

Social Media & Text Analysis

lecture 4 - Paraphrase Data Sources



CSE 5539-0010 Ohio State University
Instructor: Wei Xu
Website: socialmedia-class.org

Natural Language Processing

Dan Jurafsky



Language Technology

making good progress

mostly solved

Spam detection

Let's go to Agra!



Buy V1AGRA ...



Part-of-speech (POS) tagging

ADJ ADJ NOUN VERB ADV

Colorless green ideas sleep furiously.

Named entity recognition (NER)

PERSON ORG LOC

Einstein met with UN officials in Princeton

Sentiment analysis

Best roast chicken in San Francisco!



The waiter ignored us for 20 minutes.



Coreference resolution

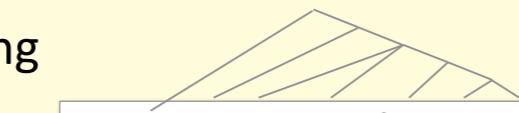
Carter told Mubarak he shouldn't run again.

Word sense disambiguation (WSD)

I need new batteries for my **mouse**.



Parsing



I can see Alcatraz from the window!

Machine translation (MT)

第13届上海国际电影节开幕...



The 13th Shanghai International Film Festival...

Information extraction (IE)

You're invited to our dinner party, Friday May 27 at 8:30



Party
May 27
add

still really hard

Question answering (QA)

Q. How effective is ibuprofen in reducing fever in patients with acute febrile illness?

Paraphrase

XYZ acquired ABC yesterday

ABC has been taken over by XYZ

Summarization

The Dow Jones is up

The S&P500 jumped

Housing prices rose



Economy is good

Dialog

Where is Citizen Kane playing in SF?



Castro Theatre at 7:30. Do you want a ticket?



what is Paraphrase?

“sentences or phrases that convey approximately the same meaning using different words” — (Bhagat & Hovy, 2012)

what is Paraphrase?

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wealthy

word

rich

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“sentences or phrases that convey approximately the same meaning using different words” — (Bhagat & Hovy, 2012)

wealthy

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rich

the king's speech

phrase

His Majesty's address

what is Paraphrase?

“sentences or phrases that convey approximately the same meaning using different words” — (Bhagat & Hovy, 2012)

wealthy

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the king's speech

phrase

His Majesty's address

*... the forced resignation
of the CEO of Boeing,
Harry Stonecipher, for ...*

sentence

*... after Boeing Co. Chief
Executive Harry Stonecipher
was ousted from ...*

What's good about Paraphrases ?

*... the forced resignation
of the CEO of Boeing,
Harry Stonecipher, for ...*

*... after Boeing Co. Chief
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What's good about Paraphrases ?

fundamentally useful for a wide range of applications

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e.g. Question Answering

Who is the CEO stepping down from Boeing?

*... the forced resignation
of the CEO of Boeing,
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What's good about Paraphrases ?

fundamentally useful for a wide range of applications

e.g. Question Answering

Who is the CEO stepping down from Boeing?

match

... the forced resignation of the CEO of Boeing, Harry Stonecipher, for ...

... after Boeing Co. Chief Executive Harry Stonecipher was ousted from ...



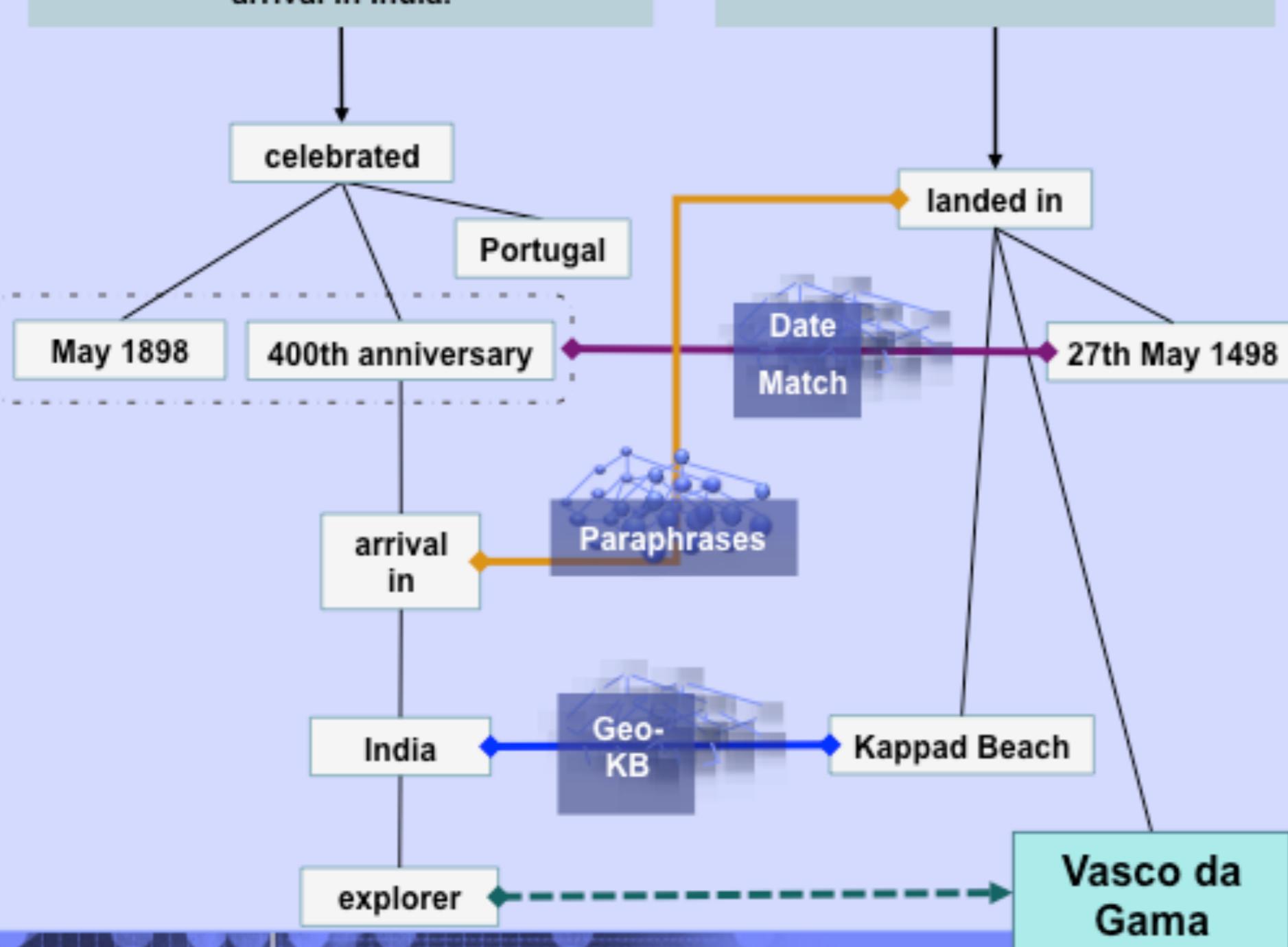
Watson leverages multiple algorithms to perform deeper analysis

[Question]

In May 1898 Portugal celebrated the 400th anniversary of this explorer's arrival in India.

[Supporting Evidence]

On the 27th of May 1498, Vasco da Gama landed in Kappad Beach



Legend

- Temporal Reasoning
- Statistical Paraphrasing
- GeoSpatial Reasoning
- Reference Text
- Answer

Stronger evidence can be much harder to find and score...

- Search far and wide
- Explore many hypotheses
- Find judge evidence
- Many inference algorithms



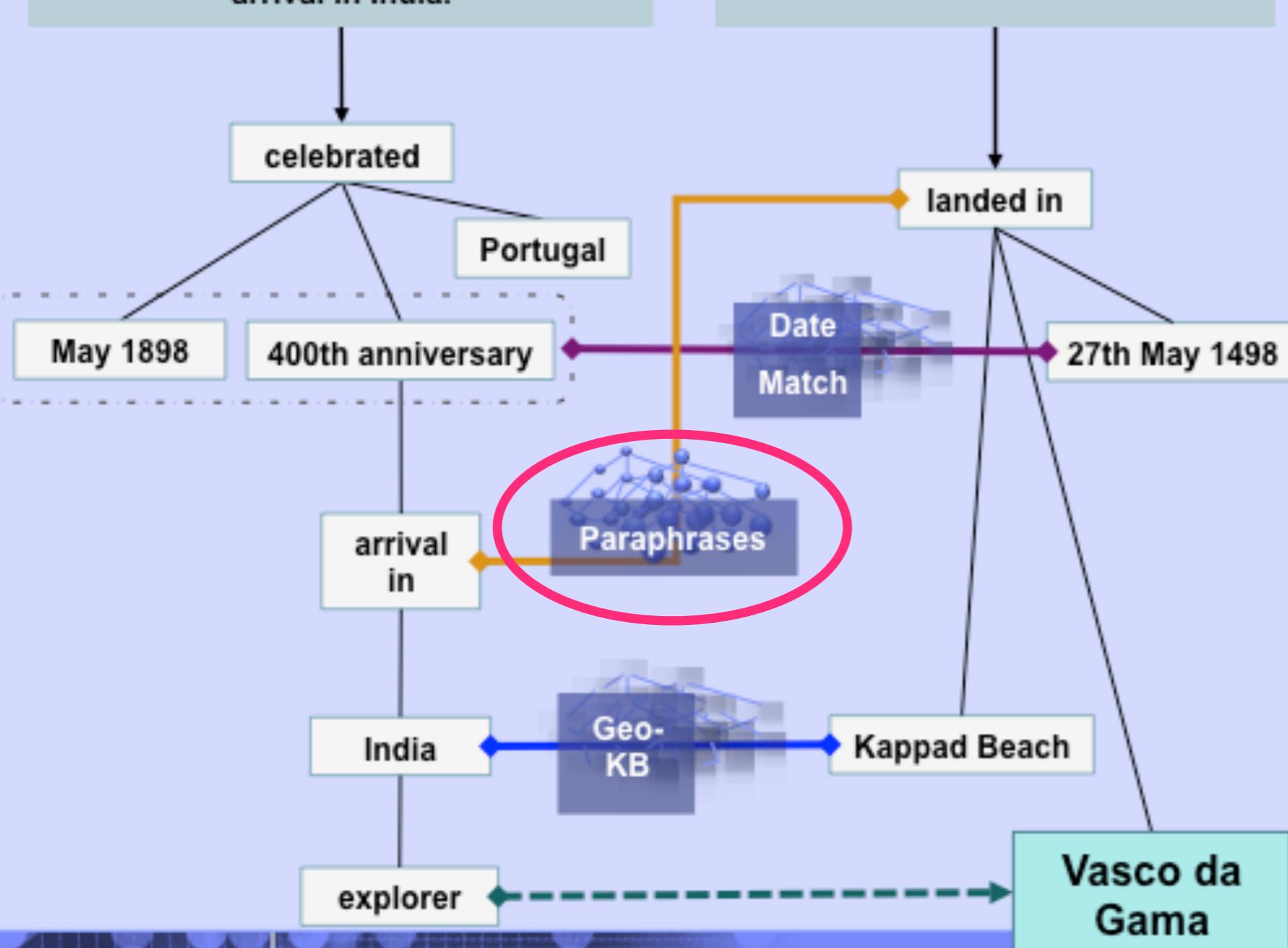
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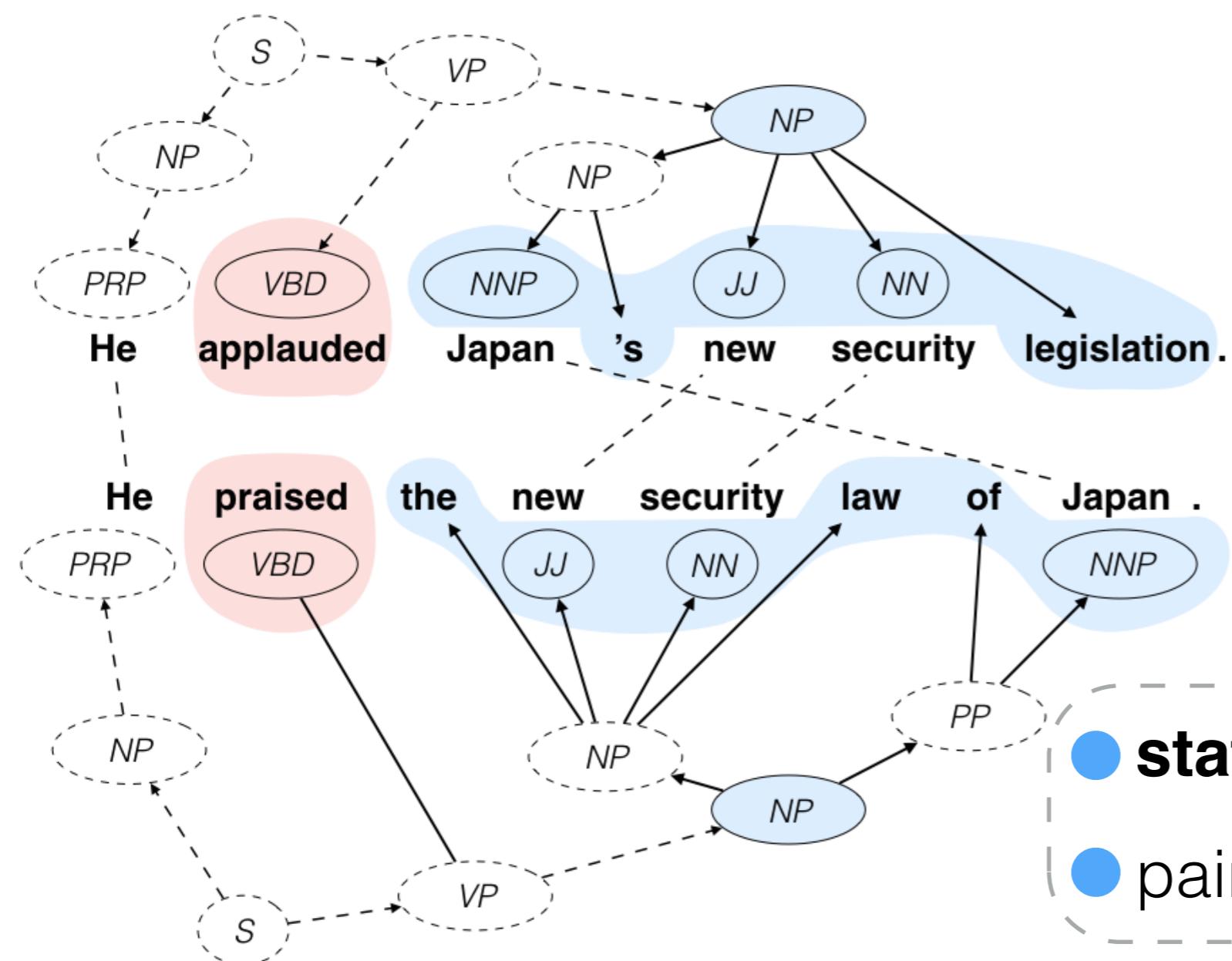
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Natural Language Generation

e.g. Text Simplification



Techniques

- statistical machine translation
- pairwise ranking optimization

Digital Humanities



e.g. Stylistic Rewriting / Poetry Generation



Palpatine:
If you will not be turned, you will be destroyed!

↓

If you will not be turn'd, you will be undone!

Luke:
Father, please! Help me!



Father, I pray you! Help me!

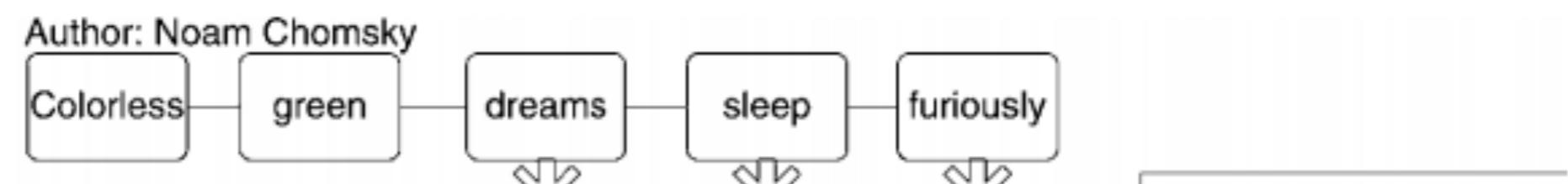
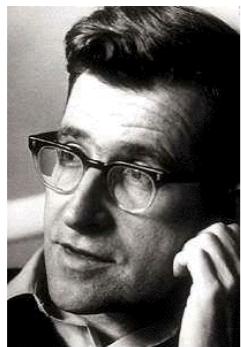


Wei Xu, Alan Ritter, Bill Dolan, Ralph Grishman, Colin Cherry. "Paraphrasing for Style" In COLING (2012)

Quanze Chen, Chenyang Lei, Wei Xu, Ellie Pavlick, Chris Callison-Burch.

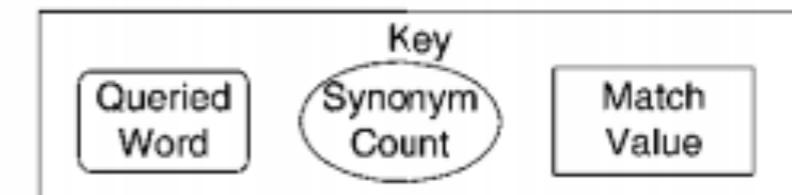
"Poetry of the Crowd: A Human Computation Algorithm to Convert Prose into Rhyming Verse" In HCOMP (2014)

Plagiarism, Anonymity, Security



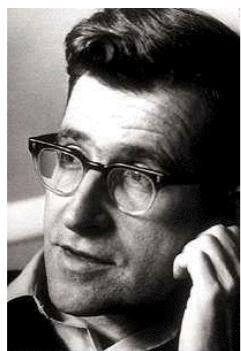
$$\begin{aligned} &= S (\#uses * \#synonyms) \\ &= 1 * 8 + 1 * 11 + 1 * 1 \\ &= 20 \end{aligned}$$

$$\begin{aligned} &= S (\#uses * \#synonyms) \\ &= 1 * 26 \\ &= 26 \end{aligned}$$

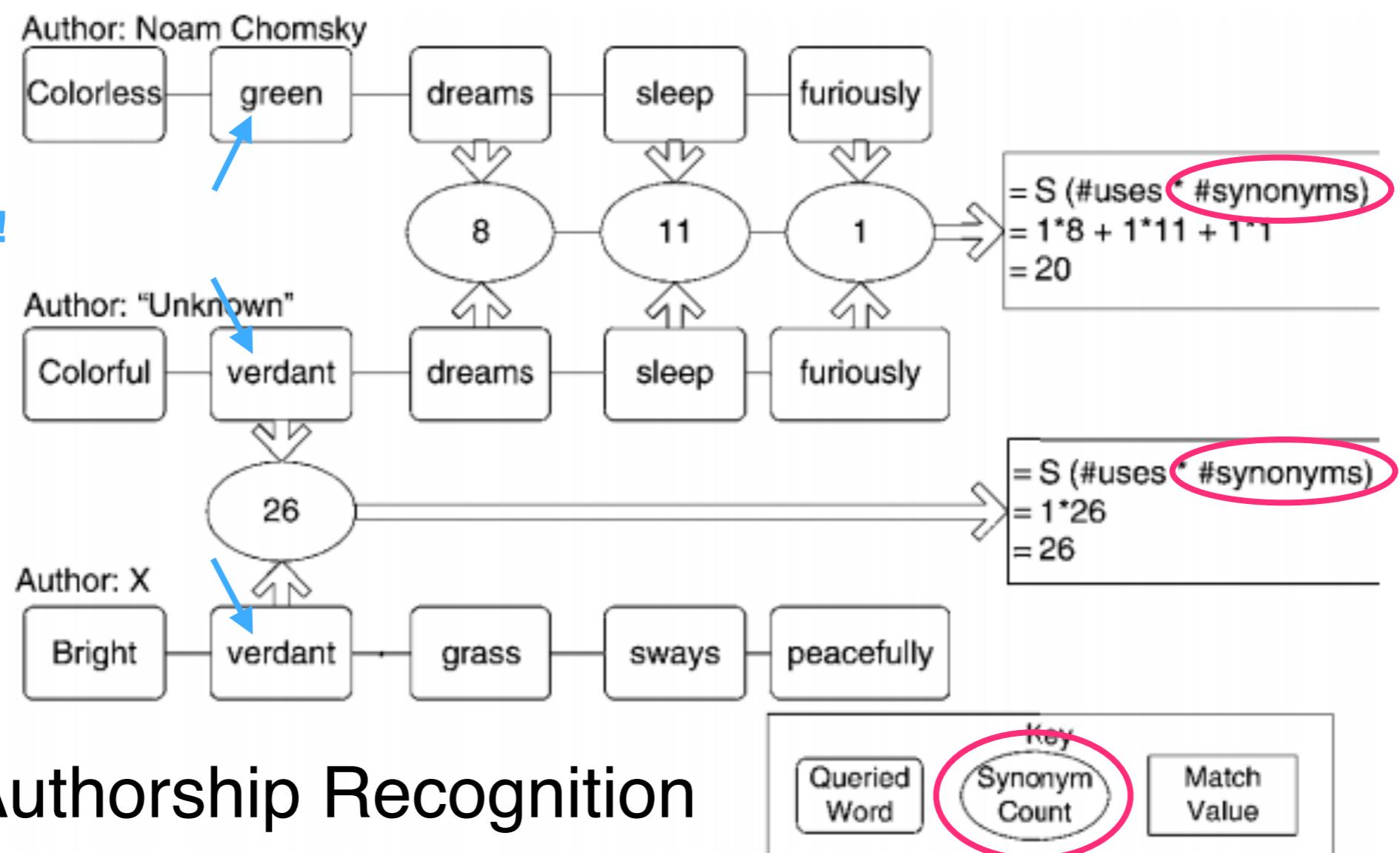


Authorship Recognition

Plagiarism, Anonymity, Security

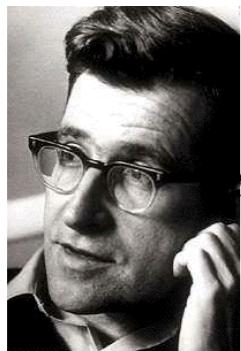


Paraphrases!!

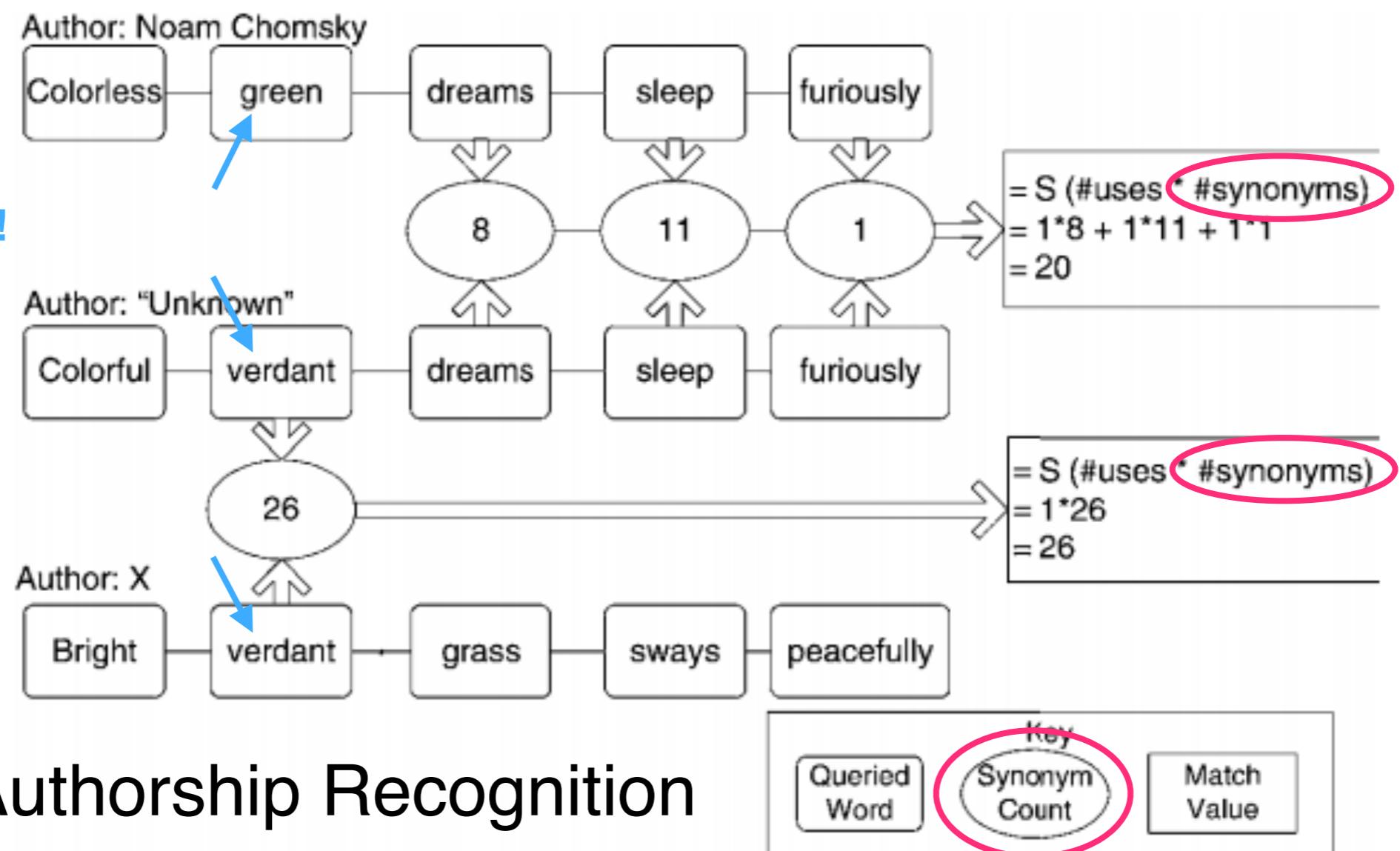


Authorship Recognition

Plagiarism, Anonymity, Security



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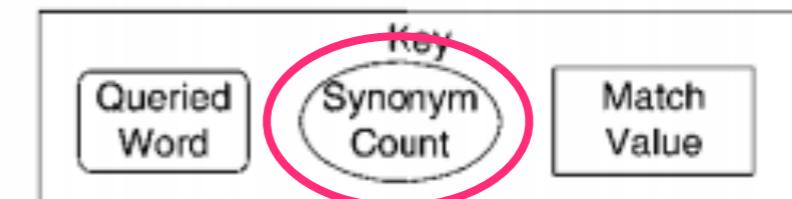
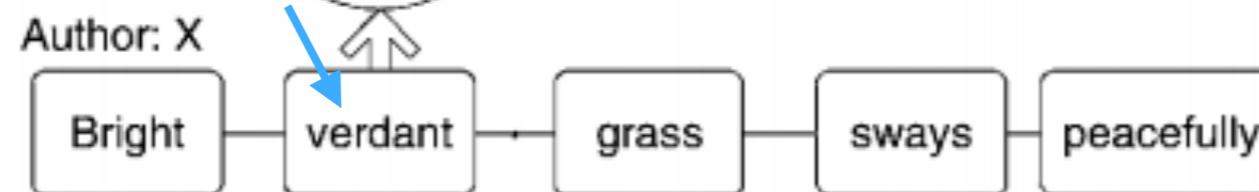
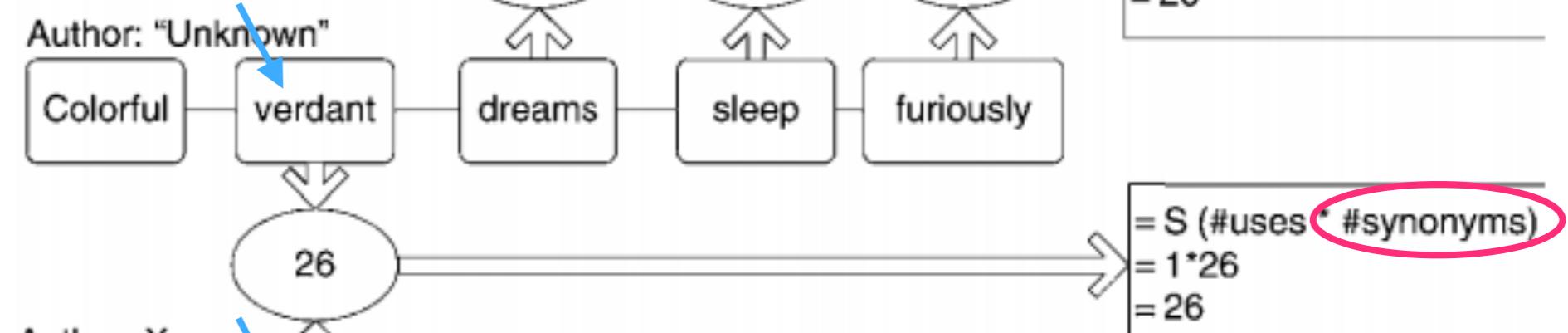
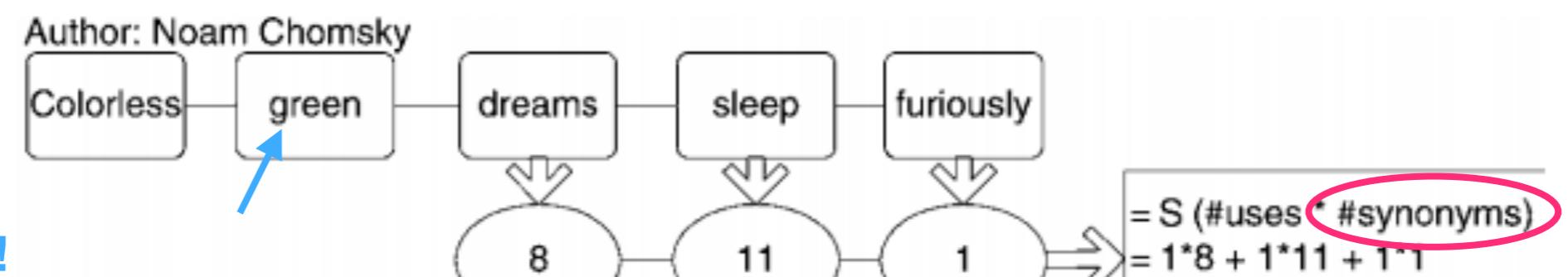


Authorship Recognition

Plagiarism, Anonymity, Security



Paraphrases!!



Authorship Recognition

Language, Vision, Robotics, VR



Pick up a black table leg off of the floor.
Pick up the black table leg.
Walk over to the white table.
Place black leg on white table bottom.
Locate the black table leg on the floor by the white table.
Find the black table leg and attach it to the white table.

Language, Vision, Robotics, VR



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Paraphrases!!

Paraphrases!!

Other Applications

fundamentally useful for a wide range of applications

* my research

Other Applications

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semantic similarity *

* my research

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semantic similarity *
machine translation *

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- semantic parsing

* my research

Other Applications

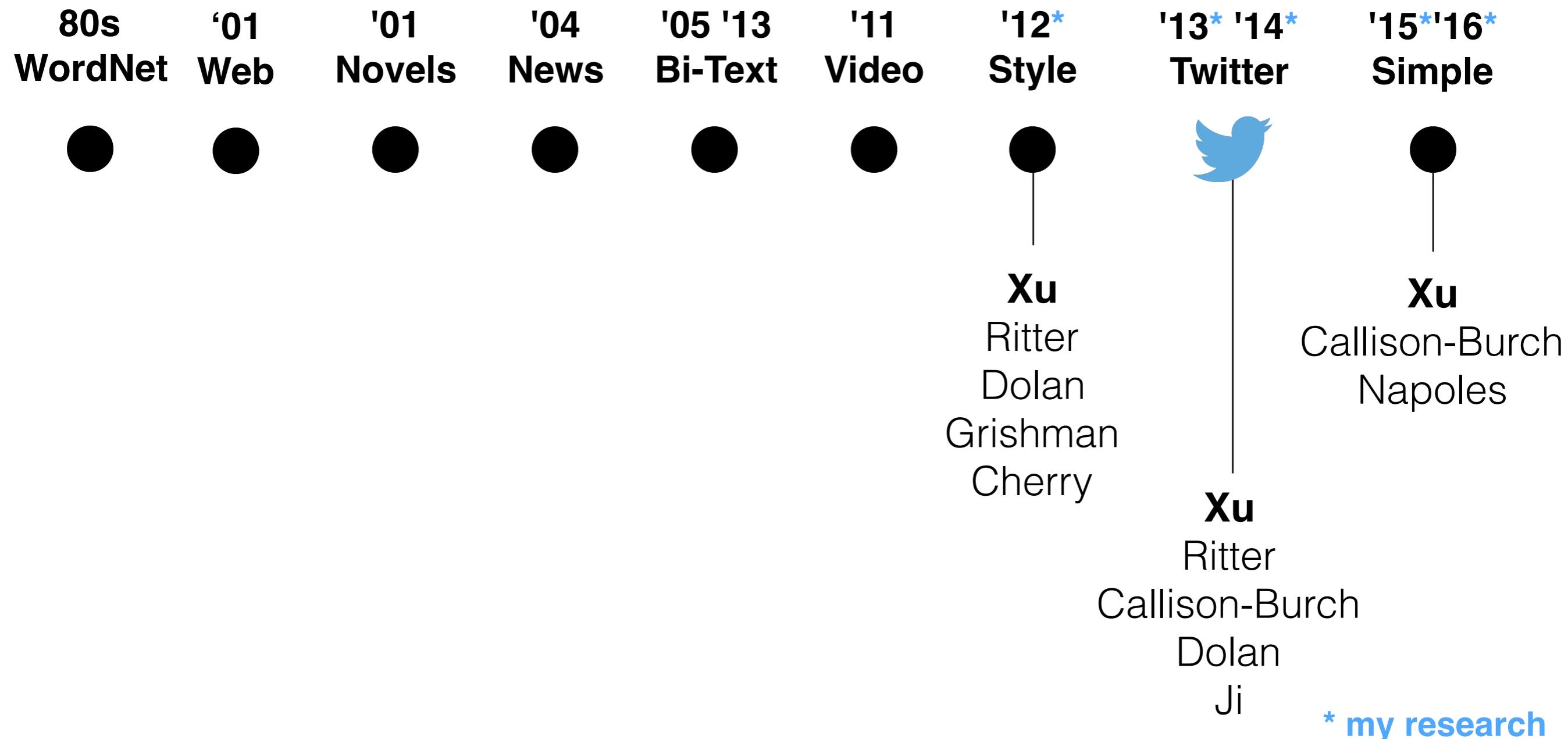
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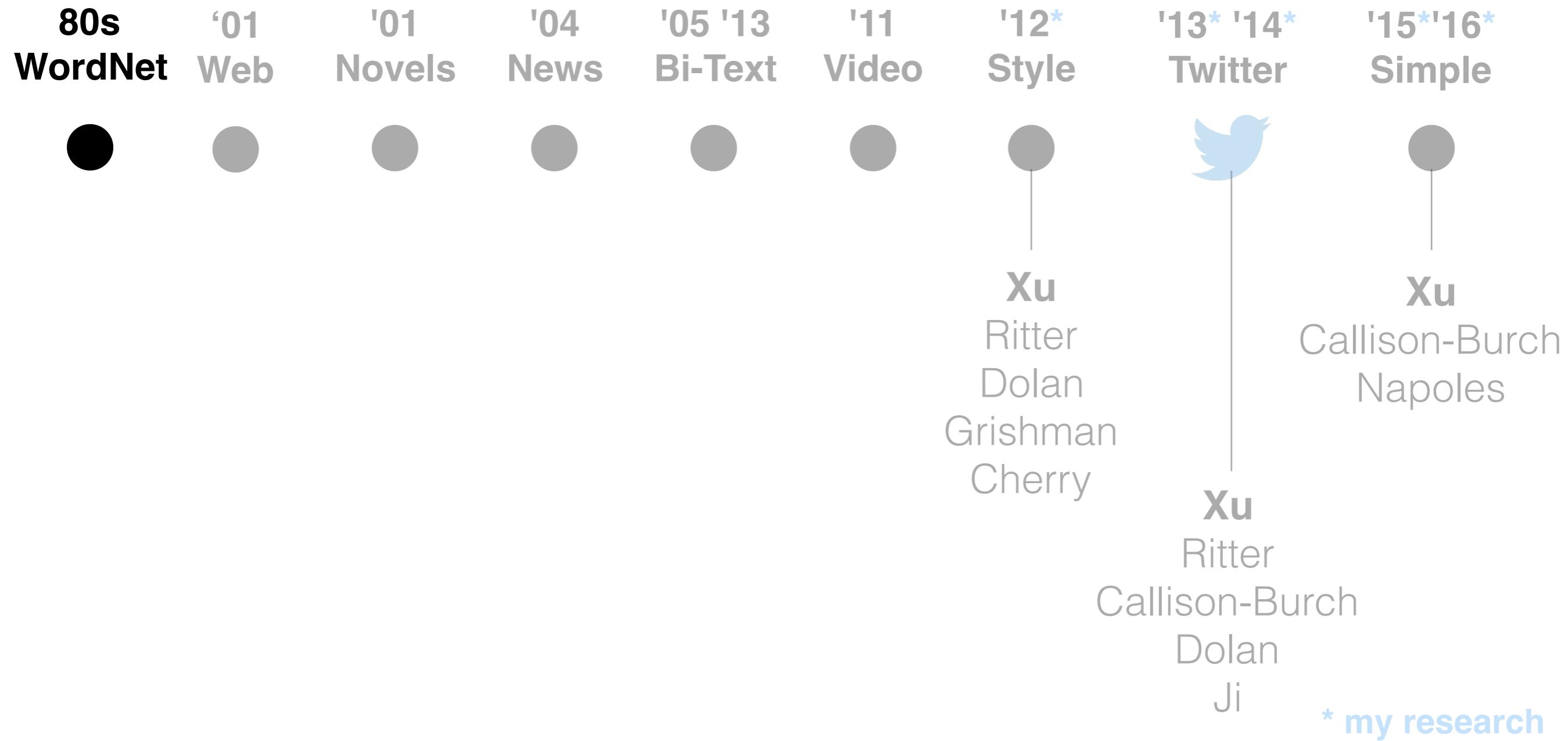
...

* my research

Paraphrase Research



Paraphrase Research



WordNet®

- What is it?
 - a large lexical database of English (155,287 words, latest version in 2005~6)
 - created (from mid-1980s) and maintained by Cognitive Science Lab of Princeton University
 - designed to establish the connections between words

WordNet®

- What is it?
 - a combination of dictionary and thesaurus
 - try it out <http://wordnet.princeton.edu/>
 - In other languages: <http://globalwordnet.org/wordnets-in-the-world/>

Dictionary contains meaning, definition, pronunciation, orthography, and etymology of a word.

Thesaurus contains synonyms and antonyms of words.

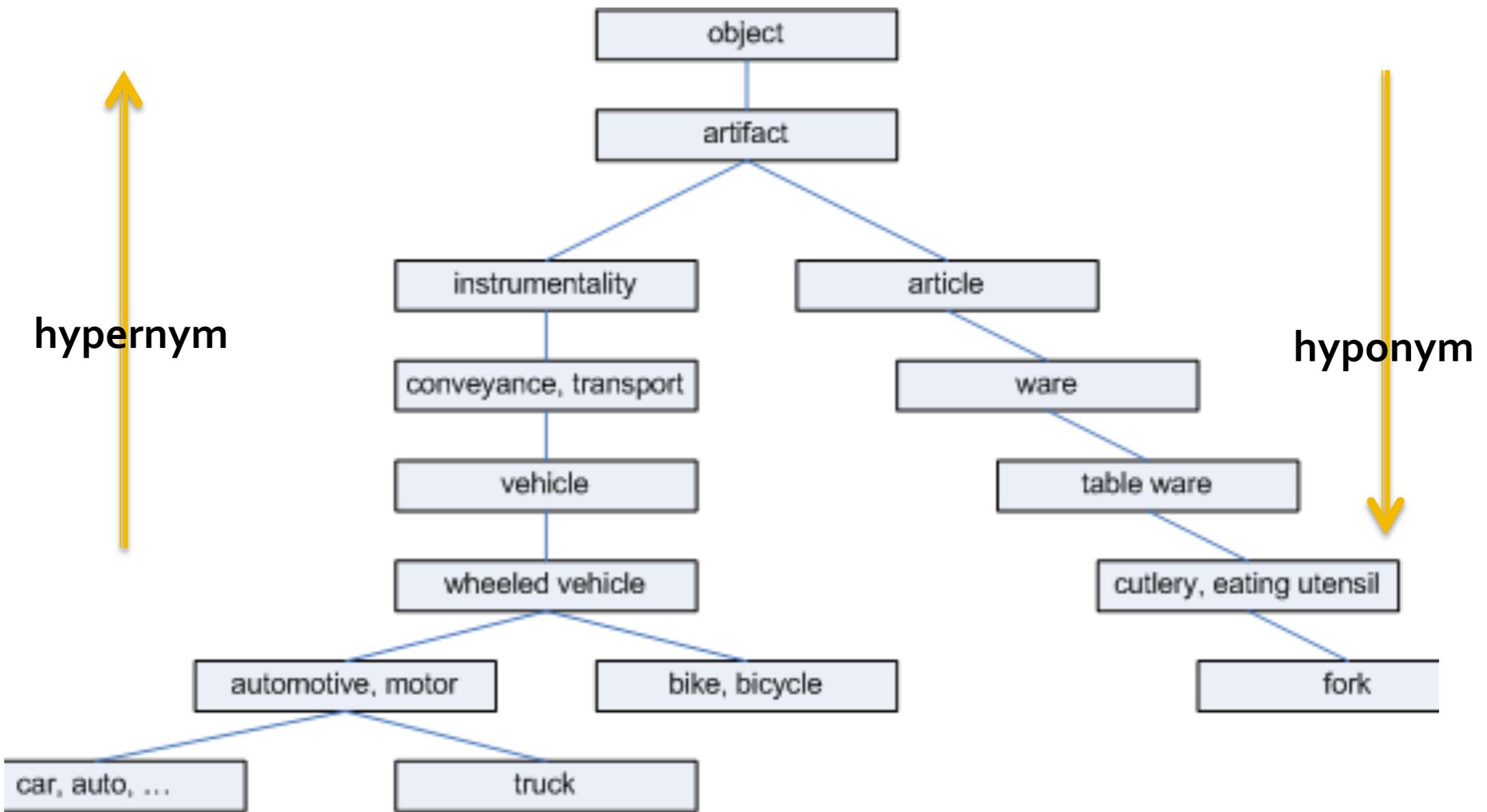
WordNet®

- 4 types of Parts of Speech (POS)
 - Noun, Verb, Adjective, Adverb
- Synset (synonym set)
 - the smallest unit in WordNet
 - represents a specific meaning of a word
- S: (n) search (an investigation seeking answers) "*a thorough search of the ledgers revealed nothing*"; "*the outcome justified the search*"
- S: (v) search, seek, look for (try to locate or discover, or try to establish the existence of) "*The police are searching for clues*"; "*They are searching for the missing man in the entire county*"

WordNet®

- Synsets are connected to one another through semantic and lexical relations
- Type of relations (based on POS)
 - hypernyms (kind-of): ‘vehicle’ is a hypernym of ‘car’
 - hyponyms (kind-of): ‘car’ is a hyponym of ‘vehicle’
 - holonym (part-of): ‘building’ is a holonym of ‘window’
 - meronym(part-of): ‘window’ is a meronym of ‘building’
 - similar to: ‘smart’ is similar to ‘intelligent’
 - antonyms: ‘smart’ is antonym of ‘unintelligent’

WordNet®

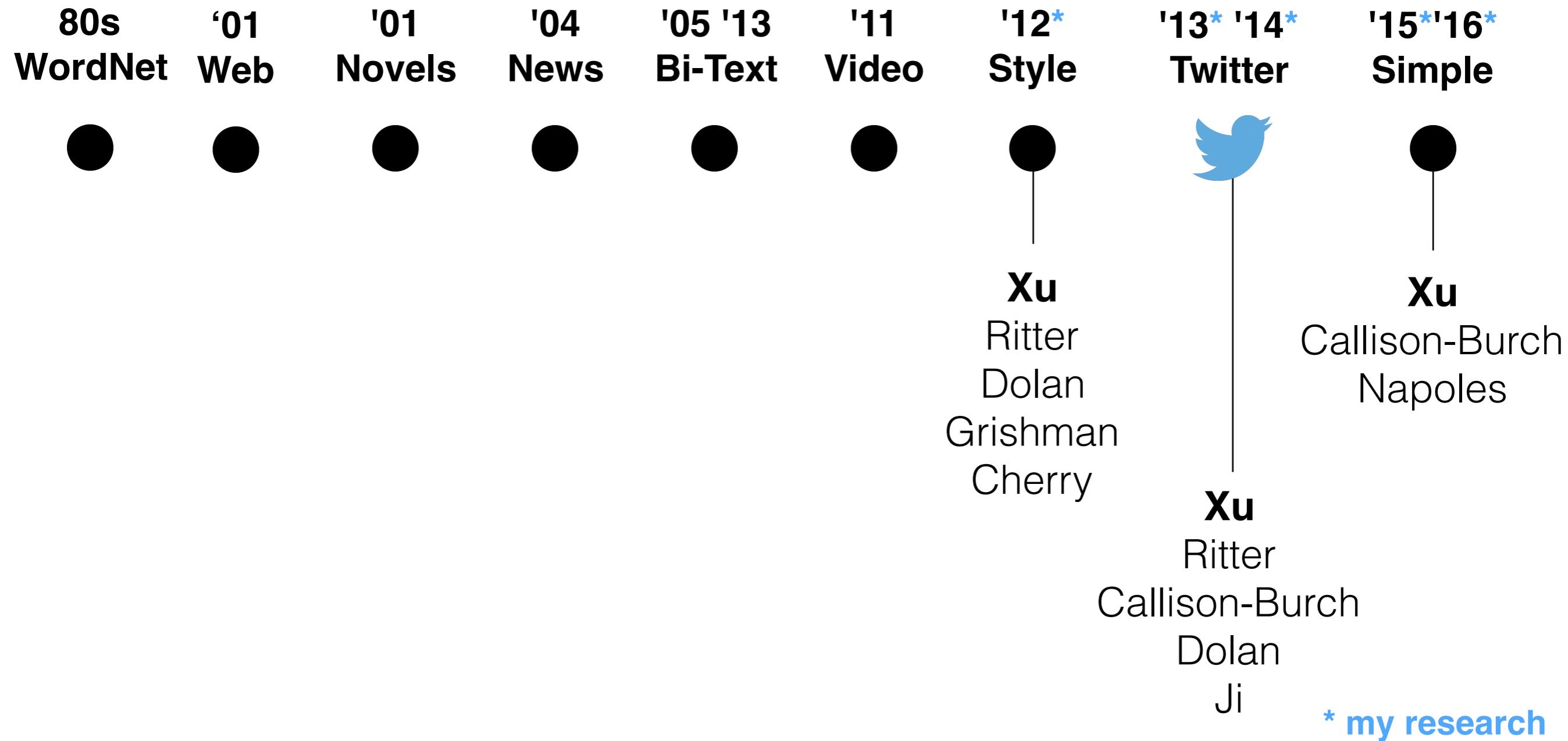


WordNet®

- Interfaces
 - Unix-style manual
 - Web Interfaces
 - Local Interfaces/APIs (Java, Python, Perl, C# ...)

<http://wordnet.princeton.edu/wordnet/related-projects/>

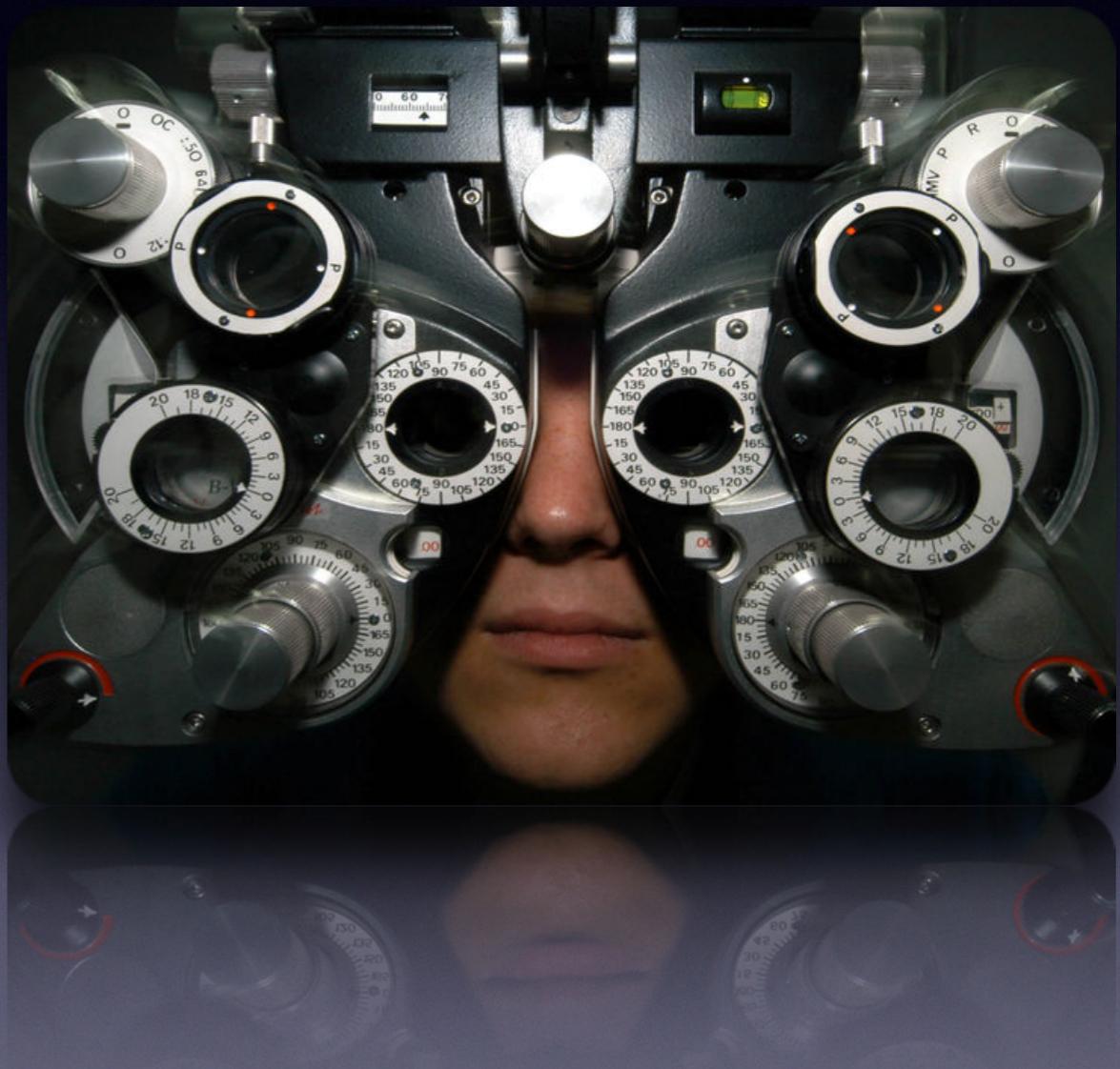
Paraphrase Research



Paraphrase Research



Distributional Hypothesis



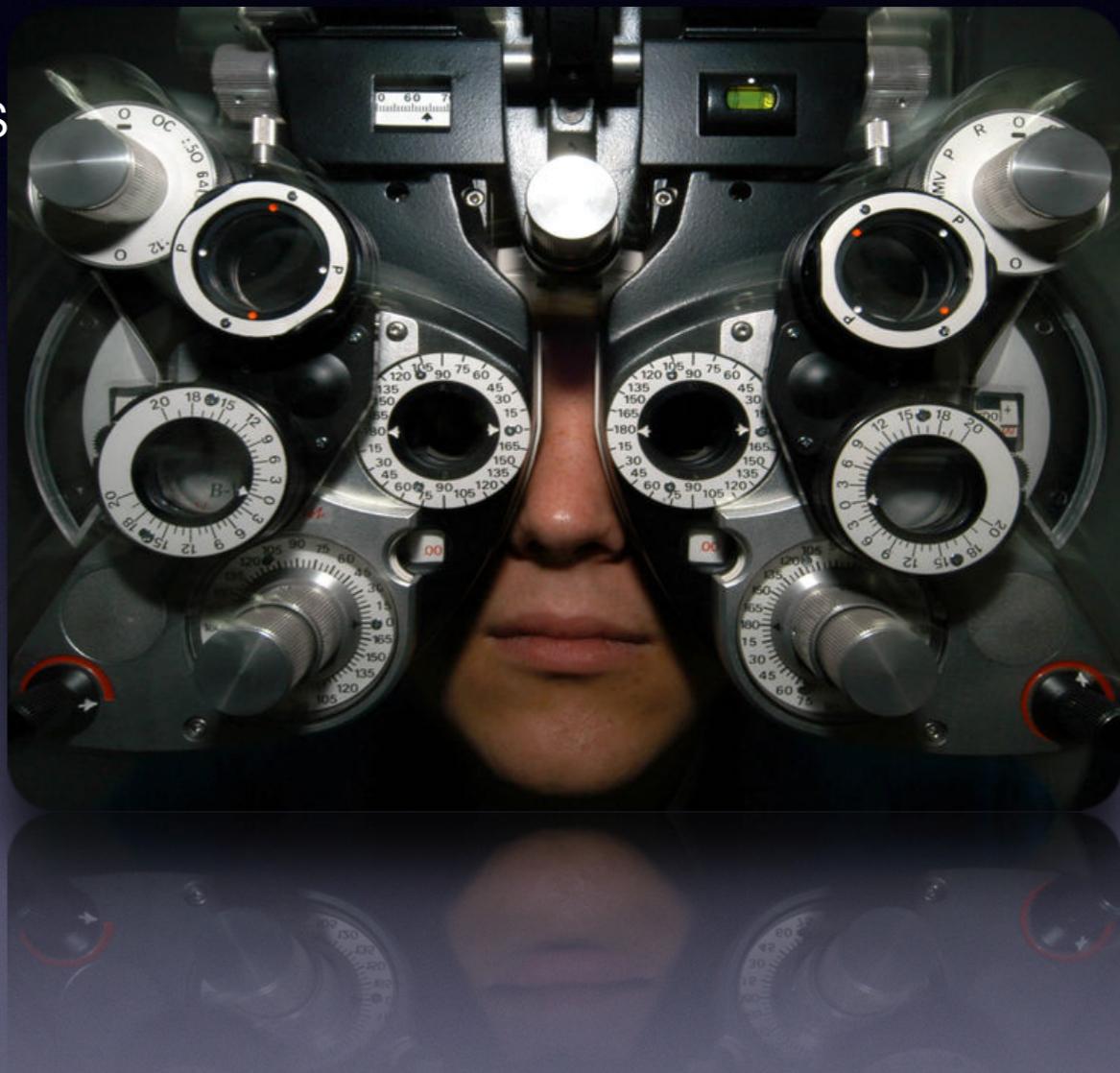
Distributional Hypothesis

If we consider **oculist** and **eye-doctor** we find that, as our corpus of utterances grows, these two occur in almost the same environments. In contrast, there are many sentence environments in which **oculist** occurs but **lawyer** does not...

It is a question of the relative frequency of such environments, and of what we will obtain if we ask an informant to substitute any word he wishes for **oculist** (not asking what words have the same meaning).

These and similar tests all measure the probability of particular environments occurring with particular elements... If A and B have almost identical environments we say that they are synonyms.

–Zellig Harris (1954)



DIRT

(Discovery of Inference Rules from Text)

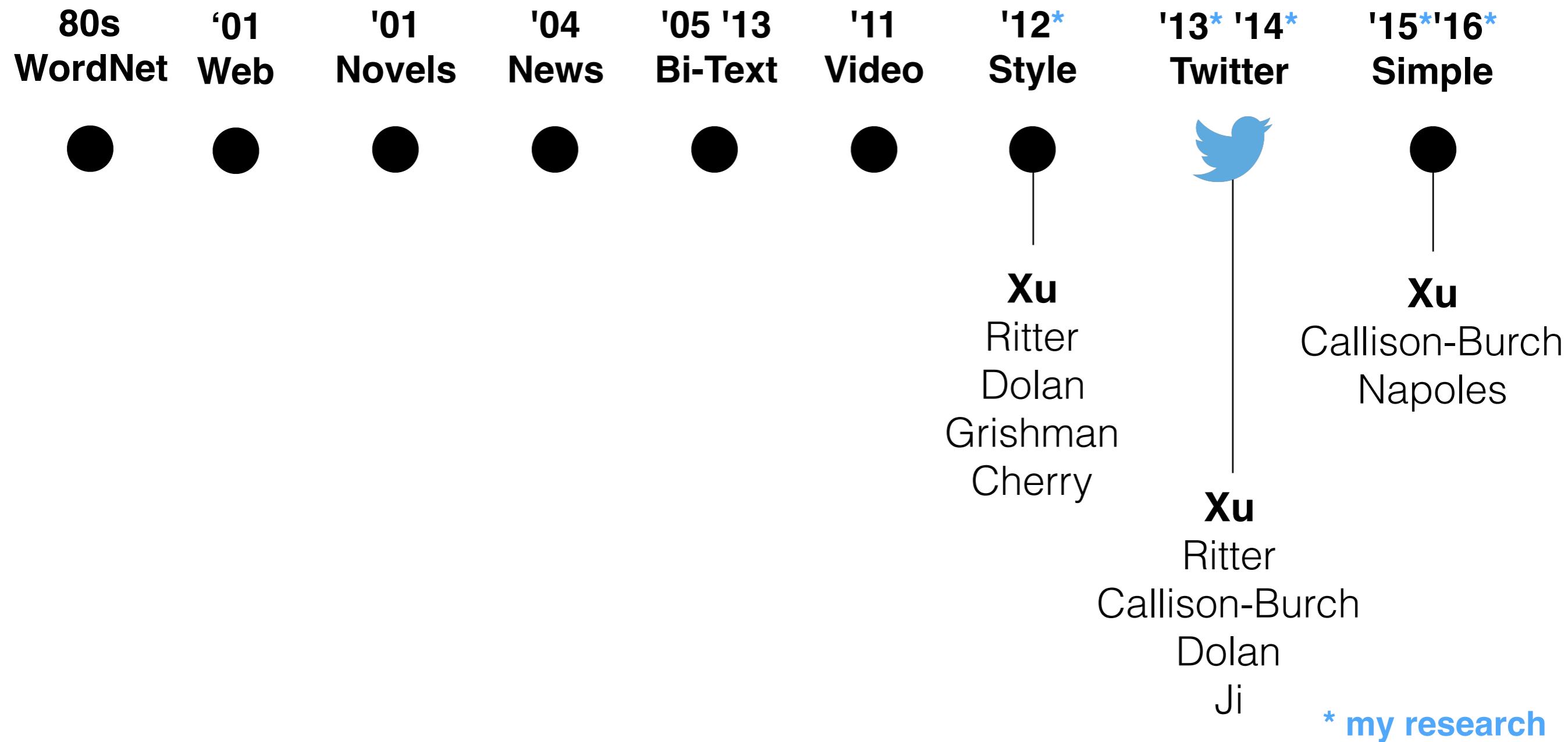
Lin and Pantel (2001) operationalize the Distributional Hypothesis using dependency relationships to define similar environments (mutual information).

Duty and responsibility share a similar set of dependency contexts in large volumes of text:

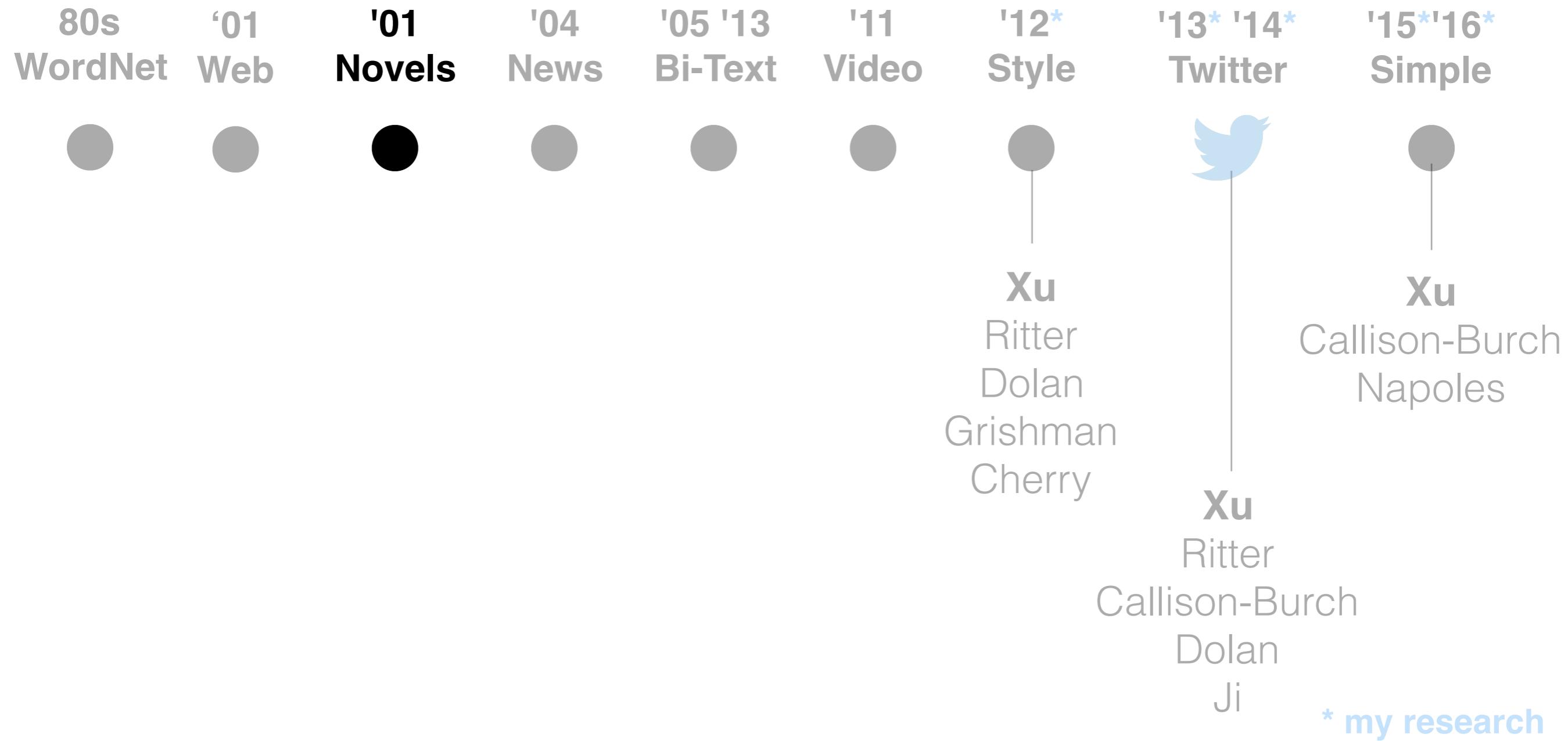
modified by adjectives	objects of verbs
additional, administrative, assigned, assumed, collective, congressional, constitutional ...	assert, assign, assume, attend to, avoid, become, breach ...

Source: Chris Callison-Burch

Paraphrase Research



Paraphrase Research

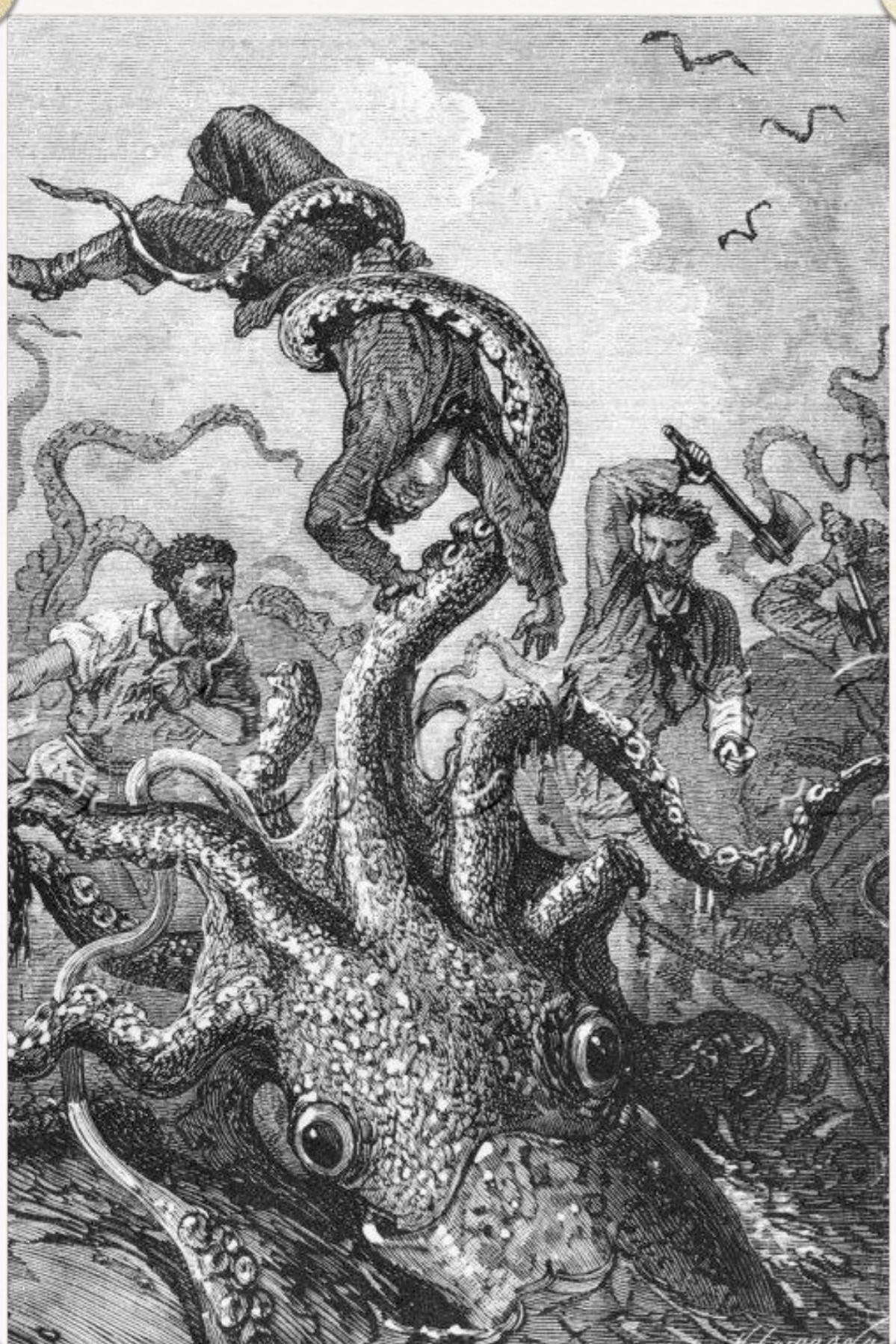




Source: Chris Callison-Burch



What a scene! Seized by the tentacle and **glued to** its suckers, the unfortunate man was **swinging in the air** at the **mercy** of this enormous appendage. He gasped, he choked, he yelled: "Help! Help!" I'll hear his **harrowing plea** the rest of my life!
The **poor fellow** was **done for**.



What a scene! Seized by the tentacle and **glued to** its suckers, the unfortunate man was **swinging in the air** at the **mercy** of this enormous appendage. He gasped, he choked, he yelled: "Help! Help!" I'll hear his **harrowing plea** the rest of my life!
The **poor fellow** was **done for**.

What a scene! The unhappy man, seized by the tentacle and **fixed to** its suckers, was **balanced in the air** at the **caprice** of this enormous trunk. He rattled in his throat, he was stifled, he cried, "Help! help!" That **heart-rending cry**! I shall hear it all my life.
The **unfortunate man** was **lost**.

Novels (parallel monolingual data)

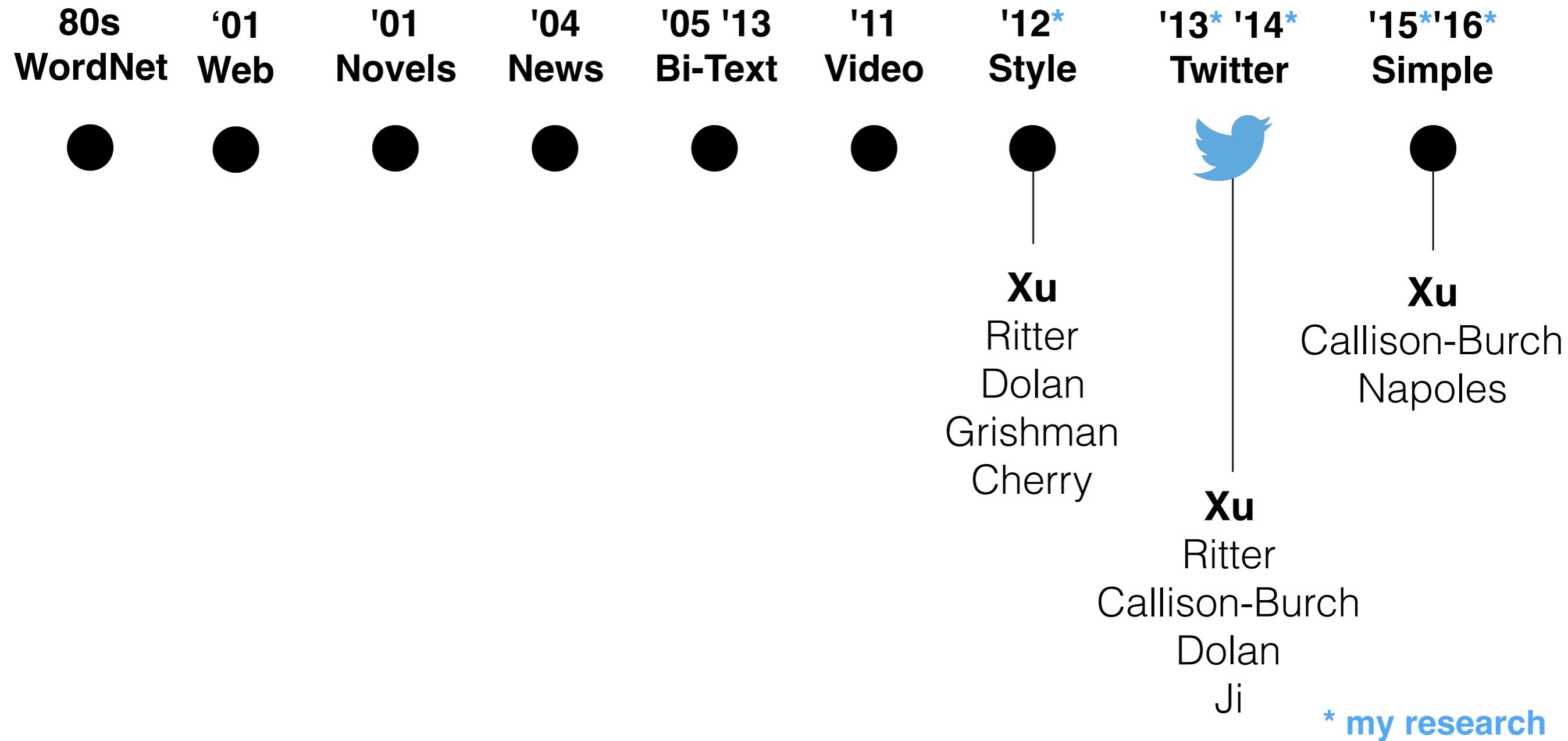
Barzilay and McKeown (2001) identify paraphrases using identical contexts in aligned sentences:

Emma burst into tears and he tried to comfort her,
saying things to make her smile.

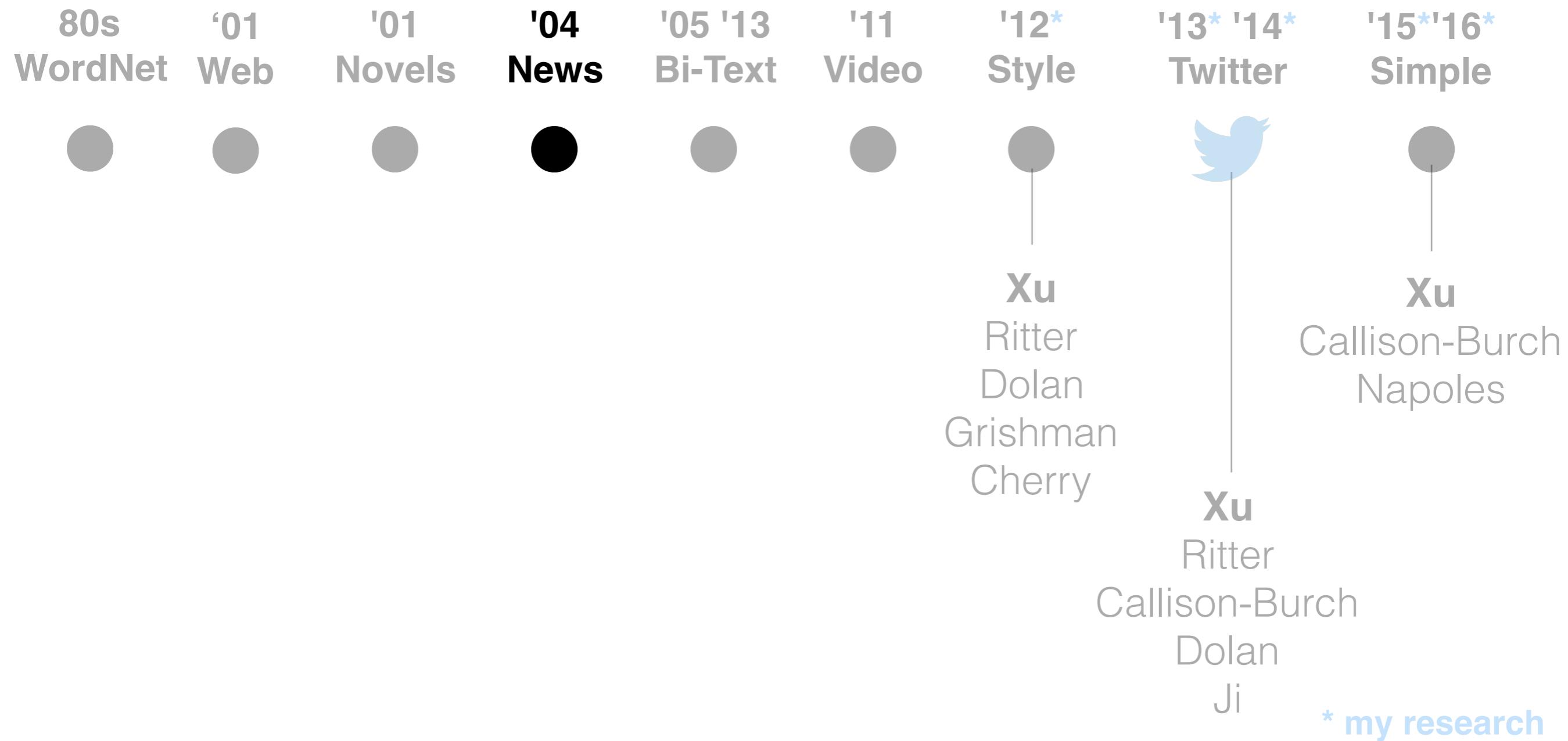
Emma cried and he tried to console her, adorning
his words with puns.

burst into tears = cried and comfort = console

Paraphrase Research



Paraphrase Research



News



Microsoft Research Paraphrase Corpus

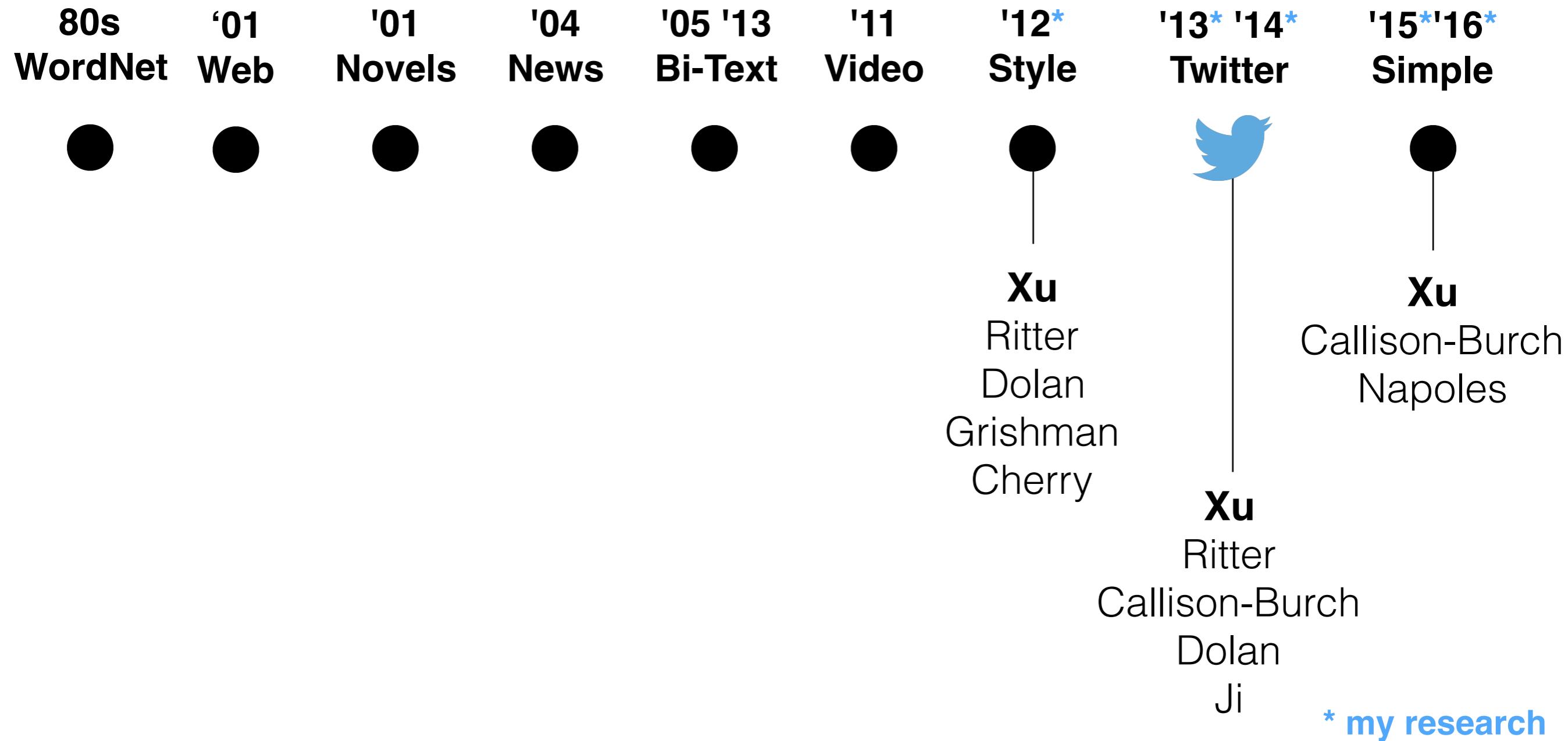
News (comparable texts)

Dolan, Quirk, and Brockett (2004) extract sentential paraphrases from newspaper articles published on the same topic and date:

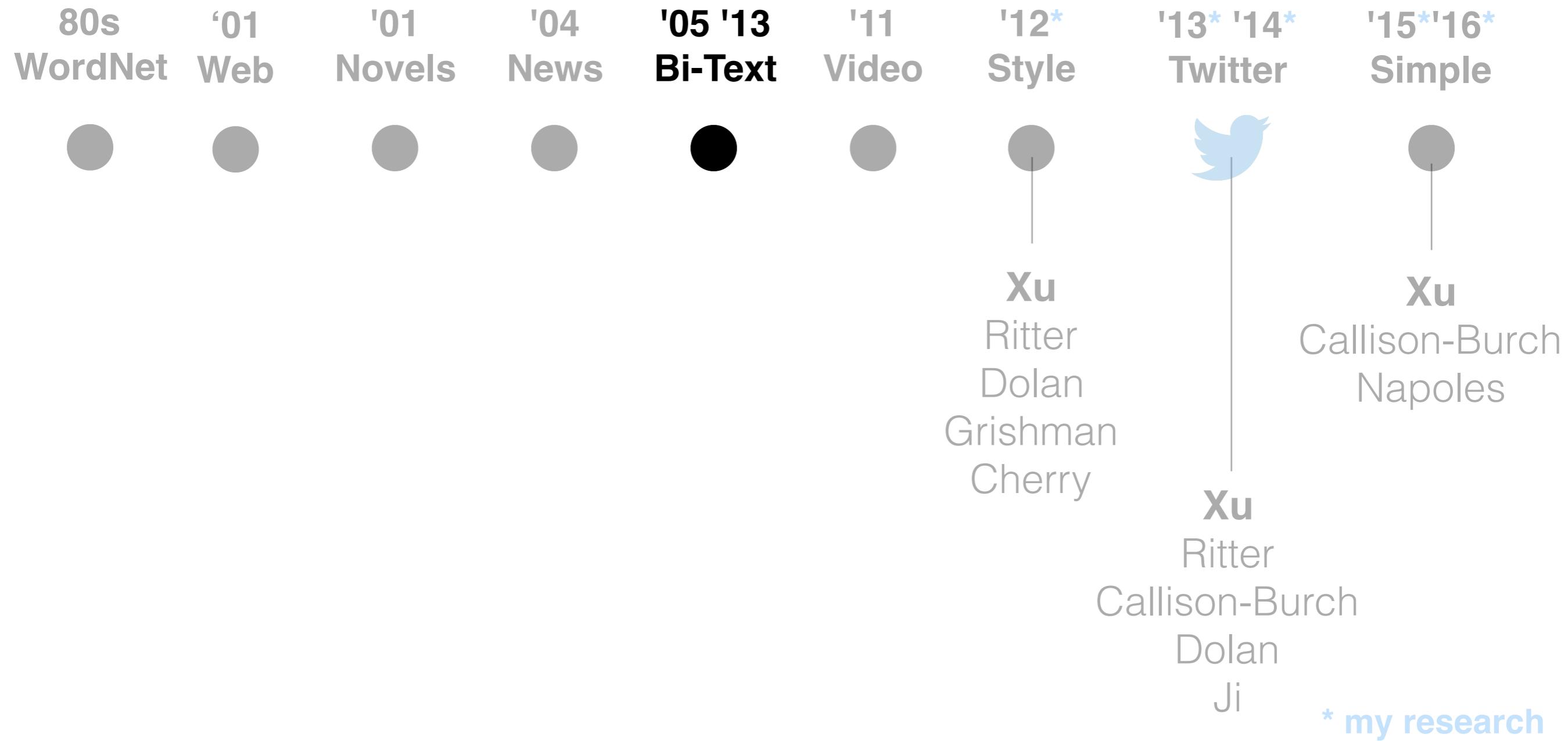
On its way to an extended mission at Saturn, the Cassini probe on Friday makes its closest rendezvous with Saturn's dark moon Phoebe.

The Cassini spacecraft, which is en route to Saturn, is about to make a close pass of the ringed planet's mysterious moon Phoebe.

Paraphrase Research



Paraphrase Research



Data-Driven Paraphrasing

'01
Novels

Monolingual parallel: English – English

Source: Chris Callison-Burch

Nitin Madnani and Bonnie Dorr. Generating Phrasal and Sentential Paraphrases: A Survey of Data-Driven Methods.
In Computational Linguistics (2010)

Data-Driven Paraphrasing

'01
Novels

Monolingual parallel: English – English

'01
Web

Plain monolingual: English

Source: Chris Callison-Burch

Nitin Madnani and Bonnie Dorr. Generating Phrasal and Sentential Paraphrases: A Survey of Data-Driven Methods.
In Computational Linguistics (2010)

Data-Driven Paraphrasing

'01 Novels	Monolingual parallel:	English – English
'01 Web	Plain monolingual:	English
'04 News	Monolingual comparable:	English ~ English

Source: Chris Callison-Burch

Nitin Madnani and Bonnie Dorr. Generating Phrasal and Sentential Paraphrases: A Survey of Data-Driven Methods.
In Computational Linguistics (2010)

Data-Driven Paraphrasing

Monolingual parallel: English – English

Plain monolingual: English

Monolingual comparable: English ~ English

Source: Chris Callison-Burch

Nitin Madnani and Bonnie Dorr. Generating Phrasal and Sentential Paraphrases: A Survey of Data-Driven Methods.
In Computational Linguistics (2010)

Data-Driven Paraphrasing

Monolingual parallel: English – English

Plain monolingual: English

Monolingual comparable: English ~ English

Bilingual parallel: English – French

Source: Chris Callison-Burch

Nitin Madnani and Bonnie Dorr. Generating Phrasal and Sentential Paraphrases: A Survey of Data-Driven Methods.
In Computational Linguistics (2010)

Data-Driven Paraphrasing

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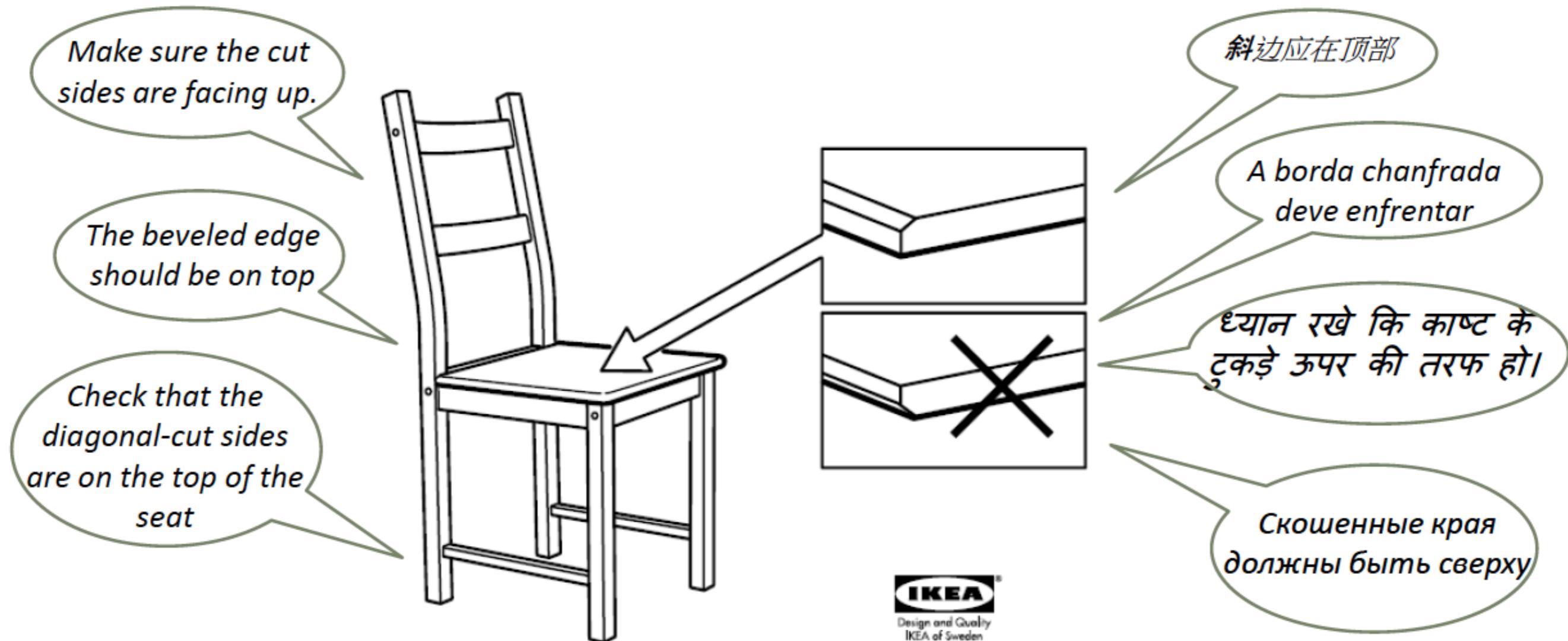
Nitin Madnani and Bonnie Dorr. Generating Phrasal and Sentential Paraphrases: A Survey of Data-Driven Methods.
In Computational Linguistics (2010)

Paraphrasing & Translation

Translation is re-writing a text using words in a different language.

Paraphrasing is translation into the same language.

Same Meaning, Different Words



IKEA
Design and Quality
IKEA of Sweden

Bilingual Data

Sentence-aligned parallel corpora in English and any foreign language

Available in large quantities

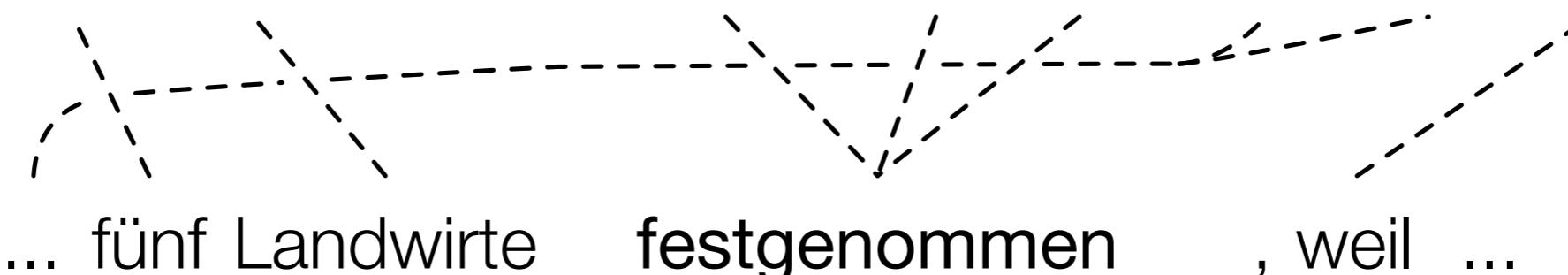
Strong meaning equivalence signal

... but different languages.

Bilingual Pivoting

word alignment

... 5 farmers were thrown into jail in Ireland ...



Bilingual Pivoting

word alignment

... 5 farmers were thrown into jail in Ireland ...
... fünf Landwirte festgenommen , weil ...



Bilingual Pivoting

word alignment

... 5 farmers were thrown into jail in Ireland ...

... fünf Landwirte , weil ...

... oder wurden , gefoltert ...

... or have been imprisoned , tortured ...

The diagram illustrates the process of bilingual pivoting for word alignment. It shows two parallel sentences, one in English and one in German, with dashed lines indicating the correspondence between words. A blue box highlights the German words 'festgenommen', which are aligned with the English words 'thrown' and 'imprisoned'.

Bilingual Pivoting

word alignment

... 5 farmers were thrown into jail in Ireland ...

... fünf Landwirte festgenommen , weil ...

... oder wurden

... or have been

festgenommen

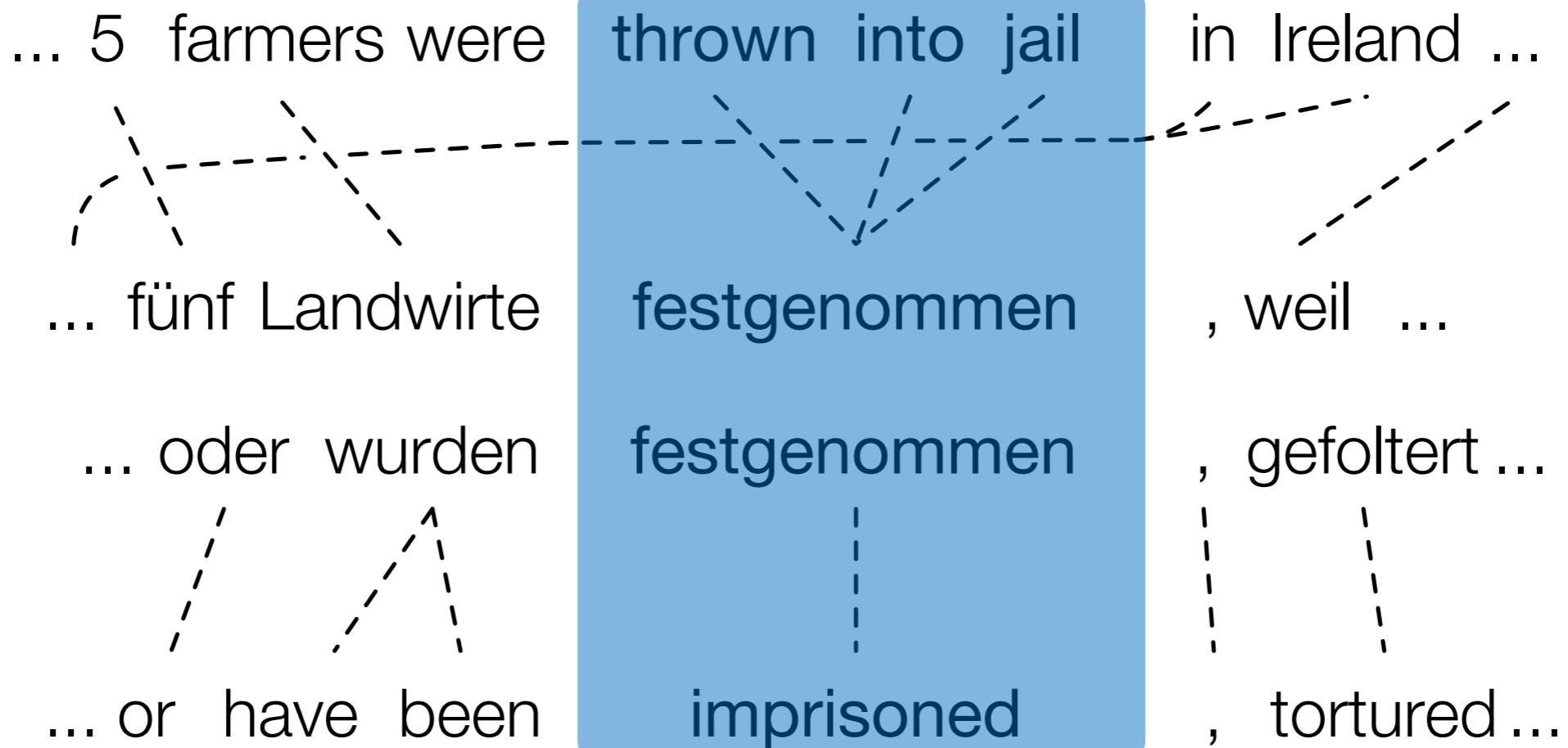
imprisoned

, gefoltert ...

, tortured ...

Bilingual Pivoting

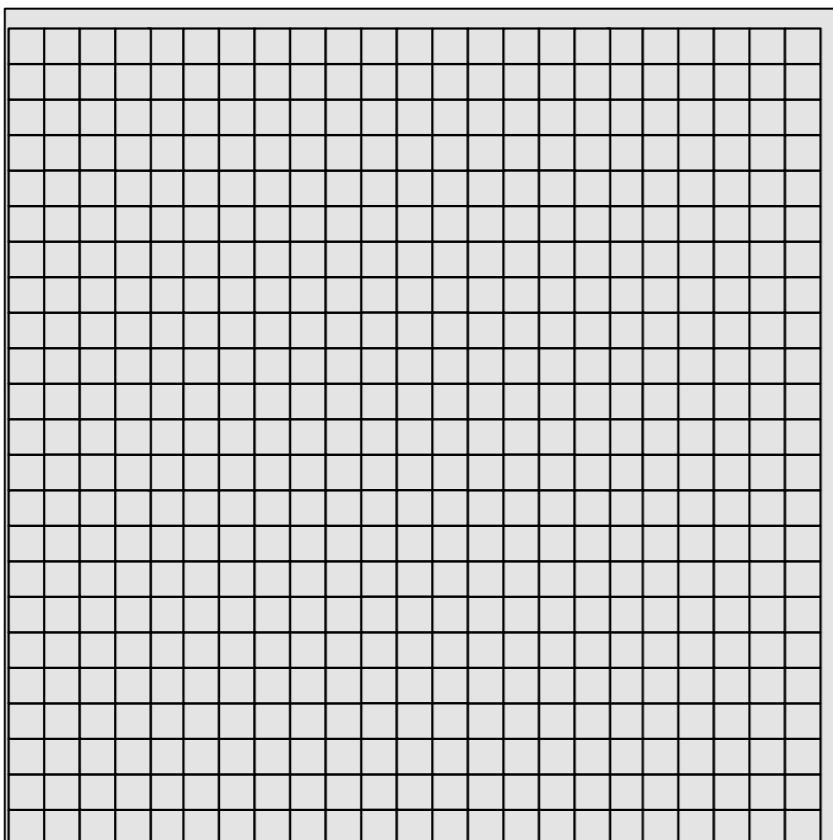
word alignment



Large and diverse

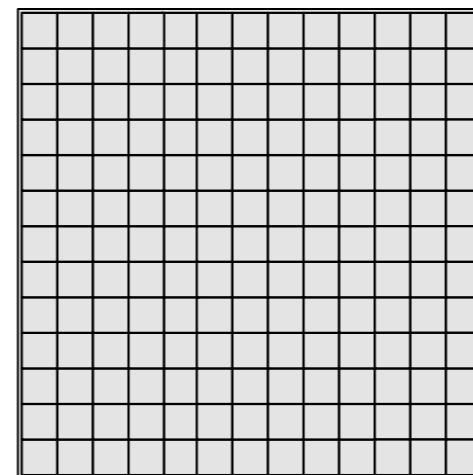
Bilingual Data Sets

1000M



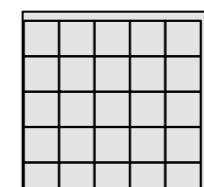
French-English
 10^9 word webcrawl

2 languages @
250M each



DARPA
GALE Program

21 languages @
50-80M each



European
Parliament

Wide range of **Paraphrases**

thrown into jail

Wide range of **Paraphrases**

thrown into jail

arrested

detained

imprisoned

incarcerated

jailed

locked up

taken into custody

thrown into prison

Wide range of

Paraphrases

thrown into jail

arrested

be thrown in prison

detained

been thrown into jail

imprisoned

being arrested

incarcerated

in jail

jailed

in prison

locked up

put in prison for

taken into custody

were thrown into jail

thrown into prison who are held in detention

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

Syntactic Constraints

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

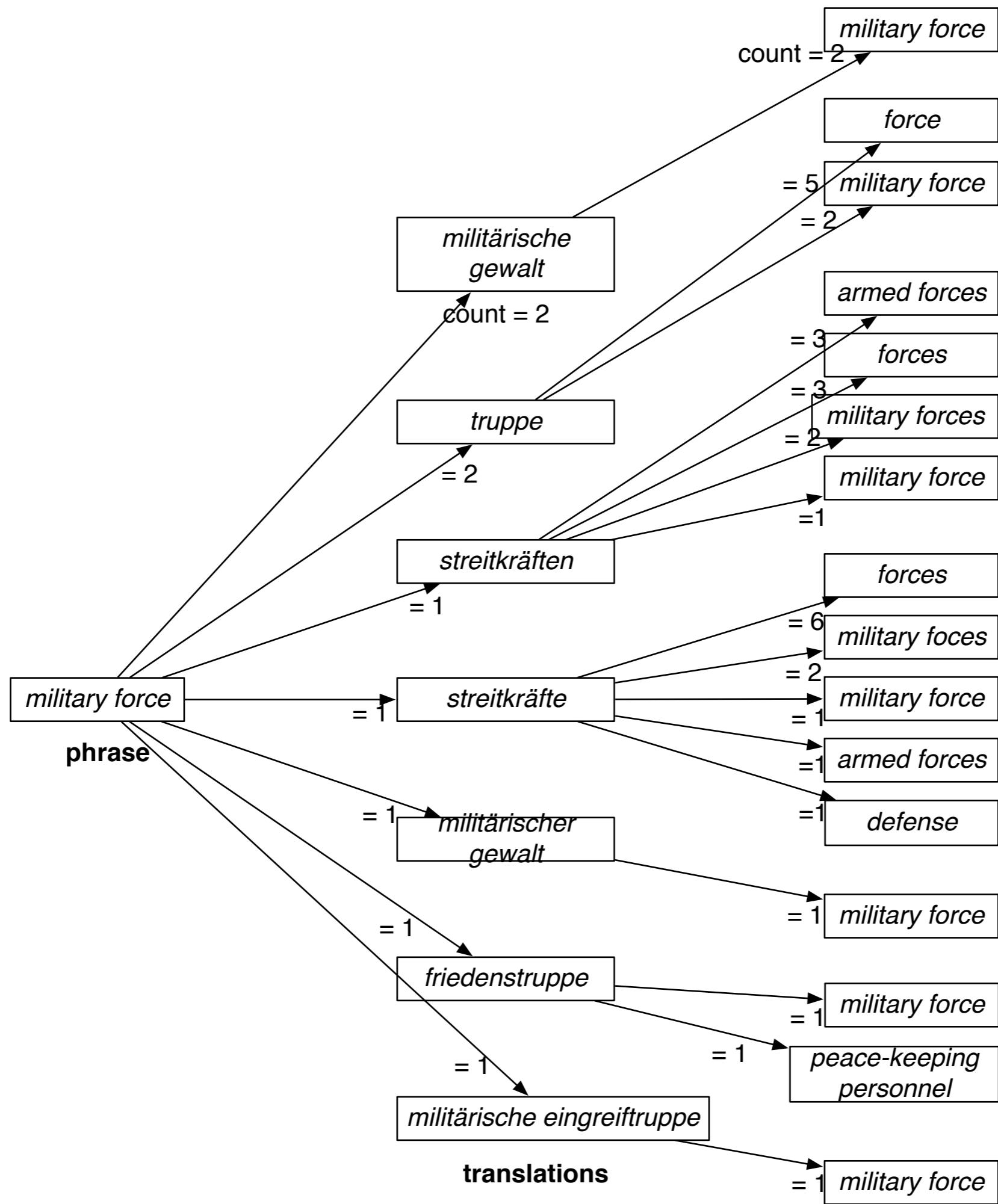
Source: Chris Callison-Burch

Paraphrase Probability

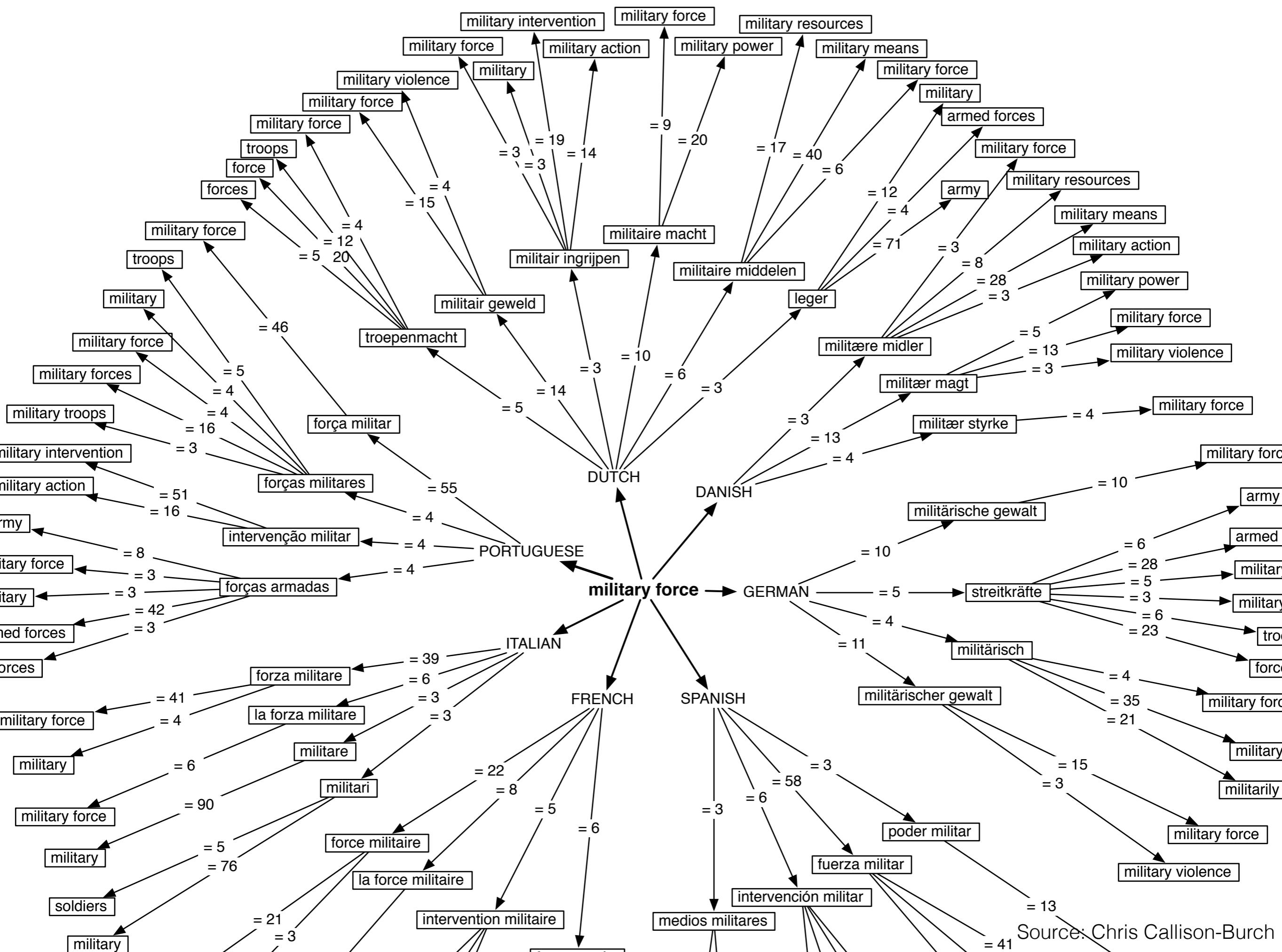
$$\begin{aligned} p(e_2|e_1) &= \sum_f p(e_2, f|e_1) \\ &= \sum_f p(e_2|f, e_1)p(f|e_1) \\ &\approx \sum_f p(e_2|f)p(f|e_1) \end{aligned}$$

Source: Chris Callison-Burch

Colin Bannard and Chris Callison-Burch. Paraphrasing with Bilingual Parallel Corpora. ACL 2005.



Source: Chris Callison-Burch



Source: Chris Callison-Burch

How about

Syntactic Paraphrases?

Bilingual parallel corpora provide an excellent source
of lexical and phrasal paraphrases.

Sentential/structural paraphrases are more obviously
learned from English-English sentence pairs.

Can we learn structural paraphrases from bitexts?
How should we represent them?

Syntactic Machine Translation

	Urdu	English
$S \rightarrow$	$NP\textcircled{1} \ VP\textcircled{2}$	$NP\textcircled{1} \ VP\textcircled{2}$
$VP \rightarrow$	$PP\textcircled{1} \ VP\textcircled{2}$	$VP\textcircled{2} \ PP\textcircled{1}$
$VP \rightarrow$	$V\textcircled{1} \ AUX\textcircled{2}$	$AUX\textcircled{2} \ V\textcircled{1}$
$PP \rightarrow$	$NP\textcircled{1} \ P\textcircled{2}$	$P\textcircled{2} \ NP\textcircled{1}$
$NP \rightarrow$	<i>hamd ansary</i>	<i>Hamid Ansari</i>
$NP \rightarrow$	<i>na}b sdr</i>	<i>Vice President</i>
$V \rightarrow$	<i>namzd</i>	<i>nominated</i>
$P \rightarrow$	<i>kylye</i>	<i>for</i>
$AUX \rightarrow$	<i>taa</i>	<i>was</i>

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

Urdu

hamd ansary na}b sdr kylye namzd taa

English

Urdu

NP1
△

hamd ansary

na}b sdr

kylye

namzd

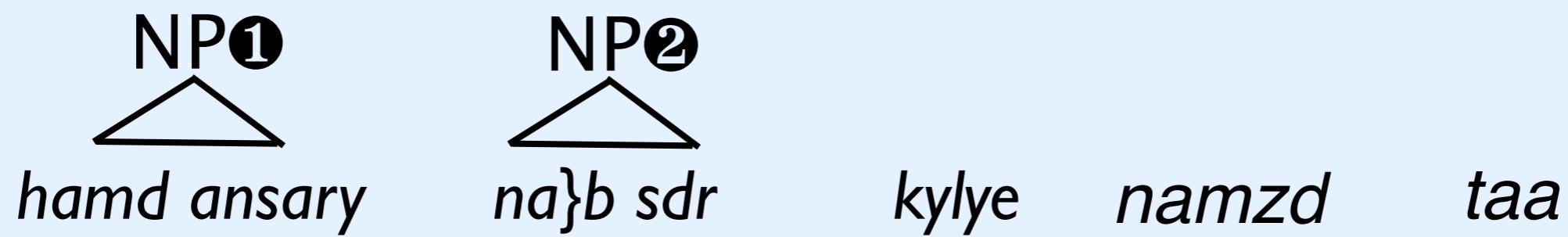
taa

English

NP1
△

Hamid Ansari

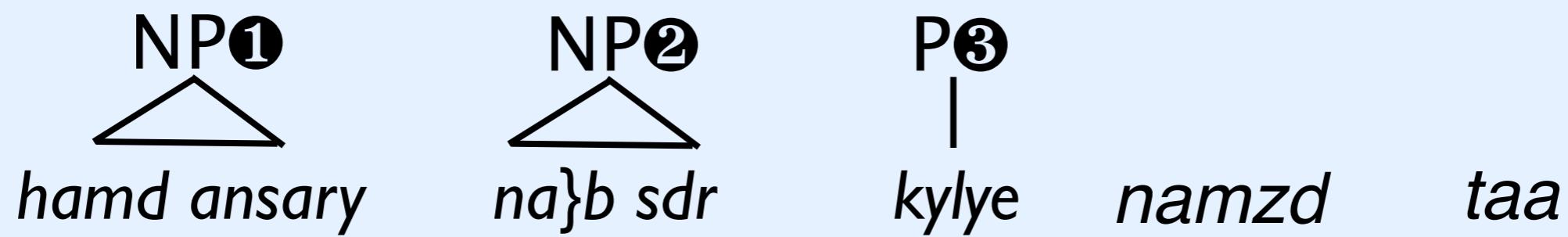
Urdu



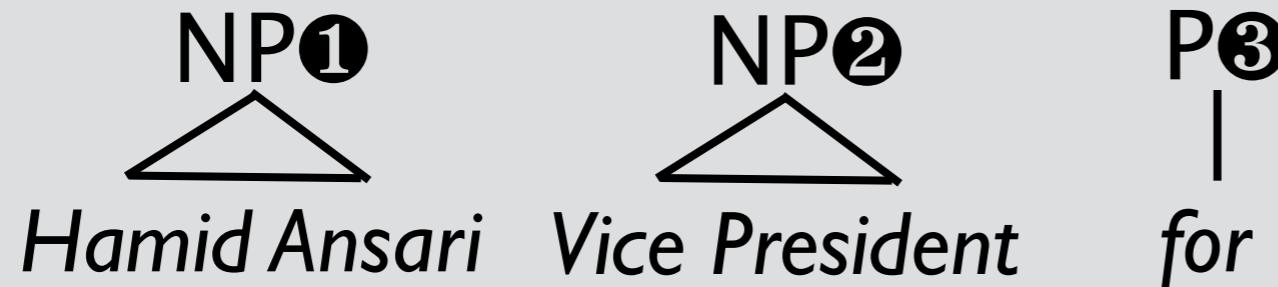
English



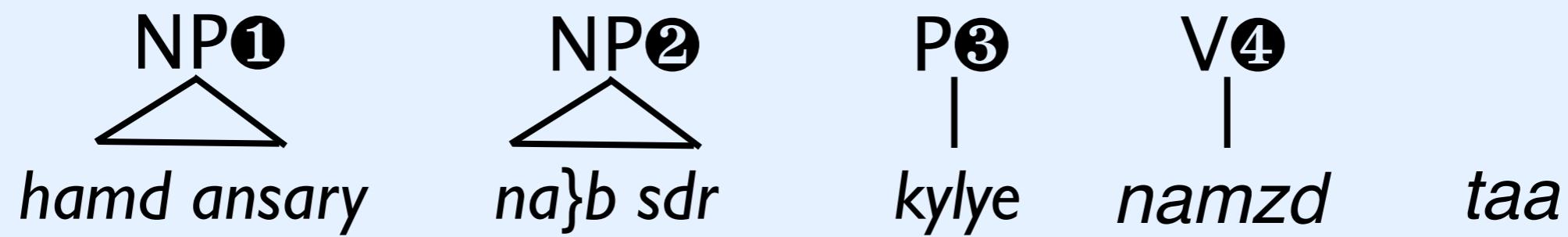
Urdu



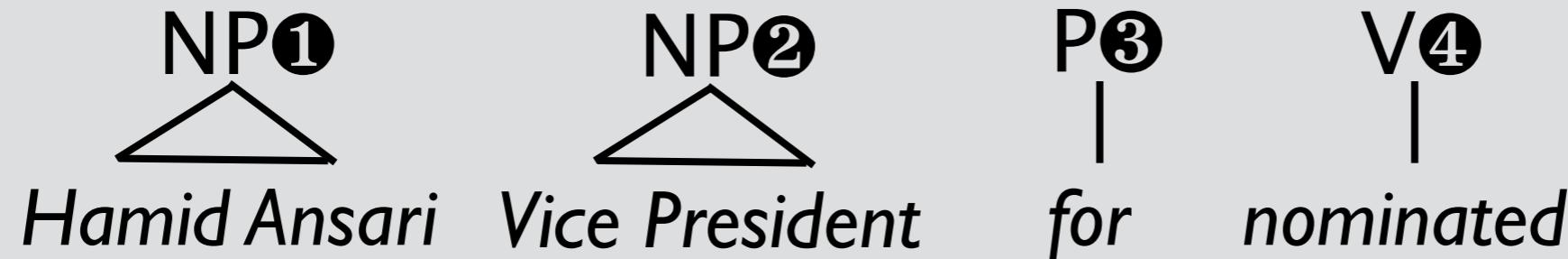
English



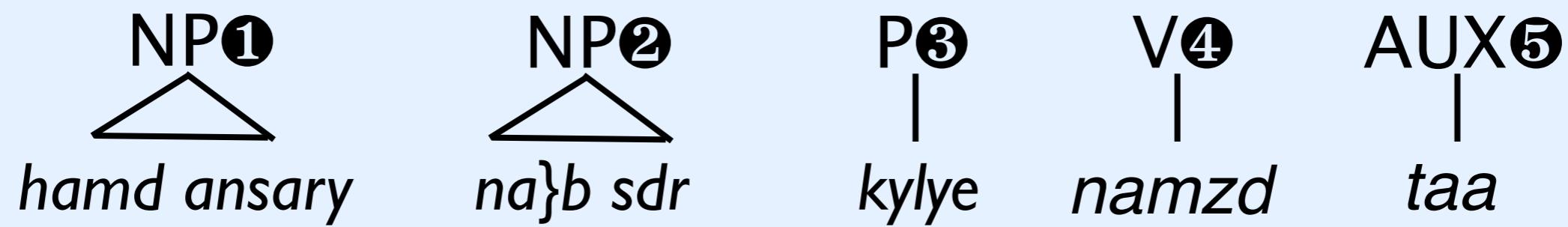
Urdu



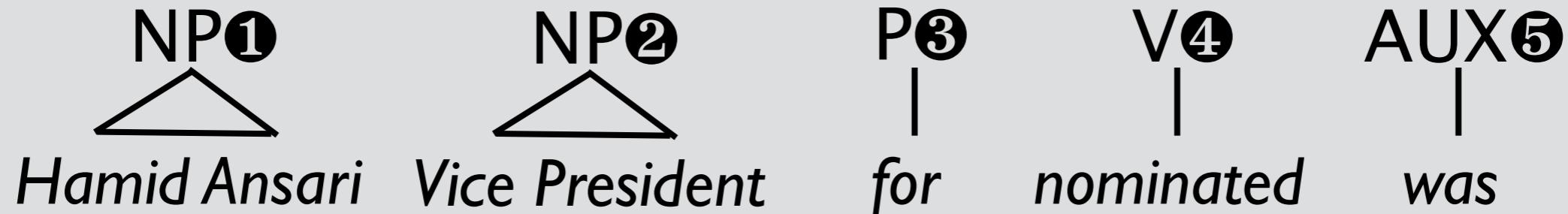
English



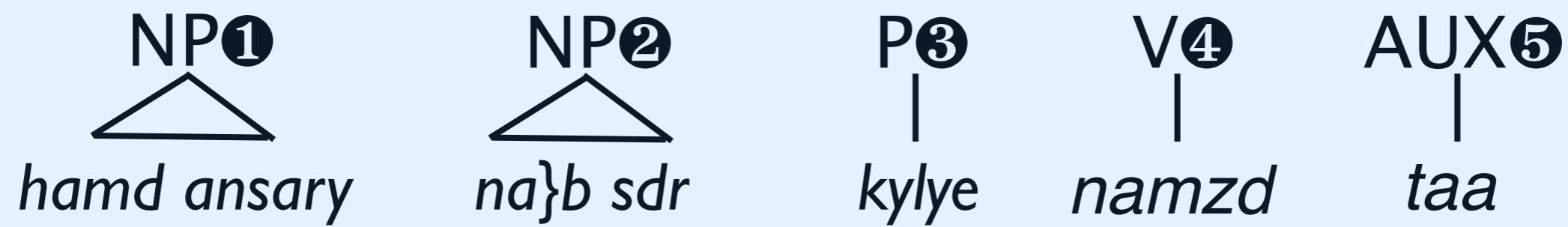
Urdu



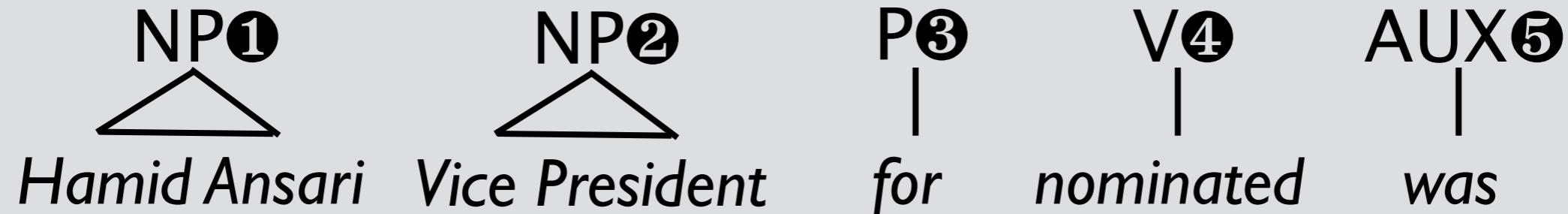
English



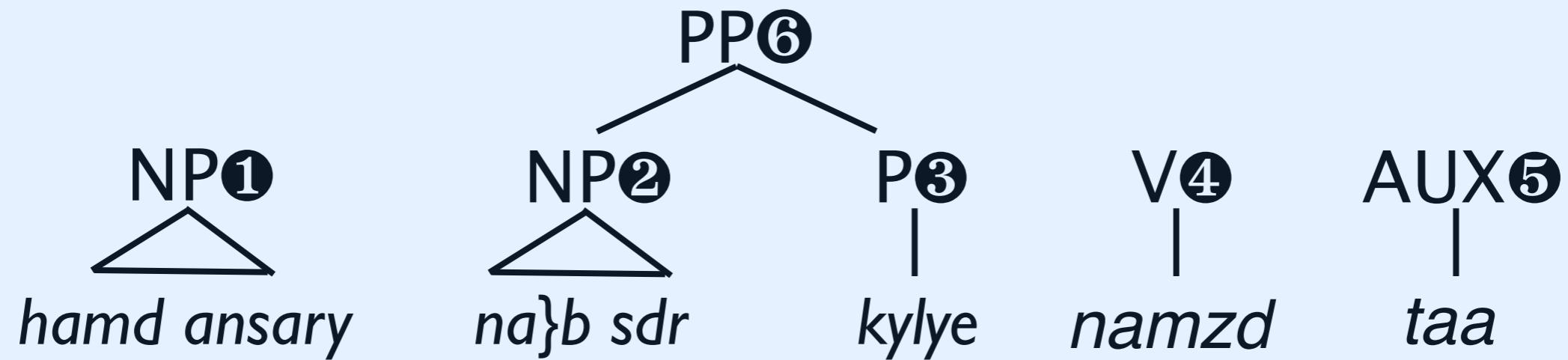
Urdu



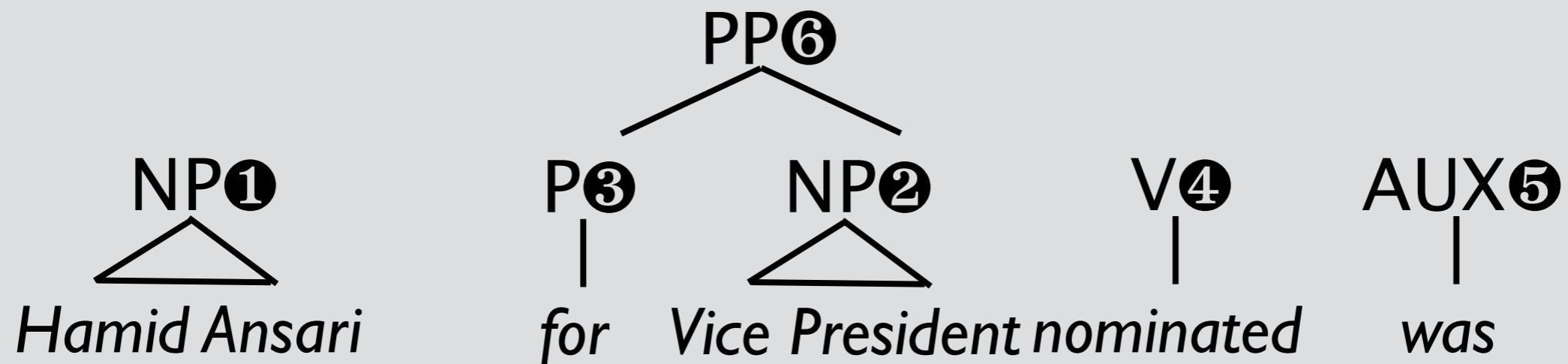
English



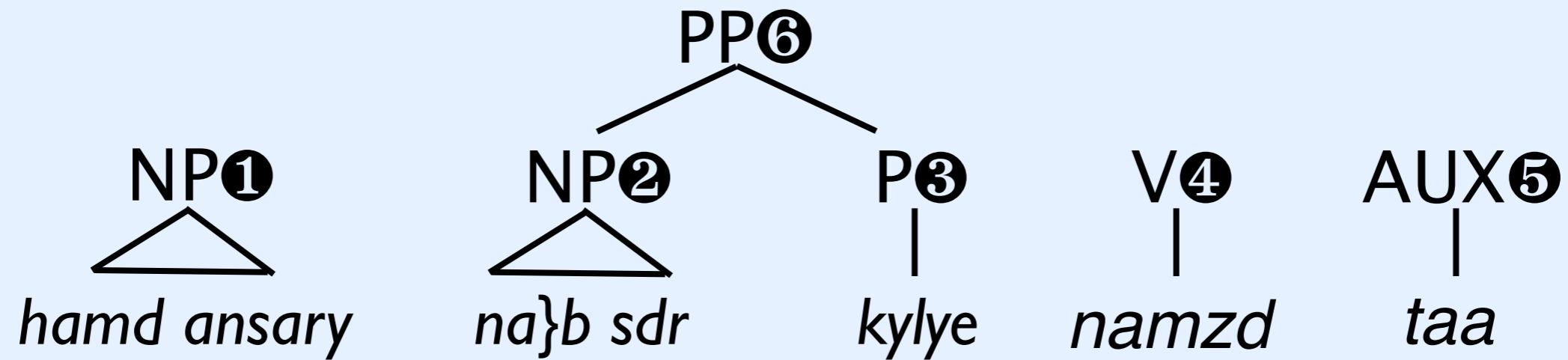
Urdu



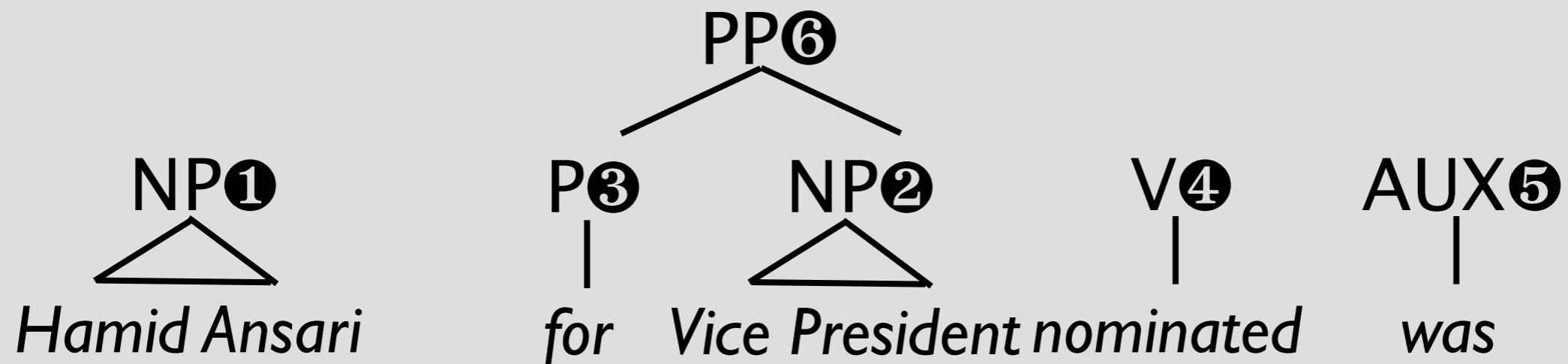
English



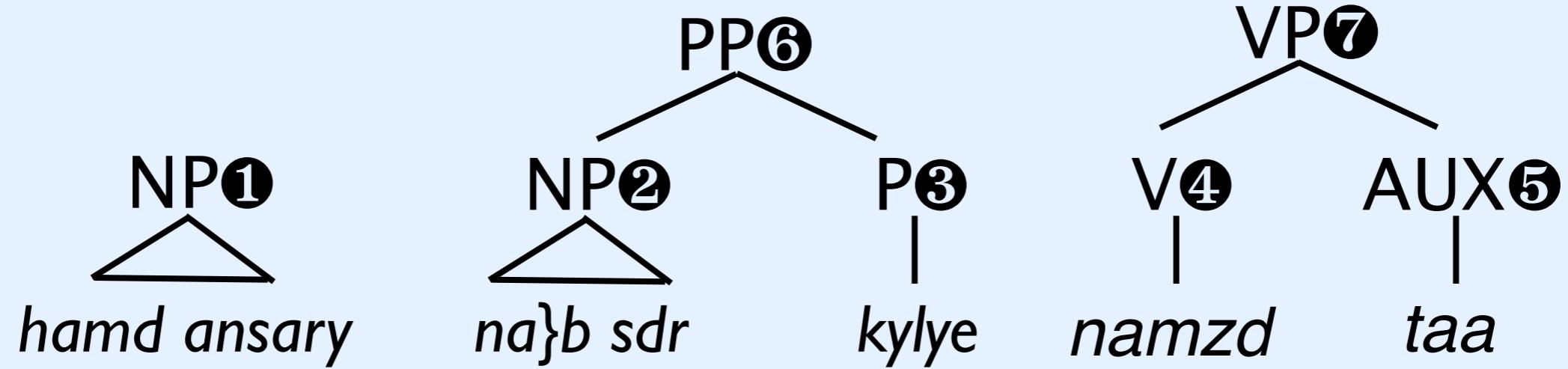
Urdu



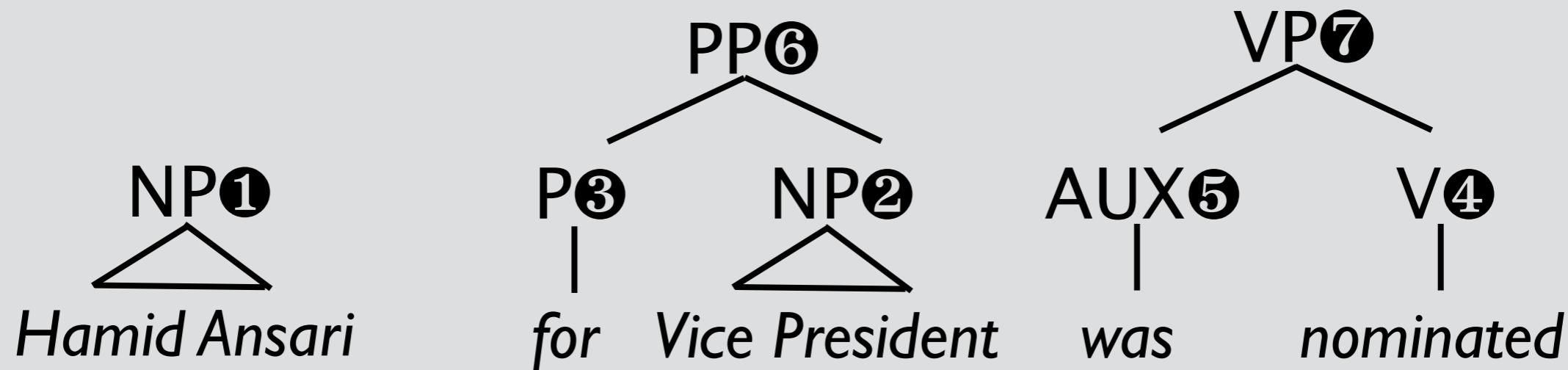
English



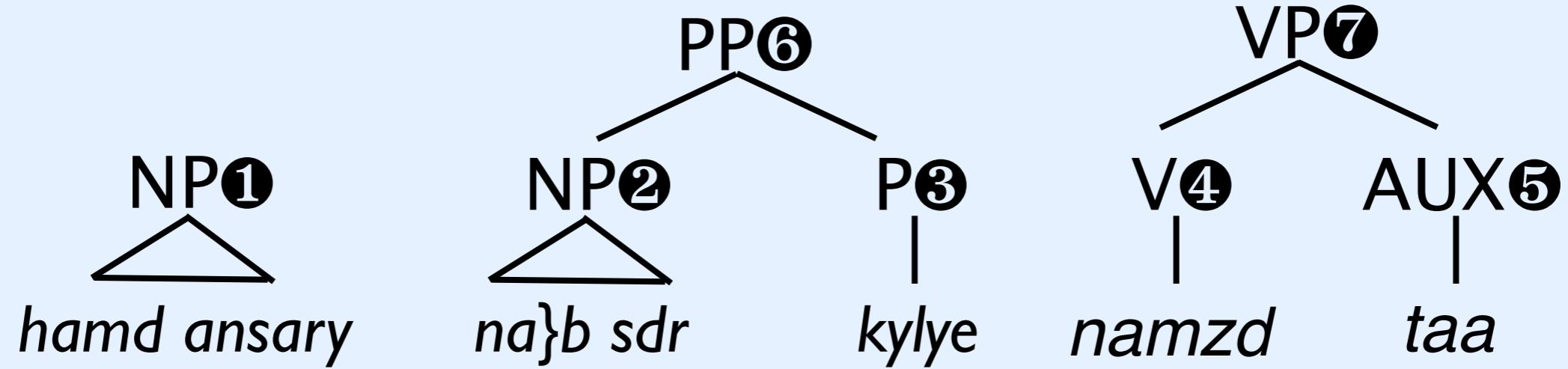
Urdu



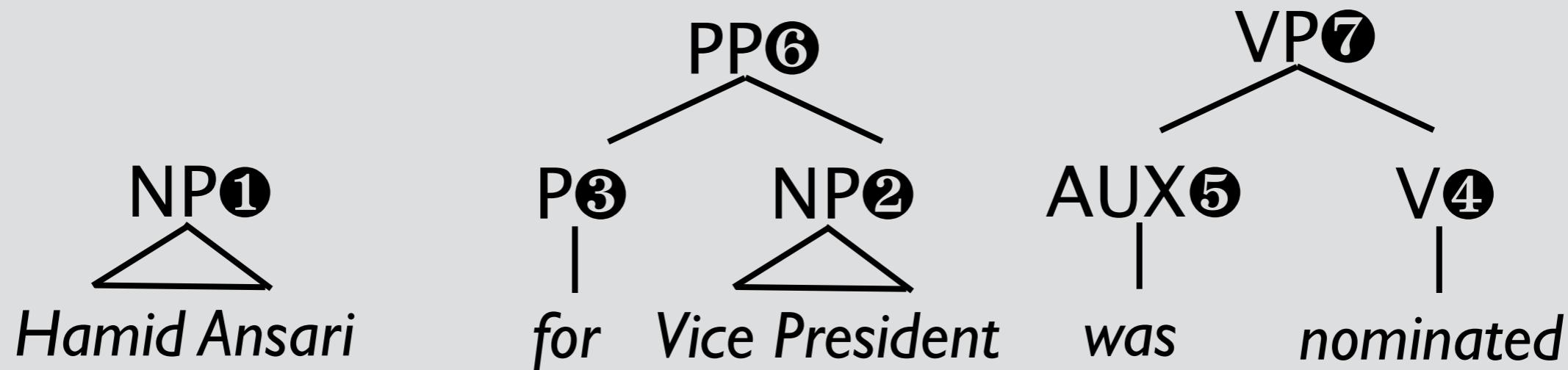
English



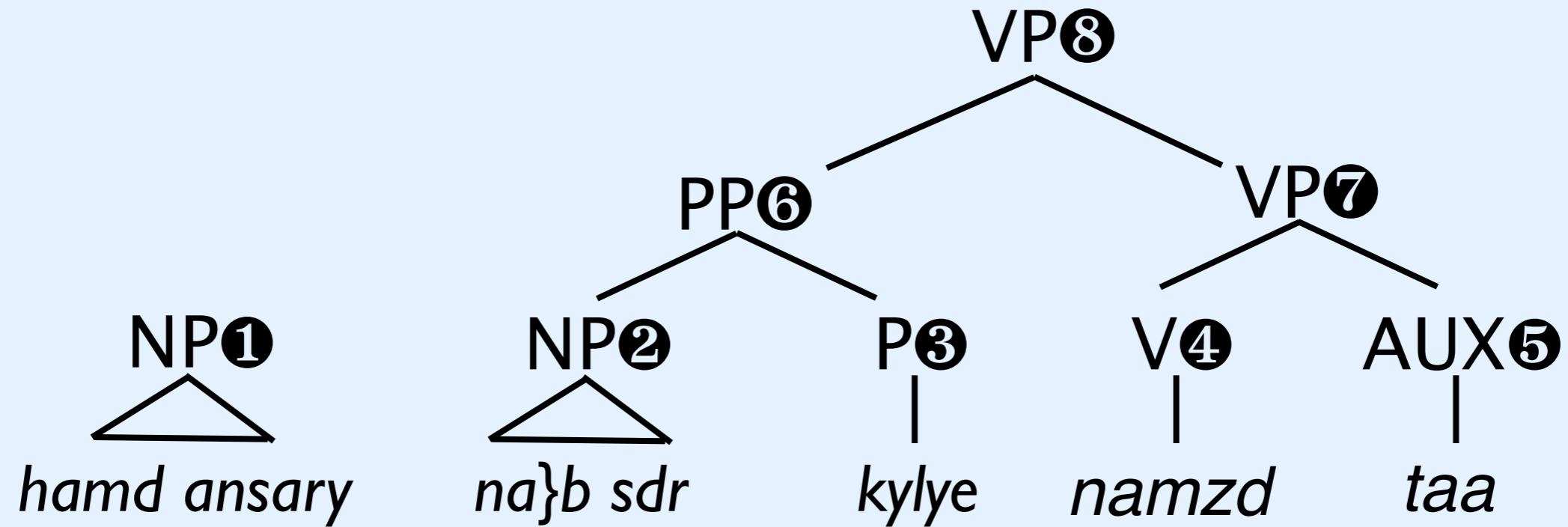
Urdu



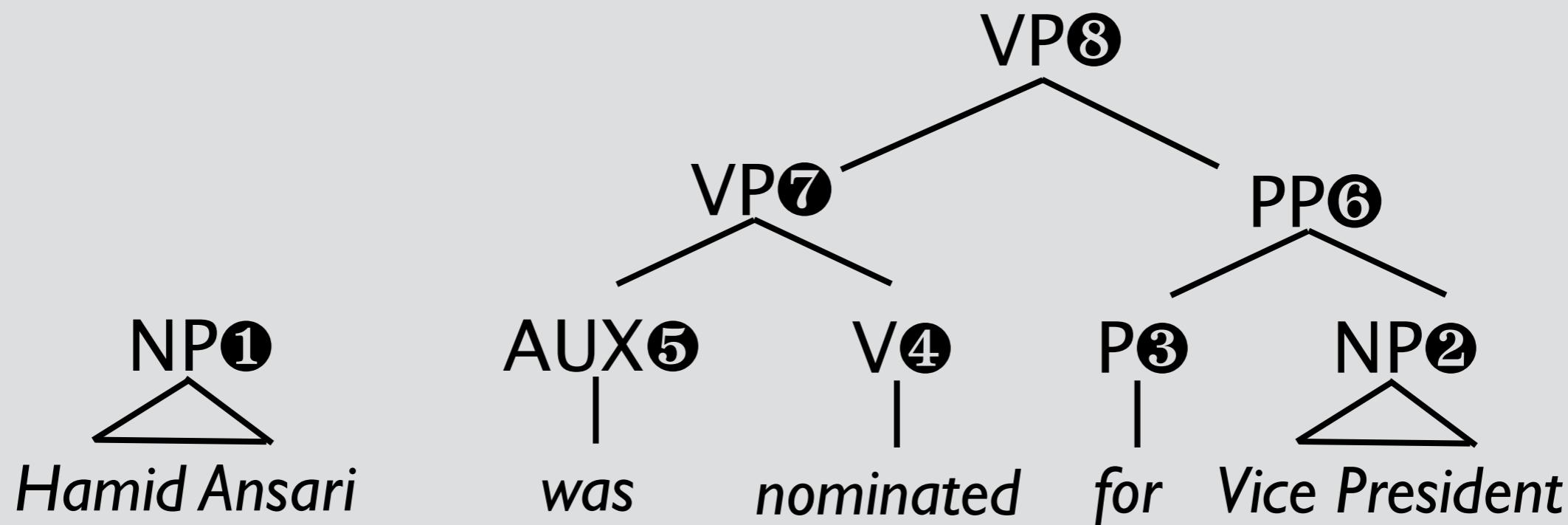
English



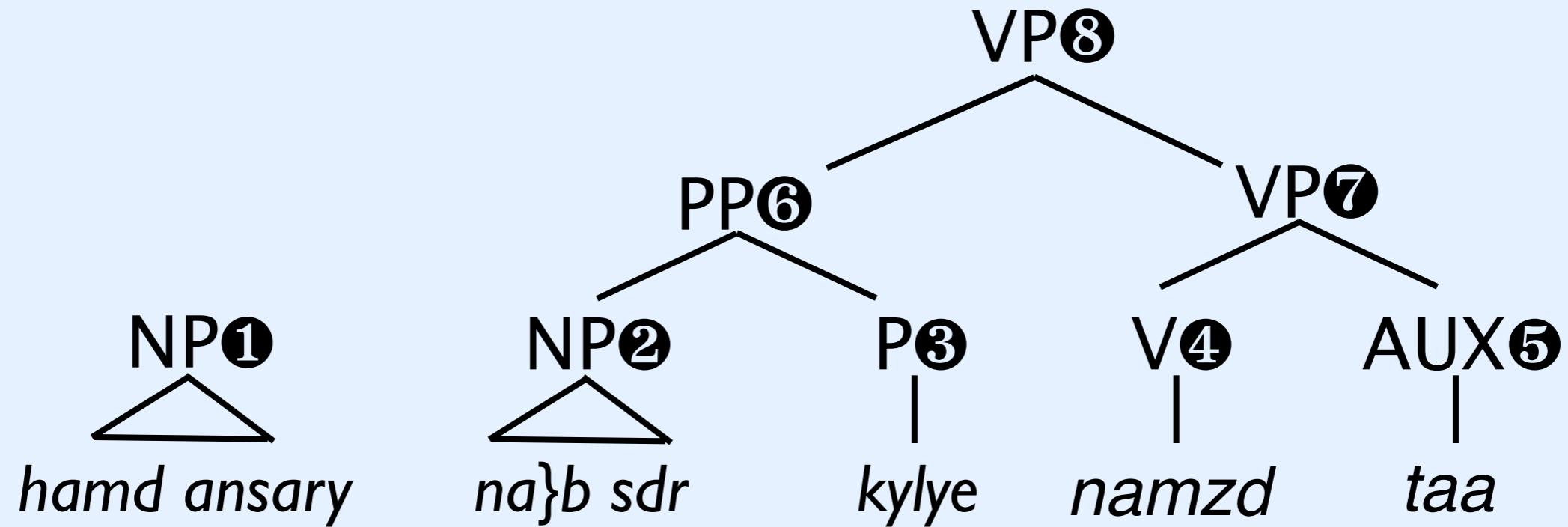
Urdu



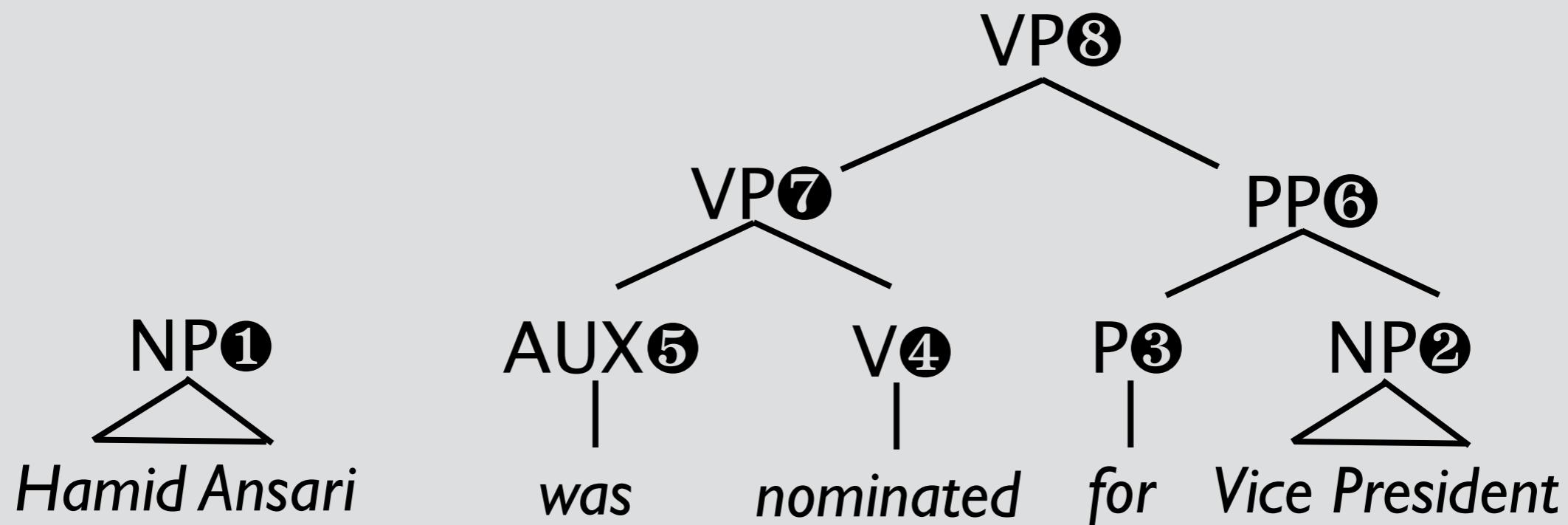
English



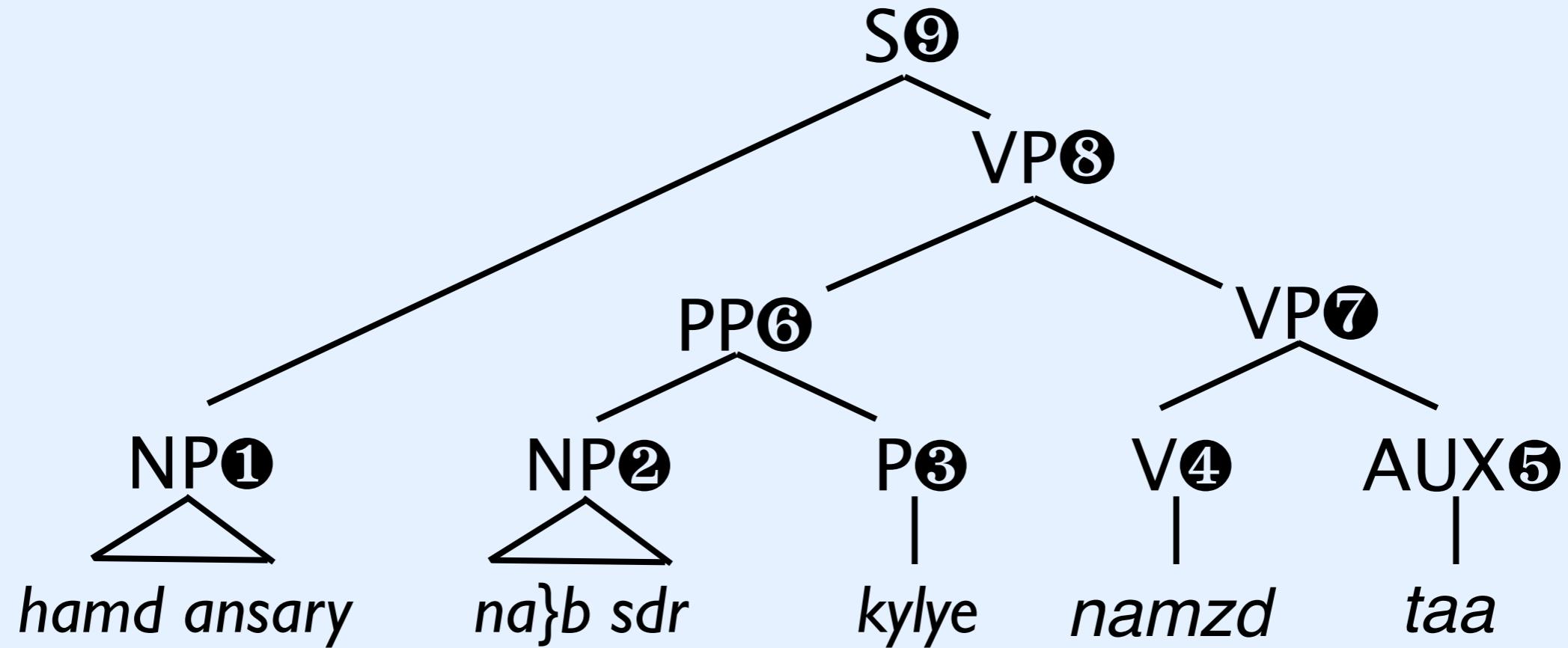
Urdu



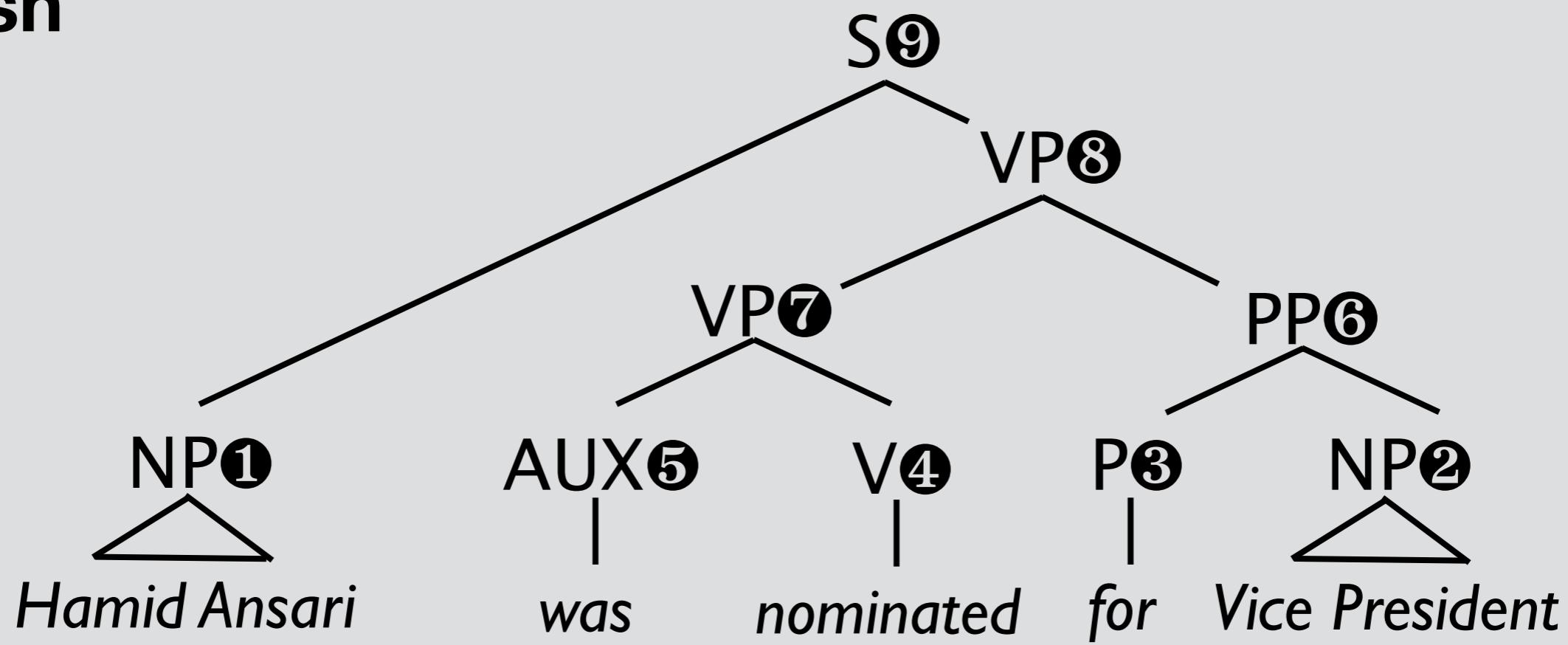
English



Urdu



English



Syntactic Paraphrase via Pivoting

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

NP →	NP 's NN		le NN de NP
NP →	the NN of NP		le NN de NP

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combine to

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NP → NP 's NN | le NN de NP

NP → the NN of NP | le NN de NP

combine to

NP → NP 's NN | the NN of NP

Distributional Similarity

Idea: similar words occur in similar contexts.

Characterize words by their contexts

Contexts represented by co-occurrence vectors, similarity quantified by cosine

“Are these paraphrases substitutable?”

Similarity

Easy for lexical & phrasal paraphrases

More involved for syntactic paraphrases

Similarity

Easy for lexical & phrasal paraphrases

More involved for syntactic paraphrases

cup

↔

mug

Similarity

Easy for lexical & phrasal paraphrases

More involved for syntactic paraphrases

..sip from a cup of cocoa..

..a cup of coffee.

cup

..sip from a mug of cocoa..

..a mug of coffee.



mug

Similarity

Easy for lexical & phrasal paraphrases

More involved for syntactic paraphrases



cup



mug

Similarity

Easy for lexical & phrasal paraphrases

More involved for syntactic paraphrases



cup



mug

the king's speech

↔ His Majesty's address

Similarity

Easy for lexical & phrasal paraphrases

More involved for syntactic paraphrases



cup



mug

..anxiously awaiting the king's
speech..

the king's speech

..anxiously awaiting His
Majesty's address..

His Majesty's address

Similarity

Easy for lexical & phrasal paraphrases

More involved for syntactic paraphrases



cup



mug



the king's speech



His Majesty's address

Similarity

Easy for lexical & phrasal paraphrases

More involved for syntactic paraphrases



cup



mug



the king's speech



His Majesty's address

one JJ instance of NP



a JJ case of NP

Similarity

Easy for lexical & phrasal paraphrases

More involved for syntactic paraphrases



cup



mug



the king's speech



His Majesty's address



one JJ instance of NP



a JJ case of NP

Syntactic Paraphrase Similarity

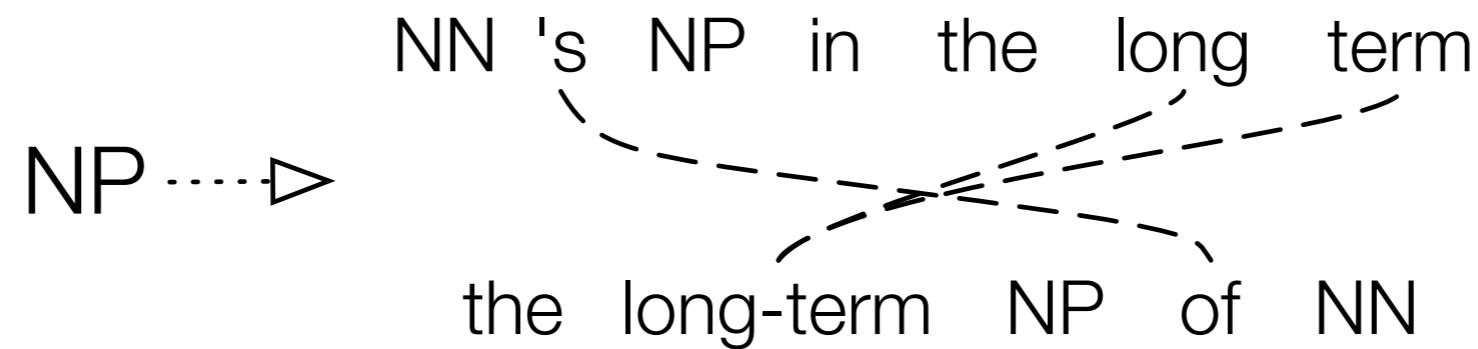
NN 's NP in the long term

NP>

the long-term NP of NN

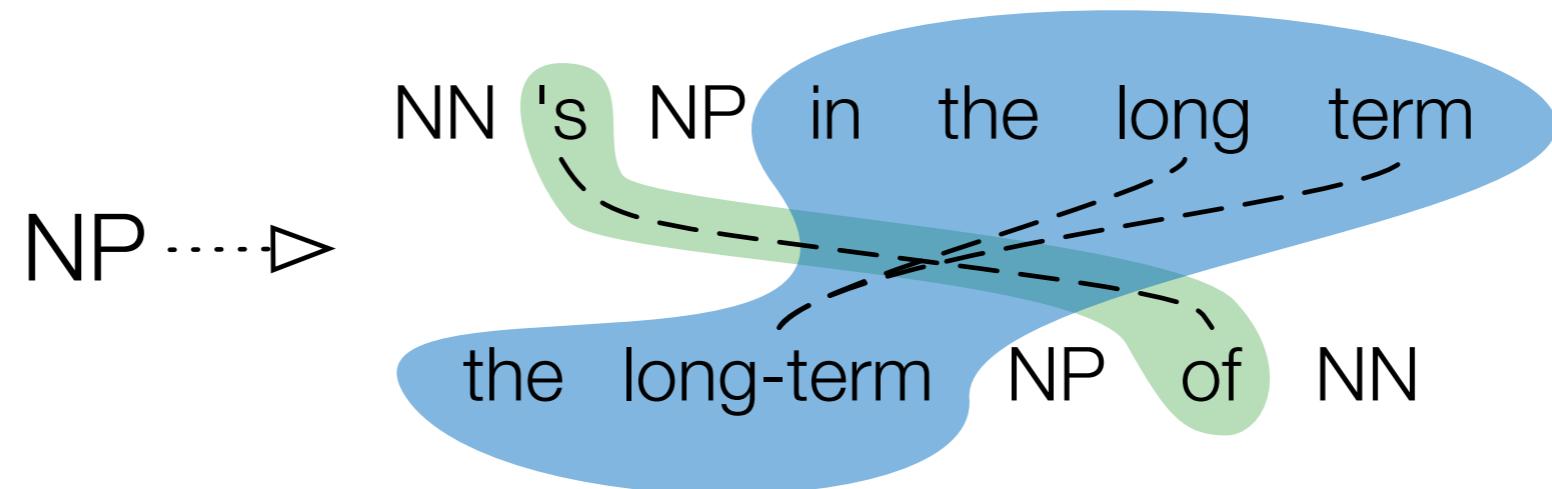
Source: Chris Callison-Burch

Syntactic Paraphrase Similarity



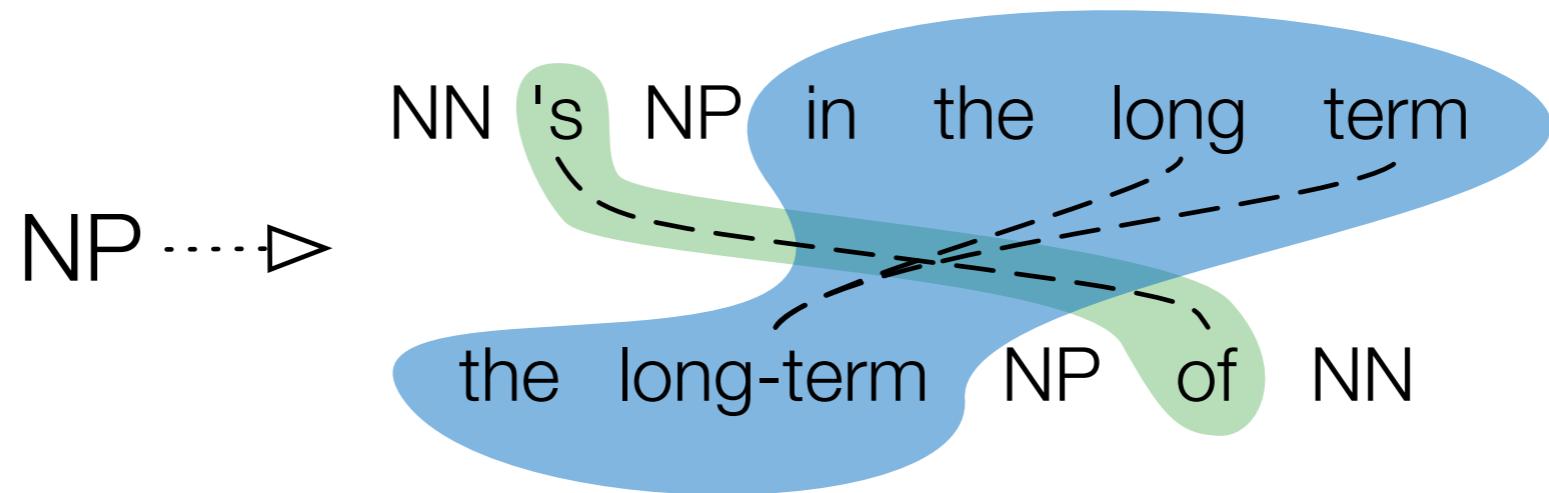
Source: Chris Callison-Burch

Syntactic Paraphrase Similarity



Source: Chris Callison-Burch

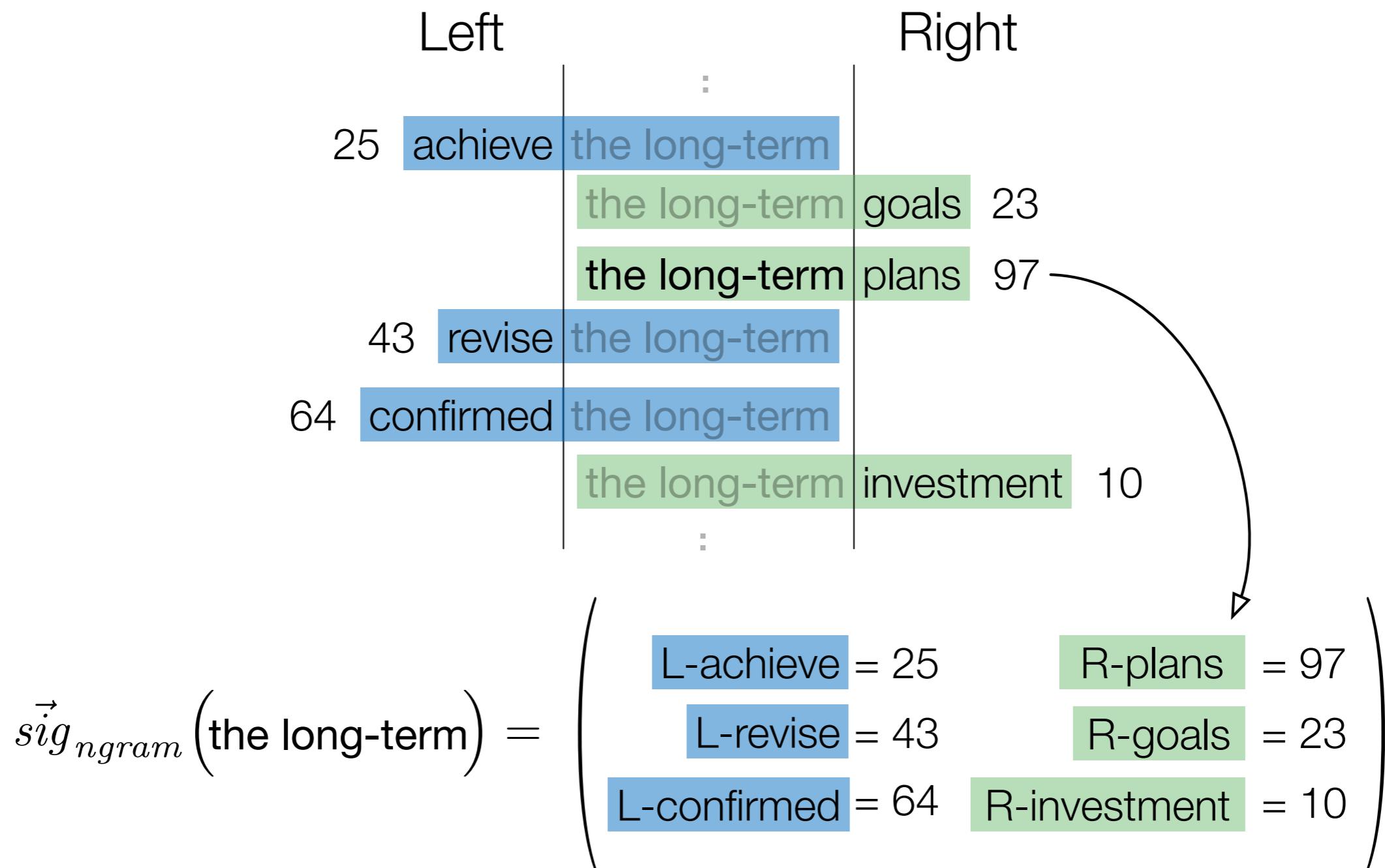
Syntactic Paraphrase Similarity



$$sim(\mathbf{r}) = \frac{1}{2} \left(sim\left(\text{the long-term} \atop \text{in the long term} \right) + sim\left(\text{'s} \atop \text{of} \right) \right)$$

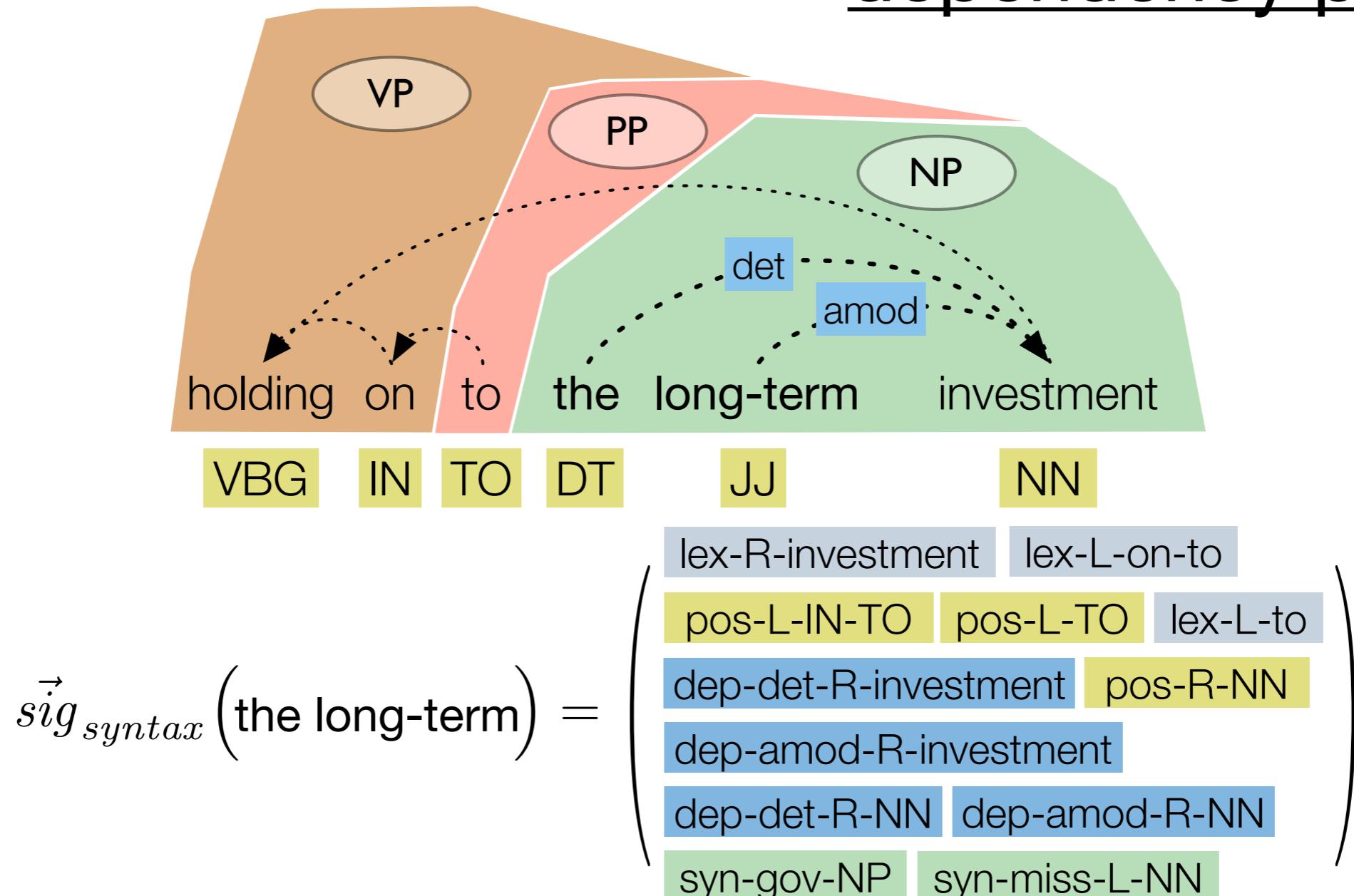
Source: Chris Callison-Burch

n -gram Context



Syntactic Context

dependency parsing



Large Monolingual Data Sets

Google n-grams

Collection of 1 trillion tokens with counts

Based on vast amounts of text

Annotated Gigaword (AKBC-WEKEX '12)

Collection of 4 billion words, parsed and tagged

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

Language

English

All

Lexical

One-To-Many

Phrasal

Syntactic

Select size of pack

S Size

M Size

L Size

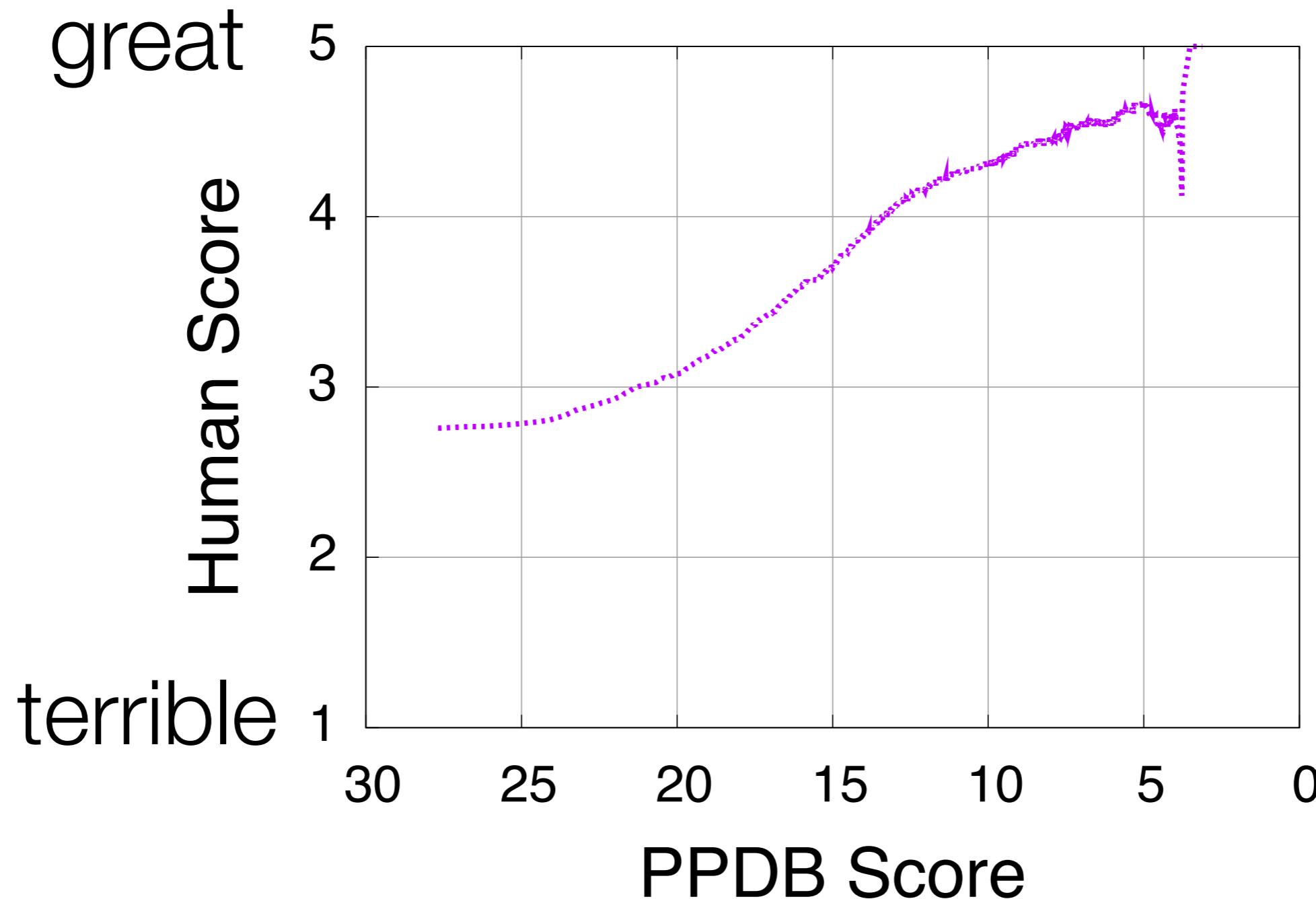
XL Size

XXL Size

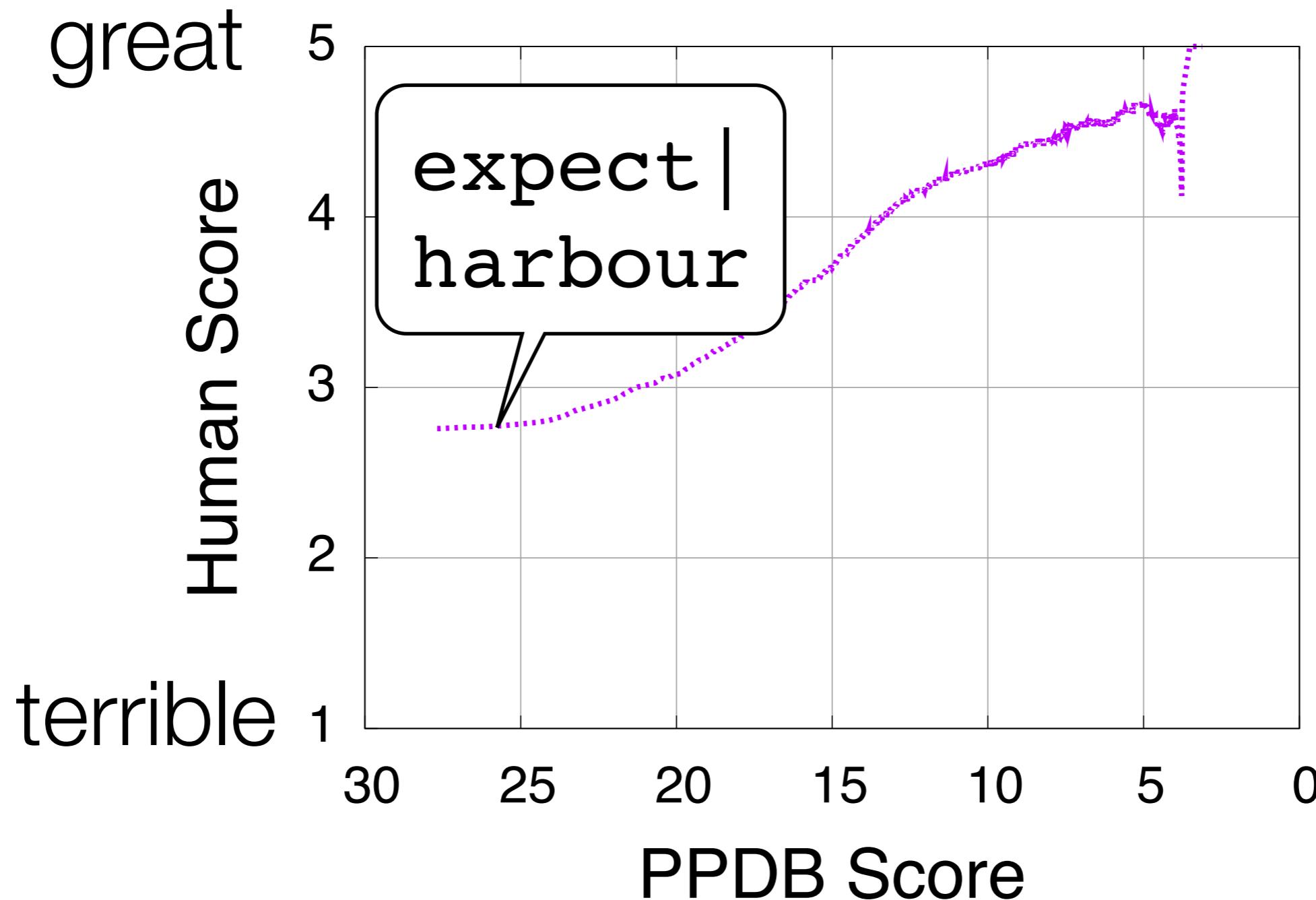
XXXL Size

💡

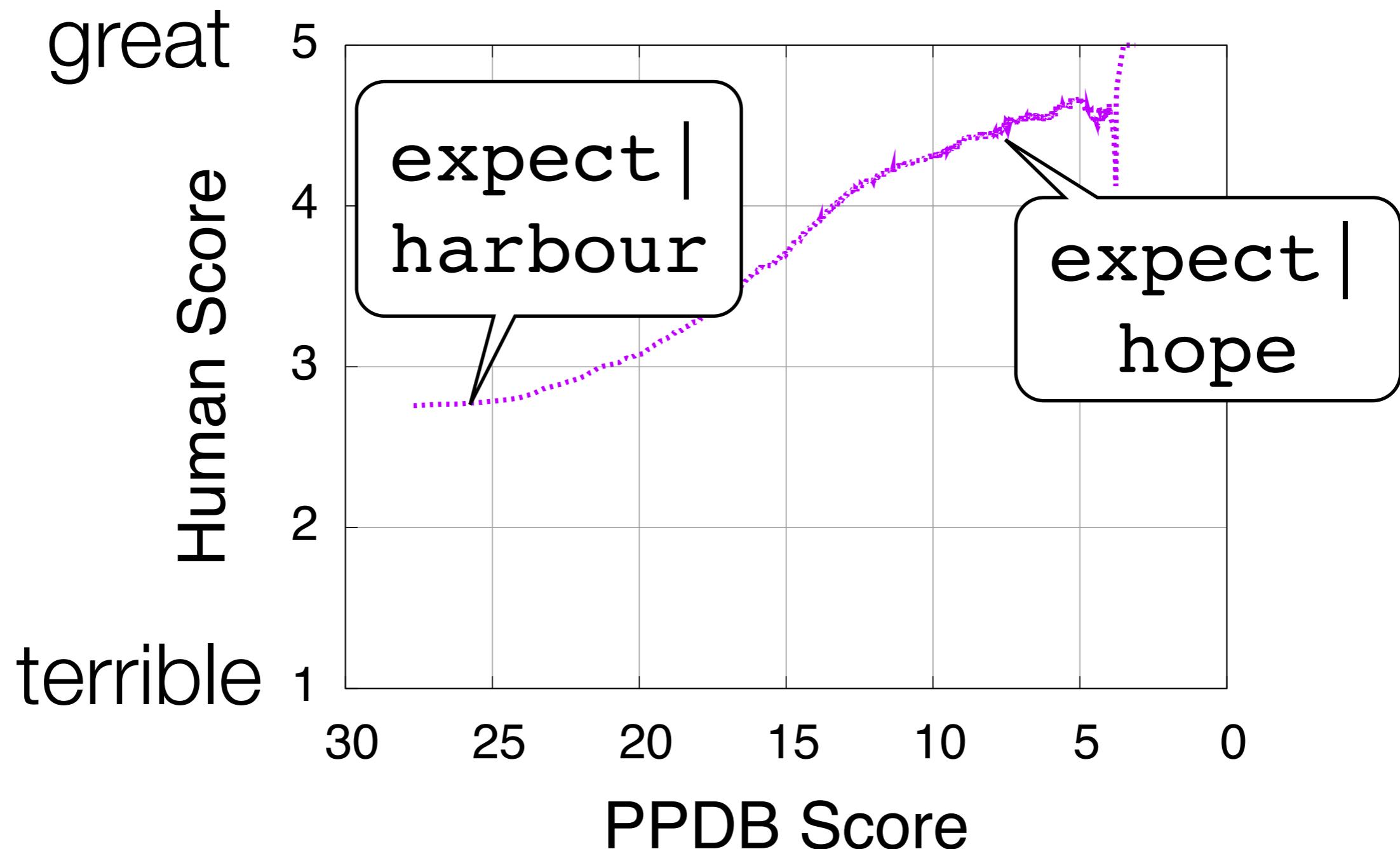
Do the Scores Work?



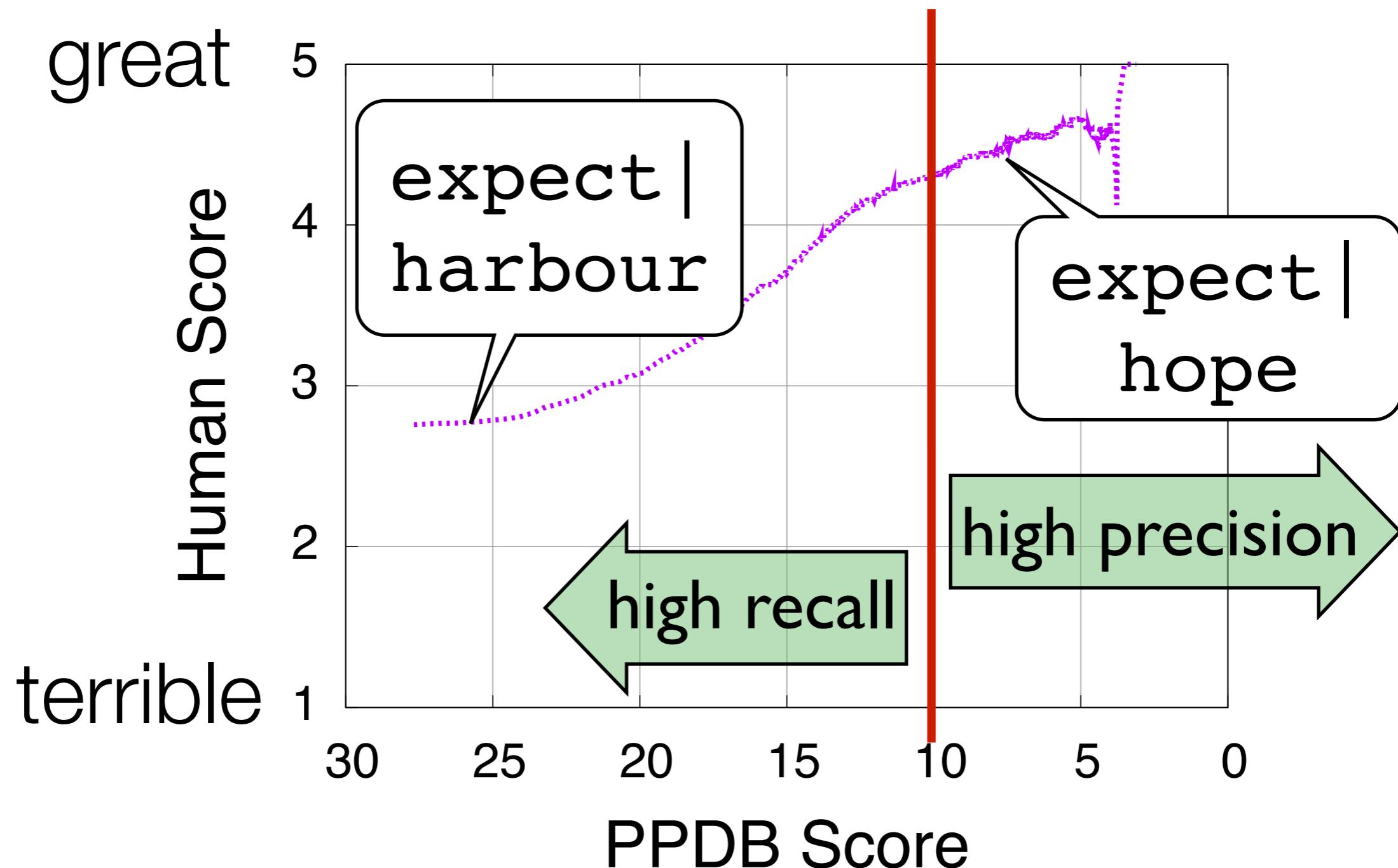
Do the Scores Work?



Do the Scores Work?



Do the Scores Work?



Fun PPDB Examples

**P A R E N T A L
A D V I S O R Y
E X P L I C I T C O N T E N T**

Fun PPDB Examples

munchies ||| hungry

hustle ||| scam

sexiest ||| hottest

dummies ||| losers

sheeit ||| dammit

abso-fucking-lutely ||| indeed

Quiz #3

socialmedia-class.org