

# Natural Language Processing

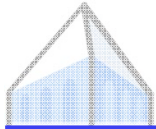


## Question Answering

Dan Klein – UC Berkeley

The following slides are largely from Chris Manning, including many slides originally from Sanda Harabagiu, ISI, and Nicholas Kushmerick.

Watson



# Large-Scale NLP: Watson

"a camel is a horse designed by"

About a multilingual tree encyclopedia

**Wiktionary** [ˈwɪkʃənəri] n., a wiki-based Open Content dictionary

Wiktionary [ˈwɪkʃənəri]

Log in / create account

Entry Discussion Read Edit History Search

a camel is a horse designed by a committee

Contents [hide]

- 1 English
  - 1.1 Alternative forms
  - 1.2 Proverb

**The Phrase Finder**

Discussion Forum

Google™ Custom Search Search

**A camel is a horse designed by committee**

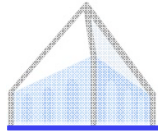
Posted by Ruben P. Mendez on April 16, 2004

Does anyone know the origin of this maxim? I heard it way back at the United Nations, which is chockfull of committees. It may have originated there, but I'd like an authoritative explanation. Thanks

- [Re: A camel is a horse designed by committee](#) SR 16/April/04
  - [Re: A camel is a horse designed by committee](#) Henry 18/April/04

If a camel is a horse de  
If a camel is a horse design

# QA vs Search



# People *want* to ask questions?

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## Examples of search queries

who invented surf music?

how to make stink bombs

where are the snowdens of yesteryear?

which english translation of the bible is used in official catholic liturgies?

how to do clayart

how to copy psx

how tall is the sears tower?

how can i find someone in texas

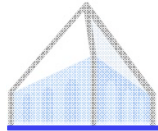
where can i find information on puritan religion?

what are the 7 wonders of the world

how can i eliminat stress

What vacuum cleaner does Consumers Guide recommend

Around 10–15% of query logs

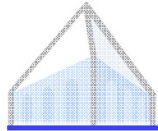


# A Brief (Academic) History

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- Question answering is not a new research area
- Question answering systems can be found in many areas of NLP research, including:
  - Natural language database systems
    - A lot of early NLP work on these
  - Spoken dialog systems
    - Currently very active and commercially relevant
- The focus on open-domain QA is (relatively) new
  - MURAX (Kupiec 1993): Encyclopedia answers
  - Hirschman: Reading comprehension tests
  - TREC QA competition: 1999–

TREC

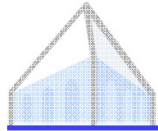


# Question Answering at TREC

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- Question answering competition at TREC consists of answering a set of 500 fact-based questions, e.g.,  
*“When was Mozart born?”*.
- For the first three years systems were allowed to return 5 ranked answer snippets (50/250 bytes) to each question.
  - IR think
  - Mean Reciprocal Rank (MRR) scoring:
    - 1, 0.5, 0.33, 0.25, 0.2, 0 for 1, 2, 3, 4, 5, 6+ doc
  - Mainly Named Entity answers (person, place, date, ...)
- From 2002+ the systems are only allowed to return a single *exact* answer and a notion of confidence has been introduced.

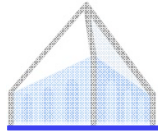




# Sample TREC questions

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1. Who is the author of the book, "The Iron Lady: A Biography of Margaret Thatcher"?
2. What was the monetary value of the Nobel Peace Prize in 1989?
3. What does the Peugeot company manufacture?
4. How much did Mercury spend on advertising in 1993?
5. What is the name of the managing director of Apricot Computer?
6. Why did David Koresh ask the FBI for a word processor?
7. What debts did Qintex group leave?
8. What is the name of the rare neurological disease with symptoms such as: involuntary movements (tics), swearing, and incoherent vocalizations (grunts, shouts, etc.)?

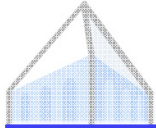


# Top Performing Systems

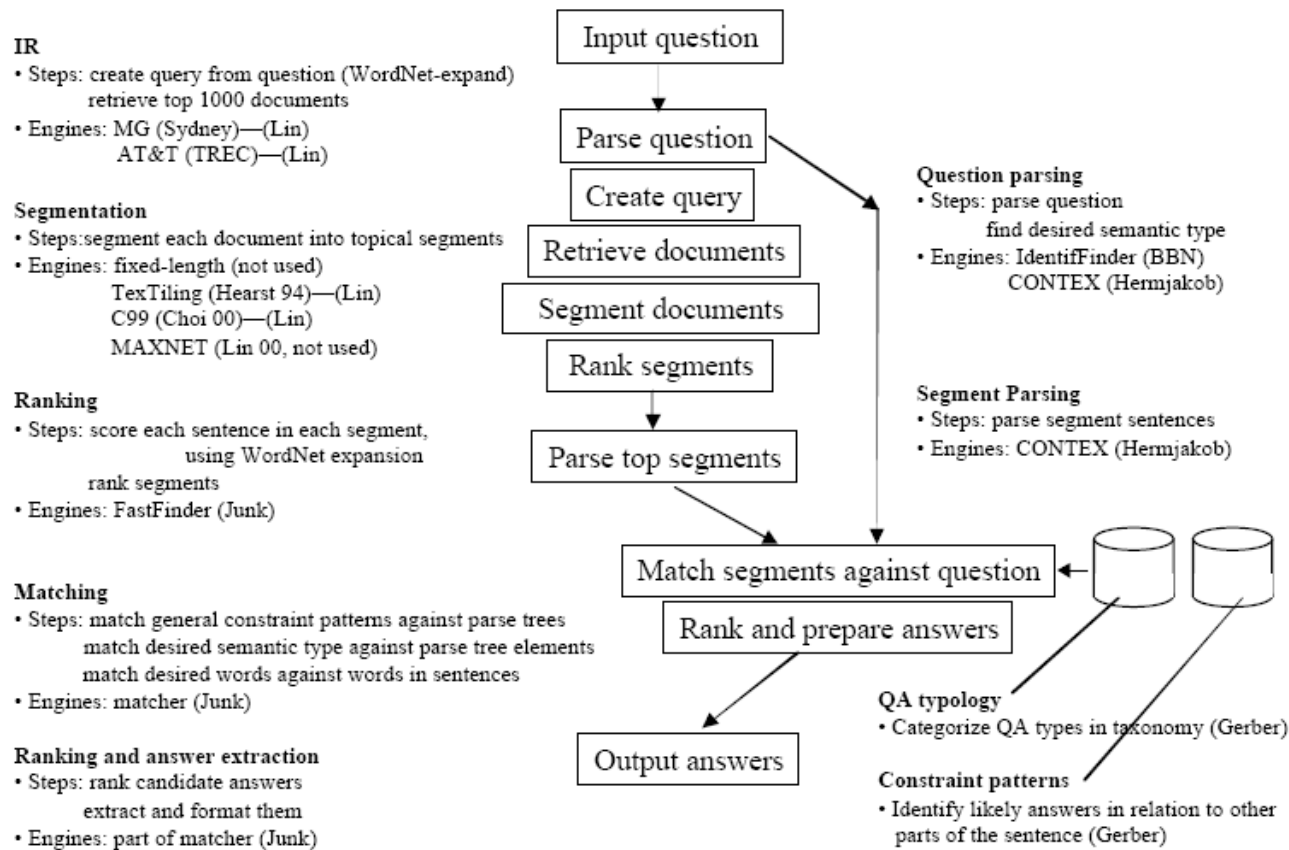
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- Currently the best performing systems at TREC can answer approximately 70% of the questions
- Approaches and successes have varied a fair deal
  - Knowledge-rich approaches, using a vast array of NLP techniques stole the show in 2000, 2001, still do well
    - Notably Harabagiu, Moldovan et al. – SMU/UTD/LCC
  - AskMSR system stressed how much could be achieved by very simple methods with enough text (and now various copycats)
  - Middle ground is to use large collection of surface matching patterns (ISI)
  - Emerging standard: analysis, soft-matching, abduction

# Pattern Induction: ISI



# Webclopedia Architecture




TextMap Question Answering - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media

Address <http://brahms.isi.edu:8080/textmap/?query=In+what+year+did+John+Lennon+die%3F&submit=Ask&options=Web> Go

Google natural language processing Search Web 16 blocked AutoFill Options isi natural language proc



In what year did John Lennon die?   Web  TREC

Please wait while [Webclopedia](#) answers to your question (potential answers will follow, with the top 10 below).

---

**At the time, these were the best 10 answers found for the question:**

- 505.4252 When **John Lennon died** in **1980**, the traumatic childhood experiences which took place 13 **years** earlier on December 8, 1967 finally made sense to me. ... (<http://www.onceaman.com/author.htm>)
- 505.4252 When **John Lennon died** in **1980**, the traumatic childhood experiences which took place 13 **years** earlier on December 8, 1967 finally made sense to me. (<http://www.onceaman.com/author.htm>)
- 504.1176 **John Lennon died** in **1980**, which is part of that era. (<http://www.johnlennon.it/guestbook1.htm>)
- 504.1176 As many people know **John Lennon died** in **1980** and she has not remarried since. ... (<http://www.public.asu.edu/~dejesus/210entries/yoko/yoko.htm>)
- 504.1176 Fourth Beatle **John Lennon died** in **1980** when he was shot by a fan outside his New York city home. ... (<http://news.bbc.co.uk/2/hi/entertainment/2775173.stm>)
- 504.1176 **John Lennon died** in **1980**. (<http://members.tripod.com/~FencerGirl/interview.html>)
- 504.1176 As many people know **John Lennon died** in **1980** and she has not remarried since. (<http://www.public.asu.edu/~dejesus/210entries/yoko/yoko.htm>)
- 504.1176 Fourth Beatle **John Lennon died** in **1980** when he was shot by a fan outside his New York city home. (<http://news.bbc.co.uk/2/hi/entertainment/2775173.stm>)
- 491.8676 Soon after **John Lennon died** in New York in December **1980** his widow, Yoko Ono, decided to release a limited edition of some of his drawings. ... (<http://www.bsn.org.uk/bsn/bsnenscripts.nsf/0/56A8E8F789C4AEDF80256DDA004A18B3?OpenDocument>)
- 491.8676 Soon after **John Lennon died** in New York in December **1980** his widow Yoko Ono decided to release a limited edition of some of his

Still searching for more answers ... (979 sec used to find 107 answers so far)

Internet

TextMap Question Answering - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media

Address <http://brahms.isi.edu:8080/textmap/?query=Who+was+the+prime+minister+of+Australia+in+1990%3F&options=Web> Go

Google natural language processing Search Web 16 blocked AutoFill Options isi natural language proc



Who was the prime minister of Australia in 1990? Ask  Web  TREC

Please wait while [Webclopedia](#) answers to your question (potential answers will follow, with the top 10 below).

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**Current top 10 (of 109) for "Who was the prime minister of Australia in 1990?" - still finding more...**

- 393.0737 ... 1986, 1987, 1990 ) Prime Minister **Paul Keating** (1992, 1994, 1995) Prime Minister John Howard (1996, 1999, 2000, 2001, 2003). (2) Visits to Australia from Japan. ... (<http://www.mofa.go.jp/region/asia-paci/australia/>)
- 354.7754 ... sound file Prime Minister **RG Menzies** opens 'Australia Calling' - 1939. ... 1990 BACK. image file Ian McNamara, presenter of Australia All Over - c. 1990. ... (<http://www.abc.net.au/ra/gallery/gallery.htm>)
- 352.0389 **John Howard** is the prime minister of Australia, Niall is something he unfortunately stepped in, though he managed to scape most of it off on the curb. ([http://spleenville.com/~lilith33/blog/mt-comments.cgi?entry\\_id=5158](http://spleenville.com/~lilith33/blog/mt-comments.cgi?entry_id=5158))
- 352.0389 **Mr. Howard** is the prime minister of Australia (<http://www.opinionjournal.com/editorial/feature.html?id=110003123>)
- 347.6498 Visit to Japan by Prime Minister **John Winston Howard** of Australia (July 2003) (<http://www.mofa.go.jp/region/asia-paci/australia/>)
- 345.3444 You can send your letter to The **Honorable John Howard**, MP Prime Minister of Australia, Parliament House, Canberra, ACT 2600 Australia. (<http://www.planetary.org/html/news/articlearchive/headlines/1997/headln-041497.html>)
- 336.8657 Prime Minister Junichiro Koizumi held talks with **Mr. John Howard**, the Prime Minister of Australia, at the Prime Minister's Official Residence. ([http://www.kantei.go.jp/foreign/koizumiphoto/2003/07/16australia\\_e.html](http://www.kantei.go.jp/foreign/koizumiphoto/2003/07/16australia_e.html))
- 334.0130 Summit Meeting Between Prime Minister Junichiro Koizumi and Prime Minister **John Winston Howard** of Australia (Summary) (May 2002) (<http://www.mofa.go.jp/region/asia-paci/australia/>)

Still searching for more answers ... (397 sec used to find 116 answers so far)

Internet

TextMap Question Answering - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media

Address <http://brahms.isi.edu:8080/textmap/?query=What+is+gum+arabic+made+from%3F&options=Web> Go

Google natural language processing Search Web 16 blocked AutoFill Options isi natural language proc

gum/What is gum arabic made from? Ask  Web  TREC

Please wait while [Webclopedia](#) answers to your question (potential answers will follow, with the top 10 below).

Abort

Searching for answer sentences on the subject: **gum arabic**

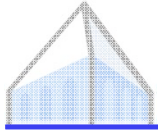
Expecting an answer of type: **Q-COMPONENTS, S-NP (0.8)**

[View analysis of question](#)

- <http://www.ars.usda.gov/is/pr/1999/990914.htm>)
- 37.0068 From a North African conifer a sap was extracted and **boiled to make an alcohol-based ... 1 ounce gum arabic (about 2 tablespoons) 1/2 cup water 2 teaspoons honey 1 ...** (<http://www.care2.com/channels/solutions/home/1329>)
- 34.2060 You **have your gum arabic solution made in five minutes of not so hard work, and all you need now is to allow some time for all the dirt to precipitate to the ...** (<http://www.microscopy-uk.org.uk/mag/artmay03/wdpart3c.html>)
- 34.2060 You **have your gum arabic solution made in five minutes of not so hard work, and all you need now is to allow some time for all the dirt to precipitate to the bottom (perhaps overnight).** 5) Decant the supernatant liquid and adjust the density to suit your preferences. (<http://www.microscopy-uk.org.uk/mag/artmay03/wdpart3c.html>)
- 34.0466 Unfortunately, **dried (crystallized) pure gum arabic is very brittle: paints made with a high proportion of gum binder often lift easily (redissolve) from the paper, but also will bronze (appear shiny or leathery) and crack or flake if applied in a thick or masstone layer.** ([http://ttt.upv.es/~gbenet/teoria%20de%20color/water\\_color/pigmt1.html](http://ttt.upv.es/~gbenet/teoria%20de%20color/water_color/pigmt1.html))
- 34.0219 **Made from the dried sap of the Sahelian acacia tree, gum arabic sales totaled two-thirds of all U.S. imports from Sudan in 1996.** ([http://www.ppionline.org/ppi\\_ci.cfm?knlgAreaID=108&subsecID=900003&contentID=251860](http://www.ppionline.org/ppi_ci.cfm?knlgAreaID=108&subsecID=900003&contentID=251860))
- 33.5295 ... **gum arabic or gum acacia - Hardened sap ... gyotaku - In Japanese tradition, a relief print made from an actual fish, and sometimes from a shell, leaf, or other ...** (<http://www.artlex.com/ArtLex/Gm.html>)
- 33.1687 **gum arabic n : gum from an acacia tree; used as a thickener (especially in candies and pharmaceuticals) [syn: gum acacia]** (<http://dict.die.net/gum%20arabic/>)
- 32.8489 **Sugar-coated confections made by the panning process employ gum arabic solutions to provide an adhesive and film coating for nuts, candy corn, jelly beans, bridge mixes, and others.** (<http://www.jumbo.th.com/application.html>)

Still searching for more answers ... (149 sec used to find 29 answers so far)

Internet



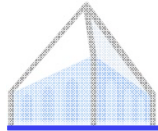
## Ravichandran and Hovy 2002

### Learning Surface Patterns

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- Use of Characteristic Phrases
- "When was <person> born"
  - Typical answers
    - "Mozart was born in 1756."
    - "Gandhi (1869-1948)..."
  - Suggests phrases like
    - "<NAME> was born in <BIRTHDATE>"
    - "<NAME> ( <BIRTHDATE>-"
  - Regular expressions

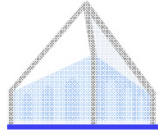




# Use Pattern Learning

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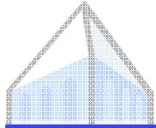
- Example: Start with “Mozart 1756”
  - Results:
    - “The great composer Mozart (1756-1791) achieved fame at a young age”
    - “Mozart (1756-1791) was a genius”
    - “The whole world would always be indebted to the great music of Mozart (1756-1791)”
  - Longest matching substring for all 3 sentences is “Mozart (1756-1791)”
  - Suffix tree would extract “Mozart (1756-1791)” as an output, with score of 3
- Reminiscent of IE pattern learning



## Pattern Learning (cont.)

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- Repeat with different examples of same question type
  - “Gandhi 1869”, “Newton 1642”, etc.
- Some patterns learned for BIRTHDATE
  - a. born in <ANSWER>, <NAME>
  - b. <NAME> was born on <ANSWER> ,
  - c. <NAME> ( <ANSWER> -
  - d. <NAME> ( <ANSWER> - )



# Pattern Precision

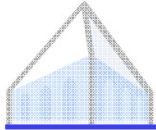
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- **BIRTHDATE table:**

- 1.0 <NAME> ( <ANSWER> - )
- 0.85 <NAME> was born on <ANSWER> ,
- 0.6 <NAME> was born in <ANSWER>
- 0.59 <NAME> was born <ANSWER>
- 0.53 <ANSWER> <NAME> was born
- 0.50 - <NAME> ( <ANSWER>
- 0.36 <NAME> ( <ANSWER> -

- **INVENTOR**

- 1.0 <ANSWER> invents <NAME>
- 1.0 the <NAME> was invented by <ANSWER>
- 1.0 <ANSWER> invented the <NAME> in



# Pattern Precision

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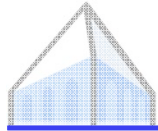
- WHY-FAMOUS

- 1.0 <ANSWER> <NAME> called
- 1.0 laureate <ANSWER> <NAME>
- 0.71 <NAME> is the <ANSWER> of

- LOCATION

- 1.0 <ANSWER>'s <NAME>
- 1.0 regional : <ANSWER> : <NAME>
- 0.92 near <NAME> in <ANSWER>

- Depending on question type, get high MRR (0.6–0.9), with higher results from use of Web than TREC QA collection

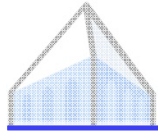


# Shortcomings & Extensions

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- Need for POS &/or semantic types
  - "Where are the Rocky Mountains?"
  - "Denver's new airport, topped with white fiberglass cones in imitation of the Rocky Mountains in the background , continues to lie empty"
  - <NAME> in <ANSWER>
- Long distance dependencies
  - "Where is London?"
  - "London, which has one of the busiest airports in the world, lies on the banks of the river Thames"
  - would require pattern like:  
<QUESTION>, (<any\_word>)\*, lies on <ANSWER>
- But: abundance of Web data compensates

# Aggregation: AskMSR

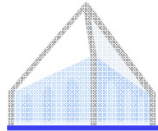


# AskMSR

- **Web Question Answering: Is More Always Better?**
  - Dumais, Banko, Brill, Lin, Ng (Microsoft, MIT, Berkeley)

- Q: “Where is the Louvre located?”
- Want “Paris” or “France” or “75058 Paris Cedex 01” or a map
- Don’t just want URLs

The screenshot shows a Google search interface. The search bar contains the text "Where is the Louvre museum located?". Below the search bar, there are navigation links for "Advanced Search", "Preferences", "Language Tools", and "Search Tips". The search results page displays several entries, including a PDF document titled "An Analysis of the AskMSR Question-Answering System" and a hotel listing for "Hotel Montpensier" located near the Louvre Museum. A sidebar on the right side of the page features an advertisement for "Paris Metro & Explore Paris" with a "See your" button.



# AskMSR: Shallow approach

- *In what year did Abraham Lincoln die?*
- Ignore hard documents and find easy ones




**Abraham Lincoln, 1809-1865**

**\*LINCOLN, ABRAHAM** was born near Hodgenville, Kentucky, on February 12, 1809. In 1816, the Lincoln family moved to Pigeon Creek in Perry (now Spencer) County. Two years later, Abraham Lincoln's mother died and his father married a woman his "angel" mother. Lincoln attended a formal school for only a few months but acquired knowledge through the reading of books. In 1830, he moved to Illinois, in 1830 where he obtained a job as a store clerk and the local postmaster. He served without distinction in the Black Hawk War. He lost his attempt at the state legislature, but two years later he tried again, was successful, and Lincoln was admitted to the bar and became noteworthy as a witty, honest, competent circuit lawyer. He served a one-year term in the U.S. House in 1846, at which time he opposed the war with Mexico. By 1858, he had gained national attention for his series of debates with Stephen A. Douglas. After losing the election he became a significant figure in his party. At the end of his inauguration on March 4, seven southern states had seceded from the Union. Lincoln called for 75,000 volunteers (approximately 40,000 were accepted) to form the Union Army. Lincoln's leadership would eventually be the central difference in maintaining the Union. His Emancipation Proclamation which expanded the purpose of the war to the dedication of a national cemetery in Gettysburg, Lincoln's explanation of the War, and his leadership during the Civil War explain the significance of his role in American history.

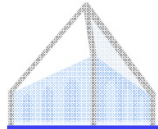
**Sixteenth President**  
1861-1865  
Married to Mary Todd Lincoln

**Abraham Lincoln**  
**16th President of the United States (March 4, 1861 to April 15, 1865)**  
Born: February 12, 1809, in Hardin County, Kentucky  
Died: April 15, 1865, at Petersen's Boarding House in Washington, D.C.

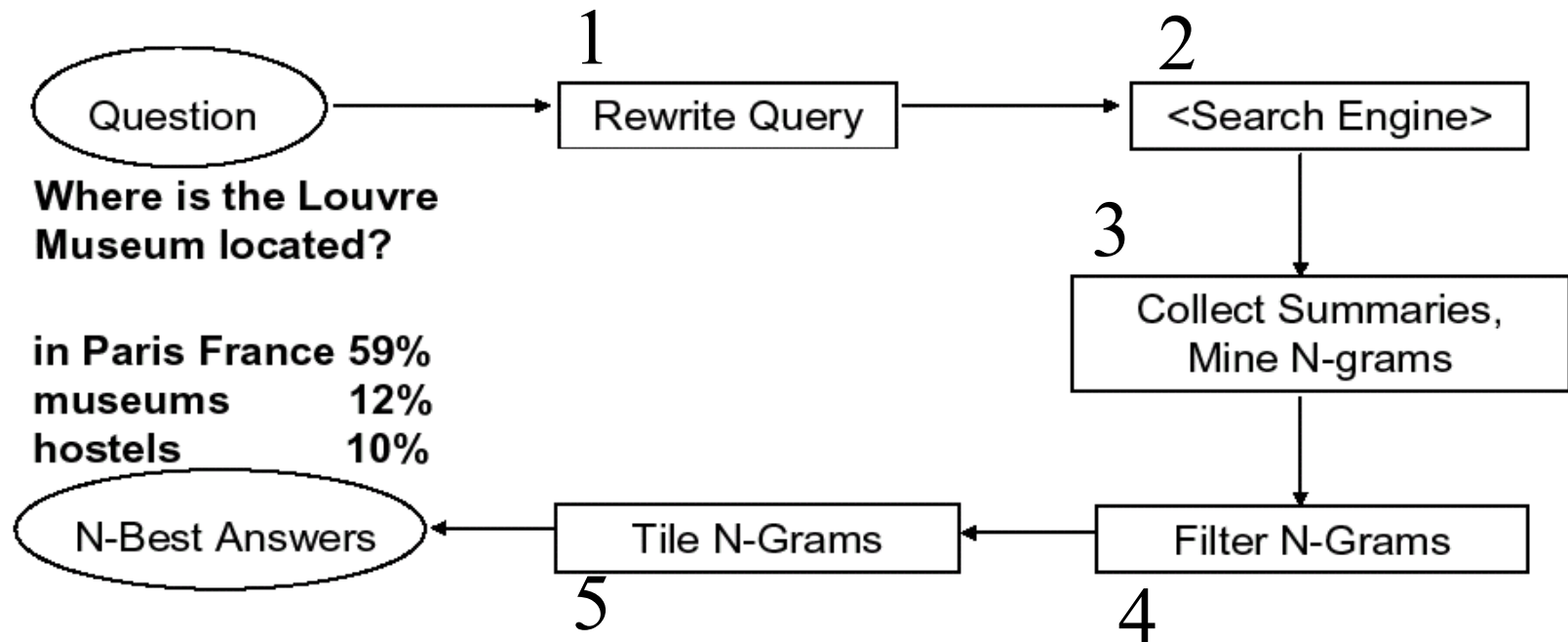
"I was born February 12, 1809, in Hardin County, Kentucky. My parents were both born in Virginia, of undistinguished families, perhaps I should say. My mother, who died in my tenth year, was of a family of the name of Hanks."

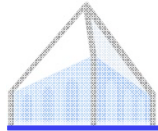






# AskMSR: Details

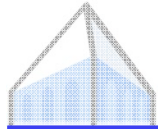




## Step 1: Rewrite queries

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- Intuition: The user's question is often syntactically quite close to sentences that contain the answer
  - Where is the Louvre Museum located?
  - The Louvre Museum is located in **Paris**
  - Who created the character of Scrooge?
  - **Charles Dickens** created the character of Scrooge.



# Query Rewriting: Variations

- Classify question into seven categories

- **Who** is/was/are/were...?
- **When** is/did/will/are/were ...?
- **Where** is/are/were ...?

- a. Category-specific transformation rules

eg “For Where questions, move ‘is’ to all possible locations”

“Where is the Louvre Museum located”

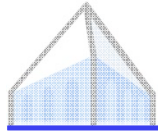
- “is the Louvre Museum located”
- “the is Louvre Museum located”
- “the Louvre is Museum located”
- “the Louvre Museum is located”
- “the Louvre Museum located is”

Nonsense,  
but who  
cares? It's  
only a few  
more queries

- b. Expected answer “Datatype” (eg, Date, Person, Location, ...)

**When** was the French Revolution? → DATE

- Hand-crafted classification/rewrite/datatype rules  
(Could they be automatically learned?)



# Query Rewriting: Weights

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- One wrinkle: Some query rewrites are more reliable than others

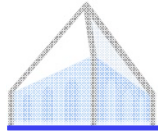
Where is the Louvre Museum located?

**Weight 1**  
Lots of non-answers  
could come back too

**Weight 5**  
If we get a match,  
it's probably right

+“the Louvre Museum is located”

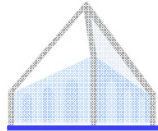
+Louvre +Museum +located



## Step 2: Query search engine

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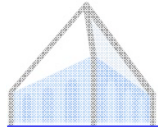
- Send all rewrites to a search engine
- Retrieve top N answers (100?)
- For speed, rely just on search engine's "snippets", not the full text of the actual document



## Step 3: Mining N-Grams

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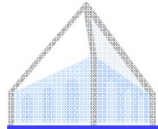
- Simple: Enumerate all N-grams (N=1,2,3 say) in all retrieved snippets
- Weight of an n-gram: occurrence count, each weighted by “reliability” (weight) of rewrite that fetched the document
- Example: “Who created the character of Scrooge?”
  - Dickens - 117
  - Christmas Carol - 78
  - Charles Dickens - 75
  - Disney - 72
  - Carl Banks - 54
  - A Christmas - 41
  - Christmas Carol - 45
  - Uncle - 31



## Step 4: Filtering N-Grams

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- Each question type is associated with one or more “**data-type filters**” = regular expression
- When... → **Date**
- Where... → **Location**
- What ... → **Location**
- Who ... → **Person**
- Boost score of n-grams that do match regexp
- Lower score of n-grams that don't match regexp
- Details omitted from paper....



## Step 5: Tiling the Answers

**Scores**

20

**Charles Dickens**

15

**Dickens**

10

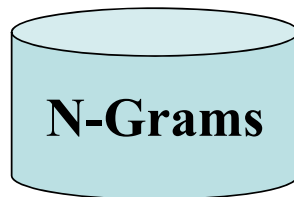
**Mr Charles**

merged, discard  
old n-grams



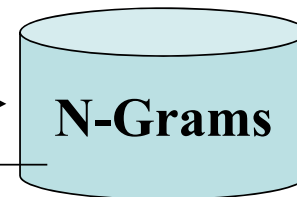
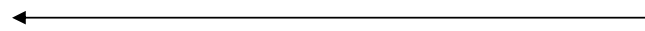
**Score 45**

**Mr Charles Dickens**



**N-Grams**

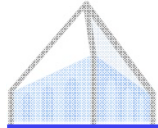
tile highest-scoring n-gram



**N-Grams**

**Repeat, until no more overlap**

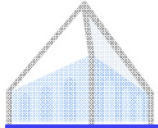




# Results

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- Standard TREC contest test-bed:  
~1M documents; 900 questions
- Technique doesn't do too well (though would have placed in top 9 of ~30 participants!)
  - MRR = 0.262 (ie, right answer ranked about #4-#5 on average)
  - Why? Because it relies on the redundancy of the Web
- Using the Web as a whole, not just TREC's 1M documents...  
MRR = 0.42 (ie, on average, right answer is ranked about #2-#3)

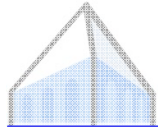


# Issues

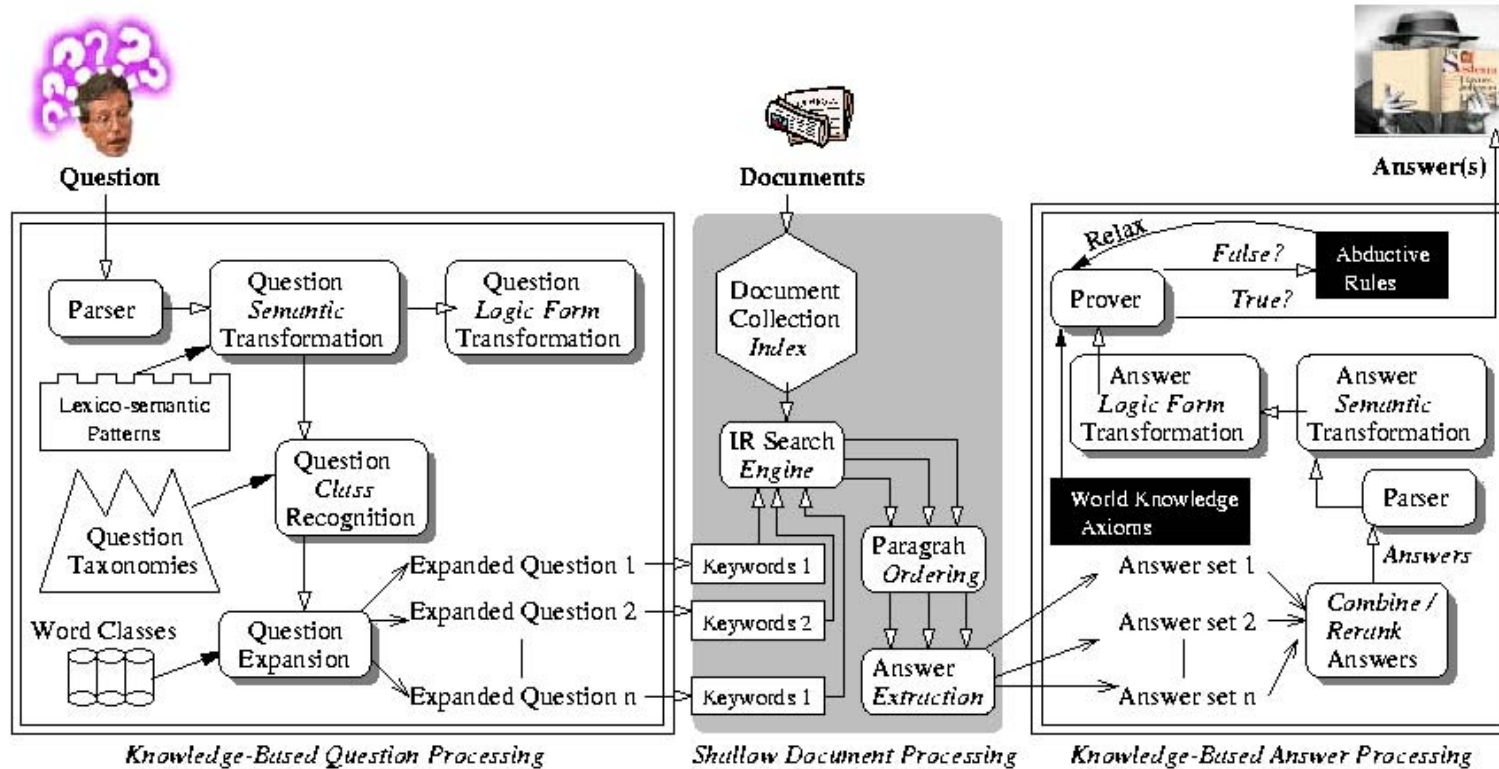
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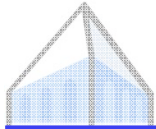
- In many scenarios (e.g., an individual's email...) we only have a limited set of documents
- Works best/only for “Trivial Pursuit”-style fact-based questions
- Limited/brittle repertoire of
  - question categories
  - answer data types/filters
  - query rewriting rules

# Abduction: LCC



# LCC: Harabagiu, Moldovan et al.

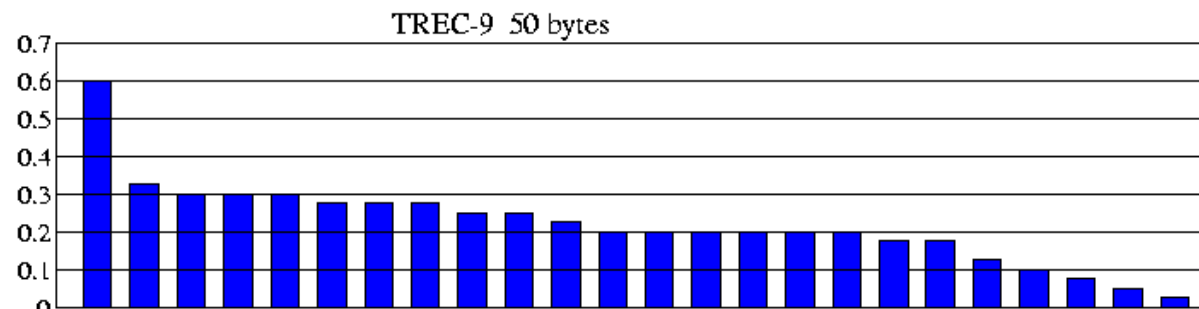


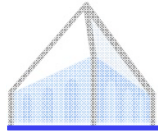


## Value from Sophisticated NLP Pasca and Harabagiu (2001)

---

- Good IR is needed: SMART paragraph retrieval
- Large taxonomy of question types and expected answer types is crucial
- Statistical parser used to parse questions and relevant text for answers, and to build KB
- Query expansion loops (morphological, lexical synonyms, and semantic relations) important
- Answer ranking by simple ML method

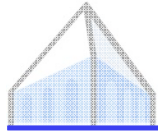




# Abductive inference

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- System attempts inference to justify an answer (often following lexical chains)
- Their inference is a kind of funny middle ground between logic and pattern matching
- But quite effective: 30% improvement
- *Q: When was the internal combustion engine invented?*
- *A: The first internal-combustion engine was built in 1867.*
- invent -> create\_mentally -> create -> build



## Question Answering Example

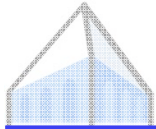
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- How hot does the inside of an active volcano get?
- “lava fragments belched out of the mountain were as hot as 300 degrees Fahrenheit”
  - volcano ISA mountain
  - lava ISPARTOF volcano    ■ lava IN volcano
  - fragments of lava HAVEPROPERTIESOF lava
- The needed semantic information is in WordNet definitions, and was successfully translated into a form that was used for rough ‘proofs’

# Watson

Slides from Ferrucci et al, AI Magazine, 2010





# Jeopardy...

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*Category:* General Science

*Clue:* When hit by electrons, a phosphor gives off electromagnetic energy in this form.

*Answer:* Light (or Photons)

*Category:* Lincoln Blogs

*Clue:* Secretary Chase just submitted this to me for the third time; guess what, pal. This time I'm accepting it.

*Answer:* his resignation

*Category:* Head North

*Clue:* They're the two states you could be reentering if you're crossing Florida's northern border.

*Answer:* Georgia and Alabama

*Category:* Decorating

*Clue:* Though it sounds "harsh," it's just embroidery, often in a floral pattern, done with yarn on cotton cloth.

*Answer:* crewel

*Category:* "Rap" Sheet

*Clue:* This archaic term for a mischievous or annoying child can also mean a rogue or scamp.

*Subclue 1:* This archaic term for a mischievous or annoying child.

*Subclue 2:* This term can also mean a rogue or scamp.

*Answer:* Rascalion

*Category:* Before and After Goes to the Movies

*Clue:* Film of a typical day in the life of the Beatles, which includes running from bloodthirsty zombie fans in a Romero classic.

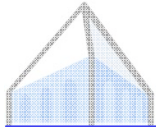
*Subclue 2:* Film of a typical day in the life of the Beatles.

*Answer 1:* (*A Hard Day's Night*)

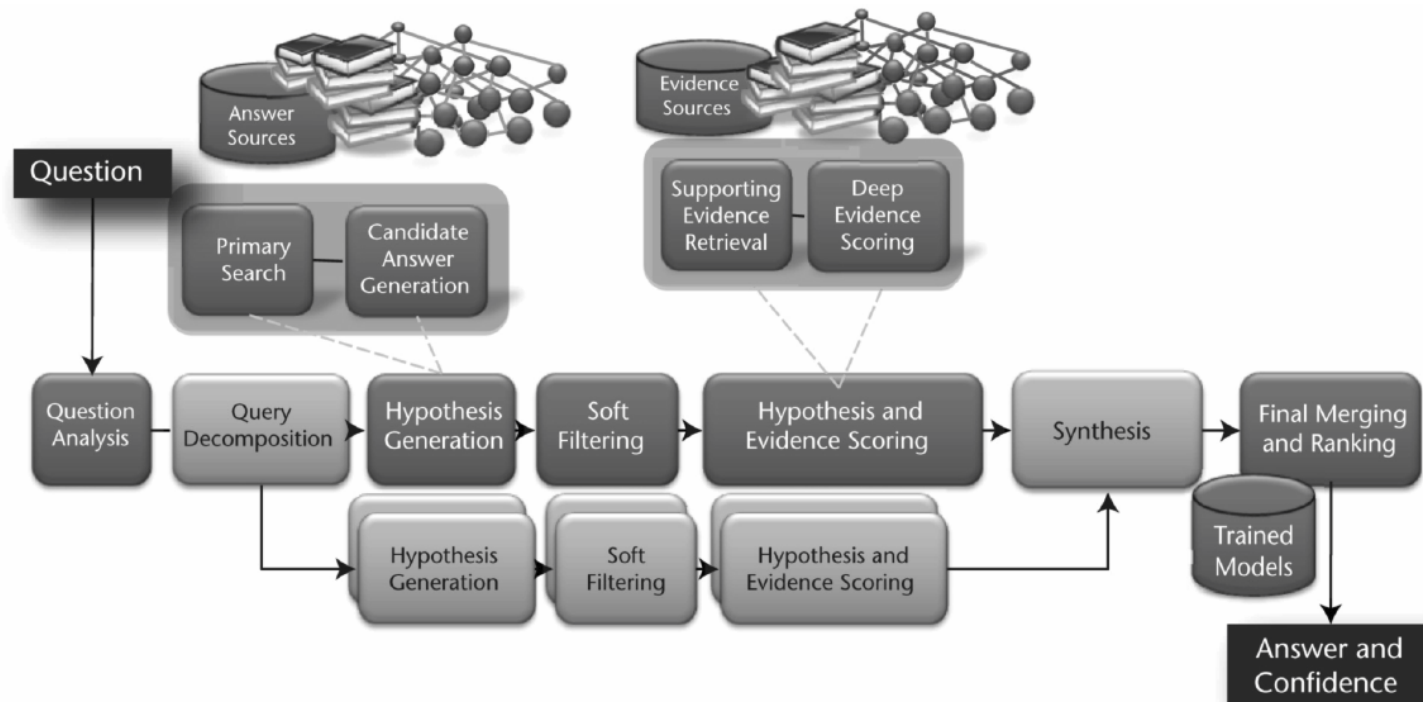
*Subclue 2:* Running from bloodthirsty zombie fans in a Romero classic.

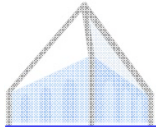
*Answer 2:* (*Night of the Living Dead*)

*Answer:* *A Hard Day's Night of the Living Dead*

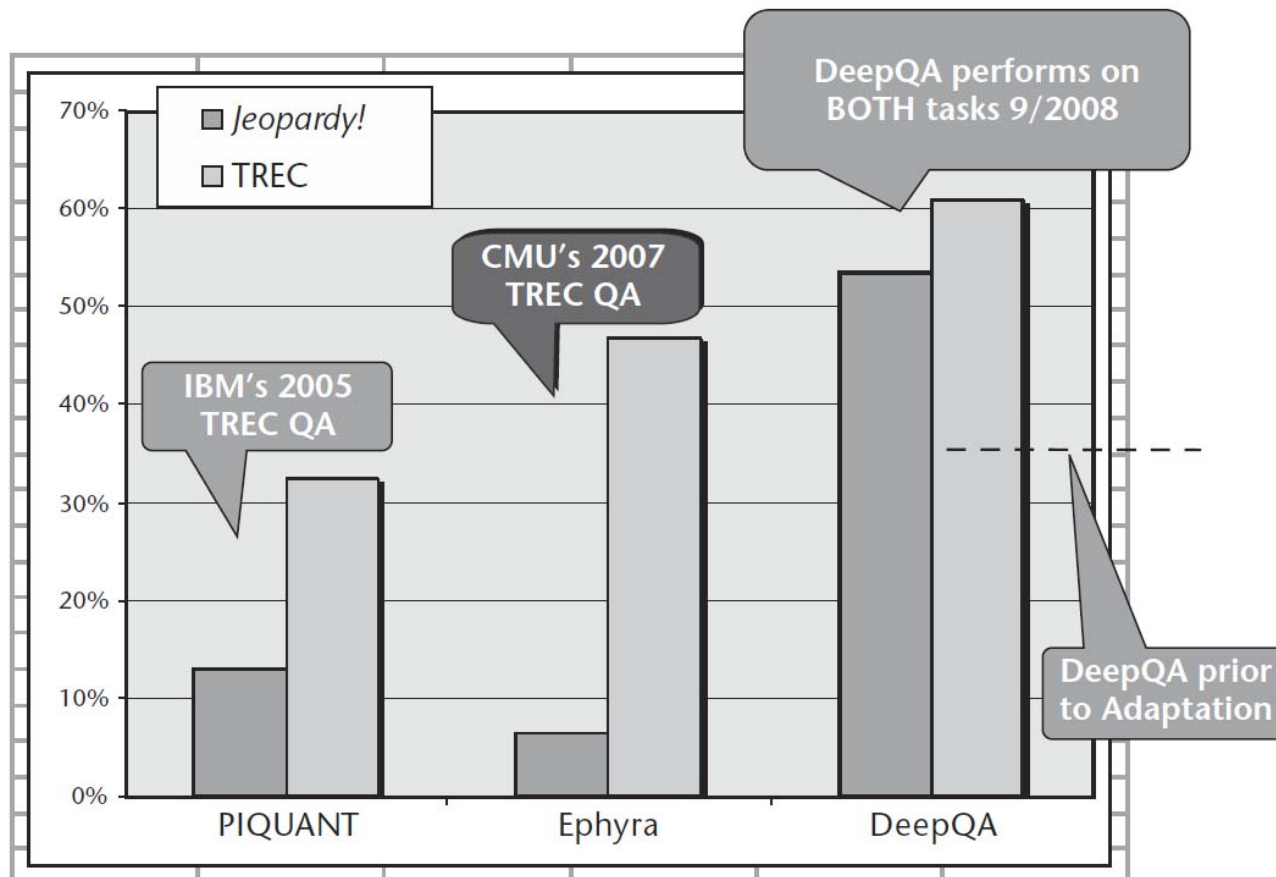


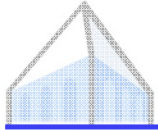
# Architecture



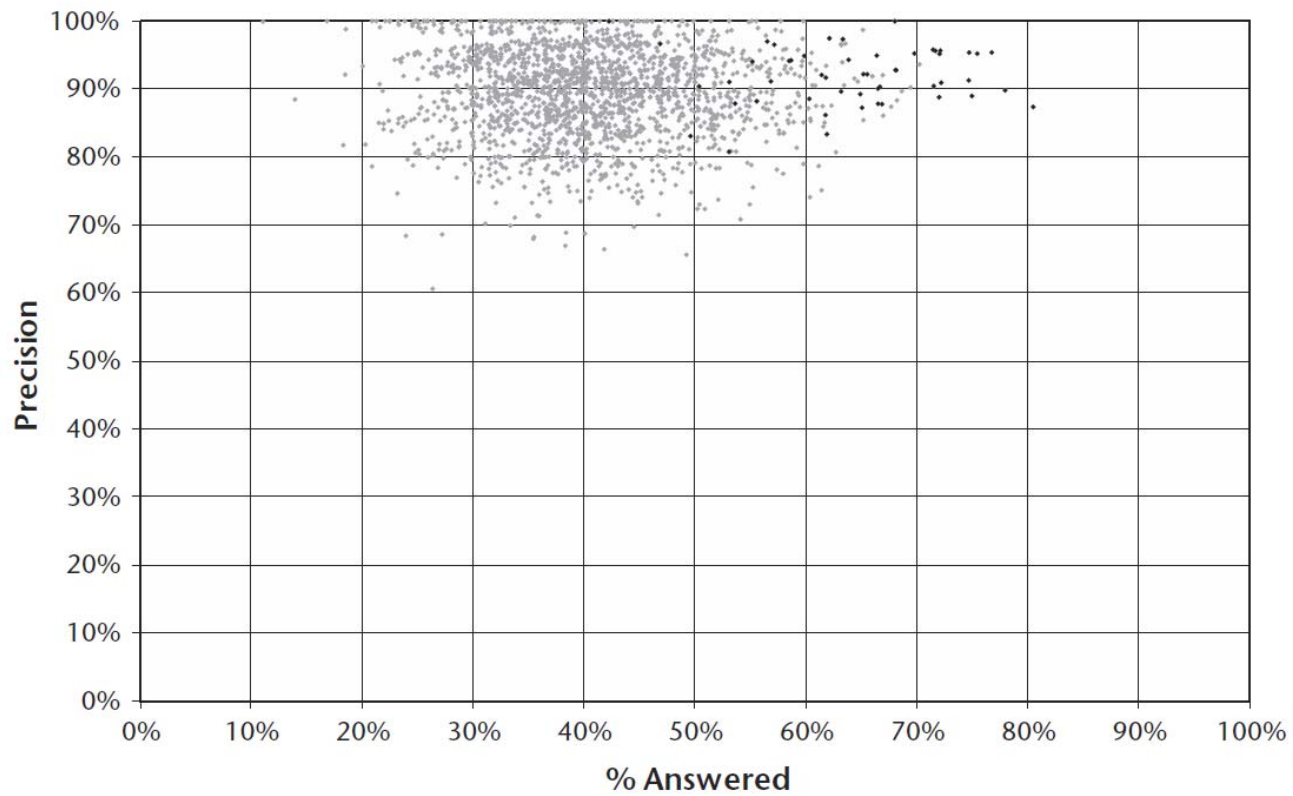


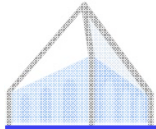
# Watson on TREC



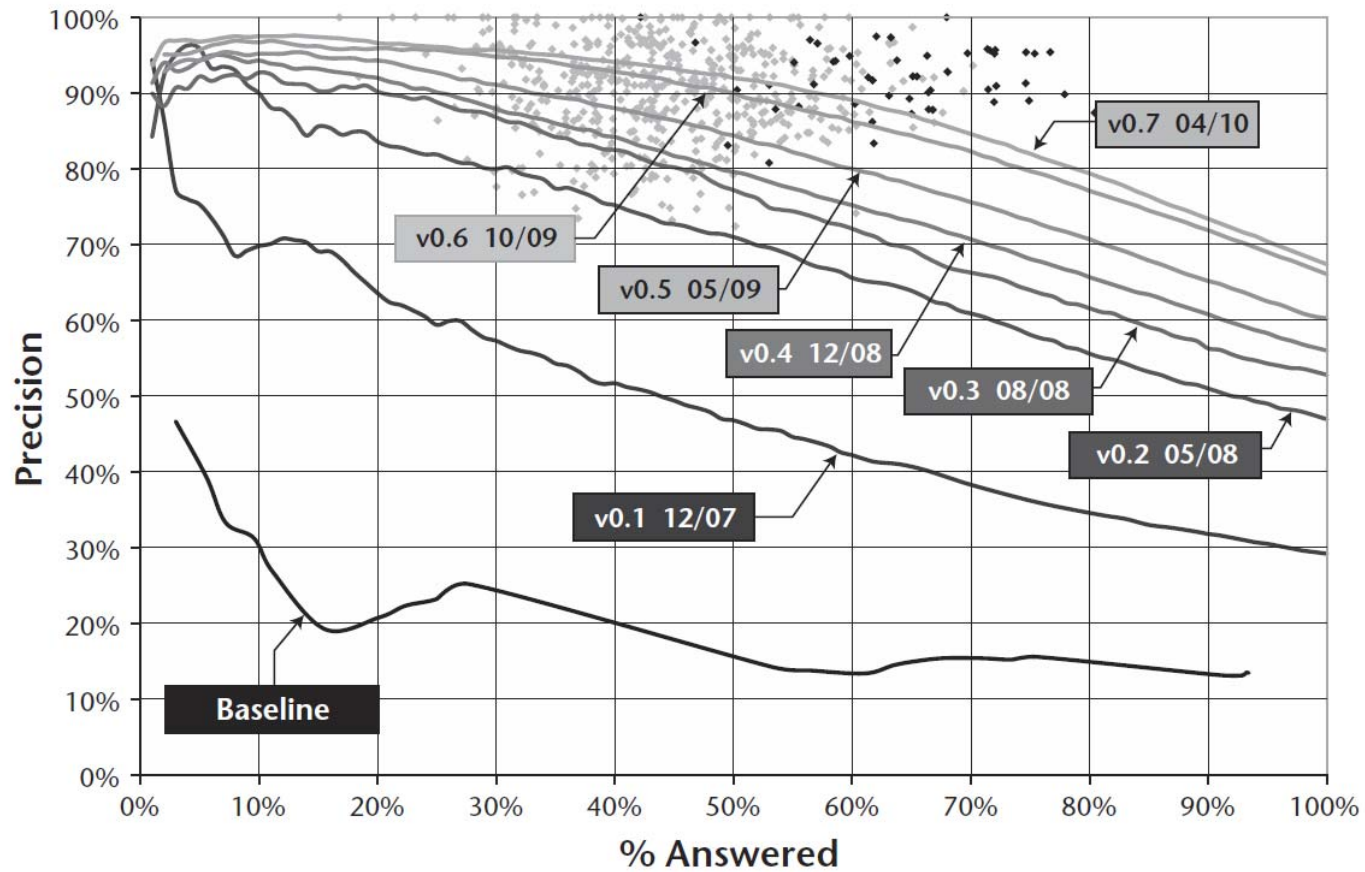


# Human P/R

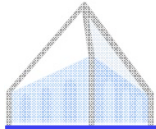




# Metric Climbing



# Complex QA



# Example of Complex Questions

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*How have thefts impacted on the safety of Russia's nuclear navy, and has the theft problem been increased or reduced over time?*

Need of domain knowledge

*To what degree do different thefts put nuclear or radioactive materials at risk?*

Question decomposition

Definition questions:

- *What is meant by nuclear navy?*
- *What does 'impact' mean?*
- *How does one define the increase or decrease of a problem?*

Factoid questions:

- *What is the number of thefts that are likely to be reported?*
- *What sort of items have been stolen?*

Alternative questions:

- *What is meant by Russia? Only Russia, or also former Soviet facilities in non-Russian republics?*