

Автоматизированная обработка естественного языка

Natural Language
Processing

A stylized, dark teal silhouette of a mountain range is positioned in the bottom right corner of the slide, extending from the right edge towards the center.

NLP: истоки

- ◆ **возникло в конце 60-х гг.**
- ◆ развивалось в рамках дисциплины «искусственный интеллект».
- ◆ АОЕЯ — разработка методов, технологий и конкретных систем, обеспечивающих общение человека с ЭВМ на естественном или ограниченном естественном языке.

Проблема организации взаимодействия с компьютерными

- ◆ Решение этой проблемы коммуникации шло по двум основным путям.
 - 1 - адаптация языков программирования и операционных систем к конечному пользователю.
 - 2 - разработка систем взаимодействия с ЭВМ на естественном языке или каком-то его ограниченном варианте.

NLP и ЛИНГВИСТИКА

- ◆ Фонология (звуки речи)
- ◆ Морфология (структура и форма слов ЕЯ)
- ◆ Синтаксис (структура и функции предложений)
- ◆ Семантика (смысл языковых высказываний)
- ◆ Прагматика (значение высказываний)
- ◆ Социолингвистика Психолингвистика
- ◆ Лексикография (описание лексикона ЕЯ)
- ◆ Прикладная лингвистика

NLP: МАТЕМАТИКА и ИНФОРМАТИКА

- ◆ Математическая лингвистика
- ◆ Квантитативная лингвистика (изучение языка/речи количественными методами)
- ◆ Теория формальных языков и грамматик – возникла из порождающих грамматик Н.Хомского (50-е гг.), для анализа синтаксических структур ЕЯ
- ◆ Теория алгоритмов
- ◆ Информатика (Computer Science)

NLP и ИСКУССТВЕННЫЙ ИНТЕЛЕКТ

- ◆ Междисциплинарный характер области ИИ: составная часть Computer Science , пересечение (по задачам и методам) с АОТ
- ◆ Задача ИИ – компьютерное моделирование интеллектуальных функций
- ◆ Первая известная программа ИИ по обработке ЕЯ – Система Т. Винограда (70-е годы);
- ◆ Пример диалога : Pick up a big red block.
(человек) ОК (машина) Is there a large block behind a pyramid? Yes, Three of them. Grasp the pyramid. I don't understand, which pyramid you mean

ОСОБЕННОСТИ ЕЯ

- ◆ ЕЯ – сложная система знаков, возникшая для обмена информацией в процессе человеческой деятельности и постоянно изменяющаяся вместе с ней
- ◆ Две стороны знака: означаемое – означающее
- ◆ Сложности ЕЯ
 - комбинаторная система яз. знаков
 - многоуровневость системы ЕЯ
 - каждый уровень (подсистема) – правила сочетания знаков
 - взаимосвязь уровней
- ◆ Разнообразие языков и языковые универсалии

ОСОБЕННОСТИ ЕЯ: УРОВНИ

1. **Фонологический**: звуки (фонемы)/ буквы – незначащие единицы , средство различения др. единиц
2. **Морфологический** – слова (словоформы)
 - ◆ подуровень морфем
3. **Синтаксический** – предложения (фразы) ЕЯ
 - ◆ подуровень словосочетаний
 - ◆ надуровень сверхфразовых единств (≈ абзацев) – предложений, объединяющихся по смыслу

⇒ возможность построить практически бесконечное число высказываний (смыслов)


ДОПОЛНИТЕЛЬНЫЕ УРОВНИ ЕЯ:

- ◆ **Семантический** : набор элементарных единиц – сем
- ◆ **Лексический** : множество лексем (лексикон)
- ◆ **Дискурсивный** (уровень связного текста): схематические структуры текстов (патентные формулы, деловые письма и т.п.)

- ◆ Сложность системы ЕЯ
- ◆ Взаимосвязь всех уровней
- ◆ Нестандартная сочетаемость (синтактика) единиц ЕЯ на всех уровнях
- ◆ Большая системность (число уровней)
- ◆ Асимметрия связи единиц и выражаемых ими смыслов: полисемия, синонимия, омонимия

**⇒ невозможность единожды
создать лингв. процессор**

Сложность ЕЯ ⇒ МОДУЛЬНОСТЬ ЛИНГВ. ПРОЦЕССОРОВ

- ◆ Графематический анализ
 - ◆ Морфологический анализ
 - ◆ Постморфологический анализ:
разрешение морфологической омонимии
 - ◆ Предсинтаксис: сегментация текста на предложения
 - ◆ Синтаксический анализ предложений
 - ◆ Семантический и прагматический анализ
- 

Архитектура систем NLP

- ◆ блок **анализа** речевого сообщения пользователя,
- ◆ блок **интерпретации** сообщения,
- ◆ блок **порождения** смысла ответа,
- ◆ блок **синтеза** поверхностной структуры высказывания,
- ◆ **диалоговый** компонент

Блок анализа

- ◆ **морфологический** анализ словоформ
- ◆ **синтаксический** и **семантический** анализ предложений.



Блок порождения смысла

- ◆ **определение информации**, которую следует передать пользователю,
- ◆ предполагаемое **членение** информации на «**порции**», соответствующие предложению;
- ◆ определение **последовательности** «порций» смысла;
- ◆ построение **семантического представления** отдельных предложений

Блок синтеза поверхностной структуры высказывания

- ◆ **упаковка** семантического представления высказывания в **синтаксические структуры предложения**.
- ◆ Здесь играют существенную роль категории коммуникативной организации смысла высказывания — тема, рема, данное, новое

Классические задачи обработки текстов

- Информационный поиск (IR)
- Извлечение информации (IE)
- Вопросно-ответные системы (QA)
- Классификация и кластеризация
- Автоматическое аннотирование и реферирование
- Диалоговые системы
- Машинный перевод

Современные речевые ТЕХНОЛОГИИ

1. Распознавание речи
2. Синтез речи по тексту
3. Выделение ключевых слов в слитной речи

– **Siri**: интеллектуальный ассистент на iPhone



ПРИКЛАДНЫЕ ЗАДАЧИ NLP

4. Определение языка сообщений
5. Идентификация диктора
6. Определение эмоционального и физического состояния человека по его голосу.
7. Шумоочистка
8. Разделение дикторов
9. Music Spotting

Диалоговые системы

Пользователь: Мне нужен самолет из СПб до Бостона, прибытие в 10 утра.

Компьютер: На какое число?

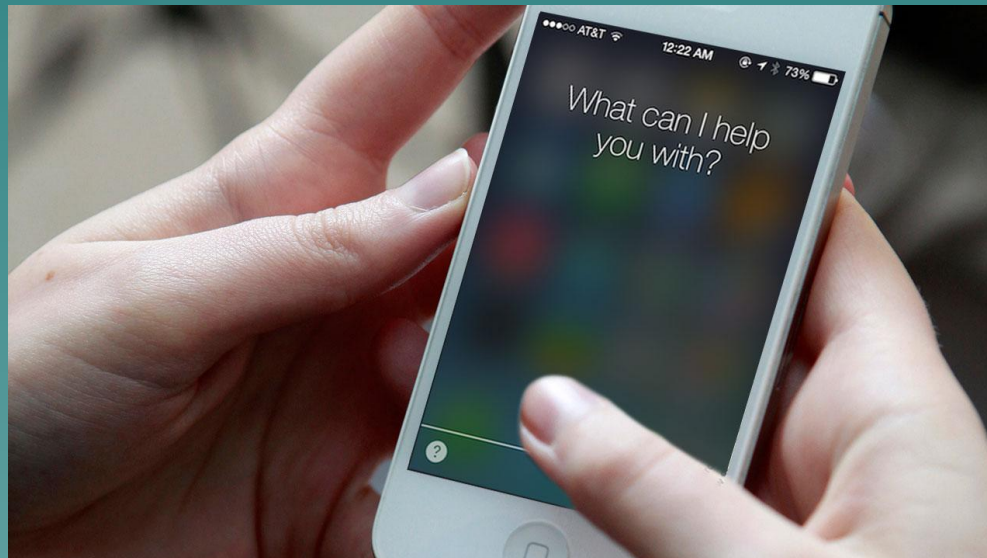
Пользователь: На завтра.

Компьютер: Доступные рейсы на завтра...

<список рейсов>

Siri

- ◆ англ. Speech Interpretation and Recognition Interface
- ◆ персональный помощник и вопросно-ответная система, адаптированная для iPhone OS.
- ◆ использует обработку естественной речи, чтобы отвечать на вопросы и давать рекомендации
- ◆ приспособливается к каждому пользователю индивидуально, изучая его предпочтения в течение долгого времени.





Question Answering: IBM's Watson

- Won Jeopardy on February 16, 2011!

WILLIAM WILKINSON'S
"AN ACCOUNT OF THE PRINCIPALITIES OF
WALLACHIA AND MOLDOVIA"
INSPIRED THIS AUTHOR'S
MOST FAMOUS NOVEL



Question Answering: IBM's Watson

- Won Jeopardy on February 16, 2011!

WILLIAM WILKINSON'S
"AN ACCOUNT OF THE PRINCIPALITIES OF
WALLACHIA AND MOLDOVIA"
INSPIRED THIS AUTHOR'S
MOST FAMOUS NOVEL



Bram Stoker

Dracula

- Open Domain Question-Answering Machine
- Given
 - Rich **Natural Language Questions**
 - Over a **Broad Domain of Knowledge**
- Delivers
 - **Precise Answers:** Determine what is being asked & give precise response
 - **Accurate Confidences:** Determine likelihood answer is correct
 - **Consumable Justifications:** Explain why the answer is right
 - **Fast Response Time:** Precision & Confidence in <3 seconds
 - At the level of human experts
- Proved its mettle in a televised match
 - Won a 2-game Jeopardy match against the all-time winners
 - viewed by over 50,000,000





Information Extraction

Subject: **curriculum meeting**

Date: January 15, 2012

To: Dan Jurafsky

Hi Dan, we've now scheduled the curriculum meeting.

It will be in Gates 159 tomorrow from 10:00-11:30.

-Chris



Information Extraction

Subject: **curriculum meeting**

Date: January 15, 2012

To: Dan Jurafsky

Event: Curriculum meeting

Date: Jan-16-2012

Start: 10:00am

End: 11:30am

Where: Gates 159

Hi Dan, we've now scheduled the curriculum meeting.

It will be in Gates 159 tomorrow from 10:00-11:30.

-Chris

Create new Calendar entry

Извлечение информации

Сдаю в г.Пушкин комнату 11 м² в 3-х комнатной квартире без соседей, в квартире никто не живет, коридор 15 м², кухня 15 м², балкон,стиральная машинка,холодильник,телевизор.До метро Купчино 15 минут на маршрутке и автобусе, остановка рядом с домом,до станции 20 минут.Аренда 9000 руб+2000 залог+свет+вода.Тел.8-921-898-59-60 Юлия



Город	Пушкин
Количество комнат	3
Метро	Купчино
Цена	9000 руб.

Извлечение информации

- ▶ Цель: представить коллекцию текстовых документов в структурированном виде
- ▶ Мотивация:
 - ▶ Запросы сложного характера: Квартира рядом с метро Петроградская ценой не больше 30 тыс. руб.
 - ▶ Статистические запросы: Как изменились цены на квартиры в Купчино за последний год?



Information Extraction & Sentiment Analysis



Great camera
This is an excellent camera. It's smaller than most other digital cameras I have to find and use. The digital eye makes it easy to see what you're taking with the camera. It's very easy to use and the battery lasts a long time. I'm very happy with it. It's a great camera. I would recommend it to anyone who wants a good camera.
www.amazon.com - 1/12/2008

Great camera
I had been looking for a high quality, small digital camera which is easy to use and I have finally found it. This camera is compact, and it delivers a clear, sharp image. It's very easy to use and I suggest you buy it now. It's a little bit more expensive than other cameras, but it's worth the extra cost. I would recommend it to anyone who wants a good camera.
www.amazon.com - 1/12/2008

High Quality Camera
A really great quality digital camera which is a delight to use if you just want to point and shoot but you don't really want to be bothered by a lot of extra features. This is a really nice camera. It's very easy to use and I suggest you buy it now. It's a little bit more expensive than other cameras, but it's worth the extra cost. I would recommend it to anyone who wants a good camera.
www.amazon.com - 1/12/2008

Great camera
This camera is a really nice one. It's very easy to use and it takes great pictures. I had been looking for a camera which is easy to use and I have finally found it. This camera is compact, and it delivers a clear, sharp image. It's very easy to use and I suggest you buy it now. It's a little bit more expensive than other cameras, but it's worth the extra cost. I would recommend it to anyone who wants a good camera.
www.amazon.com - 1/12/2008

Great camera
I was a skeptic when I saw this camera. I didn't see how it could be so good. But I was wrong. This camera is really nice. It's very easy to use and it takes great pictures. I had been looking for a camera which is easy to use and I have finally found it. This camera is compact, and it delivers a clear, sharp image. It's very easy to use and I suggest you buy it now. It's a little bit more expensive than other cameras, but it's worth the extra cost. I would recommend it to anyone who wants a good camera.
www.amazon.com - 1/12/2008

Great camera
I've only used this camera for about an hour, but it's what I need to get started. It's very easy to use and it takes great pictures. I had been looking for a camera which is easy to use and I have finally found it. This camera is compact, and it delivers a clear, sharp image. It's very easy to use and I suggest you buy it now. It's a little bit more expensive than other cameras, but it's worth the extra cost. I would recommend it to anyone who wants a good camera.
www.amazon.com - 1/12/2008

Information Extraction & Sentiment Analysis



Attributes:

zoom

affordability

size and weight

flash

ease of use

----- Canon ES (ES) camera

This is an amazing little camera. The lens opens over the view window making it easy to find the auto. The digital zoom works in great. I use video too. I came with the camera. I can't remember the price. I am pleased with the quality. It's a great little. Visit the site for more info. [www.digitalcamera.com](#) - R. Foster - 11122222

----- Canon ES (ES)

I had been looking for a high quality, light weight camera which is easy to use and I have found it! The camera is light, and is definitely a lot of money. It does not come with a lens which I expect you pay for and of course it has both digital zoom and video. (price). Visit the site for more info. [www.digitalcamera.com](#) - R. Foster - 11122222

----- High Quality Camera

I really like using digital cameras which is a really nice if you just want to use the camera for your small video editing and so on. I was not a professional. The only thing is that I don't come with the software which you pay for. It's the Canon's camera. Visit the site for more info. [www.digitalcamera.com](#) - R. Foster - 11122222

----- Great a tiny camera

This camera is tiny. It's great, but great and it's very easy to use. I had used other cameras but I was difficult to use. I like the camera. I like the camera. I like the camera. I like the camera. Visit the site for more info. [www.digitalcamera.com](#) - R. Foster - 11122222

----- Very nice camera

I was a little bit nervous in the business I got into but I really like the camera. I was a little bit nervous in the business I got into but I really like the camera. I was a little bit nervous in the business I got into but I really like the camera. Visit the site for more info. [www.digitalcamera.com](#) - R. Foster - 11122222

----- Excellent camera, compact, light, easy to use

I really love this camera. It's easy to use and it's very easy to use. I was a little bit nervous in the business I got into but I really like the camera. Visit the site for more info. [www.digitalcamera.com](#) - R. Foster - 11122222



Information Extraction & Sentiment Analysis



Attributes:

zoom
affordability
size and weight
flash
ease of use

Size and weight

- nice and compact to carry!
- since the camera is small and light, I won't need to carry around those heavy, bulky professional cameras either!
- the camera feels flimsy, is plastic and very light in weight
have to be very delicate in the handling of this camera



Information Extraction & Sentiment Analysis



Attributes:

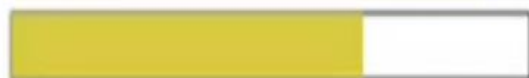
zoom



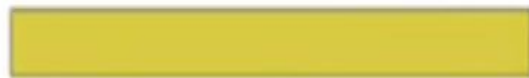
affordability



size and weight



flash



- ease of use



Size and weight

- ✓ • nice and compact to carry!
- ✓ • since the camera is small and light, I won't need to carry around those heavy, bulky professional cameras either!
- ✗ • the camera feels flimsy, is plastic and very light in weight you have to be very delicate in the handling of this camera

Пример

I bought an iPhone a few days ago. It was such a nice phone. The touch screen was really cool. The voice quality was clear too. Although the battery life was not long.

Что мы здесь наблюдаем?

Пример

I bought an iPhone a few days ago. It was such a nice phone. The touch screen was really cool. The voice quality was clear too. Although the battery life was not long.

Что мы здесь наблюдаем?

- ▶ Целевой объект
- ▶ Аспекты объекта
- ▶ Мнения (положительные и не очень)



Machine Translation

- Fully automatic

Enter Source Text:

这不过是一个时间的问题。

Translation from Stanford's *Phrasal*:

This is only a matter of time.

- Helping human translator

Enter Source Text:

رئيس اللبناني اميل لحود لـ حملة عنيفة في مجلس النواب الذي انعقد امس في جلسة تشريعية عنيفة تحولت
محاكمة " لـ رئيس الجمهورية علي مرفق هـ من المحكمة الدولية و " الملاحظات " التي اثنى بها هـ
حول هذا الموضوع .

Translate Clear

Enter Translation:

lebanese |

president
suffered
exposed
president emile
before
presented
offer



mostly solved

Spam detection

Let's go to Agra! 

Buy VIAGRA ... 

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

making good progress

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

making good progress

Sentiment analysis

Best roast chicken in San Francisco!

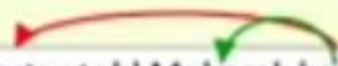


The waiter ignored us for 20 minutes.



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?



Почему анализировать тексты трудно?



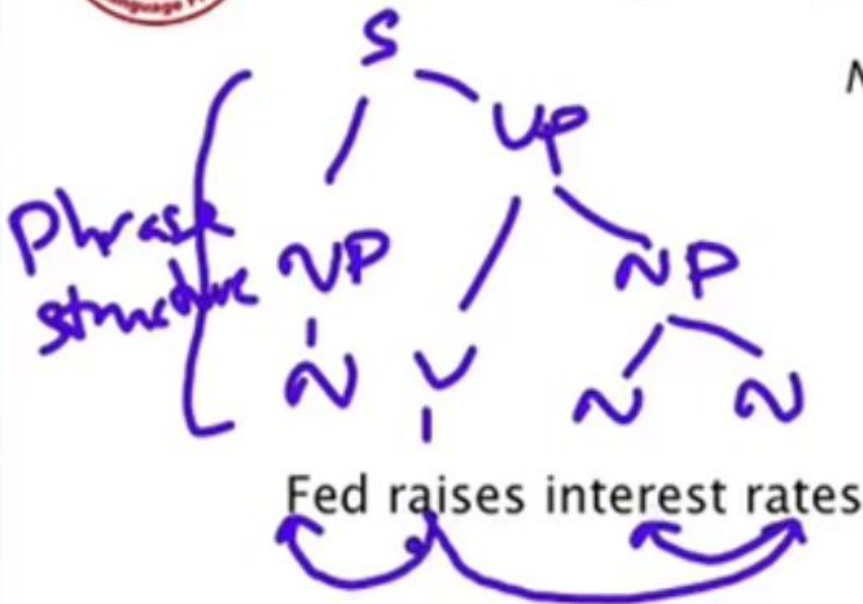
Хочу обнимать тебя
часами

- ▶ Мне улыбнулась хозяйка фермы, которая красовалась возле магазина.
- ▶ Squad helps dog bite victim.



Ambiguity is pervasive

New York Times headline (17 May 2000)



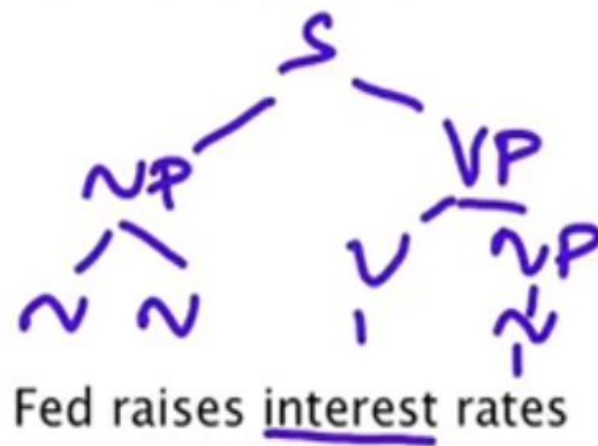
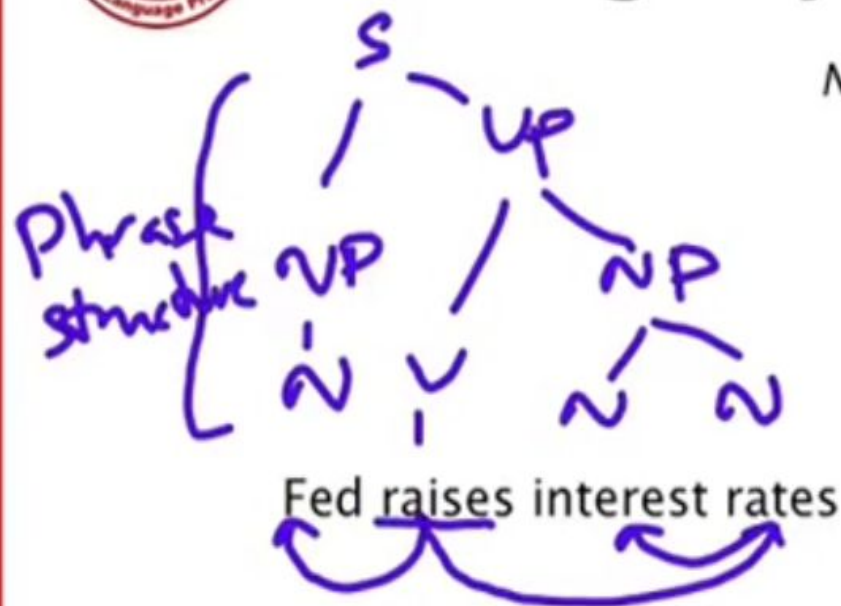
Fed raises interest rates

Fed raises interest rates 0.5%



Ambiguity is pervasive

New York Times headline (17 May 2000)

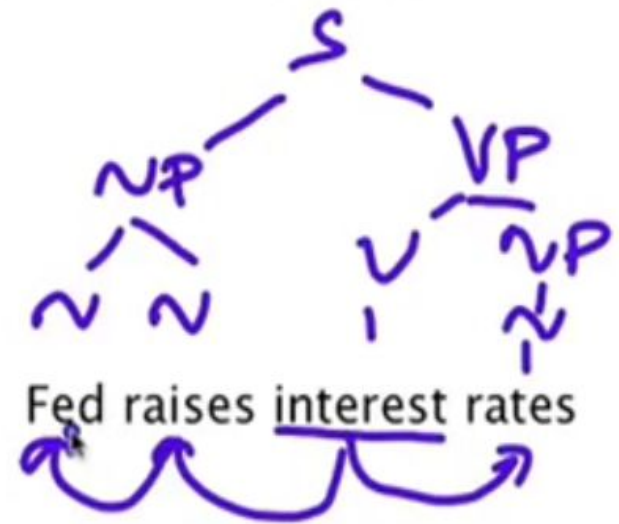
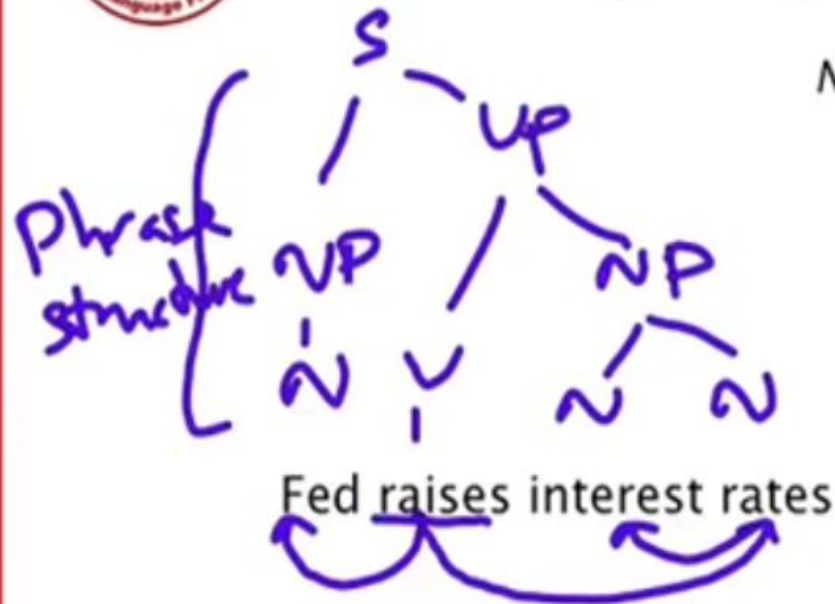


Fed raises interest rates 0.5%



Ambiguity is pervasive

New York Times headline (17 May 2000)



Многозначность

- Морфологическая

- часть речи

- мой (-- нос, -- руки)

- look (look at me, have a look)

Алгоритмы определения частей речи (part of speech tagging)

- Синтаксическая

- мужу изменять нельзя

- мать любит дочь

- Flying planes can be dangerous

Синтаксический разбор (parsing)

Многозначность

- Лексическая (семантическая)

разрешение
лексической
многозначности (word
sense disambiguation)

- Омонимия (ключ)

- полисемия (платформа)

- семантическая многозначность (лиса)

- Прагматическая

- тот человек в толпе...

- You have a green light



Why else is natural language understanding difficult?

non-standard English

Great job @justinbieber! Were SOO PROUD of what youve accomplished! U taught us 2 #neversaynever & you yourself should never give up either♥

segmentation issues

the New York-New Haven Railroad
the New York-New Haven Railroad

idioms

dark horse
get cold feet
lose face
throw in the towel

neologisms

unfriend
Retweet
bromance

world knowledge

Mary and Sue are sisters.
Mary and Sue are mothers.

tricky entity names

Where is *A Bug's Life* playing ...
Let It Be was recorded ...
... a mutation on the *for* gene ...

But that's what makes it fun!

Понимание

- Тест Тьюринга (Премия Лёбнера)
- Китайская комната
- ELIZA (1966)
 - „I am unhappy.“
 - „How long have you been unhappy?“
 - „Six months. Can you help me?“
 - „What makes you think I help you?“
 - „You remind me of my sister.“
 - „Can you tell me more about your sister?“
 - „I like teasing my sister.“
 - „Does anyone else in your family like teasing your sister?“
 - „No. Only me.“
 - „Please go on.“



"As the final part of your stress test, you have to call an automated phone system."