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A Genetic-Neural System

Gesture Recognition Methods

Highlights

Traveling Salesman Problem

Algorithm Dynamic Programming

Discovering Thoughts, Inventing Future

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A Genetic-Neural System Diagnosing Hepatitis B

By E. Areghan & S. Konyeha
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Abstract- Hepatitis B is a life threaten disease and if not diagnose early can lead to death of the infected patient. In this paper a genetic neural system for diagnosing hepatitis B was designed. The system was designed to diagnose HBV using clinical symptoms. The dataset used in training the system was gotten from UCI repository. The system incorporated both genetic algorithm and neural network. The genetic algorithm was used to optimize the dataset used in training the neural network. The neural network was trained for 300 iterations and the system had a prediction accuracy of 99.14% on predicting Hepatitis B.

Keywords: *genetic algorithm, hepatitis B, neural network.*

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A Genetic-Neural System Diagnosing Hepatitis B

E. Areghan[α] & S. Konyeha[σ]

Abstract- Hepatitis B is a life threaten disease and if not diagnose early can lead to death of the infected patient. In this paper a genetic neural system for diagnosing hepatitis B was designed. The system was designed to diagnose HBV using clinical symptoms. The dataset used in training the system was gotten from UCI repository. The system incorporated both genetic algorithm and neural network. The genetic algorithm was used to optimize the dataset used in training the neural network. The neural network was trained for 300 iterations and the system had a prediction accuracy of 99.14% on predicting Hepatitis B.

Keywords: *genetic algorithm, hepatitis B, neural network.*

I. Introduction

The human body is made up of various organs and of these organs the liver is the largest. The liver performs various functions in the human body. It produces bile which aids the breaking down of fat, it breaks down alcohol and toxic waste in the blood stream and passes them out of the body as either stool or urine and it absorbs glucose from the blood and stores them in form of glycogen for subsequent use by the body (WHO, 2014). Some diseases are known to affect the liver are they include Hepatitis A, Hepatitis B, Hepatitis C, Hepatitis D and Hepatitis E to mention but a few (Ghumbre et al, 2009). Hepatitis B is an infectious viral disease caused by the Hepatitis B virus (HBV). According to WHO about one-third of the entire world population has been infected with HBV at one point in their lives and 750,000 people die each year of the disease (WHO, 2014). In 2013 it was estimated 129 million person where infected with HBV and the number of infected individual is predicted to rise each year by 2.5% (WHO, 2014). Hepatitis B is prevalent in East Asia and Sub Saharan Africa where about 5-10% is chronically affected while in Europe and North America the prevalence rate of HBV is less than 1% (WHO, 2014). HBV is transmitted by exposure to infected blood or body fluid or sexual intercourse with an infected person or by birth from mother to child (Chen et al, 2005). Symptoms of Hepatitis B includes jaundices (yellowish eye and skin), fatigue, dark urine nausea, vomiting, skin rash, polyarteritis and in some cases abdominal pain (Shepard et al, 2006, Chen et al, 2005 and Schroth et al, 2004). These symptoms might last for several weeks. The gold standard for diagnosing HBV is by laboratory test. Although accurate, laboratory test are quite expensive and the infected patient need to wait for at least 30 days before the HBV virus can be detected in the blood. Hence, there is a need for other technique for diagnosing HBV. In recent past, machine learning techniques have been applied in diagnosing hepatitis B virus (Chen et al, 2005, Riudiger, 2001, Ghumbre et al, 2009). These techniques have provided a non-invasive means for diagnosing Hepatitis B virus and most importantly in a timely manner. Most machine learning techniques utilized by various researchers in diagnosing HBV were neural network, Fuzzy Logic, Neuro-fuzzy system and Support Vector Machine (SVM). The fundamental weakness of these approaches used by these researchers is that no attention was paid to optimal selection and extraction of the dataset used in training their systems. To this, we propose a genetic neural system for diagnosing Hepatitis B virus. The system will comprise of two components genetic algorithm and neural network. Genetic Algorithm (GA) is a strong machine learning tool which is capable of performing feature selection and extraction. On the other hand Neural Network is also a machine learning technique that is capable recognizing patterns based on input fed into it. Combining these two excellent machine learning technique to diagnose HBV will create a system with higher prediction accuracy.

II. Related Work

Several researchers have tried to improve the accuracy of HBV diagnosis and have applied various machine learning techniques in diagnosing HBV. In 2006 Plot and Günes, used a hybrid method comprising of Feature Selection (FS) and Artificial Immune Recognition System (AIRS) with fuzzy resource allocation mechanism in predicting Hepatitis. The system had an average prediction accuracy rate of 92.59% in classifying HBV. In 2011 Chen et al proposed a hybrid method which combined Local Fisher Discriminant Analysis (LFDA) and SVM in diagnosing Hepatitis. The dataset used in the study was gotten from the UCI repository. The Local Fisher Discriminant Analysis was used to perform feature extraction and SVM was using in classifying the data algorithm. The result obtained show that the system had an average prediction accuracy rate of 96.59% in classifying HBV. Also in a similar study conducted by Calisir and

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Dogantekin, they used Principle Component Analysis (PCA) and Least Square Support Vector Machine SVM (LSSVM) in diagnosing HBV. The dataset used in the study was gotten from the UCI repository. The Principle Component Analysis (PCA) was used to perform feature extraction and while Least Square Support Vector Machine SVM (LSSVM) was used to classify the Hepatitis datasets. The result obtained show that the system had an average prediction accuracy rate of 95% in classifying HBV. In 2011 Sartakhti et al, combined Support Vector Machine with Simulated Annealing (SA) to diagnose HBV. The dataset used in the study was gotten from the UCI repository. The result obtained show that the system had an average prediction accuracy rate of 96.25% in classifying HBV. In 2012 Bascil et al used a Probabilistic Neural Network structure to diagnose HBV. The result obtained show that the system had an average prediction accuracy rate of 91.25% in classifying HBV. In 2013 Mahesh et al, used Artificial Neural Network (ANN) to diagnose HBV. In their study 300 cases was used to train the ANN. The HBV dataset was divided into four categories (Normal, light, Severe and Hyper Severe) which indicated the severity of HBV. The ANN used markers in diagnosing each case. The marker were Hepatitis B surface Antigen, anti VHC and anti-VHD. The ANN had a prediction of accuracy of 87% and 89% on acute and chronic HBV respectively. Also in a similar study conducted by Mehdi et al, (2009), they designed a fuzzy expert system and an Adaptive neural Network fuzzy system to diagnose and compare their intensity rate. The dataset used in their study contained 300 diagnosed cases of HBV. The dataset was collected from Imam Reza hospital in Mashad, India. A triangular membership function was used to map the values in the dataset into each membership set for the fuzzy system and the bell membership function for the Adaptive neural Network fuzzy system. Both system had 54 rules. The Adaptive neural Network fuzzy system was trained 100 epoch with an error tolerance of 0. Upon completion of the training the system had an accuracy of 94.24% on HBV intensity. In a similar study conducted by Pushpalatha et al, (2016). They designed a framework comprising of neural network, Naïve bayes and Support Vector machine in diagnosing HBV. In their work 155 cases of HBV diagnosed patients was used. The dataset has 11 input and an output which indicated the status of HBV. The dataset was used to train the 3 techniques and it had an accuracy of 98.07, 82.58 and 84.52 for neural network, Naïve Bayes and SVM respectively. In 2019 Gulzar et al proposed an automated diagnostic system for predicting Hepatitis B using Multilayer Mamdani Fuzzy inference logic. The system has two layers. In the first layer has two inputs (Alanine Aminotransferase (ALT) and Aspartate Aminotransferase (AST)) the output of this layer is fed into the second layer. The second layer has8 inputs which are the output from layer 1, HBsAg, Anti-HBsAg, Anti-HBcAg, Anti-HBcAg-IgM, HBeAg, Anti-HBeAg and HBV-DNA. The system had an overall classification accuracy of 92.2% in classifying HBV. In 2018 Rahmon et al, proposed an Adaptive Neuro-Fuzzy Inference System for diagnosing HBV. The dataset used to train their system was obtained from Carnegie-Mellon University database, Yugoslavia. It contained 155 HBV cases. Five symptom attribute were used as inputs in training the system they are; Albumin, Ascites, Alk-Phosphate, Bilirubin, and SGOT. The output of the system graded HBV as either mild or severe. The system had a Mean Square Error (MSE) of 0.11768, Root Mean Square Error (RMSE) of 0.34305, Error Mean of -3.143e-005, Error St.D of 0.34567 and an overall prediction accuracy of 90.2%. In 2013, Mohammed et al, used Support vector Machine in classifying Hepatitis Disease. The dtaset used in their study was gotten from UCI machine learning repository. The datset contained 155 HBV cases. The result obtained from the study showed that 3SVM had a prediction accuracy of 93.2%. In 2017, Ogah et al, proposed a Generalized Regression Neural Network for diagnosing HBV. The dataset used in the study was collected through filed study and observation. The ANN was trained for 50 iterations and it had a prediction accuracy of 87 on classifying HBV%. In 2014, Khosro et al, used Support Vector Machine (SVM) and Fuzzy Cluster Mean (FCM) in diagnosing Hepatitis B. The datsset used in the study was gotten from Vasei Hospital in Sabzevar, Iran. The dataset was normalized and SVM was used to classify the dataset. The classified dataset was fed into the FCM to determine the severity of HBV. The system had an accuracy of 94.09%. In 2016, Ruijing et al, compared and evaluated the prediction of Hepatitis in Guangxi Province, China using three neural networks models; back propagation neural networks based genetic algorithm (BPNN-GA), generalized regression neural networks (GRNN), and wavelet neural networks (WNN). The incidence of hepatitis data used in their study was gotten from Chinese National Surveillance System and the Guangxi Health Information Network. The result obtained from the study showed that back propagation neural networks based genetic algorithm (BPNN-GA) was better and forecasted Hepatitis better than the generalized regression neural networks (GRNN), and wavelet neural networks (WNN). Although from the above reviewed literature these techniques generated excellent results, but it is obvious that no attention was paid to feature selection and extraction on the dataset used in training these models.

III. Experiment and Simulation

The proposed model for diagnosing HBV seeks to eliminate the challenges faced with the current system. It uses a hybrid system comprising of Genetic Algorithm (GA) and Neural Network (NN). The Genetic

algorithm will perform feature selection and extraction on the dataset before it is used to train the neural network. The GA component will optimize the clinical dataset by performing feature extraction and selection. It will utilize the value encoding method where each gene in a chromosomes is value between the lower and upper range of the in each column in the dataset. The GA component will include the fitness function component, selector, crossover, mutation and acceptance component.

a) Objective function of the Genetic Algorithm

The objective function is the function that determines the diagnosis. The Objective function will be a mathematical model used to represent the diagnostic process of HBV. The objective function was arrived at after several consultation with several medical doctor.

$$\text{Objective function} = \sum_{i}^{n} \text{Symptom}_i \text{Weight}$$

Where n= total number of symptoms, i=1, 2, 3 … n

Fitness Function: The fitness function should be able to measure how fit a given chromosome is. The fitness for the proposed model is given below

Where n= total number of symptoms
i=1,2,3 … n

Selection: The idea of selection phase is to select the fittest individuals and let them pass their genes to the next generation. Two pairs of individuals (parents) are selected based on their fitness scores. Individuals with high fitness have more chance to be selected for reproduction. The roulette selector will be employed in selecting chromosome because study has shown that it provides more optimal solution and has better convergence speed than the simple genetic algorithm (Yadav et al, 2017).

Crossover: Crossover is the most significant phase in a genetic algorithm. For each pair of parents to be mated, a crossover point is chosen at random from within the genes. Offspring are created by exchanging the genes of parents among themselves until the crossover point is reached. The new offspring are added to the population. The One point mutation operator will be used because study has shown it generates the best results (Jorge, 2013).

Mutation: In certain new offspring formed, some of their genes can be subjected to a mutation with a low random probability. Mutation occurs to maintain diversity within the population and prevent premature convergence. The power mutation operator will be employed because it performs better than other mutation techniques (Siew et al, 2017).

The multilayer perceptron neural network was used to train the model. This is a type of the feed forward neural network. The multi-layer perceptron neural network is very powerful because it utilizes non-linear activation functions. In this model the sigmoid pole activation function was utilized. Equation 3.1 shows the mathematical representation of the sigmoid transfer function.

$$f(s) = \frac{1}{1+e^{-s}} \quad (3.1)$$

The backward propagation learning algorithm was used in training the ANN. This learning algorithm is based on the minimization of errors between the actual output and the desired output. The training process of the multi-layer perceptron Neural Network involves

a) *Initialization:* In this phase all weight and thresholds in the network are initialized with random values
b) *Forward propagation of signal:* The inputs are collected with the neurons from the input layer and fed into the hidden layer.

The output of the hidden layer are computed using the equation stated in 3.2

$$y_j(p) = f\left(\sum_{i=1}^{m} x_{jk}(p).w_{ij} - 0_j\right) \quad (3.2)$$

Where n is the number of inputs for the neuron j from the hidden layer, and f is the sigmoid activation function. The outcome is then sent to the output layer to generate the final output of the system. The output layer using the equation stated in 3.3

$$y_k(p) = f\left(\sum_{i=1}^{m} x_{jk}(p).w_{jk}(p) - 0_k\right) \quad (3.3)$$

Where m is the number of inputs for the neuron k from the output layer. The Multilayer perceptron neural network computes the error per each epoch using the equation stated in 3.4

$$E = \frac{\left(\left(f\left(\sum_{i=1}^{m} x_{jk}(p).w_{jk}(p) - 0_k\right) - f\left(\sum_{i=1}^{m} x_{jk}(p).w_{ij} - 0_j\right)\right)(p)\right)^2}{2} \quad (3.4)$$

The ANN then computes the gradient error for each neuron in the output layer using the equation 3.5

$$\delta_k(p) = f'.\left(f\left(\sum_{i=1}^{m} x_{jk}(p).w_{jk}(p) - 0_k\right) - f\left(\sum_{i=1}^{m} x_{jk}(p).w_{ij} - 0_j\right)\right)(p) \quad (3.5)$$

Where f' is the derived function for the activation, the optimized dataset was the feed into the neural network for training. The snapshot below shows that training ANN process.

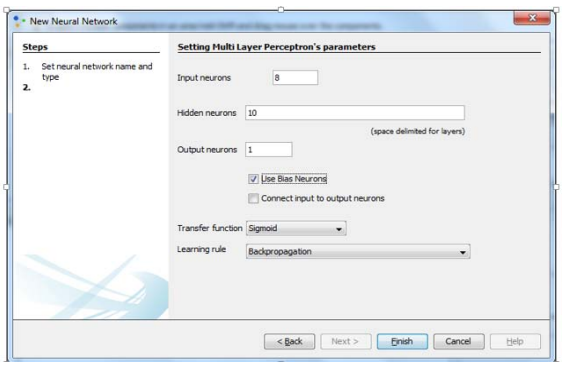

Figure 1: Multi-Layer Perceptron parameter

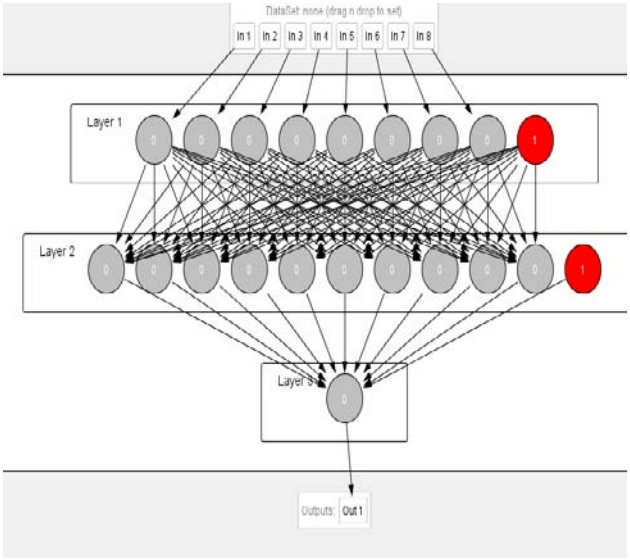

Figure 2: Multi-Layer Perceptron Neural Network

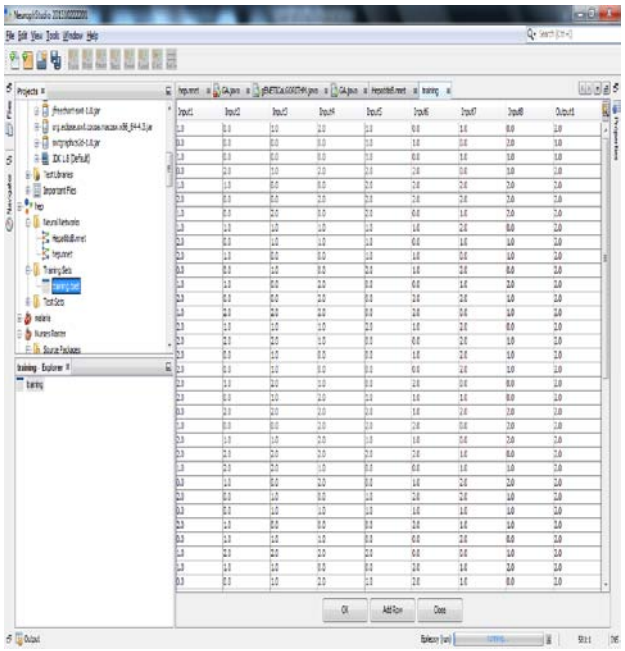

Figure 3: Training Dataset

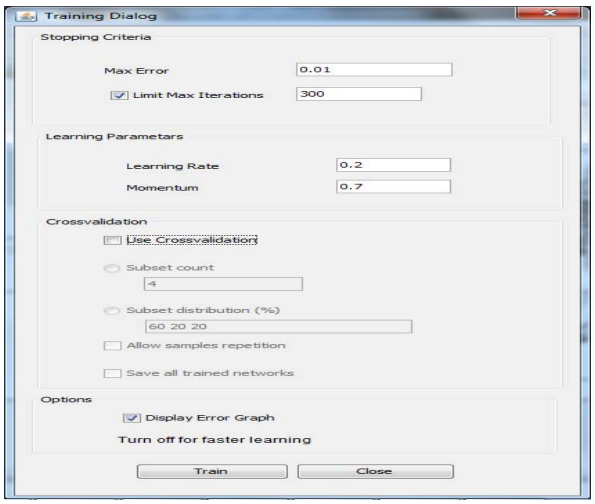

Figure 4: Training Dialogue

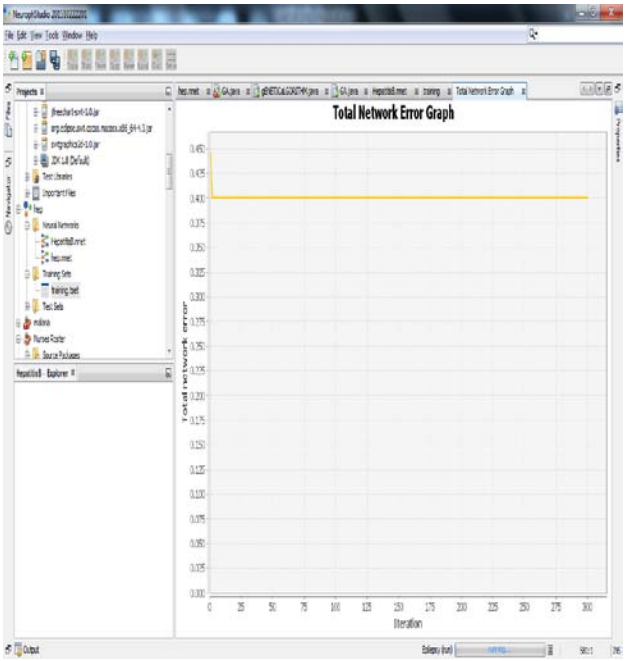

Figure 5: Training Error Graph

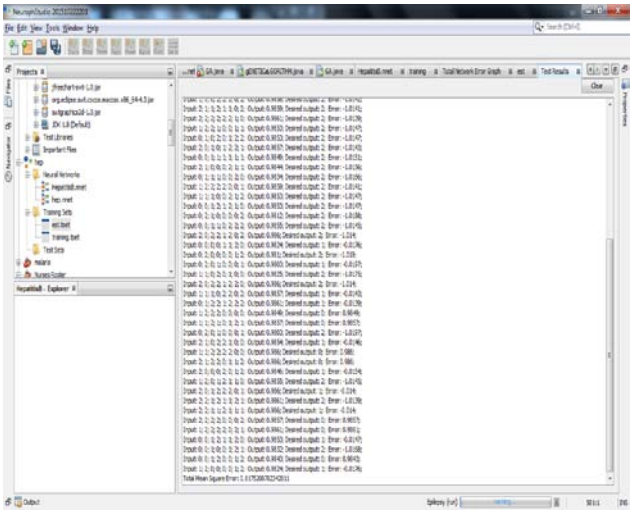

Figure 6: Testing Process

IV. Result and Discussion

The technique proposed in this project work combined Genetic Algorithm and Multilayer Perceptron Neural network. Although similar to the model proposed by Bascil et al (2012), Mahesh et al,(2013), Pushpalatha et al, (2016) and Ogah et al,(2017) were neural network was applied in diagnosing HBV. Our model incorporated a genetic algorithm component which was used in performing feature extraction and selection on the dataset which previous models failed to address. The model had a prediction accuracy of 99.14% which is higher than other models considered in our literature. The high degree in the prediction accuracy can be attributed to the optimized dataset used in training the neural network. Another technique used in diagnosing HBV as stated in the literature was Support Vector

Machine Chen et al, (2011), Calisir and Dogantekin (2011), Sartakhti et al (2011) and Mohammed et al, (2013) but they all failed to perform feature extraction and selection on the dataset used. The prediction accuracy of our model is higher than the models proposed by Chen et al, (2011), Calisir and Dogantekin (2011), Sartakhti et al (2011) and Mohammed et al, (2013). The reason for the low prediction accuracy achieved my their technique might be due to; performance degradation caused by kernel introduction for multivariate, lack of high predictive power on training due to a single optimum solution and high algorithmic complexity and extensive memory requirements usage by Support Vector Machines (SVM).

V. Conclusion

The accuracy of medical diagnosis has lately been attributed to the advancement in technology and with the advent of machine learning tools such as Artificial Neural Networks, Genetic Algorithm and Support Vector Machines medical diagnosis became easier. Hepatitis B is a life threaten disease and if not diagnose early can lead to death of the infected patient. In this project work a genetic neural system was designed to diagnoses Hepatitis B virus. The system had a prediction accuracy of 99.14% on predicting Hepatitis B.

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Evaluation of Ant Colony Optimization Algorithm Compared to Genetic Algorithm, Dynamic Programming and Branch and Bound Algorithm Regarding Traveling Salesman Problem

By A.H.M. Saiful Islam, Mashrure Tanzim, Sadia Afreen & Gerald Rozario

Notre Dame University

Abstract- We use ant colony optimization (ACO) algorithm for solving combinatorial optimization problems such as the traveling salesman problem. Some applications of ACO are: vehicle routing, sequential ordering, graph coloring, routing in communications networks, etc. In this paper, we compare the performance of ACO to that of a few other state-of-the-art algorithms currently in use and thus measure the effectiveness of ACO as one of the major optimization algorithms in regard with a few more algorithms. The performance of the algorithms is measured by observing their capacity to solve a traveling salesman problem (TSP). This paper will help to find the proper algorithm to be used for routing problems in different real-life situations.

Keywords: *swarm intelligence, vehicle routing, ant colony optimization.*

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Evaluation of Ant Colony Optimization Algorithm Compared to Genetic Algorithm, Dynamic Programming and Branch and Bound Algorithm Regarding Traveling Salesman Problem

A.H.M. Saiful Islam[α], Mashrure Tanzim[σ], Sadia Afreen[ρ] & Gerald Rozario[ω]

Abstract- We use ant colony optimization (ACO) algorithm for solving combinatorial optimization problems such as the traveling salesman problem. Some applications of ACO are: vehicle routing, sequential ordering, graph coloring, routing in communications networks, etc. In this paper, we compare the performance of ACO to that of a few other state-of-the-art algorithms currently in use and thus measure the effectiveness of ACO as one of the major optimization algorithms in regard with a few more algorithms. The performance of the algorithms is measured by observing their capacity to solve a traveling salesman problem (TSP). This paper will help to find the proper algorithm to be used for routing problems in different real-life situations.

Keywords: swarm intelligence, vehicle routing, ant colony optimization.

I. Introduction

Ant colony optimization algorithm belongs to a special class of artificial intelligence called swarm intelligence. "Swarm intelligence is a relatively new approach to problem-solving that takes inspiration from the social behaviors of insects and of other animals. In particular, ants have inspired a number of methods and techniques among which the most studied and the most successful is the general-purpose optimization technique known as ant colony optimization (ACO)" (Dorigo, Birattari and Stutzle, 2006, p. 28). ACO has a powerful capacity to find out solutions to combinatorial optimization problems. But it has some issues like stagnation and premature convergence. The convergence speed of ACO is always slow.

(Raghavendra BV, 2015). These limitations become more noticeable when the problem size increases, and the number of nodes become more and more numerous. The aim of this paper is to compare the performance of Ant Colony Optimization with a few other algorithms when it comes to solving a particular problem: the traveling salesman problem. Davendra (Davendra D, 2010, Travelling Salesman Problem, Theory and Applications) defined TSP as, "Given a set of cities of different distances away from each other, and the objective of TSP is to find the shortest path for a salesperson to visit every city exactly once and return back [sic] to the origin city". "TSP is an important applied problem with many fascinating variants; like theoretical mathematics, computer science, NP-hard problem, combinatorial optimization, and operation research" (Abid and Muhammad, 2015, p. 1). There have been some works related to this field, attempting to address such a problem (Sudholt and Thyssen, 2012) (Wang Hui, 2012). But they are usually limited to a comparison between 2 algorithms and only a fixed situation, not for dynamically changing situations that might arise in a real-life problem. We analyze different aspects of their performance, like time complexity, space complexity, scalability, etc. and thus determine which algorithm is suitable for which situation. The algorithms we intend to compare with ACO are Genetic algorithm, Dynamic programming, Branch and bound algorithm. Some research papers comparing these algorithms with each other already exist (Wang Hui, 2012). But no work has been done to compare all of their performances at once and for different situations that might arise in a real -ife routing problem. In reality, a route might be blocked due to accidents, or the number of nodes might change due to unforeseen circumstances. In that situation, the performance of different algorithms will be different. We aim to find out which algorithm serves the best in what sort of situation faced in real life.

The second section of this paper shows the process of comparing the algorithms. The third section discusses the results we obtain and its implications, and finally, the conclusion is discussed in the fourth section.

II. Comparing the Algorithms

To compare four different algorithms, we bring them in the same platform and use them to solve the same dataset. We use multiple datasets to ascertain their performance, to make sure that the algorithms are fairly adaptable to changing situations. We implemented the algorithms using Windows 10 as the operating

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system and Java as the programming language. We retrieve the program for ACO from the official ACO metaheuristic site. The software package ACOTSP-1.03 provides an implementation of various Ant Colony Optimization (ACO) algorithms applied to the symmetric Traveling Salesman Problem (TSP) (http://www.aco-metaheuristic.org/aco-code/public-software.html, January 15, 10.40 p.m).

To find the best results, the programs maintain the best universally accepted space and time complexity for their respective algorithms.

The main aspects of the performance comparison are:

- Time: The amount of time it takes to run the algorithm.
- Space: The amount of memory space required to solve an instance of the computational problem.
- Scalability: The ability of the algorithm to adapt to the increasing size of the problem.

In order to determine the various parameters for our comparison, we run the programs in a fixed platform and use a fixed dataset. We run these programs on a dataset bays29, which is a dataset of 29 cities in Bavaria with their street distances (https://github.com/pdrozdowski/TSPLib.Net/blob/master/TSPLIB95/tsp/bays29.tsp, March 3, 9.15 p.m)

To ensure that their performance is consistent, we also use a smaller dataset of 4 cities to test the algorithms. The data set has the following adjacency matrix:

0 4 1 3
4 0 2 1
1 2 0 5
3 1 5 0

Thus, the programs will give a standardized output. We then use the obtained data to formulate graphs and a table to analyze the strengths and weaknesses of each algorithm regarding solving TSP.

We test the ACO algorithm first. The obtained result will set the standard for our research. The algorithm performs reasonably well in terms of time for both large (bays29.tsp) and small (mydataset.tsp) datasets. But it also consumes a considerable amount of memory.

Genetic algorithm is based on the property of reproductive cells. It assumes two separate data bits as chromosomes of two cells and creates a new chromosome from the parent chromosomes. The processes of creating new chromosomes vary. The algorithm does poorly in terms of time for both large and small datasets but performs better in terms of memory usage.

A branch-and-bound algorithm consists of a systematic enumeration of candidate solutions using state space search. The set of candidate solutions is thought of as forming a rooted tree with the full set at the root. The algorithm explores branches of this tree, which represent subsets of the solution set. The algorithm performs admirably in terms of both time consumption and memory use for small datasets. But for large datasets, it enters into an infinite loop. Even after 30 minutes of running, it fails to produce any results. This limitation renders it unusable for large datasets.

Dynamic programming is both a mathematical optimization method and a computer programming method. After the initial emphasis on static problems, some of the focus is now shifting towards dynamic variants of combinatorial optimization problems. Recently some research is being done on TSP for dynamic problems. The program performs very well in terms of both time and memory use for small datasets. But for large datasets like bays29.tsp, it consumes a huge amount of memory. It exceeds the heap size even after setting the heap size at 3 GB. Thus, we can't use it for large datasets.

Table 1: Time and Memory use for large datasets (bays29.tsp)

Algorithms	Time (seconds)	Memory usage (mbs)
ACO	3.103 seconds	55.158203125 mbs
Genetic algorithm	5.50 seconds	33.696289 mbs
Branch and bound	undefined	undefined
Dynamic Programming	undefined	undefined

Table 2: Time and Memory use for small datasets (mydataset.tsp)

Algorithms	Time (seconds)	Memory usage (mbs)
ACO	1.6 seconds	5.250947 mbs
Genetic algorithm	2.30 seconds	4.86230468 mbs
Branch and bound	0.004 seconds	1.30078125 mbs
Dynamic Programming	0.002 seconds	1.9501953125 mbs

III. Discussion and Analysis of Result

The results obtained from the codes show us the different aspects of the algorithms in different situations. As mentioned before, we shall compare the algorithms based on the amount of time it takes to run the algorithm, the amount of memory space required to solve an instance of the computational problem and the ability of the algorithm to adapt to the increasing size of the problem. From the obtained results, we find that:

For large datasets, the fastest way to solve the problem is the Ant colony optimization algorithm. It takes the least amount of time among the 4. But it will also consume the most memory of them all.

For large datasets, the cheapest in terms of memory, to solve the problem is the Genetic Algorithm. It takes somewhat longer than ant colony optimization to solve the problem. But performs better than dynamic programming or branch and bound algorithm, none of which can solve bigger datasets efficiently due to heavy memory usage or taking too much time. Thus, both have bad scalability. They can't adapt to problems with more nodes or higher complexity.

For small datasets, the fastest way to solve the problem is Dynamic Programming. It is the quickest method to solve small datasets. Branch and bound algorithm come to a close second. But it is the cheapest method. Both genetic algorithm and ant colony optimization are far behind them in terms of time and memory usage.

The results and their analysis helps us to draw the following conclusion. We arrange the algorithms in the descending order based on the time they take, the amount of memory they use, and how well they scale when faced with more complex problems.

For large datasets, the usefulness of the algorithms in descending order:

Table 3: Usefulness for large datasets (bays29.tsp)

Serial No.	Time	Memory usage	Scalability
1	ACO	Genetic algorithm	Genetic algorithm
2	Genetic algorithm	ACO	ACO
3	Dynamic Programming	Branch and bound	Branch and bound
4	Branch and bound	Dynamic Programming	Dynamic Programming

For small datasets, the usefulness of the algorithms in descending order:

Table 4: Usefulness for small datasets (mydataset.tsp)

Serial No.	Time	Memory usage	Scalability
1	Dynamic Programming	Branch and bound	Genetic algorithm
2	Branch and bound	Dynamic Programming	ACO
3	ACO	Genetic algorithm	Branch and bound
4	Genetic algorithm	ACO	Dynamic Programming

Thus, for solving sizeable problems with many nodes, it's best to use ACO for the fastest and Genetic algorithm for the cheapest results. But for smaller problems with fewer nodes, Dynamic programming is the best algorithm to solve it quickly. Branch and bound algorithm is the primary choice for a cheap solution. This comparison helps us to determine which algorithm performs best under which circumstance. If the routing problem involves many cities or many villages connected with roads, then we use the ant colony optimization to get the fastest result. However, if we are willing to sacrifice time for achieving a lower memory use, we should choose the Genetic algorithm. This method is more suitable when a large amount of data needs to be processed, and the technology available is limited. For a routing problem that works with few nodes, such as the route between divisions, or the interstate highways connecting states, Dynamic programming gives the best result. Since there are few destinations and fewer paths, time and memory consumption is low. But we should be aware that a system made for such a purpose will have bad scalability and will not work on more complex routing problems.

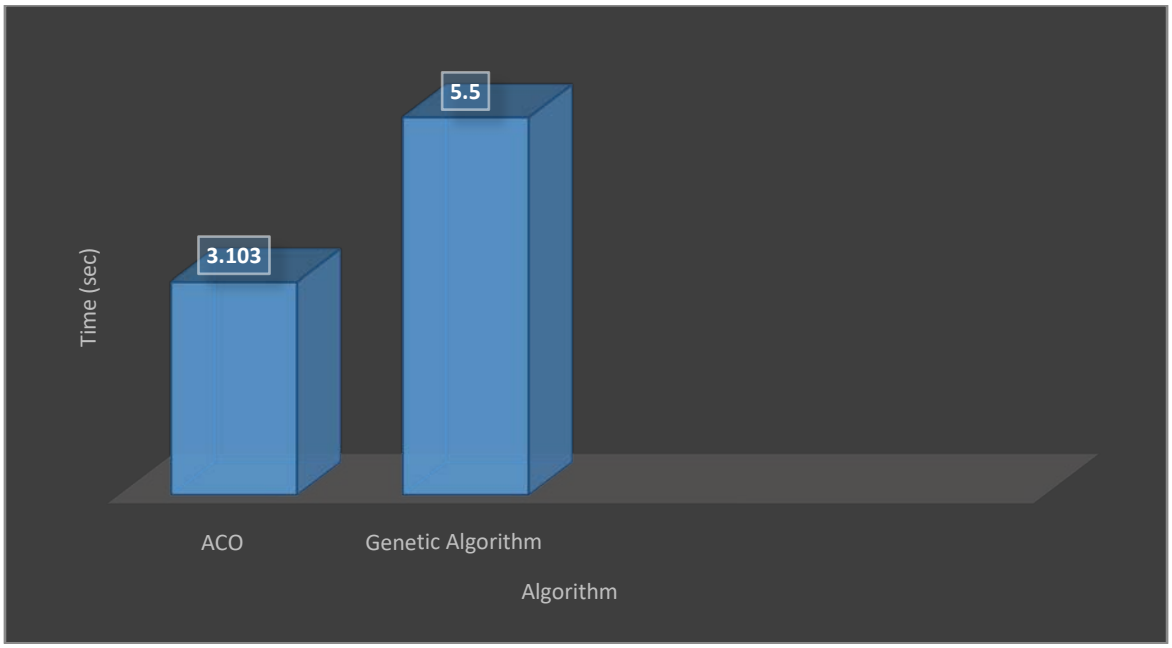

Fig. 1: Time comparison for large datasets (bays29.tsp)

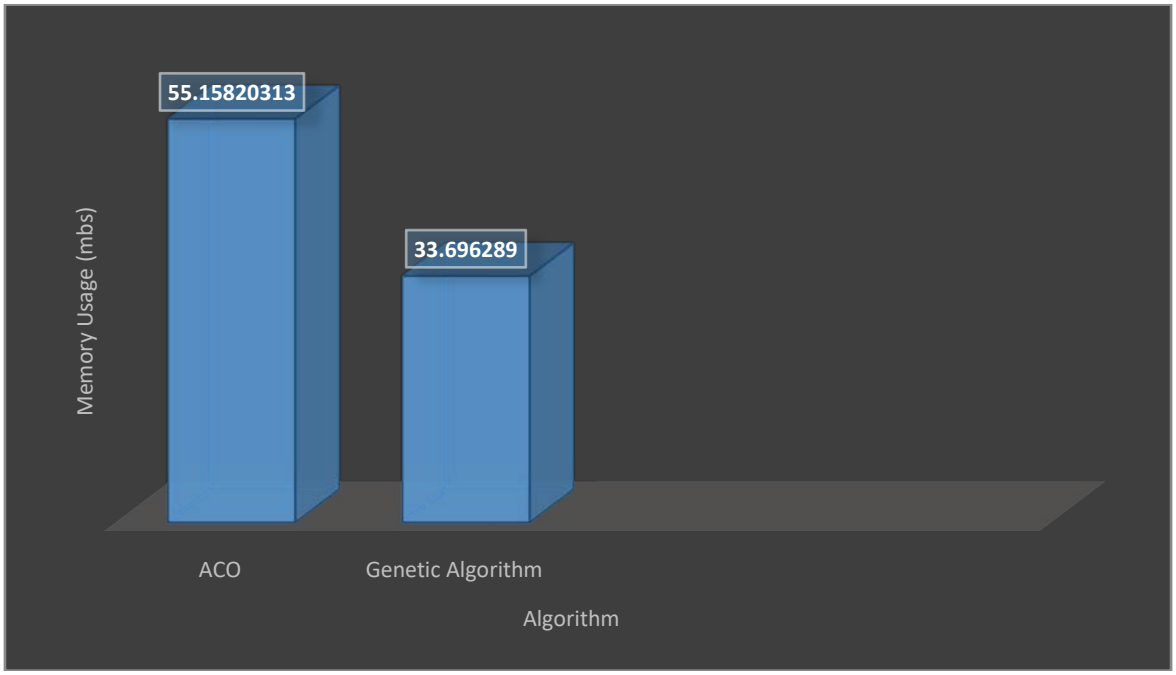

Fig. 2: Memory usage for large datasets (bays29.tsp)

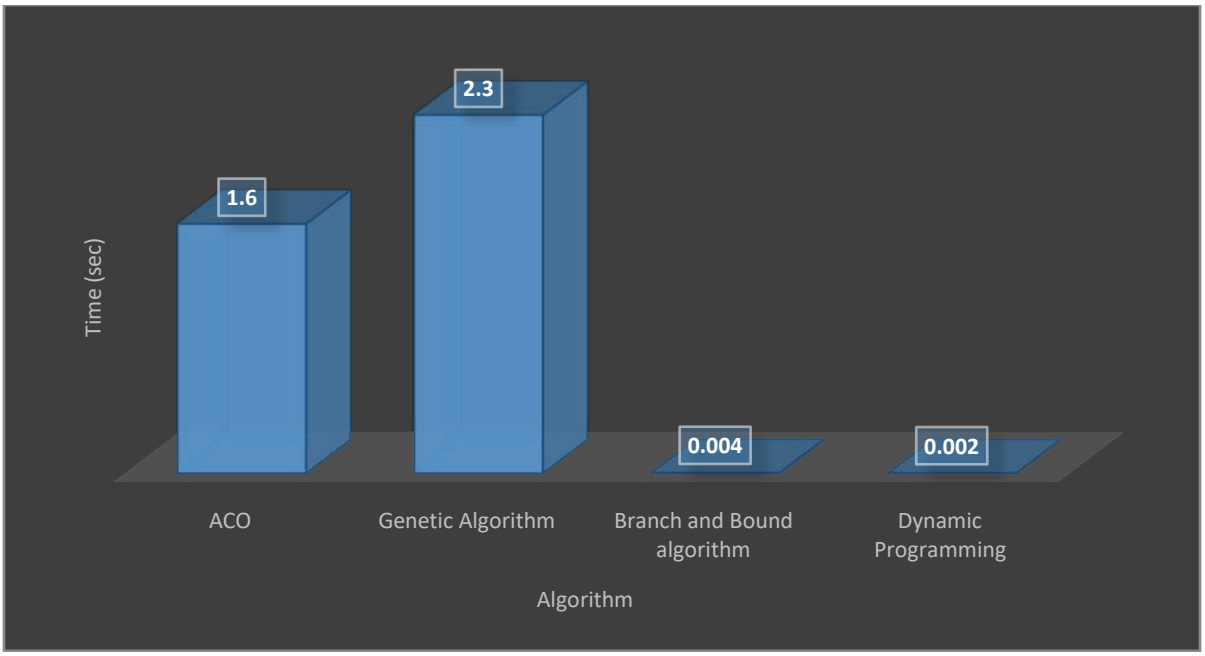

Fig. 3: Time comparison for small datasets (mydataset.tsp)

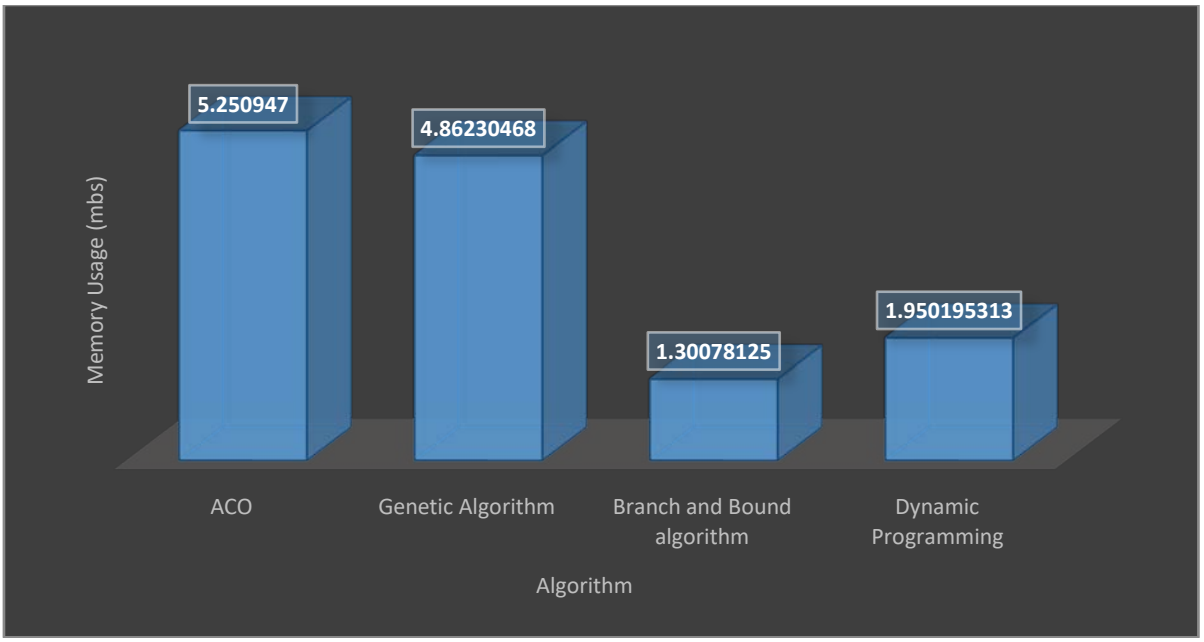

Fig. 4: Memory usage for small datasets (mydataset.tsp)

IV. Conclusion

Traveling salesman problem is one of the most important problem faced by vehicle routing procedures. Choosing the appropriate algorithm for a situation is necessary. This paper presents four different algorithms that can solve the traveling salesman problem and compares their performance. This paper will help future engineers to device the proper algorithm for dynamic and changing situations in vehicle routing and logistics. In real life, the condition on the road can change at any moment due to unforeseen circumstances. In that case, the proper algorithm must be implemented to find the quickest route efficiently. This paper is a step forward in the effort to find the most practical algorithms for continually changing situations in real life.

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Implementation and Performance Analysis of Different Hand Gesture Recognition Methods

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Abstract- In recent few years, hand gesture recognition is one of the advanced grooming technologies in the era of human-computer interaction and computer vision due to a wide area of application in the real world. But it is a very complicated task to recognize hand gesture easily due to gesture orientation, light condition, complex background, translation and scaling of gesture images. To remove this limitation, several research works have developed which is successfully decrease this complexity. However, the intention of this paper is proposed and compared four different hand gesture recognition system and apply some optimization technique on it which ridiculously increased the existing model accuracy and model running time. After employed the optimization tricks, the adjusted gesture recognition model accuracy was 93.21% and the run time was 224 seconds which was 2.14% and 248 seconds faster than an existing similar hand gesture recognition model. The overall achievement of this paper could be applied for smart home control, camera control, robot control, medical system, natural talk, and many other fields in computer vision and human-computer interaction.

Keywords: *convolutional neural network, deep learning, hand gesture recognition, PCA.*

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Implementation and Performance Analysis of Different Hand Gesture Recognition Methods

Md. Manik Ahmed[α], Md. Anwar Hossain[σ] & A F M Zainul Abadin[ρ]

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I. Introduction

In natural communication with another person, hand gesture recognition plays a vital role to interact with them naturally, convey rich and meaningful information in various ways. Because Gestures are one of the general forms of communication when people from different languages meet, and no one knows in which language they should express their feelings [1]. In compare to other body parts, a human hand which has been treated as a natural organ for a human to human interaction has been used widely for gesturing and can be best suitable for communication between humans and computers [4]. Recently a computer is an essential machine in our society which accomplishes our daily tasks. Human-computer interaction (HCI) is not only the keyboard, mouse interaction but also interaction computer with the human-like gesture, natural language, emotion and body expressions, etc. [2].

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For example, if we consider today's world without a computer, then we can easily realize HCI in our society. It is the most critical issue of advanced technology to recognize, classify and interpret various simple hand gestures and apply them in a wide range of application through HCI and computer vision.

In early, there were many gesture recognition techniques have been developed for recognizing and tracking various hand gesture images. Previously developed available hand gesture recognition techniques are instrumented gloves, optical markers and some advanced methods based on image features, color-based, vision-based, depth-based models but have their advantages and limitation [2]. But the previous gesture recognition technique fails to obtain the satisfiable result. Some automatic feature extraction based hand gesture recognition techniques have developed which was remove the limitation of previous work and made a revolutionary change on HCI and computer vision era.

In this paper provides four different hand gesture recognition techniques and compare performance among machine learning based semi-automatic and deep neural network based automatic system. These four methods tested on the same testing data with the same epoch. The classification task usually depends on the two-factor one is time, and another is recognition accuracy. A recognition method will perfect if the method takes low time and high accuracy during the train and test dataset. In this paper provides principal component analysis with backpropagation neural network based model but it showed very poor accuracy close to 77.86%. To remove this limitation presented a deep learning based primary two-layer convolutional neural network (PCNN) model that achieves the accuracy of 91.07% but consumes more time than the previous modes. Then proposed an adjustable CNN model (ACNN) which is similar to the PCNN model but there applied batch normalization and regularization that provide higher accuracy and minimize the running time half of the PCNN model. Finally, we applied two extra CNN layers with the PCNN model but it takes long running time, but provides 96.43% accuracy. There are several typical applications of hand gesture recognition such as virtual game controller, sign language recognition, Directional indication through pointing, making young children to interact with the computer, human-computer interaction, robot control,

lie detection, home appliance, Camera control, entertainment, and medical systems, Gesture talk, etc. [3].

The paper has organized as follows: Section 2 gives some literature review of present and previous work. Section 3 describes the methods of the proposed system. Experiment results and discussion have shown in Section 4. Finally, Section 5 concludes this paper.

II. Literature Review

Recognition of hand gesture offers a new era and plays a vital role in nonverbal communication and interact with the machine naturally. There is various bodily motion which can originate gesture, but the general form of gesture origination comes from the face and hands. The entire procedure of tracking gestures to their representation and converting them to some purposeful command is known as gesture recognition [4]. The hand gesture is the easiest and potential research area of machine learning and computer vision [5]. In a few years, several methods have been proposed to recognize hand gesture with the adaptive manner. The authors [6] [8] proposed a vision-based hand gesture recognition system that based on skin color model and thresholding approach which is segmented by the skin color model in YCbCr color space and separate hand region from the background by the Otsu thresholding method. Finally, they developed a template-based matching technique by Principal Component Analysis (PCA) for recognition. Their experiment tested on 80 images achieved 91.25% average accuracy and 30 images with 91.43% accuracy on the independent database.

Flores [12] proposed an approach to recognize static hand gestures whose features varied in scale, rotation, translation, illumination, noise, and background. Their approach included applying various digital image processing filter techniques to reduce noise, to improve the contrast under a variant illumination. They separate the hand from the background of the image and finally, and to detect and cut the region containing the hand gesture. Their approach achieved 96.20% recognition accuracy. Bui T.T.T [7] proposed a novel algorithm for face and hand gesture recognition system based on wavelet transform and principal component analysis that processes with two stages. At this stage, they extract object features using wavelet transformation and save it to the database so that they can compare this feature with PCA based extracted feature through the result. They achieved an efficient performance of face recognition (98.40 %) on 7320 testing face images and hand gesture recognition (94.63%) on digital image

Nasser H. Dardas and Shreyashi Narayan Sawant [9][10] proposed traditional PCA algorithm for gesture recognition which hand feature or train weight was extracted by projecting each training image onto the most eigenvectors then the small image that contains the detected hand gesture is projected onto the most eigenvectors of training images to form its test weights. Finally, they utilized the euclidian distance to recognize the hand gesture.

The above recognition method doesn't provide sustainable and remarkable results due to their limited accuracy and high time consumption and semi-automatic behavior. Nowadays, Deep learning based Convolutional Neural Networks (CNN) have shown substantial performance in different recognition tasks on computer vision that extend the traditional artificial neural network by adding additional constraints to the earlier layers and increased the depth of the network. A. Krizhevsky [11] proposed an ImageNet Large Scale Visual Recognition Challenge work which is mainly focused on the architecture to achieve great performance on a large number of data set during training.

Gongfa Li [12] proposed a convolutional neural network that removes the traditional feature extraction method and reduces the number of training parameter. They utilized the error backpropagation algorithm for learning the network in an unsupervised way. Finally, they added the support vector machine act as a classifier to improve the validity and robustness of the whole classification function of the convolution neural network. They achieved an efficient performance of gesture recognition average 98.52 % on 7320 gesture images of 10 different people. Yingxin [13] proposed an approach for hand gesture recognition based on the Adapted Deep convolutional neural network (ADCNN) with regularization technique which took shifted and rotated version of hand gesture images that extend the 20% of the original image dimension randomly. Their experiments conducted with a regularization technique on 3750 hand gesture images that remove the overfitting. Their result revealed the ADCNN approach achieved higher recognition accuracy of 99.73% and 4% improvement over the traditional CNN model. Guillaume Devineau [14] proposed an approach using a 3D deep convolutional neural network(3DCNN) for hand gesture recognition using only hand-skeletal data without depth image information. Their proposed 3DCNN only processed sequences of hand-skeletal joints' positions by parallel convolutions. Their experiment achieved a 91.28% classification accuracy for the 14 gesture classes case and an 84.35% classification accuracy for the 28 gesture classes case. In Pei Xu [15] Proposed a hand gesture classification method which is the modified CNN version from LENET 5 using only one cheap monocular camera. Their experiment also introduced the Kalman filter to estimate the hand position based on which the mouse cursor control had realized stably and smoothly. But their implemented

system only supported static gesture and worked on 3200 gesture images.

III. Methods and Methodologies

This section provides literature behind the Principal component analysis (PCA), a description of Backpropagation neural network (BPNN), a brief discussion of primary 2-layer convolutional neural network (PCNN) architecture and the basic overview of adjusted convolutional neural network (ACNN) which is the optimized version of PCNN, Description of Primary 4-layer CNN to gain better performance. Also, this section provides the Layer operation and configuration table of all neural network that has proposed in this paper.

a) PCA Based BPNN Architecture

Principal component analysis (PCA) is a dimensionality reduction technique based on extracting the relevant information of gesture images which is multidimensional. The main objectives of PCA in gesture recognition techniques are data dimension reduction and feature selection to train the Multilayer BPNN. The gesture recognition using PCA based BPNN architecture involves two phases: i) Feature Extraction Phase ii) Classifier Phase.

Fig. 1: Thebasic flow of PCA based hand gesture recognition method

During feature extraction Phase PCA is to reduce the dimensionality of the gesture images while retaining as much information as possible in the original gesture images. Each hand gesture images in the database concatenate form into one matrix. Then PCA is to move the origin to mean of the data by averaging all column matrix database images divided by the total number of hand gesture images. Next, find the normalized images by subtracting the computed average image from each image in database form into a mean centered data matrix. These adjusted images determine how each of the gesture images in the database differs from the average image which has calculated previously. Next, the PCA algorithm calculates and finds the eigenvectors using covariances matrix of normalized hand gesture images that speed up the technique and reduce the number of parameters. Eigenvectors with low eigenvalues that contribute little information in the data representation. In this step also data reduction technique is achieved by truncating the eigenvectors with small eigenvalues. Then this eigenvectors matrix multiplied by each of the normalized gesture vectors to obtain their corresponding gesture space projection. Finally, each image in normalized matrix multiplied with gesture space and created a new gesture descriptor or strong weight that is ready to feed as the input of BPNN.

In the classifier phase, A Backpropagation neural network has used as a classifier which is reverse propagates the error and adjusts the weights to near the target output. In particular, the internal (hidden) layers of multilayer networks learn to represent the intermediate features that are useful for learning the target function and that are only implicit in the network inputs. The classification of hand gesture images involves in two stages one is training stage another is the testing stage. During the training stage, BPNN design is composed of two hidden layers, Input layer, and output layer. The model of BPNN has described in (Table 01). In this stage, the gesture feature vectors that belong to the same classes have used as positive examples, i.e. network gives “1” as output, and negative examples for the others network, i.e. Network gives “0” as output which is the target value. The algorithm used to train the network is the Backpropagation Algorithm. The general idea with the Backpropagation algorithm is to use gradient descent to update the weights to minimize the squared error between the network output values and the target output values. Then, each weight is adjustedusing gradient descentaccording to its contribution to the error. The activation or transfer function used in the Back Propagation neural network is the sigmoid function which maps the output 0 to 1. When the neural network met the stopping condition, then it stops and gives the training output. During the testing stage, it is necessary to extract the feature of all unknown hand gesture images. Then calculate the projection of the test gesture to project the gesture on gesture space and form into a new descriptor. These new descriptors have inputted to every network, and the networks are simulated with these descriptors. The network outputs have compared. If the maximum output exceeds the predefined threshold level, then these new gesture images have decided to belong to the same class gesture with this maximum output. Finally, this architecture calculates overall accuracy depend on correctly recognize of hand gesture images out of total images.

Table 1: BPNN Configuration

Parameter types	Parameter
Layer	4
Input layer neuron	1080
Hidden layer neuron	75 (H1) 50 (H2)
Transfer function	Logsig
Epochs	1000
Learning rule	Backpropagation based gradient descent

b) Convolutional Neural Network

In the field of image recognition and computer vision, convolutional neural network (CNN) has achieved the most remarkable results [16]. Recently, with the development of hardware, much research about object recognition using CNN becomes practical and achieves success [11] [17]. CNN usually learn features directly from input data and often provides a better classification result in the case where features are hard to be extracted directly, such as image classification.

Traditional CNN contains two parts, namely the feature extraction part also called the hidden layer and the classification part. In feature extraction part the CNN can perform a series of convolutions and pooling operationsduring which the features have detected. In the case of a CNN, the convolution has performed by sliding the filter or kernel over the input images with some stride which the size of the step the convolution filter moves each time and the sum of the convolution produces a feature map. The most common thing in CNN network is to add a pooling layer in between CNN layers which function is to continuously reduce the dimensionality to reduce the number of parameters and computation in the network model. In CNN, two types of pooling layer available are average, and another is maxpool which are reduce the training time and controls overfitting [11]. In the classification part which contains some fully connected layers that can only accept one-dimensional data. The output of this layer produces the desired class using an activation function and classifies given images.

c) Primary CNN Architecture (PCNN)

In this section of this paper provides the primary structure of deep CNN which contains two convolutional layers, two pooling layers and with two fully connected layers with rectified linear unit (RELU) and one softmax activation function. The structure of the PCNN has shown in Figure 02 (Fig.2). In this architecture, it also contains a dropout procedure after the first convolution layer and the second dropout has performed after the first fully connected layer. The overall objectives of this primary deep CNN network have automatically extracted the feature from the direct gesture image as input that removes the traditional machine learning semi-automatic and manual techniques.

In PCNN, the first layer starts with a convolutional layer that has a kernel size of 3×3 pixels and contains 32 feature maps that followed by traditional RELU activation function with no padding. This layer performed by fed the hand gesture images with 64×64×3 pixel values and extracts the deeper information for every image in the database. The next layer is a Dropout also called regularization layer that was configured to randomly remove 20 percent of neurons to reduce overfitting or underfitting. The next deeper layer is another convolutional layer that has a kernel size of 3×3 pixels and also contains 32 feature maps followed by a RELU activation function that is the same as the previous layer. The next layer is a MaximumPooling layer that has designed with a pool dimension of 2×2 pixels. The MaxPoolinglayer uses the maximum value to progressively deduct the negative of the representation to reduce the number of parameters and computation in the network, and hence to also control overfitting. The MaxPooling layer extracts subregions of 2×2 of the feature map, keeps their maximum value and discards all other minimum values. A layer called Flatten that converts the two-dimensional image matrix data to a vector, hence allowing the final output to be processed by standard fully connected layers to obtain the next layers. The first fully connected layer in this PCNN with the RELU activation function contains 512 neurons. This layer is followed by a dropout layer toexclude 20% of neurons to reduce overfitting. The final part of the CNN structure is the output layer and acts as aclassifier which is mapped by a Softmax activation function, and contains six neurons represents every class of gesture image. The architecture of the PCNN network has shown in (Figure 02).

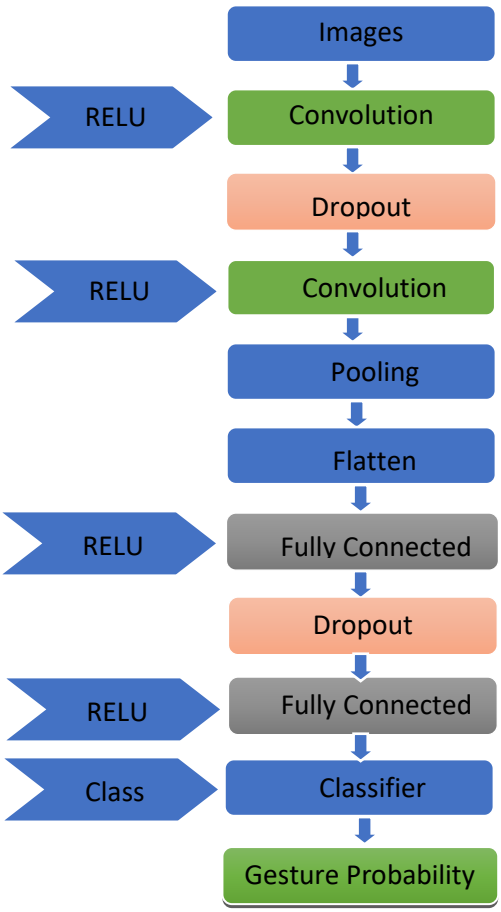

Fig. 2: Configuration of PCNN

d) Adjusted CNN Architecture (ACNN)

In this section, provides the fine regulated design of PCNN with a simple modification to get better accuracy and low running time for the real-world applications. There are existed several techniques to optimize the CNN. CNN was parameter sensitive neural network where accuracy and running time largely depend on network parameters. There are several strategies to extend recognition accuracy and running time. In this paper, the overall performance of ACNN was improved by a simple modification of the network parameter that includes i) Downsample, ii) Batch normalization and Kernel size and iii) Regularization. The ACNN is the modified version of PCNN that contains some optimization technique compare with another CNN model shown in (Table 02):

Downsample: In this ACNN architecture provides two extra downsample operation after two convolutional layers with 1×1 kernel size through pooling layer that reduces the feature map dimensionality for computational efficiency, which can, in turn, improve actual performance accuracy.

Kernel Size and Batch normalization: To preserve the low running time it will be necessary to replace filter or kernel size from a higher value to lower. In the very initial step, an acceptable kernel of suitable dimensions is decided to convolve over the input image and identify key features in the images. A larger size kernel can disregard the features and could skip the essential details in the images whereas a smaller size kernel could provide more information leading to more confusion. This ACNN model contains the second convolutional layer that has a kernel size of 2×2 pixels and also holds 64 feature maps followed by a RELU activation function which differs from PCNN. Batch normalization isthe another key factor that speeds up the model run time. This model batch size is 32 that means 32 samples from the training dataset will be used to estimate the error gradient before the model weights are updated.

Regularization: This Deep ACNN deals with a large number of parameters while training the model leads to overfitting. Regularization is the technique that decreases the complexity by constructing the model structure as simple as possible. This model contains two regularizations after the first convolutional layer and the first fully connected layer with 20% and 27% dropout.

e) Larger CNN Architecture (LCNN)

This section proposed the Larger CNN (LCNN) architecture that contains four convolutional layers with 3×3 pixels and each convolutional layer followed by RELU activation function, max-pooling layer with 2×2 pool size and batch normalization. The first convolutional layer only contains 32 feature maps, and the rest of the three convolutional layers contains 64,64 and 96 feature maps accordingly. One flattens layer that converts image to vector. Also, this structure presents two fully connected layers with RELU and Softmax activation function and output layer gives the probability value of the recognized class. This architecture did not use any regularization technique to reduce model complexity.

IV. Experimental Results and Discussions

This section presents the basic description of Hand gesture Datasets which was used to perform the experiments and fed into PCA with Backpropagation, PCNN, LCNN model and adapted version of the PCNN model called ACNN. Besides this section provides the evolution parameters and performance among these four models. Then it discusses the accuracy and running time and evaluates and measures the best network performance among them.

The presented four architecture are trained and tested on hand gesture dataset taken from the deeplearning.ai (DLAI) [17] dataset which contains 1080 randomly organized hand gesture datasets. This dataset contains six unique class from 0 to 5 that depends on the corresponding hand finger. The dimension of the individual image is 64×64×3 where 64 represents the width, the height of the corresponding images and 3 represents the channeli.e., the hand gesture data used in this experiment are color images. We divided the datasets 800 images for training and 280 images for testing from 1080 individual image datasets as shown in (Table 02).

Table 2: Dataset characteristics for our model

Dataset	Dimension	Input Dimension	No. of Data		Classes
			Training	Testing	
DLAI	(64,64,3,1080)	(12288,1080)	800	280	6

Figure 03 (Fig.3) shows a sample of five hand gestures that haveused for our experiments that taken under different scale, rotation, translation, and noise.

Training Data	class	Test Data	class
	5		0
	0		4
	2		3
	5		3
	2		5

Fig. 3: Five samples of training and test hand gesture for this experiment

This paper represents four different hand gesture methods which are tested on the same database and show different accuracy and running time depends on their architecture and network characteristics and parameters. Table 03 shows the parameters have been used in this experiment by different gesture recognition technique. From Table 03 it has been shown that only PCA with BPNN is a semiautomatic hand gesture recognition technology that only took grayscale converted images from the RGB datasets. But all models took three channel RGB data as input. The PCA with BPNN training process based on the backpropagation algorithm with stochastic gradient descent (SGD) method. The cost functions chosen for this model is mean squared error (MSE) and SGD has used as the optimization function. Besides Table 03 shows three CNN based automatic hand gesture recognitionnetwork model parameters that have been used by this experiment. The three variations of this deep CNN training process have based on the backpropagation algorithm with SGD. The cost functions chosen for this model are categorical cross-entropy as loss function, and SGD has used as the optimization function.

Table 3: Network parameters for this experiment

Network	PCA with BPNN	PCNN	ACNN	LCNN
Training Images	800	800	800	800
Testing Images	280	280	280	280
Convolutional layer/hidden layer	2	2	2	4
Learning rate	0.01	0.01	0.01	0.01
Epochs	146	25	25	25
Activation function	Sigmoid	RELU-Softmax	RELU-Softmax	RELU-Softmax
Cost function	Mse	categorical_crossentropy	categorical_crossentropy	categorical_crossentropy
Optimization	SGD	SGD	SGD	SGD
Batch normalization	None	None	Yes	Yes
Regularization	None	Yes	Yes	None
Downsampling	None	Limited	Yes	Limited

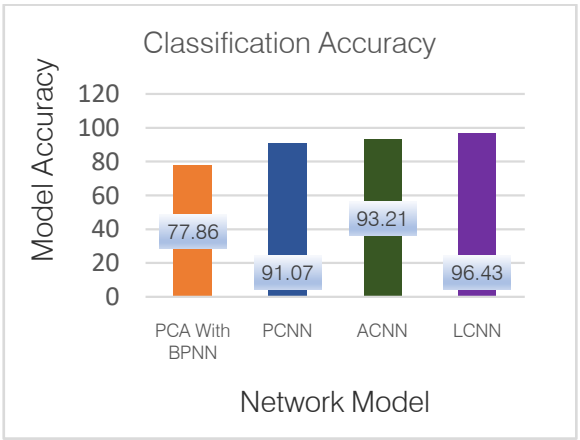

Fig. 4: Classification accuracy of proposed models

Figure 04 (Fig.4) and Figure 05 (Fig.5) shows the gesture recognition accuracy and model running time when using the four architecture on gesture datasets. The running time includes both training and testing time to classify the gesture images.

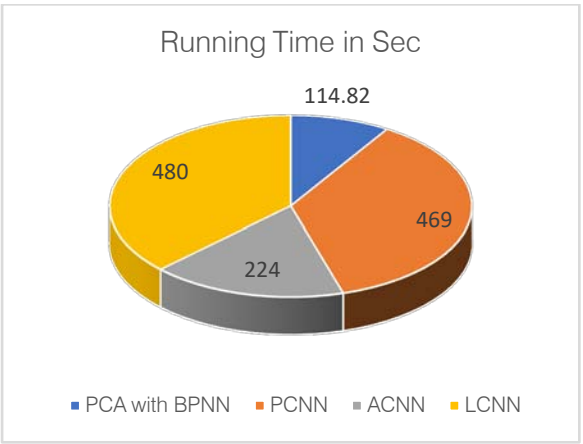

Fig. 5: Running time of proposed models

The LCNN presents the highest hand gesture recognition accuracy 96.43%, but it consumes more time approximately 480s than other recognition models. The PCA with BPNN is semiautomatic feature extraction based machine learning approach that shows very inferior accuracy closer to 78%, but it takes very quiet time both training and testing than other recognition

models. The PCNN presents overall accuracy 91.07%, but it consumes more power close to the LCNN network model. We proposed a model adjusted version of the PCNN model with fine-tuning of the network parameter. But the only difference between them is some optimization step namely batch normalization, downsampling, and regularization. This ACNN model provides better accuracy is 93.21% and less consume running time close to 224s which was 2.14% higher and 248s faster than the performance achieved by the PCNN model and compared to other models in this paper. Though the accuracy of the ACNN model is 3.22% lesser than the LCNN model, but the running time is very tiny as compared to the LCNN model.

Figure 06 (Fig.6) depict the architecture training and testing accuracy during every epoch. This figure shows that training and testing performance of different experiment during the separate epoch. In Figure 06, (iii) and (iv) depict the best training and testing performance which ismisclassified in PCA with BPNN and PCNN model.

The overall CNN model performance depends on the training a model without overfitting the data. To remove this limitation, we have used three optimization technique in the ACNN model. As a result, it shows the adequate training and recognition accuracy with very less running time compared to other models. The LCNN provides the best recognition accuracy inside this experiment, but it takes extra two convolutional layers compared to our adjusted CNN model and takes a long time to train and test the model. If we increase a convolutional layer, then it can affect the accuracy of the model. So, to get better accuracy depth is one of the proper significance factors, but it consumed more time for training and testing.

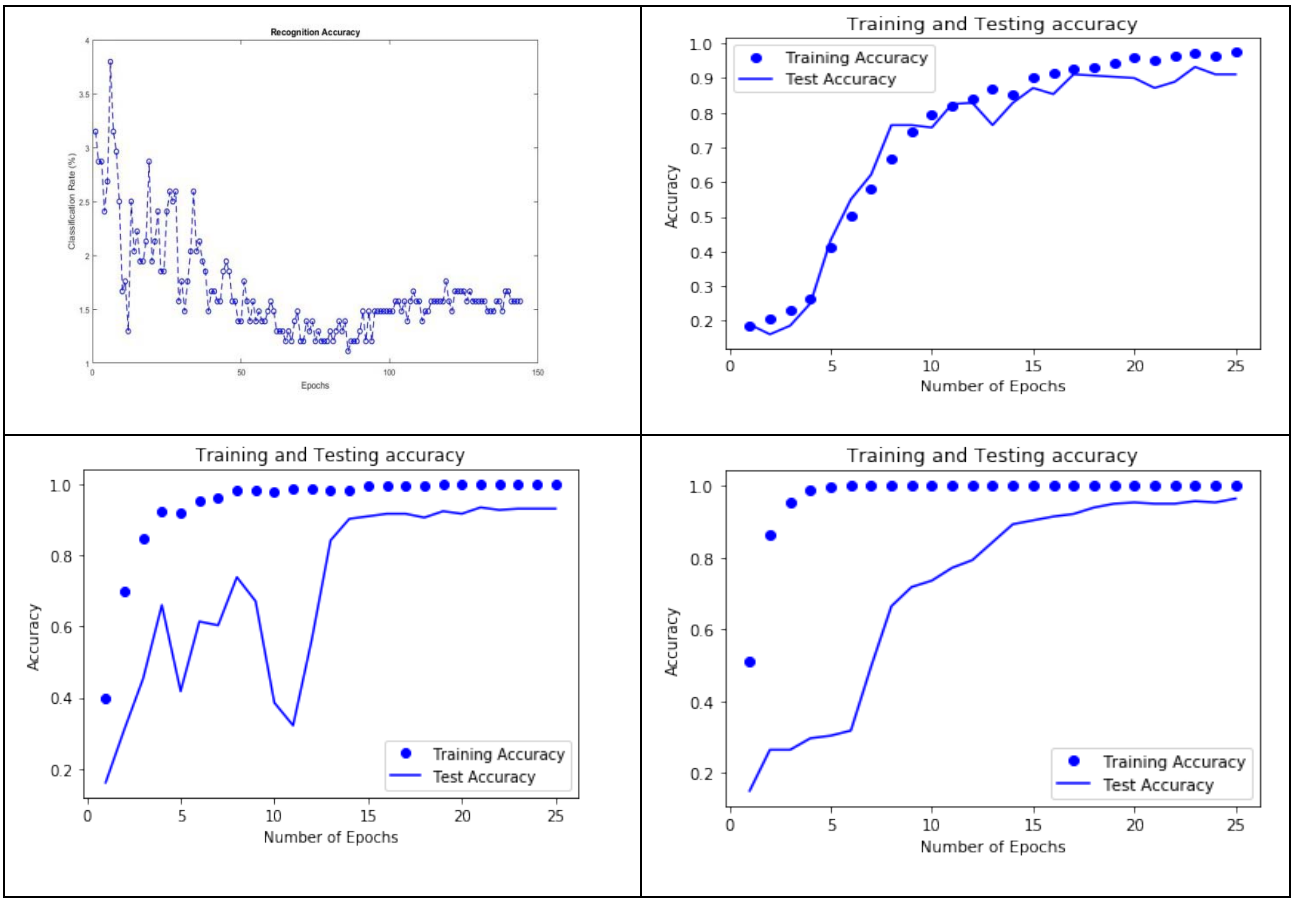

Fig. 6: Recognition accuracy curve of i) PCA with BPNN ii) PCNN iii) ACNN iv) LCNN

V. Conclusion

In this paper, we presented and compared four semi-automatic and automatic gesture recognition methods that classify hand gesture data from a large number of datasets. The semi-automatic method works in a two way. First, it extracts feature from given datasets and feeds it to the classifier for recognition. We presented PCA with BPNN methods which feature were extracted by the PCA method and the BPNN model act as a classifier that classifies the gesture class. Though this method has a low run time model accuracy was very poor. To remove the limitation, we presented three CNN based model for automatic gesture recognition from the given dataset. The proposed ACNN model provides a better optimization result from PCNN and

LCNN in this paper. Because the ACNN model consumes low running time and provides an overall accuracy compared with the LCNN model. Due to the four convolutional layers in LCNN, it provided high accuracy for gesture classification and the model running time was low.

In the future work, we would like to apply different optimization technique on the LCNN network so that we can speed up the model run time and the proposed system apply to many applications such as home appliance, Camera control, entertainment, and medical systems, Gesture talk, etc.

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A Survey on Nature-Inspired Computing (NIC): Algorithms and Challenges

By A.Krishnaveni, R. Shankar & S. Duraisamy
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Abstract- Nature employs interactive images to incorporate end users' awareness and implication aptitude form inspirations into statistical/algorithmic information investigation procedures. Nature-inspired Computing (NIC) is an energetic research exploration field that has appliances in various areas, like as optimization, computational intelligence, evolutionary computation, multi-objective optimization, data mining, resource management, robotics, transportation and vehicle routing. The promising playing field of NIC focal point on managing substantial, assorted and self-motivated dimensions of information all the way through the incorporation of individual opinion by means of inspiration as well as communication methods in the study practices. In addition, it is the permutation of correlated study parts together with Bio-inspired computing, Artificial Intelligence and Machine learning that revolves efficient diagnostics interested in a competent pasture of study. This article intend at given that a summary of Nature-inspired Computing, its capacity and concepts and particulars the most significant scientific study algorithms in the field.

Keywords: bio-inspired computing (BIC), inspiration, nature-inspired computing (NIC), nature-inspired optimization algorithms (NIOA), optimization, swarm intelligence (SI).

GJCST-D Classification: I.1.2

Strictly as per the compliance and regulations of:

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I. Introduction

One-touch of **nature** makes the entire globe nearest and dearest. William Shakespeare.

Seem to be deep into **nature** and after that you will be aware of the whole thing better. Albert Einstein.

Narrow down the remarkable thoughts to a final solution by utilizing the real environment is called as nature. In nature, the earth contains the four types of spheres like Lithosphere (solid ground), Hydrosphere (H_2O), Atmosphere (wind) and Biosphere (a breathing creature) which especially known as the ecosphere (surroundings). Nature facilitates the inspiration to human through some salient features. It includes the following 1) Satisfies the social work, 2) Belongingness Improvement, 3) Rapid information processing and 4) Get the Quick acknowledgment. Nature-inspired Computing (NIC) providing a tremendous prospect intended for conversation and information switch over for philosophers, scientists, strategy-architects, wangles along with new experts by means of an attention in concerns interrelated to geothermal liveliness. It is hypothetical to ember conversation inside the intellectual area with to association the break sandwiched between practitioners and specialists. Medicine is an important location for the sensible relevance of science. For problem-solving technique, the Bio-Inspired Computing (BIC) techniques modeled to employment as the computerized resolution support in a procedure of diseased tissues detection that imitate nature with bio-mimicry.

Fig. 1: Inspiration from nature of research by a living organism

Fig 1 gives the valuable proverb "One Picture is more worth than ten thousand words." The Complexity behavior between human and nature also considered as the foremost observation from the above picture.

The rest of the thing indicated in this manuscript is organized as purses. In slice 2 presents and discusses in details motivation related to nature-inspired computing. This slice 2 describes the need for both biological and swarm intelligence algorithmsz. In part 3, novel bio-inspired algorithms in the literature defined in a well-defined manner. The outline of the growth of the bio-inspired algorithm in the disease identification database was mentioned in fragment 4. User can identify the list of the bio-inspired algorithm in this paper. Segment 5 bring to a close this paper and things to see future work.

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II. From Nature to Natural Computing

Motivation

The key purpose of studying natural history is getting the stimulation through the careful observation of the research. Apart from the stimulation, the following contributions are made by natural world in a well-defined manner.

1. Satisfactory solutions.
2. To design the systems which mimics natural world.
3. New computing paradigms.

The example products are Washing machines, Trains, Toys, Air Conditioning devices and Motion pictures.

Definition

"Natural figure be the pastor of researching that looks at human-structured registering stir up ordinarily just as processing occurring in nature"- Rozenberg G et al.,

In the above definition, the careful investigation of the specified models and also the essential computational techniques are inspired by nature. Along these lines, regarding data handling pattern additionally occurring in characteristic history.

Respective authors De Castro and Von Zuben (2004) defined natural computing has the three main branches that are denoted by the following figure 2.

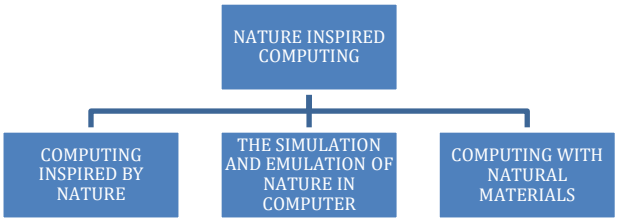

Fig. 2: Classification of Nature-inspired Computing (NIC)

The study of the above figure 2, refer the three types of systems to understand the terminology of nature-inspired computing. More data with bigger models with more computation which yields successful results.

1. Computing Inspired by Nature

The first specified type is Computational Algorithms for problem-solving developed by taking inspiration from life phenomena.

2. The imitation and follow suit of Nature in Computer

In this type, the computational systems for the simulation and emulation of nature had been considered as essential.

3. Computing with Natural Materials

Narrative computing devices or paradigms that use media other than silicon to store and process information is particularly in this type.

Nature has progress above millions of years under a variety of challenging atmosphere. Optimization in problem-solving has always been an important and challenging issue for researchers. Different methods have been utilized mostly based on (NIC) for the prediction of promising results [1].

Nature-Inspired Computing (NIC) is a promising work out archetype with the intention of illustrate on the main beliefs of identity-association, evolution, immunity, emergence moreover multifaceted structures [2, 3]. The enormous amount of ideas can be retrieved from scenery through the careful observation of how the natural world behaves to solve a hard problem. The ultimate aim is to discover the difficulties for complex problem-solving and try to develop novel algorithms, techniques and also the computational methods [4].

Table 1: Five Principles of Nature-inspired Computing

Properties	Meaning
Self-Organization	Local interactions
Complex Systems	Human Brain
Emergence	Coherent structures
Evolution	Heritable characteristics
Immune system	Protects against system.

In TABLE 1, the most imperative five principles for NIC such as self-organization, complex systems, emergence, evolution and immune system had been described clearly.

OPTIMIZATION is an arithmetical guideline that worries the judgment of minima and maxima of social affairs, subject to purported requirements. Advancement began during the 1940s, When George Dantzig utilized numerical strategies for producing "programs" (preparing timetables and calendars) for military application. From that point forward, his "straight programming" methods and their relatives were connected to a wide assortment of issues, from the planning of generation offices, to yield the board in aircrafts. Today, advancement involves a wide assorted variety of methods from activities examine, computerized reasoning and software engineering and is utilized to improve business forms in for all intents and purposes all enterprises [5].

It is mostly based on the heuristic and meta-heuristic algorithms by following the method "trial-and-error." Knowledge comes from intelligence. Heuristics comes from the depth knowledge used to discover the new procedure. Most essential discoveries were executed successfully by "thinking outside the box" by accident as an incident. Analysis of studies of learning and optimal planning are the key concepts in the research field, which yields the best solution. The living organism's tasks are much admired with real-time troubles, therefore increasing expertise and competence optimization technique is at a standstill a motivating and intensively escalating research area [6].

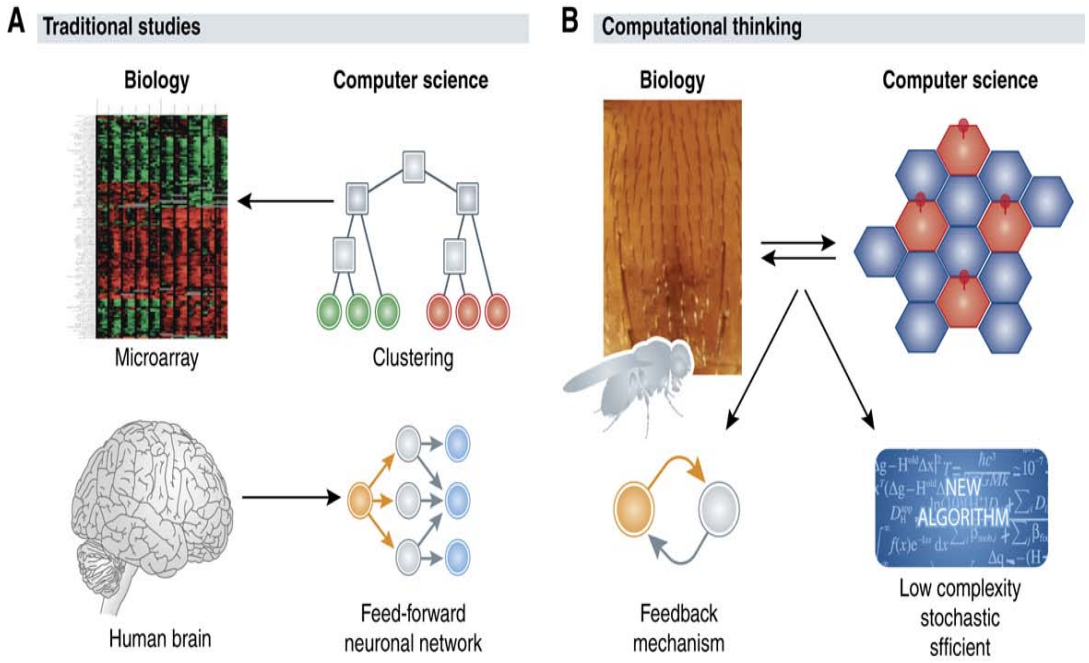

Fig. 3: Comparison of Conventional examinations versus computational reasoning [51]

In the above figure (A) traditionally, researcher utilized figuring capacity to break down and process information (e.g., progressively grouping quality articulation micro-arrays to anticipate protein capacity)and PC researchers utilized high-level plan standards of organic frameworks to provoke new computational calculations (e.g., neural systems). Seldom were these two bearings coupled and commonly useful. (B) By considering how the natural framework to process data, The user can make improved models and estimations and give an inexorably consistent enlightenment of how and why the system fills in as it does.

Nature-inspired Computing Algorithms have been ordered into three principle classifications, for example, Bio-Inspired Algorithms, Throng Aptitude Algorithm and Substantial, Compound Support Algorithms. The Bio-Inspired Algorithms had been further classified into the following categories, such as Evolutionary Algorithm and Artificial Immune System (AIS), Bacterial Foraging and many others. The Evolutionary Algorithm consists of Genetic Algorithm, Evolution strategies, Genetic Programming, Evolutionary programming, Differential Evolution and Social algorithms. Swarm intelligence includes Ant Colony Optimization, Cat Swarm Optimization, Cuckoo Search, Firefly and Bat Algorithm. Simulated Annealing and harmony Search algorithms come under the physical-based algorithms.

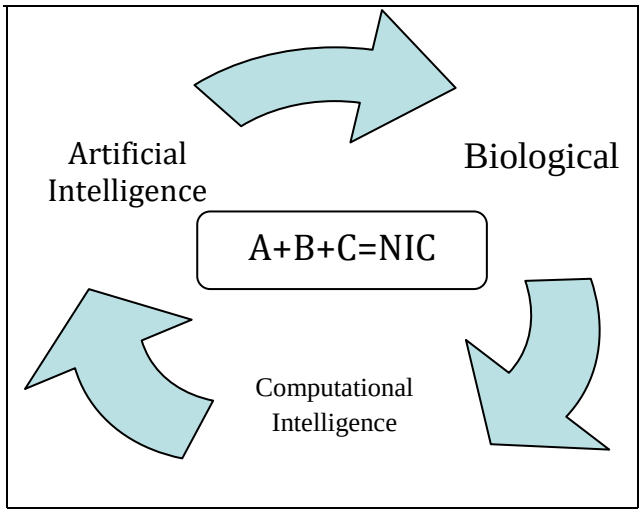

Fig. 4: Artificial+Biological+Computational=NIC

Nature is acting as an instructor. Many things to be observed and valued regularity in temperament are the major things. Adaptability and Co-habitat for several species like an ant, bee and birds are some extraordinary features of the environment. Knowledge can be distinct as a homo sapiens endeavor to identify with the character. The series of one-thousandth of one percent of what scenery has discovered to us is not known to everybody is said by Einstein. The invention of innovations is mainly made based on the need. With ever-increasing competitions using the novel method to the specified problem are recognized by the researchers. In the field of Biologically Inspired Computing (BIC,) the insights in species form are tremendously helpful.

The Need for Biologically Inspired Computing (BIC)

Bio-inspired computation (BIC) is the subset of Nature-inspired Computing (NIC) considered as a multi-disciplinary field. Nowadays, Bio-Inspired Computing (BIC) and Swarm Intelligence (SI) are measured as two main developmental areas. Real-world optimization problems are tackled in an effective manner by using bio-inspired algorithms. Several successful algorithmic approaches have been inspired by biology. To deal with hard and complex optimization problems, those methods had been frequently used.

Bio-Inspired computing algorithms such as effectionary branches and ant colony optimization algorithms have found copious applications for solving troubles or after computational biology, engineering, logistics and telecommunications. Frequent problems arising in these relevance domains belong to the field of combinatorial optimization. The researchers have achieved tremendous success when applied to such troubles in recent years is possible through Bio-inspired algorithms. In general, there are two commonly available computing known as classical computing, such as number crunching and bio-inspired computing, which includes social insects as well as evolutionary algorithms. It aims to produce informatics tools to tackle complex problems using computational methods and optimization techniques.

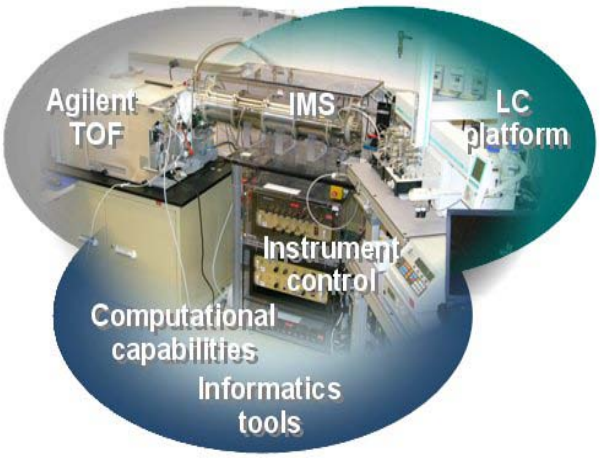

Fig. 5: Scope of Biologically Inspired Computing (BIC)

Figure 5 gives the scope of Bio-Inspired computing. Bio- Inspired registering is a consortium of procedures, (as neural systems, hereditary calculations, unpleasant sets, investigation apparatuses), that works synergistically and gives, in some structure, adaptable data preparing abilities for dealing with genuine issues. Its point is to abuse the resilience for imprecision, vulnerability, surmised thinking and fractional truth into accomplishing tractability, power, low arrangement cost and close similarity with human-like basic leadership.

The Need for Swarm Intelligence (SI)

"Dumb elements, appropriately attached interested in a multitude, give up stylish consequences"- Kevin Kelly

Swarm insight (SI) alludes to a subset of computerized reasoning (AI). Adaptability, Versatility, particularly the Self-learning capacity and flexibility, are the essential highlights. In 1989 relevent authors Gerardo Beni and Jing Wang proposed Swarm Intelligence (SI) algorithm for developing cellular robotic systems by applying those above mentioned basic features and tend to relate this algorithm to recognize several application vicinities [7]. Calculations or appropriated critical thinking gadgets enlivened by the aggregate conduct of collective creepy-crawly settlements and other creature social orders [Bonabeau, Dsorigo, Theraulaz, 1999]."The evolving cooperative intellect of groups of uncomplicated agents is very recognizable."(Bonabeau et al. 1999). Bio-Inspired Computing with swarm intelligence covers the three major areas such as

1. Genetic Algorithms (Evolution),
2. Biodegradabilty Prediction (biodegradation) and
3. Cellular automata (life).

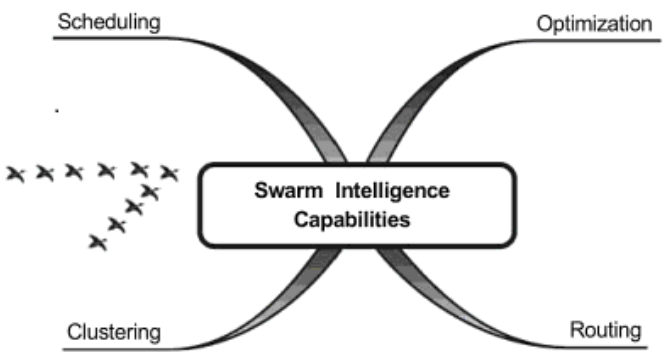

Fig. 6: Key capabilities of Swarm Intelligence

The primary targets of nature motivated advancement strategy are to expand the profitability, gain, effectiveness, achievement, etc. and to misjudge the vitality use, cost, measure, etc. Swarm knowledge is the order that manages the investigation of self-sorting out procedures both in nature and in counterfeit frameworks by using the input capabilities listed in the above figure 6.

The essential characteristics of Swarm Intelligence have been listed in the following figure 7. From the outline, the main distinctiveness is described, such as Control is distributed, there is no central or data source is the primary objective of the species. Communication means sharing ideas from one to another. Here limited interactions lead to better results. There is no explicit model of the environment had been specified. The ability reacts to the changes to the environment is recognized. Perception includes vision and speech. The visibility of the behavior in the species is marvelous one and thus nature gives the feel of the attraction.

Fig. 7: Implementing Swarm Intelligence in Social Media

a) Swarm Intelligence Algorithms

Hopefully the problem had been solved by using the nature of the algorithm, which satisfying the original needed criteria time. A number of biologically propelled enhancement calculations have been created and considered up until this point. They are, Altruism Algorithm, Animal Migration Optimization (AMO) Algorithm, Ant Colony Optimization Algorithm (ACO), Artificial Chemical Process Algorithm, Artificial Chemical Reaction Optimization Algorithm, Artificial Algae Algorithm (AAA) , Artificial Bee Colony Algorithm, Artificial Ecosystem Algorithm (AEA), Artificial Fish School Algorithm, Artificial immune systems (AIS) , Bacteria Chemo taxis (BC) Algorithm, Bacterial Colony Optimization, Bacterial Evolutionary Algorithm (BEA), Bacterial Foraging Optimization, Bat Algorithm, Bees Algorithm, Biogeography-based Optimization (BBO), Bird Mating Optimizer, Black Holes Algorithm, Boids Algorithm, Bull optimization algorithm, Bumble Bees Mating Optimization (BBMO), Central Force Optimization, Chemical Reaction Algorithm, Collective Animal Behavior (CAB) algorithm, Cuckoo Search (CS), Cultural Algorithms (CA),Cuttlefish Algorithm, Differential Evolution (DE), Differential Search Algorithm (DSA), Eagle Strategy, Elephant herding optimization (EHO), Firefly Algorithm (FA) , Fireworks algorithm for optimization, Flower pollination algorithm (FPA), Forest Optimization Algorithm, Gases Brownian Motion Optimization, Genetic Algorithm (GA), Glowworm Swarm Optimization (GSO), Golden Ball, Gravitational Search Algorithm (GSA), Grey Wolf Optimizer, Group Search Optimizer, Harmony Search (HS), Honey-Bees Mating Optimization (HBMO) Algorithm, Hunting Search Intelligent Water Drops algorithm, or the IWD algorithm, Invasive Weed Optimization (IWO), Krill Herd, League Championship Algorithm (LCA), Lion Optimization Algorithm (LOA), MBO: Marriage in Honey Bees Optimization, Memetic Algorithm (MA), Mine blast algorithm, Optics Inspired Optimization (OIO), Parliamentary optimization algorithm (POA), Particle Swarm Optimization (PSO), Plant Propagation Algorithm, River Formation Dynamics, Roach Infestation Optimization (RIO), Seed Based Plant Propagation Algorithm, Self-propelled Particles, Shuffled Frog Leaping Algorithm (SFLA), Simulated annealing (SA), Social Cognitive Optimization (SCO), Social Spider Optimization (SSO), Spider Monkey Optimization (SMO) algorithm, Spiral Dynamic Algorithm (SDA), Strawberry Algorithm, Tabu Search, The Raven Roosting Optimization Algorithm, Vortex Search Algorithm, Water Cycle Algorithm ,Water Wave Optimization.

b) Bio-Inspired Challenges

The major challenges of Bio-Inspired Computing had been described in the following:

- Computational fluid dynamics
- Data clustering
- Feature selection
- Hand gesture detection
- Image processing
- Machine learning
- Best possible nonlinear response manage devise
- Path planning
- The science of the harnessing of light
- Training neural networks

Take care of various provoking issues to grandstand the use of such systems in a wide scope of fields are essential for victories [8].

Fig. 8: Swarm Intelligence Algorithms [52]

Computational knowledge (CI), a quick developing territory, is at present pulling in heaps of analysts' consideration in managing abundant mind-boggling issues. Meta-heuristics stimulated by nature can be as a rule separated into two gatherings: evolutionary algorithms (EA) and swarm insight. As a subgroup of meta-heuristics calculations, swarm insight methodologies mimic congregation of a wide assortment of life forms from nature; such are a herd of flying creatures, hives of honey bees, states of ants, gatherings of bats, crowds of elephants and so forth, by following quality standards. These common standards depend on meeting scholarly correspondence not on the individual, because that the proportion of the learned genius is seen through assembly unification, not as an individual substance. Swarm insight meta-heuristic calculations are populace based and iterative inquiry strategies that use positive criticism, negative input, numerous connections and change among people in the pursuit procedure [26].

III. Literature Review

Frameworks of the ideas like Computational Biology and Computational Psychology, see first look to be straightforward instances of interpretation of attribute capacities into the calculation and from this comes the hypothesis that in reality, we will probably change over the cerebrums work into a computation. In any case, one of the shrouded activities is the presumptions that everybody is making about how the handling ought to been finished. The examination enthusiasm for Nature-stimulated Computing has become impressively investigating various wonders saw in nature and fundamental standards of material science, science and science. The control has achieved an adult stage and the field had been well-establishing by the respective persons or methods. This Endeavor is another endeavor at examination concerning different computational plans stimulated from nature.

The creator Seyedali Mirjalili et al.,[2017] proposes two new enhancement computations called Salp Swarm Algorithm (SSA) and Multi-target Salp Swarm Algorithm (MSSA) for taking care of advancement issues with single and various destinations. The fundamental motivation of both algorithm is the teeming conduct of particles at what time exploring and scavenging in the seas. The above mentioned two calculations are tried on top of a few numerical advancement capacities to watch and affirm their viable practices in finding the ideal answers to enhancement issues. The outcomes on the scientific facilities demonstrate that the SSA calculation can improve the underlying arbitrary arrangements viably and join towards the ideal. The aftereffects of MSSA demonstrate that this calculation can be inexact Pareto ideal arrangements with elevated combination and inclusion. The paper likewise considers explaining a few tests and computationally costly building structure issues (for example, airfoil structure and naval propeller configuration) utilizing above mentioned algorithms. The consequences of the real contextual investigations exhibit the benefits of the calculations proposed in taking care of certifiable issues with troublesome and obscure hunt spaces [14].

Salp Swarm Algorithm (SSA) has been an as of late made bio-roused advancement calculation introduced in 2017, which depends on the swarming component of salps. The authors Hegazy, A.E., et al., put effort to get better the structure of essential SSA to improve arrangement precision, dependability and union speed. Another managable constraint, being without a job weight, is extra to change the nearby most excellent arrangement. The innovative strategy known As Improved Salp Swarm Algorithm (ISSA) has that ever been tried to the highlight determination task. The ISSA calculation is merging with the K-nearest neighbor more tasteful for highlight choice in which twenty-three UCI datasets are used to evaluate the exhibition of ISSA calculation. The ISSA is contrasted with the fundamental SSA and four other swarm techniques. The outcomes exhibited that the proposed method delivered prime result than the different analyzers as far as arrangement exactness and highlight decrease [15].

The analyst Seyedali Mirjalili proposes a novel nature-animated figuring called underground bug Lion Streamlining operator (ALO). The ALO figuring duplicates the pursuing instrument of subterranean insect lions in nature. Five basic steps of pursuing prey, for instance, the subjective walk around ants, building traps, entrapment of ants in catches, getting preys and re-building traps are executed. The proposed computation had been benchmarked in three phases. At first, a ton of 19 numerical limits are used to test different characteristics.

Likewise, three old-style building issues (three-bar section arrangement, cantilever shaft plan and contraption train design) had been comprehended by ALO. Finally, the conditions of two ship propellers are progressed by ALO as attempting to force real issues. In the underlying two test organizes, the ALO count had been differentiated and a collection of calculations recorded as a hard copy. The results of the examination ability uncover that the arranged estimations can give ready results similar to the upgraded examination, close-by optima avoidance, misuse and assembly. The ALO computation moreover finds predominant perfect structures for the greater part of the conventional planning issues used, showing that this estimation has supported in handling constrained issues with various chase spaces. A definitive shape got for the ship propellers demonstrate the congruity of the proposed count in dealing with undeniable worries with cloud chase spaces as well [16].

During the previous decade, tackling complex improvement issues with meta-heuristic calculations have got extensive consideration among experts and specialists. In future numerous meta-heuristic calculations have been created throughout the most recent years. A large number of these calculations are made livelier by the different conjecture of nature. In this paper, another populace based calculation, the Lion Enhancement Calculation (LOA), is presented. An unusual way of life of lions and their collaboration attributes had been the essential inspiration for improvement to this advancement calculation. Some benchmark issues had been chosen from the writing and the arrangement of the proposed result had been compare and those of some outstanding and freshest meta-heuristics for these issues. They got outcomes to affirm the superior of the proposed calculation in contrast with different answers utilized in this paper by the authors Maziar Yazdani et al.,[17].

A tale swarm insight, advancement, method was proposed call dragonfly calculation (DA). The fundamental motivation of the DA calculation begins from the static and dynamic swarming conduct of dragonflies in nature. Two basic periods of improvement, investigation and abuse, are structured by demonstrating the social communication of dragonflies in finding the way, entering for staple and avoid rivals when overflowing enthusiastically or measurably. The creator Seyedali Mirjalili accepts the proposal of double and multi-target portrayals of DA called Binary DA (BDA) and Multi-Objective DA (MODA), individually. The proposed calculations are benchmarked by in excess of a couple of exact test capacities and one genuine contextual analysis both subjectively and quantitatively. The aftereffects of DA and BDA demonstrate that the proposed calculations are can recuperate the early easygoing occupants for a given issue, gather towards the far reaching ideal and offer incredibly forceful results assessed to other surely understood calculations in the writing. The aftereffects of MODA likewise show that this calculation has an inclination to find amazingly exact estimations of Pareto ideal arrangements with profoundly uniform dispersion for multi-target issues. The arrangement of means picked up for the submarine propeller structure issue exhibits the benefits of MODA in taking care of troublesome genuine issues with unidentified genuine Pareto ideal front as fit [18].

The Whale Optimization Algorithm (WOA) had been an as of late created meta-heuristic enhancement reckoning which depends on the chasing system of humpback whales. So also to other meta-heuristic reckonings, the fundamental issue looked by WOA is moderate intermingling speed. So to upgrade the worldwide combination speed and to show signs of improvement execution, Gaganpreet Kaur et al., [19] brings disorder hypothesis into WOA streamlining process. Different tumultuous maps have been considered in the proposed chaotic WOA (CWOA) techniques for tuning the fundamental parameter of WOA which aids in controlling investigation and abuse. The proposed CWOA strategies are benchmarked on twenty surely understood test capacities. The outcomes demonstrate that the riotous maps (particularly Tent guide) can improve the exhibition of WOA.

The improvement work which is called the Grasshopper Improvement Calculation proposed by the creators Shahrzad Saremi et al.., The proposed calculation scientifically demonstrated and imitated the swarming conduct of grasshoppers in nature for tackling streamlining issues. A scientific model was proposed to mimic repugnance and at-footing powers between the grasshoppers. Repugnance powers enable grasshoppers to investigate the pursuit space, though fascination powers urged them to exploration shows potential districts. To adjust among investigation and abuse, GOA was outfitted by means of a collaborative that pliable diminishes the safe place often used for locusts. At last.., the best arrangement got so far by the swarm was considered as an objective to be pursued and improved by the grasshoppers. To benchmark the presentation of the proposed calculation, a progression of tests had been led. Initially, a lot of 2D test capacity was comprehended by the GOA to watch it appearance subjectively [20].

The specialist Seyedali Mirjalili proposes another meta-heuristic called Gray Wolf Analyzer (GWO) moved by dull wolves (Canis lupus). The GWO estimation imitates the activity chain of significance and pursuing part of diminish blackguards. Four sorts of dull wolves, for instance, alpha, beta, delta and omega are used for duplicating the activity pecking request. Besides, the three standard endeavors of pursuing, filtering for prey, encompassing prey and ambushing unfortunate casualties, are completed. The estimation is then benchmarked on 29 definitely comprehended test

limits and the results had been affirmed by a comparative report with Molecule Swarm Streamlining (PSO), Gravitational Search Algorithm (GSA), Differential Advancement (DE), Evolutionary Programming (EP) and Evolutionary Strategies (ES). The results show that the GWO count can give very engaged items appeared differently in relation to these prominent meta-heuristics. The paper in like manner considers dealing with three old-style building plan issues (strain/weight spring, welded bar and weight vessel structures) and presents a genuine use of the proposed system in the field of optical planning. The results of the old-style building plan issues and real application show that the proposed figuring is proper for testing issues with darken interest spaces [21].

The creator, Seyedali Mirjalili proposes a novel nature-pushed estimation called Multi-Verse Optimizer (MVO). The guideline inspirations of this estimation rely upon three thoughts in cosmology: white hole, dim hole and wormhole. The numerical models of these three thoughts have been made to play out the examination, misuse and close-by chase, exclusively. The MVO estimation had been first benchmarked on 19 testing test issues. It is then associated with five veritable structure issues to further demand its exhibition. To favor the results, MVO had been differentiated and four surely understood counts: Dark Wolf Streamlining specialist, Molecule Swarm Advancement, Hereditary Calculation and Gravitational Pursuit Calculation. The impacts show that the proposed count can offer very forceful ends and beats the best responses recorded as a hard copy on the greater part of the demonstrating grounds. The results of the unadulterated relevant examinations in like manner show the ability of MVO in dealing with genuine issues with darken interest spaces [22].

The Creators Adel Sabry Eesa et al. Proposed another meta-heuristic bio-inspired optimization calculation, called Cuttlefish Calculation (CFA) had been introduced. The computation impersonates the component of shading, changing conduct utilized by the cuttlefish to take care of numerical worldwide advancement issues. The examples and hues found in cuttlefish had been created by reflecting light from various layers of cells includes (chromatophores, leucophoresand iridophores) stacked together and it is the mix of specific cells without a moment's delay that enables cuttlefish to have such a vast cluster of examples and hues. The proposed calculation thinks about two principle forms: reflection and permeability. Reflection procedure had been proposed to simulate the light reflection component employed by these three layers, while the refraction is proposed to reenact the refraction of coordinating example make use of by the cuttlefish. These two procedures are utilized as a pursuit technique to locate the worldwide ideal arrangement. Proficiency of this computation had been likewise tried with some other well-knew science motivated advancement calculations, for example, Hereditary Calculations (GA), Molecule Swarm Enhancement (PSO) and honey Bees Algorithms (BA) that have ever been recently proposed in writing. Reproductions and acquired upshots demonstrate that the proposed CFA is better than different controls [23].

Zong Woo Geem, Joong Hoon Kimand G. V. Loganathan (2001) The Harmony Search (HS) strategy is a rising meta-heuristic improvement calculation, which had been utilized to adapt to various testing assignments during the previous decade. Right off the bat had been proposed by Geem et al. In 2001 [25], the Harmony Search (HS) technique is being motivated by the hidden standards of the artists' spontaneous creation of the harmony.

Elephant Herding Optimization (EHO) was presented another meta-heuristic algorithm by Suash Deb, Gai-Ge Wang and Coelho in 2015 [27, 28, 29]. EHO had been cheered up by the crowding conduct of elephant gathering for finding the ideal or close ideal capacity esteems. Motivated by the behavior of elephants in nature, Elephants is one sort of the best warm- blooded creatures ashore for worldwide advancement. Like most other meta-heuristic calculations, EHO does not utilize the precedent, people in the presently refreshing procedure. The two elephants are African and Asian elephants, which are commonly famous varieties. A lengthy shaft is the most run of the mill highlight that is multi-reason, for example, breathing, lifting water and getting a handle on the items. In condition, monsters are societal living things and they contain composite shared arrangement of females and calves. An giant gathering is made out of a few families below the initiative of a care for, as often as possible the most seasoned dairy animals. If the supportive records in the past people were totally abused and utilized in the afterward enhancement procedure, the nature of arrangements might be enhanced basically.

Respective researchers Lam and Li [31] proposed the Chemical Reaction Optimization (CRO) calculation motivated by substance responses in 2010 [32]. Nature-enlivened meta-heuristic calculations have ruled the logical writing in the zones of AI and emotional indexing worldwide over the most recent three decades. Synthetic response, streamlining (CRO) is a populace put together meta-heuristic calculation based concerning the standards of substance response. A compound response had been viewed as a procedure of changing the reactants (or atoms) through an arrangement of responses into items. This procedure of change is actualized in the CRO calculation to take care of enhancement issues. The concoction response illustration can likewise be abused for creating meta-heuristic sums by encoding fitting data into a particle-like components and playing out a lot of synthetic response like tasks onto them to get specific sort of

subsidiary data appropriate for advancing issues. Concoction response improvement (CRO) calculation is an ongoing inquiry and enhancement calculation motivated by science, which is similarly encouraging like science and material science roused calculations.

The scientist Oguz Findik proposes another transformative improvement calculation that relies upon hereditary administrators, for example, hybrid and change alluded to as the bull streamlining calculation (BOA) in 2015 [32]. This new streamlining calculation is known as the BOA because that's the best individual is exploited to deliver posterity people. The determination, calculation utilized in the hereditary calculation (GA) had been expelled from the proposed calculation. Rather than the determination, calculation, people at first delivered endeavor to accomplish better people. In the proposed technique, hybrid activity is continually carried out by consuming the best person. The change procedure had been completed by operating individual positions. People met with the good people by making use of hybrid task, which expects to get the person that is superior to anything the best individual in the transformation arranges. BOA had been motivated by the rearing of creatures in nature. It had been acknowledged that there had been in every case, just a single shelf in a swarm and posterity are created utilizing just the pioneer. Along these lines, this calculation had been alluded to as the BOA. The research had been done on the quality that the posterity has in this calculation, with the goal that the delivered posterity can adjust to nature better.

During the previous decade, taking care of complex enhancement issues with meta-heuristic calculations have been getting extensive consideration among specialists and analysts. Thus, numerous meta-heuristic calculations have been created in the course of the most current existence. A great numeral of these calculations have been propelled by different marvels of nature. Due to this remedy, the researcher Maziar et al. Introduced the Lion Optimization Algorithm (LOA) in the year of 2016 [33]. The unique way of life of lions and their collaboration qualities had been the fundamental inspiration for improvement of this advancement calculation. LOA is built dependent on the recreation of the single and agreeable exercise of lions, for example, prey catching, mating, regional stamping, safeguards and different practices. Ruler of the wildernesses are the most publicly one-sided of all regular catlike gatherings, which exhibit irregular amount of collective endeavor and threat [34]. Cougars are very persuading an immediate aftereffect of their strong sexual dimorphism in both social lead and appearance. The lion is a wild felidae with two sorts of social affiliation: occupants and vagrants. Inhabitants live in social events, called pride [35]. A pride of lions regularly consolidates around five females, their juveniles of the two sexual orientations and at any rate one than one adult person. Young folks are disallowed from first experience with the world pride when they become unequivocally full-developed [35].

Exciting by the stream fertilization procedure of well-designed plants, Flower Pollination Algorithm (FPA), had been created in 2012 by Yang (2012) [36]. Old style enhancement calculations are lacking in enormous scale combinatorial numbers and nonlinear numbers. Consequently, meta-heuristic streamlining adding up had been proposed. Broadly useful meta-heuristic strategies were assessed in nine unique gatherings: science-support, material science-foundation, social-pedestal, music-support, concoction-pedestal, sport-stand, arithmetic-foot, swarm-based and crossover techniques which are blends of these. Concentrates on vegetation as of late have demonstrated that plants display savvy practices. Appropriately, it had been imagined that plant life have ever been sensory system. In this exertion, the majority of the calculations and functions about plant life insight have been right off the bat gathered and looked. Data had been given about plant knowledge calculations, for example, Blossom Pollination Algorithm, all-encompassing wild plant Optimization, Paddy Field Algorithm, Source Mass Optimization Algorithm, Non-natural Plant Optimization Algorithm, Seedling rising up Algorithm, Snapshot Synthetic Algorithm, Shrub Growth Optimization, Origin Growth Algorithm, Strawberry Algorithm as Shrub broadcast Algorithm, Sprinter Origin Algorithm, Trail Planning Algorithm and Entrenched Hierarchy Optimization.

Nature-propelled figuring had been a hotly debated issue in reasonable and building fields as of late. Motivated by the superficial stream gesture hypothesis, the author Y.J. Zheng shows a novel meta-heuristic technique, given name Water Wave Optimization (WWO) 2015 [37], for inclusive innovation issues. The researcher and user can show how the magnificent marvels of irrigate influences, for example, proliferation, refraction and contravention, can be utilized to determine compelling instruments for looking into a elevated-dimensional arrangement area. All in all, the algorithmic system of WWO is necessary and simple to execute with a little size populace and just a couple of control parameters. WWO is tremendously focused with cutting edge developmental calculations, including, intrusive weed streamlining (IWO), Biogeography-Based Optimization (BBO), bat algorithm (BA), etc.., The new meta-heuristic is relied upon to have broad applications in accurate building improvement issues.

The researchers, Xin-She Yang and Suash Deb, proposed the Cuckoo Search Algorithm (2009) [38]. Cuckoo Search Algorithm depends on the brood parasitism of some cuckoo species (Brajevic et al., 2012). Also, CS calculation is improved by the purported Lévy flights, as opposed to by straightforward isotropic arbitrary strolls (Layeb and Boussalia, 2012; Valian et al., 2011a). The CS was inspired by the commit brood

parasitism of some cuckoo species by laying their spawns in the homes of host winged creatures. A few cuckoos have advanced so that female parasitic cuckoos can mirror the hues and examples of the spawns of a couple of picked have species (Valian et al., 2011b). This lessens the likelihood of the eggs had been deserted and, consequently, builds their re-efficiency. It merits referencing that few hosts winged creatures connect direct clash with meddling cuckoos (Yildiz, 2012; Tiwari, 2012). In this situation, if host winged creatures find the eggs are not their own, they will either discard them or basically desert their homes and construct new ones, somewhere else (Dhivya et al., 2011; Babukartik and Dhavachelvan, 2012). For straightforwardness in portraying the Cuckoo Search, consider the accompanying three admired principles: (1) Each cuckoo sets one egg at any given moment and dump its egg in arbitrarily picked home; (2) The best homes with the highest caliber of eggs will extend to the following ages; (3) The quantity of accessible host homes is fixed and the egg laid by a cuckoo is found by the host winged creature (Rani et al., in 2012;Noghrehabadi et al., in 2011). In addition, the respective authors Yang and Deb found that the irregular walk style search had been better performed by Lévy flights instead of crucial arbitrary walk.

Firefly algorithm had been delegated swarm wise, meta-heuristic and nature-enthused, it had been created by Yang in 2008 by energizing the trademark practices of fireflies [39]. The glimmering light of fireflies is an astonishing sight in the mid-year sky in the tropical and calm districts. There are around 2,000 firefly species and most fireflies produce short and cadenced blazes. The example of the blaze is frequently one of a kind of a specific animal variety. The blazing light had been created by a procedure of bio-luminescence,s and the authentic elements of such flagging frameworks are as yet discussing. Notwithstanding.., two principal rudiments of such flashes are to pull in mating accomplices (correspondence)and to draw in potential prey. The number of residents in fireflies gives you an idea about trademark illuminator blazing exercises to work as pulling in the accomplices, correspondence and hazard cautioning for predators. As moving from those exercises, Yang planned this strategy under the suspicions of all fireflies are unisexual with the end goal that all fireflies have pulled in the potential for one another and the appeal is straightforwardly proportionate to the brilliance level of people. Thus, the more splendid fireflies draw into the less more splendid ones to push toward to them, other than that on account of no fireflies more brilliant than a specific firefly then it moves arbitrarily.

The analyst Anthony Brabazon, Wei Cui, Michael O'Neill acquires a gander at the social perching and scavenging conduct of one type of winged animal, the basic raven and take motivation from this to plan a work of fiction advancement calculation which we call the raven perching enhancement calculation (2014) [40]. A critical stream of writing, which draws motivation from the rummaging exercises of different creatures to structure enhancement calculations, has risen over the previous decade. The accomplishment of these calculations over a wide assortment of utilization spaces has prodded enthusiasm for the examination of the rummaging practices of different life forms to create narrative and incredible, improvement calculations. A variety of creatures, including a few types of winged animals and bats, take part in social perching whereby enormous quantities of specifics assemble to perch, either medium-term or for extended periods. It had been guaranteed that these perches can fill in as data focus on spreading information concerning the area of nourishment assets in nature.

Raven perches comprise of adolescent, non-reproducing, inconsequential standard ravens. Ravens ordinarily touch base at roosts in the blink of an eye before dusk and regularly leave the rest on in profoundly synchronized gatherings at first light the following day. The complete primary investigation of data, move in raven perches was attempted by Marzluff et al. (1996) who analyzed perching practices of the basic raven (Corvus Corax) in the forested piles of Maine (USA). Ravens in this locale are pro feeders on the remains of gigantic warm-blooded animals in winter, once in a while searching the slaughters of enormous carnivores, for example, wolves (Stahler et al. 2002). These nourishment sources are transient as they corrupt or had been expended rapidly and the area of remains is erratic. Thus, the quest for nourishment assets is consistent.

Mohit et al. In 2018 [41] present a novel nature-inspired optimization paradigm, named as Squirrel Search Algorithm (SSA) for solving unimodal, multimodal and multi-dimensional optimization problems in an effective manner. This analyzer impersonates the dynamic searching conduct of southern flying squirrels and their production method for velocity known as skimming. Floating is a powerful system utilized by little well evolved creatures for voyaging long separations. The search procedure starts when flying squirrels begin scrounging. During warm climate (fall) the squirrels look for sustenance assets by skimming from one tree to the next. At the same time, they change their area and investigate various regions of woodland. As the climatic conditions are hot enough, they can meet their day by day vitality needs more rapidly on the eating regimen of oak seeds accessible in wealth and henceforth they devour oak seeds quickly after discovering them. In the wake of satisfying their day by day vitality prerequisite, they begin looking for an ideal sustenance hotspot for winter (hickory nuts). The capacity of hickory nuts will help them in keeping up their vitality prerequisites in very brutal and horrible

climate and diminish the expensive scrounging outings and along these line increments the likelihood of survival. During winter, lost leaf spread in deciduous backwoods results from an expanded danger of predation and henceforth they become less dynamic; however don't rest in winter. Toward the finish off the winter season, flying squirrels again turned out to be self-motivated. Here, it is considered as a redundant procedure and proceeds until the life expectancy of a flying squirrel and structures the establishment of SSA.

The creators Seyedali Mirjalili et al. Proposes another meta-heuristic called Gray Wolf Optimizer (GWO) enlivened by dark wolves (Canis lupus) 2014 [42]. The GWO calculation copies the initiative chain of importance and a chasing system of dark scalawags. Four sorts of dark wolves, for example, alpha, beta, delta and omega are utilized for recreating the authority chain of command. What's more, the three principle ventures of chasing, looking for, encompassing and assaulting prey are actualized for productivity. Dim wolf (Canis lupus) has a place with the Canidae family. Dark wolves are considered as peak predators, implying that they are at the highest point of the natural way of life. Dim wolves, for the most part, want to live in a pack. The gathering size is 5-12 by and large. In particular noteworthy is that they have a severe social overwhelming chain of importance. Notwithstanding.., the social chain of command of wolves, bunch chasing is another intriguing social conduct of dim wolves. As indicated by Muro et al. [43] the indispensable periods of a muted wolf chasing are as per the following: Attack towards the prey when

Tracking, pursuing and drawing nearer and Pursuing, encompassing and bothering the prey until it stops moving.

It is, in general, hard for people to take care of a genuine issue. Except for the fact that for many years, nature has its particular manners to investigate these issues and comprehend them. Henceforth, presently a day when artificial strategies don't work in these circumstances; they go to Nature for issue arrangement. Along these lines, the alleged Nature roused calculations/Heuristics are mounting quickly. For the most part, it is hard to locate the ideal understanding of the issue by utilizing Heuristic strategies. Then again, these techniques are great in approximating the agreement in legitimate time. One of such calculation had been known as StrawBerry Algorithm (SBA) proposed by F. Merrikh-Bayat (2014) [44, 45]. In this paper the creator proposes another numerical improvement calculation motivated by the strawberry plant for tackling confounded building issues. Plants like strawberry create the two sprinters and ancestry for spread and quest for water assets and minerals. In these plants, sprinters and roots can be thought of as apparatuses for worldwide and nearby hunts, separately. The proposed calculation has three fundamental contrasts with the insignificant nature-propelled improvement calculations: duplication-disposal of the computer specialists at all emphases, exposing all operators to both little and huge developments from the earliest starting point to the end and the absence of correspondence (data trade) between specialists.

The finding of the appropriate parameters of a developmental calculation, as the Bumble Bees Mating Optimization (BBMO) calculation had been proposed by F. Comellas and J. Martinez Navarro (2009) [46], is one of the most testing undertakings that a specialist needs to manage the required structure. One of the most regularly utilized approaches to take care of the issue is the experimentation technique. In the ongoing couple of years, a few versatile renditions of each developmental and nature-enlivened calculation had been introduced to maintain a strategic distance from the utilization of a predefined set of parameters for all occasions of the contemplated issue. In this the creators Marinakis et al. Proposed a versatile variant of the BBMO calculation had been proposed, where introductory irregular qualities are given to every single one of the parameters and, at that point, these parameters had been adjusted during the streamlining procedure. The proposed Adaptive BBMO calculation had been utilized for the arrangement of the Multicast Routing Problem (MRP). As we might want to demonstrate that the proposed calculation is appropriate for understanding various types of combinatorial improvement issues we test the calculation, additionally, in the Probabilistic Traveling Salesman Problem (PTSP) and the Hierarchical Permutation Flowshop Scheduling Problem (HPFSP). At long last, the calculation had been tried in four exemplary benchmark capacities for worldwide advancement issues (Rosenbrock, Sphere, Rastrigin and Griewank) to demonstrate the all inclusive statement of the methodology. A few benchmark examples for all tribulations are tried utilizing the proposed calculation to set up its adequacy.

As a novel element, Bat Algorithm (BA) depended on the echolocation highlights of micro-bats (Yang, 2010) [47]. BA utilizes a recurrence tuning strategy to build the assorted variety of the arrangements in the populace as well as copying the varieties of heartbeat discharge rates and commotion of bats when looking for prey, the programmed zooming was helpful to the adjustment investigation. Therefore, it demonstrates to be exceptionally productive with an average brisk begin. Clearly there is an opportunity to get better. The standard bat calculation and its numerous variations imply that the applications are additionally extremely various. Truth be told since the first bat calculation had been created (Yang, 2010), bat calculations have been connected in pretty much every region of enhancement, orders, picture handling, include determination, planning, information mining and

others. Inside the residue of the manuscript user will quickly feature a portion of the applications (Yang, 2010; Parpinelli and Lopes, 2011; Yang et al., 2012a; Yang, 2012; Yang, 2013; Gandomi et al., 2013)

Particle Swarm Optimization (PSO) is a meta-heuristic calculation regularly utilized in discrete, persistent and combinatorial enhancement issues. It had been initially created by Kennedy and Eberhart in 1995 [48]. It had been motivated by the flying example of a group of winged animals. With regards to PSO, a solitary understanding had been known as a particle and the accumulation of all preparations is known as a swarm. The primary thought in PSO is that every tiny part just knows about its present speed, its own best collections accomplished previously denoted as (pBest),and which molecule is the current worldwide best in the swarm denoted by (gBest). At each cycle, every molecule changes its speed such that its new position will be nearer to either in the previous or global tiny part in the meantime.

Counterfeit Bee Colony (ABC) estimation, first exhibited by Karaboga in 2005 [49, 50] is another piece of transformative computations (EAs) that is propelled by the total looking through direct of authentic honey bee regions. ABC computation is a meta-heuristic streamlining figuring subject to swarm learning and it had been prodded by the astute looking through lead of a bumble bee settlement. The phony bumble bees of the swarm were characterized into three social occasions: used bumble bees, onlooker bumble bees and scout bumble bees. Used bumble bees are responsible for searching for sustenance sources, while in the hive, onlooker bumble bees are keeping it together for the information shared by used bumble bees and after that choose a decision to pick which sustenance hotspots for further maltreatment. In case the used bumble bee can't find an unrivaled sustenance hotspot for a predefined number of starters, by then, the feeding source will be betrayed and the contrasting used bumble bee transforms into a scout bumble bee. Examination search is performed by scout bumble bees, while used bumble bees and observer bumble bees are responsible for the maltreatment of sustenance sources. Half of the territory was made out of used bumble bees and the rest includes onlooker bumble bees. As it were, the masses size of used bumble bees is equal to the quantity of sustenance sources and besides the equivalent to that of onlooker bumble bees.

Software engineering and science have shared a long history simultaneously. For a long time, PC researchers have structured calculations to process and break down organic information (for example, micro-arrays) and in like manner, researcher have found a few working rules that has propelled new streamlining strategies (for neural systems). As of late, these two bearings have been joining, dependent on the view that organic procedures are intrinsically calculations that nature has intended to take care of computational issues. The new innovations are made by the demand of needs. But, the efficient innovations are mady by the demand of issues. Thus the concerns are considered as the main constraint for problem solving. The specified problem gives the two types of solutions like optimal solutions and feasible solutions. The optimal solution is the appropriate or best solution as well as the feasible solution only gives the approximate or closely relevant answers. So the optimality of a given problem is only rely on the chosen of the appropriate algorithm within the given period of time. So the target is to achieving the satisfactoty results to the end users will never fails to facing the basic requirements such as quality, time and budget [51].

IV. Problems and Directions

Over the most recent three decades, various Nature-enlivened Optimizations Algorithms have been considered and connected to the ID of different individual issue. Nature–roused progression techniques expect a basic occupation in the field of picture handling. It diminishes the bustle and clouding of pictures and moreover improves the image redesign, picture revamping, picture division, picture edge distinguishing pieces of proof, picture age, picture mix, picture plan affirmation, picture thresholding, and so on. A couple of progress methodologies have been proposed so far for various uses of picture dealing with. Restorative picture dealing with accept a significant activity in our regular daily existence, as every substance is liable to it in a part of various perspectives. The dependence is extremely basic and goes about as wandering stone to furthermore impelled applications and legitimate endeavors. To achieve better and capable results, the method itself is done in different stages.

- To improve study and execution in the medical images, actualize picture preparing procedures by thinking about more tissue locales.
- For locating the tissue in medical images further study needs to concentrate and apply various methods such as Segmentation, Classification and also Feature Extraction is playing a vital role in image processing.

Table 2: Identification of Diseases by the proposed NIOA's algorithms [53]

Year	Algorithm	Authors Name	Diseases Diagnosed
1991	Wasp Swarm Optimization	P Pinto, TA Runkler, JM Sousa	Tumor, Heart chaos
1992	Ant Colony Optimization	A. Colorni, M. Dorigo, V.	Diabetes, Tumor
1997	Bee System	Tomoya, S., Hagiwara, M.	Thyroid, Tumor
2003	Honey Bee Algorithm Foraging	Curkovic, P., Jerbic, B.	Diabetes, Tumor, Heart Chaos
2005	Bees Algorithm	Pham,D.T., Ghanbarzadeh, A	Thyroid, Tumor, Heart Chaos
2005	Artificial Bee Colony Algorithm	Karaboga, D.	Diabetes, Tumor, Heart Chaos
2005	Bee Colony Optimization	Teodorovi´c, D.,Dell'Orco, M	Thyroid, Tumor, Heart Chaos
2005	Virtual Bee Algorithm	Yang, X	Heart Chaos
2005	Glow-Worm Swarm Optimization	Krishnanand, K.N., Ghose, D.	Hypertension, diabetes, cerebrovascular disease
2005	Termite Algorithm	Roth, M., Wicker, S.	Gallbladder diseases, dengue, Heart Chaos
2006	Honey Bees Mating Optimization	Afshar, A., Haddad, O.B., Mariño, M.A., Adams, B.J	Heart Chaos, Tumor, multiple sclerosis, cerebrovascular disease
2007	Honey Bee Foraging	Baig, A., Rashid, M.	No relevant work had been found
2007	Fast Marriage In Honey Bees Optimization	Yang, C., Chen, J., Tu, X.	Heart Chaos
2008	Firefly Algorithm	Xin-She Yang	Diabetes, Tumor, Heart Chaos
2008	Bee Collecting Pollen Algorithm	Lu, X., Zhou, Y.	Dengue
2008	Roach Infestation Optimization	Havens, T.C., Alexander, G.L., Abbott, C., Keller, J.M	Motor neuron disease, liver disorder, Heart Chaos
2009	Bumble Bees Mating Optimization	F. Comellas and J. Martinez Navarro	Heart Chaos, hepatitis
2009	Bees Swarm Optimization	Akbari, R., Mohammadi, A, Ziarati, K	Heart Chaoss, Tumor, Parkinson's disease
2012	Fruit Fly Optimization Algorithm	Pan, W.T.	Thyroid, diabetes, Parkinson's disease
2013	Bees Life Algorithm	Bitam, S., Mellouk, A.	Heart Chaos
2015	Dragonfly Algorithm	S. Mirjalili	Tumor, Alzheimer's, retinal and gallbladder disease
2015	Moth-Flame Optimization	Seyedali Mirjali	Heart Chaos, Alzheimer's, Parkinson's disease
2015	Ant Lion Optimizer	S. Mirjalili	Tumor, depression, autism, epilepsy, Alzheimer's, Heart Chaos
2017	Grasshopper Optimization Algorithm	Saremi, S., Mirjalili, S., Lewis, A	Heart Chaos, Tumor, epilepsy
2018	Chaotic Bacterial Foraging Optimization	Zhennao cai et al	Parkinson's disease
2019	Case Based Reasoning	Jean-Baptiste Lany et al	Breast Tumor

The above TABLE 2 is an endeavor to give the rundown of ideas that are the reason for some nature-inspired algorithms. Contemplating the length of the disregarded zone, it was unreasonable to give detail taking a shot at these counts. As needs be, we have focused on showing the inside wellspring of inspiration so to speak. The glossary may paralyze young investigators and goad them to research their condition, find their wellspring of inspiration and use it to become new and continuously capable meta-heuristics.

Table 3: Timeline for Proposed Bio-Inspired Algorithms [9].

Year	Name of the Nature-Inspired Algorithms
1965	EP: Evolutionary Programming and ES: Evolutionary Strategy
1975	GA: Genetic Algorithm
1989	GP: Genetic Programming and SDS: Stochastic Diffusion Search
1994	PGA: Parallel Genetic Programming ACO: Ant Colony Optimization
1998	PSO:Particle Swarm Optimization and DE:Differential Evolution
2001	EDA: Estimation of Distribution Algorithm, NSGA-II:Non-dominated sorting GA II ,HS: Harmony Search and BFO: Bacterial Foraging Optimization
2003	CMA-ES: Covariance Matrix Adaptation, Evolution Strategy: Electromagnetism-like Optimization, SCA: Society and Civilization Optimization
2005	ICA: Imperialist Competitive Algorithm, ABC: Artificial Bee Colony, IPOP-CMA-ES: Covariance Matrix Adaptation Evolution Strategy with Increasing Population, GSO: Glowworm Swarm Optimization, BEA: Bees Algorithm HSM: Hierarchical-Social Meta-heuristic
2006	CLPSO: Comprehensive Learning PSO, MSA: Monkey Search Algorithm and MOEA/D: Multi-Objective Evolutionary Algorithm based on Decomposition, BBBC: Big-Bang Big-Crunch Algorithm, SFLA: Shuffled Frog Leaping Algorithm and BBO: Biogeography Based Optimization
2008	RFD: River Formation Dynamics IWD: Intelligent Water Drops
2010	SMPSO: Speed-constrained Multi-objective PSO, FA: Firefly Algorithm, BA: Bat Algorithm, GSA: Gravitational Search Algorithm, CS: Cuckoo Search
2012	BSO: Brain Storming Optimization, WSA: Weighted Swarm Algorithm, LCA: League Championship Algorithm ASO: Anarchic Society Optimization
2014	CRO: Coral Reefs Optimization CFA: Cuttle Fish Algorithm, GWA: Grey Wolf Algorithm, RO: Ray Optimization, FPA: Flower Pollination Algorithm, WCA: Water Cycle Algorithm and SHADE: Success-History based Parameter Adaptation for Differential Evolution
2016	BO: Brainstorming Optimization, AAA: Artificial Algae Algorithm, PPA: Prey-Predator Algorithm ASI: Artificial Swarm Intelligence, MBO: Monarch Butterfly Optimization
2018	MRA: Mushroom Reproduction Algorithm, ROA: Rainfall Optimization Algorithm, SSA: Squirrel Search Algorithm KWA: Killer Whale Algorithm, DA: Duelist Algorithm, HCA: Hydrological Cycle Algorithm
2019	Water Cycle Algorithm (WCA) and Symbiotic Organisms Search (SOS)

TABLE 3 shows a variety of nature-inspired optimization algorithms and the timeline were mentioned in clearly. The specified details were very helpful to the researchers to apply those algorithms to their fruitful research areas. From the above table and various studies, papers, help to list out some of the nature-inspired algorithms for computations are enlisted below [10].

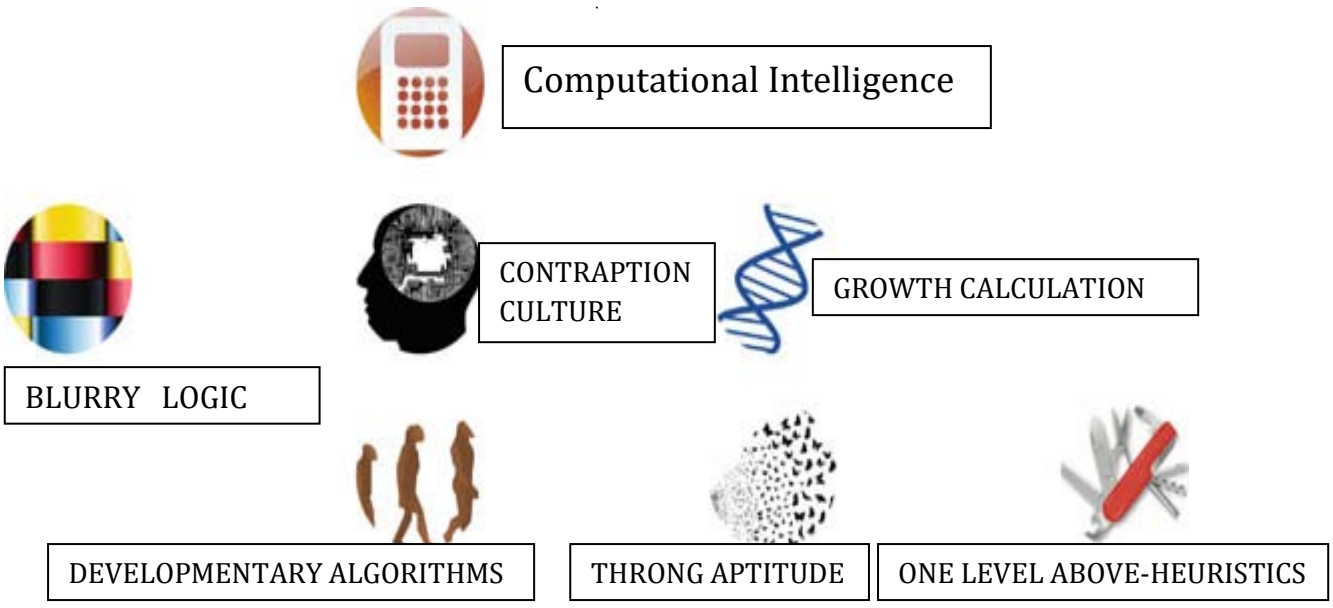

Fig. 9: Sub-fields of Nature-inspired Computing

From the above Fig 9 The Nature-Motivated Computing calculations have turned out to be definitive and chic for explaining tribulations in Computational Intelligence (CI), Evolutionary Computation (EC), Machine Learning (ML), Swarm Intelligence (SI) Data Mining (DM), Optimization, Transportation, Vehicle Routing and many others.

V. Conclusion & Future Work

In the field of image processing which was considered as one of the primary analyses in bio-inspired computing referenced in this paper, there are a few issues where a proficient inquiry of the preparations must be performed inside an intricate pursuit area to locate an ideal agreement. Multi-thresholding, which is a significant image segmentation system, is one of them. The multi-thresholding issue is really an exponential combinatorial advancement process which customarily is detailed dependent on complex target work rules which can figure out utilizing just nondeterministic techniques. Under such conditions, there is likewise no one of a kind estimation which quantitatively decides the nature of a given fragmented picture. In this manner, specialists are settling those issues by utilizing Nature-Inspired Optimization Algorithms (NIOAs) as possible systems for the multi-thresholding issues.

Therefore, future examination may be available a cutting-edge survey on all most significant NIOAs utilized in multi-thresholding based picture division area. The key issues which had been included during the detailing of NIOAs based picture multi-thresholding models were likewise examined, there were required and furthermore had been settled by the analysts. Another fascinating point is that not the majority of the algorithms take care of a similar sort of issues similarly well. According to the nature of the problem, the appropriate algorithm had been chosen in a specific time within the well-defined criteria could be recognized forever. The suitable algorithm only yields the good results and also gives the satisfactory results. The makers in future research are anxious to show express utility criteria of nature-roused computations and to contemplate likeness' among the diverse proposed plans.

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Machine Learning Approach to Forecast Average Weather Temperature of Bangladesh

By Ashfaq Ali Shafin
Stamford University Bangladesh

Abstract- Weather prediction is gaining popularity very rapidly in the current era of Artificial Intelligence and Technologies. It is essential to predict the temperature of the weather for some time. In this research paper, we tried to find out the pattern of the average temperature of Bangladesh per year as well as the average temperature per season. We used different machine learning algorithms to predict the future temperature of the Bangladesh region. In the experiment, we used machine learning algorithms, such as Linear Regression, Polynomial Regression, Isotonic Regression, and Support Vector Regressor. Isotonic Regression algorithm predicts the training dataset most accurately, but Polynomial Regressor and Support Vector Regressor predicts the future average temperature most accurately.

Keywords: *machine learning, linear regression, isotonic regression, support vector regressor, polynomial regression, temperature prediction.*

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Strictly as per the compliance and regulations of:

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Ashfaq Ali Shafin

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I. Introduction

Prediction for the future using the correct algorithm is viral nowadays. This prediction is applicable for the weather prediction as well. We can use machine learning to know whether it will rain tomorrow or what will be the temperature tomorrow. Machine learning algorithms can correctly forecast weather features like humidity, temperature, outlook, and airflow speed and direction. This sector is immensely dependent on previous data and artificial intelligence. Predicting future weather also helps us to make decisions in agriculture, sports and many aspects of our lives.

We aimed to predict the average temperature of Bangladesh in this research paper. As a subtropical country, Bangladesh has very different weather from other countries due to periodic disparities of rainfall, sophisticated temperatures, and humidity. Mainly three distinct seasons are present in Bangladesh, and those are Summer, Rainy, and Winter [1]. The summer season consists from March to June, while Rainy season lasts June to October and the Winter is from October to March. Even though Bangladesh is known as the six-seasoned country, mainly three seasons can be observed in this current time.

The dataset used in this paper contains the average temperature from the year 1901 to 2018 on a once-a-month basis. We calculated the sum of the values of temperature of the twelve months and then divided by 12 to get the average temperature of that particular year. Then we used different machine learning algorithms to extrapolate our findings and the generalize the output result.

After the modeling, also known as training or fitting in machine learning, we have forecasted the average temperature for Bangladesh in upcoming days using the machine learning prediction. Future weather forecast can use the predicted result.

II. Literature Review

Mizanur et al. used a model, produced for predicting mean temperature that adjusted with ground-based watched information in Bangladesh during the time of 1979-2006. For the comprehension of the model execution, they have utilized the Climate Research Unit (CRU) information. Better implementation of MRI-AGCM got through approval procedure expanded trust in using it later temperature projection for Bangladesh[2].

An assessment of air temperature and precipitation conduct is significant for momentary arranging and the forecast of future atmospheric conditions. Patterns in precipitation and temperature at yearly, regular and month to month time scales for the times of 1981-2008 have been dissected utilizing BMD information and MPI-ESM-LR (CMIP5) model information. Likewise, the outcomes thus structure a decent premise of future examinations on temperature changeability. Thinking about all seasons (winter, pre-storm, rainstorm and post-storm), most extreme temperature has expanded altogether in all seasons except winter which is immaterial over the entire investigation zone for BMD information however for MPI-ESM-LR (CMIP5) model information highest temperature is on increment in the area. Heat over the whole area expanded by 0.29˚celcius and 5.3˚celcisus every century individually for BMD information and MPI-ESM-LR (CMIP5) model information [3].

Holmstrom et al. recommended a method to determine the highest and lowest temperature of the subsequent seven days, given the data of the past couple days [7]. They employed a linear regression model and a variation of a functional linear regression model. Expert weather forecasting services for the prediction outperformed the two models. As a classification problem, Radhika et al. used support vector machines for climate forecast [8]. Krasnopolsky

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and Rabinivitz offer a crossbreed model that employed neural networks to model weather forecasting [9]. A predictive model based on data mining was presented in [10] to establish fluctuating weather patterns

III. Methodology

a) Dataset

We collected the dataset from the website www.kaggle.com/yakinrubaiat/bangladesh-weather-dataset. This dataset contains the monthly average value of Bangladesh temperature and rain from 1901 to 2015. Then we manually, added the data from the year 2016 to 2018 from the Bangladesh Meteorological Department which is the official weather forecasting department of Bangladesh government.

b) Pre-processing

For yearly average temperature, we have added all the monthly average temperature of a particular year and then divided it by 12 to get the annual average temperature. A mathematical equation presented for the average temperature of a year in equation (1).

$$The\ average\ temperature\ of\ year\ x = \left(\sum_{i=January}^{December} average\ temperature\ of\ the\ month\ i\ in\ year\ x\right)/12 \quad (1)$$

For seasonal average temperature, the following table (1) is used to calculate the average temperature. We have added the average temperature for those months respectively and then divided it by 4 for the seasonal average temperature.

Table 1: Months in the Season

Season	Months
Summer	March, April, May, June,
Rainy	July, August, September, October
Winter	November, December, January, February

c) Data Visualization and Statistics

First, we plot the corresponding average temperature against the years from 1901 to 2018 from the dataset. We can observe from figure 1, the lowest average temperature was 24.2055 in the year of 1905, and the highest temperature was 26.5927 in the year of 2018.

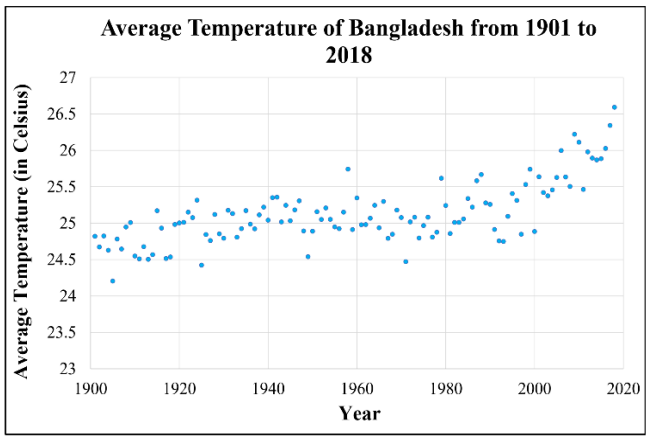

Figure 1: Average Yearly Temperature of Bangladesh from the year 1901 to 2018

Figure (2), (3), and (4) represent the seasonal average temperature of Bangladesh from 1901 to 2018 of summer, rainy, and winter seasons respectively. The lowest average temperature was 26.93° celsius for summer, 26.10° celsius for the rainy season, and 19.05° Celsius for winter.

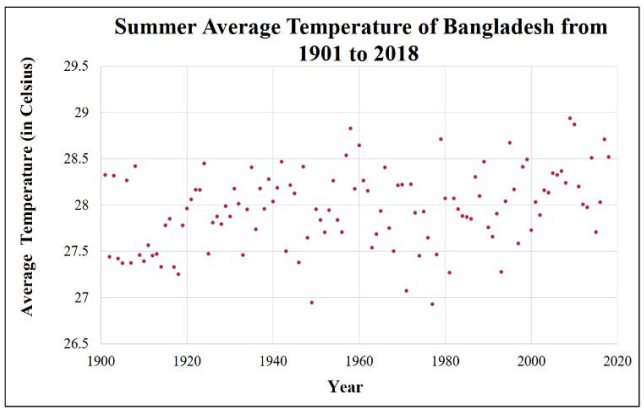

Figure 2: Summer Season Average Temperature of Bangladesh from the year 1901 to 2018

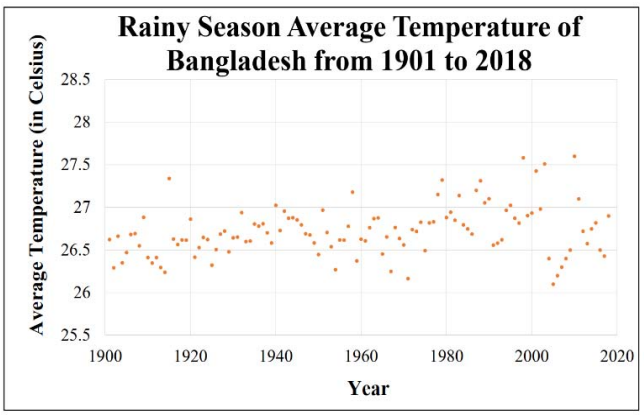

Figure 3: Rainy Season Average Temperature of Bangladesh from the year 1901 to 2018

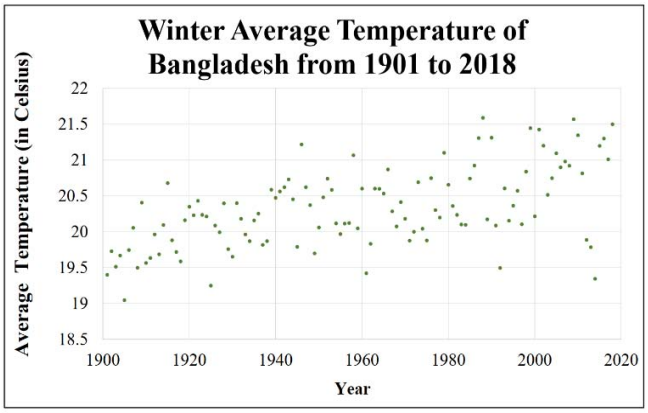

Figure 4: Winter Season Average Temperature of Bangladesh from the year 1901 to 2018

Table (2) describes the overview of the yearly and seasonal average temperature data statistics is. Standard Deviation of the annual average temperature is 0.42 while the standard deviation for the summer, rainy, and winter is 0.41, 0.29, and 0.56 respectively.

d) Estimator Selection

In this paper, we have used several machine learning algorithms described in table (3) to train our data and to predict future average temperature.

Table 3: Estimators Used in the Experiment and Their Parameter

Estimator	Parameter
Linear Regression	Default
Isotonic Regression	Default
Polynomial Regression	Degree = 2 and 3
Non-linear Support Vector Regressor (SVR)	Degree = 3

Linear regression is a direct technique of demonstrating the connection between a scalar reaction, also known as the dependent variable and one or more explanatory variables or independent factors. The instance of one logical variable is called univariate linear regression. For more than one explanatory variable, the procedure is called multiple linear regression [4]. This term is unmistakable from multivariate direct relapse, where numerous associated ward factors are anticipated, as opposed to a single scalar variable. [5]

For one variable feature x, year in our case and target value y, the average output temperature the linear regression equation is:

$$y = w_0 + w_1 x + e \quad (2)$$

Here, $w_0$and $w_1$are the weight vectors, and e is the error term.

Isotonic regression is the method of fitting a freestyle line to a succession of perceptions under the accompanying requirements: the provided freestyle line needs to be non-decreasing all over, and it needs to lie as near the opinion as would be prudent.

The isotonic regression optimization is expressed by:

$$minimize \sum_i w_i (y_i - ypred_i)^2 \quad (3)$$

Here y_i is actual output, $ypred_i$ is a prediction, and $w_i$are strictly positive weights (default to 1.0).

Table 2: Dataset Statistical Overview

Attributes	Year	Yearly Average Temperature (in Celsius)	Summer Season Average Temperature (in Celsius)	Rainy Season Average Temperature (in Celsius)	Winter Season Average Temperature (in Celsius)
Count	118	118	118	118	118
Mean	1959.5	25.13	27.96	26.72	20.33
SD*	34.2077	0.42	0.41	0.29	0.56
Minimum	1901	24.21	26.93	26.10	19.05
25%	1930.25	24.86	27.69	26.55	19.96
50%	1959.5	25.06	27.96	26.69	20.24
75%	1988.75	25.31	28.24	26.87	20.67
100%	2018	26.59	28.94	27.60	21.59

SD* indicates Standard Deviation.

Polynomial regression is a structure of regression analysis in which the connection between the independent variable x and the dependent variable y displayed as n-th degree polynomial in x. Polynomial relapse fits a nonlinear relationship between the worth of x and the corresponding conditional mean of y. In this paper, we have used polynomial regression of 2nd-degree, and 3rd-degree equations represented as follows:

$$y = w_0 + w_1 x + w_2 x^2 + e \quad (4)$$

$$y = w_0 + w_1 x + w_2 x^2 + w_3 x^3 + e \quad (5)$$

Here, w_0, w_1, w_2, w_3 are weight vectors, x is the independent input variable of year, y is the output variable average temperature, and e is the error term.

For Support Vector Regressor (SVR), the model delivered by help vector arrangement depends just on a subset of the preparation information because the cost capacity for structure the model does not think about preparing focuses that lie past the edge. Comparably, the model created by SVR depends just on a subset of the preparation information, because the cost capacity for structure the model overlooks any preparation information near the model forecast. The equation for non-linear SVR represented as:

$$y = \sum_{i=0}^{n} w_i x_i + b \qquad (6)$$

Here, w is the weight vector, x is the input vector of years, y is being outputted vector of average temperature and b is the bias term, and n is the degree of the equation. In our case, we have used n=3 for the experiment.

IV. Result Analysis

Figure (5), (6), and (7) represents the yearly average temperature for the regressors mentioned above. Linear Regression and Isotonic Regression are fitted in figure (5), while graph (6) and (7) adapted for Polynomial Regression and Support Vector Regressor.

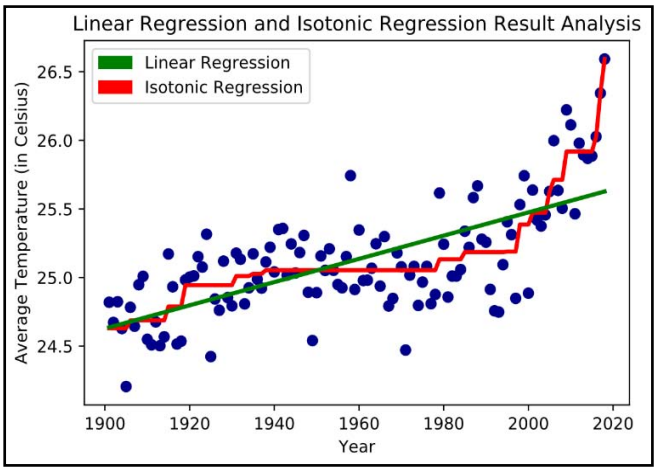

Figure 5: Result Analysis of Linear Regression and Isotonic Regression on Training Data of Yearly Average Temperature of Bangladesh from the year 1901 to 2018

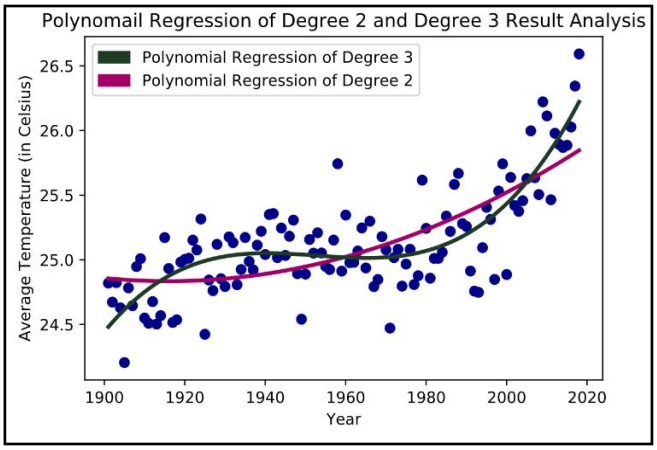

Figure 6: Result Analysis of Polynomial Regression of Degree 2nd and 3rd on Training Data of Yearly Average Temperature of Bangladesh from the year 1901 to 2018

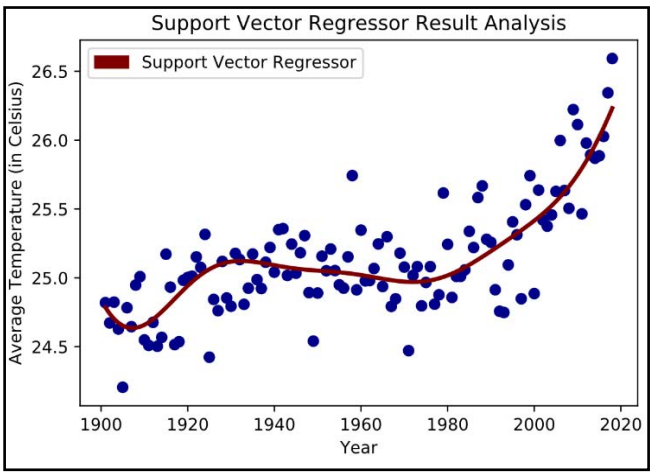

Figure 7: Result Analysis of Support Vector Regressor of Degree 3rd on Training Data of Yearly Average Temperature of Bangladesh from the year 1901 to 2018

From figure (5), (6), and (7) we can observe that,

a. Isotonic Regression works best for the yearly average temperature training dataset.
b. Both Polynomial Regression of 3rd degree and SVR of 3rd degree tries to fit the training data as accurately as possible.
c. Linear Regression works most poorly among all the estimators.

Figure (8), (9), and (10) represent the yearly summer season average temperature for the estimators. We used graph 8 for Linear and Isotonic Regression. Figure (9) and figure (10) embody the Polynomial Regression and SVR for the yearly summer season average temperature.

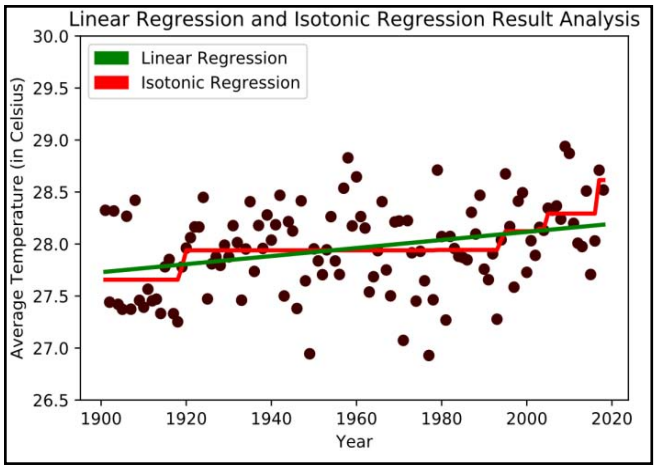

Figure 8: Result Analysis of Linear Regression and Isotonic Regression on Training Data of Summer Season Average Temperature of Bangladesh from the year 1901 to 2018

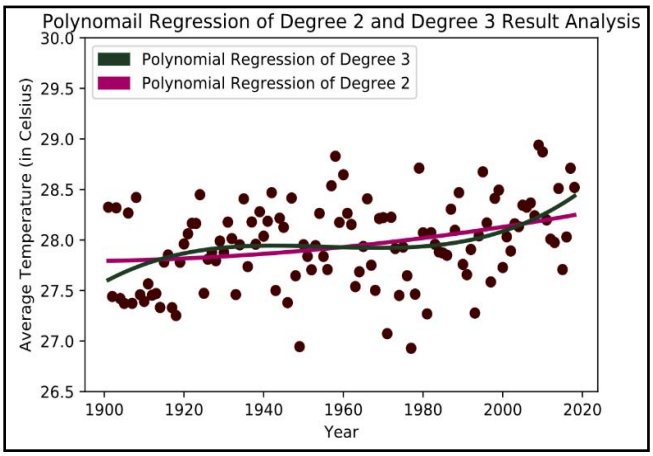

Figure 9: Result Analysis of Polynomial Regression of Degree 2nd and 3rd on Training Data of Summer Season Average Temperature of Bangladesh from the year 1901 to 2018

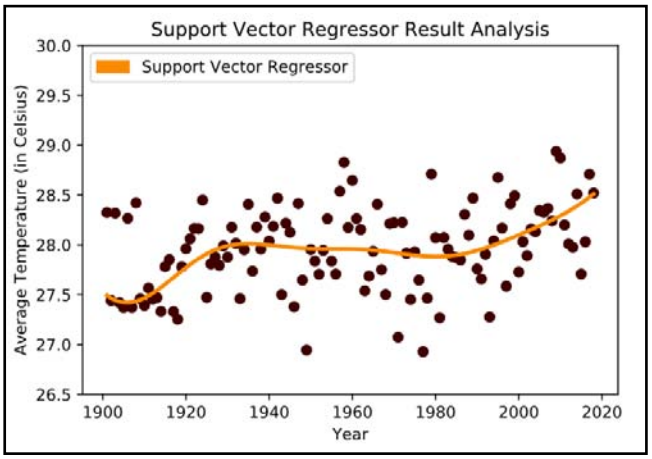

Figure 10: Result Analysis of Support Vector Regressor of Degree 3rd on Training Data of Summer Season Average Temperature of Bangladesh from the year 1901 to 2018

From figure (8), (9), and (10) we can observe that,

a. Isotonic Regression works best for summer season yearly average temperature training dataset.
b. Both Polynomial Regression of 3rd degree and Polynomial Regression of 2nd degree tries to fit the training data as accurately as possible.
c. Linear Regression works most poorly among all the estimators.

Figure 11, 12 and 13 represent the yearly rainy season average temperature for the estimators. We used graph 11 for Linear and Isotonic Regression. Diagram 12 and 13 personify the Polynomial Regression and SVR for the yearly summer season average temperature, respectively.

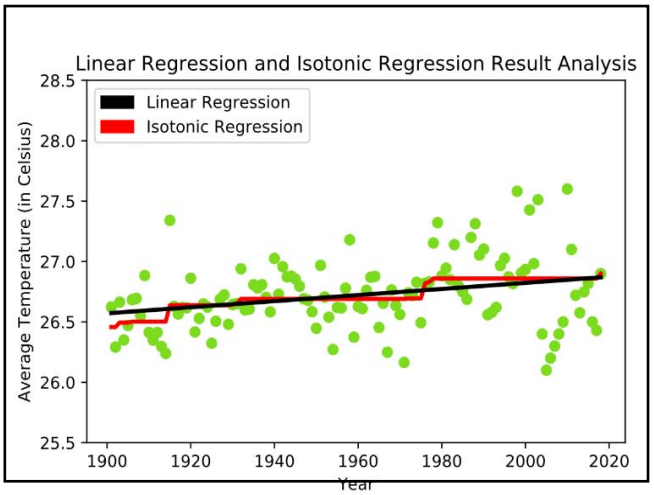

Figure 11: Result Analysis of Linear Regression and Isotonic Regression on Training Data of Rainy Season Average Temperature of Bangladesh from the year 1901 to 2018

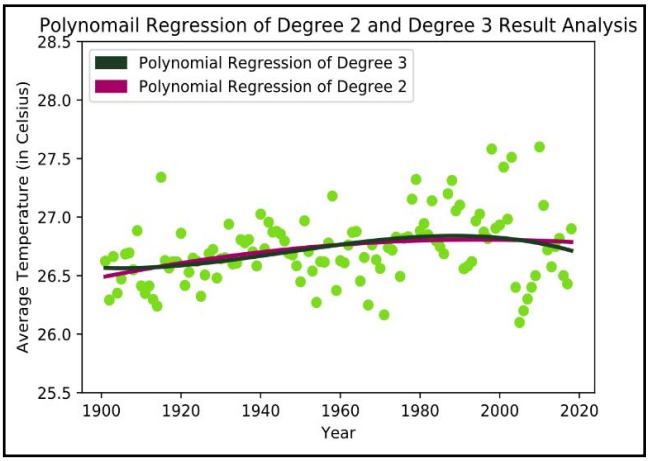

Figure 12: Result Analysis of Polynomial Regression of Degree 2nd and 3rd on Training Data of Rainy Season Average Temperature of Bangladesh from the year 1901 to 2018

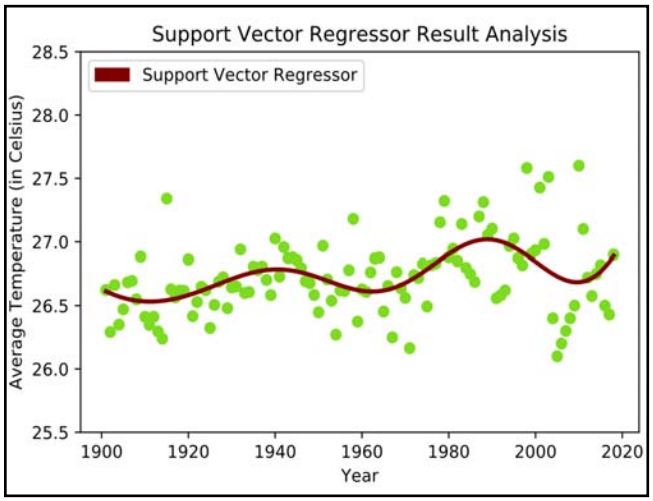

Figure 13: Result Analysis of Support Vector Regressor of Degree 3rd on Training Data of Rainy Season Average Temperature of Bangladesh from the year 1901 to 2018

From figure (11), (12), (13) we can observe that,

a. For the rainy season dataset, Isotonic Regression fits the dataset accurately than other estimators.
b. Both Polynomial Regression of 3rd degree and Polynomial Regression of 2nd degree fits quite similarly with a minimal margin line
c. SVR of 3rd degree performs better than Polynomial and Linear Regressor.

We used the figures (14), (15), and (16) to plot different estimators result for the winter season average temperature dataset. In diagram 14, we applied Linear and Isotonic Regression for the winter season. Figure (15) and figure (16) characterize the Polynomial Regression and SVR for the yearly summer season average temperature, respectively.

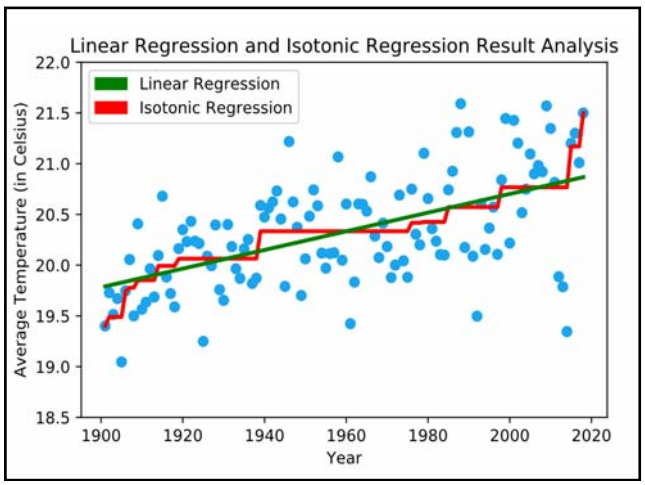

Figure 14: Result Analysis of Linear Regression and Isotonic Regression on Training Data of Winter Season Average Temperature of Bangladesh from the year 1901 to 2018

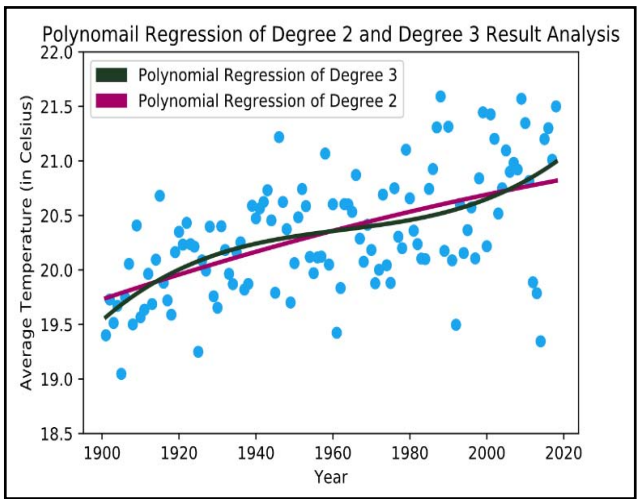

Figure 15: Result Analysis of Polynomial Regression of Degree 2nd and 3rd on Training Data of Winter Season Average Temperature of Bangladesh from the year 1901 to 2018

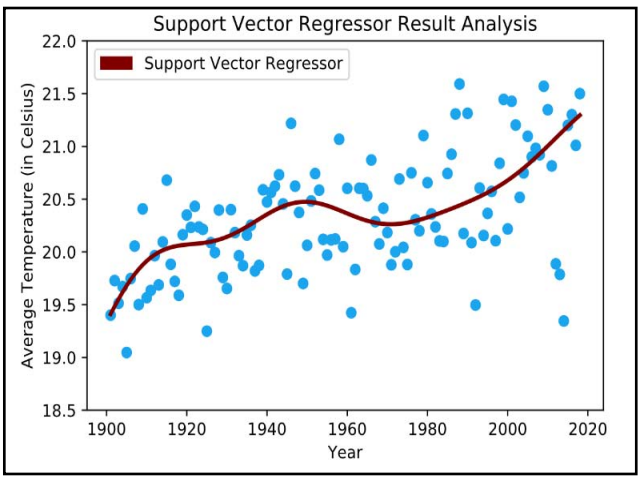

Figure 16: Result Analysis of Support Vector Regressor of Degree 3rd on Training Data of Winter Season Average Temperature of Bangladesh from the year 1901 to 2018

After observing figure (14), (15), and (16), we conclude that,

a. Aimed at the winter season dataset, Isotonic Regression fits the dataset accurately than other estimators.
b. Both Polynomial Regression of 3rd degree and Polynomial Regression of 2nd degree fits quite similarly with a minimal margin line
c. SVR of 3rd degree performs better than Polynomial and Linear Regressor.

For result analysis, we have used four estimators to predict the estimator's outcome. These are Mean Squared Error (MSE), Mean Absolute Error (MAE), Median Absolute Error (MedAE) and R2_Score.

Mean squared error (MSE) of an estimator measures the normal of the squares of the blunders-that is, the standard squared distinction between the assessed qualities and the genuine worth. MSE is a

hazard work, relating to the conventional estimation of the squared mistake misfortune. The way that MSE is quite often carefully positive (and not zero) is a direct result of haphazardness or because the estimator does not represent data that could create a progressively precise estimate [6]. If a vector of n likelihoods created from a sample of n data points on all variables, and Y is the vector of experimental values of the variable being forecast, then the within-sample MSE of the predictor is computed as:

$$MSE = \frac{1}{n}\sum_{k=1}^{n}(Y_k - \bar{Y_k})^2 \quad (7)$$

Mean Absolute Error (MAE) is a proportion of the contrast between two consistent factors. Accept X and Y are factors of combined perceptions that express a similar of n focuses, where the i number point have organized (x_i, y_i). Mean Absolute Error (MAE) is the normal vertical separation between each position and the character line. MAE is likewise the normal flat separation between each point and the personality line. If a vector of n likelihoods created from a sample of n data points on all variables, and Y is the vector of experimental values of the variable forecast, then the within-sample MSE of the marvel. Instances of Y versus X incorporate correlations of anticipated versus watched, ensuing time versus starting time, and one method of estimation versus an elective strategy of evaluation. Consider a dissipate plot predictor computed as:

$$MAE = \frac{1}{n}\sum_{k=1}^{n}|Y_k - \bar{Y_k}|^2 \quad (8)$$

The Median Absolute Error (MedAE) is especially fascinating because it is secure to exceptions. The misfortune determined by taking the middle of every apparent distinction between the objective and the forecast. If $\bar{Y_k}$ is the predicted value of the k-th sample and Y_k is the corresponding actual value, then the Median Absolute Error estimated over n samples defined as:

$$MadAE = median(|Y_1 - \bar{Y_1}|, \ldots\ldots, |Y_n - \bar{Y_n}|) \quad (9)$$

R2_Score represents the extent of fluctuation that has been clarified by the autonomous factors in the model. It gives a sign of decency of fit and subsequently a proportion of how well inconspicuous examples are probably going to be anticipated by the model, though the extent of clarified change. R2_Score will be in the range of 0.0 to 1.0. A higher value of R2_Score means better performance of the estimator. If a vector of n likelihoods created from a sample of n data points on all variables, and Y is the vector of experimental values of the variable being forecast, then the R2_Score of the predictor is computed as:

$$R2_{Score} = 1 - \frac{\sum_{k=1}^{n}(Y_k - \bar{Y_k})^2}{\sum_{k=1}^{n}(Y_k - \hat{Y})^2} \quad (10)$$

$$where\ \hat{Y} = \frac{1}{n}\sum_{k=1}^{n} Y_k$$

Table 4: Yearly Performance Metric on Training Dataset

	Mean Squared Error	Mean Absolute Error	Median Absolute Error	R2_score
Linear	0.093863	0.242148	0.205785	0.539885
Isotonic	**0.050341**	**0.172628**	**0.139777**	**0.835687**
Polynomial 2	0.083724	0.230284	0.19991	0.617148
Polynomial 3	0.061494	0.197245	0.159327	0.722697
SVR	0.061455	0.189903	0.140335	0.712918

Table 5: Summer Season Yearly Performance Metric on Training Dataset

	Mean Squared Error	Mean Absolute Error	Median Absolute Error	R2_score
Linear	0.155614	0.318922	0.297744	0.3500776
Isotonic	**0.107546**	**0.228602**	**0.236929**	**0.695183**
Polynomial 2	0.154835	0.29976	0.272486	0.555278
Polynomial 3	0.14919	0.27711	0.257635	0.657899
SVR	0.151835	0.27976	0.262486	0.645278

Table 6: Rainy Season Yearly Performance Metric on Training Dataset

	Mean Squared Error	Mean Absolute Error	Median Absolute Error	R2_score
Linear	0.077955	0.206872	0.146128	0.3800776
Isotonic	**0.030075**	**0.134821**	**0.11163**	**0.715183**
Polynomial 2	0.066564	0.174726	0.139304	0.535278
Polynomial 3	0.0557	0.153632	0.124492	0.687899
SVR	0.056564	0.151726	0.121304	0.695278

Table 7: Winter Season Yearly Performance Metric on Training Dataset

	Mean Squared Error	Mean Absolute Error	Median Absolute Error	R2_score
Linear	0.206298	0.370612	0.305485	0.472405
Isotonic	**0.114431**	**0.265708**	**0.266803**	**0.697074**
Polynomial 2	0.155757	0.307127	0.31012	0.594085
Polynomial 3	0.140985	0.305768	0.277769	0.609855
SVR	0.145712	0.307321	0.31021	0.614085

Table (4), (5), (6), and (7) represent the estimation of the estimators. We can observe that for training data, Isotonic Regression outperforms all the other estimators. As MSE, MAE, and MedAE are the lower and R2_Score of higher value means better performance for the estimator. We can notice that the boldfaced benefits of Isotonic Regressor perform better than other estimators. R2_Score for the yearly average temperature dataset is 0.835687, which is the highest value among all the datasets and estimators.

Polynomial Regressor of degree 3 and Support Vector Regressor of 3rd degree performs quite similar. All the estimator's values are the same as the other. Both Regressors perform better than Linear Regression and second-degree Polynomial Regression.

After training the dataset, we experimented with predicting the future yearly average temperature and seasonal average temperature. Table (8), (9), (10), and (11) denote the future average temperature for Bangladesh from 2019 to 2040. Extrapolated from the tables that, Isotonic Regression prediction is a constant value. As Isotonic Regressor cannot predict future projection for the average temperature, we should not rely on this estimator. The forecast for SVR or Polynomial of degree 3, can be considered as the future average temperature values.

Table 8: Prediction of Yearly Average Temperature of Bangladesh

Year	Linear (in Celsius)	Isotonic (in Celsius)	Polynomial 2 (in Celsius)	Polynomial 3 (in Celsius)	SVR (in Celsius)
2019	25.63586051	26.59269167	25.86681503	26.28186616	26.30747778
2020	25.64432853	26.59269167	25.88692782	26.34383308	26.38603639
2021	25.65279655	26.59269167	25.90723469	26.40773801	26.46720899
2022	25.66126457	26.59269167	25.92773563	26.47360977	26.5506604
2023	25.66973259	26.59269167	25.94843066	26.54147719	26.63601319
2024	25.67820061	26.59269167	25.96931976	26.61136908	26.72285181
2025	25.68666863	26.59269167	25.99040295	26.68331428	26.81072735
2026	25.69513666	26.59269167	26.01168021	26.75734161	26.89916294
2027	25.70360468	26.59269167	26.03315155	26.83347989	26.98765943
2028	25.7120727	26.59269167	26.05481697	26.91175796	27.07570159
2029	25.72054072	26.59269167	26.07667647	26.99220463	27.1627644
2030	25.72900874	26.59269167	26.09873006	27.07484874	27.24831957
2031	25.73747676	26.59269167	26.12097772	27.1597191	27.33184196
2032	25.74594478	26.59269167	26.14341946	27.24684454	27.41281603
2033	25.7544128	26.59269167	26.16605527	27.33625389	27.49074201
2034	25.76288082	26.59269167	26.18888517	27.42797597	27.56514179
2035	25.77134884	26.59269167	26.21190915	27.52203961	27.63556448
2036	25.77981686	26.59269167	26.23512721	27.61847363	27.70159143
2037	25.78828488	26.59269167	26.25853935	27.71730686	27.76284079
2038	25.7967529	26.59269167	26.28214556	27.81856812	27.81897148
2039	25.80522092	26.59269167	26.30594586	27.92228624	27.86968648
2040	25.81368895	26.59269167	26.32994023	28.02849005	27.91473551

Table 9: Prediction of Summer Season Yearly Average Temperature of Bangladesh

Year	Linear (in Celsius)	Isotonic (in Celsius)	Polynomial 2 (in Celsius)	Polynomial 3 (in Celsius)	SVR (in Celsius)
2019	28.19047834	28.615	28.25449732	28.46365767	28.54480252
2020	28.19435532	28.615	28.26160216	28.49185427	28.58082584
2021	28.19823231	28.615	28.26876079	28.5209835	28.61857476
2022	28.20210929	28.615	28.27597322	28.55105987	28.65801114
2023	28.20598628	28.615	28.28323944	28.58209792	28.69906761
2024	28.20986327	28.615	28.29055947	28.61411216	28.74164722
2025	28.21374025	28.615	28.29793329	28.64711713	28.78562362
2026	28.21761724	28.615	28.30536091	28.68112735	28.83084182
2027	28.22149422	28.615	28.31284232	28.71615735	28.87711958
2028	28.22537121	28.615	28.32037754	28.75222166	28.92424923
2029	28.2292482	28.615	28.32796655	28.78933479	28.97200001
2030	28.23312518	28.615	28.33560936	28.82751127	29.02012093
2031	28.23700217	28.615	28.34330596	28.86676564	29.06834385
2032	28.24087915	28.615	28.35105637	28.90711242	29.11638708
2033	28.24475614	28.615	28.35886057	28.94856613	29.16395902
2034	28.24863313	28.615	28.36671857	28.9911413	29.21076218
2035	28.25251011	28.615	28.37463036	29.03485245	29.2564971
2036	28.2563871	28.615	28.38259596	29.07971412	29.30086648
2037	28.26026408	28.615	28.39061535	29.12574082	29.34357913
2038	28.26414107	28.615	28.39868854	29.17294709	29.38435384
2039	28.26801806	28.615	28.40681552	29.22134744	29.42292307
2040	28.27189504	28.615	28.41499631	29.27095641	29.45903642

Table 10: Prediction of Rainy Season Yearly Average Temperature of Bangladesh

Year	Linear (in Celsius)	Isotonic (in Celsius)	Polynomial 2 (in Celsius)	Polynomial 3 (in Celsius)	SVR (in Celsius)
2019	26.87127359	26.7	26.78574892	26.70392021	26.94289087
2020	26.87379679	26.7	26.78395995	26.69387951	27.00131911
2021	26.87631998	26.7	26.7820991	26.68342312	27.06501447
2022	26.87884318	26.7	26.78016639	26.67254536	27.13357378
2023	26.88136637	26.7	26.77816181	26.66124053	27.2065319
2024	26.88388956	26.7	26.77608535	26.64950297	27.28336802
2025	26.88641276	26.7	26.77393703	26.63732698	27.3635128
2026	26.88893595	26.7	26.77171684	26.62470689	27.44635609
2027	26.89145914	26.7	26.76942478	26.611637	27.53125518
2028	26.89398234	26.7	26.76706085	26.59811164	27.61754344
2029	26.89650553	26.7	26.76462505	26.58412513	27.70453908
2030	26.89902873	26.7	26.76211738	26.56967177	27.79155413
2031	26.90155192	26.7	26.75953784	26.55474589	27.87790315
2032	26.90407511	26.7	26.75688643	26.53934181	27.96291184
2033	26.90659831	26.7	26.75416316	26.52345384	28.04592527
2034	26.9091215	26.7	26.75136801	26.5070763	28.12631559
2035	26.9116447	26.7	26.74850099	26.4902035	28.20348922
2036	26.91416789	26.7	26.74556211	26.47282977	28.27689327
2037	26.91669108	26.7	26.74255135	26.45494942	28.34602125
2038	26.91921428	26.7	26.73946873	26.43655676	28.41041796
2039	26.92173747	26.7	26.73631423	26.41764611	28.46968347
2040	26.92426067	26.7	26.73308787	26.3982118	28.52347623

Table 11: Prediction of Winter Season Yearly Average Temperature of Bangladesh

Year	Linear (in Celsius)	Isotonic (in Celsius)	Polynomial 2 (in Celsius)	Polynomial 3 (in Celsius)	SVR (in Celsius)
2019	20.87662024	21.5	20.82475133	21.01764141	21.32800987
2020	20.88581813	21.5	20.83133397	21.04367519	21.3590079
2021	20.89501601	21.5	20.83787303	21.07047585	21.38827545
2022	20.9042139	21.5	20.84436851	21.09805678	21.41564907
2023	20.91341179	21.5	20.85082039	21.12643138	21.44098258
2024	20.92260968	21.5	20.85722869	21.15561304	21.46414814
2025	20.93180756	21.5	20.8635934	21.18561516	21.48503681
2026	20.94100545	21.5	20.86991452	21.21645115	21.50355891
2027	20.95020334	21.5	20.87619206	21.24813438	21.51964396
2028	20.95940122	21.5	20.88242601	21.28067827	21.53324034
2029	20.96859911	21.5	20.88861637	21.3140962	21.54431471
2030	20.977797	21.5	20.89476314	21.34840157	21.5528512
2031	20.98699488	21.5	20.90086633	21.38360779	21.55885037
2032	20.99619277	21.5	20.90692593	21.41972823	21.56232812
2033	21.00539066	21.5	20.91294194	21.45677631	21.56331439
2034	21.01458854	21.5	20.91891437	21.49476541	21.56185188
2035	21.02378643	21.5	20.9248432	21.53370893	21.55799468
2036	21.03298432	21.5	20.93072846	21.57362028	21.55180695
2037	21.0421822	21.5	20.93657012	21.61451283	21.54336161
2038	21.05138009	21.5	20.94236819	21.6564	21.53273911
2039	21.06057798	21.5	20.94812268	21.69929518	21.52002623
2040	21.06977586	21.5	20.95383358	21.74321176	21.50531499

V. Conclusion and Future Work

We can conclude our paper by extrapolating that, even though Isotonic Regression has performed better on the training dataset, for testing data, it performs very poorly. So, we cannot recommend this estimator for the prediction of upcoming annual or seasonal temperature for Bangladesh. We recommend using Polynomial Regression or SVR of higher degrees to predict the temperature for upcoming years.

Average temperature let alone will not be very useful for the weather forecast. That is why in the future, we want to forecast weather attributes like outlook prediction, rain prediction, and rainfall amount for the imminent future. Maximum temperature and minimum temperature prediction will also be sufficient for weather estimation.

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FELLOW OF ASSOCIATION OF RESEARCH SOCIETY IN COMPUTING (FARSC)

Global Journals Incorporate (USA) is accredited by Open Association of Research Society (OARS), U.S.A and in turn, awards "FARSC" title to individuals. The 'FARSC' title is accorded to a selected professional after the approval of the Editor-in-Chief/Editorial Board Members/Dean.

- The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

FARSC accrediting is an honor. It authenticates your research activities. After recognition as FARSC, you can add 'FARSC' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, and Visiting Card etc.

The following benefits can be availed by you only for next three years from the date of certification:

FARSC designated members are entitled to avail a 40% discount while publishing their research papers (of a single author) with Global Journals Incorporation (USA), if the same is accepted by Editorial Board/Peer Reviewers. If you are a main author or co-author in case of multiple authors, you will be entitled to avail discount of 10%.

Once FARSC title is accorded, the Fellow is authorized to organize a symposium/seminar/conference on behalf of Global Journal Incorporation (USA).The Fellow can also participate in conference/seminar/symposium 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.

You may join as member of the Editorial Board of Global Journals Incorporation (USA) after successful completion of three years as Fellow and as Peer Reviewer. In addition, it is also desirable that you should organize seminar/symposium/conference at least once.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The FARSS can go through standards of OARS. You can also play vital role if you have any suggestions so that proper amendment can take place to improve the same for the benefit of entire research community.

As FARSS, you will be given a renowned, secure and free professional email address with 100 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.

The FARSS will be eligible for a free application of standardization of their researches. Standardization of research will be subject to acceptability within stipulated norms as the next step after publishing in a journal. We shall depute a team of specialized research professionals who will render their services for elevating your researches to next higher level, which is worldwide open standardization.

The FARSS member can apply for grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.
Once you are designated as FARSS, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria. After certification of all your credentials by OARS, they will be published on your Fellow Profile link on website https://associationofresearch.org which will be helpful to upgrade the dignity.

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The FARSS is eligible to earn from sales proceeds of his/her researches/reference/review Books or literature, while publishing with Global Journals. The FARSS can decide whether he/she would like to publish his/her research in a closed manner. In this case, whenever readers purchase that individual research paper for reading, maximum 60% of its profit earned as royalty by Global Journals, will be credited to his/her bank account. The entire entitled amount will be credited to his/her bank account exceeding limit of minimum fixed balance. There is no minimum time limit for collection. The FARSS member can decide its price and we can help in making the right decision.

The FARSS member is eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get remuneration of 15% of author fees, taken from the author of a respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account.

MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN SCIENCE (MARSS)

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The “MARSS” is a dignified ornament which is accorded to a person’s name viz. Dr. John E. Hall, Ph.D., MARSS or William Walldroff, M.S., MARSS.

MARSS accrediting is an honor. It authenticates your research activities. After becoming MARSS, you can add 'MARSS' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, Visiting Card and Name Plate etc.

The following benefitscan be availed by you only for next three years from the date of certification.

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As MARSS, you will be given a renowned, secure and free professional email address with 30 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The MARSC member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.

Once you are designated as MARSC, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria.

It is mandatory to read all terms and conditions carefully.

Auxiliary Memberships

Institutional Fellow of Open Association of Research Society (USA)-OARS (USA)

Global Journals Incorporation (USA) is accredited by Open Association of Research Society, U.S.A (OARS) and in turn, affiliates research institutions as "Institutional Fellow of Open Association of Research Society" (IFOARS).

The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

The IFOARS institution is entitled to form a Board comprised of one Chairperson and three to five board members preferably from different streams. The Board will be recognized as "Institutional Board of Open Association of Research Society"-(IBOARS).

The Institute will be entitled to following benefits:

The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA) The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.

The author fees of such paper may be waived off up to 40%.

The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

The Board can also play vital role by exploring and giving valuable suggestions regarding the Standards of "Open Association of Research Society, U.S.A (OARS)" so that proper amendment can take place for the benefit of entire research community. We shall provide details of particular standard only on receipt of request from the Board.

The board members can also join us as Individual Fellow with 40% discount on total fees applicable to Individual Fellow. They will be entitled to avail all the benefits as declared. Please visit Individual Fellow-sub menu of GlobalJournals.org to have more relevant details.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:

Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.

Open Association of Research Society (US)/ Global Journals Incorporation (USA), as described in Corporate Statements, are educational, research publishing and professional membership organizations. Achieving our individual Fellow or Associate status is based mainly on meeting stated educational research requirements.

Disbursement of 40% Royalty earned through Global Journals : Researcher = 50%, Peer Reviewer = 37.50%, Institution = 12.50% E.g. Out of 40%, the 20% benefit should be passed on to researcher, 15 % benefit towards remuneration should be given to a reviewer and remaining 5% is to be retained by the institution.

We shall provide print version of 12 issues of any three journals [as per your requirement] out of our 38 journals worth $ 2376 USD.

Other:

The individual Fellow and Associate designations accredited by Open Association of Research Society (US) credentials signify guarantees following achievements:

- The professional accredited with Fellow honor, is entitled to various benefits viz. name, fame, honor, regular flow of income, secured bright future, social status etc.

- In addition to above, if one is single author, then entitled to 40% discount on publishing research paper and can get 10%discount if one is co-author or main author among group of authors.
- The Fellow can organize symposium/seminar/conference on behalf of Global Journals Incorporation (USA) and he/she can also attend the same organized by other institutes on behalf of Global Journals.
- The Fellow can become member of Editorial Board Member after completing 3yrs.
- The Fellow can earn 60% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.
- Fellow can also join as paid peer reviewer and earn 15% remuneration of author charges and can also get an opportunity to join as member of the Editorial Board of Global Journals Incorporation (USA)
- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

Note :

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- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

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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

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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.

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- Writings
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- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
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- 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.

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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.

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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).

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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.

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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.

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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.

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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:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- 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:

- Explain the value (significance) of the study.
- 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.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- 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:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- 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:

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

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part 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.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

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Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

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