Trained Trigger Language Model for Sentence Retrieval in Question Answering Systems

Saeedeh Momtazi

Spoken Language Systems

Saarland University

saeedeh.momtazi@lsv.uni-saarland.de

Research Advisor: Dietrich Klakow

PIRE

Outline

❖ Question Answering System

❑ Language Models for Information Retrieval

❑ Trained Triggering Model

❑ Results

❑ Summary

Who is Warren Moon's agent? [Search]

Booking Warren Moon Appearances, Contact Warren Moon Agent ...
Call 1-888-246-7141 to Contact **Warren Moon Agent** for Booking **Warren Moon** for corporate appearances, **Warren Moon** speaking engagements, **Warren Moon** ...
www.athletepromotions.com/.../**Warren-Moon**-appearance-booking-**agent**.php -
Cached - Similar -

Warren Moon Speaker, Warren Moon Appearance, Warren Moon ...
Whether you are looking for a **Warren Moon** speaker event, **Warren Moon** appearance, or **Warren Moon** endorsement, TSE Speakers will help you book **Warren Moon** and ...
athletes-celebrities.tseworld.com/sports/.../**warren-moon**.php - Cached - Similar -

Warren Moon Speaker Warren Moon Booking Agent Warren Moon Appearance
Call 1.800.966.1380 for **Warren Moon** speaker, **Warren Moon agent** and appearance info. Find out how to hire or book **Warren Moon** and how to contact **Warren Moon** ...
www.playingfieldpromotions.com/**Warren-Moon**.php - Cached - Similar -

What league did Warren Moon join? | Smart QandA: Answers and facts ...
Newspaper article from: Seattle Post-Intelligencer (Seattle, WA) ...preseason opener, **Warren Moon** was waiting to greet...Leigh Steinberg, **Moon's agent**, ...
qanda.encyclopedia.com/.../league-did-**warren-moon**-join-211812.html -
Cached - Similar -

Warren Moon: Biography from Answers.com
Warren Moon football player Personal Information Born Harold **Warren Moon**, November 18, ... situation," **Moon's agent**, Leigh Steinberg, told the Houston Post. ...
www.answers.com/topic/**warren-moon** - Cached - Similar -

Warren Moon Collectible - Find Warren Moon Collectible items for ...
After playing two seasons in the Pacific Northwest, **Moon** signed as a free **agent** with the Kansas City Chiefs in 1999. **Warren Moon** retired in the January 2001 ...
popular.ebay.com/ns/Sports.../**Warren-Moon**-Collectible.html - Cached - Similar -

Seattle Seahawks Warren Moon Page
July 22, 1998 - **Warren Moon's agent** went on the offensive after another day of terse contract negotiations Tuesday, accusing the Seattle Seahawks of ...
www.beckys-place.net/**moon**.html - Cached - Similar -

Press Release: A New Moon, A New Genre and a New Digital Diva ...
SAN DIEGO -- Free-**agent** quarterback **Warren Moon** will decide by no later than today whether to continue his career with the San Diego Chargers or the Seattle ...
www.highbeam.com/doc/1G1-118023053.html - Cached - Similar -

Search Results - Local Search
Whitsitt has entered the **Warren Moon** talks. Whitsitt spoke over the phone with **Moon's agent**, Leigh Steinberg, late last week after Steinberg...impasse over ...
search.nwsource.com/search?from=ST&searchtype=ST... - Cached - Similar -

SurfWax: News, Reviews and Articles On Warren Moon
Clarkson also assembled an impressive collection of teachers for the camp, including Joe Montana, Matt Leinart, **Warren Moon** and **agent** Leigh Steinberg, ...
news.surfwax.com/sports/files/**Warren_Moon**.html - Cached - Similar -

3
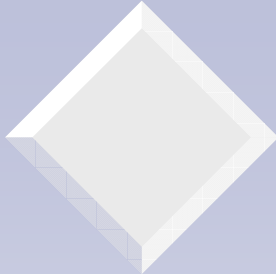
became easy to put Moon's face on the team's failure." Showing great restraint, Moon refused to acknowledge the heckling, and when the boos turned to cheers he accepted the praise without bitterness.

His tenacity was rewarded in 1977, when the Huskies won their conference championship and met the University of Michigan in the 1978 Rose Bowl game. The underdog Huskies won the Rose Bowl under Moon's leadership, and he was named Rose Bowl Most Valuable Player and the Pacific-8 Player of the Year. Overall, Moon passed for 3,277 yards and 19 touchdowns in his collegiate career.

Although Moon managed to win over Washington's fans, he failed to convince skeptical NFL scouts of his playing ability. His Rose Bowl performance notwithstanding, he was rated just the tenth best quarterback in the 1978 draft. "The stereotype was that he was a black quarterback and he was going to run around like a madman, but he wouldn't be able to throw very well," former Edmonton Eskimos and Houston Oilers coach Hugh Campbell told the *Los Angeles Times*. So, once again, Moon decided to prove himself elsewhere, signing with the Eskimos of the Canadian Football League.

During Moon's six seasons in Canada, he put up some stunning numbers--21,228 yards passing and 1,700 yards rushing. He had back-to-back 5,000-yard passing seasons. His 5,648 yards passing over 16 games in 1983 remains an all-time high for pro football. In addition, the Eskimos won five straight Grey Cup trophies as champions of the CFL from 1978 to 1982.

By 1984 Moon had nothing left to prove. When his contract with Edmonton expired, seven NFL teams sought to sign him as a free agent. Moon initially leaned toward the Seattle Seahawks, which would allow him to return to his college town, but he eventually chose the Houston Oilers, the team that had hired his former Edmonton coach, Campbell. The Oilers tendered a five-year, $5.5 million contract which, at the time, made Moon the highest paid player in the NFL--before he even played in a league game.

When Moon joined Houston, it was the sorriest franchise in the NFL, having won only three games in the previous two seasons. "One of the challenges of Houston was to be part of a growing situation," Moon's agent, Leigh Steinberg, told the *Houston Post*. "He knew it would take longer [to be on a championship team], but when it came, he knew he would be an instrumental part of the building process."

In 1984 Moon was a rookie sensation. His six years in the CFL gave him a wealth of experience, and he threw for a then-Houston-record 3,338 yards on the season. Still the Oilers went 3-13, finishing last in their division. The next season, after the club won just five of its first 14 games, Campbell was fired and a defensive-oriented coach, Jerry Glanville, took over. "Those early years [in Houston] were really hard for me to deal with at first," Moon told the *St. Louis Post-Dispatch*. "There were some uncertainties about my career here because of the coaching change. That left me disenchanted.... Plus, I think most of the people looked at the amount of money I was paid and just decided I must be a star all of a sudden. I didn't respond well to it."
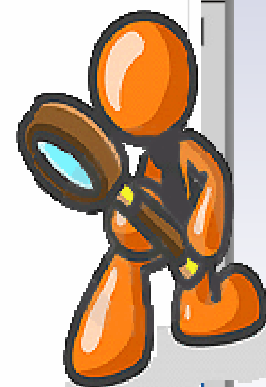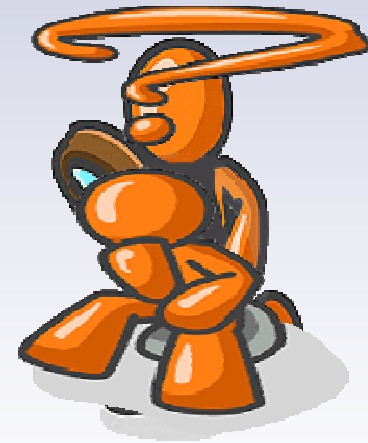
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Who is Warren Moon's agent? | Answer
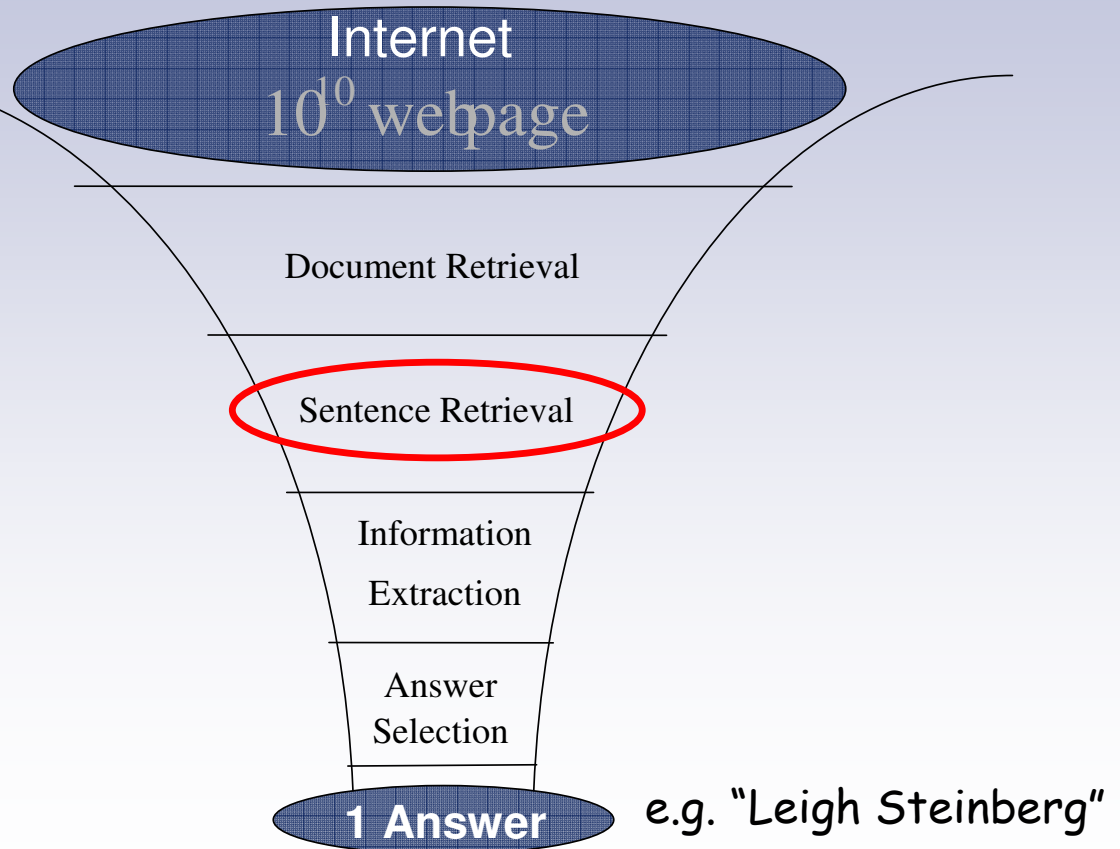
SHORT ANSWERS

Answers 1-5

- AGENT LEIGH STEINBERG
- MANNY RAMIREZ WILL CLARK STEVE
- QUARTERBACK WARREN
- CLARK STEVE YOUNG
- YOUNG WARREN

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What is Question Answering?

Goal:
answer questions like "Who is Warren Moon's Agent?"

Internet
10^0 webpage

Document Retrieval

Sentence Retrieval

Information Extraction

Answer Selection

1 Answer

e.g. "Leigh Steinberg"

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Sentence Retrieval

❑Task:

    ❑Finding a small segment of text that contains the answer

      [Corrada-Emmanuel, Croft, & Murdock, 2003]

❑Benefits beyond document retrieval:

    ❑Documents are very large

    ❑Documents span different subject areas

    ❑The relevant information is expressed much more locally

    ❑Retrieving the sentences simplifies the next step: information extraction

Outline

✓ Question Answering System

❖ Language Models for Information Retrieval

❑ Trained Triggering Model

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❑ Summary
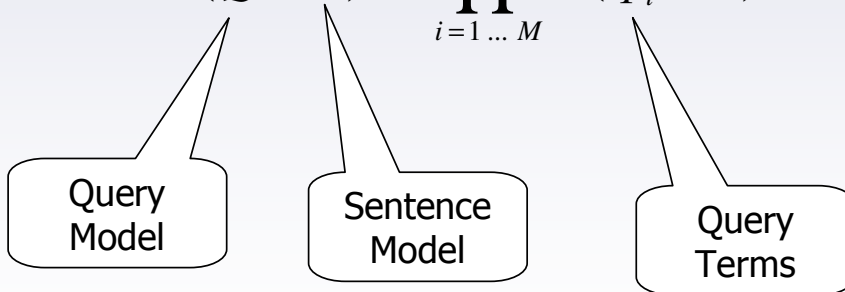
Language Models for IR

Query
Q

$P(Q|S_2)$

S_1 S_7

S_3

S_6

S_2 S_4

S_5
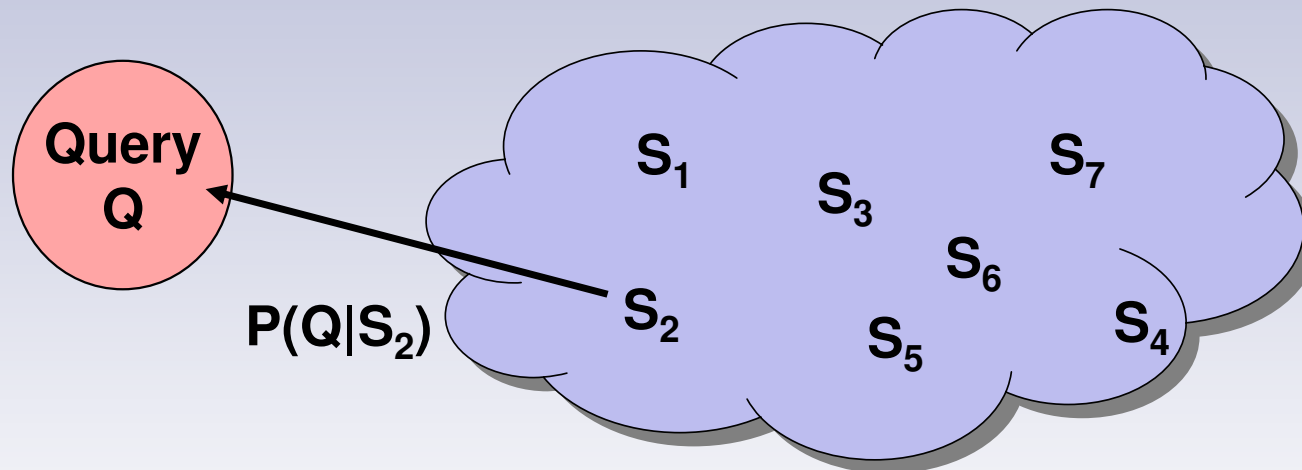
- *$P(Q|S_i)$*: language model trained on *S_i*
- Ranking sentences in descending order of this probability

Query Likelihood Model

❑ Unigram language model of sentences and queries

[Song & Croft, 1999]

$$P(Q \mid S) = \prod_{i=1 \dots M} P(q_i \mid S)$$

Query Model

Sentence Model

Query Terms

Maximum Likelihood Estimation

$$P(Q \mid S) = \prod_{i=1\ldots M} P(q_i \mid S)$$

❑ A separate language model is trained for each sentence in the search space

❑ The probability is calculated based on the frequency of query term in the sentence

$$P(q_i \mid S) = \frac{f_S(q_i)}{\displaystyle\sum_w f_S(w)}$$

Example

❑Question:

> Who invented the automobile?

❑Answers:

> An automobile powered by his own engine was invented by Karl Benz in 1885 and granted a patent.

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Example

❑Question:

Who *invented* the *automobile*?

❑Answers:

An *automobile* powered by his own engine was *invented* by Karl Benz in 1885 and granted a patent.

Nicolas Joseph Cugnot invented the first self propelled mechanical vehicle.

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Example

❑ Question:

> Who *invented* the *automobile*?

❑ Answers:

An *automobile* powered by his own engine was *invented* by Karl Benz in 1885 and granted a patent. ✔

Thomas Edison *invented* the first commercially practical light. ✖

Nic... *inv...* pr... ve...

Alexander Graham Bell of Scotland is the *inventor* of the first practical telephone. ✖

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Trained Trigger Model

$$P(Q \mid S) = \prod_{i=1\ldots M} P(q_i \mid S)$$

❑ A unique model is trained on a large corpus firstly, then it is being used for all of the sentences to be retrieved

❑ The trained model is represented by a set of triples:

$$< w, w', f_C(w, w') >$$

❑ $f_C(w, w')$ is the number of times the word w triggers the target word w'.
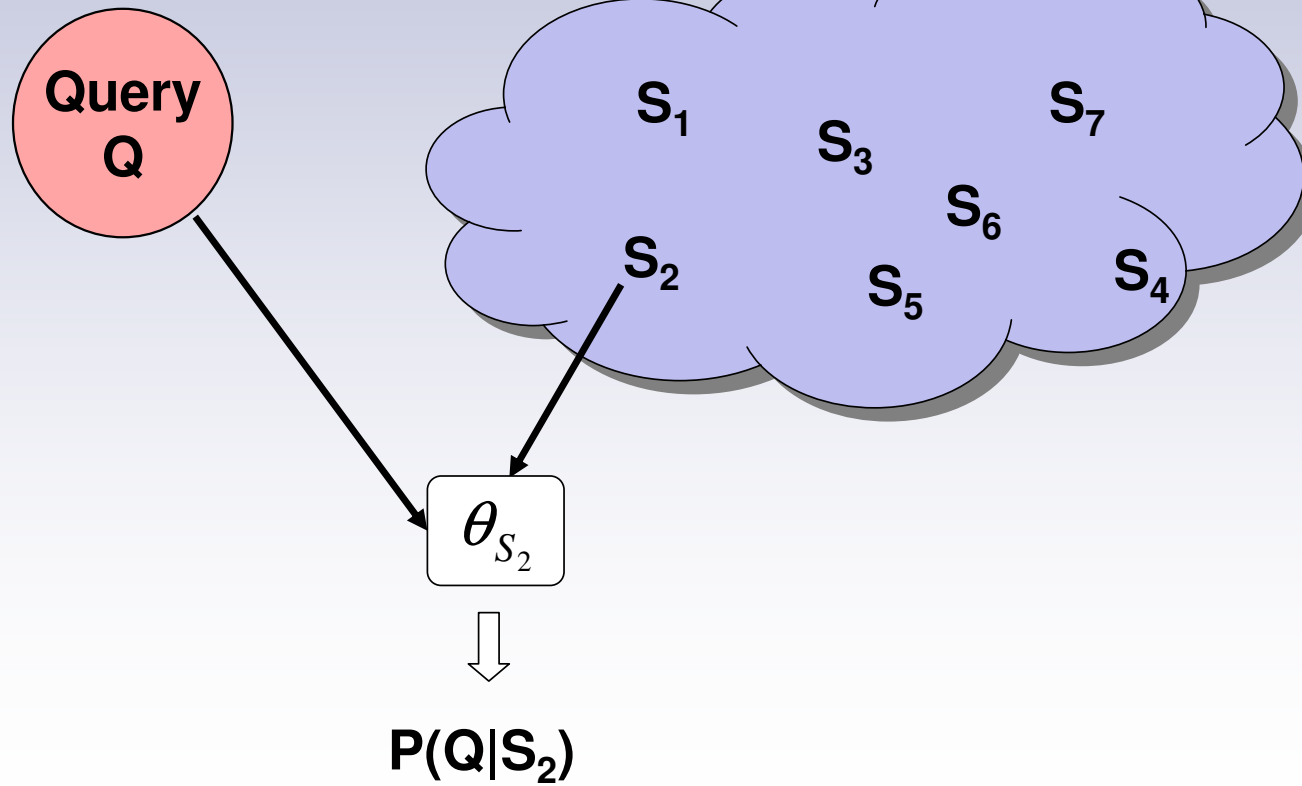
Trained Trigger Model

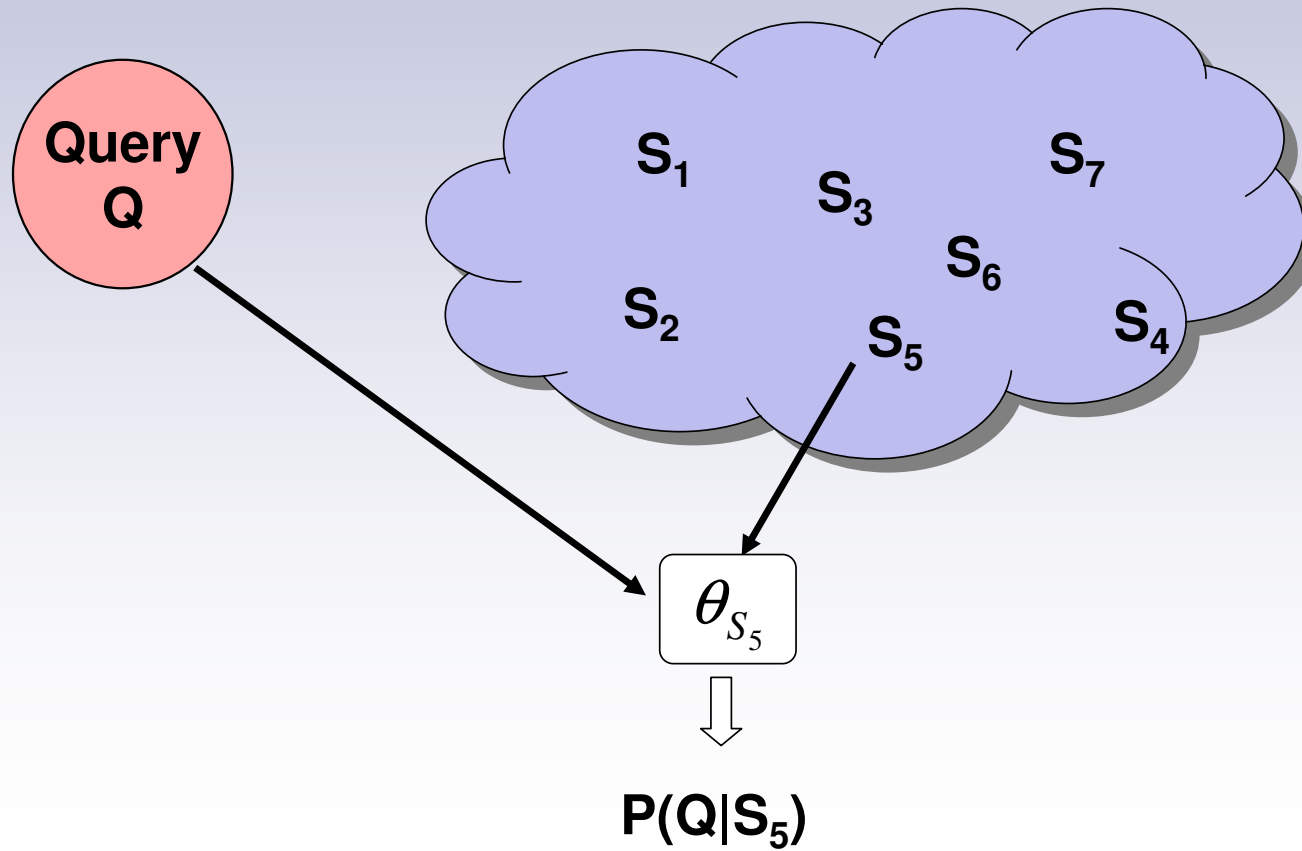$$P(Q \mid S) = \prod_{i=1 \dots M} P(q_i \mid S)$$

❑ Triggering Model:

$$P(q_i \mid s_j) = \frac{f_C(q_i, s_j)}{\sum_{q_i} f_C(q_i, s_j)}$$

$$P(q_i \mid S) = \frac{1}{N} \sum_{j=1 \dots N} P(q_i \mid s_j)$$

Word Unigram Model

Query Q

S_1 S_7
S_3
S_6
S_2 S_5 S_4

θ_{S_2}

P(Q|S$_2$)

Word Unigram Model

Query Q

S_1 S_7

S_3

S_6

S_2 S_5 S_4

θ_{S_5}

$P(Q|S_5)$

Triggering Model

Query Q

S_1 S_3 S_7

S_6

S_2 S_5 S_4

θ_C

Corpus C

$P(Q|S_2)$

Triggering Model

Query Q

S_1 S_3 S_7

S_6

S_2 S_5 S_4

θ_C

Corpus C

$P(Q|S_5)$

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Word Unigram Model

Query Q

S_1 S_7
S_3
S_6
S_2 S_4
S_5

n-gram

$P(Q|S_2)$
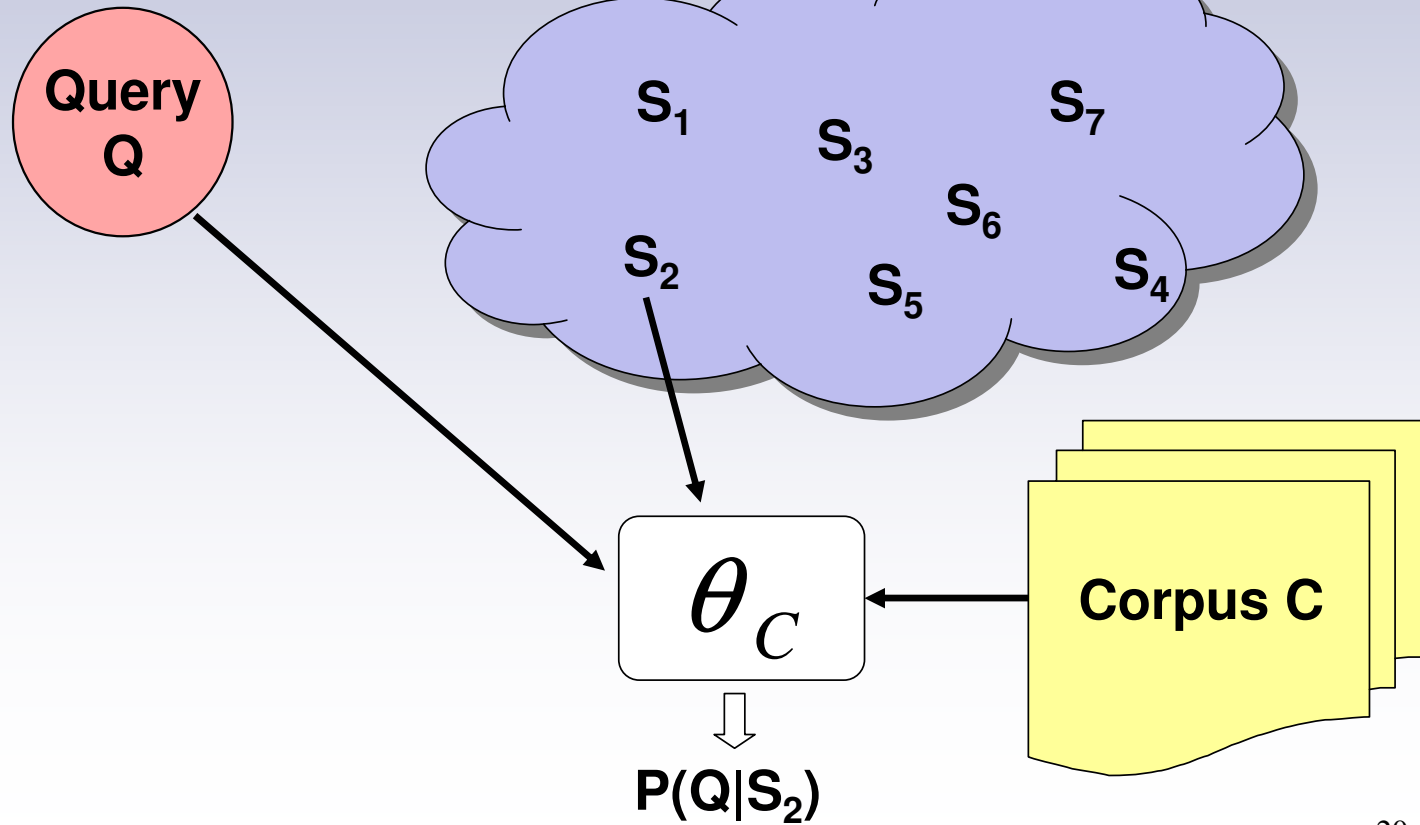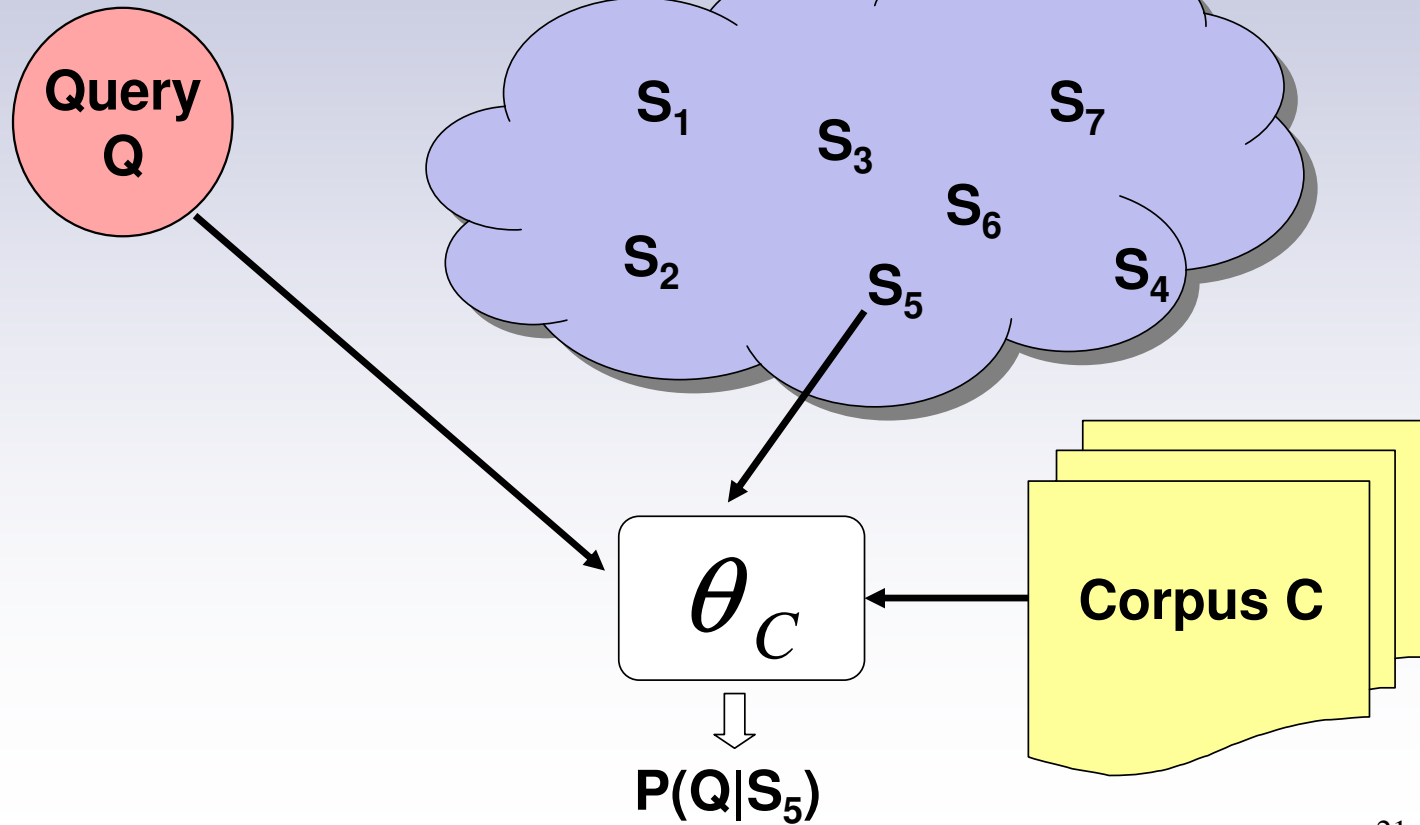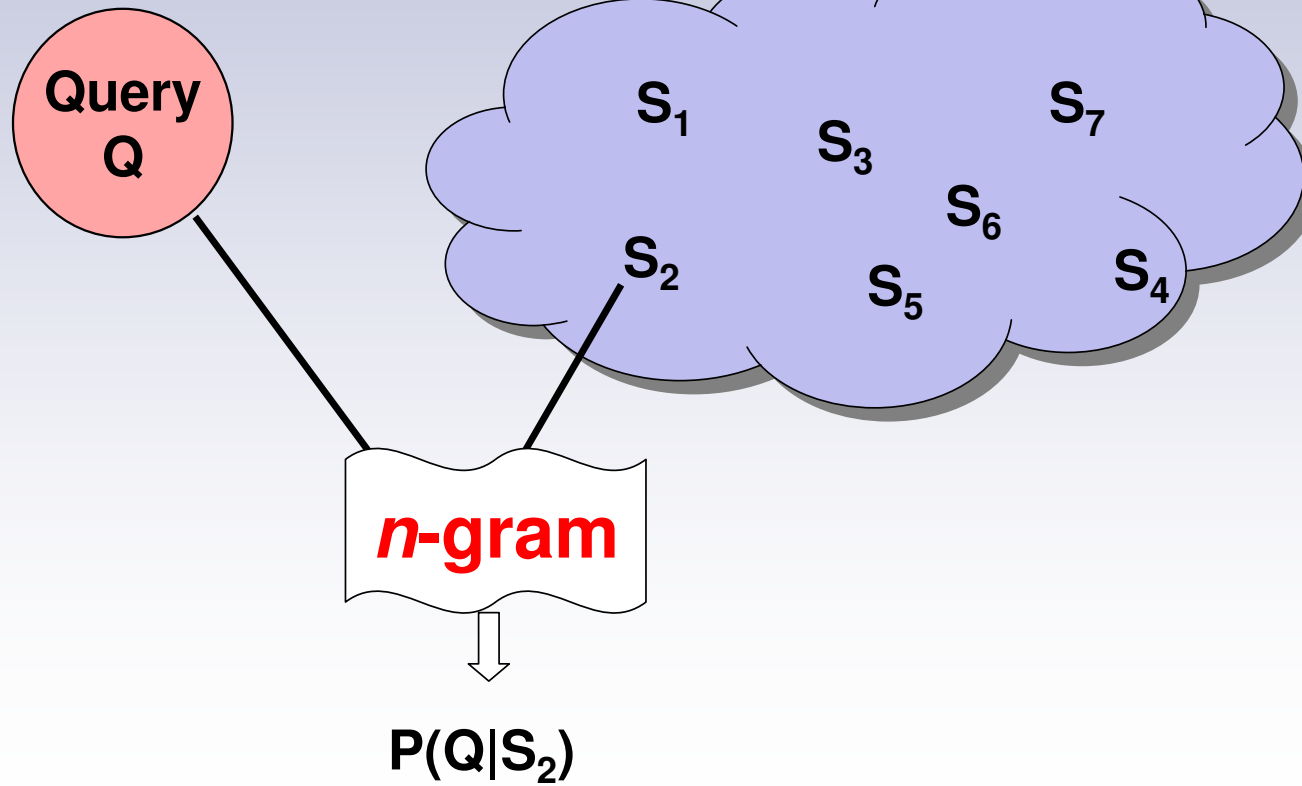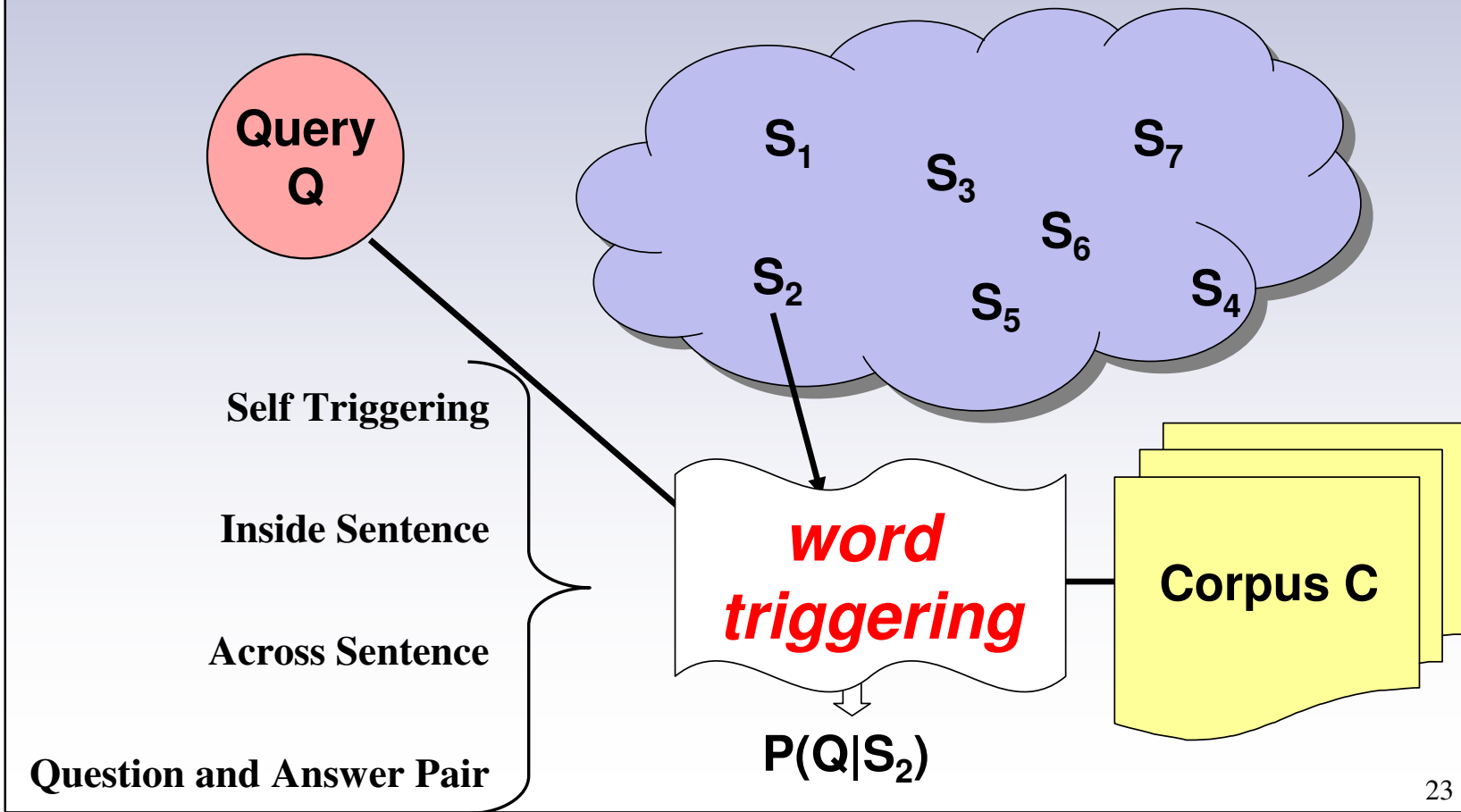
Self Triggering

❑ Each word can only trigger itself

❑ Works similar to the basic bag-of-words model

❑ The words that appeared in both the query and the sentence have the higher priority

❑ It is an essential part of a retrieval engine and have to be used beside any other triggering models

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Inside Sentence Triggering

❑ Idea: there is a relation between words appear in the same sentences

❑ Considers that each word in a sentence triggers all other words in the same sentence

❑ Uses a large unannotated corpus for training

❑ The sentence retrieval can retrieve sentences which do not share many terms with the query, but their terms frequently co-occur with query terms in the same sentences of the training corpus.

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Inside Sentence Triggering

"The word **automobile** meaning a **vehicle** that moves itself."

"An **automobile** includes at least two seats located one behind the other and attachable to a **vehicle** floor."

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Across Sentence Triggering

❑ Idea: two adjacent sentences mostly talk about the same topic by using different words with the same concept and meaning

❑ Considers that each word of a sentence triggers all of the words of the next sentence in the training corpus

❑ Uses a large unannotated corpus for trainings

❑ Uses a wider context than inside sentence triggering

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Example

❏ Question:

> Where was the first McDonald's built?

❏ Answers:

> Two brothers from
> Manchester, Dick and Mac
> McDonald, open the first
> McDonald's in California.

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Example

❑Question:

> Where was the *first McDonald's* built?

❑Answers:

> Two brothers from Manchester, Dick and Mac McDonald, open the *first McDonald's* in California. ✓

> The site of the *first McDonald's* to be franchised by Ray Kroc is now a museum in Des Plaines, Illinois. ✗

> The *first McDonald's* TV commercial was a pretty low-budget affair. ✗

Example

❑Question:

> Where was the *first McDonald's built*?

❑Answers:

Two brothers from Manchester, Dick and Mac McDonald, open the *first McDonald's* in California. ✔

The site of the *first McDonald's* to be franchised by Ray Kroc is now a museum in Des Plaines, Illinois. ✖

The *first McDonald's* TV commercial was a pretty low-budget affair. ✖

Across Sentence Triggering

"The structure of Eiffel Tower was **built** between 1887 and 1889 as the entrance arch for the Exposition Universelle, a World's Fair marking the centennial celebration of the French Revolution."

"The tower was inaugurated on 31 March 1889, and **opened** on 6 May."

"Wembley Stadium was **built** by Australian company Brookfield Multiplex."

"The stadium was scheduled to **open** on 13 May 2006."

Question and Answer Pair Triggering

❑ Idea: there is a relation between words appear in a pair of question and answer sentence

❑ Considers that each word in the question triggers all words in its answer sentence

❑ Requires a supervised training

❑ Uses a question-answer sentence corpus for training

Example

❑Question:

How high is Everest?

❑Answers:

Everest is
29,029 feet. ✔

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Example

❑Question:

> How high is *Everest*?

❑Answers:

Everest is 29,029 feet. ✔

Everest is located in Nepal. ✖

Everest has two main climbing routes. ✖

Example

❑Question:

How *high* is *Everest*?

❑Answers:

Everest is
29,029 feet.

Everest is
located in Nepal.

Everest has two main
climbing routes.

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Question and Answer Pair Triggering

Q: "How **high** is Pikes peak?"
A: "Pikes peak, Colorado At 14,110 **feet**, altitude sickness is a consideration when driving up this mountain."

Q: "How **high** is Mount Hood?"
A: "Mount Hood is in the Cascade Mountain range and is 11,245 **feet**."

Outline

✓ Question Answering System

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❑ Summary

Corpora

❑ Inside Sentence

❑ Across Sentence

❑ Question and Answer Pair

AQUAINT1 Corpus

- Consists of Engish newswire text, extracted from:
  - the Xinhua (XIN)
  - the New York Times (NYT)
  - the Associated Press Worldstream (APW)
- Contains
  - almost 450 million word tokens
  - as 23 million sentences
  - as 1.5 million documents.

QASP corpus

- Consists of TREC QA track
  - from 2002 to 2004
  - 985 questions
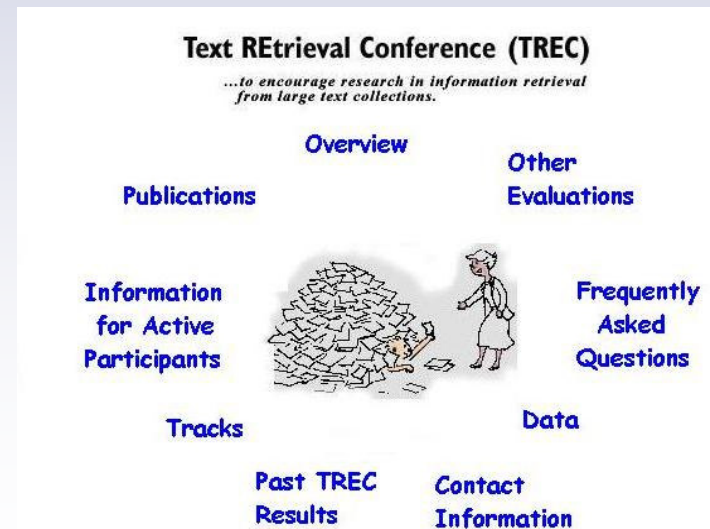- Prepared via Amazon MTurk

Yahoo! Answers Corpus

- derived from http://answers.yahoo.com/
- collected in 10/25/2007
- containing 4,483,032 questions

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Experiments

❑ TREC data set
  ❑ Development set: TREC05 (316 questions)
  ❑ Test set: TREC06 (365 questions)

❑ Judgment
  ❑ QASP Corpus
  ❑ Prepared via Amazon MTurk

❑ Evaluation Metrics
  ❑ Mean Average Precision
  ❑ Precision@5
  ❑ Mean Reciprocal Rank

Text REtrieval Conference (TREC)

...to encourage research in information retrieval from large text collections.

Overview

Other Evaluations

Publications

Information for Active Participants

Frequently Asked Questions

Tracks

Data

Past TREC Results

Contact Information

Results

Model	MAP	MRR	P@5
Maximum Likelohood	0.3701	0.5047	0.2267
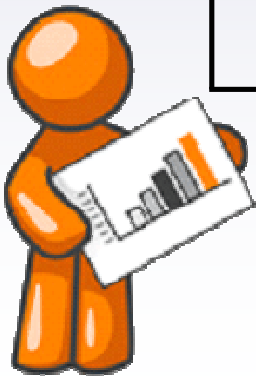
Results

Model	MAP	MRR	P@5
Maximum Likelohood	0.3701	0.5047	0.2267
Self TTLM	0.3806	0.5219	0.2349
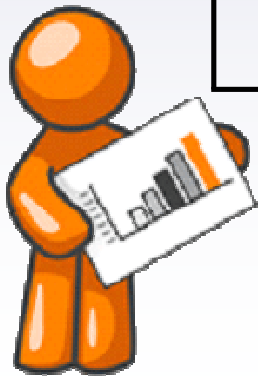
Results

Model	MAP	MRR	P@5
Maximum Likelohood	0.3701	0.5047	0.2267
Self TTLM	0.3806	0.5219	0.2349
Inside Sentence TTLM	0.1911	0.2585	0.1052
Across Sentence TTLM	0.2367	0.3047	0.1360
Question and Answer Pair TTLM (QASP)	0.2266	0.3263	0.1360
Question and Answer Pair TTLM (Yahoo)	0.0344	0.0415	0.0099

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Results (Linear Interpolation)

Model	Self Triggering			Maximum Likelihood		
	MAP	MRR	P@5	MAP	MRR	P@5
Baseline	0.3806	0.5219	0.2349	0.3701	0.5047	0.2267
+ Inside Sentence						
+ Across Sentence						
+ QA Pair (QASP)						
+ QA Pair (Yahoo)						

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Results (Linear Interpolation)

Model	Self Triggering			Maximum Likelihood		
	MAP	*MRR*	*P@5*	*MAP*	*MRR*	*P@5*
Baseline	0.3806	0.5219	0.2349	0.3701	0.5047	0.2267
+ Inside Sentence	0.4314	0.5469	0.2628	0.4351	0.5572	0.2587
+ Across Sentence	0.4274	0.5480	0.2593	0.4381	0.5631	0.2605
+ QA Pair (QASP)	0.4204	0.5408	0.2663	0.4208	0.5492	0.2622
+ QA Pair (Yahoo)	0.4358	0.5618	0.2645	0.4371	0.5654	0.2628

```
all the differences are statistically significant
at the level of p-value<0.01 based on t-tests.
```

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Results (Linear Interpolation)

Model	Self Triggering			Maximum Likelihood		
	MAP	*MRR*	*P@5*	*MAP*	*MRR*	*P@5*
Baseline	0.3806	0.5219	0.2349	0.3701	0.5047	0.2267
+ Inside Sentence	0.4314	0.5469	0.2628	0.4351	0.5572	0.2587
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+ QA Pair (Yahoo)	0.4358	0.5618	0.2645	0.4371	0.5654	0.2628

```
all the differences are statistically significant
at the level of p-value<0.01 based on t-tests.
```

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Results (Linear Interpolation)

Model	Self Triggering			Maximum Likelihood		
	MAP	MRR	P@5	MAP	MRR	P@5
Baseline	0.3806	0.5219	0.2349	0.3701	0.5047	0.2267
+ Inside Sentence	0.4314	0.5469	0.2628	0.4351	0.5572	0.2587
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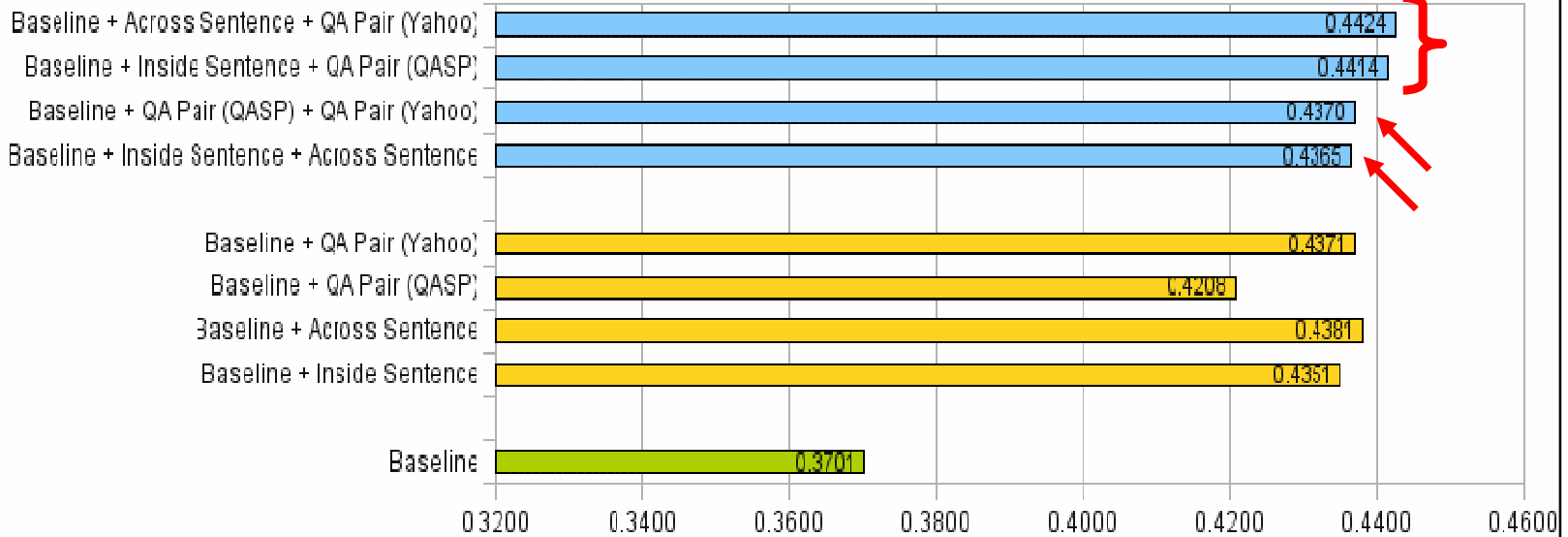
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Results (Linear Interpolation)

Model	Self Triggering			Maximum Likelihood		
	MAP	MRR	P@5	MAP	MRR	P@5
Baseline	0.3806	0.5219	0.2349	0.3701	0.5047	0.2267
+ Inside Sentence	0.4314	0.5469	0.2628	0.4351	0.5572	0.2587
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+ QA Pair (Yahoo)	0.4358	0.5618	0.2645	0.4371	0.5654	0.2628

```
all the differences are statistically significant
at the level of p-value<0.01 based on t-tests.
```

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Results (Linear Interpolation)

Outline

✓ Question Answering System

✓ Language Models for Information Retrieval

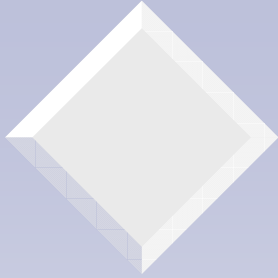✓ Trained Triggering Model

✓ Results

❖ Summary

Summary

❑ Introducing question answering systems
❑ The necessity of the sentence retrieval in a QA system
❑ Using language models for sentence retrieval
❑ Describing the current unigram model and its problems
❑ Proposing trained triggering model with different types:
    ❑ self
    ❑ inside sentence
    ❑ across sentence
    ❑ question and answer pair
❑ Linear interpolation of different models

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Thanks for your attention!