The result for Test Case Dataset:

```
Project3_K-Means_test case ×
E:\Anaconda3\python.exe "D:/Code/Algorithm/Project3_K-Means_test case.py"
After the 1th iteration, the loss is: 34.32880168555647
After the 2th iteration, the loss is: 30.96376193434194
After the 3th iteration, the loss is: 30.96376193434194
The coordinates of centroid 1: [ 0.06026253 -0.08038639]
100 points are assigned to centroid 1
The coordinates of centroid 2: [10.16808624 10.04671581]
100 points are assigned to centroid 2

Process finished with exit code 0

≡ TODO    ❶ Problems    ⊉ Terminal    🐍 Python Console
```

The result for Electric Power Consumption Dataset:
K=2:

```
Project3_K-Means_power consumption ×
E:\Anaconda3\python.exe "D:/Code/Algorithm/Project3_K-Means_power consumption.py"
After the 1th iteration, the loss is: 95.59632114807036
After the 2th iteration, the loss is: 95.44018926528467
After the 3th iteration, the loss is: 95.43570537012998
After the 4th iteration, the loss is: 95.43543279662046
After the 5th iteration, the loss is: 95.43541508883578
After the 6th iteration, the loss is: 95.43541442043103
After the 7th iteration, the loss is: 95.43541427773232
After the 8th iteration, the loss is: 95.43541426413451
After the 9th iteration, the loss is: 95.43541426062137
After the 10th iteration, the loss is: 95.43541426062137
The coordinates of centroid 1: [5.83699889e-01 1.15967353e-01 2.41537948e+02 2.52966457e+00
 5.54954328e-01 8.30905960e-01 4.19764151e-01]
1335600 points are assigned to centroid 1
The coordinates of centroid 2: [2.04214114e+00 1.38212653e-01 2.39533433e+02 8.55419039e+00
 2.18296435e+00 2.17362543e+00 1.77594020e+01]
713680 points are assigned to centroid 2

Process finished with exit code 0
```

K=3:

```
After the 19th iteration, the loss is: 59.924469617919236
After the 20th iteration, the loss is: 59.924469580809806
After the 21th iteration, the loss is: 59.924469580809806
The coordinates of centroid 1: [5.23983963e-01 1.14194861e-01 2.41614549e+02 2.27800324e+00
 5.71411901e-02 4.81562776e-01 4.13654063e-01]
1302528 points are assigned to centroid 1
The coordinates of centroid 2: [3.94879772e+00 1.95691510e-01 2.37295773e+02 1.67542555e+01
 2.17326465e+01 1.72460240e+01 1.10913647e+01]
96580 points are assigned to centroid 2
The coordinates of centroid 3: [1.80436284e+00 1.32093834e-01 2.39814331e+02 7.53383043e+00
 1.93438044e-01 5.66251700e-01 1.78801409e+01]
650172 points are assigned to centroid 3
```

K=4:

```
After the 11th iteration, the loss is: 30.338729469289166
After the 12th iteration, the loss is: 30.338729464554657
After the 13th iteration, the loss is: 30.338729464554657
The coordinates of centroid 1: [3.69322368e+00 1.91031844e-01 2.37738428e+02 1.56986838e+01
 8.42263927e-01 3.55243079e+01 1.05820312e+01]
47104 points are assigned to centroid 1
The coordinates of centroid 2: [3.99656027e+00 1.99093468e-01 2.37172909e+02 1.69480984e+01
 3.69419896e+01 2.44999010e+00 1.11539265e+01]
55559 points are assigned to centroid 2
The coordinates of centroid 3: [5.19987704e-01 1.13988751e-01 2.41619598e+02 2.26045282e+00
 5.81140587e-02 4.18780890e-01 4.13694591e-01]
1298980 points are assigned to centroid 3
The coordinates of centroid 4: [1.79971301e+00 1.31858890e-01 2.39816066e+02 7.51377917e+00
 2.03064371e-01 4.74937349e-01 1.78798138e+01]
647637 points are assigned to centroid 4
```

K=5:

```
After the 12th iteration, the loss is: 29.323820401137326
After the 13th iteration, the loss is: 29.323820401137326
The coordinates of centroid 1: [3.69379622e+00 1.91026577e-01 2.37737063e+02 1.57010983e+01
 8.42663211e-01 3.55362962e+01 1.05785303e+01]
47071 points are assigned to centroid 1
The coordinates of centroid 2: [3.99660253e+00 1.99058201e-01 2.37172636e+02 1.69481539e+01
 3.69454356e+01 2.45034114e+00 1.11527120e+01]
55549 points are assigned to centroid 2
The coordinates of centroid 3: [1.10639246e+00 2.59890573e-01 2.40697665e+02 4.81321205e+00
 7.79125322e-02 4.63294745e-01 1.09087192e+01]
43536 points are assigned to centroid 3
The coordinates of centroid 4: [1.83966644e+00 1.23512768e-01 2.39765653e+02 7.67174318e+00
 2.10946343e-01 4.76418304e-01 1.82503975e+01]
611364 points are assigned to centroid 4
The coordinates of centroid 5: [5.17335397e-01 1.13527629e-01 2.41623814e+02 2.24753793e+00
 5.79294915e-02 4.18617235e-01 3.75568991e-01]
1291760 points are assigned to centroid 5
```

K=6:

```
After the 48th iteration, the loss is: 25.05457969788218
After the 49th iteration, the loss is: 25.05457969788218
The coordinates of centroid 1: [1.79964772e+00 1.31770775e-01 2.39816154e+02 7.51313645e+00
 2.03009099e-01 4.76995105e-01 1.78903892e+01]
646971 points are assigned to centroid 1
The coordinates of centroid 2: [1.80093518e+00 1.59471460e-01 2.39404626e+02 7.65674013e+00
 4.04637704e-01 9.66362772e-01 3.78928175e-01]
126140 points are assigned to centroid 2
The coordinates of centroid 3: [3.71530311e+00 1.90649182e-01 2.37722580e+02 1.57888973e+01
 8.52811241e-01 3.57647566e+01 1.07065922e+01]
46403 points are assigned to centroid 3
The coordinates of centroid 4: [3.67006211e-01 1.13906636e-01 2.39467516e+02 1.64200367e+00
 2.63797058e-02 3.96184270e-01 4.25866225e-01]
548414 points are assigned to centroid 4
The coordinates of centroid 5: [3.99918099e-01 1.05166349e-01 2.43944907e+02 1.73267902e+00
 2.29425653e-02 3.47865329e-01 4.19990160e-01]
625998 points are assigned to centroid 5
The coordinates of centroid 6: [4.00178003e+00 1.98890595e-01 2.37169936e+02 1.69665860e+01
 3.70045706e+01 2.45517939e+00 1.11920367e+01]
55354 points are assigned to centroid 6
```

K=7:

```
After the 50th iteration, the loss is: 24.00885164711666
The coordinates of centroid 1: [1.79972053e+00 1.31763203e-01 2.39816320e+02 7.51342565e+00
 2.03029404e-01 4.77153492e-01 1.78909566e+01]
646926 points are assigned to centroid 1
The coordinates of centroid 2: [4.00179958e+00 1.98887576e-01 2.37169896e+02 1.69666540e+01
 3.70048778e+01 2.45520568e+00 1.11922208e+01]
55353 points are assigned to centroid 2
The coordinates of centroid 3: [4.15402516e-01 9.96305644e-02 2.45102066e+02 1.77942033e+00
 2.18976655e-02 3.21656845e-01 3.66015979e-01]
352960 points are assigned to centroid 3
The coordinates of centroid 4: [3.70237210e-01 1.14588602e-01 2.41361458e+02 1.64277725e+00
 2.42320897e-02 3.97519441e-01 4.95109996e-01]
653885 points are assigned to centroid 4
The coordinates of centroid 5: [1.82991902e+00 1.60858021e-01 2.39623982e+02 7.77484472e+00
 4.17070490e-01 9.90341543e-01 3.81200979e-01]
120102 points are assigned to centroid 5
The coordinates of centroid 6: [3.71573601e+00 1.90649996e-01 2.37720867e+02 1.57907433e+01
 8.53000776e-01 3.57698112e+01 1.07080279e+01]
46388 points are assigned to centroid 6
The coordinates of centroid 7: [4.05213007e-01 1.09514367e-01 2.36869906e+02 1.81533518e+00
 3.58446673e-02 3.72836364e-01 2.65325395e-01]
173666 points are assigned to centroid 7
```

K=8:

```
After the 19th iteration, the loss is: 23.544284115178893
After the 20th iteration, the loss is: 23.544239054705766
The coordinates of centroid 1: [3.87418428e-01 1.09728295e-01 2.42866989e+02 1.69603501e+00
 2.41978141e-02 3.66366079e-01 4.62726104e-01]
470745 points are assigned to centroid 1
The coordinates of centroid 2: [3.71745919e-01 1.16910335e-01 2.40201595e+02 1.65997943e+00
 2.61969550e-02 4.13101152e-01 4.90140578e-01]
411231 points are assigned to centroid 2
The coordinates of centroid 3: [1.79974043e+00 1.31764203e-01 2.39816311e+02 7.51351247e+00
 2.03058797e-01 4.77215920e-01 1.78910408e+01]
646921 points are assigned to centroid 3
The coordinates of centroid 4: [4.26381528e-01 9.52528685e-02 2.46197404e+02 1.80993736e+00
 2.01425799e-02 3.06072302e-01 3.22887666e-01]
189648 points are assigned to centroid 4
The coordinates of centroid 5: [4.15559433e-01 1.05220678e-01 2.35867578e+02 1.86221780e+00
 3.85735667e-02 3.57226718e-01 1.79639538e-01]
111579 points are assigned to centroid 5
The coordinates of centroid 6: [3.71583615e+00 1.90647737e-01 2.37721039e+02 1.57911174e+01
 8.53092728e-01 3.57715974e+01 1.07084492e+01]
46383 points are assigned to centroid 6
The coordinates of centroid 7: [1.84292752e+00 1.60937329e-01 2.39621380e+02 7.82897899e+00
 4.22770667e-01 9.96108088e-01 3.76578694e-01]
117423 points are assigned to centroid 7
The coordinates of centroid 8: [4.00185070e+00 1.98877687e-01 2.37169708e+02 1.69668220e+01
 3.70058175e+01 2.45528455e+00 1.11924481e+01]
55350 points are assigned to centroid 8
```

K=9:

```
After the 19th iteration, the loss is: 18.685728100167573
After the 20th iteration, the loss is: 18.61678912338229
The coordinates of centroid 1: [3.92140006e+00 1.97561214e-01 2.37262130e+02 1.66202629e+01
 3.70510416e+01 1.25687712e+00 1.11210598e+01]
53329 points are assigned to centroid 1
The coordinates of centroid 2: [1.63080687e+00 1.56560773e-01 2.38609280e+02 6.95292687e+00
 3.52911407e-01 5.47515956e-01 3.66378947e-01]
142268 points are assigned to centroid 2
The coordinates of centroid 3: [3.51428643e-01 1.12175935e-01 2.40135522e+02 1.57030083e+00
 2.34399944e-02 3.90391381e-01 4.39118655e-01]
657722 points are assigned to centroid 3
The coordinates of centroid 4: [6.01614822e+00 1.95818182e-01 2.35232522e+02 2.56339457e+01
 1.45760716e+01 5.76245878e+01 1.20986026e+01]
6369 points are assigned to centroid 4
The coordinates of centroid 5: [3.88153080e+00 1.94768320e-01 2.37643304e+02 1.64538310e+01
 4.67114247e-01 3.15841299e+01 1.76176225e+01]
26364 points are assigned to centroid 5
The coordinates of centroid 6: [2.66454043e+00 1.89053273e-01 2.38768826e+02 1.13791504e+01
 2.99850075e-01 3.04228886e+01 3.84557721e-01]
20010 points are assigned to centroid 6
The coordinates of centroid 7: [2.48527927e+00 1.60913258e-01 2.37048977e+02 1.05105983e+01
 4.61998960e-01 5.48049971e-01 1.82211087e+01]
186587 points are assigned to centroid 7
The coordinates of centroid 8: [1.51812139e+00 1.19929055e-01 2.40942895e+02 6.28328326e+00
 1.04044797e-01 3.90913620e-01 1.77430304e+01]
459677 points are assigned to centroid 8
The coordinates of centroid 9: [4.20991206e-01 1.03868261e-01 2.44447410e+02 1.81317023e+00
 2.50224367e-02 3.39930859e-01 3.94489228e-01]
496954 points are assigned to centroid 9
```

K=10:

```
After the 19th iteration, the loss is: 22.337850703002296
After the 20th iteration, the loss is: 22.337810072441954
The coordinates of centroid 1: [4.19441078e-01 1.04182439e-01 2.35316397e+02 1.88212896e+00
 3.89042947e-02 3.52806842e-01 1.27909957e-01]
85826 points are assigned to centroid 1
The coordinates of centroid 2: [3.71635217e+00 1.90623754e-01 2.37720297e+02 1.57932611e+01
 8.53423357e-01 3.57805988e+01 1.07085293e+01]
46358 points are assigned to centroid 2
The coordinates of centroid 3: [1.85358499e+00 1.60494041e-01 2.39619497e+02 7.87158636e+00
 4.26994840e-01 1.00808501e+00 2.99040451e-01]
114533 points are assigned to centroid 3
The coordinates of centroid 4: [4.13087951e-01 1.06209538e-01 2.43816368e+02 1.78752226e+00
 2.58453057e-02 3.48276036e-01 3.90234540e-01]
317814 points are assigned to centroid 4
The coordinates of centroid 5: [3.59009407e-01 1.11728783e-01 2.41601439e+02 1.59038107e+00
 2.26539209e-02 3.88280129e-01 4.56414221e-01]
406199 points are assigned to centroid 5
The coordinates of centroid 6: [1.07983788e+00 2.62053978e-01 2.40746861e+02 4.69614243e+00
 7.12166172e-02 4.60388112e-01 1.10524704e+01]
42462 points are assigned to centroid 6
The coordinates of centroid 7: [3.87814094e-01 1.18520571e-01 2.39322923e+02 1.73217588e+00
 3.08195739e-02 4.21369588e-01 4.04594992e-01]
246921 points are assigned to centroid 7
The coordinates of centroid 8: [4.00184077e+00 1.98854427e-01 2.37169925e+02 1.69666498e+01
 3.70093422e+01 2.45565595e+00 1.11913263e+01]
55340 points are assigned to centroid 8
The coordinates of centroid 9: [1.83983135e+00 1.23539283e-01 2.39765407e+02 7.67248216e+00
 2.11185925e-01 4.78577865e-01 1.82502277e+01]
611447 points are assigned to centroid 9
The coordinates of centroid 10: [4.19181745e-01 9.22647491e-02 2.46900415e+02 1.77201340e+00
 1.67674457e-02 2.94606962e-01 2.98316718e-01]
122380 points are assigned to centroid 10
```

K=11:

```
 After the 18th iteration, the loss is: 20.69602620343703
 After the 19th iteration, the loss is: 20.69602607157897
 After the 20th iteration, the loss is: 20.696026002756323
 The coordinates of centroid 1: [3.99584783e+00 1.98683663e-01 2.37175354e+02 1.69409824e+01
  3.70163131e+01 2.31466730e+00 1.12111633e+01]
 55109 points are assigned to centroid 1
 The coordinates of centroid 2: [3.44813743e+00 1.85394110e-01 2.37939379e+02 1.46915410e+01
  1.28260767e+00 3.97726739e+01 2.62495890e+00]
 21291 points are assigned to centroid 2
 The coordinates of centroid 3: [1.83699339e+00 1.23342436e-01 2.39767298e+02 7.66016231e+00
  2.10913915e-01 4.33331092e-01 1.82505694e+01]
 609827 points are assigned to centroid 3
 The coordinates of centroid 4: [1.07922954e+00 2.62036942e-01 2.40747348e+02 4.69358935e+00
  7.11744611e-02 4.52939098e-01 1.10519731e+01]
 42445 points are assigned to centroid 4
 The coordinates of centroid 5: [1.85439886e+00 1.60647341e-01 2.39617325e+02 7.87561588e+00
  4.26800544e-01 1.03938691e+00 2.99488799e-01]
 114632 points are assigned to centroid 5
 The coordinates of centroid 6: [3.59662715e-01 1.11551815e-01 2.41668523e+02 1.59241167e+00
  2.25958226e-02 3.87367817e-01 4.55873663e-01]
 407863 points are assigned to centroid 6
```

```
The coordinates of centroid 7: [3.86110474e-01 1.18427425e-01 2.39387996e+02 1.72455919e+00
 3.05337259e-02 4.20557321e-01 4.07901562e-01]
256405 points are assigned to centroid 7
The coordinates of centroid 8: [3.90411746e+00 1.95605858e-01 2.37604550e+02 1.65561923e+01
 7.80961632e-01 3.15851608e+01 1.76153846e+01]
26767 points are assigned to centroid 8
The coordinates of centroid 9: [4.15114239e-01 1.06000142e-01 2.43883022e+02 1.79493904e+00
 2.60130000e-02 3.46926236e-01 3.87148724e-01]
309230 points are assigned to centroid 9
The coordinates of centroid 10: [4.18695068e-01 9.19977132e-02 2.46955734e+02 1.76943143e+00
 1.63717826e-02 2.93387765e-01 2.97622577e-01]
118069 points are assigned to centroid 10
The coordinates of centroid 11: [4.19637936e-01 1.04225828e-01 2.35358402e+02 1.88255174e+00
 3.88170055e-02 3.52080053e-01 1.30416923e-01]
87642 points are assigned to centroid 11
```

K=12:

```
After the 17th iteration, the loss is: 19.167532186322145
After the 18th iteration, the loss is: 19.166459382733933
After the 19th iteration, the loss is: 19.165751471226763
After the 20th iteration, the loss is: 19.1652442109456
The coordinates of centroid 1: [3.52168913e-01 1.06957045e-01 2.42952496e+02 1.54788204e+00
 1.91851614e-02 3.57586202e-01 4.45008109e-01]
442738 points are assigned to centroid 1
The coordinates of centroid 2: [1.47699380e+00 1.28896038e-01 2.39727704e+02 6.15796149e+00
 9.98359049e-02 4.09677663e-01 1.71619551e+01]
278497 points are assigned to centroid 2
The coordinates of centroid 3: [1.33984581e+00 1.54085684e-01 2.41388633e+02 5.67460331e+00
 1.98956187e-01 5.19891956e-01 5.47076867e-01]
109215 points are assigned to centroid 3
The coordinates of centroid 4: [2.99515961e+00 1.77712634e-01 2.38134369e+02 1.26508063e+01
 6.94459367e-01 9.17058957e-01 1.82575279e+01]
109825 points are assigned to centroid 4
The coordinates of centroid 5: [4.00400109e+00 1.98523102e-01 2.37171583e+02 1.69723029e+01
 3.71007265e+01 2.46307664e+00 1.11693244e+01]
55060 points are assigned to centroid 5
The coordinates of centroid 6: [3.72732411e+00 1.89905092e-01 2.37718650e+02 1.58375378e+01
 8.61278014e-01 3.60544713e+01 1.06887637e+01]
45602 points are assigned to centroid 6
The coordinates of centroid 7: [4.04312484e-01 9.41867166e-02 2.46309987e+02 1.71845260e+00
 1.71661366e-02 3.00973525e-01 3.15579250e-01]
175753 points are assigned to centroid 7
The coordinates of centroid 8: [3.42468634e-01 1.14469319e-01 2.40264318e+02 1.53537479e+00
 2.20230328e-02 4.05043193e-01 4.63329678e-01]
403078 points are assigned to centroid 8
```

```
The coordinates of centroid 9: [2.23120228e+00 1.71496791e-01 2.37995506e+02 9.52541448e+00
 6.45345227e-01 1.70014490e+00 2.73866652e-01]
53139 points are assigned to centroid 9
The coordinates of centroid 10: [4.17227170e-01 1.05774367e-01 2.35975568e+02 1.86777112e+00
 3.74587772e-02 3.51045462e-01 1.78272355e-01]
115834 points are assigned to centroid 10
The coordinates of centroid 11: [1.60557992e+00 1.15327566e-01 2.35045337e+02 6.81776766e+00
 1.37620945e-01 4.38158477e-01 1.70802378e+01]
79065 points are assigned to centroid 11
The coordinates of centroid 12: [1.65930509e+00 1.16603646e-01 2.43039768e+02 6.80528010e+00
 1.17868124e-01 3.83195389e-01 1.90849598e+01]
181474 points are assigned to centroid 12
```

K=13:

```
After the 18th iteration, the loss is: 18.672322366150038
After the 19th iteration, the loss is: 18.672224222246147
After the 20th iteration, the loss is: 18.67215331122272
The coordinates of centroid 1: [4.13082046e-01 9.25480674e-02 2.46960420e+02 1.74675571e+00
 1.55647665e-02 2.95670863e-01 2.98195340e-01]
117252 points are assigned to centroid 1
The coordinates of centroid 2: [1.06356925e+00 2.62410523e-01 2.40801116e+02 4.62649767e+00
 6.45701303e-02 4.52564869e-01 1.10223365e+01]
41815 points are assigned to centroid 2
The coordinates of centroid 3: [3.69740609e-01 1.03369133e-01 2.43873954e+02 1.60743632e+00
 2.03942171e-02 3.38561338e-01 3.90176908e-01]
299987 points are assigned to centroid 3
The coordinates of centroid 4: [3.37663898e-01 1.10600054e-01 2.41643217e+02 1.50120642e+00
 1.93384484e-02 3.85201261e-01 4.55495270e-01]
391655 points are assigned to centroid 4
The coordinates of centroid 5: [3.01763254e+00 1.77674555e-01 2.37947770e+02 1.27548865e+01
 7.08557194e-01 9.44711941e-01 1.81507501e+01]
107582 points are assigned to centroid 5
The coordinates of centroid 6: [4.00406383e+00 1.98510117e-01 2.37171709e+02 1.69724816e+01
 3.71026447e+01 2.46298180e+00 1.11693610e+01]
55054 points are assigned to centroid 6
The coordinates of centroid 7: [1.39607795e+00 1.50810498e-01 2.41314773e+02 5.89956449e+00
 2.17513801e-01 4.79962944e-01 3.63742288e-01]
104706 points are assigned to centroid 7
The coordinates of centroid 8: [1.55860656e+00 1.12016818e-01 2.37546008e+02 6.53896179e+00
 1.18571267e-01 4.17725366e-01 1.76631772e+01]
220475 points are assigned to centroid 8
```

```
The coordinates of centroid 9: [3.63484881e-01 1.17046173e-01 2.39355935e+02 1.62976307e+00
 2.71583575e-02 4.18832474e-01 4.05763821e-01]
243866 points are assigned to centroid 9
The coordinates of centroid 10: [3.72844425e+00 1.89850936e-01 2.37718066e+02 1.58420144e+01
 8.61627626e-01 3.60719633e+01 1.06970209e+01]
45551 points are assigned to centroid 10
The coordinates of centroid 11: [2.26637399e+00 1.73328939e-01 2.37875448e+02 9.68253430e+00
 6.63105472e-01 1.88307985e+00 2.43883286e-01]
48392 points are assigned to centroid 11
The coordinates of centroid 12: [4.21649690e-01 1.04306133e-01 2.35399813e+02 1.88948115e+00
 3.77643333e-02 3.40310333e-01 1.31840316e-01]
88099 points are assigned to centroid 12
The coordinates of centroid 13: [1.61757736e+00 1.12606412e-01 2.42158136e+02 6.65294019e+00
 1.11769166e-01 3.82891106e-01 1.87267611e+01]
284846 points are assigned to centroid 13
```

K=14:

```
After the 17th iteration, the loss is: 18.37368946186427
After the 18th iteration, the loss is: 18.372532474852942
After the 19th iteration, the loss is: 18.37158773957357
After the 20th iteration, the loss is: 18.37082213653023
The coordinates of centroid 1: [2.88774115e+00 1.94884022e-01 2.38661275e+02 1.23278156e+01
 2.91670777e-01 2.83248167e+01 6.32353425e+00]
30411 points are assigned to centroid 1
The coordinates of centroid 2: [3.64149028e-01 1.03878244e-01 2.43949175e+02 1.58475447e+00
 1.94101415e-02 3.41209304e-01 3.86709474e-01]
285933 points are assigned to centroid 2
The coordinates of centroid 3: [3.19001495e-01 1.06617281e-01 2.39261404e+02 1.43345071e+00
 2.09616444e-02 3.36640307e-01 3.72062246e-01]
216109 points are assigned to centroid 3
The coordinates of centroid 4: [6.26002243e-01 1.93583624e-01 2.41156656e+02 2.80470708e+00
 6.18278052e-02 1.05072575e+00 9.36679549e-01]
123941 points are assigned to centroid 4
The coordinates of centroid 5: [3.93970084e+00 1.97765914e-01 2.37245114e+02 1.66959004e+01
 3.70944954e+01 1.55187835e+00 1.10845259e+01]
53664 points are assigned to centroid 5
The coordinates of centroid 6: [1.48747954e+00 1.45138303e-01 2.42835365e+02 6.24097277e+00
 2.13941867e-01 4.19355376e-01 3.67602232e-01]
60035 points are assigned to centroid 6
The coordinates of centroid 7: [1.42286845e+00 1.52106248e-01 2.38343496e+02 6.06975786e+00
 1.69642857e-01 5.25460005e-01 4.00875288e-01]
62608 points are assigned to centroid 7
The coordinates of centroid 8: [2.49082729e+00 1.61233122e-01 2.37052806e+02 1.05341363e+01
 4.63941273e-01 5.67704297e-01 1.82361470e+01]
185808 points are assigned to centroid 8
The coordinates of centroid 9: [4.74601127e+00 1.88281384e-01 2.36578346e+02 2.01112045e+01
 3.91905004e+00 4.28283972e+01 1.61934575e+01]
21643 points are assigned to centroid 9
```

```
The coordinates of centroid 10: [2.89859088e-01 8.96295859e-02 2.41729479e+02 1.27830393e+00
 1.23541939e-02 2.18509511e-01 4.08329703e-01]
330576 points are assigned to centroid 10
The coordinates of centroid 11: [3.91497205e-01 9.15231100e-02 2.47035710e+02 1.65807269e+00
 1.29524774e-02 2.83905280e-01 3.07042457e-01]
110558 points are assigned to centroid 11
The coordinates of centroid 12: [3.59882701e-01 1.01911814e-01 2.35237089e+02 1.63104704e+00
 3.17293387e-02 3.38852409e-01 1.33381214e-01]
77972 points are assigned to centroid 12
The coordinates of centroid 13: [2.59064681e+00 1.72899243e-01 2.38118939e+02 1.10537214e+01
 1.05506800e+00 5.17652576e-01 2.70047565e-01]
29854 points are assigned to centroid 13
The coordinates of centroid 14: [1.51838917e+00 1.19791307e-01 2.40934059e+02 6.28427400e+00
 1.04105457e-01 3.90798578e-01 1.77489395e+01]
460168 points are assigned to centroid 14
```

K=15:

```
After the 18th iteration, the loss is: 16.358088024881233
After the 19th iteration, the loss is: 16.356529499449053
After the 20th iteration, the loss is: 16.35533692878398
The coordinates of centroid 1: [4.61803496e+00 1.84996799e-01 2.36749870e+02 1.95540946e+01
 1.48155808e+00 4.32565125e+01 1.63673118e+01]
20307 points are assigned to centroid 1
The coordinates of centroid 2: [2.89038674e+00 1.95186506e-01 2.38648938e+02 1.23410906e+01
 3.53568363e-01 2.83125371e+01 6.24463590e+00]
30294 points are assigned to centroid 2
The coordinates of centroid 3: [3.89955998e-01 9.20298344e-02 2.46993611e+02 1.65281627e+00
 1.33822634e-02 2.89346236e-01 3.07977311e-01]
113359 points are assigned to centroid 3
The coordinates of centroid 4: [1.51838604e+00 1.19824931e-01 2.40947605e+02 6.28391677e+00
 1.04360810e-01 3.90615702e-01 1.77513041e+01]
458745 points are assigned to centroid 4
The coordinates of centroid 5: [1.34019330e+00 1.52845101e-01 2.38818136e+02 5.72187928e+00
 1.88390113e-01 5.22921086e-01 4.87525793e-01]
69303 points are assigned to centroid 5
The coordinates of centroid 6: [3.34056923e-01 1.12426503e-01 2.39224388e+02 1.50376891e+00
 2.33604551e-02 3.75147460e-01 3.91947404e-01]
214465 points are assigned to centroid 6
The coordinates of centroid 7: [1.49007844e+00 1.44320266e-01 2.43025122e+02 6.24967168e+00
 2.42937146e-01 3.91726754e-01 3.66624322e-01]
55891 points are assigned to centroid 7
The coordinates of centroid 8: [3.72291758e-01 1.02349629e-01 2.35205550e+02 1.68419503e+00
 3.28128999e-02 3.39992321e-01 1.32889685e-01]
78140 points are assigned to centroid 8
The coordinates of centroid 9: [2.48252010e+00 1.60716081e-01 2.37048873e+02 1.04983806e+01
 4.48345893e-01 5.67762279e-01 1.82254022e+01]
187110 points are assigned to centroid 9
```

```
The coordinates of centroid 10: [2.50982256e+00 1.71484307e-01 2.37952496e+02 1.06908134e+01
 6.49729634e-01 5.19924768e-01 2.66750911e-01]
34028 points are assigned to centroid 10
The coordinates of centroid 11: [3.53508339e-01 9.90829369e-02 2.43899950e+02 1.53605943e+00
 1.79006421e-02 2.92210830e-01 3.78838018e-01]
288593 points are assigned to centroid 11
The coordinates of centroid 12: [5.59008063e-01 1.94572368e-01 2.41647107e+02 2.51849653e+00
 4.92773133e-02 1.18400879e+00 8.30855888e-01]
141140 points are assigned to centroid 12
The coordinates of centroid 13: [3.30338240e+00 1.96705024e-01 2.38066979e+02 1.39982076e+01
 3.70153971e+01 2.18147583e+00 3.97321003e-01]
20978 points are assigned to centroid 13
The coordinates of centroid 14: [2.82316259e-01 8.15706101e-02 2.41570000e+02 1.23981053e+00
 1.23709158e-02 1.21449977e-01 4.04399944e-01]
302322 points are assigned to centroid 14
The coordinates of centroid 15: [4.40850906e+00 2.00430805e-01 2.36651857e+02 1.87032799e+01
 3.68839474e+01 2.59858402e+00 1.76345326e+01]
34605 points are assigned to centroid 15
```

K=16:

```
After the 18th iteration, the loss is: 17.88457405950045
After the 19th iteration, the loss is: 17.857706657501105
After the 20th iteration, the loss is: 17.823712949291508
The coordinates of centroid 1: [1.42308583e+00 1.48249942e-01 2.41251089e+02 6.00714870e+00
 2.17124981e-01 3.70301226e-01 3.50986427e-01]
99095 points are assigned to centroid 1
The coordinates of centroid 2: [1.06795970e+00 2.63491534e-01 2.40800699e+02 4.64069182e+00
 4.90324141e-02 4.54305757e-01 1.10800435e+01]
41340 points are assigned to centroid 2
The coordinates of centroid 3: [5.87396631e-01 2.07395728e-01 2.42029086e+02 2.64261589e+00
 5.31056984e-02 3.32940718e+00 4.65700860e-01]
48733 points are assigned to centroid 3
The coordinates of centroid 4: [3.73227739e+00 1.89967052e-01 2.37703116e+02 1.58579158e+01
 8.47820349e-01 3.60926626e+01 1.07095412e+01]
45466 points are assigned to centroid 4
The coordinates of centroid 5: [4.15990381e-01 9.20370822e-02 2.47324638e+02 1.75549269e+00
 1.40472667e-02 2.77147893e-01 2.96233026e-01]
91904 points are assigned to centroid 5
The coordinates of centroid 6: [4.19117624e-01 1.04787549e-01 2.35396012e+02 1.87945296e+00
 3.79262989e-02 3.48809796e-01 1.36655985e-01]
87380 points are assigned to centroid 6
The coordinates of centroid 7: [3.25900832e-01 9.63217209e-02 2.42243352e+02 1.43240856e+00
 1.66820652e-02 1.93526816e-01 3.93233491e-01]
309554 points are assigned to centroid 7
The coordinates of centroid 8: [1.61664785e+00 1.12475719e-01 2.42184126e+02 6.64827968e+00
 1.11178228e-01 3.82164722e-01 1.87276810e+01]
281431 points are assigned to centroid 8
The coordinates of centroid 9: [4.06226822e+00 1.95014762e-01 2.37125350e+02 1.71711331e+01
 3.80653045e+01 2.60089940e+00 1.10752957e+01]
51145 points are assigned to centroid 9
```

```
The coordinates of centroid 10: [3.53281248e-01 1.09944651e-01 2.38997802e+02 1.58002397e+00
 2.68653720e-02 3.63946080e-01 2.87412245e-01]
169363 points are assigned to centroid 10
The coordinates of centroid 11: [  2.99536595   0.24674309 238.19551296  13.40625532  19.96166
    0.72094438  12.82597055]
8217 points are assigned to centroid 11
The coordinates of centroid 12: [2.31176804e+00 1.67470812e-01 2.37647678e+02 9.83655276e+00
 2.64911168e-01 7.72276106e-01 2.25639050e-01]
44128 points are assigned to centroid 12
The coordinates of centroid 13: [3.00594093e+00 1.75170894e-01 2.37941045e+02 1.26842911e+01
 2.78829426e-01 9.47903443e-01 1.81695207e+01]
106341 points are assigned to centroid 13
The coordinates of centroid 14: [1.55425175e+00 1.11867246e-01 2.37577084e+02 6.51961682e+00
 1.21697578e-01 4.17215381e-01 1.76665961e+01]
222034 points are assigned to centroid 14
The coordinates of centroid 15: [3.59238034e-01 1.21423746e-01 2.40656930e+02 1.61270422e+00
 2.32994891e-02 3.96036807e-01 6.27505488e-01]
201807 points are assigned to centroid 15
The coordinates of centroid 16: [3.78519437e-01 9.99808073e-02 2.44347875e+02 1.63558187e+00
 2.03445733e-02 2.93686967e-01 3.70523987e-01]
241342 points are assigned to centroid 16
```

K=17:

```
After the 19th iteration, the loss is: 15.860456893909568
After the 20th iteration, the loss is: 15.857304139828338
The coordinates of centroid 1: [3.24930682e-01 1.10854368e-01 2.40846456e+02 1.45421468e+00
 1.84998383e-02 3.88105399e-01 4.51302942e-01]
309300 points are assigned to centroid 1
The coordinates of centroid 2: [1.56982002e+00 1.13205412e-01 2.39541479e+02 6.52927930e+00
 1.12882300e-01 4.15000111e-01 1.81069188e+01]
271318 points are assigned to centroid 2
The coordinates of centroid 3: [3.04172272e+00 1.77961741e-01 2.38079106e+02 1.28495880e+01
 7.28393122e-01 6.49792303e-01 1.81994776e+01]
101831 points are assigned to centroid 3
The coordinates of centroid 4: [3.72481300e-01 9.75716668e-02 2.44696646e+02 1.60527738e+00
 1.96609139e-02 3.10869510e-01 3.44291543e-01]
197295 points are assigned to centroid 4
The coordinates of centroid 5: [3.34083532e-01 1.10943959e-01 2.38657603e+02 1.50580003e+00
 2.58245530e-02 3.85675537e-01 3.51847039e-01]
150051 points are assigned to centroid 5
The coordinates of centroid 6: [2.37185497e+00 1.69731978e-01 2.37647243e+02 1.01237688e+01
 7.52100206e-01 5.16801650e-01 2.27425927e-01]
39758 points are assigned to centroid 6
The coordinates of centroid 7: [1.19761676e+00 1.56274606e-01 2.39588398e+02 5.11658061e+00
 1.52594629e-01 6.28270371e-01 4.04677885e-01]
80763 points are assigned to centroid 7
The coordinates of centroid 8: [3.95485206e-01 9.08618353e-02 2.47564294e+02 1.67033157e+00
 1.11214567e-02 2.82976412e-01 2.97731740e-01]
77328 points are assigned to centroid 8
The coordinates of centroid 9: [3.94000190e+00 1.97737043e-01 2.37242327e+02 1.66967681e+01
 3.71142276e+01 1.56132858e+00 1.10688723e+01]
53621 points are assigned to centroid 9
The coordinates of centroid 10: [3.60103273e-01 1.11237830e-01 2.42674323e+02 1.58689338e+00
 2.09555237e-02 3.80854056e-01 4.47277080e-01]
315764 points are assigned to centroid 10
The coordinates of centroid 11: [1.06106493e+00 2.62906213e-01 2.40839192e+02 4.61543733e+00
 6.42297020e-02 4.44902883e-01 1.10246592e+01]
41445 points are assigned to centroid 11
The coordinates of centroid 12: [1.60333456e+00 1.11642767e-01 2.34798435e+02 6.81127527e+00
 1.35520343e-01 4.31908535e-01 1.70993741e+01]
70934 points are assigned to centroid 12
The coordinates of centroid 13: [1.64304338e+00 1.12543596e-01 2.43239639e+02 6.72856631e+00
 1.14970131e-01 3.73805257e-01 1.89689725e+01]
167400 points are assigned to centroid 13
The coordinates of centroid 14: [1.57148773e+00 1.47631360e-01 2.43038412e+02 6.58775239e+00
 2.74896894e-01 4.69517797e-01 3.05584332e-01]
51161 points are assigned to centroid 14
The coordinates of centroid 15: [3.95869830e-01 1.03806173e-01 2.34959445e+02 1.78626227e+00
 3.45245131e-02 3.47551571e-01 1.14961583e-01]
69371 points are assigned to centroid 15
The coordinates of centroid 16: [2.88086057e+00 1.94635711e-01 2.38662818e+02 1.22991163e+01
 2.89889128e-01 2.83516134e+01 6.23461857e+00]
30215 points are assigned to centroid 16
The coordinates of centroid 17: [4.74132723e+00 1.88282255e-01 2.36587834e+02 2.00913418e+01
 3.88101266e+00 4.27822325e+01 1.62075489e+01]
21725 points are assigned to centroid 17
```

K=18:

```
After the 18th iteration, the loss is: 16.167256584917947
After the 19th iteration, the loss is: 16.16561903826709
After the 20th iteration, the loss is: 16.16436408608049
The coordinates of centroid 1: [1.49071284e+00 1.42910240e-01 2.42989687e+02 6.24785426e+00
 2.18253612e-01 3.69236292e-01 3.20739478e-01]
55715 points are assigned to centroid 1
The coordinates of centroid 2: [2.88259047e+00 1.94646341e-01 2.38661699e+02 1.23063759e+01
 2.92716066e-01 2.83681071e+01 6.23465668e+00]
30176 points are assigned to centroid 2
The coordinates of centroid 3: [1.36964525e+00 1.51995385e-01 2.38827293e+02 5.83668954e+00
 1.71522577e-01 5.10026947e-01 3.56444193e-01]
67169 points are assigned to centroid 3
The coordinates of centroid 4: [1.61740000e+00 1.12608966e-01 2.42170458e+02 6.65189009e+00
 1.11759950e-01 3.83048358e-01 1.87277019e+01]
283241 points are assigned to centroid 4
The coordinates of centroid 5: [3.94072518e+00 1.97746252e-01 2.37241758e+02 1.66997688e+01
 3.71154434e+01 1.56890057e+00 1.10709331e+01]
53628 points are assigned to centroid 5
The coordinates of centroid 6: [3.16595553e-01 8.91390077e-02 2.42781246e+02 1.38271735e+00
 1.43261082e-02 1.65429102e-01 4.24921100e-01]
249684 points are assigned to centroid 6
The coordinates of centroid 7: [1.55704541e+00 1.12102424e-01 2.37561553e+02 6.53199140e+00
 1.18484504e-01 4.24261306e-01 1.76647071e+01]
221472 points are assigned to centroid 7
The coordinates of centroid 8: [5.54604312e-01 2.00133456e-01 2.41721650e+02 2.49584441e+00
 5.09405362e-02 1.36591871e+00 5.33865103e-01]
120729 points are assigned to centroid 8
The coordinates of centroid 9: [3.56146495e-01 1.21169557e-01 2.39247324e+02 1.60587745e+00
 2.64578565e-02 4.33376455e-01 4.13200318e-01]
160784 points are assigned to centroid 9
```

```
 The coordinates of centroid 10: [3.93315492e-01 9.06798416e-02 2.47527630e+02 1.66162286e+00
  1.12747818e-02 2.80810170e-01 2.97192655e-01]
 79292 points are assigned to centroid 10
 The coordinates of centroid 11: [2.53379787e+00 1.72406407e-01 2.37989230e+02 1.08101956e+01
  9.55952564e-01 5.17572771e-01 2.22916988e-01]
 32465 points are assigned to centroid 11
 The coordinates of centroid 12: [3.01563181e+00 1.76686493e-01 2.37933726e+02 1.27452546e+01
  7.10266767e-01 6.53456697e-01 1.81673305e+01]
 106460 points are assigned to centroid 12
 The coordinates of centroid 13: [3.24103110e-01 9.68833677e-02 2.36620691e+02 1.46140889e+00
  2.49015569e-02 3.07226636e-01 1.44588781e-01]
 71361 points are assigned to centroid 13
 The coordinates of centroid 14: [3.74356564e-01 1.00708503e-01 2.44689590e+02 1.61652707e+00
  1.96314353e-02 3.29984166e-01 3.47896744e-01]
 191988 points are assigned to centroid 14
 The coordinates of centroid 15: [1.06340182e+00 2.62646292e-01 2.40800543e+02 4.62488656e+00
  6.37889228e-02 4.42513144e-01 1.10400211e+01]
 41653 points are assigned to centroid 15
 The coordinates of centroid 16: [2.86971885e-01 8.63392651e-02 2.40976648e+02 1.26778404e+00
  1.39154726e-02 1.48073905e-01 4.30521787e-01]
 231972 points are assigned to centroid 16
 The coordinates of centroid 17: [4.74060259e+00 1.88269792e-01 2.36589767e+02 2.00880763e+01
  3.85966932e+00 4.27854281e+01 1.62153549e+01]
 21713 points are assigned to centroid 17
 The coordinates of centroid 18: [4.74933172e-01 1.12493384e-01 2.33584221e+02 2.14533548e+00
  5.16152865e-02 4.02511922e-01 1.35032574e-01]
 29778 points are assigned to centroid 18
```

K=19:

```
After the 19th iteration, the loss is: 14.909825885408228
After the 20th iteration, the loss is: 14.90765321849141
The coordinates of centroid 1: [1.39228510e+00 1.51789359e-01 2.38622107e+02 5.93471142e+00
 1.72981600e-01 5.32679588e-01 3.45748354e-01]
65163 points are assigned to centroid 1
The coordinates of centroid 2: [6.53228493e-01 1.92034278e-01 2.41664017e+02 2.89560282e+00
 6.71801272e-02 1.05310128e+00 5.47536415e-01]
116984 points are assigned to centroid 2
The coordinates of centroid 3: [1.61853138e+00 1.04767623e-01 2.43408448e+02 6.61909309e+00
 1.15316556e-01 3.68760738e-01 1.85303107e+01]
155407 points are assigned to centroid 3
The coordinates of centroid 4: [2.56321234e+00 1.73173055e-01 2.37855815e+02 1.09433315e+01
 9.95337147e-01 5.16319984e-01 2.20509937e-01]
30239 points are assigned to centroid 4
The coordinates of centroid 5: [3.96652594e-01 9.00532881e-02 2.47873379e+02 1.67279271e+00
 9.61833293e-03 2.83401920e-01 3.00831114e-01]
61965 points are assigned to centroid 5
The coordinates of centroid 6: [3.05851517e+00 1.70756175e-01 2.38048335e+02 1.29210580e+01
 7.44659207e-01 6.33868549e-01 1.76031085e+01]
95351 points are assigned to centroid 6
The coordinates of centroid 7: [3.22300972e-01 9.66204600e-02 2.43099311e+02 1.41184735e+00
 1.41439047e-02 2.75477258e-01 4.18167945e-01]
266051 points are assigned to centroid 7
The coordinates of centroid 8: [1.56374181e+00 1.43603562e-01 2.42944062e+02 6.55019714e+00
 2.41628681e-01 3.89263939e-01 3.05291097e-01]
51993 points are assigned to centroid 8
The coordinates of centroid 9: [1.59419907e+00 1.11161509e-01 2.34956881e+02 6.76701590e+00
 1.34550290e-01 4.33040511e-01 1.70836020e+01]
74448 points are assigned to centroid 9
```
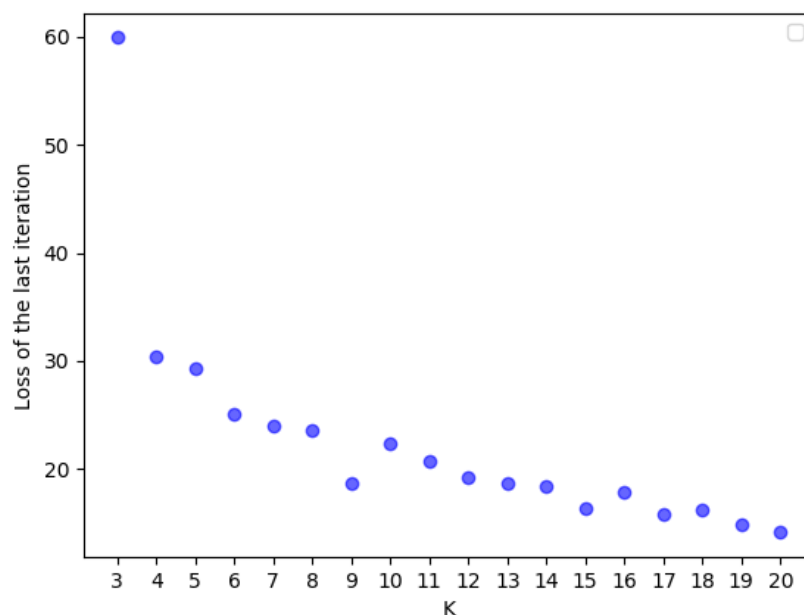
```
The coordinates of centroid 10: [2.88220402e+00 1.94566273e-01 2.38661005e+02 1.23047222e+01
 2.89878061e-01 2.83504180e+01 6.25365983e+00]
30261 points are assigned to centroid 10
The coordinates of centroid 11: [  2.3421185    0.26896265 238.99688192    9.85253625    0.25451317
    0.54465818  28.37431193]
16895 points are assigned to centroid 11
The coordinates of centroid 12: [3.67370084e-01 1.01962919e-01 2.35134477e+02 1.66329683e+00
 3.25292496e-02 3.36456855e-01 1.15298118e-01]
74702 points are assigned to centroid 12
The coordinates of centroid 13: [4.74328619e+00 1.88219866e-01 2.36582860e+02 2.00996820e+01
 3.90131367e+00 4.28000000e+01 1.61998156e+01]
21695 points are assigned to centroid 13
The coordinates of centroid 14: [3.93994942e+00 1.97658996e-01 2.37243289e+02 1.66961424e+01
 3.71233414e+01 1.55601590e+00 1.10701155e+01]
53583 points are assigned to centroid 14
The coordinates of centroid 15: [3.44436072e-01 1.15934555e-01 2.39001643e+02 1.55277327e+00
 2.55810546e-02 4.09302300e-01 3.81583160e-01]
184277 points are assigned to centroid 15
The coordinates of centroid 16: [2.82734057e-01 9.07852008e-02 2.41135799e+02 1.25374035e+00
 1.23303102e-02 2.32797836e-01 4.32210200e-01]
278744 points are assigned to centroid 16
The coordinates of centroid 17: [1.57066707e+00 1.12256398e-01 2.39637399e+02 6.52974050e+00
 1.14137089e-01 4.17894167e-01 1.79831700e+01]
269518 points are assigned to centroid 17
The coordinates of centroid 18: [1.05878094e+00 2.63240012e-01 2.40834756e+02 4.60452999e+00
 6.20200253e-02 4.43763974e-01 1.10388354e+01]
41148 points are assigned to centroid 18
The coordinates of centroid 19: [3.82145658e-01 9.86052370e-02 2.45103503e+02 1.64218804e+00
 2.02417069e-02 3.17408117e-01 3.25900184e-01]
160856 points are assigned to centroid 19
```

K=56:

K=20:

```
Project3_K-Means_power consumption ×
 After the 19th iteration, the loss is: 14.31510341563018
 After the 20th iteration, the loss is: 14.121383417004367
 The coordinates of centroid 1: [3.37276134e-01 1.04352956e-01 2.43181237e+02 1.48208546e+00
  1.60165040e-02 3.48034303e-01 4.27305663e-01]
 256423 points are assigned to centroid 1
 The coordinates of centroid 2: [2.66577575e+00 1.75502761e-01 2.36565813e+02 1.14005067e+01
  5.00734661e-01 4.59441658e-01 2.16294270e-01]
 19737 points are assigned to centroid 2
 The coordinates of centroid 3: [4.02621790e-01 1.06364518e-01 2.34088812e+02 1.82696974e+00
  3.82254056e-02 3.56234469e-01 1.14822394e-01]
 41046 points are assigned to centroid 3
 The coordinates of centroid 4: [3.29486410e-01 1.09941837e-01 2.41500394e+02 1.46826083e+00
  1.82924536e-02 3.79605162e-01 4.54357747e-01]
 292525 points are assigned to centroid 4
 The coordinates of centroid 5: [1.06070082e+00 2.62944803e-01 2.40838837e+02 4.61356620e+00
  6.38210498e-02 4.42036863e-01 1.10297848e+01]
 41397 points are assigned to centroid 5
 The coordinates of centroid 6: [1.32107068e+00 1.51310997e-01 2.38560149e+02 5.63990655e+00
  1.59992861e-01 5.27679528e-01 3.53895577e-01]
 61634 points are assigned to centroid 6
 The coordinates of centroid 7: [1.57074479e+00 1.13287105e-01 2.39536201e+02 6.53331860e+00
  1.13168974e-01 4.11545644e-01 1.81160716e+01]
 271479 points are assigned to centroid 7
 The coordinates of centroid 8: [4.10568156e+00 1.89198538e-01 2.37311209e+02 1.73909001e+01
  1.01398642e+00 3.90156985e+01 1.28664036e+01]
 34462 points are assigned to centroid 8
 The coordinates of centroid 9: [3.67431326e-01 9.52272087e-02 2.45138662e+02 1.57815928e+00
  1.84344369e-02 2.99634299e-01 3.20062877e-01]
 153951 points are assigned to centroid 9
 The coordinates of centroid 10: [3.29540103e-01 1.00997678e-01 2.37295128e+02 1.48406235e+00
  2.77000393e-02 3.30054424e-01 2.08857820e-01]
 83971 points are assigned to centroid 10
```

```
The coordinates of centroid 11: [2.38376180e+00 1.94028380e-01 2.39187581e+02 1.02892304e+01
 2.37761804e-01 2.40615318e+01 4.08414921e+00]
16138 points are assigned to centroid 11
The coordinates of centroid 12: [4.41310653e+00 2.00179804e-01 2.36645254e+02 1.87215296e+01
 3.69284950e+01 2.65838419e+00 1.76319459e+01]
34571 points are assigned to centroid 12
The coordinates of centroid 13: [4.02061151e-01 9.08322128e-02 2.47870654e+02 1.69549329e+00
 1.00846013e-02 2.83092611e-01 3.01315662e-01]
62174 points are assigned to centroid 13
The coordinates of centroid 14: [1.64208953e+00 1.12353435e-01 2.43240755e+02 6.72450373e+00
 1.15499851e-01 3.72611161e-01 1.89568964e+01]
167550 points are assigned to centroid 14
The coordinates of centroid 15: [2.08326960e+00 1.65138122e-01 2.41176261e+02 8.78899822e+00
 7.00971650e-01 4.43330668e-01 2.74921592e-01]
32522 points are assigned to centroid 15
The coordinates of centroid 16: [3.30332186e+00 1.96697506e-01 2.38066948e+02 1.39974915e+01
 3.70211741e+01 2.17521103e+00 3.97873051e-01]
20969 points are assigned to centroid 16
The coordinates of centroid 17: [1.14066566e+00 1.50396865e-01 2.42756541e+02 4.81587970e+00
 1.22620729e-01 5.17014968e-01 4.00028241e-01]
70820 points are assigned to centroid 17
The coordinates of centroid 18: [3.46170470e-01 1.18022618e-01 2.39783501e+02 1.55658559e+00
 2.36220839e-02 4.28438571e-01 4.36487750e-01]
215053 points are assigned to centroid 18
The coordinates of centroid 19: [3.04305938e+00 1.78290603e-01 2.38085519e+02 1.28547181e+01
 7.04575522e-01 7.52721892e-01 1.81903315e+01]
102043 points are assigned to centroid 19
The coordinates of centroid 20: [1.60413901e+00 1.11623300e-01 2.34792331e+02 6.81496858e+00
 1.36482384e-01 4.27451811e-01 1.70986373e+01]
70815 points are assigned to centroid 20
```

K=20:

Scatter plot:

Using the elbow method, the loss drops rapidly from K=3 and decreases slowly after each K after K=4. So the elbow point equals K=4, and this value of K fits the data best.

Additional Requirements:

Stopping criteria: In my algorithm, I use two stopping criteria: the change status of clusters and max iteration times. If clusters don't change after one iteration (the loss doesn't change), it means the clusters are well assigned so we can stop calculation. However, sometimes it takes too many iterations to make clusters unchanged. Thus we should set a maximum of iteration in order to avoid wasting time and memory on tiny loss convergence rate. Generally, when K increases, the loss needs more and more iterations to converge completely. Limited by the computing power of my computer, I can only set the maximum of iteration about 20, which makes me unable to calculate the final convergence value of losses for that K. Thus the results may not perform very well about clustering the data.

Centroid initialization method: In my algorithm, I randomly select K points in all data as the initial clusters. And because of this initial method, the initial clusters could be different for the same input and parameters. For each time running the code, different initial clusters can require different time to produce the different results. Because if the algorithm selects lucky initial clusters which are close to the final results, the less time will be required. Moreover, for the same K, the final clusters' coordinates may not be unique depends on the initial clusters, which means the final loss can be different after each time of running program. For this problem, we can run the program for many times(eg.100) and pick clustering that gave the lowest loss.