

QUESTION ANSWERING AND SUMMARIZATION

David Kauchak
CS159, Spring 2011

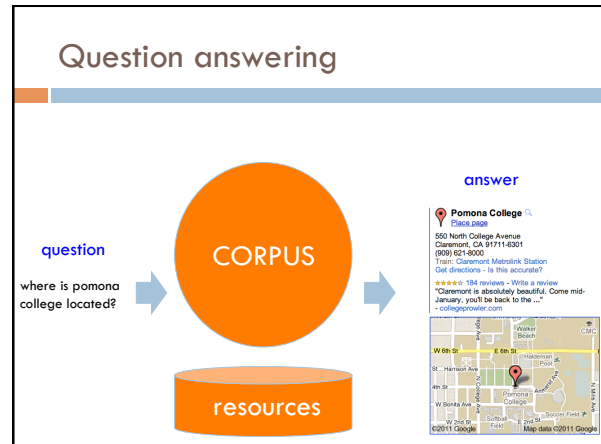
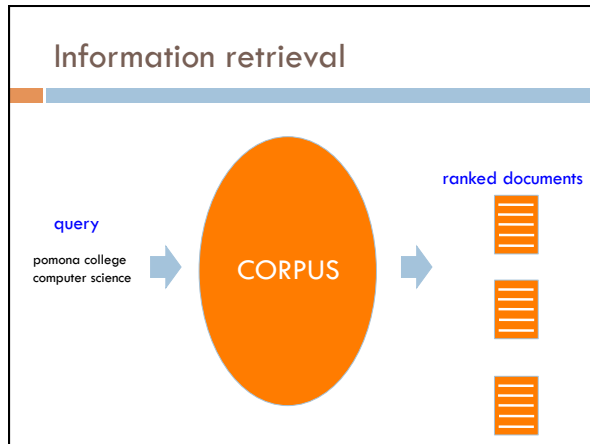
Admin?

Brin, 1998 Experiments

	1 st iteration	2 nd iteration	3 rd iteration
Unique (author, title) pairs	5	4047	9127
Occurrences	199	3972	9938
patterns	3	105	346
Result: unique pairs	4047	9127	15257

pairs → extraction → patterns → extract from corpus → new pairs

Were only able to extract from a subset of the repository



Question answering

Number of Documents:	979,000
Megabytes of Text:	3033
Document Sources:	AP, WSJ, Financial Times, San Jose Mercury News, LA Times, RBIS
Number of Questions:	682
Question Sources:	Encarta log, Excite log

Sample questions:

- How much folic acid should an expectant mother get daily?
- Who invented the paper clip?
- What university was Woodrow Wilson president of?
- Where is Rider College located?
- Name a film in which Jude law acted.
- Where do lobsters like to live?

Other variants...

Mars Polar Lander- Where Are You?

(January 18, 2000) After more than a month of searching for a single sign from NASA's Mars Polar Lander, mission controllers have lost hope of finding it. The Mars Polar Lander was on a mission to Mars to study its atmosphere and search for water, something that could help scientists determine whether life even existed on Mars. Polar Lander was to have touched down on December 3 for a 90-day mission. It was to land near Mars' south pole. The lander was last heard from minutes before beginning its descent. The last effort to communicate with the three-legged lander ended with frustration at 8 a.m. Monday. "We didn't see anything," said Richard Cook, the spacecraft's project manager at NASA's Jet Propulsion Laboratory. The failed mission to the Red Planet cost the American government more the \$200 million dollars. Now, space agency scientists and engineers will try to find out what could have gone wrong. They do not want to make the same mistakes in the next mission.

- When did the mission controllers lost Hope of communication with the Lander?
- Who is the Polar Lander's project manager?
- Where on Mars was the spacecraft supposed to touch down?
- What was the mission of the Mars Polar Lander?

Other variants...

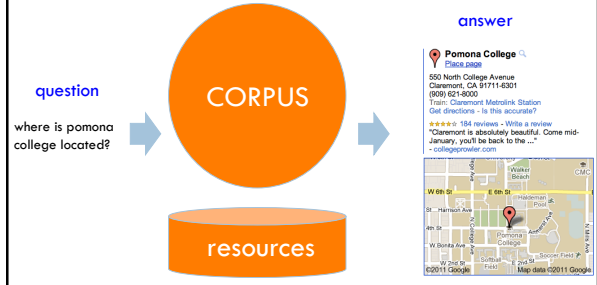
Mars Polar Lander- Where Are You?

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- ❑ When did the mission controllers last hope of communication with the Lander?
(Answer: **BAM, Monday Jan. 17**)
- ❑ Who is the Polar Lander's project manager?
(Answer: **Richard Cook**)
- ❑ Where on Mars was the spacecraft supposed to touch down?
(Answer: **near Mars' south pole**)
- ❑ What was the mission of the Mars Polar Lander?
(Answer: **to study Mars' atmosphere and search for water**)

Question answering

challenges? how is this different than IR?



Challenges

Question: "When was Wendy's founded?"

Challenges

Question: "When was Wendy's founded?"

Passage candidate:

"The renowned Murano glassmaking industry, on an island in the Venetian lagoon, has gone through several reincarnations since it was founded in 1291. Three exhibitions of 20th-century Murano glass are coming up in New York. By Wendy Moonan."

Answer: 20th Century or 1291?

Challenges

Question: When was Microsoft established?

Challenges

Question: When was Microsoft established?

Microsoft tends to establish lots of things...

Microsoft plans to establish manufacturing partnerships in Brazil and Mexico in May.

Solution?

Challenges

Question: When was Microsoft established?

Microsoft tends to establish lots of things...

Microsoft plans to establish manufacturing partnerships in Brazil and Mexico in May.

Need to be able to detect sentences in which 'Microsoft' is **object** of 'establish' or close synonym.

Matching sentence:

Microsoft Corp was founded in the US in 1975, incorporated in 1981, and established in the UK in 1982.

Challenges

Question: What is the occupation of Bill Clinton's wife?

No documents contain these keywords plus the answer

Ideas?

Challenges

Question: *What is the occupation of Bill Clinton's wife?*
 No documents contain these keywords plus the answer

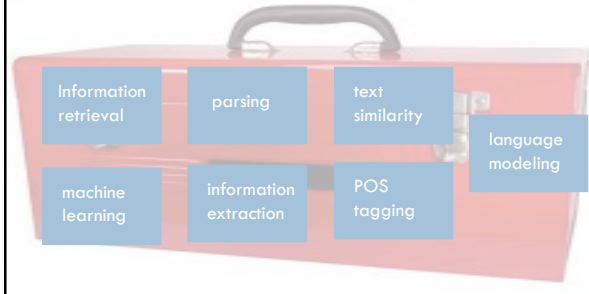
One solution: decompose into two questions:

Who is Bill Clinton's wife? = X
What is the occupation of X?

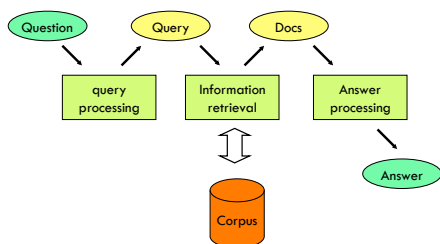
AI/planning/logic

Question answering

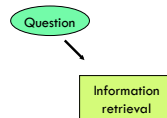
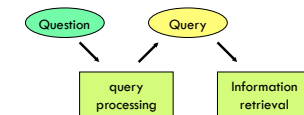
How are we going to do it?



QA basic framework



Query processing



Why do we need query processing?

What types of things might we need to do?

Query processing

- If we're going to feed the question into an IR system, often need to reformulate the query
 - Some things may already be done by the IR system
 - remove stopwords
 - remove question words
 - query expansion:
 - who is the president of the US?: US -> United States
 - Formulate as a statement rather than a question:

When was the paper clip invented?	the paper clip was invented
what is the tallest building?	the tallest building is

Query processing

- Analyze the query: **what questions might we ask about the query that might help limit our set of answers?**

Query processing

- Analyze the query: **what questions might we ask about the query that might help limit our set of answers?**
- What is the expected answer type?

	Q-Type	A-Type
When did the Titanic sink ?	event-completion	time
Who was Darth Vader's son?	concept-completion	person-name
What is thalassemia ?	definition	definition

Answer type hierarchies

Class	#	Class	#
ABBREVIATION	18	term	19
abbreviation	2	vehicle	7
expression	16	word	0
DESCRIPTION	153	HUMAN	171
definition	126	group	24
description	13	individual	140
manner	7	title	4
reason	7	description	3
ENTITY	174	LOCATION	195
animal	27	city	44
body	5	country	21
color	12	mountain	5
creative	14	other	114
currency	8	state	11
disease/medicine	3	NUMERIC	289
event	6	code	1
food	7	count	22
instrument	1	date	146
language	3	distance	38
letter	0	money	9
other	19	order	0
plant	9	other	24
product	9	period	18
religion	1	percent	7
spirit	3	speed	9
substance	20	temperature	7
symbol	2	volume/size	4
technique	1	weight	4

Question classification

	Q-Type	A-Type
When did the Titanic sink ?	event-completion	time
Who was Darth Vader's son?	concept-completion	person-name
What is thalassemia ?	definition	definition

How can we identify this?

Question classification

	Q-Type	A-Type
When did the Titanic sink ?	event-completion	time
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What is thalassemia ?	definition	definition

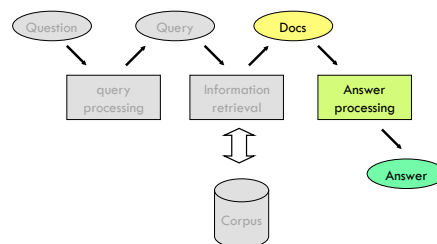
- Hand-written rules
 - **WHO:** person, organization, or country.
 - **WHERE:** location (specific or general)
 - **WHEN:** date on time period
 - **HOW MUCH:** an amount
 - **HOW MANY:** a number
 - **WHICH CITY:** a city

Question classification

	Q-Type	A-Type
When did the Titanic sink ?	event-completion	time
Who was Darth Vader's son?	concept-completion	person-name
What is thalassemia ?	definition	definition


- Better: machine learning!
- lots of *clues*
 - What *city* is pomona college in?
 - Where is pomona college *located*?
 - What is the tallest *building* in the world?

QA basic framework



Answer processing

What is the tallest building in the world? **problem?**



The *world's tallest* structure is the 828 m (2,717 ft) tall Burj Khalifa in Dubai, United Arab Emirates. The *building* gained the official title of "*Tallest Building in the World*" at its opening on 4 January 2010. It is taller than any other man-made structure ever built.

The Council on Tall *Buildings* and Urban Habitat, an organization that certifies buildings as the "*World's Tallest*", recognizes a *building* only if at least fifty percent of its height is made up of floor plates containing habitable floor area.[1] Structures that do not meet this criterion, such as the CN Tower, are defined as "towers".

There are dozens of radio and television broadcasting towers which measure over 600 meters (about 2,000 ft) in height, and only the *tallest* are recorded in publicly available information sources.

Answer processing

The *world's tallest* structure is the 828 m (2,717 ft) tall Burj Khalifa in Dubai, United Arab Emirates. The *building* gained the official title of "*Tallest Building in the World*" at its opening on 4 January 2010. It is taller than any other man-made structure ever built.

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There are dozens of radio and television broadcasting towers which measure over 600 meters (about 2,000 ft) in height, and only the *tallest* are recorded in publicly available information sources.

Burj Khalifa

ideas?

NLP to the rescue!

- Need more information than just the text
 - named entity recognition/information extraction
 - parsing
 - relationships between entities
 - Microsoft established vs. Microsoft was established
- Pair this information with information we extracted from the query
 - What are we looking for? A person? A date? ...?

Extracting entities

President George Bush announced a new bill that would send \$1.2 million dollars to Miami Florida for a new hurricane tracking system.

After applying a Named Entity Tagger, the text might look like this:

<Person="President George Bush"> announced a new bill that would send <MONEY="\$1.2 million dollars"> to <LOCATION="Miami Florida:"> for a new hurricane tracking system.

Who announced the new bill?
Where will the money from the new bill go?
How much will be provided for the new bill?

Combining and normalizing evidence

Q: What year did the Titanic sink?
A: 1912

Supporting evidence:

It was the worst peacetime disaster involving a British ship since the Titanic sank on the 14th of April, 1912.

The Titanic sank after striking an iceberg in the North Atlantic on April 14th, 1912.

The Herald of Free Enterprise capsized off the Belgian port of Zeebrugge on March 6, 1987, in the worst peacetime disaster involving a British ship since the Titanic sank in 1912.

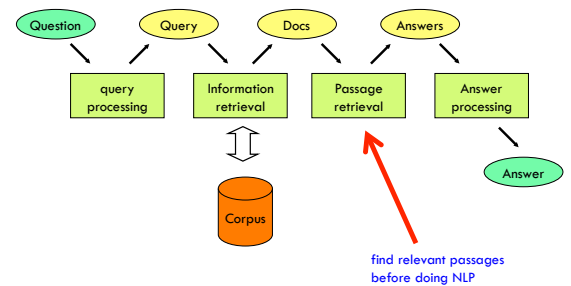
What happened?

- **Different formats** for answer candidates detected, normalized and combined:
 - 'April 14th, 1912'
 - '14th of April, 1912'
- **Supporting evidence** detected and combined:
 - '1912' supports 'April 14th, 1912'
- **Structure** of date expressions understood and correct piece output:
 - '1912' rather than 'April 14th, 1912'
- **Most frequent answer** candidate found and output:
 - 'April 14th, 1912' rather than something else.

NLP is expensive!

- We need to run:
 - sentence identifier
 - tokenizer
 - IE
 - parsers
 - ...
- These are expensive! (and there may be many documents)
- **Can we reduce this time?**

QA actual framework



Passage retrieval

- IR Systems return the N most relevant documents
- Passage retrieval systems then return the N most relevant *passages*
- The answer processing is then only run on these passages



Evaluation

- How can/should we evaluate the system?
- Ideas:
 - Accuracy
 - Precision/Recall (often we allow it to say "No Answer")
 - Produce multiple answers and use IR like measures

Reciprocal ranking scheme

For the purposes of evaluating the systems, several answer candidates are often ranked by confidence.

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Reciprocal Ranking Scheme: the score for a question is $1/R$, where R is a rank of the first correct answer in the list.

Q: What is the capital of Utah?
 A1: Ogden
 A2: Salt Lake City
 A3: Provo
 A4: St. George
 A5: Salt Lake

RRS?

Reciprocal ranking scheme

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Reciprocal Ranking Scheme: the score for a question is $1/R$, where R is a rank of the first correct answer in the list.

Q: What is the capital of Utah?

- A1: Ogden
- A2: Salt Lake City
- A3: Provo
- A4: St. George
- A5: Salt Lake

The score for the question Q would be $1/2$.

Sample Results

Javelin Batch Test results (64/16)

Question	Score	Answers	Answer Pattern
290: When was Hurricane Hugo?	0.0	Nov. 30 June 1	1989
327: When was the San Francisco fire?	0.0	# Error message: RF server EXCEPTION: No answer found! 1911 (Correct) March 25, 1911 (Correct) 1988	{20+years st+ago 1906 1849 apr bu*18 06
372: When was the Triangle Shirtwaist fire?	1.0	Dec. 31, 1906 May 28, 1977 Oct. 24, 1976 1985	{March bu*25 u*% u*%7 1911
416: When was CNN's first broadcast?	0.5	1988 June, 1980 (Correct)	June u*% u+1980

Does it work?

WolframAlpha computational knowledge engine

how tall is the tallest building

START's reply

CS159
http://www.cs.pomona.edu/classes/cs159

I don't know what the tallest building is.

Input interpretation:
tallest building
by height

Result by height:

1	Burj Khalifa	2717ft
2	ON Tower	1814ft
3	Ostankino Tower	1772ft
4	Taipei 101	1670ft
5	Shanghai World Financial Center	1614ft

Computed by Wolfram|Mathematica Source information Download as PDF Use Mathematica

Does it work?

WolframAlpha computational knowledge engine

what is the capitol of Utah?

Input interpretation:
Utah capital

Result:
Salt Lake City, Utah, United States

START's reply

what is the capitol of utah?

Salt Lake City is the capitol of Utah.

Source: START KB

Does it work?

WolframAlpha™ computational knowledge engine

who invented the light bulb?

Using closest WolframAlpha interpretation: **light bulb**

More interpretations: [the light](#)

Definition:
 noun electric lamp consisting of a transparent or translucent glass housing containing a wire filament (usually tungsten) that emits light when heated by electricity

Does it work?

START's reply

who invented the lightbulb?

[Electric lamp](#)

[Electric lamp](#)
 (inc. lamp) Sir Humphrey Davy, England, 1801; (fluorescent lamp) A.E. Hocquet, France, 1867; (incandescent lamp) Sir Joseph Swan, England, [Thomas A. Edison](#), U.S., contemporaneously, 1876; (carbon arc street lamp) [Charles F. Brush](#), U.S., 1879; (first widely marketed incandescent lamp) Thomas A. Edison, U.S., 1879; (mercury vapor lamp) Peter Cooper Hewitt, U.S., 1903; (neon lamp) Georges Claude, France, 1911; (tungsten filament) [Iveta Lengmair](#), U.S., 1915.

[Thomas Alva Edison](#)
 (1847-1931)
 Library of Congress

Sources: [InfoPlease.com](#)

Does it work?

WolframAlpha™ computational knowledge engine

who is the best natural language processing professor?

Using closest WolframAlpha interpretation: **best natural language processing**

More interpretations: [the best professor](#) | [professor](#) | [the best](#) | [natural language processing](#)

Natural Language Processing

Development of this topic is under investigation...

Leave your email address to show your interest. [send](#)

Does it work?

- Where do lobsters like to live?
 - on a Canadian airline
- Where do hyenas live?
 - in Saudi Arabia
 - in the back of pick-up trucks
- Where are zebras most likely found?
 - near dumps
 - in the dictionary
- Why can't ostriches fly?
 - Because of American economic sanctions
- What's the population of Maryland?
 - three

Text REtrieval Conference (TREC)
...to encourage research in information retrieval from large text collections. <http://trec.nist.gov>

Overview

Publications

Other Evaluations

Information for Active Participants

Frequently Asked Questions

Tracks

Data

Past TREC Results

Contact Information

NIST
National Institute of Standards and Technology

Summarization

- Summarization approaches aim to produce a summarized version of a text document

Summarization

Full-text Summarization Question Answer

Summarization

- Applications?
- Different types of summarization?

Genres

- overview/summary/abstract
- headlines
- outlines
- minutes
- biographies
- compression
- simplification
- sound bites
- movie summaries
- chronologies

Headline news — informing

The screenshot shows the TIME.com website interface from June 30, 1998. The main headline is "U.S. Plane Fires a Missile On Iraq" with a sub-headline "An Iraqi radar station targets an Allied plane, and a U.S. F-16 responds quickly — with deadly force. Is this the start of a new war with Saddam, or the way?" Other headlines include "Starr Plays the Tripp Card", "Down to Business in Shanghai", and "Pill: Does the U.S. have the right to impose its idea of human rights in China?".

TV-GUIDES — decision making

2:30am VC2 - 76
The Jackal
 Movie: Bruce Willis excels as "The Jackal," a cunning assassin who uses many disguises in this 1997 thriller. Richard Gere and Sidney Poitier costar as players from different sides of the law who unite to stop him.

3:00am KCOP - 13
The Untouchables
 Movie: Eliot Ness (Kevin Costner) and "The Untouchables" take on Robert De Niro's flamboyant Al Capone in the pulse-pounding 1987 adaptation of the popular TV series. Sean Connery won an Oscar as the Irish beat cop who shows Ness "the Chicago way." Brian De Palma directed the feature. David Mamet wrote the script. And yes, film majors, the scene at Union Station was filmed directly from the set.

3:05am STARZ - 25
Grosse Pointe Blank
 Movie: A razor-sharp script and a fine turn by John Cusack as a troubled hit man mark 1997's "Grosse Pointe Blank," a dark comedy in which the assassin encounters his old flame (Minnie Driver of "Crossed Wires Hunting") at a high-school reunion. Cusack's sister Joan ("In and Out") is hilarious as the killer's devoted assistant, and Alan Arkin makes the most of his small role as Cusack's terrified foe.

Abstracts of papers — time saving

An Incremental Interpreter for High-Level Programs with Sensing

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Abstract
 The classical planning, an extension of high-level agent programs, requires a heuristic to look all the way to a goal state. This paper introduces a novel heuristic, the *incremental heuristic*. This heuristic is computed in the process of solving a problem, and it is updated incrementally as the heuristic search progresses. It is shown that this heuristic is admissible and optimal. This paper also introduces a novel high-level language, *Incremental Planning*, which supports the heuristic search process. This language is designed to be executed over distributed networks. We give a detailed description of the language and its implementation.

Introduction
 In [1] it was argued that when it comes to providing high-level control to a robot in its environment, the solution of high-level program execution offers an alternative to classical planning. But may be more practical in many applications. Briefly, instead of looking for a sequence of actions of length n :

Action 1: $Legal(a_1, S_0) \wedge \Delta(a_1, S_0)$
 where Δ is the goal being planned for, we look for a sequence of length $2n$:

Action 1: $Do(a_1, S_0, \Delta(a_1, S_0))$

To find a sequence with the right properties. This can involve considerable search when n is very large and domains are large. This is the main reason why classical planning is the preferred method for solving classical problems. The feasibility of this approach for AI programs clearly depends on the expressive power of the programming language in question. In [1], a language called *ConcObjects* is presented, which is suitable for nondeterministic control of multiple resources, flexible, conditional, continuous, and prioritized interpretation. In this paper, we extend the expressive power of this language by providing much finer control over the nondeterminism, and by adding provisions for modeling actions. To do so in a way that will be practical even for very large programs requires introducing a different style of state program execution.

In the rest of this section, we discuss on-line and off-line execution, informally, and show why modeling actions and nondeterminism in general can be problematic. In the following section, we formally describe the program execution in the language of the abstract calculus. Next, we describe an incremental interpreter in Prolog that constructs with respect to this specification. The final section contains discussion and conclusions.

Off-line and On-line execution
 To be compatible with planning, the *ConcObjects* interpreter provides the *off-line execution* mode. In this mode, the interpreter first generates a sequence of actions before actually executing any of them in the world. Consider, for example, the following program.

Cliff notes — Laziness support

Cliff Notes for the Grapes of Wrath

Posted by [Derek](#) on December 02, 1997 at 11:35:43:

In Reply to: [Re: I need cliff notes or a summary to TO KILL A MOCKING>>](#) posted by [Kandice](#) on September 28, 1997 at 20:40:48:

Say can you send me some cliff notes for the grapes of wrath by Wednesday December 3, 1997. I would appreciate it very much and I would recomend this page to all my friends so we could ace our english tests on the grapes of wrath. PLEASE SEND ME A COPY OF THE GRAPES OF WRATH CLIFF NOTES I NEED THEM BAD!!!!!!!!!!!!!!

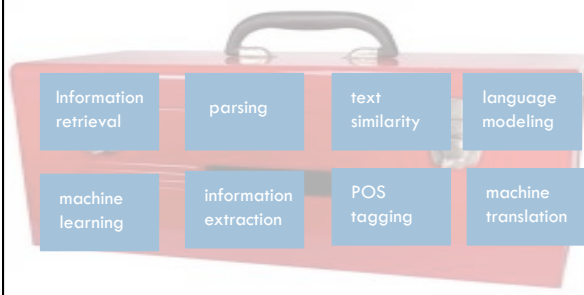
57

Different dimensions of summarization

- How much summarization
 - ▣ quick categorization vs. content processing
 - ▣ Background vs. just-the-news
- Extract vs. abstract (how the summarization is generated)
 - ▣ lists fragments of text vs. re-phrases content coherently
- Generic vs. query-oriented
- Single-document vs. multi-document source
 - ▣ ...based on one text vs. fuses together many texts.

Summarization

How are we going to do it?



Summarization

- Three common steps:
 - ▣ **Content selection:** what are the important concepts/ clauses/sentences?
 - ▣ **Content ordering:** how should this information be structured?
 - ▣ **Realization:** concepts/sentences=> output

Three common steps: the basics

content selection	content ordering	realization
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Content selection

content selection	
_____	General problem: identify important concepts
_____	Common approximation: identify important sentences







_____	How can we identify important sentences?

Identifying important sentences

- Word-based
 - Calculate the sentence as the average weight of the words in the sentence
 - TF-IDF weighting
 - likelihood ratio: likelihood of occurring in this document divided by the likelihood of occurring in the whole corpus
 - pick the highest scoring sentences
- Similarity-based
 - pick sentences that are on average closer to the other sentences in the document
 - might also discount for being generally similar to whole corpus

Identifying important sentences: supervised approach

Training data

		Could we use this to learn a sentence importance measure?
		What features might be useful?
		Challenges?

Summarization

□ Three common steps:

□ Content selection: what are the important concepts/ clauses/sentences?

→ □ Content ordering: how should this information be structured?

Often, just put them in the same order they occur in the documents

Summarization

□ Three common steps:

□ Content selection: what are the important concepts/ clauses/sentences?

□ Content ordering: how should this information be structured?

□ Realization: concepts/sentences => output

challenges?

Realization (output)

□ Input: a bunch of sentences

□ output: summary

□ challenges

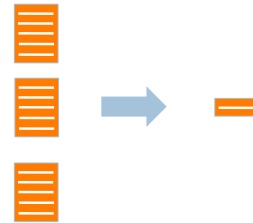
□ reference resolution/naming (show some examples)

□ fluidity

□ repetition?

Multi-document approaches

In many domains, we have multiple documents on the same topic (e.g. news) and we'd like to summarize all the documents with one summary



How does this problem differ?


ARTICLE 18853: ALGIERS, May 20 (AFP)	ARTICLE 18854: ALGIERS, May 20 (UPI)
1. Eighteen decapitated bodies have been found in a mass grave in northern Algeria, press reports said Thursday, adding that two shepherds were murdered earlier this week.	1. Algerian newspapers have reported that 18 decapitated bodies have been found by authorities in the south of the country.
2. Security forces found the mass grave on Wednesday at Chbika, near Djelfa, 275 kilometers (170 miles) south of the capital.	2. Police found the "decapitated bodies of women, children and old men, with their heads thrown on a road" near the town of Aïfa, 275 kilometers (170 miles) south of the capital Algiers.
3. It contained the bodies of people killed last year during a wedding ceremony, according to Le Quotidien Liberté.	3. In another incident on Wednesday, seven people – including six children – were killed by terrorists, Algerian security forces said.
4. The victims included women, children and old men.	4. Extremist Muslim militants were responsible for the slaughter of the seven people in the province of Medea, 120 kilometers (74 miles) south of Algiers.
5. Most of them had been decapitated and their heads thrown on a road, reported the Es Sahafe.	5. The killers also kidnapped three girls during the same attack, authorities said, and one of the girls was found wounded on a nearby road.
6. Another mass grave containing the bodies of around 10 people was discovered recently near Algiers, in the Eucalyptus district.	6. Meanwhile, the Algerian daily Le Matin today quoted Interior Minister Abdul Malik Sial as saying that "terrorism has not been eradicated, but the movement of the terrorists has significantly declined."
7. The two shepherds were killed Monday evening by a group of nine armed Islamists near the Moulou Slissen forest.	7. Algerian violence has claimed the lives of more than 70,000 people since the army cancelled the 1992 general elections that Islamic parties were likely to win.
8. After being injured in a hail of automatic weapons fire, the pair were finished off with machete blows before being decapitated, Le Quotidien d'Oran reported.	8. Mainstream Islamic groups, most of which are banned in the country, insist their members are not responsible for the violence against civilians.
9. Seven people, six of them children, were killed and two injured Wednesday by armed Islamists near Medea, 120 kilometers (75 miles) south of Algiers, security forces said.	9. Some Muslim groups have blamed the army, while others accuse "foreign elements conspiring against Algeria."
10. The same day a parcel bomb explosion injured 17 people in Algiers itself.	
11. Since early March, violence linked to armed Islamists has claimed more than 800 lives, according to press tallies.	

Evaluation?

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Libya rebels pull back as Gadhafi forces retake town near Sirte

Summary from multiple countries, from articles in English

The UN humanitarian chief said Monday that the Libyan government has promised her access to the besieged rebel city of Misrata, but with no guarantees that the assault by Muammar Gadhafi's forces would cease. (article 1) Libyan rebels fought Muammar Gadhafi's forces Sunday braving shelling and sniper fire in close-quarters battles in the city center of Misrata, the last major rebel foothold in western Libya. (article 2) President Barack Obama has signed a secret order authorizing covert U.S. government support for rebel forces seeking to oust Libyan leader Muammar Gadhafi, government officials told Reuters on Wednesday. (article 3) Britain said Tuesday it will send about a dozen senior soldiers to Libya to help organize the country's haphazard rebel forces, as international allies seek to aid the opposition's attempts to break the military stalemate. (article 4) A month into the allied air campaign in Libya the battle lines are hardening, rebel leaders want more, and Muammar Gadhafi remains defiant, but there are signs his military forces are being stretched to the limits. (article 5) TAP said on Monday that a colonel, a captain and another officer in the internal security forces turned up at El Keif port in the Ben Guerdane region Sunday. (article 6)



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