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Highlights

- Data Mining for Disease
- Neural Networks for Visual
- Review on Machine Learning
- Estimation by Analyzing EEG

Discovering Thoughts, Inventing Future

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Dr. Abdurrahman Arslanyilmaz

Computer Science & Information Systems Department
Youngstown State University
Ph.D., Texas A&M University
University of Missouri, Columbia
Gazi University, Turkey
Web: cis.ysu.edu/~aarslanyilmaz/professional_web

Dr. Chutisant Kerdvibulvech

Dept. of Inf. & Commun. Technol.,
Rangsit University
Pathum Thani, Thailand
Chulalongkorn University Ph.D. Thailand
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Multimodal Attention in Recurrent Neural Networks for Visual Question Answering

By Lorena Kodra & Elinda Kajo Meçe
Polytechnic University of Tirana

Abstract- Visual Question Answering (VQA) is a task for evaluating image scene understanding abilities and shortcomings and also measuring machine intelligence in the visual domain. Given an image and a natural question about the image, the system must ground the question into the image and return an accurate answer in a natural language. A lot of progress has been done to address the challenges of this task by combining latest advances in image representation and natural language processing. Several recently proposed solutions include attention mechanisms designed to support "reasoning". These mechanisms allow models to focus on specific part of the input in order to generate the answer and improve its accuracy. In this paper we present a novel LSTM architecture for VQA that uses multimodal attention to focus over specific parts of the image and also on specific question words to generate the answer. We evaluate our model on the VQA dataset and demonstrate that it performs better than state of the art. We also make a qualitative analysis of the results and show the abilities and shortcomings of our model.

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MULTIMODALATTENTIONINRECURRENTNEURALNETWORKSFORVISUALQUESTIONANSWERING

Multimodal Attention in Recurrent Neural Networks for Visual Question Answering

Lorena Kodra [α] & Elinda Kajo Meçe [σ]

Abstract- Visual Question Answering (VQA) is a task for evaluating image scene understanding abilities and shortcomings and also measuring machine intelligence in the visual domain. Given an image and a natural question about the image, the system must ground the question into the image and return an accurate answer in a natural language. A lot of progress has been done to address the challenges of this task by combining latest advances in image representation and natural language processing. Several recently proposed solutions include attention mechanisms designed to support "reasoning". These mechanisms allow models to focus on specific part of the input in order to generate the answer and improve its accuracy. In this paper we present a novel LSTM architecture for VQA that uses multimodal attention to focus over specific parts of the image and also on specific question words to generate the answer. We evaluate our model on the VQA dataset and demonstrate that it performs better than state of the art. We also make a qualitative analysis of the results and show the abilities and shortcomings of our model.

Keywords: visual question answering (VQA), multimodal attention mechanism, convolutional neural networks (CNN), recurrent neural networks (RNN), long short-term memory (LSTM).

I. Introduction

Visual question answering has emerged as a multidisciplinary research problem at the intersection of artificial intelligence, natural language processing and computer vision. This task requires an intelligent system to answer a question about an image. Both question and answer are in a natural language. The system must ground the question into the image; hence it requires a deep understanding of the image scene. It is a complex research problem and puts a lot of focus on artificial intelligence, and especially the inference process needed to generate the answer because different question types (e.g. color, number, location, etc.) require different answers. There are also questions requiring some commonsense reasoning such as "Do the people look happy?". With the advancement of image representation, language processing and deep learning, the most promising solutions use a combination of Convolutional Neural Networks (CNNs) to process the image and extract image features and Recurrent Neural Networks (RNNs) to model word sequences. The output of each network is later combined in order to generate the final answer as output [11]. One of the latest concepts introduced in VQA is the attention mechanism. It enables the model to focus on specific parts of the input in order to infer the answer. Recently, the idea of dual attention has been introduced in VQA [6], [14]. It allows the model to focus on specific question words, as well as specific image regions before inferring the answer.

In this paper we propose a novel architecture for long short-term memory (LSTM) networks, which includes image attention and question attention. We refer to the combined attention as multimodal attention. The standard LSTM architecture [8] has been modified in order to include multimodal attention. We evaluate our proposed solution on the VQA [9] dataset and show that it performs better compared with state of the art models. The main contributions of our work are as follows:

- We propose a novel LSTM model with multimodal attention.
- Our model uses image attention guided by the correlation between the current context and image regions, as well textual attention guided by the relevance and importance of distinct question words in relation to the whole question.
- We evaluate our proposed model on the VQA dataset [9].
- We analyze the results qualitatively and show the abilities and shortcomings of our model.

The rest of the paper is organized as follows: In section 2 we describe related work in this research area. Section 3 describes in detail our proposed model. In section 4 we describe the experimental setup and show the evaluation results. Finally in section 5 we discuss the results and conclusions.

II. Related Work

a) Visual Question Answering

Deep learning based approaches have demonstrated competitive performance in the VQA task [21], [26], [24] [25], [23]. For processing the image, most approaches extract features from images using CNNs which have shown to work best in representing images [1]. On the sentence side, most approaches use RNNs to model word sequences [22], [18], [19], [14], [7], [20], [21], [15]. Other approaches include Bag-of-Words question embedding [17] or multilayer

Author α σ: Polytechnic University of Tirana.
e-mails: lorena.kodra@gmail.com, ekajo@fti.edu.al

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perceptrons (MLP) [16] to predict the answer. All approaches treat question answering as a classification problem and learn a softmax classifier to generate the answer.

Several mechanisms and techniques have been proposed for the process of question answering. The authors in [15] use a dynamic parameter prediction RNN whose parameters are determined adaptively based on input questions. In this way the system reasons differently for each question. The motivation behind this approach is the fact that different questions require different types and levels of understanding of an image to find correct answers. Another proposed model [20] is a neural reasoner based on a MLP that is able to update the question representation iteratively by inferring image information. The model achieves this by selecting image regions relevant to the question and learns to give the correct answer by interacting it with supporting facts through multiple reasoning layers. With this technique, it is possible to make questions more specific than the original ones focusing on important image information automatically. The authors in [22] propose a multimodal compact bilinear pooling method to combine multimodal features extracted from a CNN for the image and a LSTM for the question. This mechanism reduces the dimensionality of the joint representation of the image and question and produces a model with less parameters and hence easier to train. Another alternative are multimodal systems composed of CNN and RNN that are trained end-to-end to extract question information, visual representation, store the linguistic context of the answer and combine this information into generating a relevant answer to a free language question [21].

b) Neural Attention Mechanisms

Attention mechanisms allow neural network models to use a question to selectively focus on specific inputs. This idea has been recently successfully implemented in various areas such as image captioning [2], [27], [28], [29], [30], neural machine translation [3], [4], [5], and visual question answering [6], [7], [14], [19], [18], [17]. In the case of visual question answering, attention mechanisms allow models to focus on specific parts of visual or textual inputs that are relevant to the context of the answer, at each step of the process. Instead of looking at the whole image, visual attention models selectively pay attention to specific regions in an image to extract image features that are relevant to the question as well as reduce the amount of information to process. On the other hand, textual attention mechanisms find semantic or syntactic input-output alignments under an encoder-decoder framework.

In order to tackle the VQA task, several works perform image attention multiple times in a stacked manner. In [18] the authors propose a stacked attention network which queries the image multiple times to infer the answer progressively. It uses semantic representation of a question as a query to identify the regions of the image that are related to the answer. The authors in [17] propose a multi-hop visual attention scheme. In the first hop, it aligns words to image regions while in the second hop it uses the entire question representation to obtain image attention maps.

The idea of incorporating attention into the standard RNN architecture has been explored in [7] and [19]. Xiong et al. [19] augment dynamic memory networks with a new input fusion layer that uses bidirectional gated recurrent units (GRU). They also propose an attention based GRU to retrieve the answer. Zhu et al [7] add visual attention to the standard LSTM architecture for pointing and grounded QA. However, the models mentioned above model only visual attention and do not model textual attention. Hyeonseob et al [6] propose dual attention networks which attend to specific regions in images and words in text through multiple steps and gather essential information from both modalities. Lu et al [14] propose hierarchical co-attention that jointly reasons about visual attention and question attention. Following this line of research and the idea explored in [7] and [19], we propose a novel LSTM architecture by incorporating visual and question attention in the gates of the LSTM network. Each step of the attention distribution depends on the previous LSTM state and the current focus on specific question words and image regions.

III. Multimodal Attention Model

The idea of using multimodal attention for the task of VQA has been recently explored in [6] and [14]. The main difference between these models and ours is that we include attention as a component of each LSTM gate as illustrated in Fig. 2. The intuition behind this is that by simultaneously focusing on specific image regions and specific question words, the model can decide how to change its current state and what answer word to generate next. Using the actual context (previous LSTM hidden state) helps to guide attention correctly and improve answer accuracy. We choose LSTM models because they have shown to achieve state-of-the-art results in several sequence processing tasks [30], [32] including VQA [24], [21], [25].

The input of our model is an image of size 224x224 pixels and a question comprised of a variable-length set of words. Each word is first transformed into its one-hot representation, a column vector the size of the vocabulary where there is a single one at the index of the token in the vocabulary. Each word is then embedded into a real-valued word vector $Q = \{q_j | q_j \in R^D, j = 1, \ldots, N\}$ where N is the number of question words, D is the dimensionality of the embedding space and$Q \in R^{DxT}$ for the image representation we extract the activations from the last fully connected layer (fc7) of

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VGG-16, a pretrained CNN model [31]. Given the image I, this model transforms it into a 4096-dimensional feature representation. We also learn the embedding of the input image where 4096-dimensional image features are transformed into a D dimensional embedding space denoted by $V = \{v_i | v_i \in R^D, i = 1, \ldots, M\}$ where M is the number of image features, D is the dimensionality of the embedding space and $V \in R^{DxM}$. Both embedding modalities are 512 dimensional and are learnt end-to-end.

We treat the image as the first input token and the image embedding vectors are fed one by one to the LSTM model. Afterwards we feed the tokens of the question embedding. The update rules of our LSTM model are:

$$i_t = \sigma(W_{iv} v_t + W_{ih} h_{t-1} + W_{it}^{txt} a_t^{txt} + W_{it}^{img} a_t^{img} + b_i) \quad (1)$$

$$f_t = \sigma\left(W_{fv} v_t + W_{fh} h_{t-1} + W_{ft}^{txt} a_t^{txt} + W_{ft}^{img} a_t^{img} + b_f\right) \quad (2)$$

$$o_t = \sigma(W_{ov} v_t + W_{oh} h_{t-1} + W_{ot}^{txt} a_t^{txt} + W_{ot}^{img} a_t^{img} + b_o) \quad (3)$$

$$g_t = \tanh(W_{cv} v_t + W_{ch} h_{t-1} + W_{ct}^{txt} a_t^{txt} + W_{ct}^{img} a_t^{img} + b_c) \quad (4)$$

$$c_t = f_t \circ c_{t-1} + i_t \circ g_t \quad (5)$$

$$h_t = o_t \circ \tanh(c_t) \quad (6)$$

Where σ is the sigmoid activation function and $\circ$ is the element-wise product.

Different from [7] which only use image attention, we integrate also textual (question) attention in the LSTM gates. The image and textual attention features are represented by the term a_t^{img} and a_t^{txt} respectively. These features are learnt end-to-end. The authors in [14] use the dot product of question and image representation to produce an affinity matrix. This matrix is then added to image or question representation and used to guide both the textual and image attention respectively. Different from their approach, we use the previous LSTM hidden state (h_{t-1}) and question or image representation to guide question and image attention respectively. We calculate image attention as follows:

$$l_t^{img} = tanh(W_{lh}^{img} h_{t-1} + W_{lq}^{img} CNN(I) + b_{img}) \quad (7)$$

$$r_t^{img} = softmax\,(W_{img}^T l_t^{img}) \quad (8)$$

$$a_t^{img} = r_t^{img} CNN(I) \quad (9)$$

Following [7], for generating the image attention we use the fourth convolutional layer of VGG-16 [31]. This layer returns a 196 512-dimensional convolutional feature map of image I represented by the term *CNN (I)* in equations (7) and (9). The term r_t^{img} represents the attention probabilities of each image region. Based on these attention probabilities the image attention vector is calculated as the weighted sum of the attention probabilities. The attention term a_t^{img} is a 196-dimensional vector that decides the contribution of each image feature at the t-th step. The W and b coefficients are learnable parameters.

The question attention is calculated as follows:

$$l_t^{txt} = \tanh(W_{lh}^{txt} h_{t-1} + W_{lq}^{txt} Q + b_{txt}) \quad (10)$$

$$r_t^{txt} = softmax\,(W_{txt}^T l_t^{txt}) \quad (11)$$

$$a_t^{txt} = r_t^{txt} Q \quad (12)$$

The term r_t^{txt} represents the attention probabilities of each question word. Based on these attention probabilities the question attention vector is calculated as the weighted sum of the attention probabilities. The attention term a_t^{txt} is a N-dimensional vector that decides the contribution of each word at the t-th step. Fig.1 illustrates the dataflow for generating each attention modality.

In each step, the LSTM generates new image and textual attention vectors based on the current context (previous LSTM hidden state) and the respective embeddings. The intuition behind this is that the model might need to focus on different parts of the image or different question words in order to generate the next answer word. The authors in [6] introduce accumulative attention to their model to keep track of the attended parts and guide future attention. An accumulative attention may suffer from the introduction of errors in earlier steps that might be propagated into future steps. In contrast, our model generates independent attention each step and does not suffer from this kind of problem. As in [7] the question words are feed one by one until reaching the end token of the question sequence. The model generates attention and leverages it together with the question and input image to generate the answer (Fig.2). We treat question answering as a classification task and use a softmax classifier to generate the answer. During training we also feed the ground truth answer tokens into the model and maximize their log-likelihood.

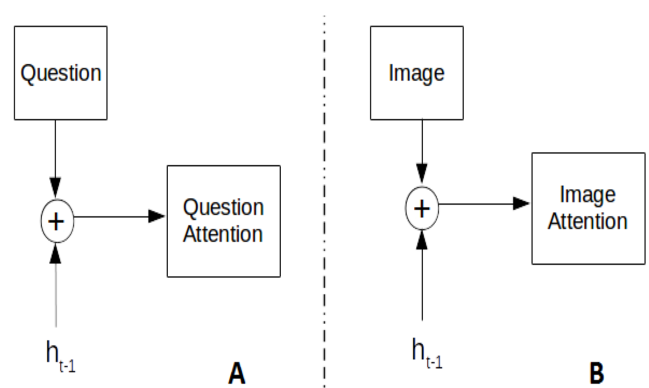

Fig. 1: Attention generation. (A) At each step, question attention is generated by combining the current context (previous LSTM cell hidden state h_{t-1}) and question representation. (B) At each step, image attention is generated by combining the current context (previous LSTM hidden state h_{t-1}) and image representation.

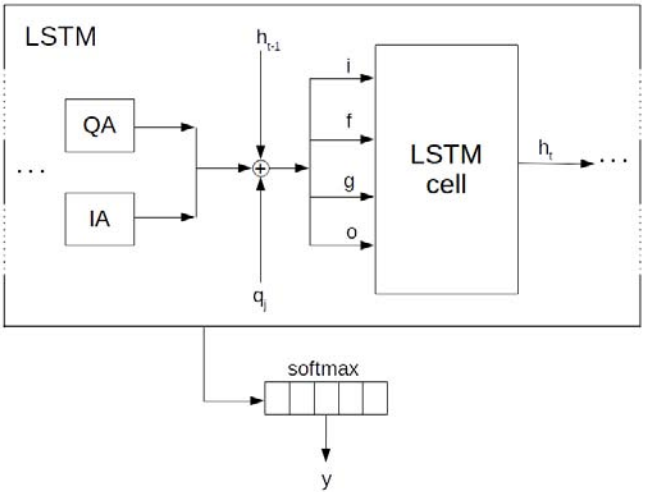

Fig. 2: Data flow for LSTM cells inside the LSTM network. Question attention (QA), image attention (IA), previous LSTM state (h_{t-1}) and current question token (q_j) are used in each LSTM cell gate to generate the context (h_t) that will be used by the next LSTM cell. A *softmax* classifier is used at the end as the output of the LSTM network to generate one by one each answer word *y*

IV. Experiments and Results

In this section we describe model implementation details, evaluation results and analyze them quantitatively. The results of the evaluation are shown in section IV.C.

a) Datasets and Evaluation Metrics

We evaluate the proposed model on the Visual Question Answering version 1 (VQA-v1) dataset [9]. The VQA dataset was used because it is the largest and most complex dataset for the visual question answering task. VQA-v1 was selected for fairness of comparison with other models.

The VQA-v1 dataset was constructed using the Microsoft COCO dataset [33] which contains 123,287 training/validation images and 81,434 test images. Each image has several related questions and each question is answered by multiple people. This dataset contains 248,349 training questions, 121,512 validation questions, and 244,302 testing questions. The total number of images, questions and answers are as follows: 204,721 COCO images (all of current train/val/test) 614,163 questions, 6,141,630 ground truth answers, 1,842,489 plausible answers.

Since we formulate VQA as a classification task, classification accuracy is used to measure the performance of our model and to compare it with state-of-the-art models.

b) Setup and Implementation Details

We use Torch [10] to develop our model. Before training, all questions are normalized to lower case and the question marks are removed. The model is initialized with Xavier initialization [13] except for the embeddings which used random uniform initialization. We train the model with Adam update rule [12] with a global learning rate of 10^{-4}. We train the model with back propagation and use cross-entropy as the loss function. During testing we select the candidate answer with the largest log-likehood. We set batch size to 128 and train for up to 256 epochs with early stopping if the validation accuracy has not improved in the last 5 epochs. The dimension of the LSTM network is 512 for all experiments. All embeddings are vectors of size 512. We apply dropout with probability 0.5 on each layer and also gradient clipping to regularize the training process. We rescale the images to 224×224. Following [7] we use the activations from the last fully connected layer (fc) of VGG-16 [31] to learn the image embeddings and the activations from the fourth convolutional layer of the same CNN for calculating image attention.

c) Quantitative Results and Analysis

The VQA dataset includes two test scenarios: open-ended and multiple-choice. We evaluate our model on both scenarios. The full release (V1.0) of this dataset contains a train set and a validation set. Following standard practice, we choose the top 1,000 most frequent answers in train and validation sets as candidate answers. We only keep the examples whose answers belong to these 1,000 answers as training data, which constitutes 86.54% of the train and validation answers. The question vocabulary size is 7477 with the word frequency of at least three.

Table 1: Open-ended results on VQA test set compared with state-of-the-art: accuracy in %. We denote with "-"the cases with lack of data

Method	Test-dev				Test-standard			
	Y/N	Num	Other	All	Y/N	Num	Other	All
HieCo[14]	79.5	38.7	48.3	60.1	-	-	-	-
D-NMN[16]	80.5	37.4	43.1	57.9	-	-	-	58
SAN(2, LSTM)[18]	79.3	36.6	46.1	58.7	-	-	-	58.9
SMem-VQA[17]	80.87	37.32	43.12	57.99	80.8	37.53	43.48	56.24
Ours-MAVQA	81.9	37.51	49.1	61.08	81.8	37.5	49.05	61

We compare the performance of our model with current state-of-the-art models and show the experimental results on free-form answers in Table 1. We also report the accuracy in each category to show the strength and weakness of our model.

We notice that all models reach top accuracy for the Yes/No questions. This is justified by the fact that there are only two possible answers and the possibility of giving an incorrect answer is decreased. We can see that our approach performs better and improves the state of the art from 60.1% (HieCo [14]) to 61.08% (Ours-MA VQA) in test-dev. In test-standard the accuracy is improved by 4.76% from 56.24% (SMem-VQA [17]) to 61% (Ours-MA VQA). For Yes/No and Other questions we achieve an improvement of 1.03% and 0.8% respectively. This indicates that our model is able to attend better and benefits from the multimodal attention and the independence of each attention modality from the other and from previous attention steps. For Number questions the counting ability of our model is weakened. This indicates that our model doesn't attend correctly and having a correlated attention like in HieCo [14] helps in achieving better performance at counting objects. We observe that all models perform worst on Number questions. This is justified by the fact that the ability to count objects is still a pervasive computer vision problem.

Table 2 shows results from multiple-choice question. The data was available for comparison only with HieCo [14]. We also report the accuracy in each category to show the strength and weakness of our model. We notice that models perform better for multiple choice questions. This comes from the fact that they exploit and tune to the biases in each of the answer options. However it is debatable whether this is indicative of progress because in realistic applications, answer options are not known beforehand. From Table 2 we see that our multimodal approach performs better and improves the state of the art by 1.48% from 64.6% to 66.08%. We also notice that our model performs 1.03% better than state of the art on Yes/No questions. As in the case of free-form answers, the models reach top accuracy for Yes/No questions and perform the worst on numbering questions. For Number questions, as in free-form answers, having a correlated attention, like the model in HieCo [14], helps the model attend the image better and achieve a higher accuracy.

Table 2: Multiple choice results on VQA test set compared with state-of-the-art: accuracy in %

Method	Test-dev			
	Y/N	Num	Other	All
HieCo[14]	79.5	39.8	57.4	64.6
Ours-MA VQA	82.1	38.68	58.61	66.08

d) Qualitative Analysis

In order to gain a better understanding on the behavior and limitations of our model we analyzed the answers generated using multimodal attention. Each question requires different type and level of understanding and attention in order to find the correct answer. Table 3, 4 and 5 show some examples for each question type on the VQA dataset.

Table 3: Answer examples on the VQA dataset for Yes/No questions. We denote questions with "Q", model answers with "A", and ground truth with "GT"

1. Q: Is the horse eating?
A: No
GT: No

2. Q: Is there a bench?
A: No
GT: Yes

3. Q: Is there a red sandal here?
A: Yes
GT: Yes

4. Q: Is the road paved?
A: Yes
GT: No

5. Q: Are there lights on in the two buildings?
A: Yes
GT: Yes

6. Q: Are these zebra confined?
A: Yes
GT: Yes

7. Q: Is the kitchen cluttered?
A: No
GT: Yes

8. Q: Is the beach crowded?
A: Yes
GT: Yes

9. Q: Are there any scissors in this picture?
A: No
GT: Yes

10. Q: Is this animal in a zoo?
A: No
GT: No

We noticed the following characteristics in our model for *Yes/No* questions:

+ The model correctly attends, identifies and infers about objects in the foreground and their characteristics. (e.g. images 1,3).
+ Difficulty inferring about background objects. The model cannot identify correctly the objects in the background. The focusing attention is weakened for this kind of objects and the model cannot infer correctly about them (e.g. images 9, 4).
+ Difficulty identifying objects that appear incomplete in the image. Attention is weakened for this kind of objects and the model cannot infer correctly about them (e.g. images 2, 7).

Table 4: Answer examples on the VQA dataset for Number questions. We denote questions with "Q", model answers with "A", and ground truth with "GT"

1. Q: How many street signs are shown?

A: Two
GT: Four

2. Q: How many horses are there?

A: Two
GT: Two

3. Q: How many bikes are there?

A: Two
GT: One

4. Q: How many people do you see?

A: Two
GT: None

5. Q: How many people are there?

A: None
GT: None

6. Q: How many yellow planes are there?

A: One
GT: Three

7. Q: How many giraffes are in this picture?

A: Two
GT: Two

8. Q: How many jets are there?

A: One
GT: Two

9. Q: How many birds?

A: Two
GT: None

10. Q: How many buses are there?

A: One
GT: One

We noticed the following characteristics in our model for *Number* questions:

+ The model correctly attends and identifies objects in foreground and their characteristics (e.g. images 1, 7, 10).
+ The model correctly attends and identifies objects in background that do not appear blended in the image but are clearly distinct from each-other. (e.g. image 2).
+ Difficulty identifying objects in background. Attention is weakened for background objects and the model cannot infer and count them correctly (e.g. images 3, 4, 9).
+ Difficulty differentiating objects in background that appear blended with each-other. Attention is weakened in this case and the model cannot infer and count them correctly (e.g. images 1, 8).

Table 5: Answer examples on the VQA dataset for other questions. We denote questions with "Q", model answers with "A", and ground truth with "GT"

1. Q: Who is with the giraffes?

A: No one
GT: No one

2. Q: What is the woman in front sitting on?

A: A bicycle
GT: A bicycle

3. Q: What color are the walls?

A: yellow
GT: yellow

4. Q: Where are the engines?

A: in the middle of the plane
GT: Behind the wings toward the back of the fuselage.

5. Q: What has a purple border?

A: The window

GT: The box truck.

6. Q: What kind of flooring is in the room?

A: White tile.

GT: Gray marble tile.

7. Q: What angle was the picture taken from?

A: From the left side of the sign

GT: Below the sign, looking up at it

8. Q: Where was this photo taken?

A: At a tennis court

GT: At a tennis court

9. Q: How is the food served?

A: In a basket

GT: In a basket

10. Q: Where was this photo taken?

A: At the park

GT: At the park

For the *Other* type of question our model has the following behavior:

+ Correctly attends, identifies and infers about objects in foreground and their characteristics. The results show that attention works correctly for this kind of objects (e.g. images 1, 9, 2).
+ Correctly attends, identifies and infers about background objects that are clearly distinct from each-other and from foreground (e.g. images 3, 8, 10).
– Difficulty inferring about objects that appear blended with each-other (e.g. images 4, 5, 6).

V. Conclusions

In this paper we proposed a novel LSTM architecture that uses multimodal attention for the task of visual question answering. Our model leverages both textual and visual attention simultaneously in order to identify question entities and ground them in the image. It learns to answer questions by generating independent visual and textual attention over the input. We evaluated our model on the VQA dataset and results show that it performs better than current state of the art. This indicates that integrating multimodal attention inside the LSTM architecture helps improving answer accuracy. Results also show that having independent attention modalities helps with overall accuracy and with questions of type other than counting. We analyzed the answers qualitatively and results show that our model is able to use multimodal attention correctly to: 1) Attend, identify and infer about foreground objects and their characteristics 2) Attend, identify and infer about background objects that are distinct from each-other and from foreground. Our attentive model has also some limitations like: 1) Difficulty inferring about incomplete objects, 2) Difficulty inferring about objects that appear blended with each-other and/or foreground/background, 3) Difficulty inferring about background objects that are not distinct from each-other and from foreground. These difficulties also weaken the counting ability of our model. These problems are indicative of the need to improve the attention mechanisms and solving them is subject to future work. Future research directions also include introducing common sense knowledge into our model and leveraging it to improve answer accuracy.

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A Review on Machine Learning Techniques for Neurological Disorders Estimation by Analyzing EEG Waves

By Vijaykumar Janga & Eedara Sreenivasareddy
Acharya Nagarjuna University

Abstract- With the fast improvement of neuroimaging data acquisition strategies, there has been a significant growth in learning neurological disorders among data mining and machine learning communities. Neurological disorders are the ones that impact the central nervous system (including the human brain) and also include over 600 disorders ranging from brain aneurysm to epilepsy. Every year, based on World Health Organization (WHO), neurological disorders affect much more than one billion people worldwide and count for up to seven million deaths. Hence, useful investigation of neurological disorders is actually of great value. The vast majority of datasets useful for diagnosis of neurological disorders like electroencephalogram (EEG) are actually complicated and poses challenges that are many for data mining and machine learning algorithms due to their increased dimensionality, non stationarity, and non linearity. Hence, an better feature representation is actually key to an effective suite of data mining and machine learning algorithms in the examination of neurological disorders.

Keywords: electroencephalogram (EEG), emotion recognition, stress, machine learning techniques.

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Vijaykumar Janga α & Eedara Sreenivasareddy σ

Abstract- With the fast improvement of neuroimaging data acquisition strategies, there has been a significant growth in learning neurological disorders among data mining and machine learning communities. Neurological disorders are the ones that impact the central nervous system (including the human brain) and also include over 600 disorders ranging from brain aneurysm to epilepsy. Every year, based on World Health Organization (WHO), neurological disorders affect much more than one billion people worldwide and count for up to seven million deaths. Hence, useful investigation of neurological disorders is actually of great value. The vast majority of datasets useful for diagnosis of neurological disorders like electroencephalogram (EEG) are actually complicated and poses challenges that are many for data mining and machine learning algorithms due to their increased dimensionality, non stationarity, and non linearity. Hence, an better feature representation is actually key to an effective suite of data mining and machine learning algorithms in the examination of neurological disorders. With this exploration, we use a well defined EEG dataset to train as well as test out models. A preprocessing stage is actually used to extend, arrange and manipulate the framework of free data sets to the needs of ours for better training and tests results. Several techniques are used by us to enhance system accuracy. This particular paper concentrates on dealing with above pointed out difficulties and appropriately analyzes different EEG signals that would in turn help us to boost the procedure of feature extraction and enhance the accuracy in classification. Along with acknowledging above issues, this particular paper proposes a framework that would be useful in determining man stress level and also as a result, differentiate a stressed or normal person/subject.

Keywords: electroencephalogram (EEG), emotion recognition, stress, machine learning techniques.

I. Introduction

Mental disorders or neurological disorders are increasing at high pace in the world. As per WHO, one among four people in the world will be affected by mental or neurological disorders at some point of time in their life. Neurological disorders are going to be second leading cause of global disease burden by year 2020, lagging behind ischemic heart illness but leading all the other diseases [1]. The increase in the number of professionals who treat the mental illness is very less as compared to the growth in number of people who are suffering from mental problems. Mental health diagnoses involve steps like specially designed interviews about symptoms and medical data and sometimes physical examination of the patient. Several psychological tests may also be conducted to make sure the symptoms are due of mental health problems and not because of any other disease. Similarity in the symptoms of several mental health disorders has made diagnosis complicated task. Diagnoses of mental health problems in children are far more difficult than diagnosing them in adults. Therefore one needs to be careful to diagnose the mental health disorders with accuracy. It's known that psychiatric/ neurological disorders affect brain function and structure. However, to date the translation of neuroimaging research findings into diagnostic tools has been very limited due to lack of adequate analysis tools. In the last years there has been a substantial increase in the use of machine learning/pattern recognition approaches to analyze neuroimaging data. Artificial Intelligence can enable the computer to think. Computer is made much more intelligent by AI. Machine learning is the subfield of AI study. Various researchers think that without learning, intelligence cannot be developed. There are many types of Machine Learning Techniques that are shown in Figure 1. Supervised, Unsupervised, Semi Supervised, Reinforcement, Evolutionary Learning and Deep Learning are the types of machine learning techniques. These techniques are used to classify the data set.

1) *Supervised Learning:* Offered a training set of examples with suitable targets and on the basis of this training set, algorithms respond correctly to all feasible inputs. Learning from exemplars is another name of Supervised Learning. Classification and regression are the types of Supervised Learning.

Classification: It gives the prediction of Yes or No, for example, "Is this tumor cancerous?", "Does this cookie meet our quality standards?"

Regression: It gives the answer of "How much" and "How many".

2) *Unsupervised Learning:* Correct responses or targets are not provided. Unsupervised learning technique tries to find out the similarities between

Author α: Reaserch scholor, Acharya Nagarjuna University Nagarjuna Nagar,Guntur. e-mail: vijaykumar.janga@gmail.com
Author σ: Principal, ANU college of Engg & Technology Acharya Nagarjuna University-Guntur. e-mail: esreddy67@gmail.com

the input data and based on these similarities, unsupervised learning technique classify the data. This is also known as density estimation. Unsupervised learning contains clustering [1]. Clustering: it makes clusters on the basis of similarity.

3) *Semi Supervised Learning:* Semi supervised learning technique is a class of supervised learning techniques. This learning also used unlabeled data for training purpose (generally a minimum amount of labeled-data with a huge amount of unlabeled-data). Semi-supervised learning lies between unsupervised-learning (unlabeled-data) and supervised learning (labeled-data).
4) *Reinforcement Learning:* This learning is encouraged by behaviorist psychology. Algorithm is informed when the answer is wrong, but does not inform that how to correct it. It has to explore and test various possibilities until it finds the right answer. It is also known as learning with a critic. It does not recommend improvements. Reinforcement learning is different from supervised learning in the sense that accurate input and output sets are not offered, nor suboptimal actions clearly précised. Moreover, it focuses on on-line performance.
5) *Evolutionary Learning:* This biological evolution learning can be considered as a learning process: biological organisms are adapted to make progress in their survival rates and chance of having off springs. By using the idea of fitness, to check how accurate the solution is, we can use this model in a computer [2].
6) *Deep Learning:* This branch of machine learning is based on set of algorithms. In data, these learning algorithms model high-level abstraction. It uses deep graph with various processing layer, made up of many linear and nonlinear transformation.

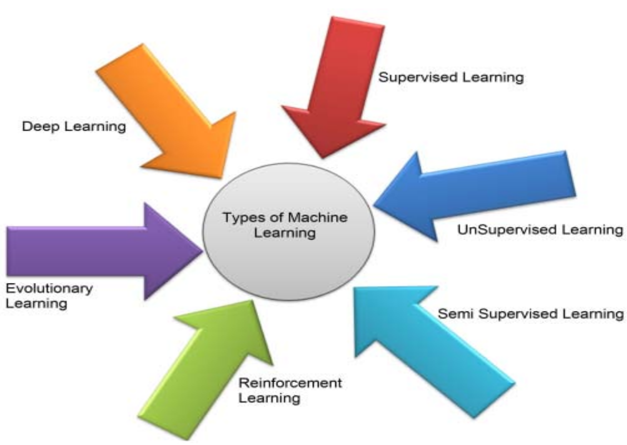

Fig. 1: Types of machine learning techniques

Electroencephalography (EEG) is a monitoring method which can help to record the electrical activity of the brain. This electrical activity can lead us to better understand the human brain and how it functioning. Brain Computer Interface combine hardware and software communication system that permits cerebral activity alone to control computers and other devices.

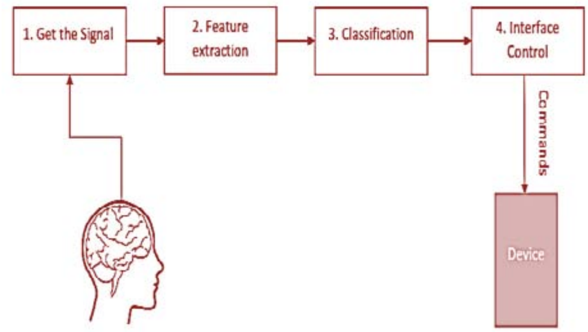

Fig. 2: Design of a BCI System

BCI enables to interact with the surroundings, without the involvement of peripheral nerves and muscles, by using control signals generated from electroencephalographic activity. There are several stages to do so as depicted in Figure.2 and its process shown below:

1) *Get the Signals:* Capture the brain signals and make noise reduction and preprocessing the signals in order to be able to process it in more a convenient way.
2) *Feature Extraction:* Identifies discriminative information in the brain signals that have been recorded. This can be a challenging job, because of the many mixed signals with large number of sets activity in the brain that overlap in time and space, and we don't want to loss information.
3) *Classification:* Classify the signals to achieve pattern recognition in order to decipher the user's intentions
4) *Interface Control:* Translate the classified signals into the user desired commands for any kind of device such as a computer.

II. Related Works

Masri RY and Jani HM [5] offered the mental health Diagnostic Expert System for the assistance of psychologists to diagnose and treat their mental patients. Three artificial techniques viz., Fuzzy Logic, Rule-Based Reasoning and Fuzzy Genetic Algorithm were applied in diagnosing and suggesting the treatment plans. Luxton et al. [7] analyzed the use of artificial intelligence for psychological task.

Razzouk D et al. [8] developed the decision supporting system for diagnosis of schizophrenia having accuracy up to 66-82%. Chattopadhyay S et al. [9] developed a neuro-fuzzy approach for categorizing of adult depression. The supervised Adaptive Network Based Fuzzy Inference System and Back Propagation Neural Network and unsupervised Self Organizing Map neural network learning techniques were utilized and compared. It was observed that Adaptive Network Based Fuzzy Inference System, a hybrid system performed far better than Back Propagation Neural Network.

Basavappa SR et al. [10] applied depth first search algorithm with the backward search approach for diagnosing dementia. An expert system was developed by them taking in consideration patient's behavior, cognition, emotions and the results of neuropsychological tests. Rahman et al. [11] compared several classification techniques; Multilayer Perceptron, Bayesian Network, Single Conjunctive Rule Learning, Decision Trees, Neuro-Fuzzy Inference System and Fuzzy Inference Systems using various data mining softwares like TANAGRA, WEKA and MATLAB for diagnosing diabetes. They observed that accuracy levels are different for different techniques on different accuracy measures such as Kappa Statistic and Error rates.

Gomuła, Jerzy et al. tried finding efficient techniques for the classification of MMPI profiles of patients having mental problem. They found that Attribute Extension methodology improves classification accuracy in case of discreatised data [12]. Anchana Khemphila, Veera Boonjing applied Multi-Layer Perceptron with Back Propagation Learning for diagnosing Parkinson's disease efficiently with selected attributes. Information Gain from all attributes is taken as a measure for the reduction of attributes [13]. Pirooznia Mehdi et al. [14] used data mining techniques to find Genome wide Association in Mood Disorders. Six classifiers Support Vector Machine, Bayesian Network, Logistic Regression, Radial-Basis Function, Random Forest and Polygenic Scoring method were being compared. It was found that a simple polygenic score classifier performed much better than others and they also found that all classifiers performed worse with small number of Single Nucleotide Polymorphisms in brain expressed set compared to whole genome set.

As it can be seen from the earlier sections, a wide range of research studies has been done for EEG artifacts removal. Methods that have been proposed can be divided into manual, semi-automatic and automatic. Manual and semi-automatic methods require expert observations to identify artifacts in EEG signal. On the other hand, automatic methods require predefined threshold value. In the past few years, machine learning techniques have been advanced significantly and used in pattern identification and classification problems. Table 1 presents a summary of the papers based on the different machine learning algorithms presented earlier in this paper. Table 1 shows that the SVM is the mostly used method and different approaches of SVM are applied to classify artifacts in EEG signal. Gaussian kernel and radial basis function (RBF) are found most appropriate approaches for EEG artifacts.

Table 1: Different Machine Learning Algorithms

Machine Learning Technique	Associated Methods	References
Support Vector Machine	ICA, BSS, Autoregressive model	(Bartels et al., 2010; Chin-Teng et al., 2012; Gao, Yang, et al., 2010; Halder et al., 2007; Hsu et al., 2012; Lawhern et al., 2012; Lawhern et al., 2013a; O'Regan et al., 2013; O'Regan & Marnane, 2013; Phothisonothai et al., 2012; Shi Yun et al., 2009; Shi-Yun et al., 2008; Singla et al., 2011; Tangermann et al., 2009; Winkler et al., 2011; Wu et al.,2009)
Artificial Neural Network	ICA, Spectral analysis	(Chin-Teng et al., 2012; Jafarifarmand & Badamchizadeh, 2013; Junfeng et al., 2009; Marquez L & Munoz G, 2013;Nguyen et al., 2012; Singla et al., 2011; Sovierzoski et al.,2009)
Fuzzy Inference system	Differential Evolution Adaptive Noise Cancellation	(Kezi Selva Vijilal et al., 2007; Sheniha et al., 2013)
Clustering	Kurtosis	(Nicolaou & Nasuto, 2007; Patidar & Zouridakis, 2008; Yuan et al., 2012)
K-NN	Polynomial fitting, Hjort descriptor	(Aydemir et al., 2012; Gao, Lin, et al., 2010; Pourzare et al.,2012)
Bayesian Model	Spectral power	(Schetinin & Maple, 2007)
Genetic programming	Power spectral analysis, kurtosis	(Fairley et al., 2010; Poli et al., 2011)

III. System Exemplary

a) System Description

In any classification system, feature selection and extraction is main and important phase toward successful classification system. In our case it's hard to think directly about which features and which classifiers to use in order to get the best results. The diversities are mainly in aspects of EEG artifacts, experiment environment, techniques of data preprocessing and feature selection. Due to all this factors, it is not easy to compare and chose the method which can be said as

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the best classifier. Hence, there is always room for the development of better classifier suitable for specific application.

Our Approach

Firstly the problem, the diagnosis of basic psychological health was identified followed by knowing the psychological health disorders that are often found in patients. A list of machine learning techniques for diagnosis of five most common psychological health disorders effectively if the symptoms of the patient are provided as input. The data sets of 25 attributes containing the class type labels that are found. The set includes these attributes: Age, Family, History, Pregnancy Complication, Delayed Speech, Under Medication, Academic Performance, Relationship Formation, Behavioural Problem, Concentration, Restless, Seizures, Learning Difficulty, Attention Aroused, Attention Sustained, CBCL Score, IQ Test Score, ADHD Positive, ODD Positive, Manic Episode Test Score, Major Depressive Episode, General Anxiety Disorder, CDI Score, PDD Score, Autism Score and Problem Since only few attributes are relevant to classify and predict the problem, Best First Search technique is used to eliminate redundant and irrelevant attributes. This will also help in achieving more accuracy.

The performance analysis of the three classification algorithms has been carried out with common dataset applying WEKA tool or Matlab tool. The classifiers were executed by including selected attributes (13) only using feature selection method. WEKA tool bestows with the various measures for understanding the classification. Among the number of measures, the three measures which are very important for the comparison of the accuracy level of different classifiers are Kappa Statistics, ROC Area and Accuracy.

Tools Used: In order to process the recorded signals, we need to use some softwares as a platform.

1) *EDF browser:* EDF Browser is a free open-source, multiplatform viewer and toolbox for time series storage files like EEG data. European Data Format (EDF) is a standard file format designed for exchange and storage of medical time series. It offers a graphic visualization of the signal, as well as an integrated list of trigger marks present in the file. It also provides filtering functionalities, power on the frequency bands computation, as well as the possibility of down-sampling the signal. This program converts all the signals in an EDF to a plain ASCII text-file. Internally it includes a header and one or more data records. The data records contain consecutive fixed duration epochs of the poly-graphic recording. The header contains some general information (patient identification, start time…) and technical specs of each signal (calibration, sampling rate), coded as ASCII characters. A screenshot from EDF browser is shown in figure 3.

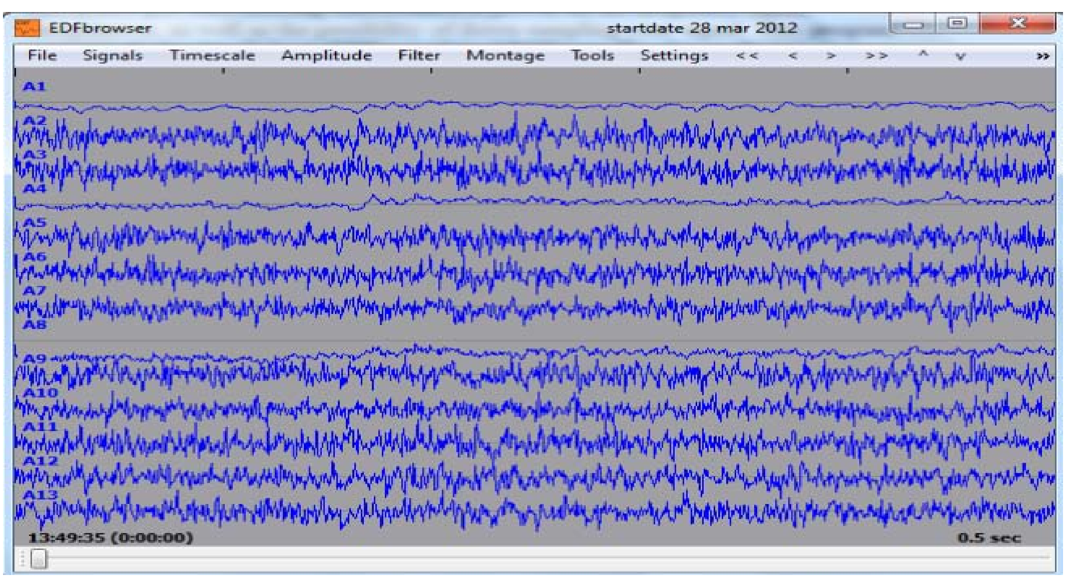

Fig. 3: EDF Browser {25}

MATLAB: MATLAB is a powerful tool, especially with the signal processing toolbox. It integrates computation, visualization, and programming environment. Furthermore, MATLAB is a modern programming language environment: it has sophisticated data structures, contains built-in editing and debugging tools, and supports object-oriented programming. MATLAB has functionality to analyze data, develop algorithms, and create models and applications.

The language tools and built-in math functions enable you to explore multiple approaches and reach a solution faster than with spreadsheets or traditional programming languages. These factors make MATLAB an excellent tool for teaching and research. It provides vast range of different functionalities for analyzing and processing EEG data filtering, time/frequency transforms, feature extraction etc. The Figure 4 is the screenshot from MATLAB.

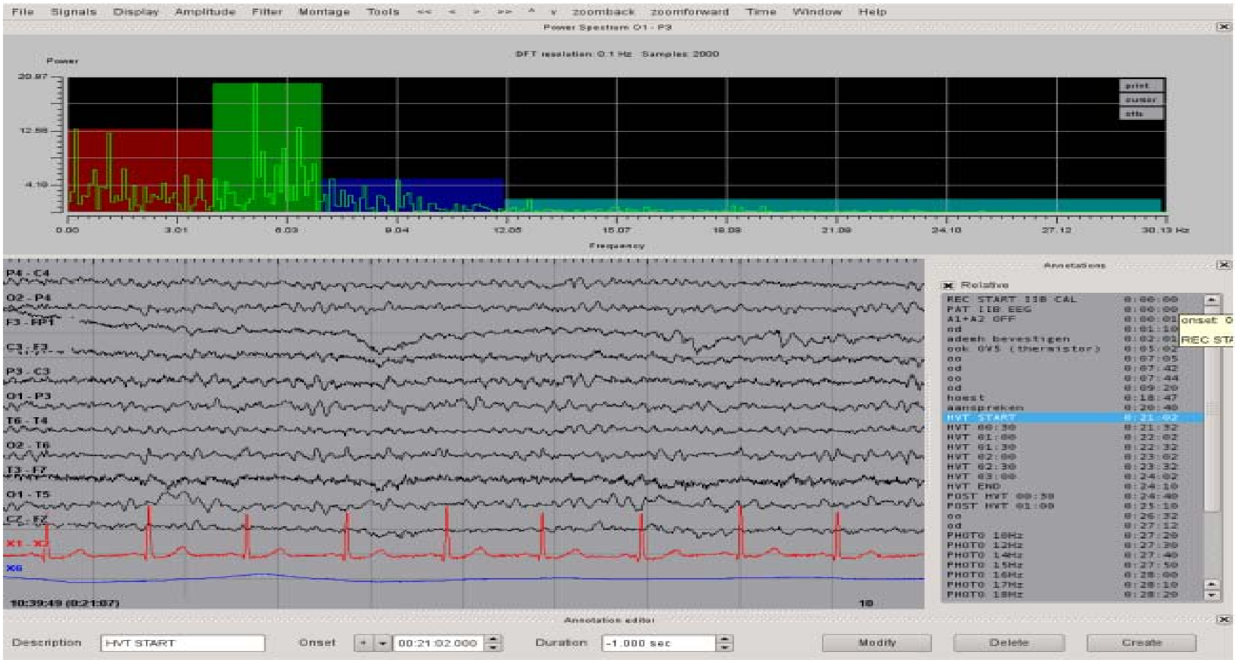

Fig. 4: Manipulating EEG Signals and their Annotations [24]

WEKA Analysis: Waikato Environment for Knowledge Analysis (WEKA) is an open-source collection of machine learning algorithms for data mining tasks. The software is a widely accepted standard in the field and is commonly used in a variety of applications, ranging from biomedical to financial data analysis. WEKA is written in the Java programming language and is normally run under a Java Virtual Machine. Each machine learning algorithm implementation requires the data to be present in its own format, and has its own way of specifying parameters and output. We use Explorer window for our project as shown in Figure 5.

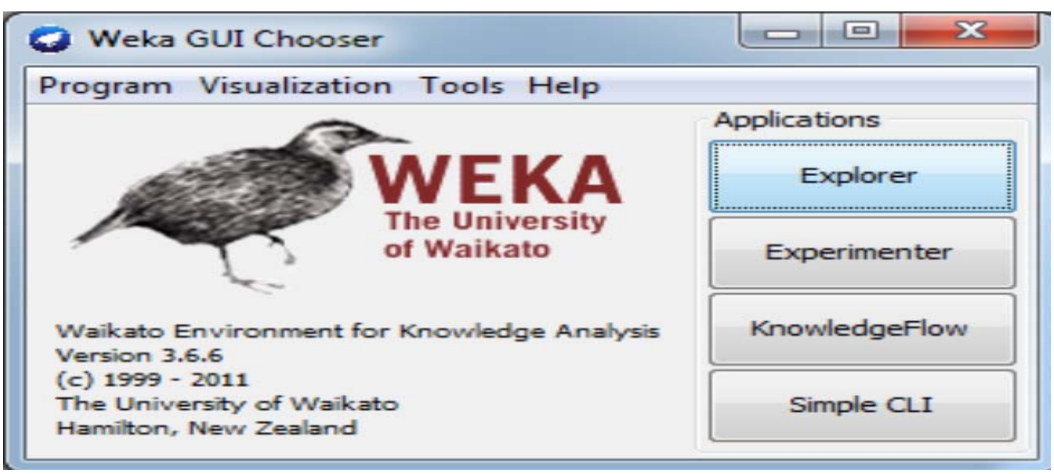

Fig. 5: Waikato GUI Chooser [25]

b) Performance and Robustness Measures

The study of different types of oscillations and rhythmicities of the brain and their relation with different pathologies and functions keep the attention of researchers since the beginnings of EEG measuring. Brain oscillations were divided in frequency bands that have been related with different brain states, functions or pathologies. The characteristic oscillations are (Table II):

- Delta rhythms (0.5–3.5 Hz) are characteristic of deep sleep stages; delta oscillations with certain specific morphologies, localizations and rhythmicities are correlated with different pathologies,
- Theta rhythms (3.5–7.5 Hz) are enhanced during sleep and they play an important role in infancy and childhood; in the awake adult, high theta activity is

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considered abnormal and it is related with different brain disorders,

- Alpha rhythms (7.5–12.5 Hz) appear spontaneously in normal adults during wakefulness, under relaxation and mental inactivity conditions; they are best seen with eyes closed and most pronounced in occipital locations,
- Beta rhythms (12.5–30 Hz) are best defined in central and frontal locations, they have less amplitude than alpha waves and they are enhanced upon expectancy states or tension, gamma rhythms (30–60 Hz) are generally not of major interest with regard to the surface EEG.

Table 2: The Characteristic Brain Oscillations

Wave	Frequency	Voltage	Condition
delta	0.5–3.5 Hz	10 mV	deep sleep
theta	3.5–7.5 Hz	adults: 10 µV kids: 50 µV	light sleep, drowsy
alpha	7.5–12.5 Hz	adults: 50 µV kids: 75 µV	relaxed
beta	12.5–30 Hz	10–20 µV	excited

IV. Conclusion

In medical domain, numbers of expert systems are available to predict diseases at very early stage to make the treatment effective and efficient. In the similar manner, expert systems have been developed in psychological health sector for predicting the mental health problems at early stage. Since number of machine techniques are present for building expert systems, analysis of the techniques and their comparison for identifying the best technique which suits domain. This paper presents a literature review of machine learning algorithms that are frequently used psychological health sector handling. This article provides an overview of how certain machine leaning techniques have been applied in handling different EEG artifacts. From the study, it is revealed that a large number of automatic and semi-automatic methods are available for EEG artifacts removal. However, the usage of machine learning algorithms is limited. It is also found that machine learning algorithms provide better classification accuracy than other approaches. Moreover, comparison of different techniques is also studied and in several studies it is suggested that SVM is better classifier than other classification methods. Finally, the survey leaves us with focus on hybrid approaches i.e., using several machine learning algorithms.

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Use of Data Mining to Predict Human Diseases

By Saumya Shandilya
Symbiosis Institute of Technology

Abstract- In this project, we intend to make an intelligent agent that asks the user about their medical symptoms and tries to predict the most probable diseases/medical conditions that they might be suffering from. Based on the results, it can also direct the user/patient to go to pharmacy or consult a doctor or to go for medical emergency services. It is truly said that "Prevention Is Better Than Cure". Sometimes diseases like cancers have very minor symptoms in the early stages but if detected this could save a patient's life. There is no harm in taking preventive medical advice than regretting later. Artificial Neural Networks (ANN) is currently a 'hot' research area in medicine and it is believed that they will receive extensive application to biomedical systems in the next few years. An application called the "Instant Physician" trained an auto associative memory neural network to store a large number of medical records. After training, the net can be presented with input consisting of a set of symptoms; it will then find the full stored pattern that represents the "best" diagnosis and treatment.

Keywords: artificial neural networks, associative memory neural network, data mining.

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1. *General Population/Patients*
   a. This can act as a preliminary advice mechanism for patients before they consult a doctor.
   b. They can get suggestions as to whether they need to consult a doctor, or a visit to the local pharmacy would be fine for them.
2. *Medical Professionals*
   a. To speed up the process of diagnosis and to reduce human errors involved in finding the possible ailments.
3. *Medical Undergraduate/Students*
   a. To understand the common diseases and the symptoms related to them.
   b. To understand all possible medical conditions which could be present in the patient who is exhibiting a said symptom.
4. *Hospitals*
   a. Based on the diagnosis, hospital websites can display their specialist doctors that the patients can visit.

Keywords: artificial neural networks, associative memory neural network, data mining.

I. Introduction

Sometimes people ignore some medical symptoms or conditions that they might be suffering from and do not feel like going to the doctor for every small medical problem that they are facing. Hence, we felt that there is a need for a medical health advisor that would guide people about the diseases or medical conditions that they might be suffering from. This medical health advisor is an intelligent learning and heuristics based system that predicts the diseases based on the symptoms that they enter. Based on this prediction the application would also suggest if they need to take medical advice from a doctor for their condition and if yes what kind of medical specialist do they need to visit. This application would also be useful for medical professionals and new medical students if they need to know about all the possible diseases that might be related to one particular symptom. Thus, particularly in the Indian context where medical advice is not readily available especially in rural areas, tie-ups could be done with local health centers and the state government in extending this application's reach. Medical ignorance could be life-threatening thus it is important to stay informed to stay safe.

II. Literature Survey

Research phase is very crucial for the success of any project. The capabilities and strengths of a project depend on how strong the research is. We devoted 40% of our time towards research on various Natural Language Processing Algorithms, Sentiment Analysis Tools and various APIs.

a) *Method of Diagnosing Cerebral Infarction (US Patent No. 5590665 A) Developed by Kazuyuki Kanai. Publication Date: Jan 7, 1997*

Abstract- A novel method of diagnosing cerebral infarction using a neural network, wherein plural sets of data previously obtained from healthy and sick persons, each including an age, measured values of coagulo-fibrinolytic molecular markers (e.g., D-dimer, TAT and PAP) , an index indicative of the state of cerebral infarction (e.g., 0 for healthy persons and 1 for sick persons) and the like, are repeatedly input into a neural network to let it learn the correlation of these characteristics and, thereafter, a set of data of a person to be diagnosed, including his age, measured values of the coagulo-fibrinolytic molecular markers and the like, are input in the neural network to obtain an index indicative of his state of cerebral infarction as a degree of dangerousness of cerebral infarction. This method is significantly higher inaccuracy as compared with the prior art methods using the same data.

b) *Artificial Neural Networks in Medical Diagnosis*

Abstract- An extensive amount of information is currently available to clinical specialists, ranging from details of clinical symptoms to various types of biochemical data and outputs of imaging devices. Each

Author: Computer Science Department, Symbiosis Institute of Technology Bachelors of Engineering in Computer Science. e-mail: saumyanda@gmail.com

type of data provides information that must be evaluated and assigned to a particular pathology during the diagnostic process. To streamline the diagnostic process in daily routine and avoid misdiagnosis, artificial intelligence methods (especially computer aided diagnosis and artificial neural networks) can be employed. These adaptive learning algorithms can handle diverse types of medical data and integrate them into categorized outputs. In this paper, we briefly review and discuss the philosophy, capabilities, and limitations of artificial neural networks in medical diagnosis.

c) A Data Mining Approach for Prediction of Heart Disease using Neural Networks

Abstract- Heart disease diagnosis is a complex task which requires much experience and knowledge. Traditional way of predicting heart disease is doctor's examination or number of medical tests such as ECG, Stress Test, and Heart MRI etc. Nowadays, health care industry contains huge amount of heath care data, which contains hidden information. This hidden information is useful for making effective decisions. Computer based information along with advanced Data mining techniques are used for appropriate results. Neural network is widely used tool for predicting heart disease and other diseases in human beings. In this research paper, a Heart Disease Prediction system (HDPS) is developed using Neural network. The HDPS system predicts the likelihood of patient getting a Heart disease. For prediction, the system uses sex, blood pressure, cholesterol like 13 medical parameters. Here two more parameters are added i.e. obesity and smoking for better accuracy. From the results, it has been seen that neural network predict heart disease accurately.

III. Research Elaboration

We have a unique approach to the classification algorithm for this project, i.e. we have developed our own classification algorithm for the dataset. This is because no standard algorithm such as Random Forests or Bayesian networks could be employed in this use case. Also, we intended to question the user dynamically, hence to find the order of questions was difficult using the standard algorithms.

To classify the diseases based on the symptoms, we thought of implementing a rule-based algorithm, which is the basis of AI. The algorithm which we initially thought of implementing was Apriori Algorithm, which talks about generating the most frequent item set from a set of transactions and gives the support count of the items occurring in a said order. In essence, Apriori algorithm talks about rule based mining. Upon implementing the same on the dataset, we couldn't get accuracy more than 70%. Hence, we discarded the approach.

Next, we thought of Longest Common Subsequence (LCS) approach to understand the patterns of the dataset and generate the dynamic questions according the most frequent longest subsequence. This approach was significantly better than Apriori Algorithm as it was giving an accuracy of 85%. Upon testing with unknown data we found that this approach couldn't yield the required results.

We then thought of performing a frequency analysis of the entire data to understand the sparsity of the data and subsequently to generate the dynamic nature of questions based on the clusters and outliers of the data. The frequency analysis was done using a MultiValueMap, a class in the org.apache.commons. collections library. The MultiValueMap map stores the data set in the format such that one key can have multiple values mapped to it. In this map the key is the frequency of the symptom and value array stores all the symptoms which have the frequency same as the key. Hence, we can say that the MultiValueMap does the clustering of the dataset upon feeding the entire dataset into it. The keyset of the MultiValueMap was sorted and used as the input of the Binary Search Tree (BST) which was made to understand the nature of the frequency distribution.

Every node of the BST has the structure as follows:

1. Frequency of the node: integer value
2. Symptom list associated with said frequency

ArrayList <String> data type

A mirroring operation is performed on the BST data structure to exchange the left and right subtrees of each node. This is done to ensure that that the most frequent symptoms fall in the left subtree of the root node, hence making the traversal of the BST simple. We are implementing an in order traversal for the entire BST to get the symptoms in decreasing order of frequency with every traversal. At every traversal, we get the symptoms associated with the node which is then used by the dynamic questioning interface to intelligently ask questions to the user. Hence, our classification algorithm builds a decision tree from the dataset and intelligently asks relevant questions based the user interactions with the system. The output of the algorithm is all the possible set of diseases associated with the set of symptoms selected by the user on runtime.

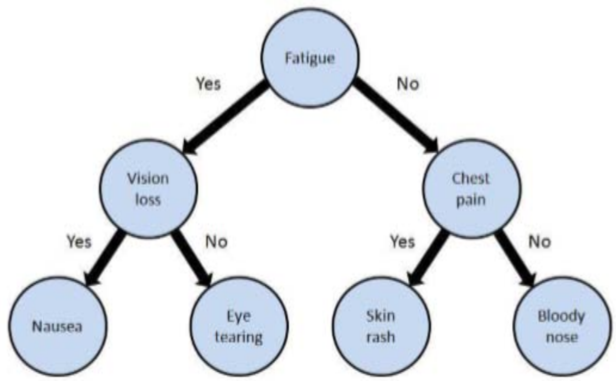

Fig. 1: Example of a decision tree

Common symptom 2 (nausea) present?	
Yes	**No**
3	2

FIG 8.16: Construction of decision tree 2

- Find entropy based on one single attribute yes/no.

Entropy(Common Symptom1) = Entropy(5,9)

=Entropy(0.36,0.64)

= -(0.36 log2 0.36) - (0.64 log2 0.64)

=0.94

Fig. 2: Entropy calculation for decision tree

IV. Results and Findings

a) Sample Code

```
def body_systems_description(url)
i=0
system_parts={}
doc = Nokogiri::HTML(open(url)) do |config|
 config.noblanks
end

arr_extensions=[]
doc.xpath('//div[@class="tp_rdbox_bborder_c"]/ul/li/a/text()').each do |x|
 i += 1
 count =0
 x.xpath('//div[@class="tp_rdbox_bborder_c"]/ul/li/a/@href').each do |y|
  count +=1
  if count.eql?i
   system_parts[x.to_s]=y.content.to_s[1..-1]
   arr_extensions<<y.content.to_s[1..-1]
  end
 end
end

i=0
keys = system_parts.keys

arr_extensions.each do |url_ext|
 temp_url = url+'#'+url_ext
 puts temp_url
 individual_doc = Nokogiri::HTML(open(temp_url)) do |config|
  config.noblanks
 end
 disease_arr=[]
 puts url_ext[0..-3]
 individual_doc.xpath("//div[@id=\"#{url_ext[0..-3]}\"]/div[@class=\"tp_rdbox_bborder\"]/div
              [@class=\"tp_rdbox_bborder_c\"]/div/ul/li/a/text()").each do |x|
  disease_arr<<x.content.to_s
 end

 system_parts[keys[i]]=disease_arr
 i +=1
end


puts system_parts.inspect
system_parts
end
```

This sample code uses the gem "Nokogiri" for the purpose of fetching the structure of a said webpage, which is passed as a parameter to the function body_systems_descriptions (url). The url is then parsed using the gem and the required element of the HTML page is selected using the xpath. Tree structure of the HTML node required is passed to the xpath and the processing of data is done to populate the dataset.

b) Screenshots and Outputs

```
431, [vomiting]
359, [nausea]
312, [fever]
260, [fatigue]
255, [headache]
193, [diarrhea]
183, [confusion]
```

Fig. 3: Symptoms and their frequencies

A
Aarskog syndrome;Belly button that sticks out";"Bulge in the groin or scrotum";"Delayed sexual maturity";"Delaye
Aase syndrome;"Absent or small knuckles";"Cleft palate";"Decreased skin creases at finger joints";"Deformed ear
Abdominal aortic aneurysm;"Pain in the abdomen or back. The pain may be severe
Abdominal pain - children under age 12;"Constipation";"Gas";"Food allergy or intolerance";"Heartburn or acid refl
ABO incompatibility;"Back pain";"Blood in urine";"Chills";"Feeling of "impending doom"";"Fever";"Yellow skin and

Fig.4: Raw data from data crawler

	A	B	C
1	Aarskog syndrome	258	595
2	Aase syndrome	98	258
3	Abdominal aortic aneurysm	1	2
4	Abdominal pain - children under age 12	27	38
5	ABO incompatibility	3	14

Fig. 5: Diseases and their associated symptoms

```
put - TinyDocs (run) #2
Task completed:Creation of Multi-Map
Total time:6278 ms

Task completed:Writing mappings
Total time:203 ms

Task completed:DataSet Creator Execution
Total time:8805 ms

end of DataSet_Creator

Welcome to Tiny Docs!
----------------------------------
Do you have vomiting
yes
----------------------------------
Do you have nausea
yes
----------------------------------
Do you have fever
no
----------------------------------
Do you have fatigue
yes
----------------------------------
Do you have headache
yes
----------------------------------
Do you have diarrhea
yes

Getting the diseases:
List:1,2,4,5,6
Line numbers:[537, 928, 1057, 1460]
Diseasees:[Drug-induced hepatitis, Kidney stones, Methemoglobinemia, Shellac poisoning]
```

Fig. 6: CLI Application

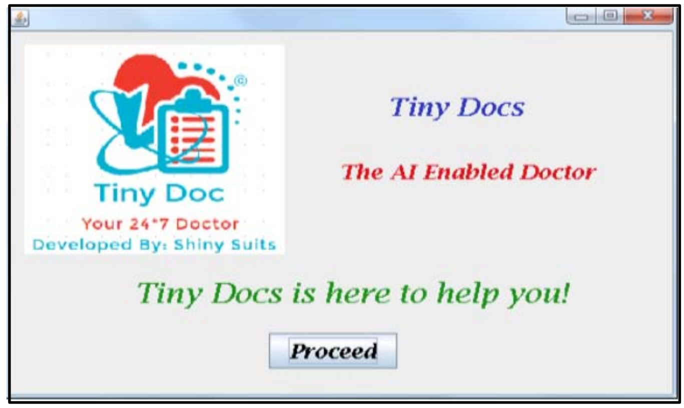

Fig. 7: Gui application

Fig. 8: Log in Page

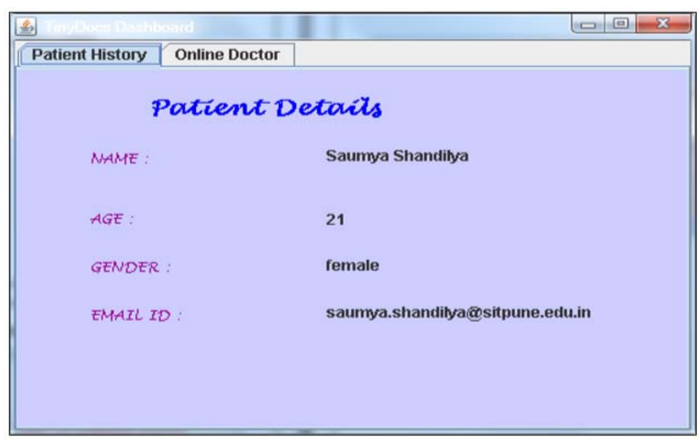

Fig. 9: Patient details page

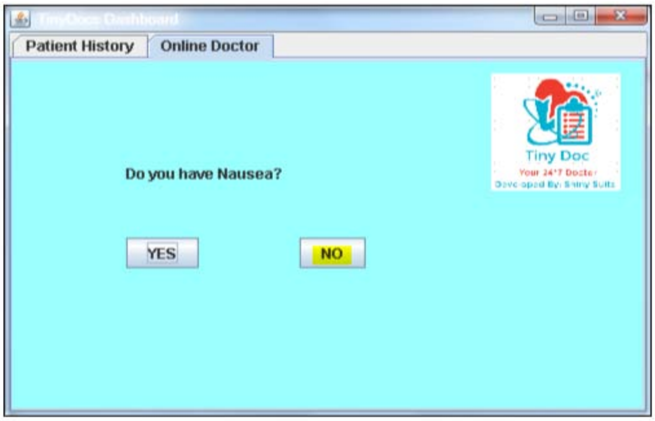

Fig. 10: Sample questions page

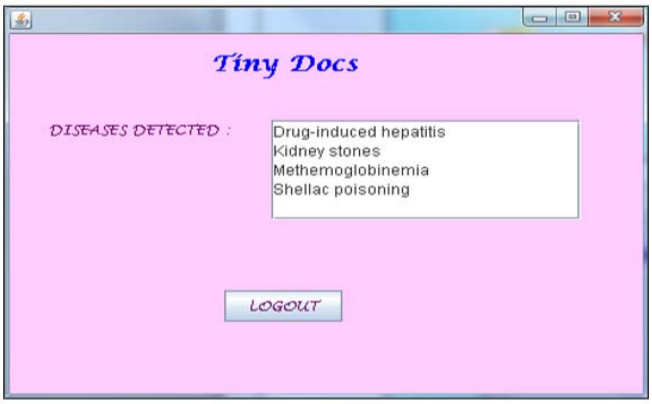

Fig. 11: Sample output page showing diseases detected

V. Conclusion

After extensive study about diseases and their symptoms, we have developed a preliminary health assessing tool for a common man to use. We aimed to tell the user about the possible diseases that the user may be suffering from depending on the symptoms.

This application could be very useful for people who are uncertain about the diseases that they might have but do not have prompt access to medical services. At the same time, we do not intend to take the place of a general physician or OPD clinics; we just aim to guide the patient to the right type of medical assistance. While working on this project, we realized that the true Indian doesn't really have the knowledge of what he/she may be having and are ignorant about the diseases that they may be suffering from. Hence, we feel that this project will be a big contribution in this area where people hesitate are ignorant about their health or those who don't have access to medical services.

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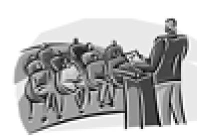

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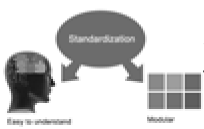

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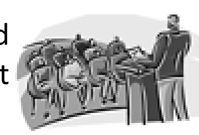

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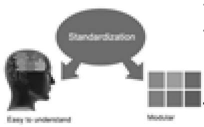

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Note :

"

- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.

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1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript’s Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

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- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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