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Hyper Parameter Tuning Approach

Highlights

Static and Dynamic Gestures

Machine Learning Model Optimization

Discovering Thoughts, Inventing Future

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Sign Language Recognition for Static and Dynamic Gestures

By Jay Suthar, Devansh Parikh, Tanya Sharma & Avi Patel

Abstract- Humans are called social animals, which makes communication a very important part of humans. Humans use shoes and non-verbal forms of language for communication purposes, but not all humans can give oral speech. Hearing impaired and mute people. Sign language became consequently advanced for them and nevertheless impairs communication. Therefore, this paper proposes a system that uses streams to use CNN networks for the classification of alphabets and numbers. Alphabet and number gestures are static gestures in Indian sign language, and CNN is used because it provides very good results for image classification. Use hand-masked (skin segmented) images for model training. For dynamic hand gestures, the system uses the LSTM network for classification tasks. LSTMs are known for their accurate prediction of time zone distributed data. This paper presents different types of hand gestures, namely two models for static and dynamic prediction, CNN and LSTM.

Keywords: indian sign language, skin-segmentation, CNN (convolutional neural network), LSTM (long shortterm memory).

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SIGNLANGUAGERECOGNITIONFORSTATICANDDYNAMICGESTURES

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Sign Language Recognition for Static and Dynamic Gestures

Jay Suthar [α], Devansh Parikh [σ], Tanya Sharma [ρ] & Avi Patel [Ѡ]

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Nomenclature:

ISL: Indian Sign Language
ROI: Region of Interest
CNN: Convolutional Neural Network
RMSProp: Root Mean Square Propagation
LSTM: Long Short-Term Memory

I. Introduction

Everyone uses language to communicate with others, whether it is English, Spanish, sign language, or touch or smell language. Sign language is the language used by deaf-mute people to talk. It varies from country to country and has its own vocabulary. Indian Sign Language (ISL) is a collection of gestures used by the deaf community in India. These gestures are also different in different parts of India.

It is always a challenge for normal people to communicate with deaf-mute people and vice versa. Sign language translation is the solution to this problem. It provides a bridge of communication between the community at large and the deaf-mute community. There are two main methods for the recognition of sign language, glove-based and computer vision-based [1]. In this article, a computer vision-based approach to interpreting ISL in two different ways is discussed. ISL letter recognition includes camera frame extraction, hand masking, feature extraction and classification recognition. This is to identify the alphabet from a single frame. The second method is to recognize gestures through words. The camera frame sequence is used to recognize gestures. It consists of the same modules as letter recognition, but it uses a series of frames instead of one frame. This article focuses on ISL recognition through deep learning and computer vision. The rest of thesis is organized as follows; the second part presents the related work done in gesture recognition. The third part contains the methodology of the two methods of recognition of the Indian sign language. The first method is suitable for static gestures and the second method is suitable for dynamic gestures. Discussion of the results and conclusions are explained in Sections 4 and 5, respectively.

II. Related Work

Many techniques have been developed to recognize sign language. There are two main approaches that use tracking sensors or computer vision to track various movements. Much research has been done on sensor-based approaches using gloves and wires [1, 2, 3]. Therefore, it is inconvenient to wear these devices continuously. Additional work will primarily focus on computer vision-based approaches.

A lot of work has been done using a computer vision based approach. The authors have proposed various methods of recognizing sign language using CNN (Convolution Neural Network), HMM (Hidden Markov Model) and contour lines [4, 5, 6, 7]. Different methods are used to split images such as HSV and color difference images [4, 5]. The authors proposed an SVM (Support Vector Machine) method for classification [6, 8]. Archana and Gajanan also compared different methods for partitioning and feature extraction [9]. All previous treatises have successfully recognized the ISL alphabet. But in reality, deaf or mute people use speech gestures to convey messages. If the word has a static action, you can use these previous methods to check the word.

ISL Many words required hand movements. The image classification method is not a simple image classification technique, but is suitable for identifying these dynamic gestures. Video-based action recognition has already attracted attention in several studies [10, 11, 12]. Instead of capturing the color image data for each

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frame of the video, some researchers performed differences between successive frames and randomly provided these segments to the TSN (Temporal Segment Network) [11]. Sun, Wang and Yeh use LSTM (Long Short-Term Memory) [13] to describe video classification and captions. Juilee, Ankita, Kaustubh and Ruhina used video to suggest a method of hydration recognition in India [14]. As a result of searching the sign language recognition system, most studies use static sign language gestures and video recognition techniques to study dynamic gesture identification and only perform video classification for various actions discovered.

III. Methodology

a) Static gesture classification

Experiments were performed on the data set provided by [15]. The dataset contains 36 folders representing 09 and A-Z, each consisting of an image of a hand subdivided by the corresponding alphanumeric skin color. There are 220 images of 110 x 110 pixels each for each alphanumeric character. Figure 1 shows an image of each label in the data set.

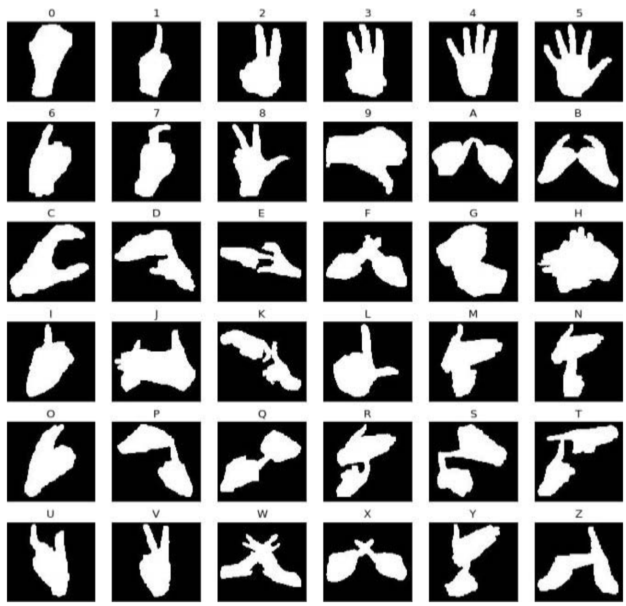

Figure 1: Hand-masked image data set

This image is split into a training dataset and a test dataset all in a ratio of 80:20. So the training dataset contains 6336 images and the test dataset contains 1584 images corresponding to 36 classes. Also, since the number of images per class is small, we performed data expansion to feed more data to the CNN model. Data scaling includes operations such as rotation, width_shift, height_shift, rescaling, etc. The specification of the CNN model is shown in Table 1 below.

Table 1: CNN Specification

Property	Value
ConvolutionLayer	3Layers (32,64,128 nodes)
ConvolutionLayer(KernelSize)	3,3, 2
MaxPoolingLayer	3 Layers-(2, 2)
FullyConnected Layer	128nodes
OutputLayer	36nodes
ActivationUsed	Softmax
Optimizer	RMSProp
Hyperparameters	
Learningrate	0.01
No.ofepochs	10

After training the model, predict the output by performing the following steps:

Frame Extraction: Uses OpenCV library to capture video from webcam for live prediction. After capturing the video, take a single frame and define a region of interest (ROI) in that frame. The area of interest is the area in which a person runs a stream.

Skinsegmentation: The ROI of the frame is transformed into a hand-masked image to provide to the model for predictive purposes. First, you need to blur the image to reduce noise. This is done by applying Gaussian Blur. After blurring ROI is converted to HSV color scale in RGB. Converting an image to the HSV color scale helps detect better skin than RGB. Next, lower and upper limits are set for skin extraction. Here, (108, 23, 82) was used in the low range and (179, 255, 255) was used in the high range. This range offers us the best results. After selecting a range, compare the values of each pixel and if the pixel value is not within the range, it will be converted to black, otherwise it will be converted to white pixels. This provides us with handmasked images. Still, the hand-masked image is noisy and the edges are not aligned. To solve this problem, use the Dilate and Erode features available in OpenCV to smooth the edges.

Prediction: The ROI of the frame is converted to a handmasked image. This hand-masked image is provided as input to the CNN model for prediction. 09 or AZ is provided for the output of the original frame, but it is a predicted value. But this leads to another problem, the frame output keeps blinking. To solve this problem, we used a 25-frame forecast and used the maximum forecast class as the output.

Figure 2 shows a handmasked image of the alphabet L and the final output.

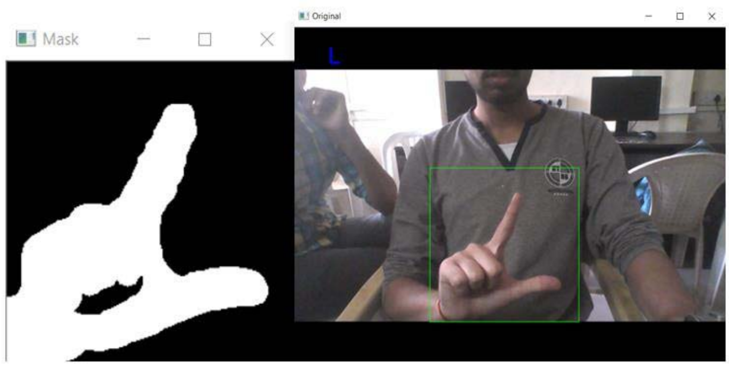

Figure 2: Hand-mask and Predicted Output

b) Dynamic gesture classification

Neural networks can help predict complex data and values most of the time. Input is not related to time or is not required in chronological order. This is the case for static gestures in ISL, so a multi-layer CNN architecture is sufficient. However, for dynamic gestures, you cannot perform CNN silver because you have to keep the previous state. Therefore, LSTM networks are useful in this case. LSTM is an RNN (Recurrent Neural Network) type that has a structure similar to a chain of repeating modules that is useful for learning long-term dependencies from sequential data.

```
Model: "sequential_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
time_distributed_1 (TimeDist (None, 8, 7, 7, 1280)     2257984
_________________________________________________________________
time_distributed_2 (TimeDist (None, 8, 1280)           0
_________________________________________________________________
lstm_1 (LSTM)                (None, 8, 64)             344320
_________________________________________________________________
dropout_1 (Dropout)          (None, 8, 64)             0
_________________________________________________________________
lstm_2 (LSTM)                (None, 64)                33024
_________________________________________________________________
dense_1 (Dense)              (None, 64)                4160
_________________________________________________________________
dropout_2 (Dropout)          (None, 64)                0
_________________________________________________________________
dense_2 (Dense)              (None, 24)                1560
_________________________________________________________________
dropout_3 (Dropout)          (None, 24)                0
_________________________________________________________________
dense_3 (Dense)              (None, 5)                 125
=================================================================
Total params: 2,641,173
Trainable params: 2,607,061
Non-trainable params: 34,112
```

Figure 3: Model Architecture

First, to train the model, we need the data. I have created a dataset that contains 12 classes of video. Today, tomorrow, yesterday, goodbye, mom, dad, time, eat, well, I (I), thank you, Namaste class. Each class has about. 57 seconds 2025 hand gesture video. The video is captured using the phone back camera at an average of 2830 frames per second. Data sets are created among different people from different backgrounds so that different situations can be trained. Currently this dataset is split into 20ta for validation and the rest for training. The model structure is shown in Figure 3. The input continuously delivers a sequence of 8 frames/images extracted from images in the training dataset. Apply an RGB difference filter before serving these 8 frames as input. The RGB difference subtracts the current frame from the previous frame. Therefore, only the changed pixels remain in the frame and the remaining still images are deleted. In this way, it helps to capture time-varying visual features. Here in our case it helps to capture the gesture pattern and the background is also removed so it becomes independent in a variety of background scenarios.

If so, these frame sizes change to 224 x 224 pixels. This is because the next layer is a MobileNetV2 layer that only accepts image sizes up to 224 x 224 pixels. As a pre-trained model, we used the weight of \`Imagenet\` and MobileNetV2. MobileNetV2 can be used as a pre-trained model used for image segmentation, eliminating the task of building CNN models for image segmentation. Separate the Mobile Net V2 layer for passing these 8 frames with Time Distributed layer used. Here I use the Time Distributed Global Average Pooling layer as I need to flatten the frames to insert a series of frames into the LSTM. Finally, there is a multi-layer LSTM structure with several dropouts and a fully connected layer to reduce the sum of overcharges. LSTMs help recognize pattern formation with dynamic / moving hand gestures. Finally, SGD is used in optimization programs because it provides better results when the available data set is low. Adam provides good results even when the dataset is large.

IV. Results and Discussion

a) Static gesture classification

During checking out of the static hand gesture version and figuring out the greatest architecture, 10epoch models were each trained using various optimizations such as RMSProp, SGD, Adam, etc. By the way, RMSProp gave the best results with a precision of 73.6°. A graph of accuracy and time is shown in Figure 4

Skin segmentation is an integral part of a system for predicting static hand gestures. It was concluded that the lower range (108,23,82) and the higher range (179,255,255) would give the best results. Figure 5-6 shows the gestures predicted to be skin segmentation.

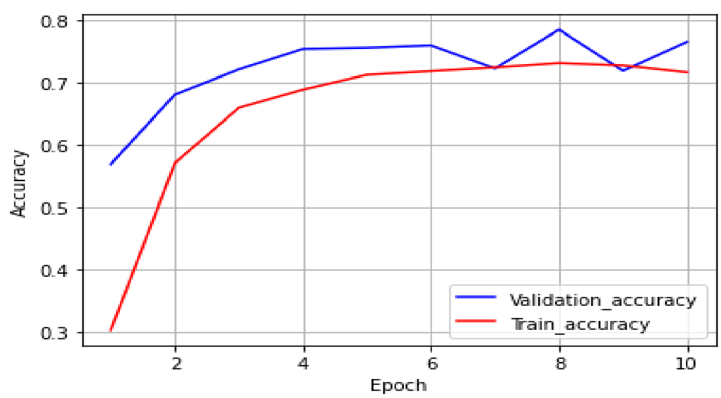

Figure 4: Accuracyvs. Epoch graph for the CNN model

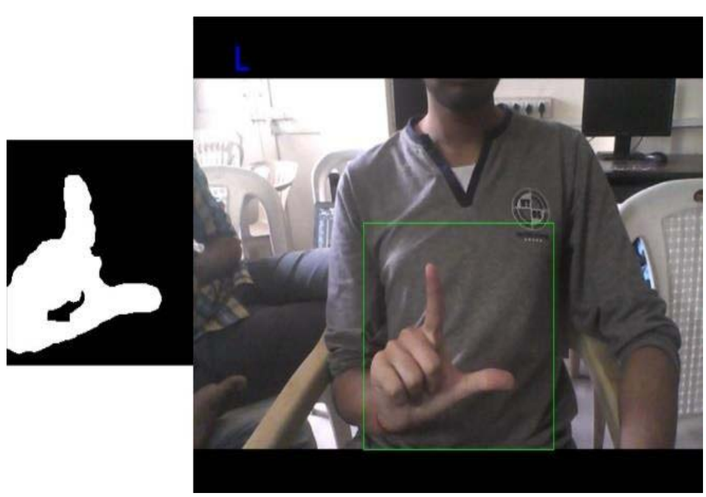

Figure 5: Prediction of Alphabet Letter ‘L’

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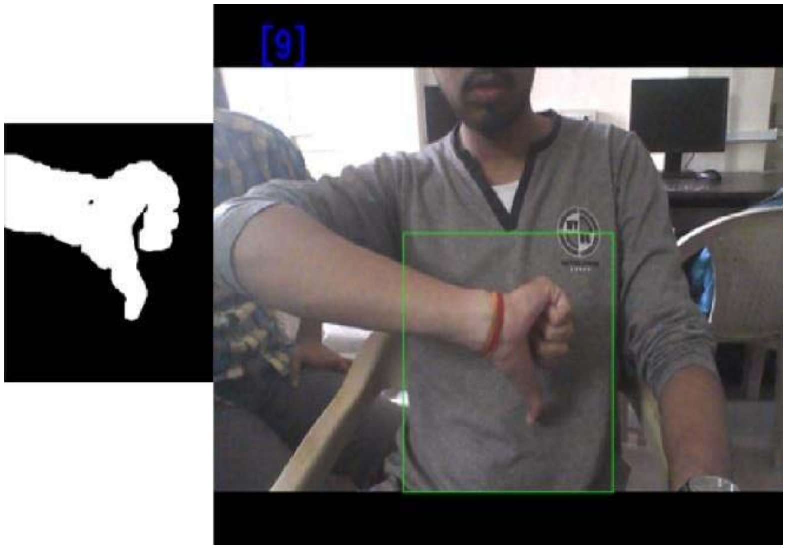

Figure 6: Prediction of Number '9'

There are some limitations to using skin segmentation to recognize static hand gestures. Most importantly, you need a skin-free background. Predictions are wrong because the background contains colors in the skin color range and it is difficult to hide the skin. For example, if the background is a shade of yellow that falls within our range, this problem will occur. The second problem is a stream of similar shape. The equal gestures with alphabets and numbers overlap. For example, the alphabet "V" and the number "2" have the same gesture and cannot be properly distinguished by the system. There is also a similar hand movement problem that reduces accuracy. For example, the letters 'M' and 'N' are very similar. Other similar pairs are `FX` and `1I`.

b) Dynamic gesture classification

Dynamic hand gesture recognition used multi-layered LSTMs to capture patterns formed by movement motions. A model was trained to recognize 12 frequently used words. Model gives medicine. 85 Deputy Pastor of the Diocese. Figures 7 and 8 show the expected behavior and accuracy. If no action is taken, the result is "No action taken".

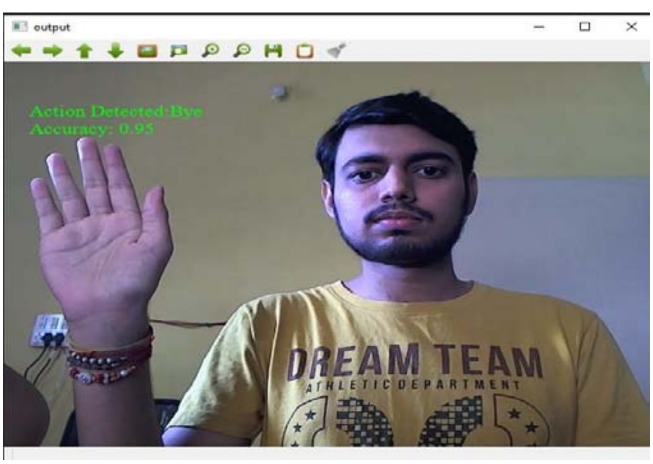

Figure 7: Prediction of Word "Bye"

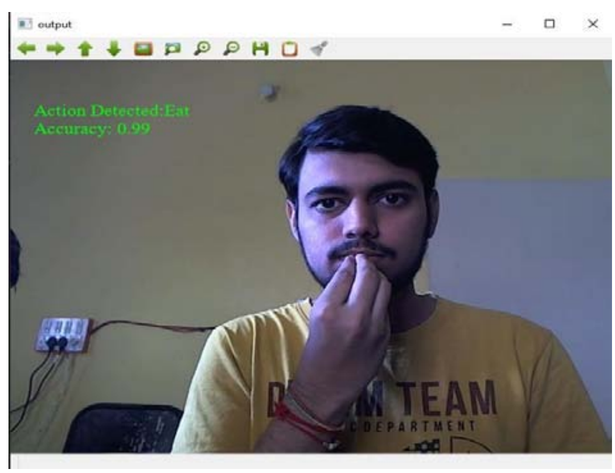

Figure 8: Prediction of Word "Eat"

Removed static parts of the frame sequence using RGB differences to overcome the background color issue. It also leaves the moving hand in the frame, which helps detect hand gesture patterns. The only problem with this approach is that if the background is moving, the sequence of frames will also have a background, which will affect the prediction accuracy. You can also add more videos to different backgrounds and people's datasets for greater accuracy.

V. Conclusion and Destiny Scope

The Deafmute community is faced with communication challenges every day. This white paper describes two methods for recognizing hand gestures: static gestures and dynamic gestures. For static gesture classification, a CNN model is implemented that classifies the motions alphabetically (AZ) and numerically (09) with a precision of 73. Use hand mask skin subdivision with the model For dynamic gestures, we trained a model using multi-layer LSTM using 12-word MobileNetV2 and gave very satisfactory results with an accuracy of 85°. For future work with static gestures, another approach to skin segmentation that does not rely on skin color can be built. For dynamic gestures, you can increase the size of data sets with different backgrounds.

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Machine Learning Model Optimization with Hyper Parameter Tuning Approach

By Md Riyad Hossain & Dr. Douglas Timmer
UTRGV

Abstract- Hyper-parameters tuning is a key step to find the optimal machine learning parameters. Determining the best hyper-parameters takes a good deal of time, especially when the objective functions are costly to determine, or a large number of parameters are required to be tuned. In contrast to the conventional machine learning algorithms, Neural Network requires tuning hyper-parameters more because it has to process a lot of parameters together, and depending on the fine tuning, the accuracy of the model can be varied in between 25%-90%.

A few of the most effective techniques for tuning hyper-parameters in the Deep learning methods are: Grid search, Random forest, Bayesian optimization, etc. Every method has some advantages and disadvantages over others. For example: Grid search has proven to be an effective technique to tune hyper-parameters, along with drawbacks like trying too many combinations, and performing poorly when it is required to tune many parameters at a time. In our work, we will determine, show and analyze the efficiencies of a real-world synthetic polymer dataset for different parameters and tuning methods.

Keywords: machine learning, hyper parameter optimization, grid search, random search, BO-GP.

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Md Riyad Hossain [α] & Dr. Douglas Timmer [σ]

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Keywords: machine learning, hyper parameter optimization, grid search, random search, BO-GP.

I. Introduction

In the era of Machine learning, performance (based on accuracy and computing time) is very important. The growing number of tuning parameters associated with the Machine learning models is tedious and time-consuming to set by standard optimization techniques. Researchers working with ML models often spend long hours to find the perfect combination of hyper-parameters [1]. If we think w, x, y, z as the parameters of the model, and if all of these parameters are integers ranging from 0.0001 to say 5.00, then hyperparameter tuning is the finding the best combinations to make the objective function optimal.

One of the major difficulties in working with the Machine learning problem is tuning hyperparameters. These are the design parameters that could directly affect the training outcome. The conversion from a non-tuned Machine learning model to a tuned ML model is like learning to predict everything accurately from predicting nothing correctly [2]. There are two types of parameters in ML models: Hyperparameters, and Model parameters. Hyperparameters are arbitrarily set by the user even before starting to train the model, whereas, the model parameters are learned during the training.

The quality of a predictive model mostly depends on the configuration of its hyperparameters, but it is often difficult to know how these hyperparameters interact with each other to affect the final results of the model [14]. To determine accuracy and make a comparison between two models it is always better to make comparisons between two models with both of the models' parameters tuned. It would be unfair to compare a Decision Tree model with the best parameter against an ANN model whose hyperparameters haven't been optimized yet.

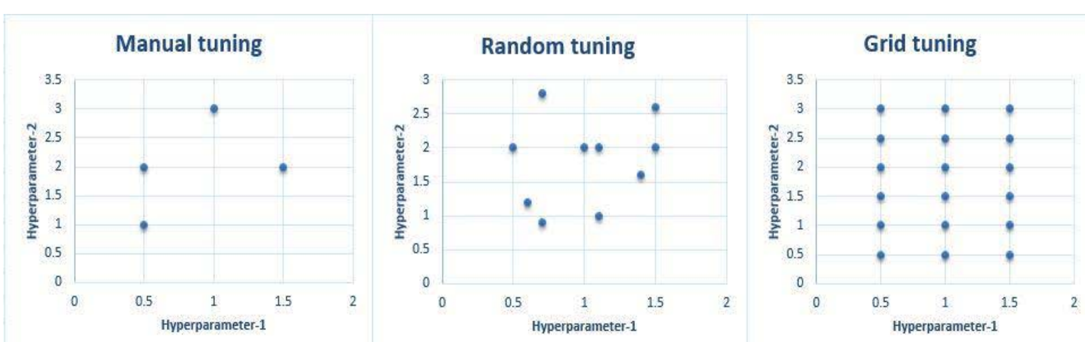

Figure 1: (a) Manual tuning (b) Random tuning (c) Grid tuning approach [From left to Right]

II. Literature Review

The hyperparameter tuning, due to its importance, has changed to a new interesting topic in the ML community. The hyperparameter tuning algorithms are either model-free or model-based.

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Model-free algorithms are free of using knowledge about the solution space extracted during the optimization; a few of this category includes manual search [4], random search [2, 6-7], and grid search [5]. In the Manual search categories, we assume the values of the parameters based on our previous experience. In this technique, the user allows some sets of hyperparameters based on judgments or previous experience, trains the algorithm by them, observes the performance, keeps repeating to train the model until achieving a satisfactory accuracy and then selects the best set of hyperparameters that gives the maximum accuracy. However, this technique is heavily dependent on the judgment and previous expertise and its reliability is dependent on the correctness of the previous knowledge [3]. Some of the few of the main parameters used by Random forest classifiers are: criterion, max_depth, n_estimators, min_samples_split etc.

In the Random search, we train and test our model based on some random combinations of the hyperparameters. This method is better used to identify new combinations of the parameters or to discover new hyperparameters. Although it may take more time to process, it often leads to better performance. Bergstra et al. (2012) in their work mentioned that, over the same domain, random search is able to find models that are as good as or even better in a reduced computation time. After granting the same computational budget for the random search, it was evident that random search can find better models by effectively searching for larger and less promising configuration spaces [16]. Random Search, which is developed based on grid research, sets up a grid of hyper-parameter values and selects random combinations to train the algorithm; Bergstra et al. (2011) [2].

In the grid search, the user sets a grid of hyperparameters and trains the model based on each possible combination. Amirabadi et al. (2020) proposes two novel suboptimal grid search techniques on the four separate dataset to show the efficiency of their hyperparameter tuning model and later compare it with some of the other recently published work. The main drawback of the grid search method is its high complexity. It is commonly used when there are a few numbers of hyperparameters to be tuned. In other words, grid search works well when the best combinations are already determined. Some of the similar works of grid search applications have been reported by Zhang et al. (2014) [17], Ghawi et al. (2019) [18], and Beyramysoltan et al. (2013) [19].

Zhang et al. (2019) [20] in their work reported a few of the drawbacks of the existing hyperparameter tuning methods. In their work, they mentioned grid search as an ad-hoc process, as it traverses all the possible combinations, and the entire procedure requires a lot of time. Andradóttir (2014) [13] shows that Random Search (RS) eradicates some of the limitations of the grid search technique to an extent. RS can reduce the overall time consumption, but the main disadvantage is that it cannot converge to the global optimal value.

The combination of randomly selected hyper-parameters can never guarantee a steady and widely acceptable result. That's why, apart from the manually tuning methods, automated tuning methods are becoming more and more popular in recent times; snoek et al. (2015) [10]. Bayesian Optimization is one of the most widely used automated hyperparameter tuning methods to find the global optimum in fewer steps. However, Bayesian optimization's results are sensitive to the parameters of the surrogate model and the accuracy is greatly depending on the quality of the learning model; Amirabadi et al. (2020) [3].

To minimize the error function of hyperparameter values, Bayesian optimization adopts probabilistic surrogate models like Gaussian processes. Through precise exploration and development, an alternative model of hyperparameter space is established; Eggensperger et al. (2013) [8]. However, probabilistic surrogates need accurate estimations of sufficient statistics of error function distribution. So, a sizable number of hyperparameters is required to evaluate the estimations and this method doesn't work well when there is to process myriad hyperparameters altogether.

III. Methodology

a) Dataset description

Denier: Denier is a weight measurement usually refers to the thickness of the threads. It is the weight (grams) of a single optical fiber for 9 kilometers. If we have a 9 km fiber weighs 1 gram, this fiber has a denier of 1, or 1D. A fiber with less than 1 gram weight calls Microfibers [22]. Microfibers become a new development trend in the synthetic polymer industry. The higher the denier is, the more thick and strong the fiber is. Conversely, less denier means that the fiber/fabric will be softer and more transparent. Fine denier fibers are becoming a new standard and are very useful for the development of new textiles with excellent performance [21].

Breaking Elongation (%): Elongation at break is one of the few main quality parameters of any synthetic fiber [24]. It is the percentage of elongation at break. Fiber elongation partly reflects the extent of stretching a filament under a certain loading condition. Fibers with high elongation at break are determined to be easily stretched under a predetermined load. Fibers showing these characteristics are known to be flexible. The elongation behavior of any single fiber can be complex because of its multiplicity of structural factors affecting it. Moreover, a cotton fiber comes up with a natural crimp, which is important for fibers to stick together while undergoing other production processes [23]. If L is the length of the fiber, then the equation for the percentages of the breaking elongation would be:

$$E_{Breaking\ \ elongation} = \frac{\Delta L_{Break}}{L_0} * 100\%$$

Breaking elongation for the cotton fiber might be varied from 5% to 10%, which is significantly lower than that of wool fibers (25%-45%), and much lower than polyester fibers (typically over 50%).

Breaking force (cN) and Tenacity (cN/tex): Breaking tenacity is the maximum load that a single fiber can withstand before breaking. For the Polypropylene and PET staple fibers, 10 mm lengths sample filaments is drawn until failure. Breaking tenacity is measured in grams/denier. Very small forces are encountered when evaluating fiber properties, so an instrument with gram-level accuracy is required [25]. The tenacity of virgin PP fibers is about 5–8 g/den, and the elongation at break is about 100%. At the same time, the tenacity of recycled PET is about 3.5-5.7 g/den; the elongation at break usually exceeds 100%.

Draw Ratio: The drawing ration is the ratio of the diameter of the initial blank form to the diameter of the drawn part. The limiting drawing ratio (Capstan speed/Nip reel speed) for the extruder section is between 1.6 and 2.2 [26], whereas, for the stretching section it is in between 3 and 4.

b) Hyper-parameter Optimization (HPO)

The purpose of hyperparameter optimization is to find the global optimal value x^* of the objective function *f*(**x**) can be evaluated for any arbitrary $\boldsymbol{x} \in \boldsymbol{X}$, $x^* = \arg min_{x \in X} f(x)$, and X is a hyperparameter space that can contain categorical, discrete, and continuous variables [27].In order to construct the design of different machine learning models, the application of effective hyperparameter optimization techniques can simplify the process of identifying the best hyperparameters for the models. HPO contains four major components: First, an estimator that could be a regressor or any classifier with one or more objective functions, second: a search space, Third: an optimization method to find the best combinations, and Fourth: a function to make a comparison between the effectiveness of various hyperparameter configurations [28]. Some of the common hyperparameter techniques is discussed below:

Grid Search: Grid search is a process that exhaustively searches a manually specified subset of the hyperparameter space of the target algorithm [30]. A traditional approach to finding the optimum is to do a grid search, for example, to run experiments or processes on a number of conditions, for example, if there are three factors, a 15 × 15× 15 would mean performing 3375 experiments under different conditions. [32]. Grid search is more practical when [31]: (1) the total number of parameters in the model is small, say M <10. The grid is M-dimensional, so the number of test solutions is proportional to L^M, where L is the number of test solutions along each dimension of the grid. (2) The solution is known to be within a specific range of values, which can be used to define the limits of the grid. (3) The direct problem d = g (m) can be computed quickly enough that the time required to compute L^M from them is not prohibitive. (4) The error function E (m) is uniform on the scale of the grid spacing, Δm, so that the minimum is not lost because the grid spacing is too coarse.

There are many problems with the grid search method. The first is that the number of experiments can be prohibitive if there are several factors. The second is that there can be significant experimental error, which means that if the experiments are repeated under identical conditions, different responses can be obtained; therefore, choosing the best point on the grid can be misleading, especially if the optimum is fairly flat. The third is that the initial grid may be too small for the number of experiments to be feasible, and it could lose characteristics close to the optimum or find a false (local) optimum [32].

Random Search: Random search [33] is a basic improvement on grid search. It indicates a randomized search over hyper-parameters from certain distributions over possible parameter values. The searching process continues till the predetermined budget is exhausted, or until the desired accuracy is reached. This methods are the simplest stochastic optimization and are very useful for certain problems, such as small search space and fast-running simulation. RS finds a value for each hyperparameter, prior to the probability distribution function. Both the GS and RS estimate the cost measure based on the produced hyperparameter sets. Although RS is simple, it has proven to be more effective than Grid search in many of the cases [33].

Random search has been shown to provide better results due to several benefits: first, the budget can be set independently according to the distribution of the search space, therefore, random search can work better especially when multiple hyper-parameters are not uniformly distributed [34]. Second: Because each evaluation is independent, it is easy to parallelize and allocate resources. Unlike GS, RS samples a number of parameter combinations from a defined distribution, which maximizes system efficiency by reducing the likelihood of wasting a lot of time in a small, underperforming area. In addition, this method can detect global optimum values or close to global if given a sufficient budget. Third, although getting optimal results using random search is not promising, more time consumption will lead to a greater likelihood of finding the best hyperparameter set, whereas longer search times cannot guarantee better results in Grid searches.

The use of random search is recommended in the early stages of HPO to narrow the search space quickly, before using guided algorithms to get better results. The main drawback [28] of RS and GS is that each evaluation in its iteration does not depend on previous evaluations; thus, they waste time evaluating underperforming areas of the search space.

Bayesian Optimization: Bayesian optimization (BO) is a commonly used reprocessing algorithm for HPO problems. Unlike GS and RS, BO determines future assessment levels based on the previous results. To determine the following parameters of the hyperparameter, BO uses two key factors: a surrogate model and an acquisition function. The division model aims to match all the points that are now seen in the objective function. The acquisition function determines the use of different points, balancing exploration and exploitation. The BO model balances the search and use process to identify the best possible area and avoid losing the best configuration in undeveloped areas [35].

The basic BO method works as follows: (i) Building a reduced-order probabilistic model (ROM) of the objective function. (ii) Finding the best hyperparameter values in the ROM model. (iii) Applying those optimal values to the objective function. (iv) Updating the ROM model with the new set of results. (v) Repeating above steps until achieving maximum number of iterations.

BO is more efficient than GS and RS because it can detect optimal combinations of hyperparameters by analyzing previously tested values, and running the surrogate model is usually much cheaper than running the objective function as a whole. However, because Bayesian optimization models are run based on previously tested values, it is difficult to belong to them with parallel sequential methods; but they are generally able to detect optimal close hyperparameter combinations in a few iterations [36]. Common substitution models for BO include the Gaussian process (GP) [37], random forest (RF) [38], and Parzen estimator (TPE) [39]. Therefore, there are three main BO algorithms based on their substitution models: BO-GP, BO-RF, BO-TPE. GP is an attractive reduced order model of BO that can be used to quantify forecast uncertainty. This is not a parametric model and the number of its parameters depends only on the input points. With the right kernel function, your GP can take advantage of the data structure. However, the GP also has disadvantages. For example, it is conceptually difficult to understand with BO theory. In addition, its low scalability with large dimensions or a large number of data points is another important issue [36].

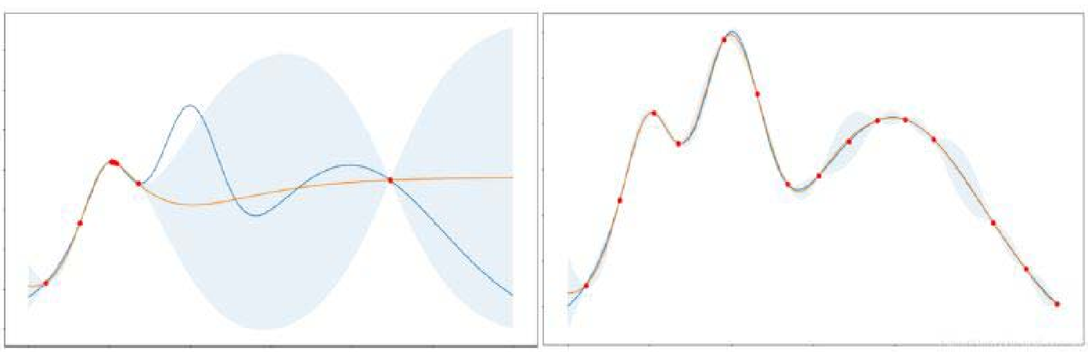

Figure 2: Exploration-based (left) and exploitation-based Bayesian optimization (right); the shadow indicates uncertainty (Yang and Shami, 2020)

IV. Applying HPO in ML Models

In order to put the theory into practice, several experiments have been performed on an industrial-based synthetic polymer model. This section describes experiments with four different HPO techniques on three general and representative ML algorithms. In the first part of the section, we discussed the experimental setup and the main HPO process. In the second part, we compare and analyze the results of the application of different HPO methods.

Table 1: An overview of common ML models we used in this work, their hyper-parameters are listed below:

ML Model	Hyper-parameter
RF Regressor	n_estimators, max_depth, min_samples_split, min_samples_leaf, criterion, max_features
SVM Regressor	C, kernel, epsilon
KNN Regressor	n neighbors

Table 2: Performance evaluation of applying HPO methods to the regressor on the synthetic polymer dataset

Model	Optimization Algorithm	MSE	Cycle time (s)
RF Regressor	Default HPs	0.42	0.07
	GS	0.32	3.62
	RS	0.65	2.8
	BO-GP	0.44	20.5
SVM Regressor	Default HPs	36.54	0.08
	GS	0.93	4
	RS	8.29	1
	BO-GP	2.21	12
KNN	Default HPs	31.01	0.1
	GS	29.45	0.3
	RS	31.02	0.43
	BO-GP	33.44	0.7
ANN	Default HPs	6.72	0.5
	GS	0.47	2
	RS	0.97	2.8
	BO-GP	3.58	30

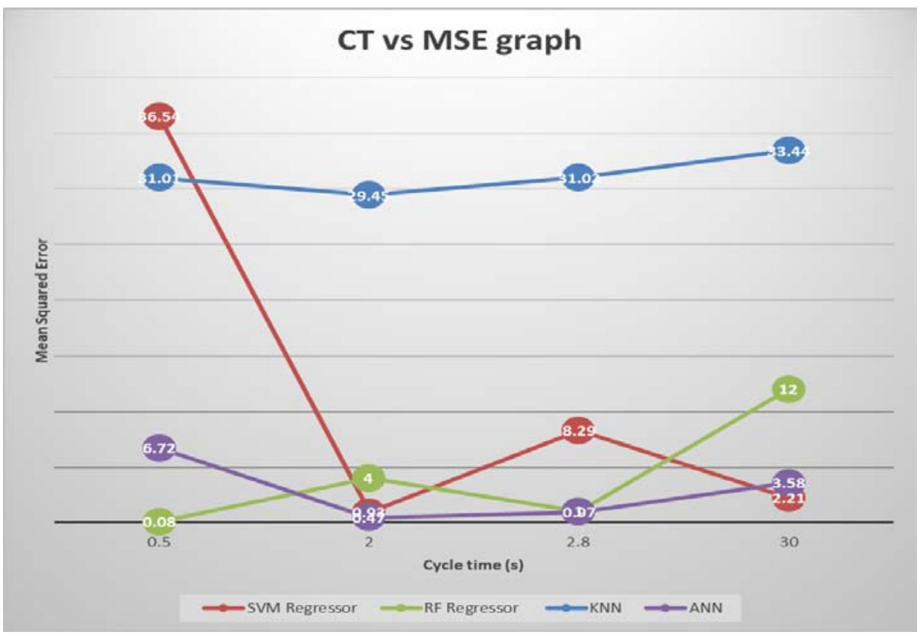

Figure 3: Cycle time vs. MSE graph

V. Discussion & Conclusion

Machine learning has become the primary strategy for dealing with data problems and is widely used in various applications. To apply ML models to practical problems, hyperparameters must be tuned to handle specific datasets. However, as the size of the generated data increases greatly in real life, and manual tuning of hyperparameters is extremely computationally expensive, it has become essential to optimize the hyperparameters by an automatic process. In this work, we used hyperparameter techniques in the ML model to find the best set of hyperparameters. Our data set was small, and in this small datset we can see that the randomly selected subsets are very representative for the given data set, as they can effectively optimize all types of hyperparameters. Our future work would be to test our model on a much larger data set and see the feedback.

Conflict of Interest: The authors whose names are listed in this work certify that they have no affiliations with or involvement in any organization or entity with any financial interest, or non-financial interest in the subject matter or materials discussed in this manuscript.

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Fuzzy Reinforcement Learning using Neural Network: An Application to Medical Diagnosis and Business Intelligence

By Poli Venkata Subba Reddy

Abstract- The information available to the system is incomplete in many applications, particularly in Decision Support Systems. The fuzzy logic deals incomplete information with belief rather than likelihood (probability). Sometimes the decision has to be taken with fuzzy information. In this paper, fuzzy machine learning is studied for decision support systems. The fuzzy Decision set is defined with two-fold fuzzy set. The fuzzy inference is studied with fuzzy neural network for fuzzy Decision sets. Business application is given as application.

Keywords: *component, formatting, style, styling.*

GJCST-D Classification: *F.1.1*

FUZZYREINFORCEMENTLEARNINGUSINGNEURALNETWORKANAPPLICATIONTOMEDICALDIAGNOSISANDBUSINESSINTELLIGENCE

Fuzzy Reinforcement Learning using Neural Network: An Application to Medical Diagnosis and Business Intelligence

Poli Venkata Subba Reddy

Abstract- The information available to the system is incomplete in many applications, particularly in Decision Support Systems. The fuzzy logic deals incomplete information with belief rather than likelihood (probability). Sometimes the decision has to be taken with fuzzy information. In this paper, fuzzy machine learning is studied for decision support systems. The fuzzy Decision set is defined with two-fold fuzzy set. The fuzzy inference is studied with fuzzy neural network for fuzzy Decision sets. Business application is given as application.

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I. Introduction

Information available to many applications like Business, Medical, Geological, Control Systems, etc is incomplete or uncertain. The fuzzy logic will deal with incomplete information with belief rather than likelihood (probable). Zadeh formulated uncertain information as fuzzy set with a single membership functions. The fuzzy set with two membership functions will give more evidence than a single membership function. The two-fold fuzzy set is with fuzzy membership functions "Belief" and "Disbelief". Usually, in Medical and Business applications, there are two opinions like "Belief" and "Disbelief" about the information and decision has to be taken under risk. For instance, in Mycin[1], the medical information is defined with belief and disbelief i.e./, CF[h,e]=MB[h,e] – MD[h.e], where "e" is the evidence for given hypothesis "h". The fuzzy set is used instead of Probability to define fuzzy certainty factor.

The fuzzy neural networks are one of the learning techniques to study fuzzy problems. In the following, some methods of fuzzy conditional inference are studied through fuzzy neural network and before that preliminaries of fuzzy logic and neural network are discussed.

In the following fuzzy logic [10] and Generalized fuzzy logic [9] are studied briefly. The fuzzy Certainty Factor is studied and fuzzy Decision set is proposed. The fuzzy inference and fuzzy reasoning are studied for fuzzy Decision set. The Business applications are studied as applications of fuzzy Decision set.

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II. Fuzzy Logic

Various theories are studied to deal with imprecise, inconsistent and inexact information and these theories deal with likelihood whereas fuzzy logic with belief. Zadeh [10] has introduced fuzzy set as a model to deal with uncertain information as single membership functions. The fuzzy set is a class of objects with a continuum of grades of membership. The set A of X is characterized by its membership function $\mu A(x)$ and ranging values in the unit interval [0, 1].

$\mu A(x)$: X →[0, 1], x Є X, where X is Universe of discourse.

A = $\mu A(x1)/x1 + \mu A(x2)/x2 + \ldots + \mu A(xn)/xn$, "+" is union

For example, the fuzzy proposition "x is young"

Young={.95/10+0.9/20+0.8/30+0.6/40+0.4/50+0.3/60+0.2/70+0.15/80+0.1/90}

Not young={ 0.05/10 + 0.1/20 + 0.2/30+0.4/40 +0.6/50 + 0.8/60+0.7/70 +0.95/80+0.9/90 }

For instance "Rama is young" and the fuzziness of "young" is 0.8 The Graphical representation of young and not young is shown in fig.1

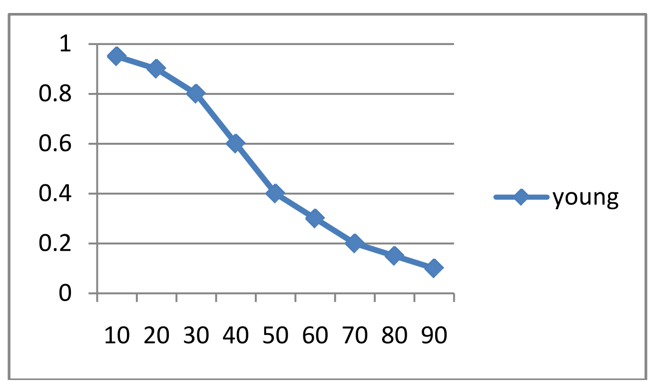

Fig. 1: fuzzy membership function

The fuzzy set of type 2 "Headache" is defined as

Headache = {0.4/mild + 0.6/moderate+ 0.8/Serious}

For example, consider the fuzzy proposition "x has mild Headache"

For instance "Rama has mild headache" with Fuzziness 0.4

The fuzzy logic is defined as combination of fuzzy sets using logical operators [21]. Some of the logical operations are given below

Let A, B and C are fuzzy sets. The operations on fuzzy sets are

Negation

$$\text{If x is not A}$$

$$A' = 1 - \mu_A(x)/x$$

Conjunction

$$\text{x is A and y is B} \rightarrow \text{(x, y) is A x B}$$

$$A \times B = \min(\mu_A(x)),\ \mu_B(y)\}(x,y)$$

$$\text{If } x = y$$

$$\text{x is A and y is B} \rightarrow \text{(x, y) is } A \wedge B$$

$$A \wedge B = \min(\mu_A(x)),\ \mu_B(y)\}/x \text{ x is A or y is B} \rightarrow \text{(x, y) is A' x B'}$$

$$A' \times B' = \max(\mu_A(x)),\ \mu_B(y)\}(x,y)$$

$$\text{If } x = y$$

$$\text{x is A and x is B} \rightarrow \text{(x, x) is A V B}$$

$$AVB = \max(\mu_A(x)),\ \mu_B(y)\}/x \text{ Disjunction}$$

Implication

$$\text{If x is A then y is B} = A \rightarrow B = \min\{1,\ 1 - \mu_A(x)) + \mu_B(y)\}/(x,y)$$

$$\text{if } x = y$$

$$A \rightarrow B = \min\{1,\ 1 - \mu_A(x)) + \mu_B(y)\}/x$$

$$\text{If x is A then y is B else y is C} = A \times B + A' \times C$$

The fuzzy proposition "If x is A then y is B else y is C" may be divided into two clause "If x is A then y is B " and "If x is not A then y is C" [15]

$$\text{If x is A then y is B else y is C} = A \rightarrow B = \min\{1,\ 1 - \mu A(x) + \mu B(y)\}/(x,y)$$

$$\text{If x is not A then y is B else y is C} = A' \rightarrow C = \min\{1,\ 1 - \mu_A(x)) + \mu_C(y)\}/(x,y)$$

Composition

$$A \text{ o } B = A \times B = \min\{\mu_A(x)),\ \mu_B(y)\}/(x,y)$$

$$\text{If } x = y$$

$$A \text{ o } B == \min\{\mu_A(x)),\ \mu_B(y)\}/x \text{ Composition}$$

The fuzzy propositions may contain quantifiers like "Very", "More or Less". These fuzzy quantifiers may be eliminated as

Concentration

$$\text{x is very A}$$

$$\mu_{\text{very }A}(x)),\ = \mu_A(x)^{2}$$

Diffusion

$$\text{x is very A}$$

$$\mu_{\text{more or less }A}(x) = \mu_A(x)^{0.5}$$

III. Generalized Fuzzy Logic with two-Fold Fuzzy Set

Since formation of the generalized fuzzy set simply as two-fold fuzzy set and is extension Zadeh fuzzy logic.

The fuzzy logic is defined as combination of fuzzy sets using logical operators. Some of the logical operations are given below

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Suppose A, B and C are fuzzy sets. The operations on fuzzy sets are given below for two-fold fuzzy sets.

Since formation of the generalized fuzzy set simply as two-fold fuzzy set, Zadeh fuzzy logic is extended to these generalized fuzzy sets.

Negation

$$A' = \{1-\mu_A^{Belief}(x),\ 1-\mu_A^{Disbelief}(x)\quad\}/x$$

Disjunction

$$AVB=\{\ \max(\mu_A^{Belief}(x)\ ,\mu_A^{Belief}(y)),\ \max(\mu_B^{Disbelief}(x)\ ,\mu_B^{Disbelief}(y))\}(x,y)$$

Conjunction

$$A\Lambda B=\{\ \min(\mu_A^{Belief}(x)\ ,\mu_A^{Belief}(y)),\ \min(\mu_B^{Disbelief}(x)\ ,\mu_B^{Disbelief}(y))\ \}/(x,y)$$

Implication

$$A\rightarrow B=\{\min(1,\ 1-\ \mu_A^{Belief}(x)+\ \mu_B^{Belief}(y)\ ,\min(\ 1,1-\mu_A^{Disbelief}(x)+\mu_B^{Disbelief}(y)\}(x,y)$$

If x is A then y is B else y is C = A x B + A' x C

If x is A then y is B else y is C $= A\rightarrow B = \{\min(1,1-\mu_A^{Belief}(x)+\mu_B^{Belief}(y)\ ,\ \min(\ 1,1-\mu_A^{Disbelief}(x)+\mu_B^{Disbelief}(y)\}/(x,y)$

if `A

If x is not A then y is B else y is C $= A'\rightarrow C = \min(1,\mu_A^{Belief}(x)+\mu_C^{Belief}(y)\ ,\min(1,\mu_A^{Disbelief}(x)+\mu_C^{Disbelief}(y)\}(x,y)$

Composition

$$A\ o\ R=\{\min_x(\ \mu_A^{Belief}(x),\mu_A^{Belief}(x)\ ),\ \min_x(\ \mu_R^{Disbelief}(x),\mu_R^{Disbelief}(x)\ )\}/y$$

The fuzzy propositions may contain quantifiers like "very", "more or less". These fuzzy quantifiers may be eliminated as

Concentration

"x is very A

$$\mu_{very\ A}(x)=\{\ \mu_A^{Belief}(x)^2,\ \mu_A^{Disbelief}(x)\mu_A(x)^2\ \}$$

Diffusion

"x is more or less A"

$$\mu_{more\ or\ less\ A}(x)=(\ \mu_A^{Belief}(x)^{0.5},\ \mu_A^{Disbelief}(x)\mu_A(x)^{0.5}$$

For instance, Let A, B and C are

$$A=\{\ 0.8/x_1+0.9/x_2+0.7/x_3+0.6/x_4+0.5/x_5,$$
$$0.4/x_1+0.3/x_2+0.4/x_3+0.7/x_4+0.6/x_5\}$$
$$B=\{\ 0.9/x_1+0.7/x_2+0.8/x_3+0..5/x_4+0.6/x_5,$$
$$0.4/x_1+0.5/x_2+0.6/x_3+0.5/x_4+0.7/x_5\}$$
$$A\ V\ B=\{\ 0.9/x_1+0.9/x_2+0.8/x_3+0.6/x_4+0.6/x_5,$$
$$0.4/x_1+0.5/x_2+0.6/x_3+0.7/x_4+0.7/x_5\}$$
$$A\ \Lambda\ B=\{\ 0.8/x_1+0.7/x_2+0.7/x_3+0.5/x_4+0.5/x_5,$$
$$0.4/x_1+0.3/x_2+0.4/x_3+0.5/x_4+0.6/x_5\}$$
$$A'=\ \text{not }A=\{\ 0.2/x_1+0.1/x_2+0.3/x_3+0.4/x_4+0.5/x_5,$$
$$0.6/x_1+0.7/x_2+0.6/x_3+0.3/x_4+0.4/x_5\}$$
$$A\rightarrow B=\{\ 1/x_1+0.8/x_2+/x_3+0.9/x_4+1/x_5,$$
$$1/x_1+1/x_2+1/x_3+0.8/x_4+1/x_5\}$$
$$A\ o\ B=\{\ 0.8/x_1+0.7/x_2+0.7/x_3+0.5/x_4+0.5/x_5,$$
$$0.4/x_1+0.3/x_2+0.4/x_3+0.5/x_4+0.6/x_5\}$$

$$\mu_{Very\ A}(x)=\{\ \mu_A^{Belief}(x)^2,\ \mu_A^{Disbelief}(x)\mu_A(x)^2\ \}$$
$$=\{\ 0.64/x_1+0.81/x_2+0.49/x_3+0.36/x_4+0.25/x_5,$$

$$0.16/x_1 + 0.09/x_2 + 0.16/x_3 + 0.49/x_4 + 0.36/x_5$$

$$\mu_{\text{More or Less A}}(x) = (\mu_A^{\text{Belief}}(x)^{1/2}, \mu_A^{\text{Disbelief}}(x)\mu_A(x)^{1/2}\}$$

$$= \{0.89/x_1 + 0.94/x_2 + 0.83/x_3 + 0.77/x_4 + 0.70/x_5,$$

$$0.63/x_1 + 0.54/x_2 + 0.63/x_3 + 0.83/x_4 + 0.77/x_5\}$$

IV. Fuzzy Neural Network

The neural network concept is taken from the Biological activity of nervous system. The neurons passes information to other neurons. There are many models described for neural networks. The McCulloch-Pitts model contributed in understanding neural network and Zedeh explain that activity of neuron is fuzzy process [13].

The McCulloch and Pitt's model consist of set of inputs, processing unit and output and it is shown in Fig.2

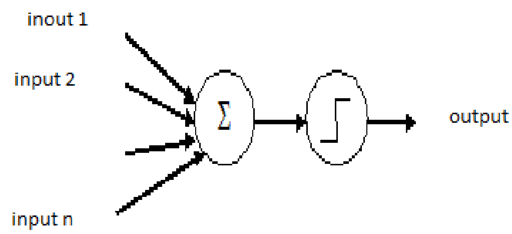

Fig. 2: McCulloch and Pitt's model

The fuzzy neuron model for fuzzy conditional inference for

If x_1 is A_1 and/or x_2 is A_2 and/or … and/or x_n is A_n then B may be defined as set of individuals of the universe of discourse, fuzziness and computational functional function and shown in Fifg.3.

Where $B=f(A_1,A_2,\ldots A_n)$

This fuzzy neuron fit for where the relation between president part and consequent part of fuzzy conditional inference is not known

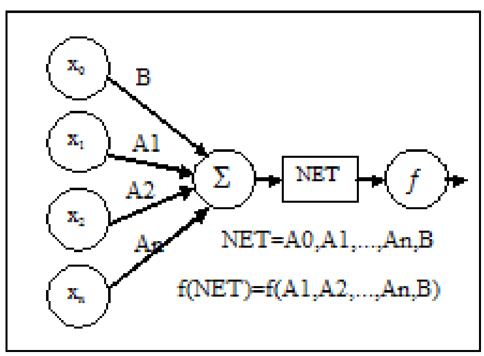

Fig. 3: Fuzzy neuron model

The multilayer fuzzy neural net work is shown in Fig.3

The fuzzy neuron for Defuzzification for Centre of Gravity (COG) is shown in fig.4

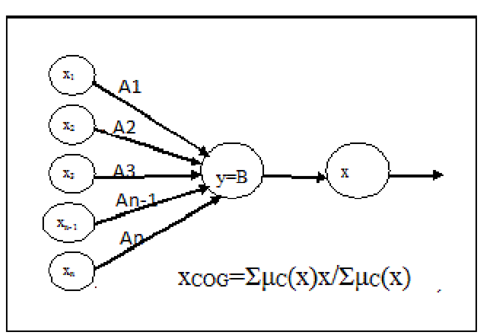

Fig. 4: Defuzzification

V. Fuzzy Decision Set

Zadeh[10] proposed fuzzy set to deal with incomplete information. Generalized fuzzy set with two-fold membership function $\mu_A(x) = \{\mu_A^{Belief}(x), \mu_A^{Disbelief}(x)\}$ is studied [18]

The fuzzy Certainty Factor may be defined as (FCF)

$$\mu_A^{FCF}(x) = \mu_A^{Belief}(x) - \mu_A^{Disbelief}(x), \text{ where}$$

$$\mu_A^{FCF}(x) = \mu_A^{Belief}(x) - \mu_A^{Disbelief}(x) \qquad \mu_A^{Belief}(x) \geq \mu_A^{Disbelief}(x)$$

$$= 0 \quad \mu_A^{Belief}(x) < \mu_A^{Disbelief}(x)$$

Fuzzy Decision set R is defined based on convex fuzzy set [10]

$$R = \{A, \ \mu_A^{FCF}(x) \geq \alpha\}, \text{ where } \alpha \in [0,1]$$

For instance,

Demand ={ 0..8/x1+0.7/x2+0.86/x3+0.75/x4+0.88/x5, 0.2/x1+0.3/x2+0.25/x3+0.3/x4+0.2/x5 }

$$\mu_{Demand}^{FCF}(x) = 0.6/x1+0.4/x2+0.61/x3+0.45/x4+0.68/x5$$

The Generalized fuzzy set for Demand for the Items and fuzzy certainty factor is shown in Fig5.

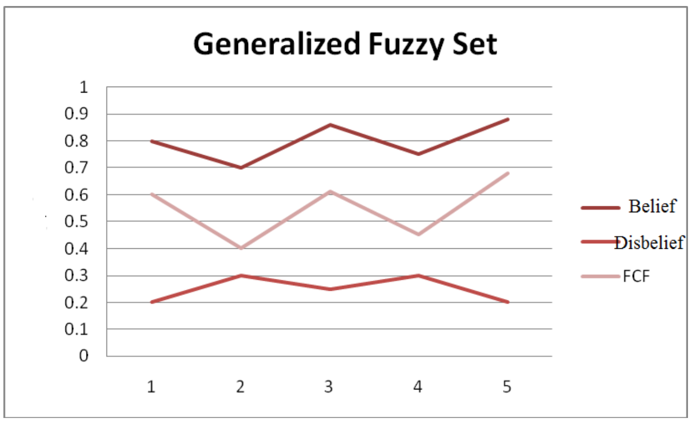

Fig. 5: Generalized fuzzy set

Suppose fuzzy Decision set is defined

$$\mu_{Demand}^{FCF}(x) \geq 0.5$$

$$= 1/x1+0/x2+1/x3+0/x4+1/x5$$

Decision may be taken under Decision shown in Fig.6.

Fig. 6: Fuzzy Decision set

The fuzzy logic is combination of logical operators. Consider the logical operations on fuzzy Decision sets r1, R2 and R3

Negation

If x is not R1

$$R1' = 1 - \mu_{R1}(x)/x$$

Conjunction

$$x \text{ is } R1 \text{ and } y \text{ is } R2 \rightarrow (x, y) \text{ is } R1 \times R2$$

$$R1 \times R2 = \min(\mu_{R1}(x)), \mu_{R2}(y)\}(x,y)$$

$$\text{If } x=y$$

$$x \text{ is } R1 \text{ and } y \text{ is } R2 \rightarrow (x, y) \text{ is } R1 \Lambda R2$$

$$R1 \Lambda R2 = \min(\mu_{R1}(x)), \mu_{R2}(y)\}/x \; x \text{ is } R1 \text{ or } y \text{ is } R2 \rightarrow (x, y) \text{ is } R1' \times R2'$$

$$R1' \times R2' = \max(\mu_{R1}(x)), \mu_{R2}(y)\}(x,y)$$

$$\text{If } x=y$$

$$x \text{ is } R1 \text{ and } x \text{ is } R2 \rightarrow (x, x) \text{ is } R1 \vee R2$$

$$R1 \vee R2 = \max(\mu_{R1}(x)), \mu_{R2}(y)\}/x \text{ Disjunction}$$

Implication

$$\text{if } x \text{ is } R1 \text{ then } y \text{ is } R2 = R1 \rightarrow R2 = \min\{1, 1 - \mu_{R1}(x)) + \mu_{R2}(y)\}/(x,y)$$

$$\text{if } x = y$$

$$R1 \rightarrow R2 = \min\{1, 1 - \mu_{R1}(x)) + \mu_{R2}(y)\}/x$$

Composition

$$R1 \text{ o } R2 = R1 \times R2 = \min\{\mu_{R1}(x)), \mu_{R2}(y)\}/(x,y)$$

$$\text{If } x = y$$

$$R1 \text{ o } R2 == \min\{\mu_{R1}(x)), \mu_{R2}(y)\}/x$$

The fuzzy propositions may contain quantifiers like “Very”, “More or Less”. These fuzzy quantifiers may be eliminated as

Concentration

$$x \text{ is very } R1$$

$$\mu_{\text{very } R1}(x)), \; = \mu_{R1}(x)^{2}$$

Diffusion

$$x \text{ is very } R1$$

$$\mu_{\text{more or less } R1}(x) = \mu_{R1}(x)^{0.5}$$

Zadeh[10] fuzzy conditional inference is give as

If x_1 is R1 and x_2 is R2 and … and x_n is Rn then y is B =f(R1,R2,…,Rn,B)=min(1,1-R1+R2+…+Rn+B)

The fuzzy neural network for Zadeh is shown in fig.7

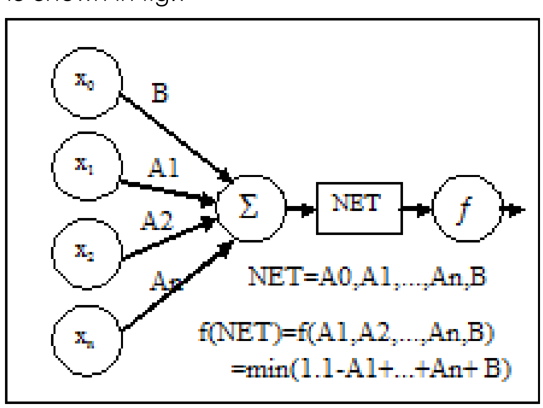

Fig. 7: Zadeh fuzzy conditional inference

Mamdani [2] fuzzy conditional inference is give as

If x_1 is R1 and x_2 is R2 and … and x_n is Rn then y is B =f(R1,R2,…,Rn,B)=min(R1,R2,…,Rn,B)

The fuzzy neural network for Mamdani is shown in fig.8

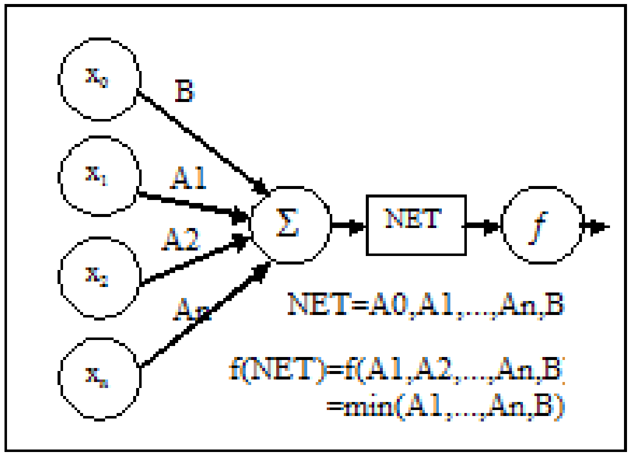

Fig. 8: Mamdani fuzzy conditional inference

Reddy [8] fuzzy conditional inference is give as

If x_1 is R1 and x_2 is R2 and … and x_n is Rn then y is B =f(R1,R2,…,Rn,B)=min(R1,R2,…,Rn)

The fuzzy neural network for Reddy is shown in fig.9

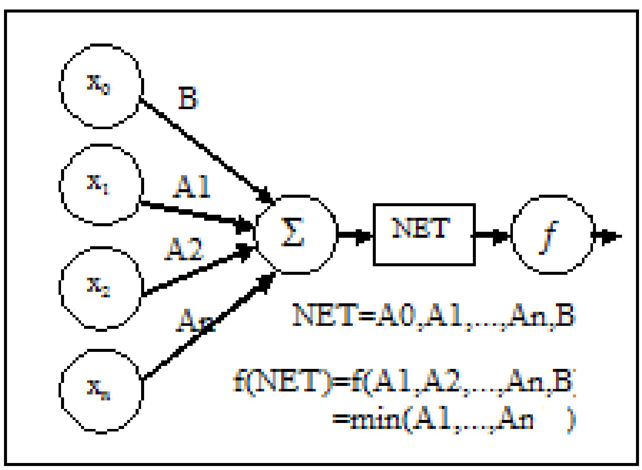

Fig. 9: Reddy fuzzy conditional inference

VI. Fuzzy Conditional Infrence in Decision Making

Decision management is usually happens in Decision Support Systems.

Example 1

Consider Business rule

If x is Demand of the product then x is High Price

Let x1, x2, x3, x4, x5 be the Items.

The Generalized fuzzy set

Demand ={ 0.56/x1+0.48/x2+0.86/x3+0.36/x4+0.88/x5, 0.06/x1+0.04/x2+0.07/x3+0.03/x4+0.2/x5 }

$$\mu_{Demand}^{FCF}(x) = 0.5/x1+0.44/x2+0.79/x3+0.33/x4+0.68/x5$$

High Price = 0.49/x1+0.52/x2+0.35/x3+0.4/x4+0.3/x5,
0.09/x1+0.02/x2+0.06/x3+0.02/x4+0.1/x5 }

$$\mu_{High\ Price}^{FCF}(x) = 0.4/x1+0.5/x2+0.29/x3+0.38/x4+0.2/x5$$

Zadeh inference is given as A→B= min{1, 1-μ_A(x) + μ_B(x)}

$$\mu_{\text{Demand} \rightarrow \text{High Price}}^{FCF}(x) = 0.9/x1+1/x2+0.5/x3+1/x4+0.52/x5$$

$$\mu_{\text{Demand} \rightarrow \text{High Price}}^{FCF}(x) \geq 0.6 = 1/x1+1/x2+0/x3+1/x4+0/x5$$

Mamdani inference is given as A→B= min{μ_A(x) , μ_B(x)}

$$\mu_{\text{Demand} \rightarrow \text{High Price}}^{FCF}(x) = 0.4/x1+.44/x2+0.29/x3+.33/x4+0.2/x5$$

$$\mu_{\text{Demand} \rightarrow \text{High Price}}^{FCF}(x) \geq 0.6 = 1/x1+1/x2+0/x3+1/x4+0/x5$$

Mamdani inference is given as A→B= min{μ_A(x) }

$$\mu_{\text{Demand} \rightarrow \text{High Price}}^{FCF}(x) = 0.4/x1+.44/x2+0.29/x3+.33/x4+0.2/x5$$

$$\mu_{\text{Demand} \rightarrow \text{High Price}}^{FCF}(x) \geq 0.6 = 1/x1+1/x2+0/x3+1/x4+0/x5$$

Example 2

Consider Medical Diagnosis

If x has infection in the leg then surgery

Let x1, x2, x3, x4, x5 are the Patients.

The fuzzy set

$$\mu_{\text{Infection}}^{FCF}(x) = 0.76/x1+0.78/x2+0.46/x3+0.86/x4+0.58/x5,$$

$$0.16/x1+0.12/x2+0.06/x3+0.14/x4+0.05/x5\}$$

$$= 0.6/x1+0.64/x2+0.4/x3+0.72/x4+0.53/x5$$

$$\mu_{\text{Surgery}}^{FCF}(x) = 0.59/x1+0.26/x2+0.55/x3+0.24/x4+0.35/x5,$$

$$0.09/x1+0.06/x2+0.05/x3+0.04/x4+0.03/x5\ \}$$

$$= 0.5/x1+0.2/x2+0.5/x3+0.2/x4+0.32/x5$$

Using inference rule A→B= min{1, 1-μ_A(x) + μ_B(x)}

$$\mu_{\text{Infection} \rightarrow \text{Surgery}}^{FCF}(x) = 0.9/x1+0.56/x2+0.9/x3+1/x4+1/x5$$

$$\mu_{\text{Infection} \rightarrow \text{Surgery}}^{R}(x) = 1 \quad \mu_{\text{Infection} \rightarrow \text{Surgery}}^{FCF}(x) \geq 6$$

$$0 \quad \mu_{\text{Infection} \rightarrow \text{Surgery}}^{FCF}(x) < 6$$

The fuzzy risk set R is

$$1/x1+0/x2+1/x3+1/x4+1/x5$$

The decision is to take for surgery is Yes for x1, x3, x4, x5 and No for x2.

The fuzzy reasoning under Risk management in Decision Support Systems may be Consider the fuzzy rule and fuzzy fact

If x has Infection of the product then x is to go for Surgery

x has very Infection

x is very Infection o Infection→Surgery

$$\mu_{\text{Infection} \rightarrow \text{Surgery}}^{FCF}(x) = 0.9/x1+0.56/x2+0.9/x3+1/x4+1/x5$$

$$\mu_{\text{very Surgery}}^{FCF}(x) = 0.25/x1+0.2\backslash 04/x2+0.25/x3+0.04/x4+0.1/x5$$

x is very Demand o Demand→Increase Price

$$=0.35/x1+0.66/x2+0.35/x3+0.04/x4 + 0.1/x5$$

Suppose Fuzzy risk set for **α**≥.5, the decision is Yes for x2 and No for x1, x4, x4 and x5.

VII. Conclusion

The decision has to be taken under incomplete information in many applications like Business, Medicine etc. The fuzzy logic is used to deal with incomplete information The fuzzy Decision set is defined with two-fold fuzzy set. The fuzzy logic is discussed with two-fold fuzzy set. The fuzzy Decision set, inference and reasoning are studied. The Business applications is discussed for fuzzy Decision set.

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Associates are authorized to organize symposium/seminar/conference on behalf of Global Journal Incorporation (USA). They can also participate in the same organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent. Additionally, they get free research conferences (and others) alerts.

Career | Credibility | Financial

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Early invitations to all the symposiums, seminars, conferences

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Financial

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Certificate, LoR and Momento **2** discounted publishing/year **Gradation** of Research **10** research contacts/day **1 GB** Cloud Storage **GJ** Community Access	**Certificate,** LoR and Momento **Unlimited** discounted publishing/year **Gradation** of Research **Unlimited** research contacts/day **5 GB** Cloud Storage **Online Presense** Assistance **GJ** Community Access	**Certificates,** LoRs and Momentos **Unlimited** free publishing/year **Gradation** of Research **Unlimited** research contacts/day **Unlimited** Cloud Storage **Online Presense** Assistance **GJ** Community Access	**GJ** Community Access

Preferred Author Guidelines

We accept the manuscript submissions in any standard (generic) format.

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

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Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

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2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

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Plagiarism is not acceptable in Global Journals submissions at all.

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- Words (language)
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- Findings
- Writings
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- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

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2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

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The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

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Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

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Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word “Abstract” in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper’s subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in a research paper?" Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for writing a good quality Computer Science Research Paper

Techniques for writing a good quality computer science research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of computer science then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10.Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

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

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite 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 approaches 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. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a 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 limit the initial two items to no more than one line each.

Reason for writing the article—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 for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- o Single section and succinct.
- o An outline of the job done is always written in past tense.
- o Concentrate on shortening results—limit background information to a verdict or two.
- o Exact spelling, clarity 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 of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- o Explain the value (significance) of the study.
- o Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- o Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- o Briefly explain the study's tentative purpose and how it meets 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 for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory 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 soundly written procedures segment allows a capable scientist to replicate 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 to give the least amount of information that would permit another capable scientist to replicate 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 section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show 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:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

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

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- o Resources and methods are not a set of information.
- o Skip all descriptive information and surroundings—save it for the argument.
- o 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 as 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. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give 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 manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit 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 section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or 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 an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of 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 other available information. Present work done by specific persons (including you) in past tense.

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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
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References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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