

# Question Answering/Semantic Parsing

CS 287

(Slides from Yoav Artzi)

## Question

It has become a popular strategy to handle sequential prediction problems using a seq2seq setup such as attention-based translation. How might you handle the following problems:

1. Segmentation (HW4)
2. Rare Word Replacement (HW3)
3. Part-of-Speech Tagging (HW2-HW5)

# Today's Lecture

## Question Answering

- ▶ Semantic Parsing: linguistic-model of questions and answers
- ▶ Knowledge Base and Dataset
- ▶ Watson and Jeopardy!

g show me flights from New  
York to LA departing on  
Thursday



## Flights from **New York, NY** (all airports) to **Los Angeles, CA (LAX)**

Depart

Thu, Jan 30

Return

Mon, Feb 3

### Nonstop only

- United from \$1,034
- Alaska from \$1,034
- American from \$1,034
- JetBlue from \$1,034
- Virgin America from \$1,034
- Delta from \$1,054

### All flights Nonstop and connecting

- Delta from \$488
- AirTran from \$682
- Other airlines from \$803



Web



Images



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Jeopardy!

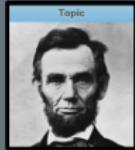
**Here's an example:**

We know that [William Shakespeare](#) wrote the play [Hamlet](#). We describe this in Freebase as such:

<b>William Shakespeare</b>	
<b>is a</b>	type <a href="#">Author</a>
<b>has a</b>	property <a href="#">Works Written</a>
<b>with a</b>	value <a href="#">Hamlet</a>

Important! Freebase is read-only and will be shut-down. [More...](#)

Created by book\_bot on 5/7/2009

Topic [Abraham Lincoln](#) enmid: /m/0gzh notable type: /government/us\_president notable for: /government/us\_president on the web: [Wikipedia.org](#) ↗

Abraham Lincoln was the 16th president of the United States, serving from March 1861 until his assassination in April 1865. Lincoln led the United States through its Civil War—its bloodiest war and its greatest moral, constitutional and political crisis. In doing so, he preserved the Union, abolished slavery, strengthened the federal government, and modernized the economy. Reared in a poor family on the western frontier, Lincoln was a self-educated lawyer in Illinois, a Whig Party leader, state legislator during the 1830s. Lincoln was elected to Congress in 1846, where he promoted rapid modernization of the economy through banks, tariffs, and railroads. He had originally agreed not to run for a second term and his opposition to the Mexican–American War was unpopular among the voters. He returned to Springfield and concentrated on his successful law practice throughout central Illinois. He returned to politics in 1854, and was a leader in building up the new Republican Party, which was had a statewide majority. After a series of highly publicized debates in 1858, during which Lincoln spoke out against the expansion of slavery, he lost the U.S. [−]

## Properties

## I18n

## Keys

## Links



View and edit specific domains, types, or properties...

Filter options:  Show all domains and properties

## Common /common

Freebase Commons

## Topic /common/topic

X

## Also known as /common/topic/alias

## Also known as

Honest Abe

Abe Lincoln

The Buffoon

Caesar

Father Abraham

The Flatboat Man

The Grand Wrestler

The Great Emancipator

The Illinois Baboon

The Jester

58 values total »

## Description /common/topic/description

Abraham Lincoln was the 16th president of the United States, serving from March 1861 until his assassination in April 1865. Lincoln led the United States through its Civil War—the bloodiest war and its greatest moral, constitutional and political crisis. In doing so, he preserved the Union, abolished slavery, strengthened the federal government, and modernized the economy. Reared in a poor family on the western frontier, Lincoln was a self-educated lawyer in Illinois, a Whig Party leader, state legislator during the 1830s. Lincoln was elected to Congress in 1846, where he promoted rapid modernization of the economy through banks, tariffs, and railroads. He

## ▼ Types:

## Common

## Topic

## Film

## Film story contributor

## Film subject

## Government

## US President

## Politician

## Political Appointee

## U.S. Congressperson

## Medicine

## Public figure with medical condition

## Military

## Military Person

## Military Commander

## Books

## Literature Subject



Item Discussion

Read View history

Search



# Abraham Lincoln (Q91)

16th President of the United States

Abe Lincoln | Lincoln | Honest Abe

▼ In more languages Configure

Language	Label	Description	Also known as
English	Abraham Lincoln	16th President of the United States	Abe Lincoln Lincoln Honest Abe
German	Abraham Lincoln	US-amerikanischer Präsident	
Spanish	Abraham Lincoln	decimosexto presidente de los Estados Unidos	
Traditional Chinese	亞伯拉罕·林肯	第16任美國總統	林肯

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  - [Query Service](#)
  - [Nearby](#)
  - [Help](#)
  - [Donate](#)
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- [Print/export](#)
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## Statements

<a href="#">family name</a>	<a href="#">Lincoln</a>	<small>0 references</small>
-----------------------------	-------------------------	-----------------------------

<a href="#">given name</a>	<a href="#">Abraham</a>	<small>0 references</small>
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<a href="#">manner of death</a>	<a href="#">homicide</a>	<small>0 references</small>
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## Geoquery (Zelle and Mooney, 1996)

a) What states border Texas

$$\lambda x. state(x) \wedge borders(x, \text{texas})$$

b) What is the largest state

$$\arg \max(\lambda x. state(x), \lambda x. size(x))$$

c) What states border the state that borders the most states

$$\begin{aligned} & \lambda x. state(x) \wedge borders(x, \arg \max(\lambda y. state(y), \\ & \quad \lambda y. count(\lambda z. state(z) \wedge borders(y, z)))) \end{aligned}$$

Figure 1: Examples of sentences with their logical forms.

## WebQuestions (Berant, 2013)

### Questions:

- ▶ what high school did president bill clinton attend?
- ▶ what form of government does russia have today?
- ▶ what movies does taylor lautner play in?

### Answers:

- ▶ Hot Springs High School  
[http://www.freebase.com/view/en/bill\\_clinton](http://www.freebase.com/view/en/bill_clinton)
- ▶ Constitutional republic  
<http://www.freebase.com/view/en/russia>
- ▶ Eclipse, Valentine's Day, The Twilight Saga: Breaking Dawn - Part 1, New Moon  
[http://www.freebase.com/view/en/taylor\\_lautner](http://www.freebase.com/view/en/taylor_lautner)

## WebQuestions

*To collect this dataset, we used the Google Suggest API to obtain questions that begin with a whword and contain exactly one entity. We started with the question Where was Barack Obama born? and performed a breadth-first search over questions (nodes), using the Google Suggest API supplying the edges of the graph. Specifically, we queried the question excluding the entity, the phrase before the entity, or the phrase after it; each query generates 5 candidate questions, which are added to the queue. We iterated until 1M questions were visited; a random 100K were submitted to Amazon Mechanical Turk.*

## WebQuestions

*The AMT task requested that workers answer the question using only the Freebase page of the questions entity, or otherwise mark it as unanswerable by Freebase. The answer was restricted to be one of the possible entities, values, or list of entities on the page. As this list was long, we allowed the user to filter the list by typing. We paid the workers \$0.03 per question. Out of 100K questions, 6,642 were annotated identically by at least two AMT workers.*

<b>Dataset</b>	<b># examples</b>	<b># word types</b>
GeoQuery	880	279
ATIS	5,418	936
FREE917	917	2,036
WEBQUESTIONS	5,810	4,525

Table 3: Statistics on various semantic parsing datasets. Our new dataset, WEBQUESTIONS, is much larger than FREE917 and much more lexically diverse than ATIS.

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# DeepQA

- ▶ (not actually deep learning)

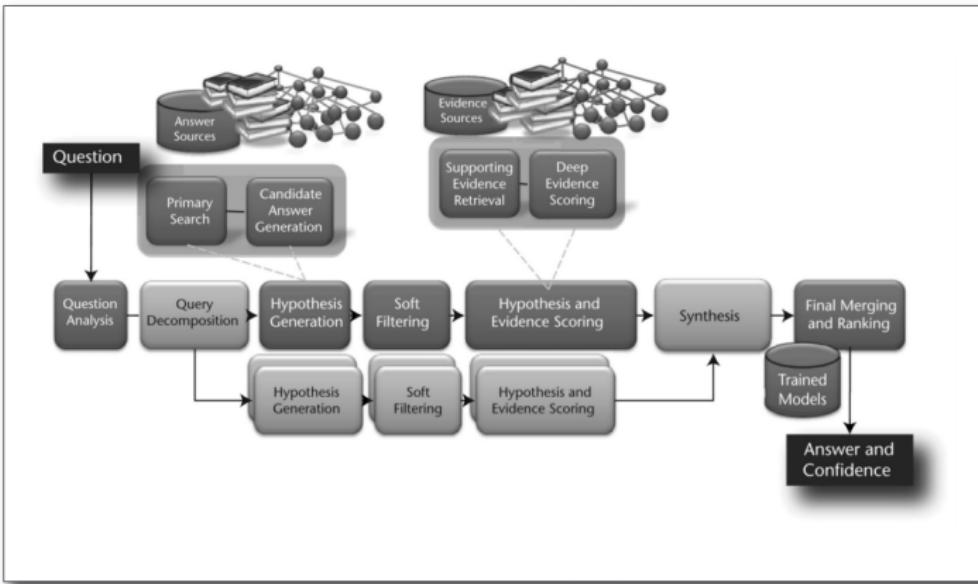


Figure 6. DeepQA High-Level Architecture.

# Candidate Generation

*This motivates an approach that merges answer scores before ranking and confidence estimation. Using an ensemble of matching, normalization, and coreference resolution algorithms, Watson identifies equivalent and related hypotheses (for example, Abraham Lincoln and Honest Abe) and then enables custom merging per feature to combine scores.*

*Given the kinds of questions and broad domain of the Jeopardy Challenge, the sources for Watson include a wide range of encyclopedias, dictionaries, thesauri, newswire articles, literary works, and so on.*

*A variety of search techniques are used, including the use of multiple text search engines with different underlying approaches (for example, Indri and Lucene), document search as well as passage search, knowledge base search using SPARQL on triple stores, the generation of multiple search queries for a single question, and backfilling hit lists to satisfy key constraints identified in the question.*

# Hypothesis Ranking

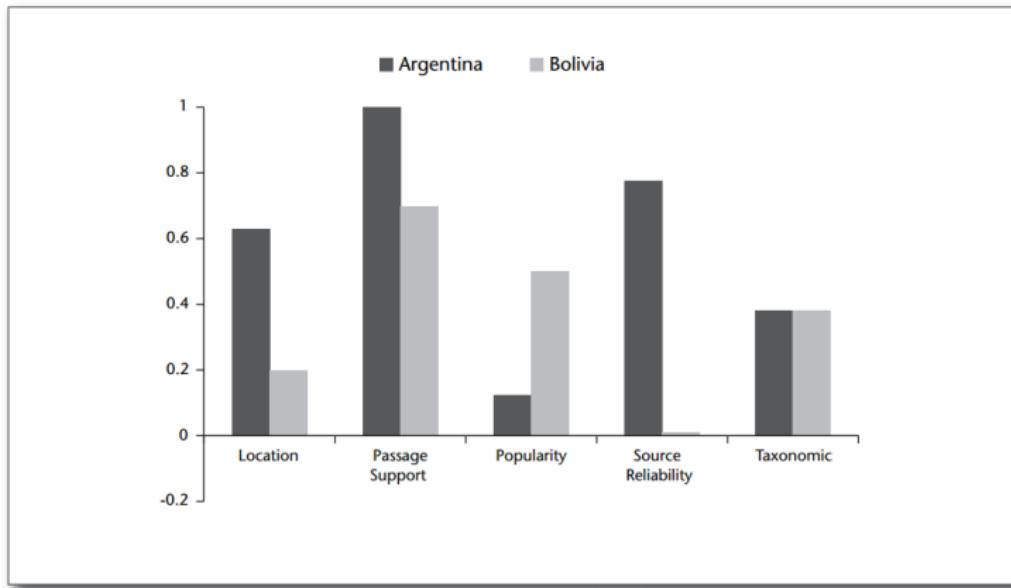


Figure 8. Evidence Profiles for Two Candidate Answers.  
Dimensions are on the x-axis and relative strength is on the y-axis.

## Other Aspects

- ▶ Parsing algorithm
- ▶ Inducing rules and parameters
- ▶ Relationship between syntax and semantics

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