Appendix I: More details on mechanical turk interface for the various steps of the question and answer-options creation process

Instructions You need to read a passage and construct questions about the information presented in the passage. For each question, you also need to provide the correct answer. The question should be answerable from the passage. Most importantly, only those questions are allowed whose answer cannot be determined from a single sentence Below are a few example passages and sample questions (and answers). Paragraph: Sent 1: A Republican bid to keep the government open past Friday includes no new money for the construction of a border wall along the U.S.-Mexico border, according to several congressional aides familiar with ongoing talks. Sent 2: GOP leaders submitted the new offer Tuesday afternoon in an effort to appease Democrats, whose votes are needed to avert a shutdown of federal agencies, several House and Senate aides said. Sent 3: However, Republicans also insisted on increases in border security and defense spending, including money to repair existing fencing and new surveillance technology to patrol the nearly 2,000-mile border. Sent 4: Democrats have indicated that they would support such appropriations so long as no money goes toward an actual wall. Here are a few example questions with our criteria: Question: Who has to be appeased to keep the government open? Correct Answer: "Democrats" Sentences needed to answer this question: ☑ 1 ☑ 2 □ 3 □ 4 Explanation: This is multi-sentence question because, "appease Democrats" is mentioned in Sent 2, while "keep the government open" is part of Sent 1. Question: When was the republican bid submitted? Correct Answer: "Tuesday afternoon" Sentences needed to answer this question: ☑ 1 ☑ 2 □ 3 □ 4 Explanation: Republican bid is mentioned in Sent 1 while Tuesday afternoon occurs in Sent 2. Question: Who does not want a border wall? Correct Answer: "Democrats" Sentences needed to answer this question: ☑ 1 ☑ 2 □ 3 □ 4 Explanation: Democrats will be appeased by the new offer (Sent 2). The new offer includes no money for the wall (Sent 1). This implies that Democrats don't want the wall. Here is another example paragraph: Paragraph: Sent 1: Obama was born on August 4, 1961, at Kapi'olani Maternity & Gynecological Hospital in Honolulu, Hawaii. Sent 2: He is the only President to have been born in Hawaii. Sent 3: He was born to a white mother and a black father. Sent 4: His mother, Ann Dunham (1942-1995), was born in Wichita, Kansas, of mostly English descent, with some German, Irish, Scottish, Swiss, and Welsh ancestry. Question: How old was Obama's mother when he was born? Correct Answer: "19" Sentences needed to answer this question: ☑ 1 □ 2 □ 3 ☑ 4 Explanation: Obama was born in 1961. His mother was born in 1942. This question reasoning about time across Sentences 1 and 4 (1961-1942=19) Question: Where was Ann living in August, 1961? Correct Answer: "Hawaii" Sentences needed to answer this question: Explanation: Ann is Obama's mother (Sent 4). She must have been there when Obama was born (Sent 1). Obama was born in Hawaii (Sent 2). Question: Was one of Ann's children a future president? Correct Answer: "Yes' □ 1 🗹 2 🗔 3 🔽 4 Explanation: Ann is Obama's mother (Sent 4). Obama was a future president (Sent 2). Exmple of a bad question: Paragraph: Sent 1: Safti succumbs to Edwina 's charms and falls hopelessly in love with her. Sent 2: Lord Esketh becomes aware of this but Safti saves him from a man-eating tiger during a safari. Question: What is the name of the man who succumbs to Edwina's charms and saves her husband from a man-eating tiger during a safari? Correct Answer: "Safti" Explanation: This is a BAD question because even though it is constructed using phrases from more than one sentence ("succumbs to Edwina's charms" and "a maneating tiger during a safari") but the answer can be guessed by reading ONLY ONE of the two sentences. • For the paragraph below, create at least 3 questions that require multiple sentences (examples above). If you create more than 3 questions, you'd get bonus rewards

· For each generated questions you write the answer in the space followed by the question, as well as denoting what sentences are required for answering it. · Items with * are required.

Sent 1: Earth processes have not changed over time	e.
Sent 2: The way things happen now is the same way	ly things happened in the past.
Sent 3: Mountains grow and mountains slowly wear	r away.
Sent 4: The same process is at work the same as it	was billions of years ago.
Sent 5: As the environment changes, living creatures	is adapt.
Sent 6: They change over time.	
Sent 7: Some organisms may not be able to adapt.	
Sent 8: They become extinct.	
Sent 9: Becoming extinct means they die out compl	letely.
Sent 10: Some geologists study the history of the Ea	arth.
Sent 11: They want to learn about Earths past.	
Sent 12: They use clues from rocks and fossils.	
Sent 13: They use these clues to make sense of eve	
Sent 14: The goal is to place things in the order they	y nappeneo.
Sent 15. They also want to know how long it took to	
Fill out a valid question	
Question: *	
Correct Answer: *	

Figure 6: Instructions and Interface for the Step 1 of the dataset creation process. In this step, we request turkers to write a question and its correct answer for a given paragraph. We emphasize the requirement for multi-sentence questions, and additionally ask them to indicate which sentence ids would be needed for answering the composed question. We also provide two example paragraphs with 3 multi-sentence questions each and the corresponding answers. We also provide an explanation indicating why these questions fit our criteria. Lastly, we provide an example of bad question before asking them to compose questions. We ask them to write 3-5 questions per paragraph but the figure only shows the form for one question.

will be shown a senten	e and a question. For each question,			
 You have to say whet When saying Yes/No when a few example set 	ner (Yes/No) the information provided in do not use any facts other than thos ntences and questions (and answers)	n the sentence is enough to answe e provided in the sentence. Only	r the question. If the answer is yes, you hav use the information given in the sentence.	e to write the correct answ
Sentence: GOP leaders	submitted the new offer Tuesday aftern and Senate aides said.	noon in an effort to appease Demo	crats, whose votes are needed to avert a sh	utdown of federal
Question: Who has to b	e appeased to keep the government of	pen?		
Can the above question	be answered using only the information	provided in the given sentence?		
Yes; the information Not the information	provided in the sentence is enough to a	nswer the question.		
Answer:	rovided in the sentence is not enough	to answer the question.		
the Democrats				
Sentence: His mother, J	nn Dunham (1942–1995), was born in	Nichita, Kansas, of mostly English	descent, with some German, Irish, Scottish	, Swiss, and Welsh
Question: How old was	Obama's mother when he was born?			
Can the above question	be answered using only the information	n provided in the given sentence?		
No; the information p Answer:	rovided in the sentence is not enough	to answer the question.		
Type the answer here				
Explanation: The senter stated above, any inform you don't have to write a	ace mentions the birth year of Ann Dun ation other than that mentioned in the iny answer in the box.	nam but it does not say that she is sentence cannot be used to answe	Obama's mother. It also doesn't say when I ar the question. Note that since the respons	ner son was born. As e in this example is "No",
nce: , the city's popula	ion had grown to an impressive 100,0	00.		
tion: When had Rome's	population grown to 100,000?			
ne above question be a	nswered using only the information pro	vided in the given sentence?		
s: the information provi	led in the sentence is enough to answ	er the question.		

Figure 7: Instructions and Interface for the Step 2 of the dataset creation process. This step was included to ensure that the questions collected from the previous step are indeed multi-sentence. In this step we show a sentence and a question to the turkers and ask them if they can answer the question using only the information present in the shown sentence. In the instructions, we discourage them from using background knowledge since some of our paragraphs are from non-fictional sources. We also provide examples along with an explanation. The bottom part of the figure shows the form for one sentence-question pair.

Instructions

Writing Answer Options for a Reading Comprehension Task

You are designing a reading comprehension test for your students. Students will read a paragraph; a question based on the paragraph; and a few options for its answer. They have to choose the correct answer from the options. For the test to make sense, you want the correct answer to be part of the options.

However, you don't want the test to be too easy! To make the test difficult for the students, you want to add incorrect options that might be confused with the correct answer to the list of options. A student who tries to answer a question without reading the paragraph carefully might choose the incorrect option! In this task, your goal is to write the list of options that will be shown to your students.

The questions showed to you in this HIT were written by people and might sometimes contain typing mistakes or other kinds of errors. In such cases, you could additionally check the box underneath the question indicating the "question is bad", and also correct it if possible. The answer-options you write would be in response to the corrected questions.

Below we show some good and bad examples of correct and incorrect options. We also show examples of bad questions

Correct Options: A correct option is one that correctly and completely answers the question. Keep in mind that for any question, there can be multiple correct answers. A bad correct option addresses the question only partially or incorrectly. We want to include only good correct options in the list of options. Here are some good and bad examples of correct options:

Paragraph:

Sent 1: Obama was born on August 4, 1961, at Kapi olani Maternity & Gynecological Hospital in Honolulu, Hawaii,

Sent 2: He is the only President to have been born in Hawaii. Sent 3: He was born to a white mother and a black father.

Sent 4: His mother, Ann Dunham (1942-1995), was born in Wichita, Kansas, of mostly English descent, with some German, Irish, Scottish, Swiss, and Welsh ancestry.

Question: How old was Obama's mother when he was born?

Good Correct options (separated via "//"): 19 // almost twenty

Bad Correct option: 20 Bad Correct option: older than twenty

Explanation: Obama was born in 1961. His mother was born in 1942 and 1961-1942=19. The good options ('19' and 'almost twenty') answer the question correctly.

The bad options give an incorrect answer

Question: Where was Ann living in August, 1961?

Good Correct options (separated via "//"): Honolulu // Hawaii

Bad Correct option: Kansas

Bad Correct option: Scotland

Explanation: Ann is Obama's mother (Sent 4). She must have been there when Obama was born (Sent 1). Obama was born in Hawaii (Sent 2). Hawaii is also in Honolulu. So both Hawaii and Honolulu answer the question correctly. Kansas and Scotland don't answer the question correctly.

Incorrect Options: An incorrect option will be closely related to the content of the paragraph and/or the guestion but will not truthfully answer the guestion. They should not be trivial, in the sense that they should not be easily eliminated as the answer without reading the paragraph. They are presented as options to confuse your students and to make the reading comprehension task challenging for them. Here are some good and bad examples of incorrect options:

Paragraph:

- Sent 1: It was hot that day.
- Sent 2: The temperature on the wall of the backyard was showing something well over 100 F.
- Sent 3: Meanwhile Tom, at home, was trying finish the remainder of carrots from last night, and packing for his trip to Chicago tomorrow. Sent 4: As employees of the Art Museum, Tom and his older cousin often had to travel to Chicago.
- Question: What was the temperature outside, when Tom was eating carrots?
- Good Incorrect options (separated via "//"): Not very hot // Far below 100 F
- Bad Incorrect option: Carrots Bad Incorrect option: Wall

Explanation: The good options appear in the paragraph (at least partially). They are also related to the content of the question (temperature), but do not answer the guestion correctly. Your student will have to carefully read the paragraph to identify that these don't answer the guestion correctly. The bad options appear in the paragraph (e.g. Wall) and sometimes also in the question (e.g. carrots) but they are trivially incorrect. A student can easily determine that they don't answer the question correctly without even reading the paragraph.

Question: What did Tom not visit?

Good Incorrect options (separated via "//"): Tom's older cousin // Art Museum of Chicago

Bad Incorrect option: A flower Bad Incorrect option: Two Chitoz bags

Explanation: The good options are closely related to the content of the paragraph and question, but do not answer the question correctly. Your student will have to carefully read the paragraph to identify that these don't answer the question correctly. The bad options are not in the paragraph at all, and don't challenge the student's comprehension skills.

Bad questions: Sometimes a question could have grammatical errors, typing mistakes, etc. or might not make sense in the context of the paragraph (for instance, it might not be related to the content of the paragraph or not be answerable at all). In such cases, please mark the question as a bad question. If the question contains minor errors please correct it in the boxed space provided underneath the question, otherwise leave the boxed space empty. Here are some examples of bad questions.

Paragraph:

Sent 1: It was hot that day.

Sent 2: The temperature on the wall of the backyard was showing something well over 100 F.

Sent 3: Meanwhile Tom, at home, was trying finish the remainder of carrots from last night, and packing for his trip to Chicago tomorrow. Sent 4: As employees of the Art Museum, Tom and his older cousin often had to travel to Chicago.

Question: What was the temperature outside, when Pom was eating carrots?

Is this a bad question?

Corrected Question, if bad: What was the temperature outside, when Tom was eating carrots? Explanation: It is easy to identify that there is a typing mistake, and Pom should be Tom.

Question: When did Tom walk out of the party?

Is this a bad question?

Corrected Question, if bad

Explanation: The question doesn't make sense for this paragraph. The paragraph does not discuss Tom attending any party. So, this is a bad question and cannot be corrected.

 Paragraph: Sent 1: Convicted murderer Seth Baxter awakens chained to a table beneath a pendulum blade . Sent 2: A videotape informs him that crushing his hands between the presses will release him ; he does so , but the blade still swings down and violently cuts him in half , while someone watches through a hole in the wall . Sent 3: The scene cuts to Agent Peter Strahm , who kills Jeff Denlon in self-defense and is sealed in the sickroom . Sent 4: He finds a hidden passage with a tape recorder that warns him to stay in the sickroom , but ignores it . Sent 5: He is attacked by a pig-masked figure in the passage and awakens with his head sealed in a box slowly filling with water , which he survives by performing a tracheotomy using a pen . Sent 6: Outside the plant , Detective Mark Hoffman delivers Corbett Denlon to the police and claims they are the only survivors , and is shocked when Strahm is brought out alive as well . Sent 7: Jill Tuck is met by John Kramer 's attorney , who is administering his will . Sent 9: She opens it with a key hung around her neck and then leaves without disclosing its contents . Sent 9: She opens it with a key hung around her neck and then leaves without disclosing its contents . Sent 11: He is informed of the death of Agent Lindsey Perez while taking Strahm 's phone and goes to the hospital to meet Strahm , who says that Hoffman 's name was Perez's last words .
Question: Whose death was Hoffman informed of? Correct Answer(s) (separated via "//") Incorrect Answer(s) (separated via "//")

Figure 8: Instructions and Interface for the Step 3 of the dataset creation process. This step was included to collect correct and in-correct answer options for the questions in our dataset. In the instructions we define what we mean by correct and incorrect answer options– correct options answer the given question correctly and completely, whereas incorrect options do not answer the question but are non-trivial and cannot be easily eliminated as an incorrect answer without reading the passage. We also show examples of good and bad inputs for both along with explanations. The bottom part of the figure shows the form for entering correct and incorrect answer-options for one paragraph-question pair.

nstructions	
Answering	a Reading Comprehension Task
ou are answering	a reading comprehension test. You will read a paragraph and some questions, and a few options for its answer. You will have to choose the correct answer(
om the options.	any more than and option and answer the question correctly and completely. In these cases, places select all such options
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iere is an exampl	3:
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He is the only	rrier August 4, 1991, at Rapiolani Materiniy a Gynecologica nospital in Foroizut, navali. President to have been born in Hawaii. He was born to a white mother and a black father. His mother. Ann Dunham (1942-1995), was born in Wichita. Kansas.
of mostly Engl	sh descent, with some German, Irish, Scottish, Swiss, and Welsh ancestry.
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teenager	/ OIU WAS ODAINA'S MOUNER WHEN HE WAS DOTH /
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Explanation: (Deama was born in 1961. His mother was born in 1942 and 1961-1942=19. The good option (almost twenty) answers the question correctly. The bad answers
give an incorre	ct answer.
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Question: Who	ve was Avin invirig in August, 1961 r I Matemity
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Figure 9: Instructions and Interface for the Step 4 of the dataset creation process. In this step we ask the annotators to read the questions and answer-options, and indicate if they find any errors in them. We also ask them to select all answer-options that correctly answer the question (illustrated through examples). Any possibly discrepancies or errors were later reviewed and corrected manually. The bottom part of the figure shows a sample form for one question.

Appendix II: Examples from the corpus

Sent 1: Dirk Diggler was born as Steven Samuel Adams on April 15, 1961 outside of Saint Paul, Minnesota.
Sent 2: His parents were a construction worker and a boutique shop owner who attended church every Sunday and
believed in God.
Sent 3: Looking for a career as a male model, Diggler dropped out of school at age 16 and left home.
Sent 4: He was discovered at a falafel stand by Jack Horner.
Sent 5: Diggler met his friend, Reed Rothchild, through Horner in 1979 while working on a film.
Question: How old was Dirk when he met his friend Reed?
A)* 18 B) 16 C) 22
Reasoning needed: Temporal and mathematical reasoning
One needs to identify that Dirk was born in 1961 (Sent 1) and he met Reed in 1979 (Sent 5). At that time he must have
been 18 (=1979-1961) years old.
Sent 1: The hijackers attacked at 9:28.
Sent 2: While traveling 35,000 feet above eastern Ohio, United 93 suddenly dropped 700 feet.
Sent 3: Eleven seconds into the descent, the FAA's air traffic control center in Cleveland received the first of two radio
transmissions from the aircraft.
Sent 4: During the first broadcast, the captain or first officer could be heard declaring "Mayday" amid the sounds of a
physical struggle in the cockpit.
Sent 5: The second radio transmission, 35 seconds later, indicated that the fight was continuing.
Sent 6: The captain or first officer could be heard shouting: "Hey get out of here-get out of here-get out of here."
Sent 7: On the morning of 9/11, there were only 37 passengers on United 93-33 in addition to the 4 hijackers.
Sent 8: This was below the norm for Tuesday mornings during the summer of 2001.
Sent 9: But there is no evidence that the hijackers manipulated passenger levels or purchased additional seats to
facilitate their operation.
Sent 10: The terrorists who hijacked three other commercial flights on 9/11 operated in five-man teams.
Sent 11: They initiated their cockpit takeover within 30 minutes of takeoff.
Sent 12: On Flight 93, however, the takeover took place 46 minutes after takeoff and there were only four hijackers.
Question: Which two factors were different between the three other hijacked planes and United 93?
the day of the takeover
A) The amount of time that passed before the takeover started
B)* United 93 took longer and had less hijackers
C) The airline operating the planes
D) The weather and fuel used by the airplane
E) The navigation system used by the planes
Reasoning needed: Discourse relation (contrast)
One needs to identify that the discourse marker <i>however</i> in Sent 12 indicates a contrast relation between Flight 95 and the disclosure of billion of the sent 10. Also, while Sent 12 indicates that the number of billions are found for a formation of the sent 10.
the fights mentioned in Sent 10. Also, only in Sent 12 indicates that the number of injackers were rewer than in the
Concretion Whet was below average for this particular dow?
A) the number of passengers in the first class
A) the number of passengers in the first class.
C) the number of biaschers
D) the amount of air traffic in the skies
B) the temperature
Reasoning needed: Event coreference
One needs to identify that <i>This</i> in Sent 8 co-refers to (event of) number of passengers in Sent 7. Note that Sent 12
contains only four hijackers and understanding that only indicates a smaller number of entities than expected (as in
previous question), might mislead a system into believing that (C) is the correct answer.
Figure 10: Examples from our MultiRC corpus. Each example shows relevant excerpts from a paragraph; mu

Figure 10: Examples from our MultiRCcorpus. Each example shows relevant excerpts from a paragraph; multisentence question; and corresponding answer-options. The correct answer(s) is indicated by a *. Each example also contains a list of reasoning phenomenon needed to answer that question.

Sent 1: Suddenly, Amy screamed. Sent 2: I whirled around and threw up my arm just in time to knock Dvorov away. Sent 3: His eyes were glowing red, and he had bared a set of fangs that could probably take my hand off. Sent 8: On the floor was Dvorov's head, separated from his body by several feet and a growing puddle of dark blood. Sent 9: Nepthys stood over him with a blue sword in his hand. Sent 10: It flashed in the strobe where it wasn't streaked with Dvorov's blood. Question: Who cut off Dvarov's head? A)* Nepthys B) the wolf Reasoning needed: Implicit semantic role (agent) and causation From sentences 8-10, indicate that Nepthys stood over Dvorov's (dead) body with a sword which was streaked with Dvorov's blood. Therefore, one can infer that the blood on the sword must have been caused by the action of killing of Dvorov and that Nepthys is the implicit agent of this action. Question: What was the weapon used to separate Dvorov's head from his body? B)* a blue sword C)* a sword A) a hook Reasoning needed: Implicit semantic role (instrument) and causation From sentences 8-10, indicate that Nepthys stood over Dvorov's (dead) body with a sword which was streaked with Dvorov's blood. Therefore, one can infer that the blood on the sword must have been caused by the separation of Dvorov's head from his body and that the sword must have been the implicit instrument of this action.

Figure 11: More example questions and corresponding reasoning phenomena from our MultiRCcorpus.