

Question 4a and 1

Your Task: The first part is based on soft leader clustering algorithm . (a) Part based on Soft Leader Algorithm

- You are supposed to cluster your data set using the soft leader algorithm and compute AM of size $n \times K$, CRM of size $K \times d$, and PM of size $n \times d$, and $\text{Error}(\theta)$ corresponding to the chosen θ value.

- Randomly shuffle the dataset 10 times and use a suitable θ value so that the number of clusters is greater than or equal to 2 and less than n .

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- Note that, the order of presentation of the data points to the algorithm will change because of the random shuffling.

- It is possible that for different orders of the data, the number of clusters K can be different even with the same threshold value θ .

- For each of the 10 data shufflings, compute $\text{Error}(\theta)$ after computing the corresponding AM, CRM, and PM matrices.

- Report a table of K_i and $\text{Error}_i(\theta)$ where i stands for the shuffle number. You will have 10 entries in the table, one for each shuffle.

Answer

The Data set - engineering of the students have following features is obtained from the web with addition of few subject fields. It has 1000 Patterns and 25 features. ` gender race/ethnicity parental level of education

lunch

test preparation course m1 score m2 score physics score m3 score m4 score

DS score

CO score

LD score

SOM score

ED score

OS-2 score etc.. Procedure Followed:

The non-numerical features like "gender", "race/ethnicity", "lunch" etc are removed. Then the KNCC Leader Algorithm impelmeented below is run on the data points.

Tables and Graph are created appropriately for " ERROR VS K " and "Clusters VS K "

Also captured the No of cluster created and Leader points for different Teeta. and CRM,AM,PM and Error processing output.

Analysis Report

Analysis Report for KNNC

The Data set - engineering of the students have following features is obtained from the web with addition of few subject fields. It has 1000 Patterns and 25 features.

- gender
- race/ethnicity
- parental level of education
- lunch
- test preparation course
- m1 score
- m2 score
- physics score
- m3 score
- m4 score
- DS score
- CO score
- LD score
- SOM score
- ED score
- OS-2 score

etc.. Procedure Followed:

The non-numerical features like "gender", "race/ethnicity", "lunch" etc are removed. Then the KNNC Leader Algorithm implemented is run on the data points.

Tables and Graph are created appropriately for " ERROR VS K " and "Clusters VS K "

Also captured the No of cluster created and Leader points for different Teeta. Also captured the CRM,AM,PM and Error processing output.

Observations:

1.If euclidean distance is > threshold, Data points (DP) will be part of different clusters.

2. Numbers of clusters created is not equal to threshold values. It depends on the data points' euclidean distance from the leaders and threshold value. Shuffling the DPs leads to different leaders formed. Classification depends on DPs' position as well as Theta.

3. If $\text{Theta} / \text{Threshold} \leq \{ \text{all data points euclidean distance} \}$, then no. of clusters created = no. of data points. Here the error is ZERO.

1. Average Case: Considered Theta = 100 based on the experiments done for cluster the DPs.

If Theta = 100 - average euclidean distance around 100 to 140, we see data points mapped to more clusters.

1. Experimented using different Theta values [35, 100, 200] and found most of the values around [100 to 140].
2. Some Data points will map to 1 or more clusters - leading to soft clustering.
3. Cluster formation is DYNAMIC not known a priori.

Example:

No. of new clusters for the patterns are 71 for index 4

Computation intensive and it is based on threshold. If threshold is small, we will have many clusters/leaders and DPs' euclidean distance should be calculated with all these leaders - leading to slow convergence. Cluster of the patterns

Cluster List : [0, 1, 2, 3, 8, 9, 10, 12, 13, 14, 18, 22, 23, 24, 33, 35, 39, 44, 46, 47, 53, 55, 57, 69, 74, 76, 83, 94, 98, 104, 107, 108, 121, 124, 132, 136, 144, 148, 151, 170, 210, 232, 276, 277, 284, 307, 310, 359, 373, 401, 417, 430, 434, 465, 467, 475, 513, 527, 535, 567, 677, 752, 775, 799, 851, 886, 892, 905, 914, 925, 981] The Error (MSE) for different shuffle is given below: It is clearly seen, number of clusters created with same (theta) changes due to shuffling of Data points.

----- K NNC Table - Error(MSE) ----->

Index 1 | Error 4282358.60 | No of cluster: 75 | Theta 100

Index 2 | Error 3866721.24 | No of cluster: 73 | Theta 100

Index 3 | Error 3959840.80 | No of cluster: 74 | Theta 100

Index 4 | Error 4022552.80 | No of cluster: 74 | Theta 100

Index 5 | Error 4086689.25 | No of cluster: 74 | Theta 100

Index 6 | Error 4223218.69 | No of cluster: 67 | Teeta 100

Index 7 | Error 4011023.12 | No of cluster: 79 | Teeta 100

Index 8 | Error 3938759.62 | No of cluster: 79 | Teeta 100

Index 9 | Error 4199622.78 | No of cluster: 71 | Teeta 100

Index 10 | Error 4160122.57 | No of cluster: 69 | Teeta 100

Program Output as part of the execution

1. Index : Threshold value used for processing ==> 1 , 100.00

Error ==> 4282358.598451711 for Threshold 100.00

No. of new cluster Leader of the patterns are 75:

Cluster Leader of the patterns

```
Cluster Leader List Index : [0, 1, 3, 4, 7, 9, 16, 17, 19, 20, 25, 27, 30, 35, 41, 42, 45, 47, 49, 70,
119, 132, 163, 178, 180, 189, 199, 208, 211, 222, 227, 238, 242, 247, 249, 258, 268, 271, 282, 321, 343,
354, 356, 390, 405, 407, 428, 440, 471, 473, 489, 505, 510, 524, 539, 551, 552, 565, 568, 573, 626, 680,
682, 720, 743, 752, 756, 786, 798, 801, 835, 898, 916, 923, 925]
```

2. Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing ==> 2 , 100.00

Error ==> 3866721.241577517 for Threshold 100.00

No. of new cluster Leader of the patterns are 73:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 1, 2, 3, 4, 6, 7, 14, 15, 20, 23, 24, 26, 38, 43, 48, 49, 57, 62, 68, 69, 71, 72, 76, 87, 107, 108, 112, 113, 116, 123, 140, 157, 159, 162, 172, 173, 178, 181, 191, 198, 205, 207, 212, 218, 223, 231, 234, 238, 278, 296, 323, 349, 397, 417, 424, 439, 453, 454, 459, 467, 493, 566, 604, 623, 641, 701, 734, 746, 760, 917, 932, 990]

3. Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing ==> 3 , 100.00

Error ==> 3959840.7985761897 for Threshold 100.00

No. of new cluster Leader of the patterns are 74:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 2, 3, 6, 7, 8, 12, 14, 15, 16, 19, 24, 26, 27, 28, 34, 37, 39, 47, 50, 55, 57, 65, 68, 69, 79, 80, 81, 85, 88, 94, 98, 99, 126, 159, 165, 169, 178, 195, 207, 209, 214, 217, 219, 221, 233, 235, 258, 327, 353, 378, 464, 476, 535, 540, 543, 544, 556, 574, 576, 611, 612, 712, 752, 753, 761, 764, 818, 826, 847, 886, 908, 958, 991]

1. Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing ==> 4 , 100.00

Error ==> 4022552.795865034 for Threshold 100.00

No. of new cluster Leader of the patterns are 74:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 1, 2, 3, 4, 5, 6, 7, 9, 11, 13, 15, 16, 17, 21, 22, 28, 32, 36, 42, 44, 49, 51, 62, 66, 68, 72, 73, 87, 92, 96, 129, 139, 160, 168, 184, 199, 208, 215, 217, 219, 229, 235, 244, 262, 265, 277, 280, 285, 295, 345, 361, 389, 392, 463, 465, 475, 535, 556, 584, 588, 599, 616, 667, 677, 709, 725, 755, 760, 781, 782, 844, 943, 957]

1. Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing =====> 5 , 100.00

Error ==> 4086689.251924409 for Threshold 100.00

No. of new cluster Leader of the patterns are 74:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 1, 3, 5, 7, 9, 10, 12, 14, 15, 16, 17, 20, 26, 29, 33, 34, 38, 48, 49, 51, 56, 61, 80, 86, 88, 110, 114, 129, 130, 137, 142, 146, 162, 179, 181, 189, 198, 207, 212, 227, 235, 262, 275, 280, 284, 287, 296, 316, 363, 395, 397, 401, 417, 440, 450, 494, 509, 535, 546, 558, 594, 600, 623, 633, 657, 716, 725, 762, 767, 825, 836, 925, 978]

1. Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing =====> 6 , 100.00

Error ==> 4223218.688681013 for Threshold 100.00

No. of new cluster Leader of the patterns are 67:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 1, 2, 3, 4, 5, 6, 7, 9, 13, 14, 17, 19, 21, 22, 24, 30, 32, 35, 39, 44, 46, 49, 52, 58, 74, 79, 85, 95, 98, 104, 121, 130, 142, 153, 171, 176, 180, 188, 199, 211, 231, 239, 294, 316, 357, 362, 402, 403, 421, 538, 578, 585, 595, 622, 623, 671, 681, 721, 770, 774, 780, 805, 819, 891, 951, 971]

1. Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing =====> 7 , 100.00

Error ==> 4011023.117916052 for Threshold 100.00

No. of new cluster Leader of the patterns are 79:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 1, 2, 3, 5, 6, 9, 10, 11, 13, 14, 15, 16, 20, 22, 23, 25, 37, 44, 52, 55, 56, 57, 67, 78, 86, 108, 113, 115, 123, 130, 135, 153, 157, 174, 175, 191, 211, 213, 217, 238, 246, 247, 249, 262, 273, 276, 281, 294, 338, 340, 344, 365, 383, 385, 388, 469, 483, 513, 516, 528, 543, 571, 575, 581, 584, 622, 647, 666, 691, 708, 712, 755, 807, 828, 868, 882, 964, 969]

8 Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing =====> 8 , 100.00

Error ==> 3938759.624419129 for Threshold 100.00

No. of new cluster Leader of the patterns are 79:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 1, 3, 4, 7, 8, 13, 16, 19, 20, 26, 29, 30, 31, 46, 51, 54, 58, 63, 64, 69, 81, 89, 90, 91, 95, 96, 97, 101, 103, 108, 110, 114, 129, 132, 133, 135, 151, 152, 157, 162, 163, 167, 168, 171, 189, 213, 218, 221, 232, 235, 240, 241, 274, 278, 320, 328, 331, 334, 420, 436, 448, 466, 469, 485, 516, 520, 545, 561, 594, 601, 615, 644, 676, 713, 750, 826, 874, 984]

Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing ==> 9 , 100.00

Error ==> 4199622.7811283255 for Threshold 100.00

No. of new cluster Leader of the patterns are 71:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 1, 2, 3, 4, 5, 6, 7, 10, 14, 17, 24, 26, 37, 49, 59, 64, 68, 79, 88, 91, 96, 101, 105, 122, 126, 131, 143, 154, 157, 169, 173, 181, 201, 211, 216, 219, 234, 237, 262, 279, 283, 308, 335, 337, 368, 372, 382, 451, 460, 484, 494, 504, 522, 557, 570, 591, 599, 634, 651, 678, 729, 748, 794, 822, 833, 842, 884, 886, 936, 972]

9 Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing ==> 10 , 100.00

Error ==> 4160122.5719714365 for Threshold 100.00

No. of new cluster Leader of the patterns are 69:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 1, 2, 7, 8, 16, 17, 20, 22, 23, 24, 35, 37, 43, 53, 55, 69, 70, 79, 97, 98, 102, 105, 110, 131, 139, 150, 152, 154, 162, 167, 168, 169, 175, 177, 182, 211, 237, 239, 243, 254, 261, 274, 281, 286, 349, 357, 394, 433, 479, 490, 491, 493, 495, 502, 513, 517, 569, 677, 685, 724, 796, 810, 837, 838, 839, 857, 878, 992]

Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index = 1, =====>

[{'Index': 1, 'Teeta': 100, 'Error': '4282358.60', 'no.leader': 75, 'Cluster Index in DP/Leaders': [0, 1, 3, 4, 7, 9, 16, 17, 19, 20, 25, 27, 30, 35, 41, 42, 45, 47, 49, 70, 119, 132, 163, 178, 180, 189, 199, 208, 211, 222, 227, 238, 242, 247, 249, 258, 268, 271, 282, 321, 343, 354, 356, 390, 405, 407, 428, 440, 471, 473, 489, 505, 510, 524, 539, 551, 552, 565, 568, 573, 626, 680, 682, 720, 743, 752, 756, 786, 798, 801, 835, 898, 916, 923, 925]}]

Index = 2, =====> [{'Index': 2, 'Teeta': 100, 'Error': '3866721.24', 'no.leader': 73, 'Cluster Index in DP/Leaders': [0, 1, 2, 3, 4, 6, 7, 14, 15, 20, 23, 24, 26, 38, 43, 48, 49, 57, 62, 68, 69, 71, 72, 76, 87, 107, 108, 112, 113, 116, 123, 140, 157, 159, 162, 172, 173, 178, 181, 191, 198, 205, 207, 212, 218, 223, 231, 234, 238, 278, 296, 323, 349, 397, 417, 424, 439, 453, 454, 459, 467, 493, 566, 604, 623, 641, 701, 734, 746, 760, 917, 932, 990]}]

Index = 3, =====> [{'Index': 3, 'Teeta': 100, 'Error': '3959840.80', 'no.leader': 74, 'Cluster Index in DP/Leaders': [0, 2, 3, 6, 7, 8, 12, 14, 15, 16, 19, 24, 26, 27, 28, 34, 37, 39, 47, 50, 55, 57, 65, 68, 69, 79, 80, 81, 85, 88, 94, 98, 99, 126, 159, 165, 169, 178, 195, 207, 209, 214, 217, 219, 221, 233, 235, 258, 327, 353, 378, 464, 476, 535, 540, 543, 544, 556, 574, 576, 611, 612, 712, 752, 753, 761, 764, 818, 826, 847, 886, 908, 958, 991]}]

Index = 4, =====> [{'Index': 4, 'Teeta': 100, 'Error': '4022552.80', 'no.leader': 74, 'Cluster Index in DP/Leaders': [0, 1, 2, 3, 4, 5, 6, 7, 9, 11, 13, 15, 16, 17, 21, 22, 28, 32, 36, 42, 44, 49, 51, 62, 66, 68, 72, 73, 87, 92, 96, 129, 139, 160, 168, 184, 199, 208, 215, 217, 219, 229, 235, 244, 262, 265, 277, 280, 285, 295, 345, 361, 389, 392, 463, 465, 475, 535, 556, 584, 588, 599, 616, 667, 677, 709, 725, 755, 760, 781, 782, 844, 943, 957]}]

Index = 5, =====> [{'Index': 5, 'Teeta': 100, 'Error': '4086689.25', 'no.leader': 74, 'Cluster Index in DP/Leaders': [0, 1, 3, 5, 7, 9, 10, 12, 14, 15, 16, 17, 20, 26, 29, 33, 34, 38, 48, 49, 51, 56, 61, 80, 86, 88, 110, 114, 129, 130, 137, 142, 146, 162, 179, 181, 189, 198, 207, 212, 227, 235, 262, 275, 280, 284, 287, 296, 316, 363, 395, 397, 401, 417, 440, 450, 494, 509, 535, 546, 558, 594, 600, 623, 633, 657, 716, 725, 762, 767, 825, 836, 925, 978]}]

Index = 6, =====> [{'Index': 6, 'Teeta': 100, 'Error': '4223218.69', 'no.leader': 67, 'Cluster Index in DP/Leaders': [0, 1, 2, 3, 4, 5, 6, 7, 9, 13, 14, 17, 19, 21, 22, 24, 30, 32, 35, 39, 44, 46, 49, 52, 58, 74, 79, 85, 95, 98, 104, 121, 130, 142, 153, 171, 176, 180, 188, 199, 211, 231, 239, 294, 316, 357, 362, 402, 403, 421, 538, 578, 585, 595, 622, 623, 671, 681, 721, 770, 774, 780, 805, 819, 891, 951, 971]}]

Index = 7, =====> [{'Index': 7, 'Teeta': 100, 'Error': '4011023.12', 'no.leader': 79, 'Cluster Index in DP/Leaders': [0, 1, 2, 3, 5, 6, 9, 10, 11, 13, 14, 15, 16, 20, 22, 23, 25, 37, 44, 52, 55, 56, 57, 67, 78, 86, 108, 113, 115, 123, 130, 135, 153, 157, 174, 175, 191, 211, 213, 217, 238, 246, 247, 249, 262, 273, 276, 281, 294, 338, 340, 344, 365, 383, 385, 388, 469, 483, 513, 516, 528, 543, 571, 575, 581, 584, 622, 647, 666, 691, 708, 712, 755, 807, 828, 868, 882, 964, 969]}]

Index = 8, =====> [{'Index': 8, 'Teeta': 100, 'Error': '3938759.62', 'no.leader': 79, 'Cluster Index in DP/Leaders': [0, 1, 3, 4, 7, 8, 13, 16, 19, 20, 26, 29, 30, 31, 46, 51, 54, 58, 63, 64, 69, 81, 89, 90, 91, 95, 96, 97, 101, 103, 108, 110, 114, 129, 132, 133, 135, 151, 152, 157, 162, 163, 167, 168, 171, 189, 213, 218, 221, 232, 235, 240, 241, 274, 278, 320, 328, 331, 334, 420, 436, 448, 466, 469, 485, 516, 520, 545, 561, 594, 601, 615, 644, 676, 713, 750, 826, 874, 984]}]

Index = 9, =====> [{'Index': 9, 'Teeta': 100, 'Error': '4199622.78', 'no.leader': 71, 'Cluster Index in DP/Leaders': [0, 1, 2, 3, 4, 5, 6, 7, 10, 14, 17, 24, 26, 37, 49, 59, 64, 68, 79, 88, 91, 96, 101, 105, 122, 126, 131, 143, 154, 157, 169, 173, 181, 201, 211, 216, 219, 234, 237, 262, 279, 283, 308, 335, 337, 368, 372, 382, 451, 460, 484, 494, 504, 522, 557, 570, 591, 599, 634, 651, 678, 729, 748, 794, 822, 833, 842, 884, 886, 936, 972]}]

Index = 10, =====> [{'Index': 10, 'Teeta': 100, 'Error': '4160122.57', 'no.leader': 69, 'Cluster Index in DP/Leaders': [0, 1, 2, 7, 8, 16, 17, 20, 22, 23, 24, 35, 37, 43, 53, 55, 69, 70, 79, 97, 98, 102, 105, 110, 131, 139, 150, 152, 154, 162, 167, 168, 169, 175, 177, 182, 211, 237, 239, 243, 254, 261, 274, 281, 286, 349, 357, 394, 433, 479, 490, 491, 493, 495, 502, 513, 517, 569, 677, 685, 724, 796, 810, 837, 838, 839, 857, 878, 992]}]

Matrix output files are attached and only sample output provided here

AM

CRM

PM

Index : Threshold value used for processing ==> 1 , 100.00

No. of new cluster Leader of the patterns are 70:

(67 57 59 40 67 63 37 72 83 59 51 100 84 55 35 86 59 54 60 85 77) ----> index [0] (69 66 61 91 59 40 60 78 55 44 98 82 51 49 80 62 75 92 49 75 41) ----> index [1] (58 76 78 86 98 46 69 38 46 83 91 98 74 86 92 90 84 45 62 70 94) ----> index [2] (71 69 68 43 53 74 96 57 79 64 100 64 94 39 49 96 79 99 46 91 90) ----> index [6] (88 85 76 37 49 56 61 77 63 99 70 50 62 70 37 50 78 80 52 38 87) ----> index [7] (68 83 78 100 56 90 72 52 39 54 93 67 85 56 83 60 47 51 40 45 71) ----> index [9] (23 44 36 67 42 43 46 40 67 79 47 87 49 49 96 79 78 61 51 78 80) ----> index [11] (57 51 54 80 98 62 41 69 77 78 73 42 54 38 77 76 62 58 61 62 91) ----> index [13] (58 54 52 45 97 77 87 55 95 39 100 93 73 94 36 94 67 53 84 39 63) ----> index [15] (72 80 83 48 52 35 54 56 65 54 97 35 38 46 86 45 44 66 74 94 78) ----> index [17] (39 39 34 70 84 96 64 39 65 49 93 95 77 46 81 62 79 95 49 89 96) - ----> index [20] (84 77 71 84 39 83 64 64 48 61 68 85 74 67 38 40 52 80 100 81 80) ----> index [22] (72 67 65 42 99 67 56 88 72 73 100 59 98 87 76 87 57 94 48 76 40) ----> index [24] (81 88 90 37 96 87 100 50 74 56 37 93 92 93 85 39 95 46 51 94 73) ----> index [26] (58 62 59 70 37 68 87 80 69 46 48 97 92 49 97 99 87 70 47 50 48) ----> index [27] (45 63 59 36 59 38 48 36 70 36 92 36 96 100 87 67 76 72 43 60 93) ----> index [31] (93 90 83 47 82 84 88 85 97 40 52 59 68 42 98 54 54 91 42 38 57) ----> index [33] (70 55 56 69 38 45 91 96 55 69 70 60 65 62 49 98 64 42 100 60 76) ----> index [43] (51 60 58 51 93 97 89 38 65 88 93 77 62 46 76 77 66 100 51 38 35) ----> index [44] (69 84 82 89 50 69 50 41 95 43 54 53 41 90 84 92 55 60 88 91 37) ----> index [47] (48 56 51 67 98 41 81 86 89 85 42 86 89 86 73 65 99 58 67 72 71) ----> index [48] (65 81 81 80 81 88 81 36 72 56 93 38 71 36 92 47 100 100 83 93 85) ----> index [50] (48 45 41 50 38 55 83 37 54 87 94 80 84 91 56 50 68 45 41 46 88) ----> index [63] (59 54 67 56 64 98 36 68 47 59 54 46 67 73 100 52 93 85 39 70 67) ----> index [64] (59 69 65 85 42 75 41 91 85 90 70 93 42 98 100 63 58 94 73 60 90) ----> index [80] (76 83 79 76 74 45 85 66 41 36 47 73 91 39 59 40 94 56 62 93 83) ----> index [92] (84 83 75 40 48 81 94 57 36 100 47 59 47 41 76 46 56 56 81 90 61) ----> index [99] (74 90 88 54 66 45 99 52 72 44 85 100 38 50 48 36 39 65 66 55 86) ----> index [112] (77 91 88 60 45 59 78 95 97 40 80 71 37 100 96 60 97 51 37 37 45) ----> index [113] (67 74 70 39 36 70 90 36 79 35 35 76 85 79 46 72 54 39 83 35 66) ----> index [116] (77 76 77 40 100 54 66 94 63 62 40 48 70 94 100 81 36 47 71 35 74) ----> index [133] (86 81 75 78 82 35 95 96 43 96 52 50 51 75 69 63 97 90 86 99 46) ----> index [135] (79 67 67 47 44 66 63 86 47 58 75 56 55 97 99 37 84 39 99 83 60) ----> index [138] (85 84 82 67 100 35 96 77 50 72 87 92 36 98 92 61 44 86 56 48 45) ----> index [144] (74 89 84 83 37 69 67 90 100 68 92 49 93 36 77 60 38 37 43 98 56) ----> index [155] (30 24 15 67 45 43 56 91 38 60 99 43 64 86 82 78 54 88 98 84 69) ----> index [157] (40 43 39 78 95 38 38 75 78 76 82 93 36 83 36 55 63 92 52 100 75) ----> index [160] (22 39 33 45 71 100 88 97 58 79

80 74 41 81 76 37 83 48 70 74 65) ----> index [164] (99 93 90 92 95 62 44 71 38 88 71 100 84 47 47 97 86 76 93 43 72) ----> index [176] (100 92 97 77 70 87 62 84 48 95 49 75 79 92 49 87 41 36 47 100 43) ----> index [180] (87 100 95 88 100 100 51 42 70 52 43 52 84 87 59 85 75 65 55 68 70) ----> index [194] (52 48 49 98 72 86 97 43 99 100 43 41 79 41 55 57 47 37 36 95 46) ----> index [198] (74 79 82 62 37 81 86 100 97 77 51 46 98 86 100 96 98 42 74 80 35) ----> index [201] (53 54 48 92 97 100 45 90 58 46 95 84 94 99 49 38 75 68 40 63 93) ----> index [218] (74 76 73 83 84 79 100 42 70 82 70 37 46 97 58 46 48 82 65 87 71) ----> index [227] (51 58 54 62 48 42 77 80 63 37 57 38 86 67 48 46 43 97 100 44 53) ----> index [298] (0 17 10 79 88 38 35 64 81 82 40 39 45 69 93 43 81 99 39 81 66) ----> index [353] (81 81 84 71 69 87 72 41 67 97 58 66 81 88 65 37 100 48 91 53 36) ----> index [471] (58 67 72 51 53 68 67 69 63 58 35 94 39 95 60 75 62 100 56 100 43) ----> index [475] (68 65 61 81 46 87 38 91 48 39 52 48 97 94 56 92 43 64 98 36 88) ----> index [486] (59 62 61 48 51 97 76 48 83 47 69 89 64 93 100 79 61 35 45 89 64) ----> index [503] (57 78 79 95 85 37 50 92 100 80 81 87 38 48 57 100 98 49 85 54 57) ----> index [505] (61 56 56 99 62 100 78 78 89 57 66 89 48 70 39 94 93 39 39 84 45) ----> index [545] (97 100 100 49 55 84 48 49 36 42 55 71 36 79 84 58 47 91 72 44 75) ----> index [552] (33 41 43 87 96 59 39 84 52 41 46 50 98 75 56 91 96 84 95 90 61) ----> index [592] (65 69 70 59 37 99 38 62 99 74 89 85 57 76 61 96 41 58 77 39 39) ----> index [598] (32 39 33 80 57 51 98 46 88 42 72 77 49 93 98 58 83 78 35 47 46) ----> index [609] (72 64 63 43 92 61 99 80 43 40 99 60 100 45 37 70 56 47 99 37 37) ----> index [629] (79 88 94 63 40 98 38 36 41 100 86 52 76 38 67 96 37 49 73 97 72) ----> index [655] (81 73 72 92 42 72 78 59 99 77 46 83 40 42 100 43 95 65 42 74 81) ----> index [681] (32 34 38 93 42 94 36 37 73 89 60 47 69 65 35 55 35 71 49 70 81) ----> index [685] (49 57 46 42 40 91 90 97 67 45 65 43 73 35 81 62 45 45 40 66 94) ----> index [705] (64 50 43 46 94 91 55 70 42 91 60 98 54 55 73 95 66 95 100 91 80) ----> index [727] (62 74 70 100 52 72 76 68 97 41 93 39 86 99 44 100 97 92 82 47 88) ----> index [731] (54 59 62 36 77 97 38 35 37 77 71 59 50 37 51 63 58 56 99 38 52) ----> index [742] (92 100 97 65 79 37 88 41 38 35 35 56 63 99 35 76 43 88 42 87 87) ----> index [774] (39 42 38 56 93 74 56 64 88 38 57 37 39 98 71 50 39 36 90 44 47) ----> index [873] (63 73 68 44 99 93 36 37 64 84 98 90 86 51 50 43 41 72 56 93 52) ----> index [880] (53 51 51 95 38 80 42 87 66 96 93 54 92 35 93 84 75 95 56 43 35) ----> index [882] (59 72 80 43 51 60 77 41 80 90 37 41 63 52 74 88 80 100 88 76 100) ----> index [942]

Mapping DP to Leader ----->

CRM Matrix for Data Points

X0	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X								
15	X16	X17	X18	X19	X20																		
67.00	57.00	59.00	40.00	67.00	63.00	37.00	72.00	83.00	59.00	51.00	100.00	84.00	55.00	35.00	86.00	59.00	54.00	60.00	85.00	77.00	69.00	66.00	61.00
91.00	59.00	40.00	60.00	78.00	55.00	44.00	98.00	82.00	51.00	49.00	80.00	62.00	75.00	92.00	49.00	75.00	41.00	58.00	76.00	78.00	86.00	98.00	46.00
69.00	38.00	46.00	83.00	91.00	98.00	74.00	86.00	92.00	90.00	84.00	45.00	62.00	70.00	94.00	71.00	69.00	68.00	43.00	53.00	74.00	96.00	57.00	79.00
64.00	100.00	64.00	94.00	39.00	49.00	96.00	79.00	99.00	46.00	91.00	90.00	88.00	85.00	76.00	37.00	49.00	56.00	61.00	77.00	63.00	99.00	70.00	50.00
62.00	70.00	37.00	50.00	78.00	80.00	52.00	38.00	87.00	68.00	83.00	78.00	100.00	56.00	90.00	72.00	52.00	39.00	54.00	93.00	67.00	85.00	56.00	83.00
60.00	47.00	51.00	40.00	45.00	71.00	23.00	44.00	36.00	67.00	42.00	43.00	46.00	40.00	67.00	79.00	47.00	87.00	49.00	49.00	96.00	79.00	78.00	61.00
51.00	78.00	80.00	57.00	51.00	54.00	80.00	98.00	62.00	41.00	69.00	77.00	78.00	73.00	42.00	54.00	38.00	77.00	76.00	62.00	58.00	61.00	62.00	91.00
58.00	54.00	52.00	45.00	97.00	77.00	87.00	55.00	95.00	39.00	100.00	93.00	73.00	94.00	36.00	94.00	67.00	53.00	84.00	39.00	63.00	72.00	80.00	83.00
48.00	52.00	35.00	54.00	56.00	65.00	54.00	97.00	35.00	38.00	46.00	86.00	45.00	44.00	66.00	74.00	94.00	78.00	39.00	39.00	34.00	70.00	84.00	96.00
64.00	39.00	65.00	49.00	93.00	95.00	77.00	46.00	81.00	62.00	79.00	95.00	49.00	89.00	96.00	84.00	77.00	71.00	84.00	39.00	83.00	64.00	64.00	48.00

61.00 68.00 85.00 74.00 67.00 38.00 40.00 52.00 80.00 100.00 81.00 80.00 72.00 67.00 65.00 42.00 99.00 67.00 56.00 88.00 72.00 73.00 100.00
59.00 98.00 87.00 76.00 87.00 57.00 94.00 48.00 76.00 40.00 81.00 88.00 90.00 37.00 96.00 87.00 100.00 50.00 74.00 56.00 37.00 93.00 92.00 93.00
85.00 39.00 95.00 46.00 51.00 94.00 73.00 58.00 62.00 59.00 70.00 37.00 68.00 87.00 80.00 69.00 46.00 48.00 97.00 92.00 49.00 97.00 99.00 87.00
70.00 47.00 50.00 48.00 45.00 63.00 59.00 36.00 59.00 38.00 48.00 36.00 70.00 36.00 92.00 36.00 96.00 100.00 87.00 67.00 76.00 72.00 43.00 60.00
93.00 93.00 90.00 83.00 47.00 82.00 84.00 88.00 85.00 97.00 40.00 52.00 59.00 68.00 42.00 98.00 54.00 54.00 91.00 42.00 38.00 57.00 70.00 55.00
56.00 69.00 38.00 45.00 91.00 96.00 55.00 69.00 70.00 60.00 65.00 62.00 49.00 98.00 64.00 42.00 100.00 60.00 76.00 51.00 60.00 58.00 51.00 93.00
97.00 89.00 38.00 65.00 88.00 93.00 77.00 62.00 46.00 76.00 77.00 66.00 100.00 51.00 38.00 35.00 69.00 84.00 82.00 89.00 50.00 69.00 50.00 41.00
95.00 43.00 54.00 53.00 41.00 90.00 84.00 92.00 55.00 60.00 88.00 91.00 37.00 48.00 56.00 51.00 67.00 98.00 41.00 81.00 86.00 89.00 85.00 42.00
86.00 89.00 86.00 73.00 65.00 99.00 58.00 67.00 72.00 71.00 65.00 81.00 81.00 80.00 81.00 88.00 81.00 36.00 72.00 56.00 93.00 38.00 71.00 36.00
92.00 47.00 100.00 100.00 83.00 93.00 85.00 48.00 45.00 41.00 50.00 38.00 55.00 83.00 37.00 54.00 87.00 94.00 80.00 84.00 91.00 56.00 50.00
68.00 45.00 41.00 46.00 88.00 59.00 54.00 67.00 56.00 64.00 98.00 36.00 68.00 47.00 59.00 54.00 46.00 67.00 73.00 100.00 52.00 93.00 85.00 39.00
70.00 67.00 59.00 69.00 65.00 85.00 42.00 75.00 41.00 91.00 85.00 90.00 70.00 93.00 42.00 98.00 100.00 63.00 58.00 94.00 73.00 60.00 90.00 76.00
83.00 79.00 76.00 74.00 45.00 85.00 66.00 41.00 36.00 47.00 73.00 91.00 39.00 59.00 40.00 94.00 56.00 62.00 93.00 83.00 84.00 83.00 75.00 40.00
48.00 81.00 94.00 57.00 36.00 100.00 47.00 59.00 47.00 41.00 76.00 46.00 56.00 56.00 81.00 90.00 61.00 74.00 90.00 88.00 54.00 66.00 45.00 99.00
52.00 72.00 44.00 85.00 100.00 38.00 50.00 48.00 36.00 39.00 65.00 66.00 55.00 86.00 77.00 91.00 88.00 60.00 45.00 59.00 78.00 95.00 97.00 40.00
80.00 71.00 37.00 100.00 96.00 60.00 97.00 51.00 37.00 37.00 45.00 67.00 74.00 70.00 39.00 36.00 70.00 90.00 36.00 79.00 35.00 35.00 76.00 85.00
79.00 46.00 72.00 54.00 39.00 83.00 35.00 66.00 77.00 76.00 77.00 40.00 100.00 54.00 66.00 94.00 63.00 62.00 40.00 48.00 70.00 94.00 100.00
81.00 36.00 47.00 71.00 35.00 74.00 86.00 81.00 75.00 78.00 82.00 35.00 95.00 96.00 43.00 96.00 52.00 50.00 51.00 75.00 69.00 63.00 97.00 90.00
86.00 99.00 46.00 79.00 67.00 67.00 47.00 44.00 66.00 63.00 86.00 47.00 58.00 75.00 56.00 55.00 97.00 99.00 37.00 84.00 39.00 99.00 83.00 60.00
85.00 84.00 82.00 67.00 100.00 35.00 96.00 77.00 50.00 72.00 87.00 92.00 36.00 98.00 92.00 61.00 44.00 86.00 56.00 48.00 45.00 74.00 89.00 84.00
83.00 37.00 69.00 67.00 90.00 100.00 68.00 92.00 49.00 93.00 36.00 77.00 60.00 38.00 37.00 43.00 98.00 56.00 30.00 24.00 15.00 67.00 45.00 43.00
56.00 91.00 38.00 60.00 99.00 43.00 64.00 86.00 82.00 78.00 54.00 88.00 98.00 84.00 69.00 40.00 43.00 39.00 78.00 95.00 38.00 38.00 75.00 78.00
76.00 82.00 93.00 36.00 83.00 36.00 55.00 63.00 92.00 52.00 100.00 75.00 22.00 39.00 33.00 45.00 71.00 100.00 88.00 97.00 58.00 79.00 80.00
74.00 41.00 81.00 76.00 37.00 83.00 48.00 70.00 74.00 65.00 99.00 93.00 90.00 92.00 95.00 62.00 44.00 71.00 38.00 88.00 71.00 100.00 84.00 47.00
47.00 97.00 86.00 76.00 93.00 43.00 72.00 100.00 92.00 97.00 77.00 70.00 87.00 62.00 84.00 48.00 95.00 49.00 75.00 79.00 92.00 49.00 87.00 41.00
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68.00 70.00 52.00 48.00 49.00 98.00 72.00 86.00 97.00 43.00 99.00 100.00 43.00 41.00 79.00 41.00 55.00 57.00 47.00 37.00 36.00 95.00 46.00 74.00
79.00 82.00 62.00 37.00 81.00 86.00 100.00 97.00 77.00 51.00 46.00 98.00 86.00 100.00 96.00 98.00 42.00 74.00 80.00 35.00 53.00 54.00 48.00
92.00 97.00 100.00 45.00 90.00 58.00 46.00 95.00 84.00 94.00 99.00 49.00 38.00 75.00 68.00 40.00 63.00 93.00 74.00 76.00 73.00 83.00 84.00 79.00
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37.00 100.00 48.00 91.00 53.00 36.00 58.00 67.00 72.00 51.00 53.00 68.00 67.00 69.00 63.00 58.00 35.00 94.00 39.00 95.00 60.00 75.00 62.00
100.00 56.00 100.00 43.00 68.00 65.00 61.00 81.00 46.00 87.00 38.00 91.00 48.00 39.00 52.00 48.00 97.00 94.00 56.00 92.00 43.00 64.00 98.00
36.00 88.00 59.00 62.00 61.00 48.00 51.00 97.00 76.00 48.00 83.00 47.00 69.00 89.00 64.00 93.00 100.00 79.00 61.00 35.00 45.00 89.00 64.00 57.00
78.00 79.00 95.00 85.00 37.00 50.00 92.00 100.00 80.00 81.00 87.00 38.00 48.00 57.00 100.00 98.00 49.00 85.00 54.00 57.00 61.00 56.00 56.00
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67.0 85.0 56.0 83.0 60.0 47.0 51.0 40.0 45.0 71.0 23.0 44.0 36.0 67.0 42.0 43.0 46.0 40.0 67.0 79.0 47.0 87.0 49.0 49.0 96.0 79.0 78.0 61.0 51.0 78.0
80.0 68.0 83.0 78.0 100.0 56.0 90.0 72.0 52.0 39.0 54.0 93.0 67.0 85.0 56.0 83.0 60.0 47.0 51.0 40.0 45.0 71.0 57.0 51.0 54.0 80.0 98.0 62.0 41.0 69.0
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66.0 73.0 69.7 45.7 51.7 67.7 65.7 58.7 89.3 53.0 47.7 44.3 81.0 61.0 60.3 72.0 61.3 77.0 70.0 39.0 39.0 34.0 70.0 84.0 96.0 64.0 39.0 65.0 49.0 93.0
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67.7 84.0 77.0 71.0 84.0 39.0 83.0 64.0 64.0 48.0 61.0 68.0 85.0 74.0 67.0 38.0 40.0 52.0 80.0 100.0 81.0 80.0 74.0 67.7 66.0 55.7 53.0 73.3 65.7 64.3
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94.0 48.0 76.0 40.0 70.0 74.2 71.2 80.8 61.0 66.6 72.2 57.8 53.4 61.2 90.0 79.2 75.6 59.4 68.4 69.6 67.4 73.4 59.4 72.4 75.2 81.0 88.0 90.0 37.0 96.0
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93.0 51.0 57.0 56.5 58.0 78.5 50.0 44.5 52.5 73.5 57.0 82.5 39.0 75.0 69.0 82.0 71.5 69.0 65.0 52.0 61.0 92.0 93.0 90.0 83.0 47.0 82.0 84.0 88.0 85.0
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62.0 59.0 70.0 37.0 68.0 87.0 80.0 69.0 46.0 48.0 97.0 92.0 49.0 97.0 99.0 87.0 70.0 47.0 50.0 48.0 65.0 81.0 81.0 80.0 81.0 88.0 81.0 36.0 72.0 56.0
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51.0 59.0 77.8 75.0 70.5 68.5 63.5 90.0 73.0 64.5 77.0 87.0 59.0 62.5 50.5 61.0 40.0 87.5 65.0 58.0 74.5 51.5 50.0 74.0 57.0 51.0 54.0 80.0 98.0 62.0
41.0 69.0 77.0 78.0 73.0 42.0 54.0 38.0 77.0 76.0 62.0 58.0 61.0 62.0 91.0 88.0 85.0 76.0 37.0 49.0 56.0 61.0 77.0 63.0 99.0 70.0 50.0 62.0 70.0 37.0
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83.0 37.0 54.0 87.0 94.0 80.0 84.0 91.0 56.0 50.0 68.0 45.0 41.0 46.0 88.0 59.0 54.0 67.0 56.0 64.0 98.0 36.0 68.0 47.0 59.0 54.0 46.0 67.0 73.0 100.0
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41.0 90.0 84.0 92.0 55.0 60.0 88.0 91.0 37.0 88.0 85.0 76.0 37.0 49.0 56.0 61.0 77.0 63.0 99.0 70.0 50.0 62.0 70.0 37.0 50.0 78.0 80.0 52.0 38.0 87.0
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54.9 57.0 58.3 59.0 74.1 56.7 70.6 68.0 66.3 70.0 68.3 87.7 79.3 77.0 71.0 54.3 62.0 71.3 78.7 48.7 61.7 63.7 72.7 60.7 52.3 63.7 55.3 64.7 77.7 62.9
60.4 60.6 63.4 75.5 56.1 63.5 82.4 65.1 63.4 66.8 57.6 72.5 69.5 75.4 70.9 66.1 71.6 66.9 61.8 64.1 75.5 67.0 65.0 62.0 53.0 73.0 50.5 68.0 65.5 60.0
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59.4 64.9 61.4 66.5 62.6 58.0 56.9 63.8 75.4 61.0 55.0 57.8 66.9 68.6 69.6 63.5 75.5 59.0 69.0 65.0 85.0 42.0 75.0 41.0 91.0 85.0 90.0 70.0 93.0 42.0
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67.0 84.0 72.0 86.0 77.0 57.0 63.5 54.5 87.0 74.0 78.5 60.0 67.2 73.2 71.0 74.1 62.6 71.2 60.0 62.8 68.0 64.2 70.8 59.5 57.2 72.3 81.6 62.2 73.1 70.6
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74.9 58.1 62.2 68.3 62.9 62.0 56.7 59.3 70.9 37.0 43.5 41.0 71.5 71.5 93.0 92.5 70.0 78.5 89.5 61.5 57.5 60.0 61.0 65.5 47.0 65.0 42.5 53.0 84.5 55.5
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90.0 63.0 53.5 72.0 62.0 70.0 45.8 49.6 49.8 64.8 76.2 79.2 55.2 50.8 64.2 70.6 72.0 69.4 61.8 50.4 86.0 69.2 75.6 79.8 50.2 67.4 73.8 43.0 46.7 43.0
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72.5 93.5 75.5 67.0 92.5 84.0 74.0 50.5 90.0 52.0 62.0 42.5 80.3 78.3 76.9 73.3 56.9 75.9 76.1 60.7 59.9 78.1 59.4 62.1 61.9 76.7 59.9 63.7 59.4 57.7
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61.8 53.5 45.0 73.2 66.5 67.0 66.5 78.0 86.0 53.5 63.0 67.5 59.0 57.0 60.0 57.5 72.5 38.5 68.0 58.0 78.0 57.0 61.5 77.5 87.0 74.0 79.0 82.0 62.0 37.0
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71.0 63.5 53.0 83.0 52.8 59.8 74.2 72.8 66.5 84.0 74.0 71.5 49.8 64.8 63.0 60.0 82.0 64.5 58.0 32.0 34.0 38.0 93.0 42.0 94.0 36.0 37.0 73.0 89.0 60.0
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67.8 72.6 72.3 70.9 60.0 79.7 68.0 60.9 80.9 77.6 69.9 73.0 68.3 60.7 76.1 86.3 74.0 50.3 75.4 61.1 51.1 62.3 66.6 68.0 64.0 87.2 52.8 71.0 70.2 70.4
58.8 50.6 76.4 72.2 68.8 61.8 57.6 60.4 62.0 71.8 65.6 65.8 58.0 71.0 81.0 80.5 81.0 92.5 36.0 73.0 84.5 75.0 76.0 84.0 89.5 37.0 73.0 74.5 80.5 71.0

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60.1 80.4 69.7 59.7 73.3 76.4 70.1 54.7 78.1 73.0 67.3 64.1 92.0 58.7 74.7 45.9 42.5 48.0 44.2 52.8 86.2 92.5 82.0 57.2 70.8 63.8 91.5 84.8 63.2 66.8
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66.5 72.6 76.7 75.1 69.7 75.1 68.1 82.8 61.1 63.0 69.7 55.8 69.1 70.4 75.1 66.6 50.2 83.0 73.3 73.4 85.8 65.3 87.0 90.3 87.3 68.7 83.7 90.3 70.3 56.0
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72.2 67.5 63.7 73.7 63.1 64.5 48.7 76.0 73.1 66.0 80.3 71.4 56.2 57.6 57.2 70.0 86.6 54.0 56.6 75.4 68.4 59.8 51.8 70.2 83.2 58.6 60.0 71.6 82.0 62.0
69.0 80.4 76.6 65.4 67.6 69.6 54.0 63.1 75.1 69.7 64.7 65.7 51.6 48.7 84.6 75.6 71.0 76.6 67.1 78.7 63.7 51.4 83.0 65.0 67.7 72.7 67.7 82.0 47.7 71.7
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66.1 75.4 62.9 61.9 76.3 72.9 52.0 71.0 81.1 77.3 80.1 58.0 76.1 81.0 85.0 87.0 76.0 52.3 79.0 66.0 75.0 80.0 71.7 51.3 58.0 72.7 89.3 77.7 91.7 64.7
46.0 69.7 90.3 38.3 75.3 80.3 74.7 54.3 62.0 72.3 75.8 83.3 71.0 56.7 66.7 56.3 65.8 66.2 82.5 61.2 59.5 60.8 47.0 43.2 71.3 54.8 50.8 49.5 71.2 62.7
61.7 60.2 81.3 58.2 58.5 73.3 51.2 78.7 65.7 61.5 88.5 66.3 72.5 83.0 70.5 79.2 65.5 68.3 66.5 68.4 55.3 75.2 76.9 67.3 67.8 54.0 66.4 76.1 68.7 65.8
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59.7 71.7 75.0 64.0 67.1 50.9 58.7 62.6 81.4 61.1 72.7 75.3 74.7 41.0 51.0 63.3 78.0 58.3 74.0 84.3 69.0 51.7 73.0 53.7 53.3 78.0 79.0 93.0 62.0 68.3

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58.2 70.1 74.6 67.4 56.5 63.4 73.4 71.8 67.2 86.2 58.1 61.8 71.1 87.4 75.1 54.5 62.9 76.6 73.5 69.7 70.0 68.8 57.3 59.2 64.7 64.8 76.2 64.7 56.2 61.0
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77.4 60.6 69.9 76.6 73.7 86.7 85.3 82.0 44.3 85.7 59.0 59.3 60.0 74.0 90.3 56.0 84.7 43.3 75.7 72.0 40.7 45.7 52.0 80.0 66.3 56.4 56.1 54.4 55.6 75.9
72.3 68.0 57.9 81.6 56.0 66.1 83.0 75.1 70.1 64.0 76.3 68.7 56.0 64.1 67.3 75.4 64.2 66.8 66.8 58.5 73.5 51.5 57.5 64.2 65.5 57.0 50.8 85.8 55.5 83.0
41.5 73.0 56.8 83.5 52.5 93.0 70.5 77.0 78.9 73.9 77.7 61.3 71.7 58.7 70.4 61.0 59.6 64.9 58.9 81.9 75.9 47.0 72.9 67.7 79.1 82.9 51.0 76.9 78.6 77.6
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67.3 78.8 79.2 75.5 51.0 46.8 70.0 74.0 59.8 56.8 87.5 55.5 58.8 61.5 57.5 56.2 56.0 66.5 79.0 80.2 71.2 82.0 74.0 75.8 76.2 66.0 59.5 82.8 60.2 59.5
54.0 77.2 68.8 57.2 73.8 71.8 71.2 49.8 79.5 66.0 55.5 51.5 65.2 63.5 53.0 55.0 74.5 68.0 53.5 66.0 82.5 66.0 73.5 71.5 51.0 59.5 50.0 63.0 87.0 63.0
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71.0 39.3 46.7 41.7 54.0 69.0 65.3 84.0 73.3 67.0 83.7 72.0 80.0 71.3 86.0 68.3 50.7 83.3 50.3 59.3 64.0 74.7 55.2 58.5 57.1 65.5 69.3 74.2 58.6 61.4
66.7 67.3 70.3 88.5 61.7 66.5 74.3 74.1 71.0 75.3 55.3 78.1 65.8 72.8 69.2 67.0 61.6 50.8 61.2 73.4 66.8 61.2 52.0 54.2 78.8 79.8 60.4 45.4 67.2 64.6
54.2 81.0 70.8 76.4 74.9 76.4 74.7 55.4 50.7 80.4 69.1 70.4 64.9 75.9 70.0 63.1 78.0 48.0 62.0 76.1 50.7 53.7 55.7 89.6 70.4 87.0 92.0 90.7 59.0 85.0
79.3 55.0 61.7 56.3 52.0 46.0 57.0 63.3 86.7 81.0 74.7 52.7 67.7 66.0 49.0 73.0 77.0 69.0 65.5 54.5 43.0 63.0 92.5 76.5 45.5 84.5 58.5 59.5 56.0 51.5
62.5 72.0 60.0 49.0 90.5 75.0 68.5

[1000 rows x 21 columns]

Error ==> 4079436.3617403163 for Threshold 100.00

No. of new cluster Leader of the patterns are 70:

Cluster Leader of the patterns Cluster Leader List Index : [0, 1, 2, 6, 7, 9, 11, 13, 15, 17, 20, 22, 24, 26, 27, 31, 33, 43, 44, 47, 48, 50, 63, 64, 80, 92, 99, 112, 113, 116, 133, 135, 138, 144, 155, 157, 160, 164, 176, 180, 194, 198, 201, 218, 227, 298, 353, 471, 475, 486, 503, 505, 545, 552, 592, 598, 609, 629, 655, 681, 685, 705, 727, 731, 742, 774, 873, 880, 882, 942]

Index Table - Teeta Details , Error(MSE) , Cluster List -----> Index = 1, =====> [{"Index": 1, "Teeta": 100, "Error": "4079436.36", "no.leader": 70, "Cluster Index in DP/Leaders": [0, 1, 2, 6, 7, 9, 11, 13, 15, 17, 20, 22, 24, 26, 27, 31, 33, 43, 44, 47, 48, 50, 63, 64, 80, 92, 99, 112, 113, 116, 133, 135, 138, 144, 155, 157, 160, 164, 176, 180, 194, 198, 201, 218, 227, 298, 353, 471, 475, 486, 503, 505, 545, 552, 592, 598, 609, 629, 655, 681, 685, 705, 727, 731, 742, 774, 873, 880, 882, 942]}]

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[1000 rows x 70 columns]

PM Matrix for Data Points

X0 X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14 X15 X16 X17 X18 X19 X20 67.0 57.0 59.0 40.0 67.0 63.0 37.0 72.0 83.0 59.0 51.0 100.0 84.0
55.0 35.0 86.0 59.0 54.0 60.0 85.0 77.0 69.0 66.0 61.0 91.0 59.0 40.0 60.0 78.0 55.0 44.0 98.0 82.0 51.0 49.0 80.0 62.0 75.0 92.0 49.0 75.0 41.0 58.0
76.0 78.0 86.0 98.0 46.0 69.0 38.0 46.0 83.0 91.0 98.0 74.0 86.0 92.0 90.0 84.0 45.0 62.0 70.0 94.0 69.0 66.0 61.0 91.0 59.0 40.0 60.0 78.0 55.0 44.0
98.0 82.0 51.0 49.0 80.0 62.0 75.0 92.0 49.0 75.0 41.0 69.0 66.0 61.0 91.0 59.0 40.0 60.0 78.0 55.0 44.0 98.0 82.0 51.0 49.0 80.0 62.0 75.0 92.0 49.0
75.0 41.0 69.0 66.0 61.0 91.0 59.0 40.0 60.0 78.0 55.0 44.0 98.0 82.0 51.0 49.0 80.0 62.0 75.0 92.0 49.0 75.0 41.0 71.0 69.0 68.0 43.0 53.0 74.0 96.0
57.0 79.0 64.0 100.0 64.0 94.0 39.0 49.0 96.0 79.0 99.0 46.0 91.0 90.0 88.0 85.0 76.0 37.0 49.0 56.0 61.0 77.0 63.0 99.0 70.0 50.0 62.0 70.0 37.0 50.0
78.0 80.0 52.0 38.0 87.0 71.0 69.0 68.0 43.0 53.0 74.0 96.0 57.0 79.0 64.0 100.0 64.0 94.0 39.0 49.0 96.0 79.0 99.0 46.0 91.0 90.0 68.0 83.0 78.0
100.0 56.0 90.0 72.0 52.0 39.0 54.0 93.0 67.0 85.0 56.0 83.0 60.0 47.0 51.0 40.0 45.0 71.0 68.0 83.0 78.0 100.0 56.0 90.0 72.0 52.0 39.0 54.0 93.0
67.0 85.0 56.0 83.0 60.0 47.0 51.0 40.0 45.0 71.0 23.0 44.0 36.0 67.0 42.0 43.0 46.0 40.0 67.0 79.0 47.0 87.0 49.0 49.0 96.0 79.0 78.0 61.0 51.0 78.0
80.0 68.0 83.0 78.0 100.0 56.0 90.0 72.0 52.0 39.0 54.0 93.0 67.0 85.0 56.0 83.0 60.0 47.0 51.0 40.0 45.0 71.0 57.0 51.0 54.0 80.0 98.0 62.0 41.0 69.0
77.0 78.0 73.0 42.0 54.0 38.0 77.0 76.0 62.0 58.0 61.0 62.0 91.0 57.5 63.5 66.0 83.0 98.0 54.0 55.0 53.5 61.5 80.5 82.0 70.0 64.0 62.0 84.5 83.0 73.0
51.5 61.5 66.0 92.5 58.0 54.0 52.0 45.0 97.0 77.0 87.0 55.0 95.0 39.0 100.0 93.0 73.0 94.0 36.0 94.0 67.0 53.0 84.0 39.0 63.0 70.0 67.5 64.5 67.0 56.0
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66.0 73.0 69.7 45.7 51.7 67.7 65.7 58.7 89.3 53.0 47.7 44.3 81.0 61.0 60.3 72.0 61.3 77.0 70.0 39.0 39.0 34.0 70.0 84.0 96.0 64.0 39.0 65.0 49.0 93.0
95.0 77.0 46.0 81.0 62.0 79.0 95.0 49.0 89.0 96.0 64.7 66.7 64.3 90.3 71.0 64.0 57.7 66.3 57.0 58.7 88.0 63.7 63.3 47.7 80.0 66.0 61.3 67.0 50.0 60.7
67.7 84.0 77.0 71.0 84.0 39.0 83.0 64.0 64.0 48.0 61.0 68.0 85.0 74.0 67.0 38.0 40.0 52.0 80.0 100.0 81.0 80.0 74.0 67.7 66.0 55.7 53.0 73.3 65.7 64.3
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87.0 100.0 50.0 74.0 56.0 37.0 93.0 92.0 93.0 85.0 39.0 95.0 46.0 51.0 94.0 73.0 58.0 62.0 59.0 70.0 37.0 68.0 87.0 80.0 69.0 46.0 48.0 97.0 92.0 49.0
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88.7 64.0 49.0 91.0 80.0 80.0 74.3 49.0 67.7 56.3 45.0 63.0 59.0 36.0 59.0 38.0 48.0 36.0 70.0 36.0 92.0 36.0 96.0 100.0 87.0 67.0 76.0 72.0 43.0 60.0
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64.0 57.7 66.3 57.0 58.7 88.0 63.7 63.3 47.7 80.0 66.0 61.3 67.0 50.0 60.7 67.7 66.0 66.9 66.0 67.4 60.3 61.7 63.9 66.3 66.7 57.0 80.0 69.6 71.1 47.4
72.4 74.9 64.7 70.0 53.9 71.7 70.9 57.0 51.0 54.0 80.0 98.0 62.0 41.0 69.0 77.0 78.0 73.0 42.0 54.0 38.0 77.0 76.0 62.0 58.0 61.0 62.0 91.0 69.0 66.0
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84.5 45.0 58.5 83.5 82.0 76.0 55.0 81.5 49.5 75.5 80.5 46.5 99.0 80.5 67.0 91.0 53.5 82.0 62.2 64.4 64.9 61.9 64.8 77.5 58.1 67.4 65.6 70.7 78.1 75.5
59.8 71.5 80.8 72.6 62.7 81.4 59.0 61.5 50.1 76.5 82.1 79.1 69.9 68.8 79.1 79.1 55.2 55.1 62.4 55.0 70.0 69.8 71.9 64.8 53.9 66.1 67.0 63.8 82.2 69.0
48.0 56.0 51.0 67.0 98.0 41.0 81.0 86.0 89.0 85.0 42.0 86.0 89.0 86.0 73.0 65.0 99.0 58.0 67.0 72.0 71.0 61.0 56.0 56.0 99.0 62.0 100.0 78.0 78.0 89.0
57.0 66.0 89.0 48.0 70.0 39.0 94.0 93.0 39.0 39.0 84.0 45.0 81.0 81.6 83.1 66.0 69.8 83.2 58.8 64.5 52.1 64.9 58.4 60.1 69.6 83.2 79.9 62.1 65.4 57.8
64.2 62.2 62.0 76.2 79.8 78.0 67.5 51.8 74.0 73.8 71.5 81.0 78.5 68.0 50.2 81.8 85.8 61.5 70.8 93.2 65.5 74.8 54.5 61.5 70.4 72.8 69.4 69.0 53.0 60.4
66.0 74.4 67.0 52.2 63.0 69.0 85.6 52.8 51.4 54.4 57.2 64.8 73.0 80.2 69.8 64.2 64.0 62.6 68.4 42.8 80.6 56.8 77.6 74.0 63.8 70.0 75.0 65.0 84.6 73.2
85.6 53.4 58.6 78.6 56.8 71.4 70.0 65.2 61.5 59.8 52.2 58.8 83.8 63.0 60.5 84.2 76.0 56.8 64.2 80.0 50.0 61.0 64.5 62.2 64.5 57.8 80.5 63.0 68.5 66.5
90.5 54.5 77.5 82.0 66.5 99.5 84.0 67.5 45.0 86.0 38.5 66.0 58.5 42.5 37.0 39.5 96.5 51.0 63.0 65.0 62.8 62.0 56.5 54.5 71.5 74.5 64.0 44.5 50.8 77.0
88.2 52.5 59.8 67.8 70.8 69.2 67.2 68.0 65.2 67.7 67.3 66.8 68.2 70.6 62.6 65.3 75.1 56.7 64.4 61.4 67.9 72.2 75.5 70.5 59.0 82.6 75.1 72.0 81.1 57.1
57.4 56.0 54.9 61.0 82.9 70.6 63.2 64.4 71.4 59.4 83.8 73.6 76.8 58.8 62.9 81.2 71.1 81.0 60.3 71.7 66.0 58.0 62.0 59.0 70.0 37.0 68.0 87.0 80.0 69.0
46.0 48.0 97.0 92.0 49.0 97.0 99.0 87.0 70.0 47.0 50.0 48.0 71.7 73.3 71.2 68.8 56.8 51.2 73.2 75.7 67.7 53.3 73.8 77.3 70.3 48.5 58.0 63.7 61.5 57.7
63.3 77.7 69.8 62.5 68.0 65.5 67.0 88.5 88.0 94.5 40.0 67.5 85.0 81.5 57.0 54.0 71.5 67.0 61.5 57.0 91.0 58.0 62.5 53.0 66.8 61.0 61.5 51.2 79.2 66.5
57.5 71.5 77.8 68.5 81.0 66.2 82.5 54.8 59.2 86.2 64.2 76.2 53.8 78.5 74.5 58.5 55.5 51.0 70.5 48.5 47.5 71.5 57.5 54.5 65.5 96.0 81.0 67.5 70.0 68.0
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76.7 87.7 82.0 62.0 48.0 71.3 61.0 86.3 58.3 67.3 40.0 83.3 61.7 80.3 84.3 64.3 81.3 90.7 81.5 75.0 71.0 43.5 46.0 73.5 78.5 71.5 41.5 79.0 61.0 57.5
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69.0 80.4 76.6 65.4 67.6 69.6 54.0 63.1 75.1 69.7 64.7 65.7 51.6 48.7 84.6 75.6 71.0 76.6 67.1 78.7 63.7 51.4 83.0 65.0 67.7 72.7 67.7 82.0 47.7 71.7

71.0 65.3 50.0 50.7 72.7 63.3 81.7 63.3 56.3 48.7 47.3 76.0 80.0 56.7 68.0 72.7 77.7 74.7 76.0 67.7 77.0 78.3 66.4 65.9 53.0 77.1 64.9 85.0 53.1 57.6
72.1 68.9 56.3 54.9 73.7 64.6 55.6 59.4 56.6 74.5 82.6 61.6 58.6 75.8 82.9 72.5 75.1 78.9 59.0 75.1 62.0 81.0 76.2 73.9 75.5 65.6 76.9 81.2 78.8 75.8
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63.0 52.0 74.0 88.0 80.0 100.0 88.0 76.0 100.0 43.5 47.5 44.0 67.8 40.5 68.2 65.8 67.5 65.5 70.5 60.5 59.2 64.0 52.8 65.2 73.5 55.5 54.8 60.0 68.5
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70.0 65.3 71.7 81.7 70.9 73.7 73.8 54.6 60.6 72.8 71.5 50.2 60.8 76.6 67.5 61.8 54.9 62.5 70.1 53.2 67.1 72.2 66.2 61.8 70.5 74.7 76.7 72.7 54.0 63.7
61.7 56.0 87.3 70.3 83.7 60.0 63.7 58.0 87.3 79.0 64.7 57.3 73.7 65.3 44.3 83.7 61.4 54.0 51.6 55.4 67.4 70.4 62.8 80.8 64.8 68.4 63.8 68.6 66.0 49.0
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63.0 68.3 73.3 59.7 48.7 49.0 71.0 68.3 71.0 74.0 73.0 70.2 68.2 67.2 62.5 69.2 70.0 69.2 62.8 75.2 60.8 73.2 74.8 84.5 68.8 44.8 83.8 56.2 89.2 72.2
61.8 72.8 79.8 77.8 67.2 62.8 41.2 74.5 63.0 58.2 44.5 81.8 72.5 54.5 46.0 68.2 45.8 63.0 69.8 62.8 79.2 72.0 75.2 80.2 83.5 61.0 68.0 87.5 50.5 57.0
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89.5 49.0 64.5 88.5 48.5 51.0 43.5 46.0 39.0 73.0 86.5 67.0 60.5 66.0 79.5 61.5 78.5 63.0 68.5 56.0 56.5 45.0 40.5 56.0 91.0 74.4 72.8 70.1 67.0 57.2
65.4 60.3 82.0 62.2 72.0 75.4 63.3 65.9 72.4 75.1 57.1 70.2 76.8 65.4 75.6 63.0 64.1 65.9 66.9 54.0 78.3 87.9 58.0 49.3 56.1 83.3 70.6 62.7 63.9 53.4
70.7 56.3 68.0 67.9 68.3 63.4 56.3 52.2 51.0 49.2 62.2 46.0 49.5 72.8 84.0 54.8 56.0 65.2 58.8 63.5 77.5 59.8 74.2 55.8 81.8 88.5 72.0 60.2 55.8 59.2
58.2 70.1 74.6 67.4 56.5 63.4 73.4 71.8 67.2 86.2 58.1 61.8 71.1 87.4 75.1 54.5 62.9 76.6 73.5 69.7 70.0 68.8 57.3 59.2 64.7 64.8 76.2 64.7 56.2 61.0
61.5 62.2 66.0 70.5 56.5 67.5 90.8 56.3 60.8 58.0 70.0 70.7 70.5 72.8 60.7 73.0 67.2 71.7 59.3 74.3 58.2 67.5 53.2 84.2 70.8 56.5 68.3 88.5 69.8 82.8
66.2 65.2 64.6 63.2 71.0 65.4 53.8 64.6 82.0 75.0 70.8 62.4 83.6 70.0 63.6 50.4 77.8 74.4 56.6 82.4 70.4 72.2 84.5 79.0 74.0 64.5 45.5 64.0 69.5 68.0
81.0 88.0 58.0 66.5 51.0 56.0 68.5 46.5 86.5 72.5 47.0 56.0 84.0 60.8 59.5 57.6 62.8 64.4 66.0 47.1 70.6 64.9 74.9 65.4 74.8 57.9 60.9 74.8 70.4 71.1
77.4 60.6 69.9 76.6 73.7 86.7 85.3 82.0 44.3 85.7 59.0 59.3 60.0 74.0 90.3 56.0 84.7 43.3 75.7 72.0 40.7 45.7 52.0 80.0 66.3 56.4 56.1 54.4 55.6 75.9
72.3 68.0 57.9 81.6 56.0 66.1 83.0 75.1 70.1 64.0 76.3 68.7 56.0 64.1 67.3 75.4 64.2 66.8 66.8 58.5 73.5 51.5 57.5 64.2 65.5 57.0 50.8 85.8 55.5 83.0
41.5 73.0 56.8 83.5 52.5 93.0 70.5 77.0 78.9 73.9 77.7 61.3 71.7 58.7 70.4 61.0 59.6 64.9 58.9 81.9 75.9 47.0 72.9 67.7 79.1 82.9 51.0 76.9 78.6 77.6
77.4 77.4 56.0 74.0 73.4 70.2 74.0 77.0 54.8 78.4 79.0 62.4 81.8 74.4 93.2 60.2 69.4 60.0 54.4 73.5 78.5 78.0 40.0 50.0 58.0 69.0 59.0 71.5 94.5 53.5
45.5 62.5 61.0 55.5 69.0 79.0 90.0 70.0 57.0 93.5 64.3 67.0 63.3 63.3 39.7 75.0 71.7 69.0 65.3 40.0 45.0 73.7 91.3 74.0 66.3 87.7 61.3 57.7 76.0 40.3
67.3 78.8 79.2 75.5 51.0 46.8 70.0 74.0 59.8 56.8 87.5 55.5 58.8 61.5 57.5 56.2 56.0 66.5 79.0 80.2 71.2 82.0 74.0 75.8 76.2 66.0 59.5 82.8 60.2 59.5
54.0 77.2 68.8 57.2 73.8 71.8 71.2 49.8 79.5 66.0 55.5 51.5 65.2 63.5 53.0 55.0 74.5 68.0 53.5 66.0 82.5 66.0 73.5 71.5 51.0 59.5 50.0 63.0 87.0 63.0
50.0 80.5 61.0 83.5 58.0 59.0 58.4 76.8 80.8 48.0 45.2 77.2 78.6 67.4 77.0 80.8 52.6 54.6 57.0 75.8 71.4 69.0 61.4 75.2 68.2 65.7 70.0 67.3 50.0 50.0
55.3 68.3 75.3 63.0 64.7 54.0 60.7 62.3 77.3 48.3 57.0 61.0 92.3 69.3 60.7 61.0 80.0 74.0 75.5 59.0 56.5 76.5 67.5 63.5 57.0 77.5 66.5 61.0 68.0 92.5
82.0 37.0 92.0 43.5 95.0 68.0 48.0 75.6 72.4 70.8 58.6 64.8 55.8 69.4 72.8 53.6 77.2 68.8 48.4 49.0 59.4 81.4 53.4 68.6 61.8 80.2 85.6 67.2 65.5 60.5

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 71.0 39.3 46.7 41.7 54.0 69.0 65.3 84.0 73.3 67.0 83.7 72.0 80.0 71.3 86.0 68.3 50.7 83.3 50.3 59.3 64.0 74.7 55.2 58.5 57.1 65.5 69.3 74.2 58.6 61.4
 66.7 67.3 70.3 88.5 61.7 66.5 74.3 74.1 71.0 75.3 55.3 78.1 65.8 72.8 69.2 67.0 61.6 50.8 61.2 73.4 66.8 61.2 52.0 54.2 78.8 79.8 60.4 45.4 67.2 64.6
 54.2 81.0 70.8 76.4 74.9 76.4 74.7 55.4 50.7 80.4 69.1 70.4 64.9 75.9 70.0 63.1 78.0 48.0 62.0 76.1 50.7 53.7 55.7 89.6 70.4 87.0 92.0 90.7 59.0 85.0
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 62.5 72.0 60.0 49.0 90.5 75.0 68.5

[1000 rows x 21 columns]

Error ==> 4079436.3617403163 for Threshold 100.00

No. of new cluster Leader of the patterns are 70:

Cluster Leader of the patterns Cluster Leader List Index : [0, 1, 2, 6, 7, 9, 11, 13, 15, 17, 20, 22, 24, 26, 27, 31, 33, 43, 44, 47, 48, 50, 63, 64, 80, 92, 99, 112, 113, 116, 133, 135, 138, 144, 155, 157, 160, 164, 176, 180, 194, 198, 201, 218, 227, 298, 353, 471, 475, 486, 503, 505, 545, 552, 592, 598, 609, 629, 655, 681, 685, 705, 727, 731, 742, 774, 873, 880, 882, 942]

Index Table - Teeta Details , Error(MSE) , Cluster List -----> Index = 1, =====> [{'Index': 1, 'Teeta': 100, 'Error': '4079436.36', 'no.leader': 70, 'Cluster Index in DP/Leaders': [0, 1, 2, 6, 7, 9, 11, 13, 15, 17, 20, 22, 24, 26, 27, 31, 33, 43, 44, 47, 48, 50, 63, 64, 80, 92, 99, 112, 113, 116, 133, 135, 138, 144, 155, 157, 160, 164, 176, 180, 194, 198, 201, 218, 227, 298, 353, 471, 475, 486, 503, 505, 545, 552, 592, 598, 609, 629, 655, 681, 685, 705, 727, 731, 742, 774, 873, 880, 882, 942]}]

```
In [4]: import pandas as pd
import numpy as np
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D # noqa: F401 unused import
from matplotlib import cm
import seaborn as sns
from sklearn.model_selection import train_test_split
import csv
```

```

In [5]: PATTERNS = 1000
        FEATURES = 21

import csv
data = pd.read_csv("engineering-mark-sheet - Sheet1.csv")
#df = pd.DataFrame(plot_data)

data.describe()

```

Out[5]:

	m1 score	m2 score	physics score	m3 score	m4 score	DS score	CO score	LD score	SOM score	ED scc
count	1000.00000	1000.000000	1000.000000	1000.000000	1000.000000	1000.000000	1000.000000	1000.000000	1000.000000	1000.0000
mean	66.08900	69.169000	68.054000	68.411000	66.580000	68.168000	67.518000	67.232000	67.862000	67.0910
std	15.16308	14.600192	15.195657	19.288964	19.387611	19.472261	19.271249	19.389795	18.799531	19.3007
min	0.00000	17.000000	10.000000	35.000000	35.000000	35.000000	35.000000	35.000000	35.000000	35.0000
25%	57.00000	59.000000	57.750000	51.000000	49.000000	51.000000	51.000000	50.000000	52.000000	51.0000
50%	66.00000	70.000000	69.000000	69.000000	66.000000	68.000000	67.000000	68.000000	69.000000	67.0000
75%	77.00000	79.000000	79.000000	85.000000	83.000000	85.250000	84.000000	85.000000	84.000000	84.0000
max	100.00000	100.000000	100.000000	100.000000	100.000000	100.000000	100.000000	100.000000	100.000000	100.0000

8 rows × 21 columns

In []:

```
In [6]: data.head(10)
```

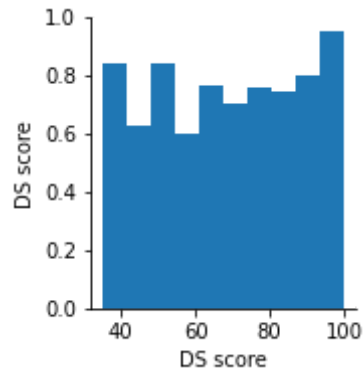
```
Out[6]:
```

	gender	race/ethnicity	parental level of education	lunch	test preparation course	m1 score	m2 score	physics score	m3 score	m4 score	...	OS-2 score	MICRO- 1score	MICRO- 2 score	Che
0	female	group B	bachelor's degree	standard	none	72	72	74	62	64	...	37	74	67	
1	female	group C	some college	standard	completed	69	90	88	80	87	...	89	62	55	
2	female	group B	master's degree	standard	none	90	95	93	94	36	...	72	35	97	
3	male	group A	associate's degree	free/reduced	none	47	57	44	43	87	...	74	66	77	
4	male	group C	some college	standard	none	76	78	75	84	54	...	43	45	43	
5	female	group B	associate's degree	standard	none	71	83	78	82	82	...	52	71	88	
6	female	group B	some college	standard	completed	88	95	92	79	43	...	52	90	96	
7	male	group B	some college	free/reduced	none	40	43	39	78	95	...	93	36	83	
8	male	group D	high school	free/reduced	completed	64	64	67	77	72	...	73	48	67	
9	female	group B	high school	free/reduced	none	38	60	50	81	63	...	61	88	75	

10 rows × 26 columns

```
In [7]: sns.pairplot(data[['DS score']])  
  
plt.figure(figsize=(20,20))
```

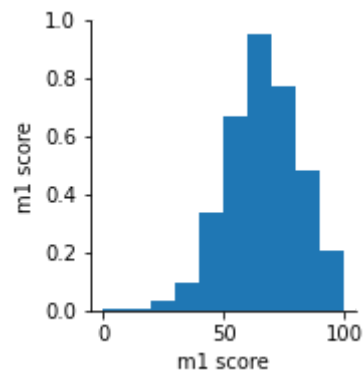
Out[7]: <Figure size 1440x1440 with 0 Axes>



<Figure size 1440x1440 with 0 Axes>

```
In [8]: sns.pairplot(data[['ml score']])  
  
plt.figure(figsize=(20,20))
```

Out[8]: <Figure size 1440x1440 with 0 Axes>



<Figure size 1440x1440 with 0 Axes>

```

In [9]: cluster_list_pattern={}
Error_Threshold_List={}
Error_Threshold_List_Print={}
c1l_value = {}
c1l_dict= {}

def eqclidean_dist(leader_features, test_features):
    sum = 0
    for i in range(len(leader_features) ):
        sum = sum + np.power( (leader_features[i] - test_features[i] ), 2)

    eqcli = "{:.2f}".format(np.sqrt(sum))

    #print(f"{name} is an {type_of_company} company.")
    #print(f"Eqclidean distance {eqcli }")
    return np.sqrt(sum)

def process_clustering(pl, thresh_hold, f):

    c1l = [0] # Cluster leader list
    c1l_value = {}
    c1l_value[0]= 0
    cluster_list_pattern[0] = [0] # pattern 1 associated with cluster 1.
    # calcualte cluster leader association

    # thresh_hold = 2
    #d_o = f"\n\n Eqclidean Dist Calculation ----->\n"

    #print(d_o)
    #f.write(d_o)

    for i in range(len(pl) ):#enumerate(pl).index: # Patterns - 1000 rows
        #print(" Pattern processing ",i)
        if i == 0: # first pattern leader
            continue
        found = False
        cluster_list = [] # List of Clusters associated with a pattern
        for cl in c1l:
            #print('c1l ',c1l)
            c = c1l_value[cl]

```

```

# print(f"Leader \n {pl.iloc[c,:]} Test Pattern {pl.iloc[i,:]}")
eqcli_dist_val = eqclidean_dist(pl.iloc[c,:], pl.iloc[i,:])

l = pl.iloc[[c]].to_string(header=None,index=False)
#dp = pl.iloc[[i]].to_string(header=None,index=False)
eqcli = "{:.2f}".format(eqcli_dist_val)
#d_o = f" DP ({dp}) Leader({l}) =>{ eqcli} \n "
#d_o = f" DP ({i}) Leader({c}) =>{ eqcli} \n "

#print(f" Eqclidean Dist of DP ({}) from Leader ({l}) => {eqcli}" )
#print(d_o)
#f.write(d_o)

#print(d_o)

if ((eqcli_dist_val - thresh_hold ) <= 0):
    cluster_list.append(c)
    found = True
if found == False:
    new_cluster = len(c)
    cll_value[new_cluster] = i
    cluster_list_pattern[i] = [new_cluster] # New cluster
    #cluster_list_pattern[i] = [i] # New cluster
    cll.append(new_cluster)
else:
    cluster_list_pattern[i] = cluster_list

#print(" \n No. of new cluster Leader of the patterns are :\n ", len(cll_value))
#d_o=f' \n No. of new cluster Leader of the patterns are { len(cll_value) }:\n'
#f.write(d_o)
#dp = pl.iloc[[i]].to_string(header=None,index=False)

cll_dict[thresh_hold] = cll_value

#d_o = f'Cluster Leader of the patterns\n'
#print(d_o)
#f.write(d_o)
for k,v in cll_value.items():
    l = pl.iloc[[v]].to_string(header=None,index=False)
    #d_o = f"({l}) ----> index [{v}] \n"
    #print(d_o)

```



```

        #print(d_o)
        #f.write(d_o)

        #print( f"{l} '[' , pl.iloc[v][0] , pl.iloc[v][1] , '']' )
#d_o =f'\n Mapping DP to Leader ----->\n'
#print(d_o)
#f.write(d_o)

for k,v in cluster_list_pattern.items():
    l = pl.iloc[[k]].to_string(header=None,index=False)
    o = []
    for i in v:
        cl_p = cll_value[i]
        o.append(cll_value[i])
    #d_o = f" DP :index [{k}] <-----> Leader index {o}\n"

    #print(d_o)
    #f.write(d_o)

# print("c11_value ", c11_value)


# Determine Assignment Matrix

ROWS = len(pl)
COLS = len(c11)
AM = np.zeros((ROWS,COLS))

for i in range(len(pl)):
    for cl in cluster_list_pattern[i]:
        AM[i,cl] = 1 / len(cluster_list_pattern[i])

# Determine C R Matrix
CRM = []
l = len(c11)

CRM = np.zeros((l,len(pl.columns)))

#for cl in c11:
for i, cl in enumerate(c11):

```

```

        for j in range(len(pl.columns)):
            c = cll_value[cl]
            CRM[i][j] = pl.iloc[c][j]
        #i = i + 1

# Calcualte Multiplication
CRM_DataFrame = pd.DataFrame(data=CRM)
#print("CRM Matrix for Data Points \n")

#header_list = [ 'X'+ str(i-0) for i in range(len(pl.columns))]
#d_o = "\n CRM Matrix for Data Points \n"
#f.write(d_o)
#print(d_o)

#d_o=f"{CRM_DataFrame.to_string(header=header_list,index=False, show_dimensions=True, float_form
at=lambda x: '%.2f' % x)}"
#print(d_o)
#f.write(d_o)

AM_DataFrame = pd.DataFrame(data=AM)

#d_o = f"\n\n AM Matrix for Data Points \n"
#print("\n\n AM Matrix for Data Points \n")

#obj_res.writerow(f"{AM_DataFrame.to_string(header=None,index=False)}")
#d_o = f"{AM_DataFrame.to_string(header=None,index=False)}"
#print(d_o)
#f.write(d_o)

#header_list = [ 'c'+ str(i-0) for i in range(len(cll_value))]
#index_list = ['p' + str(i-0) for i in range(ROWS)]

#d_o = f"{AM_DataFrame.to_string(header=header_list, index=False,show_dimensions=True, float_for
mat=lambda x: '%.2f' % x)}"

#print(d_o)
#f.write(d_o)

```

```

#PM = CRM_DataFrame.dot(AM_DataFrame )
PM = np.dot(AM,CRM)
PM_DataFrame = pd.DataFrame(data=PM)

#d_o="\n \n PM Matrix for Data Points \n"
#print(d_o)
#f.write(d_o)

#print("PM Matrix for Data Points \n")
#header_list = [ 'X'+ str(i-0) for i in range(len(pl.columns))]

#d_o = f"{PM_DataFrame.to_string(header=header_list,index=False, show_dimensions=True, float_form
at=lambda x: '%.1f' % x)}"
#print(d_o)
#f.write(d_o)

# Calculate Error

Error_Threshold = 0
for i in range(PATTERNS):
    for j in range(FEATURES):
        #print(f"{pl.iloc[i,j] } { PM_DataFrame.iloc[i,j]}")
        Error_Threshold = Error_Threshold + np.power(( pl.iloc[i,j] - PM_DataFrame.iloc[i,j]),2)

    return (Error_Threshold)

threshold = {}
Error_Threshold_List={}

Error_Threshold_List = {}
Error_Threshold_List_Print = {}
c1l_dict ={}

DM = pd.read_csv("engineering-mark-sheet - Sheet1.csv")

```

```

for index in [1,2,3,4,5,6,7,8,9,10]:

    ErrThreshold_List = []
    for Threshold in [100]: #[35,100,200] :
        DM = pd.read_csv("engineering-mark-sheet - Sheet1.csv")
        DM=DM.sample(frac=1)
        DM = DM.reset_index(drop=True)
        DM.drop(['gender','race/ethnicity','parental level of education', 'lunch','test preparation c
ourse'], axis=1, inplace=True)

        #DM.drop(DM.loc[1:990].index, inplace=True)

        DM.reset_index(drop=True)
        DM.head()
        DM.describe()

        PATTERNS = len(DM.index)

        FEATURES = len(DM.columns)

        DM.head(20)

        file_name = 'fileName_' + str(Threshold) + '_' + str(index) + '_.txt'

        f = open(file_name, 'w')

        #d_o = '\n DM Matrix for Data Points \n '
        # print(d_o)
        #f.write(d_o)
        #d_o = f" \n{DM.to_string(index=False, show_dimensions=True)}\n "
        #print(d_o)
        #f.write(d_o)

        Thresh = "{:.2f}".format(Threshold)
        d_o = f" \n \nIndex : Threshold value used for processing ==> {index} , {Thresh} \n"
        print(d_o)
        f.write(d_o)

```

```

Error_Threshold = process_clustering(DM, Threshhold, f)

d_o=f"\n \n Error ==> {Error_Threshold } for Threshold {Thresh}\n"

Error_Threshold_List[ Threshhold ] = "{:.2f}".format(Error_Threshold)

print(d_o)

f.write(d_o)


d_o = f'\n No. of new cluster Leader of the patterns are { len(c11_dict[Threshhold]) }:\n'
f.write(d_o)
print(d_o)


d_o = f"-----\n"
d_o = d_o + f'Cluster Leader of the patterns\n'
print(d_o)
f.write(d_o)
c11 = c11_dict[Threshhold]
leaders = list(c11.values())
d_o = f"\t Cluster Leader List Index : {leaders} \n\n "
print(d_o)
f.write(d_o)


ErrThrehold_List.append({ 'Index': index, 'Teeta': Threshhold, 'Error': Error_Threshold_List[
Threshhold ], 'no.leader':len(c11_dict[Threshhold]) , 'Cluster Index in DP/Leaders' : list(c11.values
())}
)
Error_Threshold_List_Print[index] = ErrThrehold_List
d_o = f"\n Index Table - Teeta Details , Error(MSE) , Cluster List ----->"
print(d_o)
f.write(d_o)

index = []
error = []

for e, v in Error_Threshold_List_Print.items():

```

```
d_o = f'\n Index = {e}, =====> \n {v} \n'

index.append(e)
error.append(v)
f.write( d_o )
print(d_o)

f.close()
```

Index : Threshold value used for processing ==> 1 , 100.00

Error ==> 4282358.598451711 for Threshold 100.00

No. of new cluster Leader of the patterns are 75:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 1, 3, 4, 7, 9, 16, 17, 19, 20, 25, 27, 30, 35, 41, 42, 45, 47, 49, 70, 119, 132, 163, 178, 180, 189, 199, 208, 211, 222, 227, 238, 242, 247, 249, 258, 268, 271, 282, 321, 343, 354, 356, 390, 405, 407, 428, 440, 471, 473, 489, 505, 510, 524, 539, 551, 552, 565, 568, 573, 626, 680, 682, 720, 743, 752, 756, 786, 798, 801, 835, 898, 916, 923, 925]

Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing ==> 2 , 100.00

Error ==> 3866721.241577517 for Threshold 100.00

No. of new cluster Leader of the patterns are 73:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 1, 2, 3, 4, 6, 7, 14, 15, 20, 23, 24, 26, 38, 43, 48, 49, 57, 62, 68, 69, 71, 72, 76, 87, 107, 108, 112, 113, 116, 123, 140, 157, 159, 162, 172, 173, 178, 181, 191, 198, 205, 207, 212, 218, 223, 231, 234, 238, 278, 296, 323, 349, 397, 417, 424, 439, 453, 454, 459, 467, 493, 566, 604, 623, 641, 701, 734, 746, 760, 917, 932, 990]

Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing ====> 3 , 100.00

Error ==> 3959840.7985761897 for Threshold 100.00

No. of new cluster Leader of the patterns are 74:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 2, 3, 6, 7, 8, 12, 14, 15, 16, 19, 24, 26, 27, 28, 34, 37, 39, 47, 50, 55, 57, 65, 68, 69, 79, 80, 81, 85, 88, 94, 98, 99, 126, 159, 165, 169, 178, 195, 207, 209, 214, 217, 219, 221, 233, 235, 258, 327, 353, 378, 464, 476, 535, 540, 543, 544, 556, 574, 576, 611, 612, 712, 752, 753, 761, 764, 818, 826, 847, 886, 908, 958, 991]

Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing ====> 4 , 100.00

Error ==> 4022552.795865034 for Threshold 100.00

No. of new cluster Leader of the patterns are 74:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 1, 2, 3, 4, 5, 6, 7, 9, 11, 13, 15, 16, 17, 21, 22, 28, 32, 36, 42, 44, 49, 51, 62, 66, 68, 72, 73, 87, 92, 96, 129, 139, 160, 168, 184, 199, 208, 215, 217, 219, 229, 235, 244, 262, 265, 277, 280, 285, 295, 345, 361, 389, 392, 463, 465, 475, 535, 556, 584, 588, 599, 616, 667, 677, 709, 725, 755, 760, 781, 782, 844, 943, 957]

Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing ==> 5 , 100.00

Error ==> 4086689.251924409 for Threshold 100.00

No. of new cluster Leader of the patterns are 74:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 1, 3, 5, 7, 9, 10, 12, 14, 15, 16, 17, 20, 26, 29, 33, 34, 38, 48, 49, 51, 56, 61, 80, 86, 88, 110, 114, 129, 130, 137, 142, 146, 162, 179, 181, 189, 198, 207, 212, 227, 235, 262, 275, 280, 284, 287, 296, 316, 363, 395, 397, 401, 417, 440, 450, 494, 509, 535, 546, 558, 594, 600, 623, 633, 657, 716, 725, 762, 767, 825, 836, 925, 978]

Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing ==> 6 , 100.00

Error ==> 4223218.688681013 for Threshold 100.00

No. of new cluster Leader of the patterns are 67:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 1, 2, 3, 4, 5, 6, 7, 9, 13, 14, 17, 19, 21, 22, 24, 30, 32, 35, 39, 44, 46, 49, 52, 58, 74, 79, 85, 95, 98, 104, 121, 130, 142, 153, 171, 176, 180, 188, 199, 211, 231, 239, 294, 316, 357, 362, 402, 403, 421, 538, 578, 585, 595, 622, 623, 671, 681, 721, 770, 774, 780, 805, 819, 891, 951, 971]

Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing ==> 7 , 100.00

Error ==> 4011023.117916052 for Threshold 100.00

No. of new cluster Leader of the patterns are 79:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 1, 2, 3, 5, 6, 9, 10, 11, 13, 14, 15, 16, 20, 22, 23, 25, 37, 44, 52, 55, 56, 57, 67, 78, 86, 108, 113, 115, 123, 130, 135, 153, 157, 174, 175, 191, 211, 213, 217, 238, 246, 247, 249, 262, 273, 276, 281, 294, 338, 340, 344, 365, 383, 385, 388, 469, 483, 513, 516, 528, 543, 571, 575, 581, 584, 622, 647, 666, 691, 708, 712, 755, 807, 828, 868, 882, 964, 969]

Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing ==> 8 , 100.00

Error ==> 3938759.624419129 for Threshold 100.00

No. of new cluster Leader of the patterns are 79:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 1, 3, 4, 7, 8, 13, 16, 19, 20, 26, 29, 30, 31, 46, 51, 54, 58, 63, 64, 69, 81, 89, 90, 91, 95, 96, 97, 101, 103, 108, 110, 114, 129, 132, 133, 135, 151, 152, 157, 162, 163, 167, 168, 171, 189, 213, 218, 221, 232, 235, 240, 241, 274, 278, 320, 328, 331, 334, 420, 436, 448, 466, 469, 485, 516, 520, 545, 561, 594, 601, 615, 644, 676, 713, 750, 826, 874, 984]

Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing ==> 9 , 100.00

Error ==> 4199622.7811283255 for Threshold 100.00

No. of new cluster Leader of the patterns are 71:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 1, 2, 3, 4, 5, 6, 7, 10, 14, 17, 24, 26, 37, 49, 59, 64, 68, 79, 88, 91, 96, 101, 105, 122, 126, 131, 143, 154, 157, 169, 173, 181, 201, 211, 216, 219, 234, 237, 262, 279, 283, 308, 335, 337, 368, 372, 382, 451, 460, 484, 494, 504, 522, 557, 570, 591, 599, 634, 651, 678, 729, 748, 794, 822, 833, 842, 884, 886, 936, 972]

Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index : Threshold value used for processing ==> 10 , 100.00

Error ==> 4160122.5719714365 for Threshold 100.00

No. of new cluster Leader of the patterns are 69:

Cluster Leader of the patterns

Cluster Leader List Index : [0, 1, 2, 7, 8, 16, 17, 20, 22, 23, 24, 35, 37, 43, 53, 55, 69, 70, 79, 97, 98, 102, 105, 110, 131, 139, 150, 152, 154, 162, 167, 168, 169, 175, 177, 182, 211, 237, 239, 243, 254, 261, 274, 281, 286, 349, 357, 394, 433, 479, 490, 491, 493, 495, 502, 513, 517, 537, 540, 543, 547, 550, 553, 556, 559, 562, 565, 568, 571, 574, 577, 580, 583, 586, 589, 592, 595, 598, 601, 604, 607, 610, 613, 616, 619, 622, 625, 628, 631, 634, 637, 640, 643, 646, 649, 652, 655, 658, 661, 664, 667, 670, 673, 676, 679, 682, 685, 688, 691, 694, 697, 700, 703, 706, 709, 712, 715, 718, 721, 724, 727, 730, 733, 736, 739, 742, 745, 748, 751, 754, 757, 760, 763, 766, 769, 772, 775, 778, 781, 784, 787, 790, 793, 796, 799, 802, 805, 808, 811, 814, 817, 820, 823, 826, 829, 832, 835, 838, 841, 844, 847, 850, 853, 856, 859, 862, 865, 868, 871, 874, 877, 880, 883, 886, 889, 892, 895, 898, 901, 904, 907, 910, 913, 916, 919, 922, 925, 928, 931, 934, 937, 940, 943, 946, 949, 952, 955, 958, 961, 964, 967, 970, 973, 976, 979, 982, 985, 988, 991, 994, 997, 1000]

69, 677, 685, 724, 796, 810, 837, 838, 839, 857, 878, 992]

Index Table - Teeta Details , Error(MSE) , Cluster List ----->

Index = 1, =====>

```
[{'Index': 1, 'Teeta': 100, 'Error': '4282358.60', 'no.leader': 75, 'Cluster Index in DP/Leaders':  
[0, 1, 3, 4, 7, 9, 16, 17, 19, 20, 25, 27, 30, 35, 41, 42, 45, 47, 49, 70, 119, 132, 163, 178, 180,  
189, 199, 208, 211, 222, 227, 238, 242, 247, 249, 258, 268, 271, 282, 321, 343, 354, 356, 390, 405,  
407, 428, 440, 471, 473, 489, 505, 510, 524, 539, 551, 552, 565, 568, 573, 626, 680, 682, 720, 743,  
752, 756, 786, 798, 801, 835, 898, 916, 923, 925]]]
```

Index = 2, =====>

```
[{'Index': 2, 'Teeta': 100, 'Error': '3866721.24', 'no.leader': 73, 'Cluster Index in DP/Leaders':  
[0, 1, 2, 3, 4, 6, 7, 14, 15, 20, 23, 24, 26, 38, 43, 48, 49, 57, 62, 68, 69, 71, 72, 76, 87, 107, 1  
08, 112, 113, 116, 123, 140, 157, 159, 162, 172, 173, 178, 181, 191, 198, 205, 207, 212, 218, 223, 2  
31, 234, 238, 278, 296, 323, 349, 397, 417, 424, 439, 453, 454, 459, 467, 493, 566, 604, 623, 641, 7  
01, 734, 746, 760, 917, 932, 990]]]
```

Index = 3, =====>

```
[{'Index': 3, 'Teeta': 100, 'Error': '3959840.80', 'no.leader': 74, 'Cluster Index in DP/Leaders':  
[0, 2, 3, 6, 7, 8, 12, 14, 15, 16, 19, 24, 26, 27, 28, 34, 37, 39, 47, 50, 55, 57, 65, 68, 69, 79, 8  
0, 81, 85, 88, 94, 98, 99, 126, 159, 165, 169, 178, 195, 207, 209, 214, 217, 219, 221, 233, 235, 25  
8, 327, 353, 378, 464, 476, 535, 540, 543, 544, 556, 574, 576, 611, 612, 712, 752, 753, 761, 764, 81  
8, 826, 847, 886, 908, 958, 991]]]
```

Index = 4, =====>

```
[{'Index': 4, 'Teeta': 100, 'Error': '4022552.80', 'no.leader': 74, 'Cluster Index in DP/Leaders':  
[0, 1, 2, 3, 4, 5, 6, 7, 9, 11, 13, 15, 16, 17, 21, 22, 28, 32, 36, 42, 44, 49, 51, 62, 66, 68, 72,  
73, 87, 92, 96, 129, 139, 160, 168, 184, 199, 208, 215, 217, 219, 229, 235, 244, 262, 265, 277, 280,  
285, 295, 345, 361, 389, 392, 463, 465, 475, 535, 556, 584, 588, 599, 616, 667, 677, 709, 725, 755,  
760, 781, 782, 844, 943, 957]]]
```

Index = 5, =====>

```
[{'Index': 5, 'Teeta': 100, 'Error': '4086689.25', 'no.leader': 74, 'Cluster Index in DP/Leaders':  
[0, 1, 3, 5, 7, 9, 10, 12, 14, 15, 16, 17, 20, 26, 29, 33, 34, 38, 48, 49, 51, 56, 61, 80, 86, 88, 1  
10, 114, 129, 130, 137, 142, 146, 162, 179, 181, 189, 198, 207, 212, 227, 235, 262, 275, 280, 284, 2  
87, 296, 316, 363, 395, 397, 401, 417, 440, 450, 494, 509, 535, 546, 558, 594, 600, 623, 633, 657, 7
```

16, 725, 762, 767, 825, 836, 925, 978]]]

Index = 6, =====>
[{'Index': 6, 'Teeta': 100, 'Error': '4223218.69', 'no.leader': 67, 'Cluster Index in DP/Leaders':
[0, 1, 2, 3, 4, 5, 6, 7, 9, 13, 14, 17, 19, 21, 22, 24, 30, 32, 35, 39, 44, 46, 49, 52, 58, 74, 79,
85, 95, 98, 104, 121, 130, 142, 153, 171, 176, 180, 188, 199, 211, 231, 239, 294, 316, 357, 362, 40
2, 403, 421, 538, 578, 585, 595, 622, 623, 671, 681, 721, 770, 774, 780, 805, 819, 891, 951, 971]]]

Index = 7, =====>
[{'Index': 7, 'Teeta': 100, 'Error': '4011023.12', 'no.leader': 79, 'Cluster Index in DP/Leaders':
[0, 1, 2, 3, 5, 6, 9, 10, 11, 13, 14, 15, 16, 20, 22, 23, 25, 37, 44, 52, 55, 56, 57, 67, 78, 86, 10
8, 113, 115, 123, 130, 135, 153, 157, 174, 175, 191, 211, 213, 217, 238, 246, 247, 249, 262, 273, 27
6, 281, 294, 338, 340, 344, 365, 383, 385, 388, 469, 483, 513, 516, 528, 543, 571, 575, 581, 584, 62
2, 647, 666, 691, 708, 712, 755, 807, 828, 868, 882, 964, 969]]]

Index = 8, =====>
[{'Index': 8, 'Teeta': 100, 'Error': '3938759.62', 'no.leader': 79, 'Cluster Index in DP/Leaders':
[0, 1, 3, 4, 7, 8, 13, 16, 19, 20, 26, 29, 30, 31, 46, 51, 54, 58, 63, 64, 69, 81, 89, 90, 91, 95, 9
6, 97, 101, 103, 108, 110, 114, 129, 132, 133, 135, 151, 152, 157, 162, 163, 167, 168, 171, 189, 21
3, 218, 221, 232, 235, 240, 241, 274, 278, 320, 328, 331, 334, 420, 436, 448, 466, 469, 485, 516, 52
0, 545, 561, 594, 601, 615, 644, 676, 713, 750, 826, 874, 984]]]

Index = 9, =====>
[{'Index': 9, 'Teeta': 100, 'Error': '4199622.78', 'no.leader': 71, 'Cluster Index in DP/Leaders':
[0, 1, 2, 3, 4, 5, 6, 7, 10, 14, 17, 24, 26, 37, 49, 59, 64, 68, 79, 88, 91, 96, 101, 105, 122, 126,
131, 143, 154, 157, 169, 173, 181, 201, 211, 216, 219, 234, 237, 262, 279, 283, 308, 335, 337, 368,
372, 382, 451, 460, 484, 494, 504, 522, 557, 570, 591, 599, 634, 651, 678, 729, 748, 794, 822, 833,
842, 884, 886, 936, 972]]]

Index = 10, =====>
[{'Index': 10, 'Teeta': 100, 'Error': '4160122.57', 'no.leader': 69, 'Cluster Index in DP/Leaders':
[0, 1, 2, 7, 8, 16, 17, 20, 22, 23, 24, 35, 37, 43, 53, 55, 69, 70, 79, 97, 98, 102, 105, 110, 131,
139, 150, 152, 154, 162, 167, 168, 169, 175, 177, 182, 211, 237, 239, 243, 254, 261, 274, 281, 286,
349, 357, 394, 433, 479, 490, 491, 493, 495, 502, 513, 517, 569, 677, 685, 724, 796, 810, 837, 838,
839, 857, 878, 992]]]

In []:

In []:

```
In [10]: file_name = 'file_KNNC_RESULT' + '__.txt'

with open(file_name, 'w') as f :
    d_o = f"\n----- K NNC Table - Error(MSE) ----->"
    print(d_o)
    f.write(d_o)

    for e, v in Error_Threshold_List_Print.items():
        d_o = f"\n Index {e} | Error {v[0]['Error']} | No of cluster: { v[0]['no.leader']} | Teeta {
v[0]['Teeta'] }"
        print(d_o)
        f.write( d_o )
f.close()
```

```
----- K NNC Table - Error(MSE) ----->
```

```
Index 1 | Error 4282358.60 | No of cluster: 75 | Teeta 100

Index 2 | Error 3866721.24 | No of cluster: 73 | Teeta 100

Index 3 | Error 3959840.80 | No of cluster: 74 | Teeta 100

Index 4 | Error 4022552.80 | No of cluster: 74 | Teeta 100

Index 5 | Error 4086689.25 | No of cluster: 74 | Teeta 100

Index 6 | Error 4223218.69 | No of cluster: 67 | Teeta 100

Index 7 | Error 4011023.12 | No of cluster: 79 | Teeta 100

Index 8 | Error 3938759.62 | No of cluster: 79 | Teeta 100

Index 9 | Error 4199622.78 | No of cluster: 71 | Teeta 100

Index 10 | Error 4160122.57 | No of cluster: 69 | Teeta 100
```

```

In [12]: import matplotlib.pyplot as plt
fig= plt.figure(figsize=(12,8))

plt.title('Errors Calcualtion')
s = " Error X axis ".format(index)
plt.xlabel(s, fontsize=12, color='black')
plt.ylabel("Shuffle Index Y axis",fontsize=12, color='black')

index = []
Err=[]
Leader=[]
#for i in range(len(v)):
for i, v in Error_Threshold_List_Print.items():
    index.append(i)
    Err.append( v[0][ 'Error' ])
    Leader.append(v[0][ 'no.leader' ])

plt.plot(Err,index,color='darkred', marker='*' , markersize=16)

import matplotlib.pyplot as plt
fig= plt.figure(figsize=(12,8))

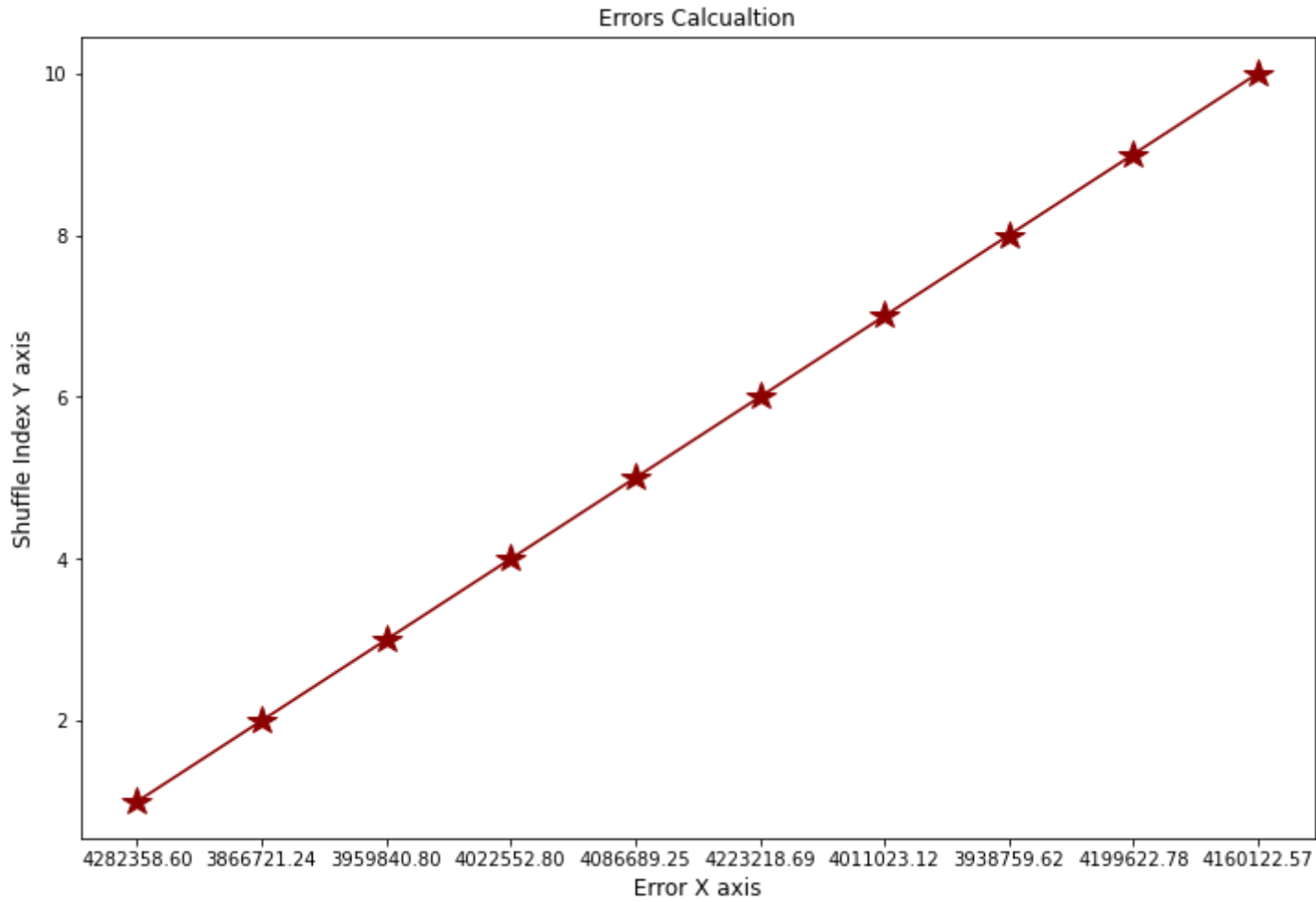
plt.title('Leader Count Calcualtion')
s = " Leader X axis ".format(index)
plt.xlabel(s, fontsize=12, color='black')
plt.ylabel("Shuffle Index Y axis",fontsize=12, color='black')

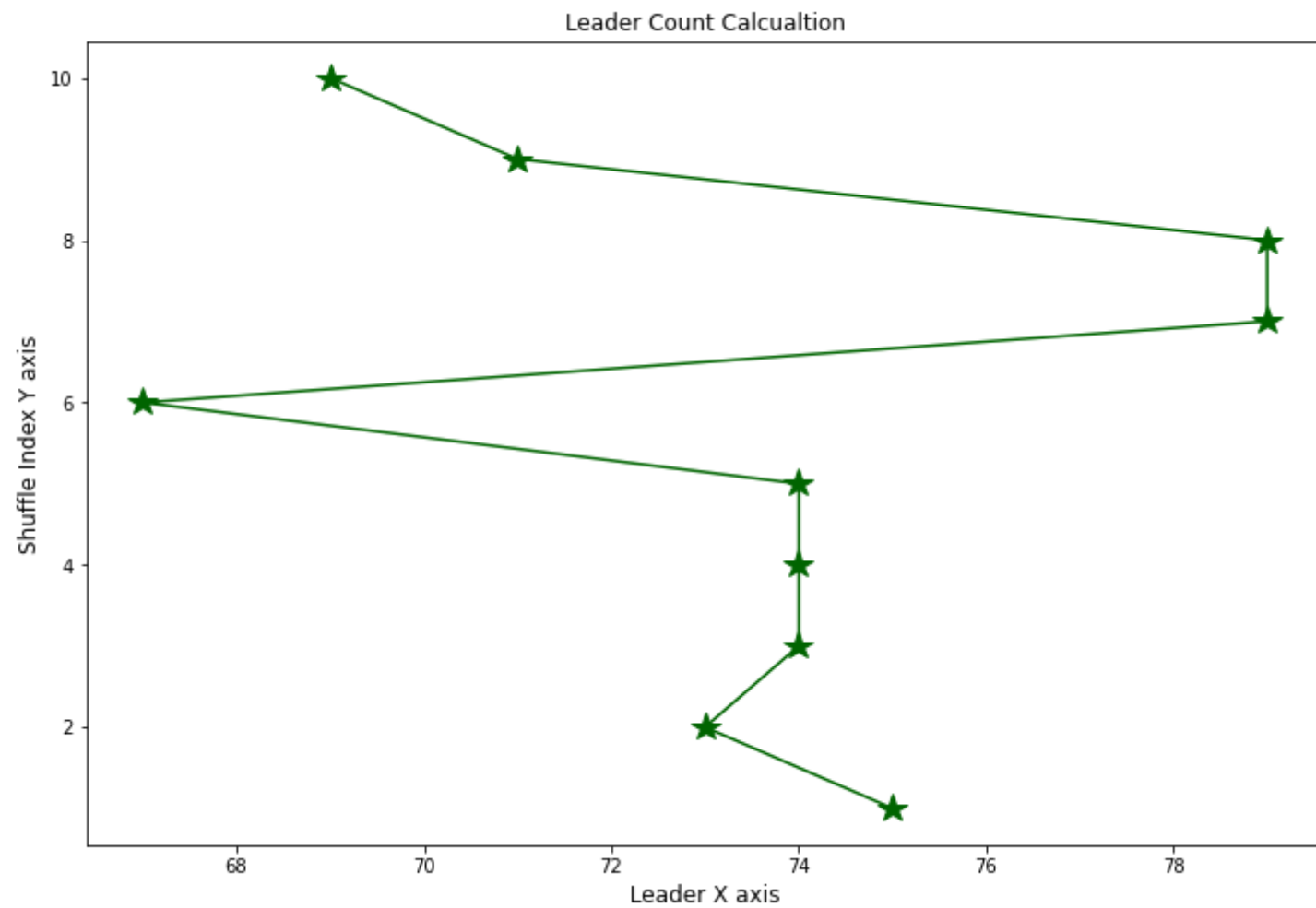
plt.plot(Leader,index,color='darkgreen', marker='*' , markersize=16)
df = pd.DataFrame({ "Shuffle Index ": index, 'No of leaders ': Leader})
df1 = df.head(10)
df.head()

```


Out[12]:

	Shuffle Index	No of leaders
0	1	75
1	2	73
2	3	74
3	4	74
4	5	74





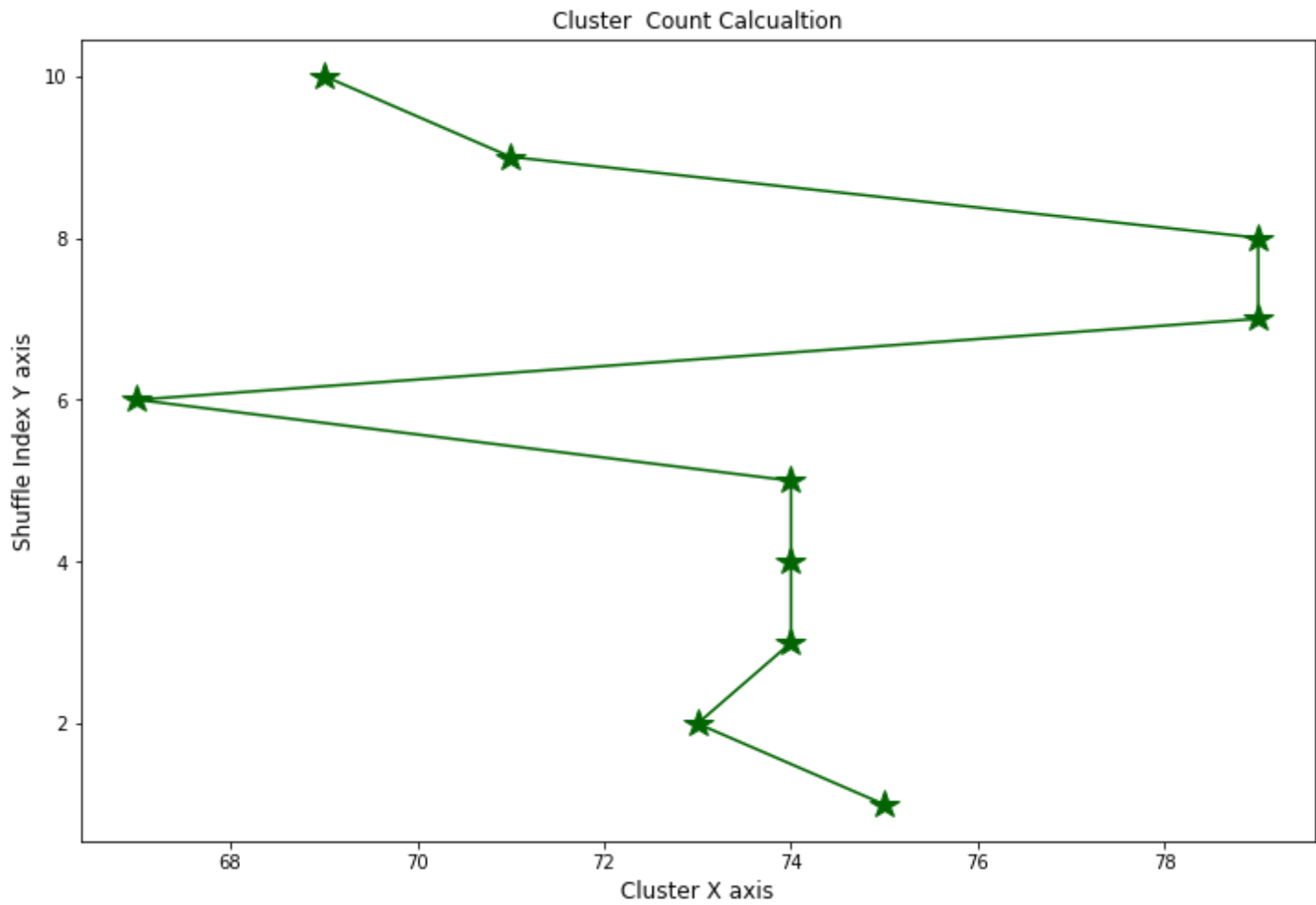
```
In [13]: import matplotlib.pyplot as plt
fig= plt.figure(figsize=(12,8))

plt.title('Cluster Count Calculation')
s = " Cluster X axis ".format(index)
plt.xlabel(s, fontsize=12, color='black')
plt.ylabel("Shuffle Index Y axis",fontsize=12, color='black')

plt.plot(Leader,index,color='darkgreen', marker='*' , markersize=16)
df = pd.DataFrame({ "Shuffle Index ": index, 'No of Clusters ': Leader})
df1 = df.head(10)
df.head()
```

Out[13]:

	Shuffle Index	No of Clusters
0	1	75
1	2	73
2	3	74
3	4	74
4	5	74

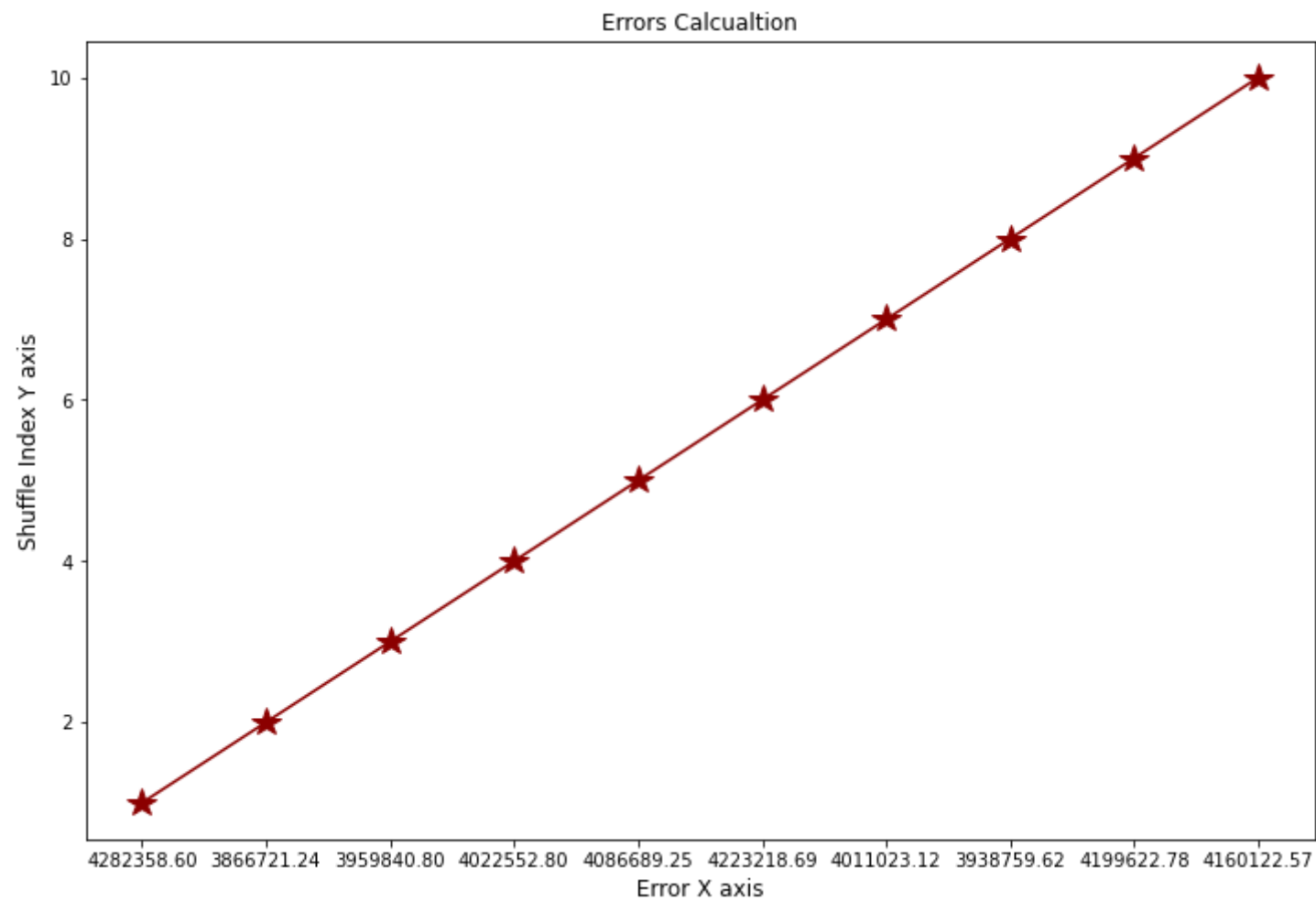


```
In [14]: import matplotlib.pyplot as plt
fig= plt.figure(figsize=(12,8))

plt.title('Errors Calcualtion')
s = " Error X axis ".format(index)
plt.xlabel(s, fontsize=12, color='black')
plt.ylabel("Shuffle Index Y axis",fontsize=12, color='black')
plt.plot(Err,index,color='darkred', marker='*' , markersize=16)
df = pd.DataFrame({ "Shuffle Index ": index, 'Error ': Err})
df1 = df.head(10)
df.head(10)
```

Out[14]:

	Shuffle Index	Error
0	1	4282358.60
1	2	3866721.24
2	3	3959840.80
3	4	4022552.80
4	5	4086689.25
5	6	4223218.69
6	7	4011023.12
7	8	3938759.62
8	9	4199622.78
9	10	4160122.57



Analysis Report for KNNC

The Data set used is from web - engineering of the students , with addition of few engineering subject fields

gender
race/ethnicity
parental level of education
lunch
test preparation course
m1 score
m2 scorep
physics score
m3 score
m4 score
DS score
CO score
LD score
SOM score
ED score
OS-2 score

etc.. Procedure Followed:

The non-numerical features like "gender", "race/ethnicity", "lunch" etc are removed. Then the KNCC Leader Algorithm impelmeented above is run on the data points.

Tables and Graph are created appropriately for " ERROR VS K " and "Clusters VS K "

Also captured the No of cluster created and Leader points for different Teeta. Also caputured the CRM,AM,PM and Error processing output.

Observations:

1.The eqclidean distance is > threshold, Data points (DP) will be part of different clusters.

2. Numbers of clusters created is not equal to threshold values. It depends on the data points' euclidean distance from the leaders and threshold value. Shuffling the DPs leads to different leaders formed. Classification depends on DPs' Position as well as Teeta.

1. If $Teeta \leq$ all data points' euclidean distance, then no. of clusters created = no. of data points. Here the error is ZERO.
2. Average Case: Considered $Teeta = 100$ based on the experiments done for clustering the DPs.

If $Teeta = 100$ - average euclidean distance around 100, we see data points mapped to more clusters.

Experimented using different teeta values [35, 100, 200] and found most of the values around [100 to 140].

Some Data points will map to 1 or more clusters - leading to soft clustering.

Cluster formation is DYNAMIC not known a priori.

Example:

No. of new clusters for the patterns are 71 for index 4

1. Computation intensive and it is based on threshold. If threshold is small, we will have many clusters/leaders and DPs' euclidean distance should be calculated with all these leaders - leading to slow convergence.

Cluster of the patterns

```
Cluster List : [0, 1, 2, 3, 8, 9, 10, 12, 13, 14, 18, 22, 23, 24, 33, 35, 39, 44, 46, 47, 53, 55, 57,
69, 74, 76, 83, 94, 98, 104, 107, 108, 121, 124, 132, 136, 144, 148, 151, 170, 210, 232, 276, 277, 284, 3
07, 310, 359, 373, 401, 417, 430, 434, 465, 467, 475, 513, 527, 535, 567, 677, 752, 775, 799, 851, 886, 8
92, 905, 914, 925, 981]
```

The Error (MSE) for different shuffle is given below: It is clearly seen, number of clusters created with same (teeta) changes due to shuffling of Data points.

----- K NNC Table - Error(MSE) ----->

Index 2 | Error 4134738.61 | Leader 74 | Teeta 100

Index 3 | Error 3977252.38 | Leader 79 | Teeta 100

Index 4 | Error 4267254.04 | Leader 71 | Teeta 100

Index 5 | Error 4053880.62 | Leader 76 | Teeta 100

Index 6 | Error 3906880.06 | Leader 74 | Teeta 100

Index 7 | Error 3970945.15 | Leader 74 | Teeta 100

Index 8 | Error 4342531.24 | Leader 64 | Teeta 100

Index 9 | Error 3858590.03 | Leader 78 | Teeta 100

Index 10 | Error 4149569.91 | Leader 73 | Teeta 100

In []:

In []:

In []: