Hybrid Bacterial Foraging Optimization – Tabu Search for Medical Image Classification

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Abstract: Delicate registering is presented in the preparing of restorative picture as is has a viable way to deal with the treatment of vulnerabilities that are inborn in the procured picture information. It has space that is high-dimensional which can debase the picture characterization execution principally as far as its exactness for structure an order display as it contains certain excess and unimportant highlights. Accordingly, include choice has been utilized for the decrease of the element number that is separated from pictures by methods for evacuating any excess or insignificant highlights. The meta-heuristics have been creating for a significant drawn-out period of time and are accepting an imperative employment in the fields of the administrators and money related issues. Among all the present computations, TABU chase (TS) has been appearing couple of productive applications to issues of this present reality that is demonstrate by innumerable all the world over. Picture enlistment or picture course of action is a fundamental development in remedial picture examination when various pictures are incorporated. In by far most of such applications, the selection is performed following the power based strategy, which changes IR into a complex, computationally expensive, steady progression issue.

Index Terms: Soft computing, feature selection, Tabu search (TS), hybrid Bacterial Foraging Optimization (BFO) Algorithm and medical image classification.

I. INTRODUCTION

The restorative pictures [9] structure an imperative piece of the wellbeing of a patient and are likewise connected with the control, the preparing and the treatment of the information by the PCs. This is the premise whereupon PC helped radiology is created. The Medical Image Classification assumes a basic job in diagnostics and the showing purposes in the field of medication. For such reasons, there are several other imaging modalities that are used. There are additionally numerous different orders made for the medicinal pictures by utilizing the dim scale and the shading restorative pictures.

There are a couple of information pictures orchestrated according to a ton of these conscious features. These highlights have been removed from a retinal picture database that is from an underlying component space that is likewise high-dimensional. These highlights may not really add to a high figure of legitimacy and they may likewise cut down the exactness of arrangement at the time there are just a predetermined number of purposes of preparing. Further, the immaterial highlights that are available have been by implication expanding the unpredictability of calculation and furthermore the time taken for the preparation of classifiers. In this manner, expelling every single inconsequential component is basic to ensure that there is a high exactness of arrangement in a brief timeframe period. Such tasks are additionally performed for the procedure of highlight choice. The primary target of this is twofold: (a) the improving of the exactness of characterization and (b) the decrease of the time taken for the preparation of classifiers. The essential criteria of these calculations are the decision of ideal subsets of unique highlights that contain data that is fundamental for the errand of order.

The solid, just as fast finding of these ailments, is required for dealing with issues identified with wellbeing in a proficient way amid the beginning times. The perfect way in which this can be cultivated is to build up an imaging framework that can assess this issue and further recommend healing activity for reasons for treatment. The principle target of the investigation of the medicinal picture is to help restorative specialists in certain particular applications that need visual appraisal of these therapeutic pictures for developing objectivity and the repeatability of this examination. A medicinal picture investigation additionally incorporates different stages that need restorative pictures from a few focuses giving therapeutic information, extraction of important highlights, decrease of highlight measurement and therapeutic picture characterization that depends on a few ideal highlights [1].

Highlight determination has been characterized into four unique classes which are the wrapper, the channel, the implanted and the mixture. A wrapper approach makes utilization of a managed learning calculation or an arrangement for the assessment of the component subsets and their importance. This is costly regarding calculation as it embraces a managed learning calculation with poor sweeping statement since it gives a higher exactness of characterization for a particular figuring of collection used amid the time burned through segment decision.

Revised Manuscript Received on July 09, 2019
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The implanted strategy makes utilization of one piece of this regulated learning calculation to pick the highlights and furthermore remain computationally costly as it makes utilization of an administered learning calculation. Be that as it may, it might be less expensive as far as calculation contrasted with a wrapper approach. This channel strategy makes utilization of a factual measure to pick critical highlights independent of the sort of arrangement calculation. Along these lines, the channel approach is less expensive regarding calculation and furthermore offers a higher all-inclusive statement. At long last, the half and half methodology is the one that joins both the wrapper and the channel based methodologies [2].

Meta-heuristics have been characterized as the method of stochastic improvement utilizing a savage power or an irregular hunt to distinguish ideal answers for issues that are under thought. The fundamental point of these MHs' learning or improvement calculations was to understand another exchange off among escalation and broadening in which the investigation (or enhancement) demonstrates the formation of different answers for finding a pursuit space internationally and the abuse (or strengthening) involves guiding inquiry to a neighbourhood area where there are some great arrangements set up. The improvement calculations additionally have certain normal attributes like (I) being both hearty and dependable, (ii) an inferred parallelism, (iii) simple to execute, (iv) being surmised and furthermore non-deterministic, (v) investigating the productivity of the pursuit space and (vi) a worldwide capacity to seek. The MHs procedures might be gathered into Memetic calculations, strategies dependent on populace and the Trajectory techniques [6]. The memetic calculations are those neighborhood or worldwide ways to deal with pursuit that are half breed in which a technique for nearby improvement had been incorporated into a method dependent on populace. An essential idea to this is the imitating of a social collaboration or a learning impact of people by methods for a neighborhood procedure of upgrade that is joined to the courses of action that are set up by means of look heads all around. Thusly, the estimations may include distinctive virtual and potential hybridizations of the techniques that success. The methodologies that depend on the populace can deal with the answer for every cycle in the system.

As of late, there are a few meta-heuristic calculations that are bio-propelled having a functioning influence in discovering answers for complex issues in advancement. Certain amazing calculations that are bio-blended are the Genetic Algorithm, the Bacterial Foraging Optimization, the Particle Swarm Optimization, the Bee Colony, the Ant Colony, etc. From among them, the Bacterial Foraging Optimization (BFO) that began in the year 2002 has been getting an epic extent of thought in the space of insightful research. A few papers have been distributed and have been detailing a deficiency of this unique BFO in certain circumstances where a great deal of time is required for rendering an answer that is tip top. This implies the BFO requires countless iterative circles for finding worldwide arrangements. Oversimplified TS can likewise now and again experience nearby devices. In these cases, the calculations may move around some neighborhood arrangements without seeing any improvement or else hits the breaking points of emphasis.

The paper has other than proposed using the Tabu Search (TS) close to the Bacterial Foraging Optimization (BFO) figuring in a way that was fulfilling. Owing to the overwhelming thought of the explorative property of BFO estimation, modified TS nearby a certain BFO can begin to check for a basic plan that is top of the line. These calculations proposed will in general move towards their answers in a fast way. The writing identified with this work is clarified in Section 2. The subtleties of all procedures utilized for the work are talked about in Section 3. Area 4 talks about the outcomes and furthermore its investigation and the end is made in Section 5.

II. RELATED WORKS

Sarasiri et al [13] had proposed another new meta-heuristic calculation for the issue of recognizable proof of a nonlinear and grating modular. These calculations proposed are framed from a bacterial scavenging advancement or BFO calculation alongside the TABU Search or the TS. The paper likewise reports a relative inquiry investigation of the BFO, the GA and the TS alongside the proposed meta-heuristics. The exhibitions of the hunt are altogether evaluated by making utilization of the issues in surface improvement. The calculations proposed have demonstrated predominance and these present reality issues of a Stribeck grinding model parameters are additionally exhibited. The test setup is explained with their outcomes.

Panikhom et al [11] had exhibited certain concise depictions of the BFO, the TABU Search and all the half and half calculations,

for example, the bacterial scrounging TABU inquiry enhancement (BTSO) calculations. These half breed BTSO calculations can perform fast ventures and furthermore render a brilliant arrangement dependent on the activity of a versatile TABU hunt (ATS).

A BTSO calculation is additionally connected to the investigation of the strength of both the straight and the nonlinear frameworks that depend on the strategies for Lyapunov. The results of this examination are appeared differently in relation to the Threshold Accepting (TA) procedure. This article further covers all audits of the strategies for Lyapunov and the TA. Daoudi and Djemal [4] had displayed another Artificial Immune System (AIS) calculation that was utilized for the order and the analysis of bosom malignant growth. The essential commitment of this is to pick the memory cells as per their being a piece of the legitimacy interim which depended on the closeness of

the preparation cells. The made memory cells have a conduct to save the assorted variety of all the first classes of malignant growth learning. These exercises concede the age of a memory cell set having an overall representativeness of this database enabling portrayal and moreover the affirmation of chest danger. There have been some consoling outcomes that are hopped on the Wisconsin Diagnosis Breast Cancer Database (WDBC) and the (DDSM) Digital Database for the Screening Mammography.

III. METHODOLOGY

a. The area here gives subtleties on the BFO, the Tabu Search, the half and half BFO-TS, and classifiers like the RIPPER, the AIS, the FURIA and the OneR.

b. Bacterial Foraging Optimization (BFO) Algorithm

The BFO is figured dependent on the microscopic organisms' natural searching conduct. This calculation proposed goes for driving bacterial searching utilizing a most extreme supplement fixation through chemotaxis, proliferation, swarming and end dispersal [3]. This denotes the bacterial tracks to be wanted edges. It starts with the number of inhabitants in N being irregular with immunized spores $K = \{k_1, k_2, ..., k_N\}$. A spore determines km to be the contextual investigation that portrays the administrators of bacterial searching.

Dispersal: Based on the concentration map of nutrients, in case the location of a spore k_m km, which is denoted by l_m , is in a noxious position, which is as per equation (1):

$$J(l_m) < T \qquad (1)$$

- In which the edge T will decide whether an area is supplement rich or toxic and the spore k_m will scatter independent of its outside condition. At the season of dispersal, the km floats in a pixel by pixel way along a course that is arbitrarily introduced until such time it touches base at a position d_m that is supplement rich. When it floats from the space of the picture it is moved to an irregular position.

- **Reproduction**: In case the k_m locates either at or is able to reach a position that is nutrient-rich, it may stop dispersing and begin reproduction. It may also reactivate and then develop into a bacterium that is fully functional and is called b_m for showing its difference. After this the b_m further splits into two different bacteria the b_{m1} and b_{m2} in a similar location $l_{m1} = l_{m2} = l_m$ and the opposite and initial

directions $d_{m1} = -d_{m2}$, that satisfy the $d_{m1} \perp d_{m2}$ and the $d_{m2} \perp d_m$.

- **Chemotaxis:** These chemotactic processes will simulate bacterium movement and for this the children bacteria b_{m1} and b_{m2} will forage alongside the nutrient-rich positions. For tumble, generate in a random manner ([-1,1]) that are the elements in the random vector and compute its adaptive step size and further updates a solution. For every child bacterium, the $b_{mi}(i=1,2)$ is in the location l_{mi} , and examines the neighbours in the neighbourhood $\eta(l_{mi})$ in a counter-clockwise manner aiming to identify the location t that has a concentration of nutrient as per equation (2):

$$J(t) \geq \eta(l_{mi}) \qquad (2)$$

In the meantime, a look bearing for the bacterium can change not exactly the $\pi/2$. If the bmi finds a position that is supplement rich t, it moves to it and alters the course of chemotaxis to the swim heading $d_{mi} = t - l_{mi}$ $dmi = t - lmi$. When the bacterium at the lmi can't discover a position that is supplement wealthy in an area in (3):

$$\forall t \in \eta(l_{mi}), \ J(t<T) \qquad (3)$$

It terminates the chemotaxis. Aside from this location, its health condition is also a critical parameter. For moving from location s_1 to s_2 , the bacterium has to consume energy and therefore decrease health as per equation (4):

$$\overset{v}{H}(s_1, s_2) = \begin{cases} 1, & |\rho(s_2) - \rho(s_1)| \ \geq T_h \\ 0, & |\rho(s_2) - \rho(s_1)| \ < T_h \end{cases}$$

(4)

- In which threshold T_h may determine it in case there is any change in the environment at the time of a one-step movement which is large and can harm the health of the bacterium. As soon as it arrives at the location s_2 , the bacterium absorbs the nutrients and increases the health as according to equation (5):

$$\overset{v}{H}(s_2) = \begin{cases} 1, & \rho(s_2) \geq \alpha T_h \\ 0, & \rho(s_2) < \alpha T_h \end{cases} \qquad (5)$$

- In which, α denotes the parameter, and a threshold

- αT_h which determines it in case the location is sufficiently rich in nutrients. Utilizing these definitions, the strength of the m-th bacterium is determined at is nth chemotactic venture according to condition (6):

$$H(m,n) = H(m,n-1) - \check{H}(s_{m,n-1}, s_{m,n}) + \check{H}(s_{m,n})$$
(6)

  - In which the $s_{m,n}$ is the m-th bacterium's location in the n-th chemotaxis step to determine the H(m,0) = 0. In case the health value satisfies the H(m,n) ≥ 0 while chemotaxis, it may continue its movement or else it stops at the current location.

- **Swarming:** a bacterial swarming [12] is the place two microorganisms are pulled in to each other and they are situated a long way from the other and repulse each other when they are close. Here, the way toward swarming guarantees a base separation among the tracks of two microorganisms in a solitary pixel. Along these lines, any area is visited just by a solitary bacterium.

- **Elimination:** at the time the bacterium stops the progression of chemotaxis, it gets disposed of once it creates a spore and starts the procedure of dispersal utilizing an irregular beginning course. On the off chance that the $km1$ and the $km2$ are spores created by the $bm1$ and the $bm2$, it must be expected that just a single one gets by to keep up the extent of the populace steady. This calculation likewise ends at the time the spore can't locate a supplement rich position inside a specific number of ventures of dispersal. In the event that the track of two distinct microorganisms is created by one spore is not as much as its foreordained esteem, it will in general be achieved by the fuss or the collectibles and are subsequently abstained from. The rest of the tracks of microorganisms are the articles and their recognized edges.

- The stream graph for the system about the given procedures. It shows Figure (1.1)

Figure 1 Flowchart of Bacterial Foraging Optimization (BFO)

An ideal act has been chosen to a great extent by a few parameters like the measure of the number of inhabitants in microscopic organisms, the development venture of the microorganisms, the inclination activities, and the occasions the tasks of duplicate and exchange happen, etc. Inferable from such parameters not having versatility, the iterative occasions are dictated by the most extreme number of times these activities and the no combination measure have been acquainted and accordingly are trying with guarantee any

exactness those outcomes in including undesirable iterative procedure.

c. Tabu search (TS)

The Tabu Search [14] is a heuristic computation of a progressively raised sum used to deal with issues of combinatorial streamlining. The TS had been proposed a specific number of years prior by Glover. The principle part of this calculation was to utilize a memory for making it is possible that at least one of the TABU rundown containing verifiable data of the arrangements of late got. This rundown will save a lot of arrangements as TABU for staying away from a rehashed visit. The TABU Search is utilized on an expansive scale for non-direct issues and has demonstrated that it can discover worldwide arrangements in a viable way. The TS calculation's flowchart is delineated in the figure underneath.
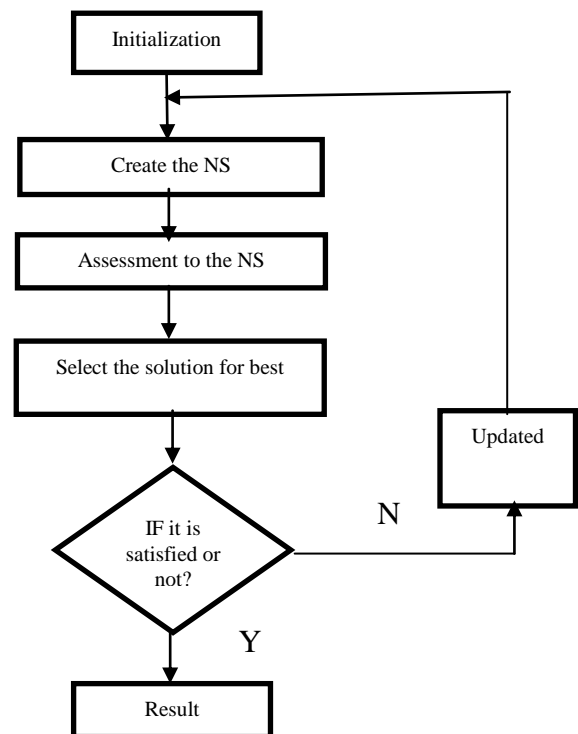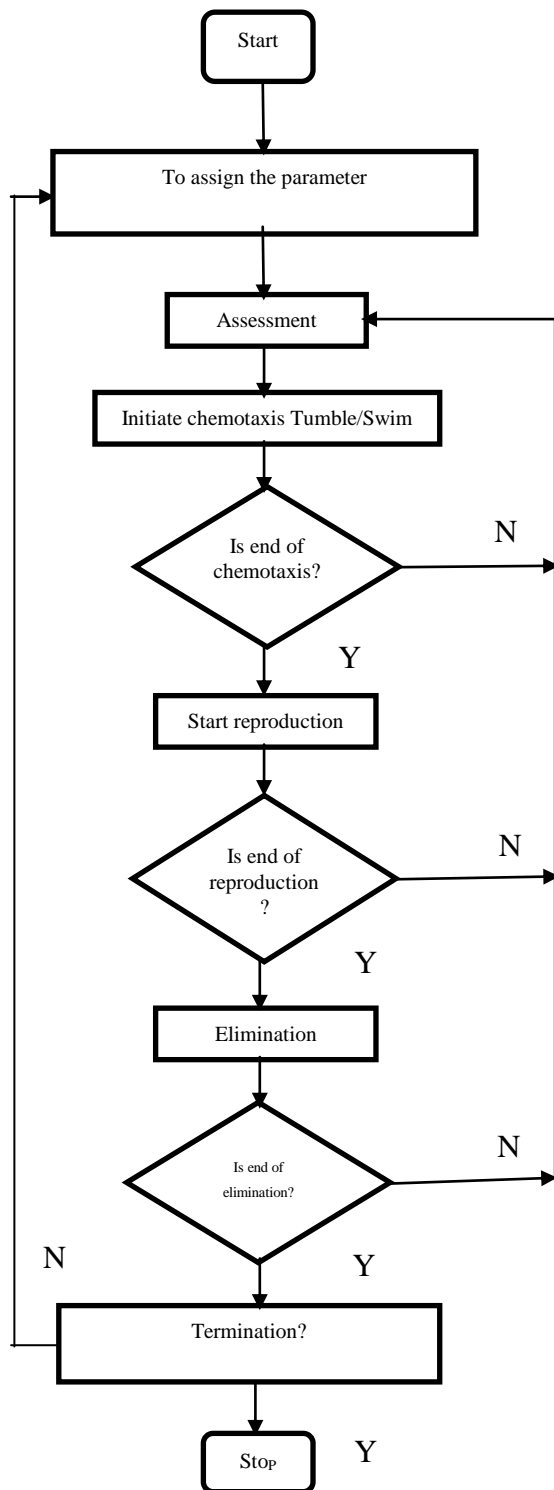
Retrieval Number: I8706078919/19©BEIESP
DOI:10.35940/ijitee.I8706.078919

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Figure 2 Flowchart for Standard Tabu search Algorithm
[11]

framing new meta-heuristics that work helpfully. For this, it isn't important to utilize any propagation component of a BFO part as the positioning was accessible as answers to identify the one that has a negligible expense. This arrangement was exchanged to the piece of the TS as its underlying arrangement. The means of the proposed BFO-TS are:

Step1: Initialize the parameters of both BFO and TS algorithms.

Step 2: Initial solution θ_i are generated randomly from its search space i.e the feature vector. Set θ_i to be its current solution.

Stage 3: Elimination-dispersal circle: $l = l + 1$.

Stage 4: Reproduction circle: $k = k + 1$.

Stage 5: Chemotaxis circle: $j = j + 1$ **.**

For $I = 1,2,..., S$, make a chemotactic stride for bacterium I as pursues.

Process target work, $J (I, j, k, l)$.

Tumble

Swimming.

Go to next bacterium (i+1), proceed with chemotaxis since the life of the microbes isn't finished.

Stage 6: Reproduction

Let the prosperity H of the minuscule life forms be handled. From this time forward, sort of tiny creatures in the given solicitation of climbing regards the data set. The minuscule creatures S with the best characteristics split and the copies that are made are put at a comparative territory as their parent.**S**et $S_0 = best \_ \theta$

Step 7: Generate the neighbourhood to be around S_0 in an initial radius of search R. Set the N solutions to be the members of this set $S_1(r)$.

Step 8: Evaluate all objective functions for every member that belongs to $S_1(r)$. Now define $S_1 = best \_ neighbor1$ to be the solution with a minimum cost, J_1 .

Step 9: In case $J_1 < J_0$ then store S_0 in the TL, and assign $S_0 = S_1$. Else, store S_1 in the TL.

Step10: In case the criterion for termination of maximum iteration: $count > count_{max} (count = 1, 2, ..., count_{max})$ then exit along with its global solution.

d. Proposed Hybrid BFO-TS for feature selection

As referenced before, the TS and its qualities are overwhelming and centering while the BFO is observed to be solid in its explorative task. These kinds of properties will supplement one and other. As the TS contains direct techniques and moves towards neighbourhood arrangements quickly, the strategy will frame chasing ventures for the issue and its answer. The two calculations are consolidated for

e. Classifier

i. Repeated Incremental Pruning to Produce Error Reduction (RIPPER)

The Ripper is the program which incites the standards of characterization from the arrangement of these models. In contrast to that of different calculations, this may not require any element vector. This will shape the on the off chance that decides that are the disjunctions of the conjunctions. The Ripper [5] further works by methods for including rules for covering the positive models and this prunes the principles so as to frame its best fit for a different pruning set.

The fundamental preferences of the Ripper are as beneath:

• All in the event that provisos will be straightforward for people.

• The Ripper is amazingly quick in both preparing and testing.

• It licenses clients to have the capacity to supply the earlier learning imperatives.

• The Ripper further allows the qualities to remain ostensible, set-esteemed or constant.

• The Ripper is additionally nonlinear.

ii. OneR

The OneR is a straightforward calculation of characterization that works by methods for finding a solitary trait from preparation information giving a least mistake that is utilized for making a standard of arrangement. For the OneR to over-fit there will be a need of this to be the quality that happens an arrangement of the preparation information however did not sum up to the test information in future. Almost certainly, the OneR gives models which are strong and incorrect.

The OneR had been depicted by Holte (1993) containing a trial assessment of 16 datasets by making use of cross-endorsement and the results were illustrative of things to come data execution. The quantity of examples (with the end goal of discretization) had been set to 6 once experimentation (min Bucket Size parameter found in the Weka). It has more straightforward standards which are performed and are not more terrible than the more mind boggling choice trees.

iii. Fuzzy Unordered Rules Induction Algorithm (FURIA)

The FURIA is another accurate soft showing computation that has been persuading in general affirmation to be very exact. The conspicuousness of FURIA has been getting to be over the span of the latest couple of years has more than 100 particular works alluding to its one of a kind dispersion and further appearing at be a solid procedure that performs well in various circumstances [10, 8]. The Fuzzy Unordered Rules Induction Algorithm (FURIA) [7] is that novel technique for cushioned rule request that widens the built up RIPPER. The essential qualification between the FURIA and the RIPPER is that they are stressed over rule models and the usage of the default rules. The standard model sort FURIA will play out a fuzzification with principle

predecessors with a covetous calculation stretching out help to each standard to improve the criteria of immaculateness. For the default choices use, the standards in the RIPPER will be in a rising request by the likelihood of classes. The standard that coordinates the example of the question initially is utilized for grouping. The precedents that are revealed will be doled out to an incessant class (the default rule). The FURIA makes utilization of a one-versus rest deterioration. There is no default rule required for this. While the example of an inquiry is revealed utilizing standards of fuzzy grouping that is gotten from the FURIA, a standard that is the closest in the fuzzy information base has been connected to a similar question. This is resolved through a procedure known as "rule extending", in which all tenets will be summed up step by step until such time an extended precursor is appropriately fulfilled by its revealed example.

iv. Artificial Immune System (AIS) Classifier

On being contrasted with a customary measurable classifier, the AIS classifier will have a limit which is profoundly hearty and has all points of interest of the counterfeit invulnerable frameworks dependent on the hypothetical angles referenced underneath. Directly off the bat, the AIS are techniques that are self-flexible and data driven and can adjust themselves to any data without a specific of either a handy or a distributional structure for this model to given issue because of bacterial handling.

```
sTabu ←{s}
pre-eminent←S
Lay off ← false
u←s
despite the fact(¬ Lay off)
v←Inferior (Succ (u)\Tabu)
if (f (v) < f (u)) v←best←uelse
r←Select(0,1)
if (r < (f (v) < f (u)) / r)
v←u
Tabu←Cultivate (Tabu)
Lay off←modernize (Lay off)
Return superlative.
```

Tabu working procedure

Additionally, there have been some far reaching and utilitarian approximates found in the AIS that had the ability to evaluated limits with a self-decisive precision. Thirdly, the AIS are the nonlinear models making them adaptable in the intricate true connections. By methods for these investigations, the AIS calculation of order will have a high level of exactness utilized if there should be an occurrence of remote detecting characterization of the picture.

IV. RESULTS AND DISCUSSION

In this segment, the RIPPER, OneR, FURIA and AIS classifiers are utilized. The component determination utilizing BFO-TS are assessed. Table 1 and 2 demonstrates the parameters of BFO and TS individually. The arrangement exactness, accuracy, review and f measure as tables 3 to 6 and figures 3 to 6.

Table 1 Parameters of Bacterial Foraging Optimization (BFO)

Quantity of Bacterium	20
Sum of Chemotactic steps	10
Be drowned of length	10
Total of facsimile steps	4
Numeral of eradication of dispersal events	2
Prospect of eradication and dispersal	0.02
Gravity of attractant	0.1
Elevation of repellent	0.1
Measurement of attract	0.2
Thickness of repellent	10

Table 2 Parameters of Tabu Search

|	
Maximum number if Recapitulations	2000
Dimension of Tabu Lists	96
Extent of candidate lists	48
Tabu Length	10
Number of Tabus in Tabu List	5*number of variables

Table 3 Results of Classification Accuracy, Precision, Recall and F-Measure for Feature Selection Using Proposed BFO-TS

| Techniques Used	Classification Accuracy	Precision	Recall	F-Measure
FURIA	97.13	0.9718	0.971	0.9715
RIPPER	97.2	0.9724	0.9723	0.9722
OneR	97.27	0.9731	0.9727	0.9729
AIS classifier	98.07	0.9808	0.9807	0.9807

Graph 1 Classification Accuracy for Feature Selection Using Proposed BFO-TS

From the table 3 and graph 1, it can be observed that the feature selection using Proposed BFO-TS with AIS classifier has higher classification accuracy by 0.96%, 0.89% & 0.82% compared to the FURIA, RIPPER and OneR respectively.
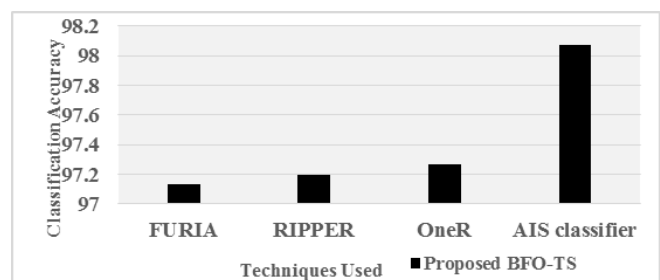
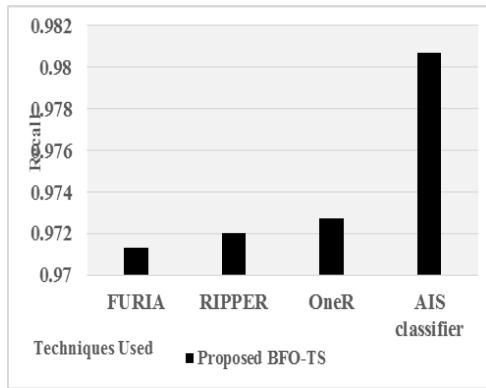**Graph 2 Precision for Feature Selection Using Proposed BFO-TS**

From the table 3 and figure 4, it very well may be seen that the element determination utilizing Proposed BFO-TS with AIS classifier has higher accuracy by 0.92%, 0.86% and 0.79% contrasted with the FURIA, RIPPER and OneR separately.
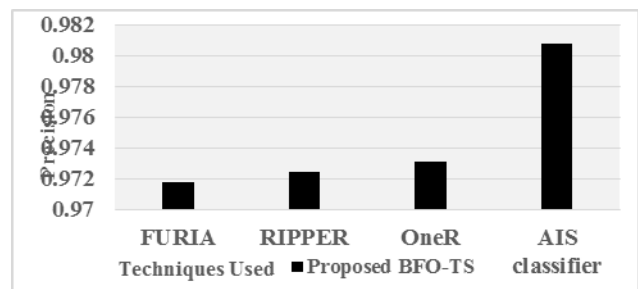
**Graph 4 Recalls for Feature Selection Using Proposed BFO-TS**

From the table 3 and graph 4 , it can be observed that the feature selection using Proposed BFO-TS with AIS classifier has higher recall by 0.96%, 0.89% & 0.82% compared to the FURIA, RIPPER and OneR respectively.

Graph 5 F Measures for Feature Selection Using Proposed BFO-TS

From the table 3 and graph 5, it very well may be seen that the element determination utilizing Proposed BFO-TS with AIS classifier has higher f measure by 0.94%, 0.87% and 0.799% contrasted with the FURIA, RIPPER and OneR individually.
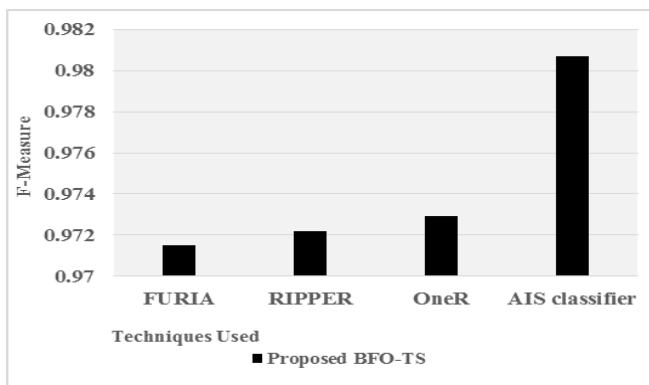
V. CONCLUSION

The viable medicinal pictures will in general assume a basic job in the analysis and treatment. The headway in the advancements of computerized imaging has made a vast development in the quantity of advanced pictures that were taken as of late. Highlight determination is an issue in enhancement which goes for diminishing the time taken for calculation and for improving the exactness alongside a calculation of highlight improvement by methods for evacuating the repetitive, uproarious and disconnected highlights. For this work, there is a half and half BFO with the TS that has been proposed for its picture arrangement. The outcomes demonstrate that this component choice which uses the Proposed BFO-TS alongside the AIS classifier has a higher precision of grouping by about 0.96%, 0.89% and 0.82% on being contrasted with the FURIA, the RIPPER and the OneR individually.

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Retrieval Number: I8706078919/19©BEIESP
DOI:10.35940/ijitee.I8706.078919

2849

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication