

## ANALYSIS OF MALARIA DIAGNOSIS ON PATIENTS USING DATA MINING CLUSTERING TECHNIQUES

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### ABSTRACT

The research was carried out on the malaria patients with some symptoms on high rate that shows positive +ve result while those with some symptoms on low rate that shows negative -ve result. KNIME data mining tool was used to build a comprehensive work flow model consisting of nodes with their respective functions. Fuzzy c-mean, k-mean and hierarchical clustering nodes were utilized to produce

grouped subsets termed clusters from the malaria\_result.csv file (training-set). A decision tree level classifier was designed from the patient's diagnosis of the malaria symptoms. Data Analysis Knowledge Discovery Process for the clustering was also built. The result obtained in this research shows statistical clustering means such as scatter plots, interactive histogram, clustered data table and interactive tables which will be helpful for future observations and predictions of malaria in health care.

**KEYWORDS:** KNIME, Fuzzy c-means node, k-mean node, hierarchical node, Knowledge Discovery.

### INTRODUCTION

In most medical sectors across the world today especially in Nigeria, large amount of medical

data related to patients suffering from malaria has been retrieved for medical history. The process of mining, analyzing these medical data records of malaria victims can effectively support medical practitioners and the health sector to predict likely occurrence of malaria thereby taking preventive measures to reduce the rate at which people contracted this ailment now and the future. The World Health Organization (WHO) statistical reports proved that malaria is the second leading cause of mortality from vulnerable disease in most African countries after HIV/AIDS.<sup>[1]</sup>

The *anopheles mosquitoes* bite on human transmits *genus of unicellular eukaryotes* (obligate parasites) called *plasmodium* is one of the main causes of malaria. There are different types of plasmodium parasites but only five types cause malaria in humans. *Plasmodium falciparum* which is the most common malaria parasite, mainly found in Africa also responsible for most malaria deaths worldwide while the *plasmodium malariae* is quite rare and found in Africa. The *plasmodium ovale* is a fairly uncommon parasite but usually found in countries located in the western part of Africa; this particular parasite can reside in the human's liver for several years without showing the victim any symptoms.<sup>[2]</sup> The *plasmodium knowlesi* is found in Southeast Asia. In some countries in Asia and the Southern part of America, the *plasmodium vivax* can be found, it causes milder symptoms than the *plasmodium falciparum* and it can stay in the liver for an approximately 3- 4 years which could result in relapses.<sup>[3]</sup>

The World Health Organization, World Bank, UNDP and UNICEF established a new initiative health sector-wide partnership known as the Roll Back Malaria RBM to support researches and discover products such as drugs to combat malaria at global, regional, country and local levels. The Roll Back Malaria movement saved an estimate of 3 million lives across the World; the global mortality rate drastically reduced by 43% while in Sub-Saharan Africa regions (such as Botswana, Gabon, Rwanda, Uganda, Senegal, Tanzania, Zimbabwe, Congo, Ghana and especially Nigeria) the rate decreased by 49%.<sup>[4]</sup> This paper focuses on using the data mining clustering technique to effectively analyze the large amount of data and medical examination history obtained from patients who were diagnosed of malaria to transform this data into useful knowledge. Data mining is a process used in extracting rules; predicting certain performances in numerous professions such as medicine and surgery, sciences, military, aviation, education, human resource and information technology.<sup>[5]</sup> Data mining can be described as the collection or gathering of pure driven data algorithms to achieve

meaningful knowledge pattern from the raw data. Data mining also known as “data dredging” or “data fishing” or “knowledge mining in data” is a process that involves searching of large information of data or records to discover knowledgeable patterns and utilizing these patterns for predicting future occurrences especially in the medical area which is the main scope of this research.<sup>[6]</sup> As a result of technological advancement, it is possible to gather, store and easily retrieve large quantities of medical records containing vital information which could help in diagnosing and treating malaria. Data mining techniques such as clustering can extract intelligent knowledge through data analytics from medical data for convenient treatment and diagnosis. Clustering is a data mining task of assigning a set of objects into groups called *Clusters*. Clustering is a solution for data analytics which involves partitioning a set of data objects into subsets. In clustering techniques, objects in a subset are identical to one another yet dissimilar to objects in other subsets.<sup>[6]</sup> Clustering is an unsupervised learning performed on data sets by observations, this is before the semantic of the classes is not known beforehand. The main types of clustering methods include partitioning method, hierarchical clustering, fuzzy C-means clustering, density-based clustering, model-based clustering or grid-based clustering.<sup>[6]</sup> The main goal of clustering in data mining application particularly in the medical aspect is group both similar and different set of data objects derived for the medical results into the same clusters and different clusters respectively.<sup>[7]</sup> Clustering can also be defined as a process of grouping a given set of unlabeled patterns into a number of clusters such that identical patterns are attributed to one cluster.<sup>[8]</sup>

### Decision Tree Level Classifier

Decision tree is a tree-like structure consisting of internal nodes, branches, and leaf node, in which each branch denotes an attribute value, each internal node denoted a test on an attribute which is used for and a leaf node represents the predicted classes or class distributions.<sup>[9]</sup> The decision tree have *nodes* that form *rooted tree*, this implies that decision tree is a *directed tree* with a node known as *root*.<sup>[10]</sup> Decision tree supports a predictive approach in data mining and machine learning.<sup>[11,12]</sup> The decision tree level classifier used in this research is an organized hierarchical structure which shows set of condition such as the list of malaria symptoms in the patient (high temperature/ fever, nausea, common cold, headache, body pain, diarrhea and vomiting), the decision and the result of the decision which states YES which depicts the test is positive +*ve*; or NO which depicts the patient is being checked for other malaria symptom, else they are tested negative –*ve*.

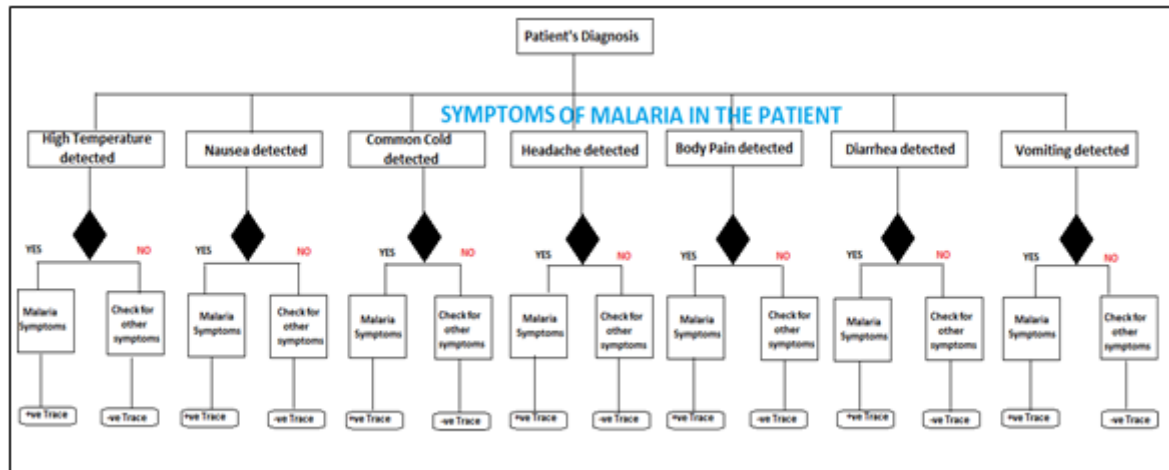


Figure 1: Hierarchical Structure Showing the Malaria Symptom and Results.

### Fuzzy C-Means Clustering

The fuzzy c-means clustering algorithm is a well-known unsupervised learning technique that is used to reveal the underlying data structure. Fuzzy clustering allows each data point to belong to several clusters, with a degree of membership to each one.<sup>[13]</sup> Fuzzy C-Means clustering is widely applied in medical diagnosis, shape analysis, image processing and analysis, target recognition, geology and engineering. It is a data clustering technique used for analyzing distance between various input data points.<sup>[14]</sup> Clusters are formed based on the distance between data points, likewise the centers of the cluster are formed for each cluster.<sup>[15]</sup>

### Hierarchical Clustering

Hierarchical Clustering approach creates a decomposition of data sets (or objects) in multiple levels of hierarchies using some criterion. It is method of analyzing clusters with the aim of building the cluster in a hierarchical form.<sup>[7]</sup> There are two approaches to hierarchical clustering known as the *agglomerative/ bottom-top* and *divisive/ top-bottom*. The agglomerative hierarchical clustering starts with a single data point and merge two or more cluster in a recursive pattern.<sup>[7]</sup> The divisive hierarchical clustering starts with big cluster and splits this cluster into smaller clusters in a recursive pattern.<sup>[7]</sup>

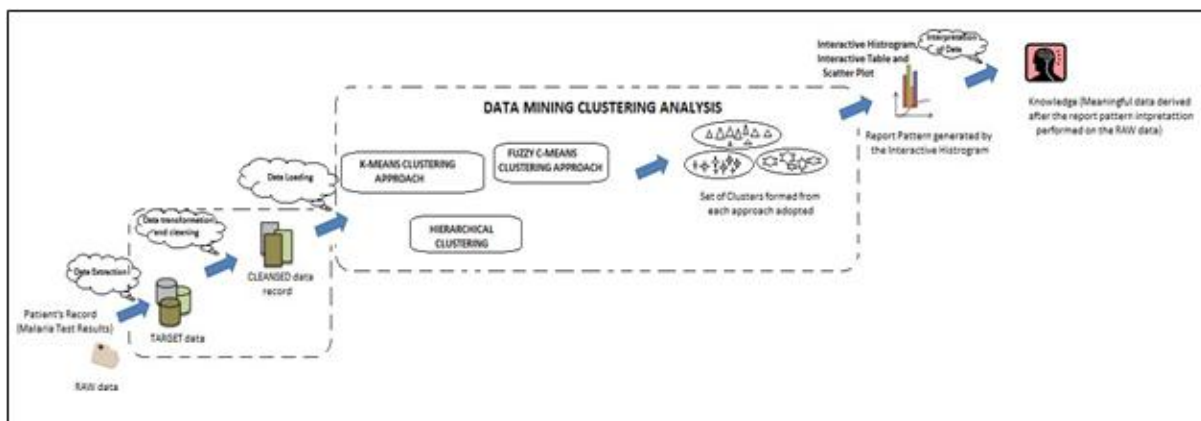
### K-Means Clustering

K-Means is one of typical partitioning clustering approach in which each cluster is represented by the centre of the cluster. It is a method of clustering observations into a specific number of disjoint clusters.<sup>[16]</sup> The aim of the algorithm is to minimize the measurement between the centroid of the clusters and a given observation by iteratively

appending the observation to and clusters when the lowest distance is achieved. K-means performance is determined by initialization and appropriate distance measure.<sup>[17]</sup>

### Data Analysis Framework

The result obtained from the malaria diagnosis conducted on the patient is termed as the RAW data; to derived meaningful information from this RAW data, we decided to perform data transformation and cleansing process before analyzing these data with three clustering methods (k-Means, Fuzzy C-means and Hierarchical clustering) respectively. The main target is to easily produce different set of clusters from the respective clustering method which we utilized. The final stage of this data analysis framework is the report patterns generated from the *interactive histograms*, *interactive tables* and *scatter plots* in the three clustering approaches employed in this work. From the outputs of the report patterns, we could discover knowledge due the RAW data which is being interpreted and effectively useful for most medical centre across the counties where malaria parasite is predominant for convenient diagnosis now and the future.



**Figure 2: Data Analysis Knowledge Discovery Process on the Malaria Results.**

### RESULTS AND DISCUSSION

The goal of this research was to build a workflow model which reads the malaria patients data from **malaria\_result.csv** file, perform three major clustering (fuzzy c-means, k-means and hierarchical) for the chosen attributes (Patient Medical File No, High Temperature, Nausea, Common Cold, Headache, Body Pain, Diarrhea, vomiting and the test result) hence displaying the results. The workflow model was build and the nodes were connected using the KNIME data mining software. Figure 3 shows the workflow model:

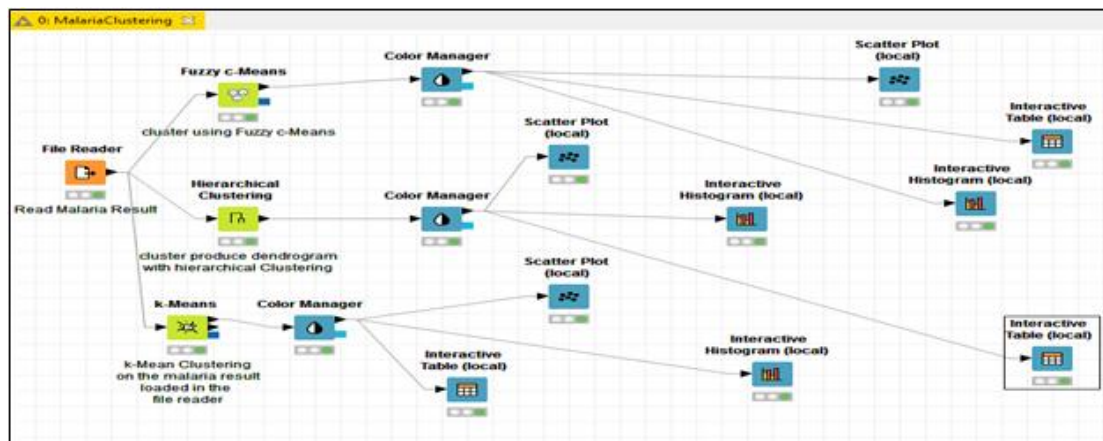


FIGURE 3: Workflow Model that read the malaria result and perform clustering.

### 3.0 Fuzzy C-Means Node Clustering on the Malaria Results

Fuzzy c-means clustering on the malaria data produced three clusters (cluster 0, cluster 1 and cluster 2) with their clusters centers on each attributes. Other results such as the within and between Cluster Variation, the value of partition coefficient, the value of the partition entropy, the Xie-Beni (XB) index and Fuzzy Hyper volumes for the three clusters were computed as shown in Figure 4:

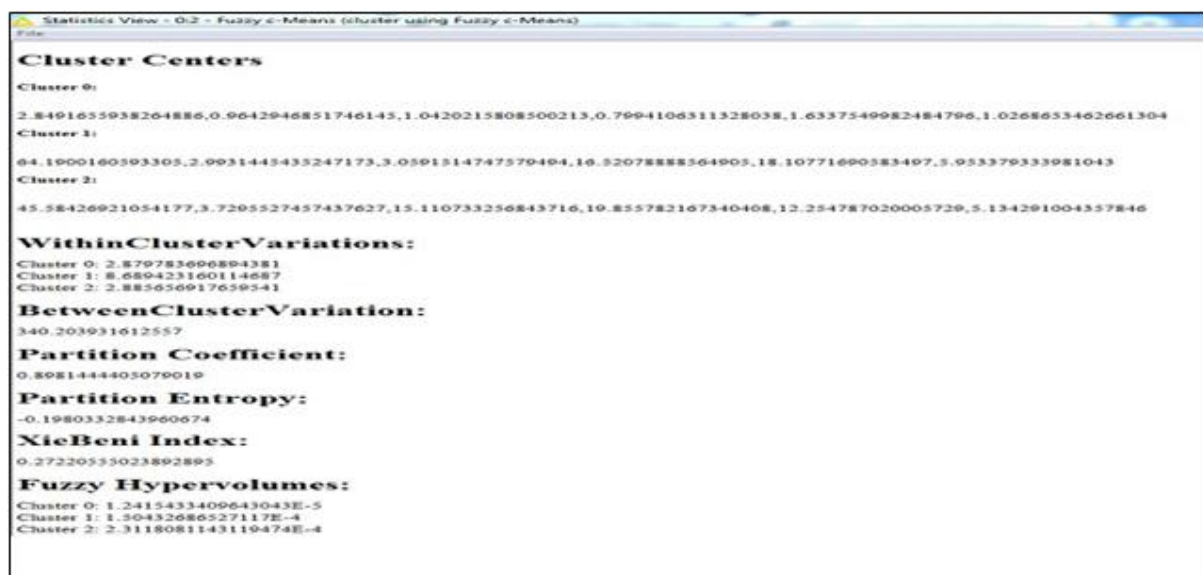


FIGURE 4: Statistics View of the Fuzzy C-Means Clustering on the Malaria Results.

### 3.1 Hierarchical Clustering on the Malaria Results

Hierarchical clustering on the malaria data produced a dendrogram of the clusters on the row attributes, the distance between these clusters and the clustered data table produced by the dendrogram.



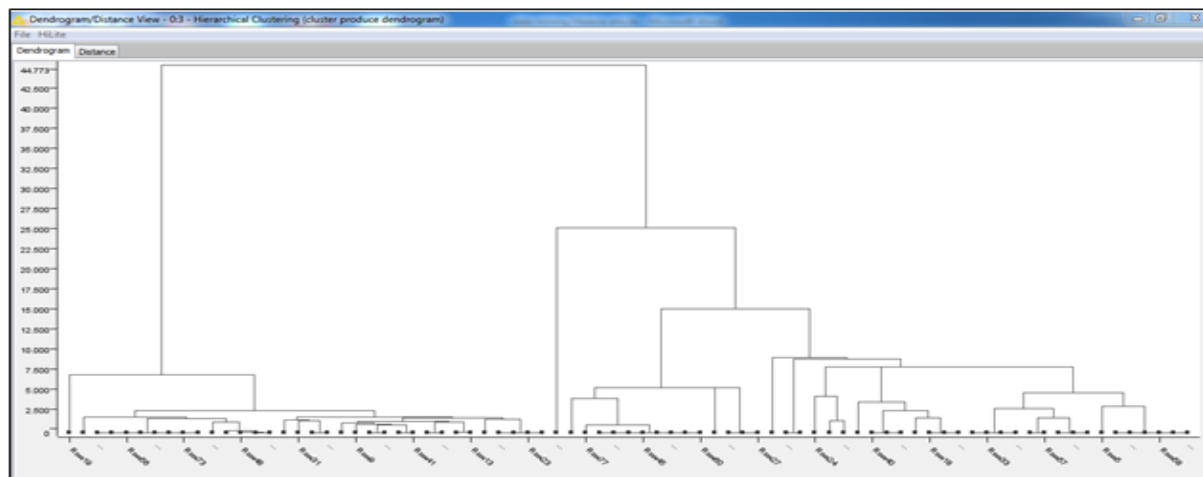


Figure 5: Hierarchical Clustering Dendrogram produced on the malaria result.

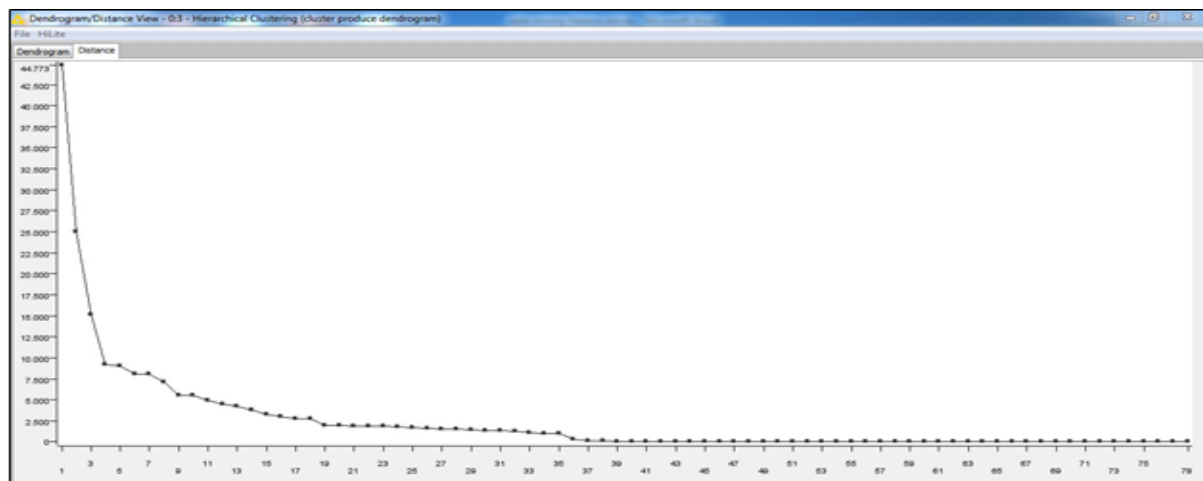


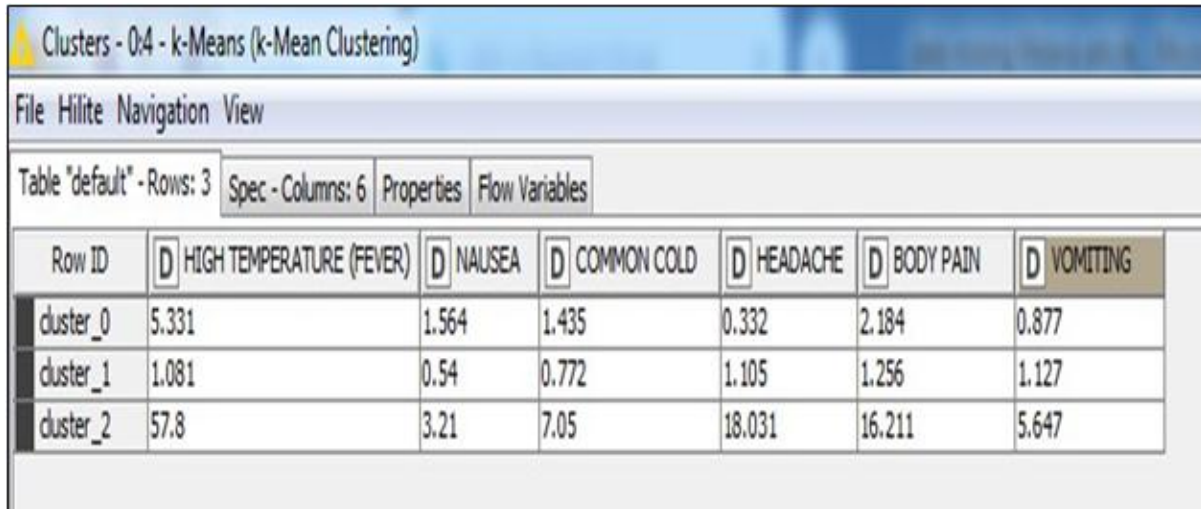
Figure 6: Hierarchical Clustering distance between the clusters produced from the data.

Cluster	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
Cluster	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
Cluster	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78

Figure 7: Clustered Data Table produced from dendrogram hierarchical clustering.

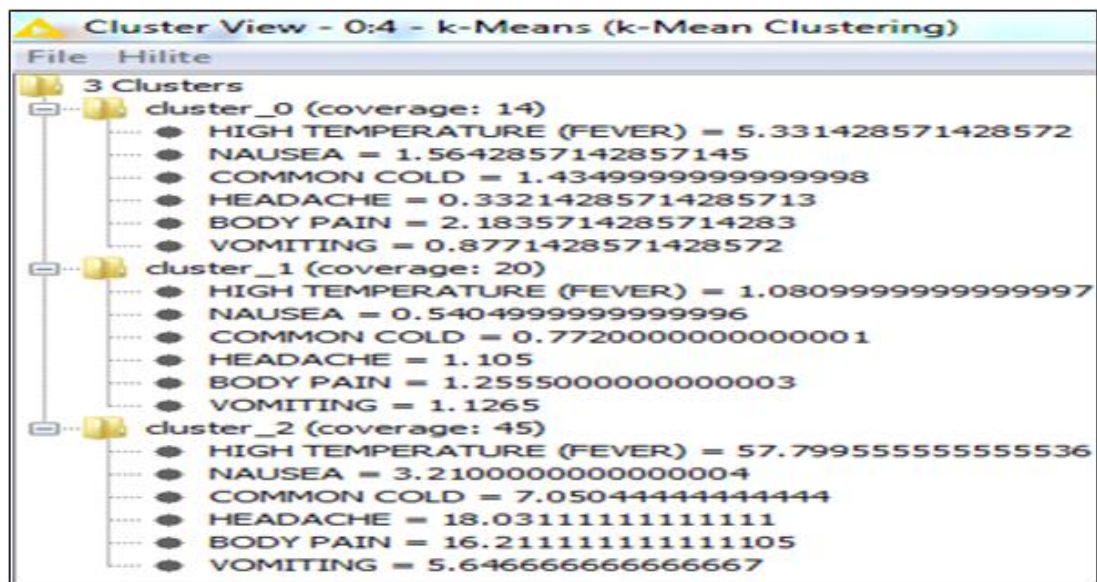
### 3.2 K-Means Clustering on the Malaria Results

Clusters produced on the malaria result from the k-Means clustering were cluster\_0, cluster\_1 and cluster\_2. K-Means clustering on the training data load generated a cluster view and k-means cluster table.



Row ID	HIGH TEMPERATURE (FEVER)	NAUSEA	COMMON COLD	HEADACHE	BODY PAIN	VOMITING
cluster_0	5.331	1.564	1.435	0.332	2.184	0.877
cluster_1	1.081	0.54	0.772	1.105	1.256	1.127
cluster_2	57.8	3.21	7.05	18.031	16.211	5.647

Figure 8: K-Means Clustered Data Table on the attributes.



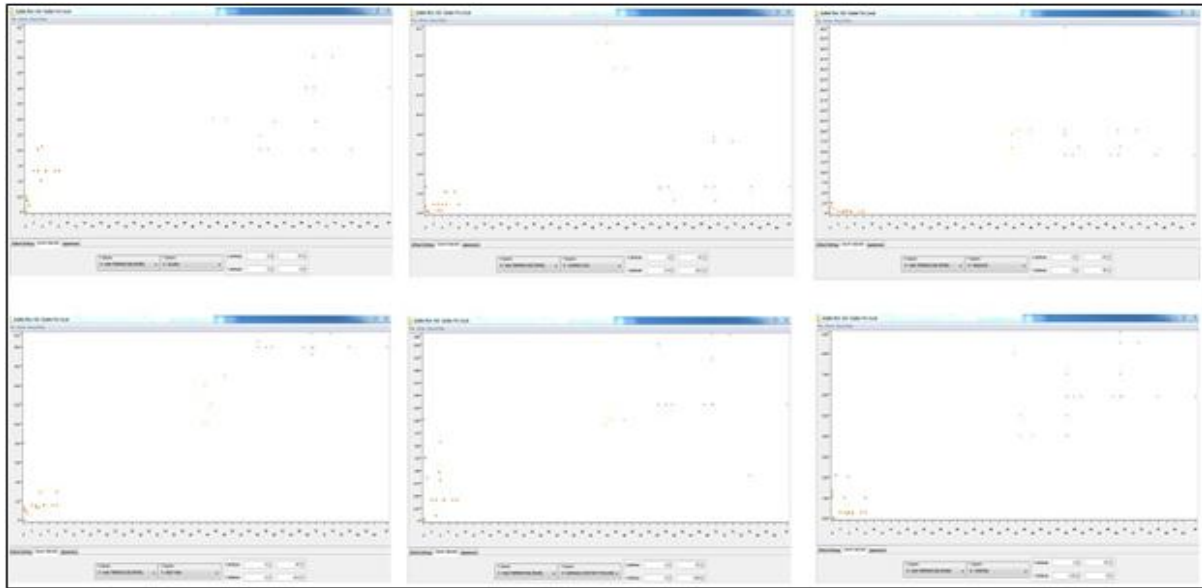
Cluster	Coverage	Attributes
cluster_0	14	<ul style="list-style-type: none"> <li>HIGH TEMPERATURE (FEVER) = 5.331428571428572</li> <li>NAUSEA = 1.5642857142857145</li> <li>COMMON COLD = 1.4349999999999998</li> <li>HEADACHE = 0.33214285714285713</li> <li>BODY PAIN = 2.1835714285714283</li> <li>VOMITING = 0.8771428571428572</li> </ul>
cluster_1	20	<ul style="list-style-type: none"> <li>HIGH TEMPERATURE (FEVER) = 1.0809999999999997</li> <li>NAUSEA = 0.5404999999999996</li> <li>COMMON COLD = 0.7720000000000001</li> <li>HEADACHE = 1.105</li> <li>BODY PAIN = 1.2550000000000003</li> <li>VOMITING = 1.1265</li> </ul>
cluster_2	45	<ul style="list-style-type: none"> <li>HIGH TEMPERATURE (FEVER) = 57.7995555555555536</li> <li>NAUSEA = 3.2100000000000004</li> <li>COMMON COLD = 7.050444444444444</li> <li>HEADACHE = 18.031111111111111</li> <li>BODY PAIN = 16.211111111111105</li> <li>VOMITING = 5.646666666666667</li> </ul>

Figure 9: K-Means Cluster View on the attributes.

### 3.3 Scatter Plot (Fuzzy C-Means, K-Means, And Hierarchical) Clustering.

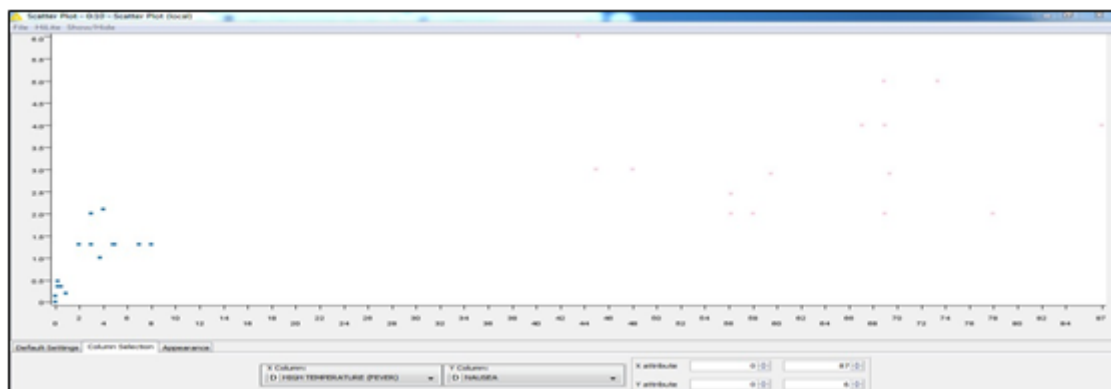
Fuzzy C-means Clustering Scatter Plot on the attributes.



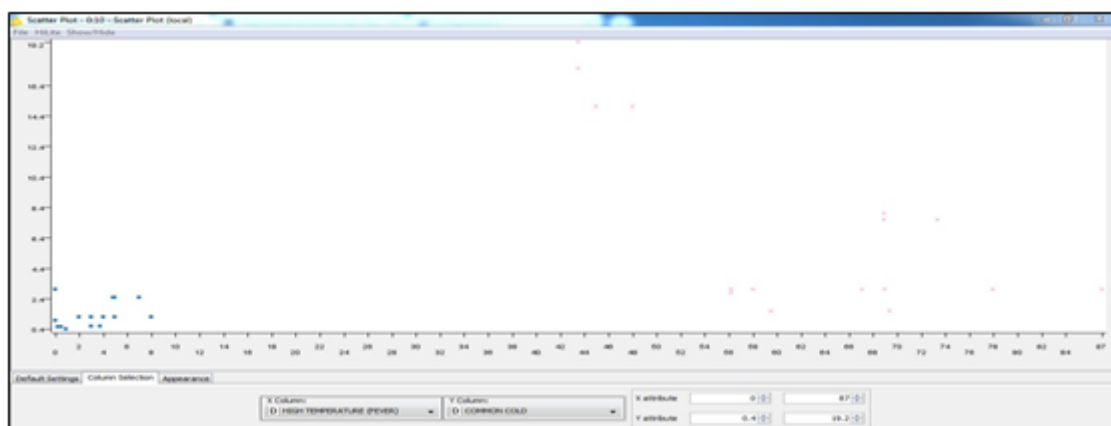


**Figure 10: Scatter Plot generated by Fuzzy C-Means on the attributes.**

Hierarchical Clustering Scatter Plot on the attributes.



**Figure 11: Scatter Plot generated by Hierarchical clustering on attributes (High temperature and Nausea).**



**Figure 12: Scatter Plot generated by Hierarchical clustering on attributes (High temperature and Common Cold).**

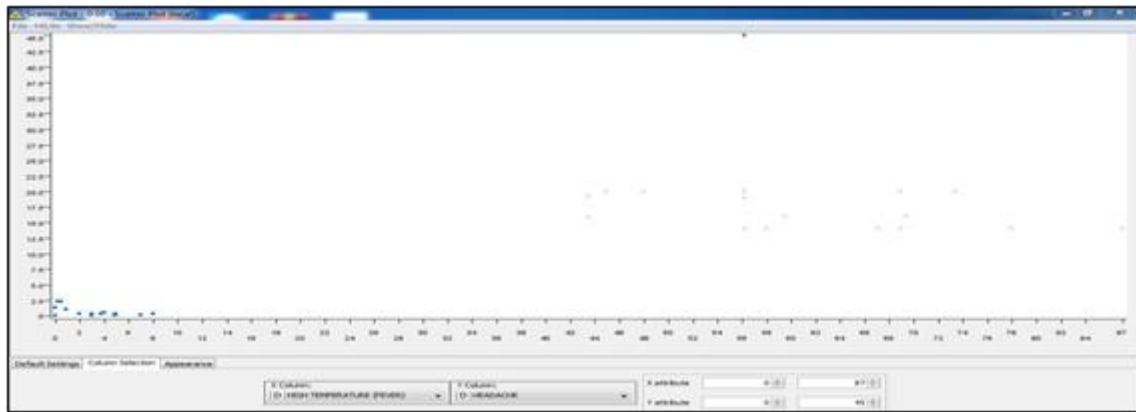


Figure 13: Scatter Plot generated by Hierarchical clustering on attributes (High temperature and Headache).

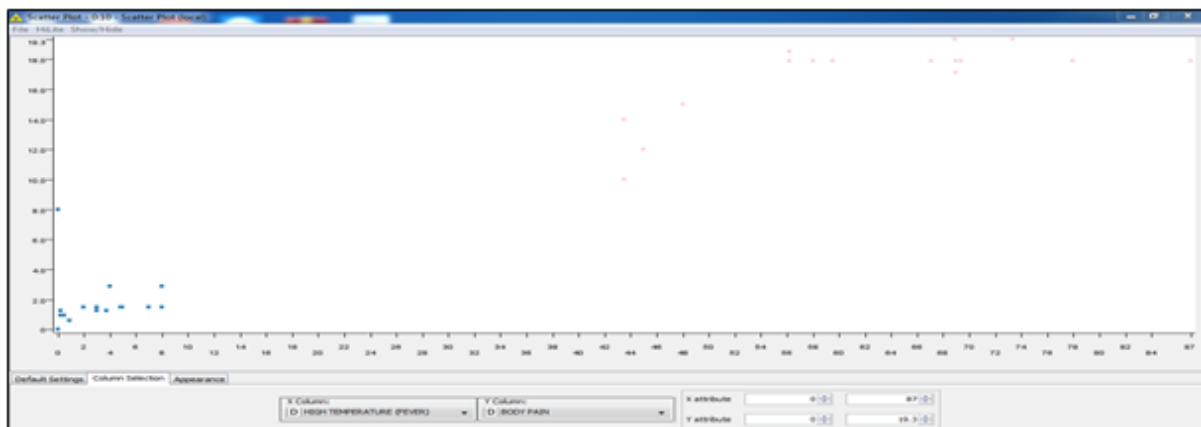


Figure 14: Scatter Plot generated by Hierarchical clustering on attributes (High temperature and Body Pain).

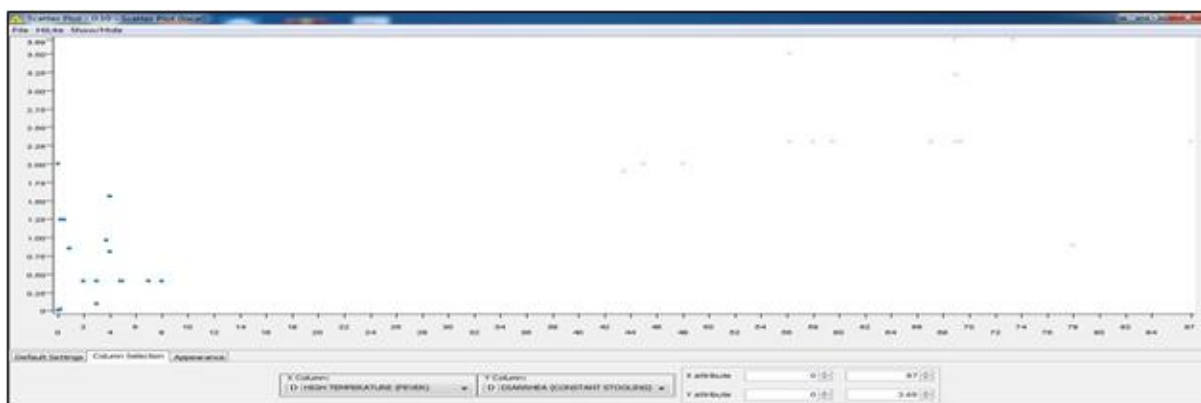
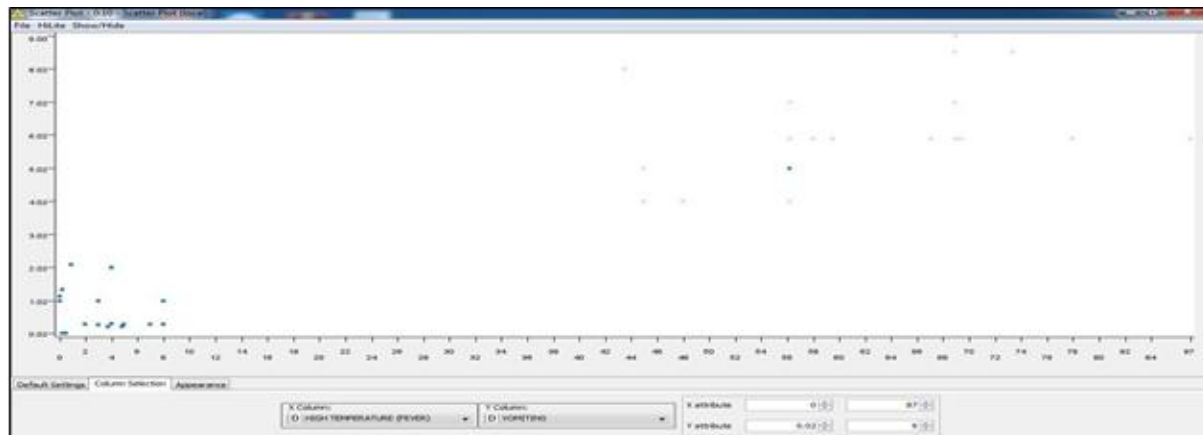
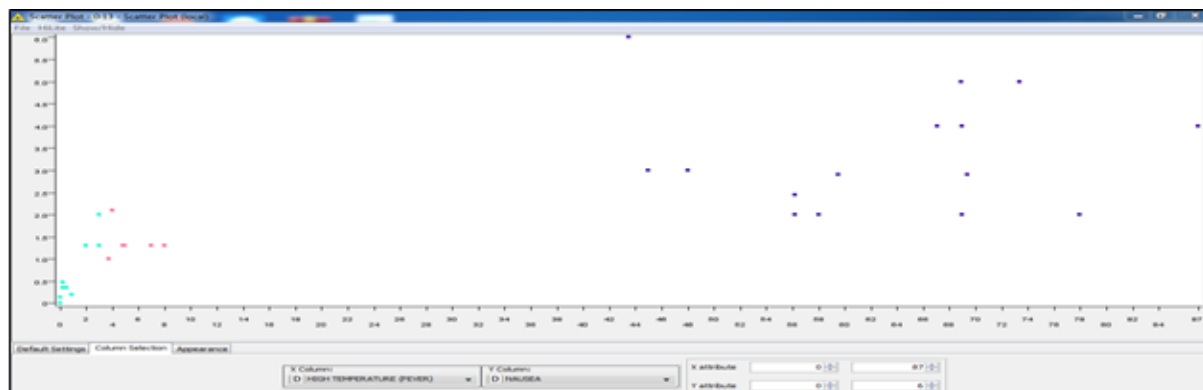


Figure 15: Scatter Plot generated by Hierarchical clustering on attributes (High temperature and Diarrhea).

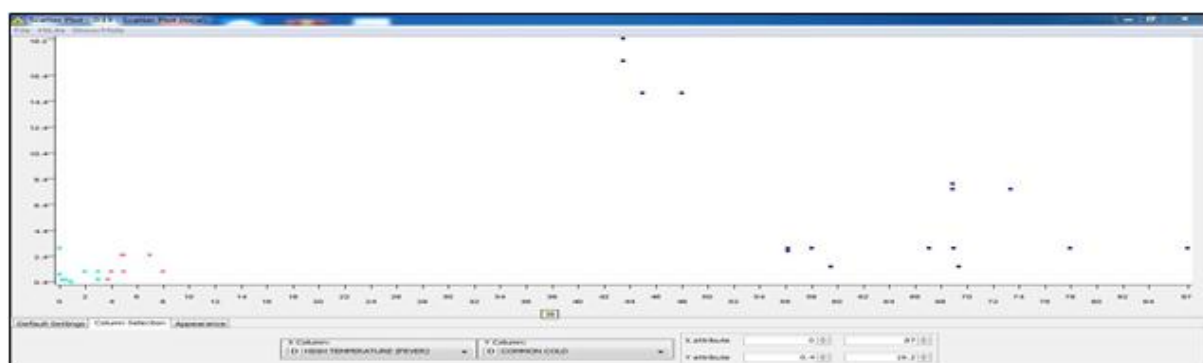


**Figure 16: Scatter Plot generated by Hierarchical clustering on attributes (High temperature and Vomiting).**

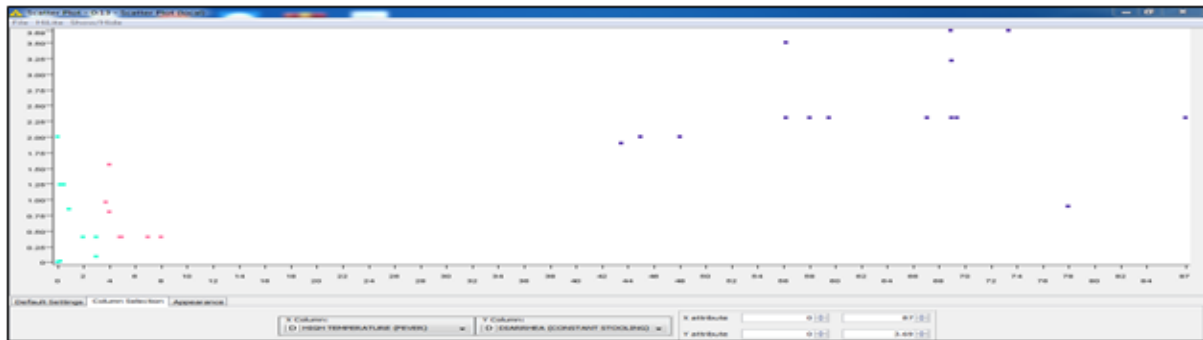
K-Means Clustering Scatter Plot on the attributes.



**Figure 17: Scatter Plot generated by k-Means clustering on attributes (High temperature and Nausea).**

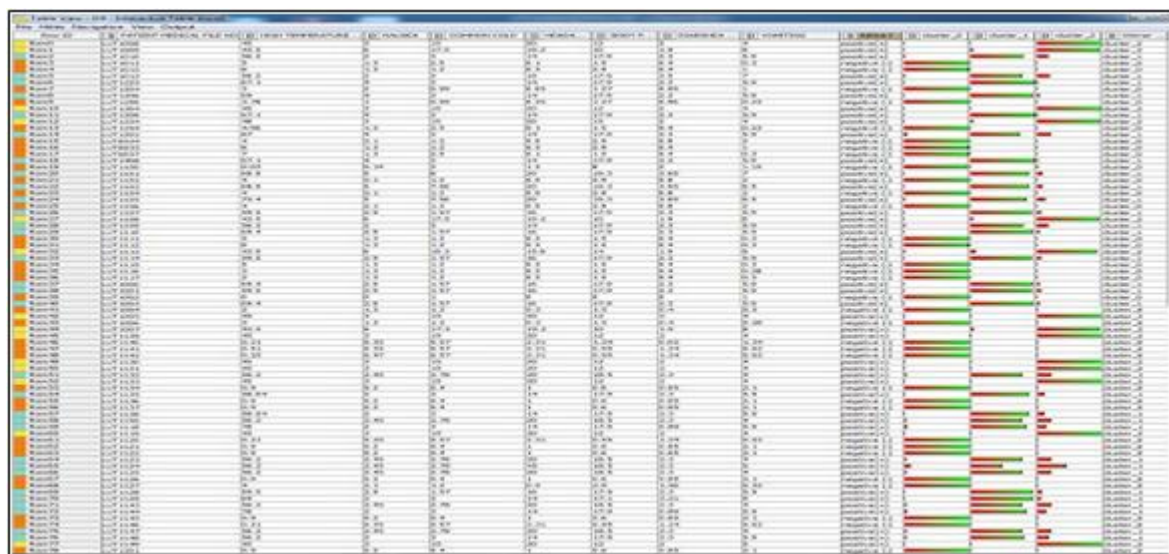


**Figure 18: Scatter Plot generated by k-Means clustering on attributes (High temperature and Cold).**

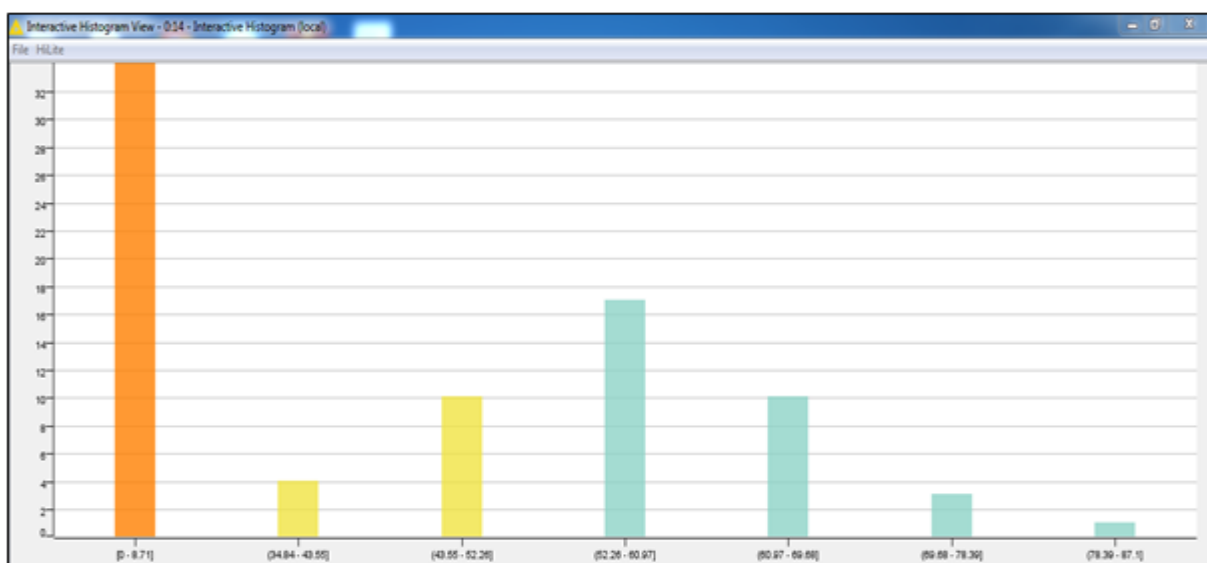


**Figure 19: Scatter Plot generated by k-Means clustering on attributes (High temperature and Diarrhea).**

### 3.4 Interactive Table And Histogram Fuzzy C-Means Clustering.



**Figure 20: Interactive Table generated by Fuzzy C-Means clustering on all attributes.**



**Figure 21: Interactive Histogram View of Fuzzy C-Means clustering.**

### 3.5 Interactive Table and Histogram K-Means Clustering.

Figure 22 shows an interactive table generated by K-Means clustering. The table has columns for Patient Medical File No., High Temperature, Cough, Headache, Body Pain, Coughing, and Result. The data is organized into rows, with each row representing a patient's record. The table is color-coded by cluster, with different colors used for different clusters.

Figure 22: Interactive Table generated by K-Means clustering on all attributes.

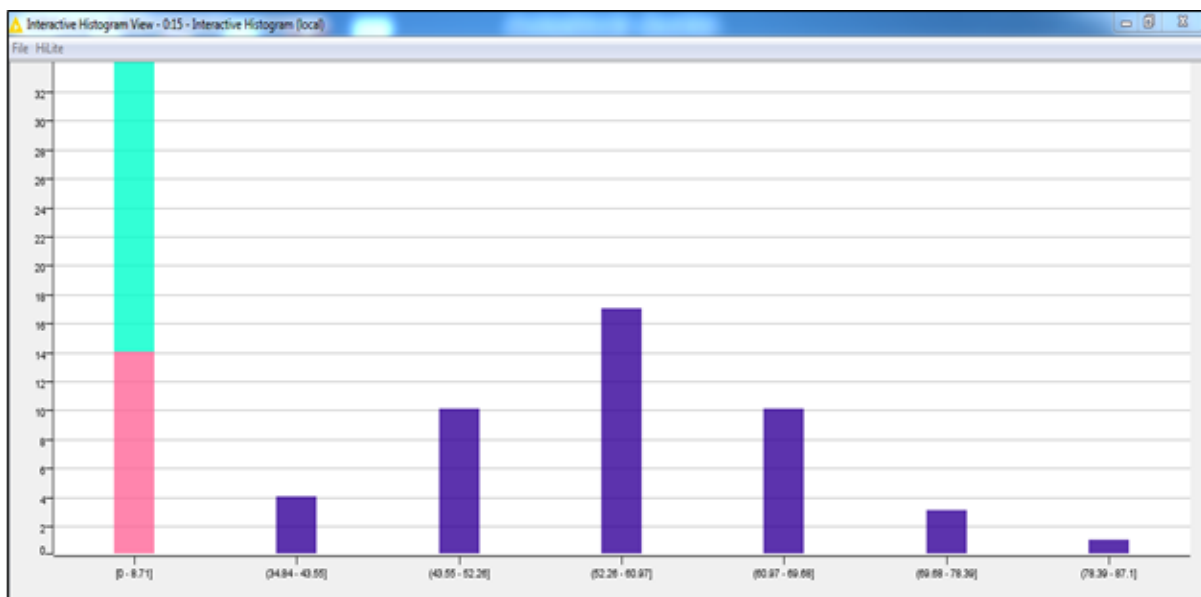


Figure 23: Interactive Histogram View of K-Means clustering.



### 3.6 Interactive Table and Histogram Hierarchical Clustering.

Row ID	Age	Gender	Marital Status	Education	Occupation	Religion	Body Mass Index	Glucose Level	Blood Pressure	Heart Rate	Cholesterol	Triglycerides	HDL	LDL	Cluster
Row 1	35	Male	Married	High School	Teacher	Hindu	25.5	100	120/80	75	180	100	150	100	Cluster 1
Row 2	40	Female	Single	College	Engineer	Muslim	28.0	110	130/90	80	190	110	160	110	Cluster 2
Row 3	30	Male	Married	High School	Farmer	Hindu	22.0	90	110/70	70	170	90	140	90	Cluster 1
Row 4	45	Female	Married	College	Doctor	Muslim	30.0	120	140/100	85	200	120	170	120	Cluster 2
Row 5	38	Male	Single	High School	Business	Hindu	26.0	105	125/85	78	185	105	155	105	Cluster 1
Row 6	42	Female	Married	College	Engineer	Muslim	29.0	115	135/95	82	195	115	165	115	Cluster 2
Row 7	32	Male	Married	High School	Farmer	Hindu	23.0	95	115/75	72	175	95	145	95	Cluster 1
Row 8	47	Female	Married	College	Doctor	Muslim	31.0	125	145/105	88	205	125	175	125	Cluster 2
Row 9	36	Male	Single	High School	Business	Hindu	27.0	110	130/90	80	190	110	160	110	Cluster 1
Row 10	41	Female	Married	College	Engineer	Muslim	28.5	118	138/98	84	198	118	168	118	Cluster 2
Row 11	31	Male	Married	High School	Farmer	Hindu	21.5	88	108/72	68	168	88	138	88	Cluster 1
Row 12	46	Female	Married	College	Doctor	Muslim	30.5	122	142/102	86	202	122	172	122	Cluster 2
Row 13	34	Male	Single	High School	Business	Hindu	25.0	102	122/82	76	182	102	152	102	Cluster 1
Row 14	43	Female	Married	College	Engineer	Muslim	29.5	112	132/92	81	192	112	162	112	Cluster 2
Row 15	33	Male	Married	High School	Farmer	Hindu	22.5	92	112/72	71	172	92	142	92	Cluster 1
Row 16	48	Female	Married	College	Doctor	Muslim	31.5	128	148/108	90	208	128	178	128	Cluster 2
Row 17	37	Male	Single	High School	Business	Hindu	26.5	108	132/88	79	188	108	158	108	Cluster 1
Row 18	44	Female	Married	College	Engineer	Muslim	30.2	116	136/96	83	196	116	166	116	Cluster 2
Row 19	32	Male	Married	High School	Farmer	Hindu	23.5	96	116/76	73	176	96	146	96	Cluster 1
Row 20	49	Female	Married	College	Doctor	Muslim	32.0	130	150/110	92	210	130	180	130	Cluster 2
Row 21	39	Male	Single	High School	Business	Hindu	27.5	115	135/95	83	195	115	165	115	Cluster 1
Row 22	45	Female	Married	College	Engineer	Muslim	29.8	114	134/94	81	194	114	164	114	Cluster 2
Row 23	35	Male	Married	High School	Farmer	Hindu	24.0	98	118/78	74	178	98	148	98	Cluster 1
Row 24	50	Female	Married	College	Doctor	Muslim	32.5	135	155/115	95	215	135	185	135	Cluster 2
Row 25	40	Male	Single	High School	Business	Hindu	28.0	120	140/100	87	200	120	170	120	Cluster 1
Row 26	46	Female	Married	College	Engineer	Muslim	30.8	118	138/98	84	198	118	168	118	Cluster 2
Row 27	36	Male	Married	High School	Farmer	Hindu	24.5	100	120/80	76	180	100	150	100	Cluster 1
Row 28	51	Female	Married	College	Doctor	Muslim	33.0	140	160/120	98	220	140	190	140	Cluster 2
Row 29	41	Male	Single	High School	Business	Hindu	28.5	125	145/105	90	205	125	175	125	Cluster 1
Row 30	47	Female	Married	College	Engineer	Muslim	31.2	120	140/100	88	200	120	170	120	Cluster 2
Row 31	37	Male	Married	High School	Farmer	Hindu	25.5	105	125/85	78	185	105	155	105	Cluster 1
Row 32	52	Female	Married	College	Doctor	Muslim	33.5	145	165/125	100	225	145	195	145	Cluster 2
Row 33	42	Male	Single	High School	Business	Hindu	29.0	130	150/110	92	210	130	180	130	Cluster 1
Row 34	48	Female	Married	College	Engineer	Muslim	31.8	122	142/102	89	202	122	172	122	Cluster 2
Row 35	38	Male	Married	High School	Farmer	Hindu	26.0	110	130/90	80	190	110	160	110	Cluster 1
Row 36	53	Female	Married	College	Doctor	Muslim	34.0	150	170/130	105	230	150	200	150	Cluster 2
Row 37	43	Male	Single	High School	Business	Hindu	30.0	135	155/115	95	215	135	185	135	Cluster 1
Row 38	49	Female	Married	College	Engineer	Muslim	32.2	125	145/105	91	205	125	175	125	Cluster 2
Row 39	39	Male	Married	High School	Farmer	Hindu	27.0	115	135/95	83	195	115	165	115	Cluster 1
Row 40	54	Female	Married	College	Doctor	Muslim	34.5	155	175/135	110	235	155	205	155	Cluster 2
Row 41	44	Male	Single	High School	Business	Hindu	30.5	140	160/120	98	220	140	190	140	Cluster 1
Row 42	50	Female	Married	College	Engineer	Muslim	32.8	128	148/108	93	208	128	178	128	Cluster 2
Row 43	40	Male	Married	High School	Farmer	Hindu	28.0	120	140/100	87	200	120	170	120	Cluster 1
Row 44	55	Female	Married	College	Doctor	Muslim	35.0	160	180/140	115	240	160	210	160	Cluster 2
Row 45	45	Male	Single	High School	Business	Hindu	31.0	145	165/125	100	225	145	195	145	Cluster 1
Row 46	51	Female	Married	College	Engineer	Muslim	33.2	130	150/110	94	210	130	180	130	Cluster 2
Row 47	41	Male	Married	High School	Farmer	Hindu	29.0	130	150/110	92	210	130	180	130	Cluster 1
Row 48	56	Female	Married	College	Doctor	Muslim	35.5	165	185/145	120	245	165	215	165	Cluster 2
Row 49	46	Male	Single	High School	Business	Hindu	31.5	150	170/130	105	230	150	200	150	Cluster 1
Row 50	52	Female	Married	College	Engineer	Muslim	33.8	132	152/112	96	212	132	182	132	Cluster 2
Row 51	42	Male	Married	High School	Farmer	Hindu	30.0	135	155/115	95	215	135	185	135	Cluster 1
Row 52	57	Female	Married	College	Doctor	Muslim	36.0	170	190/150	125	250	170	220	170	Cluster 2
Row 53	47	Male	Single	High School	Business	Hindu	32.0	155	175/135	110	235	155	205	155	Cluster 1
Row 54	53	Female	Married	College	Engineer	Muslim	34.2	135	155/115	97	215	135	185	135	Cluster 2
Row 55	43	Male	Married	High School	Farmer	Hindu	30.5	140	160/120	98	220	140	190	140	Cluster 1
Row 56	58	Female	Married	College	Doctor	Muslim	36.5	175	195/155	130	255	175	225	175	Cluster 2
Row 57	48	Male	Single	High School	Business	Hindu	32.5	160	180/140	115	240	160	210	160	Cluster 1
Row 58	54	Female	Married	College	Engineer	Muslim	34.8	138	158/118	99	218	138	188	138	Cluster 2
Row 59	44	Male	Married	High School	Farmer	Hindu	31.0	145	165/125	100	225	145	195	145	Cluster 1
Row 60	59	Female	Married	College	Doctor	Muslim	37.0	180	200/160	135	260	180	230	180	Cluster 2
Row 61	49	Male	Single	High School	Business	Hindu	33.0	165	185/145	120	245	165	215	165	Cluster 1
Row 62	55	Female	Married	College	Engineer	Muslim	35.2	140	160/120	100	220	140	190	140	Cluster 2
Row 63	45	Male	Married	High School	Farmer	Hindu	31.5	150	170/130	105	230	150	200	150	Cluster 1
Row 64	60	Female	Married	College	Doctor	Muslim	37.5	185	205/165	140	265	185	235	185	Cluster 2
Row 65	50	Male	Single	High School	Business	Hindu	33.5	170	190/150	125	250	170	220	170	Cluster 1
Row 66	56	Female	Married	College	Engineer	Muslim	35.8	142	162/122	102	222	142	192	142	Cluster 2
Row 67	46	Male	Married	High School	Farmer	Hindu	32.0	155	175/135	110	235	155	205	155	Cluster 1
Row 68	61	Female	Married	College	Doctor	Muslim	38.0	190	210/170	145	270	190	240	190	Cluster 2
Row 69	51	Male	Single	High School	Business	Hindu	34.0	175	195/155	130	255	175	225	175	Cluster 1
Row 70	57	Female	Married	College	Engineer	Muslim	36.2	145	165/125	104	225	145	195	145	Cluster 2
Row 71	47	Male	Married	High School	Farmer	Hindu	32.5	160	180/140	115	240	160	210	160	Cluster 1
Row 72	62	Female	Married	College	Doctor	Muslim	38.5	195	215/175	150	275	195	245	195	Cluster 2
Row 73	52	Male	Single	High School	Business	Hindu	34.5	180	200/160	135	260	180	230	180	Cluster 1
Row 74	58	Female	Married	College	Engineer	Muslim	36.8	148	168/128	106	228	148	198	148	Cluster 2
Row 75	48	Male	Married	High School	Farmer	Hindu	33.0	165	185/145	120	245	165	215	165	Cluster 1
Row 76	63	Female	Married	College	Doctor	Muslim	39.0	200	220/180	155	280	200	250	200	Cluster 2
Row 77	53	Male	Single	High School	Business	Hindu	35.0	185	205/165	140	265	185	235	185	Cluster 1
Row 78	59	Female	Married	College	Engineer	Muslim	37.2	150	170/130	108	230	150	200	150	Cluster 2
Row 79	49	Male	Married	High School	Farmer	Hindu	33.5	170	190/150	125	250	170	220	170	Cluster 1
Row 80	64	Female	Married	College	Doctor	Muslim	39.5	205	225/185	160	285	205	255	205	Cluster 2
Row 81	54	Male	Single	High School	Business	Hindu	35.5	190	210/170	145	270	190	240	190	Cluster 1
Row 82	60	Female	Married	College	Engineer	Muslim	37.8	152	172/132	110	232	152	202	152	Cluster 2
Row 83	50	Male	Married	High School	Farmer	Hindu	34.0	175	195/155	130	255	175	225	175	Cluster 1
Row 84	65	Female	Married	College	Doctor	Muslim	40.0	210	230/190	165	290	210	260	210	Cluster 2
Row 85	55	Male	Single	High School	Business	Hindu	36.0	195	215/175	150	275	195	245	195	Cluster 1
Row 86	61	Female	Married	College	Engineer	Muslim	38.2	155	175/135	112	235	155	205	155	Cluster 2
Row 87	51	Male	Married	High School	Farmer	Hindu	34.5	180	200/160	135	260	180	230	180	Cluster 1
Row 88	66	Female	Married	College	Doctor	Muslim	40.5	215	235/195	170	295	215	265	215	Cluster 2
Row 89	56	Male	Single	High School	Business	Hindu	36.5	200	220/180	155	280	200	250	200	Cluster 1
Row 90	62	Female	Married	College	Engineer	Muslim	38.8	158	178/138	114	238	158	208	158	Cluster 2
Row 91	52	Male	Married	High School	Farmer	Hindu	35.0	185	205/165	140	265	185	235	185	Cluster 1
Row 92	67	Female	Married	College	Doctor	Muslim	41.0	220	240/200	175	300	220	270	220	Cluster 2
Row 93	57	Male	Single	High School	Business	Hindu	37.0	205	225/185	160	285	205	255	205	Cluster 1
Row 94	63	Female	Married	College	Engineer	Muslim	39.2</								

cluster's centre is a minimal range and compactness between the different clusters is low. The hierarchical clustering on malaria results produced a dendrogram (divisive/top-down tree-like structure), and computed the distances between each clusters. The k-means clustering computed the coverage for cluster\_0, cluster\_1 and cluster\_2 as values of 14, 20 and 45 as shown in figure We could conclude that the cluster\_2 with the highest value (45) shows that patients within the attributes ranges tends to have a positive trace of malaria symptoms while cluster\_0 and cluster\_1 with values of 14 and 20 tends to read negative trace of malaria symptoms. The results can help the medical sectors to predict future occurrences of malaria in most countries.

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