Chatbot with BERT

Activity Guide

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David S. Touretzky

Carnegie Mellon University

NEOM

Chatbot with BERT Activity

Summary

Implement a simple chatbot that represents a character in a story and can answer questions about itself and the story. This activity uses the question answering version of the BERT language model.

Grade Bands: 6-8, 9-12

Learning Objectives

Construct a chatbot using the BERT question answering Scratch extension in Machine Learning for Kids. Students will be able to:

- Explain how the question answering process works.
- Experiment with BERT by formulating questions that reference the text and seeing if the model can answer them.

Materials/Resources Required

- Access to the Machine Learning for Kids website (https://machinelearningforkids.co.uk)
- A suitable story to feed the chatbot.
- Optional: pre-made demo Chatbot with BERT.sb3.

Guidelines and Standards

AI4K12 Guidelines

Big Idea 4: Natural Interaction
4-A-iv: Natural language (Applications)

Other Relevant Educational Standards

Computer Science Teacher Association Standards

1A-AP-10 K-2	Develop programs with sequences and simple loops, to experess ideas or address a problem.
1A-AP-14 K-2	Debug (identify and dix) errors in an algorithm or program that includes sequences and simple loops.
1A-AP-09 K-2	Model the way programs store and manipulate data by using numbers or other symbols to represent information

1B-AP-09 3-5   Create programs that use varibales to store and modify data.

1B-AP-10 3-5   Create programs that include sequences, events, loops, and conditionals.

2-AP-11 6-8   Create clearly named variables that represent different data types and perform operations on their values.

2-AP-12 6-8   Design and iteratively develop programs that combine control structures, including nested loops and compound conditionals.

2-AP-14 6-8   Create procedures with parameters to organize code and make it easier to reuse.

2-AP-16 6-8   Incorporate existing code, media, and libraries into original programs, and give attribution.

3A-AP-14 9-10   Use lists to simplify soultions, generalizing computational problems instead of repeatedly using simple variables.

3A-AP-15 9-10   Justify the selection of specific structures when tradeoffs involves implementation, readability, and program performance, and explain the benefits and drawbacks of choices made.

3A-AP-18 9-10   Create artifacts by using procedures within a program, combinations of data and procedures, or interrelated programs.

3A-AP-16 11-12   Demonstrate code reuse by creating programming solutions using libraries and APIs.

Other Relevant Activities

1. Intelligent Assistant with Keywords) (Cognimates)
2. Intelligent Assistant with Keywords (ML4K)
3. Word Embeddings

Vocabulary Terms

**Flashcards for these vocabulary terms are located at the end of this guide.**
- Chatbot
- Language model
- Transformer Neural Network

What Is A Language Model?

A language model is a neural network model that captures the statistics of how words in a given language (such as English) are related to each other. Language models are constructed by exposing the neural network to huge bodies of text, such as all of Wikipedia, and asking it to perform tasks such as predicting the missing word(s) in a sentence. Once trained, language models can be adapted to perform many other language tasks, such as sentiment analysis (determining whether a passage of text is expressing a positive, negative, or neutral view) or question answering. BERT (Bidirectional Encoder Representations from Transformers) is a language model developed by Google. The version of BERT used in this activity performs "extractive question answering": it answers questions about a text by identifying a sequence of words from the text.

Setup

1. Go to the Machine Learning for Kids website (https://machinelearningforkids.co.uk).
2. Click on "Get started".
3. If you have an account, click on "Log in". Otherwise click on "Try it now".
4. Click on the "Pretrained" link in the top nav bar.
5. Click on the "Get started" button or the "Scratch 3" link (they do the same thing).

6. In the bottom left corner of the Scratch window is a blue button labeled "Add Extension". Click on that button.

7. Scroll down until you see the "Question Answering" extension, and click on that:

Question Answering
Finds the answer to a question in some text

Collaboration with
ML for Kids
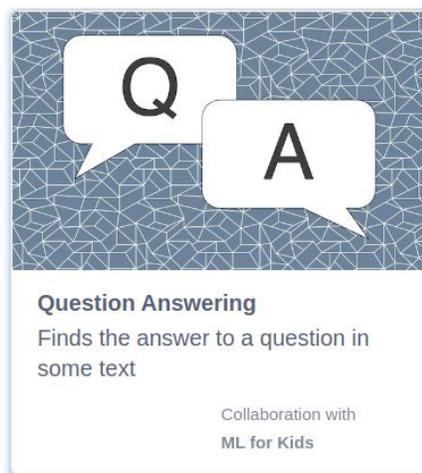
Programming
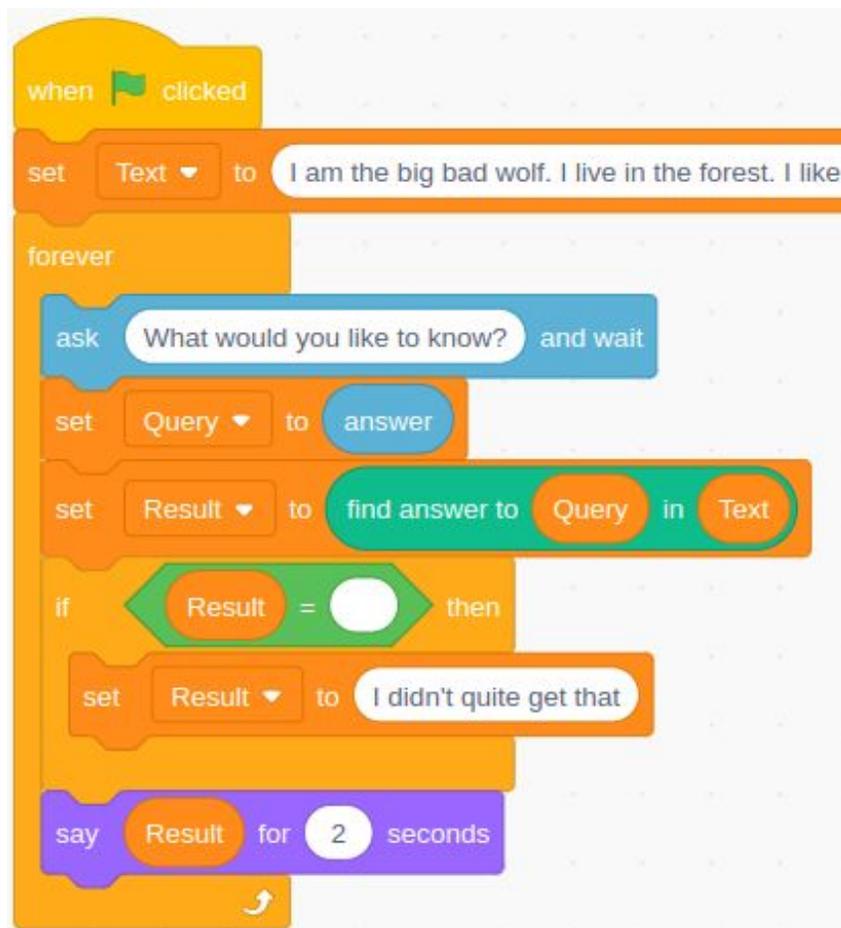
1. Create three new variables called "Text", "Query", and "Result".

2. Uncheck the box for Text so its value is not displayed on the canvas.

Variables

Make a Variable

- my variable
- ☑ Query
- ☑ Result
- Text
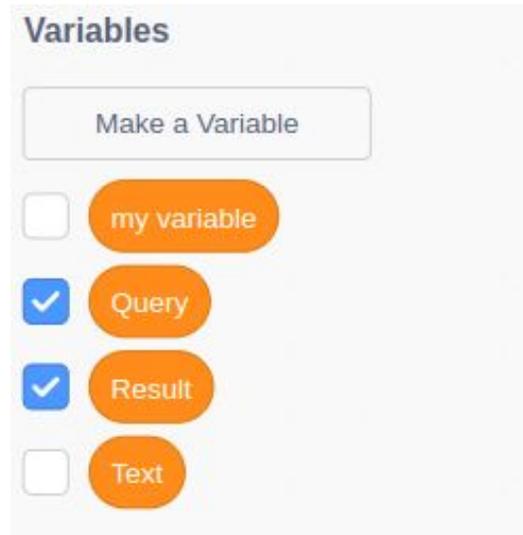
3. Select the text of your story. Here is the example we're using:

> *I am the big bad wolf. I live in the forest. I like to eat little children. I met Little Red Riding Hood when she went to visit her grandmother.*

4. Enter the following Scratch code. Note that the comparison "Result = __" is comparing the variable Result against the empty string; you must erase the default value of 50.

```
when [flag] clicked
set Text to (I am the big bad wolf. I live in the forest. I like t...)
forever
    ask (What would you like to know?) and wait
    set Query to (answer)
    set Result to (find answer to (Query) in (Text))
    if <(Result) = ()> then
        set Result to (I didn't quite get that)
    say (Result) for (2) seconds
```

Running the Program

Click on the green flag to run the program. Type questions to your chatbot, such as "Where do you live?", and see if it can answer them. Because BERT is a language model, not a simple keyword matching program, you can phrase a question in several different ways, using different vocabulary, and it will usually understand it.

Questions Your Chatbot Can Answer

Who are you?
What is your name?   } **Same meaning, different words**
What are you called?

Who is big?
Who is bad?

Where do you live?
Where do you reside?   } **Same meaning, different words**
Where is your home?

What do you eat?
What do you consume?
What do you like?
What do you do with children?
What kind of children do you like?

Who did you meet?

When did you meet Little Red Riding Hood?
Who did she visit?
Who did Little Red Riding Hood visit?
Who visited her?
Who visited her grandmother?
Who visits a grandmother?
Who visited her grandma?
Who went to visit her grandmother?
Where did she go?

Things to notice:

- Words with similar meanings are recognized successfully, e.g., eat/consume, live/reside, grandmother/grandma.

- Successful queries are things that match a segment of the original text and can be answered by quoting another segment of the original text. That's because this version of BERT was trained on an "extractive question answering" task.

Limitations of the Chatbot

- The chatbot cannot handle yes/no questions, because they can't be answered by quoting a segment of the original text.

- The chatbot has trouble with questions that require inference, such as reasoning that if the wolf lives in the forest, then the wolf is in the forest.

Questions Your Chatbot Cannot Answer (as of October 2022)

Do you live in the forest?
Do you eat children? 　　　　　　　**Yes/No questions: not extractive**
Did you meet Little Red Riding Hood?

Who lives in the forest?
Who is in the forest?
Where are you?
Where is the big bad wolf?
Who has a grandmother?
Who visited a grandmother?
Where did Little Red Riding Hood go?
What is red?
What color is the riding hood?

Why do you think the chatbot can't answer these questions that a human could answer?

Make It Your Own

Make up a short story of your own and try it with the chatbot. Try to find all the questions it can answer successfully, and all the ones that it cannot answer although a human could.

Assessments
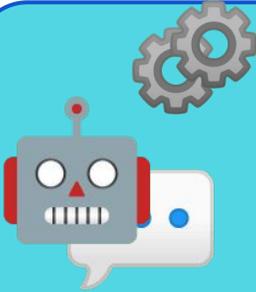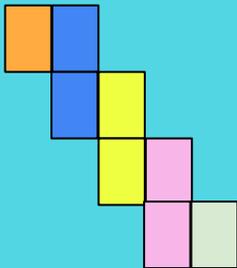
To be determined.

Other resources
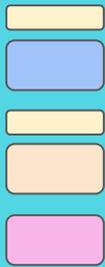
Vocabulary Flash Cards

CHATBOT

A computer program designed to simulate conversation with human users, especially over the internet.

LANGUAGE MODEL

A statistical model of language, trained on a large body of text, that captures the patterns of how words fit together.

TRANSFORMER NETWORK

A type of neural network that uses many layers of neurons to learn complex representations of language, such as in a language model.