Language Technology

CUNY Graduate Center, Spring 2013

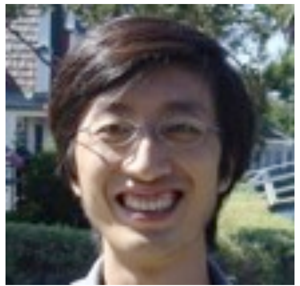
Professor Liang Huang

huang@cs.qc.cuny.edu

http://acl.cs.qc.edu/~lhuang/teaching/nlp

Logistics

- Lectures M 4:15-6:15 pm Room 5383
- Personnel
  - Instructor Prof. Liang Huang huang@cs.qc.cuny.edu
  - TA TBD



- Office Hours
  - LH right after class (and occasionally on Fridays)
  - additional office hours available before quizzes/exams
- Homepage: http://acl.cs.qc.edu/~lhuang/teaching/nlp

Communication

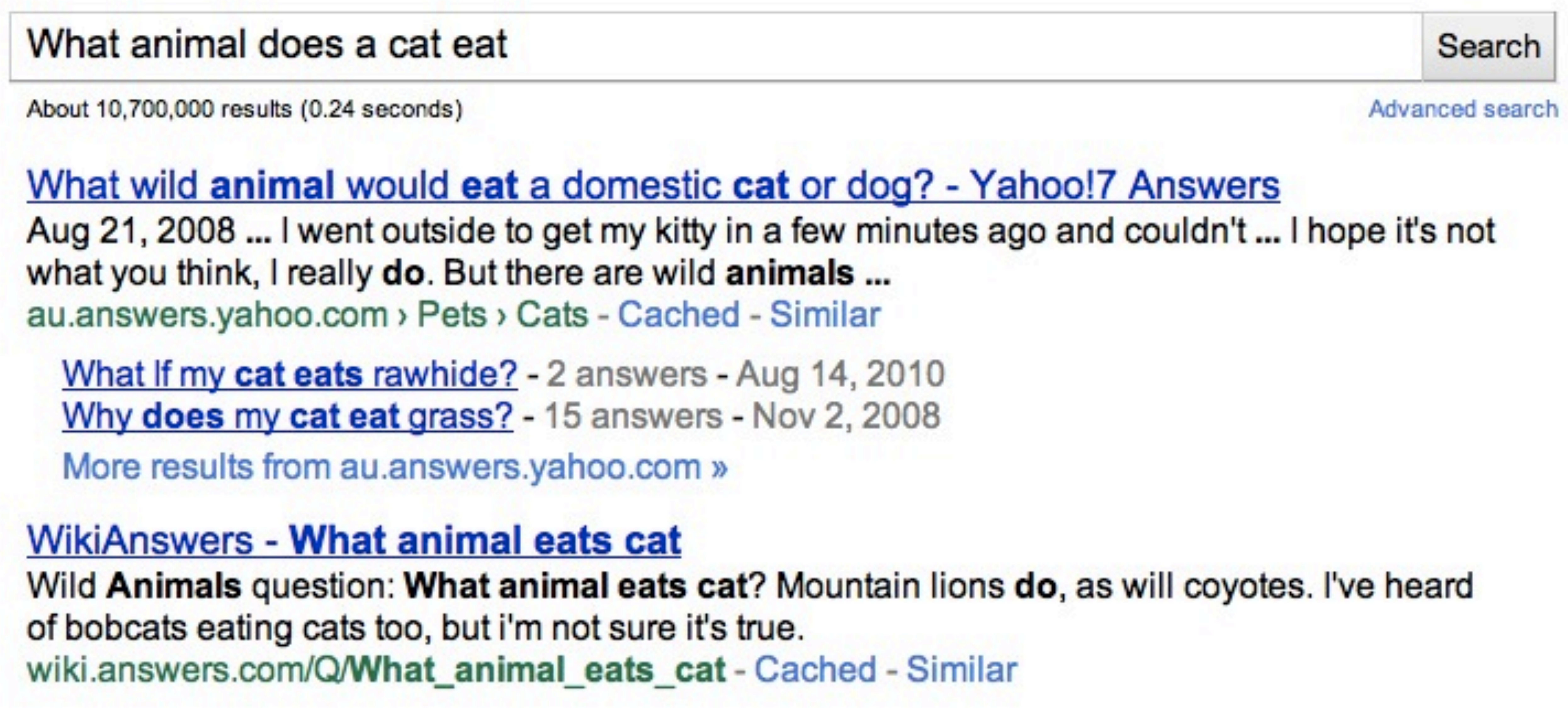
- Course Homepage
  - schedule, syllabus, homework, handouts, etc.
- Newsgroup
  - questions and discussions => post your Qs here first!
  - part of class participation (5% of grades)
  - we'll monitor newsgroup
- Announcements will be emailed to you
- Blackboard -- the [2nd] worst software I ever used!
  - grades and electronic submissions

Grades (subject to change; version 3/15)

- Homework: 10+15+10+13 = 48%.
  - programming exercises in Python + pen-n-paper exercises
  - late penalty: you can submit two HWs late (by 48 hours each).
- Quizzes: 7%
- Final Project: 5 (proposal) + 5 (talk) +15 (report) =25% -- indiv. or pair
- Exercises: 5+5=10% -- graded by completeness, not correctness
- Class Participation: 10%
  - asking/answering questions in class; helping peers on HWs (5%)
  - catching/fixing bugs in slides/exams/hw & other suggestions (2%)
  - reward for submitting less than 2 HWs late (3%)

Doesn’t Google know everything?

What animal does a cat eat?



About 10,700,000 results (0.24 seconds)

What wild **animal** would **eat** a domestic **cat** or dog? - Yahoo!7 Answers

Aug 21, 2008 ... I went outside to get my kitty in a few minutes ago and couldn't ... I hope it's not what you think, I really **do**. But there are wild **animals** ...

au.answers.yahoo.com › Pets › Cats - Cached - Similar

What If my **cat eats** rawhide? - 2 answers - Aug 14, 2010

Why **does** my **cat eat** grass? - 15 answers - Nov 2, 2008

More results from au.answers.yahoo.com »

WikiAnswers - **What animal eats cat**

Wild **Animals** question: **What animal eats cat**? Mountain lions **do**, as will coyotes. I've heard of bobcats eating cats too, but i'm not sure it's true.

wiki.answers.com/Q/**What_animal_eats_cat** - Cached - Similar

Retrieved August 2010

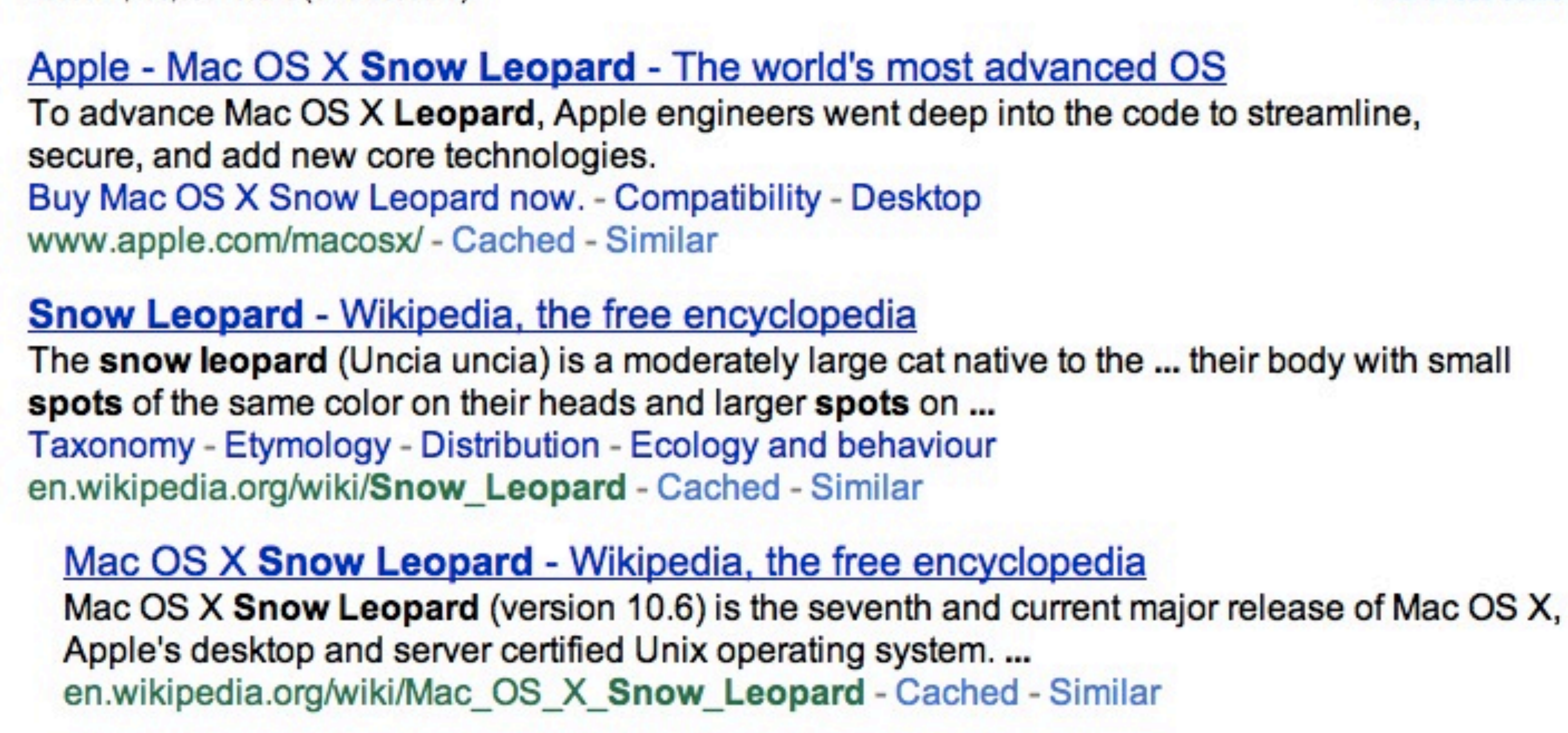
Even Key Word Queries

- Paris Hilton -- not easy to book! (vs. Boston Hilton)

Ambiguity

Where can I spot a snow leopard?

Where can I spot a snow leopard



About 27,400,000 results (0.19 seconds)

Apple - Mac OS X **Snow Leopard** - The world's most advanced OS
To advance Mac OS X **Leopard**, Apple engineers went deep into the code to streamline, secure, and add new core technologies.
Buy Mac OS X Snow Leopard now. - Compatibility - Desktop
www.apple.com/macosx/ - Cached - Similar

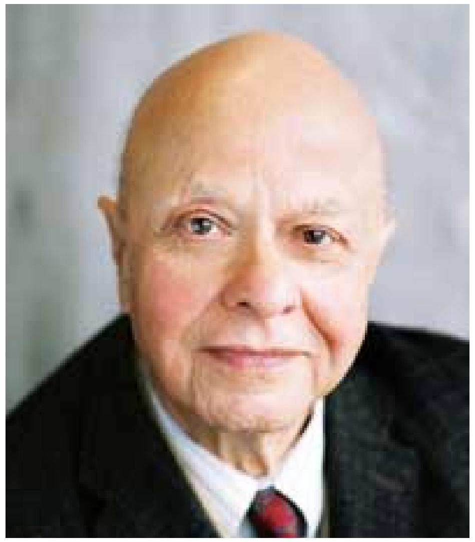
Snow Leopard - Wikipedia, the free encyclopedia
The **snow leopard** (Uncia uncia) is a moderately large cat native to the ... their body with small **spots** of the same color on their heads and larger **spots** on ...
Taxonomy - Etymology - Distribution - Ecology and behaviour
en.wikipedia.org/wiki/**Snow_Leopard** - Cached - Similar

Mac OS X **Snow Leopard** - Wikipedia, the free encyclopedia
Mac OS X **Snow Leopard** (version 10.6) is the seventh and current major release of Mac OS X, Apple's desktop and server certified Unix operating system. ...
en.wikipedia.org/wiki/Mac_OS_X_**Snow_Leopard** - Cached - Similar

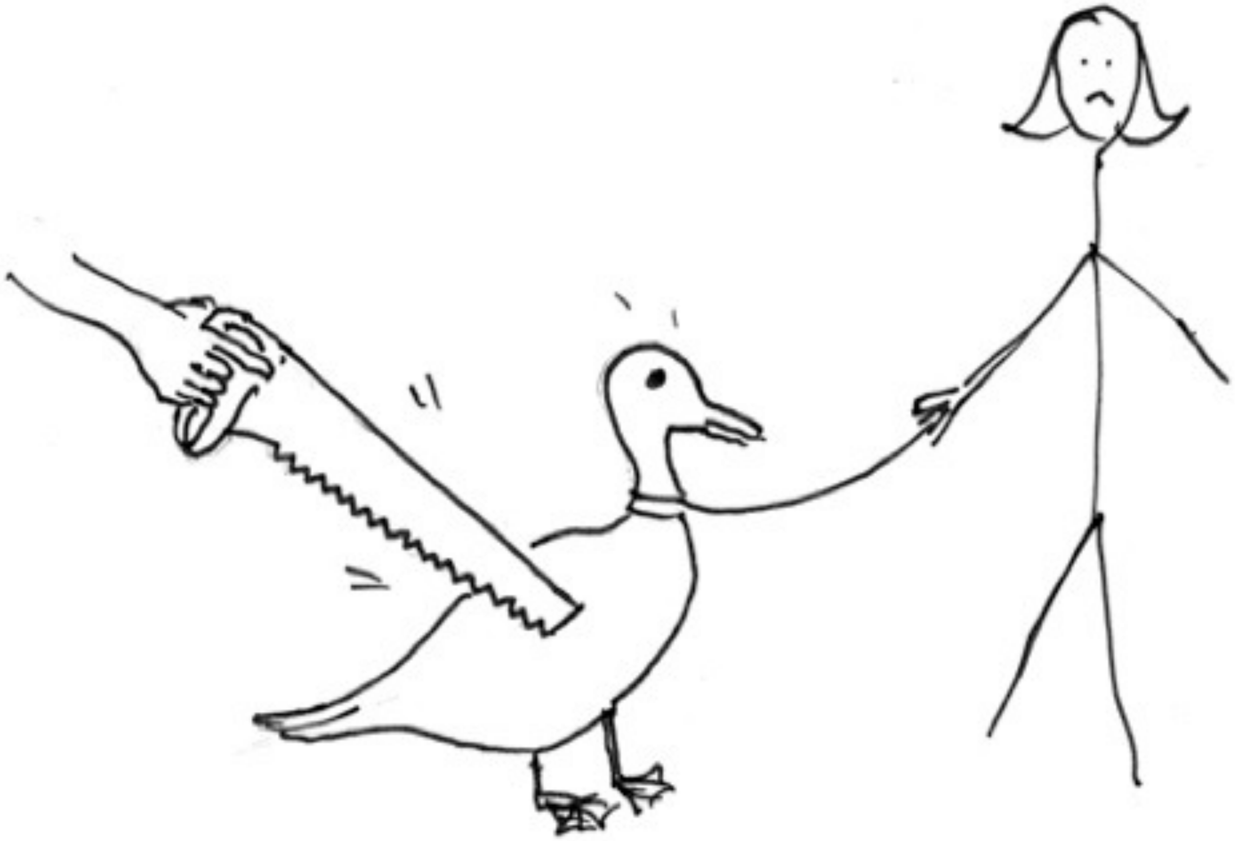
More about Ambiguities

- to middle school kids: what does this sentence mean?

I saw her duck.



Aravind Joshi

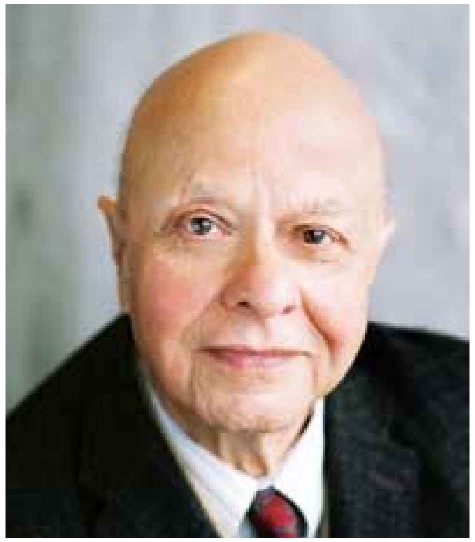


lexical ambiguity (word-sense)

More about Ambiguities

- to middle school kids: what does this sentence mean?

I eat sushi with tuna.



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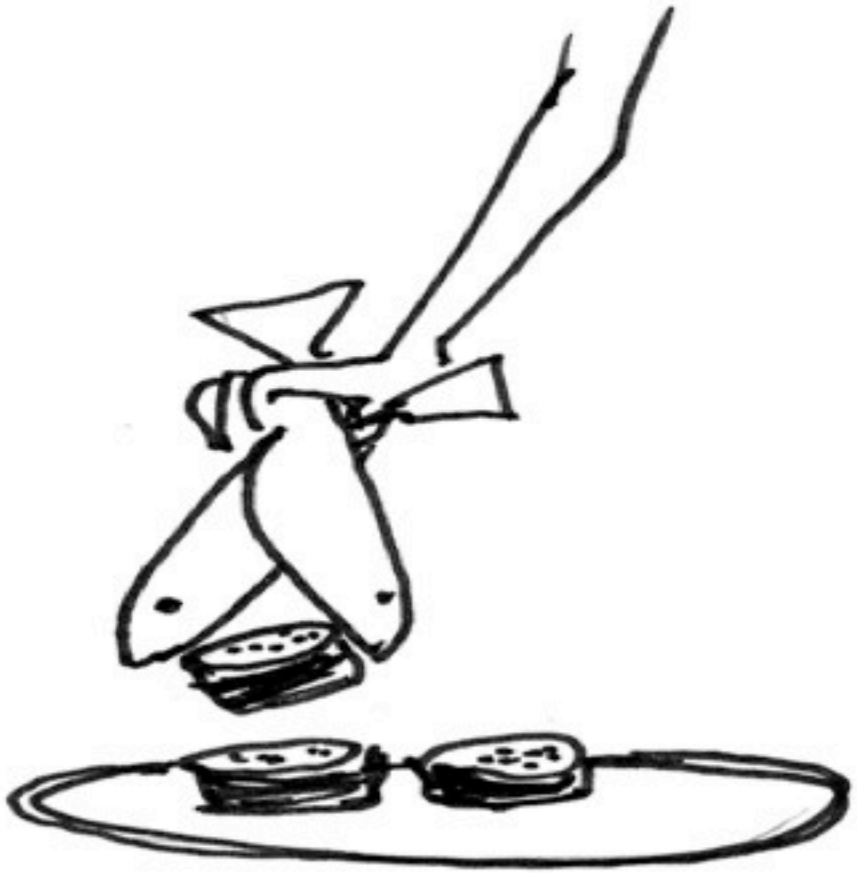

structural ambiguity
(PP-attachment)

More about Ambiguities

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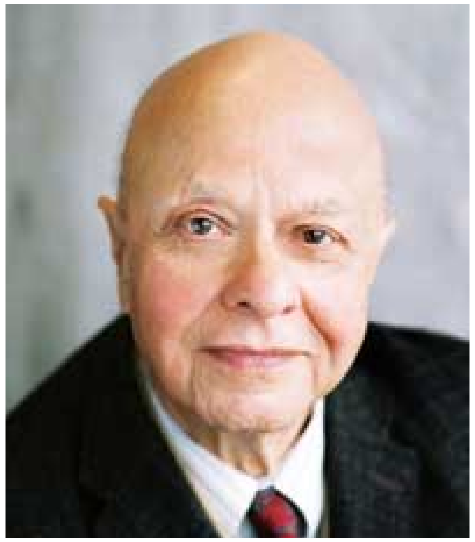

Aravind Joshi

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lexical ambiguity
(word-sense)

More about Ambiguities

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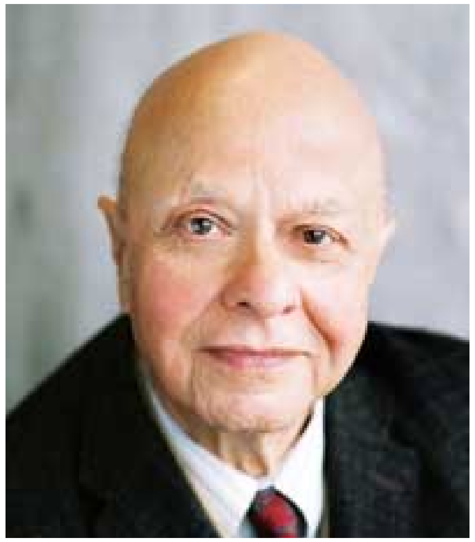
Everybody loves somebody.



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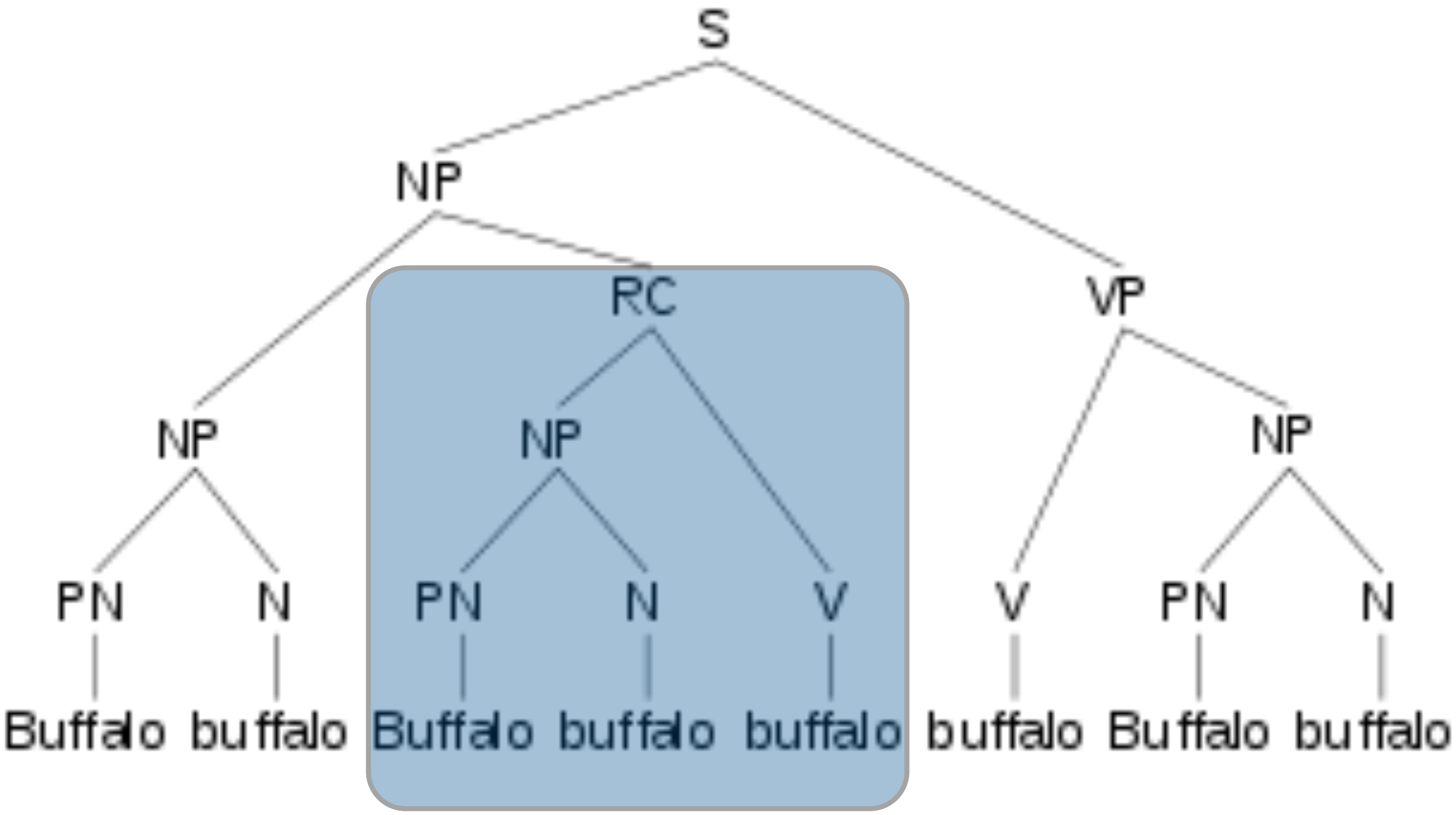
???

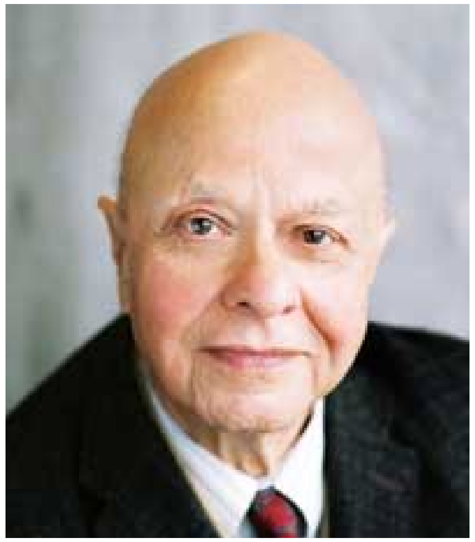
structural ambiguity
(quantifier scope)

More about Ambiguities

- to middle school kids: what does this sentence mean?

Buffalo buffalo Buffalo buffalo buffalo buffalo Buffalo buffalo





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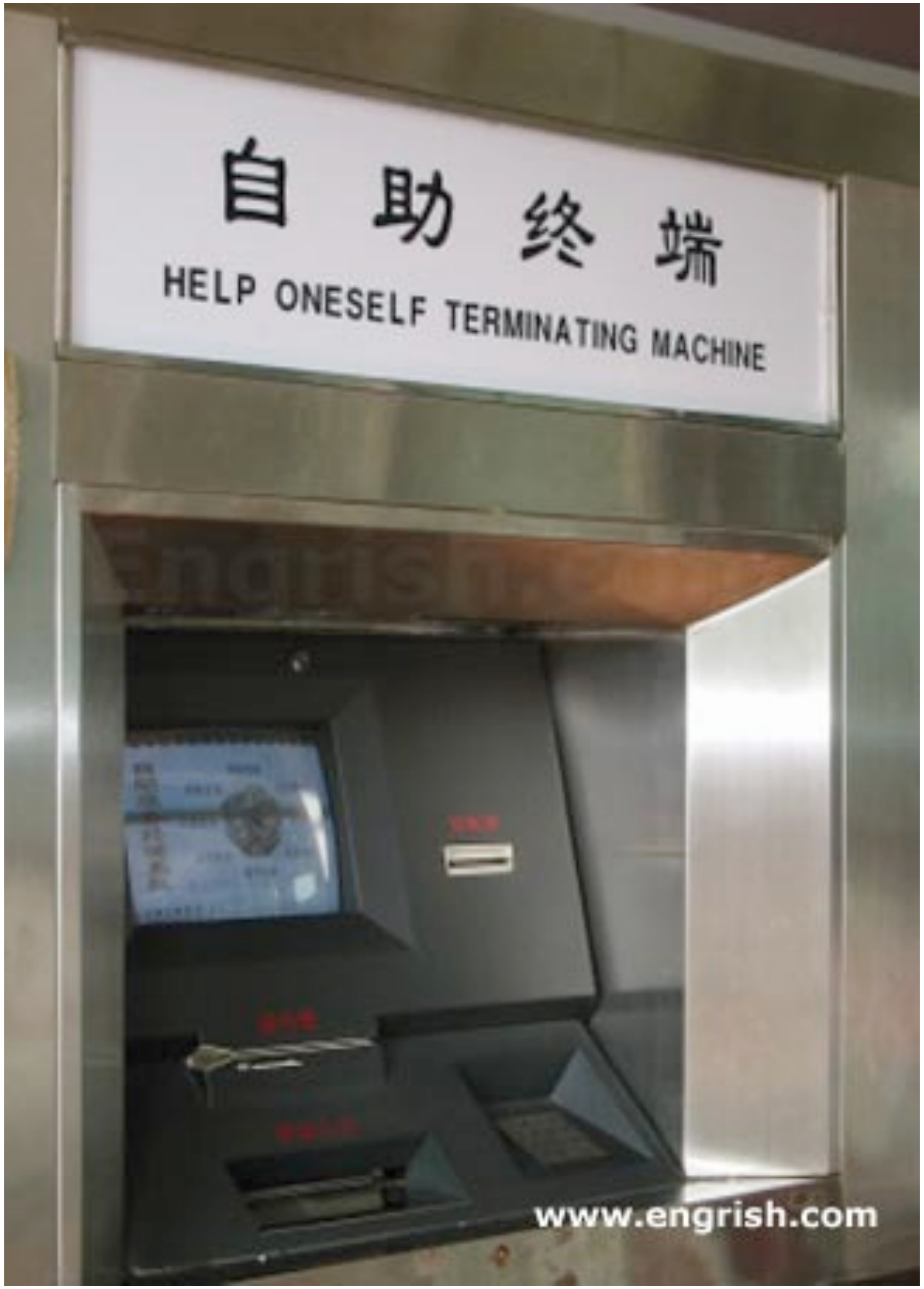
Dogs dogs dog dog dogs.

`Police police police police police`

http://www.cse.buffalo.edu/~rapaport/BuffaloBuffalo/buffalobuffalo.html

Ambiguities in Translation

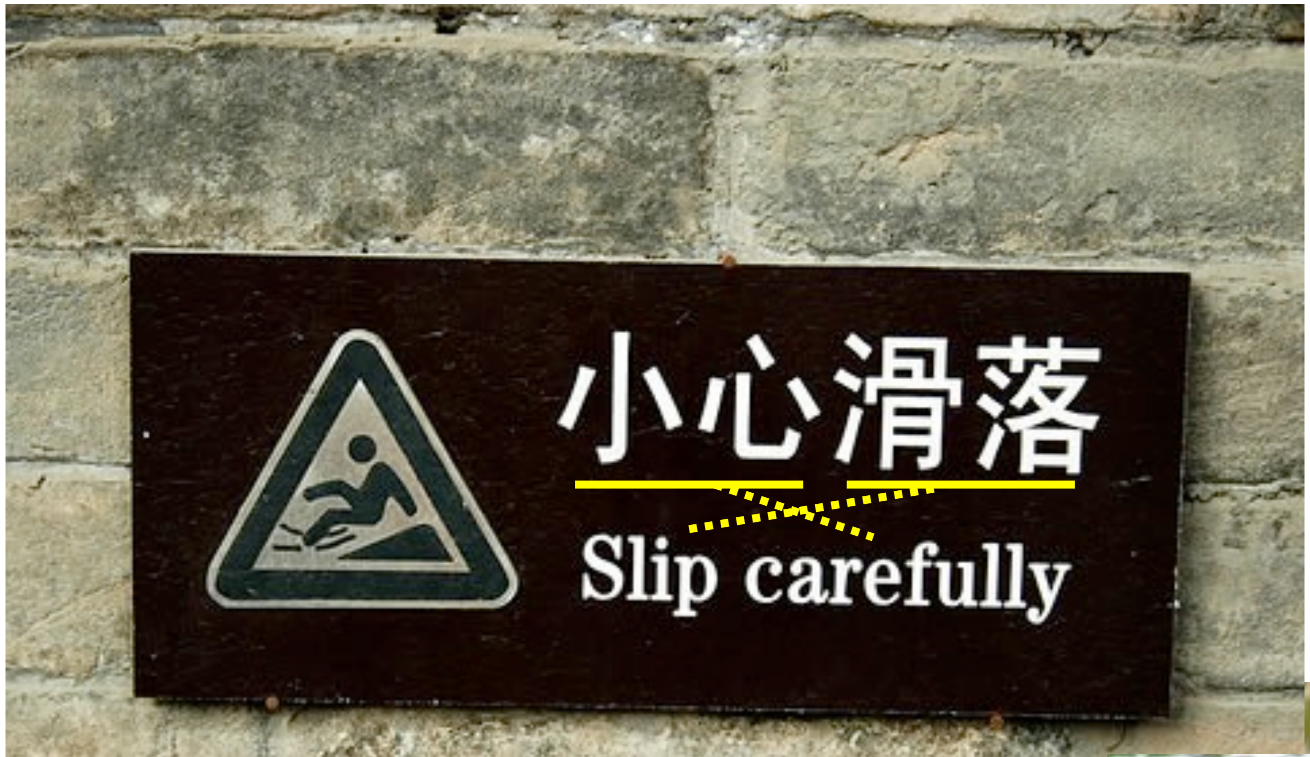


zi zhu zhong duan

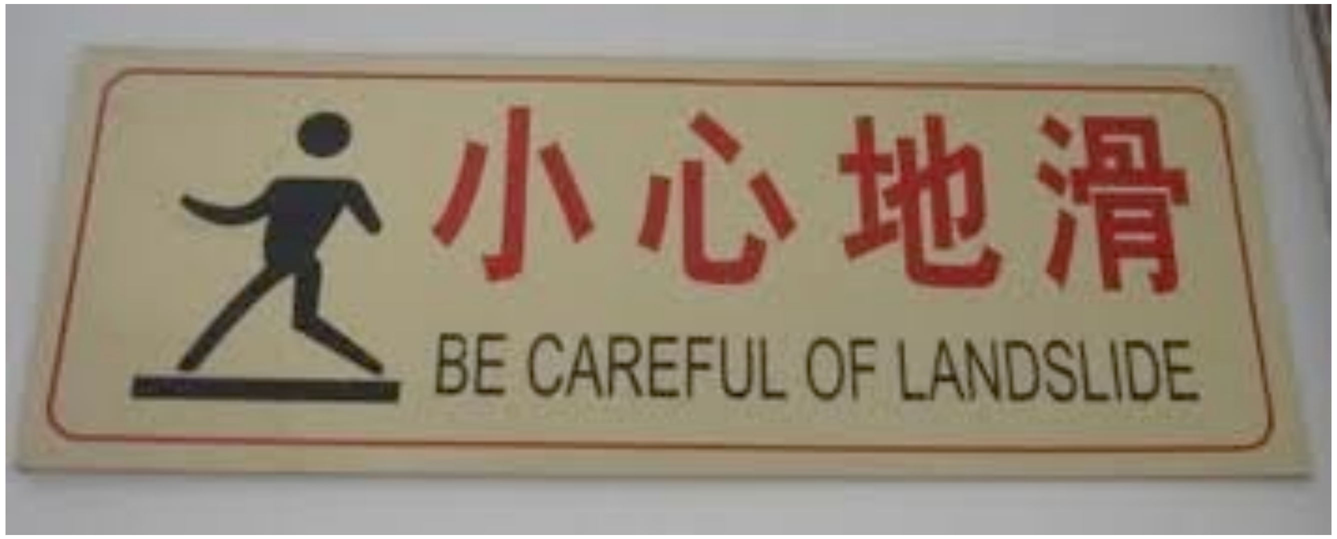
自 助 终 端

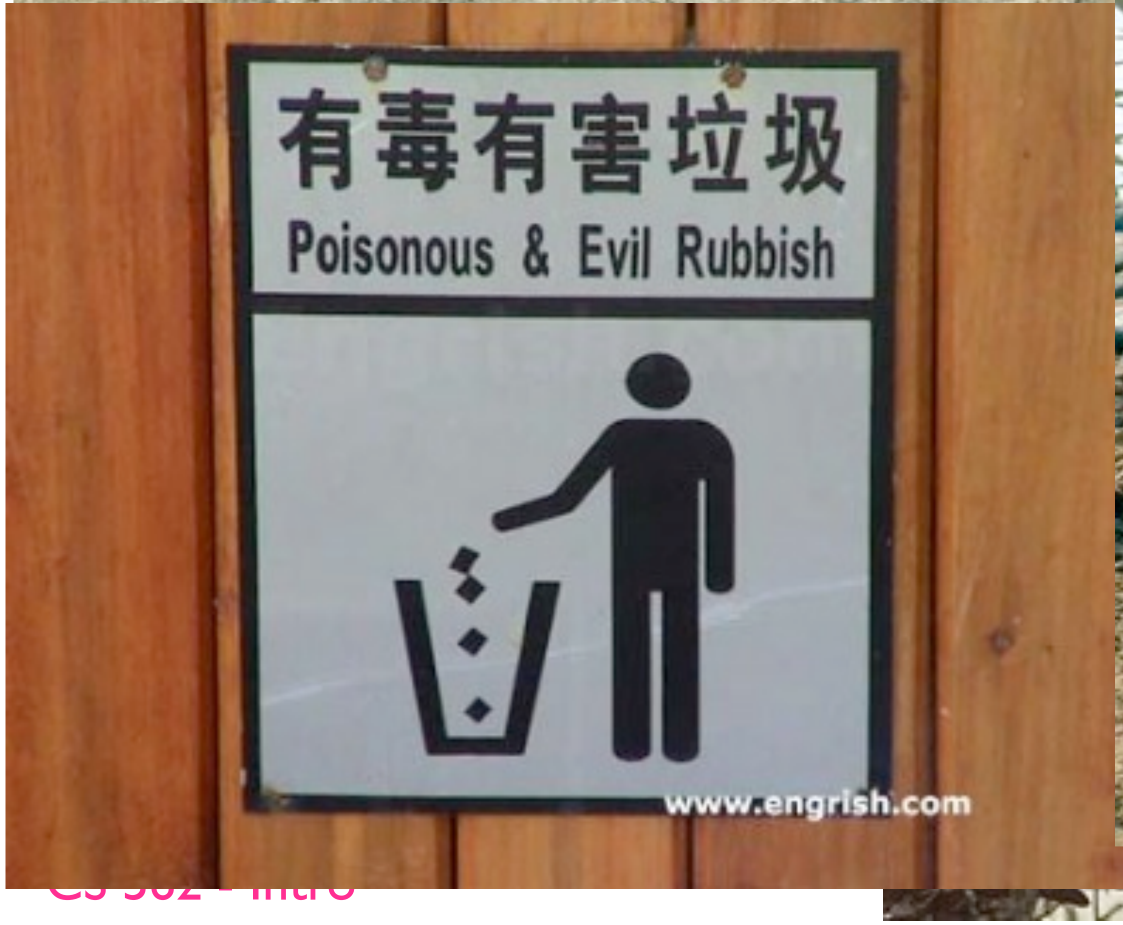
self help terminal device

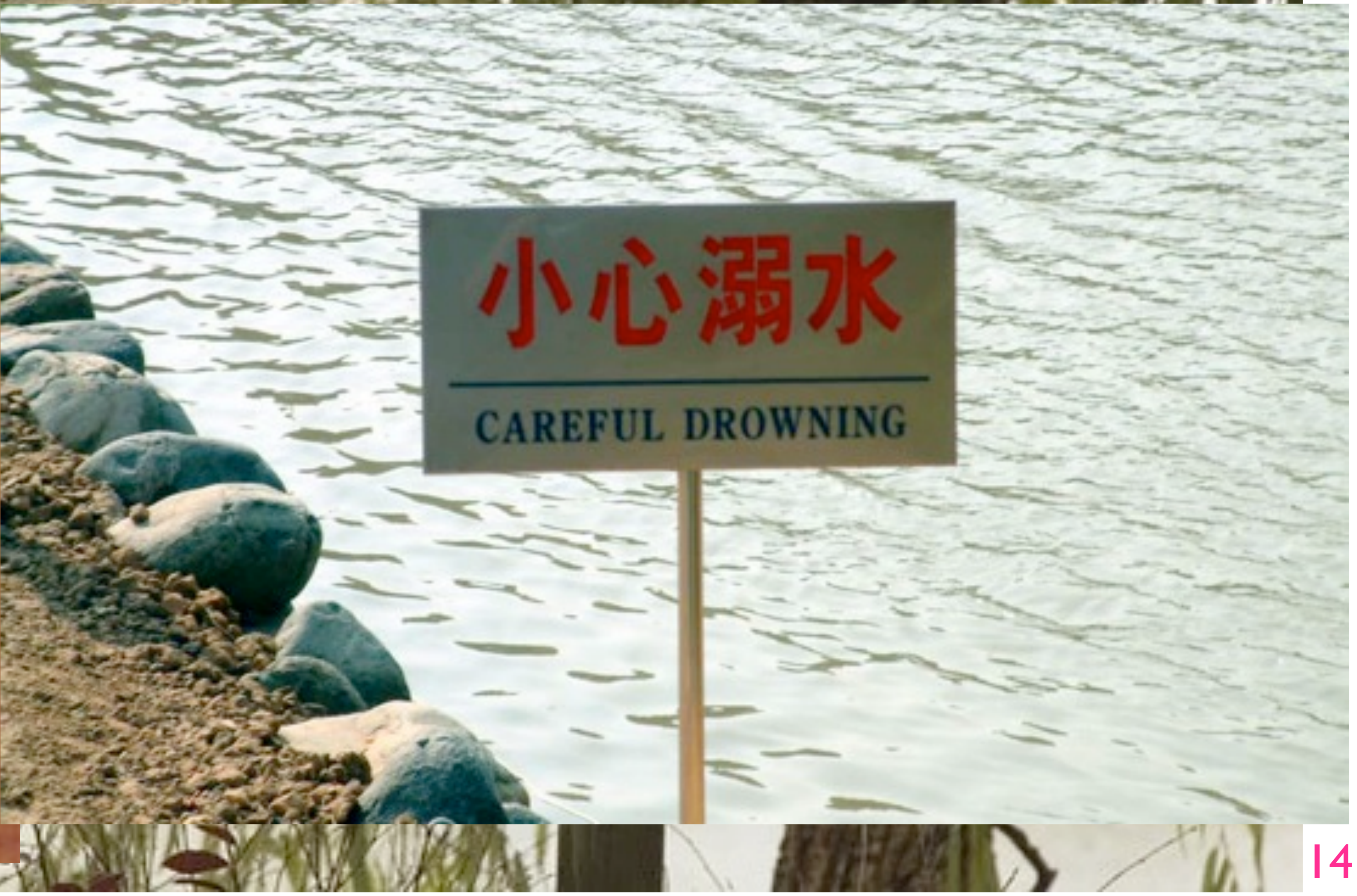
Ambiguities in Translation



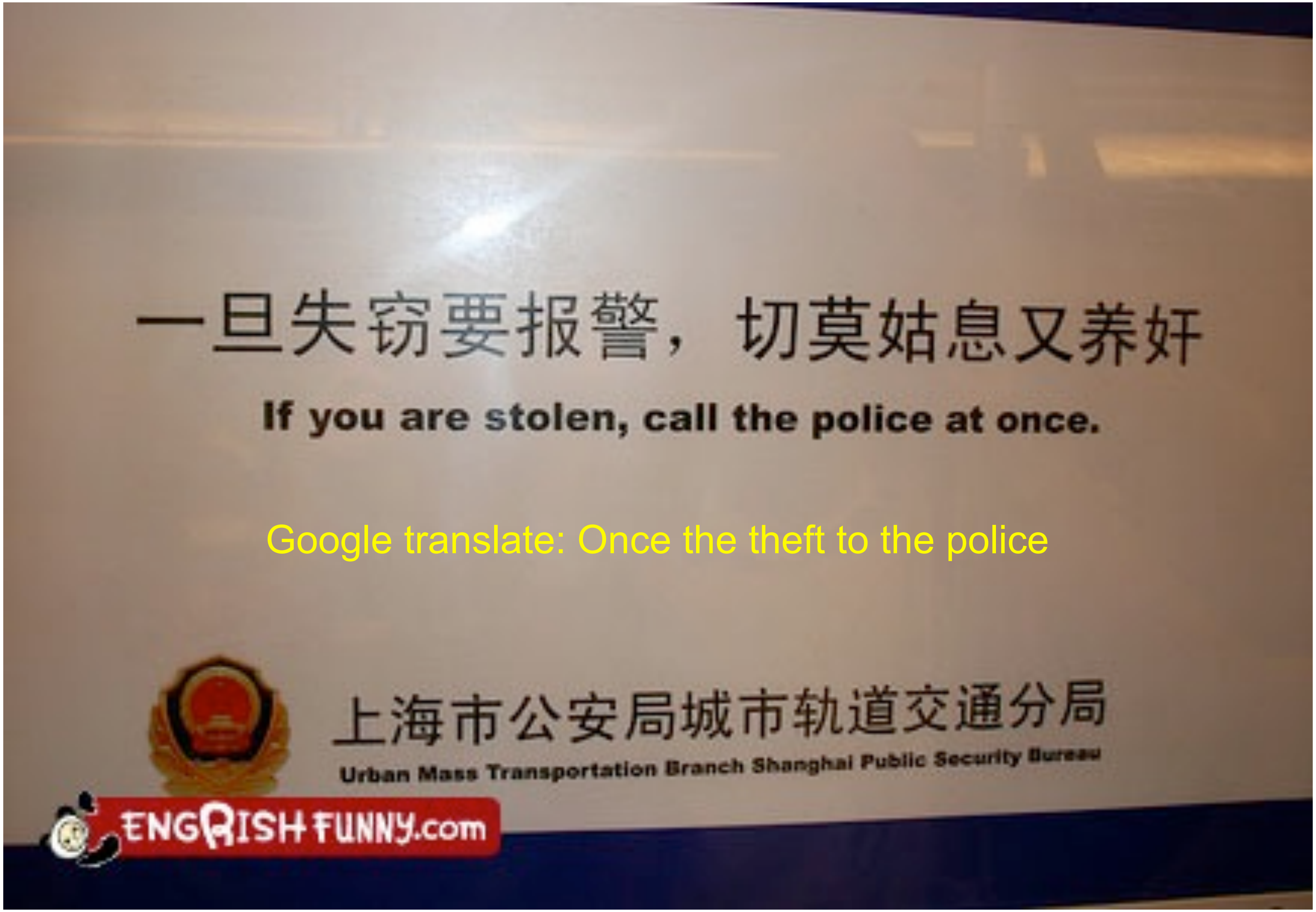
Google translate: carefully slide







If you are stolen...



一旦失窃要报警，切莫姑息又养奸

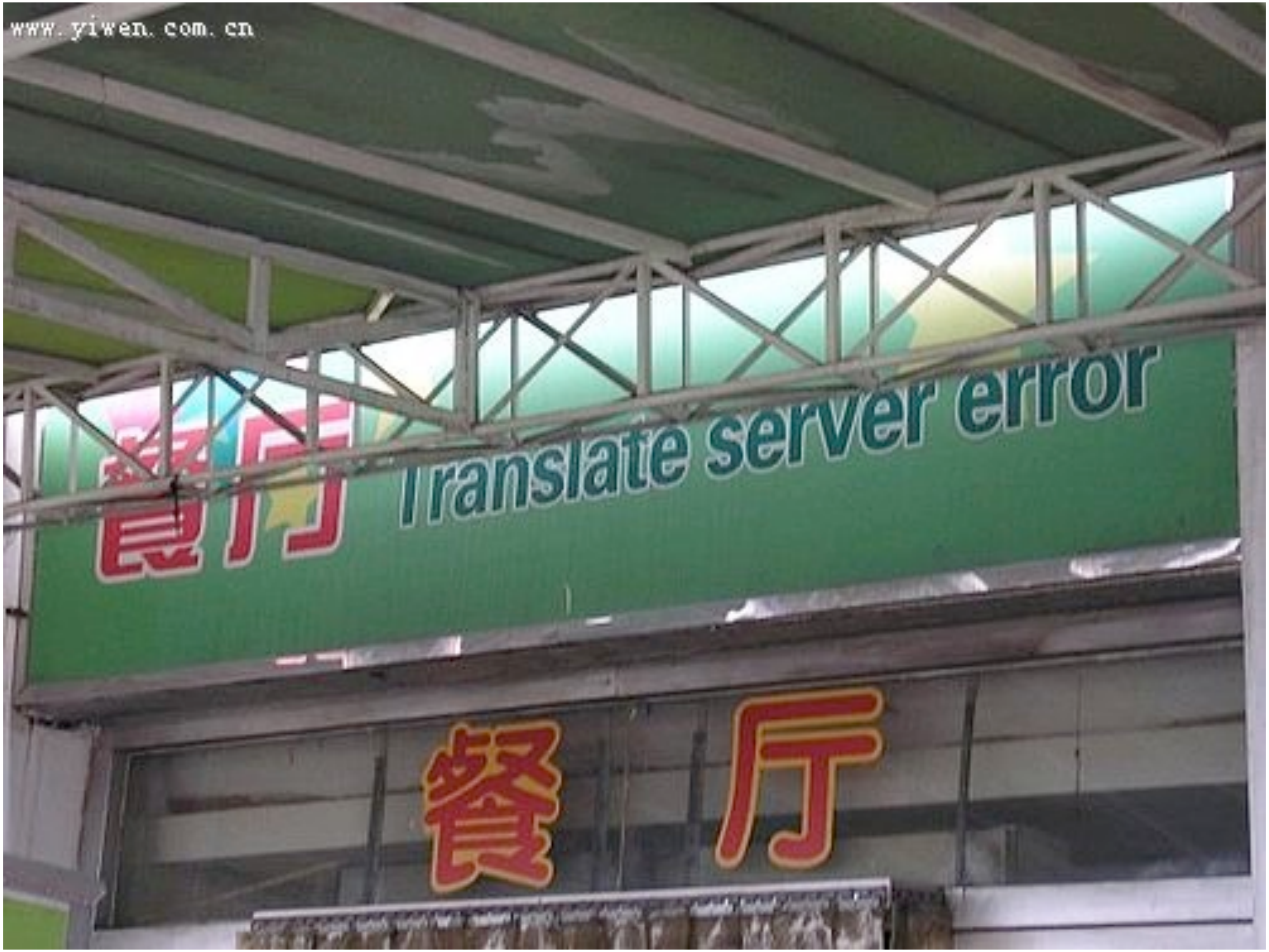
If you are stolen, call the police at once.

Google translate: Once the theft to the police

上海市公安局城市轨道交通分局

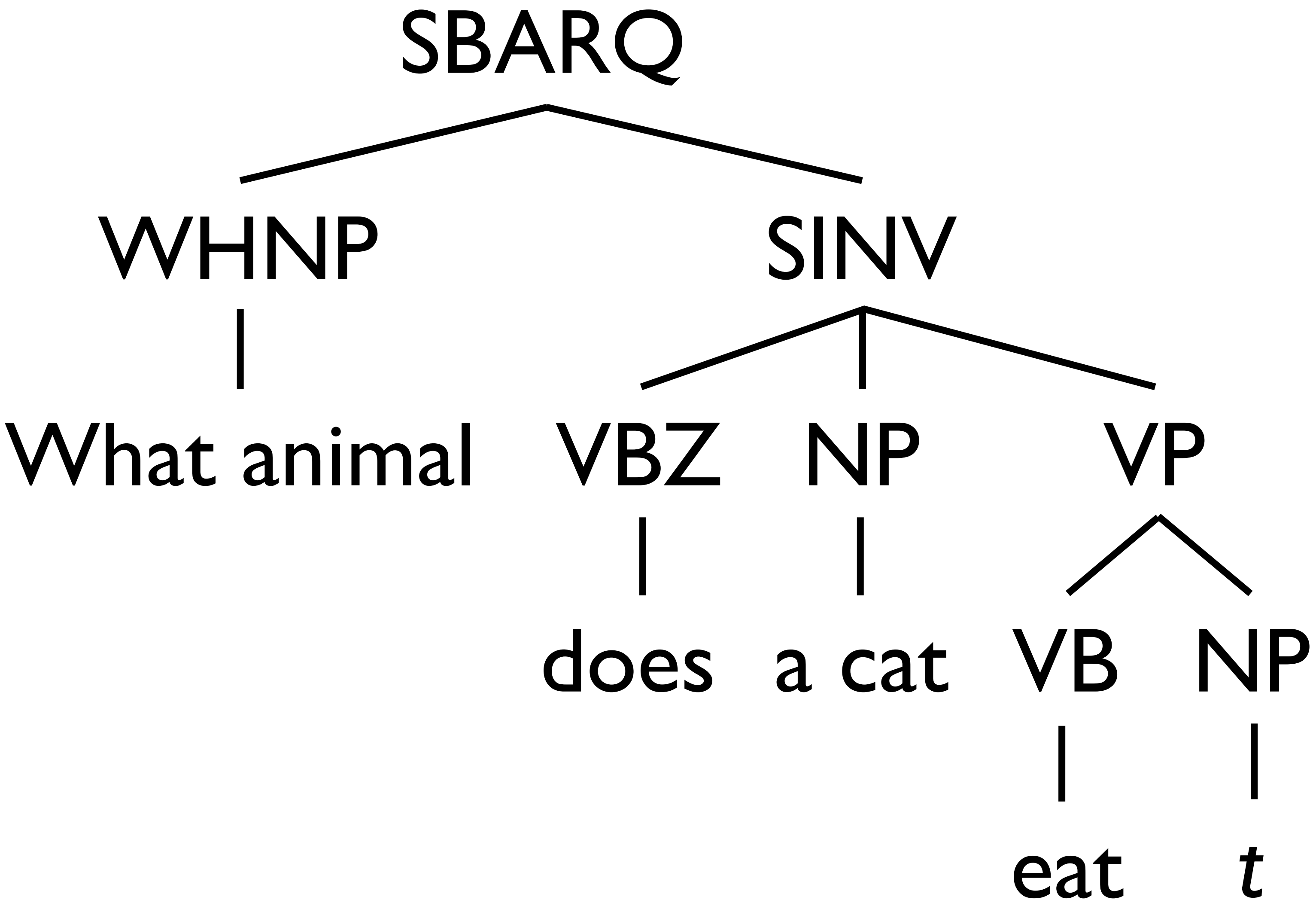
Urban Mass Transportation Branch Shanghai Public Security Bureau

or even...



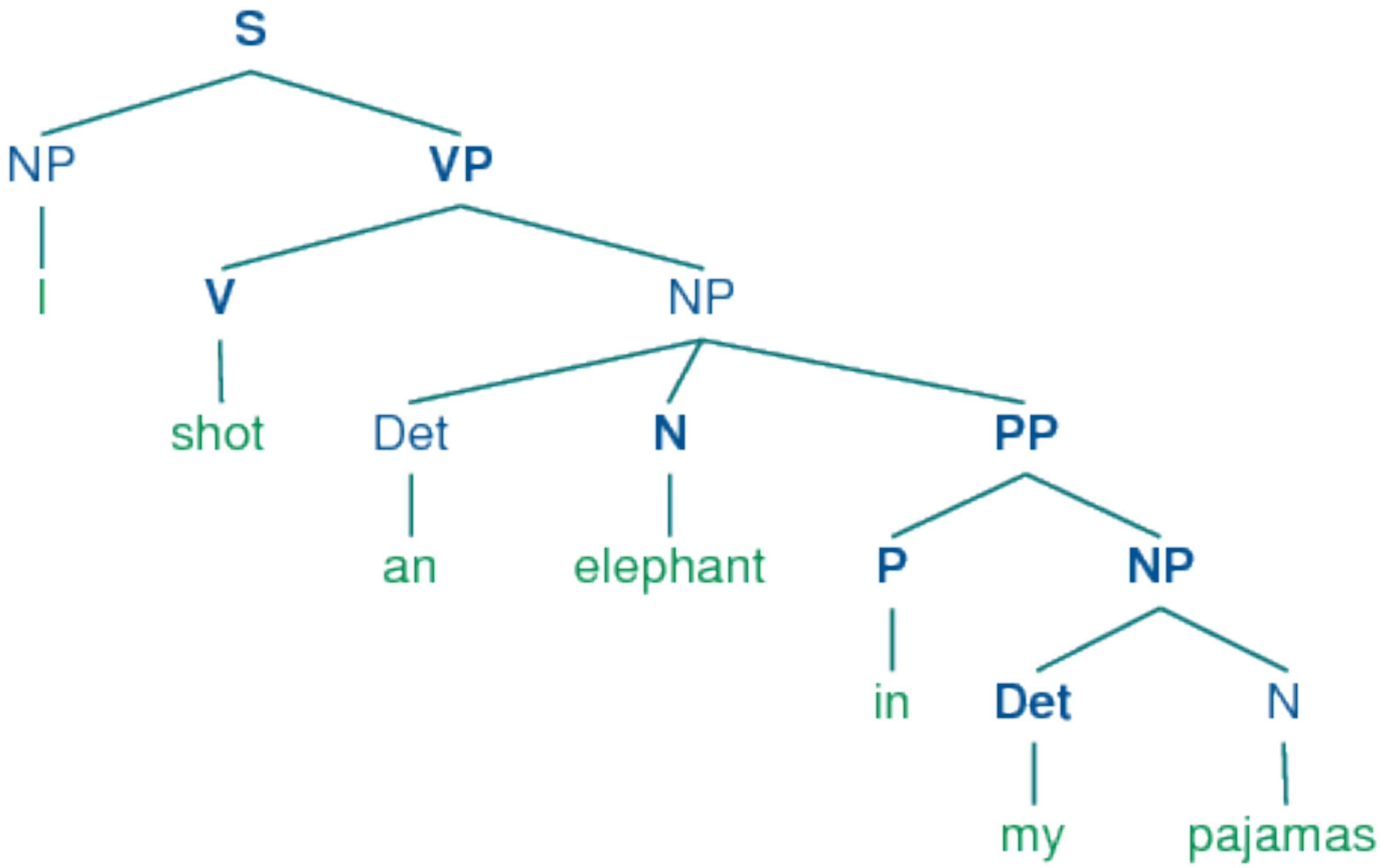
clear evidence that NLP is used in real life!

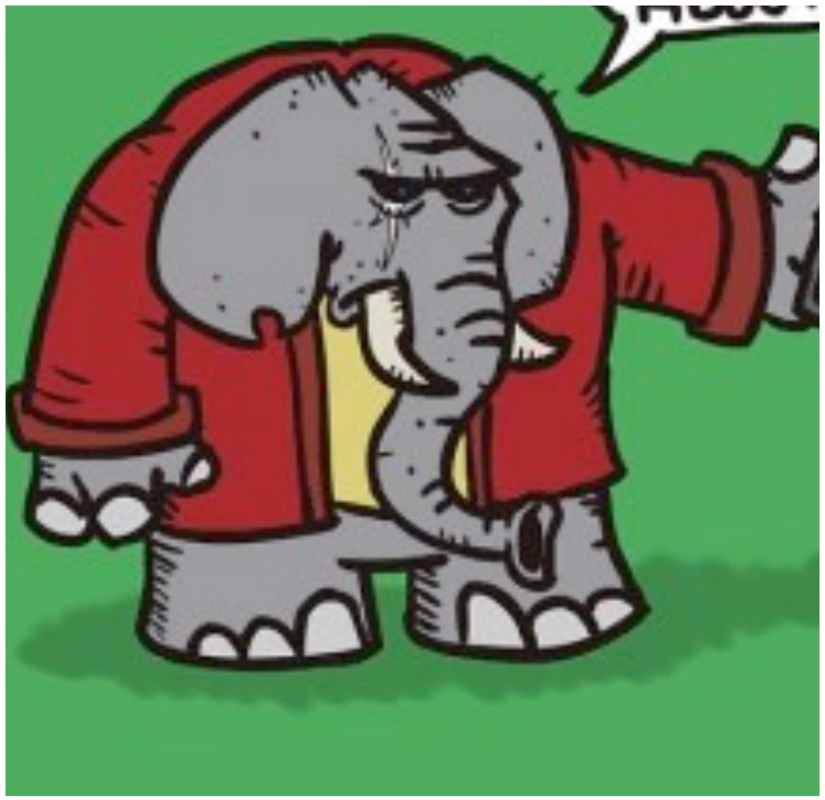
Grammar



PP Attachment Ambiguity

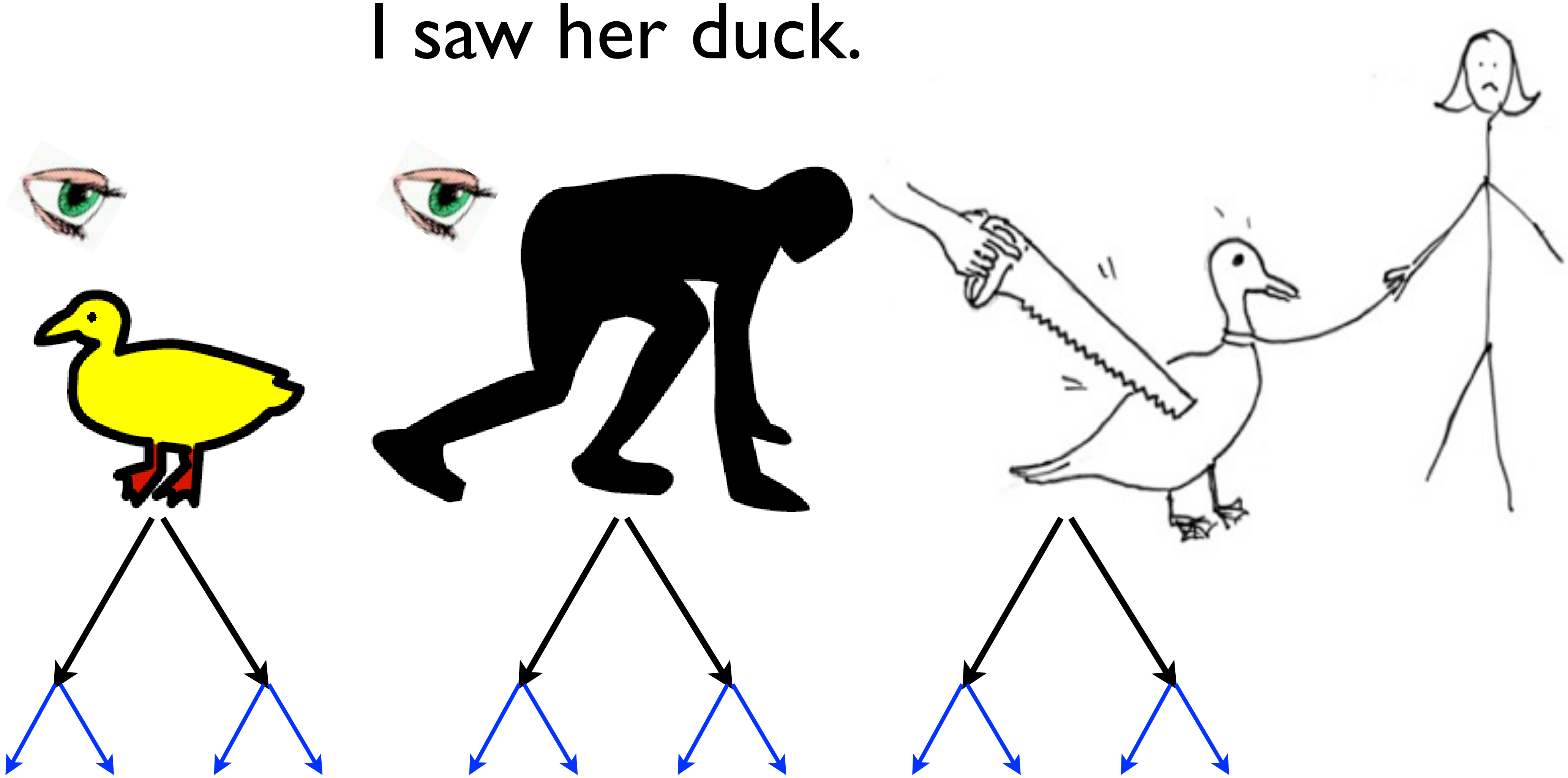
One morning in Africa,
I shot an elephant in my pajamas;
how he got into my pajamas I'll never know.





Ambiguity Explosion

I saw her duck.

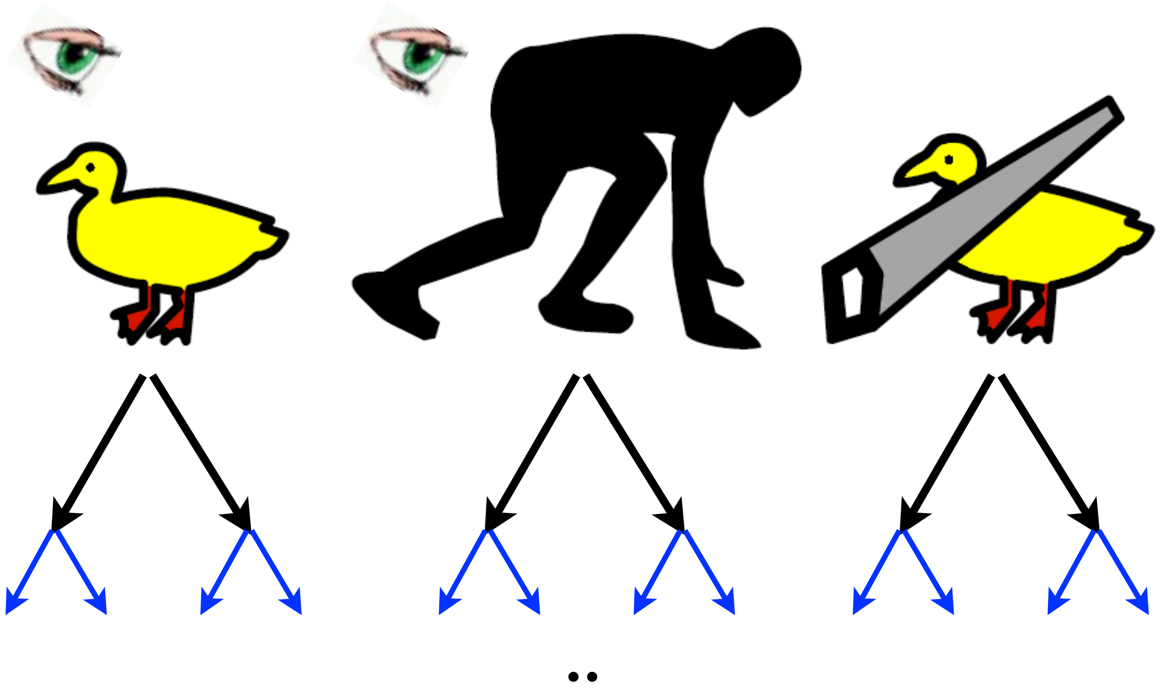


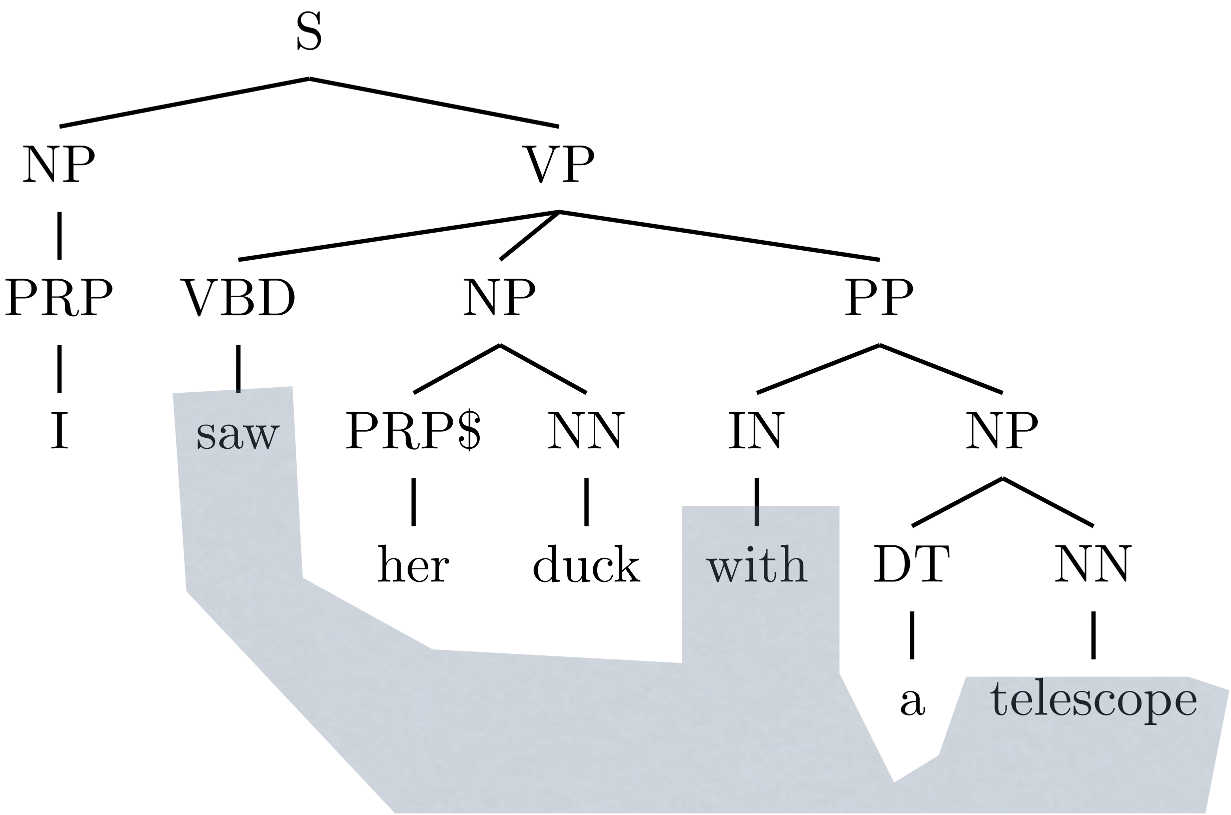
...

- how about...
  - I saw her duck with a telescope.
  - I saw her duck with a telescope in the garden...

Ambiguity Explosion

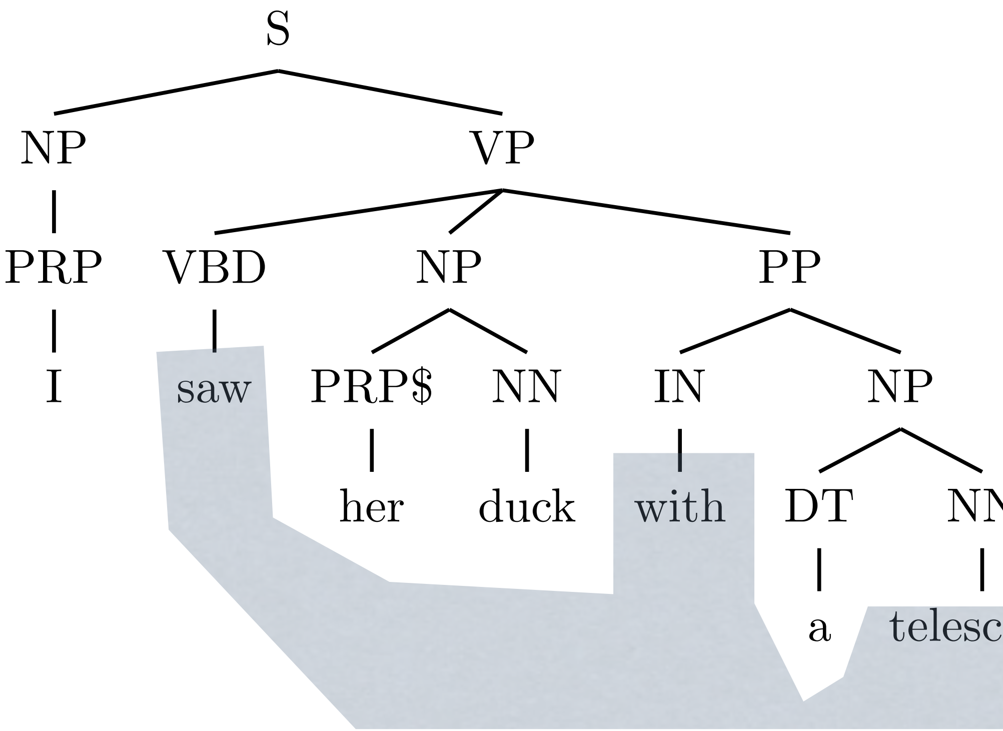
- exponential explosion of the search space
  - Q1: how to *represent* ambiguities (compactly)?
  - Q2: how to *search* over this space (efficiently)?
  - Q3: how to *rank* different hypotheses?





Answers...

- Q1: how to *represent* ambiguities?
    - context-free grammar (unit 2)
    - finite-state automata (unit 1)
- Q2: how to *search* in this space?
    - dynamic programming (units 1&2)
- Q3: how to *rank* these hypotheses?
    - weighted grammar (units 1-3)
    - weights *learned* from data
        - (saw, with, telescope) seen more often in texts

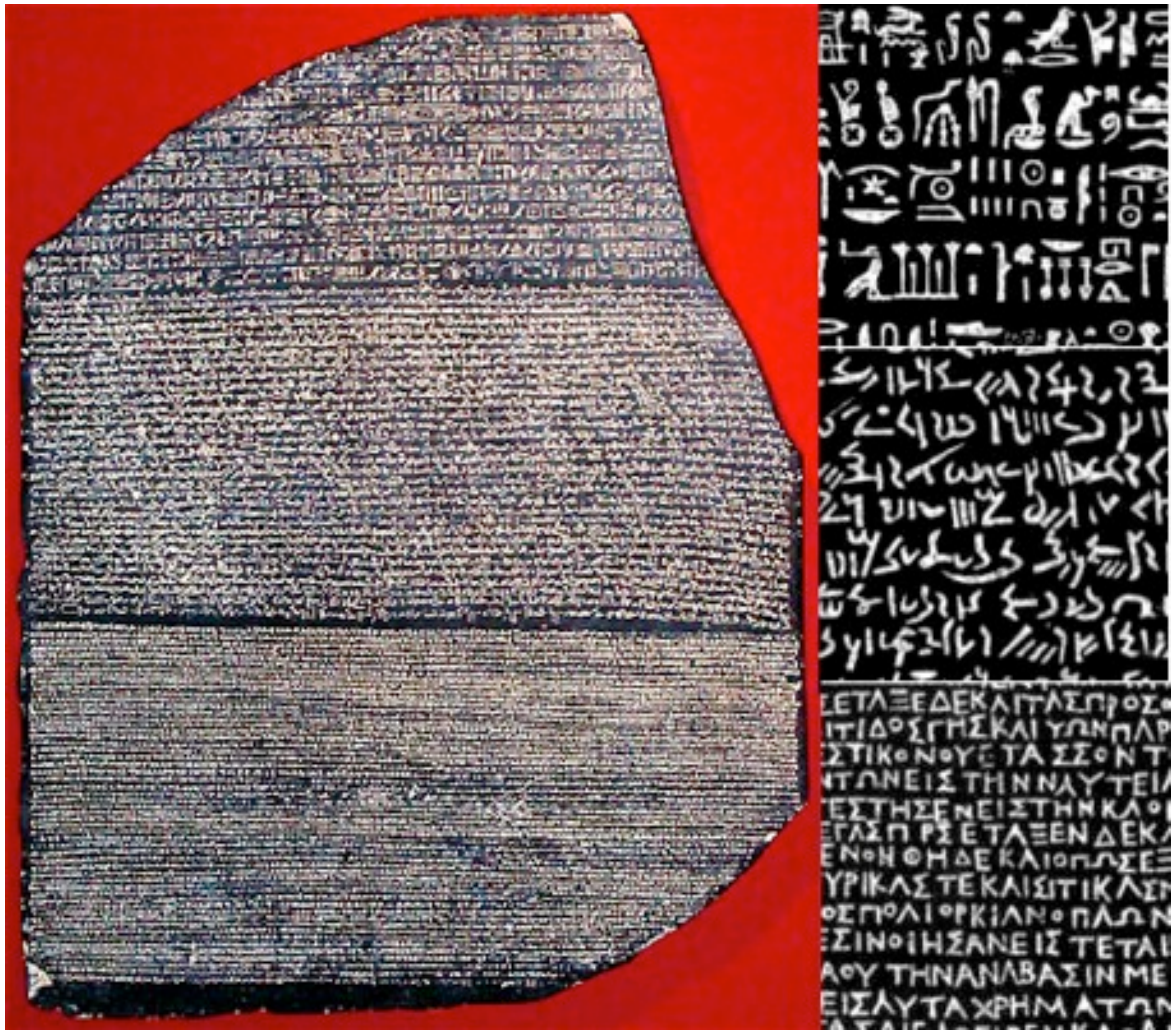


Why Learning?

- learning is better than hand-written rules, because:
  - less work; easily adapts to new languages/domains
    - Powerset (now bing.com): 15 years for English grammar!
    - now they are writing their Chinese grammar...
    - and languages constantly change!
  - learning *can* work, and often works better!
    - machine translation: used to be dominated by rule-based
      - now statistical methods are better: google vs. systran
      - google learns from the web, and translates 40+ langs

[see also Machine Learning class this Spring]

Example - Rosetta Stone



- the most famous (tri-)parallel text
- machines can do the same job! (if given parallel text)
  - UN/EU/Ca proceedings, News, tech manuals, ...

A sci-fi example
(Knight, 1997)

Your assignment: translate this Centauri sentence into Arcturan

farok crrrok hihok yorok clok kantok ok-yurp

farok crrrok hihok yorok clok kantok ok-yurp

1c. ok-voon ororok sprok .

1a. at-voon bichat dat .

2c. ok-drubel ok-voon anok plok sprok .

2a. at-drubel at-voon pippat rrat dat .

3c. erok sprok izok hihok ghirok .

3a. totat dat arrat vat hilat .

4c. ok-voon anok drok brok jok .

4a. at-voon krat pippat sat lat .

5c. wiwok farok izok stok .

5a. totat jjat quat cat .

6c. lalok sprok izok jok stok .

6a. wat dat krat quat cat .

7c. lalok farok ororok lalok sprok izok enemok .

7a. wat jjat bichat wat dat vat eneat .

8c. lalok brok anok plok nok .

8a. iat lat pippat rrat nnat .

9c. wiwok nok izok kantok ok-yurp .

9a. totat nnat quat oloat at-yurp .

10c. lalok mok nok yorok ghirok clok .

10a. wat nnat gat mat bat hilat .

11c. lalok nok crrrok hihok yorok zanzanok .

11a. wat nnat arrat mat zanzanat .

12c. lalok rarok nok izok hihok mok .

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(Knight,1997)

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3c. erok sprok izok hihok ghirok . 3a. totat dat arrat vat hilat .	9c. wiwok nok izok kantok ok-yurp . 9a. totat nnat quat oloat at-yurp .
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(Knight,1997)

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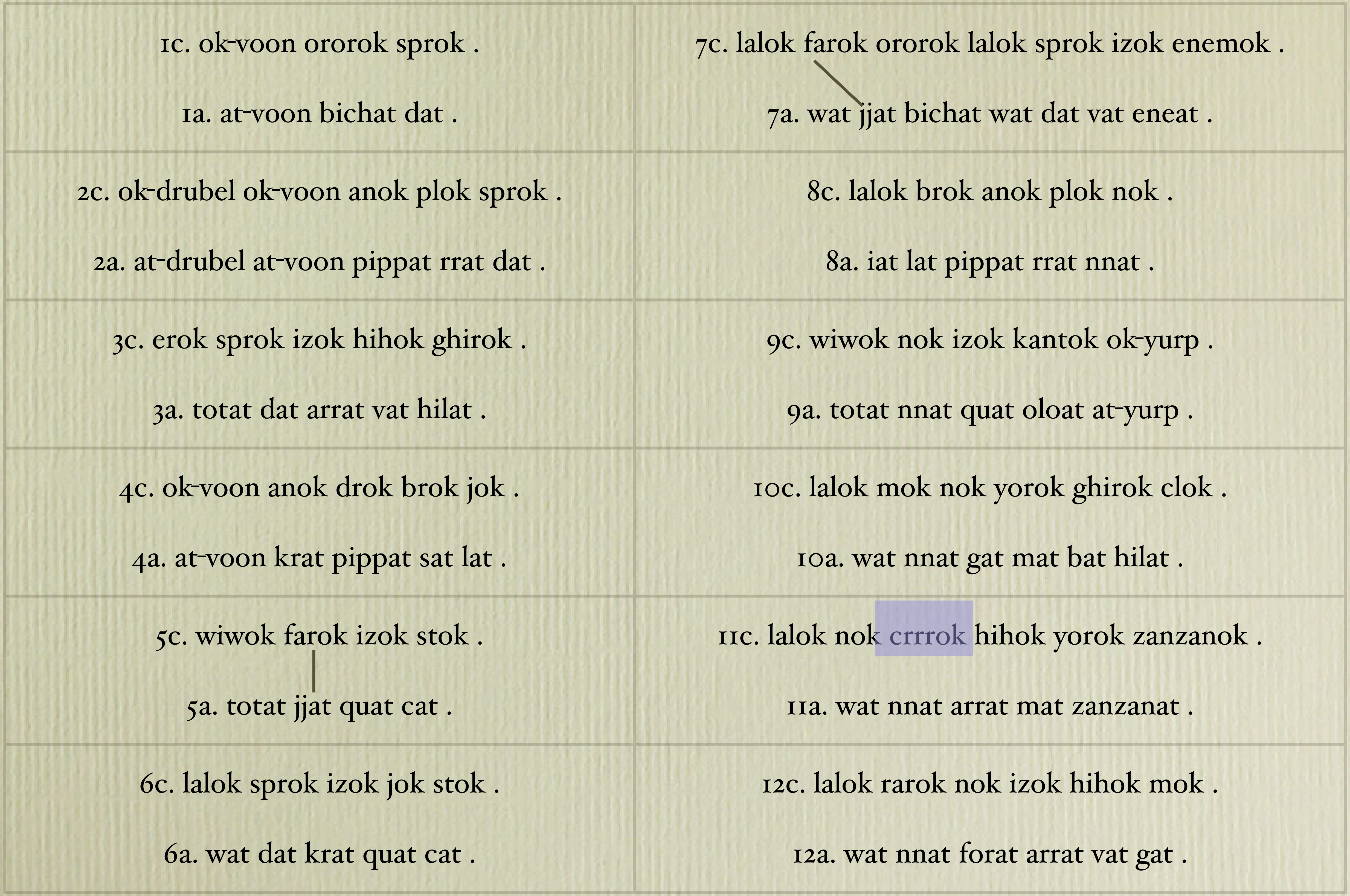

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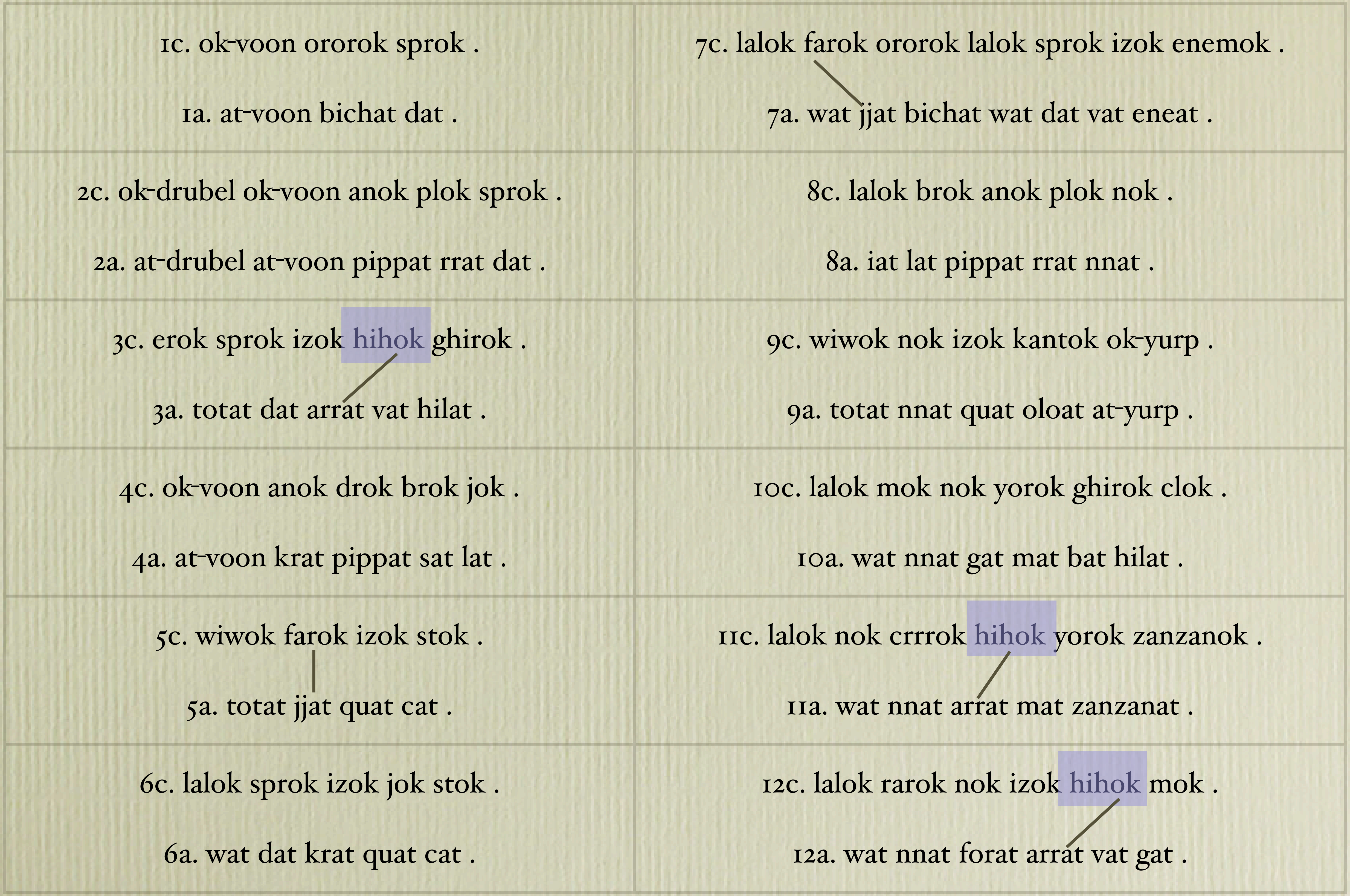

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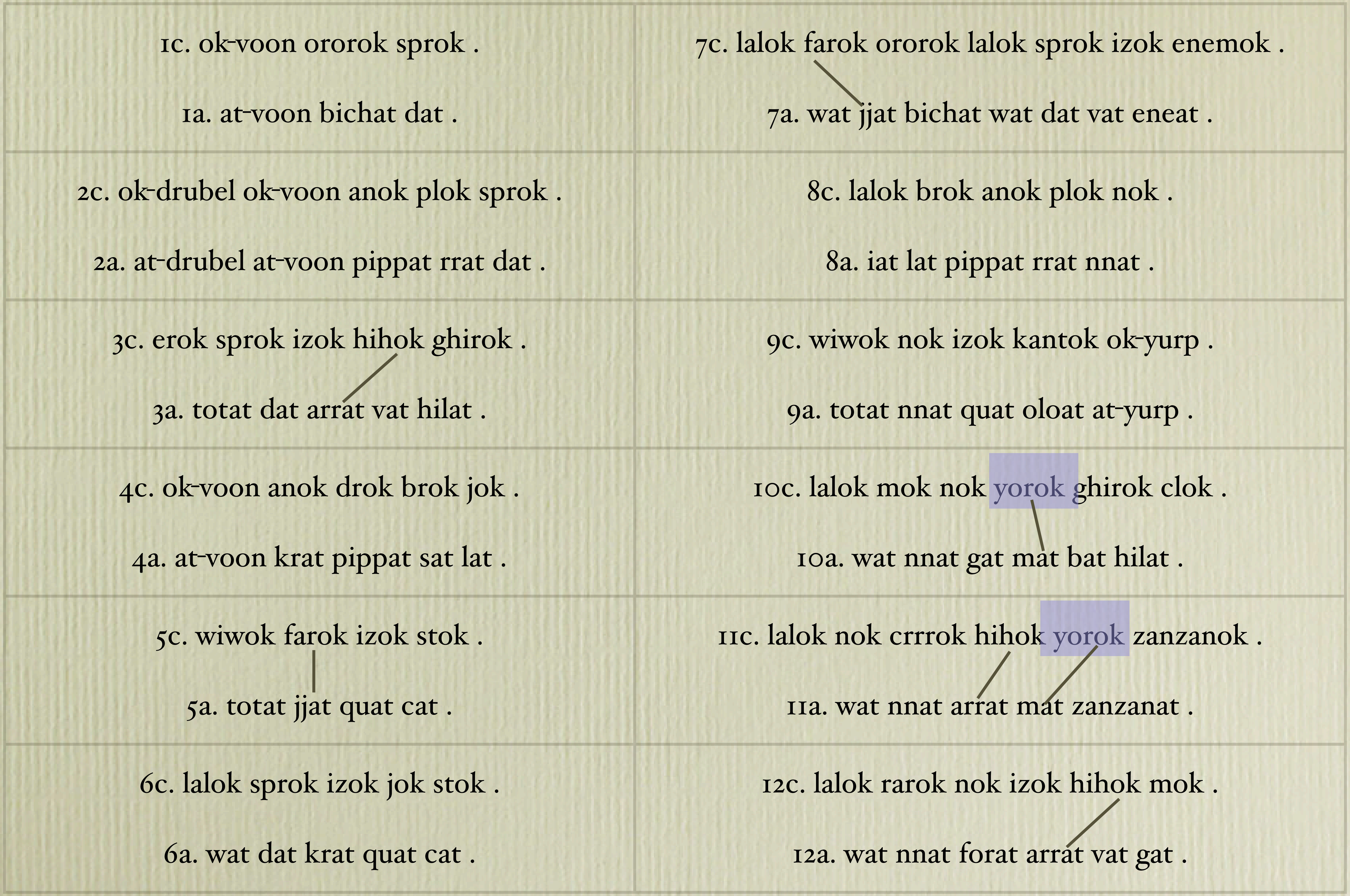

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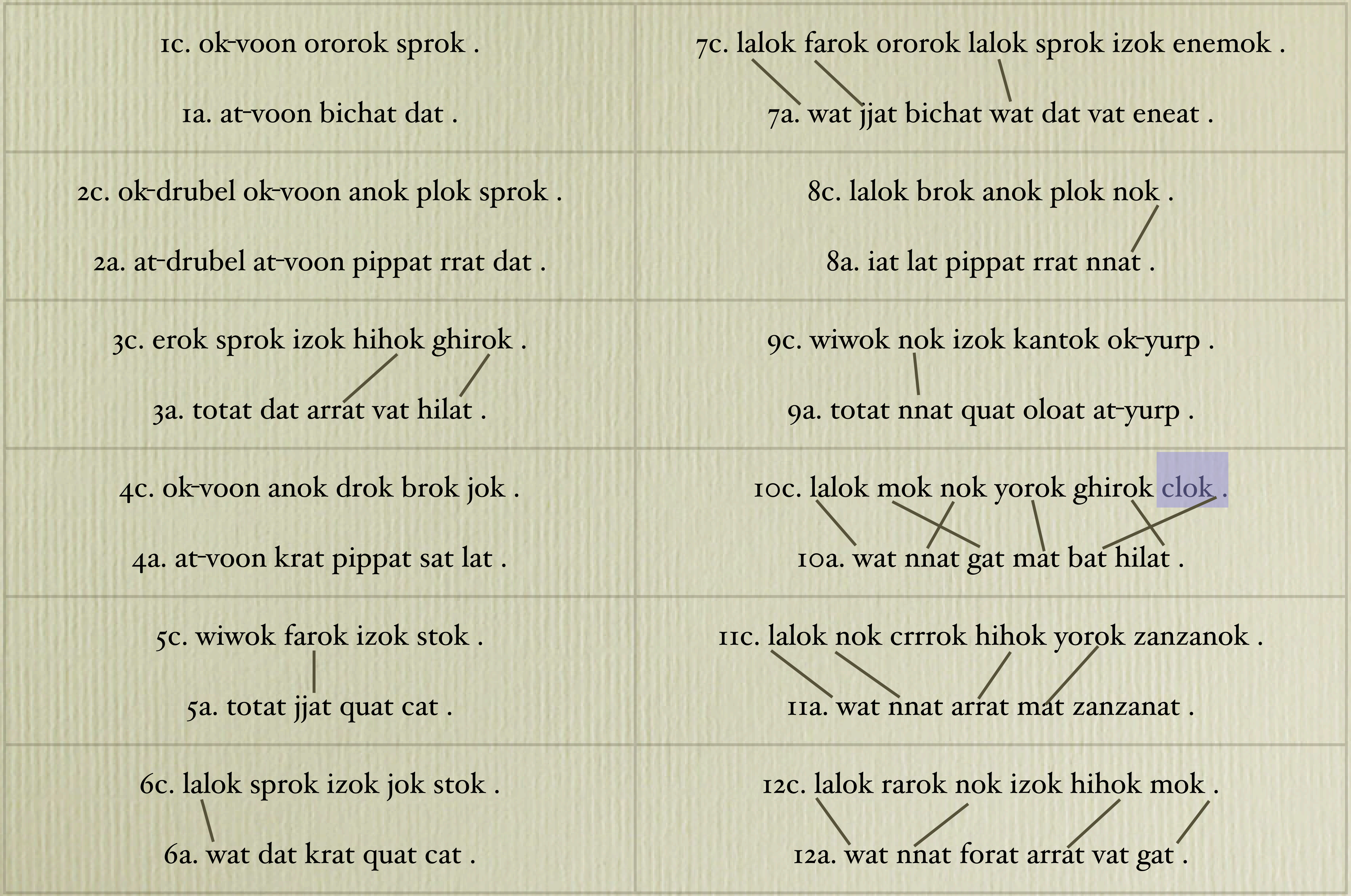

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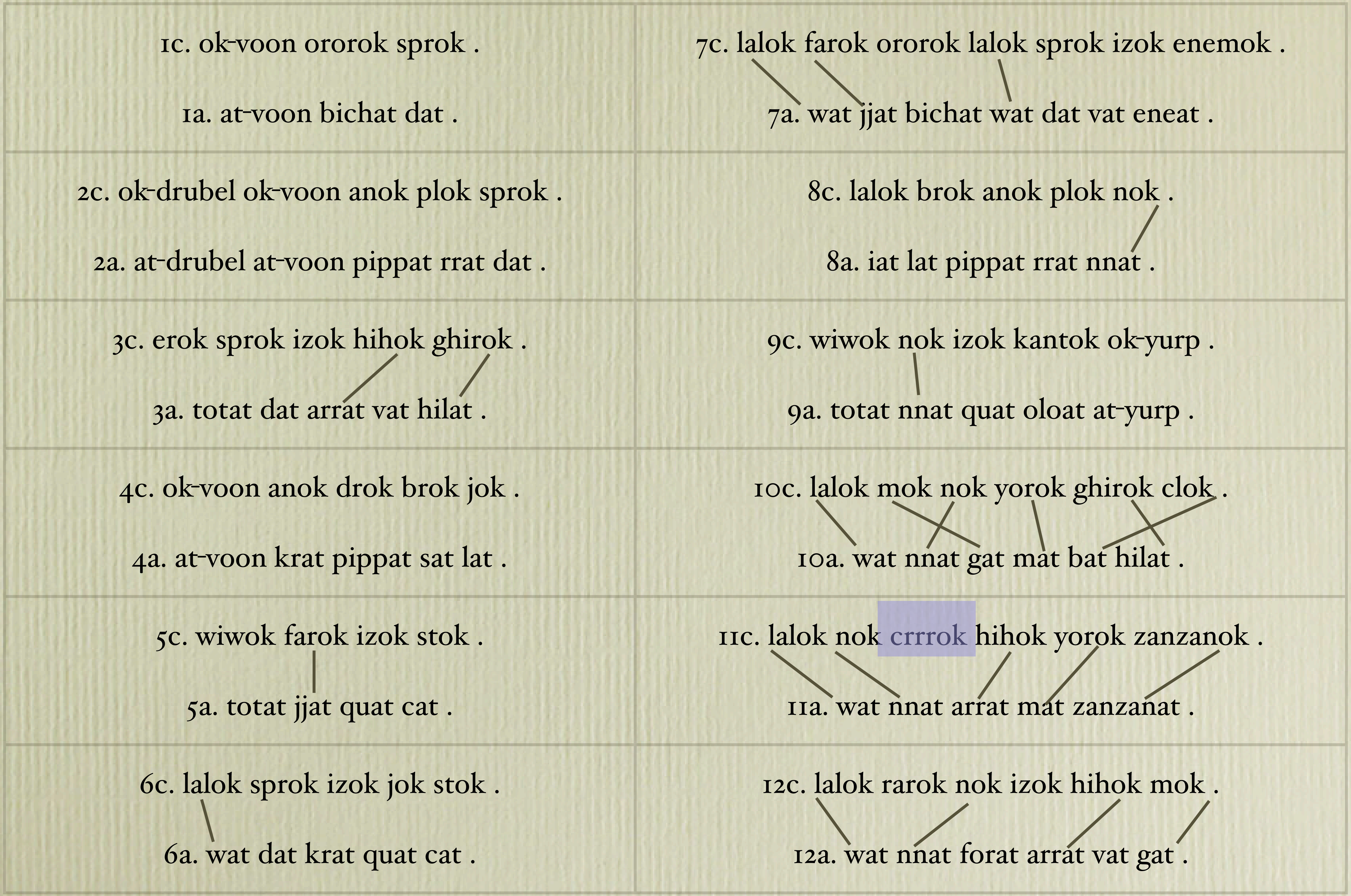

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5c. wiwok farok izok stok .

5a. totat jjat quat cat .

6c. lalok sprok izok jok stok .

6a. wat dat krat quat cat .

7c. lalok farok ororok lalok sprok izok enemok .

7a. wat jjat bichat wat dat vat eneat .

8c. lalok brok anok plok nok .

8a. iat lat pippat rrat nnat .

9c. wiwok nok izok kantok ok-yurp .

9a. totat nnat quat oloat at-yurp .

10c. lalok mok nok yorok ghirok clok .

10a. wat nnat gat mat bat hilat .

11c. lalok nok crrrok hihok yorok zanzanok .

11a. wat nnat arrat mat zanzanat .

12c. lalok rarok nok izok hihok mok .

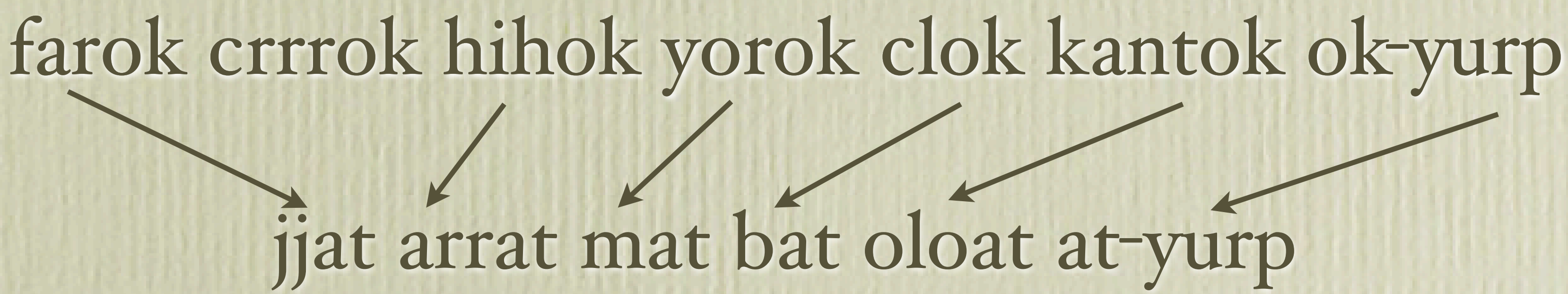
12a. wat nnat forat arrat vat gat .

(Knight,1997)

A sci-fi example

(Knight, 1997)

Your assignment: translate this Centauri sentence into Arcturan



farok crrrok hihok yorok clok kantok ok-yurp

jjat arrat mat bat oloat at-yurp

Are these Arcturan words in Arcturan order?

Clients do not sell pharmaceuticals in Europe .

1e. Garcia and associates .
1s. Garcia y asociados .

2e. Carlos Garcia has three associates .
2s. Carlos Garcia tiene tres asociados .

3e. his associates are not strong .
3s. sus asociados no son fuertes .

4e. Garcia has a company also .
4s. Garcia tambien tiene una empresa .

5e. its clients are angry .
5s. sus clientes estan enfadados .

6e. the associates are also angry .
6s. los asociados tambien estan enfadados .

7e. the clients and the associates are enemies .
7s. los clients y los asociados son enemigos .

8e. the company has three groups .
8s. la empresa tiene tres grupos .

9e. its groups are in Europe .
9s. sus grupos estan en Europa .

10e. the modern groups sell strong pharmaceuticals .
10s. los grupos modernos venden medicinas fuertes .

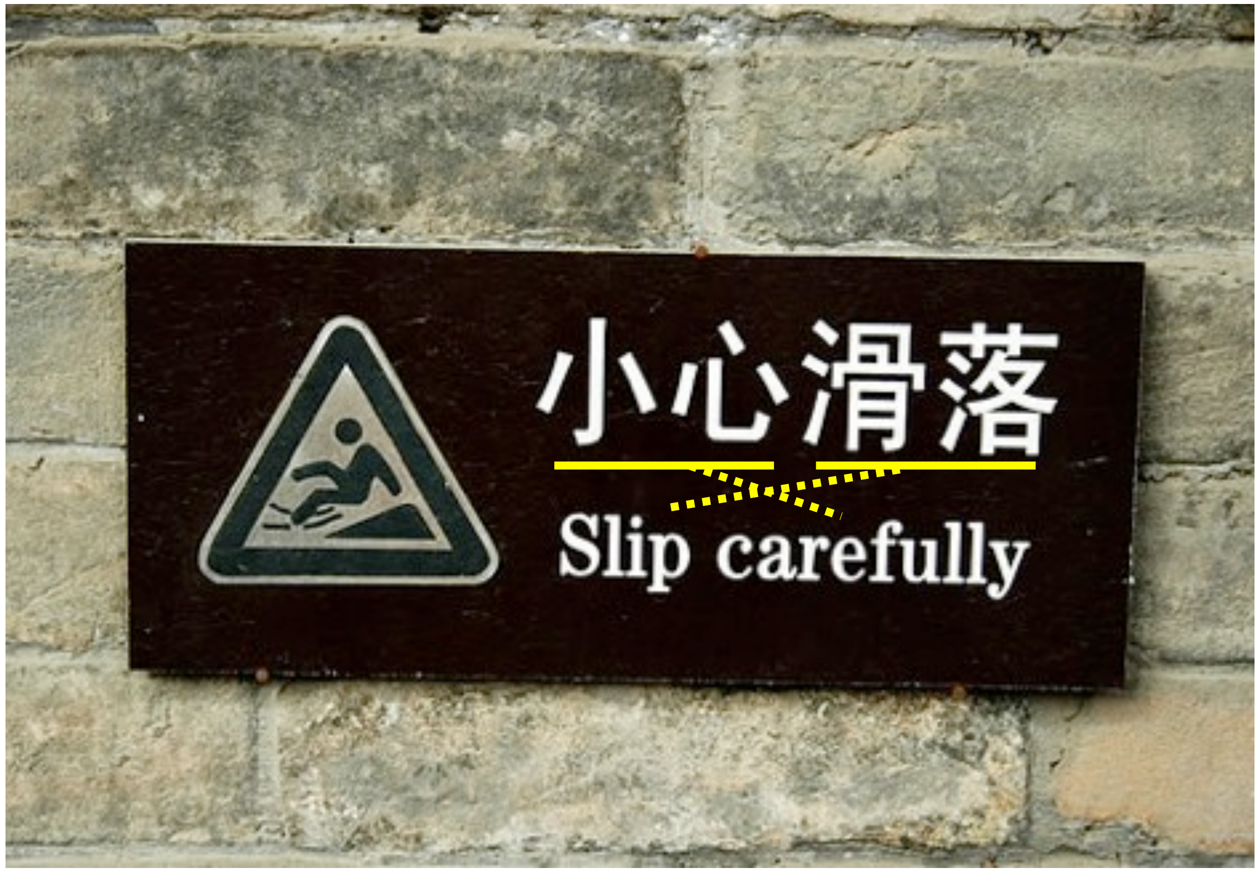
11e. the groups do not sell zenzanine .
11s. los grupos no venden zanzanina .

12e. the small groups are not modern .
12s. los grupos pequenos no son modernos .

(Knight,1997)

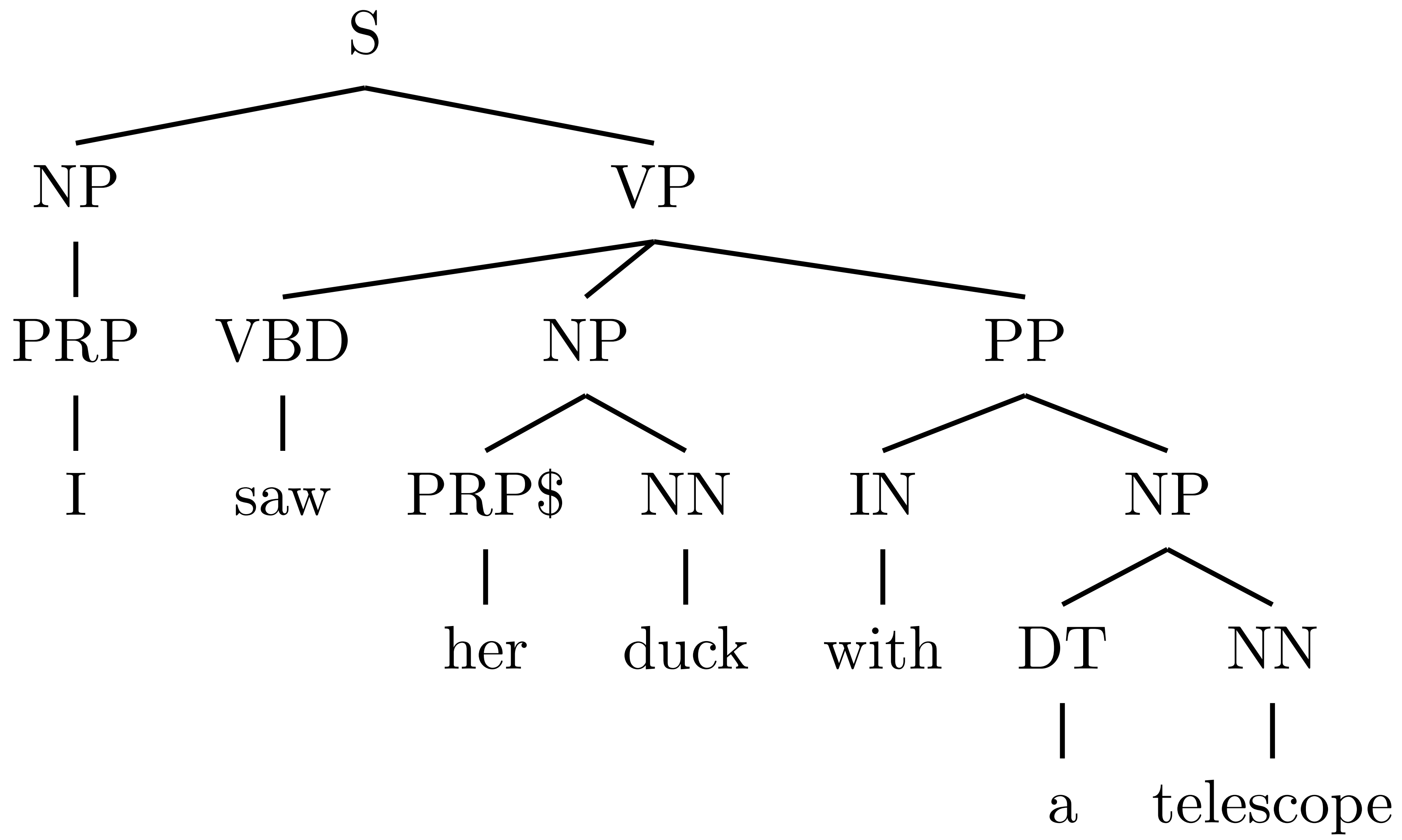
Take Home Message

- languages are *beyond* just bags of words!
  - ambiguity is everywhere, and NLP is all about that
- we'll teach machines how to read and translate...
  - and how to *learn* to read and translate from data
- have fun in this class! :)



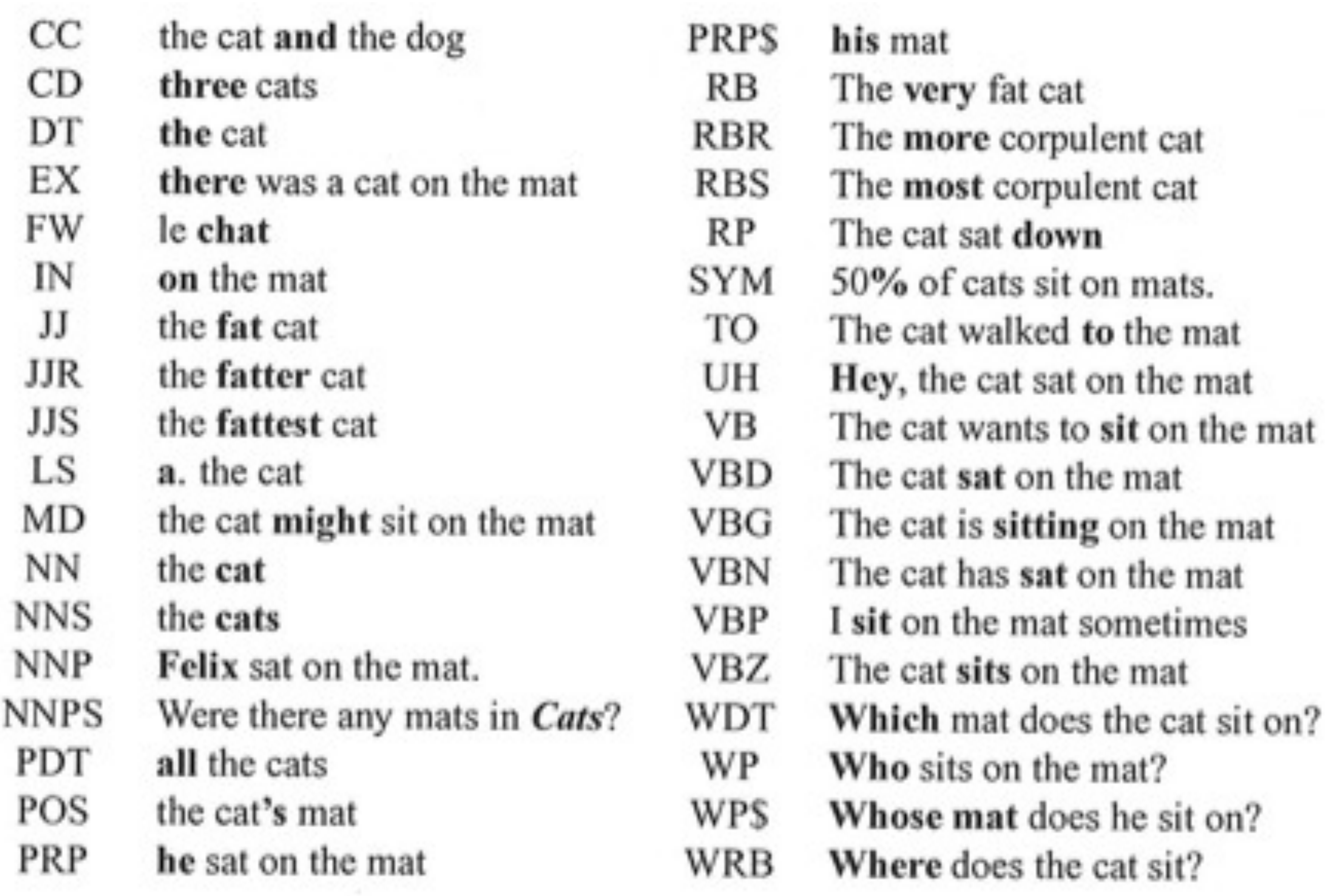
Basic Linguistic Structures

- parse tree; grammar rules like S -> NP VP; NP -> PRP
- nonterminals like S, NP, VP, ...
- preterminals (part-of-speech tags): PRP, VBD, IN



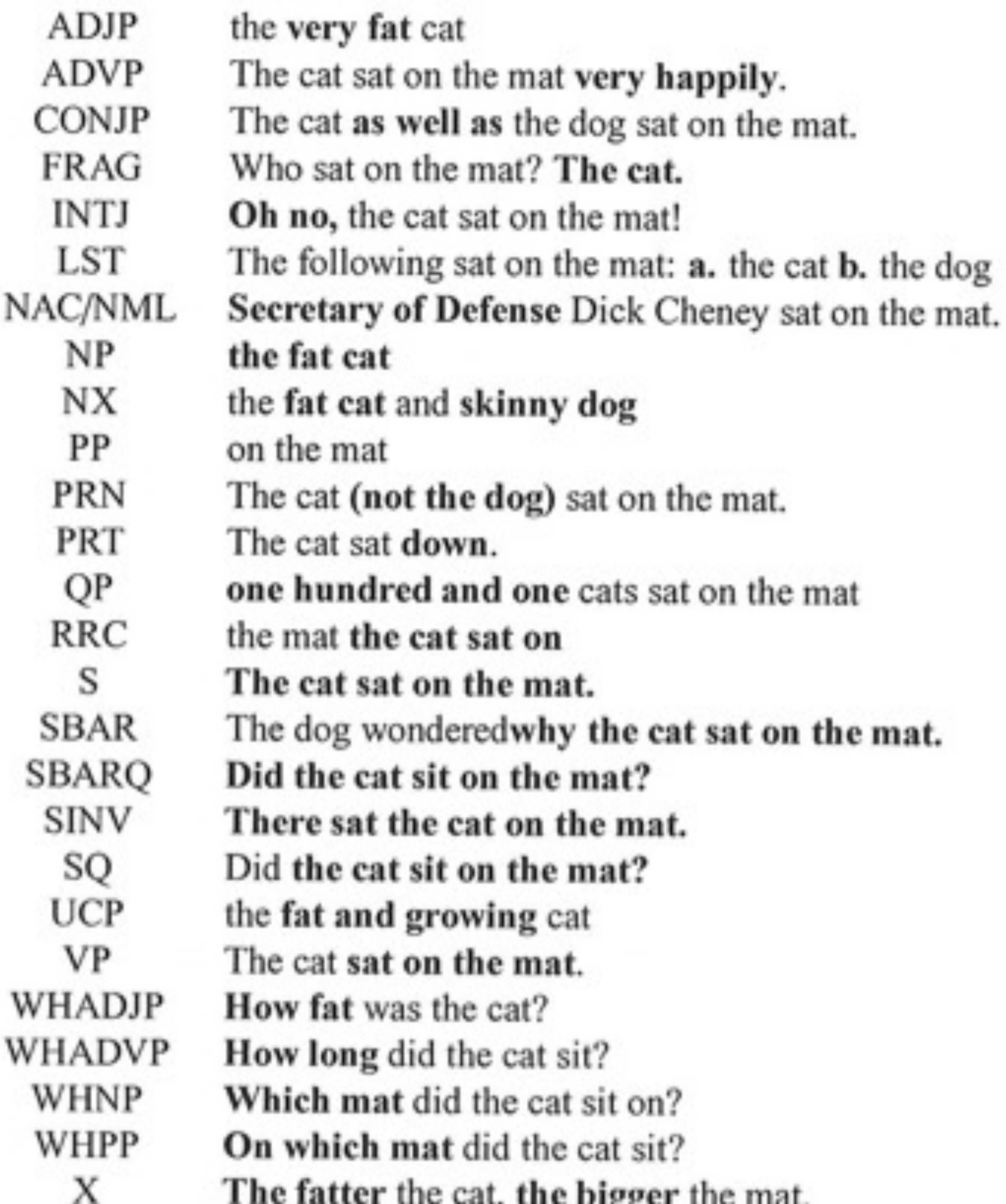
Part-of-Speech Tags

- Penn Treebank Part-of-Speech Tags



CC	the cat **and** the dog	PRP$	**his** mat
CD	**three** cats	RB	The **very** fat cat
DT	**the** cat	RBR	The **more** corpulent cat
EX	**there** was a cat on the mat	RBS	The **most** corpulent cat
FW	le **chat**	RP	The cat sat **down**
IN	**on** the mat	SYM	50**%** of cats sit on mats.
JJ	the **fat** cat	TO	The cat walked **to** the mat
JJR	the **fatter** cat	UH	**Hey**, the cat sat on the mat
JJS	the **fattest** cat	VB	The cat wants to **sit** on the mat
LS	**a**. the cat	VBD	The cat **sat** on the mat
MD	the cat **might** sit on the mat	VBG	The cat is **sitting** on the mat
NN	the **cat**	VBN	The cat has **sat** on the mat
NNS	the **cats**	VBP	I **sit** on the mat sometimes
NNP	**Felix** sat on the mat.	VBZ	The cat **sits** on the mat
NNPS	Were there any mats in ***Cats***?	WDT	**Which** mat does the cat sit on?
PDT	**all** the cats	WP	**Who** sits on the mat?
POS	the cat**'s** mat	WP$	**Whose mat** does he sit on?
PRP	**he** sat on the mat	WRB	**Where** does the cat sit?

Nonterminal Labels



ADJP	the **very fat** cat
ADVP	The cat sat on the mat **very happily**.
CONJP	The cat **as well as** the dog sat on the mat.
FRAG	Who sat on the mat? **The cat.**
INTJ	**Oh no,** the cat sat on the mat!
LST	The following sat on the mat: **a.** the cat **b.** the dog
NAC/NML	**Secretary of Defense** Dick Cheney sat on the mat.
NP	**the fat cat**
NX	the **fat cat** and **skinny dog**
PP	on the mat
PRN	The cat **(not the dog)** sat on the mat.
PRT	The cat sat **down**.
QP	**one hundred and one** cats sat on the mat
RRC	the mat **the cat sat on**
S	**The cat sat on the mat.**
SBAR	The dog wondered**why the cat sat on the mat.**
SBARQ	**Did the cat sit on the mat?**
SINV	**There sat the cat on the mat.**
SQ	Did **the cat sit on the mat?**
UCP	the **fat and growing** cat
VP	The cat **sat on the mat**.
WHADJP	**How fat** was the cat?
WHADVP	**How long** did the cat sit?
WHNP	**Which mat** did the cat sit on?
WHPP	**On which mat** did the cat sit?
X	**The fatter** the cat, **the bigger** the mat.