

Question Answering Medical Chat-bot

*Note: Sub-titles are not captured in Xplore and should not be used

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Abstract—This paper proposes an Ai chatbot framework that based on text similarity model. to help answering complex medical questions. the chatbot system implements a novel text representation and similarity deep learning model, Hierarchical BiLSTM Attention Model (HBAM),to find the most similar question from a large QA dataset. We train and test the models with a subset of the Quora duplicate questions dataset in the medical area. The experimental results show that our model is able to achieve a superior performance than these existing methods.

Index Terms—

I. INTRODUCTION

Difficulty in seeing a doctor, long queuing time, and inconvenience of making appointments have long been hurdles facing patients when they try to access primary care services. Adding also that the whole world is suffering until now from the global health crises Covid-19.

II. PROBLEM STATEMENT

All of this increases the need of doctors to cover the growth of healthcare needs. so, governments and health care providers around the world are investing in new methods that facilitate more effective use of resources to meet demands. in the hope to better harness the power of digital medical data and information technology to deliver enhanced services.

III. PROPOSED SOLUTION

Artificial intelligence plays a crucial role in the advancement of information technology to improve healthcare service quality and efficiency. In particular, chatbots amount to one of the most popular AI technologies for this purpose. A chatbot is a software system that consists of an interactive interface with patients or medical practitioners to provide a range of knowledge extraction tasks and real-time, personalized feedback. Chatbot technologies have been rapidly developed, especially in the medical field. Many medical chatbot systems have been proposed over the years. Typical applications of chatbot include medical assistants that help patients to identify their symptoms, medical service front desks that direct the

patient to suitable healthcare service departments, i.e., doctors, and so on. Our work aligns with the main themes of medical chatbot technology and aims to serve three main objectives: The first objective is to reduce waste on resources and time for users when accessing information with chatbot technologies. We aim to maximally help users to search for the necessary information with a human-like interface. The second objective is to provide more precise answers to ordinary users who have little domain knowledge. In other words, we hope that with AI technologies, the system can understand the meaning of the natural language and be able to reply with high-quality feedback accordingly. The third objective is to make it easier to manage and extend the features and databases. We want to design a system with a flexible and scalable structure to enable efficient management of the functionality and datasets.

IV. PROPOSED SOLUTION FRAMEWORK

The diagram below of the new hierarchical BiLSTM Attention model we proposed is shown below in Figure 1. It is designed for semantic similarity comparison. The whole structure based on a Siamese LSTM framework . We apply one BiLSTM layer and one word attention layer into the Siamese framework. The bottom left, and the right sentences represent user input query and the question from the QA dataset. The two questions will be represented by using word embedding firstly and then using BiLSTM to form the whole sentence embedding based on the context. After that, each BiLSTM encoder will be multiplied by a word attention value, which can be assumed as a weight to highlight the key-point in a sentence. Context vector will be combined with attention to understanding the sentence representation.

A. Model Structure

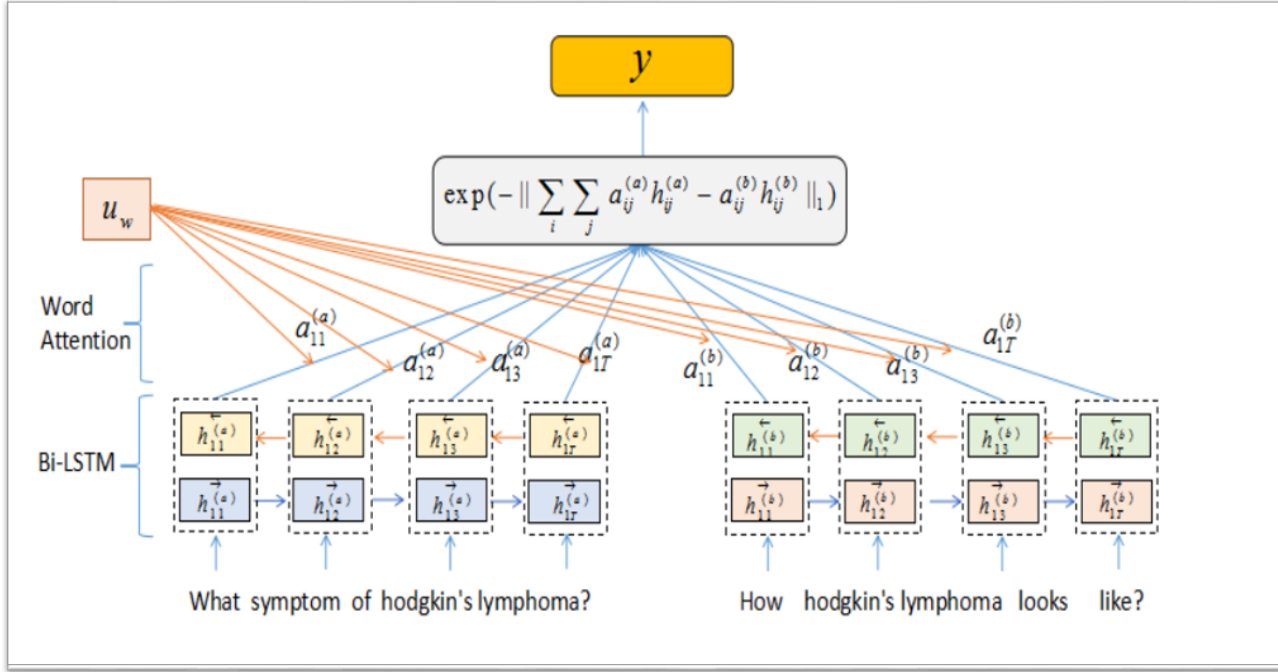


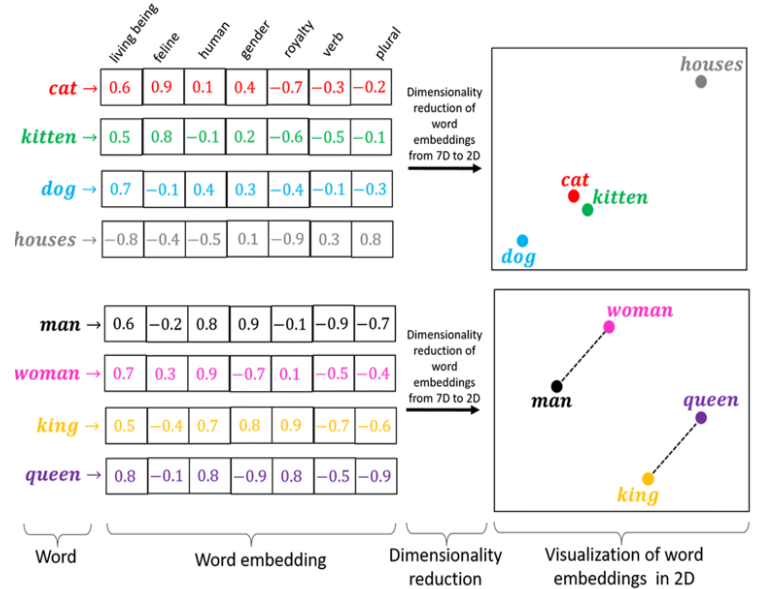
Figure1: Hierarchical BiLSTM Attention Model

B. Embedding equation

Word Embeddings are a numerical vector representation of the text in the corpus that maps each word in the corpus vocabulary to a set of real valued vectors in a pre-defined N-dimensional space.

$$x_{it} = W_e w_{it}, t \in [1, T]$$

The Word Embeddings try to capture the semantic, contextual and syntactic meaning of each word in the corpus vocabulary based on the usage of these words in sentences. Words that have similar semantic and contextual meaning also have similar vector representations while at the same time each word in the vocabulary will have a unique set of vector representation.

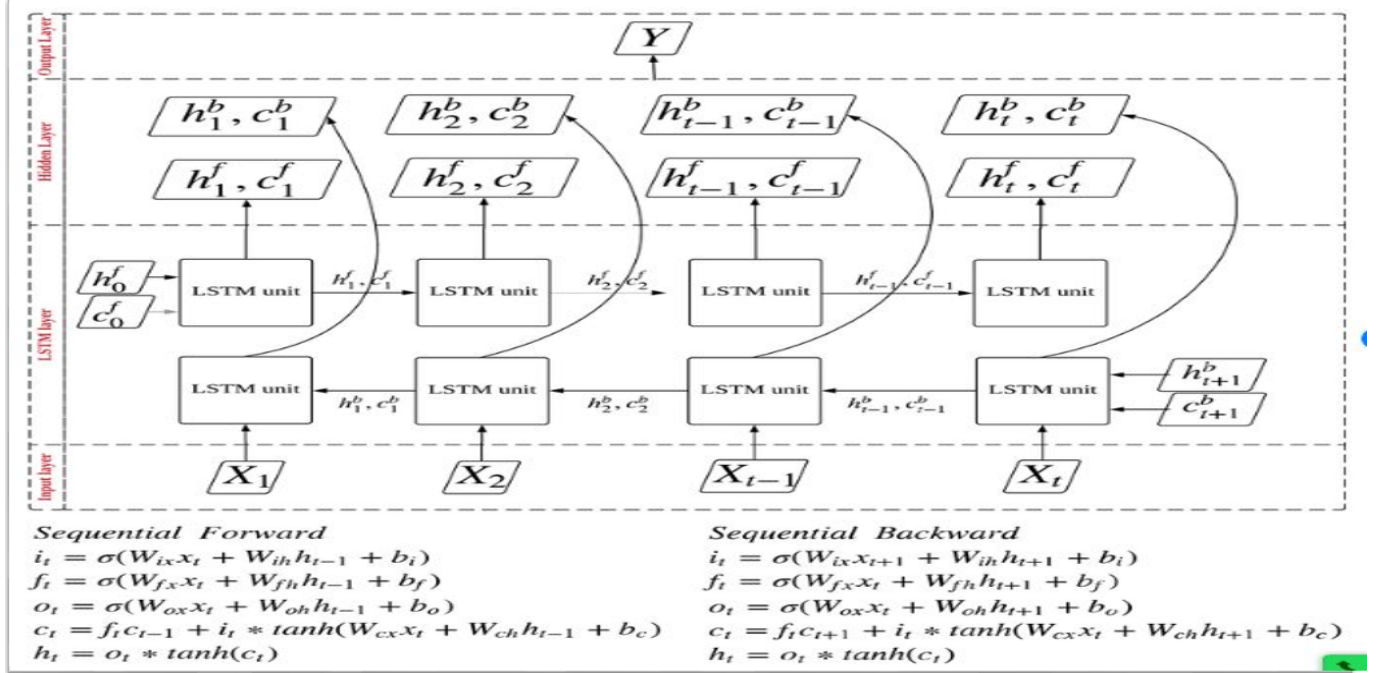


C. bilstm Structure equation

We use Bidirectional LSTM to capture both forward and reverse direction information of each word. The bidirectional LSTM contains forward LSTM forward and reverse LSTM backward.

$$\vec{h}_{it} = \text{LSTM}(x_{it}), t \in [1, T]$$

$$\overleftarrow{h}_{ti} = \text{LSTM}(x_{ti}), t \in [1, T]$$



D. Attention equation

We try to use Attention. Firstly, we feed the hit into the tanh function to get uit as a hidden representation of hit. Secondly, we calculate the importance of each word uit and get a normalized importance weight it by using a SoftMax function. Then, we calculate the sentence vector si as a weight sum of each word with its weight

$$u_{it} = \tanh(W_w h_{it} + b_w)$$

$$\alpha_{it} = \frac{\exp(u_{it})}{\sum_t \exp(u_{it})}$$

$$s_i = \sum_t \alpha_{it} h_{it}$$

E. Similarity function

The formula is based on Manhattan distance. From this formula, the representation from two sentences can be represented

$$f(s_i^{(a)}, s_j^{(b)}) = \exp\left(-\left\|\sum_i \sum_j a_{ij}^{(a)} h_{ij}^{(a)} - a_{ij}^{(b)} h_{ij}^{(b)}\right\|_1\right) \in [0, 1]$$

V. EXPERIMENTS

A. Dataset

Train and Test Dataset. , we tried to train model on full Quora medical dataset as a part of our novility but not give us good results. so, we worked on selective Quora research medical dataset and was balanced.

The Quora duplicate questions dataset is an open domain sentence pair dataset. It has more than 400,000 tagged sentence pairs formatted like “text1 text2 is duplicate” means whether the two sentences are semantically similar. If they are semantically equal, the tag will be “1”, otherwise “0”.

For the evaluation we choose Medical Question/Answer datasets ehealthforumQAs,questionDoctorQAs, and webmdQAs

For Selective dataset
train.csv

For full quora dataset
Quora Question Pairs(kaggle)

For evaluation datasets
Medical Question/Answer dataset

id	qid1	qid2	question1	question2	is_duplicate
447	895	896	What are natural numbers?	What is a least natural number?	0
1518	3037	3038	Which pizzas are the most popularly ordered pizzas on Domino's menu?	How many calories does a Dominos pizza have?	0
3272	6542	6543	How do you start a bakery?	How can one start a bakery business?	1
3362	6722	6723	Should I learn python or Java first?	If I had to choose between learning Java and Python, what should I choose to learn first?	1

```
{
  "answer": "hi you are 100 % hiv free good luck",
  "answer_author": "Dr Ahmed Fawzy",
  "question": "is my anti hiv test conclusive or need retest?",
  "question_text": "Is my Anti Hiv Test Conclusive or need retest?",
  "tags": [
    "hiv test"
  ],
  "url": "https://questiondoctors.com/is-my-anti-hiv-test-conclusive-or-need-retest/"
}
```

B. Environment Specs

We have experimented the deep learning models on Google Colab (Tesla P100-PCIE,16GB) to validate the semantic similarity between two sentences.

C. Experiments Results

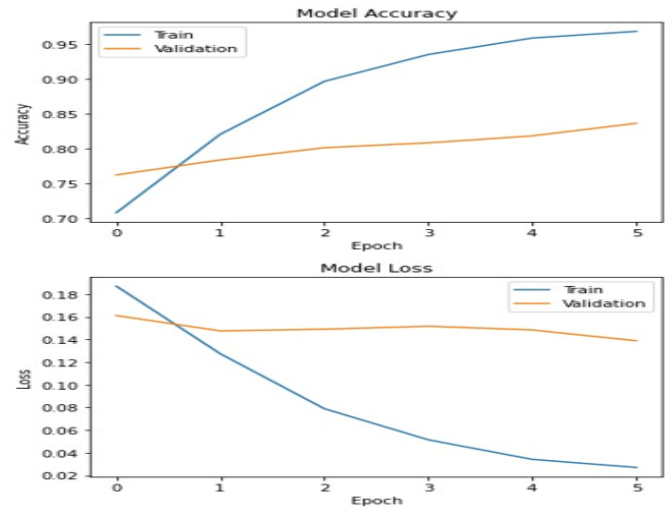
partial experiments report/total experiment count:
approx. 100/Best experiment result with snapshot

Full Dataset = 240000

Batch size	epochs	max seq	embeded dim	Model Drop ou	Hidden Layers	Reults
1024	9	62	300	0.1	50	77%
1024	6	62	300	0.1	50	78%
512	25	62	300	0.1	50	77%
512	20	62	300	0.1	50	76%
64	25	62	300	0.1	50	77%
64	20	62	300	0.1	50	78%
64	15	62	300	0.1	50	78.50%
64	12	62	300	0.3	100	79%

Filtered balanced Dataset =10000

Batch size	epochs	max seq	embeded dim	Model Drop ou	Hidden Layers	Reults
1024	9	32	300	0.3	100	80%
1024	15	32	300	0.3	100	81%
512	10	32	300	0.3	100	81%
512	15	32	300	0.3	100	80%
64	25	32	300	0.3	100	80%
64	15	32	300	0.3	100	82%
64	10	32	300	0.3	100	82.50%
64	6	32	300	0.3	100	83.00%
64	6	32	300	0.5	100	82.55%
64	6	32	300	0.2	100	83.4%-83.65%
64	6	32	300	0.1	100	81.50%
64	6	10	300	0.2	100	83%



D. Best experiment result

This is our best experiment result we got in the below snapshot Comparing to the research paper their Final result : max seq length 10, batch size 1024, n epoch 9, n hidden 50, Dropout 0.1 Average accuracy by 30 times experiments: 0.8043

Baseline result

Batch size	epochs	max_seq	embeded_dim	Model Drop ou	Hidden Layers	Reults
1024	9	10	30	0.1	50	80.43

Best result in our experiment

Batch size	epochs	max_seq	embeded_dim	Model Drop ou	Hidden Layers	Reults
64	8	32	300	0.2	100	83.4%-83.85%

E. Qualitative Results

Our Qualitative result as per below figure as we found similar words in both questions like ear, pain and infection

input Q	Related Q	Related Q, pr ediation	Related Q, tag :	Related Q, answer	Related Q, index
Hi I'm swollen through the stomach, neck and face. I have no energy like I used to?	neck inflammation and head tension affecting my life	0.98146	["neck inflammation"]	I suggest you do neck exercises to strengthen the neck muscles apply local gel heat fomentation apply cervical collar thanks	5542
I have had a loud high pitched ringing in both of my ears for the past year now?	ear pain in my right ear	0.89577	["ear pain"]	hi, if the doctor says its not infection then it may be neuritis a inflammation of the nerves inside the ear, consult a ent specialist and get a otoscopy done to see whats wrong, thanks	5451
2 year old girl cannot walk doctors baffled?	two years ago I was diagnosed with colon cancer?	0.89131	["diagnosed with colon cancer"]	it is common after surgeries as digestion is not as it used to be before so you should try eating small portions and avoid excess dairy products and increase fiber intake.	850
I had a spider crawl in my ear got out but I was left with an ear infection?	ear pain in my right ear	0.2723	["ear pain"]	hi, if the doctor says its not infection then it may be neuritis a inflammation of the nerves inside the ear, consult a ent specialist and get a otoscopy done to see whats wrong, thanks	5451
Hi I'm a 32 year old male. I had a uti just over a year?	my mom has kidney failure diabetes sarcoidosis heart failure she now has these big knots why?	0.06931	["sarcoidosis"]	hi this is probably swollen lymph nodes from sarcoidosis also if she is on corticosteroids then she can have pumps like this all over if I am here doctor I would not focus on this instead I would focus on the bigger issues good luck	55

F. Novility

as our Team tried to add novelty to this research by trying to enhance the existing model or try another model to get better results and in the following points, we will demonstrate in brief our final efforts that leads to enhance model results and accuracy.

- Preprocessing Data (remove stop words).
- Model hyper parameters drop-out amendment.
- Modify max seq