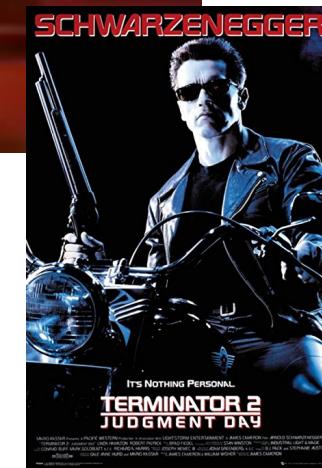


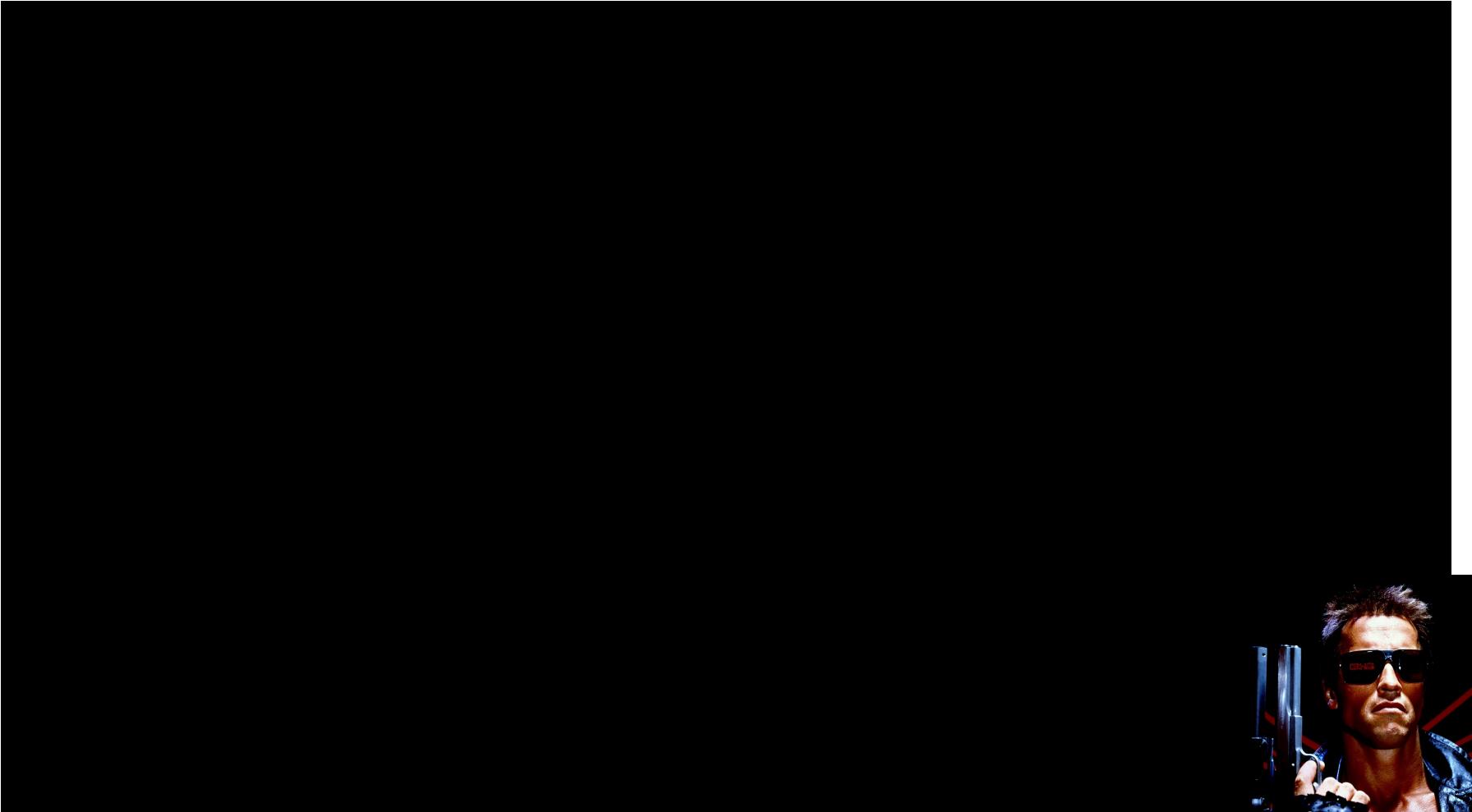
Science Fiction and Science Fact



[https://www.youtube.com/watch?v=JknRYYrV5V
k](https://www.youtube.com/watch?v=JknRYYrV5V
k)



Science Fiction and Science Fact



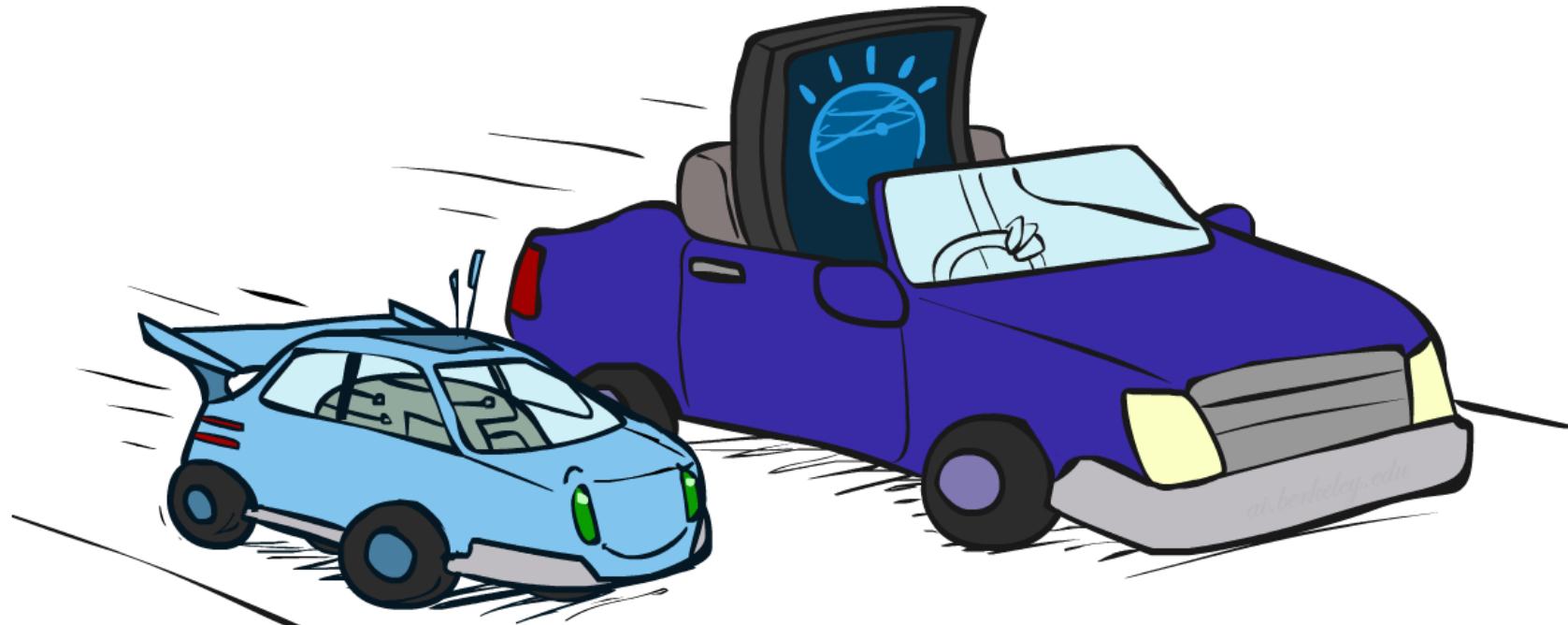
Announcements

- First part of Optional HW10 was released yesterday.
 - Second part coming soon.
 - Both due on Monday 12/10 (you can use your remaining late days).
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- Reminder: Midterm 3 will be held on Thursday in class.
 - Topics for midterm 3: Bayes' Nets, Naive Bayes, Perceptrons, Kernels, Clustering, Neural Networks

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Computer Vision, Self Driving Cars, and NLP



Slides Courtesy of Dan Klein and Pieter Abbeel --- University of California, Berkeley

[These slides were created by Dan Klein and Pieter Abbeel for CS188 Intro to AI at UC Berkeley. All CS188 materials are available at <http://ai.berkeley.edu>.]

Additional slides from Fereshteh Sadeghi, Larry Zitnick, Alyosha Efros, Sebastian Thrun, Adam Lopez



www.image-net.org

22K categories and **14M** images

- Animals
 - Bird
 - Fish
 - Mammal
 - Invertebrate
- Plants
 - Tree
 - Flower
- Food
- Materials
- Structures
 - Artifact
 - Tools
 - Appliances
 - Structures
- Person
- Scenes
 - Indoor
 - Geological Formations
- Sport Activities



Deng, Dong, Socher, Li, Li, & Fei-Fei, 2009

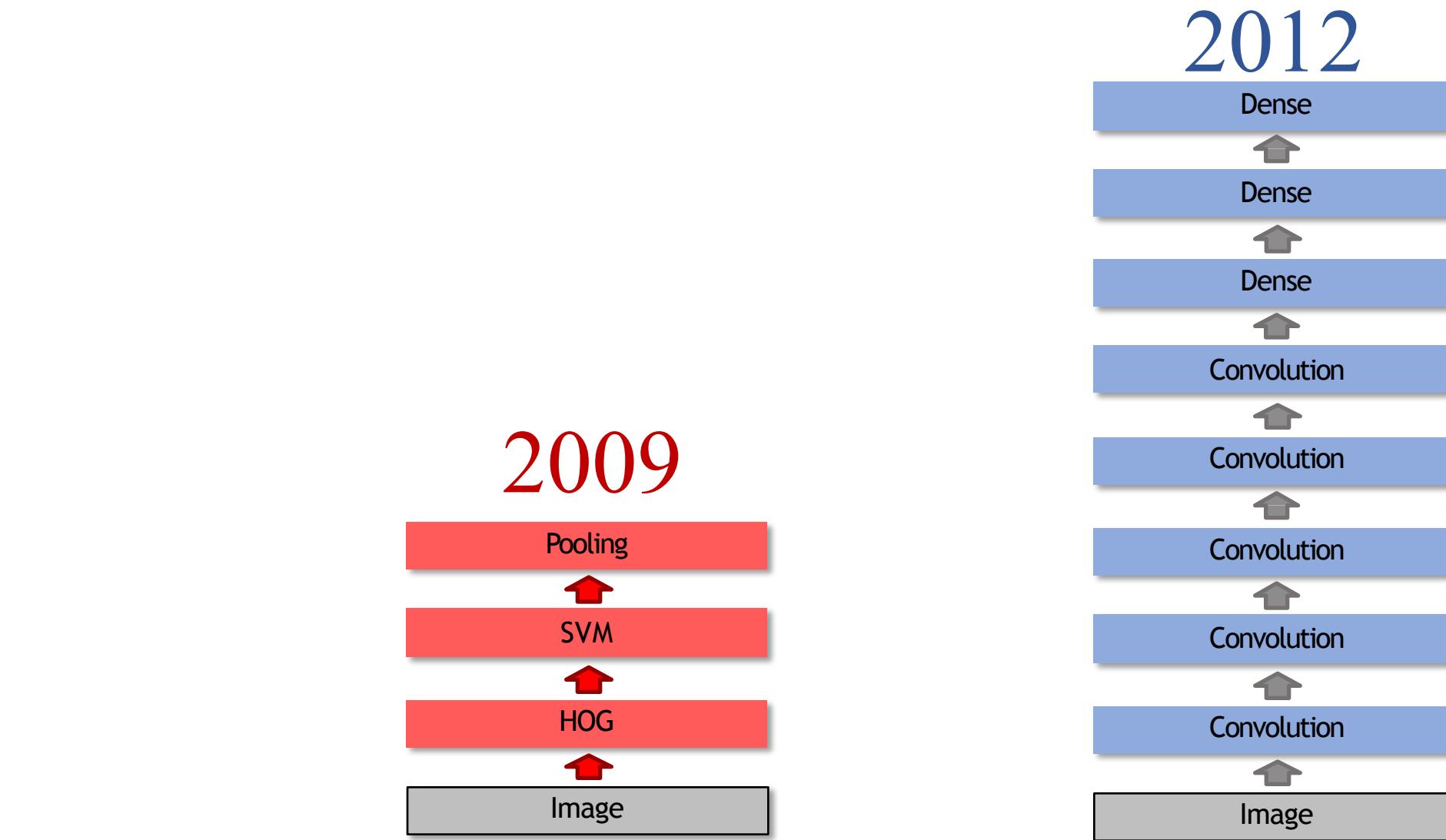
2009 ImageNet

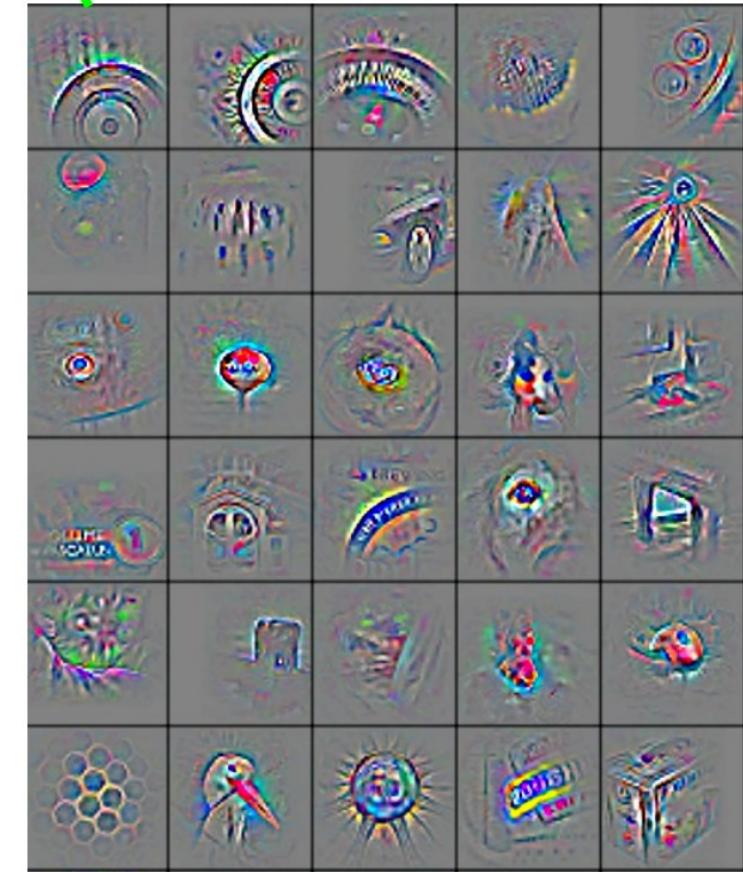
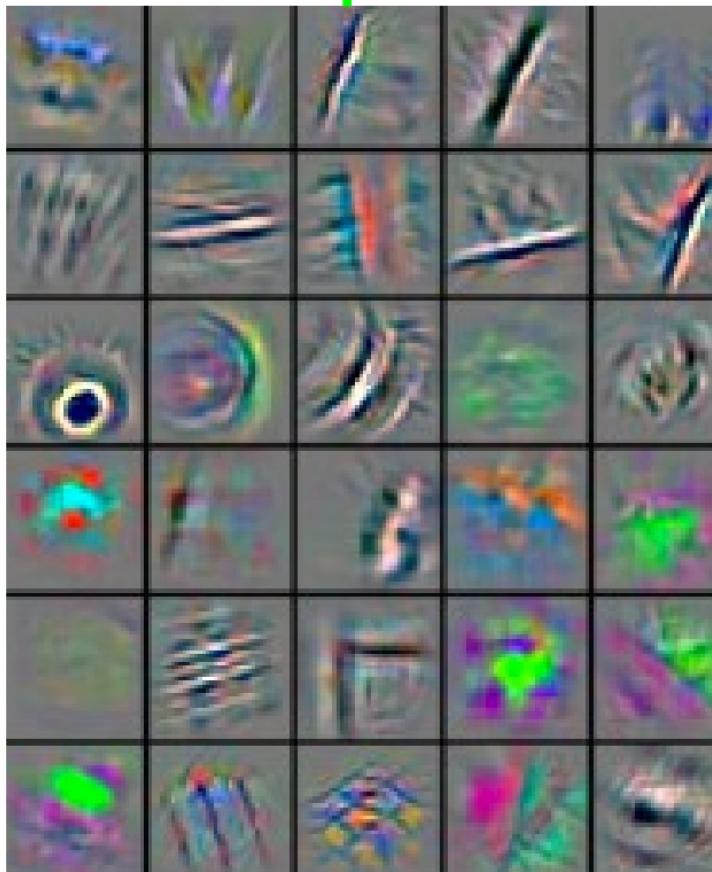
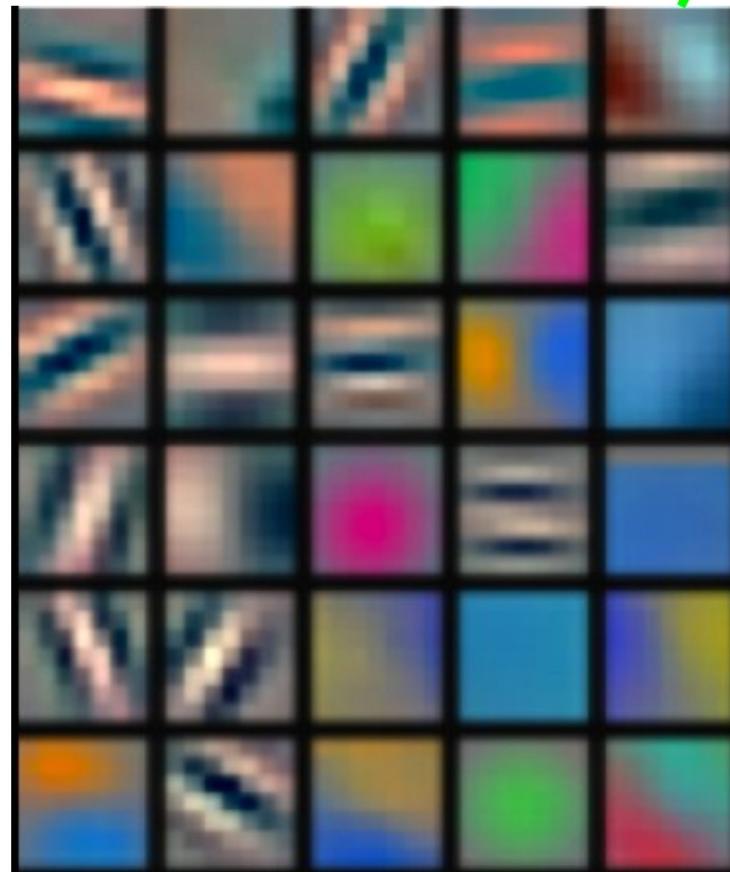
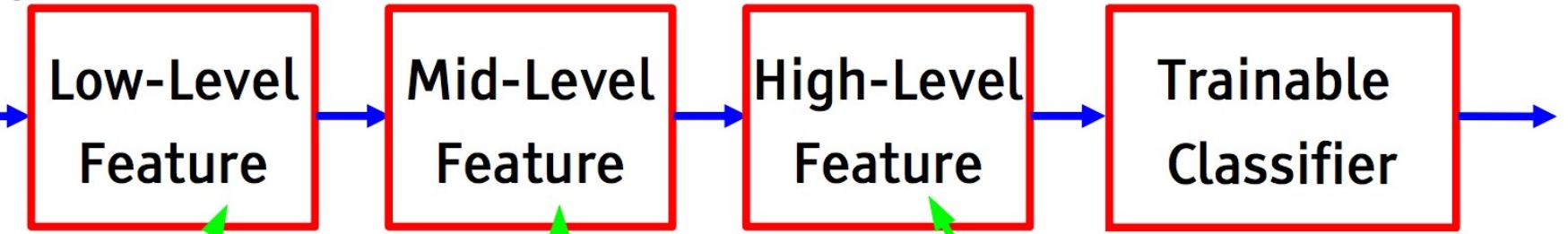
22K categories, 14M images



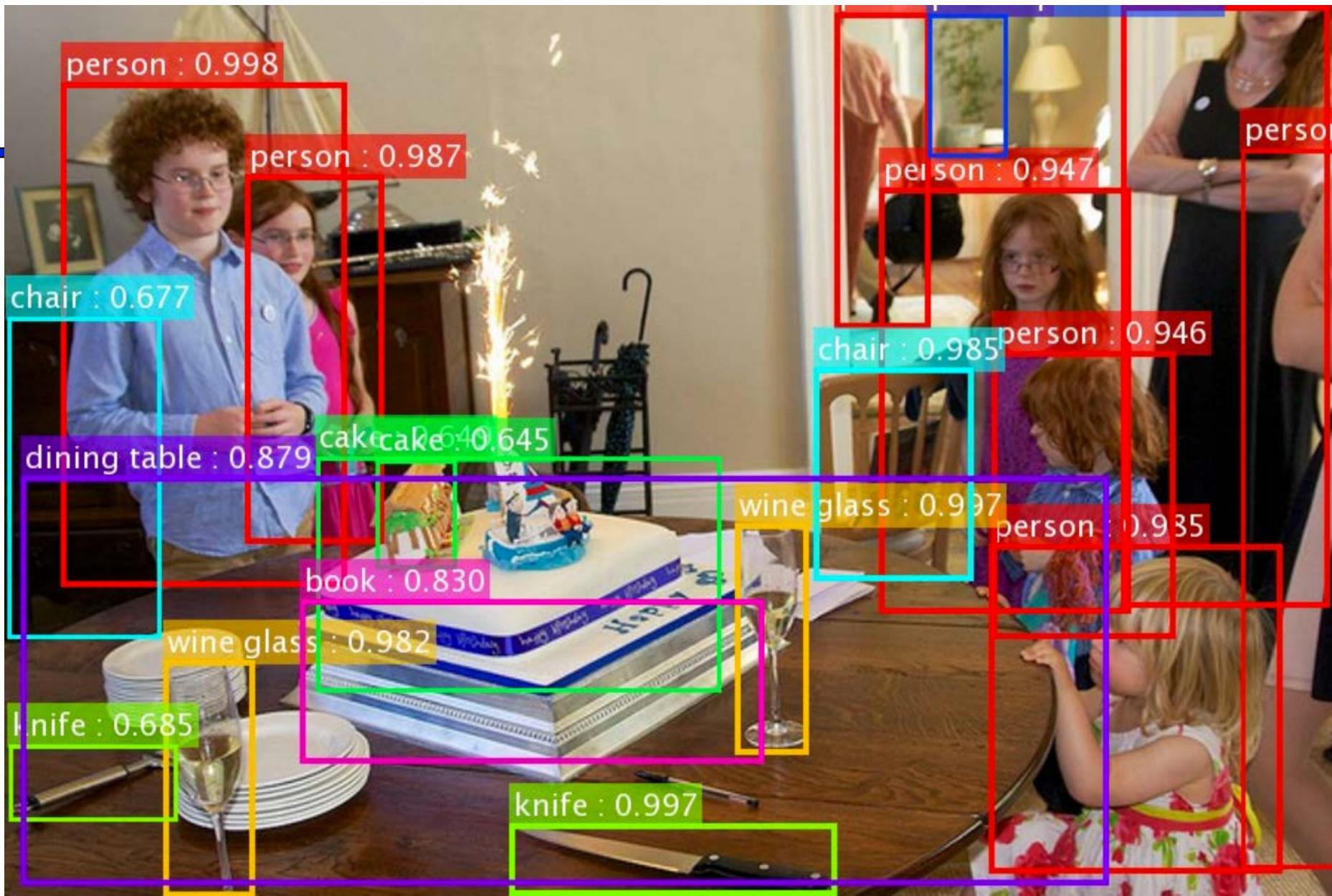
ImageNet: A Large-Scale Hierarchical Image Database,
Deng, Dong, Socher, Li, Li and Fei-Fei, CVPR, 2009

Algorithms





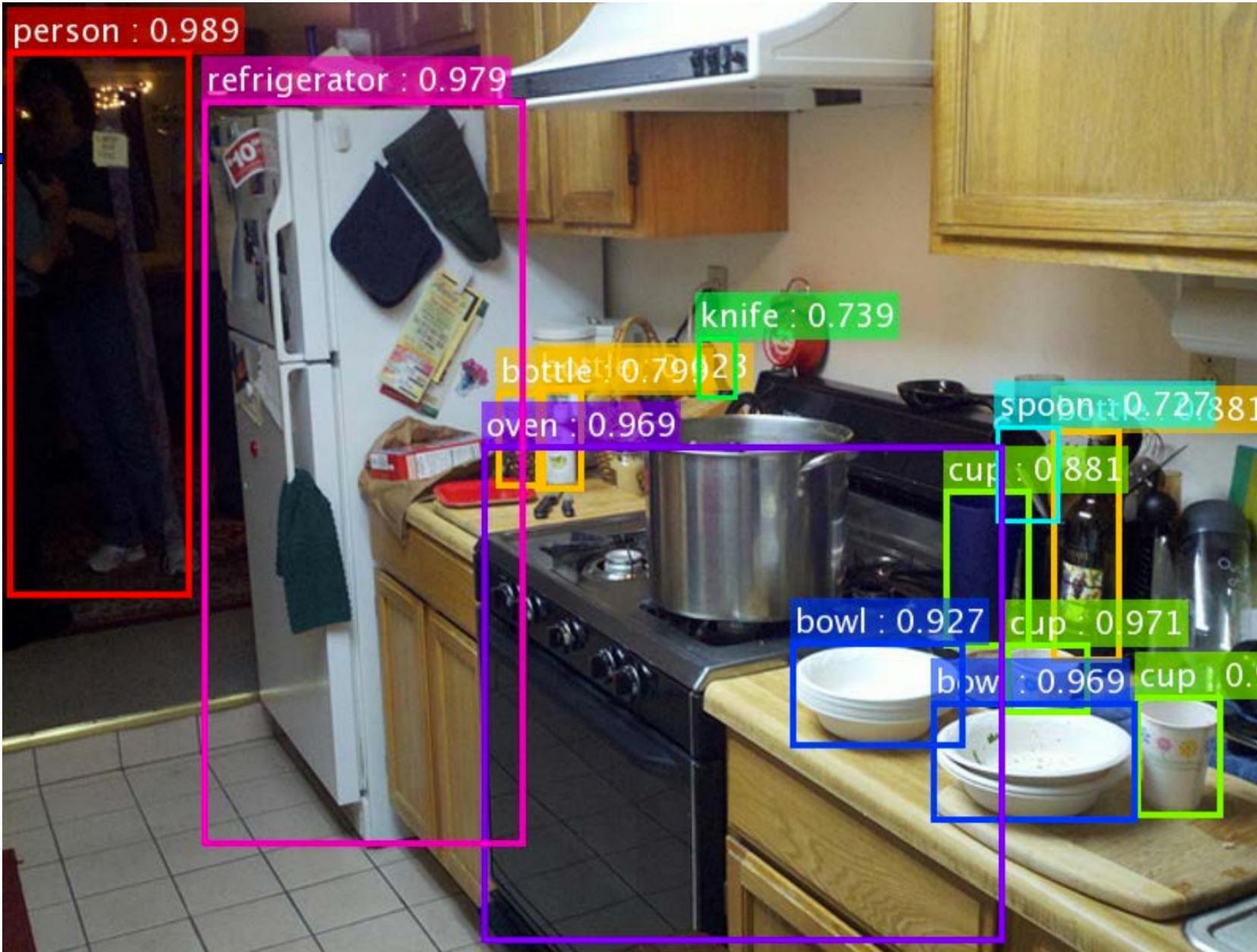
Feature visualization of convolutional net trained on ImageNet from [Zeiler & Fergus 2013]



*the original image is from the COCO dataset

Kaiming He, Xiangyu Zhang, Shaoqing Ren, & Jian Sun. "Deep Residual Learning for Image Recognition". arXiv 2015.

Shaoqing Ren, Kaiming He, Ross Girshick, & Jian Sun. "Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks". NIPS 2015.



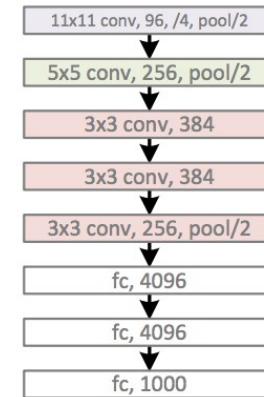
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Kaiming He, Xiangyu Zhang, Shaoqing Ren, & Jian Sun. "Deep Residual Learning for Image Recognition". arXiv 2015.

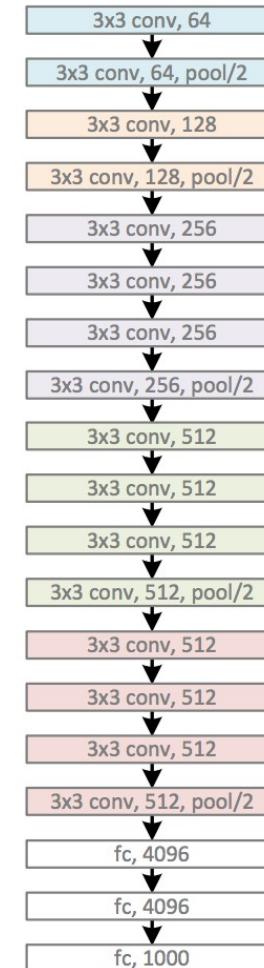
Shaoqing Ren, Kaiming He, Ross Girshick, & Jian Sun. "Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks". NIPS 2015.

Revolution of Depth

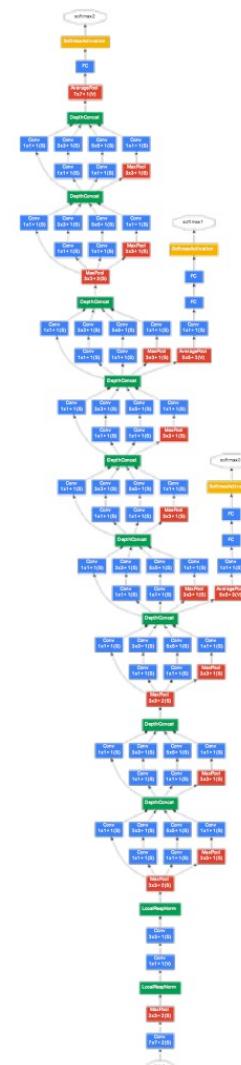
AlexNet, 8 layers
(ILSVRC 2012)



VGG, 19 layers
(ILSVRC 2014)



GoogleNet, 22 layers
(ILSVRC 2014)



Revolution of Depth

AlexNet, 8 layers
(ILSVRC 2012)



VGG, 19 layers
(ILSVRC 2014)



ResNet, **152 layers**
(ILSVRC 2015)





Oren Etzioni

@etzioni

Following



The winner of the 2014 ImageNet competition had 4 million parameters, while the winner of the 2017 challenge had 145.8 million parameters - a 36X increase in three years. source: [@jackclarkSF](#) Shall we increase parameters by another 36X, or solve more interesting problems?

9:21 PM - 27 Nov 2018

63 Retweets 222 Likes



12

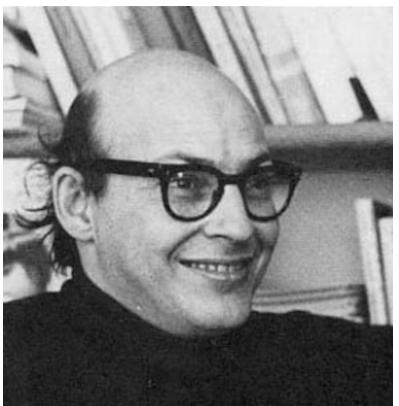
63

222



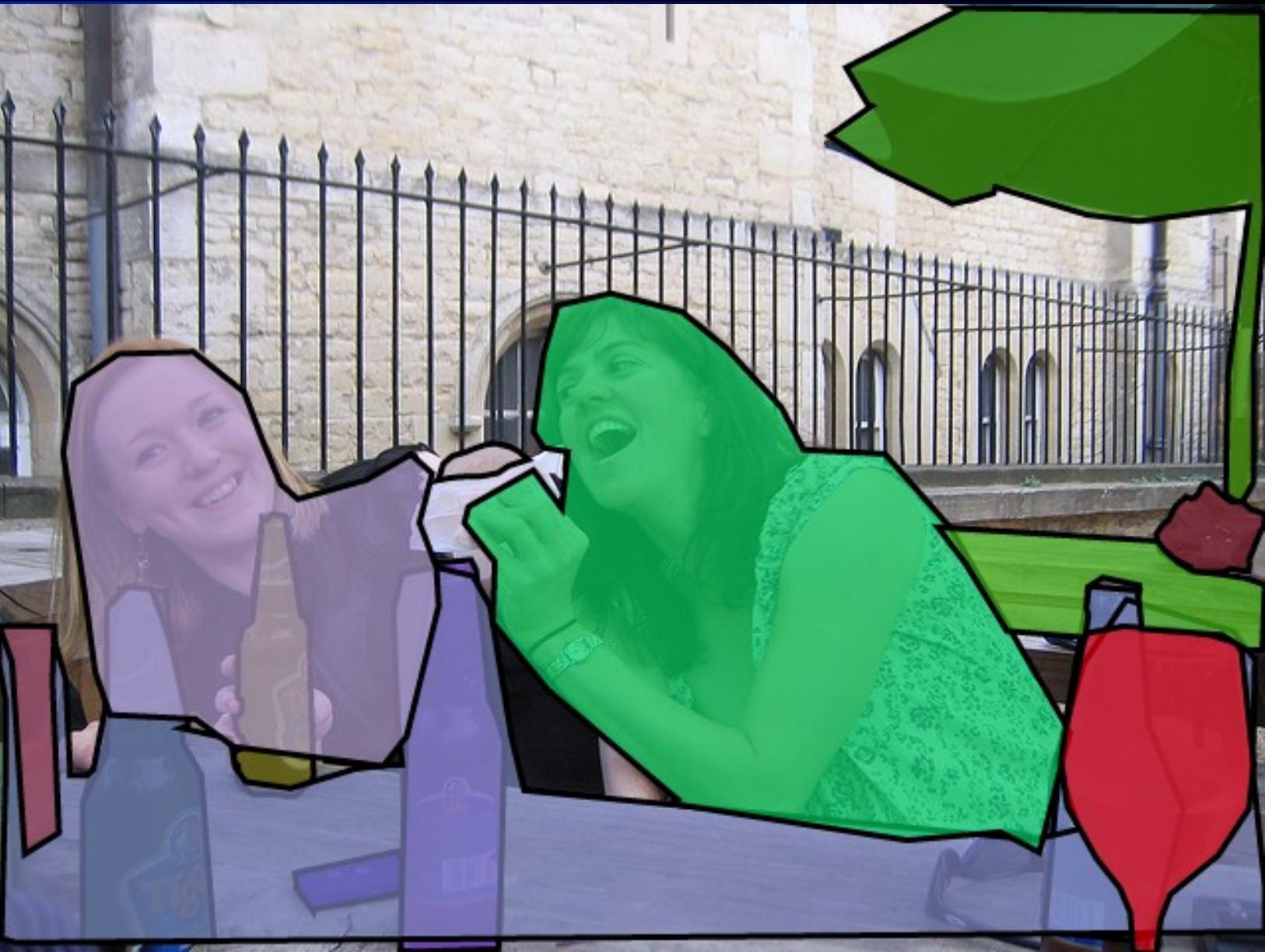
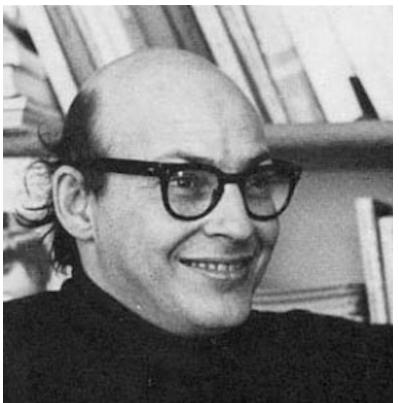
Going beyond categorization...

“Connect a television camera to a computer and get the machine to describe what it sees.”



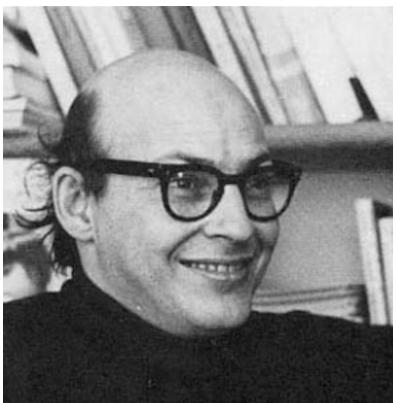
Going beyond categorization...

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Going beyond categorization...

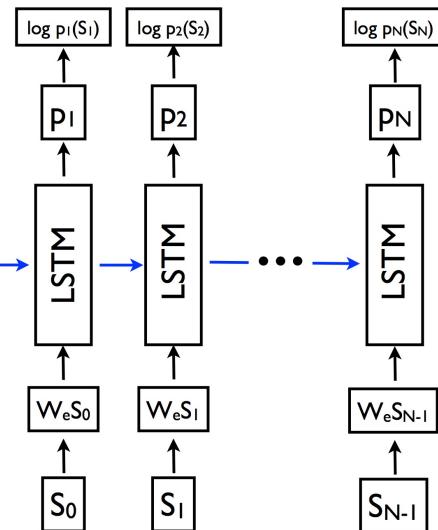
“Connect a television camera to a computer and get the machine to describe what it sees.”



two girls sitting at a table smiling and eating and drinking.
a woman is eating a doughnut and drinking beer.
there are two woman drinking beers and eating food
a woman leaning into another woman as she holds a sandwich towards her.
two ladies are enjoying beer and treats at the table.

Going beyond categorization...

image



Describes without errors

Describes with minor errors

Somewhat related to the image

Unrelated to the image

VQA: Visual Question Answering

www.visualqa.org

Stanislaw Antol*, Aishwarya Agrawal*, Jiasen Lu, Margaret Mitchell,
Dhruv Batra, C. Lawrence Zitnick, Devi Parikh



What color are her eyes?
What is the mustache made of?



How many slices of pizza are there?
Is this a vegetarian pizza?

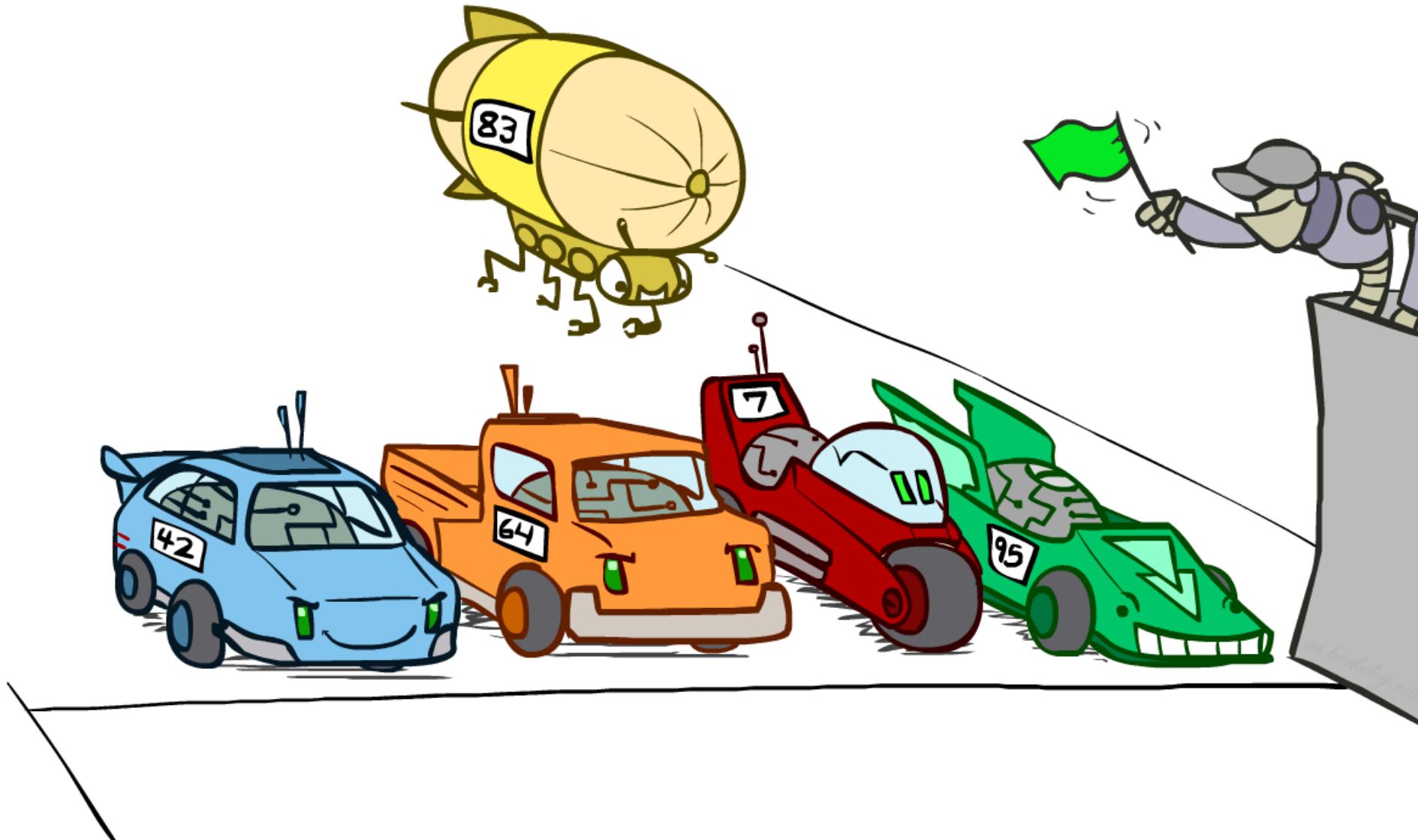


Is this person expecting company?
What is just under the tree?

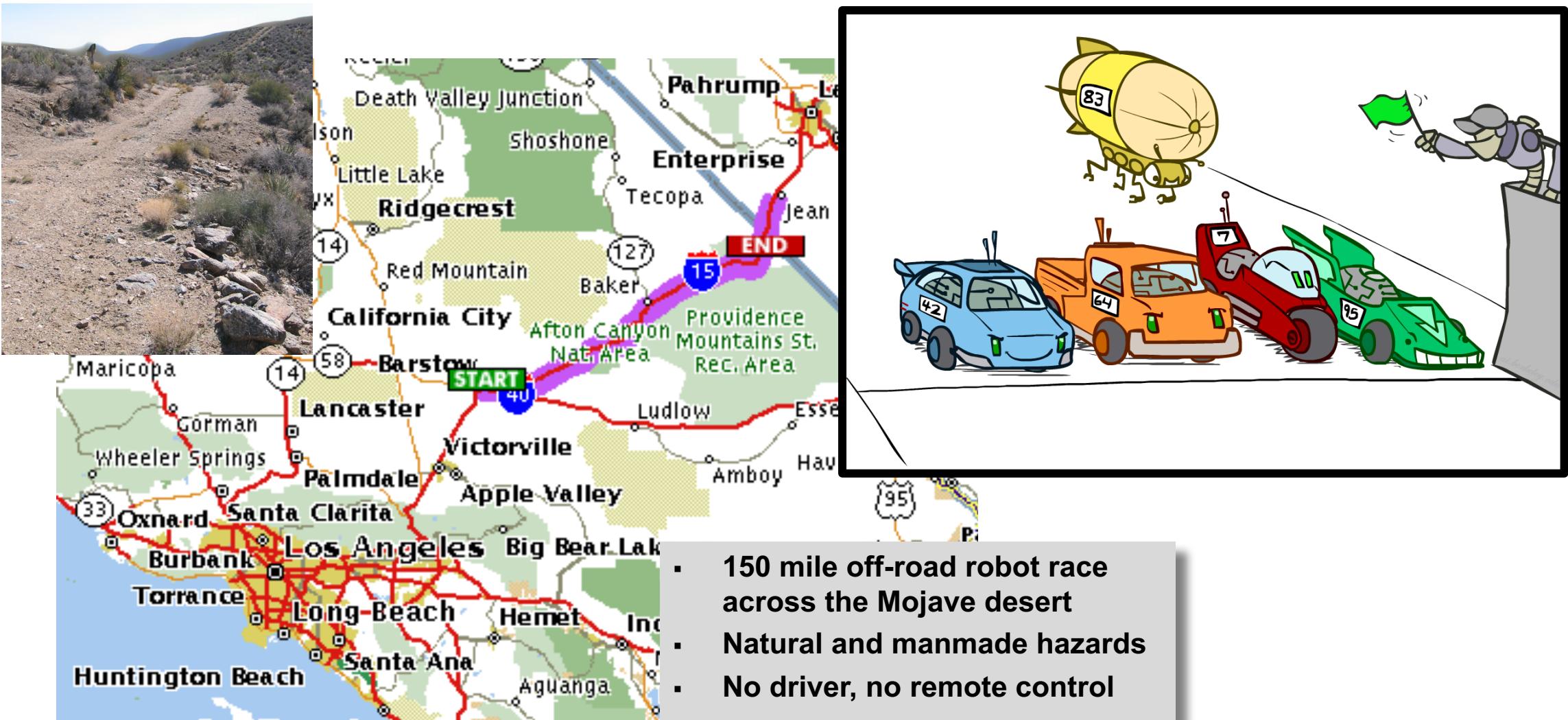


Does it appear to be rainy?
Does this person have 20/20 vision?

Autonomous Driving



Grand Challenge 2005: Barstow, CA, to Primm, NV



Grand Challenge 2005 Nova Video



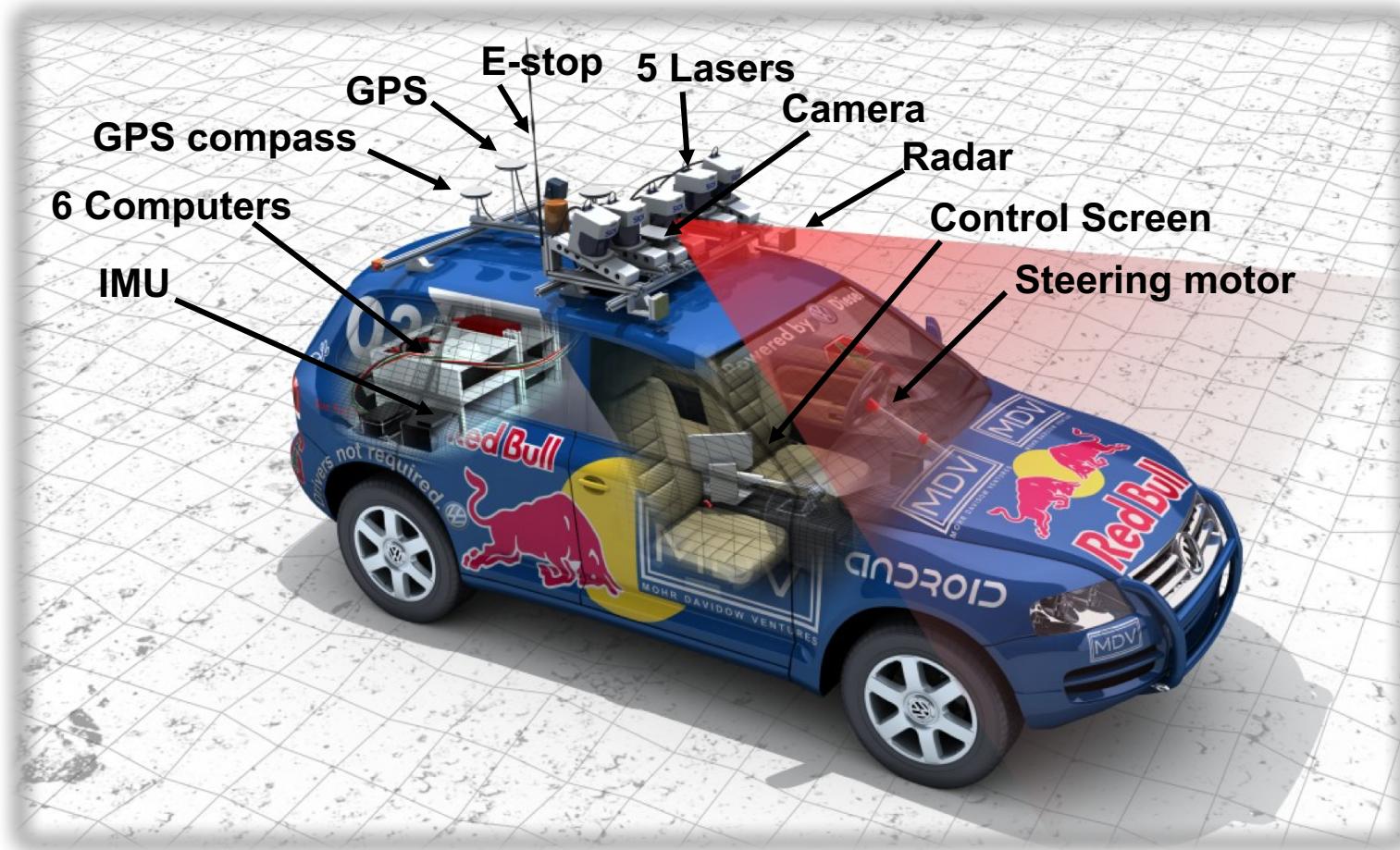
[VIDEO: nova-race-supershort.mp4]

Grand Challenge 2005 – Bad

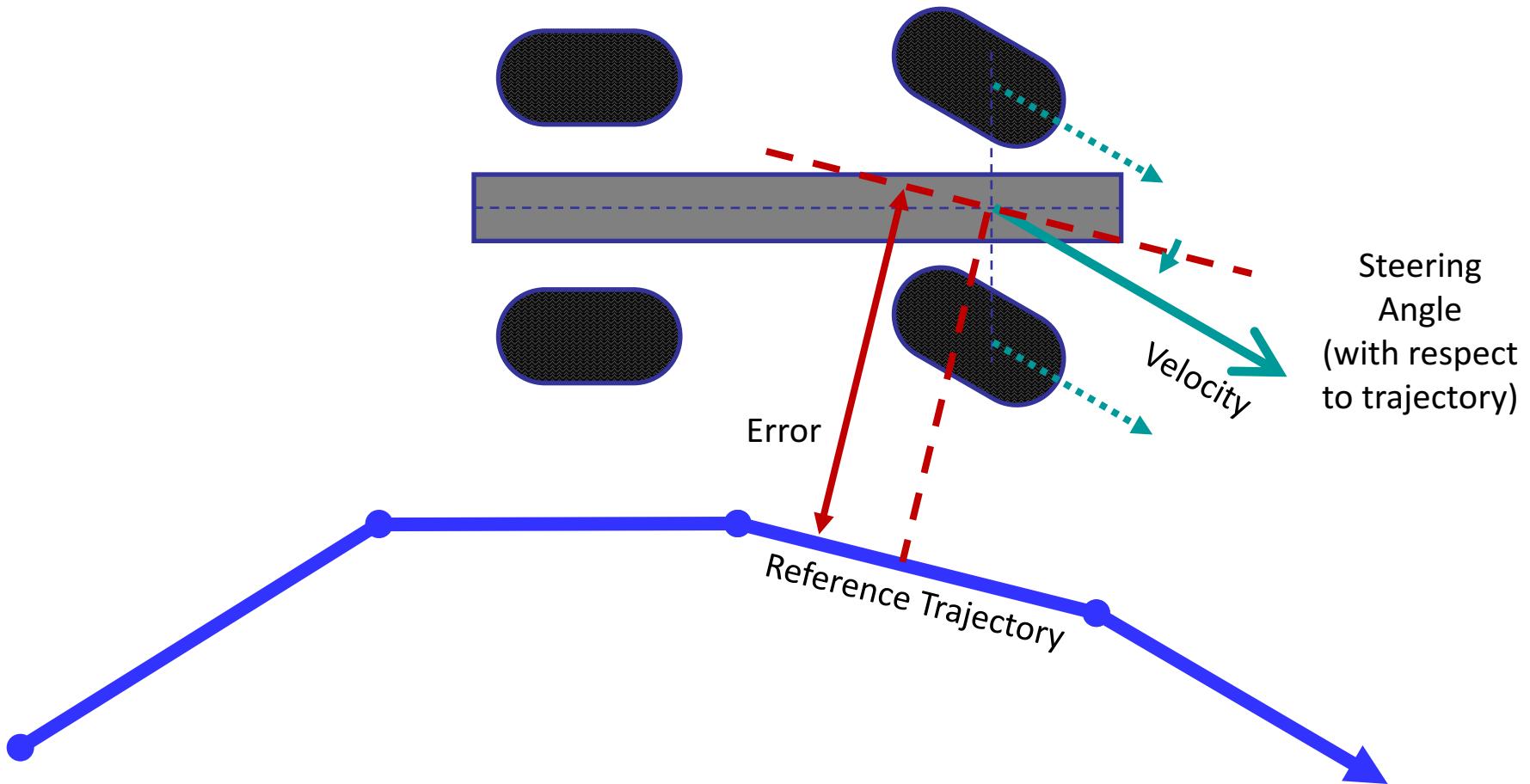


[VIDEO: grand challenge – bad.wmv]

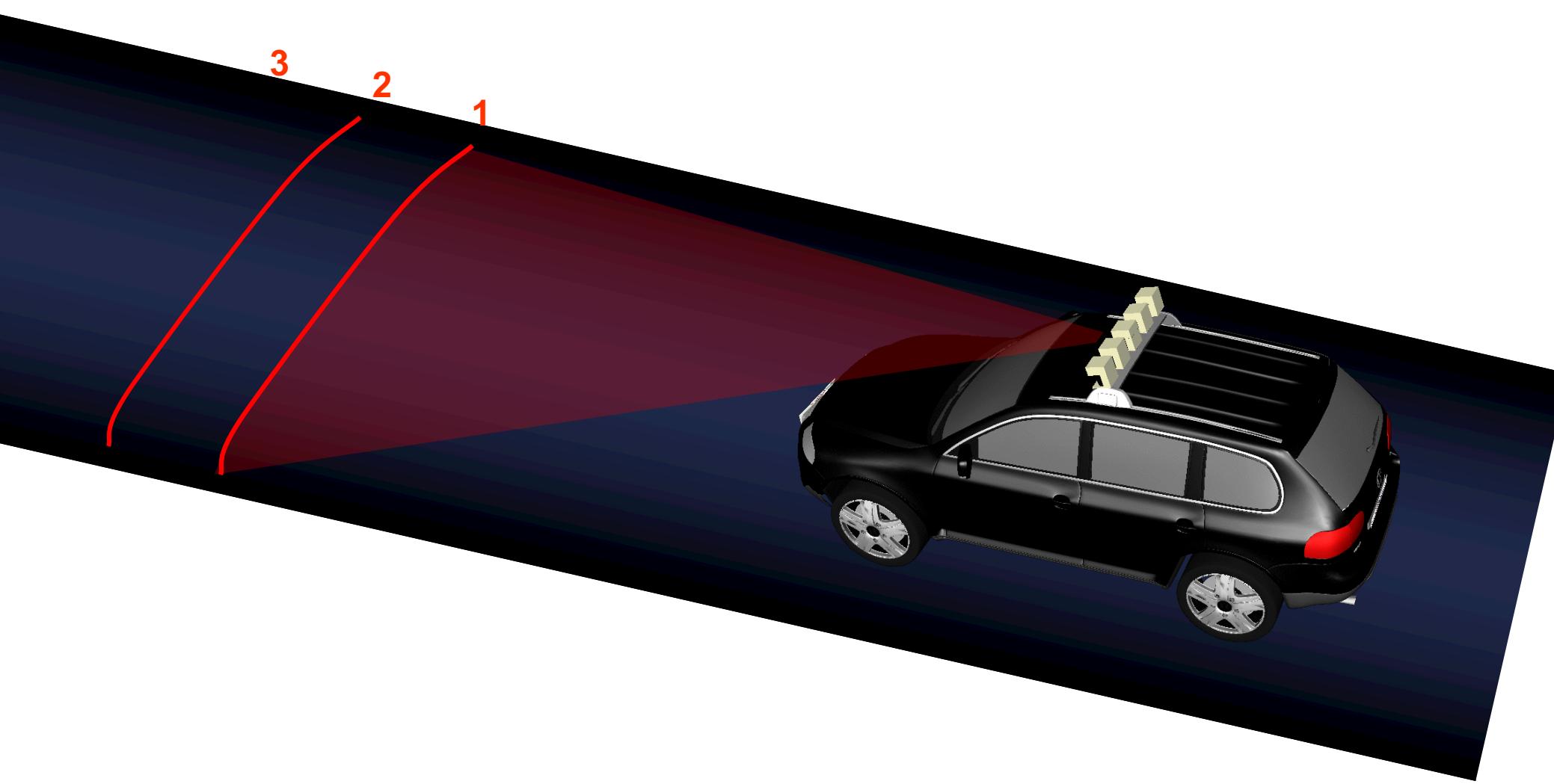
An Autonomous Car



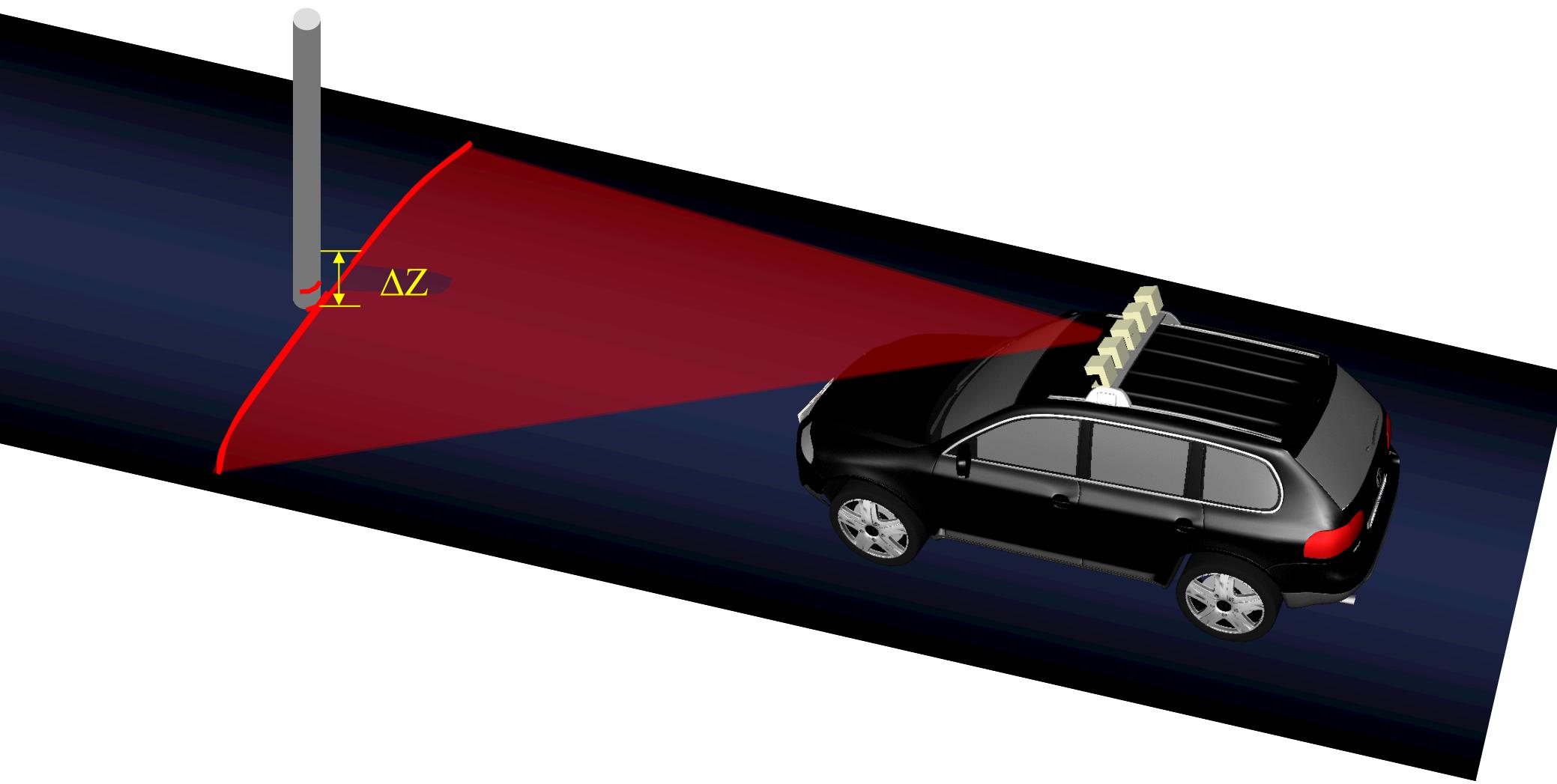
Actions: Steering Control



Laser Readings for Flat / Empty Road

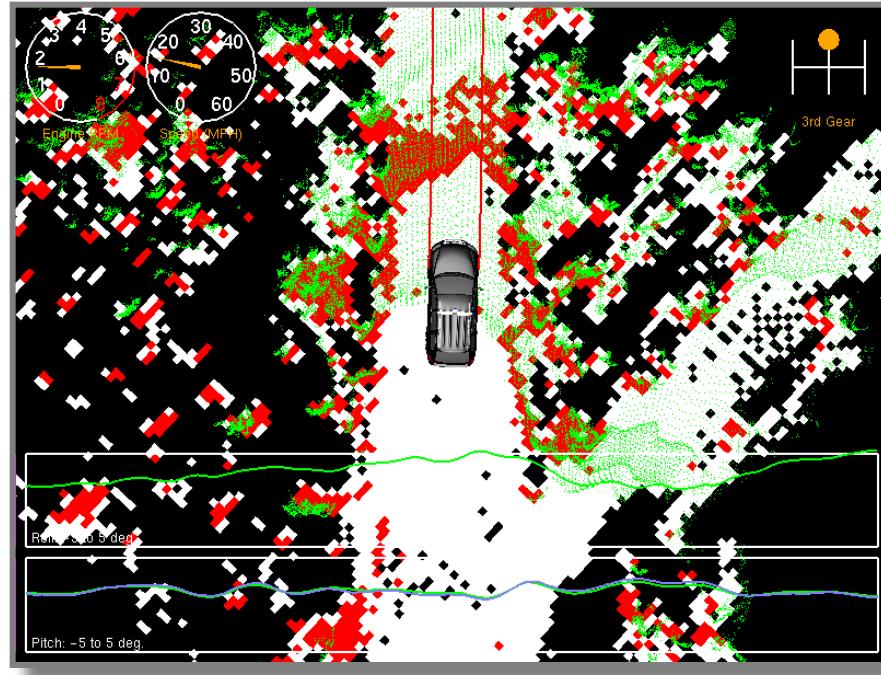


Laser Readings for Road with Obstacle



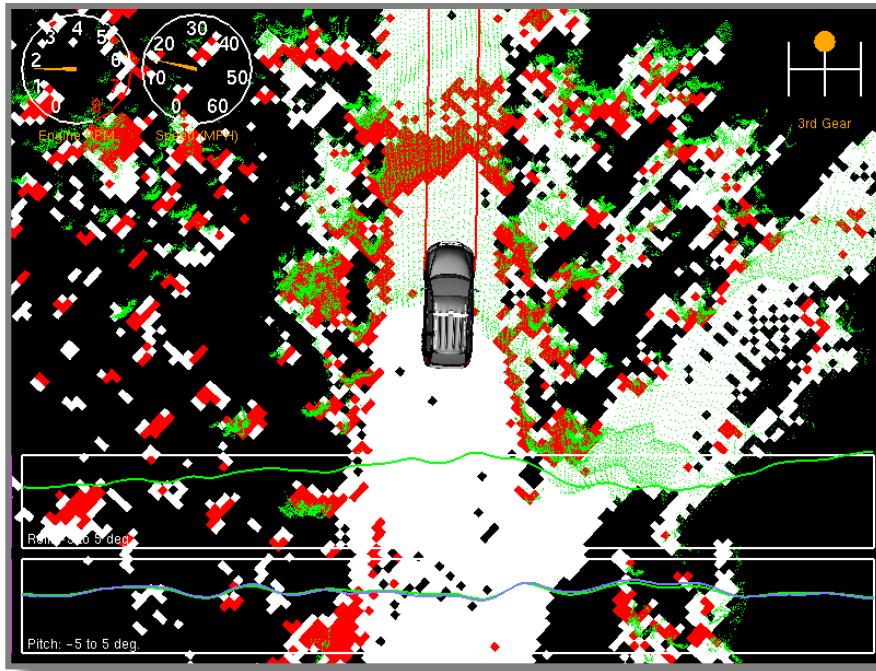
Obstacle Detection

Trigger if $|Z^i - Z^j| > 15\text{cm}$ for nearby z^i, z^j

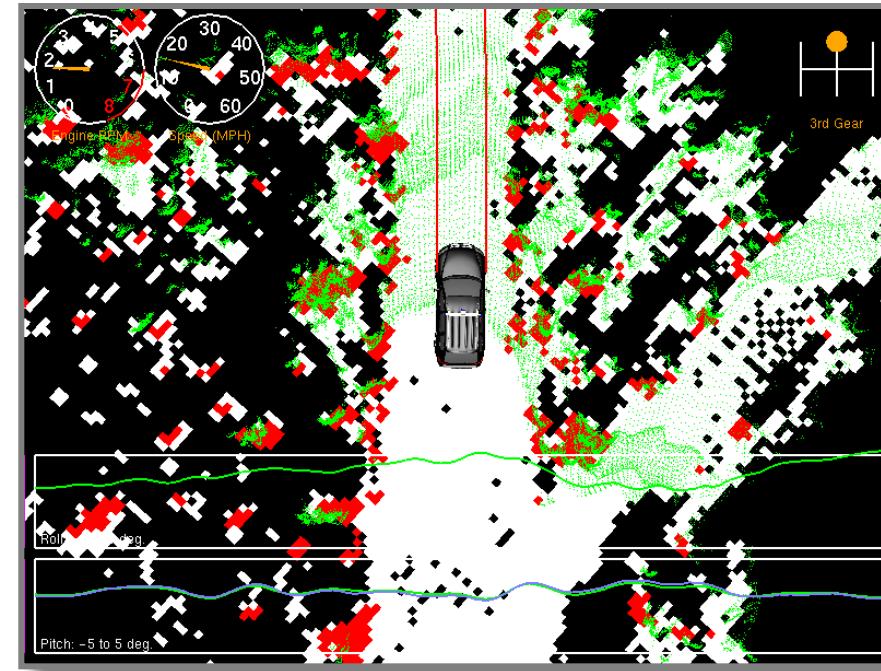


Raw Measurements: 12.6% false positives

HMMs for Detection

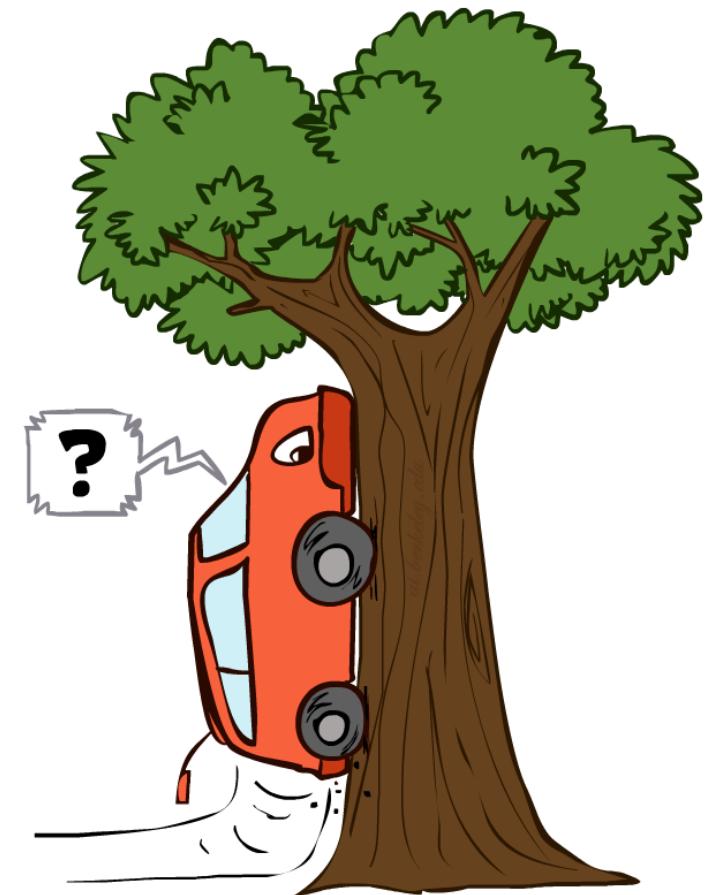


Raw Measurements: 12.6% false positives

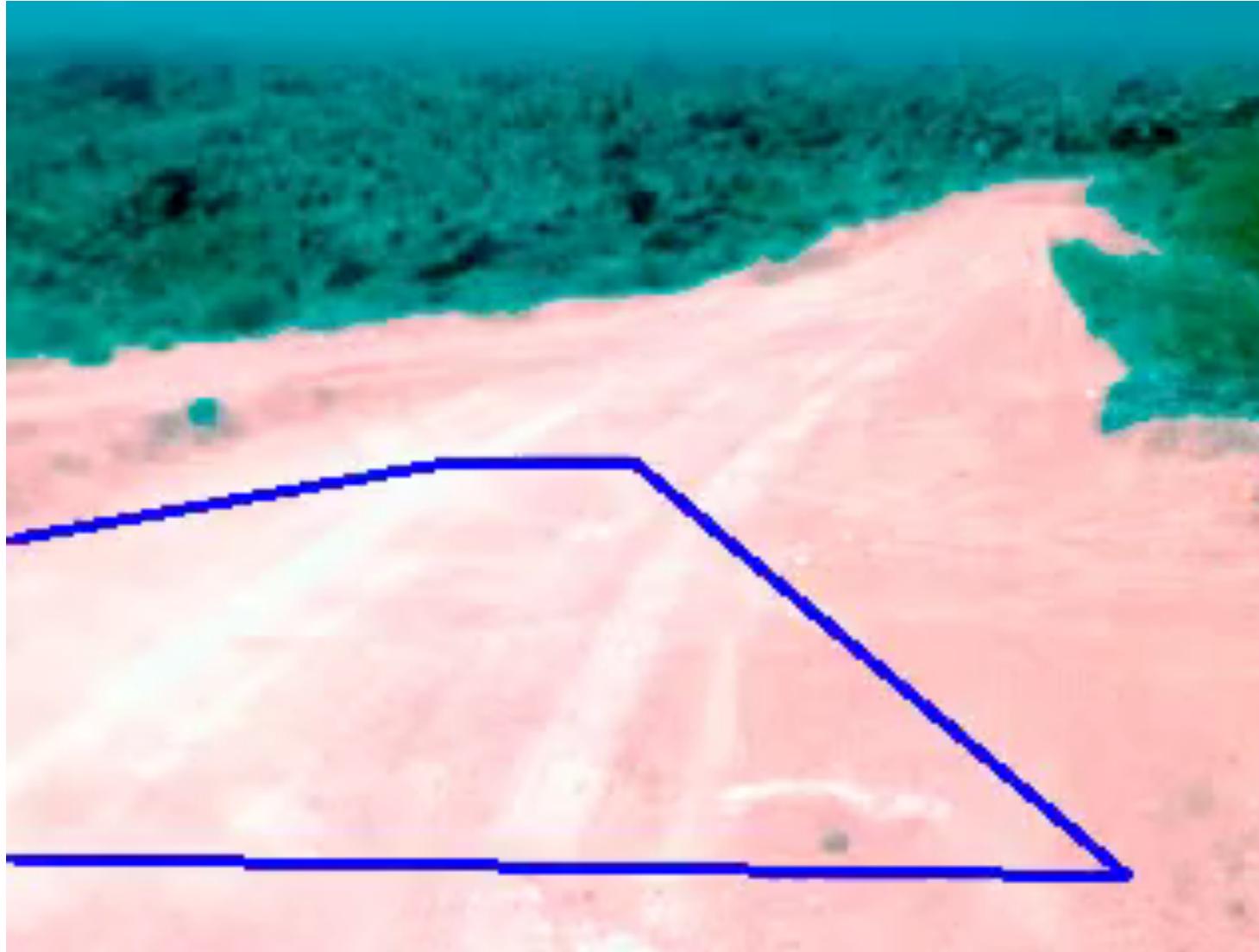


HMM Inference: 0.02% false positives

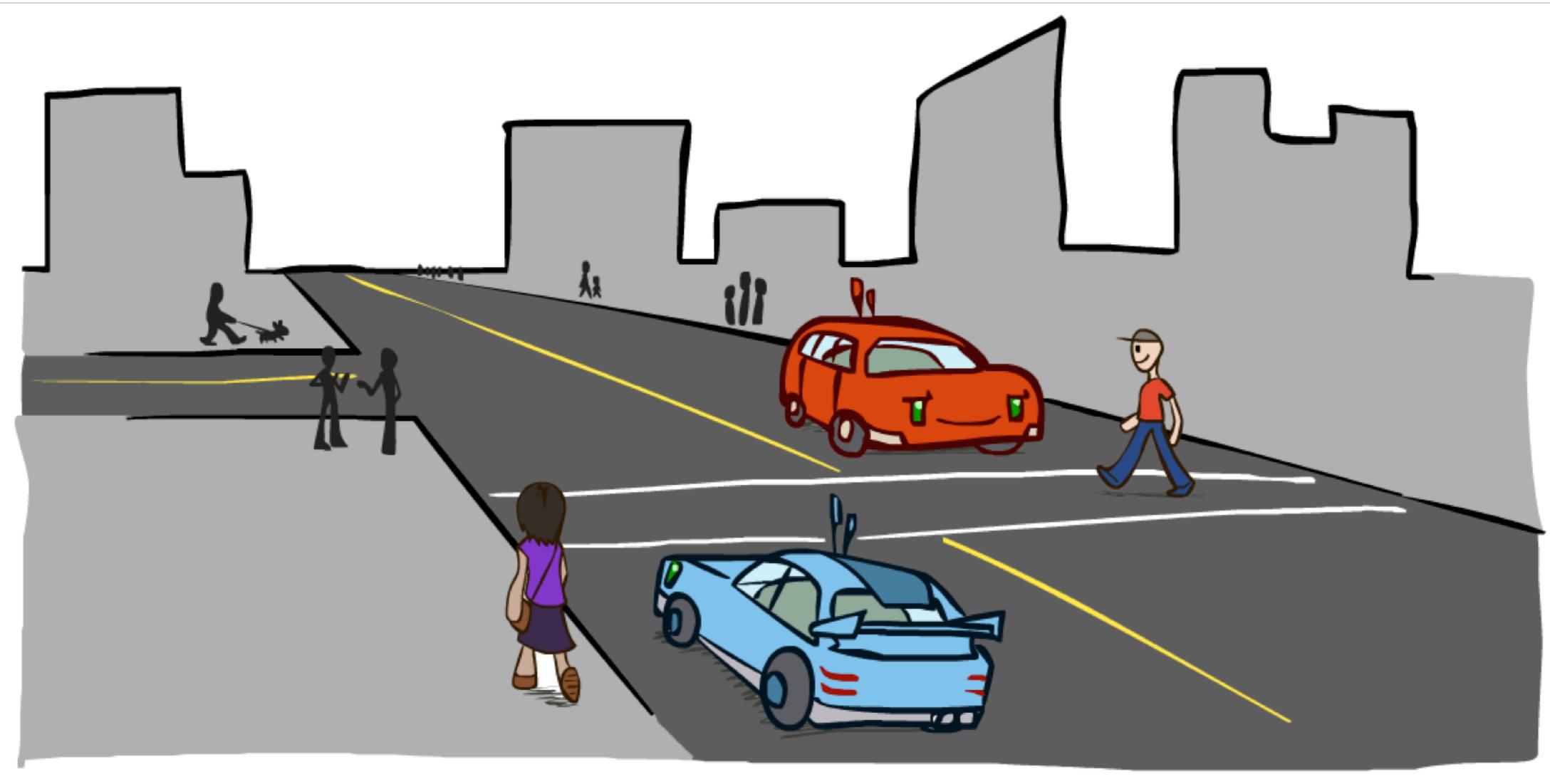
Sensors: Camera



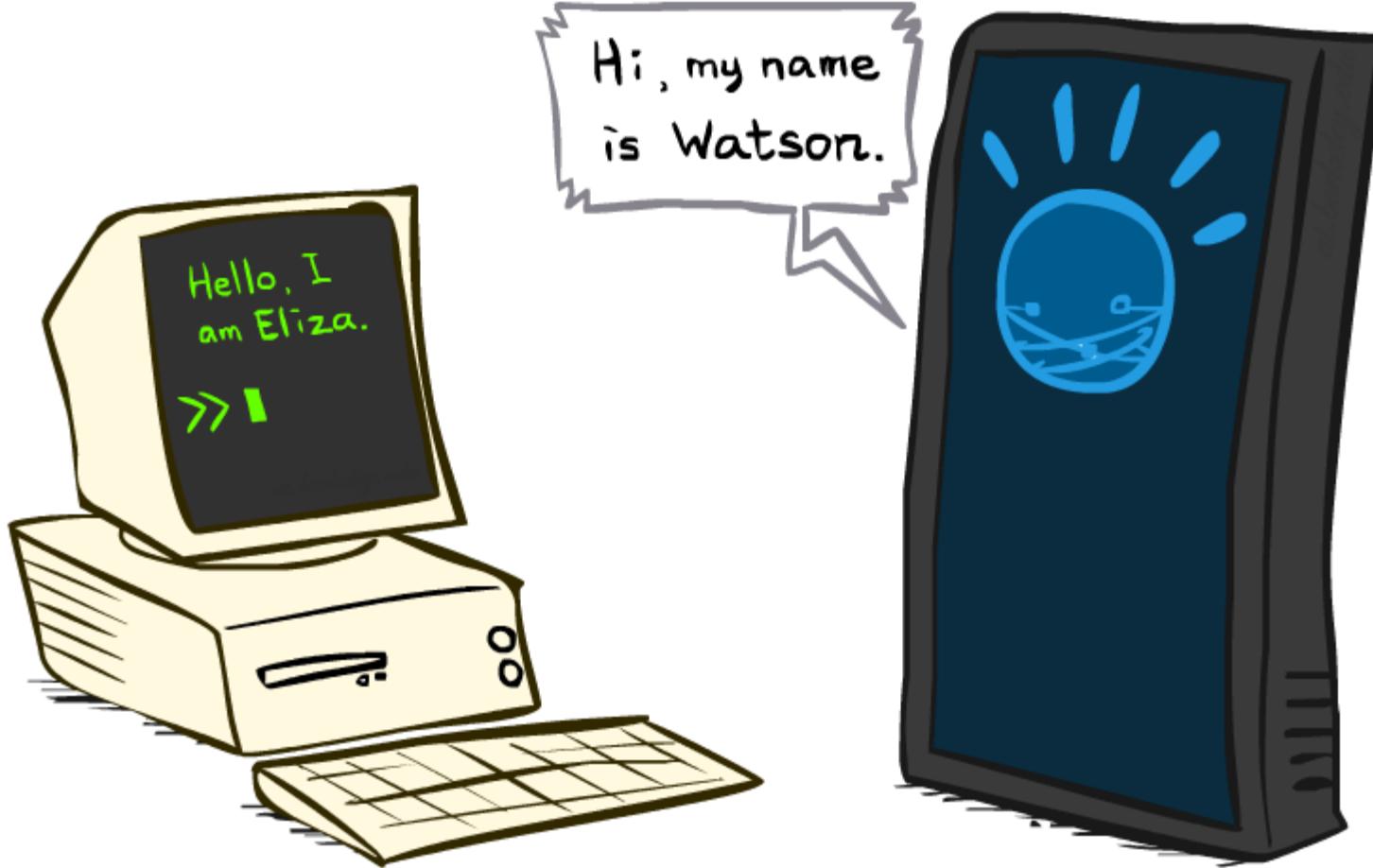
Self-Supervised Vision



Urban Environments



Natural Language Processing



What is NLP?



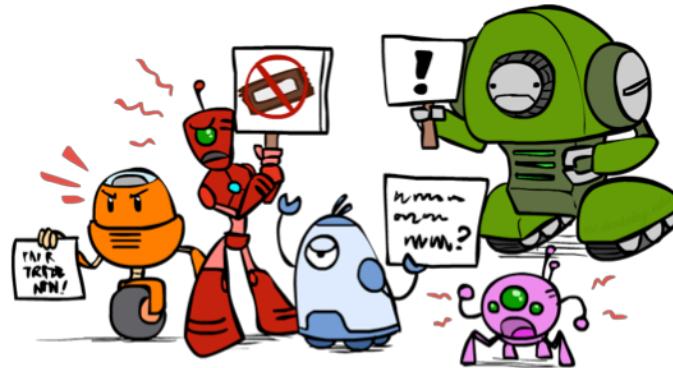
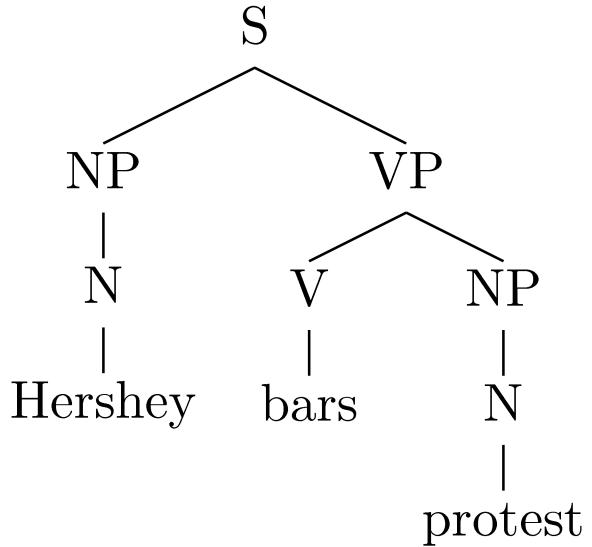
- Fundamental goal: analyze and process human language, broadly, robustly, accurately...
- End systems that we want to build:
 - Ambitious: speech recognition, machine translation, information extraction, dialog interfaces, question answering...
 - Modest: spelling correction, text categorization...

Problem: Ambiguities

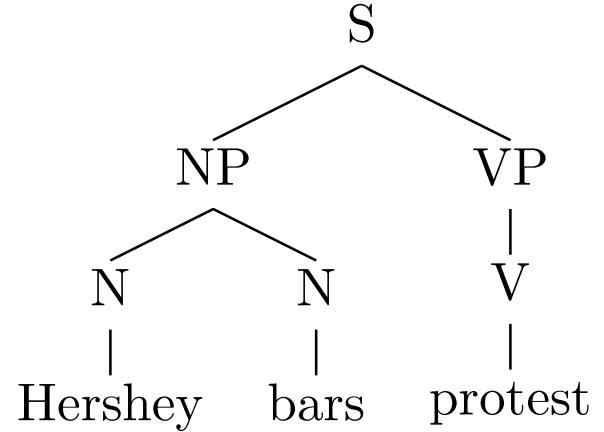
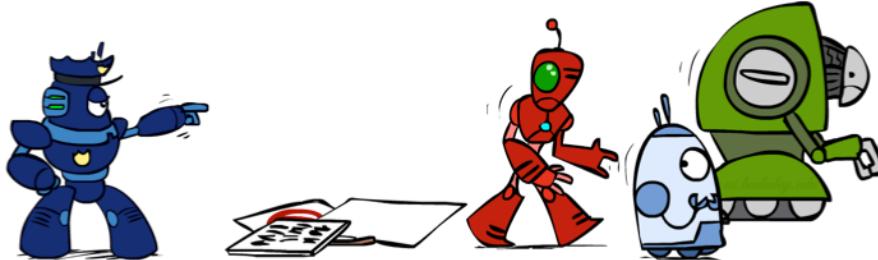
- Headlines:
 - Enraged Cow Injures Farmer With Ax
 - Hospitals Are Sued by 7 Foot Doctors
 - Ban on Nude Dancing on Governor's Desk
 - Iraqi Head Seeks Arms
 - Local HS Dropouts Cut in Half
 - Juvenile Court to Try Shooting Defendant
 - Stolen Painting Found by Tree
 - Kids Make Nutritious Snacks
- Why are these funny?



Parsing as Search

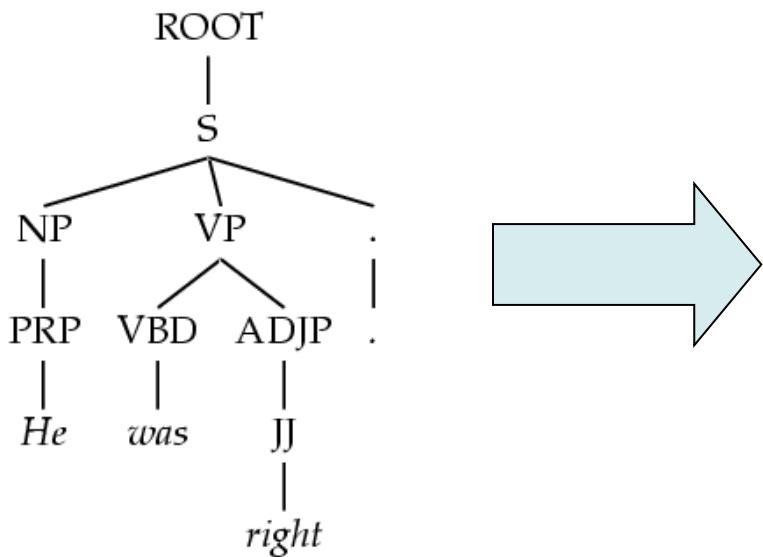


Hershey bars protest



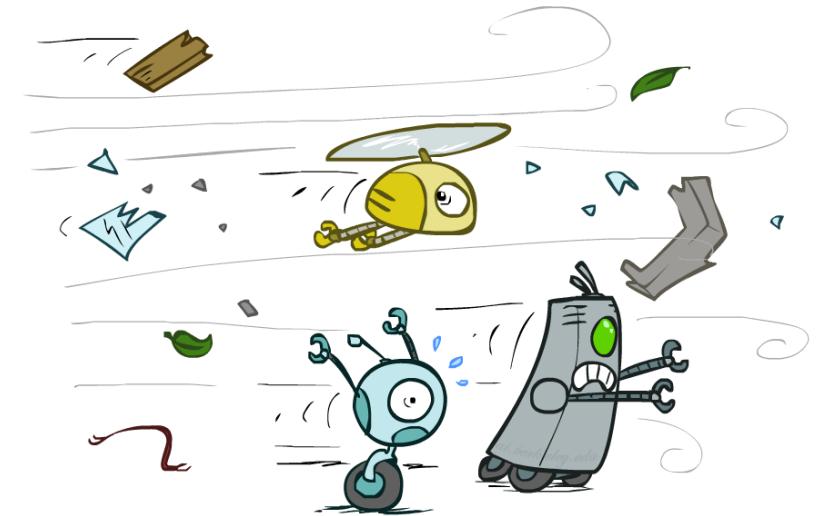
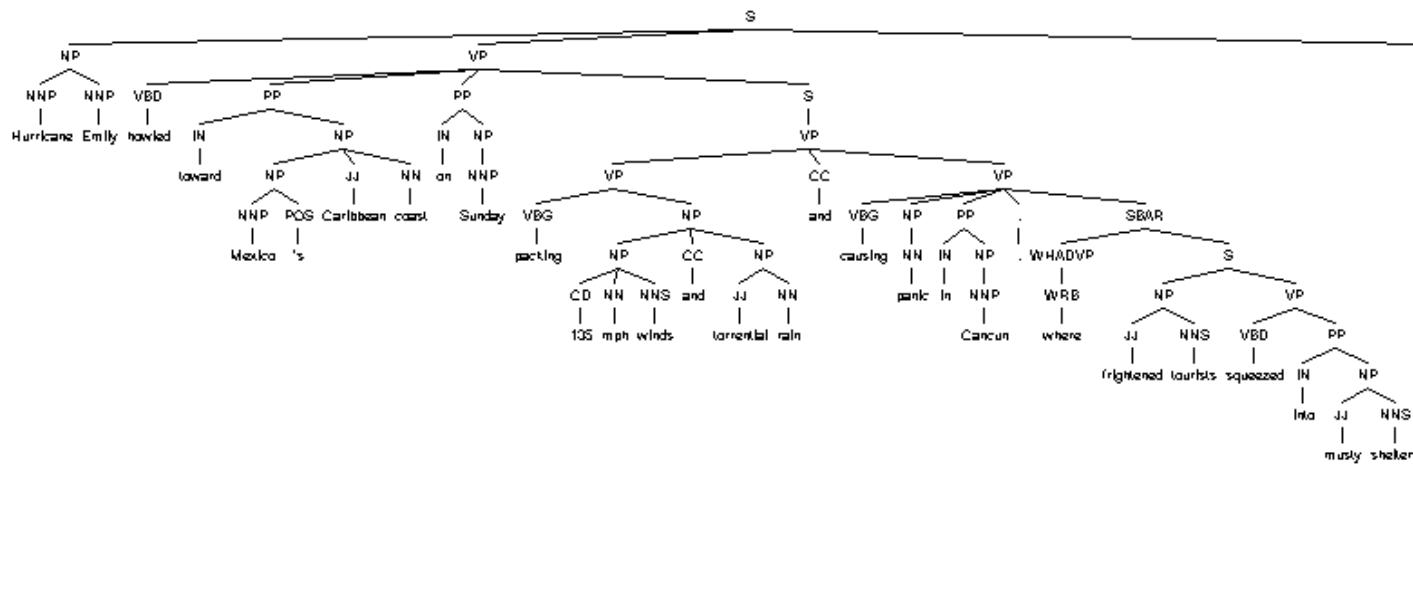
Grammar: PCFGs

- Natural language grammars are very ambiguous!
- PCFGs are a formal probabilistic model of trees
 - Each “rule” has a conditional probability (like an HMM)
 - Tree’s probability is the product of all rules used
- Parsing: Given a sentence, find the best tree – search!



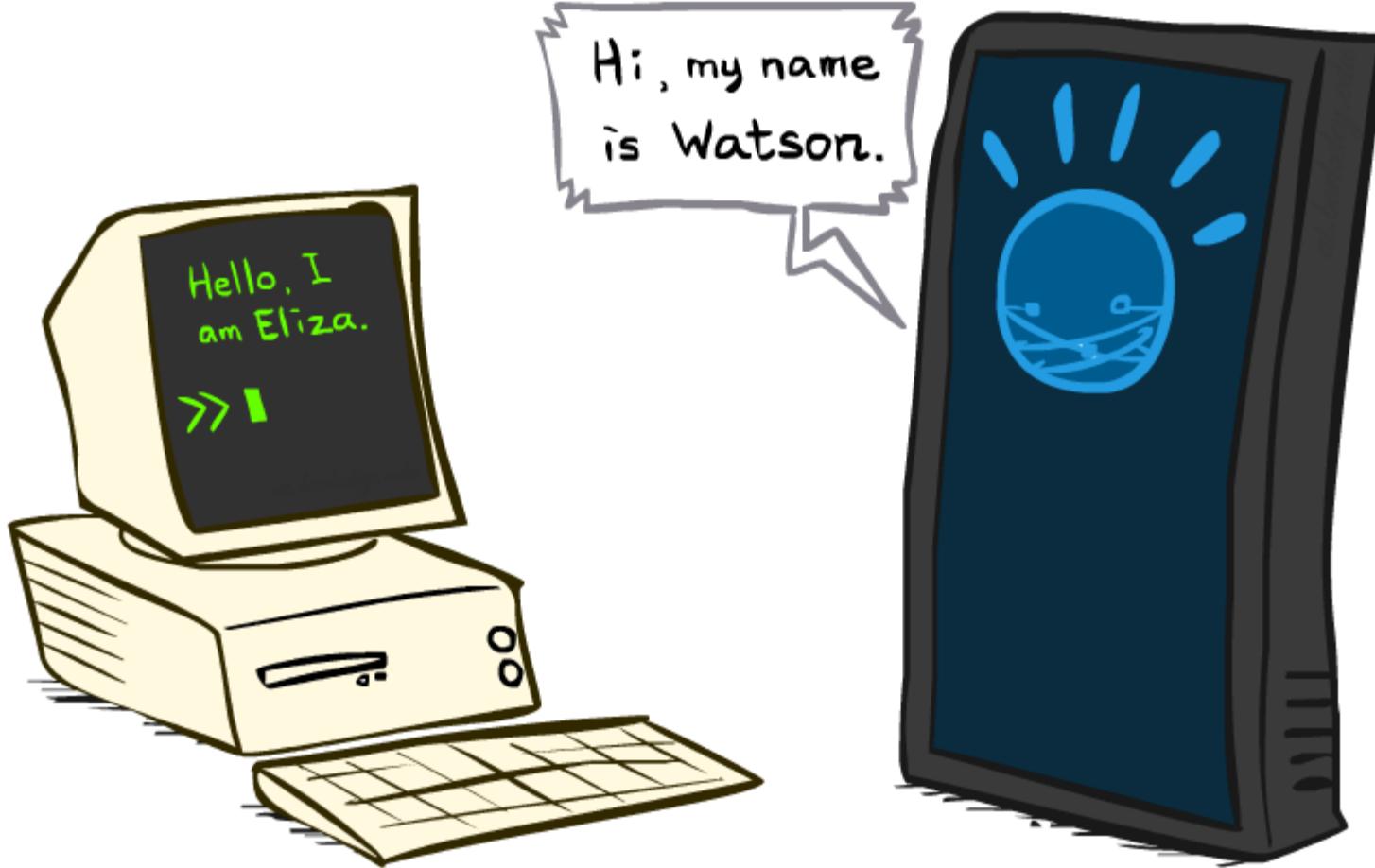
$\text{ROOT} \rightarrow \text{S}$	375/420
$\text{S} \rightarrow \text{NP VP .}$	320/392
$\text{NP} \rightarrow \text{PRP}$	127/539
$\text{VP} \rightarrow \text{VBD ADJP}$	32/401
.....	

Syntactic Analysis



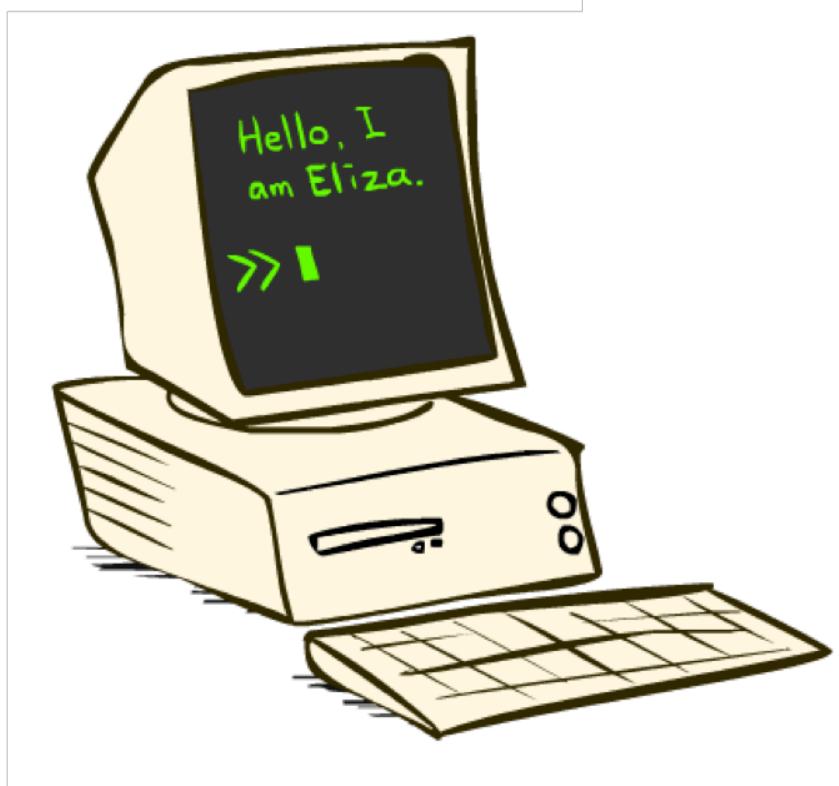
Hurricane Emily howled toward Mexico 's Caribbean coast on Sunday packing 135 mph winds and torrential rain and causing panic in Cancun, where frightened tourists squeezed into musty shelters.

Dialog Systems



ELIZA

- A “psychotherapist” agent (Weizenbaum, ~1964)
- Led to a long line of chatterbots
- How does it work:
 - Trivial NLP: string match and substitution
 - Trivial knowledge: tiny script / response database
 - Example: matching “I remember __” results in “Do you often think of __”?
- Can fool some people some of the time?



What's in Watson?

- A question-answering system (IBM, 2011)
- Designed for the game of Jeopardy
- How does it work:
 - Sophisticated NLP: deep analysis of questions, noisy matching of questions to potential answers
 - Lots of data: onboard storage contains a huge collection of documents (e.g. Wikipedia, etc.), exploits redundancy
 - Lots of computation: 90+ servers
- Can beat all of the people all of the time?



Amazon Alexa Prize



Machine Translation

"Il est impossible aux journalistes de rentrer dans les régions tibétaines"

Bruno Philip, correspondant du "Monde" en Chine, estime que les journalistes de l'AFP qui ont été expulsés de la province tibétaine du Qinghai "n'étaient pas dans l'illégalité".

Les faits Le dalaï-lama dénonce l'"enfer" imposé au Tibet depuis sa fuite, en 1959

Vidéo Anniversaire de la rébellion tibétaine : la Chine sur ses gardes



"It is impossible for journalists to enter Tibetan areas"

Philip Bruno, correspondent for "World" in China, said that journalists of the AFP who have been deported from the Tibetan province of Qinghai "were not illegal."

Facts The Dalai Lama denounces the "hell" imposed since he fled Tibet in 1959

Video Anniversary of the Tibetan rebellion: China on guard



- Translate text from one language to another
- Recombines fragments of example translations
- Challenges:
 - What fragments? [learning to translate]
 - How to make efficient? [fast translation search]

The Problem with Dictionary Lookups

顶部 /**top**/roof/

顶端 /summit/peak/**top**/apex/

顶头 /coming directly towards one/**top**/end/

盖 /lid/**top**/cover/canopy/build/Gai/

盖帽 /surpass/**top**/

极 /extremely/pole/utmost/**top**/collect/receive/

尖峰 /peak/**top**/

面 /fade/side/surface/aspect/**top**/face/flour/

摘心 /**top**/topping/

MT: 60+ of History



Warren Weaver

When I look at an article in Russian, I say: "This is really written in English, but it has been coded in some strange symbols. I will now proceed to decode."



John Pierce

"Machine Translation" presumably means going by algorithm from machine-readable source text to useful target text... In this context, there has been no machine translation...

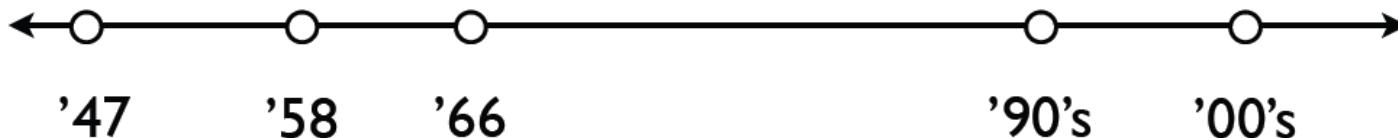
MT is the “first” non-numeral compute task

ALPAC report deems MT bad

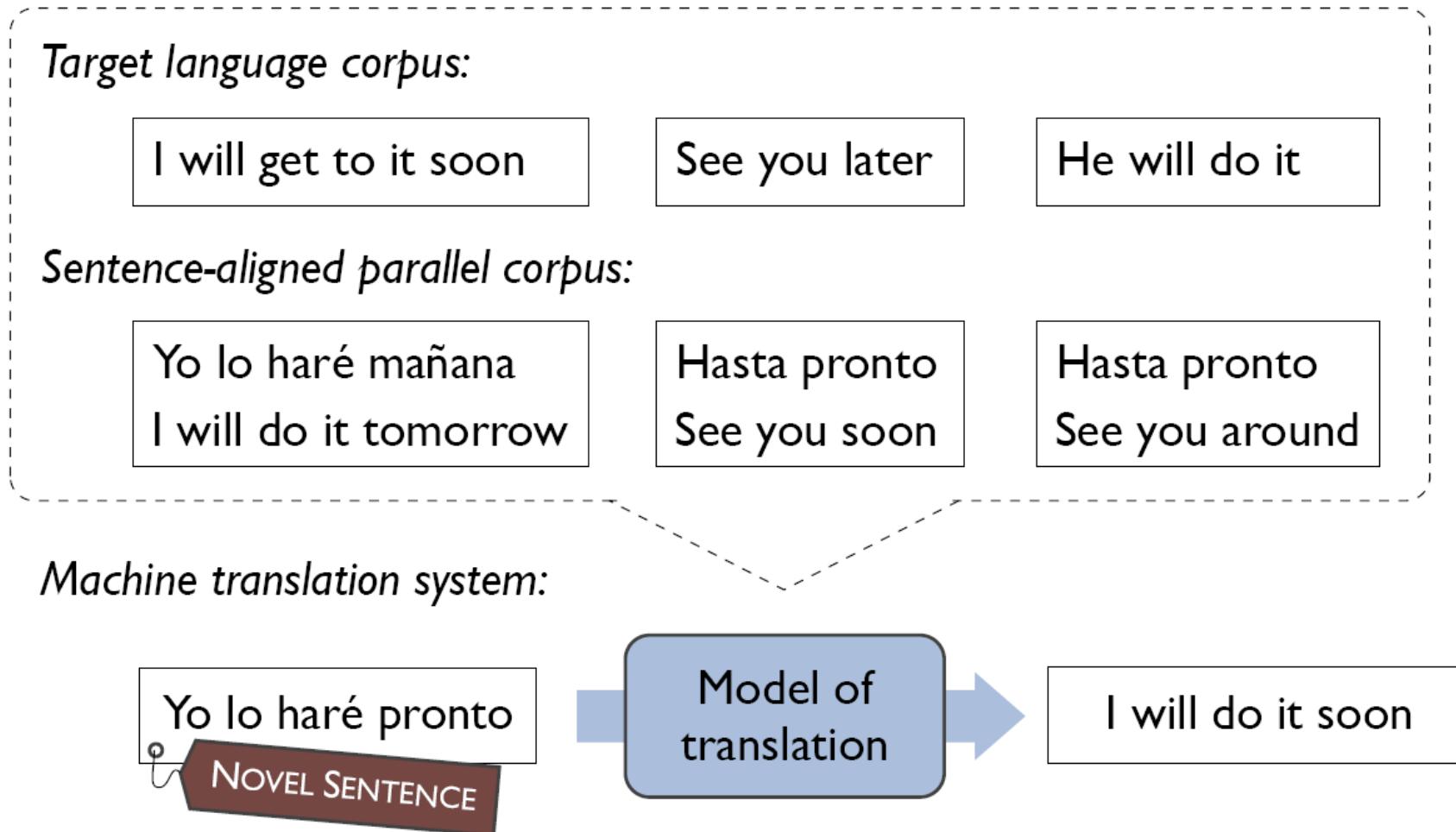
Statistical data-driven approach introduced

Statistical MT thrives

Neural MT



Data-Driven Machine Translation

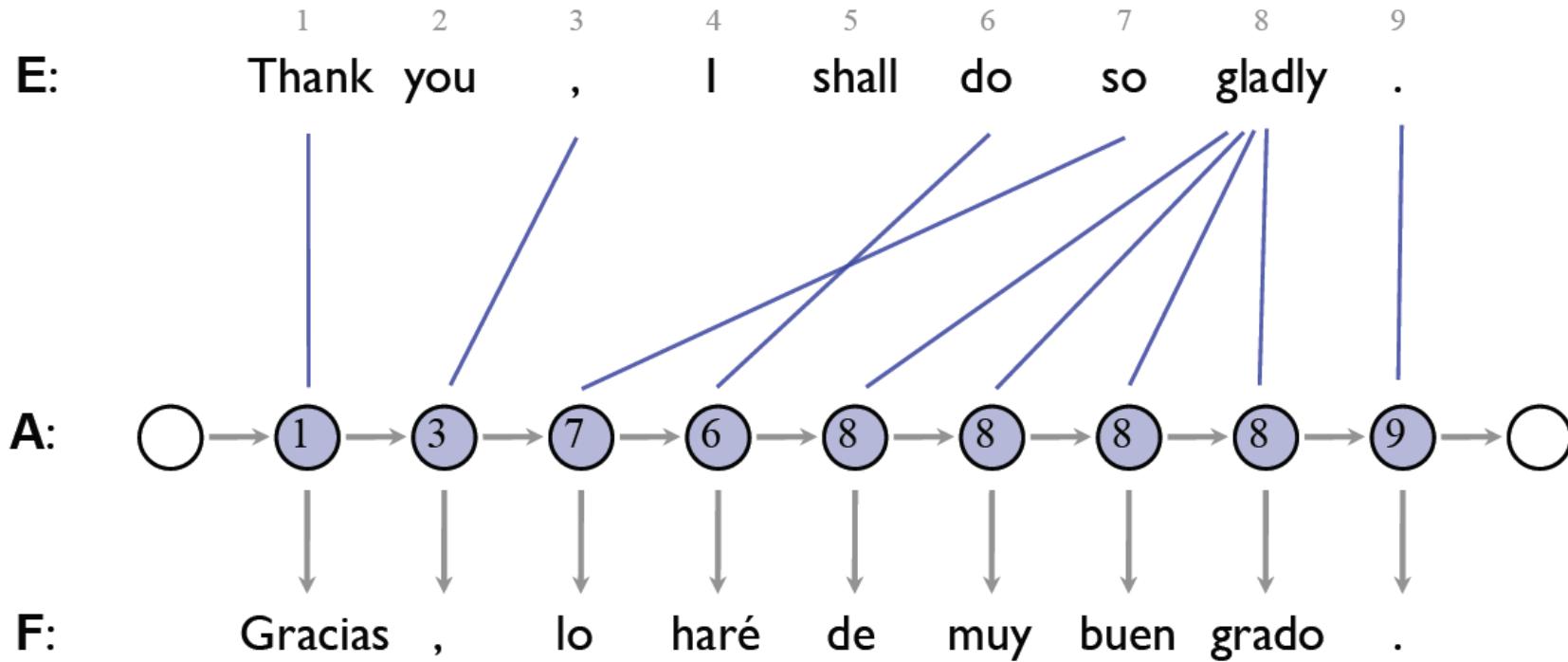


Learning to Translate

		CLASSIC SOUPS	Sm.	Lg.
清 燉 雞 湯	57.	House Chicken Soup (Chicken, Celery, Potato, Onion, Carrot)	1.50	2.75
雞 飯 湯	58.	Chicken Rice Soup	1.85	3.25
雞 麵 湯	59.	Chicken Noodle Soup	1.85	3.25
廣 東 雲 吞	60.	Cantonese Wonton Soup.....	1.50	2.75
蕃 茄 蛋 湯	61.	Tomato Clear Egg Drop Soup	1.65	2.95
雲 吞 湯	62.	Regular Wonton Soup	1.10	2.10
酸 辣 湯	63.	Hot & Sour Soup	1.10	2.10
蛋 花 湯	64.	Egg Drop Soup.....	1.10	2.10
雲 蛋 湯	65.	Egg Drop Wonton Mix.....	1.10	2.10
豆 腐 菜 湯	66.	Tofu Vegetable Soup	NA	3.50
雞 玉 米 湯	67.	Chicken Corn Cream Soup	NA	3.50
蟹 肉 玉 米 湯	68.	Crab Meat Corn Cream Soup.....	NA	3.50
海 鮮 湯	69.	Seafood Soup.....	NA	3.50

Example from Adam Lopez

An HMM Translation Model

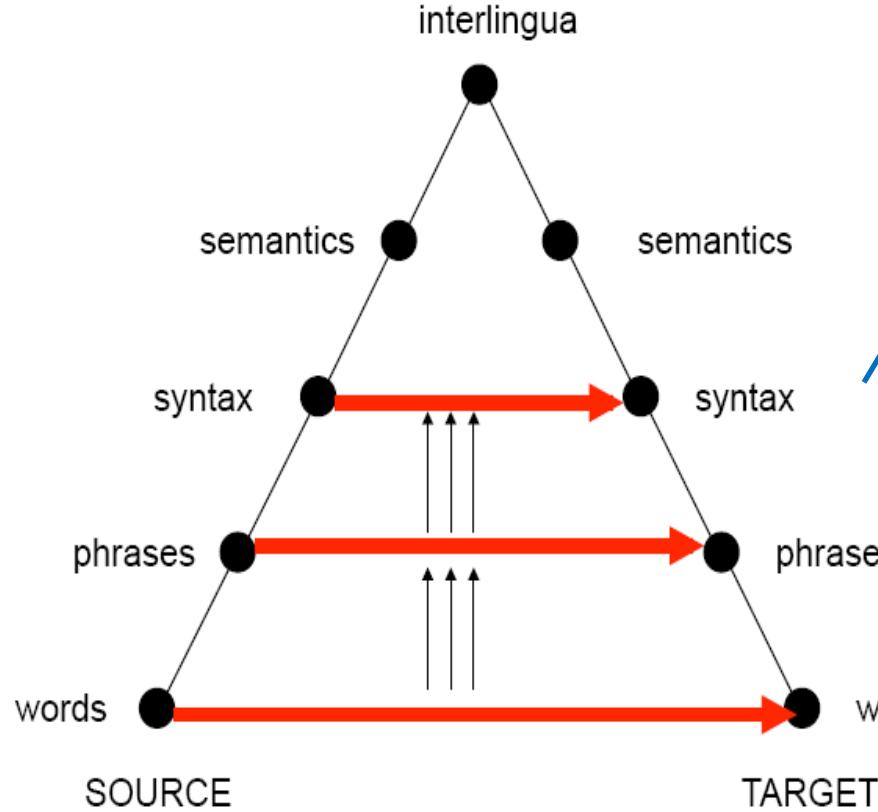


Model Parameters

Emissions: $P(F_1 = \text{Gracias} | E_{A1} = \text{Thank})$

Transitions: $P(A_2 = 3 | A_1 = 1)$

Levels of Transfer



Yo lo haré mañana
I will do it tomorrow

Yo lo haré mañana
I will do it tomorrow

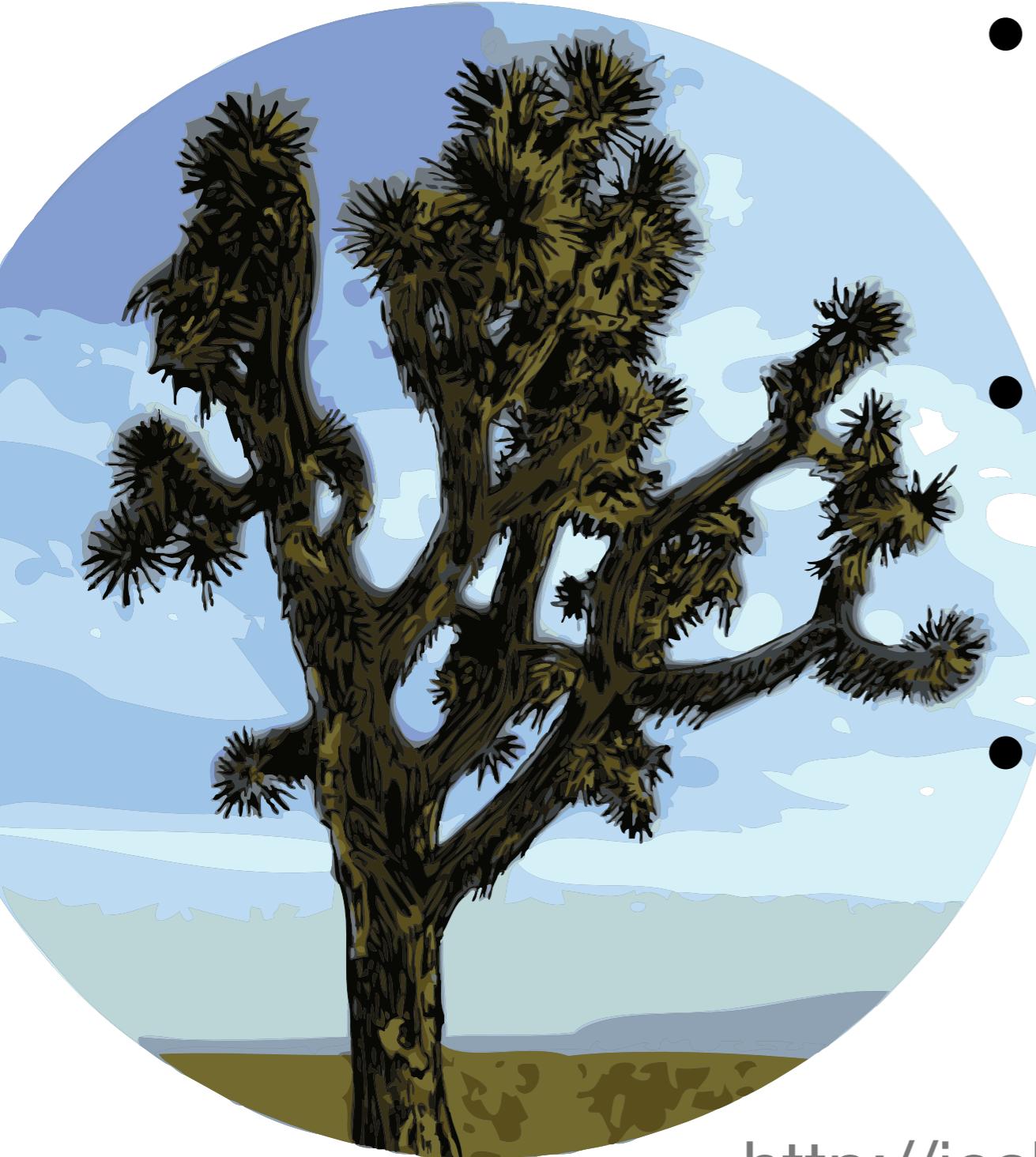
Yo lo haré mañana
I will do it tomorrow

$$P(\text{MD VP} \mid \text{will do it}, \text{NP VP} \mid \text{lo haré NP}) = 0.8$$

English (E)	$P(E \mid \text{lo haré})$
will do it	0.8
will do so	0.2

English (E)	$P(E \mid \text{mañana})$
tomorrow	0.7
morning	0.3

Syntactic MT in the Joshua Decoder



- Synchronous context free grammars generate pairs of corresponding strings
- Can be used to describe translation and re-ordering between languages
- Because Joshua uses SCFGs, it translates sentences by parsing them

Translation

	Urdu	English
S →	NP① VP②	NP① VP②
VP →	PP① VP②	VP② PP①
VP →	V① AUX②	AUX② V①
PP →	NP① P②	P② NP①
NP →	<i>hamd ansary</i>	<i>Hamid Ansari</i>
NP →	<i>na}b sdr</i>	<i>Vice President</i>
V →	<i>namzd</i>	<i>nominated</i>
P →	<i>kylye</i>	<i>for</i>
AUX →	<i>taa</i>	<i>was</i>

NP1
hamd ansary

NP2
na}b sdr

P3
kylye

V4
namzd

AUX5
taa

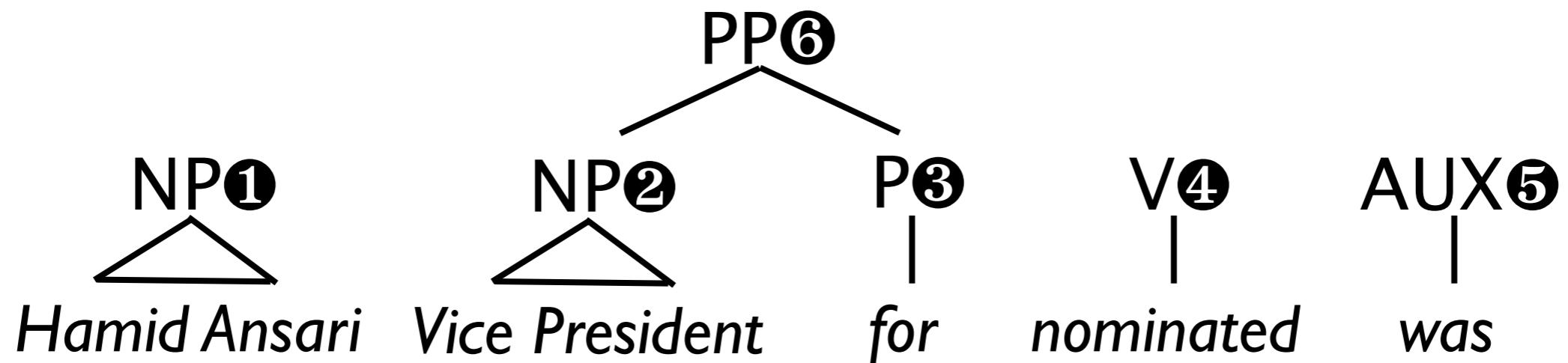
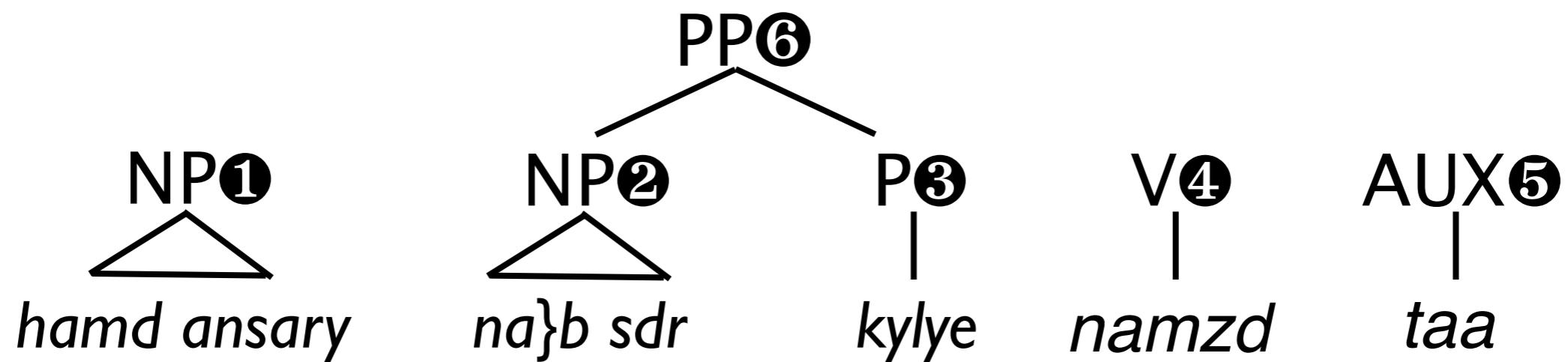
NP1
Hamid Ansari

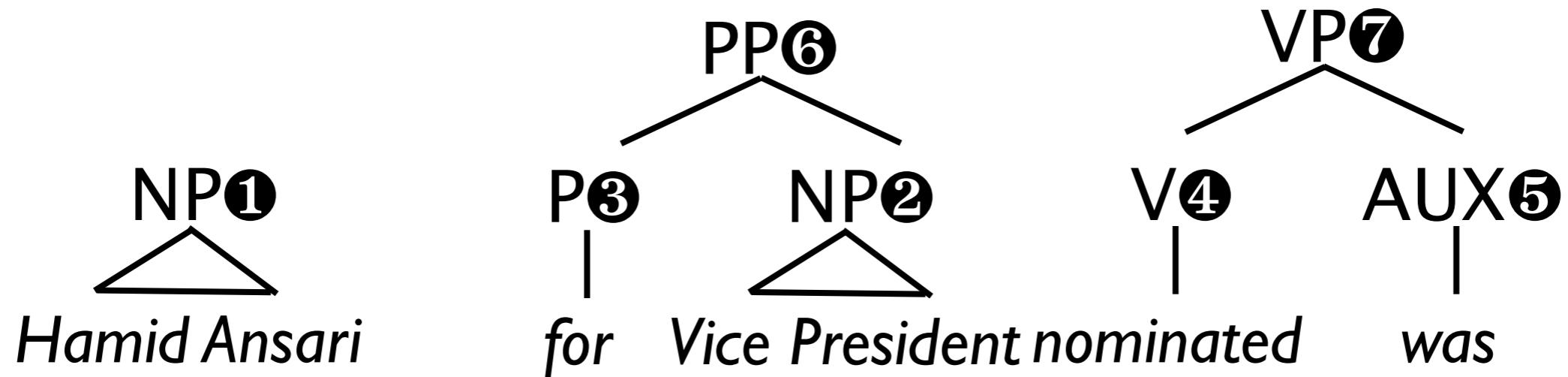
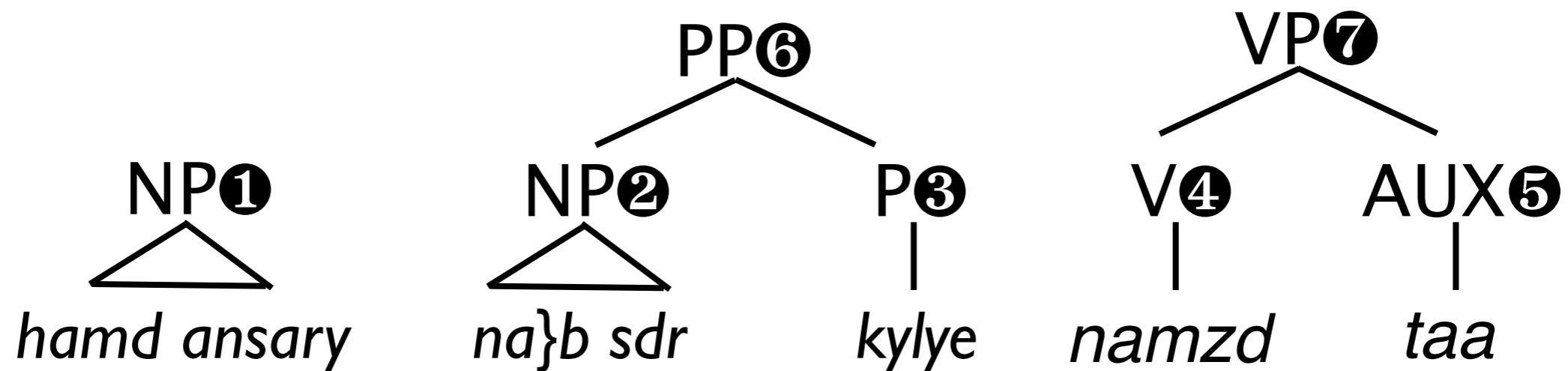
NP2
Vice President

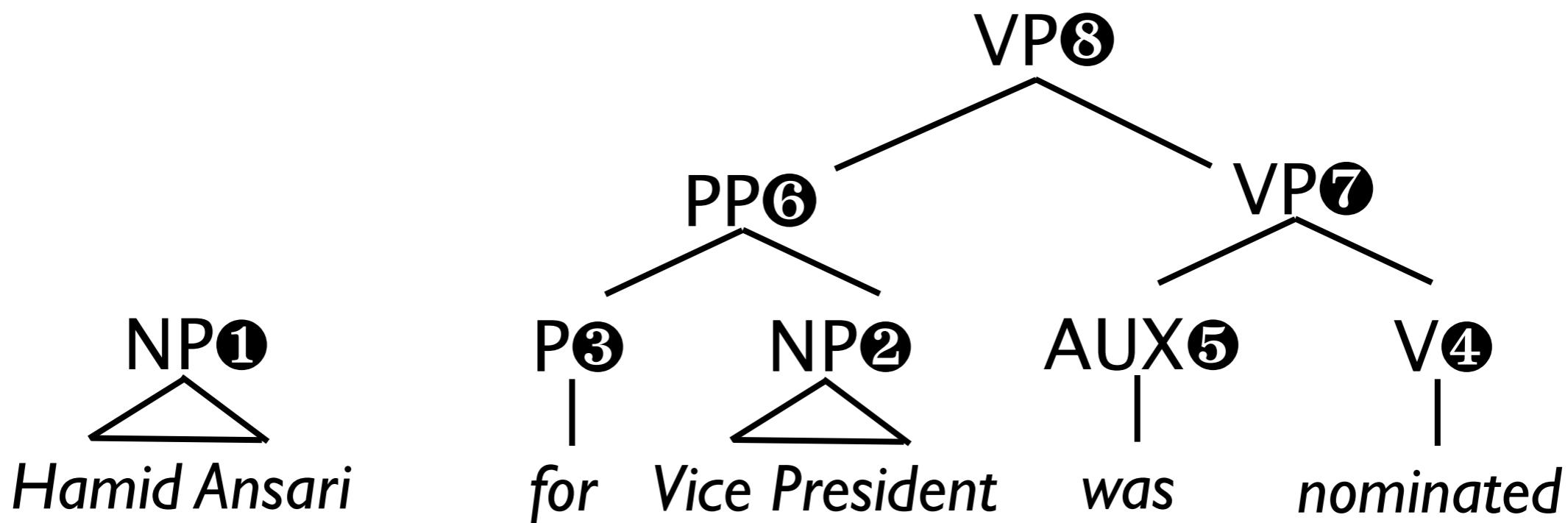
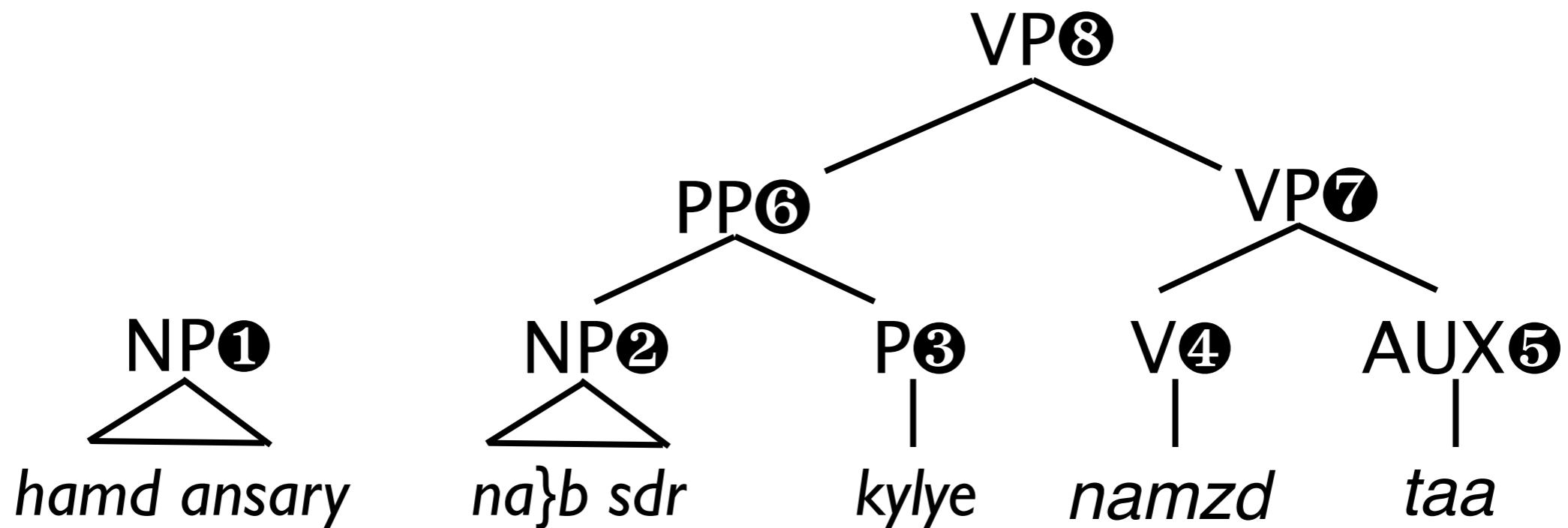
P3
for

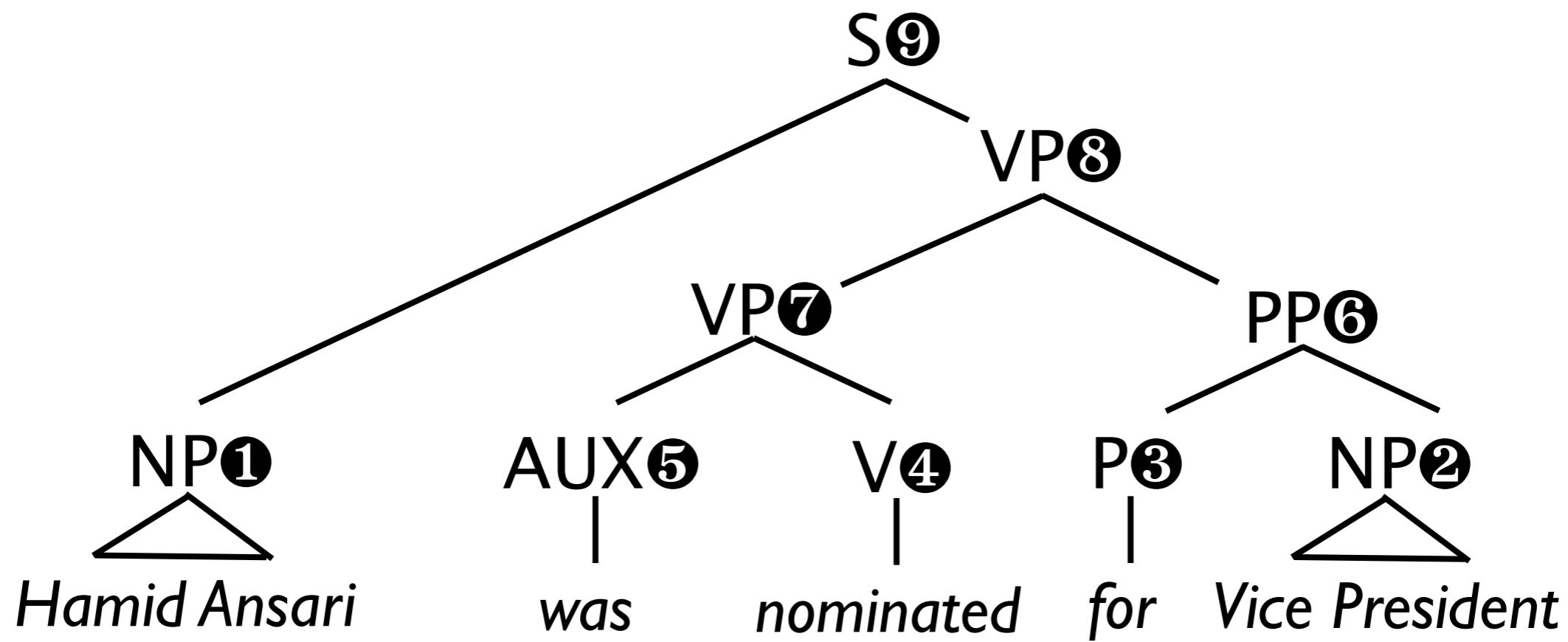
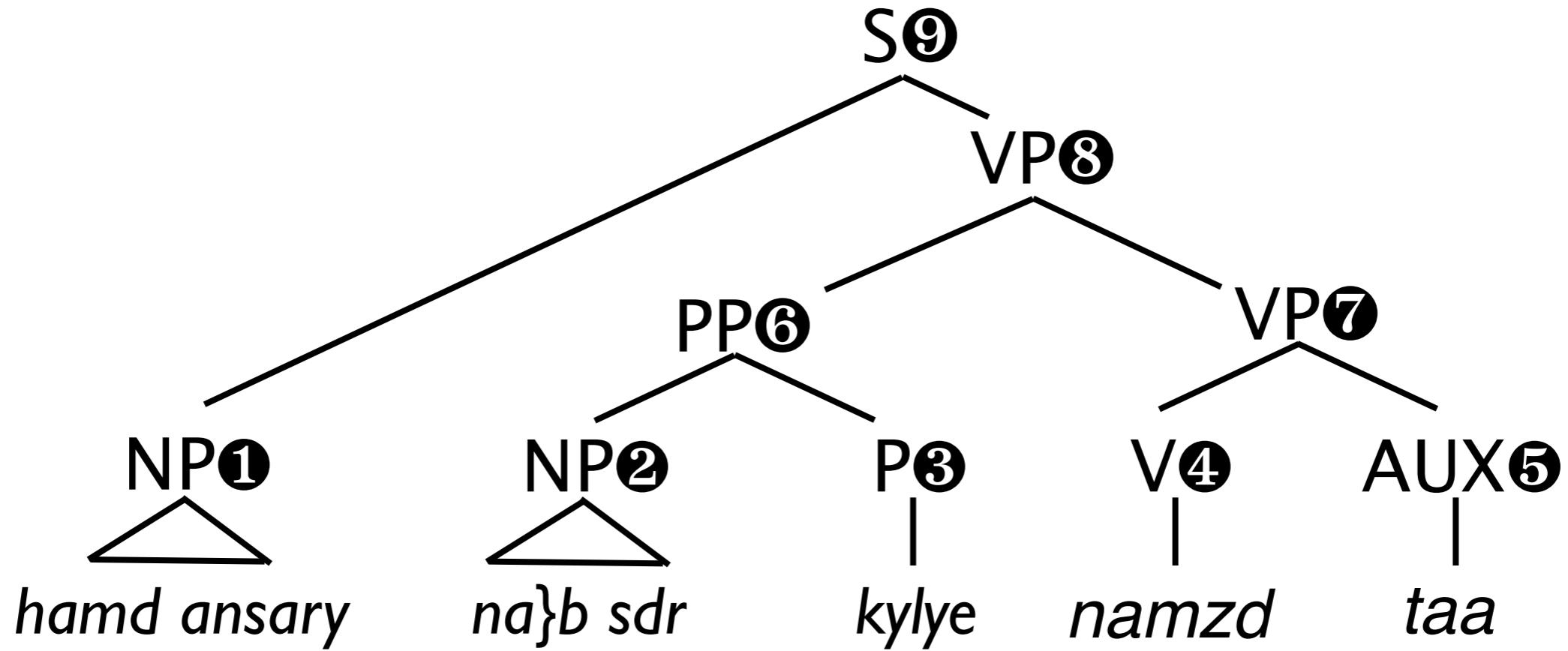
V4
nominated

AUX5
was









Paraphrases

Differing textual expressions of the same meaning:

cup \leftrightarrow mug

the king's speech \leftrightarrow His Majesty's address

X_1 devours X_2 \leftrightarrow X_2 is eaten by X_1

one JJ instance of NP \leftrightarrow a JJ case of NP

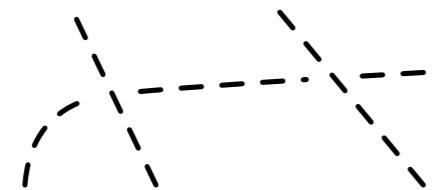
Paraphrasing in NLU

Recognition or generation of paraphrases plays a part in...

...information extraction, question answering, entailment recognition, summarization, translation, compression, simplification, automatic evaluation of translation or summaries, natural language generation, etc.

Bilingual Pivoting

... 5 farmers were



... fünf Landwirte

... oder wurden



... or have been

thrown into jail

festgenommen

festgenommen

imprisoned

in Ireland ...

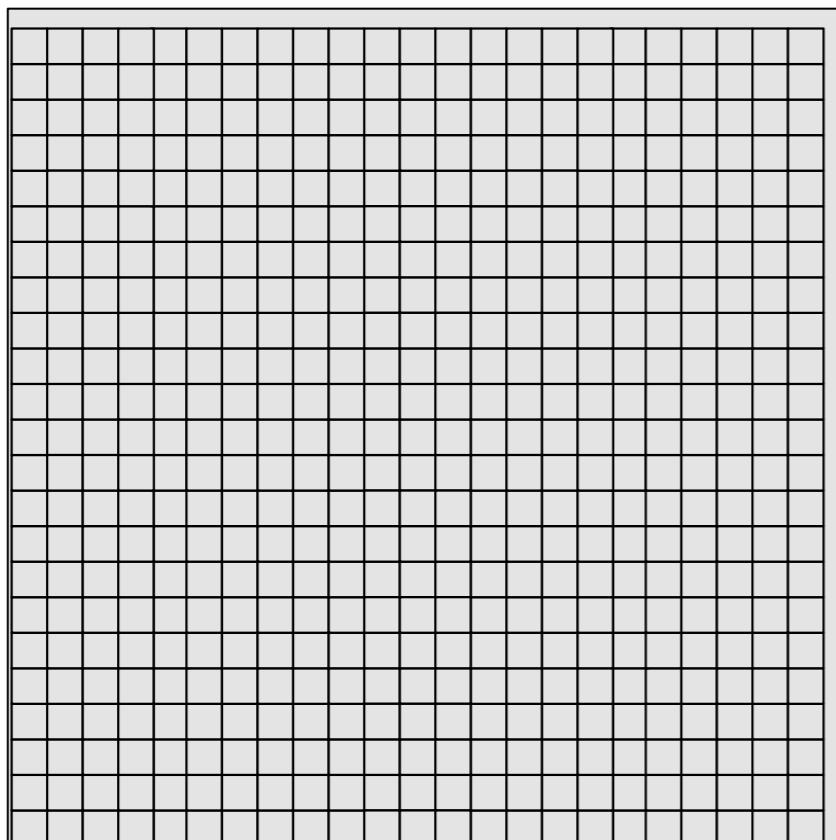
, weil ...

, gefoltert ...

, tortured ...

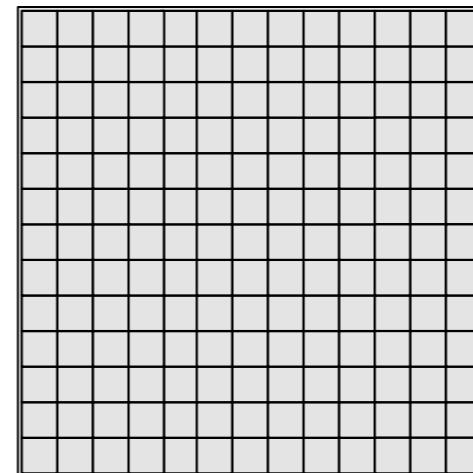
Large, diverse sets of bilingual training data

1000M



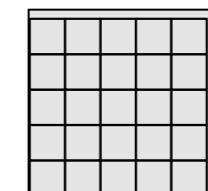
French-English
 10^9 word webcrawl

2 languages @
250M each



DARPA
GALE Program

21 languages @
50-80M each



European
Parliament

Wide range of paraphrases

thrown into jail

arrested

be thrown in prison

arrest

detained

been thrown into jail

cases

imprisoned

being arrested

custody

incarcerated

in jail

maltreated

jailed

in prison

owners

locked up

put in prison for

protection

taken into custody

were thrown into jail

thrown

thrown into prison who are held in detention

SCFGs via Pivoting

- Adapting our syntactic MT models, we learn structural transformations, like the English possessive rule

$$\begin{array}{l} \text{NP} \rightarrow \quad \text{NP}'s \text{ NN} \quad | \quad \text{le NN de NP} \\ \\ \text{NP} \rightarrow \quad \text{the NN of NP} \quad | \quad \text{le NN de NP} \end{array}$$

combine to

$$\text{NP} \rightarrow \quad \text{NP}'s \text{ NN} \quad | \quad \text{the NN of NP}$$

Possessive rule	NP → NP →	the NN of the NNP the NNP's NN the NNS ₁ made by the NNS ₂ the NNS ₂ 's NNS ₁
Dative shift	VP → VP →	give NN to NP give NP the NN provide NP ₁ to NP ₂ give NP ₂ NP ₁
Adv. adj. phrase move	S VP → S →	ADVP they VBD they VBD ADVP it is ADJP VP VP is ADJP
Verb particle shift	VP →	VB NP up VB up NP
Reduced relative clause	SBAR S ADJP →	although PRP VBD that although PRP VBD very JJ that S JJ S
Partitive constructions	NP → NP →	CD of the NN CD NN all DT\NP all of the DT\NP
Topicalization	S →	NP, VP. VP, NP.
Passivization	SBAR →	that NP had VBN which was VBN by NP
Light verbs	VP → VP →	take action ADVP to act ADVP to make a decision PP to decide PP

Text-to-Text Generation

T2T involves generating meaning-equivalent text that is *subject to some constraints*:

sentence compression, *shorter*

simplification, *easier to understand*

poetry from prose, *rhyme and meter*

Sentence Compression

Reduce length of a sentence (#chars) while retaining the meaning

Compression ratio: $\varphi = \frac{\text{length}_{compression}}{\text{length}_{original}}$

Paraphrasing as a task and problem is of paramount importance to a multitude of applications in the field of NLP.

Sentence Compression

Reduce length of a sentence (#chars) while retaining the meaning

$$\text{Compression ratio: } \varphi = \frac{\text{length}_{\text{compression}}}{\text{length}_{\text{original}}}$$

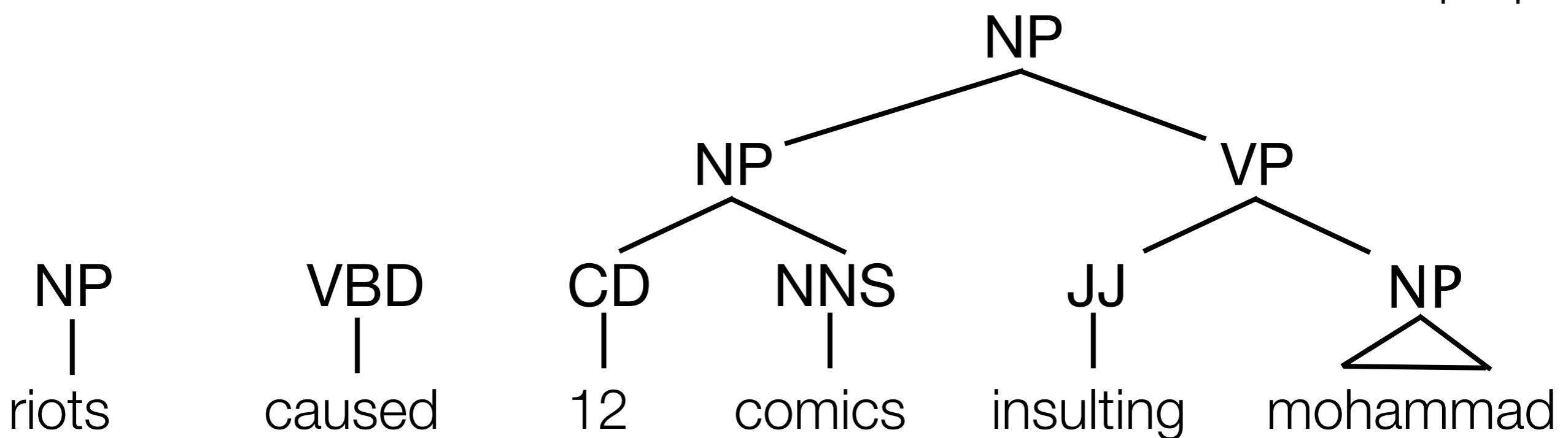
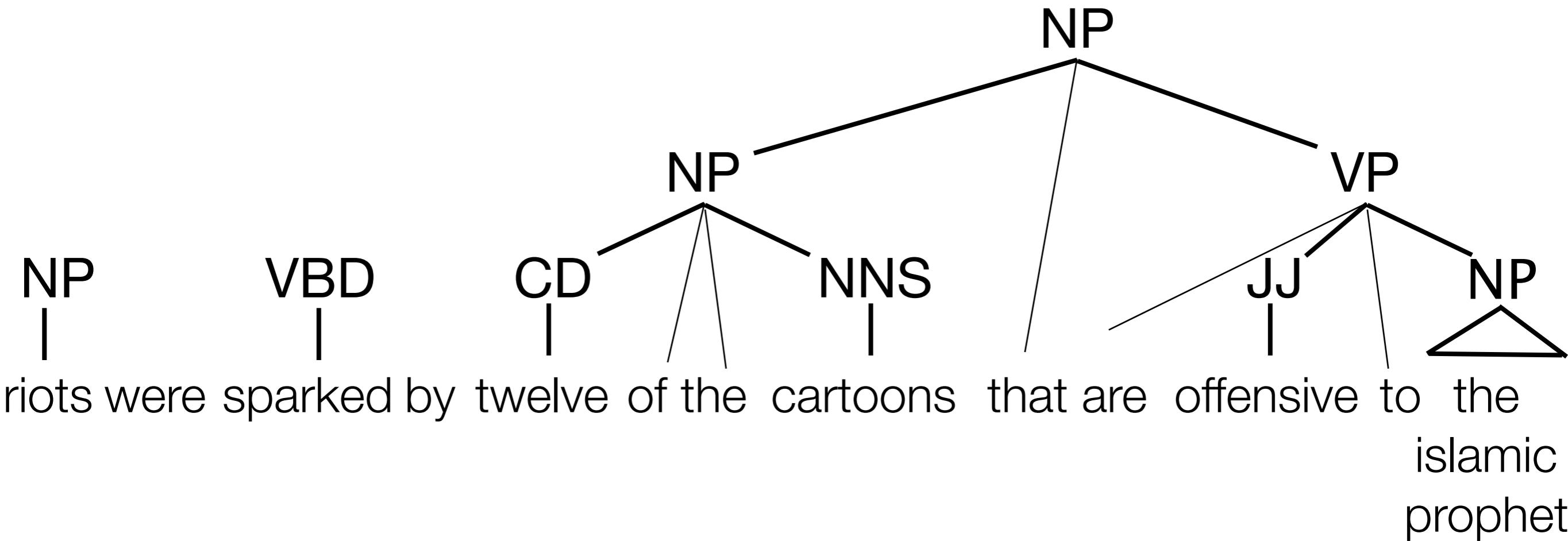
~~Paraphrasing as a task and problem is of paramount importance to a multitude of applications in the field of NLP.~~
is awesome

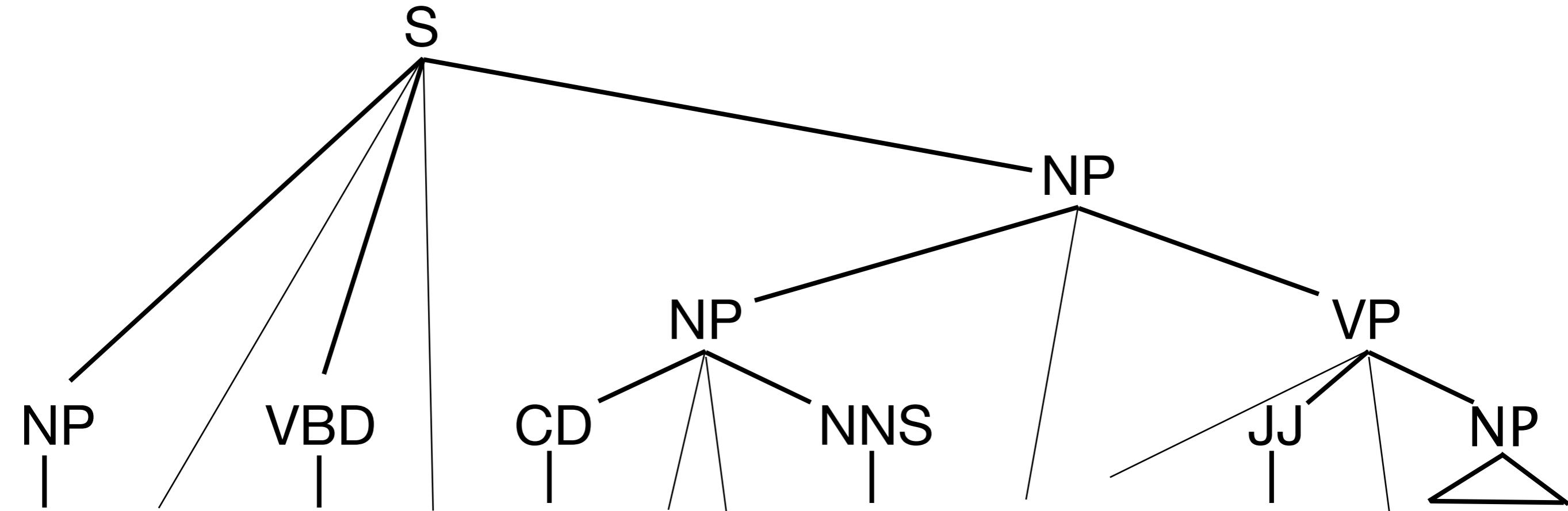
Paraphrase Grammar

	English	English
$S \rightarrow NP① \text{ were VBD by } NP②$	$NP② \text{ VBD } NP①$	
$NP \rightarrow NP \text{ that VP}$		$NP \text{ VP}$
$VP \rightarrow \text{ are JJ to NP}$		$JJ \text{ NP}$
$NP \rightarrow CD \text{ of the NNS}$		$CD \text{ NNS}$
$CD \rightarrow \text{ twelve}$		12
$NNS \rightarrow \text{ cartoons}$		comics
$JJ \rightarrow \text{ offensive}$		insulting
$NP \rightarrow \text{ the islamic prophet}$		mohammed
$VBD \rightarrow \text{ sparked}$		caused

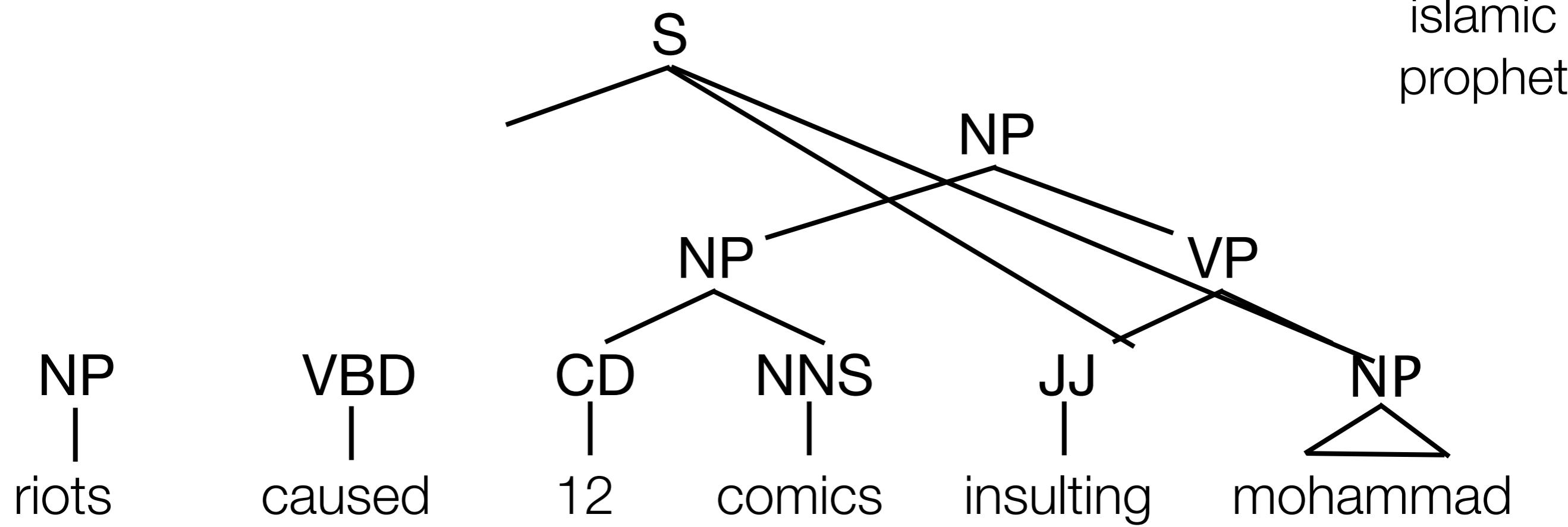
NP VBD CD NNS JJ NP
| | | | | |
riots were sparked by twelve of the cartoons that are offensive to the
islamic prophet

NP VBD CD NNS JJ NP
| | | | | |
riots caused 12 comics insulting mohammad

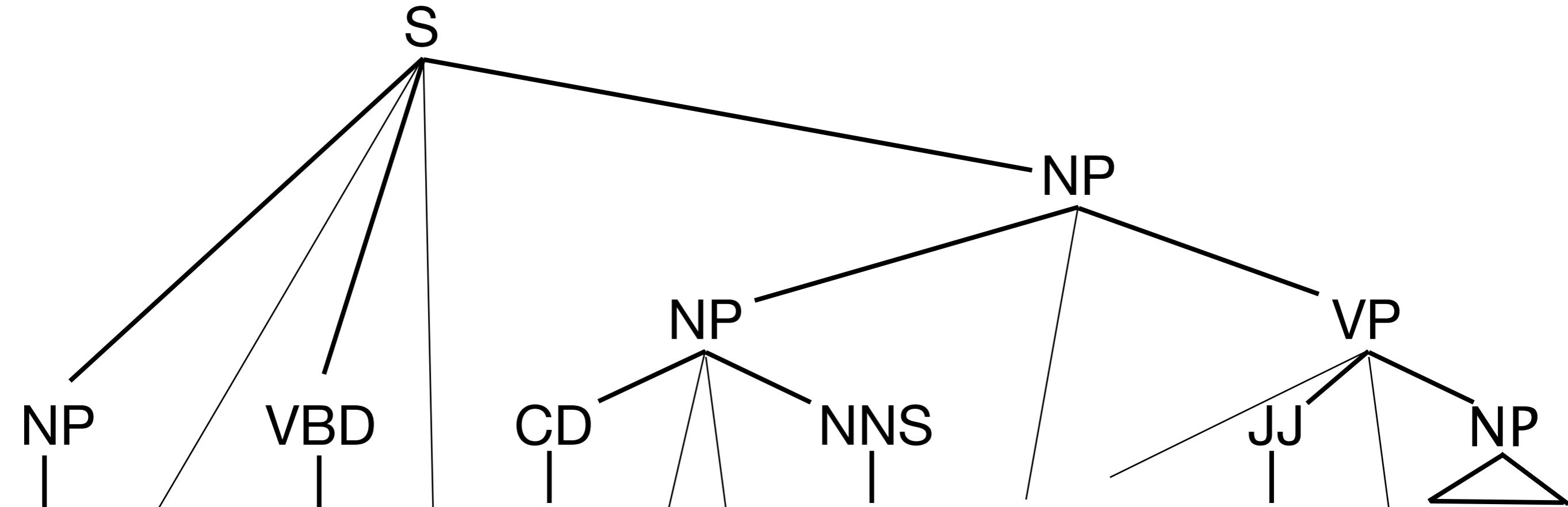




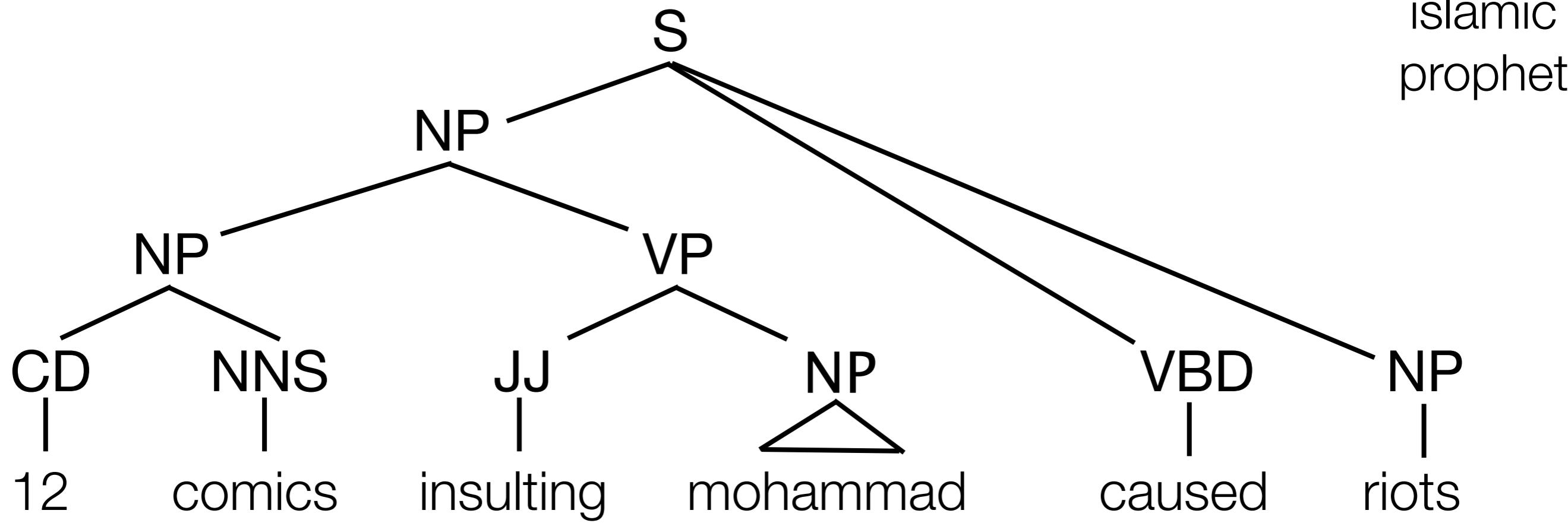
riots were sparked by twelve of the cartoons that are offensive to the
islamic prophet



riots caused 12 comics insulting mohammad



riots were sparked by twelve of the cartoons that are offensive to the
islamic prophet



12 comics insulting mohammad caused riots

Joshua Decoder



- An open source decoder that synchronous context free grammars to translate
- Implements all algorithms needed for translating with SCFGs
- Now available: "Language Packs" for T2T generation

<http://joshua-decoder.org>

PPDB: The Paraphrase Database

- A huge collection of paraphrases
- Extracted from 106 million sentence pairs,
2 billion English words, 22 pivot languages

	Paraphrases
Lexical	7.6 M
Phrasal	68.4 M
Syntactic	93.6 M
Total	169.6 M



huge amount

English ▾

Go



Download PPDB

Result for **huge amount**

129 search results

1

enormous amount

Noun phrase missing determiner on the left



0



0

2

tremendous amount

Noun phrase missing determiner on the left



0



0

3

huge sum

Noun phrase missing determiner on the left



0



0

4

enormous number

Noun phrase missing determiner on the left



0



0

5

huge number

Noun phrase missing determiner on the left



0



0

6

awful lot

Noun phrase missing determiner on the left



0



0

7

massive amount

0



PPDB

paraphrase.org/#/download

Reader

Cloud

Download PPDB

Search here...

English ▾

Go

Paraphrase.org

Language

English ▾

Options

All

Lexical

One-To-Many

Phrasal

Syntactic

Select size of pack

S Size

M Size

L Size

XL Size

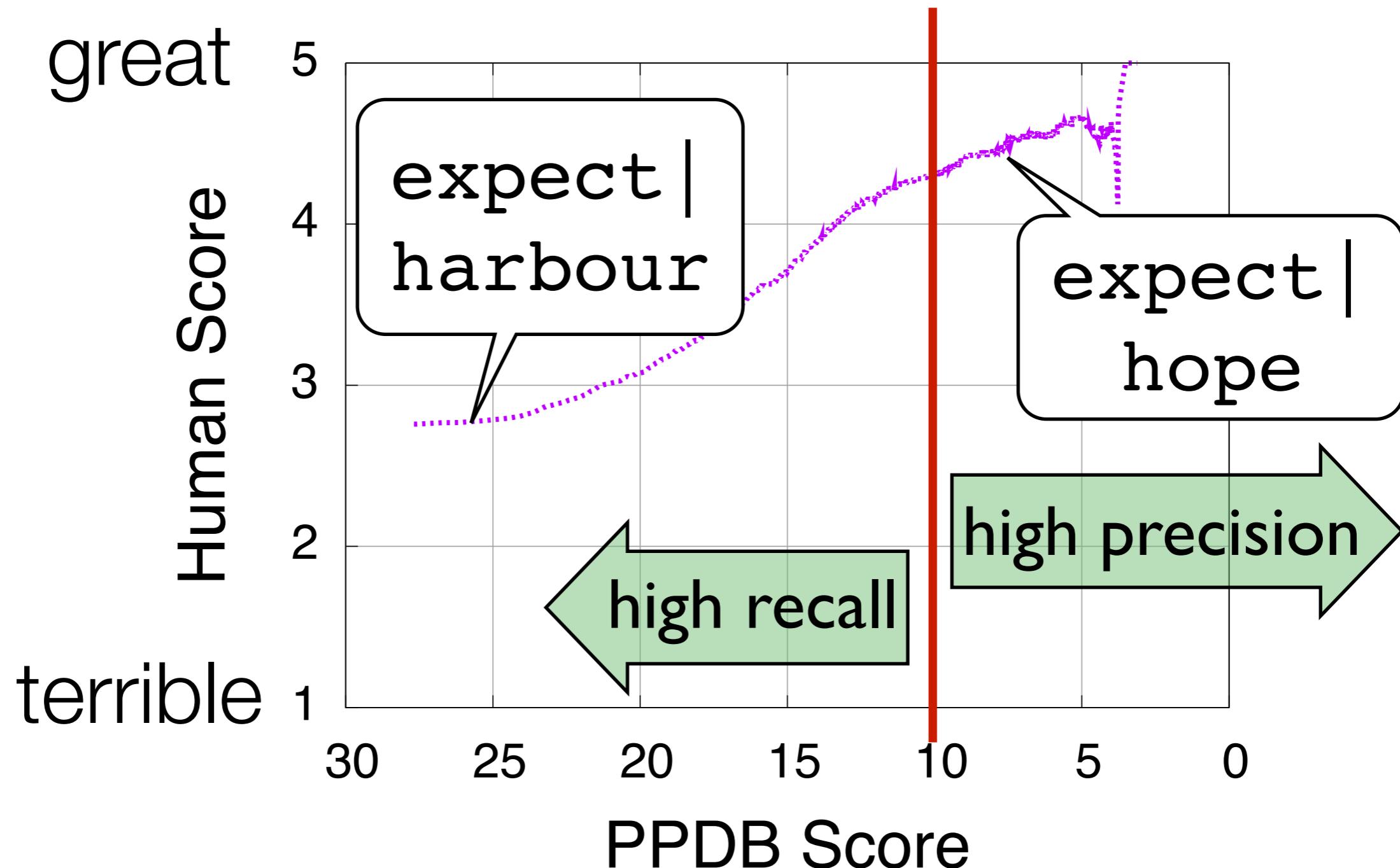
XXL Size

XXXL Size

💡

The screenshot shows a web browser window with the title "PPDB" at the top. The address bar contains the URL "paraphrase.org/#/download". To the right of the address bar are several icons: a refresh button, a plus sign, a cloud icon, a clock icon, and a key icon. Below the address bar is the Paraphrase.org logo, which consists of a blue cube with a white "P" and a speech bubble icon. To the right of the logo is a search bar with the placeholder text "Search here...". Next to the search bar is a dropdown menu set to "English" with a downward arrow. To the right of the dropdown is a blue "Go" button with a magnifying glass icon. Further to the right is a "Download PPDB" button with a blue hexagon icon and the text "Download PPDB". Below these controls are three horizontal sections: "Language" (with a dropdown set to "English"), "Options" (with five buttons: "All", "Lexical", "One-To-Many", "Phrasal", and "Syntactic"), and "Select size of pack" (with six options: "S Size", "M Size", "L Size", "XL Size", "XXL Size", and "XXXL Size"). Each size option is accompanied by a small blue 3D cube icon. In the bottom right corner of the page area, there is a green lightbulb icon with a white question mark inside it.

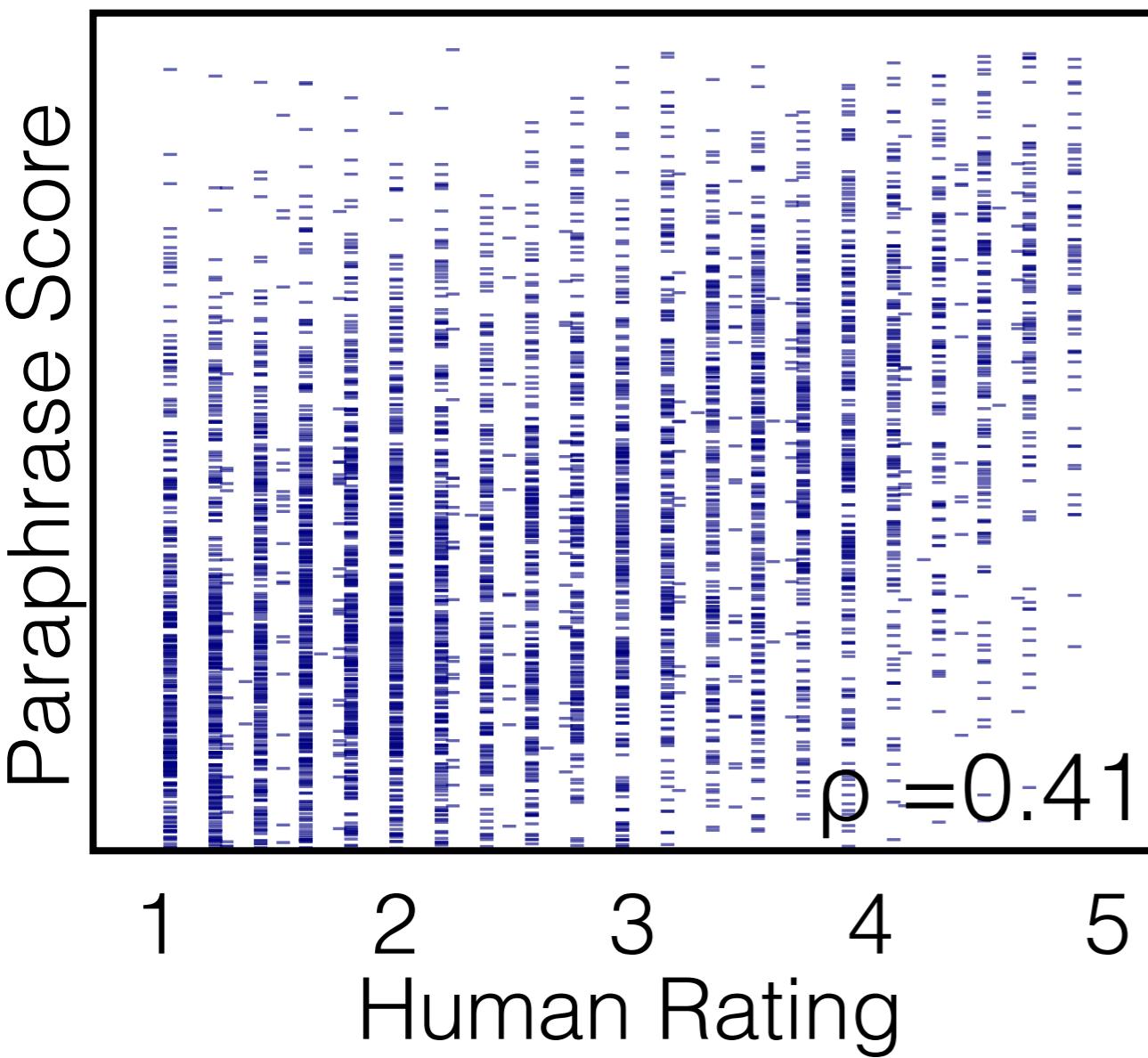
Do the Scores Work?



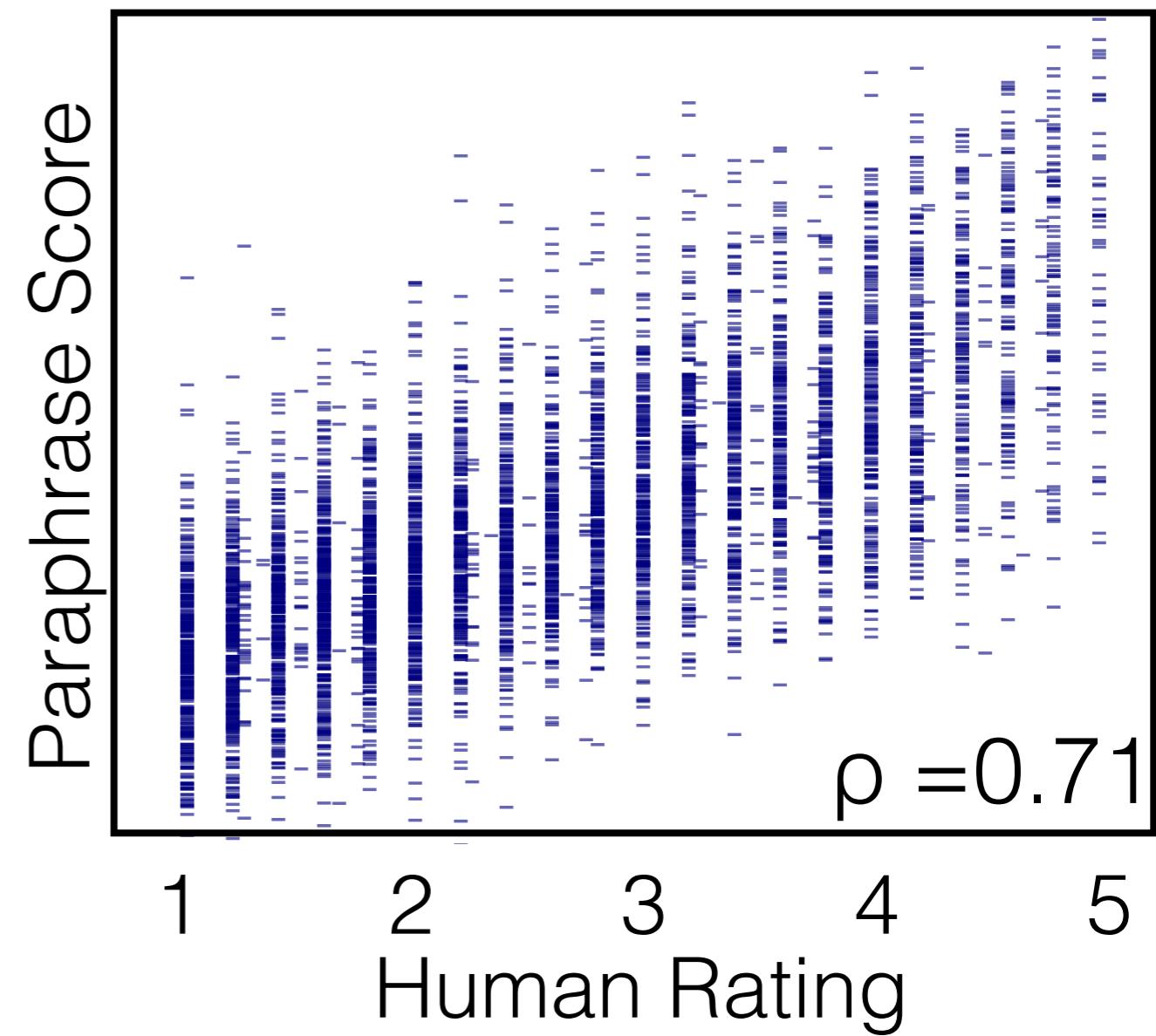
PPDB 2.0

Re-ranked paraphrases better correlate with human judgments

PPDB 1.0



PPDB 2.0



PPDB 2.0: Better paraphrase ranking, fine-grained entailment relations, word embeddings, and style classification. Ellie Pavlick, Pushpendre Rastogi, Juri Ganitkevich, Ben Van Durme, Chris Callison-Burch. ACL-2015.

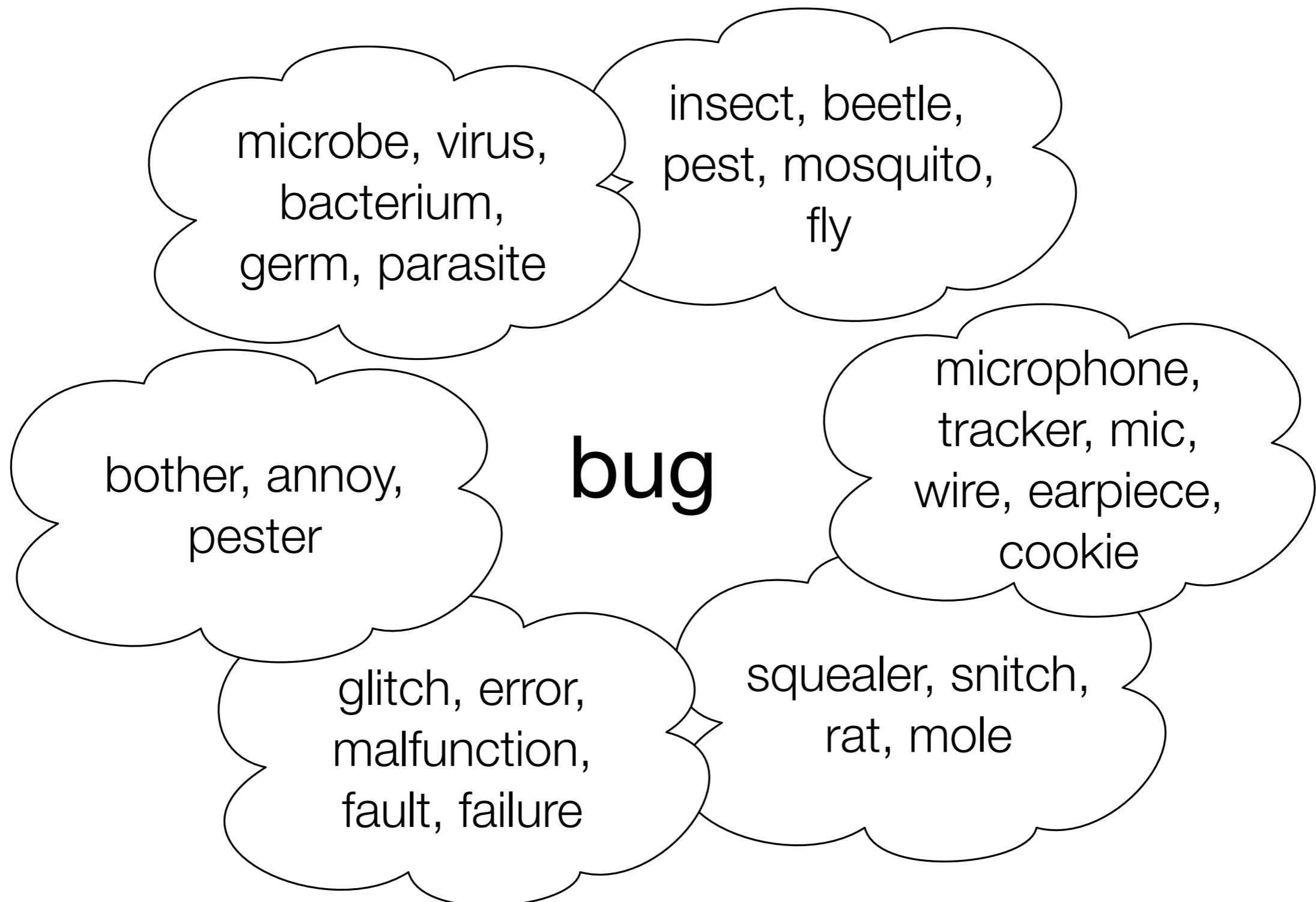
Fun PPDB Examples

munchies ||| hungry



abso-fucking-lutely ||| indeed

Word Sense



Semantic Relationships

twelve	12	equivalence
cartoons	illustrations	forward entailment
ε	in Denmark	reverse entailment
caused	prevented	negation
Europe	the middle East	alternation

CIS 530 and NETS 213

Want to learn more about AI from me?

Next semester I'll be teaching two courses:

CIS 550 computational-linguistics-class.org

NETS 213 crowdsourcing-class.org

thank you for your time

many thanks

here you go anyway , thanks

leave a message

gee , thanks

thanks , man you look amazing

bless you

diet coke

Thank you!

thank you very much

keep the change thank you for your attention

uh , thanks

why , thank you

don't thank me

hey , thanks

thank you , frank