

Pattern Recognition and Stylometry Analysis of Pathittrupathu in Tamil Literature



Manimannan G., M. Salomi, R. Lakshmi Priya

Abstract: This research paper attempts to identify the structure and clustering of Sangam Literature Pathittrupathu in Tamil using Data Mining Techniques. Pathittrupathu means, it is split into ten tens poems, which is a poetic work and one of the eight anthologies available in ancient Tamil literature. This work originally contains ten divisions of ten poems each dedicated to various Chera kings rule of Tamil, except the poetic works of first and the last ten poems have been lost in before sangam period of Tamil. The remain eight poetic works is considered as a database in this research paper. Twenty parameters were used to identify the structure and pattern of Sangam literature of Tamil. Initially, usage of words is identified using descriptive statistics and pattern of poetic structure is traced by using hierarchical data mining techniques. The result shows that all the eight Pathittrupathu split into two cluster and their writing styles were unique. The clustering methods achieved same clusters and named as natural clusters.

Keywords: Sangam Literature, Pathittrupathu, Stylometry Analysis, Data Mining, Descriptive Statistics and Cluster Analysis.

I. INTRODUCTION

Pathittrupathu poems were written by numerous poets and a poetess, and thus signifying the scholarly role accepted for women in ancient South India. The poems praise the rulers and heroes in the form of a biography but the core seems to be based on real history of old empires. Hindu god Lord Shiva, Murugan and Korraivai (Uma, Durga), their worship by Chera soldiers and the emperor is mentioned. The Pathittrupathu composed by two different parts in the period of second and fourth century. The first parts were collected and compiled by Kamil Zvelebil. The second part collected and compiled during the period of third and fifth century by Meenakshisundaram (1949). The author said Pathittrupathu is the only available book of ancient Tamil period of Chera kings.

II. REVIEW OF LITERATURE

The Pathittrupathu poems are about ten decades of Chera kings. Its describe the king of Imayavaramban dynasty in the part of second, third, fourth and fifth tens and the other three parts of tens, namely sixth, seventh and eighth is dealt with the Irumporai Cheralathan king dynasty [1].

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Each ten years has written ten poems. Every poem has an average sentence length of twenty one lines and the entire decade's average sentence length is 211 lines. The minimum stanza consists of five lines and maximum stanza in the work contains fifty seven lines.

The auxiliary patikams at the end of each decade vary in length from ten to twenty one lines [2]. The poems include explicit details of war and violence [3]. Each of the stanzas of the existing eight tens of Pathittrupathu has at its end a work known as Patikam. They offer supplementary information about the decade. The versions patikams were added to these tens at a later year. The scholar of medieval commentator Atiyarkkunallar, who wrote a commentary on Silapatikaram because he quotes from these versions [4].

A. First part of Pathittrupathu

These poems are lost during the period of Sangam Literature.

B. Second Part of Pathittrupathu

These parts of ten poems were written by Kumattur Kannan and discussed about the Chera king Imayavaramban Nedum Cheralathan.

C. Third Part of Pathittrupathu

The second king of Chera dynasty Palyani-Sel Kelu Kuttuvan was the brother of Nedum Cheralathan and the hero of thirteen years of Pathittrupathu was composed by Palai Gautamanar. He helped his brother in captures of northern Malabar. In later time of his life, Palyanai retired from military life and spent time in arts, letters, gifts and helping Brahmins [5].

D. Fourth Part of Pathittrupathu

The fourth part of pathittrupathu compiled by the poet Kappiyatru Kaapiyanaar. These poems are describes about the Chera prince, Narmudi Cheral. Narmud. He won a series of victories over his enemies, but was always generous to the beaten. [6]. The poet Kapiyanar received 4,000,000 gold coins for his composition from the king [7].

E. Fifth Part of Pathittrupathu

The Tamil Poet Parinar composed these ten poems about the Chera king Senguttuvan [8]. According to Parinar poems are probably the best examples of the heroic genre in the entire collection of Pathittrupathu [9]. In this subdivision, it is notable for dating of the earliest Tamil epic Silapatikaram. The fifth ten includes many details about Senguttuvan's family and rule [10]. This has been one of the reasons to consider the renowned author Ilango Adikal to be a legend extrapolated later into an epic was a part of Sangam literature. [11, 12]



G. Sixth Part of Pathittrupathu

The sixth parts of tens poems describes the king Adu Kottu Pattu Cheralathan was a crown prince for a long 38 years and hero of sixthdecade. He never ascended Chera king and hewas a supporter of trade, commerce, the letters and the arts. The king given an entire village in Kuttanad to Brahmins [13].

H. Seventh Part of Pathittrupathu

These ten poems compiled by the great poet Kapilar. Its describe about the king Chera Celvakkadungo Vazhi Aathan ruling activities.

I. Eighth Part of Pathittrupathu

Eighth part of the tenth poems describes the Chera king Perunceral Irumporai..

J. Ninth Part of Pathittrupathu

These part of ten poems were written about the Cheral king Perunceral Irumporai who may perhaps be the brother of king in the previous ten poems were compiled by Perunkunrurkizhar.

K. Tenth Part of Pathittrupathu

The last part of the ten tens poems of pathittrupathu were lost in the period of Sangam literature of tamil.

Manimannan G.[15] studied in his research work, the disputed writings of Mahakavi Bharathiar and identified the writing style of *may be plausible writer* of Mahakavi Bahrathiar and identified the stylometry analysis. Authorship attribution is also identified for Subrmaniya Iyer and Thiru. V. Kalyanasundaranar writings of Indian freedom movements. It is the first Doctoral Thesis of Statistical linguistic studies in Tamil literature. He has published many research papers in the fieldof linguistic studies using various statistics and data mining techniques. Manimannan G and Bagavandas M. [15] studied quantitative analysis and identification of authorship of these three authors using cluster analysis, Principal Component Analysis, Discriminant Analysisand Neural Networks of Learning Vector Quantization. Manimannan G. and R. Chandrasekaran[16]has identified authorship problem using machine learning methods of GRNN (Generalized Regression Neural Network), RBF (Radial Basis Function), SOM (Self Organizing Map),etc. The main objective of this paper is to identify the structure and pattern of Pathittrupathu using Data mining techniques.

III. DATABASE

The database was collected from Sangam Literature of Tamil. Pathittrupathu means ten tens of poetic structure of the authors. In Pathittrupatthu, only eight athigaram is now available and the first and last tens were lost. The remaining eight Pathittrupathu is considered as a database using twenty grammatical parameters. These parameters are used to identify the pattern and writing style of author.These poems have different headings like Punnumizh Kuruthi, Nizalvidu Katti, etc. The Pathittrupathu was chanted by Kumatoor Kannanaar. The poem describes about different Chera kings and their characters. Parameters were identified manually and it's a difficult task for researchers. The parameters used in this research paper are listed below (Table 1).

Table 1. Pathittrupathu Grammatical Parameters with their meaning

S.No.	Grammatical Category (in Tamil)	Grammatical Category (in English)
1.	பெயர்ச்சொல்	Noun
2.	அடுக்குத்தொடர்	Reduplication
3.	குறையெச்சம்	Infinitive
4.	குறிப்புப்பெயரெச்சம்	Appellative relative participle
5.	குறிப்புவினைமுற்று	Appellative finite verb
6.	தற்சுட்டு	Reflexive
7.	வினைச்சொல்	Verb
8.	திரிபு	Oblique
9.	தொழிற்பெயர்	Verbal noun
10.	பதினொன்பெயர்	Pronoun
11.	பெயரடை	Adjective
12.	பெயரெச்சம்	Relative participle
13.	வியங்கோள்	Optative
14.	வினைமுற்று	Finite verb
15.	வினையடை	Adverb
16.	வினையாலணையும்பெயர்	Participial noun
17.	வினையெச்சம்	Verbal participle
18.	இறந்தகாலம்	Past tense
19.	இறப்பில்லாகாலம்	Non Past tense
20.	பொருளடங்குபு	Empty morph

IV.METHODOLOGY

A. General Algorithm of Clustering Methods

The clustering techniques proceeded by either a series of successive mergers or series of successive divisions. The following are the steps are described the hierarchical clustering algorithm for grouping N objects ofparameters. [14]

Step 1: Starts with Ngroups, each containing a single entity and N * N symmetric of distances and is denoted by $D = \{d_{ik}\}$

Step 2: To identify the distance matrix for the nearest pair of groups,the distance between most similar groupsX and Ybe d_{xy} .

Step 3: Merge groupsXandY, Label the newly formed group(XY). Revise the entire in the distance matrix by (a) deleting rows and columns corresponding the cluster X and Y and (b) adding row and column giving the distances between the cluster (XY)and the remaining clusters.

Step 4: Repeat steps 2 and 3 a total ofN – 1. (Figure 1.)



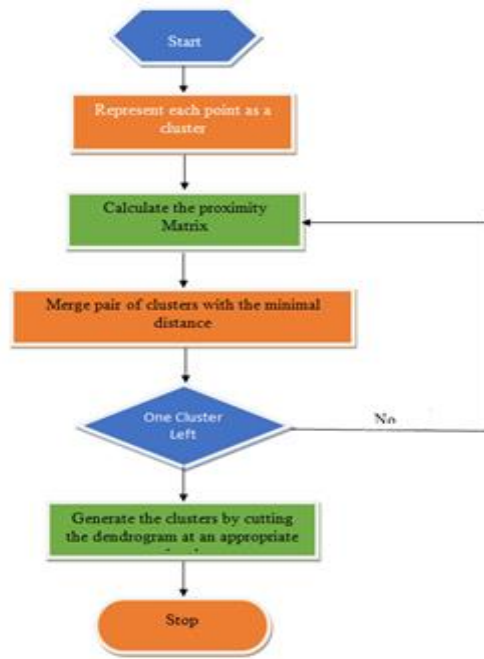


Figure 1. Flow Chart of Agglomerative Approach

B. Single Linkage Method

Step 1: The input to a single linkage method algorithm can be distance or similarities between pairs of items.

Step 2: Clusters are formed from individual entities by merging nearest neighbours, where the term nearest neighbour connects the smallest distance or largest distance similarity.

Step 3: Initially, to find smallest distance in $D = \{d_{ik}\}$ and merge the corresponding objects, X and Y , to get the cluster (XY) . For step 3 of the general algorithm of hierarchical clustering method, the distances between XY and any other cluster W are computed by

$$d_{(XY)W} = \min\{d_{XW}, d_{YW}\}$$

where d_{XW} and d_{YW} are the distance between the nearest neighbours of clusters X and W and clusters Y and W respectively.

Step 4: The results of single linkage clustering can be graphically displayed in the forms of a dendrogram.

C. Complete Linkage Method

Step 1: Complete linkage clustering algorithm similar to single linkage clustering's with one important exception.

Step 2: Every stage, the distance between clusters is determined by similarities between two elements one from each cluster, that are most distant.

Step 3: Complete linkage ensures that all items in a cluster are within some maximum distance of each other.

Step 3: The general algorithm hierarchical clustering again starts by finding the maximum entry in $D = \{d_{ik}\}$ and merging the corresponding objects, such as X and Y , to get the cluster (XY) .

Step 4: For step 3 of the general algorithm, the distances between XY and any other cluster W are computed by

$$d_{(XY)W} = \max\{d_{XW}, d_{YW}\}$$

Where d_{XW} and d_{YW} are the distance between the nearest neighbours of clusters X and W and clusters Y and W respectively.

Step 4: The results of single linkage clustering can be graphically displayed in the forms of a dendrogram.

C. Average Linkage Method

Step 1: Average linkage method treats the distance between two clusters as the average distance between all pairs of parameters where one number of a pair belongs to each other.

Step 2: Repeat, the input to the average linkage algorithm may be distances or similarities, and the model can be used to group parameters or variables.

Step 3: Step 3 of the above general algorithm in the distance between (XY) and any other cluster W are computed by

$$d_{(XY)W} = \frac{\sum_i \sum_k d_{ik}}{N_{xy} N_w}$$

Where d_{ik} is the distance i in the cluster between (XY) and the object k in the cluster W and N_{xy} and N_w are the number of items in clusters (XY) and W respectively.

D. Weighted Average Linkage Method

Step 1: This clustering method is also known as the Weighted Pair Group Method Average (WPGMA).

Step 2: The distance between two clusters is defined as the average of distance between all pairs of data points, each of which comes from a different group.

Step 3: The difference is that distances between newly formed cluster and rest are weighted based on number of data points in each cluster. When two clusters C_i and C_j are merged, the distance to a third cluster C_l can be recomputed as:

$$D(C_l(C_i, C_j)) = \frac{n_i}{n_i + n_j} D(C_l + C_i) + \frac{n_j}{n_i + n_j} D(C_l, C_j)$$

E. Wards Method

Ward's hierarchical clustering algorithms based on minimizing the loss of information from joining two groups.

Step 1: This method is usually implemented with loss of information taken to be an increase in an error sum of squares criterion. ESS, first for a given cluster k , let ESS, be the sum of squared deviations of every item in cluster from cluster mean (centroid).

Step 2: If there are currently k , clusters define ESS as the sum of the ESS, or $ESS = ESS_1 + ESS_2 + ESS_3 + \dots + ESS_k$.

Step 3: At each step in analysis, the union of every possible pair of clusters is considered, and the two clusters whose combination results in the smallest increase in ESS are joined.

Step 4: Initially, each cluster consists of a single item, and, if there are N items, $ESS_k = 0, k = 1, 2, \dots, N$, so $ESS = 0$.

Step 5: At the other extreme, when all clusters are combined in a single group of N terms, the value of ESS is given by

$$ESS = \sum_{j=1}^N (x_j - \bar{x})(x_j - \bar{x})$$

Where, x_j is the multivariate measurement associated with the j th item and \bar{x} is mean of all the items. The results of Ward's method can be displayed as a dendrogram [17].

F. Cosine Distance Similarity

Cosine distance matrix is computed using the following formula:



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$$\text{Similarity}(X, Y) = \frac{X * Y}{\|X\| * \|Y\|} = \frac{\sum_{i=1}^n X_i * Y_i}{\sqrt{\sum_{i=1}^n X_i^2} * \sqrt{\sum_{i=1}^n Y_i^2}}$$

Values range between -1 and 1, where -1 is perfectly dissimilar and 1 is perfectly similar.

The above formula contains both procedures and functions to calculate similarity between sets of data. The function is best used when calculating the similarity between small numbers of sets. The procedures parallelize the computation and are therefore more appropriate for computing similarities on bigger datasets

G. Pathittrupathu Model developing Algorithm

Step 1: Pathittrupathu is given as input data matrix to file widget.

Step 2: To view the data matrix from data table, widget to be connected in file widget.

Step 3: The Cosine distancematrix is calculated by distance widget, after that it is connected to distance matrix widget, Distance map widget and Hierarchical clustering widget.

Step 4: The distance map, distance matrix widgets are calculated using the distance matrix and display the distance map of Pathittrupathu database.

Step 5: The hierarchical clustering widget is used to calculate various methods of clustering and visualize the results in dendrogram.(Figure 2) and the formation of clusters can be viewed from data table(2) widget.

Step 6: Each method of clustering results are interpreted in result and discussion section.

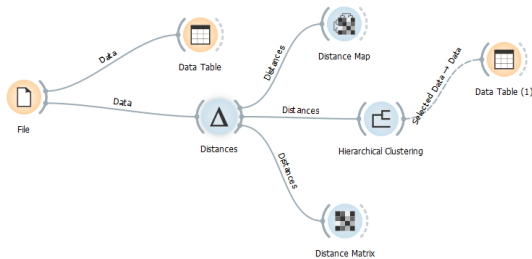


Figure 2. Workflow and Widget of Hierarchical Clustering Techniques

V. RESULT AND DISCUSSION

From the above workflow, visualization map and distance matrix has been computed. The maximum distance matrix similarity value is represented in dark colors and minimum distance matrix similarity value is highlighted in light shade. The maximum distance similarity value is 28.718 and minimum similarity value is 6.557 (Table 3 and Figure 3).

Table 2. Results of Hierarchical Clustering Methods (Mean)

Cluster	Noun1	Reduplication2	infinitive3	APP8	APV9	REF13	Verb14	OBL15	VN16
1 C2	63.90	0.00	5.00	0.60	1.20	0.70	40.50	0.70	1.50
2 C2	69.50	0.00	6.00	0.10	0.50	0.60	44.90	1.10	2.10
3 C1	46.90	0.10	5.40	0.30	0.30	0.20	30.10	1.90	1.00
4 C2	59.60	0.10	5.90	0.20	1.30	0.60	42.60	1.20	2.00
5 C1	51.50	0.00	4.90	0.70	1.80	0.40	35.90	1.90	1.90
6 C1	55.50	0.00	4.30	0.20	1.20	0.40	36.10	1.40	1.10
7 C1	46.67	0.11	3.89	0.22	0.78	0.44	33.33	2.11	1.33
8 C2	59.45	0.36	6.27	0.00	1.18	0.27	38.00	1.82	1.91

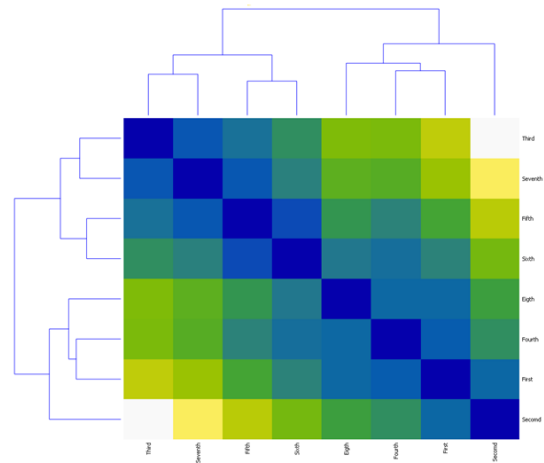


Figure 3 Distance Map

Table 3. Distance Matrix

	1	2	3	4	5	6	7	8
1		8.182	21.697	7.119	14.716	10.887	19.631	8.327
2	8.182		28.718	12.083	21.344	17.719	26.712	14.045
3	21.697	28.718		18.089	9.104	12.066	6.557	18.247
4	7.119	12.083	18.089		10.823	8.794	15.897	8.318
5	14.716	21.344	9.104	10.823		5.451	6.755	12.882
6	10.887	17.719	12.066	8.794	5.451		10.696	9.791
7	19.631	26.712	6.557	15.897	6.755	10.696		16.360
8	8.327	14.045	18.247	8.318	12.882	9.791	16.360	

From the following figure, it is clear that the result of Fifth, Sixth, Third and Seventh tens of Pathittrupathu are formed as first cluster based on their similarity/distance matrix of database with their parameters and are labeled as C1 (Table 2). The second cluster shows that the results of eighth, second, first and fourth tens of Pathittrupathu are formed as second cluster based on their similarity/distance matrix of database with their parameters and are labeled as C2. This may possibly be written by two different authors in Sangam period of Tamil literature.

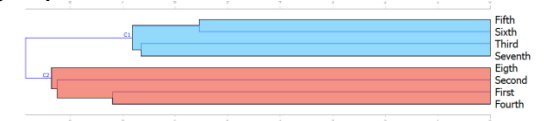


Figure 4. Single Linkage

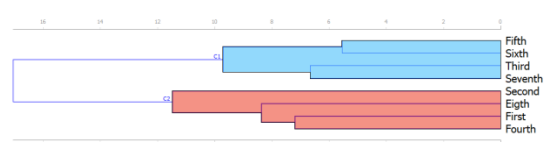


Figure 5. Average Linkage

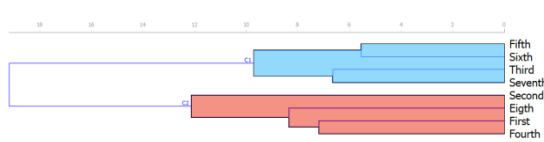


Figure 6. Weighted Linkage



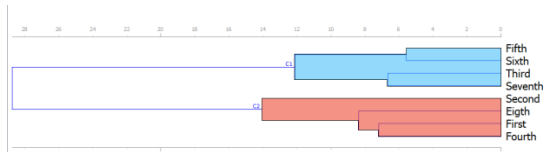


Figure 7. Complete Linkage



Figure 8. Ward's Linkage Method

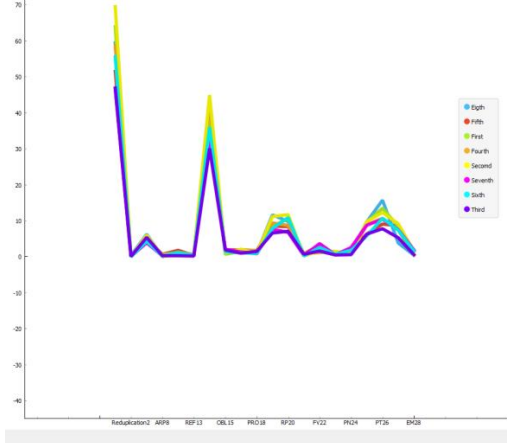


Figure 9. Mean Charts of Pathittrupathu

Two clusters C1 and C2 were formed, where C1 consists of Fifth, Sixth, Seventh and Third Pathittrupathu and C2 consists of First, Second, Fourth and Eighth Pathittrupathu which has been confirmed by all the clustering methods by the use of Cosine similarity distance matrix. These similarities of clustering formation techniques are called natural clusters (Figure 4 to 8). The line chart shows the mean values of every Pathittrupathu poems. The following table clearly represents the maximum usage of grammatical parameters namely, Nouns, Adjective, Verb, Verb Participle and Relative Participle. Rests of the grammatical parameters are used on a minimum usage.

The consistency of matured writers can be achieved by using unique words in their writing style (Table 4). In Pathittrupathu, structures are based on their usage of words or by the writing style of matured writers. A pattern of two clusters were formed and are labeled as C1 (Authorship 1) and C2 (Authorship 2). All these eighty (Eight tens) poems may perhaps be written by two different authors in the same period of Sangam Literature.

Table 4. Summary Statistics of Pathittrupathu

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Noun (Peyarcholl)	80	15	149	56.6	27.1	737.7
Reduplication (Aduku Thodar)	80	0	2	.09	.363	.131
Infinitive (Keuraiyecham)	80	0	17	5.2	3.2	10.2
Negative Relative Participate (Ethimarari Peyaracham)	80	0	0	.00	.000	.000

Negative Verbal Participle (Ethimarari Venaiyecham)	80	0	0	.00	.000	.000
Imperative (Eval)	80	0	1	.01	.112	.013
Onomatopoeia (olikkurippu)	80	0	1	.05	.219	.048
Conjugated Noun (Kurippu Vinaippeyar)	80	0	2	.29	.556	.309
Postposition (Sollurubu)	80	0	2	.16	.434	.188
Appellative Verbal Participle (Kurippu Venaiyecham)	80	0	0	.00	.000	.000
Appellative Finite Verb (Kurippu Vinaimuttru)	80	0	5	1.04	1.09	1.20
Reflexive (Tharchuttu)	80	0	4	.45	.692	.478
Oblique (Thiribu)	80	0	5	1.5	1.27	1.62
Pronoun (pathilidupayear)	80	0	5	1.1	1.15	1.34
Condition Participle (Nibanthanaiyecham)	80	0	2	.16	.404	.163
Adjective (Perayadai)	80	1	31	8.9	5.7	33.4
Optative (Vyangoal)	80	0	3	.58	.823	.678
Finite Verb (Vinai Muttru)	80	0	8	2.2	1.81	3.27
Verbal Noun (Thozhir paeayar)	80	0	7	1.6	1.47	2.16
Verb (Vinaichol)	80	3	87	37.1	17.3	300
Appellative Relative Participle (Kurippu Peyarachem)	80	0	2	.29	.532	.283
Participial Noun (Vinaiyalanaiyum peyar)	80	0	5	1.3	1.31	1.72
Adverb (Vinaiyadai)	80	0	4	.81	.956	.914
Verbal Participle (Vinaiyecham)	80	1	25	8.1	4.96	24.6
Relative Participle (Peayracham)	80	2	22	9.2	4.65	21.6
Past Tense (Irantha Kaalam)	80	0	37	11.	6.96	48.4
Non Past Tense (Irappilla Kaalam)	80	0	17	7.1	4.01	16.1
Empty Morph (Porulal urubu)	80	0	6	1.0	1.27	1.61

VI. CONCLUSION

Pathittrupathu consist of ten tens, which is a poetic work and one of the eight anthologies of Ettuthokai available in Tamil literature. This work originally contains ten parts of ten poems each dedicated to a decade of rule in ancient Chera king of Tamil. The first and last ten poetic works were lost in the ancient period of Tamil literature. Remaining eight poetic works is considered as a database in this research paper. Twenty parameters were used to identify the structure and pattern of Sangam literature of Tamil. Initially, usage of words is identified using descriptive statistics and the structures are based on their usage of words or by the writing style of matured writers.



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The patterns of clustering methods are visualized in the results. A pattern of two clusters were formed and are labeled as C1 (Authorship 1) and C2 (Authorship 2). All these eighty (Eight tens) poems may perhaps be written by two different authors in the same period of Sangam Literature. These poems may be written by two unknown authors. Based on their database and grammatical parameters all the clustering methods achieved same clusters formation and are called as natural clusters. The summary statistics is identified by the usage of words and their structure.

application of Statistics and Data Mining. She has published more than forty five research papers in various National and International journals.

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