to Speech (TTS)

- Text in, audio out
- SOTA: nearly perfect aside from prosody



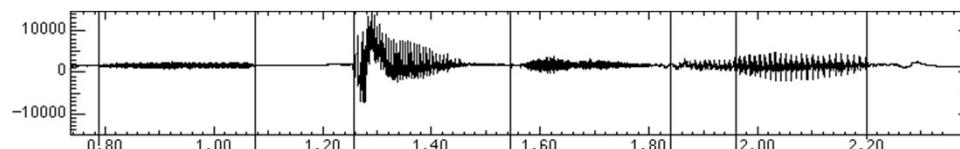
GOOGLE \ TECH \ ARTIFICIAL INTELLIGENCE

Google launches more realistic text-to-speech service powered by DeepMind's AI



▪ Automatic Speech Recognition (ASR)

- Audio in, text out
- SOTA: <<1% error for digit strings, 5% conversational speech, still >>20% hard acoustics



“Speech Lab”

MICROSOFT \ TECH \ ARTIFICIAL INTELLIGENCE

Microsoft reaches 'human parity' with new speech recognition system

Speak-N-Spell / Google WaveNet / The Verge



Machine Translation

EN CE MOMENT Impôts Kenya Syrie Pakistan Emploi Scandale Prism

Impôt sur le revenu : combien paierez-vous en 2014 ?

DÉCOUVREZ TOUS LES SERVICES ABONNÉS
S'abonner au Monde à partir de 1 €

APPEL À TÉMOIGNAGES

Adhérent(e) d'Europe Ecologie-Les Verts, partagez-vous le constat sévère de Noël Mamère sur EELV ?
Partagez votre expérience

En continu

- Comment le budget pour 2014 est-il réparti ? [VISUEL INTERACTIF](#)
- Budget : ces dépenses qu'aucun gouvernement ne peut diminuer
- Un budget 2014 soumis aux critiques
- Budget : ces dépenses qu'aucun gouvernement ne peut diminuer
- Budget 2014 : le détail des économies [VISUEL INTERACTIF](#)
- Budget : des dépenses incompréhensibles
- Entendu à la "fashion week" de Paris
- Commande géante à Airbus
- Plainte contre "Valeurs actuelles"
- Venezuela : 17 personnes arrêtées
- Vidberg : le budget nouveau est arrivé
- La "mission noble" de la NSA
- Roms : Joutes entre Bruxelles et Paris

AT THIS MOMENT Taxes Kenya Syria Pakistan Use Prism scandal

Income tax: how much do you pay in 2014?

DÉCOUVREZ TOUS LES SERVICES ABONNÉS
S'abonner au Monde à partir de 1 €

CALL FOR EVIDENCE

Member(s) of Europe Ecology-Greens, do you share the finding of severe Christmas Mamère EELV?
Share your experience

Continuous

- Budget : des dépenses incompréhensibles
- Entendu à la "fashion week" de Paris
- Actual Values" of NSA
Week" in Paris
- Commande géante à Airbus
- Plainte contre "Valeurs actuelles"
- Venezuela : 17 personnes arrêtées
- Vidberg : le budget nouveau est arrivé
- La "mission noble" of the NSA
- Roms : Joutes entre Bruxelles et Paris

- Translate text from one language to another
- Challenges:
 - What's the mapping? [learning to translate]
 - How to make it efficient? [fast translation search]
 - Fluency (next class) vs fidelity (later)

Example: Yejin Choi



Spoken Language Translation



Image: Microsoft Skype via Yejin Choi



Summarization

- Condensing documents
 - Single or multiple docs
 - Extractive or abstractive
- Very context-dependent!

The screenshot shows a CNN news article from February 27, 2013. The headline reads "Official: Egypt balloon explosion probe can take 2 weeks". The story highlights include:

- CNN: official investigation into yesterday air balloon accident in Luxor could take 2 weeks
- Governor bans all hot air balloon flights until further notice
- Foul play not suspected in fatal balloon accident
- Official: Egypt balloon explosion probe can take 2 weeks
- Egypt balloon explosion
- An official investigation into the cause of a balloon accident that killed 19 people in Egypt could take two w...
- Egypt: Balloon probe could take weeks

Below the story highlights, there are three video thumbnails:

- Tourists killed in hot air balloon blast
- 2009 balloon crash survivor speaks
- How to stay safe in a hot air balloon

Textual summary snippets from the article include:

- The Tuesday accident was the world's deadliest hot air balloon accident in at least 20 years.
- Preliminary investigations confirmed no foul play was involved when gas canisters aboard the balloon exploded, causing it to plummet about 1,000 feet (300 meters) to the ground. Gov. Ezzat Saad said.
- CNN iReport: After tragedy, vacationers recall glorious balloon rides in Egypt
- Passengers in the balloon included 19 foreign tourists: nine from Hong Kong, four from Japan, three from Britain, two from France and one from Hungary, officials said.
- How safe is hot air ballooning?
- An Egyptian pilot and another Egyptian were also aboard, Luxor province spokesman Badawi al-Masri said.
- Balloon rides offering panoramic aerial views of the Nile River and the ancient temples of Karnak and Hatshepsut are a popular tourist attraction in Luxor, about a nine-hour drive southeast of Cairo.
- "You can see Valley of the Kings in the background bordered by farmland," Pauline Liang of Vancouver, Canada, told CNN's iReport last year. "Below were banana farms, and behind us was the city of Luxor. There was a great contrast between desert landscape, lush farmland and urban development."
- Tuesday's crash prompted the governor to ban all hot air balloon flights until further notice.

Image: CNN via Wei Gao



Google

Web

Tip: Have a question? Ask

[Web definitions for capital](#)

Cheyenne: the capital of Wyoming
wordnet.princeton.edu

[Scholarly articles for Wyoming](#)

The Cultural Contexts of Capital Requirements

[MSN Encarta - Cheyenne](#)

Cheyenne (city, Wyoming)
... In 1869 the city was selected as the capital.
encarta.msn.com/encyclopedia_761572571/Cheyenne.html

[capital of Wyoming](#)

Note: click on a word near the noun capital of Wyoming
www.answers.com/topic/capital

[Cheyenne: Weather](#)

Cheyenne (shē-ān)
the state near the North Pole
www.answers.com/t/city/Cheyenne

How many US states' capitals are their second largest cities? Please reason about this by listing out all 50 states and their three most populous cities.

To determine how many U.S. states have their capitals as the second-largest city, we can reason through the list of all 50 states by identifying their capitals and then comparing their population ranks among the state's cities. Here's the process:

Step 1: List All 50 States and Their Capitals

We'll list each state with its capital and then identify the three most populous cities in that state. For brevity, only the relevant information will be highlighted.

Step 2: Identify the Three Largest Cities in Each State

Using population data, we'll compare the capital city's population to the largest and third-largest cities in the state.

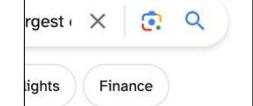
Analysis:

1. Alabama:

- Capital: Montgomery
- Largest Cities: Birmingham, Montgomery (2nd), Huntsville

2. Alaska:

g



largest City:



Text to Image

Amsterdam canal in post-impressionist style with reflection of narrow houses and bridge. The scene is channelling van Gogh's 'Starry Night' from pedestrian perspective.



Here is the image depicting the first day in the classroom.

generate images of a person biking next to bus, where the person is to the right of the bus



Here is the image of a person biking next to a bus with the cyclist positioned on the right side of the bus. Let me know if you need any changes or additional details!



Source: <https://www.linkedin.com/pulse/prompt-hack-midjourney-stable-diffusion-marenco-kemp>



Virtual Assistants

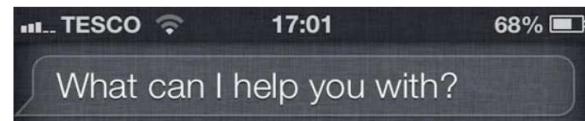


- Virtual assistants must do
 - Speech recognition
 - Language analysis
 - Dialog processing
 - Text to speech
 - ... and back-end actions!

Image: Wikipedia



Conversations with Devices?





ELIZA

```
ELIZA: You're not really talking about me -- are you ?
YOU: What?
ELIZA: What do you think ?
YOU: I mean, I feel happy to be writing right now, to be typing this as we speak. Lately, I've had writer's block.
ELIZA: You say you mean ?
YOU: That's what I said.
ELIZA: Can you elaborate on that ?
YOU: I only really feel happy when I'm writing.
ELIZA: How long have you been writing ?
YOU: Always, but I've been writing seriously since I was eighteen.
ELIZA: What incident are you thinking of ?
YOU: Um.
ELIZA: What does that suggest to you ?
YOU: I don't think it's enough, to only be happy when you write.
ELIZA: Does that trouble you ?
YOU: ...Um, because you can't write all the time. And then there's the real world, and you still have to deal with real people.
ELIZA: What are your feelings now ?
YOU: I've been thinking a lot of that poem by Yeats: "The Man and the Echo."
Do you know it?
ELIZA: Do you say you've been thinking a lot of that poem by yeats: "the man and the echo for some special reason ?
YOU: Yes █
```



Chatbot Competitions!



- Alexa Prize competition to build chatbots that keep users engaged
 - First winner in 2017: UW's Sounding Board (Fang, Cheng, Holtzman, Ostendorf, Sap, Clark, Choi)
- Compare to the Turing test (eg Loebner Prize) where the goal is to fool people



SoundingBoard Example

Turn	User	Sounding Board
1	Let's chat	Hi! This is an Alexa Prize socialbot. How's your day?
2	I'm <u>five</u> .	Glad to hear it! We could talk about robots, batman, or superman. Say "next", to chat about other things.
3	Superman.	It looks like you wanna chat about superman. I was high up in the cloud when I realized: If people don't recognize Clark Kent as Superman because of his glasses, does his eye doctor know his identity?
4	I guess so.	Did you know that Henry Cavill almost missed the call for the role of Superman cause he was playing "World of Warcraft"
5	Really, I didn't know that.	Weird, right? Speaking of superman, Did you see: Superman? It was released in 1997. It's a comedy.
6	Yes, it was hilarious.	I'm glad you feel this is hilarious. Which part was about this movie?
7	The part when he met lewis leah.	Interesting. meccartin, and raffi co-directed this film. The movie has a 6.3 out of 10 on IMDB. which seems pretty good! do you like the movie's director?
8	Yeah, he's cool.	Cool! By the way, do you wanna know something interesting about raffi?
9	Okay, go ahead.	Super! My friend told me that Raffi is a worldwide children's rights activist and has fought against exploitative advertising to children.

Negotiation

Thought

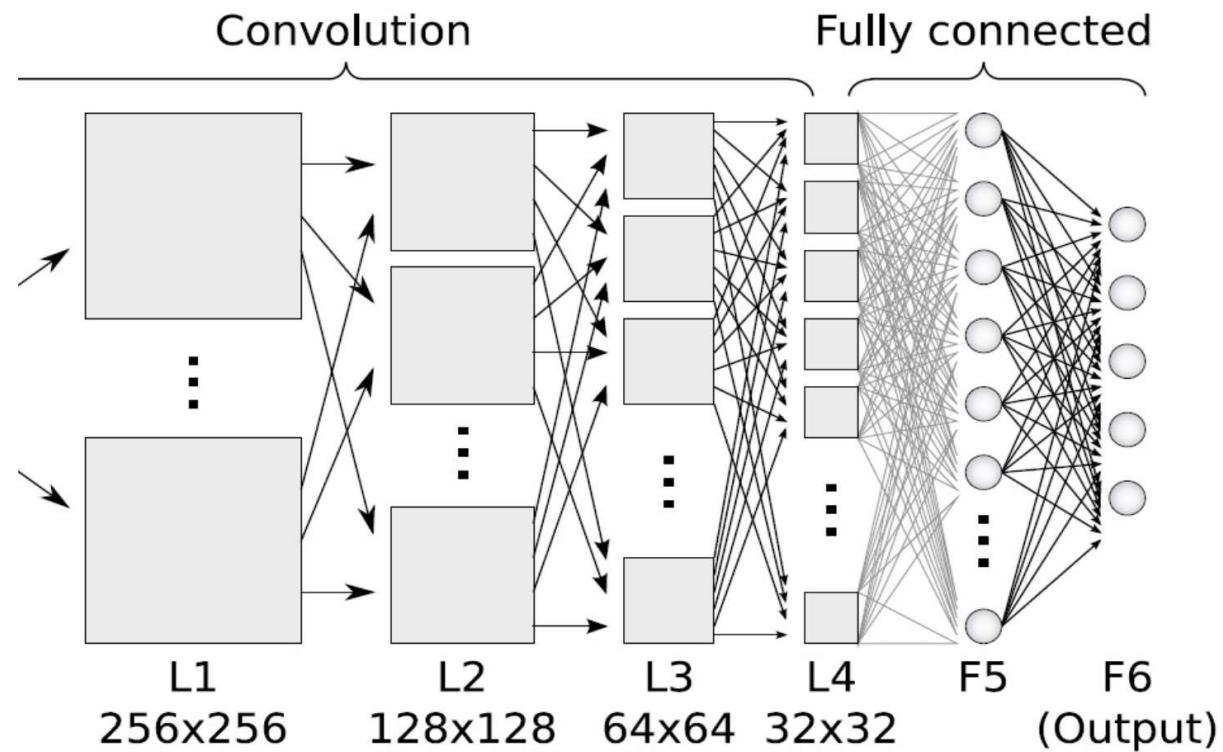
Movie

Fact

Source: Mari Ostendorf



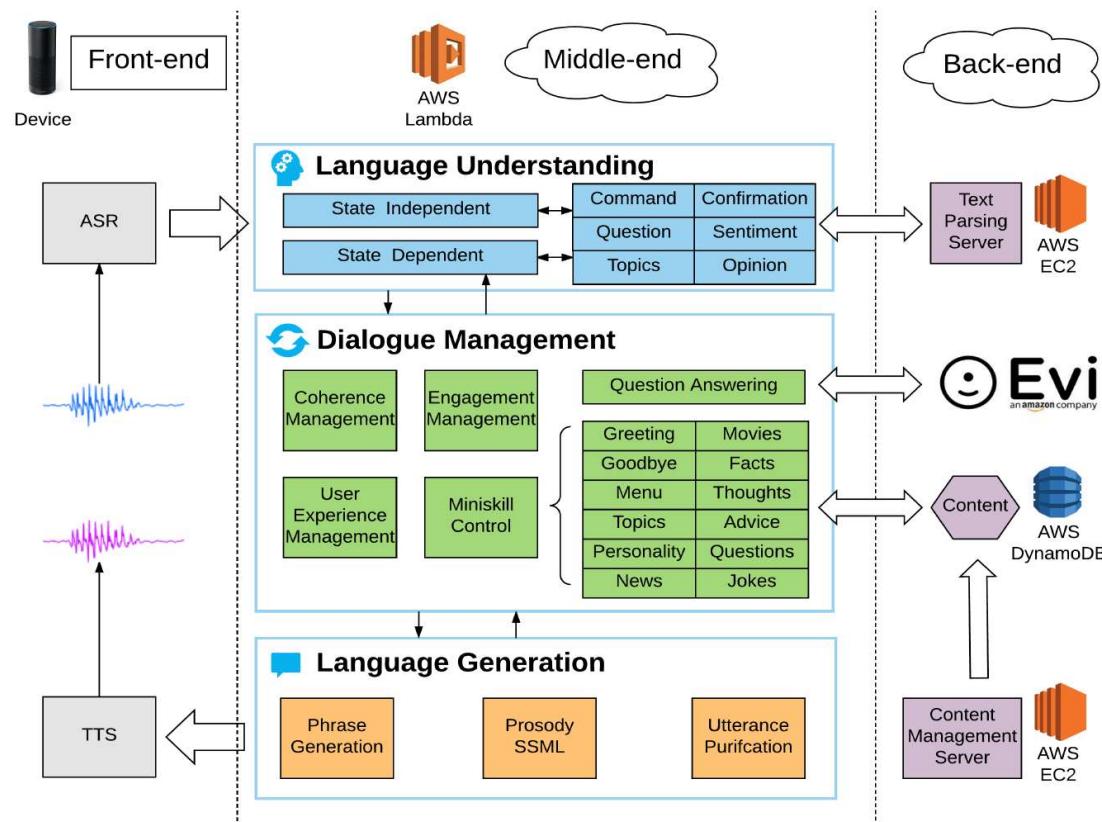
Sounding Board's Architecture?



Source: Yejin Choi



Sounding Board's Architecture



Source: Yejin Choi

 My roomba seems to be br ...  I'd be happy to help you try diagnose and potentially fix <ol style="list-style-type: none">Check for Obstructions: Inspect the Roomba's path or brush erratically.Clean the Roomba: Dust off the Roomba's body and brushes to remove any debris.	 The light on the roomba is white and it's not moving at all.  If the light on your Roomba is white and it's not moving at all, it's possible that the Roomba is attempting to dock or it's trying to locate the dock automatically. This behavior is accompanied by the Roomba making noise and spinning its wheels. Here's what you can do to address this issue: <ol style="list-style-type: none">Check Dock Placement: Ensure the Roomba is positioned correctly near the charging dock.Check Sensors: Inspect the sensors on the Roomba, specifically the bumper sensors. These sensors help the Roomba detect obstacles and navigate.	 I tried resetting it with the clean button and it's still not working.  If resetting the Roomba using the "Clean" button isn't resolving the issue, it's possible that there might be a more serious issue with its internal components. Here are some steps you can take to address this situation: <ol style="list-style-type: none">Check Battery: Make sure your Roomba has a sufficient battery charge. If the battery is completely drained, the Roomba won't respond. If necessary, connect the Roomba to the charging dock and let it charge for a while before attempting to power it on again.
---	---	--

 that was extremely helpful and not at all too verbose or irrelevant to my situation

 I'm glad to hear that you found the information helpful and relevant! If you have any more questions or need further assistance in the future, feel free to reach out. Good luck with resolving the issue with your Roomba, and take care!

electronics, you might attempt to repair them yourself. However, if you're not comfortable with electronics, it's best to seek professional help from a technician.	attempting repairs that could potentially cause further damage to the Roomba. It's important to handle electronic components carefully to prevent damage.	Professional Repair: If your Roomba is not responding at all and you're not comfortable with electronics, you might consider opening the Roomba and attempting to repair it yourself. However, if you're not experienced with electronics, it's best to seek professional help from a technician.	Consider Replacement: If your Roomba is significantly older and has been experiencing multiple issues, it might be more cost-effective to consider replacing it with a newer model. Given that your Roomba isn't responding at all, and it's not a simple issue like an obstruction or connectivity problem, it's best to involve the manufacturer's support team or a professional technician who specializes in repairing Roombas. They will have the expertise and tools necessary to diagnose and fix the issue correctly.
---	---	--	---



Ambiguities

CNN

Live TV • ☰

Stevie Wonder announces he'll be having kidney surgery during London concert

By Amir Vera, CNN

Updated 11:16 PM EDT, Sat July 06, 2019



(CNN) — Stevie Wonder will be taking a break from music.

The legendary singer-songwriter announced during a concert in London Saturday that he will be undergoing kidney surgery.



Problem: Ambiguity

- Headlines:
 - Teacher Strikes Idle Kids
 - Hospitals Are Sued by 7 Foot Doctors
 - Ban on Nude Dancing on Governor's Desk
 - Stolen Painting Found by Tree
 - Kids Make Nutritious Snacks
 - Iraqi Head Seeks Arms
 - Local HS Dropouts Cut in Half

- Why are these funny?

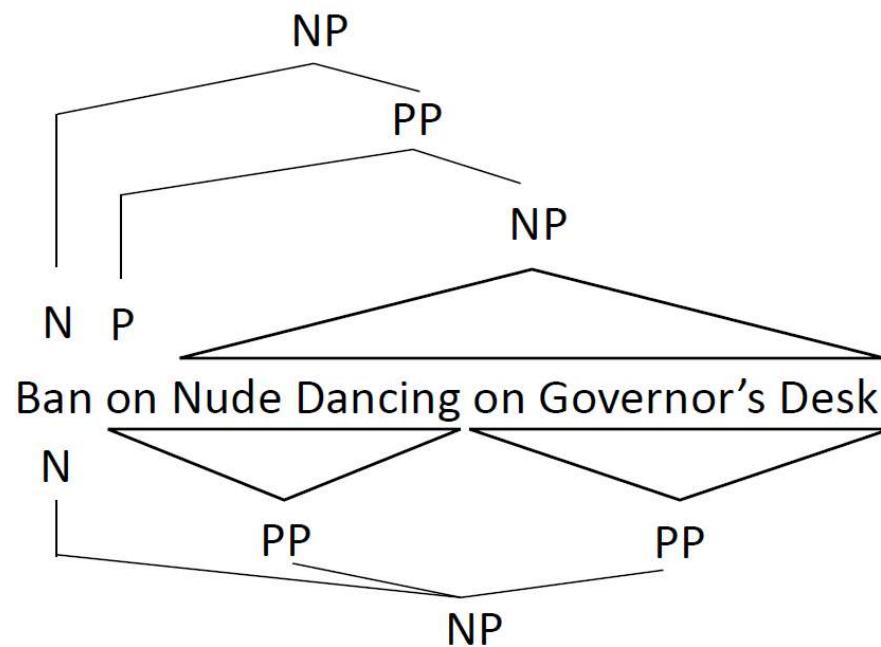
What Do We Need to Understand Language?



We Need Representation: Linguistic Structure?

N N V N
N V ADJ N
Teacher Strikes Idle Kids

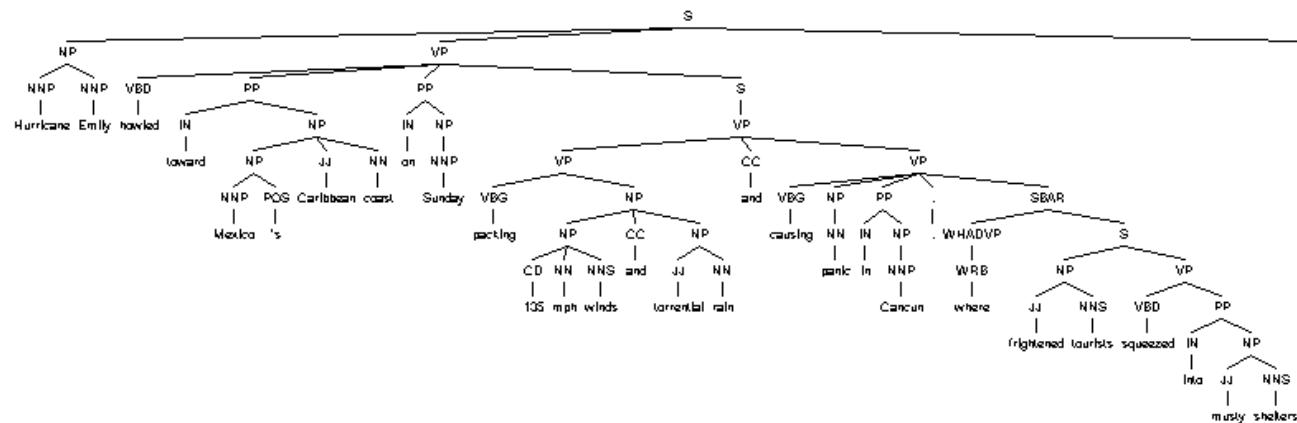
body/
position body/
weapon
Iraqi Head Seeks Arms



- ▶ Syntactic and semantic ambiguities: parsing needed to resolve these, but need context to figure out which parse is correct



Example: Syntactic Analysis



Hurricane Emily howled toward Mexico 's Caribbean coast on Sunday packing 135 mph winds and torrential rain and causing panic in Cancun, where frightened tourists squeezed into musty shelters .

Accuracy: 95+



Latent Representations

Personal Pronouns (PRP)

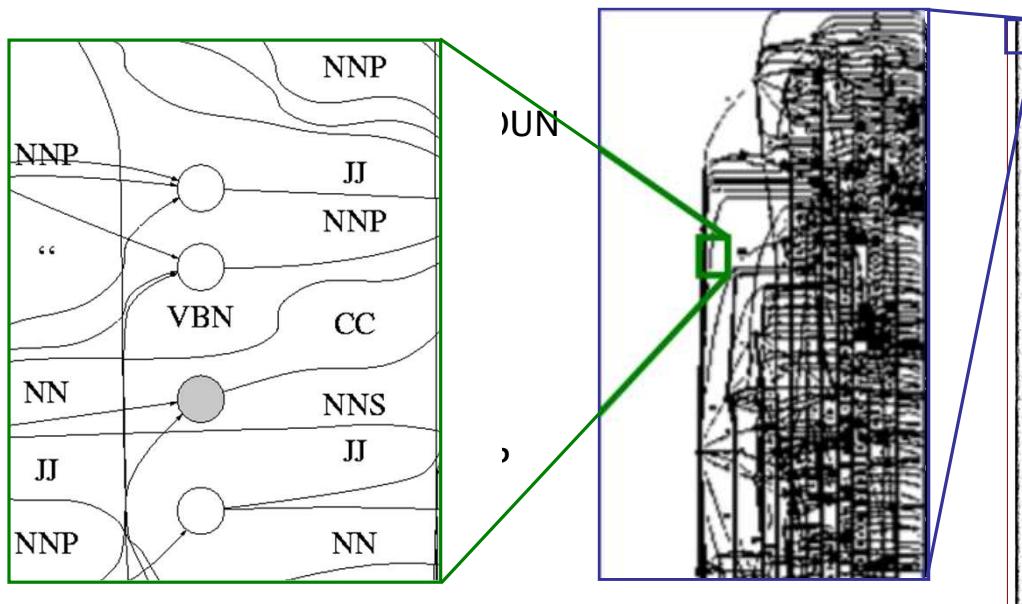
PRP-1	it	them	him
PRP-2	it	he	they
PRP-3	It	He	I

Proper Nouns (NNP)

NNP-14	Oct.	Nov.	Sept.
NNP-12	John	Robert	James
NNP-2	J.	E.	L.
NNP-1	Bush	Noriega	Peters
NNP-15	New	San	Wall
NNP-3	York	Francisco	Street



We Need Data





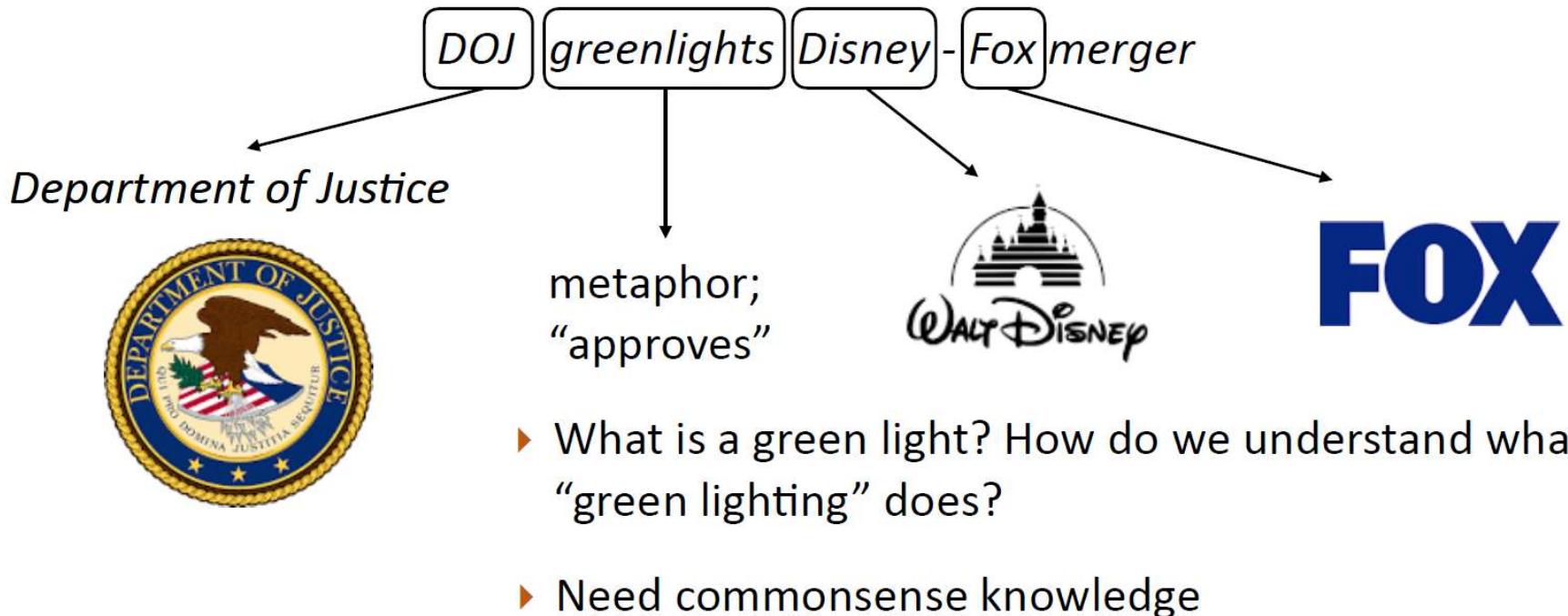
We Need A Lot of Data

SOURCE	Cela constituerait une solution transitoire qui permettrait de conduire à terme à une charte à valeur contraignante.
HUMAN	That would be an interim solution which would make it possible to work towards a binding charter in the long term .
1x DATA	[this] [constituerait] [assistance] [transitoire] [who] [permettrait] [licences] [to] [terme] [to] [a] [charter] [to] [value] [contraignante] [.]
10x DATA	[it] [would] [a solution] [transitional] [which] [would] [of] [lead] [to] [term] [to a] [charter] [to] [value] [binding] [.]
100x DATA	[this] [would be] [a transitional solution] [which would] [lead to] [a charter] [legally binding] [.]
1000x DATA	[that would be] [a transitional solution] [which would] [eventually lead to] [a binding charter] [.]



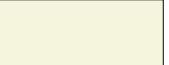
We Need Knowledge

- ▶ World knowledge: have access to information beyond the training data





Data and Knowledge

- Classic knowledge representation worries: How will a machine ever know that...
 - Ice is frozen water?
 - Beige looks like this: 
 - Chairs are solid?
- Answers:
 - 1980: write it all down
 - 2000: get by without it
 - 2020: learn it from web data



Knowledge from Large LMs?

AI2 Allen Institute for AI

AllenNLP

>Annotate a sentence ^

Semantic Role Labeling

Named Entity
Recognition

Constituency Parsing

Dependency Parsing

Open Information
Extraction

Sentiment Analysis

Annotate a passage ^

Coreference Resolution

Answer a question ^

Reading
Comprehension

Semantic parsing ^

Language Modeling

This demonstration uses the public 345M parameter OpenAI GPT-2 language model to generate sentences.

Enter some initial text and the model will generate the most likely next words. You can click on one of those words to choose it and continue or just keep typing. Click the left arrow at the bottom to undo your last choice.

Sentence:

At high temperatures, ice becomes

Predictions:

32.0% The

10.3% Ice

5.2% ←

3.7% Water

2.7% When

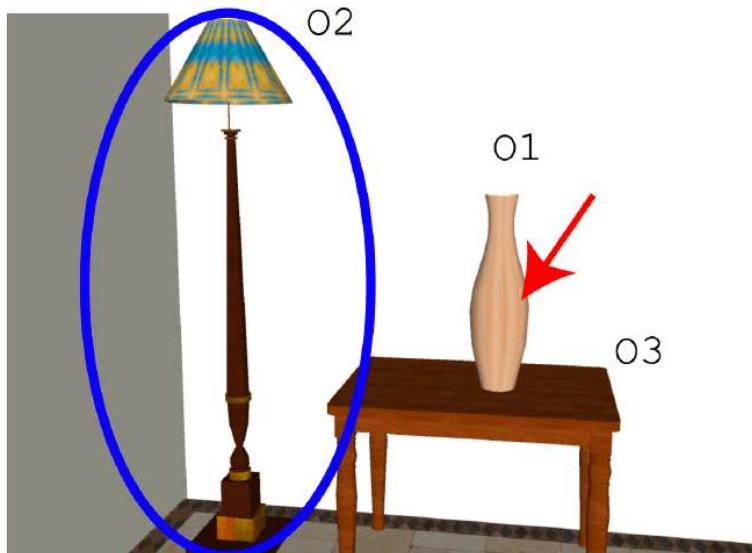
← Undo



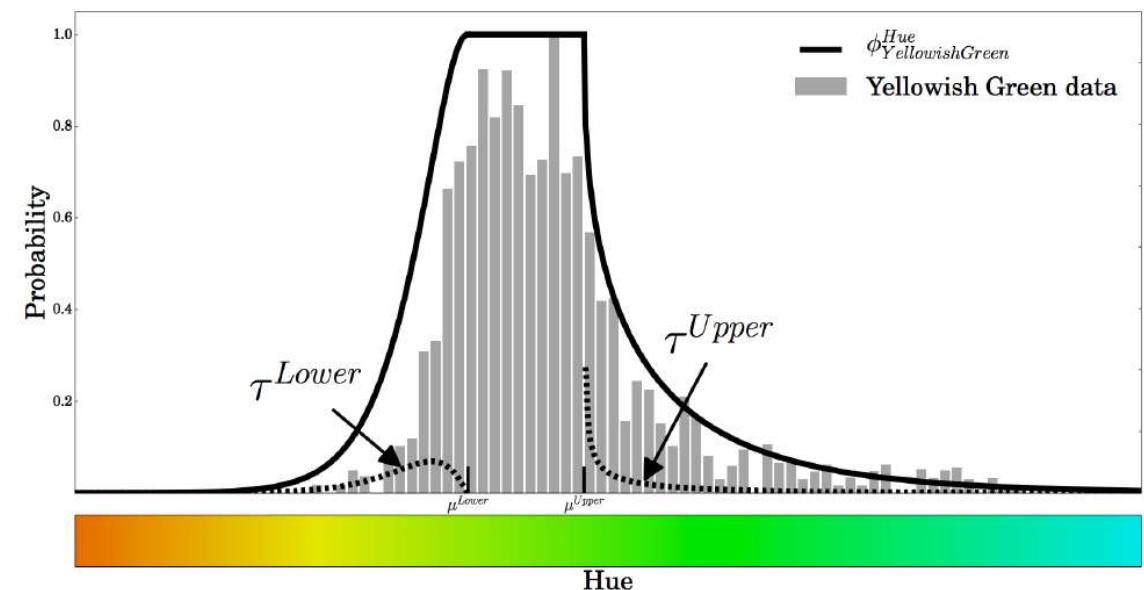
We Need Grounding

Grounding: linking linguistic concepts to non-linguistic ones

Question: What object is right of **O2** ?



Golland et al. (2010)



McMahan and Stone (2015)

Slide: Greg Durrett



Example: Grounded Dialog



When is my package arriving?

Friday!





Why is Language Hard?

- We Need:
 - Representations
 - Models
 - Data
 - Grounding
 - Learning
 - Scale
 - Efficient Algorithms
- ... and often we need all these things at the same time



Course Overview (Subject to Change)

- 6 Lectures: Language / Sequence Modeling
- 2 Lectures: NLP Tasks, Data, and Evaluation
- 5 Lectures: Structured Prediction
- 4 Lectures: Transformers and LLMs
- 5 Lectures: NLP Beyond Text
- 5 Lectures: Panels on Current Topics