Human Language Technology: What Computers do with Text and Speech

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Anything machines do with text and speech

- Automatic translation of human languages
- Question answering
- Hands-free text and email
- Device control
- Analyzing online sentiment
- Web search

etc.

Hard for Computers!

olive oil

peanut oil

sesame oil

source:
Elaine Rich

Hard for Computers!

olive oil

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sesame oil

baby oil?

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Hard for Computers!

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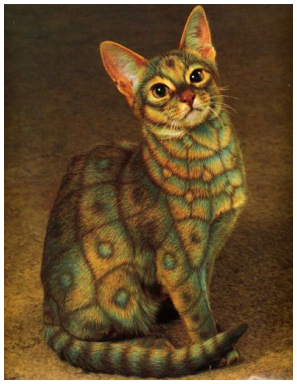
why cats paint ≠ why paint cats



source:
Elaine Rich

Hard for Computers!

interest

bank loan interest?

concern, fascination?

part ownership?

Hard for Computers!

interest in IBM

bank loan interest?

concern, fascination?

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Hard for Computers!

a financial **interest** in IBM

bank loan interest?

concern, fascination?

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Humans do this effortlessly.

Hard for Computers!

company? spokesperson? building?

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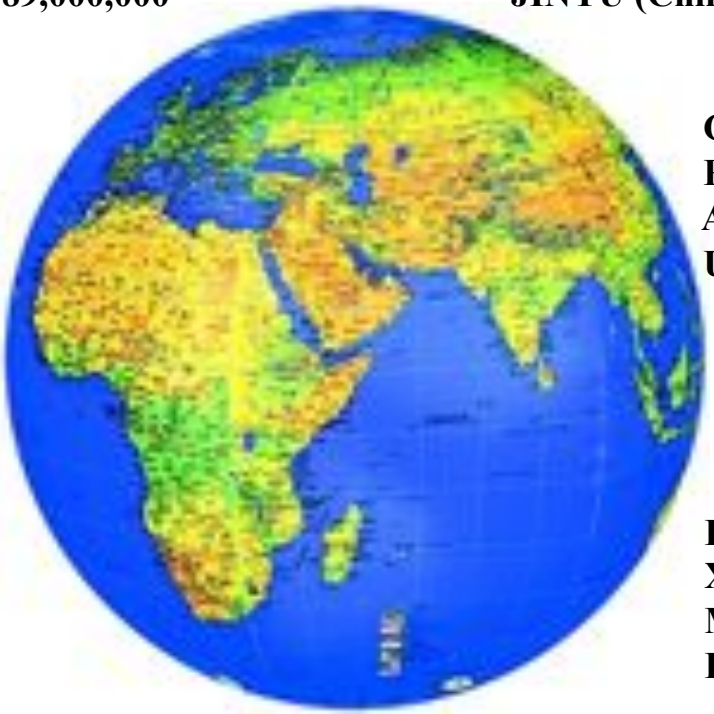
Thousands of Languages

MANDARIN	885,000,000
SPANISH	332,000,000
ENGLISH	322,000,000
BENGALI	189,000,000
HINDI	182,000,000
PORTUGUESE	170,000,000
RUSSIAN	170,000,000
JAPANESE	125,000,000
GERMAN	98,000,000
WU (China)	77,175,000
JAVANESE	75,500,800
KOREAN	75,000,000
FRENCH	72,000,000
VIETNAMESE	67,662,000
TELUGU	66,350,000
YUE (China)	66,000,000
MARATHI	64,783,000
TAMIL	63,075,000



TURKISH	59,000,000
URDU	58,000,000
MIN NAN (China)	49,000,000
JINYU (China)	45,000,000
GUJARATI	44,000,000
POLISH	44,000,000
ARABIC	42,500,000
UKRAINIAN	41,000,000
ITALIAN	37,000,000
XIANG (China)	36,015,000
MALAYALAM	34,022,000
HAKKA (China)	34,000,000
KANNADA	33,663,000
ORIYA	31,000,000
PANJABI	30,000,000
SUNDA	27,000,000

Source: Ethnologue

Machine Translation

美国关岛国际机场及其办公室均接获一名自称沙地阿拉伯富商拉登等发出的电子邮件，威胁将会向机场等公众地方发动生化袭击後，关岛经保持高度戒备。

Chinese/ English

The U.S. island of Guam is maintaining a high state of alert after the Guam airport and its offices both received an e-mail from someone calling himself the Saudi Arabian Osama bin Laden and threatening a biological/chemical attack against public places such as the airport.

Kowane mutum na da hakkin ya sami yancin yin tunani da na sanin yakamata da na bin addini; saboda haka yana da yancin sake addini ko ra'ayin da ya bada gaskiya gare shi, da kuma yancin nuna addininsa ko ra'ayinsa, shi daya ko a cikin taro kuma a fili ko a boye ta hanyar koyarwa ko yin ibada, ko bauta wa abin da ya bada gaskiya gare shi da yin abubuwan da abin da yake bauta wa din ya nuna masa.

Hausa/ English

Everyone has the right to freedom of thought, conscience and religion; this right includes freedom to change his religion or belief, and freedom, either alone or in community with others and in public or private, to manifest his religion or belief in teaching, practice, worship and observance.

Grand Challenge for Artificial Intelligence

- Why have people gotten involved?
  - Passion for how human language works
    - When is a word sequence grammatical, sensible?
  - Interest in foreign languages
    - What's the difference between English and Chinese?
  - Desire to change the world
    - What happens when language barrier disappears?

- We spent a lot of time in the laboratory!

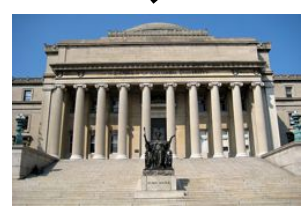
Today: End-User Products

...

US Government funded HLT research

SRI International

IBM T. J. Watson



Columbia University

...

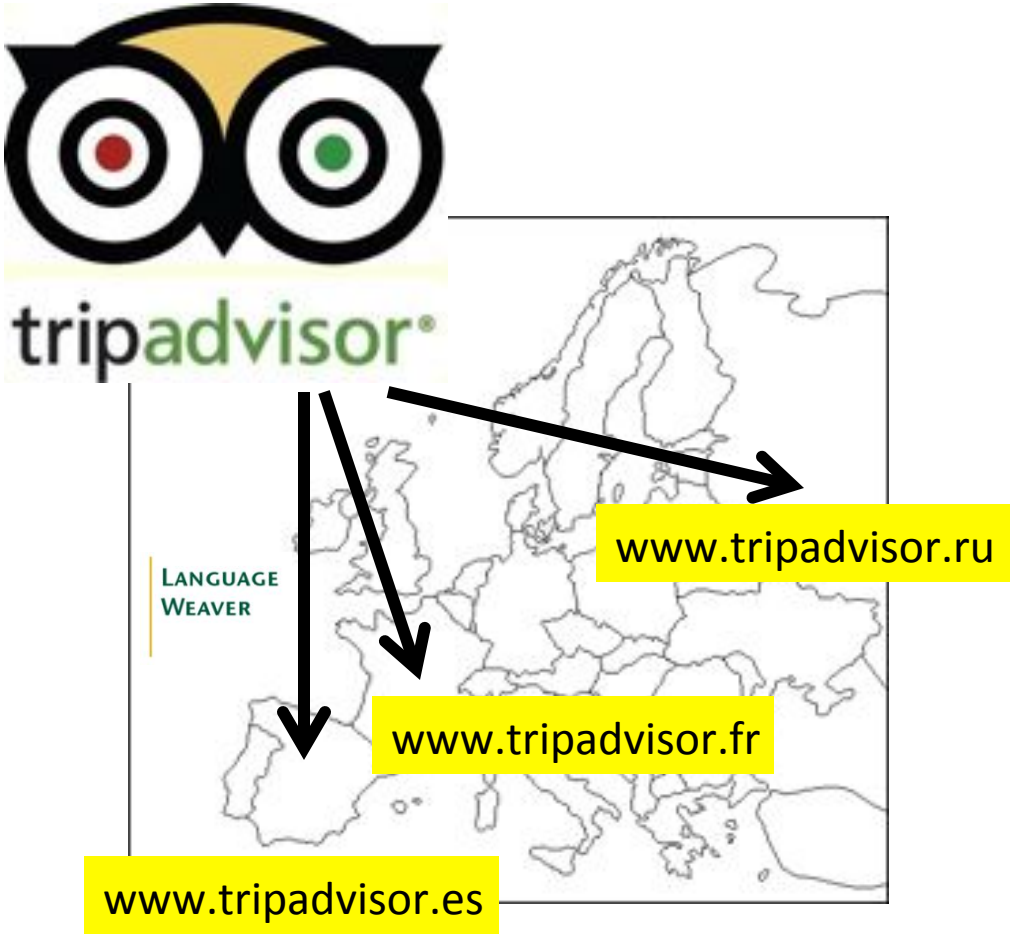
many research institutions + many universities + researchers, faculty, graduate students

+ US Government funding of computing systems research

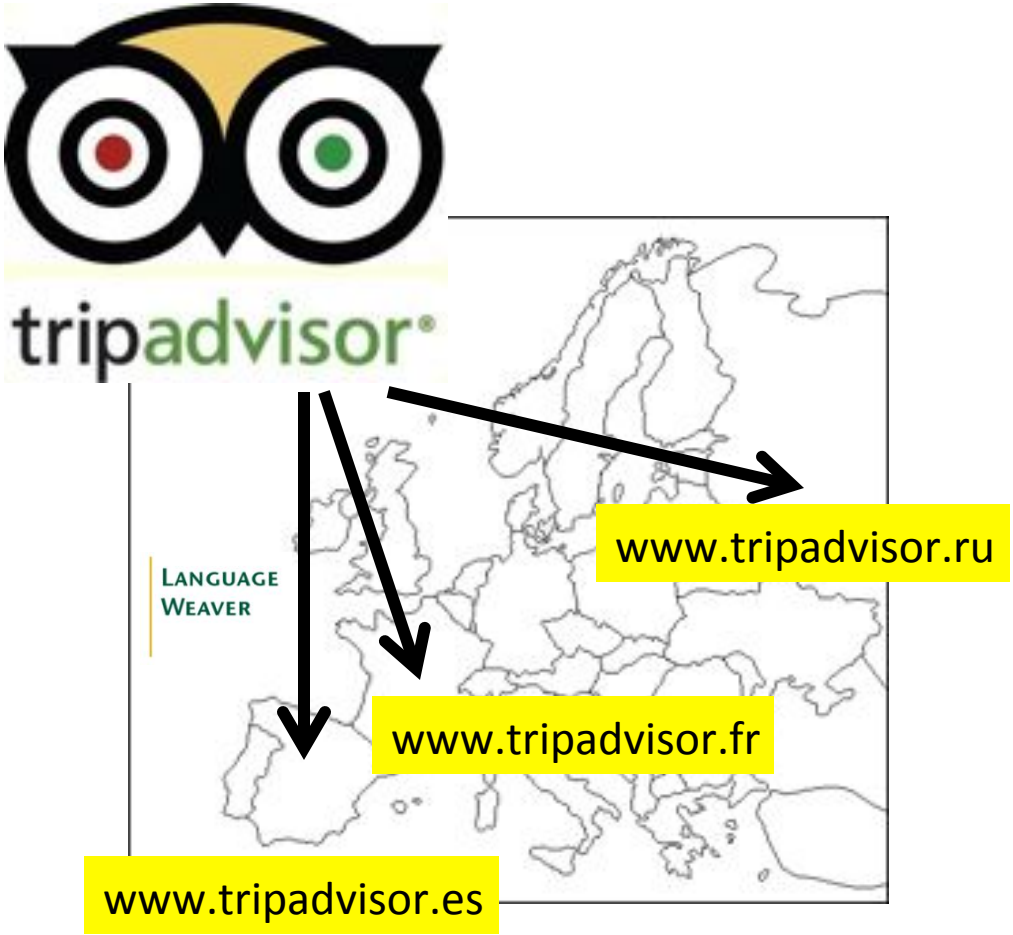
Tools for Companies

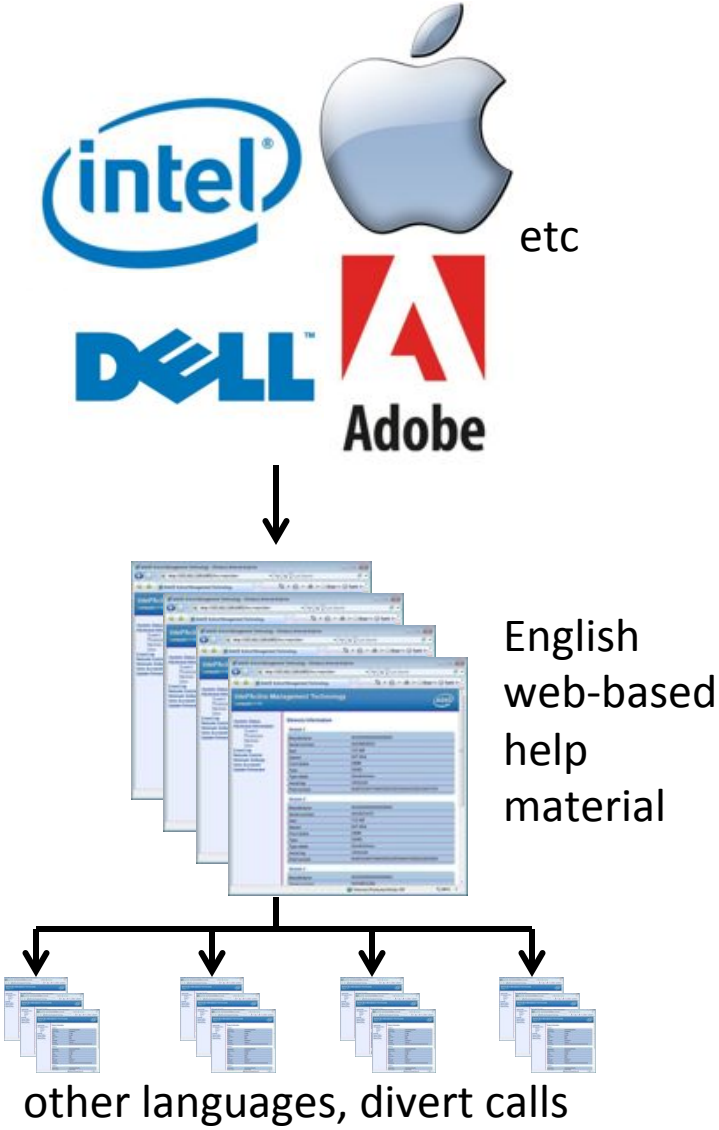
Tools for Companies

Tools for Companies



Tools for Companies





Tools for Military & Intelligence

US Government funded research

Sources: Virage, BBN, Language Weaver, Voxtec

What Has Been Working?

- Focus on **common** linguistic phenomena
  - rather than obscure, difficult cases
- Have machines **learn** from online text and speech data
- **Manage uncertainty** with probabilistic models
- **Evaluate** accuracy of systems
- Develop **common tasks**, compare notes
- **Refine** models

Learning from Data

I have an **interest** in gardening.
I earned 5% **interest** last year.
Zuckerberg holds a controlling **interest**.
My **interest** is purely out of curiosity.

Human annotation of online text.

Learning from Data

concern, fascination

bank loan interest

part ownership

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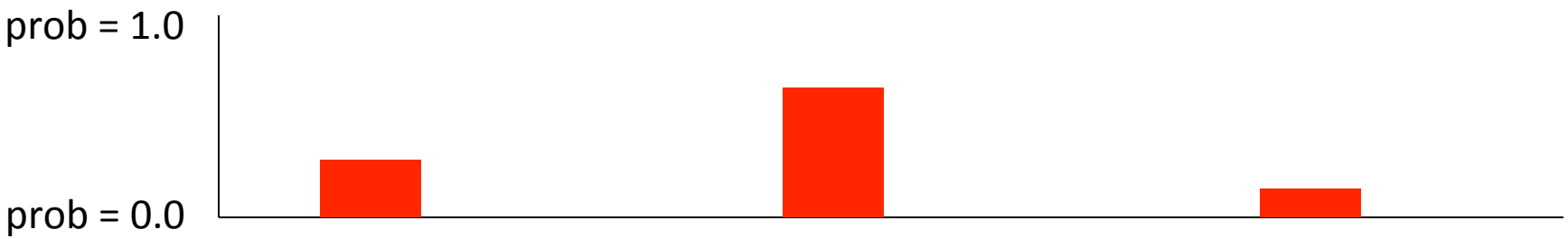

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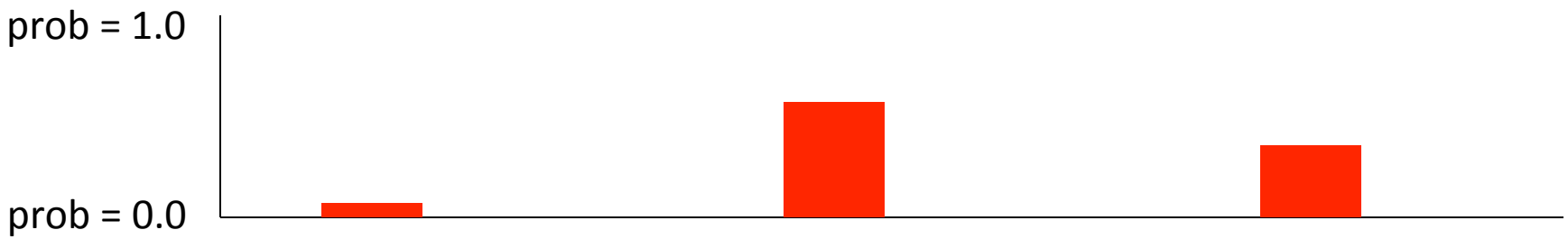

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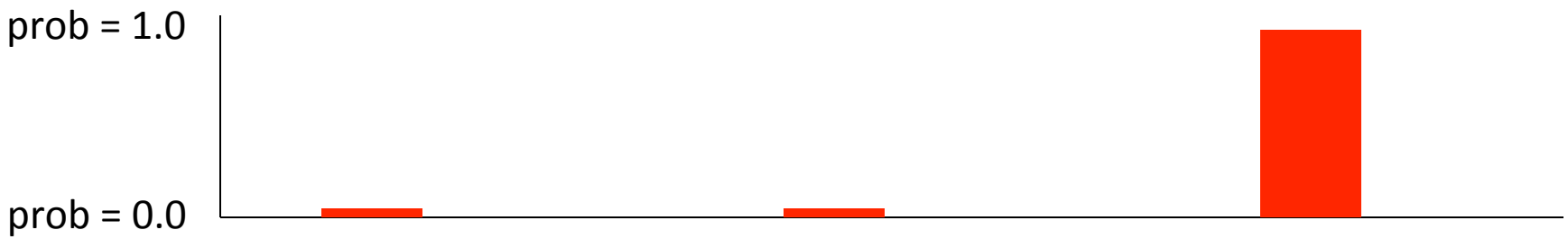
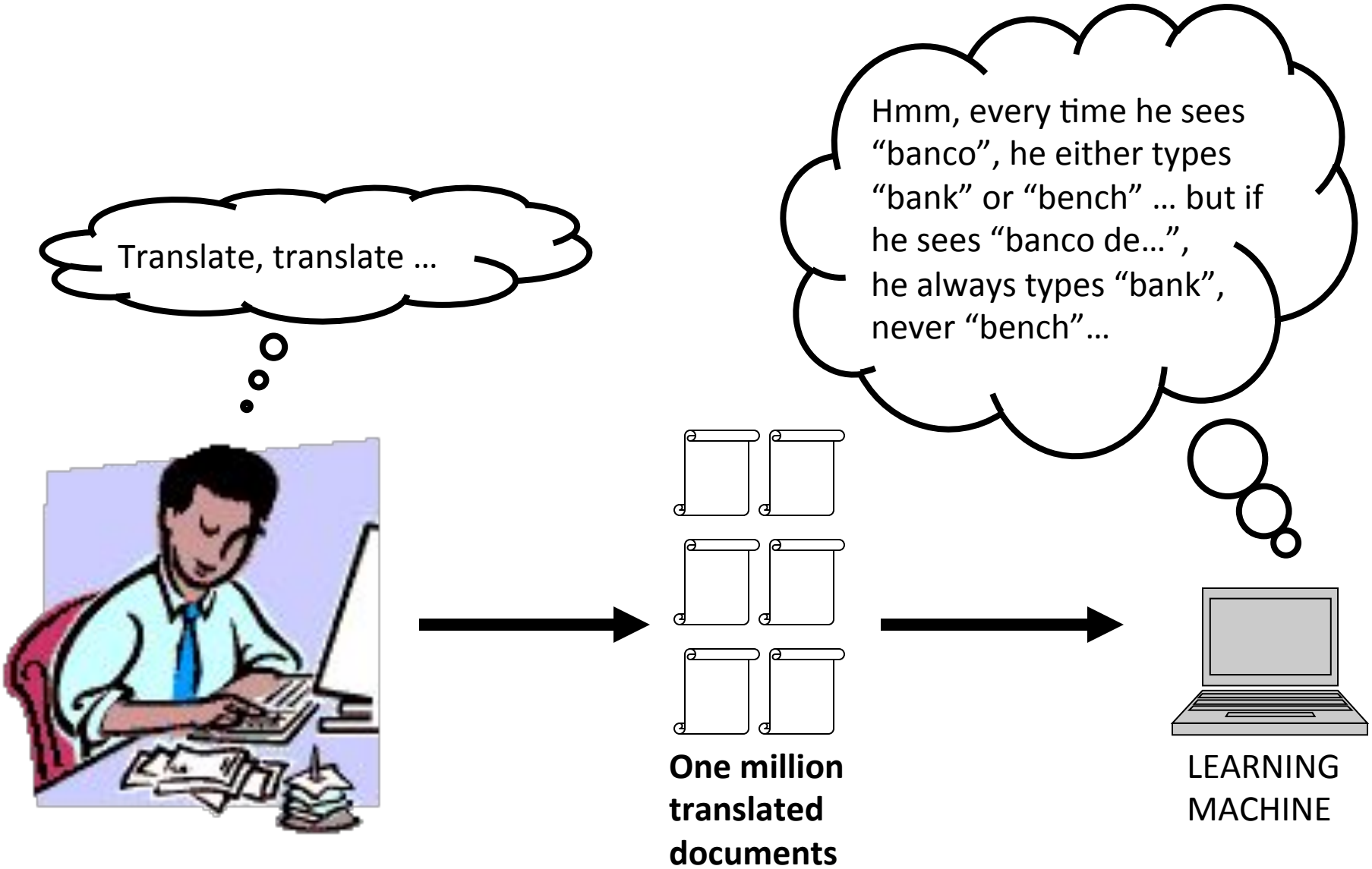


Learning to Translate



Learning to Translate

12 English sentences translated manually into Spanish.

1a. Garcia and associates . 1b. Garcia y asociados .	7a. the clients and the associates are enemies . 7b. los clients y los asociados son enemigos .
2a. Carlos Garcia has three associates . 2b. Carlos Garcia tiene tres asociados .	8a. the company has three groups . 8b. la empresa tiene tres grupos .
3a. his associates are not strong . 3b. sus asociados no son fuertes .	9a. its groups are in Europe . 9b. sus grupos estan en Europa .
4a. Garcia has a company also . 4b. Garcia tambien tiene una empresa .	10a. the modern groups sell strong pharmaceuticals . 10b. los grupos modernos venden medicinas fuertes .
5a. its clients are angry . 5b. sus clientes estan enfadados .	11a. the groups do not sell zenzanine . 11b. los grupos no venden zanzanina .
6a. the associates are also angry . 6b. los asociados tambien estan enfadados .	12a. the small groups are not modern . 12b. los grupos pequenos no son modernos .

Learning to Translate

Your assignment, translate this: farok crrrok hihok yorok clok kantok ok-yurp

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2a. ok-drubel ok-voon anok plok sprok . 2b. at-drubel at-voon pippat rrat dat .	8a. lalok brok anok plok nok . 8b. iat lat pippat rrat nnat .
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4a. ok-voon anok drok brok jok . 4b. at-voon krat pippat sat lat .	10a. lalok mok nok yorok ghirok clok . 10b. wat nnat gat mat bat hilat .
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process of elimination

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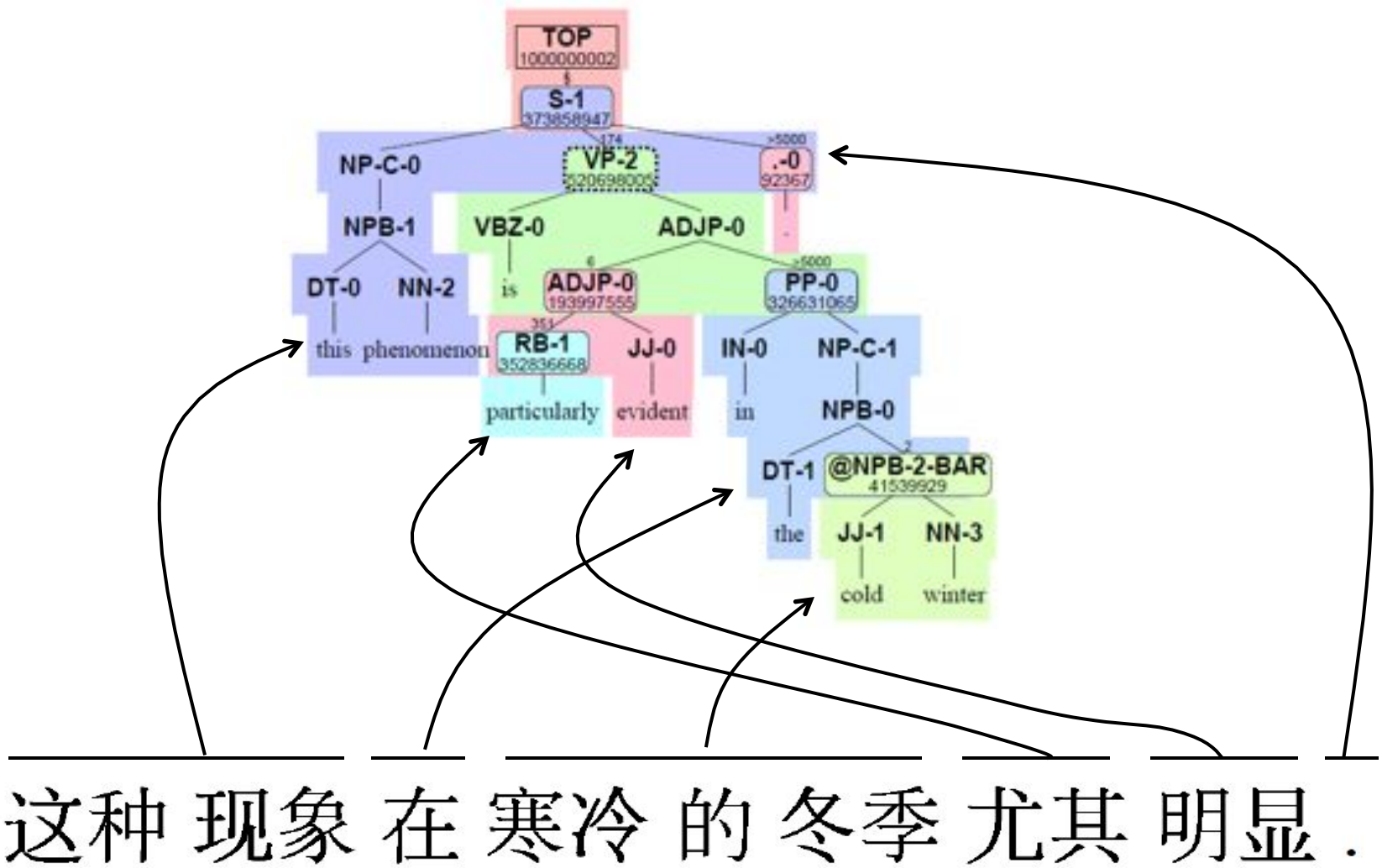
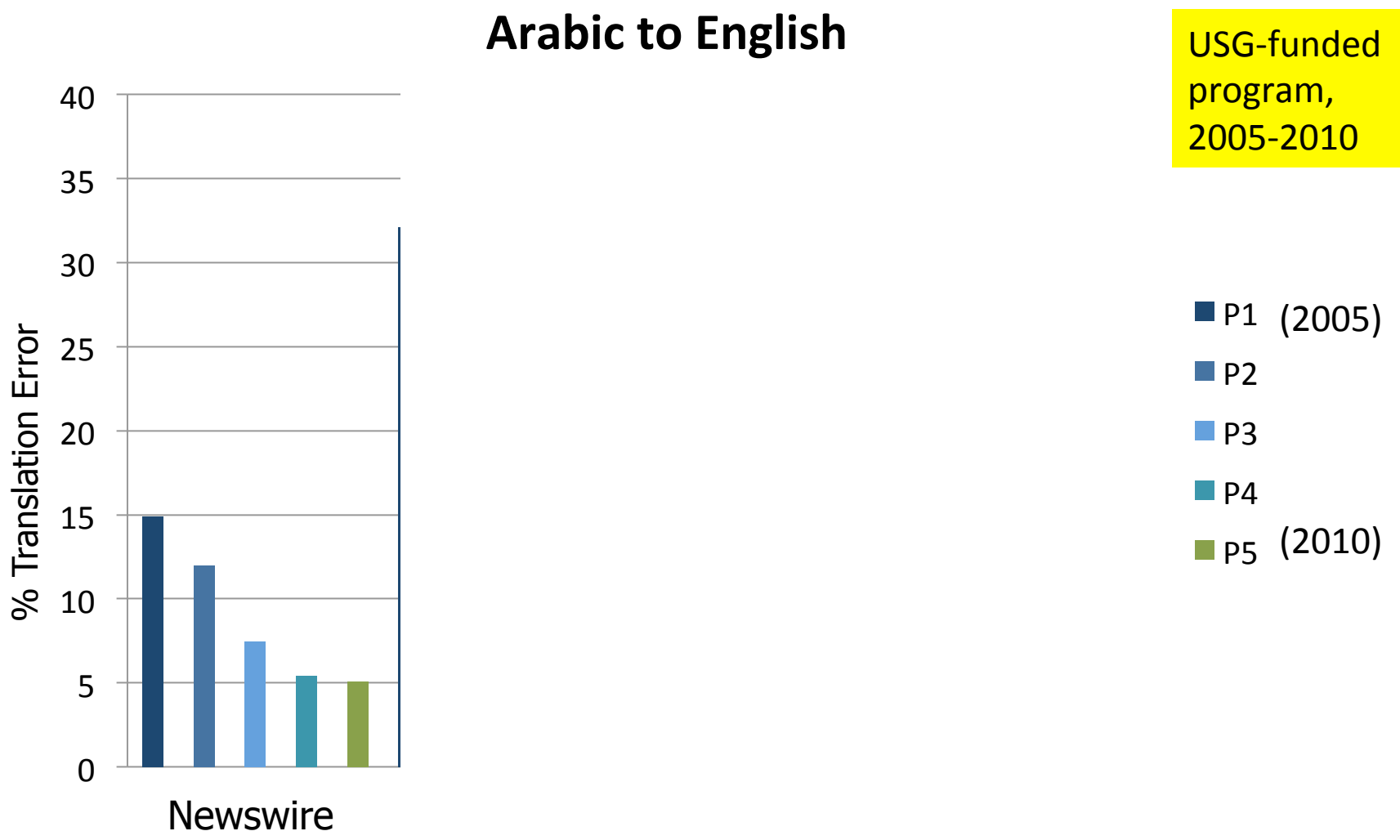
4a. ok-voon anok drok brok jok . 4b. at-voon krat pippat sat lat .	10a. lalok mok nok yorok ghirok clok . 10b. wat nnat gat mat bat hilat .
5a. wiwok farok izok stok . 5b. totat jjat quat cat .	11a. lalok nok crrrok hihok yorok zanzanok . 11b. wat nnat arrat mat zanzanat . cognate?
6a. lalok sprok izok jok stok . 6b. wat dat krat quat cat .	12a. lalok rarok nok izok hihok mok . 12b. wat nnat forat arrat vat gat .

Assembling a Translation from Automatically Learned Rules

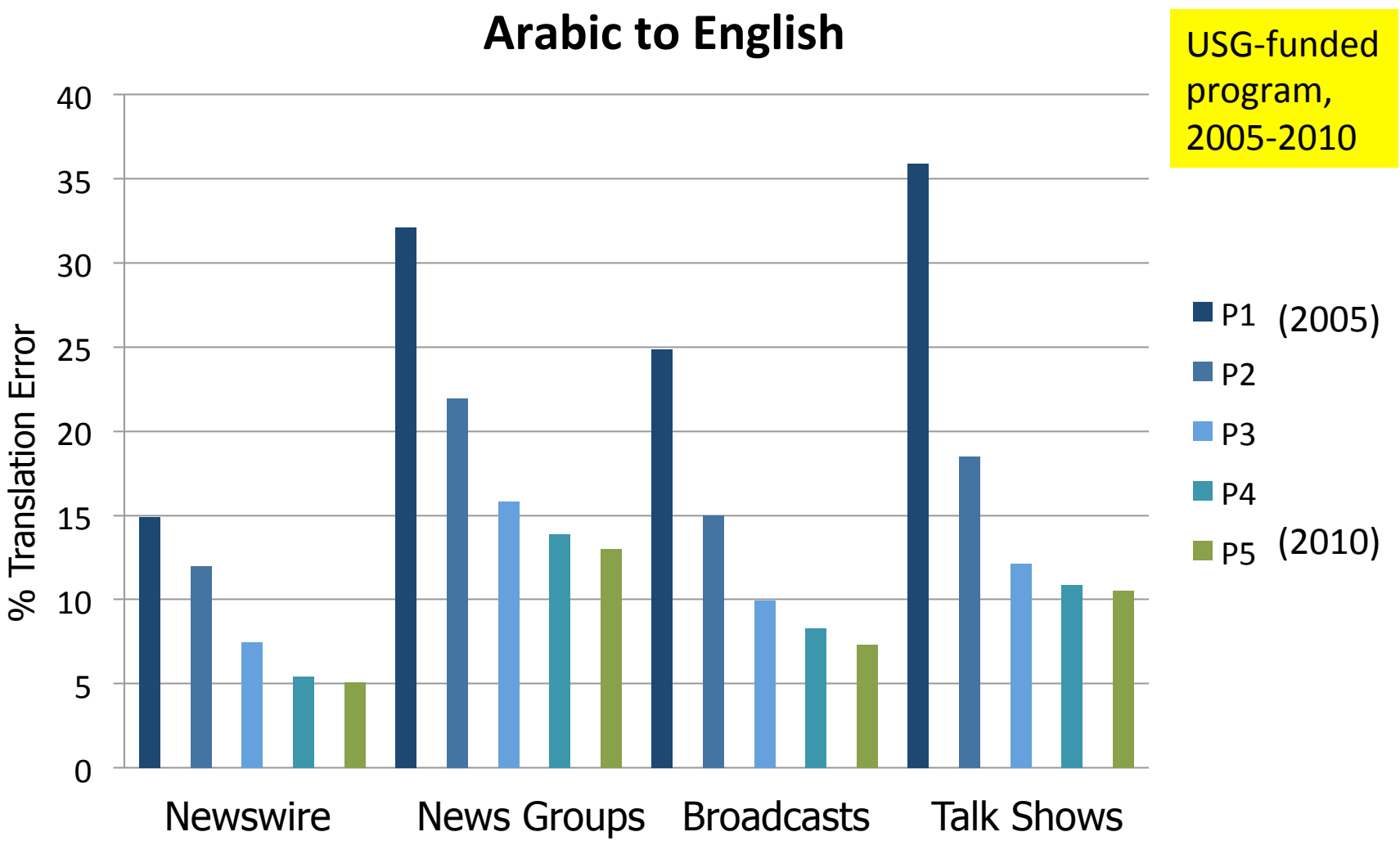


Machine Translation Error Rate



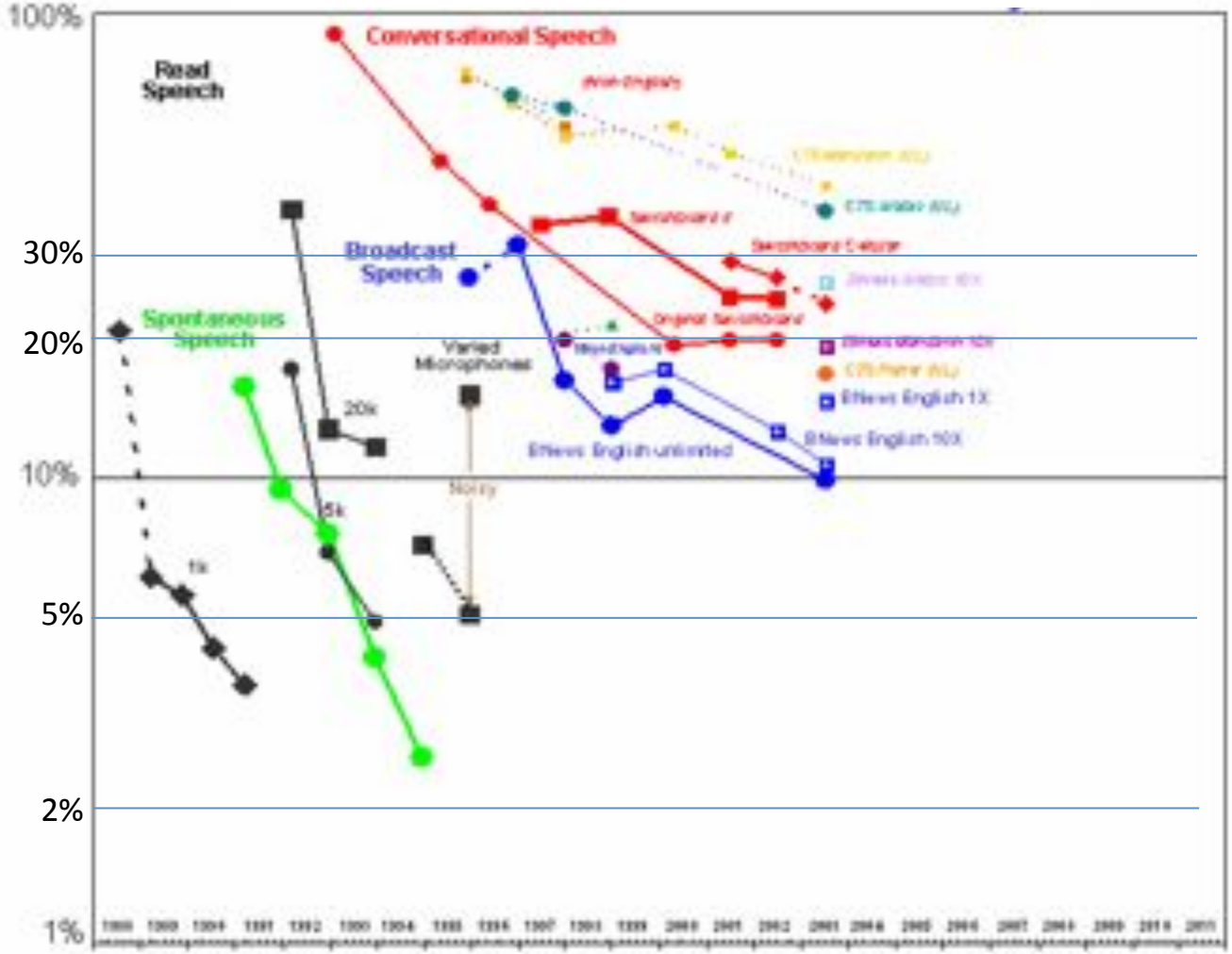
source: DARPA

Machine Translation Error Rate



source: DARPA

Speech Recognition Error Rate



USG-funded programs 1988-2003

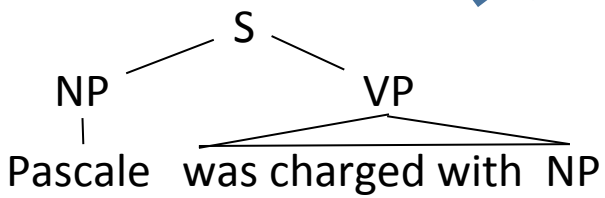
Benchmarking by NIST

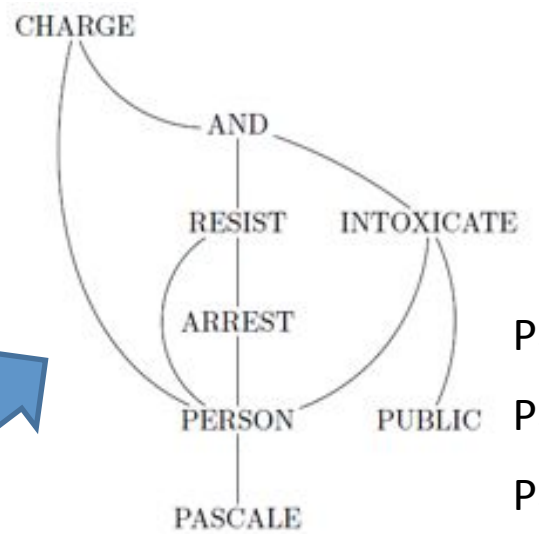
http://1.usa.gov/xKaL7U

Lots of Progress, But …

- Machines make lots of errors
- Machines need a **deeper understanding** of what they read and hear

Pascale was charged with public intoxication and resisting arrest.





Pascale was charged

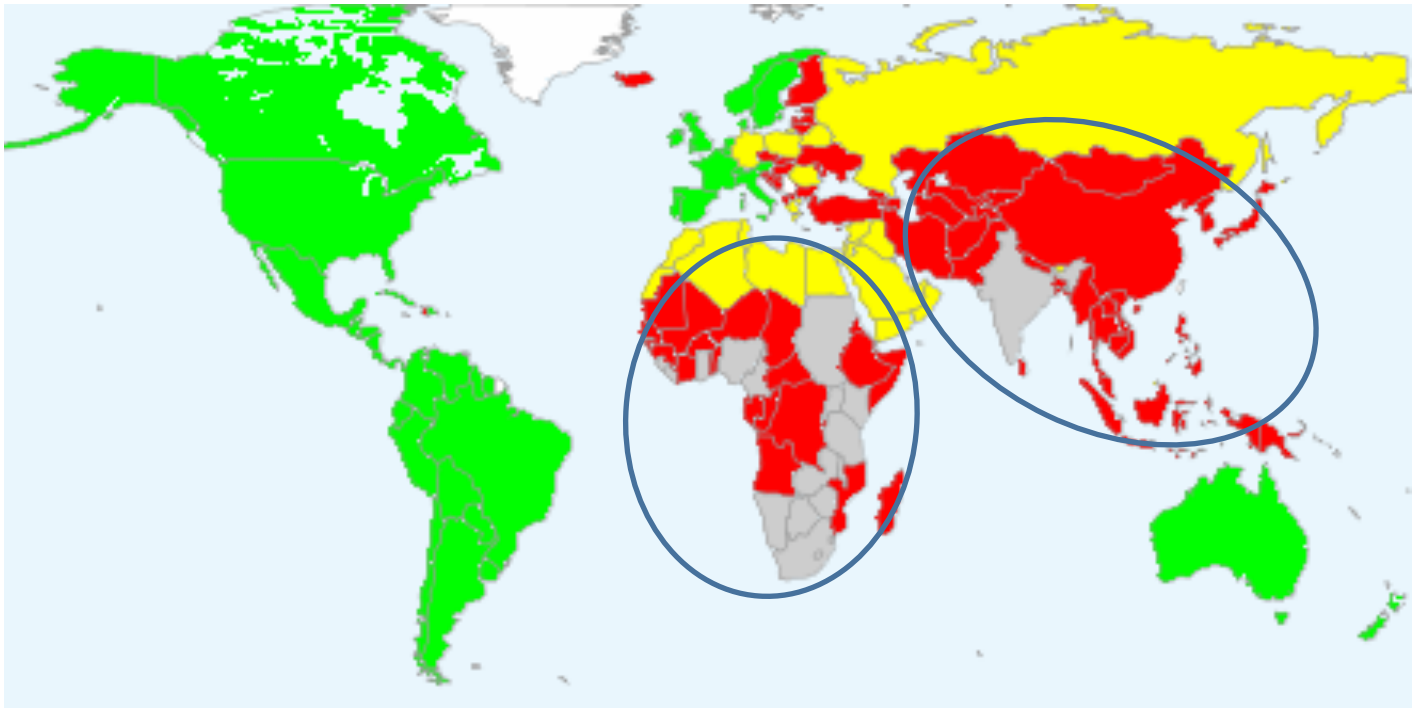
Pascale was intoxicated (?)

Pascale was resisting (?)

Pascale was being arrested

Things We Can't Do Yet

Let's Not Forget …



Good machine translation

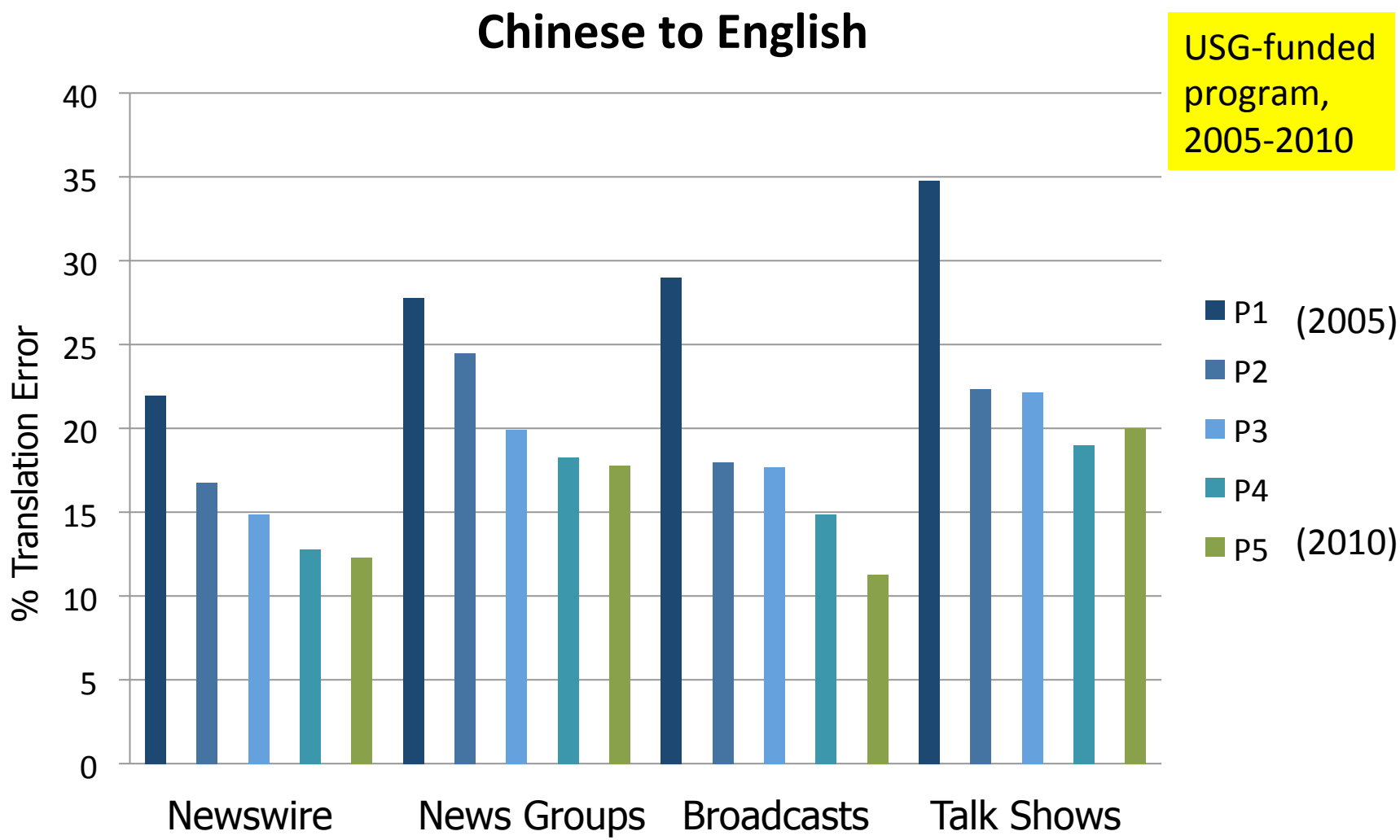
Passable translation

Poor translation

questions?

backup

Machine Translation Error Rate



source: DARPA