# Natural Language Processing: An Introduction

Penn
University of Pennsylvania

# NLP: The Ultimate Goal (1990)

**The *Ultimate* Goal – For computers to use NL as effectively as humans do….**

**"Natural language, whether spoken, written, or typed, is the most natural means of communication between humans, and the mode of expression of choice for most of the documents they produce. As computers play a larger role in the preparation, acquisition, transmission, monitoring, storage, analysis, and transformation of information, endowing them with the ability to understand and generate information expressed in natural languages becomes more and more necessary."**

# NLP: Grand Challenges (1990)

**The *Ultimate* Goal – For computers to use NL as effectively as humans do….**

**Reading and writing text**

- **Abstracting**
- **Monitoring**
- **Extraction into Databases**

**Interactive Dialogue: Natural, effective access to computer systems**

- **Informal Speech Input and Output**

**Translation: Input and Output in Multiple Languages**

# Significant Advances In NLP I

- **Web-scale information extraction & question answering**
  - **IBM's Watson**


- **Interactive Dialogue Systems**
  - **Apple's Siri**
  - **(Microsoft Cortana)**
  - **(Amazon Echo)**
  - **(Google Now)**

# Significant Advances In NLP II

## Automatic Machine Translation

### Xinhua story (Chinese) → Google translate (2015)

新华网海牙３月２４日电（记者陈贽潘治）第三届核安全峰会２４日在荷兰海牙举行。国家主席习近平出席并发表重要讲话，介绍中国核安全措施和成就，阐述中国关于发展和安全并重、权利和义务并重、自主和协作并重、治标和治本并重的核安全观，呼吁国际社会携手合作，实现核能持久安全和发展。

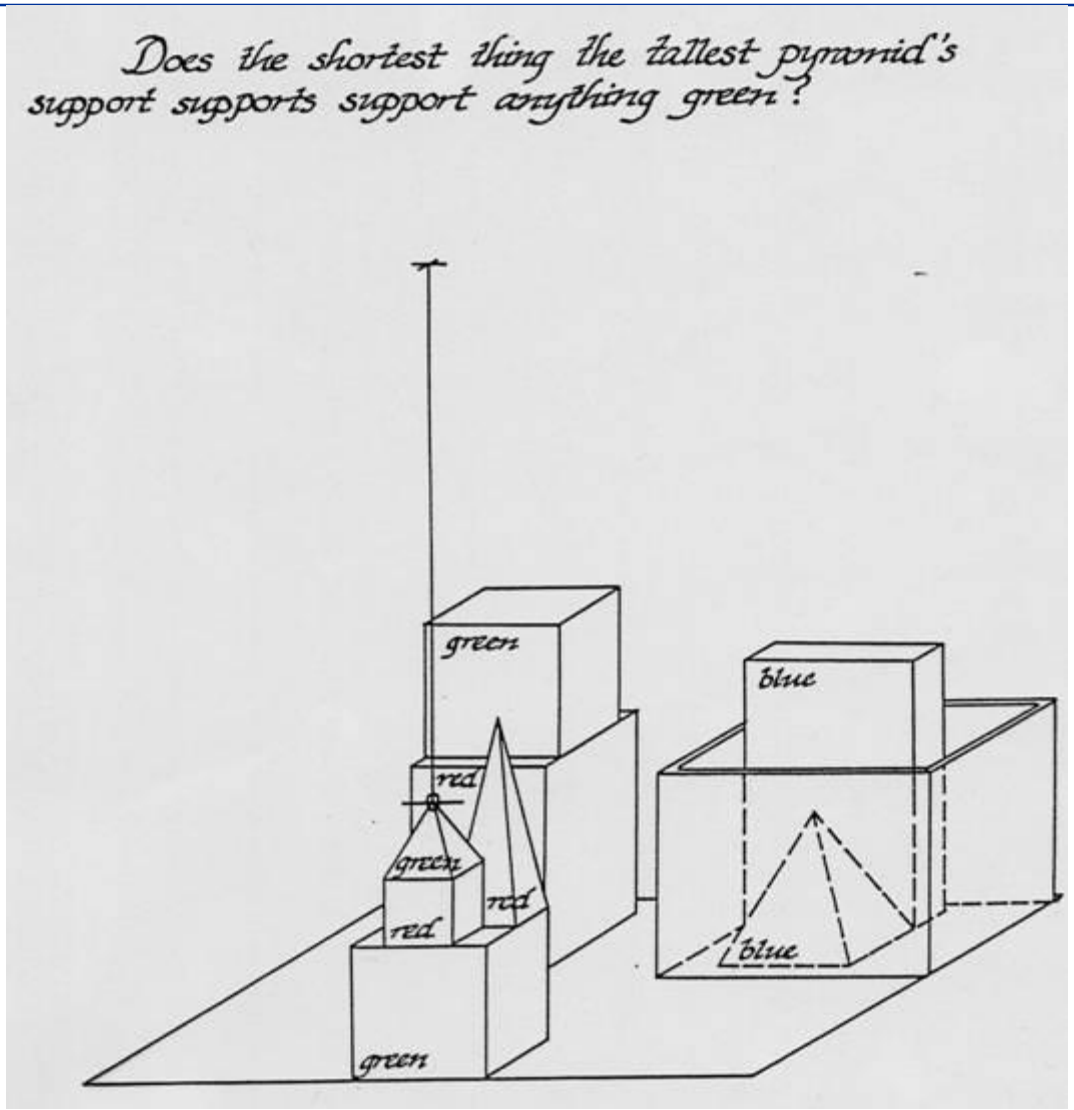
The Hague, *March 24* Xinhua (Reporter Chen Zhi Pan Governance ) Third Nuclear Security Summit held in The Hague on the 24th . State President Xi Jinping attended and delivered an important speech on China's nuclear safety measures and achievements , elaborated China on the development and security of both the rights and obligations of both, both independently and in collaboration , both temporary and permanent nuclear security concept , called on the international community to work together nuclear achieve lasting security and development.

# Early Successes: Human Machine Interfaces

- **SHRDLU (Winograd, 1969)**
  - A fragile demonstration of the fundamental vision

- **LUNAR (Woods, Webber, Kaplan  1971)**
  - Answering geologist's questions about the Apollo 11 moon rocks

# Review: SHRDLU: A demonstration proof



# LUNAR – William Woods 1971

- **NLP interface to database of analyses of Apollo 11 moon rocks**

- **Examples**
  - What is the average concentration of aluminum in high alkali rocks?
  - How many breccias contain olivine?
  - Give me the modal analyses of those samples for all phases.
- **Handled 78% of sentences typed by geologists at 1971 Lunar Rocks conference**
  - (90% after “minor fixes”)

# The Past: Crucial flaws in the paradigm

**These and other later systems worked well, BUT**

1. **Person-years of work to port to new applications**
2. **Very limited coverage of English**

**Crucially, they worked well because of a magical fact:**

*People automatically adapt and limit their language given a small set of exemplars if the underlying linguistic generalizations are HABITABLE*

**This won't handle pre-existing text!**

# The State of NLP

**NLP Past before 1995:**

- **Rich Representations**

***NLP Present:***

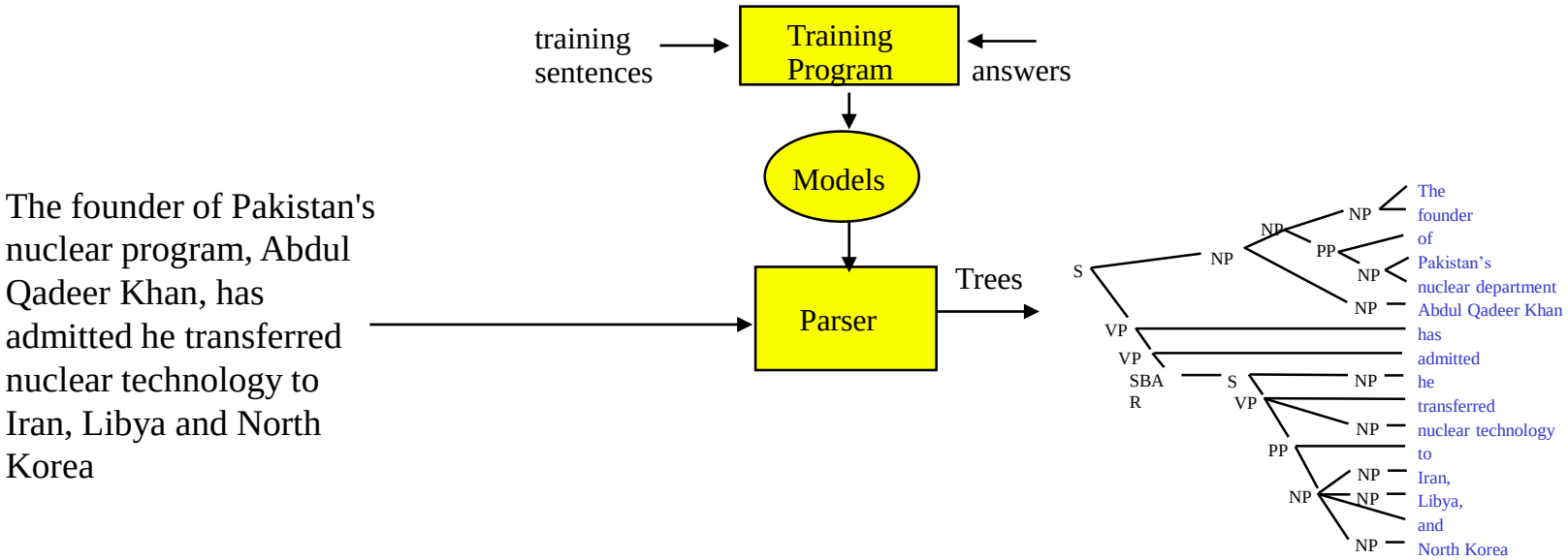
- ***Powerful Statistical Disambiguation***

# 1995: A breakthrough in parsing

$10^6$ words of Treebank Annotation

+ Machine Learning = Robust Parsers

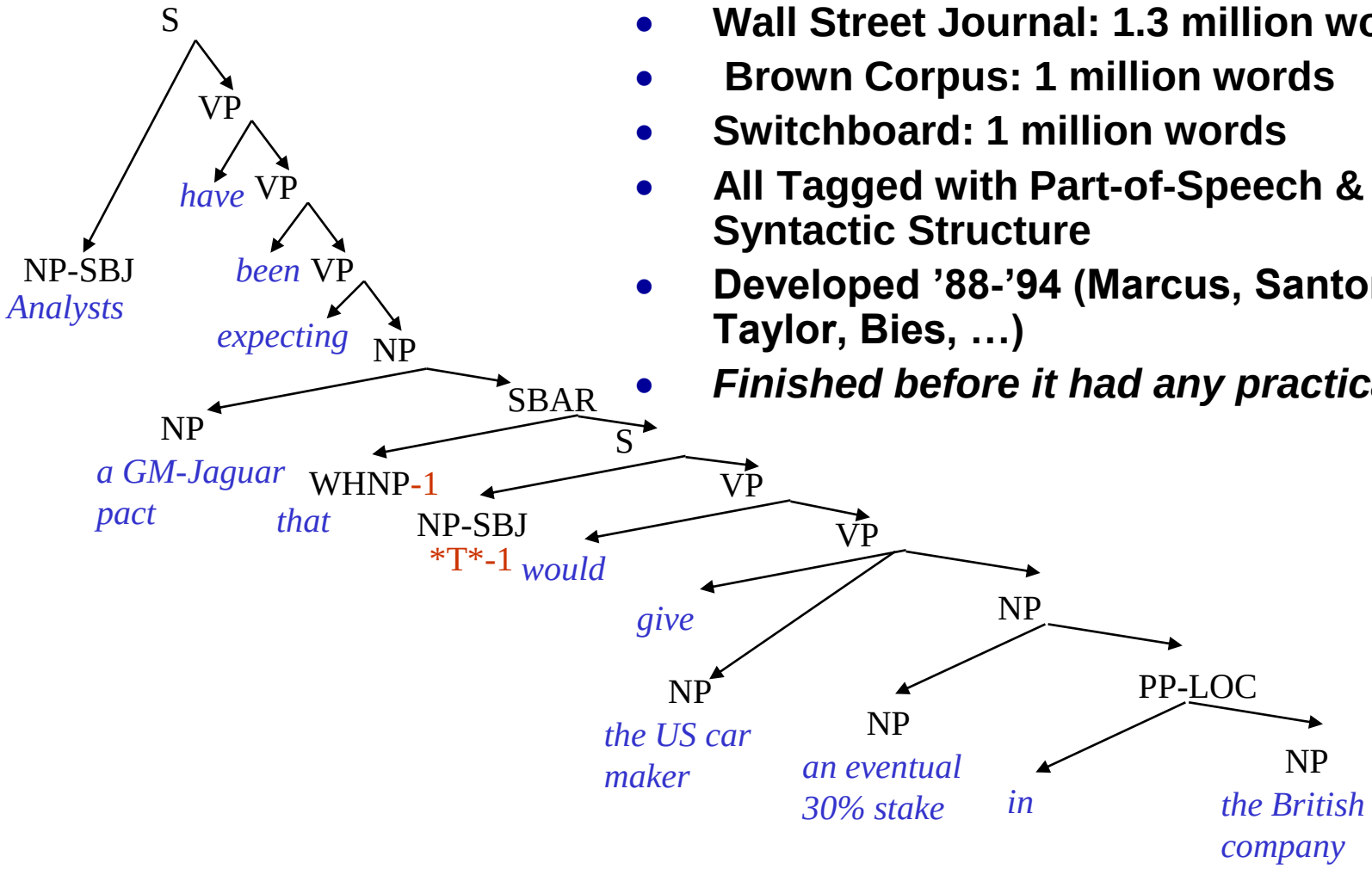
*(Magerman '95)*




- 1990 Best hand-built parsers: ~40-60% accuracy (guess)
- 1995+ Statistical parsers: >90% accuracy

*(both on short sentences)*

# The Penn Treebank: 1988-94




- **Wall Street Journal: 1.3 million words**
- **Brown Corpus: 1 million words**
- **Switchboard: 1 million words**
- **All Tagged with Part-of-Speech & Syntactic Structure**
- **Developed ’88-’94 (Marcus, Santorini, Taylor, Bies, …)**
- ***Finished before it had any practical use!***

# Lexicalized parsing results
## (Labeled Constituent Precision/Recall F1)

**Results**

| Method | Accuracy |
|---|---|
| PCFGs (Charniak 97) | 73.0% |
| Conditional Models – Decision Trees (Magerman 95) | 84.2% |
| Lexical Dependencies (Collins 96) | 85.5% |
| Conditional Models – Logistic (Ratnaparkhi 97) | 86.9% |
| Generative Lexicalized Model (Charniak 97) | 86.7% |
| Generative Lexicalized Model (Collins 97) | 88.2% |
| Logistic-inspired Model (Charniak 99) | 89.6% |
| Boosting (Collins 2000) | 89.8% |

*(Chris Manning, Stanford)*

# A Few Core Technologies

1. Named Entity Recognition& Information Extraction
2. Machine Translation
3. Text Summarization

# Information Extraction & Named Entity Recognition

# Information Extraction

- **Information extraction is the identification, in text, of specified classes of Named Entities +**
  - **—Relations**
  - **—Events**

- **For relations and events, this includes finding the participants and modifiers (date, time, location, etc.).**

- **Goal: fill out a data base with given relation or event types:**
  **people's jobs**
  - —people's whereabouts
  - —merger and acquisition activity
  - —disease outbreaks
  - —genomics relation

# Extraction Example

- George Garrick, 40 years old, **president of the London-based European Information Services Inc., was appointed chief executive officer of**

  Nielsen Marketing Research, USA.

| Position | Company | Location | Person | Status |
|---|---|---|---|---|
| President | European Information Services, Inc. | London | George Garrick | Out |
| CEO | Nielsen Marketing Research | USA | George Garrick | In |
| | | | | |

# Named Entity Recognition

**The task:** ***identify atomic elements of information in text***

- Flag the who, where, when & how much in text

- **Person names**
- **Company /organization names**
- **Locations**
- **Dates & times**
- **Percentages**
- **Monetary  amounts**

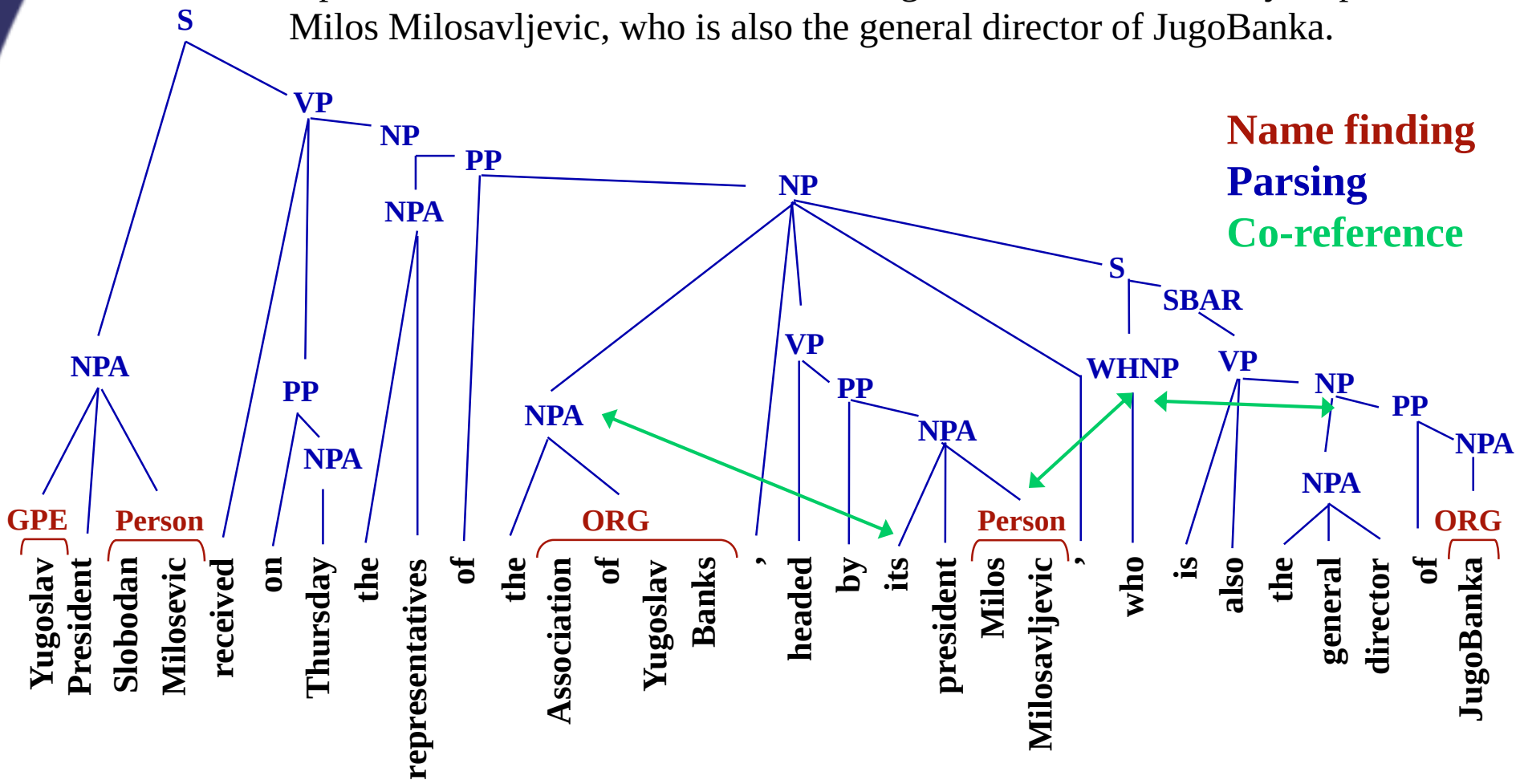
# Won‘t simple lists solve the problem?

- too numerous to include in dictionaries
- changing constantly
- appear in many variant forms
- subsequent occurrences might be abbreviated

$\Rightarrow$ list search/matching doesn‘t perform well

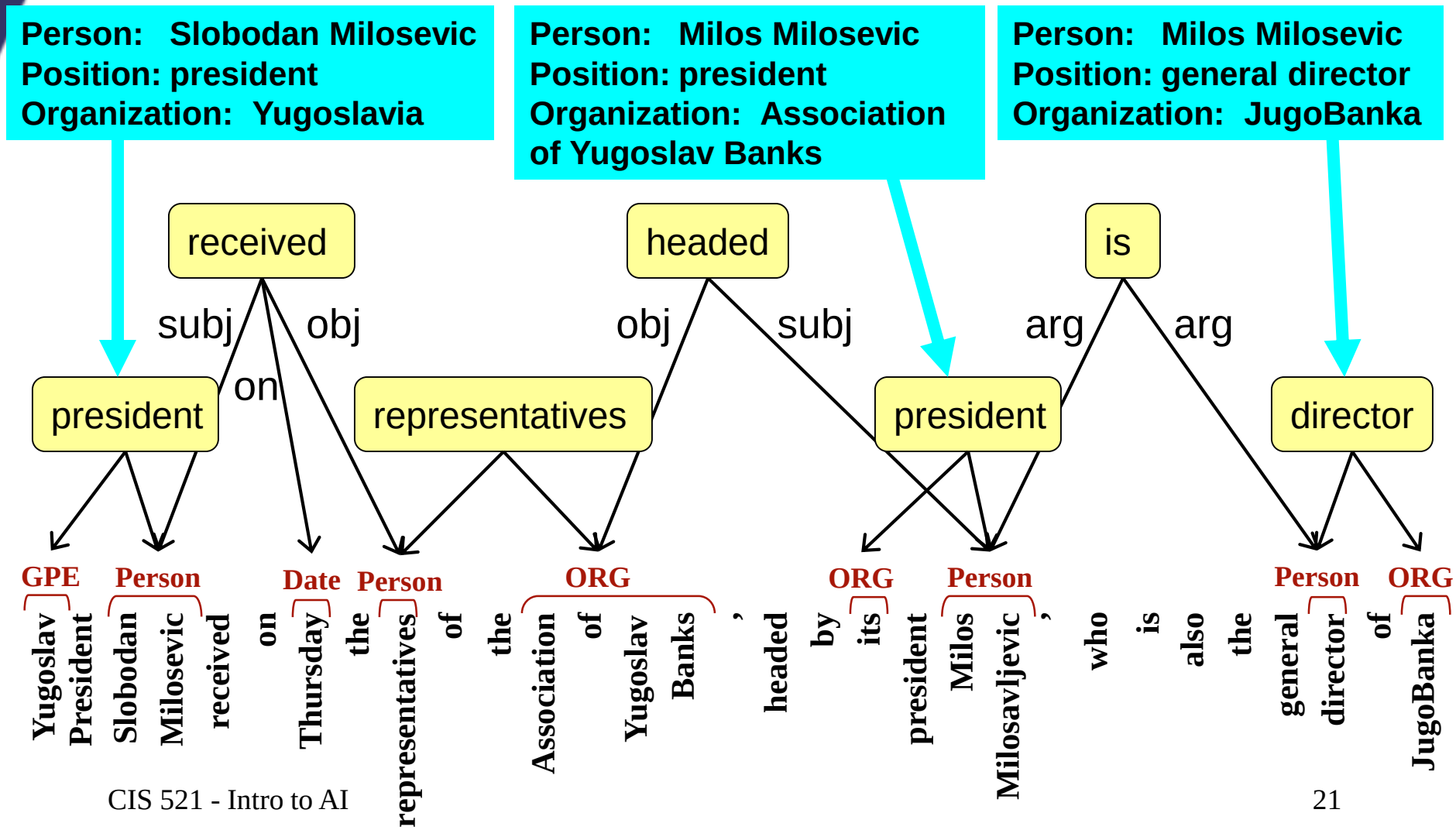
# Levels of BBN Statistical Analysis (2005)

Yugoslav President Slobodan Milosevic received on Thursday the representatives of the Association of Yugoslav Banks, headed by its president Milos Milosavljevic, who is also the general director of JugoBanka.



# Information Extraction from Propositions

Propositions are normalized connections from the parse trees.
Entities and relations are extracted statistically from propositions.

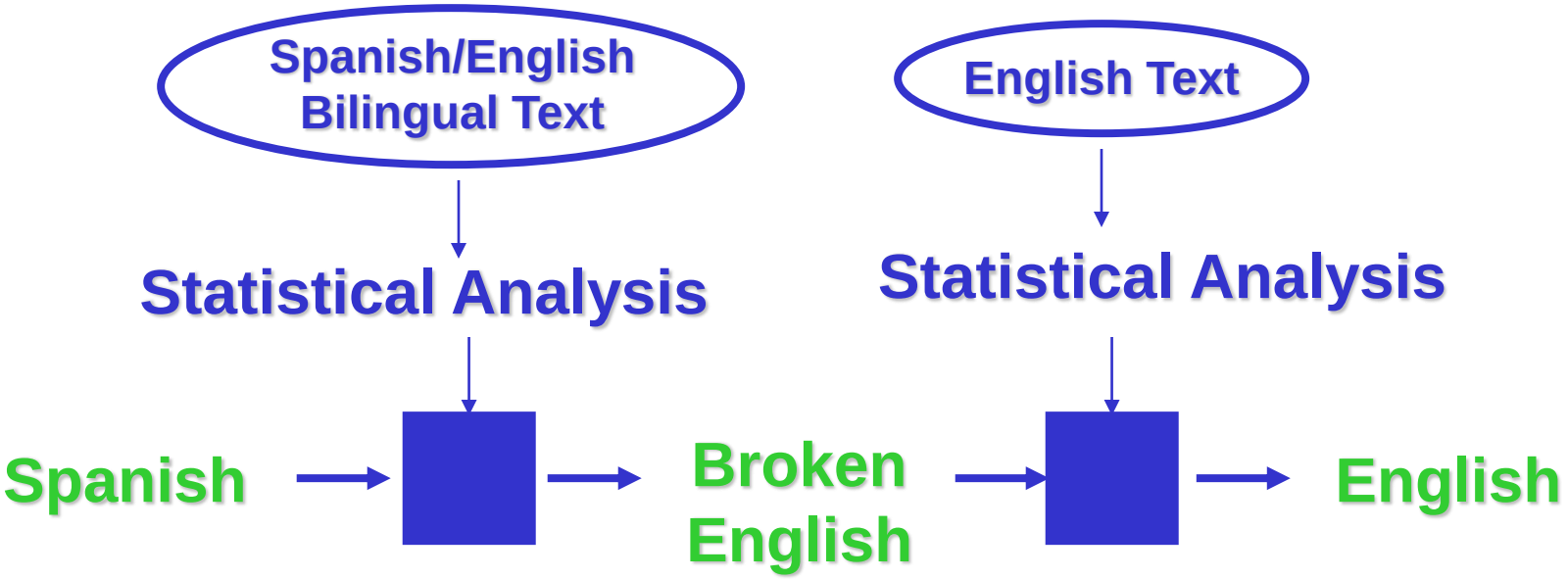


# Statistical Machine Translation

**(For more on this topic, check out courses taught by Prof. Chris Callison-Burch)**

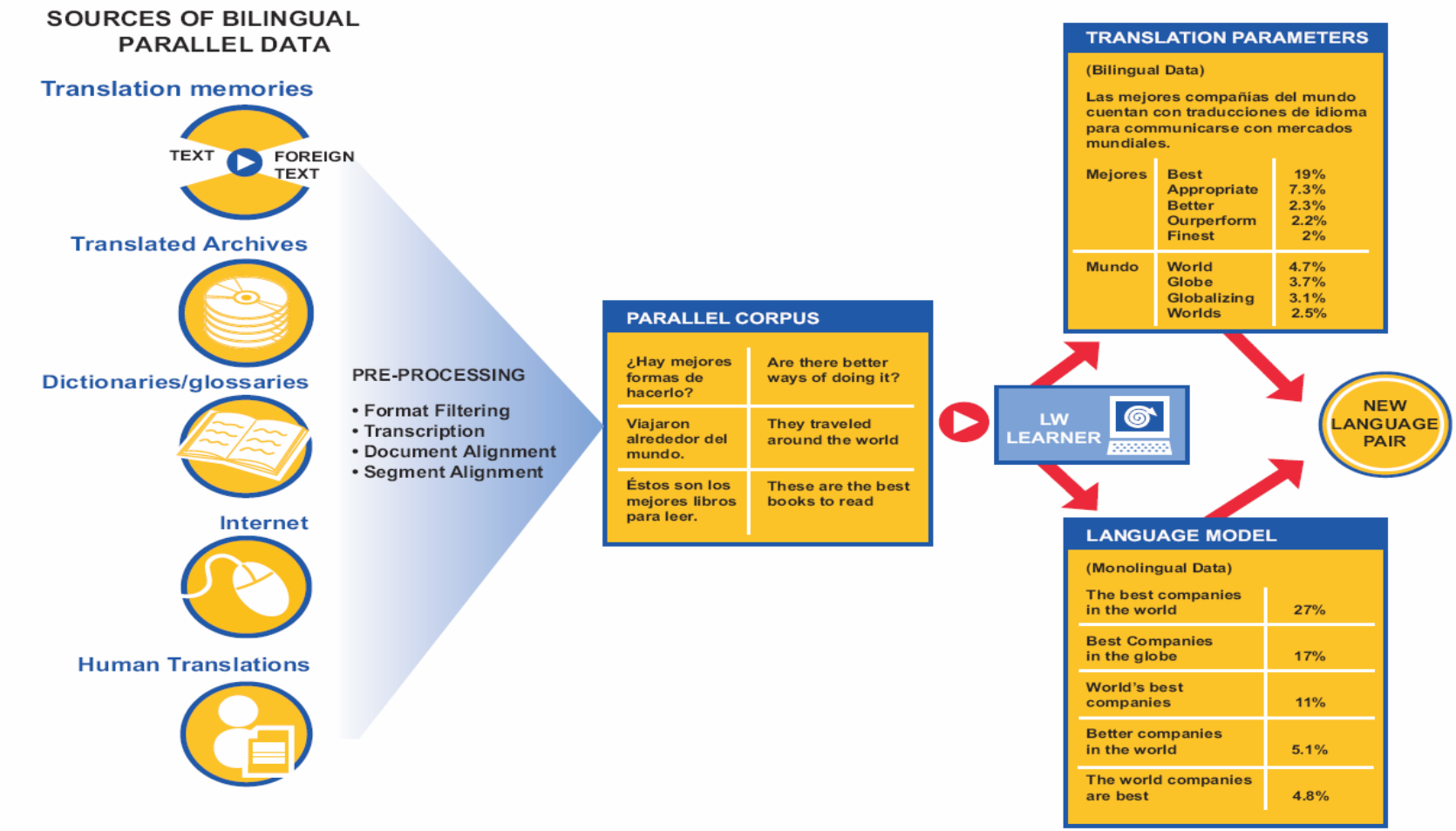
***(Next several slides from Language Weaver)***

## Statistical Machine Translation Technology

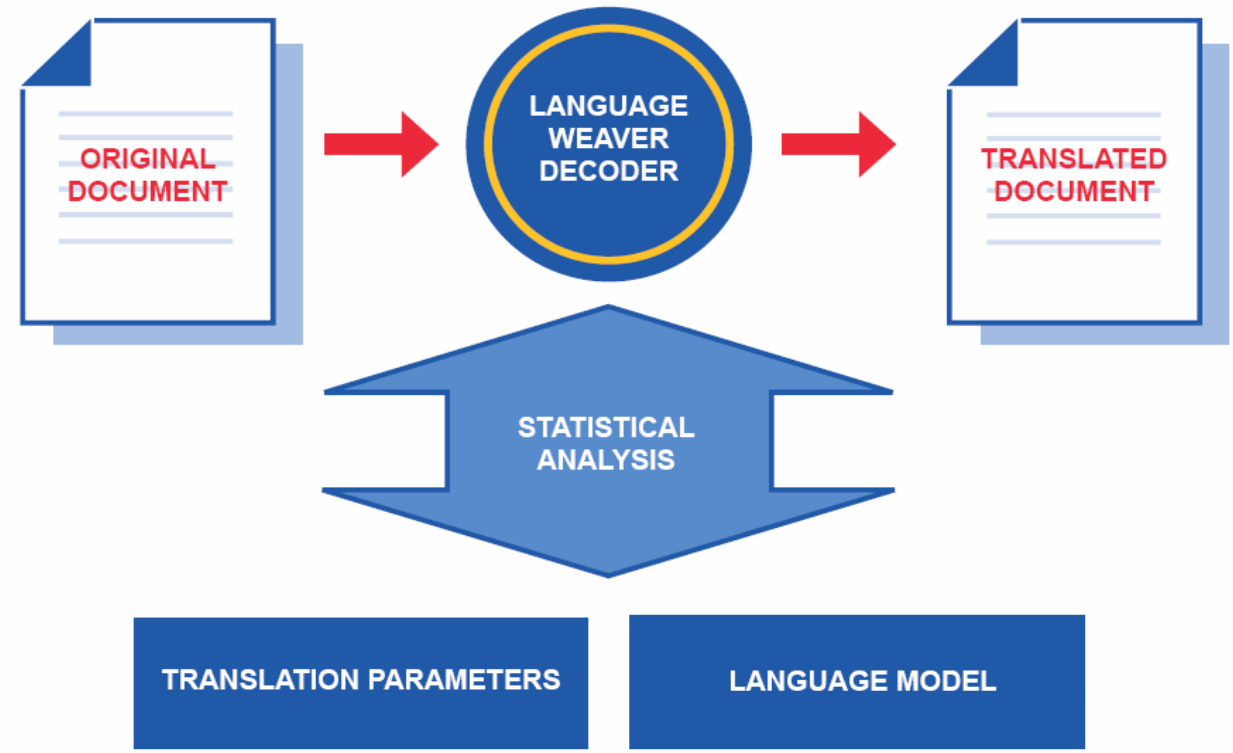



Que hambre tengo yo → What hunger have I, Hungry I am so, I am so hungry, Have I that hunger … → I am so hungry

# How A Statistical MT System Learns



# Translating a New Document



# Broadcast Monitoring
# BBN MAPS & Language Weaver MT

Edit View Favorites Tools Help

Back Search Favorites

http://vms.bbn.com/web_ui/app/root_menu.aspx

Search: Go

pic Keyboard | since midnight | in English | all channels

Results Overview Intro

ze of economic activity is expected
be.

الاقتصادي المنتظر.

**ale 34**

he Palestinians nearly 10 percent of
ne entire population of Lebanon and
ne estimated unemployment rates
etween the Lebanese about twenty-
ght percent, according to figures
om non-official, unemployment
mong refugees ranging between five
nd fifty and five sixty-six percent and
efers to statistics that between the
ears two ninety thousand of the last
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umber of permits for the work
ubber five Palestinians out of some
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orkers.

ويشكل الفلسطينيون قرابة العشرة في المئة من مجمل سكان لبنان وفيما تقدر معدلات البطالة بين اللبنانيين بحوالي ثمانية وعشرين في المئة وفق أرقام غير رسمية فإن البطالة بين اللاجئين تتراوح بين خمسة وخمسين وخمسة وستين في المئة وتشير الإحصاءات إلى أنه بين الأعوام اثنين وتسعين وألفين من القرن الماضي لم يتجاوز عدد رخص العمل المطاط الفلسطينيين الخمسة من أصل حوالي خمسين ألف ترخيص مصدر للعمال الأجانب.

**ale 38**

ocial conditions for Palestine
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الأوضاع الاجتماعية للاجئين
الفلسطينيين في لبنان وان بدأ بشكل


In Point: Not set

Out Point: Not set

use: http://192.1.120.236/BBN-AMS-Stream.mpg?start-time=2005-06-28T16:31:30.550000+00:00

Internet

# Language Weaver Hybrid Translation Technology

- Chinese Source Text
  Sample 1:

  车展，一向是衡量一个国家汽车消费现状和市场潜力的**“晴雨表”。本届北京国**际车展有**24个国家的1200余家厂商参展，8天接待40余万名参**观者，创下了中国车展的新纪录，让人深切地感受到汽车市场启动的信号。

  **“中国是世界最后一个最大的汽**车市场**”。多年来**，这句话更多地包含着汽车商人的一种希冀。然而如今，越来越多的事实预示着它正在变为现实。

  **来自本届**车展的一组数据很有说服力。**《北京青年**报》的一份现场调查显示，**35**岁以下参观者约占**35%；62.1%的被**访者表示，参观车展主要**是**为近期买车搜集信息，甚至在展会上就有可能购买或预订合适的产品；**76%的被**访者表示最近两年会购买私家车。

  **今年以来，国内**轿车市场的强劲增长让厂家喜上眉梢。据国家统计局公布的数字，前**4个月，全国共生**产轿车**26.79万**辆，增长**27.6%；特**别是**4月份，生**产轿车**9万**辆，同比增长**50.5%**，创造了十几年来轿车月产增长的最高纪录。从销售看，一季度，全国轿车生产企业共销售轿车**18.8万**辆，同比增长 **22%**，产销率达**105%**；轿车库存比年初下降**1.1万**辆，下降幅度近**25%。**

  Language Weaver Experimental Syntax MT
  Sample 1 :

  **The motor show, has always been the' barometer' of a national car consumption and market potential. The Beijing International Auto Show has more than 1,200 exhibitors from 24 countries and 8 days of receiving more than 40 million visitors, setting a new record in China's auto show, are deeply aware of the automobile market signals.**

  **"China is one of the largest automobile market in the world. Over the years, this phrase implies more auto businessmen. But now, more and more facts indicates that it is to become a reality.**

  **Data from the Motor Show is very convincing. The Beijing Qingnian Bao Report on-the-spot investigation showed that about 35 percent of 35-year-old visitors, 62.1 percent of the respondents said that the truck was mainly to buy a car in the near future to collect information, even at the exhibition may purchase or suitable products; 76% of respondents indicated in the past two years to buy private cars.**

  **Since the beginning of this year, the strong growth of the domestic car market. According to the figures released by the National Bureau of Statistics, in the first four months, the country produced 267,900 vehicles, up 27.6 percent; in particular, in April, the production of 90,000 vehicles, an increase of 50.5% over the same period last year, setting a record high for the monthly output growth over the past 10-odd years. In terms of sales in the first quarter, manufacturing enterprises in the country sold 188,000 cars, up 22 percent over the same period of last year, up 10.5 percent; 11,000 vehicles, dropping by nearly 25 percent lower than the beginning of the year.**

# Text Summarization

**(For more on this topic, check out courses taught by Prof. Ani Nenkova)**


*(Includes old work by Prof. Nenkova)*