Question Answering Using a Domain Specific Knowledge Base

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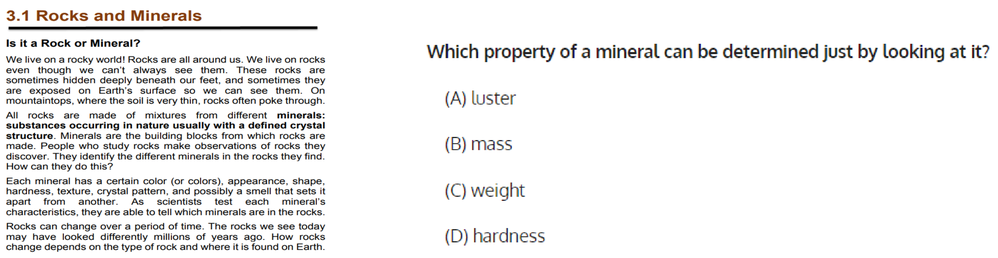
OVERVIEW



3.1 Rocks and Minerals

Is it a Rock or Mineral?

We live on a rocky world! Rocks are all around us. We live on rocks even though we can't always see them. These rocks are sometimes hidden deeply beneath our feet, and sometimes they are exposed on Earth's surface so we can see them. On mountaintops, where the soil is very thin, rocks often poke through.

All rocks are made of mixtures from different **minerals: substances occurring in nature usually with a defined crystal structure**. Minerals are the building blocks from which rocks are made. People who study rocks make observations of rocks they discover. They identify the different minerals in the rocks they find. How can they do this?

Each mineral has a certain color (or colors), appearance, shape, hardness, texture, crystal pattern, and possibly a smell that sets it apart from another. As scientists test each mineral's characteristics, they are able to tell which minerals are in the rocks.

Rocks can change over a period of time. The rocks we see today may have looked differently millions of years ago. How rocks change depends on the type of rock and where it is found on Earth.

Which property of a mineral can be determined just by looking at it?

(A) luster

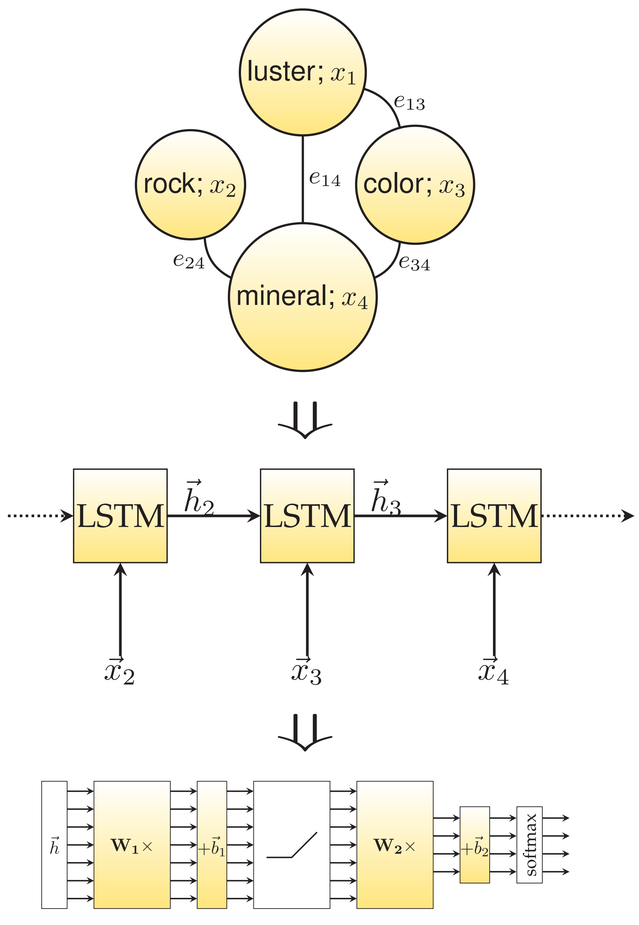
(B) mass

(C) weight

(D) hardness

Part of a textbook and an example multiple choice question

KNOWLEDGE BASE



The Graph Neural Network [1, 4] consists of nodes of word2vec [3] embeddings of unique words found in the textbook and question and answer pairs.

Based on question and answer sentences the LSTM picks out the word embeddings and filters them through to create a sentence embedding at its last hidden state.

Then a simple MLP scores the pairs on relatedness. The model is trained on both sentences found in the textbook and on training multiple choice questions provided by the AI2 Reasoning Challenge (ARC).

READING STRATEGIES

To train the model to extract knowledge from the corpus of information and the question and answer pairs, the reading strategy of switching the second half of the sentence was used [5]. For a corpus sentence four training sentences might look like

- Minerals are the building blocks FROM WHICH ROCKS ARE MADE.
- Minerals are the building blocks THEY DO THIS?
- Minerals are the building blocks MILLIONS OF YEARS AGO
- Minerals are the building blocks ALL AROUND US.

The correct sentence is in the first position. For question and answer pairs a similar thing is done but concatenating each answer onto the end of the question to produce four sentences of question ANSWER. This allows the model to learn word associations in the LSTM/ MLP part within sentences while the message passing part of the Graph Neural Network allows the embeddings to share knowledge between sentences. This how I make the "leap of logic."

TESTING AND FUTURE RESEARCH

The ARC corpus consists of ∼14 million sentences about 4th grade science, selected from textbooks and wikipedia articles about 4th grade science. The questions are split into EASY and CHALLENGING. The EASY questions can be answered by search-proximity methods. The CHALLENGING questions require a 'leap of logic'.

This method achieves an accuracy of _ on EASY questions and _ on CHALLENGING questions. This allows for much improvement in future work:

- Bi-LSTM to create forwards and backwards sentence embeddings.
- Penalization to force created sentence embeddings to be close to BERT embeddings using embedding learning [2].
- Highlighting embeddings by using attention. While messaging in Graph Neural Network train edges to multiply by elementwise-weights [5].

REFERENCES

[1] Battaglia, Peter W., et al. "Relational inductive biases, deep learning, and graph networks." arXiv preprint arXiv:1806.01261 (2018).

[2] Dai, B., Shen, X. (2019). Embedding learning.

[3] Mikolov, Tomas, et al. "Distributed representations of words and phrases and their compositionality." Advances in neural information processing systems. 2013.

[4] Scarselli, Franco, et al. "The graph neural network model." IEEE Transactions on Neural Networks 20.1 (2009): 61-80.

[5] Sun, Kai, et al. "Improving machine reading comprehension with general reading strategies." arXiv preprint arXiv:1810.13441 (2018).