Compositional Questions Do Not Necessitate Multi-hop Reasoning

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Multi-hop Question Answering

Q: What is the former name of the Bonobo Apes?

Single-hop QA

Q: What is the former name of the animal whose habitat the Reserve Naturelle Lomako Yokokala was established to protect?

Multi-hop QA

Multi-hop Question Answering

Compositional

Q: What is the former name of the Bonobo Apes?

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Q: What is the former name of the animal whose habitat the Reserve Naturelle Lomako Yokokala was established to protect?

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Multi-hop Question Answering

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Yang et al. 2018, “HotpotQA: A dataset for diverse, explainable multi-hop question answering”. EMNLP.

Multi-hop Question Answering

Q: What is the former name of the animal whose habitat the Reserve Naturelle Lomako Yokokala was established to protect?

P1: The Lomako Forest Reserve was established to protect the habitat of the Bonobo apes

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Multi-hop Question Answering

Q: What is the former name of the animal whose habitat the Reserve Naturelle Lomako Yokokala was established to protect?

P1: The Lomako Forest Reserve was established to protect the habitat of the Bonobo apes

P2: The bonobo, formerly called the **pygmy chimpanzee**, is an endangered great ape ...

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Multi-hop Question Answering

Q: What is the former name of the animal whose habitat the Reserve Naturelle Lomako Y

otect

P2: The bonobo, formerly called the **pygmy chimpanzee**, is an endangered great ape ...

Compositional Questions == Multi-hop Questions ???

Yang et al. 2018, "HotpotQA: A dataset for diverse, explainable multi-hop question answering". EMNLP.

Research Questions

1. Do compositional questions necessarily require multi-hop?

2. How many are solvable in single-hop?

3. What factors lead to single-hop?

4. Can we turn them into multi-hop?

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Distractor Setting

Q: What is the former name of the animal whose habitat the Reserve Naturelle Lomako Yokokala was established to protect?

P1: The Lomako Forest Reserve was established to protect the habitat of the Bonobo apes.

P2: The bonobo, formerly called the **pygmy chimpanzee** is (...)

P3 Nature Reserve of Saint Bartholomew

P4 Grand Cote National Wildlife Refugei

P5 La Tortue, Saint Barthelemy

P6 Reserve Naturelle Lomoko Yokokala

P7 Cereste

P8 Guadeloupe National Park

P9 Ile fourchue

P10 La National Nature Reserve

Distractor Setting

Q: What is the former name of the animal whose habitat the Reserve Naturelle Lomako Yokokala was established to protect?

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P7 Cereste

P8 Guadeloupe National Park

P9 Ile fourchue

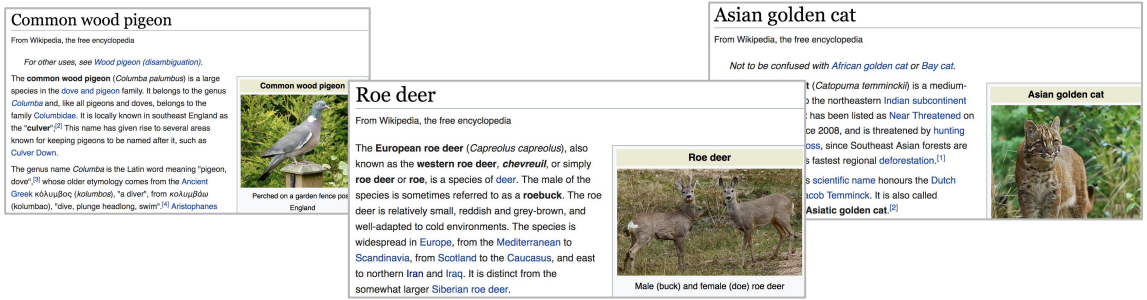
P10 La National Nature Reserve

No other paragraph about an animal
→ Can be Single hop in distractor setting

Full-wiki Setting

Q: What is the former name of the animal whose habitat the Reserve Naturelle Lomako Yokokala was established to protect?

WIKIPEDIA
The Free Encyclopedia



Full-wiki Setting

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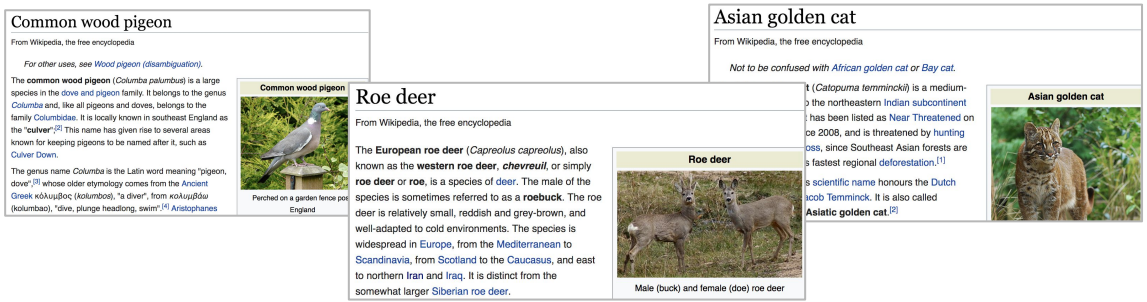
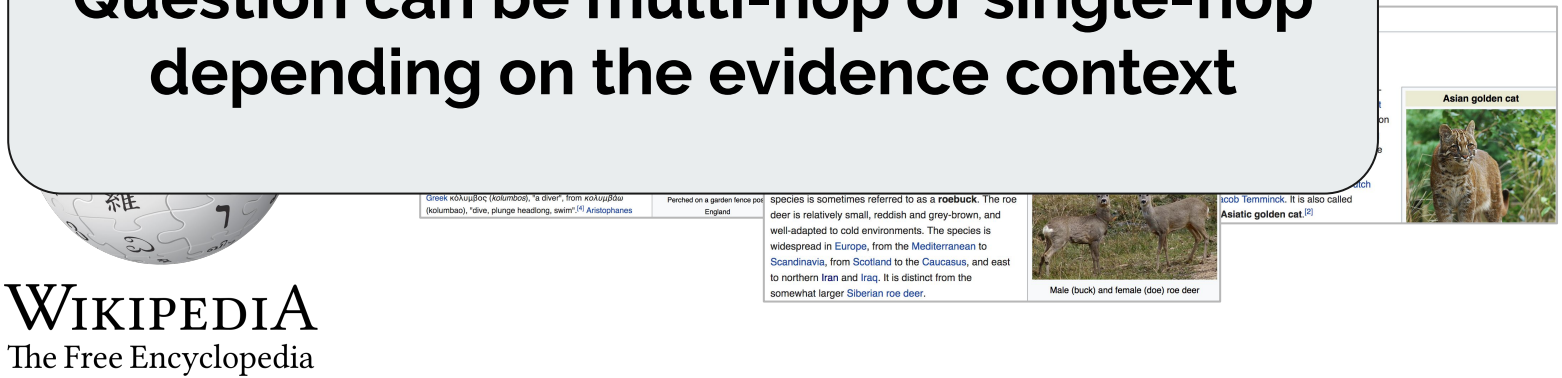


Other articles about animals with former names
→ Multi-hop in full-wiki setting

Full-wiki Setting

Q: What is the former name of the animal whose habitat the Reserve Naturelle Lomak

Question can be multi-hop or single-hop depending on the evidence context



Other articles about animals with former names
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Research Questions

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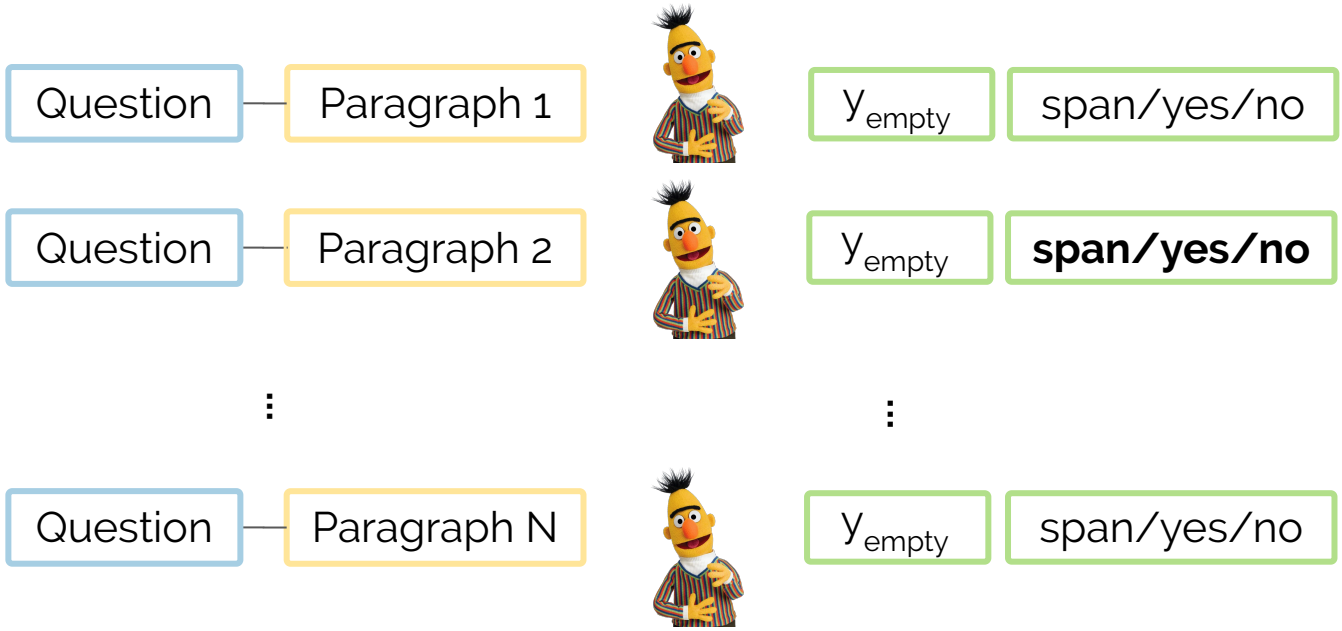
Single-hop QA Model

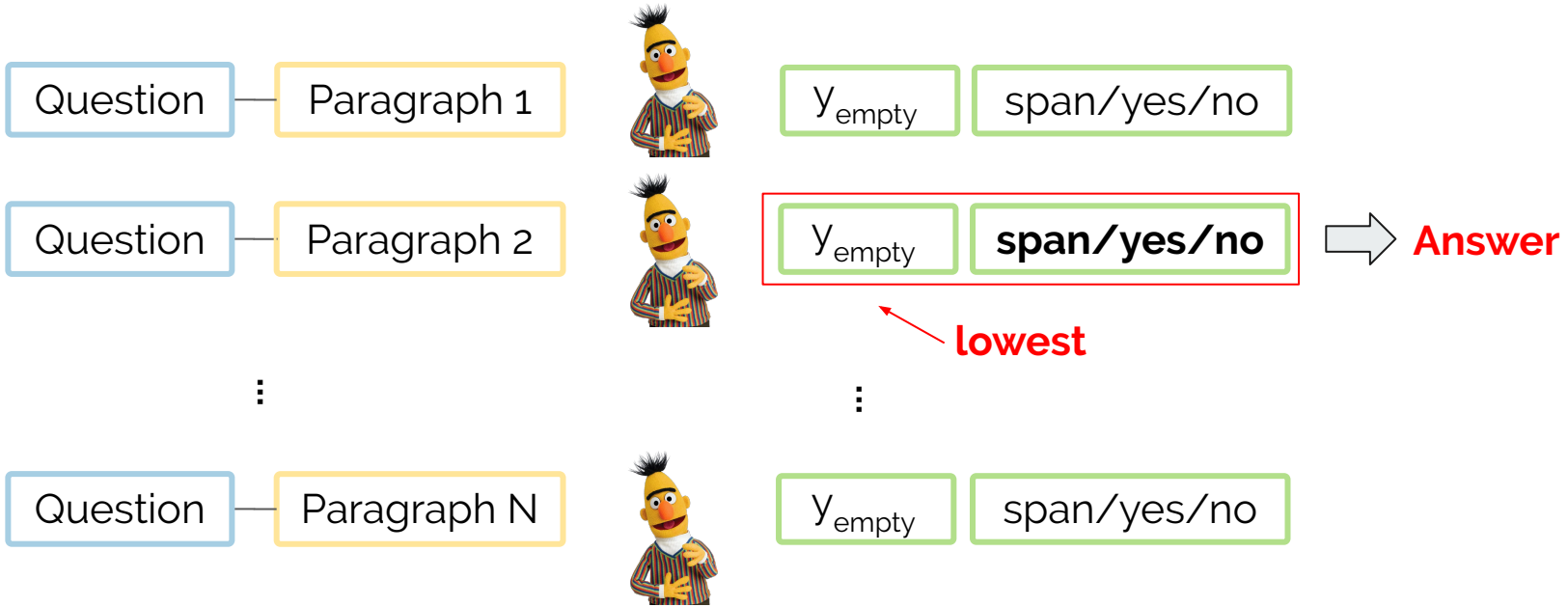
Question — Paragraph 1

y_{empty} span/yes/no

Single-hop QA Model



Single-hop QA Model



Single-hop QA Result

	Distractor	Full-Wiki
Single-hop QA Model ❇	67.1	38.4
BiDAF ❇ (Seo et al 17)	58.3	34.4
BiDAF (Seo et al 17)	59.0	32.9
QFE (Nishida et al 19)	68.1	38.1
DecompRC (Min et al 19)	69.6	40.7
DFGN (Xiao et al 19)	**69.7**	
Cognitive Graph QA (Ding et al 19)	-	**48.9**

❇ Official validation set; others are hidden test set
Published models only

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❇ Official validation set; others are hidden test set
Published models only

Humans with Multi-hop

Q: What is the former name of the animal whose habitat the Reserve Naturelle Lomako Yokokala was established to protect?

P1: The Lomako Forest Reserve was established in 1991 ...

P2: The bonobo, formerly called the **pygmy chimpanzee** is ...

P3 **P4** **P5** **P6** **P7** **P8** **P9** **P10**

87.4 F1

Humans with Single-hop

Q: What is the former name of the animal whose habitat the Reserve Naturelle Lomako Yokokala was established to protect?

P2: The bonobo, formerly called the **pygmy chimpanzee** is ...

P3 P4 P5 P6 P7 P8 P9 P10

87.4 F1

⇩

82.1 F1

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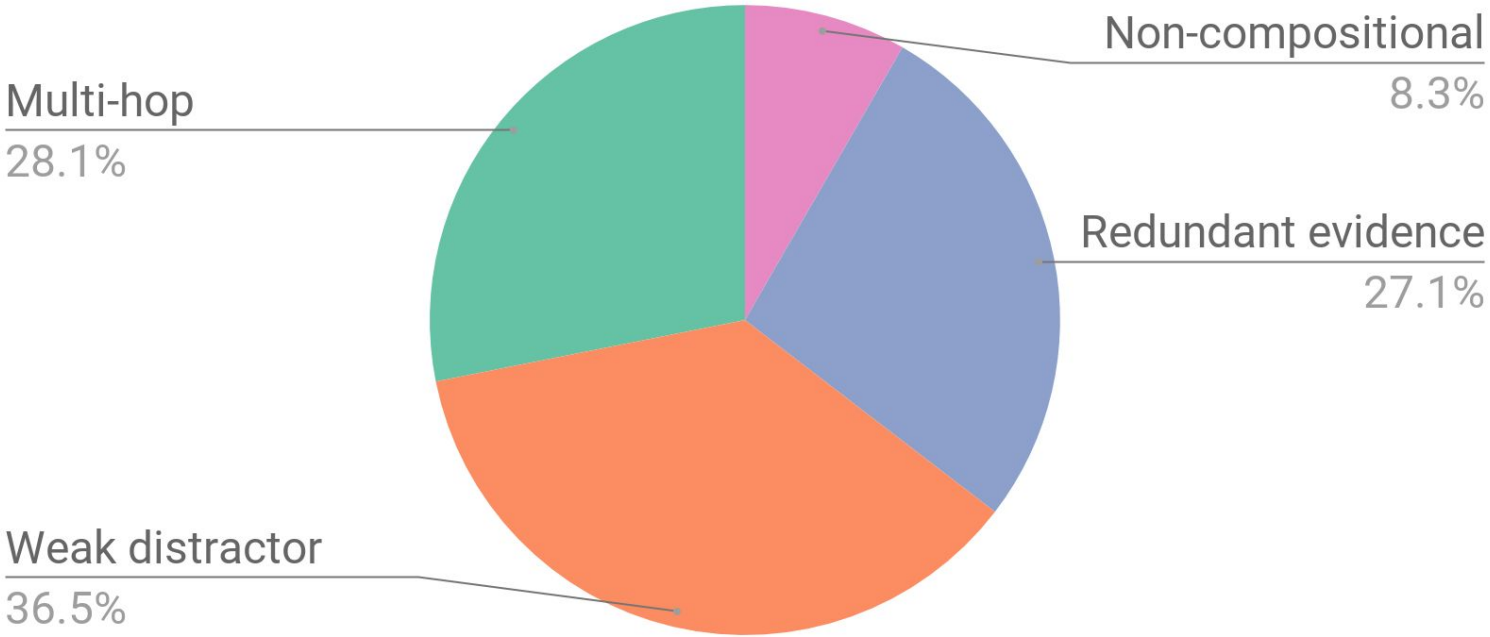
What leads to single-hop?

Categorization of 100 random samples



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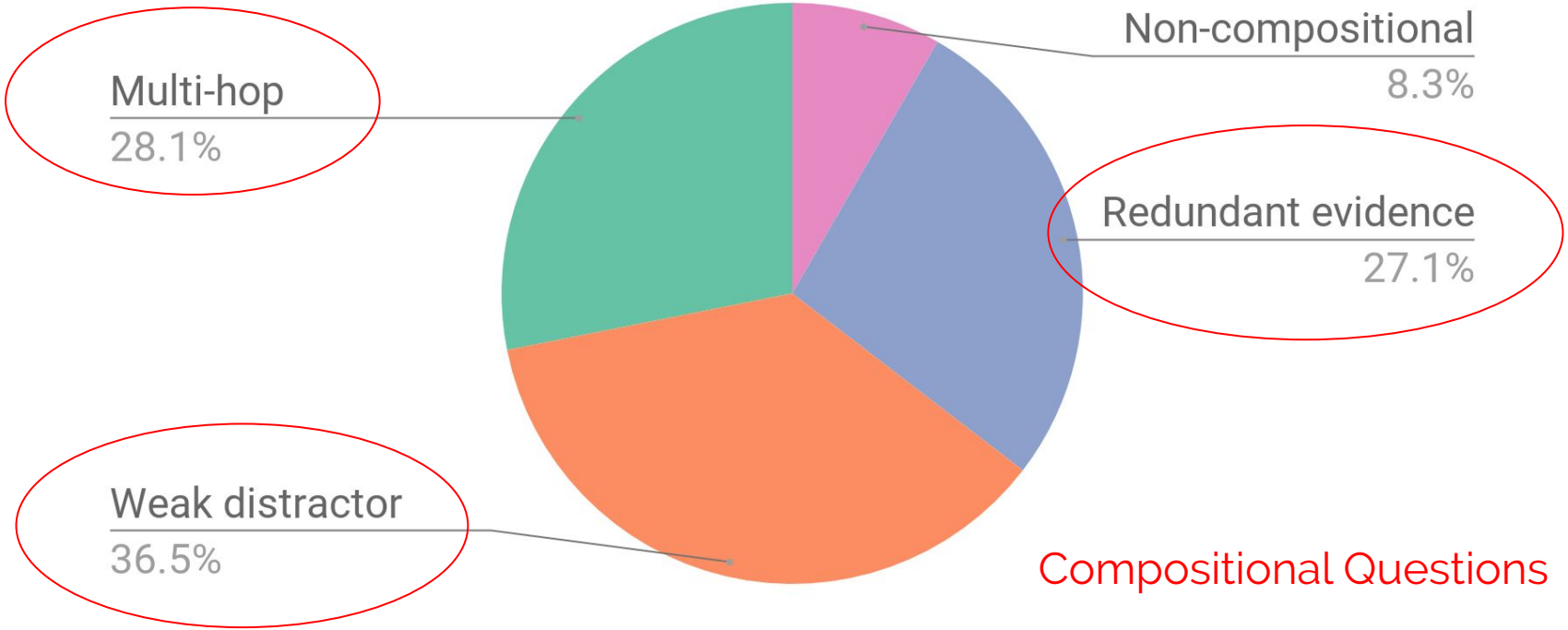

Compositional Questions

What leads to single-hop?

Multi-hop **(27%)**	Weak Distractor (35%)	Redundant Evidence (26%)	Non-compositional one-hop (8%)

Q: Ralph Hefferline was a psychology professor at a university that is located in what city?

What leads to single-hop?

Multi-hop (27%)	Weak Distractor (35%)	Redundant Evidence (26%)	Non-compositional one-hop (8%)

Q: Ralph Hefferline was a psychology professor at a university that is located in what city?

P1: Ralph Hefferline was a psychology professor at Columbia University.

P2: Columbia University is ... in **New York City**.

P3: Stanley Coren is a psychology professor at the University of British Columbia in Vancouver, British Columbia.

What leads to single-hop?

Multi-hop **(27%)**	Weak Distractor (35%)	Redundant Evidence (26%)	Non-compositional one-hop (8%)

Q: Ralph Hefferline was a psychology professor at a university that is located in what city?

P1: Ralph Hefferline was a psychology professor at Columbia University.

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P1: Ralp

P2: Colu

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Distractor setting	Full-wiki setting
✓	✓

What leads to single-hop?

Multi-hop (27%)	**Weak Distractor (35%)**	Redundant Evidence (26%)	Non-compositional one-hop (8%)

Q: What government position was held by the woman who portrayed Corliss Archer in the film Kiss and Tell?

What leads to single-hop?

Multi-hop (27%)	**Weak Distractor (35%)**	Redundant Evidence (26%)	Non-compositional one-hop (8%)

Q: What government position was held by the woman who portrayed Corliss Archer in the film Kiss and Tell?

P1: Shirley Temple Black was an American actress, singer, dancer, businesswoman (..), she also served as **Chief of Protocol of the United States**.

What leads to single-hop?

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No other paragraphs are about actresses *with* government positions

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Distractor setting

Full-wiki setting

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Multi-hop	Weak Distractor	**Redundant Evidence (26%)**	Non-compositional one-hop
(27%)	(35%)		(8%)

Q: Kaiser Ventures corporation was founded by an American industrialist who became known as the father of modern American shipbuilding ?

What leads to single-hop?

Multi-hop (27%)	Weak Distractor (35%)	**Redundant Evidence (26%)**	Non-compositional one-hop (8%)

Q: Kaiser Ventures corporation was founded by an American industrialist who became known as the father of modern American shipbuilding ?

P1: Kaiser Ventures corporation was founded by **Henry J. Kaiser** to provide steel plate for the Pacific Coast shipbuilding industry.

Only one founder of Kaiser Ventures; can ignore "American shipbuilding.."

What leads to single-hop?

Multi-hop (27%)	Weak Distractor (35%)	**Redundant Evidence (26%)**	Non-compositional one-hop (8%)

Q: Kaiser Ventures corporation was founded by an American industrialist who became

P1: Kais steel plate fo

Distractor setting ✗ Full-wiki setting ✗

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Research Questions

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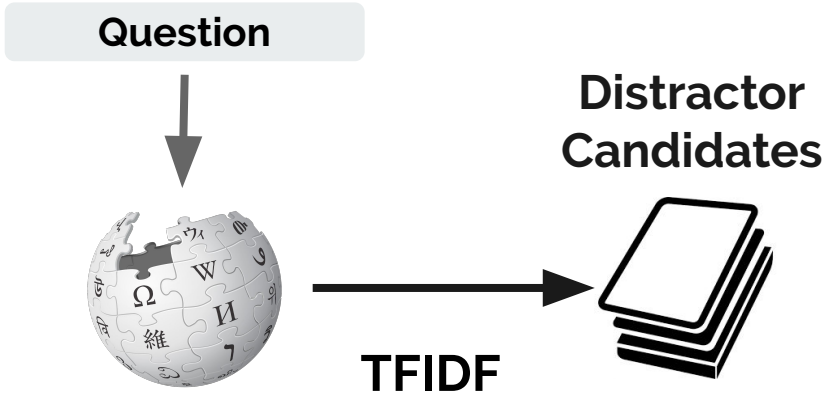
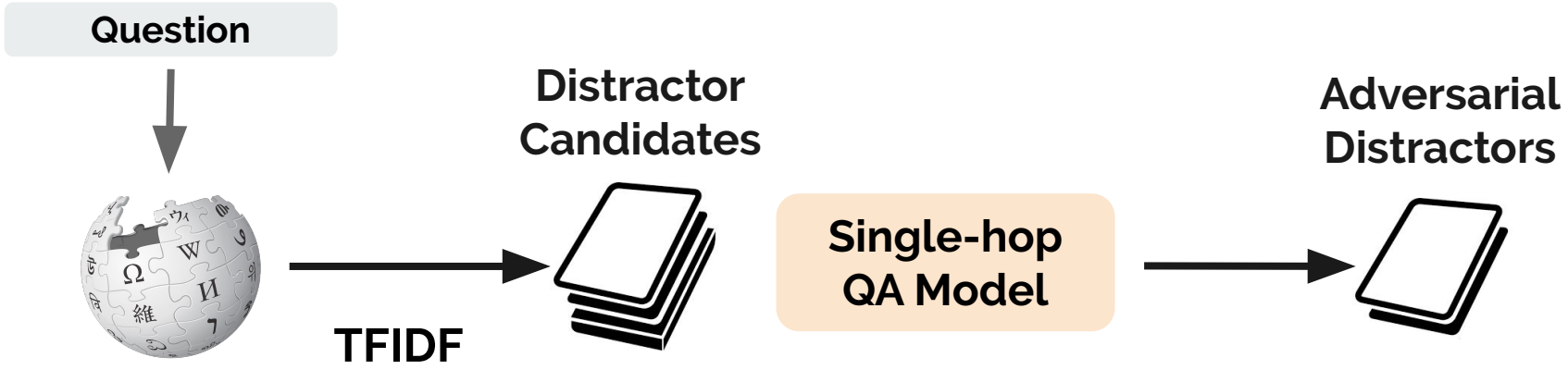
Can We Collect Stronger Distractors?

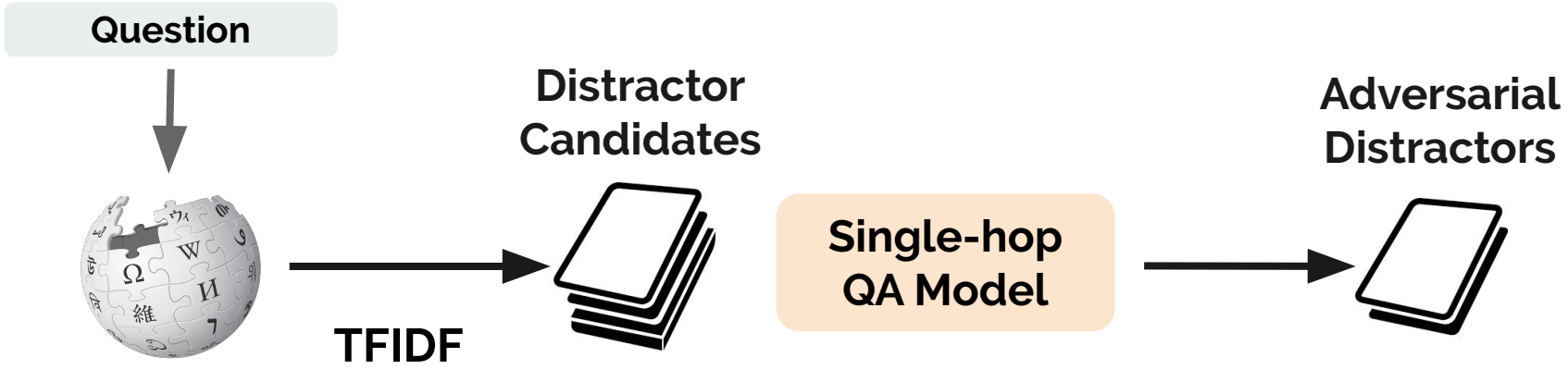


Can We Collect Stronger Distractors?



Paragraphs which confuse single-hop model are those which prevent reasoning shortcut

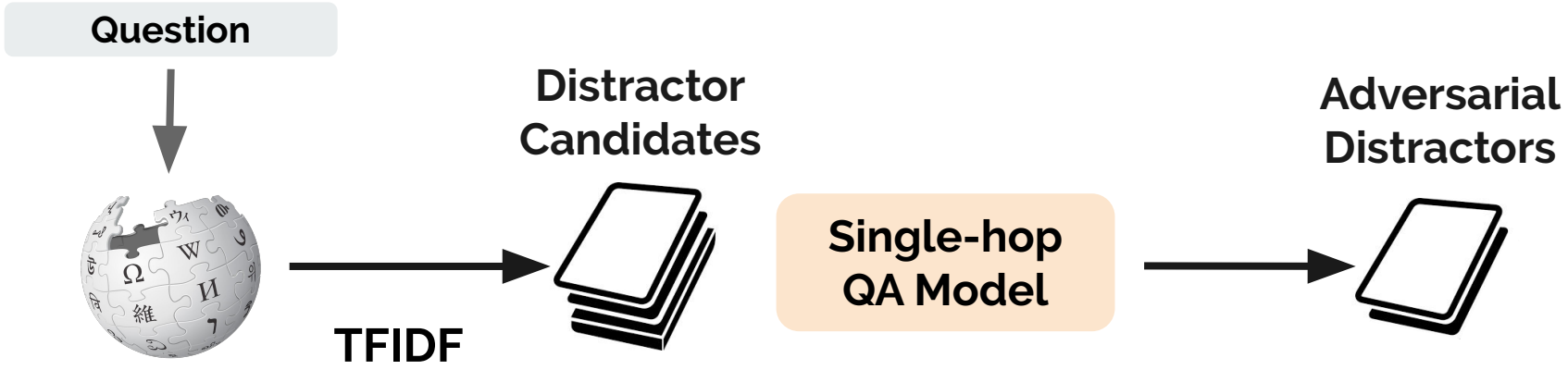
Can We Collect Stronger Distractors?



Paragraphs which confuse single-hop model are those which prevent reasoning shortcut

Original train Original test	Original train Adversarial test
67.1	46.8

Can We Collect Stronger Distractors?



Paragraphs which confuse single-hop model are those which prevent reasoning shortcut

Original train Original test	Original train Adversarial test	Adversarial train Adversarial test
67.1	46.8	60.1

Related Work

Chen & Durrett (NAACL 2019)

- Show that single-hop-only QA model works on par with the state-of-the-art on HotpotQA and WikiHop.

Jiang & Bansal (ACL 2019)

- Reveal reasoning shortcut, and create adversarial examples by editing the contents of the distractors..

Jifan Chen and Greg Durrett. 2019. “Understanding dataset design choices for multi-hop reasoning”. NAACL.
Yichen Jiang, Mohit Bansal, 2019. “Avoiding Reasoning Shortcuts: Adversarial Evaluation, Training, and Model Development for Multi-Hop QA”. ACL.

Related Work

Our work is unique in that...

- Reveal that multi-hop depends on the evidence context.
- Categorize different factors.
- Focus on real, retrieval-based adversarial distractors, and demonstrate standard IR system fails.

Jifan Chen and Greg Durrett. 2019. “Understanding dataset design choices for multi-hop reasoning”. NAACL.
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Takeaways

Open-domain multi-hop QA

- Many single-hop Qs in distractor setting are multi-hop in open-domain setting
- Single-hop QA model is still far from SOTA

Collecting strong distractors for multi-hop

- No obvious way to collect strong distractors
  - May be as difficult as solving open-domain multi-hop QA

Thank you for listening!

Code: https://github.com/shmsw25/single-hop-rc
Paper: https://arxiv.org/abs/1906.02900