cmt_research

hw

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In order to create a adequate system that can take on this mission and vision that we shared above, we certainly need to leverage the state-of-art algorithms and even more advanced ones that will be developed soon. Let's first take a look at some methods that might come handy when tackling our problem.

Note that here we will mainly focus on how to possibly set our foot into this problem by exploring muliple existing deep learning algorithms in the related domains.

Why deep learning?

Just as any other problems that can be solved with deep learning, our problem could be simplied as a function that maps the input to the output. Deep learning is known as one of the most flexible machine learning algorithms that can learn and map the **deep representation** from the data and in turn contribute to our unique set of problems i.e. automatic question and answer gnerating or visual question answering problems. Moreover, by leveraging neural network architecture, deep nueral networks architecture can be composed into a single differentiable function and trained end-to-end and they can help identify the suitable *inductive biases* catered to the input data type.

Automatic Question and Answer Generative Methods

Problem Foumlation

The goal of an automatic question generation is to generate a question Q that is syntactically and semantically correct, relevant to the context and meaningful to answer.

In order to achieve this goal,, we need to train an algorithm to learn the underlying conditional probability distribution $P_\theta(Q|X)$ parametrized by θ. Or in other words, we can think of this problem is the one to learn a model θ during training using text-question pairs so that the probability $P_\theta(Q|P)$ is maximized over the given training dataset.

Case Studies:

1. We can think of it as a seq2seq learning problem; In this paper QG-Net: A Data-Driven Question Generation Model for Educational Content. They use a bi-directional LSTM network to process the input context words sequence. Encoding the answer into context word vectors.

QG-Net generates questions by iteratively sampling question words from the conditional probability distribution $P(Q|C, A, \theta)$ where θ denotes the set of parameters. In order to construct the probability distribution, they first create a **context reader** that process each word c_j in the input context and turns it into a fix-sized representation h_j

Then, they used a **question generator** generates the question text word-by-word, given all context word representation and all question words in previous time steps.

As for the quantitative evaluation, they aimed to minimize the difference between the generated question and the true question in the training set during training. Also, they used the standard back-propagation through time with the mini-batch stochastic gradient descent algorithm to learn the model parameters. They employed teacher forcing procedure for training LSTMs. To enhance performance, they also implemented

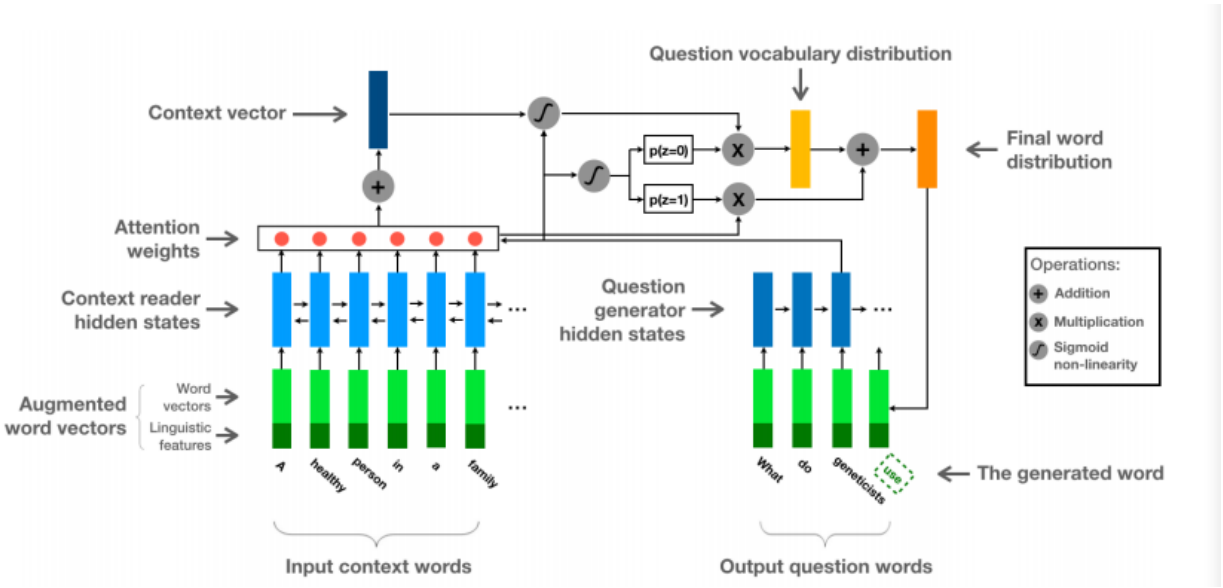

Figure 1: ma

beam search, a greedy but effective approximation to exhausitively search and select the top 25 cancidate output question sentences. The final one would be the one with the lowest negative log likelihood.

The general QG-Net model Architecture is as below:

2. In this summary Learning to Ask, they used a sentence- and paragraph-level seq2seq model to read text from the input content and generate a question about the input sentence.

For the second option, we need to encode both sentence and paragraph that sentence belongs to as input, but only attending source sentence hidden states. The performance could be improved with beam search and UNK replacement.

3. In this paper TOPIC-BASED QUESTION GENERATION, they proposed a topic-based question generation algorithm. The algorithm will be able to take in a input sentence, a topic and a question type; then generate a word sequence related to the topic, question type and the input sentence.

They are formulating a conditional likelihood objective function to achieve this goal.

Also, in the paper, they proposed a few frameworks that were used to tackle this problem. The first type is seq2seq model. This model typically uses a bidirectional LSTM as the encoder to encode a sentence and a LSTM as the decoder to generate the target question. The second approach is question pattern prediction and question topic selection algorithms. It takes in an automatically selected phrase Q and fill this phrase into the pattern that was predicted from pre-mined patterns, which is not done with deep learning.

The last approach is multi-source seq2seq learning which aims to integrate information from multiple sources to boost learning.

4. In this paper A Framework for Automatic Question Generation from Text using Deep Reinforcement Learning they proposed a novel way of solving this problem in which they used a reinforcement learning framework that consists of a generator and an evaluator.

They refer to the generator as the *agent* and the *action* of the agent is to generate the next work in the question. The probability of decoding a word $P_\theta(word)$ gives a stochastic policy.

The evaluator will in turn assign a reward for the output sequence predicted using the current policy of the generator. Based on the reward assigned by the evaluator, the generator updates and improves its current

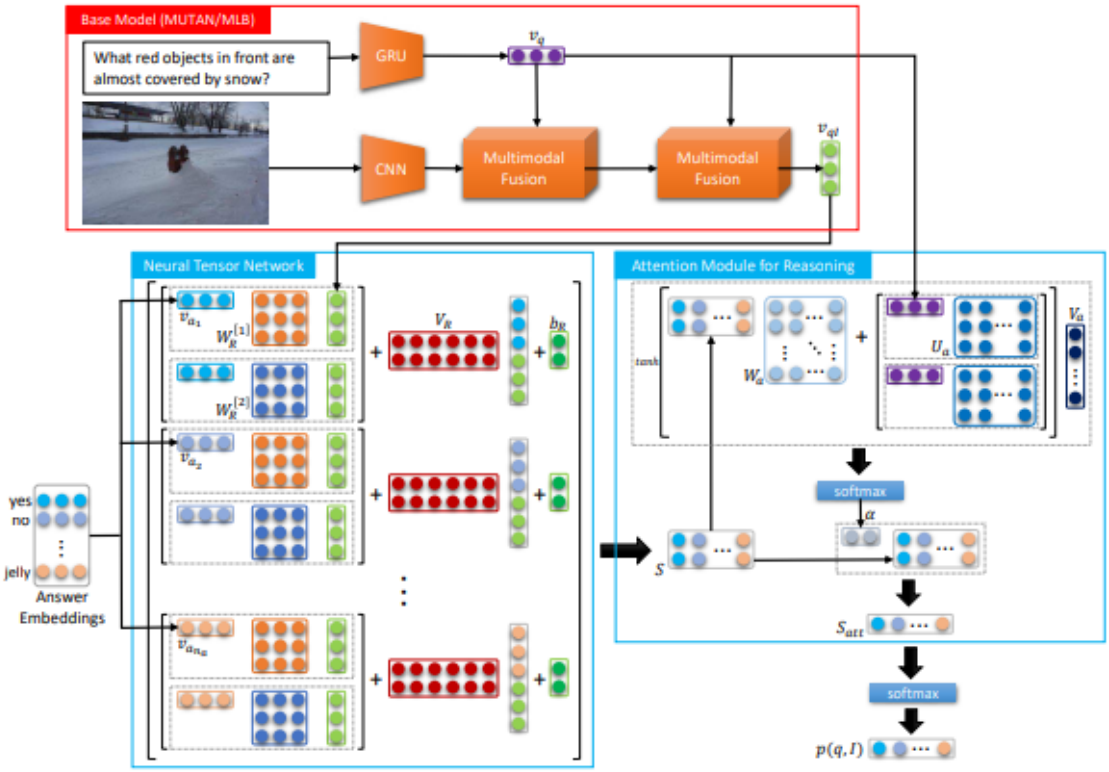

Figure 2: ma

policy. The goal in RL-based question generation is to find a policy that can maximize the sum of the expected return at the end of the sequence generated.

Visual Question Answering (VQA)

Why VQA?

As what we have discussed above, most Question-Answering System focuses solely on generating proper questions but not the answers.

VQA aims to enable the machine to answer the question automatically which could in turn automated the whole question generating and evaluation process.

Started from the question-guided attention mechanism that can adaptively learn the most relevant image regions for a given question. Then to stack multiple question-guided attention mechanisms to learn the attention in an iterative way. Also, it is possible to use bilinear features to integrate the visual features from the image spatial grids with question features to predict attention.

Considering the questions in natural language may also contain some noise, the co-attention mechanism can jointly learn the attention for both the image and question.

1. In this paper Deep Attention Neural Tensor Network for Visual Question Answering,
2. In this paper Question Type Guided Attention in Visual Question Answering, they proposed a model called Question Type-guided Attention (QTA). This model utilizes the information of question type to dynamically balance visual features from both top-down and bottom-up orders. Meanwhile, it has a

novel neural architecture that dynamically gates the conribution of ResNet and Faster R-CNN features based on the question type.

Quality Evaluation

The key to create an education or a learning/teaching system is to be able to present a high quality study material and provide a high quality feedback on student's learning.

Let's begin with the first issue, we can easily identify the association of our problem with a problem that has been solved with recommender system.

As we all know that a recommender system is an intuitive line of defense against consumer over-choice given the evern growing information available on the web. As we mentioned earlier in the knowledge graph, a authoritative and personalized recommending system is essential for facilitating the learning.

Typically, a recommendation models can be classified into 3 main categories: 1. Collaborative filtering 2. Content based 3. Hybrid recommender system

As I mentioned, here we will mainly focus on hybrid recommender system.

There are a diverse array of achitectual paradigms that are closely related recommending system. Let's take a look at few of them: 1. Autoencoder 2. Convolutional Neural Network 3. Recurrent Neural Network 4. Restricted Boltzmann Machine (RBM) 5. Adversarial Networks 6. Attentional Models (AM) 7. Deep Reinforcement Learning (DRL)

As for the automated feedback or learning grading system, there are plenty of suggestions have been proposed as well to tackle such a question. The framework is called automated essay scoring (AES) which focuses on automatically analyzing the quality of writing and assigning a score to the text.

In terms of knowledge or learning evaluation, the format could be diversed i.e. a lecture given by the student or an short summary essay written by the student. Regardless the form, we can always convert the content into a predictable text, graphic or audible format that model can process.

As we mentioned above, for these type of task, we can implementing RNN to process the content and even enhance the model performance by adversarially craft input as this paper Neural Automated Essay Scoring and Coherence Modeling for Adversarially Crafted Input illustrated.

Reference 1. A Framework for Automatic Question Generation from Text using Deep Reinforcement Learning 2. Learning to Ask: Neural Question Generation for Reading Comprehension 3. Deep Attention Neural Tensor Network for Visual Question Answering 4. Learning to Ask 5. TOPIC-BASED QUESTION GENERATION

5. Deep Learning based Recommender System