Implementation of Fuzzy C-Means (FCM) Method For Grouping Heart Disorder Patient Data

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Abstract. Heart disease is a fatal disease for human health, resulting in death. Heart disease is a non-communicable disease, but the biggest contributor to mortality, in the amount of 37% (Indonesia Heart Foundation, 2016). The problems are there no system that is able to read the result of electrocardiogram (ECG), so the ECG result still require a doctor to read the result of electrocardiogram and there is no system that can grouping patients with cardiac abnormalities. This research aims to clustering data on patients with cardiac abnormalities with variable age, heart rate (HR) and bipolar waves (QRS, PQ, QT and QTc) using the Fuzzy C-Means approach. The sample data used in this research were 30 patients. The result of this research indicate that the clustering process stops at 17th iteration with objective function value 1033148,1702, there are 2 patients entered into cluster 1 and 28 patients entered into cluster 2.

Keywords: Fuzzy C-Means, Clustering, Heart Disease, Electrocardiogram, Bipolar Waves

1 Introduction

Diseases in humans are increasingly increasing and various kinds. Diseases that appear increasingly complex because the pattern of human life is getting worse (M. Cl 2018.). One of the vital organs of humans and is often attacked by diseases, namely the heart. to pump blood throughout the body is the role of the heart. Seeing from heart function that is very important for humans, the risk for people who have heart problems is very large and even leads to death. (al. 2018). [1].

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Recent research from the Ministry of Health, states that cardiovascular or heart disease is still the deadliest disease in Indonesia. more specifically, the study shows that of the total population at risk of heart disease 39.1% are aged between 15 and 45 years, contrary to the perception that heart disease is a disease of the elderly. Cardiovascular or heart disease is the most common disease among other non-communicable diseases and accounts for 37% of the mortality rate due to non-communicable diseases [2].

One way to look at heart abnormalities in a person can be seen from age, heart rate and bipolar waves (QRS, PQ, QT and QTc) using the FCM calculation method to cluster patient data.

2 Literature Review

Fuzzy c-means (FCM) technique has been widely used in data clustering. The advantages of FCM such as balancing of individual number of cluster points, drifting of small cluster centers to large neighboring cluster centers, and presence of fuzzy factor, make it more popular. However, early trapping at local minima and high sensitivity to the cluster center initialization are the major limitations of FCM. Clustering is an unsupervised pattern recognition technique used for partitioning the untrained data into various clusters which results in the high degree of similarity in the similar clusters and high degree of dissimilarity in case of dissimilar clusters. In general, there exist two groups of clustering namely hierarchical and partitioning. The first method works in a nested hierarchy fashion by taking an input and producing the corresponding output. On the other hand, the second clustering method is based on the objective function for partitioning the input into a set of fixed number of clusters to produce the output. This clustering process initiates with a random cluster partition and progressively refines the partition for the optimization of the objective function value. Again, the partitioning clustering can be grouped into either hard clusters or soft clusters. FCM is a soft partitioned clustering method introduced by Dunn and Bezdek. FCM is quite popular due to its fuzziness factor in the membership of cluster objects. Although, several attempts have been made to solve the problem of cluster size sensitivity, a very few have been successful in coming close toward the optimal cluster center and achieving the best fitness values of the cluster [3].

The FCM method can be implemented in the fields of education, industry and even medicine, for examples "Penerapan Fuzzy C-Means untuk Penentuan Besar Uang Kuliah Tunggal Mahasiswa Baru"[4], "Penentuan Penerima Beasiswa dengan Algoritma *Fuzzy C-Means* di Universitas Megos Pak Tulang Bawang"[5], "*Clustering* Data Nilai Siswa SMA untuk Penentuan Jurusan Menggunakan Algoritma *Fuzzy C-Means"*[6], "Klastering Industri di Kabupaten Kudus Menggunakan Metode Fuzzy C-Means"[7] and "Deteksi Penyakit Diabetes dengan Metode *Fuzzy C-Means* dan *K-Means Clustering"*[8].

A. Fuzzy C-Means (FCM) algorithm

The FCM algorithm makes use of fuzzy membership function which is used to assign a degree of membership for each class. FCM is able to form new clusters having close membership values to existing classes of the data points. The technique of FCM relies on three basic operators such as fuzzy membership function, partition matrix and the objective function. FCM is used to partition a set of N clusters through minimization of the objective function.

Steps of the FCM algorithm[9]:

1. Input the data that will be cluster X, in the form of a matrix size n x n (n = number of sample data, m = attribute of each data). X_ij = ith sample data (i = 1, 2, ..., n), the j-attribute (j = 1,2, ..., m).
2. Specify :
   - Number of clusters (c);
   - Exponent (w);
   - Maximum iteration (MaxIter);
   - Error expected value (ε);
   - Initial objective function (P_0) = 0;
   - Initial iteration (t) = 1
3. Create a random number μ_ik, i = 1, 2, ..., n; k = 1, 2, ..., c as the initial U partition matrix elements.

   Calculate each column:

$$Q_i = \sum_{k=1}^{c} \mu_i$$

With j = 1, 2,..., m

Calculate:

$$\mu_{ik} = \frac{\mu_{ik}}{Q_i}$$

4. Calculate the center of the cluster k: V_{kj}, with k = 1, 2,..., c; and j=1,2,...,m

$$V_{kj} = \frac{\sum_{j=1}^{n}((\mu_{ik})^{w} x\, X_{ij})}{\sum_{j=1}^{n}(\mu_{ik})}$$

5. Calculate the objective function in the initial iteration (t), p_t (Yan, 1994)

$$p_t = \sum_{i=1}^{n}\sum_{k=1}^{c}\left(\left[\sum_{j=1}^{m}(X_{ij} - V_{kj})^2\right](\mu_{ik})^{w}\right)$$

6. Calculate changes of the matrix partition (Yan, 1994)

$$\mu_{ik} = \frac{\left[\sum_{j=1}^{m}(X_{ij} - V_{kj})^2\right]^{\frac{-1}{w-1}}}{\sum_{k=1}^{c}\left[\sum_{j=1}^{m}(X_{ij} - V_{kj})^2\right]^{\frac{-1}{w-1}}}$$

With : i = 1, 2,...n and k = 1, 2,...c.

7. Check the stop condition:

- if: (|Pt – Pt-1| < ε) or (t > MaxIter) then stop;
- if not: t = t + 1, repeat step 4

3 Research Methodology

This study begins by collecting patient ECG (Electrocardiogram) data, the variables involved are 6 (six) variables consisting of variable X1 (QRS), variable X2 (QTc), variable X3 (PQ), variable X4 (QT) , variable X5 (age) and variable X6 (heart rate). the value weight data from each of the above variables will then be obtained with FCM to determine clustering. Where QRS, QTc, PQ and QT are bipolar waves.

FCM tools from MATLAB are used to analyze and cluster data according to the desired amount.

4 Result and Discussion

This research examined 30 sample patients data, according to the specified variable. consists of 6 variables

Table. 1 Sample patients data

Patient number	X1	X2	X3	X4	X5	X6
1	63	376	135	376	31	90
2	93	364.702	171	350	26	82
3	48	354.056	144	344	43	82
4	49	198.89	114	270	30	80
5	65	353.999	135	308	35	81
6	54	378.598	137	327	35	87
7	65	266.674	0	215	41	84
8	41	262.85	0	229	48	82
9	67	372.528	67	354	24	80
10	39	216.6582	0	196	40	98
11	20	207.6112	135	188	23	97
12	43	319.123	138	276	24	88
13	55	-1220.591	63	-110	21	93
14	44	349.669	112	256	22	92
15	54	207.5406	43	175	23	86
16	26	323.102	108	268	21	85
17	89	295.434	0	223	40	100
18	58	345.9155	62	289	22	90
19	83	-1404	78	-1283	22	98
20	65	297.703	153	318	21	102
21	64	283.797	150	305	24	87
22	68	335.036	142	342	23	91
23	48	417	152	488	33	93
24	67	424	148	393	45	73
25	53	423	200	379	23	74
26	86	424	181	429	35	98
27	75	350	0	288	27	92
28	89	229	128	222	30	71
29	78	352	117	283	21	81
30	90	406	145	338	22	88

FCM calculations start with:

- Determine the initial value

Table. 2 Initial value

Initial	Velue	Information
number of clusters (C)	2;	X_1 = Umur
Exponent (W)	2;	X_2 = HR
Maximum iteration (MaxIter)	100;	X_3 = QRS
Error expected value (X)	10^{-5};	X_4 = PQ
Initial objective function (P_0)	0;	X_5 = QT
Initial iteration (t)	1;	X_6 = QTc

- Create random number

Table. 3 Matrixs U

Column 1	Column 2
0.3	0.7
0.2	0.8
0.4	0.6
0.1	0.9
0.5	0.5
0.6	0.4
0.8	0.2
0.7	0.3
0.2	0.8
0.4	0.6
0.1	0.9
0.5	0.5
0.6	0.4
0.8	0.2
0.7	0.3
0.3	0.7
0.4	0.6
0.1	0.9
0.5	0.5
0.6	0.4
0.8	0.2
0.7	0.3
0.3	0.7
0.2	0.8
0.1	0.9
0.5	0.5
0.6	0.4
0.8	0.2
0.7	0.3
0.2	0.8

- Calculate cluster center

Table. 4 1st cluster center in final iteration

Membership degree of 1st cluster	Data on the cluster						(mi1)2	(mi1)2*Xi1	(mi1)2*Xi2	$(m_{i1})^2*X_{i3}$	$(m_{i1})^2*X_{i4}$	$(m_{i1})^2*X_{i5}$
	xi1	xi2	xi3	xi4	xi5	xi6						
0.0022	31	90	63	135	376	376	0.0000	0.000144335	0.000419038	0.000293327	0.000628557	0.001750648
0.0022	26	82	93	171	350	364.702	0.0000	0.000127854	0.000403232	0.000457324	0.000840886	0.001721111
0.0011	43	82	48	144	344	354.056	0.0000	5.09313E-05	9.71248E-05	5.68535E-05	0.000170561	0.00040745
0.0051	30	80	49	114	270	198.89	0.0000	0.000765165	0.002040441	0.00124977	0.002907629	0.006886489
0.0004	35	81	65	135	308	353.999	0.0000	6.54569E-06	1.51486E-05	1.21563E-05	2.52477E-05	5.76021E-05
0.0011	35	87	54	137	327	378.598	0.0000	4.22713E-05	0.000105074	6.52186E-05	0.000165462	0.000394935
0.0064	41	84	65	0	215	266.674	0.0000	0.001705421	0.003494034	0.002703717	0	0.008943064
0.0061	48	82	41	0	229	262.85	0.0000	0.001783082	0.003046099	0.001523049	0	0.008506788
0.0017	24	80	67	67	354	372.528	0.0000	6.71584E-05	0.000223861	0.000187484	0.000187484	0.000990587
0.0106	40	98	39	0	196	216.6582	0.0001	0.004471792	0.010955891	0.004359997	0	0.021911781
0.0089	23	97	20	135	188	207.6112	0.0001	0.001819341	0.007672875	0.001582036	0.010678743	0.014871139
0.0005	24	88	43	138	276	319.123	0.0000	6.141E-06	2.2517E-05	1.10026E-05	3.53107E-05	7.06215E-05
0.8563	21	93	55	63	-110	-1220.591	0.7333	15.39984058	68.19929398	40.33291579	46.19952173	-80.66583159
0.0008	22	92	44	112	256	349.669	0.0000	1.33921E-05	5.60035E-05	2.67843E-05	6.81782E-05	0.000155836
0.0105	23	86	54	43	175	207.5406	0.0001	0.002518205	0.009415897	0.005912307	0.004707948	0.019160255
0.0006	21	85	26	108	268	323.102	0.0000	8.27527E-06	3.34951E-05	1.02456E-05	4.25585E-05	0.000105608
0.0054	40	100	89	0	223	295.434	0.0000	0.001187993	0.002969982	0.002643284	0	0.006623061
0.0007	22	90	58	62	289	345.9155	0.0000	1.10381E-05	4.51559E-05	2.91005E-05	3.11074E-05	0.000145001
0.9510	22	98	83	78	-1283	-1404	0.9044	19.89648727	88.62980692	75.06402014	70.54209122	-1160.326962
0.0009	21	102	65	153	318	297.703	0.0000	1.70418E-05	8.27745E-05	5.27485E-05	0.000124162	0.000258062
0.0010	24	87	64	150	305	283.797	0.0000	2.18802E-05	7.93156E-05	5.83471E-05	0.000136751	0.00027806
0.0008	23	91	68	142	342	335.036	0.0000	1.39707E-05	5.52753E-05	4.13046E-05	8.62538E-05	0.000207738
0.0099	33	93	48	152	488	417	0.0001	0.00322067	0.009076433	0.00468461	0.0148346	0.047626873
0.0046	45	73	67	148	393	424	0.0000	0.000967103	0.001568856	0.001439909	0.003180693	0.00844603
0.0056	23	74	53	200	379	423	0.0000	0.000720101	0.002316847	0.001659363	0.006261748	0.011866013
0.0072	35	98	86	181	429	424	0.0001	0.001814217	0.005079808	0.004457791	0.009382095	0.02223712

0.0032	27	92	75	0	288	350	0.0000	0.000283295	0.0009653	0.00078693	0	0.00302181
0.0050	30	71	89	128	222	229	0.0000	0.000747405	0.001768858	0.002217301	0.003188927	0.005530795
0.0004	21	81	78	117	283	352	0.0000	3.24402E-06	1.25126E-05	1.20492E-05	1.80738E-05	4.3717E-05
0.0024	22	88	90	145	338	406	0.0000	0.000130599	0.000522398	0.00053427	0.000860769	0.002006482
						Σ	1.6384	35.31899631	156.8916451	115.4340042	116.8001767	-1240.798569
						Σ [(mi12)*Xij] / Σ (mi12)		21.55689106	95.75855647	70.45495381	71.28879492	-757.319357

Table. 5 2sd cluster center in final iteration

Membership degree of 2st cluster	Data on the cluster						$(\mu_{i1})^2$	$(\mu_{i1})^2*X_{i1}$	$(\mu_{i1})^2*X_{i2}$	$(\mu_{i1})^2*X_{i3}$	$(\mu_{i1})^2*X_{i4}$	$(\mu_{i1})^2*X_{i5}$	$(\mu_{i1})^2*X_{i6}$
0.9978	31	90	63	135	376	376	0.9957	30.86636251	89.61202018	62.72841412	134.4180303	374.3791065	374.3791065
0.9978	26	82	93	171	350	364.702	0.9956	25.88481604	81.63672752	92.58799584	170.242444	348.4494467	363.0863146
0.9989	43	82	48	144	344	354.056	0.9978	42.9064551	81.82161204	47.89557778	143.6867333	343.2516408	353.2857643
0.9949	30	80	49	114	270	198.89	0.9899	29.69774725	79.19399266	48.50632051	112.8514395	267.2797252	196.886165
0.9996	35	81	65	135	308	353.999	0.9991	34.96973449	80.92995697	64.94379263	134.8832616	307.7336635	353.6928869
0.9989	35	87	54	137	327	378.598	0.9978	34.92311381	86.80888291	53.8813756	136.6990455	326.2816634	377.7663155
0.9936	41	84	65	0	215	266.674	0.9871	40.472849	82.91998331	64.1642728	0	212.2356716	263.2452813
0.9939	48	82	41	0	229	262.85	0.9878	47.41667471	81.00348597	40.50174298	0	226.2170523	259.6556864
0.9983	24	80	67	67	354	372.528	0.9967	23.91977265	79.7325755	66.77603198	66.77603198	352.8166466	371.2827111
0.9894	40	98	39	0	196	216.6582	0.9790	39.15860731	95.9385879	38.17964212	0	191.8771758	212.1008343
0.9911	23	97	20	135	188	207.6112	0.9823	22.59269905	95.28225253	19.64582526	132.6093205	184.6707575	203.9346679
0.9995	24	88	43	138	276	319.123	0.9990	23.97572578	87.91099453	42.95650869	137.8604232	275.7208465	318.8002308
0.1437	21	93	55	63	-110	-1220.59	0.0206	0.433375523	1.919234461	1.135031133	1.30012657	-2.270062265	-25.18925064
0.9992	22	92	44	112	256	349.669	0.9984	21.96568398	91.85649666	43.93136797	111.8253003	255.6006864	349.1235797
0.9895	23	86	54	43	175	207.5406	0.9792	22.52119206	84.20967466	52.87584223	42.10483733	171.3568961	203.2200745
0.9994	21	85	26	108	268	323.102	0.9987	20.97364309	84.89331729	25.96736764	107.8644502	267.6636357	322.6964777
0.9946	40	100	89	0	223	295.434	0.9891	39.56520763	98.91301907	88.03258697	0	220.5760325	292.2226888

0.9993	22	90	58	62	289	345.9155	0.9986	21.9688445	89.87254567	57.91786277	61.91219813	288.59073	345.4256286
0.0490	22	98	83	78	-1283	-1404	0.0024	0.052839249	0.235374834	0.199348074	0.187339154	-3.081488902	-3.372104769
0.9991	21	102	65	153	318	297.703	0.9982	20.96218171	101.8163112	64.88294338	152.7244667	317.427323	297.1668753
0.9990	24	87	64	150	305	283.797	0.9981	23.95419072	86.83394137	63.87784193	149.713692	304.4178404	283.255311
0.9992	23	91	68	142	342	335.036	0.9984	22.96416285	90.85820954	67.89404669	141.7787446	341.4671172	334.5139681
0.9901	33	93	48	152	488	417	0.9803	32.35120196	91.17156916	47.05629376	149.0115969	478.4056532	408.801552
0.9954	45	73	67	148	393	424	0.9907	44.58373996	72.32473371	66.38023505	146.630967	389.3646623	420.0779054
0.9944	23	74	53	200	379	423	0.9888	22.74333071	73.17419447	52.40854469	197.7680932	374.7705365	418.279517
0.9928	35	98	86	181	429	424	0.9857	34.4978396	96.59395087	84.76612015	178.4031133	422.8449482	417.9166854
0.9968	27	92	75	0	288	350	0.9935	26.82536666	91.40495307	74.5149074	0	286.1372444	347.7362345
0.9950	30	71	89	128	222	229	0.9900	29.7012669	70.29299834	88.11375848	126.7254055	219.7893751	226.7196707
0.9996	21	81	78	117	283	352	0.9992	20.98349574	80.93634071	77.93869847	116.9080477	282.7775855	351.7233572
0.9976	22	88	90	145	338	406	0.9951	21.89292635	87.57170542	89.56197145	144.2942873	336.3549595	404.0240045
						$\sum$	27.8132	825.7250469	2417.669642	1690.222269	2999.179396	8363.107071	9042.45814
					$\sum [(\mu_{i1}^2)*X_{ij}] / \sum (\mu_{i1}^2)$			29.68824832	86.92527489	60.7705175	107.8329681	300.6884681	325.1139633

Table. 6 Cluster Center Results in Final Iteration

V_{kj}	21,55689106	95,75855647	70,45495381	71,28879492	-757,319357	-1321,188519
	29,68824832	86,92527489	60,7705175	107,8329681	300,6884681	325,1139633

- Calculating objective function

Table. 7 Results of Objective Functions in

Squared membershio degree of i data		X2	X3	L1+L2
m_{i1}^2	m_{i2}^2	L1	L2	
0.0000	0.9957	19.41123002	8976.544002	8995.955232
0.0000	0.9956	20.0585322	9025.353185	9045.411717
0.0000	0.9978	4.768339106	4376.589796	4381.358135
0.0000	0.9899	85.91859452	16926.63194	17012.55054
0.0000	0.9991	0.737914038	1705.587428	1706.325342
0.0000	0.9978	4.915394425	4467.778644	4472.694039
0.0000	0.9871	144.4342422	22250.28769	22394.72193
0.0000	0.9878	129.6019305	21134.44027	21264.0422
0.0000	0.9967	11.484064	6853.676291	6865.160355
0.0001	0.9790	366.7100905	34315.8762	34682.58629
0.0001	0.9823	256.0893679	28537.62961	28793.71898
0.0000	0.9990	0.963021518	1902.837879	1903.8009
0.7333	0.0206	314932.3793	52831.04629	367763.4256
0.0000	0.9984	2.325942334	2978.831717	2981.15766
0.0001	0.9792	351.1692074	33209.77844	33560.94764
0.0000	0.9987	1.48104149	2357.830062	2359.311103
0.0000	0.9891	106.3336456	19405.28195	19511.6156
0.0000	0.9986	1.943857895	2742.334952	2744.27881
0.9044	0.0024	256307.9224	13208.53961	269516.462
0.0000	0.9982	3.070665086	3405.588247	3408.658912
0.0000	0.9981	3.383055713	3539.761322	3543.144378
0.0000	0.9984	2.403329954	3081.268486	3083.671816
0.0001	0.9803	446.9193219	44792.03954	45238.95886
0.0000	0.9907	94.04282422	20191.9036	20285.94642
0.0000	0.9888	136.2168834	24208.11029	24344.32718
0.0001	0.9857	231.4682346	31918.48842	32149.95666
0.0000	0.9935	40.82287342	12561.94041	12602.76329
0.0000	0.9900	83.86865977	16718.93559	16802.80425
0.0000	0.9992	0.60001835	1526.024681	1526.624699
0.0000	0.9951	24.86601574	10180.92371	10205.78973
			Objective function	1033148.17

Final Iteration

- Conversion of the matrix

Table. 8 Results of Changes in the Matrix on Iteration

$\sum_{k=1}^{3}\left[\sum_{j=1}^{6}(X_{ij}-V_{kj})^2\right]^{-1}$ L1	$\left[\sum_{j=1}^{6}(X_{ij}-V_{1j})^2\right]$ L2	$\left[\sum_{j=1}^{6}(X_{ij}-V_{2j})^2\right]$ LT = L1+L2	m_{i1} L1/LT	m_{i2} L2/LT
2.39860E-07	0.000110921	1.11161E-04	2.15777E-03	9.97842E-01
2.45156E-07	0.000110308	1.10553E-04	2.21753E-03	9.97782E-01
2.48399E-07	0.000227991	2.28240E-04	1.08832E-03	9.98912E-01
2.96857E-07	5.84833E-05	5.87801E-05	5.05029E-03	9.94950E-01
2.53444E-07	0.000585801	5.86055E-04	4.32458E-04	9.99568E-01
2.45708E-07	0.000223333	2.23579E-04	1.09898E-03	9.98901E-01
2.87990E-07	4.43654E-05	4.46534E-05	6.44946E-03	9.93551E-01
2.86628E-07	4.67411E-05	4.70277E-05	6.09487E-03	9.93905E-01
2.43665E-07	0.000145419	1.45663E-04	1.67280E-03	9.98327E-01
3.04859E-07	2.85281E-05	2.88329E-05	1.05733E-02	9.89427E-01
3.08884E-07	3.44209E-05	3.47298E-05	8.89391E-03	9.91106E-01
2.65700E-07	0.000524999	5.25265E-04	5.05840E-04	9.99494E-01
2.32852E-06	3.90621E-07	2.71914E-06	8.56344E-01	1.43656E-01
2.61715E-07	0.000335178	3.35440E-04	7.80213E-04	9.99220E-01
3.11779E-07	2.94848E-05	2.97965E-05	1.04636E-02	9.89536E-01
2.66070E-07	0.000423586	4.23853E-04	6.27742E-04	9.99372E-01
2.79308E-07	5.09722E-05	5.12515E-05	5.44975E-03	9.94550E-01
2.58111E-07	0.000364136	3.64394E-04	7.08330E-04	9.99292E-01
3.52851E-06	1.81836E-07	3.71035E-06	9.50992E-01	4.90077E-02
2.64280E-07	0.000293106	2.93371E-04	9.00840E-04	9.99099E-01
2.69482E-07	0.000281966	2.82235E-04	9.54814E-04	9.99045E-01
2.52741E-07	0.000324036	3.24289E-04	7.79371E-04	9.99221E-01

- Check the stop condition
  (|Pt – Pt-1| < ε) or (t > MaxIter) it will be stop;
  (|1033148,170248 – 1033148,170231 |< ε) = true OR (17>100) = false.

  The calculation stops, because the results have shown the error results stably. The test results show that the clustering process stops at the 17th iteration with an objective function value of 1033148,1702. And produce 2 (two) clusters.

- Result of cluster

Table. 9 Degree of Membership of Each Data in Each Cluster

Data	Membership degree of Data (m) in Cluster		Cluster Data based on Membership Degree	C1	C2
	1	2			
1	0.0022	0.9978	0.9978		*
2	0.0022	0.9978	0.9978		*
3	0.0011	0.9989	0.9989		*
4	0.0051	0.9949	0.9949		*
5	0.0004	0.9996	0.9996		*
6	0.0011	0.9989	0.9989		*
7	0.0064	0.9936	0.9936		*
8	0.0061	0.9939	0.9939		*
9	0.0017	0.9983	0.9983		*
10	0.0106	0.9894	0.9894		*
11	0.0089	0.9911	0.9911		*
12	0.0005	0.9995	0.9995		*
13	0.8563	0.1437	0.8563	*	
14	0.0008	0.9992	0.9992		*
15	0.0105	0.9895	0.9895		*
16	0.0006	0.9994	0.9994		*
17	0.0054	0.9946	0.9946		*
18	0.0007	0.9993	0.9993		*
19	0.9510	0.0490	0.9510	*	
20	0.0009	0.9991	0.9991		*
21	0.0010	0.9990	0.9990		*
22	0.0008	0.9992	0.9992		*
23	0.0099	0.9901	0.9901		*
24	0.0046	0.9954	0.9954		*
25	0.0056	0.9944	0.9944		*
26	0.0072	0.9928	0.9928		*
27	0.0032	0.9968	0.9968		*
28	0.0050	0.9950	0.9950		*
29	0.0004	0.9996	0.9996		*
30	0.0024	0.9976	0.9976		*

6 CONCLUSION

This study only clustered data rather than classification and after calculating, the FCM method succeeded in conducting data clustering according to the weight of the bipolar wave values, age and heart rate of the patient to determine the 1st or 2nd cluster. The test results show that out of 30 patient data tests, as many as 2 patients entered into cluster 1 and as many as 28 patients entered into cluster 2.

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