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Career Brief

After completing my M. Tech (IIT, Kharagpur) in Industrial Engineering and Operations Research, I joined Department of Management Studies, NIT Tiruchirappalli (then REC), in 1987 as a Research Associate. I am currently Professor, Department of Management Studies-NITT. I completed my Ph.D. from the Bharathidasan University, Tiruchirappalli. My academic and professional pursuits have over these years cut across several disciplines. My academic areas of interest include Machine Learning, Game Theory, Applied Statistics & Data Analysis, Operations Management, Project Management and Costing, Logistics and Supply Chain Management, and Operations Research & Decision Sciences. I have also taught courses in these areas as visiting professor to several leading management institutes in India including the Department of Management Studies IIT-M. I have conducted executive training programmes. I have authored over **80 papers/articles** that have been published / presented at national and international journals and conferences. I have **published a patent** (Application No: 201741002082) on the title of *"A Logic to decipher the dynamic architecture from music and vice-versa"*. Awarded **Best Paper Award** for the paper titled *"Strategic Decision Model for Technology Selection"* by the **ASME** (**American Society of Mechanical Engineers**) during May 2003. I have authored a **book on production management** for Anna University Distance Learning programme, a book on "**Service Quality in Indian Hospitals – perspectives from an emerging market**" by Springer Publications (ISBN 978-3-319-67888-7), a book on "**Resource Allocation Problems in Supply Chains**" by Emerald Group Publishing Limited in 2015 (ISBN 178560399X, 9781785603990) and A book on **Data Analytics** is getting ready for publication by Pearson Publications. I have also been on the editorial board of several journals and have been a reviewer for many others.

Work Experience

Primary Appointment	• **Professor-Higher Administrative Grade (HAG), NIT-Tiruchirappalli (Since April 2019)**
	• Professor, NIT-Tiruchirappalli (Since April 2007)
	• Assistant Professor, NIT-Tiruchirappalli (1995-2007)
	• Lecturer, NIT-Tiruchirappalli (1988-1995)
	• Sr. Research Associate, NIT-Tiruchirappalli (1988-1988)
	• Research Associate, NIT-Tiruchirappalli (1987-1988)
Department / Institution positions	• **Nodal Officer, NIT-Tiruchirappalli (Since 2015)**
	• **Dean – Institute Development,** NIT-Tiruchirappalli (2012 to 2015)
	• **Head of the Department**, Management Studies, NIT-Tiruchirappalli
	o Period from 28-11-2007 to10-02-2011
	o Period from04-02-2004 to21-12-2005
	o Period from1991 to 1993
Teaching Experience	• Taught on an average of 5 Courses every year for the last 5 years
	• Consistently rated as the best faculty by the MBA class several times.

Research Experience	• Published **14 SCI papers**
	• Published **6 ESCI Indexed Journals**
	• Published **34 Scopus Indexed Journals**
	• Have over 18 publications in peer-reviewed Journals
	• Three papers in National Academic / Professional Journals
	• Five papers in Conference proceedings
	• Guided 10 Ph.D., 17 Ph.D. researches are ongoing, and over 300 MBA Research Thesis.
Extended Professional Activities	• Acted as **Director In-charge intermittently** at **NIT Trichy** for **144 days during the periods of 2013- 2015**.
	• I have coordinated five development programs
	• I have been a member on various boards, committees, and editorship in journals

Tasks/Responsibilities undertaken as Nodal Officer (SC, ST, OBC, PwDand Minorities) at NIT- T

Activities as a Nodal Officer

- Various welfare schemes are implemented for SC/ST/PwD students and staff members of NIT Trichy SCSP and TSP plan based on the communication from MHRD.

- The tuition fee is waived for SC/ST students under SCSP and TSP plan.

- Soft skill training to both UG and PG students belongs to SC/ST and PwD.

Periodical interaction with SC/ST students are organized for solving any issue related to academic and social.

Tasks/Responsibilities undertaken as Dean Institute Development at NIT- T

Activities Carried out as Dean – ID

In charge of Hospital, Guest House, School, Transportation, SC/ST/OBC/Women Cell and PwD

- **Hospital**
  - Specialized Doctors were appointed for Cardio, Diabetes, Homeopathy, Dentist, Radiologist, Physiotherapist and Ayurveda
  - Dental Chair for filling and scaling.
  - Hospital working hours extended to 24x7 with Life Saving Ambulance.
  - Augmented Facilities – Auto counter, Minor OT, Fumigator & Wax bath, 55 Air Conditioned rooms.

- **Guest House**
  - 55 rooms were Air Conditioned.
  - Amenities arranged well equipped with two single cots, cushioned chairs, study table, shoe racks, coat stand, kettles, LED TV and attached restrooms.
  - On-site Facilities: Doctor-on-call, round-the-clock room service, Wi-Fi service, laundry, 24 hours hot & cold water supply, power back-up and travel desk, 2 state of art rooms - hosted our Honourable President and our Governor, 2 common rooms and a conference hall- gathering/meeting.

- **School**
  - NIT, Nursery School has been renovated.
  - Fencing has been made on all the sides of NIT, Nursery School for safety of the Kids.
  - Salary (50%) hike has been made with the patron of Director for all the staff of school.
  - New UPS has been procured to solve the problems of Electricity.

- **Transport**

- o Shuttle bus service was arranged within the campus for every one hour, from Admin block covering all Hostels.
- o During Festival holidays and long holidays, the bus trip arranged morning and evening from junction to NITT and from NITT to junction.
- o School services are provided for wards of Staff on payment.
- o Buses to pick up and drop all our staff members, both in the morning and evening has become operational.

- **SC/ST/OBC/Women Cell**
  - o Research projects are sanctioned to faculty members belong to SC/ST and PwD under Scheduled Caste Sub Plan (SCSP), Tribal Sub Plan (TSP) and Persons with Disabilities (PwD)
  - o Intern with scholarship is provided to the SC/ST/PwD student under the SCSP, TSP and PwD plan
  - o Special lectures are arranged for week SC/ST/PwD students under SCSP and TSP plan
  - o Specific attention is given to SC/ST/PwD students on various difficult subjects under SCSP and TSP plan
  - o Training program on preparation of GATE and CAT for SC/ST students under SCSP and TSP plan
  - o Training programme on Communication skill development for employees and wards
  - o Transport facility has been arranged for those who are residing outside the campus.
  - o Organized Health Awareness Camp, physiotherapy and Yoga programme periodically
  - o Health and Fitness practice session arranged for Women employees every week
  - o Internal Complaint committee is formed to handle the women harassment issues.
  - o Women Harassment Cell is functioning to sort-out the harassment related issues

- **PwD Cell**
  - o Temporary conveyance facilities (auto rickshaw) have been arranged for PH/PwD Students within the campus from Hostel to Lecture Hall complex, Library and Hospital and the expenditure is borne by the institute.
  - o Any welfare measures related to PH/PwD students will be taken care.
  - o Temporary residential Quarters have been provided for a period of 3 to 6 months to stay along with their parents on medical grounds.

Tasks/Responsibilities undertaken as Head of Department at Management Studies, NITT

Activities Carried out as HoD

- Instrumental in bringing GD & PI as part of MBA student selection process during 1992-93.
- Conducted & coordinated REC All India MBA Entrance Examination, GD & PI
- Instrumental in bringing in the trimester pattern for MBA during 1992-1993.
- Instrumental in bringing Business Analysis as a specialization in MBA during 2007-11.
- Under my stewardship, Department of Management Studies has been selected as an "Outstanding B-School (South)" for the National B School Award from Star News for the year 2010.

Tasks/Responsibilities undertaken as Teaching Faculty at Department of Management Studies, NITT

Curriculum Development

- New subjects introduced: Game Theory, Machine Learning, Data Analysis, Supply Chain Management, Logistics Management, Enterprise Resource Planning, Production Planning and Control.
- Syllabus revisions were done for all the subjects in the Operations Management area.

Innovative Teaching Method

- Introduced 'Marathon Task Analysis' as a part of evaluation for my core subjects.

- Hands on learning for Machine Learning Techniques and Data Analysis, where the students model the data analysis problem on computers and use large datasets to learn about 15 core data analysis tools covering Multiple Regression, Conjoint Analysis, Principal Component Analysis, Canonical Correlation, Multidimensional Scaling, Cluster Analysis, Discriminant Analysis, Factor Analysis, Support Vector Machines among many others

Other Notable Academic contribution

- A patent entitled "*A logic to decipher the dynamic architecture from music and vice-versa*" was published on Intellectual property of India, July-2018, (Application no: 201741002082).

- The paper titled "*Strategic Decision Model for Technology Selection*" was selected as one the best paper for Technology selection by the ASME (American Society of Mechanical Engineers) during May 2003.

- The book on "*Data Analysis for Business Decision*" is almost to be completed. This book is shortly in the process of publication by Pearson Education, India.

- The Solution Manual has been prepared for the reputed book on "*PROJECT: Planning, Analysis, Selection, Financing, Implementation and Review*" Written by renowned author Dr. Prasanna Chandra and it is available online.

- A detailed suggestion has been given to modify the chapter on Credit management in the famous management text book "*Financial Management – Theory and Practice*" written by well-known author Dr. Prasanna Chandra.

- Received an appreciation letter and consultancy was sought by Mr. J.K. Ghose, Additional Chief Engineer, M.N. Dastur & Co Ltd after studying my article titled – "*Economic Justification of FMS*" (IIIE Journal volume XXVII number 6 of June 1998)

- An appreciation letter of appreciation was given by the publisher Palgrave Macmillan for the article, "*An empirical model for brand loyalty measurement*", published in Journal of targeting, measurement and analysis for marketing.

Task/Responsibilities undertaken as Researcher

Papers in International Academic/ Professional Journals

SCI Journals:

1. Manochandar, S., Punniyamoorthy, M, Jeyachitra. R.K (2020) "Development of new seed with modified validity measure for K-means clustering", *Computers and Industrial Engineering, Volume 141, March 2020, 106290.*

2. Sivaguru M, Punniyamoorthy M, (2020) "Modified dynamic fuzzy c-means clustering algorithm – Application in dynamic customer segmentation", *Applied Intelligence* **– Accepted.**

3. Vijaya Prabhagar, M., Punniyamoorthy, M, (2020) "A new initialization and performance measure for the rough k-means clustering", *Soft Computing* doi:10.1007/s00500-019-04625-9

4. Anu Sendhil, Muthukkumaran, K, Punniyamoorthy, M, Veerapandian, S. A., & Sangeetha, G, (2019), "Deciphering the frozen music in building Architecture and Vice-Versa process", *Multimedia tools and applications* – **In print**.

5. Vijaya Prabhagar, M. & Punniyamoorthy, M. (2019), "Development of new agglomerative and performance evaluation models for classification". *Neural Computing and Applications*, 1-12. https://doi.org/10.1007/s00521-019-04297-4

6. Sundar R, Punniyamoorthy M, (2019) "Performance enhanced Boosted SVM for Imbalanced data sets", *Applied Soft Computing,* Volume 83, October 2019, 105601

7. Manochandar, S., Punniyamoorthy, M, (2018) "Scaling Feature selection method for enhancing the classification performance of support vector machines in text mining", *Computers & Industrial Engineering,* Volume 124, October 2018, Pages 139-156

8. Punniyamoorthy, M., & Sridevi, P. (2017). "Influence of fuzzy index parameter on new membership function for an efficient FCM based FSVM classifier". *Journal of the National Science Foundation of Sri Lanka,* 45(4), pp – 367-379.

9. Punniyamoorthy, M., Mathiyalagan, P., & Parthiban, P. (2011). "A strategic model using structural equation modelling and fuzzy logic in supplier selection". *Expert Systems with Applications*, 38(1), Pp- 458-474.

10. Parameshwaran, R., Srinivasan, P. S. S., Punniyamoorthy, M., & Charunyanath, S. T. (2009). "Integrating fuzzy analytical hierarchy process and data envelopment analysis for performance management in automobile repair shops. *"European Journal of Industrial Engineering*, *3*(4), Pp- 450-467.

11. Punniyamoorthy, M., & Ragavan, P. V. (2005). "Justification of automatic storage and retrieval system (AS/RS) in a heavy engineering industry". *The International Journal of Advanced Manufacturing Technology*, *26*(5-6), Pp- 653-658.

12. Ganesh, K., &Punniyamoorthy, M. (2004). "Optimization of continuous-time production planning using hybrid genetic algorithms-simulated annealing. *"The International Journal of Advanced Manufacturing Technology*, *26*(1-2), Pp- 148-154.

13. Ragavan, P., & Punniyamoorthy, M. (2003). "A strategic decision model for the justification of technology selection. *"The International Journal of Advanced Manufacturing Technology*, *21*(1), Pp- 72-78.

14. Aravindan, P., &Punniyamoorthy, M. (2002). "Justification of advanced manufacturing technologies (AMT)." *The International Journal of Advanced Manufacturing Technology*, *19*(2), 151-156.

15. Manochandar, S., and Punniyamoorthy, M, (2019) "A new user similarity measure in a new prediction model for collaborative filtering", *Applied Intelligence*- **Under Review**.

16. Vijaya Prabhagar, M., Punniyamoorthy, M, (2019) "Means to enhance the performance of Kohonen Self–Organizing map", *Neurocomputing*- **Communicated**.

17. Sarin Abraham, Punniyamoorthy, M. (2019) "Analysis and assessment of divergence of final offers in negotiation using Gamma and Beta distribution". *International journal of advanced operations management* - **Communicated**.

18. Sarin Abraham, Punniyamoorthy, M. (2019) "A fuzzy approach using asymmetrical triangular distribution in a two-person zero-sum game for multi-criteria decision making problem". *Fuzzy Set and systems* – **Under review**.

19. Sivaguru, M. & Punniyamoorthy, M. (2019), "Dynamic fuzzy c-means clustering algorithm using cumulative cost curve – Application in dynamic retail customer segmentation", *Decision Support Systems*- **Communicated**.

20. Sivaguru, M. & Punniyamoorthy, M. (2019), "A modified rough k-means clustering algorithm", *Soft Computing* - **Communicated**.

21. Anu Sendhil, Muthukkumaran, K, Punniyamoorthy, M, Veerapandian, S. A., & Sangeetha, G, (2019), "Transformations of Architectural Forms into Music and Vice Versa", *Multimedia tools and applications* – **Communicated**.

SSCI Indexed Journals:

22. Sarin Abraham, Punniyamoorthy, M. and Jose Joy Thoppan (2019) "A method to select best among Multi-Nash Equilibria". *International Journal of Process Management and Benchmarking* – **Communicated**.

ESCI Indexed Journals:

23. Ramanathan M., Punniyamoorthy, M., Balamurugan V., (2020) "Means to rank the R&D Projects based on their criticality", *International Journal of Information Technology Project Management* (IJITPM)- **Accepted.**

24. Prabha M, Punniyamoorthy M. (2019) "A model to quantify Psychological Empowerment of Technical Institutional Faculty" *Benchmarking: An International Journal*. – **Accepted**

25. Ande Raja Ambedkar, Punniyamoorthy. M, Thamaraiselvan. N, (2017), "Brand Resonance Score for CBBE Model-An Application in Financial Services. *"Benchmarking: An International Journal*, 24(6), pp.1490-1507

26. Punniyamoorthy, M., & Sridevi, P. (2016) "Identification of a standard AI based technique for credit risk analysis". *Benchmarking: An International Journal*, *23*(5), Pp- 1381-1390.

27. Punniyamoorthy, M., Thamaraiselvan, N., Manikandan, L. (2013). "Assessment of supply chain risk: Scale development and validation", *Benchmarking: an international Journal,* 20(1), Pp- 79-105.

28. Punniyamoorthy M., Mathiyalagan, P., & Lakshmi, G. (2012) "A combined application of structural equation modelling (SEM) and analytic hierarchy process (AHP) in supplier selection*". Benchmarking: An International Journal,* 19(1), Pp- 70-92.

29. Punniyamoorthy, M., & Murali, R. (2008). "Balanced score for the balanced scorecard: a benchmarking tool". *Benchmarking: An International Journal*, 15(4), Pp- 420-443.

30. Hari hara Krishna kumar V, Punniyamoorthy M, Sundar R, and Lavanya V " A Modified Boosted SVM to rate banks", *Benchmarking: An International Journal – Communicated.*

Scopus Indexed Journals:

31. Nafeesathul Basariya I, Punniyamoorthy M. (2019) "An Approach to arrive at Stationarity in Time Series Data", *International Journal of Applied Management Science* – **Accepted**

32. Sarin Abraham, Punniyamoorthy, M. (2019), "A development in the existing non-linear model and to study its impact on the Nash equilibrium in a two-person non-zero sum game", *International Journal of Enterprise Network Management - Accepted*.

33. Prabha M, Punniyamoorthy M., Nivethitha. S (2019) "A Study on the Impact of Psychological Empowerment on Motivation and Satisfaction among the Faculty Working in the Technical Educational Institutions in India through based on Age and Work Experience difference", *International Journal of Enterprise Network Management* – **Accepted**

34. Nafeesathul Basariya I, Punniyamoorthy M. (2019) "Data Analysis framework to predict the behaviour of macroeconomic indicators of countries", *International Journal of operations research* – **Accepted**

35. Nafeesathul Basariya I, Punniyamoorthy M. (2019) "A study on the Impact of macroeconomic indicators on the stock price by relaxing the assumptions of stationary in time series data in General Linear model", *International Journal of Enterprise Network Management* – **Accepted**

36. Chitradevi. N, Punniyamoorthy. M (2019), "Herding behaviour in beta based portfolios", *International Journal of Management Practices* - **Accepted**

37. Maruthamuthu, A., Punniyamoorthy, M., Paluru, S. M., & Tammuluri, S. (2019). Prediction of carotid atherosclerosis in patients with impaired glucose tolerance-a performance analysis of machine learning techniques. *International Journal of Enterprise Network Management*, 10(2), 109-117.

38. Ganapathy, G., Sivakumaran, N., Punniyamoorthy, M., Surendheran, R., & Thokala, S. (2019). Comparative study of machine learning techniques for breast cancer identification/diagnosis. *International Journal of Enterprise Network Management*, 10(1), 44-63.

39. Punniyamoorthy, M., & Asumptha, J. A. (2019). A study on knowledge sharing behaviour among academicians in India. *Knowledge Management & E-Learning: An International Journal*, 11(1), 95-113.

40. Ganapathy G, Sivakumaran N, Punniyamoorthy M, Tryambak Chatterjee, Monisha Ravi (2018) "Improving the prediction accuracy of low back pain using machine learning through data pre-processing techniques" *International Journal of Medical engineering and informatics*. **(In print)**

41. Raja Ambedkar, A., Murugesan, P., & Thamaraiselvan, N. (2018). Modelling Brand resonance score (BRS)– an application in financial services. *Journal of Modelling in Management*, 13(1), 119-136.

42. Antonette Asumptha J, & Punniyamoorthy, M, (2017) "Succession Planning and Knowledge Management in family owned business firms. *International Journal of Pure & Applied Mathematics*. 119(7), Pp- 293-302

43. Punniyamoorthy, M., & Sridevi, P. (2017). "Evaluation of a FCM-based FSVM classifier using fuzzy index". *International Journal of Enterprise Network Management*, 8(1), Pp- 14-34.

44. Sivakumar, P., Ganesh, Punniyamoorthy, M., Lenny Koh, S.C., (2013*), "*Genetic Algorithm for Inventory Levels and Routing Structure Optimization in Two Stage Supply Chain*", International Journal of Information Systems and Supply Chain Management*, 6(2), Pp- 33-49, April-June

45. M. Punniyamoorthy, Rani Susmitha and K. Ganesh (2013), "A study on the impact of demographics, clinical quality variables and service quality factors on cardiac patient satisfaction in India", **International Journal of Operational Research**.

46. Thoppan, J. J., & Punniyamoorthy, M. (2013). Market manipulation and surveillance–a survey of literature and some practical implications. *International Journal of Value Chain Management*, 7(1), 55-75.

47. Punniyamoorthy, M., Thoppan, J.J. (2013) *"ANN-GA based model for Stock Market Surveillance", Journal of Financial Crime,* Emerald Publications, 20(1), pp. 52-66.

48. Malairajan, R.A., Ganesh, K., Punniyamoorthy, M. and Anbuudayasankar, S.P. (2013) "Decision Support System for Real Time Vehicle Routing in Indian Dairy Industry-A Case Study", *International Journal of Information System and Supply Chain management*, *6*(4), 77-101.

49. Kiruthika, A., Chandramohan, S., Punniyamoorthy, M., & Latha, S. (2012). "Evaluation of service quality of banks–a fuzzy approach*". International Journal of Enterprise Network Management,* 5(4), Pp- 333-354.

50. Sivakumar, P., Ganesh, K., Anbuudayashankar, S.P., Punniyamoorthy, M., Lenny Koh, S.C., (2012), *"*Heuristic approach for balanced allocation problem in logistics: a comparative study*", International Journal of Operational Research*, 14(3), 2012, Pp- 255 - 270

51. Punniyamoorthy, M., Mahadevan, B., Shetty, N.K., Lakshmi, G. (2011),*"*A framework for assessment of brand loyalty score for commodities *"Journal of Targeting, Measurement and Analysis for Marketing* 201119(3 / 4), Pp- 243–260

52. Manikandan, L., Thamaraiselvan, N., & Punniyamoorthy, M. (2011). "An instrument to assess supply chain risk: establishing content validity." *International Journal of Enterprise Network Management*, 4(4), Pp- 325-343.

53. Parameshwaran, R., Srinivasan, P. S. S., &Punniyamoorthy, M. (2010). "An integrated approach for performance enhancement in automobile repair shops*". International Journal of Business Excellence*, *3*(1), Pp- 77-104

54. Punniyamoorthy, M., & Murali, R. (2010) "Identification of benchmarking service units through productivity and quality dimensions*". International Journal of Business Performance Management*, 12(2), Pp- 103-122.

55. Parthiban, P., M. Punniyamoorthy, K. Ganesh and G.R. Janardhana, (2009). "A model for selection of suppliers by comparison of two clustering algorithms". *International Journal of Applied Decision Sciences*. 2: Pp- 422-443.

56. Parthiban, P., Punniyamoorthy, M., Ganesh, K., & Ranga Janardhana, G. (2009). "A hybrid model for sourcing selection with order quantity allocation with multiple objectives under fuzzy environment". *International Journal of Applied Decision Sciences*, 2(3), Pp- 275-298.

57. Punniyamoorthy, M., & Murali, R. (2009). "A framework to arrive at a unique performance measurement score for the balanced scorecard". *International Journal of Data Analysis Techniques and Strategies*, 1(3), Pp- 275-296.

58. Parthiban, P., Punniyamoorthy, M., Ganesh, K., &Ranga Janardhana, G. (2009). "Bidding process and integrated fuzzy model for global sourcing based on customer preferences*". *International Journal of Electronic Customer Relationship Management*, 3(1), Pp- 18-37.

59. Parameshwaran, R., Srinivasan, P. S. S., &Punniyamoorthy, M. (2009). "Modified closed loop model for service performance management". *International Journal of Quality & Reliability Management,* 26(8), Pp- 795-816.

60. P. Mathiyalagan M. Punniyamoorthy, P. Parthiban (2009) "An integrated model for a class of sourcing problem using multiple regression analysis and analytical hierarchy process." *International Journal of Enterprise Network Management*. 3(4). Pp- 374-394.

61. Parthiban, P., Punniyamoorthy, M., Mathiyalagan, P., & Dominic, P. D. D. (2009). "A hybrid decision model for the selection of capital equipment using AHP in conjoint analysis under fuzziness". *International Journal of Enterprise Network Management,* 3(2), Pp- 112-129.

62. Parthiban, P., Punniyamoorthy, M., Ganesh, K., & Parthasarathi, N. L. (2008). "Logical approach for evaluation of supply chain alternatives". *International Journal of Management and Decision Making*, 9(2), Pp- 204-223.

63. Punniyamoorthy, M. Prasanna Mohan Raj. M (2007) "An empirical model for brand loyalty measurement" *Journal of Targeting, Measurement and Analysis for Marketing*, 15, 222 – 233. doi: 10.1057/palgrave.jt.5750044.

64. Nafeesthul Basariya, Punniyamoorthy, M. (2019) "An approach to arrive to stationarity in time series data", *International journal of applied management science*– **Communicated**.

65. Prabha M, Punniyamoorthy M., Nivethitha. S (2019), "Examining the bi-directional relationship between Motivation and Satisfaction: Based on the impact of Psychological Empowerment", *International Journal of Process Management and Benchmarking* – **Communicated**.

66. Santhosh Kumar A, Punniyamoorthy M. (2018) "SVM as an agent performance evaluation tool - Application in customer service industry"**, *International Journal of Business Performance Management* - Communicated.**

67. Punniyamoorthy, M. & Santhosh Kumar A. (2015). "Opinion Mining of Movie Review using new Jaccard dissimilarity Kernel function". *International Journal of Business Intelligence and Data Mining* - **Under Review**

Non – SCI Journals:

68. Antonette Asumptha J, M. Punniyamoorthy and Roshan Rayen (2018) "Knowledge sharing behaviour of physicians (Dentists) in Hospitals", *Global journal of Medical Research: K interdisciplinary*, Vol 18, No 1-K .

69. Thoppan, J. J. (2017). Competitive Models to Detect Stock Manipulation. *Communications of the IIMA*, 15(2), 5.

70. Antonette Asumptha J, M. Punniyamoorthy. (2017). "Compare and Contrast of Knowledge Sharing of Academicians to Students-A Study in Private and Public Universities". *Journal of Education and Learning.* 11 (4), pp. 311-326. DOI: 10.11591/edulearn.v11i1.6580

71. M. Punniyamoorthy G. Lakshmi, &S. Chandramohan 2015). "A methodology for identifying significant factors in supplier selection: a context based approach", *International Journal of logistics and supply chain management,* 4(2) Pp- 2319-9032.

72. M. Punniyamoorthy, G. Lakshmi, & S. Chandramohan (2015). "A methodology to prioritize the constructs in supplier selection- An application in Engineering Industry, *Global Journal for Research Analysis*, 4(5), pp 349-351.

73. Punniyamoorthy, M., & Lavanya, V. (2015). "A conglomerate model for identification of the interaction between job satisfaction and job performance in a service institution-a context bound approach". *International Journal of Higher Education and Sustainability*, 1(1), Pp- 66-87.

74. Murugesan Punniyamoorthy and Lavanya Vilvanathan (2013) "A study on job satisfaction in service institution – context and model bound approach", *International journal of Logistics Economics and Globalization*, 5(4), Pp- 269-291 (2013).

75. Mathiyalagan, P., Punniyamoorthy, M., Sezhiyan, D. M., & Meena, M. (2013). "An Empirical investigation on the impact of supply effort management and supplier selection on business performance using SEM approach*". Journal of Contemporary Research in Management,* 5(2).

76. Kiruthika, A., Chandramohan, S., Punniyamoorthy, M., &Latha, S. (2013). "Fuzzy-DEA as a diagnostic tool to measure and compare the performance of public and private banks including foreign banks in India," *International Journal of Logistics Economics and Globalisation*, 5 (3).

77. M. Punniyamoorthy, Rani Susmitha and K. Ganesh (2012) "*A* casual model to assess the cardiac patient satisfaction – A comparative study of speciality cardiac hospitals and multispecialty hospitals", *International Journal of Information Logistics Economics and Globalization*, 4(4).

78. Malairajan, R. A., Ganesh, K., Nallasivam, K., & Punniyamoorthy, M. (2012). "Comparison of fuzzy C-mean clustering and 0-1 integer programming model for employee routing problem*". International Journal of Value Chain Management*, 6(4), Pp- 303-330.

79. Punniyamoorthy, M., & Thoppan, J. J. (2012). "*Detection of stock price manipulation using quadratic discriminant analysis". International Journal of Financial Services Management*, 5(4), 369-388.

80. Punniyamoorthy, M., & Shetty, N. K. (2011). "A study of customers' brand preference pattern and factors influencing brand preference in a commodity product". *International Journal of Indian Culture and Business Management*, 4(5), Pp- 523-542.

81. Parthiban, P., Mathiyalagan, P., Punniyamoorthy, M., & Dominic, P. D. D. (2010). "Optimisation of supply chain performance using MCDM tool–a case study". *International Journal of Value Chain Management*, 4(3), Pp- 240-255.

82. Parthiban, P., Punniyamoorthy, M., Ganesh, K., & Janardhana, G. R. (2009). "*Development* and assessment of modified VIKOR method for multi-criteria single sourcing in supply chain". *International Journal of Business and Systems Research*, 4(1), Pp- 94-116.

83. P. Mathiyalagan M. Punniyamoorthy, S. Sudhakar (2009) "A supplier selection construct for exploring supplier selection production in Indian manufacturing company", *Journal of contemporary research in management*, 1(4), P-123

84. Parthiban, P., Punniyamoorthy, M., & Dominic, P. D. D. (2008). "An integrated model for Optimization of production-distribution inventory levels and routing Structure for a multi-period, multi-product, bi-echelon supply chain". *International Journal of Applied Management and Technology*, 6(2).

85. Parthiban, P., Punniyamoorthy, M., Janardhana, G. R., & Ganesh, K. (2008). "Supply chain architectural framework and supplier relationship model for customer facing business". *International Journal of Electronic Customer Relationship Management*, 2(4), Pp332-363.

Papers in National Academic / Professional Journals

86. *"A scheduling Technique for the service institutions"*, *Journal of Industrial Engineering*, NITIE, Mumbai,

87. *"Managing time 'one should first plan the work and then work the plan"*. *Journal of Industrial Engineering*, NITIE, Mumbai,

88. *"Economic justification of FMS"*. *Journal of Industrial Engineering*, NITIE, Mumbai

Seminars & Conference Papers

89. "FCM based FSVM classifier using Fuzzy Index on credit risk evaluation", *International conference on Business Analytics and Intelligence (ICBAI 2013)*, IIM, Bangalore, December 11 -13, 2013.

90. "DINLIP: Model to Solve Integrated Resource Allocation and Routing Problem with Bound and Time Window", *International Conference on Modelling, Optimisation and Computing (ICMOC 2012)*, Noorul Islam University, Kumaracoil, TamilNadu, India, April 10 – 11, 2012.

91. "Framework for Knowledge Management Need Assessment", *International Conference on Modelling Optimisation and Computing- (ICMOC-2012),* Procedia Engineering 38(2012) Pp- 3668 – 3690

92. "Service quality model to measure customer satisfaction", *Proceedings of the International Conference on Delivering Service Quality: Managerial Challenges for the 21 St Century*, I.I.M., Ahmadabad. December, 1999

93. "A model to measure customer satisfaction", *Total Quality management, sponsored by UGC*, SNR Sons College, Coimbatore (1999).

Current Research Areas:

- Machine Learning algorithms and Applications
- Deep Learning

- Text Mining
- Recommender Systems
- Clustering Techniques
- Optimization Techniques
- Game Theory and applications

Books/Book Chapters

- K. Ganesh, Sanjay Mohapatra, R. A. Malairajan and M. Punniyamoorthy "Resource Allocation Problems in Supply Chains" *Emerald Group Publishing Limited*, 2015. ISBN 178560399X, 9781785603990)

- Mohapatra, S., Ganesh, K., Punniyamoorthy, M., and Susmitha, R." Service Quality in Indian Hospitals – perspectives from an emerging market" *Springer Publications*, 2018.

- *Production Management*, Anna University, Chennai, MBA distance Education Program

- *Data Analysis for Business Decision*, getting ready for publication by Pearson Education, India.

- Solution Manual for the book PROJECTS: Planning, Analysis, Selection, Financing, Implementation, and Review by Prasanna Chandra.

Extended Professional Responsibilities

Position in Academic Councils and Committees
- Member, **NBA Accreditation** Committee
- Member, **UGC Accreditation** Committee
- Member of **Expert Committee** by UGC for Accreditation at Arni University, Kangra.
- Head of **Expert Committee** by UGC for Accreditation at DAV University, Punjab.
- Member, **AICTE Inspection** Committee
- Member, Faculty Selection Committee, **NIT Warangal**
- Member, Faculty Selection Committee, **NIT Calicut**
- Member, Faculty Selection Committee, **NIT Uttarakhand**
- Member, Faculty Selection Committee, **Central University – Hyderabad**
- Member, Faculty Selection Committee, **Central University – Thiruvarur.**
- **Chairman of Inspection Committee** for Grant of Permanent Affiliation, Anna University – Chennai.

Positions at NIT Tiruchirappalli
- Member of **Advisory**
- **Committee** on faculty Recruitment (ACoFAR) at NIT- Trichy.
- Member of **Selection Committee** for the posting of Registrar.
- Member of **recruitment committee** for faculty promotion and in handling issues pertaining to NMR with Chairperson.
- Member of **Equivalence Committee** for framing recruitment rules at entry level for Non- Teaching Staff.
- Member of **grievance committee** appointed by BOG
- **Special recruitment** drive for PwD screening committee.
- Member of **Committee for Stipend payment** for M. Tech students.
- Member of interview committee for **Apprenticeship Trainee.**

Editorship in Journals – Current

- *Editor in Chief*, International Journal of Decision Making in Supply Chain and Logistics, International Science Press, Serial Publications

- *Guest Editor - Special Issue,* Theme: "Special Issue on Application of Multivariate Techniques in Decision-Making Models for Customer Service", International Journal of Electronic Customer Relationship Management, Volume 4 - Issue 4 – 2010, Inderscience Publishers.

- *Member on the Editorial board*, International Journal of Logistics and Supply Chain Management, International Science Press, Serial Publications

- *Member on the Editorial board*, International Journal of Operations, Systems and Human Resource Management, International Science Press, Serial Publications

Reviewer in International Journals

Elsevier: European Journal of Operations Research

Academic Journals (Lagos): African Journal of Business Management.

My Dissertation

Justification of Advanced Manufacturing Technology

Dissertations Guided

The Ph.D. dissertations completed with me as Guide:

- Developing a Model to measure Brand Loyalty - M. Prasana Mohan Raj
- Unified heuristics for a class of sourcing problems in supply chain– P. Parthiban
- Supplier Selection through Structural Equation Modelling and fuzzy Logic - P. Mathiyalagan
- A Study on the Performance Management System - Murali R
- A study of customers' brand preference pattern in commodity market with a special reference to cement industry – Nandha Kishore Shetty
- Detection of Stock Price Manipulation: Developing an Effective Model for Detecting Trade Based Market Manipulation – Jose Joy Thoppan
- A study on Service quality of cardiac hospitals in India: Model based approach - Rani Susmitha.
- Fuzzy Support Vector Machines for Credit Risk Evaluation - Sridevi.
- Framework on Job Satisfaction - Lavanya.
- Knowledge Management in Health care industry - Antonette Asumptha

The Ph.D. dissertations on going, with me as guide

- Opinion Mining using Fuzzy Support Vector Machine - A. Santhosh Kumar, Since 2012
- Psychological Empowerment of Faculty - M. Prabha, since 2014
- Kernel Methods in SVM – S. Manochandar, since 2014
- Production and Operation Management – M. Ramanathan, since 2014
- Time Series Analysis - M.I Nafeesathul Basariya, since 2015
- Classification Techniques – M. Sivaguru, since 2015
- Spare parts Inventory Management – S. Kathirvel, since 2015

- Equilibrium selection in Non-zero sum two-person game - Sarin Abraham, since 2015
- Classification Techniques – M. Vijayprabhagar, since 2015
- Sourcing in Materials Management – A. Maruthamuthu, since 2016
- Logistics Network Planning – B. Saravanar, since 2016
- Rural Banking – S. Balu, since 2016
- Service Level Determination in Supply Chain – R. Sundar, since 2016
- Comprehensive Frame work on Quality in Health Care – S. Niranjani, since 2017
- Activity Based Costing in Software Project Management – G. Kala Nisha, since 2018

In addition to the Doctoral Program, I have also guided over a 300 MBA projects and around 8 ME Industrial Engineering Dissertations.

Examiner for Thesis

- Ph.D. Thesis, IIT Dhanbad
- Ph. D. Thesis, Anna University, Chennai
- Ph. D. Thesis, JNTU, Hyderabad
- Ph. D. Thesis, Visvesvaraya Technological University, Belagavi, Karnataka.
- Ph. D. Thesis, Bharathiar University, Coimbatore
- Ph. D. Thesis, Sambalpur University, Sambalpur, Orissa
- Ph. D. Thesis, Alagappa University, Karaikudi
- Ph. D. Thesis, Manonmaniam Sundaranar university, Tirunelveli

Software's Developed

- Detection of Stock Price Manipulation using Genetic Algorithm and Neural Network

Executive Development Programs

Coordinated:

- "Nuances of Support Vector Machine", Department of Management Studies, NIT, Tiruchirappalli, October 5th – 7th 2012.
- "Data Mining and its Applications", Department of Management Studies, NIT Tiruchirappalli, October 2nd 2011.
- *"Emerging Trends in Supply Chain and Changing Business Environment"*, Department of Management Studies, NIT Tiruchirappalli, Jan 22-23, 2011
- *"MDP Program on Data Analytics for Business Decisions",* Department of Management Studies, NIT Tiruchirappalli, Jan 21-26, 2006

Resource Person for:

- "Business Analytics and Intelligence", Department of Computer Application, CIT Coimbatore, April 24th 2017
- "Data Analytics Workshop", Department of Computer Science & Engineering, NIT Tiruchirappalli, Jun 8th 2012

- Training program for Promotee Executives, Bharat Heavy Electricals Limited (BHEL) Tiruchirappalli, November 11-16, 2002
- Training program for Promotee Executives, Bharat Heavy Electricals Limited (BHEL) Tiruchirappalli, October 21-26, 2002
- Training program for Executive Trainees, Bharat Heavy Electricals Limited (BHEL) Tiruchirappalli, February 17, 1997.

Sponsored or consultancy Projects:

Sl. No.	Title of the Project	Funding Agency	Period	Remarks (Completed/Ongoing)
1.	Cognitive Based Curriculum Development Tool For Emerging Areas Of Computer Engineering And Management Studies For Improving Teaching Learning Process	**University Grants Commission (UGC) Under Obama Singh 21st Century Knowledge Initiative Grant, Govt. of India**	2013-2016	Ongoing
2.	Deciphering the Dynamic Architecture Design from Music and developing software	**MHRD, Govt. of India Under SCSP/TSP/ Sub plan**	2014-2017	Ongoing **(PATENT PUBLISHED) Application No: 201741002082**
3.	Data Mining - Opinion Mining	**DEITY**	2015-2020	Ongoing

Scholastic Record

Ph.D., **Bharathidasan University**, **Tiruchirappalli**

I.C.W.A.I. – Inter
The Institute of Cost and Works Accountant of India, **Calcutta**

M. Tech. — Industrial Engineering & Operations Research
Indian Institute of Technology, **Kharagpur**

B. Tech. — Production Technology
Madras Institute of Technology, **Anna university, Chennai**

B.Sc. – Mathematics
Rajah Serfoji Govt. College, **Thanjavur**

ANNEXURE I

Courses Taught

1. **Machine Learning** - This is an elective course at NIT, Tiruchirappalli, meant for students specialising in Data analytics but has a lot of cross functional applications and hence opted by students from Operations, Marketing and Finance Streams also. The course is designed to provide an in-depth understanding of complex models and algorithms which is used for predictive analytics.

2. **Advanced Data Analytics** – This is an elective course at NIT, Tiruchirappalli, meant for students specialising in Data analytics. The course is designed to provide an in-depth understanding of the modelling of data with special emphasis on Time series analysis and clustering Techniques.

3. **Game Theory and Applications** - This is an elective course at NIT, Tiruchirappalli, meant for students specializing in Operations but has a lot of cross functional applications and hence opted by students from Marketing, Data Analytics and Finance Streams also. The course is designed to provide an in—depth understanding of application of game theory in decision making and strategy selection by an organization.

4. **Data Analytics** – This is an elective course at NIT, Tiruchirappalli, meant for students specialising in Operations but has a lot of cross functional applications and hence opted by students from Marketing and Finance Streams also. The course is designed to provide an in-depth understanding of the modelling of data with special emphasis on multivariate techniques.

5. **Logistics Management** – This is an elective course at NIT, Tiruchirappalli, meant for students specialising in Operations. The course is designed to provide an in-depth perspective into the world of logistics management focusing on materials management, distribution management, location and routing and scheduling, issues faced and customer service across various industries.

6. **Production Planning and Control** – This is an elective course at NIT, Tiruchirappalli, meant for students specialising in Operations. The course is designed to provide a good theoretical base on forecasting, facilities decision, aggregate planning, scheduling and process planning.

7. **Supply Chain Management** – This is an elective course at NIT, Tiruchirappalli, meant for students specialising in Operations. The course covers the fundamentals of supply chain management, supply chain planning, strategies, alliances, outsourcing, performance metrics, planning and managing inventories, distribution management and strategic cost management in a supply chain.

8. **Production and Operations Management** – This is a compulsory course at NIT, Tiruchirappalli. The course is designed to provide a detailed view on the history of production management, technology forecasting, environment, product design & development, process planting, plant location issues, plant layout and material handling principles, job design, job evaluation, purchasing and warehousing functions, vendor development and rating and value analysis.

9. **Project System Management** – his is a compulsory course at NIT, Tiruchirappalli. The course is designed to provide a detailed coverage on projects covering understanding of the environment, lift cycle, feasibility analysis – market, technical, financial and economic, economic appraisal, social cost, network techniques, multi project scheduling with limited resources, implementation, funds planning, performance, budgeting and control, tendering and contract administration, ecology and bio diversity issues and environmental impact assessment.

10. **Fundamental of Financial Accounting** – This is a compulsory course at NIT, Tiruchirappalli. The course is designed to provide an introduction to concepts and conventions of accounting, accounting standards, journal, ledger and trial balance, final accounts, P&L, balance sheet and adjustments, depreciation, intangibles, inventory valuation etc.

11. **Cost and Management Accounting** – This is a compulsory course at NIT, Tiruchirappalli. The course is designed to provide inputs on functional budget, cost ascertainment allocation and control, reconciliation of cost & final account, process costing, working in process costing, joint products, bye products costing, cost accounting methods - job, batch, and contract, standard costing, utility of costing for managerial decision.

12. **Quantitative Techniques**– This is a compulsory course at NIT, Tiruchirappalli. The course is designed to provide inputs on statistics, probability theory, binomial, Poisson and normal, decision making under certainty, uncertainty and risk, sampling and sampling distribution, estimation, testing hypotheses and non-parametric methods.

SUMMARY SHEET			
Name of Applicant	DR. M. PUNNIYAMOORTHY		
Date of Birth	07-05-1962	**Age (as on 29-Jul-2019)**	57 years 5 months
Correspondence Address	Professor, National Institute of Technology, Tiruchirappalli, Tamilnadu, India -620 015	**Permanent Address**	Door No: 15, S. S. Nagar, Near R.R. Nagar, Thanjavur, Tamilnadu, India-613 005
Official Phone No	0431-2503032	**Mobile No**	+91-9443866660 (Office) +91-9489066223 (Personal)
Email id	punniya@nitt.edu	**Alternate Mail id**	mpuniya@yahoo.co.in
Current Position	Professor	**Date of appointment of current position**	23 April 2007
Current Affiliation	National Institute of Technology, Tiruchirappalli, Tamil Nadu, India-620 015		
Work Experience	**Total Work Experience**		**32 Years 09 Months**
	Teaching Experience as Professor		**12 Years 09 Months**
	Administrative Experience		**13 Years 08 Months**
Research Contributions	**Number of Journal Publications (in UGC approved list)**		75
	Number of Presentations in International Conferences		05
	Number of Books/Proceedings Published		03 books
	Number of Patents Awarded		**01**
	Sponsored research (Total Value)		₹ 98 Lacs
No. of Ph.D. Completed			**11**
No. of Ph.D On-going			16

PATENT PUBLISHED

A LOGIC TO DECIPHER THE DYNAMIC ARCHITECTUR FROM MUSIC AND VICE-VERSA
(App. No. : 201741002082)

The efforts to discover the logic of defreezing the music in architecture started from Vitruvius (80-15 BC) and continued in the modern era by Iannis Xenakis among many others. As a continuation and also to defreeze the architecture in music, a process has been laid out. At first, rhythm, texture, harmony, geometry, proportion and dynamics are considered as a base to evolve the aural parameters and the corresponding visual parameters. These parameters involved in visual format (Architecture) and aural format (Music) are used to form logic to decipher the music from architecture and vice-versa. In the case of frontal elevation of a building design, visual perception involved the movements in x-direction relating to the visual scanning the length, and y-direction relating to the visual scanning the height, and in the z-direction relating to the visual scanning the depth. As in the visual, the aural perception includes the length of time, the height of frequency and the depth of loudness. Hence the visual and the aural perception have complimentary dimensions. With the axes scaling as the base, for both aural and visual parameters, a comparison emerged out as: Timbre in aural format to the ground level separation in visual format, the chords in a musical composition to the vertical members of the visual design, the periodicity in a visual design to the form of musical composition in aural format. Thus, the aural parameters are extracted from the grid (visual parameters in the axes) to compose a music and a vice-versa process of extracting the visual parameters from the grid (aural parameters in the axes) to arrive at an architectural design. This process resulted in a development of the logic for an evolutionary algorithm. The logic is validated and found feasible.

Invention Title	A LOGIC TO DECIPHER THE DYNAMIC ARCHITECTURE FROM MUSIC AND VICE-VERSA
Publication Number	29/2018
Publication Date	20/07/2018
Publication Type	INA
Application Number	201741002082
Application Filing Date	19/01/2017
Priority Number	
Priority Country	
Priority Date	
Field Of Invention	ELECTRONICS
Classification (IPC)	H03D9/00; H03K19/177; H01L
Inventor	

Name	Address	Country	Nationality
Dr. M. Punniyamoorthy	National Institute of Technology, Tanjore Main Road, Tiruchirappalli, Tamil Nadu, India-620015.	India	India
Dr.S.A.Veerapandian	National Institute of Technology, Tanjore Main Road, Tiruchirappalli, Tamil Nadu, India-620015.	India	India
ANU. S	National Institute of Technology, Tanjore Main Road, Tiruchirappalli, Tamil Nadu, India-620015.	India	India

CURRENT RESEARCH CONTRIBUTION

Text Mining using Machine Learning Techniques

The classification of opinion based on customer reviews is a complex process owing to high dimensionality. This research objective is to select the minimum number of features to classify reviews effectively. The tf-idf and Glasgow methods are commonly for feature selection in opinion mining. We propose two modifications to the traditional tf-idf and Glasgow expressions using graphical representations to reduce the size of the feature set. The accuracy of the proposed expressions is established through the support vector machine technique. Also, a new framework is devised to measure the effectiveness of the term weighting expressions adopted for feature selection. Finally, the strength of the expressionsis established through evaluation criteria and effectiveness. The modified term weighting expressions isadopted for the extraction of the minimum number of prominent features required for classification, thus enhancing the performance of the Support Vector Machine.

Publication:

Manochandar, S., Punniyamoorthy, M, (2018) "Scaling Feature selection method for enhancing the classification performance of support vector machines in text mining", *Computers & Industrial Engineering*, Volume 124, October 2018, Pages 139-156.

Performance enhancement of a new user similarity model in collaborative filtering

Collaborative filtering (CF) is a widely utilized automated product recommendation technique in e-commerce. The CF-based recommender system (RS) depends on similarities among users or items determined by a user-item rating matrix. The similarity is calculated using conventional distance measures or vector similarity measures such as Pearson's correlation, cosine similarity, Jaccard similarity, or Spearman rank correlation. However, these methods are not very effective owing to the sparse matrix. To improve the performance of CF- based RS, a modified similarity measure is introduced based on Proximity-Impact-Popularity (PIP). In conventional PIP the magnitude of each component is unequal, resulting in unequal component weights in different scenarios. To overcome this problem, our proposed PIP measure has a range of 0-1. Moreover, a mean-based prediction formula is typically used to predict the rating, which only considers the user-related deviation. Therefore, we also propose a more accurate modified prediction expression, which is also applicable for unavailable rating and prediction for new user / item with no records. The proposed method is tested using datasets such as Movie Lens, Netflix, Eopinion, Ciao DVD, MovieTweet, and Flim Trust. The performance criteria adopted for this study are the mean absolute error, root mean squared error, precision, recall, and F-measure. Our results are compared with those from existing methods, which reveals that our proposed framework provides better results for sparse matrix than the conventional methods. Finally, the statistical test is conducted for the cold start problem our proposed method provides a significant result than the conventionalmethods.

Publication:

Manochandar, S., and Punniyamoorthy, M, (2019) "A new user similarity measure in a new prediction model for collaborative filtering", *Applied Intelligence*- **Under Review.**

Opinion Mining using Support Vector Machine with improved kernel functions

To extract opinion from text documents various machine learning algorithms are used and Support Vector Machine (SVM) is one among them. The SVM is more popular because of its efficient classification of non-linear data using Kernel trick (Kernel function) which implicitly transforms the input to a higher dimensional vector space, thereby data can be classified linearly. In this research, the dissimilarity kernel function is proposed to handle the sparse data. The new kernel functions are adopted to classify opinions from customer feedback of B2C (Business to Consumer industry) contact

center. Also, the performance of the proposed method is evaluated the contact center agent from the customer feedback data.

SVM as an agent performance evaluation tool - Application in customer service industry

In the present digital world, the rapid growth in unstructured text data prompts the business to revamp the organization strategy based on the knowledge discovered from the data using text or opinion mining. To extract opinion from text documents various machine learning algorithms are used and Support Vector Machine aka SVM was one among them. The SVM was more popular because of its efficient classification of non-linear data using Kernel trick (Kernel function) which implicitly transforms the input to a higher dimensional vector space, thereby data can be classified linearly. In this paper, we have applied dissimilarity kernel function which can be used when the data are sparse. In our study, we have evaluated the new kernel functions to classify opinions from customer feedback of B2C (Business to Consumer industry) contact centre and evaluate the performance and ranked the contact centre agent from customer feedback data.

A new mean to identify the number of clusters through Self –Organizing map

Self-organizing map (SOM) is a popular technique for data reduction and data clustering. In conventional SOM, the weights of each node are created and assigned randomly. We proposed a procedure to create the initial weights and way to assign those weights to the grid. Also, we also proposed a new way to determine the number of clusters. The performance of the proposed algorithm and the existing algorithm of SOM is compared against the performance criteria regarding Accuracy, Number of iterations and Elapsed time. It is found that the proposed algorithm excels in all criteria.

A modified rough k-means clustering algorithm

The soft clustering technique in the field of data mining has recently been enriched by the introduction of the rough k-means clustering algorithm along with the fuzzy c-means clustering algorithm. This technique is being applied in several areas for its ability to handle uncertainty in a dataset. Even though its usage is important from the perspective of handling uncertainty in the dataset, its performance is put under continuous scrutiny. The cluster initialization function is one important function that affects the good clustering performance of the rough k-means algorithm. Another parameter that determines the clustering performance is the weight parameter used in calculating cluster means. In this paper these two important parameters are investigated in detail and it is found that there is room to improve this algorithm through modifications. For this purpose, a novel initialization procedure is proposed to overcome the shortcomings of the random initialization function of the rough k-means algorithm. A formula for calculating the dynamic weight that is to be used in calculating the cluster means in the rough k-means algorithm is also proposed. The proposed methods help in increasing the clustering effectiveness which is demonstrated using the large synthetic, forest cover, microarray, bank marketing, Coil 2000, and telecom

datasets. The experimental results show that our modified algorithm has better clustering performance than the existing rough k-means clustering algorithm.

Publication:

Sivaguru, M. & Punniyamoorthy, M. (2020), "A Modified Rough K– Means Clustering Algorithm", *Soft Computing* (**Communicated**).

A new initialization and performance measure for the Rough k-means Clustering

In this research, an initialization method is proposed to compute initial cluster centers for Peter's rough k-means algorithm. A new means to choose appropriate zeta values in Peters refined rough k-means clustering algorithm is proposed. Also, we have introduced a new performance measure S/T index. The performance criteria like Root Mean Square Standard Deviation, S/T index and Running time complexity are used to validate the performance of the proposed and random initialization with Peters refined rough k-means clustering algorithm. In addition, other initialization algorithms like Peters k-means^{++}, Peters Π, Bradley and Ioannis' are also compared

Publication:

Murugesan, V.P., Murugesan, P. A new initialization and performance measure for the rough k-means clustering. *Soft Comput (2020)*.

A New Seed and Performance Measure for k- Means Clustering

Conventional k-means clustering algorithm takes initial points to compute centroid each time in a random manner. We propose two new initialization procedures for the k-means clustering algorithm to obtain the consistent sum of squared error. This algorithm is applied for various benchmark data sets, and the results are compared with the results obtained in conventional k-means and k-means++ clustering algorithm. It shows the error value obtained by our proposed algorithm is consistent and it provides better results for most of the cases. We develop a composite performance measure for the analysis of the algorithm. We introduce the technique to determine the number of replications in the evaluation of the performance measure of the datasets. The performance measure and its comparative analysis of the proposed algorithms with conventional k-means and k-means++ algorithms are presented. Also, the validity measure such as Dunn index and Silhouette index are included.

Publication:

Manochandar, S., Punniyamoorthy, M, (2018) "Development of new seed with modified validity measures for k-means clustering", *Computers & Industrial Engineering*, volume 141, March 2020.

Equilibrium selection in Non-zero sum two person game

A non-zero sum bi-matrix game may yield numerous Nash solutions while solving the game. The player will then have to make a selection of a good Nash equilibrium among the many options. This poses a dilemma for the players. In this research work, three methods have been proposed to select a good Nash Equilibrium. The first approach helps in identifying the most payoff-dominant Nash equilibrium while the second method selects the most risk dominant Nash equilibrium. The third method combines risk dominance and payoff dominance by giving due weight to the two criterion. This provides the player with the best Nash Equilibrium chosen over the other Nash Equilibria thus easing out the selection process for the players

Publication:

Sarin Abraham, Punniyamoorthy, M. and Jose Joy Thoppan (2018) " A Method to select best among multi-Nash equilibria ". *International journal of Process management and Benchmarking* (**Under Review**).

A development in the existing Non-linear model and to study its impact on the Nash Equilibrium in a two-person non-zero sum game

A non-zero sum two-person game can be formulated as a non-linear program problem for finding the Nash equilibrium. Although intensive research has been done in developing methods for solving such non-linear problems, very less work has been done in modifying the existing model in order to generate a more refined Nash solution. The study focuses on modifying the nonlinear programming model by incorporating some additional constraints and analyzing if the altered model would generate a better result. The utility of the additionalconstraintsis discussed, in terms of expected payoff and actual payoff, for different problem situations.

Publication:

A Fuzzy Approach using Asymmetrical Triangular Distribution in a Two-person Zero-Sum Game for a Multi-Criteria Decision Making Problem

A Multi-Criteria Decision Making (MCDM) problem can be formulated as a two-person zero-sum game. The decision-maker has to evaluate a set of given alternatives weighed against several criteria to arrive at an expected score for each of the alternatives. The performance for the alternatives under each of the criterion forms the payoff matrix. But, the payoff matrix for such games cannot always be determined with certainty. Under such uncertainty condition, it may be possible to assign an interval for the payoffs. Thus the payoff matrices can be formed by using fuzzy numbers. Unlike most of the papers, where the membership function of the fuzzy numbers is assumed to have a symmetrical shape, in this paper, the membership function is assumed to have a skewed triangular shape. Since an asymmetrical triangular distribution is used, two additional parameters, β_1 and β_2, representing the rejection region on either side of the mode is being introduced. The parameters α, and β_1 / β_2, representing the acceptance region and either side of the rejection region, are used to determine the lower and upper limit of the crisp set of fuzzy numbers. Finally, by using the crisp set of fuzzy matrices, the expected score for each of the alternatives can be calculated, which will thus help to rank the alternatives based on their expected return.

Publication:

Deciphering the frozen music in building architecture and vice- versa Process

The efforts to discover the logic of de-freezing the music in architecture started from Vitruvius (80 -15 BC) and continued in the modern era by Iannis Xenakis among many others. As a continuation and also to de-freeze the architecture in music, a process has been laid out. At first, rhythm, texture, harmony, geometry, proportion, and dynamics are considered as a base of complementary aural and visual formats, to evolve the aural parameters and the corresponding visual parameters. These parameters involved in visual format (Architecture) and aural format (Music) are used to form logic to decipher the music from architecture and vice-versa. With the axes scaling as the base, for both aural and visual parameters, a comparison is emerged out. Thus, the aural parameters are extracted from the grid (visual parameters in the axes) to compose a music and a vice-versa process of extracting the visual parameters from the grid (aural parameters in the axes) to arrive at architectural design. This process resulted in the development of an algorithm

Publication:

Anu Sendhil, Muthukkumaran, K, Punniyamoorthy, M, Veerapandian, S. A., & Sangeetha, G, (2019), "Deciphering the frozen music in building Architecture and Vice-Versa process",*Multi Media Tools and applications – Accepted*.

Transformations Involved in Visual and Musical Grid

Every architectural design is a combination of various geometrical forms. These forms are generated from basic shapes such as circles, squares, and triangles. All these geometrical shapes undergo transformations to form substructures. These substructures are then organized to form an architectural design. A substructure may involve one or more notes in the chosen musical scale, which undergo transformations to form substructures and are then organized in appropriate measures to compose music. In this paper, we present a new music and architecture deciphering method employing such transformations and structures. Furthermore, these transformed substructures are converted into musical substructures, which can enhance existing musical libraries. Moreover, through the process of deciphering architectural building design from music and vice versa process, the existing libraries in both building design and music composing software are enhanced through the transformation of substructures. This paper explores the transformations that occur in both architectural designs deciphered from music and music deciphered from architectural designs, thereby enhancing substructure libraries in both architectural design and music.

Publication:

Fuzzy Support Vector Machines for Credit Risk Evaluation

Credit risk assessment has gained importance in recent years due to the global financial crisis and credit crunch. Financial institutions, therefore, seek the support of credit rating agencies to predict the ability of creditors to meet financial persuasions. The purpose of this paper is to construct a neural network (NN) and fuzzy support vector machine (FSVM) classifiers to discriminate good creditors from bad ones and identify the best classifier for credit risk assessment. This study uses an artificial neural network, the most popular AI technique used in the field of financial applications for classification and prediction and the new machine learning classification algorithm, FSVM to differentiate good creditors from bad. As membership value on data points influence the classification problem, this paper presents the new FSVM model. The instances membership is computed using fuzzy c-means by evolving a new membership. The FSVM model is also tested on different kernels and compared, and the classifier with the highest classification accuracy for a kernelis identified. The paper identifies a standard AI model by comparing the performances of the NN model and FSVM model for a credit risk data set. This work proves that that FSVM model performs better than the backpropagationneural network. The proposed model can be used by financial institutions to accurately assess the credit risk pattern of customers and make better decisions. This paper has developed a new membership for data points and has proposed a new FCM-based FSVM model for more accurate predictions.

Publication:

Evaluation of an FCM-based FSVM classifier using fuzzy index

Support vector machine (SVM), the new machine learning classification algorithm, has shown good generalization capability in binary classification problems. But, on datasets with outliers or noises, SVM has not shown good classification performance. As fuzzy support vector machine can significantly reduce the effect of outliers or noises, this study has adopted FSVM for model analysis. As membership value on data points influence model performance, fuzzy C-means algorithm was used to evolve membership values on different fuzzy index values. With the new

formulation of the membership function, new membership values are created and used to run the FSVM model. The computational process of FSVM model on RBF kernel is tested by grid search for different combinations of parameters, and the performance of the model on different indices was observed. The classifier with the highest classification accuracy for a particular index and kernel parameters is identified as the best classifier for the dataset.

Publication:

Punniyamoorthy, M., & Sridevi, P. (2017). "Evaluation of a FCM-based FSVM classifier using fuzzy index". *International Journal of Enterprise Network Management*, *8*(1), Pp- 14-34

Application of machine learning techniques to predict carotid atherosclerosis

The focus of this paper is to examine factors associated with carotid atherosclerosis in patients with impaired glucose tolerance (IGT) and to predict the rapid progression of carotid intima-media thickness (IMT). The proposed machine learning methods performed well and accurately predicted the progression of carotid IMT. The linear support vector machine, non-linear support vector machine with a radial basis kernel function, multilayer perceptron (MLP), and the Naive Bayes method was employed. A comparison of these methods was conducted using the Brier score, and the accuracy was tested using a confusion matrix

Publication:

Maruthamuthu, A., Punniyamoorthy, M., Paluru, S. M., & Tammuluri, S. (2019). Prediction of carotid atherosclerosis in patients with impaired glucose tolerance-a performance analysis of machine learning techniques. *International Journal of Enterprise Network Management*, 10(2), 109-117.

Comparative study of machine learning techniques for breast cancer diagnosis

The number of new cases of female breast cancer was 124.9 per 100,000 women per year. Similarly, deaths were 21.2 per 100,000 women per year. It calls for an urge to increase the awareness of breast cancer and very accurately analyse the causes which may differ in minute variations. This is why the application of computation techniques are widely growing to support the diagnostic results. In this paper, we present the application of several machine learning techniques and models like a neural network, SVM is used to quantify the classifications. The methods that are most reliable, accurate and robust are emphasized. It gives a plethora of explorations into the research field for developing predictive models. To achieve higher reliability on the data, we present the comparison of various Machine Learning techniques on a dataset that is available on the website KAGGLE.

Publication:

Ganapathy, G., Sivakumaran, N., Punniyamoorthy, M., Surendheran, R., & Thokala, S. (2019). Comparative study of machine learning techniques for breast cancer identification/diagnosis. *International Journal of Enterprise Network Management*, 10(1), 44-63.

Improving the Prediction Accuracy of Low Back Pain using Machine Learning techniques

Application of machine learning algorithms in the healthcare industry has been increasing by many folds. Low back pain has caused problems to many persons all around the world. An early treatment or detection of whether a person has the symptoms about low back pain can help faster medication and treatment of the patient and help them with getting their medical condition degraded. This paper focuses on four different machine learning algorithms viz. SVM, Logistic Regression, K-NN and Naïve Bayes which can be used to predict whether a person is suffering from low back pain or not. Finally, the modification is carried out in Naïve Bayes algorithm to enhance the performance of the algorithm. The KAGGLE dataset is adopted to validate the machine-learning algorithm. The accuracy of each algorithm is compared.

Publication:

Ganapathy G, Sivakumaran N, Punniyamoorthy M, Tryambak Chatterjee, Monisha Ravi (2018) "Improving the

prediction accuracy of low back pain using machine learning through data pre-processing techniques" *International Journal of Medical engineering and informatics.* **(Accepted)**

Analysis and Assessment of divergence of final offers in negotiation with reference to Gamma and Beta distribution

A Final Offer Arbitration game involves two parties trying to resolve a dispute with the help of an outside negotiator. The two parties submit an offer to the arbitrator, who then selects one of the offers closer to his assumption of a fair settlement. This game can be modeled as a zero-sum game, where the offer that each party proposes represents the strategies available for the two players of the game. Although the arbitrator's choice is not known to either of the players, the distribution that the arbitrator's offer follows is known to them. Taking an appropriate guess of the distribution that the arbitrator's fair settlement may follow, both the parties propose an offer around the median of that distribution. Many labour relationship managers claim that such an approach of the two parties will lead to an automatic convergence of the two proposals, but game theorists have shown that there is always be a divergence between the two equilibrium strategies. In this research work, the divergence between the equilibrium strategies hasbeen computed for two new distributions namely Gamma and Beta distribution. The calculateddivergence for Gamma and Beta distribution are then compared with the known divergence of other distributions.

Publication:

Sarin Abraham, Punniyamoorthy, M. (2019) "Analysis and assessment of divergence of final offers in negotiation with using Gamma and Beta distribution". *International journal of advanced operations management* (**Under Review**).

Influence of fuzzy index parameter on FSVM classifier performance

Support vector machine (SVM), a machine learning algorithm used extensively for pattern analysis and recognition, is found sensitive to outliers and noise. Fuzzy support vector machine (FSVM) has been used in many applications as a most prominent technique by researchers to overcome the sensitivity issue faced by SVM and for its goodgeneralization performance. In this research, a method to justify the performance of FSVM classifier by showing the influence of fuzzy index m on membership function of the model has been proposed. In the first phase of the study, an algorithm to find the optimal fuzzy index using fuzzy C-means (FCM) and to avoid testing all fuzzy index values on the FSVM model has been proposed. This process can reduce the operational complexity of the model. In the second phase of this study,an FSVM algorithm to incorporate new membership function is proposed. The model is tested on six different datasets and kernel functions,and the kernel with the highest classification accuracy is identified as an efficient kernel for the applied dataset. The experimental results on the chosen fuzzy index have proven that the proposed alternate methodology enhances classifier accuracy compared to other research findings. Hence, the model could be applied to diverse fields of FSVM applications.

Publication:

Sridevi, P., Punniyamoorthy, M., & Senthil Arasu B. (2017). Influence of fuzzy index parameter on new membership function for an efficient FCM based FSVM classifier. *Journal of the National Science Foundation of Sri Lanka*. 45(4) pp 367 -379.

Dynamic fuzzy clustering using cumulative marginal error (cost curve)

The management of customer dynamics is critical for any organization that aspires to build an effective customer relationship with customers. In this study, our objective is to improve the dynamic customer segmentation effectiveness using the dynamic fuzzy c-means clustering algorithm. The dynamic fuzzy c-means clustering algorithm is the most commonly used algorithm in the literature for doing dynamic customer segmentation. We propose two modifications to the existing dynamic fuzzy c-means clustering algorithm; the first one uses the graphical representations to identify the changes in the cluster structure. Secondly, a modification to the current structure strength formula is proposed to determine the number of new clusters needs to be created. The effectiveness of the proposed expressions is established through the sum of squared error. The modified approaches are tested using the online retail dataset for dynamic customer segmentation comparing with the existing method. The modified approach improved the effectiveness of customer segmentation results.

PSO clustering with a different perception

In the Standard PSO (SPSO) algorithm, normal random variate is used to create the coordinates of the particle. It considers each coordinate separately and is assumed to follow the normal distribution individually. In PSO clustering algorithm, the particle is assumed as a vector of cluster centres. The same technique from SPSO is followed to assign the initial particle locations for PSO clustering. Usually, the cluster centres are created from the data points, and their mean and standard deviations of each variable are used to createeach coordinate of the particle randomly. Instead of assuming a normal distribution for individual coordinates of the particle, we propose the multi normality assumption for creating a segment of the particle. Also, we added a new dimension to the velocity update. We proposed a family best concept in addition to the existing bests (global best, and personal best). Each particle in PSO helps to form the cluster. Based on it, we cluster the particles which help to form a cluster are grouped similarly every other particleare grouped. From them, we find the family best which in turn helps to attain a better clustering performance.

Fuzzy Matrix for a Zero-Sum Game with Varied Values α -Cut and Lambda, λ

The payoff matrix for a bimatrix game cannot always be determined with certainty. Under such uncertainty condition, it may be possible to give an interval for the payoffs, thus representing the payoff matrix with fuzzy numbers. Unlike most of the papers where the fuzzy numbers were assumed to follow a symmetrical triangular distribution, in this paper we have introduced the concept of the fuzzy numbers following an asymmetrical triangular distribution. Since an asymmetrical triangular distribution is used, two additional parameters, α_1 and α_2, representing the rejection region on either side of the mode is being introduced. The parameters α, and α_1 / α_2, representing the acceptance region and the either side of the rejection region, is used to determine the lower and upper limit for the fuzzy numbers. In the defuzzification process, the parameter λ, representing the weight assigned to the upper fuzzy matrix, is also accustomed to variations. The sensitivity analysis of the Nash equilibrium, for different values of α, α_1, α_2, and λ is checked to see which combination yields a better result.

Courses Taught Presently and their Contents

Course 1	Machine Learning

Supervised Learning

- Bayesian Classification: Naive Bayes. Rule-Based Classification,
- Artificial Neural Network: Classification by Backpropagation.
- Support Vector Machines,
- Associative Classification,
- K-NN classifier, Case-Based Learning,
- Rough set, Fuzzy set approaches, Hidden Markov models.

Unsupervised Learning-I

- Clustering Methods K-Means, K-Medoids.
- Fuzzy C-Means Clustering.
- Hierarchical Methods: Agglomerative and Divisive.

Unsupervised Learning-II:

- Grid-Based Methods: Statistical Information Grid,
- Model-Based Clustering Methods: EM algorithm,
- Self – Organizing Map.
- Outlier Analysis.

Soft Computing Components:

- Neighborhood-based algorithms, Simulated Annealing, Tabu search.
- Population-based algorithms- Evolutionary computation: Evolutionary programming and strategies, Genetic algorithms, Genetic programming,
- Differential evolution. Swarm Intelligence: Ant colony optimization, Particle swarm optimization

Course 2	Game Theory & Applications

Introduction

- Trees – Game Trees – Information Sets;
- Choice functions and Strategies – Choice Subtrees;
- Games with Chance moves – Theorem on Payoffs;
- Equilibrium N – tuples of Strategies; Normal Forms.

Two - Person zero – Sum Games

- Saddle Points; Mixed Strategies – Row values and Column Value, Dominated rows and columns;
- Small Games – 2 x n and m x 2 games;
- Symmetric Games – Solving Symmetric Games.

Non-zero- sum games

- Non-cooperative Games – Mixed Strategies, Max-min Values,
- Equilibrium N – tuples of Mixed Strategies,
- A Graphical Method for Computing Equilibrium Pairs;
- Solution Concepts for Non-Cooperative Games – Battle of the Buddies, Prisoner's Dilemma, Another game, Super games;
- Cooperative Games – Nash Bargaining Axioms, Convex Sets, Nash's Theorem, Computing Arbitration Pairs.

N-Persons Cooperative Games

- Coalitions – The Characteristic function, Essential and Inessential Games; Imputations – Dominance of Imputations, the Core,
- Constant – Sum Games, A Voting Game;

- Strategic Equivalence - Equivalence and Imputations, (0, l) -Reduced Form, Classification of Small Games;
- Two Solution Concepts - Stable Sets of Imputations, Shapley Values.

Applications

- Voting – Voting Rules, Paradoxes, Strategic Manipulations; Bargaining
- Nash Bargaining Solution, Ultimatum game, alternating – offers game, Threat Points, Bargaining Shares; Auction.

Course 3	Basic Data Analytics

Multiple Regression

- Assumptions for General Linear Regression Model,
- Ordinary Least Square (OLS) Approach – measures of fit,
- Statistical inferences – Hypothesis testing and interval estimation
- Data cleaning – Outliers and influential observations

Variable Selection

- Retaining of predictors – Forward, backward, stepwise, sequential and all possible subsets
- Dummy regressions and conjoint analysis,
- Multicollinearity

Discriminant Analysis – I

- The Two-Group problem –Variable contribution
- The case of Discrete Variables
- Logistic regression, Error rate estimation.

Discriminant Analysis – II

- The K groups problem, Error rate estimate in multiple groups,
- Interpretation of multiple discriminant analysis solutions.

Factor Analysis

The basic model, Extraction of factors
- Principal factor
- maximum likelihood method,
- factor rotation – orthogonal, oblique rotations,
- factor score,
- Interpretations of factor analysis solutions.

Course 4	Advanced Data Analytics

Principal Component Analysis

- Extracting Principal components
- Test of significance
- Component scores.

Time Series Analysis

- Pre-Processing of Data- Outlier Analysis
- Introduction to Stationarity – Correlogram: Auto Correlation; Partial Auto Correlation; Q-Stat
- Checking for Stationarity- Unit Root Test: Dicky Fuller Test, Augmented Dickey-Fuller
- Analysis of Residual- Durbin Watson Test; Run Test
- Auto-Regressive Integrated Moving Average Models- AR(p), MA(q), ARMA (p, q) and ARIMA (p, d, q)
- Estimation of Parameters for ARIMA – Levenberg Marquardt Method; Gauss-Newton Method; Berndt, Hall, Hall and Hausman Method
- AutoRegressive Conditional Heteroscedasticity (ARCH(p))

- Generalized AutoRegressive Conditional Heteroscedasticity (GARCH (p, q))

Multidimensional scaling

- Proximities, and Data collection,
- Spatial map-metric,
- Non-metric data,
- Joint space analysis.
- Naming and interpreting the dimension,
- Attribute-based perceptual mapping using factor analysis,
- Spatial map using preference data through internal analysis and external analysis.

Cluster Analysis

- Similarity measures,
- Hierarchical and partitioning methods,
- Graphical methods, Assessing cluster solutions and implementation

PENNING BOOK ON DATA ANALYTICS

The book titled on "**Data analytics for Decision Making**" is prepared for publication. It deals with the multivariate analysis and its applications in engineering and management fields. Each multivariate analysis techniques are explained with the detailed flow charts and solved examples.

The content of the book is as follows:

Chapter 1	Multiple Regression
	1.1. Introduction to Multiple Regression
	1.2 Assumption for Ordinary Least Square
	1.3 Analysis of Multiple Regression Techniques
	1.4 Test of Significance of the model
	1.4.1 ANOVA
	1.4.2 t-test
	1.4.3 Co-efficient of determination
	1.5 Arriving at an optimum model
	1.5.1 Forward Regression
	1.5.2 Backward Regression
	1.5.3 Stepwise Regression
	1.5.4 Subset Regression
	Solved Example

Chapter 2	Multi Collinearity
	2.1 Diagnosis of Multi-Collinearity
	2.2 Variance in Inflation Factor (VIF)
	2.3 Condition Index (CI)
	2.4 Ridge Regression
	Solved Example

Chapter 3	Discriminant Analysis
	3.1 Introduction
	3.2 Assumptions
	3.3 Derivation of Fisher Discriminant Analysis
	3.4 Classification rules
	3.5 Calculation of misclassification error
	3.6 Statistical Tests
	3.7 Interpretation of the attributes concerning Discriminant axes
	3.8 Variable contribution

Declaration

I hereby declare that all the statements/particulars made/furnished in this application are true, complete and correct to the best of my knowledge and belief.

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