Open Question Answering Over Curated and Extracted Knowledge Bases

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What is illegal in the US but legal in Mexico?

What is illegal in the US but legal in Mexico?

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About 198,000,000 results (0.68 seconds)

Illegal immigration to the **United States** - Wikipedia, the free ...
en.wikipedia.org/.../**Illegal**_immigration_to_the_**United_States** ▾ Wikipedia ▾
Jump to **Mexican** federal and state government assistance - [edit]. The **US** Department
of Homeland Security and some advocacy groups have criticized a ...

Gun politics in **Mexico** - Wikipedia, the free encyclopedia
en.wikipedia.org/wiki/Gun_politics_in_**Mexico** ▾ Wikipedia ▾
A common misconception is that firearms are **illegal** in **Mexico** and that no .... Decree
for the Liberty of **Mexican America** in Article 81 **prohibited** appearing at Vestry ....
outside the home (in public) was no longer a right **but** a privilege federal **law** ...

Immigration to the **United States** - Wikipedia, the free ...
en.wikipedia.org/wiki/Immigration_to_the_**United_States** ▾ Wikipedia ▾
Jump to **Illegal** immigration - The majority of the **illegal** immigrants are from **Mexico**. ...
"**But** we're also a nation of **laws**, that's part of our tradition," he ...

Question Answering

What is illegal in the US but legal in Mexico?

Find a concept x that satisfies:
x illegal in US
x legal in Mexico

x = Cuban cigars, absinthe

Previous Approaches to QA
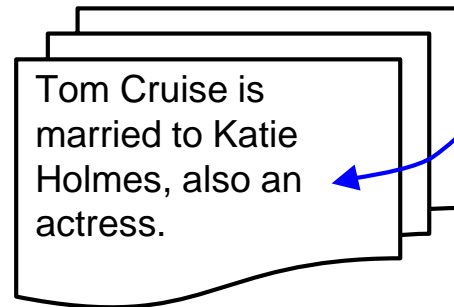
Semantic Parsing for QA

How many states have a higher point than the highest point of the state with the largest capital city in the US?

Zelle & Mooney, '96
Zettlemoyer & Collins, '05
Liang et al., '11

Answer Retrieval from Documents

Who is Tom Cruise married to?

Tom Cruise is married to Katie Holmes, also an actress.

Voorhees & Tice, '00
Ravichandran & Hovy '02

Open QA: The Best of Both Worlds

Open-Domain KBs

Knowing

is half the battle!

ProBase

Freebase
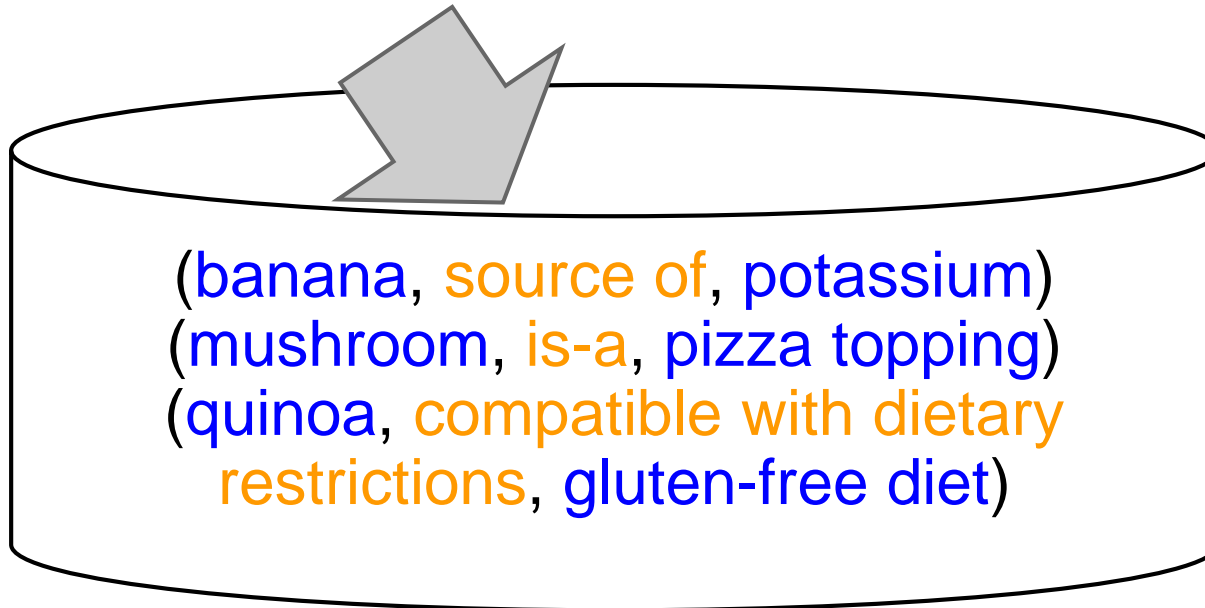
Open IE

NELL

Don't require:
   Normalization
   Canonicalization
   Ontologization

(banana, source of, potassium)
(mushroom, is-a, pizza topping)
(quinoa, compatible with dietary
   restrictions, gluten-free diet)

Knowledge Base Statistics

Source	Type	# Triples	# Relation Phrases
Freebase	Curated	300M	18K
Open IE	Extracted	500M	6M
Probase	Extracted	200M	1
NELL	Extracted	2M	300

OQA Contributions

- Combine extracted and curated KBs for QA
- Learn to interpret questions from KBs, question corpus, and QA pairs
- Empirical evaluation on multiple question sets

How can I tell if I have the flu?　　　(flu, symptoms, the chills)

Paraphrase

How can I tell if I have strep throat?
What are signs of strep throat?
Am I sick with strep throat?

Answers.com®

5 million paraphrase templates

What are signs of the flu?

Parse

(?, sign of, flu)

sign of → (cough, cold) (fever, strep) ...
symptoms⁻¹ → (cough, cold) (fever, strep) ...

75 million rewrite rules

Rewrite

(flu, symptoms, ?)　　　(?, causes, flu)

Execute

score(... → the chills) = 1.2
score(... → virus)　　　　　　=
-0.3

the chills　　　　　virus

Comparison to Sempre (Berant et al., 2013)
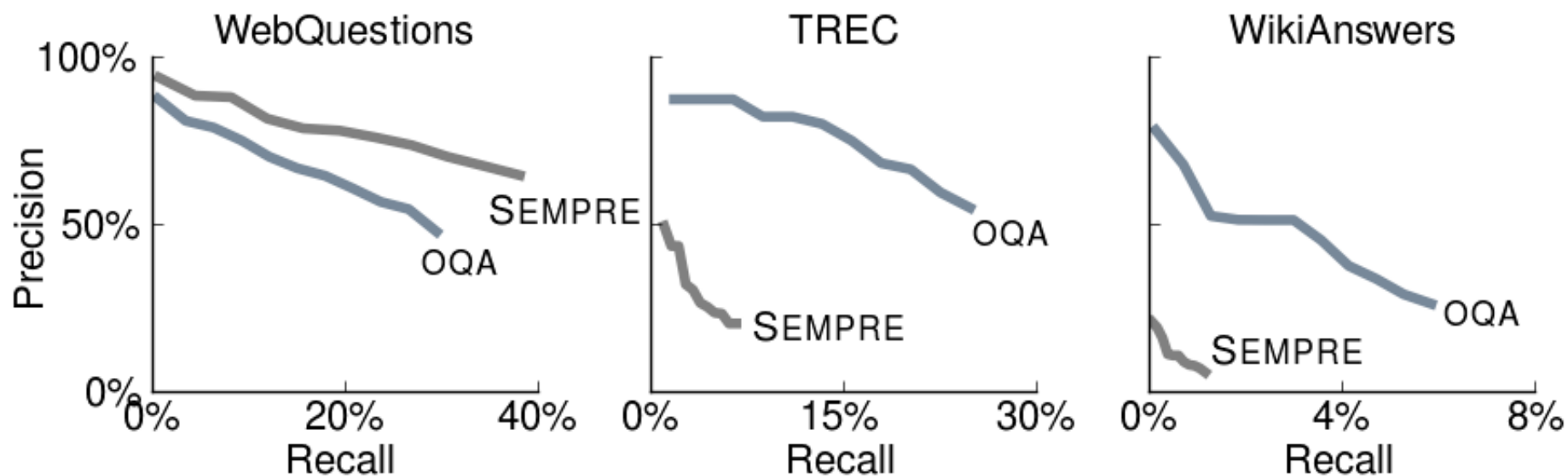
Effect of Knowledge Sources
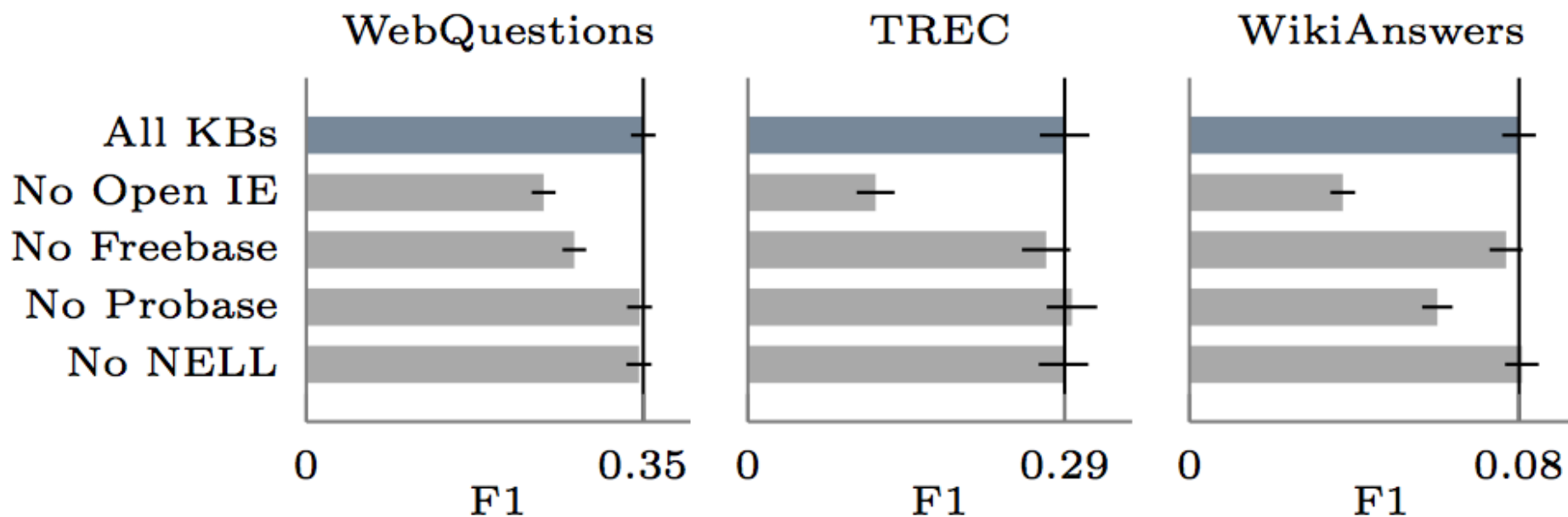
Future Work

Answerability

Compositional Analysis of Questions

Question-Guided Information Extraction

Conclusion - OQA

- Multiple knowledge sources

- Learns from KB, question corpus, QA pairs

- Has high performance across question sets

Thanks!

github.com/afader/oqa

Experiments

- How does OQA compare to state-of-the-art QA systems?
- How do different knowledge sources affect performance?
- How do different system components affect performance?

Question Sets

WebQuestions   Berant et al., 2013
where was nicki minaj born?

TREC   Vorhees and Tice, 2000
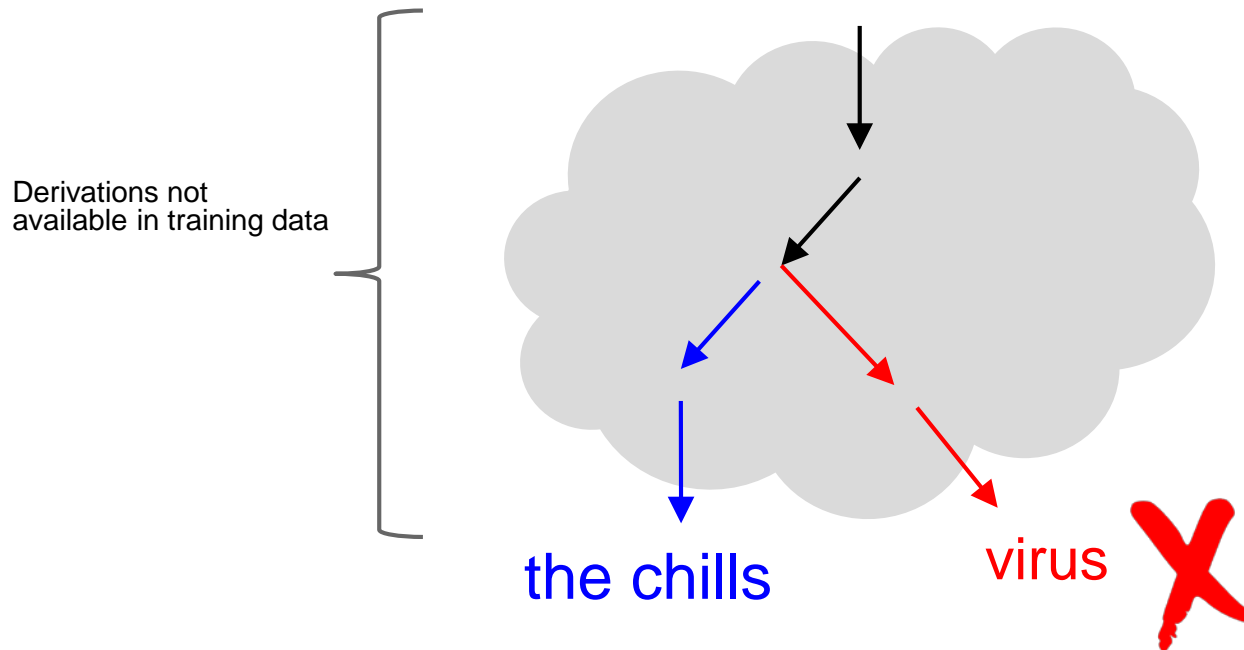What other countries do kurds live in ?

WikiAnswers   Held-out from corpus
Who is a retired gay nfl player?

Learning and Inference

Learning w/QA pairs: Clarke et al., '10, Berant et al., '13, Kwiatkowski et al., '13
Latent-Variable Structured Perceptron: Liang et al., 2006; Sun et al., 2009

How can I tell if I have the flu?

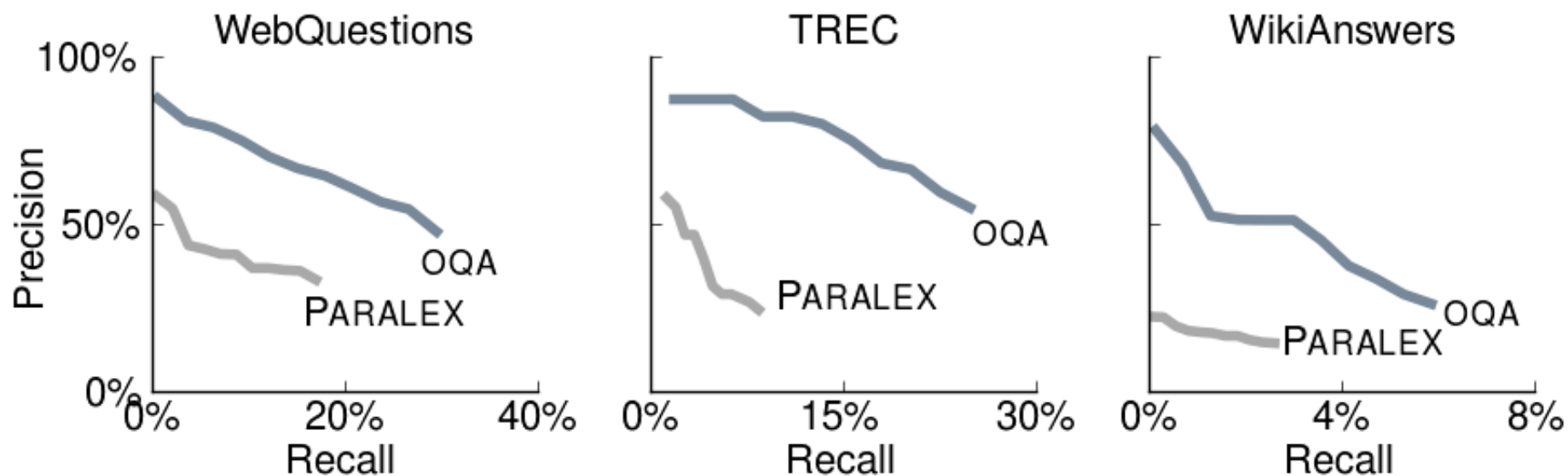Derivations not available in training data

the chills

virus ✗

$\mathbf{w} = \mathbf{w} + \mathbf{f}(\ldots \rightarrow \text{the chills}) - \mathbf{f}(\ldots \rightarrow \text{virus})$

Example Errors

Input	What animal represents California?
Paraphrase	What are California's symbols?
Parse	?x: (california, symbols, ?x)
Execute	**CWT:**
	(California Water Service, Trading symbol, CWT)

Input	What actor first portrayed James Bond?
Parse	?x: (?x, is-a, actor first)
	(?x, portrayed, James Bond)
Execute	**Daniel Craig:**
	(Daniel Craig, is-a, first class actor)
	(Danny Craig, portrays, James Bond)

Comparison to Paralex

Effect of System Components

WebQuestions | TREC | WikiAnswers

Full Model
No Weight Learning
No Paraphrases
No Query Rewrites

0 — 0.35 F1
0 — 0.29 F1
0 — 0.08 F1
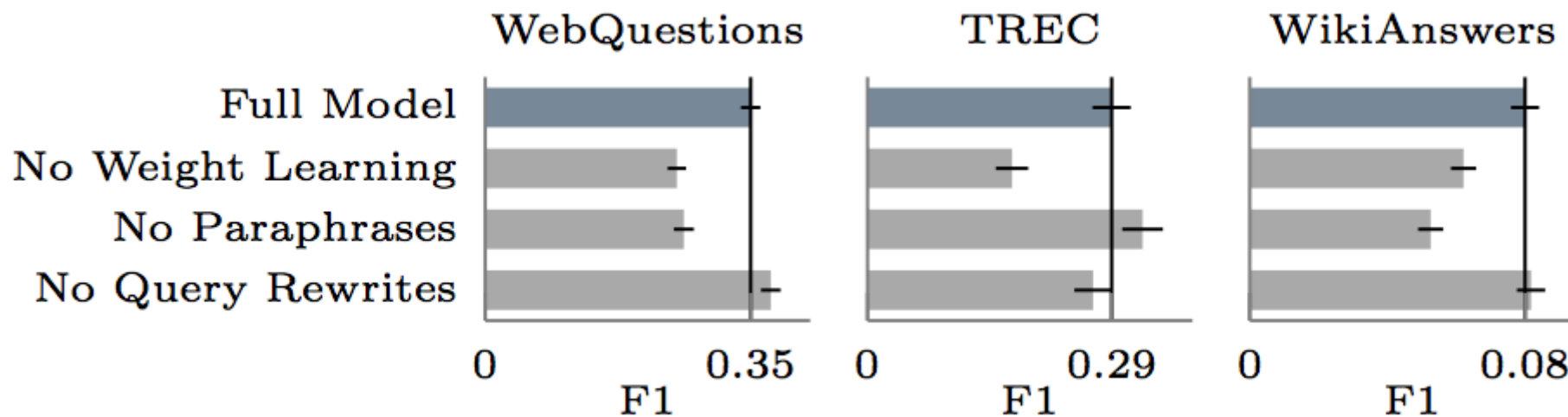
Mining Query Rewrite Operators

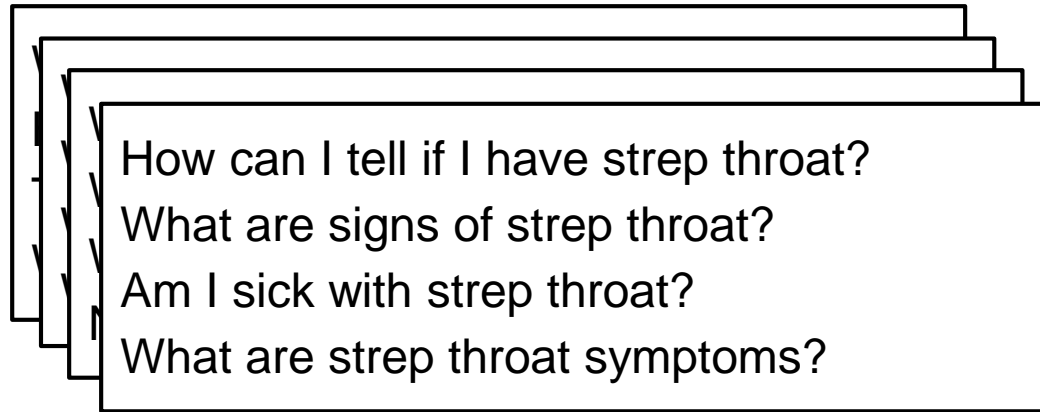| arg1 arg2	sign of	symptom^{-1}
cough cold	✓	✓
jealousy love	✓	
diziness Meniere's	✓	✓
chills flu		✓

74 million $\{r_1, r_2\}$ pairs with ≥ 10 shared arguments

DIRT (Lin and Pantel, 2001)

Cherry-Picked Rewrite Rules

Source Relation	Target Relation
(?x, children, ?y)	(?y, was born to, ?x)
(?x, birthdate, ?y)	(?x, date of birth, ?y)
(?x, headquartered in, ?y)	(?y, is based in, ?x)
(?x, invented, ?y)	(?y, was invented by, ?x)
(?x, is the language of, ?y)	(?y, languages spoken, ?x)

WikiAnswers Paraphrase Corpus

How can I tell if I have strep throat?
What are signs of strep throat?
Am I sick with strep throat?
What are strep throat symptoms?

20 million user-created clusters

Mining Paraphrase Templates

How can I tell if I have strep throat?
What are signs of strep throat?
Am I sick with strep throat?
What are strep throat symptoms?

t_1	t_2	count(t_1, t_2)	count(t_1)	count(t_2)
How can I tell if I have _	What are signs of _	8	21	45
How can I tell if I have _	Am I sick with _	11	21	52
How can I tell if I have strep _	What are signs of strep _	1	1	1

5 million $\{t_1, t_2\}$ pairs with count(t_1, t_2) ≥ 5

Cherry-Picked Paraphrase Templates

Template 1	Template 2
How does _ affect your body?	What body system does _ affect?
What is the latin name for _?	What is _'s scientific name?
Why do we use _?	What did _ replace?
What to use instead of _?	What is a substitute for _?
Was _ ever married?	Who has _ been married to?

Task

Input   =   Question

Output   =   Most confident answer (or none)

Precision =   correct / returned answers

Recall   =   correct / questions

Baseline Systems

Paralex (Fader et al., 2013)

    Learns from WikiAnswers corpus

    Lexicalized feature representation

    Queries all knowledge sources

Sempre (Berant et al., 2013)

    Learns from QA pairs

    Lexicalized feature representation

    Queries Freebase only