BoolQ: Exploring the Surprising Difficulty of Natural Yes/No Questions

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Motivation: Inference

- Humans can infer many things from text

“The Sharks have advanced to the Stanley Cup finals once, losing to the Pittsburgh Penguins in 2016.”

- Pittsburgh has a sports team called the “Penguins”
- The Sharks got second place in 2016
- The Sharks have never won the Stanley Cup
Motivation: Testing Inference is Difficult

● Crowd-sourcing interesting examples can be challenging

“The Sharks have advanced to the Stanley Cup finals once, losing to the Pittsburgh Penguins in 2016.”

● The Sharks advanced to the Stanley cup in 2016

● The Sharks lost to the Pittsburgh Penguins
Motivation: Testing Inference is Difficult

- Recognizing entailment is an artificial task
- Have to make a number of arbitrary decisions:
  - What things are important to infer?
  - How strictly should we define entailment?
  - What kinds of inferential abilities should be tested?
- Hard to interpret results
This Work: Natural Yes/No Questions

- Yes/No questions generated without any prompting
  - No pre-specified source text or topic
  - No knowledge of the answer
  - Not required to write yes/no questions
- Paired with passages selected by independent annotators

Did the US qualify for the World Cup?

Does Tyrion survive in Game of Thrones?
Natural Yes/No Questions

- Often require inference
- Are challenging for existing models
- Have an obvious end-task
- Real-word test of inference
Example

Question: Do all neurons have the same action potential?

Passage: In the early development, the action potential of neurons is initially carried by calcium current. The longer opening times for the calcium channels can lead to action potentials that are considerably slower than those of mature neurons.

Answer: ?
Example

**Question:** Do all neurons have the same action potential?

**Passage:** In the early development, the action potential of neurons is initially carried by calcium current. The longer opening times for the calcium channels can lead to action potentials that are considerably slower than those of mature neurons.

**Answer:** No
The Rest of this Talk

● Dataset Construction
● Dataset Analysis
● Transfer Learning Baselines
Dataset Construction
Collecting Questions

Anonymized Queries

- Are there blue whales in the Atlantic Ocean?
- Is chess a fun game?
- Has a car ever gone the speed of sound?

Heuristic Filtering

- Are there blue whales in the Atlantic Ocean?
- Is chess a fun game?
- Has a car ever gone the speed of sound?

Manual Validation

- Are there blue whales in the Atlantic Ocean?
- Is chess a fun game?
- Has a car ever gone the speed of sound?
Collecting Passages

Are there blue whales in the Atlantic Ocean?

Yes

No

Occasionally blue whales get lost in the Baltic Sea. The remains of two blue whales have been identified in Finland (1964). One 19-meter skeleton was found on the bottom of the Gulf of Finland during the construction of Nord Stream pipeline (1964). The vertebrae of a second individual were recovered from a field near Pori on the coast of the Bothnian Sea in 1942 and identified in the Copenhagen Zoological Museum by Magnus Degerbøll (1964). Radiocarbon dating revealed the former had wandered into the Litorina Sea over 7,000 years ago and perished, while the latter bones were shown to be 800-900 years old (1964).

Pipeline from Natural Questions (Kwiatkowski et al., 2019)
The Dataset

- (Question, Paragraph, Answer) triples where the answer is either “yes” or “no”
- 9.4k train questions
- 3.2k dev/test questions
- 62% “Yes” answers
- 110 average paragraph tokens
- 90% human performance
Dataset Analysis
Question Topics

Other 26.0%
Fictional Events 4.0%
History 5.0%
Law/Government 10.0%
Entertainment Media 22.0%
Nature/Science 22.0%
Sports 11.0%
Paraphrasing (38.7%)

The passage explicitly asserts or refutes what is stated in the question

**Question:** Is Tim Brown in the Hall of Fame?

**Passage:** ...Brown has also played for the Tampa Bay Buccaneers. In 2015, he was inducted into the Pro Football Hall of Fame.

**Answer:** Yes
**Question:** Has the UK been hit by a hurricane?

**Passage:** The Great Storm of 1987 was a violent extratropical cyclone which caused casualties in England, France and the Channel Islands...

**Answer:** Yes
Factual Reasoning (8.5%)

Answering the question requires using world-knowledge to connect what is stated in the passage to the question.

**Question:** Was Designated Survivor filmed in the White House?

**Passage:** The series is... filmed in Toronto, Ontario

**Answer:** No
The passage mentions or describes entities in the question in a way that would not make sense if the answer was not yes/no.

**Question**: Is static pressure the same as atmospheric pressure?

**Passage**: The aircraft designer’s objective is to ensure the pressure in the aircraft’s static pressure system is as close as possible to the atmospheric pressure...

**Answer**: No
We can conclude the answer is yes or no because, if this was not the case, it would have been mentioned in the passage.

**Question:** Did Mickey Rourke win an Oscar for the Wrestler?

**Passage:** In the 2008 film The Wrestler... Rourke received a 2009 Golden Globe award, a BAFTA award, and an Academy Award nomination...

**Answer:** No
Other Inference (25.9%)

The passage states a fact that can be used to infer whether the answer is true or false, and does not fall into any of the other categories.

**Question:** Is the sea snake the most venomous snake?

**Passage:** ...the venom of the inland taipan, drop by drop, is the most toxic among all snakes.

**Answer:** No
Why are Yes/No Question Interesting?

- Rarely factoid
  - Unusual to ask “Was Obama born in 1961?”
- “No” Answers usually have to be inferred
- Easy to use non-trivial kinds of reasoning when labelling them
Simple Baselines

- Majority Guess: 62.2%
- Question-Only BERT_L model: 64.5%
- Passage-Only BERT_L model: 66.7%
- Word-Overlap Model: 62.2%
Transfer Baselines

- Supervised transfer sources:
  - Question Answering (SQuAD, QNLI, NQ)
  - Entailment (MNLI, SNLI)
  - Paraphrasing (QQP)
  - Heuristic Y/N data (MSMarco)
- Supervised tasks are used to pre-train a standard recurrent + co-attention model (see paper for details)
- Recent unsupervised transfer methods (BERT, OpenAI GPT, ELMo)
No Transfer

Majority: 62.2
RACE: None
SQuAD 2.0: 69.6
QQP: Heuristic Y/N
QNLI: ELMO
NQ: OpenAI GPT
SNLI: MultiNLI
BERT
Paraphrasing

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Test Set Results

- Majority: 62.31
- Recurrent: 67.52
- Recurrent + MNLI: 74.24
- BERT: 76.7
- BERT + MNLI: 80.43
Thank You

Data: goo.gl/boolq
Will become part of the SuperGLUE benchmark (Wang et al., 2019)
  ○ super.gluebenchmark.com