

HotpotQA: A Dataset for Diverse, Explainable Multi-hop Question Answering

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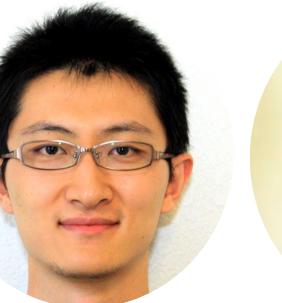
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3 Université de Montréal



4 CIFAR
CANADIAN INSTITUTE
for ADVANCED RESEARCH

5 Google AI

TriviaQA

NewsQA

QAngaroo

CNN/Daily Mail

Winograd Schema Challenge

RecipeQA

CliCR

Do we really need yet another QA dataset?

MS MARCO

RACE

ARC

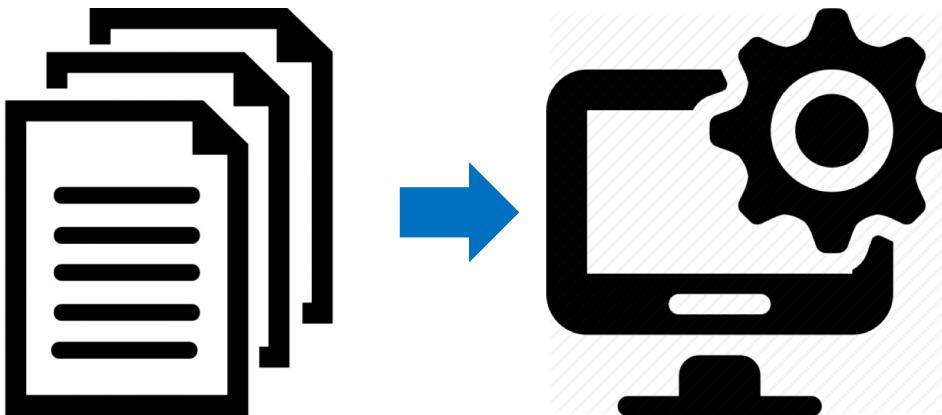
Story Cloze Test

SQuAD

MultiRC

+ Many more you will hear about today...

The Promise of Question Answering



In which city was Facebook first launched?

Cambridge, Massachusetts.

This is because Mark Zuckerberg and his business partners launched it from his Harvard dormitory [1], and Harvard is located in Cambridge, Massachusetts [2].

[1] https://en.wikipedia.org/wiki/Mark_Zuckerberg

[2] https://en.wikipedia.org/wiki/Harvard_University

Reality

The ~~Promise~~ of Question Answering

A screenshot of a search engine interface. The search bar contains the query "in which city was facebook first launched". Below the search bar are navigation links: All (highlighted), News, Images, Videos, Maps, More, Settings, and Tools. A sidebar on the left shows a vertical stack of five gray rectangular cards. The top card contains the search query. The second card displays the search results count: "About 310,000,000 results (0.80 seconds)". The third card contains a summary: "On February 4, 2004, Zuckerberg launched 'TheFacebook', originally located at thefacebook.com.". The fourth card is titled "Facebook - Wikipedia" with the URL "https://en.wikipedia.org/wiki/Facebook". The fifth card shows a thumbnail image of a Facebook profile for Mark Zuckerberg. The main content area below the sidebar lists several search results, with the first one being a snippet from Wikipedia about the launch of Facebook.

in which city was facebook first launched

All News Images Videos Maps More Settings Tools

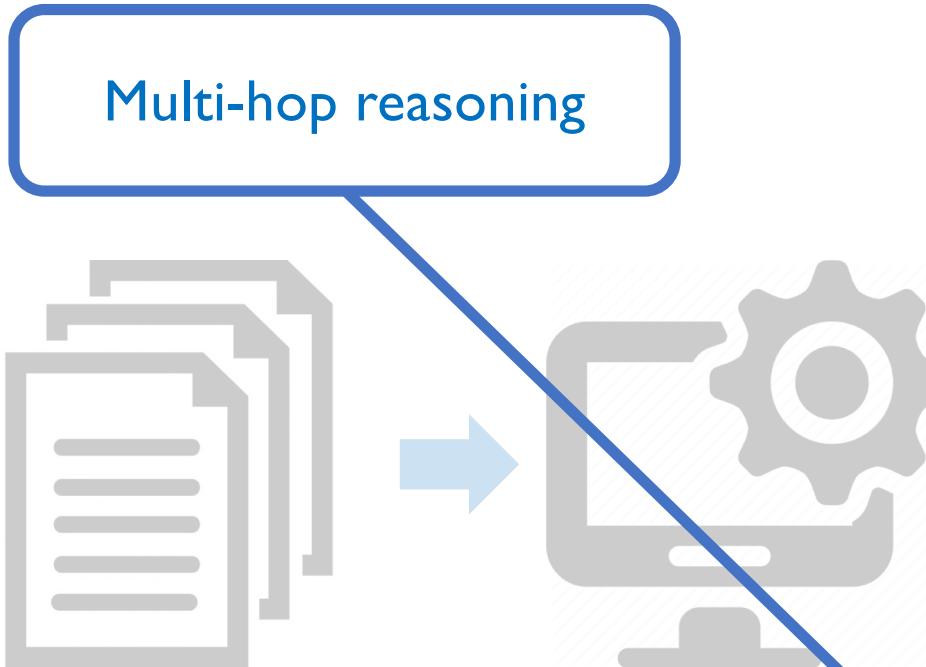
About 310,000,000 results (0.80 seconds)

On February 4, 2004, Zuckerberg launched "TheFacebook", originally located at thefacebook.com.

[Facebook - Wikipedia](https://en.wikipedia.org/wiki/Facebook)
https://en.wikipedia.org/wiki/Facebook

[1] https://en.wikipedia.org/wiki/Mark_Zuckerberg
[2] https://en.wikipedia.org/wiki/Harvard_University
Sorry, folks from Google!

The Promise of Question Answering



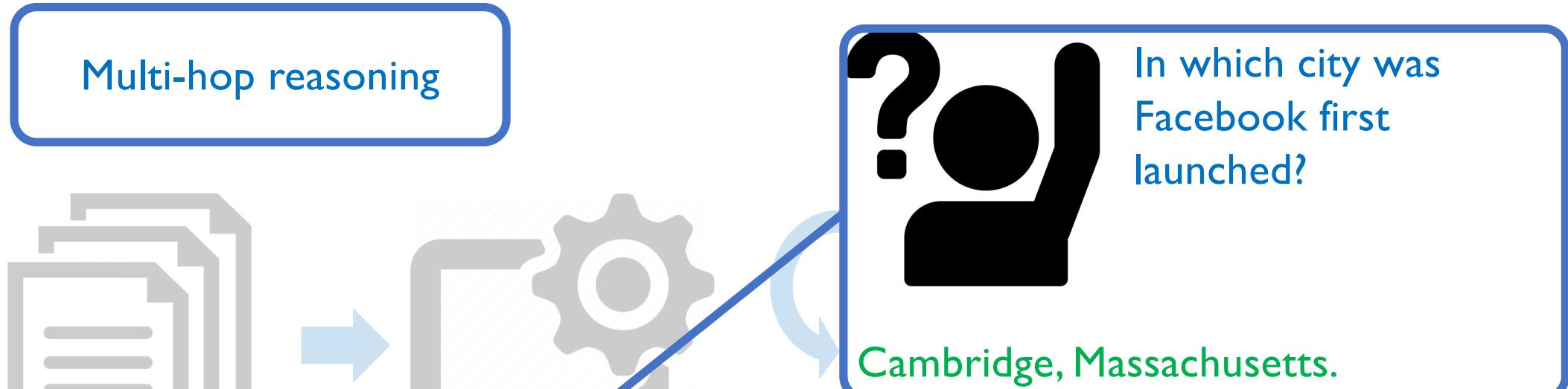
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The Promise of Question Answering

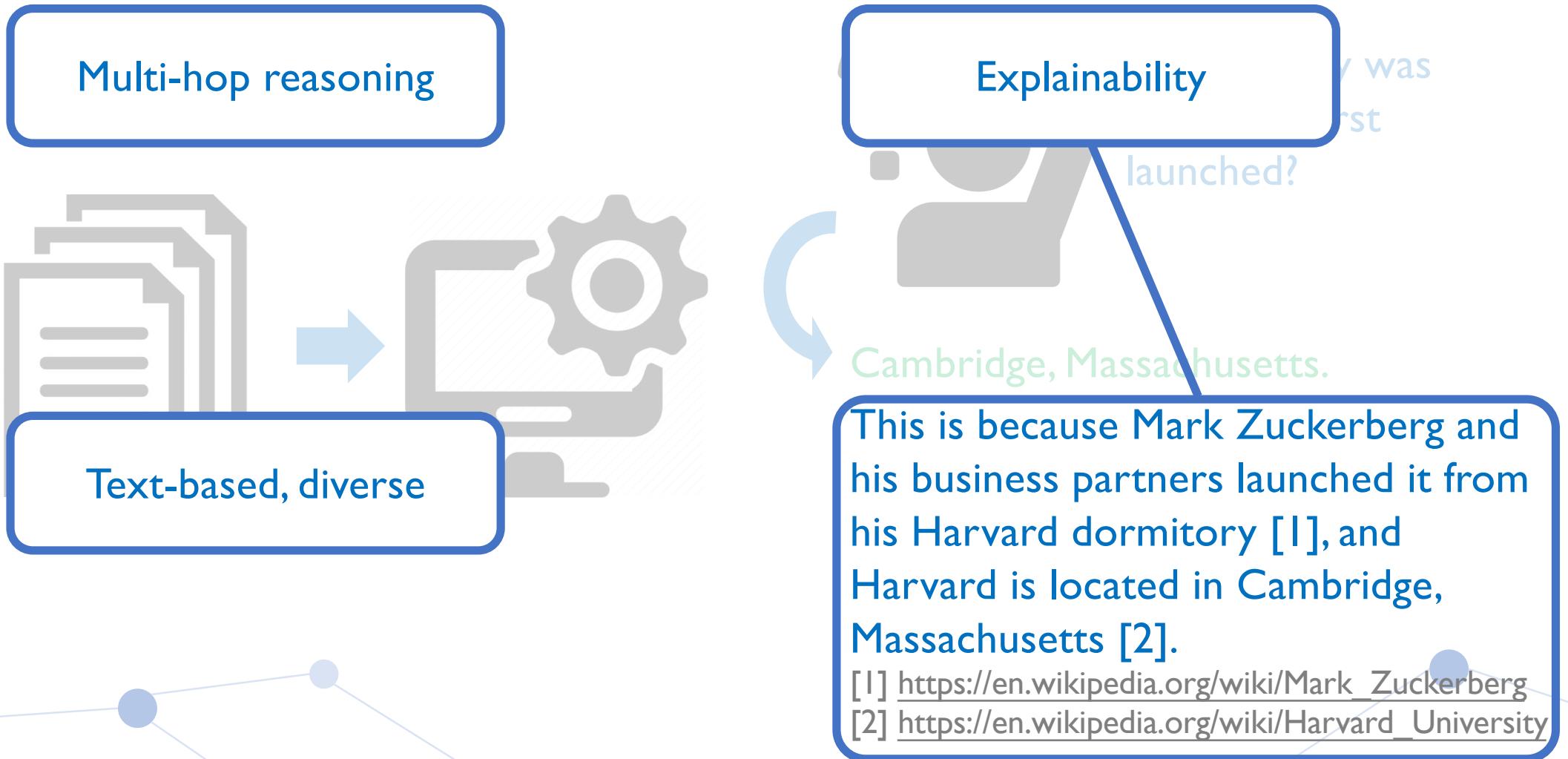


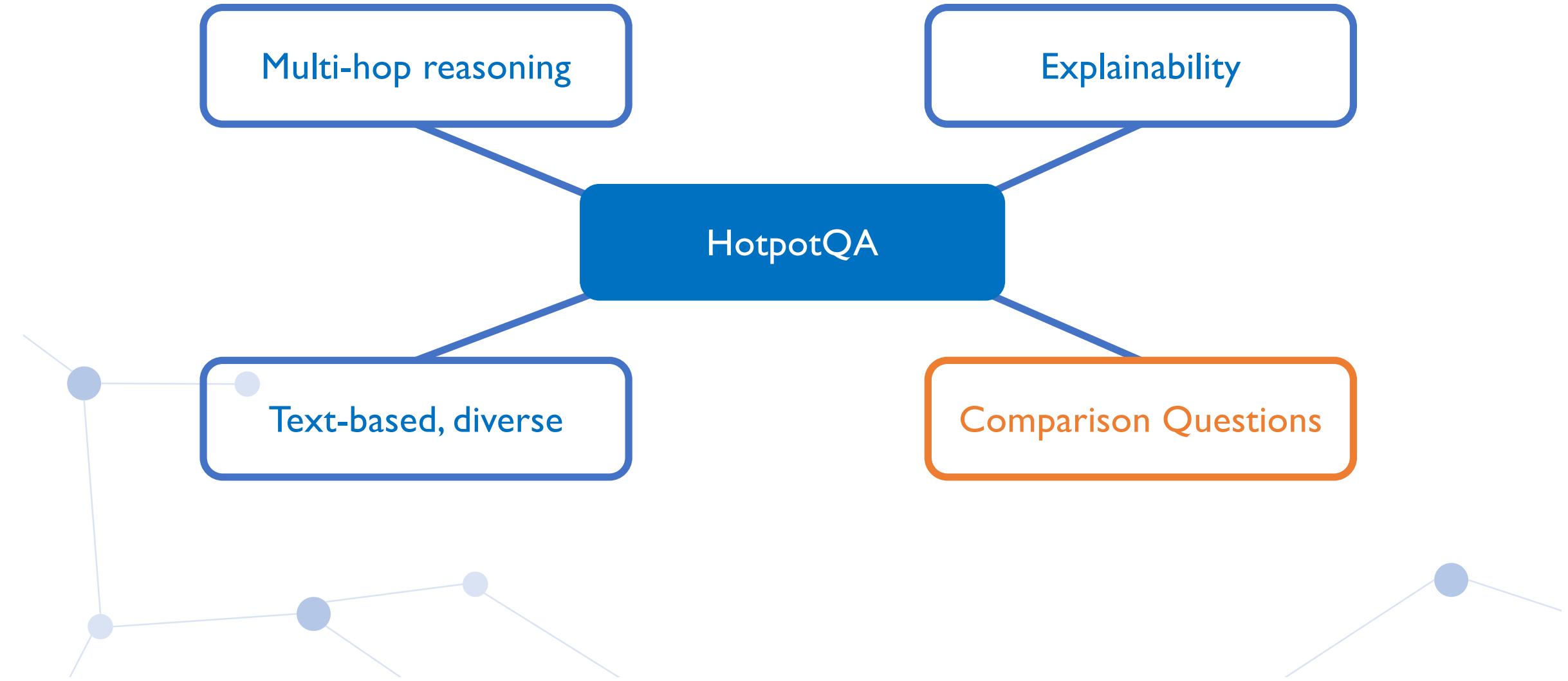
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The Promise of Question Answering

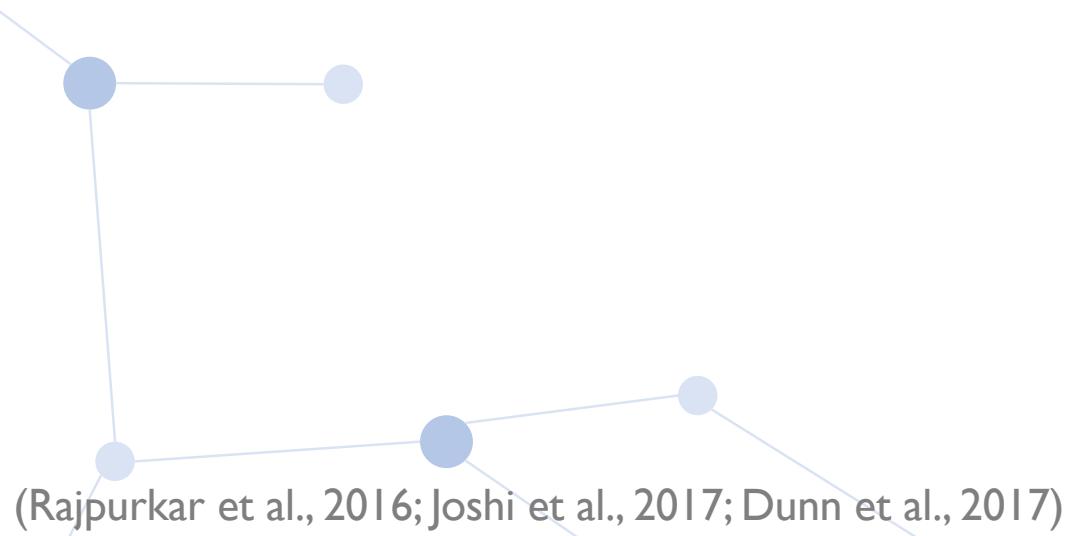




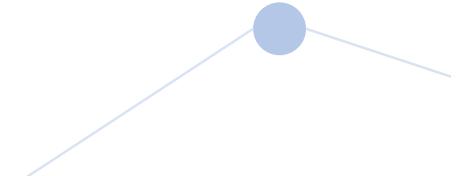
Multi-hop Reasoning across Multiple Documents

- Previous work (SQuAD, TriviaQA, etc)
- HotpotQA

When was Chris Martin born?

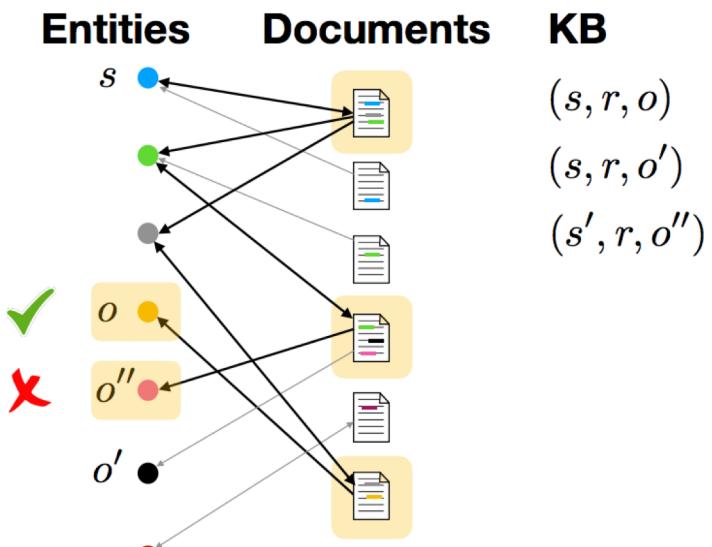


When was the lead singer of Coldplay born?

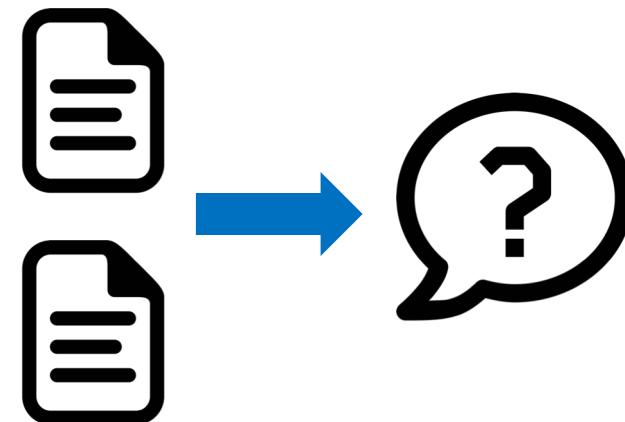


Open-domain Text-based Questions and Answers

- Previous work (QAngaroo, ComplexWebQuestions, etc)
- HotpotQA

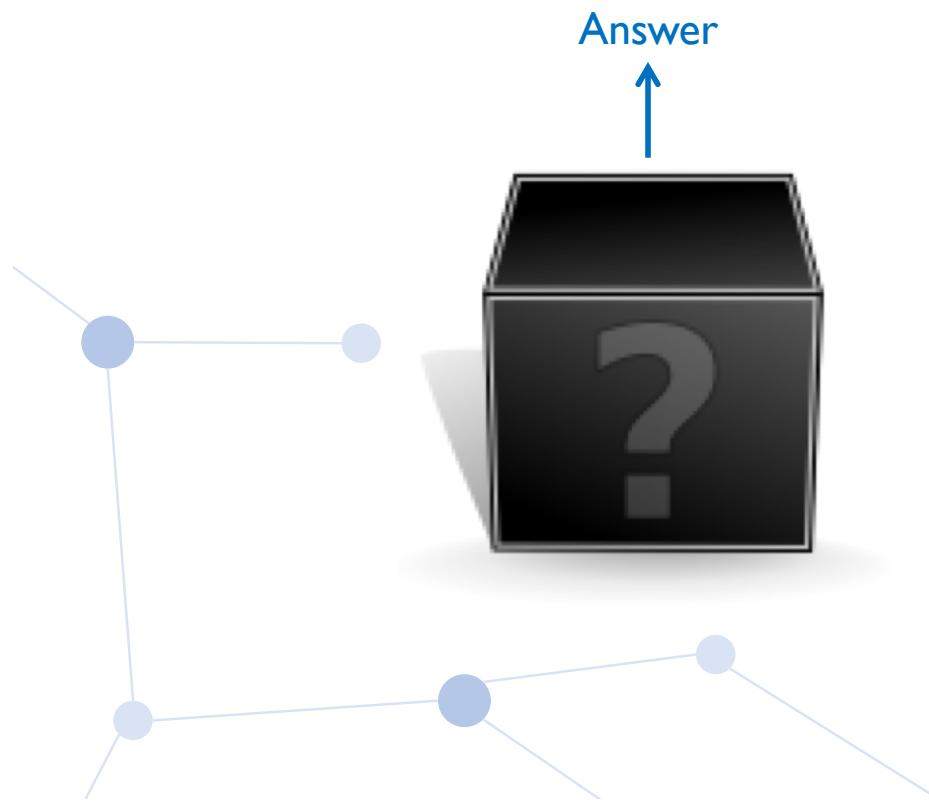


(Welbl et al., 2018; Talmor and Berant, 2018)

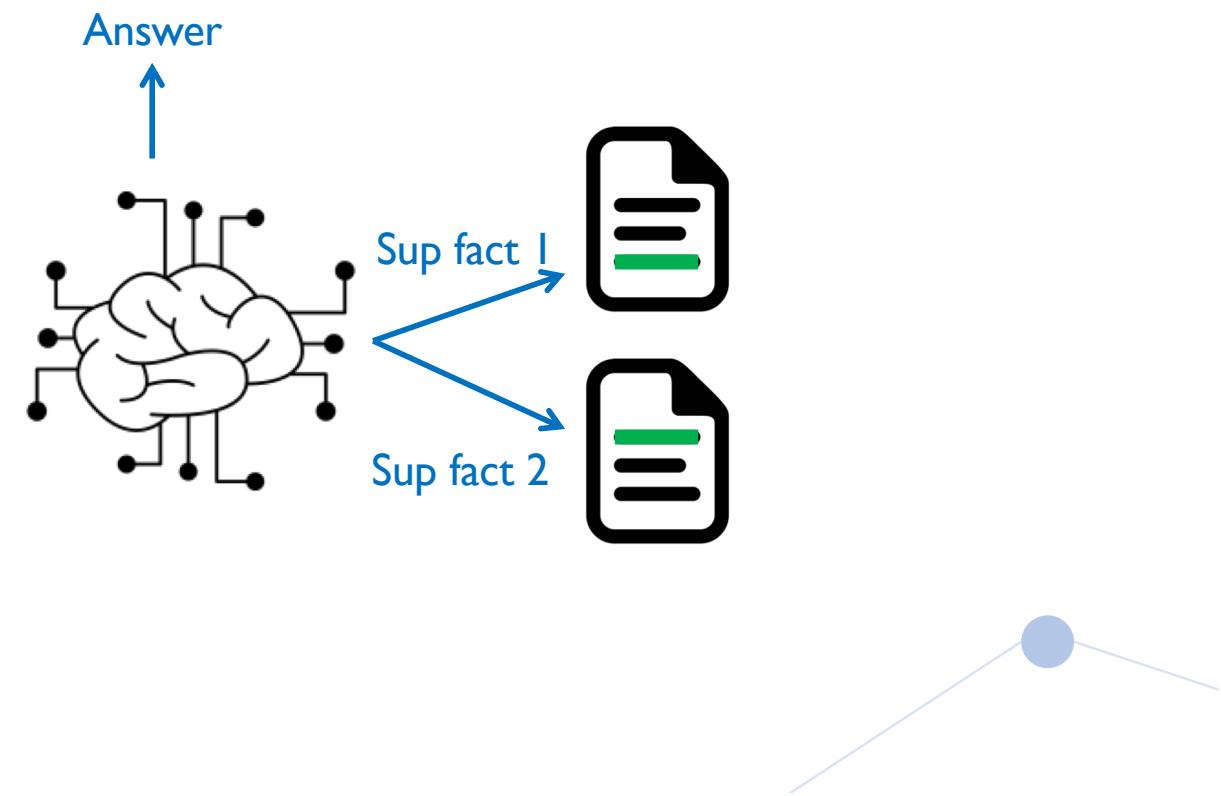


Explainability

- Previous work



- HotpotQA



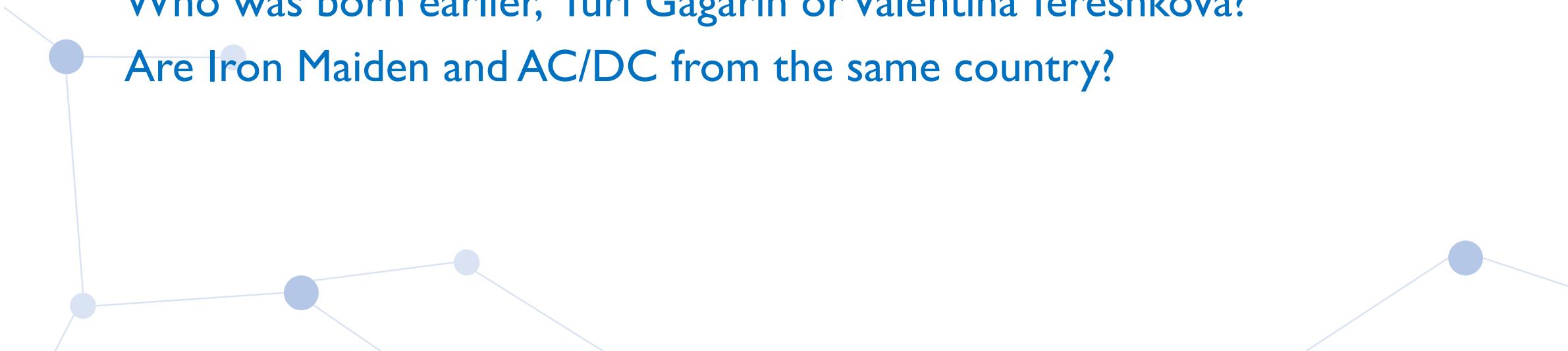
Comparison Questions (~25% of HotpotQA)

- Arithmetic comparison & comparing properties
- Answer could be yes/no

Who has played for more teams, Michael Jordan or Kobe Bryant?

Who was born earlier, Yuri Gagarin or Valentina Tereshkova?

Are Iron Maiden and AC/DC from the same country?

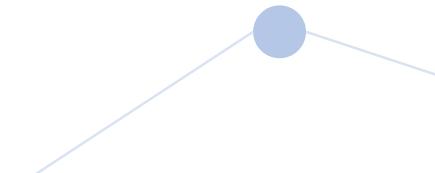


Data Collection

- Entity graph through hyperlinks
- Bridge entity questions
 - In which city was Facebook first launched?
Zuckerberg → **Harvard University** → Cambridge, Massachusetts
- Comparison questions
 - Wikipedia “List of Lists of Lists”



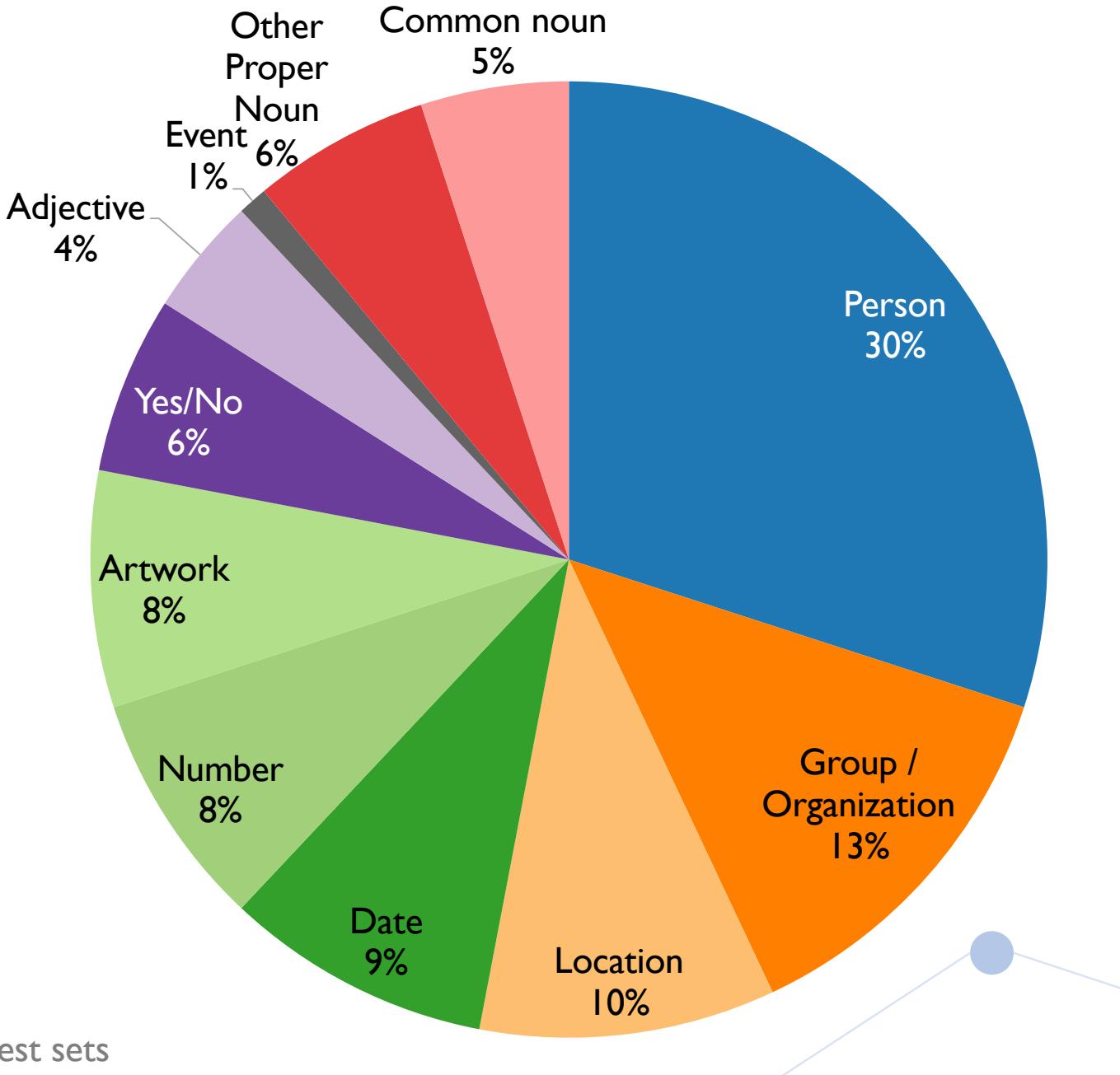
112,779 Examples



Answer Types

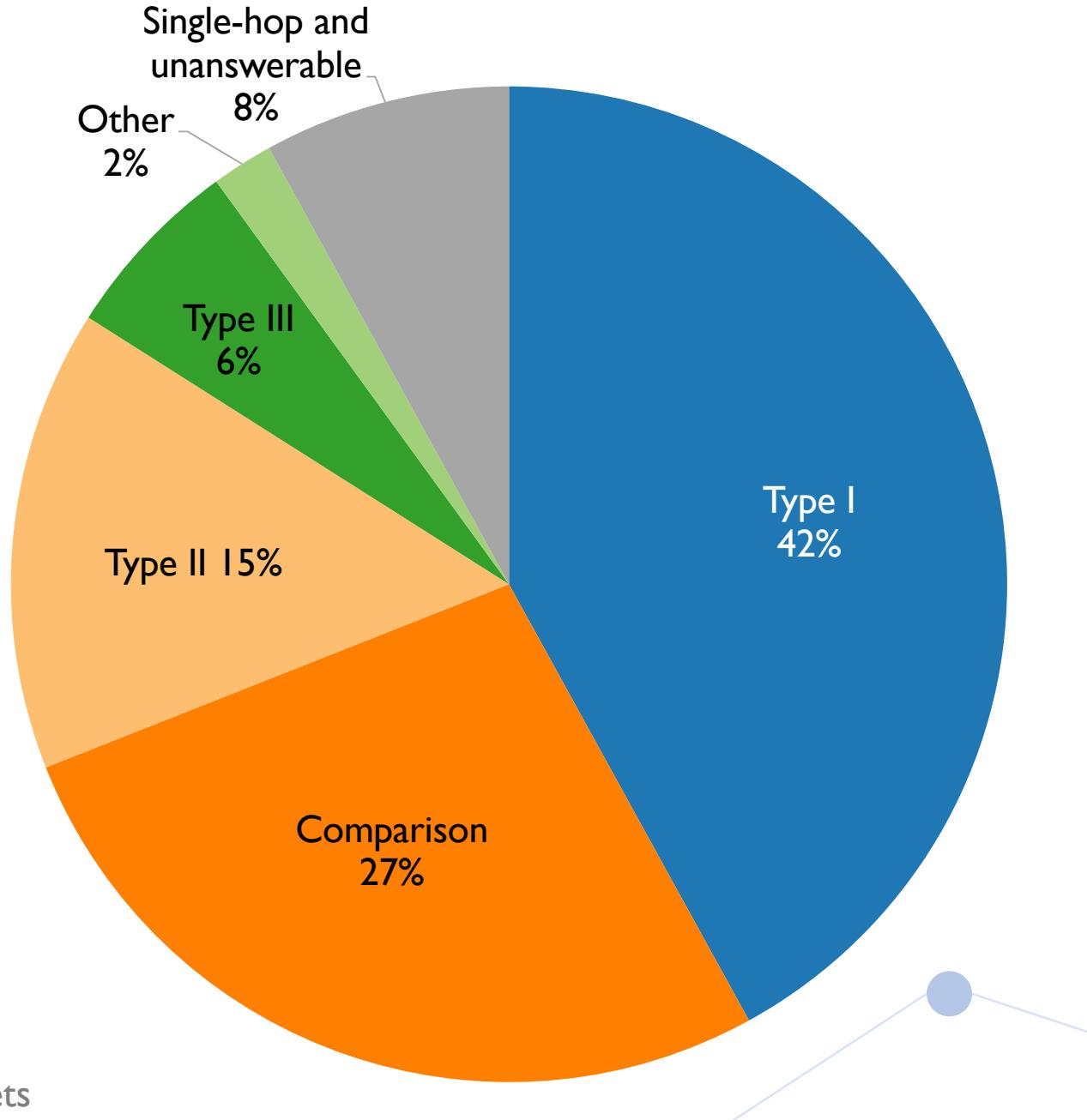
- Person
 - *King Edward II, Rihanna*
- Group / Organization
 - *Cartoonito, Apalachee*
- Artwork
 - *Die schweigsame Frau*
- Other proper noun
 - *Laban Movement Analysis*

Statistics based on 100 random samples from the dev/test sets



Types of reasoning

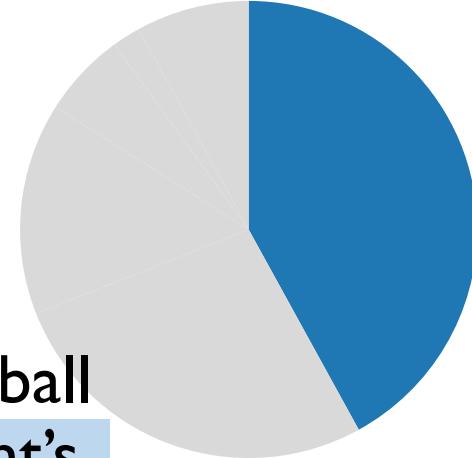
- Type I
 - *Where's the US President born?*
- Type II
 - *What contains ice and fire?*
- Type III
 - *Zuck → Harvard → Cambridge*



Statistics based on 100 random samples from the dev/test sets

Types of reasoning (Type I: 42%)

“Where’s the US President born?”



- Paragraph A

The 2015 Diamond Head Classic was a college basketball tournament... Buddy Hield was named the tournament's MVP.

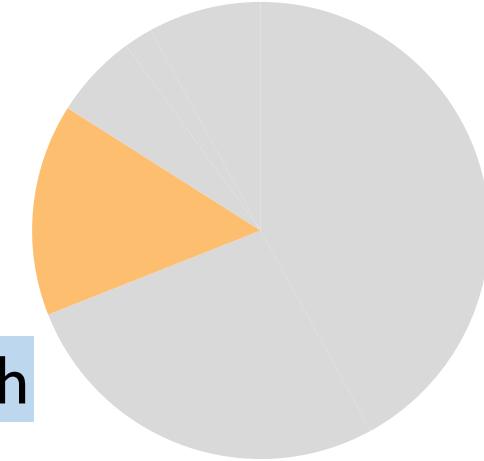
- Paragraph B

Chavano Rainier “Buddy” Hield is a Bahamian professional basketball player for the Sacramento Kings of the NBA.

- Q: Which team does the player named 2015 Diamond Head Classic's MVP play for?

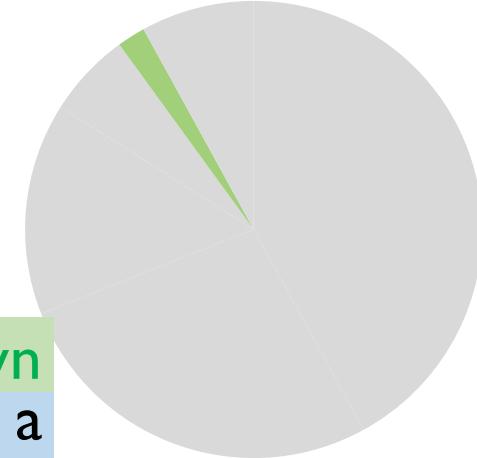
Types of reasoning (Type II: 15%)

“What contains ice and fire?”



- Paragraph A
Several current and former members of the Pittsburgh Pirates -- ... John Milner, **Dave Parker**, and Rod Scurry...
- Paragraph B
David Gene Parker nicknamed “The Cobra”, is an American former player in Major League Baseball...
- Q: Which former member of the Pittsburgh Pirates was nicknamed “The Cobra”?

Types of reasoning (Other: 2%)



- Paragraph A

... the towns of Yodobashi, Okubo, Totsuka, and Ochiai town were merged into Yodobashi ward, ... Yodobashi Camera is a store with its name taken from the town and ward.
- Paragraph B

Yodobashi Camera Co., Ltd. is a major Japanese retail chain specializing in electronics, PCs, cameras and photographic equipment.
- Q: Aside from Yodobashi, what other towns were merged into the ward which gave the major Japanese retail chain specializing in electronics, PCs, cameras and photographic equipment its name?

Evaluation settings

- Distractor
 - 2 gold paragraphs + 8 from information retrieval (fixed for all models)
- Fullwiki
 - Entire Wikipedia as context
 - (In this work) 10 paragraphs from IR

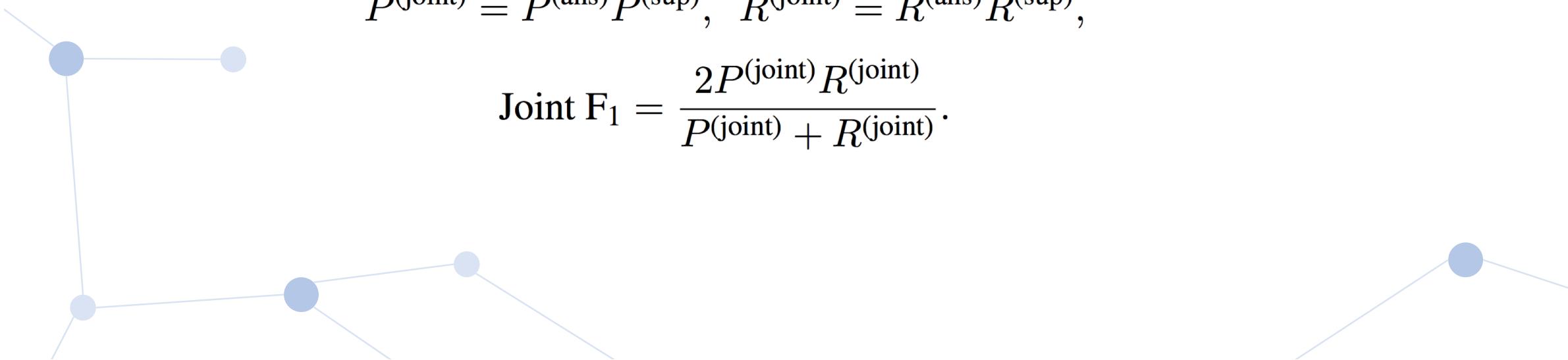


Evaluation Metrics

- Evaluate the answer (ans) and the supporting facts (sup)
 - Standard Exact Match (EM) and F_1 metrics
 - Yes/no questions don't enjoy partial credits
- And a joint metric to combine the two

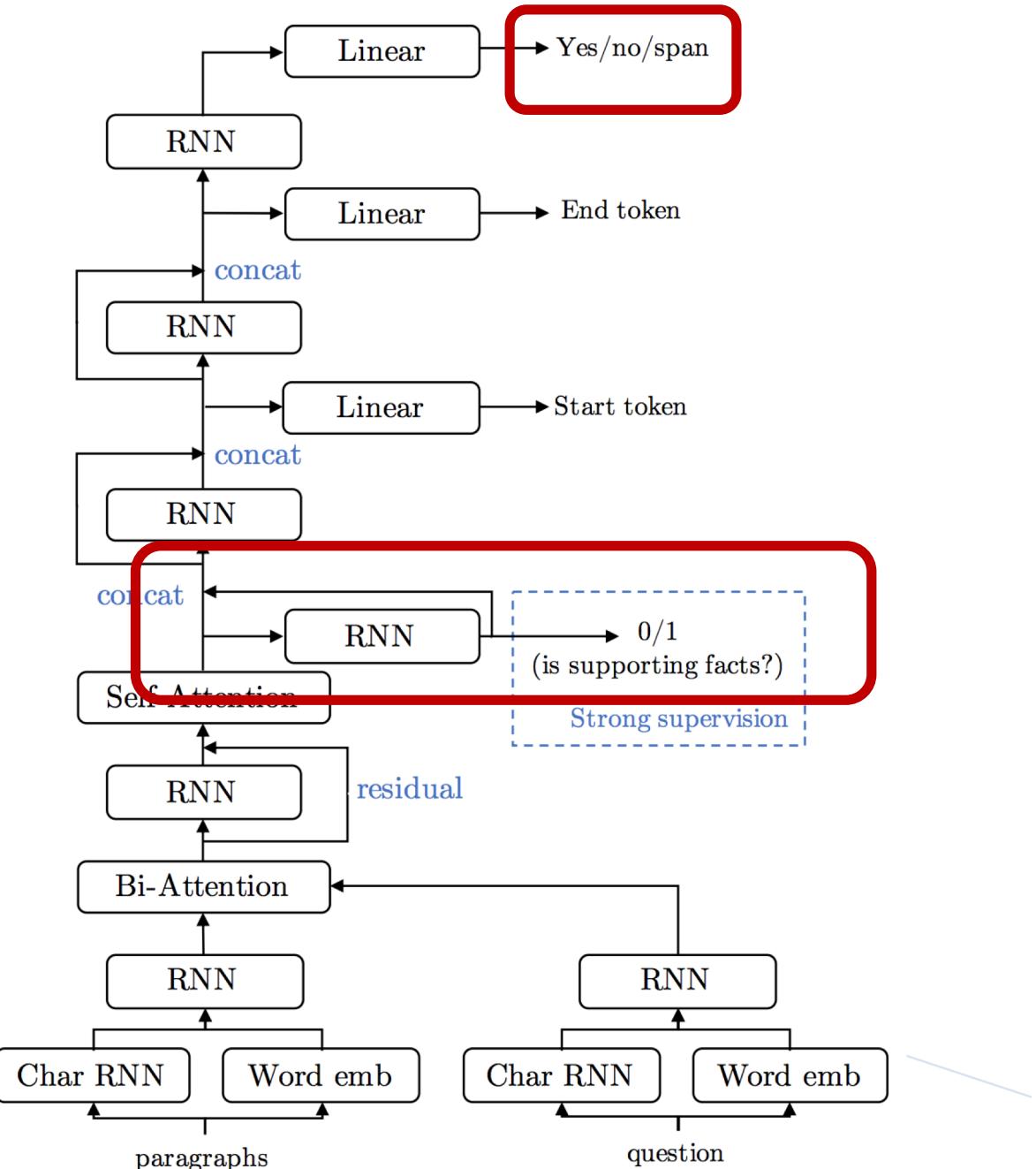
$$P^{(\text{joint})} = P^{(\text{ans})} P^{(\text{sup})}, \quad R^{(\text{joint})} = R^{(\text{ans})} R^{(\text{sup})},$$

$$\text{Joint } F_1 = \frac{2P^{(\text{joint})}R^{(\text{joint})}}{P^{(\text{joint})} + R^{(\text{joint})}}.$$



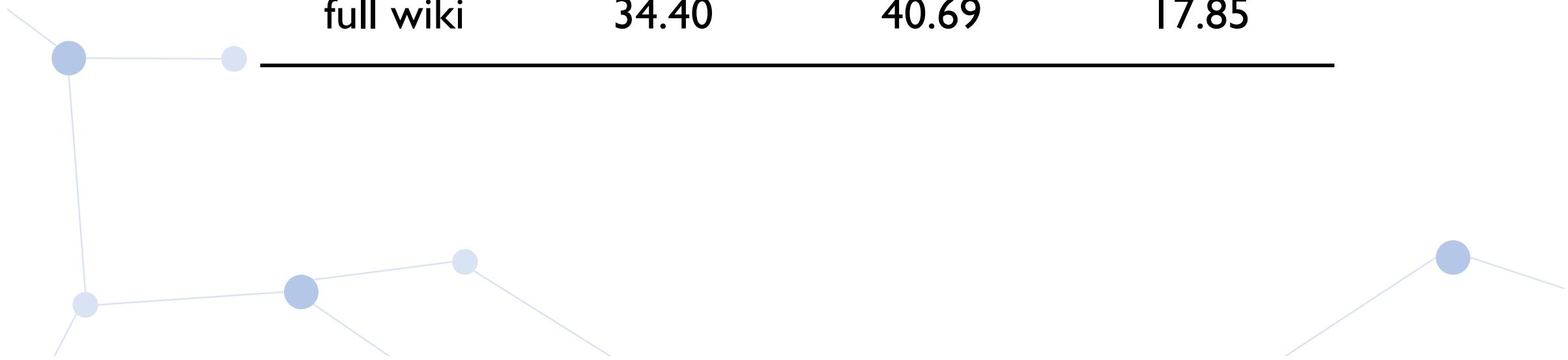
Baseline Model

- Adapted from BiDAF++ w/ S-Norm (Clark and Gardner, 2018)
 - Character-level model
 - Self attention (Wang et al., 2017)
 - Bi-attention (Seo et al., 2017)
 - HotpotQA-specific augmentations

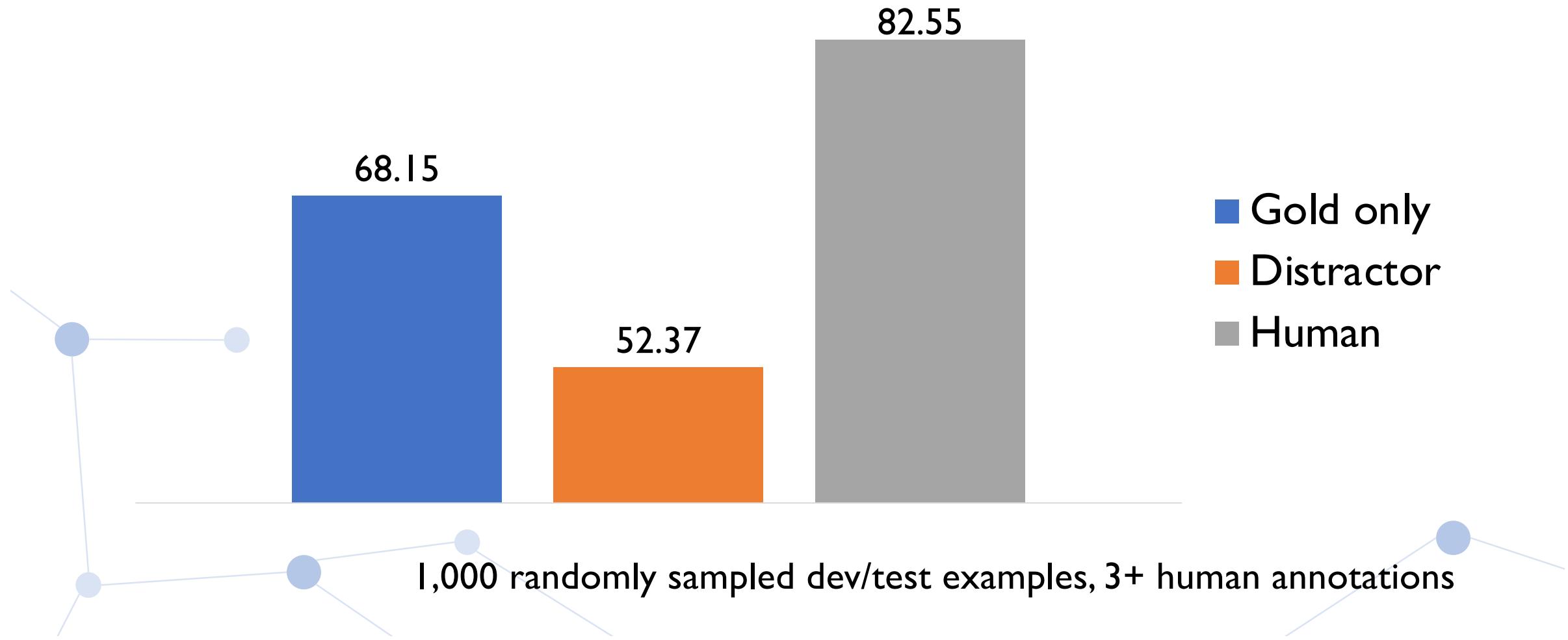


Baseline Results

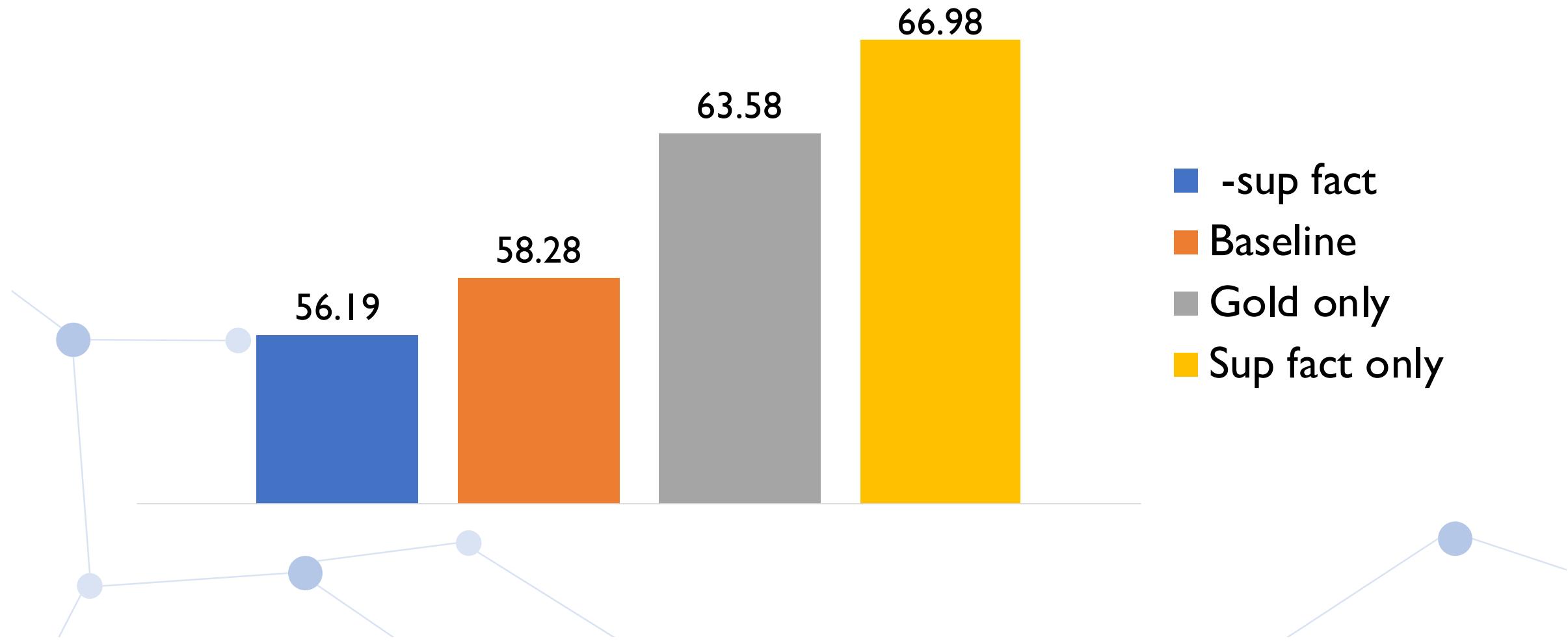
Setting	Answer F ₁	Sup Fact F ₁	Joint F ₁
distractor	58.99	66.62	41.37
full wiki	34.40	40.69	17.85



Human Performance (% joint F_1)



Baseline Model Ablation (% Answer F₁)



In summary

Harvard University

Mark Zuckerberg

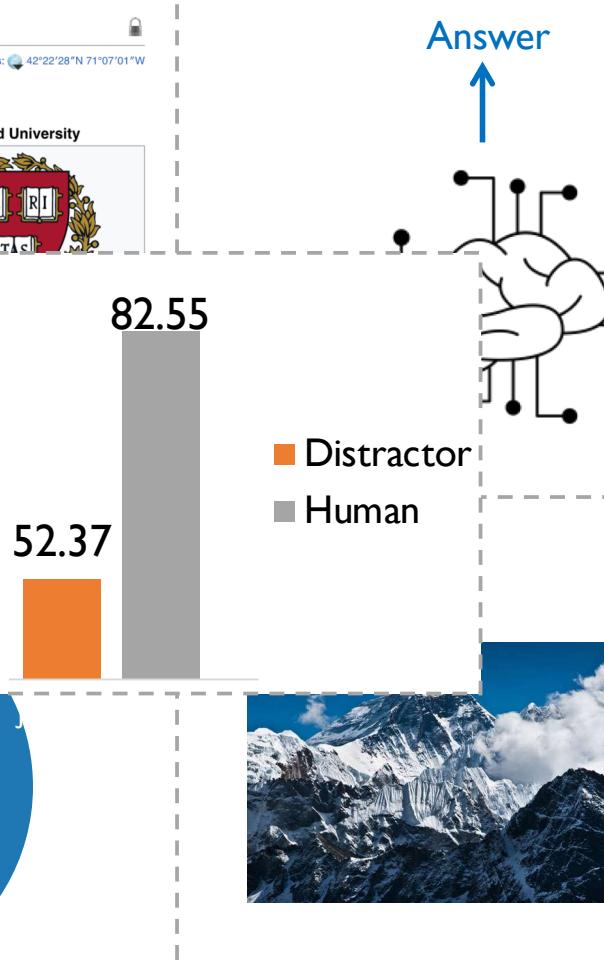
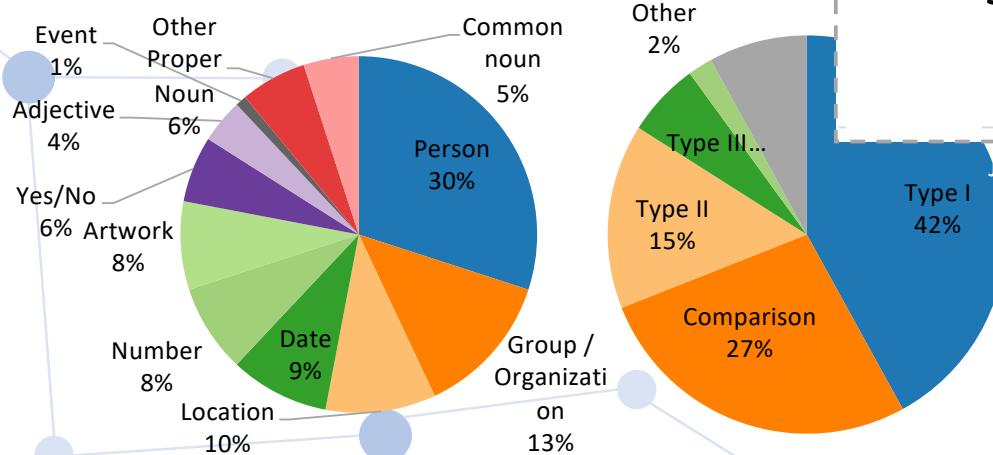
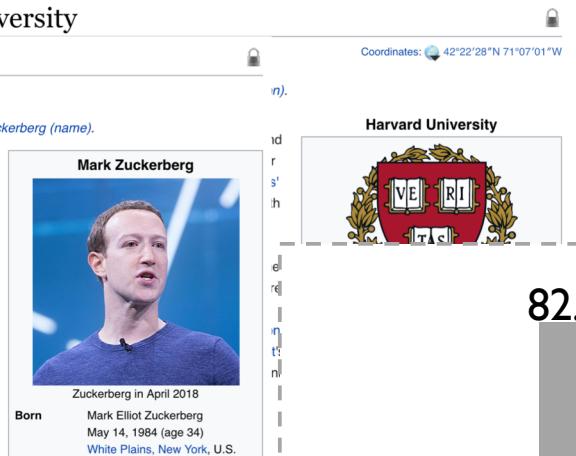
From Wikipedia, the free encyclopedia

"Zuckerberg" redirects here. For other people with the surname, see [Zuckerberg \(name\)](#).

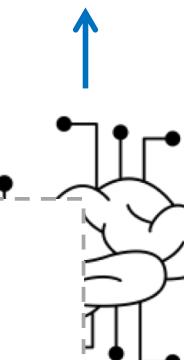
Mark Elliot Zuckerberg ([/zəkərbərg/](#); born May 14, 1984) is an American technology entrepreneur and philanthropist. He is known for co-founding and leading Facebook as its chairman and chief executive officer.^{[3][4]}

Born in White Plains, New York, Zuckerberg attended Harvard University, where he launched Facebook from his dormitory room on February 4, 2004, with college roommates Eduardo Saverin, Andrew McCollum, Dustin Moskovitz, and Chris Hughes.^[5] Originally launched to select college campuses, the site expanded rapidly and eventually beyond colleges, reaching one billion users by 2012. Zuckerberg took the company public in May 2012 with majority shares. His net worth is estimated to be US\$67.1 billion as of July 26, 2018, a \$15.4 billion decrease from the previous day after Facebook stock plunged 19 percent.^[6]

Since 2010, *Time* magazine has named Zuckerberg among the 100 wealthiest and most influential people in the world as a part of its *Person of the Year* award.^{[2][7][8]} In December 2016, Zuckerberg was ranked 10th on

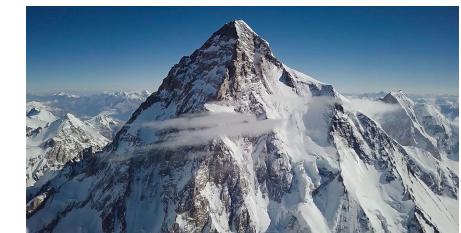


Answer



Distractor

Human



Paragraph A

HotpotQA is released at <https://hotpotqa.github.io/>, where you can also find the leaderboard, submission guide, a blog post introducing HotpotQA, and an interactive data explorer.

Paragraph B

Our baseline model is available at <https://github.com/hotpotqa/hotpot>.

Q: What are some questions you have about HotpotQA that I can help answer?

Thank you for listening!

(Peng Qi, pengqi@cs.stanford.edu)