

Project 3

Problem 2

Synthetic Dataset

Test Case 1: K=2

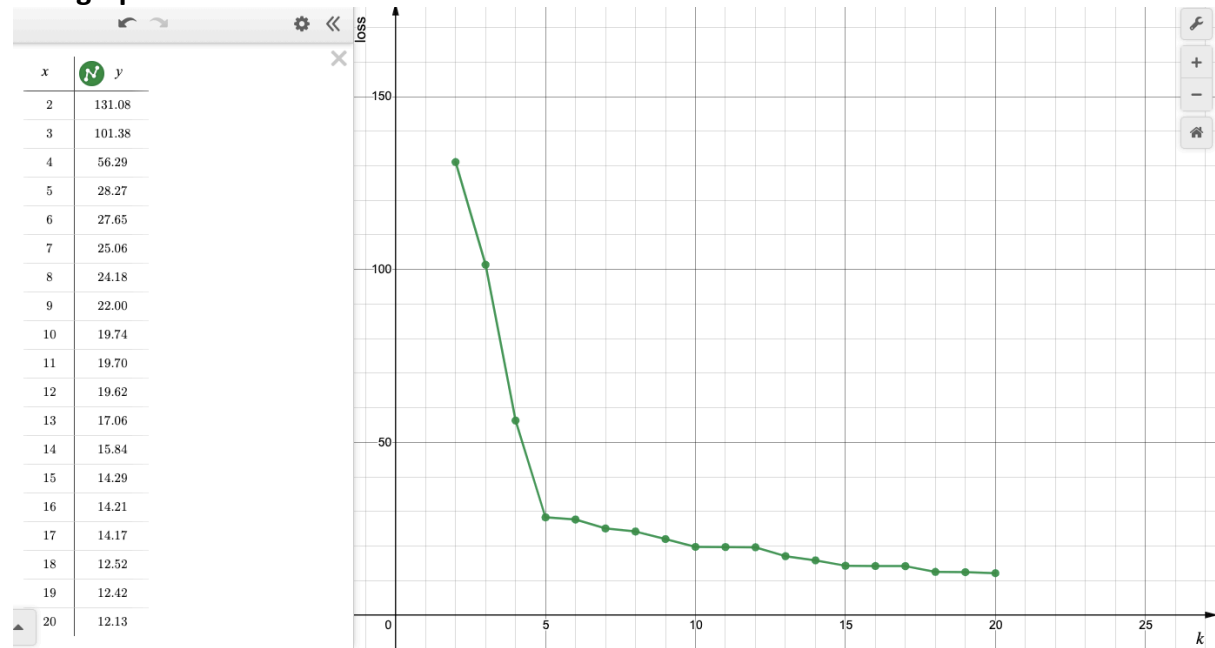
```
Dataset 1
K means Clustering of Data
Cluster 1
Centroid points:
[0.0602625332870772, -0.08038639294559313]
Number of points in cluster 1 is 100
Cluster 2
Centroid points:
[10.168086243285892, 10.046715814097373]
Number of points in cluster 2 is 100
Loss: 30.963761934341946
```

Power Plan Dataset (take approx. 2-3 mins to run)

Test Case 2: K=2

```
Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[0.9437573404299188, 0.11983278430806046, 241.02198898522155, 3.999456865728675, 0.0889081829764498, 0.4626330607044511, 6.197639328428753]
Number of points in cluster 1 is 1946480
Cluster 2
Centroid points:
[3.891245856031152, 0.19721287937743096, 237.39127461089612, 16.52443385213972, 20.681682879377433, 17.125729571984436, 11.396758972762646]
Number of points in cluster 2 is 102800
Loss: 131.08174387827782
```

Loss graph for different k values



The optimal number of clusters for the second data set is $K=5$

Additional Information:

Explain the stopping criteria you selected for your algorithm (see Resources) and how they may impact your results.

- I used maximum number of iterations as a stopping criteria (50 in both the programs). This would enable the algorithm to run beyond getting same centroid values. With using no change in centroid as stopping criteria earlier I discovered that centroid can become redundant for some iterations and would actually change when iterations are increased. With max iterations it would give my algorithm enough time to compute centroid values and give out result to match the correct output

Explain the centroid initialization method you selected and how that may impact your results.

- Centroid Initialization is done by selecting the top values (eg first two points when $k=2$). In case the first two points are closely associated it would take more number of iterations to get proper approximate values. The centroids would start from being close to diverging into different points. The centroid initialization will also affect the final centroid values to some extent.

Explain why your algorithm may require different amounts of time to run on the same input and parameters.

- Algorithm may take different times run for same input and parameters because of the OS/platform I am running the algorithm on. If the OS is

occupied with many different tasks it may take more time for an algorithm to execute compared to if the OS was idle or was not occupied too much. For instance, in case of running the second dataset problem which involves a heavy read from the csv file, the algorithm ran faster when I was just running the algorithm without scheduling anything else. When there were multiple tasks ongoing it took twice the amount of time for algorithm to execute completely

Explain why your algorithm may produce different results on the same input and parameters.

- Algorithm may produce different results on the same input and parameters because of non-deterministic nature. The initial computation heavily determines the probability of the final result. In my implementation even though first two points are selected when $k=2$ it did not affect the final result much but as the k value is increased I could see there are changes in the final result when computed multiple times. This is probably because of the randomness, as centroid values differ for each computation for same k it also directly affects the number of points in the cluster and the final loss function.

Centroid points, number of points and loss from $K=3$ to 20

K=3

```
Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[0.9428859121593572, 0.119784995884149, 241.82286658642328, 3.995389854923665, 0.89747376555198452, 0.4286448141815978, 6.288907853639639]
Number of points in cluster 1 is 1943723
Cluster 2
Centroid points:
[3.9831887268189326, 0.28015729828528694, 237.18973459464328, 16.982487843692886, 36.5959154885857, 2.419856776589161, 11.276888912386172]
Number of points in cluster 2 is 56555
Cluster 3
Centroid points:
[3.657128525366317, 0.1913565976898895, 237.79334312885356, 15.544769681248779, 0.8161895465491285, 34.826313211785646, 18.795688179584588]
Number of points in cluster 3 is 49882
Loss: 181.38266679149834
```

K=4

```
Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[0.9423945988458222, 0.11975481862361112, 241.82337188285873, 3.9934804188719245, 0.89388365271143579, 0.42855429818846587, 6.288458536878654]
Number of points in cluster 1 is 1943214
Cluster 2
Centroid points:
[3.292179624917548, 0.1974452926288652, 238.07898236546995, 13.9633822335513, 36.7965319888576, 2.168869738958146, 0.39675888123645273]
Number of points in cluster 2 is 21222
Cluster 3
Centroid points:
[3.6544734368614686, 0.19128218226399718, 237.79746751123753, 15.533897678617892, 0.7748498569677156, 34.825296281168684, 18.794853943684414]
Number of points in cluster 3 is 48948
Cluster 4
Centroid points:
[4.3737165218368855, 0.28238487976827836, 236.69131899599834, 18.577985739758662, 36.19738747771836, 2.6873139483865955, 17.66284322638146]
Number of points in cluster 4 is 35984
Loss: 56.29524144668225
```

K=5

```
Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[1.7992903099260193, 0.1318189124864801, 239.81652857168697, 7.511810612577264, 0.1986325382986577, 0.4748786443379456, 17.879410388322675]
Number of points in cluster 1 is 647477
Cluster 2
Centroid points:
[3.292916709875098, 0.19747735093094518, 238.06881498939444, 13.9659486212586, 36.802215413622434, 2.1620551496582685, 0.39769031345745937]
Number of points in cluster 2 is 21215
Cluster 3
Centroid points:
[3.690479515254615, 0.19095069628999622, 237.74272881896437, 15.686616349527, 0.7950037206335707, 35.524843201870944, 10.582077176570639]
Number of points in cluster 3 is 47035
Cluster 4
Centroid points:
[4.407889478058988, 0.20089036659118886, 236.64652899194732, 18.704955716701804, 36.76921092607985, 2.6654246324056294, 17.634354667660293]
Number of points in cluster 4 is 34889
Cluster 5
Centroid points:
[0.5196093693210818, 0.1139603284063762, 241.62015561379326, 2.258586670608532, 0.05354117770262362, 0.41872647582438566, 0.41369438130263103]
Number of points in cluster 5 is 1298664
Loss: 28.27440679356023
```

K=6

```
Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[2.9780905989403268, 0.2506709790945241, 238.18283314095237, 13.330950870542992, 17.40130819545979, 0.7024496601256893, 13.958702064096755]
Number of points in cluster 1 is 7797
Cluster 2
Centroid points:
[3.330537929002009, 0.19572219767270715, 238.05254431187788, 14.082918446506666, 37.49256149653052, 2.2205037560760053, 0.3923503706769724]
Number of points in cluster 2 is 20367
Cluster 3
Centroid points:
[3.6898829511126237, 0.19082678806960846, 237.74422882185402, 15.683610602901773, 0.78407011870825, 35.53286814449219, 10.578011317704123]
Number of points in cluster 3 is 47006
Cluster 4
Centroid points:
[4.477779840930903, 0.19669575712561496, 236.5043180763168, 10.95731748831756, 37.900009284189025, 2.823105251756259, 17.622969083650542]
Number of points in cluster 4 is 32313
Cluster 5
Centroid points:
[1.7931902790343226, 0.1311923470822664, 239.82346947553683, 7.482008890517077, 0.12801040901659325, 0.47450613843184686, 17.8709113305927]
Number of points in cluster 5 is 644057
Cluster 6
Centroid points:
[0.5185216946383524, 0.11386225283955181, 241.6220798157035, 2.253234237982413, 0.043060243192010725, 0.4186038805924145, 0.41350424584277284]
Number of points in cluster 6 is 1297740
Loss: 27.65583203176515
```

K=7

```
Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[2.9942531217481902, 0.250002029136317, 238.1891779396473, 13.395785639958344, 17.553720083246617, 0.7092872008324662, 14.224245577523414]
Number of points in cluster 1 is 7688
Cluster 2
Centroid points:
[3.3301459366560384, 0.19572266142892347, 238.05289761046387, 14.081198134053581, 37.490351092560765, 2.2198379572796463, 0.3920451755462804]
Number of points in cluster 2 is 20365
Cluster 3
Centroid points:
[3.694823840833406, 0.1906937067714118, 237.7455123380284, 15.703629066689446, 0.7855862010075997, 35.5897873793869, 10.60543506105371]
Number of points in cluster 3 is 46844
Cluster 4
Centroid points:
[4.478909102174865, 0.1966680711320403, 236.5830327157825, 10.96158374124807, 37.91331557097713, 2.8253299460933143, 17.62184769812256]
Number of points in cluster 4 is 32278
Cluster 5
Centroid points:
[1.793416749512257, 0.1311595450535112, 239.8234999720486, 7.482776093250607, 0.1280771955114265, 0.47506710491978477, 17.883290253631742]
Number of points in cluster 5 is 643768
Cluster 6
Centroid points:
[0.4012231817102953, 0.10485055695358336, 243.43890953618512, 1.7410620998761095, 0.02422856385270624, 0.35529915379771204, 0.42587890052342675]
Number of points in cluster 6 is 704401
Cluster 7
Centroid points:
[0.699085666026445, 0.1277405400928931, 238.84521585317316, 3.041929903423394, 0.07524358278311938, 0.5204625105323891, 0.3998104656434925]
Number of points in cluster 7 is 513936
Loss: 25.061937840057664
```

K=8

```
Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[2.9818168459217813, 0.25801841249499445, 238.2373581535184, 13.3497530369777, 17.880256307569884, 0.7159257775997864, 14.112801867948285]
Number of points in cluster 1 is 7491
Cluster 2
Centroid points:
[3.3383149838575167, 0.19573854540897366, 238.8523885989382, 14.881785591514879, 37.491774296518194, 2.2288559838923537, 0.39288368118646564]
Number of points in cluster 2 is 28363
Cluster 3
Centroid points:
[3.6985751878889754, 0.19833921226688158, 237.74781445829962, 15.718991321575487, 0.7898658397398626, 35.73956112582639, 10.555168755432891]
Number of points in cluster 3 is 46437
Cluster 4
Centroid points:
[4.47952784323454, 0.1966126131712761, 236.5827877398557, 18.96377899845837, 37.921741287362825, 2.826615483695895, 17.621542858085581]
Number of points in cluster 4 is 32252
Cluster 5
Centroid points:
[1.5188622588835195, 0.11984181454289161, 240.97899138927347, 6.28286782987295, 0.18156643552689792, 0.39875478127776635, 17.745651345443715]
Number of points in cluster 5 is 456578
Cluster 6
Centroid points:
[0.4818655472688813, 0.18488175639519482, 243.43887429763646, 1.7483476868627174, 0.824231417698975456, 0.3553142849671856, 0.4229632218892962]
Number of points in cluster 6 is 784188
Cluster 7
Centroid points:
[0.6986878467715, 0.12771128197258137, 238.84538897488967, 3.848173847619528, 0.87498348945845748, 0.5215112669724645, 0.3975229988988714]
Number of points in cluster 7 is 513853
Cluster 8
Centroid points:
[2.4655856888226743, 0.15924135256848771, 237.8369257898613, 10.415221618864294, 0.28251745427882215, 0.715535185158739, 18.19789254752771]
Number of points in cluster 8 is 188286
Loss: 24.186532248857664
```

K=9

```
Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[3.7512966123618845, 0.2438882854926293, 237.19769871631785, 16.37858885275485, 27.123892836824412, 0.868615464184122, 17.848186198845618]
Number of points in cluster 1 is 3867
Cluster 2
Centroid points:
[3.3688318478919314, 0.19485885959885532, 238.82876238231737, 14.28982398698138, 37.99887433483422, 2.2813651248465883, 0.39249897666883113]
Number of points in cluster 2 is 19544
Cluster 3
Centroid points:
[3.6935928637386525, 0.19843116961199894, 237.7467645181841, 15.698477593352113, 0.7798478464452127, 35.68914131111636, 10.525986688122823]
Number of points in cluster 3 is 46571
Cluster 4
Centroid points:
[4.513786246297654, 0.19488918588925485, 236.5515481829795, 19.88254459298472, 38.373329822944775, 2.9527884841783415, 17.599914434278944]
Number of points in cluster 4 is 38386
Cluster 5
Centroid points:
[1.5181468735931465, 0.11989488963566835, 240.97285794931327, 6.282359589693866, 0.89929896655911789, 0.3988851264191873, 17.746428808359227]
Number of points in cluster 5 is 456537
Cluster 6
Centroid points:
[0.5173333919543984, 0.11374866367882282, 241.6237148823892, 2.247311228845186, 0.83527446234444283, 0.41895896838294993, 0.4115731891871879]
Number of points in cluster 6 is 1296462
Cluster 7
Centroid points:
[2.959885388459976, 0.2517947818783226, 238.53991375497614, 13.168327288818295, 13.795886775762936, 0.6596638655462185, 18.834948291986235]
Number of points in cluster 7 is 4522
Cluster 8
Centroid points:
[2.882423128728926, 0.24857858769931648, 238.99728875178984, 9.87878159453382, 17.68223234624146, 0.7875748318986686, 0.4729498861847836]
Number of points in cluster 8 is 3512
Cluster 9
Centroid points:
[2.46447457139965, 0.15879826394647167, 237.82788672496485, 18.489346441868334, 0.17969811978478355, 0.7146993543716966, 18.175581892885864]
Number of points in cluster 9 is 187879
Loss: 22.888669637679632
```

K=10

```
Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[3.751058428128233, 0.2438252326783861, 237.19783350568798, 16.37761116856254, 27.12150982419855, 0.860392967942089, 17.839968976215097]
Number of points in cluster 1 is 3868
Cluster 2
Centroid points:
[3.3694314538843595, 0.19402611768320935, 238.0198094945465, 14.211737594100505, 38.00752803810109, 2.2829415680852154, 0.39227735955343884]
Number of points in cluster 2 is 19527
Cluster 3
Centroid points:
[3.6984102122158866, 0.1903146827534209, 237.74831196811496, 15.718022191102024, 0.7806528062048906, 35.74471614779705, 10.555984056878165]
Number of points in cluster 3 is 46415
Cluster 4
Centroid points:
[4.513786246297654, 0.19408918580925405, 236.5515401829795, 19.08254459290472, 38.373329822944775, 2.9527084841703415, 17.599914434278944]
Number of points in cluster 4 is 30386
Cluster 5
Centroid points:
[1.5178780408607238, 0.11981896566854863, 240.97662791362214, 6.280960174816747, 0.09923386105943062, 0.3905575350159722, 17.74610787376698]
Number of points in cluster 5 is 455792
Cluster 6
Centroid points:
[0.40127831883565307, 0.10478480151858283, 243.4444975489695, 1.7409531966016485, 0.022387401494282994, 0.3553376836696216, 0.42266094859487546]
Number of points in cluster 6 is 782315
Cluster 7
Centroid points:
[2.958850066342329, 0.2518934099955769, 238.5400486510398, 13.159398496240634, 13.793896505970809, 0.6596638655462185, 18.033171163202123]
Number of points in cluster 7 is 4522
Cluster 8
Centroid points:
[2.0842017976224967, 0.24029573789504183, 239.03893302406541, 9.886807770368211, 17.97709481008988, 0.7068715569730356, 0.47434038851841115]
Number of points in cluster 8 is 3449
Cluster 9
Centroid points:
[2.461114842011896, 0.15880124457753475, 237.03376256391238, 10.394761517917196, 0.17969384666847193, 0.7154356286868752, 18.193520126156837]
Number of points in cluster 9 is 188337
Cluster 10
Centroid points:
[0.695708044620511, 0.12745948949714248, 238.85101822725474, 3.0256522153075953, 0.05604378736624899, 0.5210125342695985, 0.3980655528116129]
Number of points in cluster 10 is 514669
Loss: 19.745932409807263
```

K=11

```
Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[3.74224084800637, 0.24510397877984028, 237.20609018567652, 16.34795755968169, 26.883023872679043, 0.773474801061008, 17.839522546419097]
Number of points in cluster 1 is 3770
Cluster 2
Centroid points:
[3.2701895361380697, 0.19120161812297842, 238.13962243797158, 13.783991370010787, 38.03079827400216, 0.6571736785329019, 0.39298813376483277]
Number of points in cluster 2 is 18540
Cluster 3
Centroid points:
[3.6431993813579786, 0.1898571895353657, 237.8132696538666, 15.477282331670576, 0.30498616768684517, 35.39919837933213, 10.5121876837955]
Number of points in cluster 3 is 45907
Cluster 4
Centroid points:
[4.367468553236671, 0.1909044216483903, 236.7065206933153, 18.443565617262315, 38.42235585426247, 0.6109656880084896, 17.626317651220376]
Number of points in cluster 4 is 28270
Cluster 5
Centroid points:
[1.5179122653728614, 0.11983681148602493, 240.9794132291403, 6.281037957454434, 0.09920528638229677, 0.3907795657614542, 17.746374393536914]
Number of points in cluster 5 is 455510
Cluster 6
Centroid points:
[0.40133831917200896, 0.10479639822598193, 243.44571489411294, 1.7412014609659698, 0.022387677953009662, 0.3553023986249725, 0.42260994337219354]
Number of points in cluster 6 is 781948
Cluster 7
Centroid points:
[2.958060454748147, 0.2518408381631741, 238.55178555506066, 13.142978154257717, 13.739180586714222, 0.6627284086312974, 18.038118591172537]
Number of points in cluster 7 is 4486
Cluster 8
Centroid points:
[2.082816540477574, 0.24101863715783317, 239.03897845078676, 9.882644146767603, 17.926033779848574, 0.7108328479906815, 0.47408270238788586]
Number of points in cluster 8 is 3434
```

```
Cluster 9
Centroid points:
[2.459262127474409, 0.1586583296635619, 237.03159138780606, 10.386830223316217, 0.17953914801275486, 0.7006106845928151, 18.192575221379798]
Number of points in cluster 9 is 188477
Cluster 10
Centroid points:
[0.6951541622486461, 0.12740896185561143, 238.85229144091772, 3.0232913476965084, 0.05597178689473296, 0.5173904431213078, 0.3981178316612874]
Number of points in cluster 10 is 514938
Cluster 11
Centroid points:
[6.1090369999999705, 0.2358155000000005, 234.85472499999966, 26.121300000000055, 35.9865, 35.96725, 12.3005]
Number of points in cluster 11 is 4000
Loss: 19.709632806507575
```

K=12

```
Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[3.8758877310924413, 0.23676033613445355, 237.00363025210046, 16.838588235294107, 29.80941176470588, 0.7294117647058823, 17.7872268907563]
Number of points in cluster 1 is 2975
Cluster 2
Centroid points:
[3.2701315207422894, 0.1912055880223564, 238.13949182715612, 13.783654312995628, 38.03182823542105, 0.6572000345255435, 0.39170308032583404]
Number of points in cluster 2 is 18537
Cluster 3
Centroid points:
[3.6431993013579786, 0.1898571895353657, 237.8132696538666, 15.477282331670576, 0.30498616768604517, 35.39919837933213, 10.5121876837955]
Number of points in cluster 3 is 45907
Cluster 4
Centroid points:
[4.371405409293651, 0.19025205006473914, 236.71855920011603, 18.454876996115825, 38.5084520212919, 0.6106675298518199, 17.628434757588835]
Number of points in cluster 4 is 27804
Cluster 5
Centroid points:
[1.517826012289323, 0.11982595519090469, 240.9799404639155, 6.200555348146865, 0.09795455843146211, 0.39079408541135029, 17.746507113147135]
Number of points in cluster 5 is 455354
Cluster 6
Centroid points:
[0.40133831917200896, 0.10479639022598193, 243.44571489411294, 1.7412014609659698, 0.022387677953009662, 0.3553023986249725, 0.42260994337219354]
Number of points in cluster 6 is 781948
Cluster 7
Centroid points:
[2.7592128315854456, 0.24966070326958642, 238.9025694016038, 12.276804441702685, 11.270203578038249, 0.5619987661937076, 18.08574953732264]
Number of points in cluster 7 is 3242
Cluster 8
Centroid points:
[2.0828501415671397, 0.24097232741042796, 239.03036120011706, 9.88272647829885, 17.930381590445673, 0.7110399067870667, 0.4715991843868337]
Number of points in cluster 8 is 3433
Cluster 9
Centroid points:
[2.4588094626304366, 0.158513139592907, 237.03055865832548, 10.384421486286882, 0.17325150508006426, 0.7006296386744673, 18.191779658317493]
Number of points in cluster 9 is 188362
Cluster 10
Centroid points:
[0.6951541622486461, 0.12740896185561143, 238.85229144091772, 3.0232913476965084, 0.05597178689473296, 0.5173904431213078, 0.3981178316612874]
Number of points in cluster 10 is 514938
Cluster 11
Centroid points:
[3.408076231571372, 0.25805177993527495, 237.60147788565288, 15.06961524631428, 19.846098525710175, 0.8407047824523552, 17.900035958288385]
Number of points in cluster 11 is 2781
Cluster 12
Centroid points:
[6.108945736434079, 0.23578144536134005, 234.85519129782412, 26.120730182545692, 35.98774693673418, 35.97199299824956, 12.299074768692172]
Number of points in cluster 12 is 3999
Loss: 19.62091030325824
```

K=13

```
Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[3.8769125168236918, 0.23668438761776556, 236.99937752355277, 16.84279946164198, 29.811911170928667, 0.7301480484522207, 17.79172274562584]
Number of points in cluster 1 is 2972
Cluster 2
Centroid points:
[2.9172662182685922, 0.17031807333478013, 238.91811600491718, 12.254024734215667, 37.35387285745281, 0.47103493165545673, 0.41997541042887104]
Number of points in cluster 2 is 13827
Cluster 3
Centroid points:
[3.6431993813579786, 0.1898571895353657, 237.8132696538666, 15.477282331670576, 0.30498616768684517, 35.39919837933213, 10.5121876837955]
Number of points in cluster 3 is 45907
Cluster 4
Centroid points:
[4.370951462598519, 0.1901951570539346, 236.71931925305026, 18.45279746698825, 38.50516317058252, 0.6106933400496528, 17.63238945058108]
Number of points in cluster 4 is 27793
Cluster 5
Centroid points:
[1.517826012289323, 0.11982595519090469, 240.9799404639155, 6.20055348146865, 0.09795455843146211, 0.3907948541135029, 17.746507113147135]
Number of points in cluster 5 is 455354
Cluster 6
Centroid points:
[0.40136056089029504, 0.1047958918180588, 243.44634658854582, 1.7412896846455082, 0.022379076874271674, 0.35528559386100794, 0.4226044666053518]
Number of points in cluster 6 is 781757
Cluster 7
Centroid points:
[2.75970459451126, 0.2496978106691333, 238.9023712611778, 12.27912426765344, 11.27690410114092, 0.5624421831637373, 18.090348442799876]
Number of points in cluster 7 is 3243
Cluster 8
Centroid points:
[2.0667671150971567, 0.2413626307922271, 239.00715097159997, 9.829237668161436, 17.4863976083707, 0.7070254110612855, 0.470254110612855]
Number of points in cluster 8 is 3345
Cluster 9
Centroid points:
[2.4588092141237627, 0.15051338107802035, 237.03055764666894, 10.384423692550927, 0.17328243869549753, 0.7006259191030085, 18.191778640178804]
Number of points in cluster 9 is 180363
Cluster 10
Centroid points:
[0.6949601862169785, 0.12739435990822115, 238.85306832875173, 3.0223949617357193, 0.055472939130029625, 0.5173539792427849, 0.39813006457023714]
Number of points in cluster 10 is 515098
Cluster 11
Centroid points:
[3.4080719165767666, 0.25804746494066866, 237.60370010787517, 15.068967997123343, 19.855807263574253, 0.8399856166846458, 17.893563466379]
Number of points in cluster 11 is 2781
Cluster 12
Centroid points:
[6.1132880002807, 0.23563020572002058, 234.85050175614612, 26.13938785750132, 35.97992975413949, 36.02257902659308, 12.338936276969394]
Number of points in cluster 12 is 3986
Cluster 13
Centroid points:
[4.262690976514238, 0.2522772970745778, 235.94313967861524, 18.108075813761904, 39.73135558302431, 1.2435105067985166, 0.33106716110424395]
Number of points in cluster 13 is 4854
Loss: 17.06168203974168
```

K=14


```
Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[3.874479110512133, 0.2364487806199438, 237.00126684636083, 16.83241239892182, 29.81266846361186, 0.7075471698113207, 17.79380053908356]
Number of points in cluster 1 is 2968
Cluster 2
Centroid points:
[2.916588499420614, 0.1701982908458868, 238.91968424101896, 12.25101390498262, 37.34957995365086, 0.47421784472769407, 0.41910486674391656]
Number of points in cluster 2 is 13808
Cluster 3
Centroid points:
[5.983715481171553, 0.17572180838395278, 235.52777750430747, 25.13019936007876, 2.5973418656165395, 69.18631553039626, 11.990647304947084]
Number of points in cluster 3 is 4063
Cluster 4
Centroid points:
[4.368237428756968, 0.1900307337132964, 236.72223108000964, 18.440819565688052, 38.506493030020345, 0.5662289878075175, 17.631989033980233]
Number of points in cluster 4 is 27722
Cluster 5
Centroid points:
[1.5178142793505924, 0.11994002196415868, 240.99675287674492, 6.280110526478415, 0.09783313412692463, 0.3905033673968941, 17.747321739667363]
Number of points in cluster 5 is 453466
Cluster 6
Centroid points:
[0.40170223973497443, 0.10483805624367584, 243.4548751909493, 1.7426699695799388, 0.02240633543402087, 0.35374465736545546, 0.42249746505628216]
Number of points in cluster 6 is 779110
Cluster 7
Centroid points:
[2.7588081729462684, 0.2493452748610251, 238.90141445336613, 12.275972822730111, 11.280111179740581, 0.5348980852378011, 18.090487955528104]
Number of points in cluster 7 is 3238
Cluster 8
Centroid points:
[2.0635512282084043, 0.2409922109047333, 239.0135590173762, 9.81629718394248, 17.488016776512882, 0.6659676452965848, 0.47094068304373876]
Number of points in cluster 8 is 3338
Cluster 9
Centroid points:
[2.4459552891127325, 0.15748265535048586, 237.01669197637767, 10.329606544192195, 0.17234062817473755, 0.582828902810701, 18.18818785980359]
Number of points in cluster 9 is 188992
Cluster 10
Centroid points:
[0.6904251097399345, 0.12704861460568107, 238.86199130596978, 3.0028725932695597, 0.05504997329080507, 0.48113517949353174, 0.39826699904775914]
Number of points in cluster 10 is 516676
Cluster 11
Centroid points:
[3.4063598990263206, 0.258073566534439, 237.6103065272271, 15.059718716191854, 19.86080857699243, 0.7811034980165885, 17.89542012261089]
Number of points in cluster 11 is 2773
Cluster 12
Centroid points:
[5.932098360655713, 0.2410845693460649, 235.01527972937768, 25.353942232630825, 36.15899037210512, 32.871975019516, 12.115534738485557]
Number of points in cluster 12 is 3843
Cluster 13
Centroid points:
[4.258537282072561, 0.2520058031088083, 235.93701761657985, 18.089533678756545, 39.766424870466324, 1.0437305699481865, 0.33181347150259066]
Number of points in cluster 13 is 4825
Cluster 14
Centroid points:
[3.4036369607270016, 0.19224517522155887, 238.0718176706131, 14.46007467722347, 0.2981915515767691, 31.640447163615087, 10.368122722569616]
Number of points in cluster 14 is 44458
Loss: 15.841509420987027
```

K=15

```
Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[3.8739836388140202, 0.23667789757412375, 237.0017452830185, 16.830323450134756, 29.806603773584907, 0.7075471698113207, 17.79177897574124]
Number of points in cluster 1 is 2968
Cluster 2
Centroid points:
[2.916588499420614, 0.1701982908458868, 238.91968424101896, 12.25101390498262, 37.34957995365006, 0.47421784472769407, 0.41910486674391656]
Number of points in cluster 2 is 13808
Cluster 3
Centroid points:
[5.904115706548503, 0.17576514032496313, 235.52633924175313, 25.131905465288032, 2.5979812900049235, 69.19079271294929, 11.989167897587395]
Number of points in cluster 3 is 4062
Cluster 4
Centroid points:
[4.3682035059876165, 0.1900170249603233, 236.7224592410917, 18.440672341653592, 38.50620401096523, 0.5661881402395037, 17.632051651998260]
Number of points in cluster 4 is 27724
Cluster 5
Centroid points:
[1.5831252421780675, 0.11492425021663502, 242.2665540964208, 6.51204091841051, 0.10085176235196314, 0.30185231892124194, 18.32065415912245]
Number of points in cluster 5 is 283612
Cluster 6
Centroid points:
[0.40180383039061787, 0.1048582564281883, 243.45722212661624, 1.7434518426400016, 0.022408690111606684, 0.3537949869483896, 0.4233410581053584]
Number of points in cluster 6 is 778409
Cluster 7
Centroid points:
[2.7429016444306598, 0.2407303754266209, 238.87640086875572, 12.212038473471955, 11.294135898231461, 0.5349053676698728, 18.053986968662738]
Number of points in cluster 7 is 3223
Cluster 8
Centroid points:
[2.0635512202004043, 0.2409922109047333, 239.0135590173762, 9.81629718394248, 17.488016776512882, 0.6659676452965848, 0.47094068304373876]
Number of points in cluster 8 is 3338
Cluster 9
Centroid points:
[1.4798653452124733, 0.12782518413420266, 237.8318862436603, 6.220967721743182, 0.10625326016650323, 0.4240782857262086, 16.890871533790975]
Number of points in cluster 9 is 240009
Cluster 10
Centroid points:
[0.6891255762642793, 0.12688004118524646, 238.86475937216468, 2.9969788461169045, 0.055025256923080055, 0.48102343765120287, 0.3868354332384989]
Number of points in cluster 10 is 516642
Cluster 11
Centroid points:
[2.9048222712385496, 0.17592599090969552, 238.02350975001283, 12.246927010226473, 0.19159815520352919, 0.6599492012566005, 18.730382327384532]
Number of points in cluster 11 is 119590
Cluster 12
Centroid points:
[5.932090360655713, 0.2410845693460649, 235.01527972937768, 25.353942232630025, 36.15899037210512, 32.871975019516, 12.115534738485557]
Number of points in cluster 12 is 3843
Cluster 13
Centroid points:
[4.250537202072561, 0.2520050031080083, 235.93701761657985, 18.089533678756545, 39.766424870466324, 1.0437305699481865, 0.33181347150259066]
Number of points in cluster 13 is 4825
Cluster 14
Centroid points:
[3.403319434740493, 0.192133201108088338, 238.06723740563437, 14.458915000226487, 0.29818116252330345, 31.67050001092655, 10.353264666771846]
Number of points in cluster 14 is 44370
Cluster 15
Centroid points:
[3.4075513143600185, 0.250107310046013, 237.60964350010020, 15.065034209578688, 19.84515664386028, 0.780338494778538, 17.902052574720923]
Number of points in cluster 15 is 2777
Loss: 14.29816479428077
```

K=16

```
Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[5.21129569954795, 0.2340658398052624, 234.73153935319326, 22.21149878289096, 37.75982380897183, 0.7998145357598239, 17.412657934392026]
Number of points in cluster 1 is 8633
Cluster 2
Centroid points:
[2.875490446878243, 0.16886369813734045, 239.3325541610036, 12.054184986809492, 37.59533136141978, 0.4703813254456791, 0.43240866576065234]
Number of points in cluster 2 is 12502
Cluster 3
Centroid points:
[5.925571572074338, 0.17592265193370166, 235.51228026117562, 25.217780018045225, 2.6449020592667, 69.54093420391763, 11.908839779005525]
Number of points in cluster 3 is 3982
Cluster 4
Centroid points:
[3.91701982378853, 0.1732137521547584, 237.62090308370162, 16.408536678797182, 37.10108216816702, 0.5063685117793526, 17.744349741420845]
Number of points in cluster 4 is 20878
Cluster 5
Centroid points:
[2.0582551415797283, 0.24056810730253342, 239.02994336810784, 9.792846497764526, 17.41520119225037, 0.6083457526080477, 0.4944058420268256]
Number of points in cluster 5 is 3352
Cluster 6
Centroid points:
[3.2108114331083777, 0.20528245335450493, 238.5714757840408, 13.71996824136561, 0.3305875347360063, 22.163457721317982, 17.684001587931718]
Number of points in cluster 6 is 10076
Cluster 7
Centroid points:
[2.4401584647699974, 0.15729905132776567, 237.00981439251385, 10.305280924439415, 0.19359156829850043, 0.4790027565991714, 18.18812598875138]
Number of points in cluster 7 is 188994
Cluster 8
Centroid points:
[0.6871168189465865, 0.12677213770831794, 238.864592077579, 2.988622665218677, 0.05454777795203327, 0.4429342301682727, 0.3984526112185687]
Number of points in cluster 8 is 516754
Cluster 9
Centroid points:
[1.5177963042316205, 0.12002389040805245, 241.0032942301793, 6.280099131057221, 0.10099528641542274, 0.38604125159585984, 17.747065605852445]
Number of points in cluster 9 is 452740
Cluster 10
Centroid points:
[2.6574796780482757, 0.18843673448982579, 238.76604459331176, 11.34768784682288, 0.2289156626506024, 30.387791831225318, 0.35619657051442283]
Number of points in cluster 10 is 20003
Cluster 11
Centroid points:
[6.420158030147146, 0.3060136239782018, 234.6264850136242, 27.465395095367832, 71.54632152588556, 1.6403269754768393, 13.880108991825614]
Number of points in cluster 11 is 734
Cluster 12
Centroid points:
[5.920230871767505, 0.2401039727406058, 235.03807251399593, 25.29768061850182, 36.0079978672354, 33.01892828579046, 12.016795521194340]
Number of points in cluster 12 is 3751
Cluster 13
Centroid points:
[4.016430481283448, 0.23771824866310162, 235.73333054012787, 17.07607165775398, 37.88836898395722, 0.9667446524064172, 0.3292112299465241]
Number of points in cluster 13 is 5991
Cluster 14
Centroid points:
[4.192776351390268, 0.18763652063784403, 237.18881353980785, 17.719428933279602, 0.3917440621265327, 36.09602210580853, 17.55442979678775]
Number of points in cluster 14 is 17371
Cluster 15
Centroid points:
[3.188982635342194, 0.2524290091930541, 238.12889002303488, 14.121586653047357, 17.43224378617637, 0.6283622744296902, 17.984167517075385]
Number of points in cluster 15 is 5876
Cluster 16
Centroid points:
[0.4017560418143912, 0.10489241456618527, 243.4580315382983, 1.742911794649552, 0.022391992924649575, 0.3495523915301474, 0.4225400816544802]
Number of points in cluster 16 is 777643
Loss: 14.210847309102897
```

K=17

```
Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[5.224095480431378, 0.23342299769780656, 234.6357542711738, 22.265794256633953, 37.867199806131104, 0.79134860805089059, 17.3927056287282]
Number of points in cluster 1 is 8253
Cluster 2
Centroid points:
[2.8747079148252275, 0.1686492567296096, 239.35440899959775, 12.049497790277213, 37.60883889112093, 0.4690237042989152, 0.43198071514664527]
Number of points in cluster 2 is 12445
Cluster 3
Centroid points:
[5.925571572074338, 0.17592265193370166, 235.51228026117562, 25.217780018045225, 2.6449020592667, 69.54093420391763, 11.908839779005525]
Number of points in cluster 3 is 3982
Cluster 4
Centroid points:
[3.9387668775845643, 0.1707904937471961, 237.6477584574769, 16.552060186338515, 37.53021772706891, 0.49977579592446814, 17.746200986497932]
Number of points in cluster 4 is 20071
Cluster 5
Centroid points:
[2.0580030039050734, 0.24073115049564428, 239.03002403124117, 9.793391400831479, 17.486933012916793, 0.6097927305497146, 0.47341544007209374]
Number of points in cluster 5 is 3329
Cluster 6
Centroid points:
[3.211195939267656, 0.20536965366676502, 238.5688736727195, 13.721821970824632, 0.33412722040289766, 22.163838443981344, 17.683437531011215]
Number of points in cluster 6 is 10077
Cluster 7
Centroid points:
[2.9059459331278212, 0.24900649751007802, 238.64672041735895, 12.928954232866992, 13.192553948304482, 0.52833768008157458, 18.057623903248754]
Number of points in cluster 7 is 4217
Cluster 8
Centroid points:
[0.6866514103019903, 0.12675144200288613, 238.8680059961118, 2.986668625419731, 0.0547555167241406, 0.44288624800903087, 0.39861328034391574]
Number of points in cluster 8 is 517445
Cluster 9
Centroid points:
[2.4381161955796204, 0.15697244432206361, 237.0079358128474, 10.29535726010555, 0.17623137450093723, 0.4791426181071092, 18.18696453344912]
Number of points in cluster 9 is 188851
Cluster 10
Centroid points:
[2.6574796780482757, 0.18843673448982579, 238.76604459331176, 11.34768784682288, 0.2289156626506024, 30.387791831225318, 0.35619657051442283]
Number of points in cluster 10 is 20003
Cluster 11
Centroid points:
[6.420158038147146, 0.3060136239782018, 234.6264850136242, 27.465395095367832, 71.54632152588556, 1.6403269754768393, 13.880108991825614]
Number of points in cluster 11 is 734
Cluster 12
Centroid points:
[5.92116777807413, 0.24001387036543115, 235.03632168578255, 25.30141371032284, 36.01333680983729, 33.02667377967458, 12.015737530008002]
Number of points in cluster 12 is 3749
Cluster 13
Centroid points:
[4.006120370554204, 0.23735616211745247, 235.72438709677365, 17.033846153846113, 37.86120760959471, 0.9644334160463193, 0.3296939619520265]
Number of points in cluster 13 is 6045
Cluster 14
Centroid points:
[4.192776351390268, 0.18763652063784403, 237.18801353980785, 17.719428933279602, 0.3917440621265327, 36.09602210580853, 17.55442979678775]
Number of points in cluster 14 is 17371
Cluster 15
Centroid points:
[3.6753114561969027, 0.2508139466744794, 237.1836536771168, 16.101259888661005, 25.242894813946673, 0.7658951069440375, 17.802519777322004]
Number of points in cluster 15 is 3413
Cluster 16
Centroid points:
[1.517635190704008, 0.12000811807465282, 241.00551140334346, 6.279175104571195, 0.0986129411660668, 0.38599543689921384, 17.747205542929404]
Number of points in cluster 16 is 452327
Cluster 17
Centroid points:
[0.40178390301079087, 0.10408408227242642, 243.46071711042848, 1.7429997284688963, 0.022401898396169233, 0.3494853140400995, 0.42246392571135166]
Number of points in cluster 17 is 776968
Loss: 14.17885264072526
```

K=18

```
Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[5.237239136986321, 0.23328647571606448, 234.6837447873472, 22.328249866802496, 37.9214196762142, 0.7943968149439682, 17.383561643835616]
Number of points in cluster 1 is 8038
Cluster 2
Centroid points:
[2.874723240115715, 0.16863693346198867, 239.3544037287841, 12.049517839922846, 37.6093699774992, 0.4690613950498232, 0.43129218908675026]
Number of points in cluster 2 is 12444
Cluster 3
Centroid points:
[5.925571572074338, 0.17592265193370166, 235.51228026117562, 25.217780010045225, 2.6449020592667, 69.54093420391763, 11.908839779005525]
Number of points in cluster 3 is 3982
Cluster 4
Centroid points:
[3.9508885491483473, 0.16908749025241, 237.6306905397099, 16.584568027908897, 37.728452698542995, 0.500615637184486, 17.732403037143442]
Number of points in cluster 4 is 19492
Cluster 5
Centroid points:
[3.3819204126750133, 0.25780619012527617, 237.61942151805454, 14.962269712601339, 19.336035372144437, 0.7044952100221076, 17.892041267501842]
Number of points in cluster 5 is 2714
Cluster 6
Centroid points:
[3.2108114331083777, 0.20528245335450493, 238.5714757840408, 13.71996824136561, 0.3305875347360063, 22.163457721317982, 17.684001587931718]
Number of points in cluster 6 is 10076
Cluster 7
Centroid points:
[2.7365245692405913, 0.2495526403726864, 238.94842054881934, 12.174792597319748, 11.053286534779835, 0.4964901084875558, 18.087747287811105]
Number of points in cluster 7 is 3134
Cluster 8
Centroid points:
[0.6863838034629414, 0.126739640570539, 238.86973072726857, 2.9855277973600813, 0.054729462207758345, 0.44288432010661205, 0.3987021138933686]
Number of points in cluster 8 is 517765
Cluster 9
Centroid points:
[2.437820295322176, 0.15686765601902586, 237.00712095282748, 10.29371473379131, 0.17122224400375113, 0.4791065099103013, 18.186719507478422]
Number of points in cluster 9 is 188743
Cluster 10
Centroid points:
[2.6574796780482757, 0.18843673440982579, 238.76604459331176, 11.34768784682288, 0.2289156626506024, 30.387791831225318, 0.35619657051442283]
Number of points in cluster 10 is 20003
Cluster 11
Centroid points:
[6.420158038147146, 0.3060136239782018, 234.6264850136242, 27.465395095367832, 71.54632152588556, 1.6403269754768393, 13.880108991825614]
Number of points in cluster 11 is 734
Cluster 12
Centroid points:
[5.920695118698297, 0.2401552413977064, 235.0371459055745, 25.299279807948874, 36.01013603627634, 33.027207255268074, 12.014403841024274]
Number of points in cluster 12 is 3749
Cluster 13
Centroid points:
[4.006128370554204, 0.23735616211745247, 235.72438709677365, 17.033846153846113, 37.86120760959471, 0.9644334160463193, 0.3296939619520265]
Number of points in cluster 13 is 6045
Cluster 14
Centroid points:
[4.192776351390268, 0.18763652063784403, 237.18881353980785, 17.719428933279602, 0.3917448621265327, 36.09602210580853, 17.55442979678775]
Number of points in cluster 14 is 17371
Cluster 15
Centroid points:
[3.8017532789790915, 0.23869984289259133, 237.25952499113757, 16.545196738745105, 29.107054236086494, 0.6898263027295285, 17.87699397376817]
Number of points in cluster 15 is 2821
Cluster 16
Centroid points:
[1.5175558071649693, 0.11999648385669894, 241.00577034499312, 6.278731092437112, 0.09747014595311089, 0.38596196373286157, 17.747253427686864]
Number of points in cluster 16 is 452200
Cluster 17
Centroid points:
[0.401804954110378, 0.10487987093253347, 243.46210418364586, 1.743073309915722, 0.022401396771767904, 0.3494350878800177, 0.422417877854575]
Number of points in cluster 17 is 776648
Cluster 18
Centroid points:
[2.0580432562330997, 0.24071973565635318, 239.02940823070045, 9.793391408831479, 17.48843496545509, 0.6097927305497146, 0.4728146590567738]
Number of points in cluster 18 is 3329
Loss: 12.521657964426531
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K=19

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Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[5.237602189327049, 0.2335039183978104, 234.5939300371685, 22.322975494464483, 37.91503918397811, 0.791640751337231, 17.368329394203258]
Number of points in cluster 1 is 8042
Cluster 2
Centroid points:
[3.2462527970310453, 0.19054080623042207, 238.16767614473557, 13.679823173061177, 37.75779075478906, 0.6123451399879932, 0.3921301096981935]
Number of points in cluster 2 is 18323
Cluster 3
Centroid points:
[5.925864355689529, 0.17587691534790256, 235.5117960311483, 25.218889726199468, 2.645566440592816, 69.54559155990957, 11.91183119819141]
Number of points in cluster 3 is 3981
Cluster 4
Centroid points:
[3.9506279475086923, 0.16907268812794626, 237.63094474062052, 16.586856674184958, 37.72898298134099, 0.5007176542956736, 17.729239286446585]
Number of points in cluster 4 is 19505
Cluster 5
Centroid points:
[3.75778661844485, 0.23810922242314625, 237.374502712477, 16.354936708860723, 29.163110307414104, 0.6839059674502712, 17.90235081374322]
Number of points in cluster 5 is 2764
Cluster 6
Centroid points:
[3.209990270055602, 0.20523054011119854, 238.57436556791052, 13.716064336775204, 0.3232724384432089, 22.16590548054011, 17.683379666401905]
Number of points in cluster 6 is 10072
Cluster 7
Centroid points:
[2.69939092558984, 0.25037749546279475, 238.90218140820324, 11.991280566243188, 10.18983666061706, 0.4827586206096552, 18.091833030852996]
Number of points in cluster 7 is 2755
Cluster 8
Centroid points:
[1.797949642067753, 0.15627638306996677, 239.39391053343513, 7.619082571834215, 0.15223666413749876, 0.5441559726849866, 0.3574786395275954]
Number of points in cluster 8 is 121254
Cluster 9
Centroid points:
[2.435315040349023, 0.15679482345963483, 237.00791180394933, 10.282701798233395, 0.16898417808654395, 0.4792324148010082, 18.19926185584479]
Number of points in cluster 9 is 188854
Cluster 10
Centroid points:
[2.6615168115796175, 0.1884195607377989, 238.7634095592306, 11.364336332110277, 0.22928079609991456, 30.469417500125648, 0.35638538473136655]
Number of points in cluster 10 is 19897
Cluster 11
Centroid points:
[6.413463414634153, 0.30597831978319806, 234.627508075881, 27.436585365853638, 71.46883468834689, 1.6314363143631436, 13.804878048780488]
Number of points in cluster 11 is 738
Cluster 12
Centroid points:
[5.914698353690896, 0.24027031332979323, 235.0393441317044, 25.273499734466363, 36.01938396176315, 32.96229421136484, 11.963621879978758]
Number of points in cluster 12 is 3766
Cluster 13
Centroid points:
[2.074494081942334, 0.23947374810318647, 239.04518664643456, 9.853657056145677, 18.327465857359634, 0.6267071320182094, 0.47678300455235206]
Number of points in cluster 13 is 3295
Cluster 14
Centroid points:
[4.192776351390268, 0.18763652063784403, 237.18881353980785, 17.719428933279602, 0.3917448621265327, 36.09602210580853, 17.55442979678775]
Number of points in cluster 14 is 17371
Cluster 15
Centroid points:
[4.31862121212121, 0.2875303030303032, 234.9047340484049, 18.9215909090909, 18.645833333333332, 1.0378787878787878, 17.62405303030303]
Number of points in cluster 15 is 1056
Cluster 16
Centroid points:
[0.3668544193665473, 0.11399245358574296, 239.47484927195146, 1.6413808597013397, 0.026605387695668, 0.39896796505270487, 0.42430833636694576]
Number of points in cluster 16 is 549400
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Cluster 17
Centroid points:
[0.39911321930496807, 0.10508983373143069, 243.94899500346094, 1.729191597341458, 0.02253973280734459, 0.34816277948387697, 0.41594858313669136]
Number of points in cluster 17 is 624229
Cluster 18
Centroid points:
[2.9097435432714085, 0.23958948799275054, 239.0964431354777, 12.977797915722702, 18.689623923878568, 0.5573176257362936, 18.024014499320344]
Number of points in cluster 18 is 2208
Cluster 19
Centroid points:
[1.5171337444551676, 0.11996168863940056, 241.0081467200406, 6.276872847365637, 0.09704009987338746, 0.3858716343642368, 17.74637870430217]
Number of points in cluster 19 is 451770
Loss: 12.421964426576531
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K=20

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Power plant data
K-means Clustering of Data
Cluster 1
Centroid points:
[5.240173139564035, 0.2330496116261586, 234.60368955149073, 22.33162114758206, 37.94713104485091, 0.794287146078677, 17.38524179403658]
Number of points in cluster 1 is 7982
Cluster 2
Centroid points:
[2.8750529364440824, 0.16860466613032918, 239.36260659694233, 12.05050683829444, 37.61238938053097, 0.4723250201126307, 0.43177795655671763]
Number of points in cluster 2 is 12430
Cluster 3
Centroid points:
[5.925571572074338, 0.17592265193370166, 235.51228026117562, 25.217780010045225, 2.6449020592667, 69.54093420391763, 11.908839779005525]
Number of points in cluster 3 is 3982
Cluster 4
Centroid points:
[3.9519235695104054, 0.16887360312332038, 237.64915719892676, 16.58950630035117, 37.75537079115885, 0.5006713488948564, 17.735488535426565]
Number of points in cluster 4 is 19364
Cluster 5
Centroid points:
[3.6300686985969977, 0.2620145137880987, 237.0731494920175, 15.970875665215342, 22.490082244799225, 0.8006773101112724, 17.810353160843736]
Number of points in cluster 5 is 2067
Cluster 6
Centroid points:
[3.2115833167825243, 0.2052129096325712, 238.55834061568964, 13.724111221449835, 0.33028798411122146, 22.204071499503474, 17.68311817279047]
Number of points in cluster 6 is 10070
Cluster 7
Centroid points:
[2.585016531294793, 0.2406003631151459, 238.9104204491158, 11.480172001911122, 8.933508150979455, 0.40877209746774963, 17.94839942660295]
Number of points in cluster 7 is 2093
Cluster 8
Centroid points:
[2.056042565947239, 0.24054976019184643, 239.03154076738664, 9.785311750599519, 17.461330935251798, 0.6106115107913669, 0.4661270983213429]
Number of points in cluster 8 is 3336
Cluster 9
Centroid points:
[1.476000568470931, 0.12823858403564597, 237.06837443703574, 6.20660981957018, 0.10426518715272175, 0.4233081369129627, 16.875850741205042]
Number of points in cluster 9 is 241764
Cluster 10
Centroid points:
[2.6574796780482757, 0.18843673448982579, 238.760604459331176, 11.34768784682288, 0.2289156626506024, 30.307791831225318, 0.35619657051442283]
Number of points in cluster 10 is 20003
Cluster 11
Centroid points:
[6.420158038147146, 0.3060136239782018, 234.6264850136242, 27.465395095367832, 71.54632152588556, 1.6403269754768393, 13.880108991825614]
Number of points in cluster 11 is 734
Cluster 12
Centroid points:
[5.921225186766253, 0.2400779082177165, 235.03651013874034, 25.301440768409908, 36.01307363927428, 33.03094983991462, 12.014674493062968]
Number of points in cluster 12 is 3748
Cluster 13
Centroid points:
[4.002037762006950, 0.23726357484733454, 235.7159465250208, 17.020300379600556, 37.854431424327444, 0.9565934972767783, 0.3209321670242614]
Number of points in cluster 13 is 6059
Cluster 14
Centroid points:
[4.193493775933631, 0.18762759336099522, 237.18701590594765, 17.722268326417705, 0.3919432918395574, 36.103331028123556, 17.55411479944675]
Number of points in cluster 14 is 17352
Cluster 15
Centroid points:
[3.8335124210526357, 0.2332446315789477, 237.09789894736026, 16.63637894736042, 30.442947360421052, 0.6846315789473604, 17.81642105263158]
Number of points in cluster 15 is 2375
Cluster 16
Centroid points:
[0.6050371175960202, 0.12658092756322983, 238.87215969742567, 2.9794053844100315, 0.05452799901097012, 0.44270677308083045, 0.38665273267797223]
Number of points in cluster 16 is 517679
Cluster 17
Centroid points:
[0.40198989718051037, 0.10489447063933061, 243.46433020500746, 1.7438605398557843, 0.022414341879923354, 0.34943641989069885, 0.4231534971347425]
Number of points in cluster 17 is 776021
Cluster 18
Centroid points:
[3.0197076602564007, 0.2404158653846154, 238.60146233974336, 13.453205120205107, 15.520833333333334, 0.5268429487179487, 18.134615384615383]
Number of points in cluster 18 is 2496
Cluster 19
Centroid points:
[1.58689825574178, 0.11483935733002924, 242.27376318654285, 6.526926254650367, 0.09997127771611745, 0.3758505873884352, 18.376042062280984]
Number of points in cluster 19 is 281974
Cluster 20
Centroid points:
[2.908048481452224, 0.17480161525594714, 237.9911875833103, 12.258986049907746, 0.18713331125771585, 0.48559565959397843, 18.679096937432607]
Number of points in cluster 20 is 117751
Loss: 12.1399964426576531
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