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Highlights

- Stability of Equilibrium Points
- Non-Invariant Hypersurfaces
- Salagean Integral Operator
- Stable Ecological Environment

Discovering Thoughts, Inventing Future

VOLUME 15 ISSUE 6 VERSION 1.0

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Intuitionistic Fuzzy Sets Approach in Appointment of Positions in an Organization Via Max-Min-Max Rule

By P. A. Ejegwa
University of Agriculture, Nigeria

Abstract- From the myriads of research on the applications of intuitionistic fuzzy sets theory in decision making, one can easy say that intuitionistic fuzzy sets theory is of great importance in decision science due to its efficiency and reliability. Here, we proposed a new area of application of intuitionistic fuzzy sets theory in appointment of positions in an organisation using intuitionistic fuzzy sets approach via max-min-max rule.

Keywords: appointments, fuzzy sets, intuitionistic fuzzy sets, max-min-max rule, organisation.

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Keywords: appointments, fuzzy sets, intuitionistic fuzzy sets, max-min-max rule, organisation.

I. Introduction

Zadeh [20] introduced the concept of fuzzy sets with the aim to model the vagueness and ambiguity in complex systems. Fuzzy sets theory is the generalization of classical or crisp set. It has greater flexibility to capture various aspects of incompleteness or imperfection in information about a situation. The key elements in the human thinking are not just the numbers but can be approximated to classes of objects in which the transition from membership to non-membership is gradual rather than abrupt. In dealing with vague notions, it is sometimes difficult to determine the exact boundaries of class, hence the decision that whether an element belongs to it or not is replaced by a measure from some scale. Each element of the class is evaluated by a measure which expresses its place and role in the class. This measure is called the grade of membership of the given class. This class in which each element is characterised by its membership grade is called a fuzzy set. These membership grades are very often represented by real number values ranging from the closed interval [0, 1].

Subsequently, Atanassov [1] proposed the concept of intuitionistic fuzzy sets (IFSs) as the generalisation of fuzzy sets. Since fuzzy set is only concern with the membership function without minding the significance of non-membership function and hesitation margin (which is integral in decision making), Atanassov then included the non-membership function and defined the hesitation margin as 1 minus the sum of the membership and non-membership functions. Lots have been done on IFSs theory; see [2, 5, 10, 15]. Sequel to the introduction of IFSs theory, many studies examined its applications in various areas such as in medical diagnosis, sustainable supplier

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evaluation, pattern recognition, medical imaging, electoral system [3-4, 6-9, 11-14, 16-19] etc.

In this paper, we shall propose a new application of our "famous" IFSs theory in appointment of positionsin an organisation with the aid of max-min-max rule.

a) *Meaning of intuitionistic fuzzy sets*

Definition 1: Crisp set A of X is defined as the characteristic function of A and is denoted by $f_A(x)$, mathematically, $f_A(x): X \to \{0,1\}$

$$\text{where, } f_A(x) = \begin{cases} 1, if\ x \in A \\ 0, if\ x \notin A \end{cases}$$

Definition 2: Fuzzy set A of a set X is defined by the membership function of the set $A s.t.$ `$_A(x): X \to [0,1]$,

$$\text{where, } \mu_A(x) = \begin{cases} 1,\ if\ x\ is\ totally\ in\ A \\ 0, if\ x\ is\ not\ in\ A \\ (0,1), if\ x\ is\ partly\ in\ A \end{cases}$$

The closer the membership value $\mu_A(x)$ to 1, the more x belongs to A, where the grades 1 and 0 represents full membership and full non-membership.

Definition3[2]: Let X be nonempty set. An intuitionistic fuzzy set (IFS) A in X is an object having the form;

$A = \{\langle x, \mu_A(x), \nu_A(x)\rangle : x \in X\}$, where the functions $\mu_A(x), \nu_A(x): X \longrightarrow [0,1]$define the degree of membership and degree of non-membership of the element$x \in X$ to the set $A.$ For every $x \in X, 0 \le \mu_A(x) + \nu_A(x) \le 1$.

Furthermore, $\pi_A(x) = 1 - \mu_A(x) - \nu_A(x)$ is the intuitionistic fuzzy set index or hesitation margin and is the degree of indeterminacy concerning the membership of$x$ in A, then $0 \le \mu_A(x) + \nu_A(x) + \pi_A(x) \le 1$. Whenever $\pi_A(x) = 0$, IFS reduces automatically to fuzzy set.

b) *Appointment of positions in an organisation via max-min-max rule for IFSs*

Suppose an organisation wants to reshuffle its cabinet, the challenge is how to appoint suitable officers into different positions assuming we have more than enough candidates for the positions. IFSs approach provides the solution because of its competency in handling uncertainties in decision making.

Let A be an IFS of nonempty set X and let R be the intuitionistic fuzzy relation (IFR) from $X \to Y$, then the max-min-max composition B of X with the IF relation R$(X \to Y)$ is defined as $B = R \circ A$ with membership and non-membership function defined as

$\mu_B(y) = \max_{x \in X}\{\min[\mu_A(x),\ \mu_R(x,y)]\}$and
$\nu_B(y) = \min_{x \in X}\{\max[\nu_A(x),\ \nu_R(x,y)]\}$.

Also let $Q = \{q_1, q_2, \dots, q_l\}; P = \{p_1, p_2, \dots, p_m\}; C = \{c_1, c_2, \dots, c_n\}$; be the finite set of qualifications, positions, and candidates respectively.
Suppose we have two IFRs $R(C \to Q)$ and $S(Q \to P)$ s.t.

$$R = \{\langle (c,q), \mu_R(c,q), \nu_R(c,q)\rangle : (c,q) \in C \times Q\}$$

Ref

3. T. Chaira, Intuitionistic fuzzy set theory in medical imaging, *Int. J. of Soft Computing and Engineering* 1 (2011) 35-37.

Notes

$S = \{\langle (q,p), \mu_S(q,p), \nu_S(q,p)\rangle : (q,p) \in Q \times P\}$ where,
$\mu_R(c,q)$ indicate the degree to which the candidate c possesses the qualification q and $\nu_R(c,q)$ indicate the degree to which the candidate c does not possess the qualification q.
Similarly,
$\mu_S(q,p)$ indicate the degree to which the qualification q determines the position p and $\nu_S(q,p)$ indicate the degree to which the qualification q does not determine the position p.

The composition T of the IFRs R and S is given as $T = R \circ S$. It describes the state in which the candidates c_i in terms of the qualifications fit the positions p_j. It is given by membership and non-membership degrees as:

$\mu_T(c_i, p_j) = max_{q_j \in Q}\{min\,[\mu_R(c_i, q_j),\ \mu_S(q_j, p_j)]\}$ and

$\nu_T(c_i, p_j) = \min_{q_j \in Q}\{\max\,[\nu_R(c_i, q_j),\ \nu_S(q_j, p_j)]\} \forall c_i \in C$ and $p_j \in P$ for $i, j \in \mathbb{N}$.

From R and S, one can compute new measure of IFR T for which, the appointments of the candidates c_i for any position p s.t. the following are to be satisfied:
(i) $S_T = \mu_T - \nu_T . \pi_T$ is the greatest and
(ii) The equality $T = R \circ S$ is retained.
To see the application of this method, we frame a hypothetical case study:

Let $C = \{c_1, c_2, c_3, c_4\}$ be the set of candidates to be appointed, let $P = \{p_1, p_2, p_3, p_4, p_5\}$ be the positions to be occupied and let $\boldsymbol{Q}$={ **honesty, team spirit, hardworking, transparency, academic fitness**} be the set of qualifications the expected candidates ought to possessed. We assume the candidates are score by impartial member of the organisation appointment committee (10-member committee) using IFSs values.

Suppose the IFR $R(C \to Q)$ is given hypothetically below as scored by the 10-member committee.

Table 1

R	honesty	team spirit	hardworking	transparency	acad. fitness
c_1	(0.5, 0.2)	(0.6,0.3)	(0.7,0.1)	(0.8,0.1)	(0.6,0.2)
c_2	(0.8,0.1)	(0.5,0.2)	(0.7,0.2)	(0.6,0.2)	(0.4,0.5)
c_3	(0.5, 0.2)	(0.6,0.1)	(0.4,0.3)	(0.5,0.3)	(0.8,0.1)
c_4	(0.7,0.1)	(0.5,0.3)	(0.8,0.1)	(0.6,0.2)	(0.7,0.2)

Note that, the first entry is the membership value and the second entry is the non-membership value.

Suppose the IFR $S(Q \to P)$ is given hypothetically below as stipulated by the organisation appointment committee as standing qualifications for the positions.

Table 2

S	p_1	p_2	p_3	p_4	p_5
Honesty	(0.7,0.2)	(0.7,0.1)	(0.6,0.2)	(0.8,0.0)	(0.6,0.3)

team spirit	(0.8,0.1)	(0.7,0.2)	(0.8,0.0)	(0.7,0.2)	(0.8,0.1)
Hardworking	(0.8,0.2)	(0.8,0.1)	(0.8,0.1)	(0.6,0.2)	(0.8,0.1)
Transparency	(0.7,0.2)	(0.7,0.2)	(0.9,0.0)	(0.8,0.1)	(0.7,0.1)
acad. Fitness	(0.9,0.1)	(0.9,0.0)	(0.6,0.3)	(0.7,0.2)	(0.5,0.3)

The composition $T = R \circ S$ is as follows:

Table 3

T	p_1	p_2	p_3	p_4	p_5
c_1	(0.7,0.2)	(0.7,0.1)	(0.8,0.1)	(0.8,0.1)	(0.7,0.1)
c_2	(0.7,0.2)	(0.7,0.1)	(0.7,0.2)	(0.8,0.1)	(0.7,0.2)
c_3	(0.8,0.1)	(0.8,0.1)	(0.6,0.1)	(0.7,0.2)	(0.6,0.1)
c_4	(0.8,0.2)	(0.8,0.1)	(0.8,0.1)	(0.7,0.1)	(0.8,0.1)

Now, we calculate S_T as below:

Table 4

S_T	p_1	p_2	p_3	p_4	p_5
c_1	0.68	0.68	0.79	0.79	0.68
c_2	0.68	0.68	0.68	0.79	0.68
c_3	0.79	0.79	0.57	0.68	0.57
c_4	0.79	0.79	0.79	0.68	0.79

From Table 4 above, c_1 can fit into p_3 and p_4; c_2 can fit into p_4 only; c_3 can fit into p_1 and p_2; c_4 can fit into p_1, p_2, p_3 and p_5.

II. Conclusion

We conclude that IFSs theory is a very suitable and decisive tool use in critical decision making problem like this. We observe that without IFSs theory, this exercise would have been compromised with a consequent effect on the organisation.

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Existence of Solution of First order Differential Balance Equation in Interpolation

By Ms. K. Vijaya
Kgisl Institute of Technology, India

Abstract- In this paper I derive the formula from the first order differential balance equation. In Numerical methods we are finding the missing values and derivativs from the available data by using different formula. One can solve problem directly using balance equation.

Keywords: dependent variable, interpolation.

GJSFR-F Classification : *FOR Code : MSC 2010: 31B35 , 03C40*

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Ms. K. Vijaya

Abstract- In this paper I derive the formula from the first order differential balance equation. In Numerical methods we are finding the missing values and derivativs from the available data by using different formula. One can solve problem directly using balance equation.

Keywords: dependent variable, interpolation.

I. Introduction

Interpolation is one of the concept in mathematics. In Numerical methods we are finding the missing values and derivatives from the available data by using different formula.

Here I have derived three formulae from the first order balance equation. The first two formulae denotes the process of computing the values of a function for any value of the Independent variable and also the value of a Independent variable for any value of a function either within an interval values from the available data.

Numerical differentiation is the process of computing the value of the derivatives for some particular value, from given data, when the actual relationship between X and Y is not known. The balance derivative formula to be used depends as usual on the particular value of X at which the value of first derivative is required.

II. Balance Differential Equation and an Application

The balance differential equation is $dp = k\sqrt{p}dt$ -----(I)

This is a seperable equation whose solution can be developed as follows.

Integrating (I), we get

$$2\sqrt{p} = kt + c \qquad \text{----------(i)}$$

where c is constant

When $p = p_1$, $t = t_1$, (i) becomes

$$2\sqrt{p_1} = kt_1 + c \qquad \text{-----------------(ii)}$$

When $= p_2$, $t = t_2$, (i) becomes

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$$2\sqrt{p_2} = kt_2 + c \qquad \text{-----------------(iii)}$$

(iii)-(ii) gives $k = \frac{2(\sqrt{p_2}-\sqrt{p_1})}{t_2-t_1}$

From (ii) $c = 2\sqrt{p_1} - \frac{2(\sqrt{p_2}-\sqrt{p_1})}{(t_2-t_1)} t_1$

Substituting 'k' and 'c' in (i), we get

$$P = \left\{ \frac{(\sqrt{p_2} - \sqrt{p_1})(t - t_1)}{(t_2 - t_1)} + \sqrt{p_1} \right\}^2$$

From this formula we can find the dependent variable for any value of the independent variable. The other formula is as follows

$$t = \frac{(\sqrt{p} - \sqrt{p_1})(t_2 - t_1)}{(\sqrt{p_2} - \sqrt{p_1})} + t_1$$

From this formula we can calculate the independent variable for any value of the dependent variable.

III. Applications

The following are data from the steam table

Temperature(t)	140	150	160	170	180
Pressure(p)	3.685	4.854	6.302	8.076	10.225

The solution is as follows

t_1	t_2	p_1	p_2	t	p
140	160	3.685	6.302	When t=150	P=4.9 app
140	160	3.685	6.302	t=150 app	When p=4.854

Now, we consider the unequal interval data

t	5	6	9	11
p	12	13	14	16

The solution is as follows

t_1	t_2	p_1	p_2	t	p
5	9	12	14	When t=6	P=12.4 8app
5	9	12	14	t=6 app	When p=13
5	11	12	16	When t=9	P=14 app

IV. Balance Difference Formula to Compute the Derivatives

Consider

$$P = \left\{ \frac{(\sqrt{p_2} - \sqrt{p_1})(t - t_1)}{(t_2 - t_1)} + \sqrt{p_1} \right\}^2$$

$$\acute{P} = \frac{2\sqrt{p}(\sqrt{p_2} - \sqrt{p_1})}{t_2 - t_1}$$

Consider the table of values

Notes

t	1.00	1.05	1.10	1.15
p	1.00	1.02470	1.04881	1.07238

Here, when $p_1 = 1.00$ $t = 1.00$ $p_2 = 1.04881$ $t_2 = 1.10$ P=1.02470 $(\acute{p})at\ t = 1.05 = ?$

By using the above formula $\acute{p}$=0.447

Notes

V. Conclusion

These formulae we have used are to find out the values of both equal and unequal intervals. This can be applied for all types of data.

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Discriminant Analysis by Projection Pursuit

By Okeke, Joseph Uchenna, Onyeagu, Sidney & Okonkwo, Evelyn Nkiruka
Nnamdi Azikiwe University, Nigeria

Abstract- A non-parametric discriminant analysis (projection pursuit by principal component analysis) is discussed and used to compare three robust linear discriminant functions that are based on high breakdown point (of location and covariance matrix) estimators. The major part of this paper deals with practical application of projection pursuit by principal component. In this study 10 simulated data sets that are binomially distributed and a real data set on the yield of two different progenies of palm tree were used for comparisons. From the findings we concluded that the non-parametric procedure (projection pursuit by principal component) have the highest predictive power among other procedures we considered. S-estimator performed better than the other two estimators when real data is considered, while MCD estimator performed better than MWCD estimator.

Keywords: discriminant analysis (DA), principal component analysis (PCA), projection pursuit, minimum covariance determinant (MCD), minimum within covariance determinant (MWCD), and s-estimator.

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Discriminant Analysis by Projection Pursuit

Okeke, Joseph Uchenna [α], Okeke, Evelyn Nkiruka [σ], and Onyeagu, Sidney [ρ]

Abstract- A non-parametric discriminant analysis (projection pursuit by principal component analysis) is discussed and used to compare three robust linear discriminant functions that are based on high breakdown point (of location and covariance matrix) estimators. The major part of this paper deals with practical application of projection pursuit by principal component. In this study 10 simulated data sets that are binomially distributed and a real data set on the yield of two different progenies of palm tree were used for comparisons. From the findings we concluded that the non-parametric procedure (projection pursuit by principal component) have the highest predictive power among other procedures we considered. S-estimator performed better than the other two estimators when real data is considered, while MCD estimator performed better than MWCD estimator.

Keywords: discriminant analysis (DA), principal component analysis (PCA), projection pursuit, minimum covariance determinant (MCD), minimum within covariance determinant (MWCD), and s-estimator.

I. Introduction

The problem of discriminant analysis arises when one wants to assign an individual into one of k groups on the basis of a p-dimensional characteristic vector. In classical discriminant analysis, the populations under study are, assumed to be, normally distributed with equal covariance matrices. But in some practical situations, problems with data that are categorical, mixed, sparse, and contaminated abound. In these situations, classical discriminant analysis will not be optimal in classifying objects into the existing populations. The need for robust methods that will be optimal in classifying objects becomes necessary.

Robust methods for discriminant analysis have been proposed by many authors; Todorov et al (1990) replaced the classical estimates of linear and quadratic discriminant functions by MCD estimates, Chork and Rousseeuw (1992) used MVE instead, Hawkins and Mclachlan (1997) defined MWCD especially for the case of linear discriminant analysis, He and Fung (2000) and Croux and Dehon (2001) used S estimates, Hubert and Van Driessen (2004) applied the MCD estimates computed by the FAST MCD algorithm, Todorov and Pires (2007) used M-iteration described by Woodruff and Rocke (1996). Most of these works concentrated on replacing the classical mean vectors and covariance matrices by their robust counterpart. However when the covariance structure is singular or close to it the later methods may fail to be optimal. To solve singularity problem, projection pursuit approach has come up as a remedy. This method aimed at reducing a high dimensional data set to low dimension so that the statistical tool for the low dimensional data can be applied. Polzehl (1993) studied discriminant analysis based on projection pursuit density estimation and chose his projection to minimize estimates of the expected overall loss in each projection pursuit

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stage. According to him cross-validation techniques are used to avoid overfitting effect and at last he concluded that his procedure competes favorably with other classification methods in situations where parametric approaches are not flexible enough and when sample sizes are too small to use fully non-parametric procedure.

Pires and Branco (2010) studied projection pursuit estimator of the normalized discriminant vector induced by robust estimators of location, T, and the univariate estimator of scale, S and discovered that under contaminated data their method performed well and is strong competitor of other methods they studied.

Gunduz and Fokoue (2015) in their work explored and compared the predictive performance of robust classification and robust principal component analysis and applied it to variety of large small data sets. They also explored the performance of random forest by way of comparing and contrasting the differences of single model methods and ensemble method. Their work revealed that random forest although not robust to outlier substantially outperforms the existing techniques specifically design to achieve robustness.

In this paper we proposed projection pursuit by method of principal component because it allows prior standardization that is important for badly scaled data. This method was compared with the robust linear estimates: MCD and MWCD estimates obtained using Mahalanobis distance of the data points on 10 simulated data sets that are distributed binomially with a view of coming out with classifier with the highest predictive power.

II. Principal Component and Projection Pursuit (Nonparametric DA)

In many fields of research, principal component analysis (PCA) is used as an efficient tool for providing an informative and low-dimensional representation of multivariate data in which features in the data such as clustering, skewness and outliers can be easily detected (Bolton and Krzanowski 1999). PCA does not necessarily afford the 'best" view of the data structures and it may miss other interesting characteristics of the data. With this in mind, much research have been done in recent years on approaches to identifying projections that display, particularly, "interesting" features of the data. These techniques go under the generic name "projection pursuit" (Friedman and Tukey 1974). In projection pursuit the dimension that will give the required projection and the criterion that will find projections of the desired structure when optimized are studied.

Local optimization of the criterion over all projections of the required dimensionality yields "interesting" projections of the data that can be graphically displayed. The projection is usually chosen to be one, two, or three dimensional for convenience.

Projection pursuit indices are diverse but the construction of most of them is motivated by consideration of central limit theorem results. Diaconis and Freedman (1984) showed that projected subspaces of high-dimensional data converged, weakly in probability, to normality. Consequently, most projection pursuit indices are developed from the standpoint that normality represents the notion of "uninterestingness" (Huber 1985). These indices are thus optimized to find projections showing departures from normality.

PCA can be viewed as a particular case of projection pursuit in which the index of "interest" is the variance of the data, which is maximized over all unit length projections. In this paper, the first principal component was used to transform the p-

Notes

dimensional data space to one, so that we can apply the statistical tool for one dimensional data space.

Notes

a) Procedures of PCA

- Taking the whole dataset ignoring the class labels
- Computing the p -dimensional mean vector
- Computing the Covariance Matrix
- Computing eigenvectors and corresponding eigenvalues
- Sorting the eigenvectors by decreasing eigenvalues
- Choosing g eigenvectors with the largest eigenvalues
- Transforming the samples onto the new g subspace(s)

$$Y_i = a'X$$

Where $i = 1, \dots, g$ with $g \leq p$; a is the selected eigenvectors

Note: If the p variables of the original data are measured with different scales correlation matrix is used in place of covariance matrix.

b) Allocation Based on Point-Group Transvariation

This is a nonparametric allocation option suggested by Montanari (2004) which is based on the ranking of new observations among two samples used for classification. This utilizes the point group transvariation defined by Gini (1916) between the projected new observation and the projected X and Y. Allocate a new observation $Z = z$ into Π_x if $T_x(z)$ ¿ $T_y(z)$; otherwise, it is assigned to Π_y where

$$T_x(z) = \frac{1}{n}\sum_{i=1}^{n} I\{(\hat{u}'_{opt} X_i - \hat{u}'_{opt} z)\}[m_x(\hat{u}'_{opt}) - \hat{u}'_{opt} z] < o\} \qquad 2.1$$

The formula for $T_y(z)$ will be obtained when you replace all x in (2.1) with y.

$$\hat{u}_{opt} = \arg\min_{\|u\|=1} \left\{ \frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} I\{(u'x_i - u'y_j)(m_x(u) - m_y(u)) < o \right\} \qquad 2.2$$

where m_x (u) and m_y (u) are the locations of the two projected X and Y samples $u'x$ and $u'y$ respectively.

$\hat{u}_{opt}$ is found using projection pursuit

The allocation scheme is based on ranks. It gets rid of the non optimality problem that transvariation distance (TD) has when skewed distributions are considered. Although the allocation scheme makes this method completely non parametric and works better than TD for skewed distributions, it does not perform as well for data with unequal sample sizes. This is due to the fact that an equal prior restriction is imposed by counting and we neglect group two (one) when we find the ranking of the new point in group one (two). So the priors are not necessarily taken into account and the effect shows in the misclassification error rate especially when the sample sizes are unequal.

III. Methodology

The discriminant procedures considered would be evaluated on 10 simulated data sets of two groups with different specifications distributed binomially and a real life data. The real life data we used were obtained from Ph.D. seminar paper presented at the Department of Statistics, Nnamdi Azikiwe University, Awka, by Ekezie (2010). The data were from Nigeria Institute for Oil Palm Research and is on the characteristics and yield of two different progenies of palm tree. Table 1 below shows 10 simulated data sets and their specifications and optimal probability of misclassification.

Table 1 : Data Specifications and their Optimal Probability of Misclassification P(MC)

S/N	Sample Size	No. of variables	No. of trials		Probability of success		P(MC)
			Group X	Group Y	Group X	Group Y	
1	50	5	30	40	0.5, …,0.5	0.7,…,0.7	0.3300
2	45	3	60	70	0.4,…,0.4	0.5,…,0.5	0.426
3	40	4	50	100	0.4,…,0.4	0.3,…,0.3	0.5883
4	35	6	50	36	0.5,…,0.5	0.5,…,0.5	0.5000
5	30	6	30	50	0.5,…,0.5	0.5,…,0.5	0.5000
6	25	7	30	60	0.8,…,0.8	0.6,…,0.6	0.698
7	20	4	30	20	0.4,…,0.4	0.6,…,0.6	0.352
8	15	6	30	50	0.5,…,0.5	0.5,…,.5	0.5000
9	10	4	20	30	0.4,…,0.4	0.6,…,0.6	0.352
10	5	2	25	30	0.3,…,0.3	0.6,…,0.6	0.365

The steps we follow in computing the projection pursuit discriminant procedure are explained in detail in section 3.1 and 3.2.

a) *Projection Pursuit (by Method of Principal Component)*

We started by pooling the two samples of X and Y. The pooled data was centered. The principal component analysis of pooled data was computed using Minitab computer package. From the computed result the first principal component was chosen for the final analysis. The coefficients of the variables $\hat{u}_{opt}$, which are the projection direction that maximizes the separation of the data between two groups were made to be orthogonal. The first principal component with orthogonal coefficient was used to sweep the p-dimensional data space R^p to one dimension R data space. With reduced data space, point-group transvariation probability that is univariate statistical tool was then used to cross validate the training samples.

b) *Probability of classification*

In order to evaluate the performance of this method in classification of future observations we estimate the overall probability of misclassification. A number of methods to estimate this probability exist in the literature but in this study we used apparent error rate (known also as resubstitution error rate or reclassification error rate). This is a straightforward estimator of the actual (true) error rate in discriminant analysis and is calculated by applying the classification criterion to the same data set from which it was derived and counting the number of misclassified observations. If there are plenty of observations in each class the error rate can be estimated by splitting the data into training and validation sets. The first one is used to estimate the discriminant rules and the second to estimate the misclassified error.

IV. Results

The non-parametric discriminant method was evaluated with regard to its performance assessed by misclassification probabilities using 11 data sets. This method

Notes

Global Journal of Science Frontier Research (F) Volume XV Issue VI Version I Year 2015

competes favorably with robust linear estimators: MCD estimator, MWCD estimator, and S-estimator with the following misclassification probabilities.

Table 2.below contain the results of the 10 simulated data in terms of their misclassification probabilities,

Table 2 : Estimated Probability of Misclassification According to Sample Size

Notes

Sample size	MCD Estimator	MWCD Estimator	S-estimator	PP (PCA)
50	0.0000	0.0000	0.0000	0.0000
45	0.0111	0.0111	0.0111	0.0000
40	0.0000	0.0000	0.0000	0.0000
35	0.0142	0.0142	0.0142	0.0000
30	0.0000	0.0000	0.0000	0.0000
25	0.0000	0.0000	0.0000	0.0000
20	0.0000	0.0000	0.0000	0.0000
15	0.0000	0.0000	0.0000	0.0000
10	0.0000	0.0000	0.0000	0.0000
5	0.0000	0.0000	0.0000	0.0000
Life Data	0.0750	0.1000	0.0500	0.0125

The result of real life data showed that projection pursuit has the highest predictive power with P(MC) of 0.0125, followed by S-estimator with P(MC) of 0.05, MCD with P(MC) of 0.075 and then, MWCD estimator which have P(MC) of 0.1.

Considering the computational ease and P(MC), projection pursuit (by PC) performed better than the other three procedure. S-estimator performed better than the other two estimators when real data is considered, while MCD estimator performed better than MWCD estimator. Although the quality of the estimates (for robust linear estimators) is important since it entirely determines the robustness of the discriminant rule towards outlier. In our study we only concentrated on the predictive power of the procedures leaving the other aspects for further work.

V. Conclusion

Based on our observations during iteration and our findings after the analysis, we conclude that nonparametric classification procedure (projection pursuit by principal component) has highest predictive power among other procedures we considered.

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Harmonic Univalent Function with Varying Arguments Defined by using Salagean Integral Operator with Fixed Point

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Abstract- In this paper authors study a new class of harmonic functions defined by using Salagean Integral operator with varying arguments. We obtain coefficient inequalities, extreme points and distortion bounds.

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GJSFR-F Classification : *FOR Code : MSC 2010: 30F15*

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Strictly as per the compliance and regulations of :

7. Libera, R. J., (1965), Some classes of regular univalent functions, Proc. Amer. Math. Soc., 16, pp.755-758.

Harmonic Univalent Function with Varying Arguments Defined by using Salagean Integral Operator with Fixed Point

Dr. Poonam Dixit [α], Nikhil Kumar [σ] & Puneet Shukla [ρ]

Abstract- In this paper authors study a new class of harmonic functions defined by using Salagean Integral operator with varying arguments. We obtain coefficient inequalities, extreme points and distortion bounds .

Keywords: harmonic, analytic, varying arguments, sense preserving, salagean integral operataor, fixed point.

I. Introduction

A continuous complex-valued function $f = u + iv$ which is defined in a simply-connected complex domain D is said to be harmonic in D if both u and v are real harmonic in D. In any simply-connected domain we can write

$$f = h + \bar{g} \tag{1}$$

where h and g are analytic in D. We call h the analytic part and g the co-analytic part of f. A necessary and sufficient condition for f to be locally univalent and sense preserving in D is that $|h'(z)| > |g'(z)|, z \in D$ (see[7]).

Denote by S_H The class of functions f of the form (1) that the harmonic univalent and sense preserving in the unit disc $U=\{z \in C : |z| < 1\}$ for which

$$f(0) = h(0) = f_z'(0) - 1 = 0$$

then for $f = h + \bar{g} \in S_H$ we may express the analytic functions h and g as

$$h(z) = a_1 z + \sum_{k=2}^{\infty} a_k z^k, g(z) = \sum_{k=1}^{\infty} b_k z^k, |b_1| < 1 \tag{2}$$

In 1984 Clunie and Shell-Small [7] investigated the class S_H as well as its geometric subclasses and obtained some coefficient bounds . Since then , there have been several related papers on S_H and its subclasses.

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Salagean integral operator I^n is defined as follows (see[9])

(a) $I^0 f(z) = f(z)$

(b) $I^1 f(z) = I f(z) = \int_0^z f(t) t^{-1} dt$

....

....

(c)$I^n f(z) = I(I^{n-1} f(z))$ $(n \in N = \{1,2,3,....\})$.

In [4], Cotirla defined Salagean integral operator for harmonic univalent functions $f(z)$ such that h(z) and g(z)are given by (2) as follows

$$I^n f(z) = I^n h(z) + (-1)^n \overline{I^n g(z)}, \tag{3}$$

where

$$I^n h(z) = a_1 z + \sum_{k=2}^{\infty} k^{-n} a_k z^k$$

and

$$I^n g(z) = \sum_{k=1}^{\infty} k^{-n} b_k z^k$$

With the help of the modified Salagean integral operator we let$E_H(m,n,\gamma,\rho,)$ be the family of harmonic functions $f = h + \bar{g}$, which satisfy the following condition [11]

$$R_e\left[(1+\rho e^{i\alpha})\frac{I^n f(z)}{I^m f(z)} - \rho e^{i\alpha}\right] \geq \gamma \tag{4}$$

$(\alpha \in R, 0 \leq \gamma < 1, \rho \geq 0, m \in N, n \in N_0 = N \cup \{0\}, m > n$, and $z \in U)$,

where $I^n f$ is defined by (3) , we note that

(a) taking $\alpha = 0$, $E_H(n+1, n; 2\beta - 1, 1) = H(n, \beta)(0 \leq \beta < 1)$(see Cotirla[4])

(b) taking $m = n + q$, $E_H(n+q, n; \gamma, \rho) = H_{\rho,q}\ (n, \gamma)$ $(q \in N)$ (see Guney and Sakar [5]).

also we note that , by the special choices of α, γ, ρ, m and n , we obtain the following special cases

(a)Taking $\alpha = 0, then E_H(m, n, 2\beta - 1, 1) = H(m, n; \beta) = \{f \in S_H :$

$$R_e\left[\frac{I^n f(z)}{I^m f(z)}\right] > \beta(0 \leq \beta < 1; m \in N; n \in N_0; m > n; z \in U)\}$$

(b)$E_H(n+1, n; \gamma, \rho) = E_H(n; \gamma, \rho) = \{f \in S_H$:

$$R_e\left[(1+\rho e^{i\alpha})\frac{I^n f(z)}{I^{n+1} f(z)} - \rho e^{i\alpha}\right] \geq \gamma(\alpha \in R; 0 \leq \gamma < 1; \rho \geq 0; n \in N_0; z \in U)\}$$

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Notes

(c) $E_H(1,0;\gamma,\rho)=E_H(\gamma,\rho)=\{f\in S_H:$

$$R_e\left[(1+\rho e^{i\alpha})\frac{f(z)}{If(z)}-\rho e^{i\alpha}\right]\geq\gamma(\alpha\in R;0\leq\gamma<1;\rho\geq 0;z\in U)\}$$

also we define the subclass $V_{\bar{H}}(m,n;\gamma,\rho)$ consists of harmonic functions $f_n=h+\bar{g_n}$ in $E_H(m,n;\gamma,\rho)$ such that h and g_n are the form

$$h(z)=a_1z+\sum_{k=2}^{\infty}a_kz^k,g_n(z)=\sum_{k=1}^{\infty}b_kz^k \tag{5}$$

and there exists a real number ϕ such that , mod 2π,

$$arg(a_k)+(k-1)\phi\equiv\pi,k\geq 2\;and\;arg(b_k)+(k+1)\phi\equiv(n-1)\pi,k\geq 1. \tag{6}$$

also we note that, by the special choices of α,γ,m and n, we obtain:

(a) taking $\alpha=0$, $V_{\bar{H}}(n+1,n;2\beta-1,1)$=$V_{\bar{H}}(n,\beta)$;

(b) taking $\alpha=0$, $V_{\bar{H}}(m,n;2\beta-1,1)$=$V_{\bar{H}}(m,n,\beta)$;

(c) $V_{\bar{H}}(n+1,n;\gamma,\rho)$=$V_{\bar{H}}(n;\gamma,\rho)$;

(d) $V_{\bar{H}}(1,0;\gamma,\rho)$=$V_{\bar{H}}(\gamma,\rho)$;

II. Main Result

Unless otherwise mentioned , we assume in the reminder of this paper that , $\alpha\in R,0\leq\gamma<1,\rho\geq 0,m\in N,n\in N_0,m>n$ and $z\in U$. We begin with a sufficient coefficient condition for functions in the class $E_H(m,n;\gamma,\rho,z_0)$.

Theorem 2.1 . Let $f=h+\bar{g}$ be such that h and g are given by 2. Furthermore,

$$\sum_{k=2}^{\infty}\left[\frac{(1+\rho)k^{-n}-(\gamma+\rho)k^{-m}}{1-\gamma}|a_k|+\frac{(1+\rho)k^{-n}-(-1)^{m-n}(\gamma+\rho)k^{-m}}{1-\gamma}|b_k|\right]\leq 2a_1 \tag{7}$$

where $a_1=1$ Then $f\in E_H(m,n;\gamma,\rho,z_0)$. $0\leq\gamma<1,\rho\geq 0$

Proof. We need to show that if (7) holds the condition (4) is satised, then we want to prove that

$$R_e\left[\frac{(1+\rho e^{i\alpha})I^nf(z)-\rho e^{i\alpha}I^mf(z)}{I^mf(z)}\right]=R_e\frac{A(z)}{B(z)}\geq\gamma \tag{8}$$

Using the fact that $R_e(\omega)>\gamma$ if and only if $|1-\gamma+\omega|>|1+\gamma-\omega|$, it suffices to show that

$$|A(z)+(1-\gamma)B(z)|-|A(z)-(1+\gamma)B(z)|\geq 0, \tag{9}$$

Where $A(z) = (1+\rho e^{i\alpha})I^n f(z) - \rho e^{i\alpha} I^m f(z)$ and $B(z) = I^m f(z)$. Substituting for $A(z)$ and $B(z)$ in the left side of (9) we obtain,

$$|(1+\rho e^{i\alpha})I^n f(z) - \rho e^{i\alpha} I^m f(z) + (1-\gamma) I^m f(z)|$$

$$-\,|(1+\rho e^{i\alpha})I^n f(z) - \rho e^{i\alpha} I^m f(z) - (1+\gamma) I^m f(z)|$$

$$= |(1+\rho e^{i\alpha})(I^n h(z) + (-1)^n I^n g(z)) - \rho e^{i\alpha}(I^m h(z) + (-1)^n I^n g(z)) + (1-\gamma) I^m f(z)|$$

$$-\,|(1+\rho e^{i\alpha})(I^n h(z) + (-1)^n I^n g(z)) - \rho e^{i\alpha}(I^m h(z) + (-1)^n I^n g(z)) - (1+\gamma) I^m f(z)|$$

$$= |a_1(z) + \sum_{k=2}^{\infty} k^{-n} a_k z^k + \rho e^{i\alpha} a_1(z) + \rho e^{i\alpha} \sum_{k=2}^{\infty} k^{-n} a_k z^k$$

$$+ (-1)^n \sum_{k=1}^{\infty} k^{-n} b_k z^k + \rho e^{i\alpha}(-1)^n \sum_{k=1}^{\infty} k^{-n} b_k z^k - \rho e^{i\alpha} a_1(z)$$

$$-\,\rho e^{i\alpha} \sum_{k=2}^{\infty} k^{-m} a_k z^k - \rho e^{i\alpha}(-1)^m \sum_{k=1}^{\infty} k^{-m} b_k z^k + a_1(z) + \sum_{k=2}^{\infty} k^{-m} a_k z^k$$

$$+ (-1)^m \sum_{k=1}^{\infty} k^{-m} b_k z^k - \gamma a_1(z) - \gamma \sum_{k=2}^{\infty} k^{-m} a_k z^k - (-1)^m \gamma \sum_{k=1}^{\infty} k^{-m} b_k z^k|$$

$$-\,|a_1(z) + \sum_{k=2}^{\infty} k^{-n} a_k z^k + \rho e^{i\alpha} a_1(z) + \rho e^{i\alpha} \sum_{k=2}^{\infty} k^{-n} a_k z^k$$

$$+ (-1)^n \sum_{k=1}^{\infty} k^{-n} b_k z^k + \rho e^{i\alpha}(-1)^n \sum_{k=1}^{\infty} k^{-n} b_k z^k - \rho e^{i\alpha} a_1(z)$$

$$-\,\rho e^{i\alpha} \sum_{k=2}^{\infty} k^{-m} a_k z^k - \rho e^{i\alpha}(-1)^m \sum_{k=1}^{\infty} k^{-m} b_k z^k - a_1(z)$$

$$-\sum_{k=2}^{\infty} k^{-m} a_k z^k - (-1)^m \sum_{k=1}^{\infty} k^{-m} b_k z^k - \gamma a_1(z) - \gamma \sum_{k=2}^{\infty} k^{-m} a_k z^k - (-1)^m \gamma \sum_{k=1}^{\infty} k^{-m} b_k z^k|$$

$$= |(2-\gamma) a_1(z) + \sum_{k=2}^{\infty} [((1+\rho e^{i\alpha}) k^{-n} + (1-\gamma-\rho e^{i\alpha}) k^{-m})] a_k z^k$$

$$+ (-1)^n \sum_{k=1}^{\infty} [(1+\rho e^{i\alpha}) k^{-n} - (-1)^{m-n} (\rho e^{i\alpha} + \gamma - 1) k^{-m}] \times \overline{b_k z^k}|$$

$$-\,|\gamma a_1(z) - \sum_{k=2}^{\infty} [(1+\rho e^{i\alpha}) k^{-n} - (1+\rho e^{i\alpha}+\gamma) k^{-m}] a_k z^k$$

Notes

$$-(-1)^n\sum_{k=1}^{\infty}[(1+\rho e^{i\alpha})k^{-n}-(-1)^{m-n}(1+\rho e^{i\alpha}+\gamma)k^{-m}]\overline{b_k z^k}|$$

$$\geq 2(1-\gamma)a_1|z|-2\sum_{k=2}^{\infty}[(1+\rho)k^{-n}-(\gamma+\rho)k^{-m}]|a_k||z|^k-2\sum_{k=1}^{\infty}[(1+\rho)k^{-n}-(-1)^{m-n}(\gamma+\rho)k^{-m}]|b_k||z|^k$$

Notes

$$\geq 2(1-\gamma)|z|\left[a_1-\sum_{k=2}^{\infty}\frac{(1+\rho)k^{-n}-(\gamma+\rho)k^{-m}}{(1-\gamma)}|a_k||z|^{k-1}-\sum_{k=1}^{\infty}\frac{(1+\rho)k^{-n}-(-1)^{m-n}(\gamma+\rho)k^{-m}}{1-\gamma}|b_k||z|^{k-1}\right]$$

By using (7), then the last expression is non negative, then (9) is satised.

The harmonic function

$$f(z)=a_1(z)+\sum_{k=2}^{\infty}\frac{(1-\gamma)}{(1+\rho)k^{-n}-(\gamma+\rho)k^{-m}}x_k z^k+\sum_{k=1}^{\infty}\frac{1-\gamma}{(1+\rho)k^{-n}-(-1)^{m-n}(\gamma+\rho)k^{-m}}\overline{y_k z^k} \tag{10}$$

Where $\sum_{k=2}^{\infty}|x_k|+\sum_{k=1}^{\infty}|y_k|=1$, shows that the coefficient bound given by (7) is sharp .

In the following theorem , it is shown that the condition (7) is also necessary for function $f_n=h+g_n$, where h and g_n are of the form(5) .

Theorem 2.2 . Let $f_n=h+g_n$, where h and g_n are given by (5). Then $f_n\in V_{\bar{H}}(m,n;\gamma,\rho,z_0)$, if and "only if" the coecient condition (7) holds .

Proof. Since $V_{\bar{H}}(m,n;\gamma,\rho,z_0)\subseteq E_{\bar{H}}(m,n;\gamma,\rho,z_0)$ we only need to prove the only if part of the theorem.For functions $f_n=h+g_n$, where h and g_n are given by (5), the inequality (4) with $f=f_n$ is equivalent to

$$R_e\left\{\frac{(1+\rho e^{i\alpha})\left(a_1z+\sum_{k=2}^{\infty}k^{-n}a_kz^k+(-1)^n\sum_{k=1}^{\infty}k^{-n}\bar{b}_k\bar{z}^k\right)}{a_1z+\sum_{k=2}^{\infty}k^{-m}a_kz^k+(-1)^m\sum_{k=1}^{\infty}k^{-m}\bar{b}_k\bar{z}^k}\right\}-$$

$$-R_e\left\{\frac{(\gamma+\rho e^{i\alpha})\left(a_1z+\sum_{k=2}^{\infty}k^{-m}a_kz^k+(-1)^m\sum_{k=1}^{\infty}k^{-m}\bar{b}_k\bar{z}^k\right)}{a_1z+\sum_{k=2}^{\infty}k^{-m}a_kz^k+(-1)^m\sum_{k=1}^{\infty}k^{-m}\bar{b}_k\bar{z}^k}\right\}>0.$$

The above condition holds for all values of $\alpha\in R$ and $z\in U$.Upon choosing ϕ according (6) and substituting $\alpha=0$ and $z=re^{i\phi}(0<r<1)$, we must have

$$\frac{E}{a_1-\left[\sum_{k=2}^{\infty}k^{-m}|a_k|-(-1)^{m+n-1}\sum_{k=1}^{\infty}k^{-m}|b_k|\right]r^{k-1}}>0, \tag{11}$$

Where

$$E = (1-\gamma) - \left(\sum_{k=2}^{\infty} [(1+\rho)k^{-n} - (\gamma+\rho)k^{-m}] |a_k| \right) r^{k-1} -$$

$$- \left(\sum_{k=1}^{\infty} [(1+\rho)k^{-n} - (-1)^{m-n}(\gamma+\rho)k^{-m}] |b_k| \right) r^{k-1} .$$

If the inequality(7) does not hold , then E is negative for r sufficiently close to 1. Thus there exists $z_0 = r_0$ in$(0,1)$ for which the quotient in (11) is negative. But this is a contradiction, the proof of Theorem (2.2) is completed.

We now obtain the distortion bounds for functions in $V_{\bar{H}}(m,n;\gamma,\rho,z_0)$.

Theorem 2.3 . Let $f_n = h + g_n$, where h and g_n are given by (5) and $f_n \in V_{\bar{H}}(m,n;\gamma,\rho,z_0)$. Then for $|z| = r < 1$, we have

$$|f_n(z)| \le (a_1 + |b_1|)r + \left[\frac{(1-\gamma)a_1}{(1+\rho)2^{-n} - (\gamma+\rho)2^{-m}} - \frac{(1+\rho) - (-1)^{m-n}(\gamma+\rho)}{(1+\rho)2^{-n} - (\gamma+\rho)2^{-m}} |b_1| \right] r^2 \quad (12)$$

and

$$|f_n(z)| \ge (a_1 + |b_1|)r + \left[\frac{(1-\gamma)a_1}{(1+\rho)2^{-n} - (\gamma+\rho)2^{-m}} - \frac{(1+\rho) - (-1)^{m-n}(\gamma+\rho)}{(1+\rho)2^{-n} - (\gamma+\rho)2^{-m}} |b_1| \right] r^2. \quad (13)$$

Proof. We prove the first inequality.

Let $f_n \in V_{\bar{H}}(m,n;\gamma,\rho,z_0)$, we have

$$(a)\ .\ |f_n(z)| \le (a_1 + |b_1|)r + \sum_{k=2}^{\infty} (|a_k| + |b_k|) r^k \le (a_1 + |b_1|)r + \sum_{k=2}^{\infty} (|a_k| + |b_k|) r^2$$

$$\le (a_1 + |b_1|)r + \frac{(1-\gamma)}{(1+\rho)2^{-n} - (\gamma+\rho)2^{-m}} \sum_{k=2}^{\infty} \frac{(1+\rho)2^{-n} - (\gamma+\rho)2^{-m}}{(1-\gamma)} (|a_k| + |b_k|) r^2$$

$$\le (a_1 + |b_1|)r + \frac{(1-\gamma)}{(1+\rho)2^{-n} - (\gamma+\rho)2^{-m}} \times \sum_{k=2}^{\infty} \left[\frac{(1+\rho)k^{-n} - (\gamma+\rho)k^{-m}}{(1-\gamma)} |a_k| + \frac{(1+\rho)k^{-n} - (-1)^{m-n}(\gamma+\rho)k^{-m}}{(1-\gamma)} |b_k| \right] r^2$$

$$\le (a_1 + |b_1|)r + \frac{(1-\gamma)}{(1+\rho)2^{-n} - (\gamma+\rho)2^{-m}} \left[a_1 - \frac{(1+\rho) - (-1)^{m-n}(\gamma+\rho)}{(1-\gamma)} |b_1| \right] r^2$$

$$\le (a_1 + |b_1|)r + \left[\frac{(1-\gamma)a_1}{(1+\rho)2^{-n} - (\gamma+\rho)2^{-m}} - \frac{(1+\rho) - (-1)^{m-n}(\gamma+\rho)}{(1+\rho)2^{-n} - (\gamma+\rho)2^{-m}} |b_1| \right] r^2 .$$

The proof of the second inequality is similar, thus it is left.

The bounds given in Theorem (2.3) for functions $f_n = h + g_n$ such that h and g_n are given by (6) also hold for functions $f_n = h + g_n$ such that h and g_n are given by (2) if the coefficient condition (7) is satisfied .

Using the same technique used earlier by Aghalary [1] we introduce the extreme points of the class $V_{\bar{H}}(m,n;\gamma,\rho,z_0)$.

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Notes

Theorem 2.4 . The closed convex hull of the class $V_H(m,n;\gamma,\rho,z_0)$ (denoted by $clcoV_{\bar{H}}$ $(m,n;\gamma,\rho,z_0))$ is

$$\{f(z) = a_1(z) + \sum_{k=2}^{\infty} a_k z^k + \overline{\sum_{k=1}^{\infty} b_k z^k} \in V_H(m,n;\gamma,\rho,z_0):$$

$$\sum_{k=1}^{\infty}\left[\frac{(1+\rho)k^{-n}-(\gamma+\rho)k^{-m}}{(1-\gamma)}|a_k| + \frac{(1+\rho)k^{-n}-(-1)^{m-n}(\gamma+\rho)k^{-m}}{(1-\gamma)}|b_k|\right] \le 2a_1\}$$

where $a_1 = 1$ .Set $\lambda_k = \frac{(1-\gamma)a_1}{(1+\rho)k^{-n}-(\gamma+\rho)k^{-m}}$ and $\mu_k = \frac{(1-\gamma)a_1}{(1+\rho)k^{-n}-(-1)^{m-n}(\gamma+\rho)k^{-m}}$

For b_1 fixed , $|b_1| \le \frac{(1-\gamma)a_1}{(1+\rho)k^{-n}-(-1)^{m-n}(\gamma+\rho)k^{-m}}$,the extreme points of the class $V_{\bar{H}}(m,n;\gamma,\rho,z_0)$ are

$$\left\{z + \lambda_k x z^k + \bar{b_1} z\right\} \cup \left\{\overline{z + \mu_k x z^k + b_1 z}\right\} \tag{14}$$

where k ≥ 2 and $|x| = 1 - \frac{(1+\rho)-(-1)^{m-n}(\gamma+\rho)}{(1-\gamma)}$.

Proof. Any function $f \in V_{\bar{H}}(m,n;\gamma,\rho,z_0)$ may be expressed as .

$$f(z) = a_1(z) + \sum_{k=2}^{\infty} |a_k| e^{i\beta_k} z^k + \overline{\sum_{k=2}^{\infty} |b_k| e^{i\delta_k} z^k} + \overline{b_1 z} \ ,$$

where the coefficients satisfy the inequality (7) . Set

$h_1(z) = z$,$g_1(z) = b_1 z$, $h_k(z) = z + \lambda_k e^{i\beta_k} z^k$, $g_k(z) = b_1 z + \mu_k e^{i\delta_k} z^k$,$k = 2, 3, \ldots$.

Writing $X_k = \frac{|a_k|}{\lambda_k}$, $Y_k = \frac{|b_k|}{\mu_k}$, $k = 2, 3, \ldots$. and $X_1 = 1 - \sum_{k=2}^{\infty} X_k$, $Y_1 = 1 - \sum_{k=2}^{\infty} Y_k$, we have

$$f(z) = \sum_{k=1}^{\infty}(X_k h_k(z) + \overline{Y_k g_k(z)})$$

In particular , setting $f_1(z) = z + \overline{b_1 z}$ and $f_k(z) = z + \lambda_k x z^k + \overline{b_1 z} + \overline{\mu_k y z^k}$,

$$\left(k \ge 2, |x| + |y| = 1 - \frac{(1+\rho)-(-1)^{m-n}(\gamma+\rho)}{(1-\gamma)}|b_1|\right)$$

we see that extreme points of the class $V_{\bar{H}}(m,n;\gamma,\rho,z_0)$ are contained in $\{f_k(z)\}$. To see that $f_1(z)$ is not an extreme point, note that $f_1(z)$ may be written as

$$f_1(z) = \frac{1}{2}\left[f_1(z) + \lambda\left(1 - \frac{(1+\rho)k^{-n}-(-1)^{m-n}(\gamma+\rho)k^{-m}}{(1-\gamma)}|b_1|\right) z^2\right]$$
$$+ \frac{1}{2}\left[f_1(z) - \lambda\left(1 - \frac{(1+\rho)k^{-n}-(-1)^{m-n}(\gamma+\rho)k^{-m}}{(1-\gamma)}|b_1|\right) z^2\right] ,$$

a convex linear combination of functions in the class $V_{\bar{H}}(m,n;\gamma,\rho,z_0)$. Next we will show if both $|x| \neq 0$ and $|y| \neq 0$, then f_k is not an extreme point .

Without loss of generality, assume $|x| \geq |y|$ choose $\epsilon > 0$ small enough so that $\epsilon < \frac{|x|}{|y|}$ Set $A = 1 + \epsilon$ and $B = 1 - \left|\frac{\epsilon x}{y}\right|$, we then see that both

$$t_1(z) = z + \lambda_k x A z^k + \overline{b_1 z + \mu_k y B z^k}$$

and

$$t_2(z) = z + \lambda_k x(2-A) z^k + \overline{b_1 z + \mu_k y(2-B) z^k}$$

are in the class $V_{\bar{H}}(m,n;\gamma,\rho,z_0)$ and note that

$$f_k(z) = \tfrac{1}{2} t_1(z) + t_2(z) \ .$$

The extremal coefficient bounds shows that functions of the form (14) are the extreme points for the class $V_{\bar{H}}(m,n;\gamma,\rho,z_0)$, then the proof of Theorem (2.4) is completed.

Now we will examine the closure properties of the class $V_{\bar{H}}(m,n;\gamma,\rho,z_0)$ under the generalized Bernardi - Libera - Livingston integral operator (see[2, 7])$L_c(f)$ which is defined by

$$L_c f(z) = \frac{c+1}{z^c} \int_0^z t^{c-1} f(t) dt (c > -1) \tag{15}$$

Theorem 2.5. Let $f_n = h + g_n \in V_{\bar{H}}(m,n;\gamma,\rho,z_0)$, where h and g_n are given by (5).Then $L_c(f_n(z))$ belongs to the class $V_{\bar{H}}(m,n;\gamma,\rho,z_0)$.

Proof. From the representation of $L_c\{f_n(z)\}$, it follows that

$$L_c(f_n(z)) = \tfrac{c+1}{z^c} \int_0^z t^{c-1} \{h(t) + \bar{g}_n(t)\} \, dt =$$

$$= \tfrac{c+1}{z^c} \int_0^z t^{c-1} \left[t + \sum_{k=2}^{\infty} a_k t^k + \overline{\sum_{k=1}^{\infty} b_k t^k} \right] dt =$$

$$= a_1(z) + \sum_{k=2}^{\infty} A_k z^k + \overline{\sum_{k=1}^{\infty} B_k z^k} \ ,$$

Where $A_k = \left(\frac{c+1}{c+k}\right) a_k$, $B_k = \left(\frac{c+1}{c+k}\right) b_k$. Therefore , we have ,

$$\sum_{k=2}^{\infty} \frac{(1+\rho)k^{-n} - (\gamma+\rho)k^{-m}}{(1-\gamma)} \frac{c+1}{c+k}|a_k| + \sum_{k=1}^{\infty} \frac{(1+\rho)k^{-n} - (-1)^{m-n}(\gamma+\rho)k^{-m}}{(1-\gamma)} \frac{c+1}{c+k}|b_k| \leq$$

$$\leq \sum_{k=2}^{\infty} \frac{(1+\rho)k^{-n} - (\gamma+\rho)k^{-m}}{(1-\gamma)}|a_k| + \sum_{k=1}^{\infty} \frac{(1+\rho)k^{-n} - (-1)^{m-n}(\gamma+\rho)k^{-m}}{(1-\gamma)}|b_k| \leq 2a_1 \ ,$$

and the proof of Theorem (2.5) is completed.

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Numerical Investigation of the Stability of Equilibrium Points for the Model of Three Mutually Competing, Symmetric and Continuous Time Reproducing Organism in a Fairly Stable Ecological Environment

By A. A. Obayomi & M. O. Oke
Ekiti State University, Nigeria

Abstract- In this paper, we examined the stability of the equilibrium points for the model of three mutually competing species within a stable ecosystem. For the stable ecosystem, we proposed that there are combinations of initial population densities and efficiency parameters that can balance the coexistence of these species for a very long time. This desirable biological property of a stable non-extinction equilibrium point for the ecosystem was obtained for all cases considered in this research work.

Keywords: Stability, Equilibrium points, Ecosystem, Population density.

GJSFR-F Classification : FOR Code : MSC 2010: 010499

NUMERICALINVESTIGATIONOFTHESTABILITYOFEQUILIBRIUMPOINTSFORTHEMODELOFTHREEMUTUALLYCOMPETINGSYMMETRICANDCONTINUOUSTIMEREPRODUCINGORGANISMINAFAIRLYSTABLEECOLOGICALENVIRONMENT

Strictly as per the compliance and regulations of :

Numerical Investigation of the Stability of Equilibrium Points for the Model of Three Mutually Competing, Symmetric and Continuous Time Reproducing Organism in a Fairly Stable Ecological Environment

A. A. Obayomi [α] & M. O. Oke [σ]

Abstract- In this paper, we examined the stability of the equilibrium points for the model of three mutually competing species within a stable ecosystem. For the stable ecosystem, we proposed that there are combinations of initial population densities and efficiency parameters that can balance the coexistence of these species for a very long time. This desirable biological property of a stable non-extinction equilibrium point for the ecosystem was obtained for all cases considered in this research work.

Keywords: stability, equilibrium points, ecosystem, population density.

I. Introduction

In Obayomi and Oke (2015), we investigated the equilibrium state for the kind of system considered in this paper. We also confirmed the analytic equilibrium points and showed that all the numerical equilibrium points coincide with at least one of the analytic ones. This implies that the schemes may not possess numerical instabilities, Mickens (1994) and Mickens (2000). In this paper, we shall investigate the stability of these equilibrium points based on various combinations of parameters and initial values. Consider a general first order ordinary differential equation (ODE) of the form

$$y' = f(t, y), \; y(t_0) = y_0 \tag{1}$$

Suppose equation (1) possesses the properties of existence and uniqueness of solution in its domain U, then the following definitions holds.

Definition 1: The zeros of the function f in equation (1) is a critical point. A point $\underline{y} \in R$ is called a fixed point or equilibrium point of the dynamical system defined by (1) if $f(\underline{y}) = 0$. If c is any critical point of f, then $y(x) = c$ is a constant solution of the differential equation.

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Remark 1: A fixed point y is stable if all nearby solutions stay nearby. It is asymptotically stable if all nearby solutions stay nearby and also tend to y or are attracted by y.

Definition 2: (Stability of equilibrium point)

Let $U \in R^m$ be the domain of definition of f in equation (1), then any equilibrium point y of (1) is said to be stable if and only if, for every neighborhood **Ω** of y in U, there is an open neighborhood V of y such that any orbit starting globally in V remains in **Ω** for all $t \geq 0$. If V = U then y is globally stable. If y is stable and there exists a domain V_0 such that any orbit originally in V_0 tends to y as t tends to infinity, then y is asymptotically stable, Beltrami (1986).

II. Materials and Methods

a) Stability of Non-standard Finite Difference Schemes

We derived our standard reference for the qualitative property of non-standard schemes from the work of Anguelov and Lubuma (2003) and the references therein.

It is a common fact to write the functional dependence y_{n+1} on the quantities x_n, y_n and h in the form

$$y_{k+1} = y_k + h\varphi(x_k, y_k; h) \tag{2}$$

where $\varphi(x_k, y_k; h)$ is called the increment function.

Definition 3:

Let us denote (2) by the sequence

$$y_k = F(h; y_k) \tag{3}$$

and let us assume that the solution of equation (1) satisfies some property $\boldsymbol{\mathcal{P}}$. The numerical scheme (3) is said to be qualitatively stable with respect to property $\boldsymbol{\mathcal{P}}$ or $\boldsymbol{\mathcal{P}}$-stable, if for every value $h > 0$, the set of solutions of (3) satisfies $\boldsymbol{\mathcal{P}}$, Anguelov and Lubuma(2003).

Definition 4: A set $G(\Omega)$ of real-valued functions defined on a subset Ω of $[t_0, \infty)$ monotonically depend on the initial value (t_0) if for every two functions $y, z \in G(\Omega)$, we have $y(t_0) \leq z(t_0)$ implies that $y(t) \leq z(t)$, for $t \in \Omega$, Anguelov and Lubuma(2003).

Definition 5: The finite difference scheme (3) is stable with respect to the property of monotonicity of solutions if for every $y_0 \in \mathbb{R}$, the solution y_k of (3) is an increasing or a decreasing sequence just as the $y(t)$ of equation (1) is increasing or decreasing.

Definition 6: Any fixed point $\bar{y}$ of (1) is called hyperbolic fixed point if it satisfies the relationship $j \equiv f'(\bar{y}) \neq 0$, Anguelov and Lubuma(2003).

Remark 2: The asymptotic behavior of solutions of (1) with initial data near y may be reduced to the behavior of linear equation of the form

$$\epsilon' = J\epsilon. \tag{4}$$

Definition 7: A hyperbolic fixed point is called linearly-stable provided that the solution ϵ of equation (1) corresponding to any small initial data $\epsilon(0)$, for $|\epsilon(0)| << 1$ say,

Notes

satisfies $\lim_{t\to\infty} \epsilon(t) = 0$. Otherwise the fixed point is linearly unstable. The discrete analogue of (4) is given by

$$\epsilon_{k+1} = J_h \epsilon_k \quad \text{where } J_h = \frac{\partial F}{\partial y}(h; \bar{y}) \tag{5}$$

Definition 8: Assume that a hyperbolic fixed point $\bar{y}$ of the differential equation (1) is a solution to the discrete method (3). We say that the constant solution $\bar{y}$ is linearly stable provided that the solution ϵ_k of the equation (1) corresponding to any initial data $\epsilon(0)$, for $|\epsilon(0)| << 1$ say, satisfies $\lim_{k\to\infty} \epsilon_k = 0$. This is equivalent to saying that $|J_h|<1$ in (5). Otherwise the fixed point is linearly unstable, Anguelov and Lubuma (2003).

Definition 9: The finite difference method (3) is called elementary stable if for any value of the step size h , its only fixed points $\bar{y}$ are those of the differential equation (1), the linear stability property of each $\bar{y}$ being the same for both the differential equation and the discrete method.

Theorems and conditions supporting these stability properties above may be found in Anguelov and Lubuma (2003).

Numerical experiments have been carried out in which several set of different initial values have been used to test the stability of the equilibrium points while fixing the efficiency parameters. The equilibrium points tested for stability are those that were obtained in Obayomi and Oke (2015).

III. Numerical Experiments

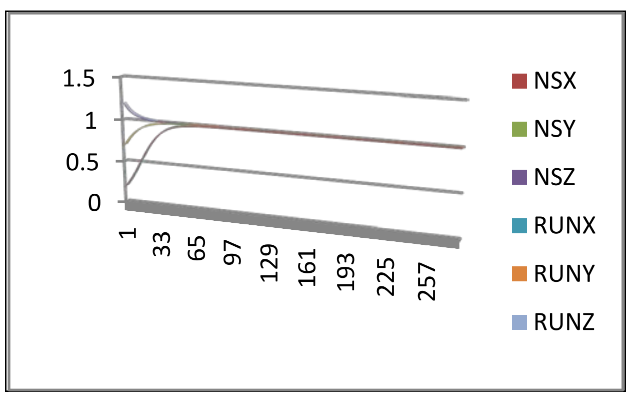

Figure 1 : Orbit of the schemes for $\propto = 0\,, \beta = 0$

The equilibrium state is (1, 1, 1) for any non-zero initial values

Note: NS = Non-standard and RUN= Runge Kutta

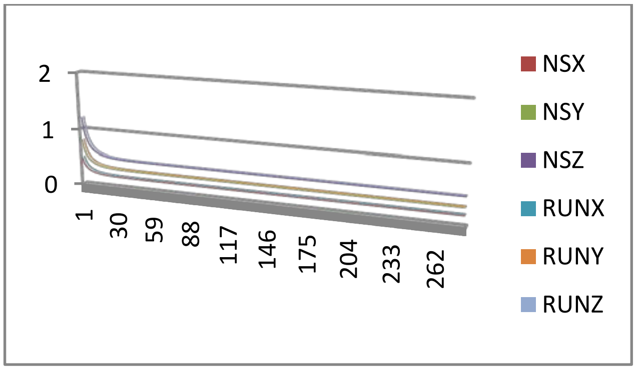

Figure 2 : Orbit of the schemes when $\propto = 1, \beta = 1$

The equilibrium state is (0.195, 0.317, 0.488) for initial value (0.5, 0.8, 1.2) which is in the form (X, Y, Z) such that $X + Y + Z = 1$

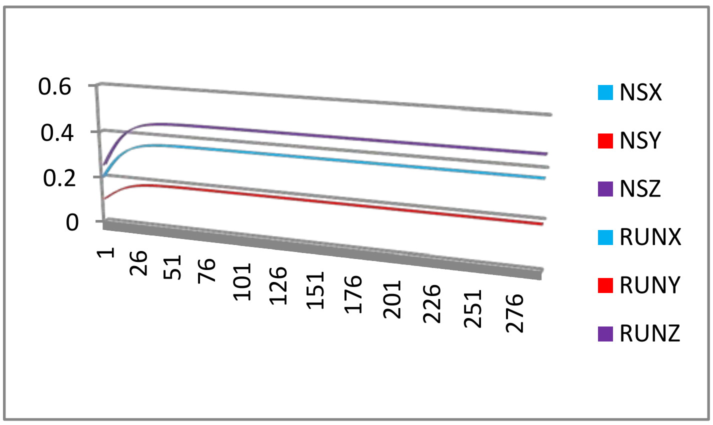

Figure 3 : Orbit of the schemes when $\propto = 1, \beta = 1$

The equilibrium state is (0.364, 0.183, 0.453) for initial value (0.2, 0.1, 0.25) which is in the form (X, Y, Z) such that $X + Y + Z = 1$

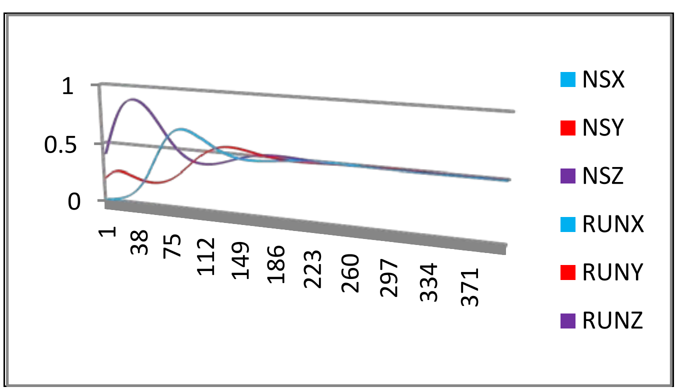

Figure 4 : Orbit of the schemes for $\propto = 1, \beta = 0$ or $\propto = 0, \beta = 1$

The equilibrium state is (0.5 ,0.5, 0.5) for any non-zero initial value

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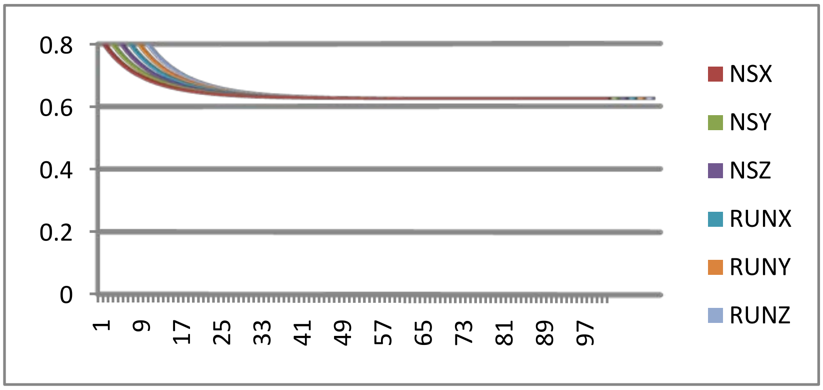

Figure 5 : Orbit of the schemes for $\alpha, \beta \epsilon (0,1)$ *and* $\alpha\,\beta < 1$

The equilibrium point is (0.625, 0.625, 0.625) when $(\alpha = 0.25, \beta = 0.35)$ with initial value (0.8, 0.8,0.8) which confirms (k, k, k) where $k = \frac{1}{1+\alpha+\beta}$.

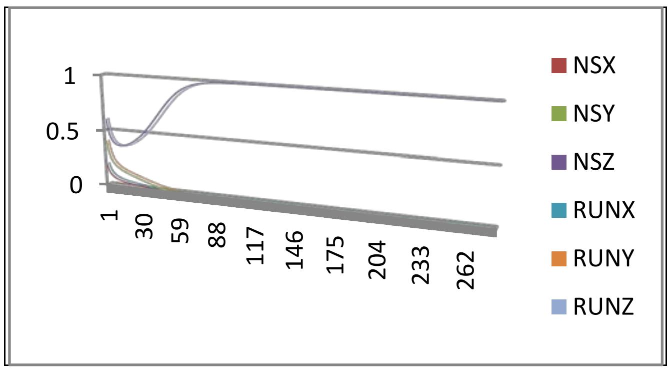

Figure 6 : Orbit of the schemes for $\alpha, \beta > 1$ i.e $\alpha\,\beta > 1$

The equilibrium point is (0, 0, 1) for $(\alpha = \beta = 3)$ with initial value (0.2, 0.4, 0.6).

Note: The equilibrium point is (1,0,0), (0,1,0) or (0,0,1) depending on the initial values. The specie with the highest initial value will wipe out the other two species on the long run

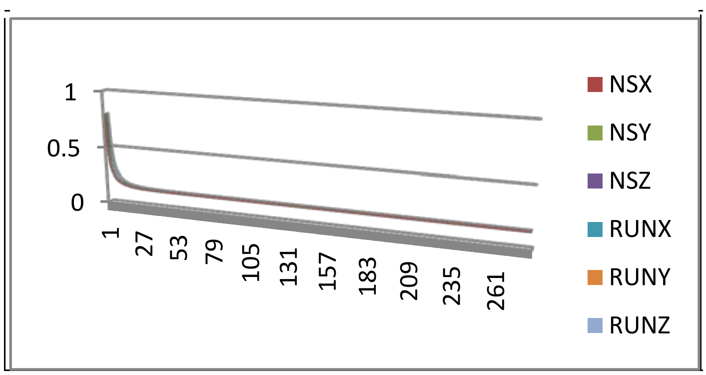

Figure 7 : Orbit of the schemes for $\alpha, \beta > 1$ i.e $\alpha\,\beta > 1$

The equilibrium point is (0.14286, 0.14286, 0.14286) for $(\alpha = \beta = 3)$ with initial value (0.8, 0.8, 0.8) which confirms (k, k, k) where $k = \frac{1}{1+\alpha+\beta}$

Notes

Note: The equilibrium point is (k, k, k) where $k = \frac{1}{1+\alpha+\beta}$ if the initial values are the same.

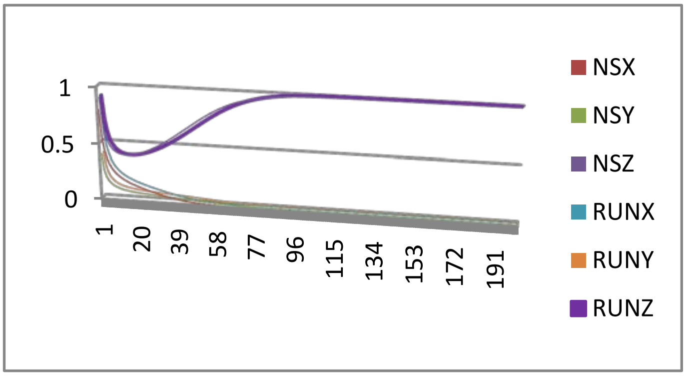

Figure 8 : Orbit of the schemes for $\alpha, \beta > 1, \alpha \neq \beta$ i.e $\alpha\, \beta > 1$

The equilibrium point is (0, 1, 0) for $\alpha = 2, \beta = 3$

The equilibrium point is reduced to one of (1, 0, 0), (0, 1, 0) or (0, 0, 1) in relation to the density at the initial time

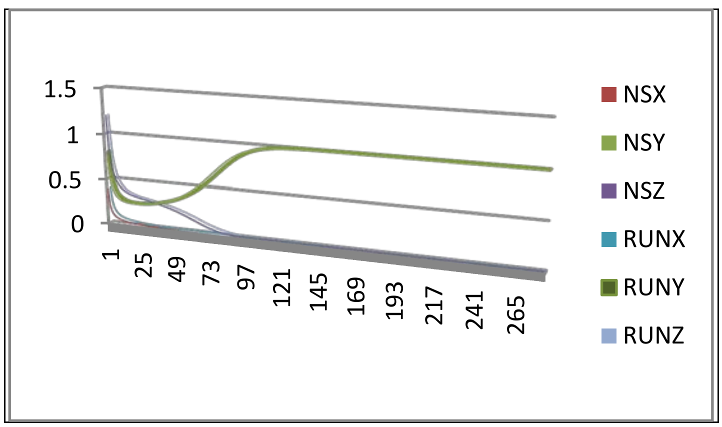

Figure 9 : Orbit of the schemes for $\alpha, \beta > 1, \alpha \neq \beta$ i.e $\alpha\, \beta > 1$

The equilibrium point is (0,0,1) for $\alpha = 3, \beta = 2$, initial value is (0.4, 0.8, 1.2).

The equilibrium point is reduced to one of (1,0,0),(0,1,0) or (0,0,1) in relation to the initial density.

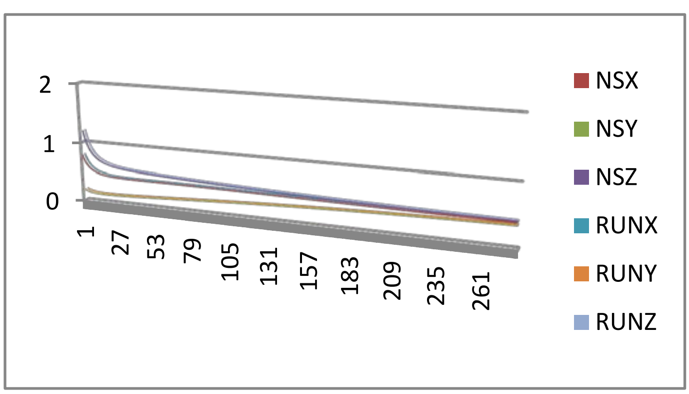

Figure 10 : Orbit of the schemes for $\alpha, \beta \in (0,1)$ *and* $\alpha\, \beta < 1$

The equilibrium point is (0.4, 0.4, 0.4), $(\alpha = \beta = 0.75)$ with initial value (0.8, 0.2, 1.2) which confirms (k, k, k) where k = $\frac{1}{1+\alpha+\beta}$.

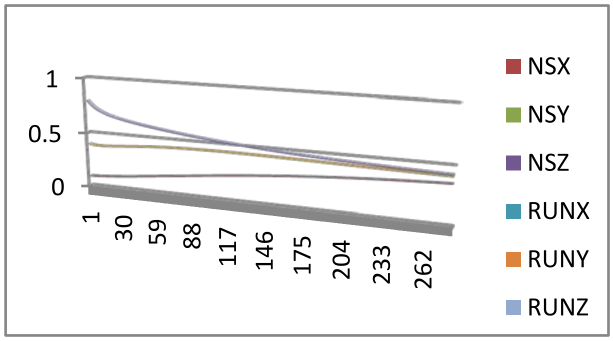

Figure 11 : Orbit of the schemes for $\alpha, \beta \epsilon (0,1)$ *and* $\alpha\, \beta < 1$

The equilibrium point is (0.4, 0.4, 0.4), $(\alpha = \beta = 0.75)$ with initial value (0.1, 0.4, 0.8) which confirms (k, k, k) where k = $\frac{1}{1+\alpha+\beta}$.

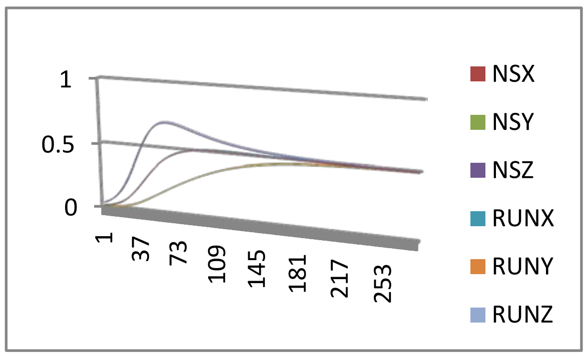

Figure 12 : Orbit of the schemes for $\alpha, \beta \epsilon (0,1)$ *and* $\alpha\, \beta < 1$

The equilibrium point is (0.5, 0.5, 0.5), $(\alpha = \beta = 0.5)$, initial value is (0.01, 0.003, 0.03) which confirms (k, k, k) where k = $\frac{1}{1+\alpha+\beta}$.

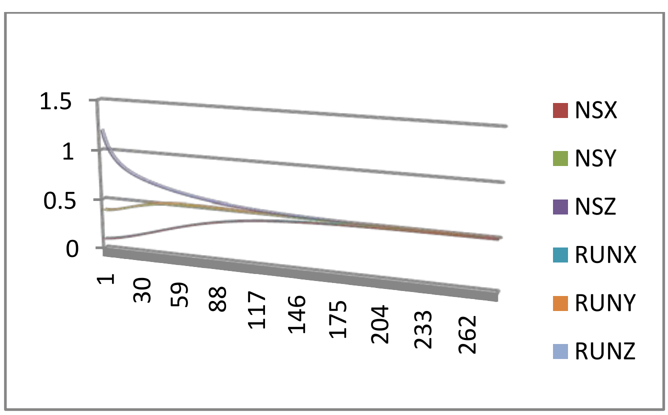

Figure 13 : Orbit of the schemes for $\alpha, \beta \epsilon (0,1)$ *and* $\alpha\, \beta < 1$

The equilibrium point is (0.5, 0.5, 0.5), $(\alpha = \beta = 0.5)$ with initial value (0.1, 0.4, 1.2) which confirms (k, k, k) where k = $\frac{1}{1+\alpha+\beta}$.

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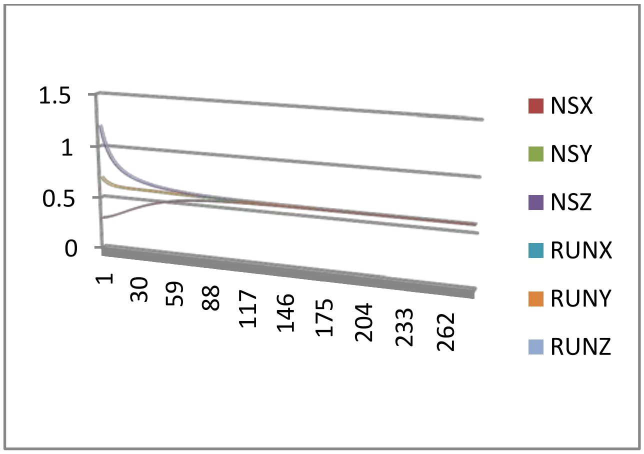

Figure 14 : Orbit of the schemes for $\alpha, \beta \epsilon (0,1)$ *and* $\alpha \beta < 1$

The equilibrium point is (0.588, 0.588, 0.588), $(\alpha = \beta = 0.35)$ initial value is (0.3, 0.7, 1.2) which confirms (k, k, k) where k $= \frac{1}{1+\alpha+\beta}$.

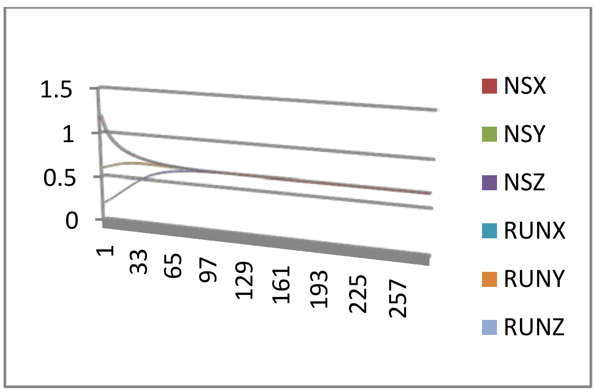

Figure 15 : Orbit of the schemes for $\alpha, \beta \epsilon (0,1)$ *and* $\alpha \beta < 1$

The equilibrium point is (0.67, 0.67, 0.67), $(\alpha = \beta = 0.25)$ with initial value (1.2, 0.6, 0.2) which confirms (k, k, k) where k $= \frac{1}{1+\alpha+\beta}$

IV. Discussion of Results

The following were observed from the result of the numerical experiment.

i For $\propto = \beta = 0$, the equilibrium state is $(1,1,1)$. Therefore, for any initial value, it is expected that if the co-existent of the species are either mutually beneficial or of insignificant effect on each other then all species are expected to grow to the full carrying capacity of the ecological environment and the point $(1,1,1)$ is a stable equilibrium.

ii For $\propto = \beta = 1$, the equilibrium state is (X_1, X_2, X_3) such that $X_1 + X_2 + X_3 = 1$. It may however reduce the habitat to a partially extinct equilibrium state with only the specie with the largest initial value remaining and growing to its full capacity as competition fades away. This equilibrium points depends on the initial value and therefore it is not stable.

Global Journal of Science Frontier Research (F) Volume XV Issue VI Version I Year 2015

Notes

iii For $\propto = 1$, $\beta = 0$ or $\propto = 0$, $\beta = 1$ the equilibrium state is $(0.5, 0.5, 0.5)$ for any initial value. The equilibrium point in this case is stable.

iv For $\alpha, \beta \epsilon (0,1)$ *and* $\alpha \beta < 1$ the equilibrium point is (k, k, k) where $k = \frac{1}{1+\alpha+\beta}$ for any initial value. The equilibrium point here is also stable.

v For $\alpha, \beta > 1$ i.e $\alpha \beta > 1$ the equilibrium point is (k, k, k) where $k = \frac{1}{1+\alpha+\beta}$. If the initial values are the same, the equilibrium points are unstable.

vi For $\alpha, \beta > 1$, $\alpha = \beta$ i.e $\alpha \beta > 1$, the equilibrium point is (k, k, k) where $k = \frac{1}{1+\alpha+\beta}$. If the initial values are the same and the habitat is reduced to one of $(1,0,0)$, $(0,1,0)$ or $(0,0,1)$ depending on the specie with the largest initial value, then the equilibrium point is unstable.

vii For $\alpha, \beta > 1, \alpha \neq \beta$ i.e $\beta > 1$. If the habitat is reduced to one of $(1,0,0)$, $(0,1,0)$ or $(0,0,1)$ depending on the initial values, then the equilibrium points are unstable.

viii The computational results also confirm the trivial equilibrium points.

V. Conclusion

Our results support and confirm the earlier studies on this model and exposed the expected physical situation in the ecological environment. With a suitable control mechanism on the efficiency parameters, ecologists, zoologists etc can apply this model for research and ecological planning. The information obtained here may also be used for pest control in Agrarian science.

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On Non-Invariant Hypersurfaces of $\delta-$lorentzian Trans-Sasakian Manifolds

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Abstract- The object of the present paper is to study non-invariant Hypersurfaces of $\delta-$Lorentzian trans-Sasakian Manifolds equipped with $(f, g, u, v, \lambda)-$ structure and some properties obeyed by this structure are obtained also. The necessary and sufficient conditions have been otained for totally umbilical non-invariant hypersurfaces with (f, g, u, v, λ) –structure of δ–Lorentzian trans-Sasakian Manifold to be totally geodesic.

Keywords: *δ–Lorentzian trans-Sasakian, totally umbilical, totally geodesic.*

GJSFR-F Classification : *FOR Code : MSC 2000: 14J70, 53C20*

ONNONINVARIANTHYPERSURFACESOFLORENTZIANTRANSSASAKIANMANIFOLDS

Strictly as per the compliance and regulations of :

On Non-Invariant Hypersurfaces of $\delta-$lorentzian Trans-Sasakian Manifolds

Shyam Kishor [α] & Puneet Kumar Gupt [σ]

Abstract- The object of the present paper is to study non-invariant Hypersurfaces of $\boldsymbol{\delta}-$Lorentzian trans-Sasakian Manifolds equipped with $(f, g, u, v, \lambda)-$ structure and some properties obeyed by this structure are obtained also. The necessary and sufficient conditions have been obtained for totally umbilical non-invariant hypersurfaces with (f, g, u, v, λ) $-$structure of $\boldsymbol{\delta}-$Lorentzian trans-Sasakian Manifold to be totally geodesic.

Keywords and phrases: $\delta-$Lorentzian trans-Sasakian, totally umbilical, totally geodesic.

I. Introduction

Recently, many authors have studied Lorentzian $\alpha-$Sasakian manifold [1] and Lorentzian $\beta-$Kenmotsu manifolds [7], [3]. S.S.Pujar and V.J.Khairnar [12] have initiated the study of Lorentzian Trans-Sasakian manifolds and studied the basic results with some of its properties. Earlier to this, S.S.Pujar [13] has initiated the study of $\delta-$Lorentzian, $\alpha-$Sasakian manifold [3] and $\delta-$Lorentzian $\beta-$Kenmotsu manifolds [4].

In 2010, S.S.Shukla and D.D. Singh [14] have introduced the notion of $\varepsilon-$trans-Sasakian manifolds and studied its basic results and using these results some of its properties were studied. Earlier to this in 1969 Takahashi [16] had introduced the notaion of almost contact metric manifold equipped with pseudo Riemannian metric. In particular he studied the Sasakian manifolds equipped with Riemannian metric g. These indefinite almost contact metric manifolds and indefinite Sasakian manifolds are also known as $\varepsilon-$almost contact metric manifolds and $\varepsilon-$Sasakian manifolds respectively.

Recently, it has been observed that there does not exists a light like surface in the $\varepsilon-$Sasakian manifolds ([8], [16]). On the other hand in almost para contact manifold defined by Motsumoto [6] , the semi Riemannian manifold has the index 1 and the structure vector field ξ is always a time like. This motivated Tripathi et. al [8] to introduce $\varepsilon-$almost para contact structure where the vector field ξ is space like or time like according as $\varepsilon = 1$ or $\varepsilon = -1$.

In 1970, S.I.Goldberg et. al [10] introduced the notion of a non-invariant hypersurfaces of an almost contact manifold in which the transform of a tangent vector of the hypersurface by the $(1,1)$ structure tensor field ϕ defining the almost contact structure is never tangent to the hypersurface.

The notion of (f, g, u, v, λ) -structure was given by K.Yano [4]. It is well known that a hypersurface of an almost contact metric manifold always admits a (f, g, u, v, λ) -structure ([5] [2]). Goldberg et. al [10] proved that there always exists a (f, g, u, v, λ) -structure on a non-invariant hypersurface of an almost contact metric manifold.

Ref

3. G. T. Srinivas, Venkatesh and C.S. Bagewadi, On Lorentzian $\beta-$ Kenmotsu manifolds, General Mathematics, 18(4)(2010), 61 – 69:

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They also proved that there does not exist invariant hypersurface of a contact manifold. R.Prasad [9] studied the non-invariant hypersurfaces of a trans-Sasakian manifolds. Non-invariant hypersurfaces of nearly trans-Sasakian manifold have been studied by S.Kishor et. al [11]. In the present paper, we study the non-invariant hypersurfaces of $\delta-$Lorentzian trans-Sasakian manifolds.

II. Preliminaries

A $(2n+1)$ dimensional manifold $\widetilde{M}$, is said to be the $\delta-$almost contact metric manifold if it admits a $(1,1)$ tensor field ϕ, a structure tensor field ξ, a $1-$form η, and an indefinite metric g such that

$$\phi^2 = I + \eta \otimes \xi, \eta(\xi) = -1, \phi \circ \xi = 0, \eta \circ \phi = 0 \tag{2.1}$$

$$g(\xi, \xi) = -\delta, \eta(X) = \delta g(X, \xi) \tag{2.2}$$

$$g(\phi X, \phi Y) = g(X, Y) + \delta \eta(X) \eta(Y) \tag{2.3}$$

$$g(X, \phi Y) = g(\phi X, Y) \tag{2.4}$$

for all $X, Y \in T\widetilde{M}$, where δ is such that $\delta^2 = 1$.

The above structure $(\phi, \xi, \eta, g, \delta)$ on $\widetilde{M}$ is called the $\delta-$Lorentzian structure on $\widetilde{M}$.

A $\delta-$Lorentzian manifold with structure $(\phi, \xi, \eta, g, \delta)$ is said to be $\delta-$Lorentzian trans-Sasakian manifold $\widetilde{M}$ of type (α, β) if it satisfies the condition

$$\left(\widetilde{\nabla}_X \phi\right) Y = \alpha \{g(X, Y)\xi - \delta \eta(Y) X\} + \beta \{g(\phi X, Y)\xi - \delta \eta(Y)\phi X\} \tag{2.5}$$

for any vector fields X and Y on $\widetilde{M}$. where $\widetilde{\nabla}$ is the operator of covariant differentiation with respect to g. From above, we have

$$\widetilde{\nabla}_X \xi = \delta(-\alpha \phi X - \beta(X + \eta(X)\xi)) \tag{2.6}$$

and

$$\left(\widetilde{\nabla}_X \eta\right) Y = \alpha g(\phi X, Y) + \beta \{g(X, Y) + \delta \eta(X) \eta(Y)\} \tag{2.7}$$

A hypersurface of an almost contact metric manifold $\widetilde{M}$ is called a non-invariant hypersurface, if the transform of a tangent vector of the hypersurface under the action of $(1,1)$ tensor field ϕ defining the contact structure is never tangent to the hypersurface. Let X be a tangent vector on non-invariant hypersurface of an almost contact metric manifold $\widetilde{M}$, then ϕX is never tangent to the hypersurface.

Let M be a non-invariant hypersurface of an almost contact metric manifold. Now, if we define the following

$$\phi X = fX + u(X)\hat{N}, \tag{2.8}$$

$$\phi \hat{N} = -U, \tag{2.9}$$

$$\xi = V + \lambda \hat{N}, \lambda = \eta\left(\hat{N}\right), \tag{2.10}$$

$$\eta(X) = v(X), \tag{2.11}$$

Ref

9. R. Prasad, On Non-invariant Hypersurfaces of Trans-Sasakian Manifold, J. Inter. Acad. Phys. Sci.

Notes

where, f is a $(1,1)$ tensor field, u,v are $1-$form, $\hat{N}$ is a unit normal to the hypersurface, $X\in TM$ and $u(X)\neq 0$, then we get an induced $(f,g,u,v,\lambda)-$structure on M satisfying the conditions

$$f^2=-I+u\otimes U+v\otimes V, \tag{2.12}$$

$$fU=-\lambda V, fV=\lambda U, \tag{2.13}$$

$$u\circ f=\lambda v, v\circ f=-\lambda u, \tag{2.14}$$

$$u(U)=1-\lambda^2, u(V)=v(U)=0, v(V)=1-\lambda^2, \tag{2.15}$$

$$g(fX,fY)=g(X,Y-u(X)u(Y)-v(X)v(Y)), \tag{2.16}$$

$$g(X,fY)=-g(fX,Y), g(X,U)=u(X), \tag{2.17}$$

$$g(X,V)=v(X), \tag{2.18}$$

for all $X,Y\in TM$, where $\lambda=\eta\left(\hat{N}\right)$.

The Gauss and Weingarten formulae are given by

$$\widetilde{\nabla}_XY=\nabla_XY+\sigma(X,Y)\hat{N}, \tag{2.19}$$

$$\widetilde{\nabla}_X\hat{N}=-A_{\hat{N}}X, \tag{2.20}$$

for all $X,Y\in TM$, where $\widetilde{\nabla}$ and ∇ are the Riemannian and induced Riemannian connections on $\widetilde{M}$ and M respectively and $\hat{N}$ is the unit normal vector in the normal bundle $T^{\perp}M$. In this formula σ is the second fundamental form on M related to $A_{\hat{N}}$ by

$$\sigma(X,Y)=g\left(A_{\hat{N}}X,Y\right), \text{ for all } X,Y\in TM.$$

III. Some Properties of Non-Invariant Hypersurfaces

Lemma 1. :*Let M be a non-invariant hypersurface with $(f,g,u,v,\lambda)-$structure of $\delta-$Lorentzian trans-Sasakian manifold $\widetilde{M}$. Then*

$$\left(\widetilde{\nabla}_X\phi\right)Y=(\nabla_Xf)Y-u(Y)\left(A_{\hat{N}}X\right)+\sigma(X,Y)U+((\nabla_Xu)Y+\sigma(X,fY))\hat{N} \tag{3.1}$$

$$\left(\widetilde{\nabla}_X\eta\right)Y=(\nabla_Xv)Y-\lambda\sigma(X,Y) \tag{3.2}$$

$$\widetilde{\nabla}_X\xi=\nabla_XV-\lambda A_{\hat{N}}X+(\sigma(X,V)+X\lambda)\hat{N} \tag{3.3}$$

Proof. Consider

$$\begin{aligned}\left(\widetilde{\nabla}_X\phi\right)Y &= \left(\widetilde{\nabla}_X\phi Y\right)-\phi\left(\widetilde{\nabla}_XY\right)\\ &= \widetilde{\nabla}_X\left(fY+u(Y)\hat{N}\right)-\phi\left(\nabla_XY+\sigma(X,Y)\hat{N}\right)\\ &= \widetilde{\nabla}_X(fY)+\widetilde{\nabla}_X\left(u(Y)\hat{N}\right)-\phi(\nabla_XY)-\sigma(X,Y)\phi\left(\hat{N}\right)\end{aligned}$$

$$
\begin{aligned}
&= \nabla_X (fY) + \sigma(X, fY)\hat{N} + u(Y)\left(\widetilde{\nabla}_X \hat{N}\right) + \left(\widetilde{\nabla}_X u(Y)\right)\hat{N} - f(\nabla_X Y) \\
&\quad -u(\nabla_X Y)\hat{N} + \sigma(X, Y)U
\end{aligned}
$$

which gives

$$
\left(\widetilde{\nabla}_X \phi\right) Y = (\nabla_X f) Y - u(Y)\left(A_{\hat{N}} X\right) + \sigma(X, Y) U + ((\nabla_X u) Y + \sigma(X, fY))\hat{N}
$$

Also we have,

$$
\begin{aligned}
\left(\widetilde{\nabla}_X \eta\right) Y &= \widetilde{\nabla}_X \eta(Y) - \eta\left(\widetilde{\nabla}_X Y\right) \\
&= \widetilde{\nabla}_X (v(Y)) - \eta\left(\nabla_X Y + \sigma(X, Y)\hat{N}\right) \\
&= \nabla_X (v(Y)) + \sigma(X, v(Y))\hat{N} - \eta(\nabla_X Y) - \sigma(X, Y)\eta\left(\hat{N}\right) \\
&= \nabla_X (v(Y)) - v(\nabla_X Y) - \lambda\sigma(X, Y)
\end{aligned}
$$

$\left(\widetilde{\nabla}_X \eta\right) Y = (\nabla_X v) Y - \lambda\sigma(X, Y)$

Further, consider

$$
\begin{aligned}
\widetilde{\nabla}_X \xi &= \nabla_X \xi + \sigma(X, \xi)\hat{N} \\
&= \nabla_X V + \nabla_X \lambda\hat{N} + \sigma(X, V)\hat{N} \\
&= \nabla_X V + \lambda\nabla_X \hat{N} + (X\lambda)\hat{N} + \sigma(X, V)\hat{N}
\end{aligned}
$$

which gives

$$
\widetilde{\nabla}_X \xi = \nabla_X V - \lambda A_{\hat{N}} X + (\sigma(X, V) + X\lambda)\hat{N}
$$

□

Theorem 1.: *Let M be a non-invariant hypersurface with $(f, g, u, v, \lambda)-$structure of $\delta-$Lorentzian trans-Sasakian manifold $\widetilde{M}$. Then*

$$
\sigma(X, \xi) U = \alpha\delta f^2 X - \alpha\delta u(X) U + \delta\beta f(X) + f(\nabla_X \xi) \tag{3.4}
$$

$$
u(\nabla_X \xi) = -\alpha\delta u(fX) - \beta\delta u(X) \tag{3.5}
$$

Proof. :Consider

$$
\begin{aligned}
\left(\widetilde{\nabla}_X \phi\right)\xi &= \widetilde{\nabla}_X \phi\xi - \phi\left(\widetilde{\nabla}_X \xi\right) \\
&= -\phi(\delta(-\alpha\phi X - \beta(X + \eta(X)\xi)))
\end{aligned}
$$

or

$$
\left(\widetilde{\nabla}_X \phi\right)\xi = \alpha\delta f^2 X + \alpha\delta u(fX)\hat{N} - \alpha\delta u(X) U + \delta\beta f(X) + \beta\delta u(X)\hat{N}
$$

and we know that the relation

$$
\begin{aligned}
\left(\widetilde{\nabla}_X \phi\right)\xi &= \widetilde{\nabla}_X \phi\xi - \phi\left(\widetilde{\nabla}_X \xi\right) \\
&= -\phi\left(\nabla_X \xi + \sigma(X, \xi)\hat{N}\right) \\
&= -\phi(\nabla_X \xi) + \sigma(X, \xi) U \\
&= -f(\nabla_X \xi) - u(\nabla_X \xi)\hat{N} + \sigma(X, \xi) U
\end{aligned}
$$

from above two equation,we have

$$
\begin{aligned}
-f(\nabla_X \xi) - u(\nabla_X \xi)\hat{N} + \sigma(X, \xi) U &= \alpha\delta f^2 X + \alpha\delta u(fX)\hat{N} - \alpha\delta u(X) U \\
&\quad + \delta\beta f(X) + \beta\delta u(X)\hat{N}
\end{aligned}
$$

Notes

Euating tangential and normal parts on both side, we get

$$\sigma(X,\xi)U = \alpha\delta f^2 X - \alpha\delta u(X)U + \delta\beta f(X) + f(\nabla_X \xi)$$

and

$$u(\nabla_X \xi) = -\alpha\delta u(fX) - \beta\delta u(X)$$

□

Theorem 2.: *Let M be a non-invariant hypersurface with $(f,g,u,v,\lambda)-$structure of $\delta-$Lorentzian trans-Sasakian manifold $\widetilde{M}$. Then*

$$\begin{aligned}(\nabla_X f)Y &= u(Y)\left(A_{\hat{N}}X\right) - \sigma(X,Y)U + \alpha(g(X,Y)V - \delta v(Y)X) \\ &\quad +\beta(g(fX,Y)V - \delta v(Y)fX)\end{aligned} \tag{3.6}$$

$$(\nabla_X u)Y = \alpha\lambda g(X,Y) + \beta(\lambda g(fX,Y) - \delta u(X)v(Y)) - \sigma(X,fY) \tag{3.7}$$

$$\nabla_X V = \lambda A_{\hat{N}}X - \delta\alpha fX - \delta\beta(X + v(X)V) \tag{3.8}$$

$$\sigma(X,V) = -\delta\alpha u(X) - \delta\lambda\beta v(X) - X\lambda \tag{3.9}$$

$$(\nabla_X v)Y = \lambda\sigma(X,Y) + \alpha g(fX,Y) + \beta\{g(X,Y) - \delta v(X)v(Y)\} \tag{3.10}$$

Proof. : Using (2.8), (2.10) in (2.5) and (3.1) we obtain

$$\begin{aligned}&(\nabla_X f)Y - u(Y)\left(A_{\hat{N}}X\right) + \sigma(X,Y)U + ((\nabla_X u)Y + \sigma(X,fY))\hat{N} \\ = \;&\alpha g(X,Y)V + \alpha\lambda g(X,Y)\hat{N} - \alpha\delta v(Y)X + \beta g(fX,Y)V \\ &+\beta\lambda g(fX,Y)\hat{N} - \beta\delta v(Y)fX - \beta\delta v(Y)u(X)\hat{N}\end{aligned}$$

Equating tangential and normal parts in the above equation, we get (3.6) and (3.7) respectively.

Using equation (2.6), (2.8) and (2.11) we get,

$$\widetilde{\nabla}_X \xi = -\delta\alpha fX - \delta\alpha u(X)\hat{N} - \delta\beta X - \delta\beta v(X)V - \lambda\delta\beta v(X)\hat{N}$$

and also we have,

$$\widetilde{\nabla}_X \xi = \nabla_X V - \lambda A_{\hat{N}}X + (\sigma(X,V) + X\lambda)\hat{N}$$

Equating the tangential and normal part of the above two equation, we get (3.8) and (3.9).

In last using (2.7), (2.8) and (3.2) we get (3.10)

□

Theorem 3. :*Let M be a non-invariant hypersurface with $(f,g,u,v,\lambda)-$structure of $\delta-$Lorentzian trans-Sasakian manifold $\widetilde{M}$. Then*

$$\begin{aligned}\left(\widetilde{\nabla}_X\phi\right)Y &= \alpha(g(X,Y)V - \delta v(Y)X) + \beta(g(fX,Y)V - \delta v(Y)fX) \\ &\quad + \{\alpha(\lambda g(X,Y)) + \beta(\lambda g(fX,Y) - \delta u(X)v(Y))\}\hat{N}\end{aligned} \tag{3.11}$$

Proof. :Consider

$$\begin{aligned}\left(\widetilde{\nabla}_X\phi\right)Y &= \left(\widetilde{\nabla}_X\phi Y\right) - \phi\left(\widetilde{\nabla}_X Y\right) \\ &= \widetilde{\nabla}_X\left(fY + u(Y)\hat{N}\right) - \phi\left(\nabla_X Y + \sigma(X,Y)\hat{N}\right) \\ &= \widetilde{\nabla}_X(fY) + \widetilde{\nabla}_X\left(u(Y)\hat{N}\right) - \phi(\nabla_X Y) - \sigma(X,Y)\phi\left(\hat{N}\right) \\ &= \nabla_X(fY) + \sigma(X,fY)\hat{N} + u(Y)\left(\widetilde{\nabla}_X\hat{N}\right) + \left(\widetilde{\nabla}_X u(Y)\right)\hat{N} - f(\nabla_X Y) \\ &\quad -u(\nabla_X Y)\hat{N} + \sigma(X,Y)U\end{aligned}$$

Notes

which gives

$$\left(\widetilde{\nabla}_X\phi\right)Y=\left(\nabla_Xf\right)Y-u\left(Y\right)\left(A_{\hat{N}}X\right)+\sigma\left(X,Y\right)U+\left(\left(\nabla_Xu\right)Y+\sigma\left(X,fY\right)\right)\hat{N} \quad (3.12)$$

and we have also from (3.6) and (3.7)

$$\begin{aligned}\left(\nabla_Xf\right)Y &= u\left(Y\right)\left(A_{\hat{N}}X\right)-\sigma\left(X,Y\right)U+\alpha\left(g\left(X,Y\right)V-\delta v\left(Y\right)X\right) \\ &\quad+\beta\left(g\left(fX,Y\right)V-\delta v\left(Y\right)fX\right)\end{aligned} \quad (3.13)$$

and

(3.14) $$\left(\nabla_Xu\right)Y=\alpha\lambda g\left(X,Y\right)+\beta\left(\lambda g\left(fX,Y\right)-\delta u\left(X\right)v\left(Y\right)\right)-\sigma\left(X,fY\right)$$

now equation (3.12) , (3.13) , and (3.14) enables us to deduce (3.11) □

Theorem 4. :*Let M be a totally umbilical noninvariant hypersurface with $(f,g,u,v,\lambda)-$structure of $\delta-$Lorentzian trans-Sasakian manifold. Then it is totally geodesic if and only if*

(3.15) $$\delta\alpha u\left(X\right)+\delta\lambda\beta v\left(X\right)+X\lambda=0$$

Proof. :From equation (2.6) we have,

$$\widetilde{\nabla}_X\xi=\delta\left(-\alpha\phi X-\beta\left(X+\eta\left(X\right)\xi\right)\right)$$

Using (2.8) and (2.11) in above equation we get

$$\begin{aligned}\widetilde{\nabla}_X\xi &= -\delta\alpha fX-\delta\alpha u\left(X\right)\hat{N}-\delta\beta X-\delta\beta v\left(X\right)V \\ &\quad-\delta\lambda\beta v\left(X\right)\hat{N}\end{aligned}$$

Equating the normal parts of above equation and equation (3.3) we obtain

(3.16) $$\sigma\left(X,V\right)=-\delta\alpha u\left(X\right)-\delta\lambda\beta v\left(X\right)-X\lambda$$

If M is totally umbilical, then $A_{\hat{N}}=\zeta I$
where ζ is Kahlerian metric

$$\sigma\left(X,Y\right)=g\left(A_{\hat{N}}X,Y\right)=g\left(\zeta X,Y\right)=\zeta g\left(X,Y\right)$$

$$\sigma\left(X,V\right)=\zeta g\left(X,V\right)=\zeta v\left(X\right) \quad (3.17)$$

Then, from (3.13) and (3.14) we get

$$\delta\alpha u\left(X\right)+\delta\lambda\beta v\left(X\right)+X\lambda+\zeta v\left(X\right)=0$$

If M is totally geodesic, i.e. $\zeta=0$
then,

$$\delta\alpha u\left(X\right)+\delta\lambda\beta v\left(X\right)+X\lambda=0$$

□

Theorem 5. :*Let M be a non-invariant hypersurface with $(f,g,u,v,\lambda)-$structure of $\delta-$Lorentzian trans-Sasakian manifold $\widetilde{M}$. If U is parallel, then we have*

$$f\left(A_{\hat{N}}X\right)+\delta\lambda\alpha X+\delta\lambda\beta fX=0 \quad (3.18)$$

Proof. :Consider

$$\left(\widetilde{\nabla}_X\phi\right)\hat{N}=\widetilde{\nabla}_X\left(\phi\hat{N}\right)-\phi\left(\widetilde{\nabla}_X\hat{N}\right)$$

Using (2.9) , (2.19) and (2.20) we get

$$\left(\widetilde{\nabla}_X\phi\right)\hat{N}=-\nabla_XU+f\left(A_{\hat{N}}X\right) \quad (3.19)$$

and from (2.5) we write

$$\left(\widetilde{\nabla}_X\phi\right)\hat{N}=\alpha\left\{g\left(X,\hat{N}\right)\xi-\delta\eta\left(\hat{N}\right)X\right\}+\beta\left\{g\left(\phi X,\hat{N}\right)\xi-\delta\eta\left(\hat{N}\right)\phi X\right\}$$

Notes

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Using (2.10) in above equation we get,

$$\left(\widetilde{\nabla}_X \phi\right) \hat{N} = -\delta\alpha\lambda X - \beta\delta\lambda\phi X \tag{3.20}$$

Using (3.19) and (3.20), we get

$$\begin{aligned} \nabla_X U &= \delta\alpha\lambda X + \beta\delta\lambda\phi X + f\left(A_{\hat{N}} X\right) \\ &= \delta\alpha\lambda X + f\left(A_{\hat{N}} X\right) + \beta\delta\lambda f X + \beta\delta\lambda u\left(X\right)\hat{N} \end{aligned}$$

If U is parallel,then $\nabla_X U = 0$

$$\delta\alpha\lambda X + f\left(A_{\hat{N}} X\right) + \beta\delta\lambda f X + \beta\delta\lambda u\left(X\right)\hat{N} = 0$$

Now, equating the tangential part, we have the result. □

Notes

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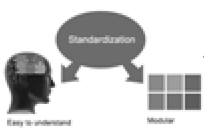

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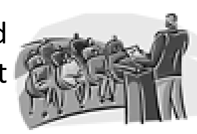

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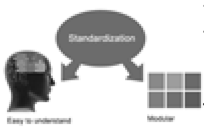

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Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

Structure

All manuscripts submitted to Global Journals Inc. (US), ought to include:

Title: The title page must carry an instructive 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) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

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

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin 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 research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

Tables, Figures and Figure Legends

Tables: Tables should be few in number, 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. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

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

Color Charges: It is the rule of the Global Journals Inc. (US) for authors to pay the full cost for the reproduction of their color artwork. Hence, please note that, if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a color work agreement form before your paper can be published.

Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.

6. AFTER ACCEPTANCE

Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

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The corresponding author will receive an e-mail alert containing a link to a website or will be attached. A working e-mail address must therefore be provided for the related author.

Acrobat Reader will be required in order to read this file. This software can be downloaded

(Free of charge) from the following website:

www.adobe.com/products/acrobat/readstep2.html. This will facilitate the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof.

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Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. 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.

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

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

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

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

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. 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 to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

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

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

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

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After 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 to 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 in 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 criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of 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 the 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 evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

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

Title Page:

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

Abstract:

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

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

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

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

Approach:

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

Introduction:

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

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

Approach:

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

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

Procedures (Methods and Materials):

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

Materials:

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

Methods:

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

Approach:

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

What to keep away from

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

Results:

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

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

Content

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

What to stay away from

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

Approach

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

Figures and tables

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

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a 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 implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly 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 with prospect, and let it drop at that.

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

Approach:

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

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- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.
- Do not give permission to anyone else to "PROOFREAD" your manuscript.
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- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

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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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