For Test Case:

The content in parentheses is centroid point in each cluster.

Iteration 1:

[7.280652704921236 5.774801403936647] nodes number for cluster: 162

[-4.121864751051137 1.608292491511601] nodes number for cluster: 38

After 1 times iteration, the loss is: 6.073235478545753

Iteration 2:

[8.829255193084338 7.809018002836296] nodes number for cluster: 130

[-1.785261392052385 -0.2648485464791498] nodes number for cluster: 70

After 2 times iteration, the loss is: 5.49445303346825

Iteration 3:

[9.890246649770267 9.630853037375761] nodes number for cluster: 106

[-0.27160922572714624 -0.2578455302835389] nodes number for cluster: 94

After 3 times iteration, the loss is: 5.034017404217683

Iteration 4:

[10.168086243285888 10.046715814097372] nodes number for cluster: 100

[0.06026253328707723 -0.08038639294559319] nodes number for cluster: 100

After 4 times iteration, the loss is: 4.966752652275003

For Electric Power Consumption:

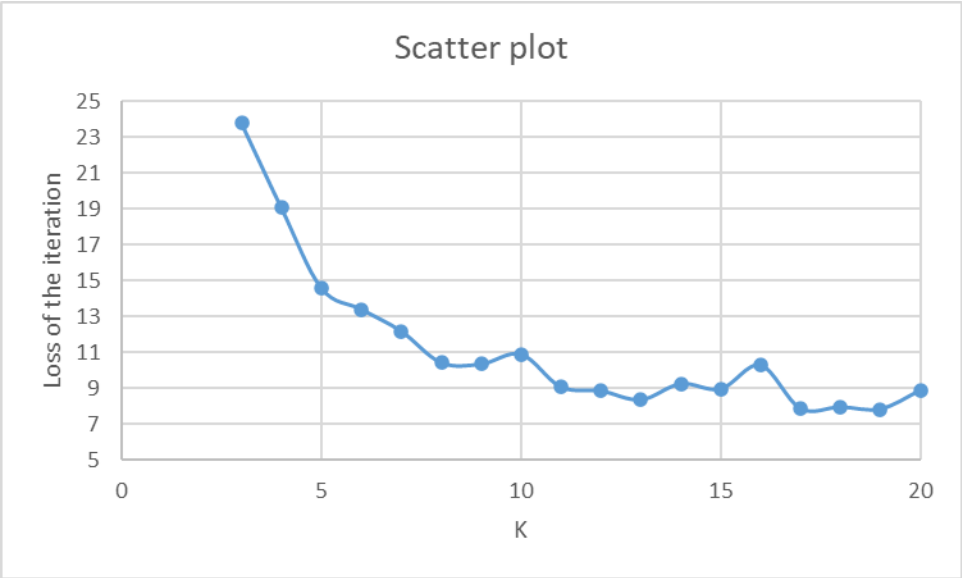
As shown in the plot, the point (k = 5) is the best data.

Question:

1. Explain the stopping criteria you selected for your algorithm (see Resources) and how they may impact your results.
   The stopping criterion of algorithm selection is convergence, which will make the algorithm complete the process faster when dealing with high number of iterations.
2. Explain the centroid initialization method you selected and how that may impact your results.

Using random particles as starting particles is a simple and easy method in general, but when two similar centroids are close, it will lead to cluster overlap.

3. Explain why your algorithm may require different amounts of time to run on the same input and parameters.
   This is because the algorithm uses a random starting node, which will make the running time different.
4. Explain why your algorithm may produce different results on the same input and parameters.
   Since random initial nodes are used every time, the algorithm will produce different results. When the centroid approaches or even overlaps, the operation results will also be affected.



_____k = 3_____

[[0.5239839634923366 0.11419486107018675 241.61454899245223 2.2780032367840706 0.057141190055031446 0.48156277638561323 0.4136540634827044][3.948797722095709 0.1956915096293244 237.29577345206144 16.754255539449083 21.732646510664733 17.24602402153655 11.091364671774695][1.8043628362955615 0.13209383363172572 239.81433079249427 7.533830432561683 0.1934380440867955 0.5662516995502729 17.880140947318555]]

[1302528 96580 650172]

After 14 times iteration, the loss is: 23.776671102856913

_____k = 4_____

[[0.7324924298292858 0.13002201535393393 238.76350589374036 3.1882363134463434 0.11318986882669407 0.7300388885530638 0.39667533095569124][1.804751153122984

0.1320709659155694 239.8143485431999 7.535347875452703 0.1932554225245933
0.5704397406665498 17.884461532307448][0.3980408120292902 0.10458415081251728
243.36238830265228 1.7283655370576974 0.024814209274673007 0.35167707094728495
0.42717003567181927][3.963082692146887 0.19567222129296735 237.29002477628148
16.811192188675996 21.925597976080958 17.186783892280673 11.17531571464414]]

[496290 649974 807360 95656]

After 38 times iteration, the loss is: 19.056708423765095

_____k = 5_____

[[0.4005214282905037 0.10484404568154429 243.42585895196166 1.7383337117707653
0.025028953720981267 0.35523710338476294 0.42613407887843496][3.9977608358854098
0.19905022518465154 237.174001981625 16.952271662763664 36.9578814627995
2.4517744550531435 11.16319582057287][3.698297517843814 0.19090064983487942
237.73981271972136 15.719254287844784 0.8441248535208267 35.58359433258762
10.610226909555768][0.7055094793636691 0.1281938090198315 238.83079260432814
3.0713881873301707 0.1110839399565305 0.5222013330385806
0.3996846407114756][1.7999017000207935 0.1318262719261088 239.81619637135813
7.514409472537053 0.20309263221311666 0.4755485869204211 17.88423483613838]]

[788327 55510 46935 511163 647345]

After 44 times iteration, the loss is: 14.581825748993927

_____k = 6_____

[[0.40038636380938214 0.10479843698045692 243.42592340750306 1.737715016712889
0.025034202156956807 0.35527093946154764 0.42314984732766303][1.5182391625998954
0.11981420240196662 240.9190384349249 6.2843746755253544 0.104268334890804
0.3908883639635898 17.74171944761707][3.702262252794489 0.19049127257093884
237.74208039553102 15.735472914875196 0.8496345657781599 35.73701633705933
10.558147033533963][2.504010320416683 0.16228668182477637 237.073332150781
10.59070947489473 0.4665365864146765 0.7235149619165874
18.21785754599842][0.7050387699723385 0.1281619507652537 238.83097360231125
3.0693293266272916 0.11101003046114297 0.5232273551628409
0.39739564075024014][3.9983991469057094 0.19876659196067087 237.17681264459242
16.9528050896474 37.01825477154424 2.4554655870445345 11.141447368421053]]

[787962 462288 46520 186039 511143 55328]

After 46 times iteration, the loss is: 13.402825245294181

_____k = 7_____

[[1.0724818508365594 0.2610723130730713 240.77611730787493 4.665284998582218
0.06954816145193307 0.45826637678419513 10.979865771812081][1.576479387360832
0.11065795003288671 240.94095553005312 6.513074263243374 0.11206969640725287
0.39250287002729106 18.415728895274366][0.7017187084785286 0.12753827499257653
238.8278056419053 3.05300017125326 0.11071983244787124 0.5227638227553585
0.3421236523687013][3.9983802776171027 0.1987552053209948 237.1768786148064
16.952718334297483 37.018290919606706 2.4554655870445345
11.141555812608445][2.4993282406356374 0.1562864926220177 236.83882752553615
10.577163450624145 0.474988649262202 0.7241657207718502
17.812258796821794][3.7022405691808276 0.19051312254154015 237.74272187950268
15.73537390108106 0.8496227672334115 35.73604453711068
10.558154031339338][0.399400730415455 0.10452257213330189 243.43070082923435
1.7324818192817335 0.02507122507122507 0.3553554242592274 0.4000420658138779]]

[42316 436407 508021 55328 176200 46523 784485]

After 37 times iteration, the loss is: 12.185331085207702

_____k = 8_____

[[1.842564999063752 0.16093283061262512 239.62133862154494 7.827494169914806
0.42270243586906564 0.9959827735884386 0.3768447750523431][1.799732212528303
0.13176331393875979 239.81630667662677 7.513475010665202 0.20303254209201813
0.47716550525879714 17.891066228072887][0.42627681612416785 0.09508105195084592
246.23384172235305 1.8090353524472316 0.019977365811597328 0.30584177624488035
0.3220144427678379][0.4155450872927698 0.10543900994475108 235.8978870276272
1.8620640883977249 0.038497237569060774 0.35816132596685085
0.18226740331491711][0.3712916646704242 0.1168432490442049 240.23488671753472
1.657768557821053 0.026077249599954007 0.4124641874994011
0.49093308931326235][0.3881983438866514 0.1095894363347133 242.90375289347975
1.6987852170353839 0.02423570172827663 0.36561476840322316
0.46106291903374114][4.001859225668899 0.1988828747448104 237.16983035536845
16.966858774006113 37.00547415584181 2.455258260916695
11.192589113114488][3.715849563436451 0.1906518055405857 237.72089037404598
15.791186806079443 0.8530559448097446 35.770787970249 10.708720491538212]]

[117494 646916 185560 113125 417452 466997 55351 46385]

After 19 times iteration, the loss is: 10.429899136566078

_____k = 9_____

[[3.720402853216404 0.1900657897607066 237.72063303012672 15.809768121632407
0.8576881966712475 35.9719477346596 10.644874899112187][0.4045642018190717
0.10944262993876575 236.8726643279697 1.8122672104422546 0.03585808837506697

0.37260154031370785 0.2537254969729437][1.8296664524474975 0.16069513833826962
239.62683528773397 7.77307849601438 0.4184617952677044 1.0018528564870843
0.35224304135542295][2.9345746492445213 0.17826330960351183 237.95257802180907
12.4008506184426 0.6509307792628527 0.8873512040736649
18.50418248423781][0.3698582063857557 0.11449918513815352 241.3635411983815
1.640983037099738 0.02421172635944207 0.39736336717751747
0.4892369373436269][1.4772196942867108 0.12871957827033334 237.90701337240841
6.209171398912979 0.10826972787038733 0.4204840121308339
16.86631658219861][1.598638107425889 0.11531329143010526 242.26175116836464
6.576549983385137 0.11022575422272814 0.38335089120951377
18.48100921258228][0.41514564770296725 0.09954448463186616 245.10304741641787
1.7782653220435576 0.021896940555721032 0.32144731429868234
0.3611988142348553][4.003010034658571 0.1986126041118512 237.17104012048858
16.968934293854208 37.08602950516249 2.4625015877624343 11.163421582681595]]

[45843 173601 119815 120383 653485 245655 282874 352515 55109]

After 66 times iteration, the loss is: 10.346330901096628

_____k = 10_____

[[3.9973403299441497 0.19847494497899207 237.17677604176163 16.945317302970437
37.07142727223122 2.3415667800432893 11.185707270048564][2.4875058230731217
0.16103468059046944 237.0512952577366 10.51999505790817 0.4633855476052343
0.5490986054706805 18.227690753991276][1.8436590618445658 0.1609161934966814
239.61848236056258 7.832114174637824 0.423431718587481 1.0295752553412791
0.35985642914386073][0.3882083240540028 0.10957424237233433 242.90362459955008
1.6987789731551288 0.024279204426704126 0.36554571462833846
0.45869451630034436][3.905606073102161 0.19556513589503272 237.61224929709493
16.56151452671033 0.7785567010309279 31.64303655107779
17.613833177132147][0.42586805885145146 0.09495179488285271 246.2337898023896
1.8072280709329702 0.019955127928549855 0.3053296371402684
0.31528023471545064][0.3712291466508802 0.11680955678172934 240.23467776291653
1.657436526513108 0.02609618596048196 0.41210985698849245
0.4888506609101081][0.4156649844891562 0.10543424041291387 235.8987685046915
1.8625663959273566 0.038498590329394504 0.3569780904487083
0.1824352391137193][3.4449637398297552 0.18538813902083415 237.944457508347
14.678305036918497 1.2289422941259465 39.76912947373371
2.624606123312797][1.518051984077771 0.11988282277542747 240.93848980515668
6.283047129591288 0.10407250639691991 0.3911197490363858 17.743523186524836]]

[54979 186156 117294 466984 26675 185416 417379 113147 21263 459987]

After 55 times iteration, the loss is: 10.895478322693306

_____k = 11_____

[[1.8418659092071983 0.16075133493696167 239.6226756742911 7.823923093982718
0.42395550778784313 1.0080693314226248 0.34683624204582286][1.6064923813613234
0.11500860105919185 234.97549765129847 6.823578092672873 0.13783815435062655
0.4373527995732001 17.06887353450183][1.65643737473321 0.11628924303651653
243.01308559851662 6.793894022947196 0.11737971680227079 0.38237110386444645
19.061260197393366][0.41484679853086087 0.10540627461392074 235.89949378291362
1.8589512810300695 0.038497278640647815 0.3579538917651223
0.17327315367936635][1.4759734599411427 0.1292382765184251 239.69300614293456
6.155349829843433 0.10004614408490511 0.4109058660667936
17.14176688585107][2.9919221996591485 0.177784421800774 238.13890923595363
12.63685861406237 0.6918899807810857 0.9135420821699242
18.27153062334554][4.0032219318305415 0.19859835202729695 237.17042578678004
16.969690369886592 37.08944063305383 2.462866165741043
11.162347090638498][3.7205336388434183 0.19003059465357497 237.72004386252277
15.81033933442432 0.858025095471904 35.97854882705946
10.643753409710856][0.37035102745887843 0.11660566931779079 240.23540826047727
1.6532987848022882 0.026026559182351458 0.4118832547594199
0.4768320917455405][0.38806154861358105 0.10957267334115064 242.90399558223808
1.698167124795925 0.024259083498124275 0.3657073441413339
0.45799598502848404][0.42585419576836975 0.09496123788514832 246.2339003198258
1.8071882769822372 0.019977024264749507 0.3056204257522396 0.3158839995038104]]

[117234 76851 184606 112995 277392 110308 55098 45825 416805 466753 185413]

After 77 times iteration, the loss is: 9.072413538661031

_____k = 12_____

[[1.55878101392597 0.11203534737862683 237.5476058495316 6.539654773934953
0.11858139187100926 0.4176564687968749 17.664208966451714][0.35461922767758597
0.10728898998110362 242.9356280340746 1.5576816852953899 0.019763875354209422
0.36001598713843697 0.4292658939549755][0.4173532489274407 0.10569146524362562
235.95131360957404 1.867941473963176 0.03763384604652785 0.35024066129538556
0.1650273795821562][1.3891353549953296 0.15133835506017757 241.22092095875922
5.872844687809899 0.217212848949792 0.48260462703023227
0.3657151328163364][3.728691728332703 0.18986166311675376 237.71809402516627
15.843046924748998 0.8614215761621397 36.075338705781604
10.698886717463385][4.0040599059088375 0.19851052622018803 237.17169963489738
16.972455633662317 37.10297349826531 2.4630265380633207
11.16925508146695][1.0633670275049514 0.26225798743040263 240.79975458217012
4.625832198246101 0.06459244390278873 0.4523143833488661
11.018495949530433][3.0181286463759536 0.17767815151063968 237.9467926774774
12.75706764399454 0.7091643101652032 0.945164831076053

18.14853400803691][0.34281520209235045 0.11446282579834177 240.25293270912113
1.5356978148666087 0.022260598740229794 0.4070545135110854
0.436896692853649][1.617689241964462 0.11261033378287198 242.15914710468925
6.65337856821768 0.1117561530681052 0.38296878512025173
18.72730178129917][0.40674934422270764 0.09426908494492024 246.28881055759118
1.7281009700450392 0.017440586857492713 0.30320221531963176
0.30680267141485007][2.2814364860858043 0.17369566690668817 237.8512008132477
9.748189249862426 0.6726036680926766 1.929370155449193 0.24117921131771783]]

[220667 445358 114684 107931 45541 55053 41847 107504 400708 284736 178033 47218]

After 58 times iteration, the loss is: 8.857381735627373

_____k = 13_____

[[0.3718573536117651 0.10347168128538162 243.89502635389334 1.6166029612942434
0.02055001207049167 0.33841970440707064 0.40362382983289075][4.004057102381068
0.1985225303765054 237.17158738807473 16.97251312228721 37.10098258232078
2.4631032165495195 11.169835994115404][2.9911783028611927 0.17783362023664778
238.13999374852378 12.633583996230916 0.6916212151412471 0.9150977585300886
18.280999148350155][0.42352357414870173 0.1044400283092004 235.4156792522748
1.897700439241846 0.03775683296448993 0.34141793140636056
0.14152352921352102][0.363162931820585 0.11712400442210497 239.37916177788114
1.62974669754583 0.02688362935048377 0.4176746850867071
0.43945837334473825][0.33966043218100594 0.1109559234387534 241.6664944986907
1.510806554844677 0.019259684449004888 0.3849447836555557
0.48540856031128404][1.6064088976973299 0.11502868542519562 234.97067788875248
6.823430776853521 0.13788562338644483 0.4376222390278249
17.066954390173937][1.656167124000822 0.116228891226772 243.01652433270655
6.792636739298848 0.11723300181126019 0.38245246797757076
19.057938634071213][0.4147324423344789 0.09268772038460588 246.97551490445207
1.7537970655518755 0.015618280957049728 0.296110910435695
0.30693878253091833][2.280118604063046 0.17399443648318244 237.87349637528325
9.742733709854265 0.6714153249599596 1.9265362893028746
0.27238051083199866][1.395666548408179 0.15229939314723118 241.2636639902885
5.904436560545459 0.2187844272243488 0.47661282793389975
0.47929231631033514][1.47629599576261 0.12915703110643117 239.6908218541384
6.156519451880803 0.1001077357124069 0.4106352083190707
17.14694574660128][3.7287475905069214 0.18987863619399076 237.7171641528924
15.843337943752756 0.8613361434938198 36.0722738150124 10.700388592504774]]

[298248 55059 110374 89017 247846 393724 76694 184402 116274 47452 107110 277531 45549]

After 102 times iteration, the loss is: 8.360753342418782

_____k = 14_____

[[0.4123792769224102 0.09253344769910087 246.96964343612186 1.7441574816655545
0.015302140069477206 0.2882446283827251 0.30651456019213447][0.33820042563503333
0.11069607880618249 241.65841663800015 1.5044926151053934 0.018985357648048325
0.3825795516815129 0.48302685068369206][0.36936492449237296 0.10330694589738222
243.88684131996186 1.6063698666884156 0.020348837209302327 0.33758482873313483
0.40309071645073896][3.9394146277785893 0.1977309413695361 237.24347419066115
16.69445770550528 37.10909294345815 1.5527189318215724
11.070043264210055][4.744449681763665 0.18830956553823422 236.58146065861175
20.104621344894255 3.9111705562217507 42.80712111428835
16.197214279125543][2.260201755805482 0.1665320414272989 237.87665527146046
9.636762683065063 0.6836313617606602 0.5243749494295655
0.2670928068613965][1.6032952061875778 0.1149963225190084 234.96830024472843
6.810176545261863 0.13749329285050582 0.43742393110939526
17.052505529308608][2.9843794826974226 0.17714465718005054 238.13103187392056
12.603676289842301 0.6907109496626881 0.6270723513506131
18.34003404983658][1.4759480943542185 0.12918033625862343 239.69181222857276
6.154893770385214 0.10003784261077973 0.4135548627754852
17.15189303155353][1.6537229009589507 0.11588803297188142 243.03390156409174
6.78184801749003 0.11705891652901122 0.3808994215745602
19.03260116993496][0.41774948595696965 0.10434837426847852 235.41478059967616
1.873522832546183 0.0369659036988499 0.3552206430621145
0.14081388254965316][2.882270013836755 0.19461823812347426 238.66148876589602
12.304796731896927 0.2891546418923371 28.325492521578706
6.277492258022007][0.3644481824257464 0.1172462625812631 239.37124441564458
1.6352870653514442 0.027047935357135625 0.41713683954717595
0.43931225824743314][1.3655115613301068 0.15453152437214485 241.3980297387064
5.780429516578539 0.20076022327968365 0.5569162126710263 0.5033846212766773]]

[116585 392355 298248 53624 21682 49436 76411 109839 277465 183429 88514 30354 246895
104443]

After 75 times iteration, the loss is: 9.25158411484294

_____k = 15_____

[[1.5949435787210904 0.11530725557849343 242.26652164229654 6.561287083911051
0.10970332871404734 0.38354096552504313 18.443497412257134][1.3623660299989238
0.1550593013331758 241.54308877051187 5.766290944406803 0.20107517388190746
0.5639463590256727 0.5430118602666353][0.41367613734202136 0.09182211201799965
247.40477964895754 1.7459517167748824 0.013855885020261506 0.28477459792678306
0.3040373775986959][0.4003660521868632 0.10283573388734736 234.82009628056105
1.8052527946169026 0.034543171211956776 0.3483154777593451
0.11744368129738446][2.6758850563253773 0.18919908284318593 238.7467460871297

11.428182633835068 0.4042966802910976 30.49023028611305
0.38640215332469346][2.2398739642304424 0.1662846676722352 237.8979033869406
9.549566103155854 0.6702188093792238 0.5282179866402867
0.2694078238555114][0.42621231606545557 0.1191761011204783 238.34460122351013
1.9013208472181569 0.038573854472336105 0.4267565704866317
0.3657872860461977][2.928241137606083 0.17772730321628216 237.957645219166
12.372131669852552 0.6534443438307006 0.5943253848475701
18.570354160378308][1.4790131873254517 0.12845380755909194 237.88929565369926
6.216556738212031 0.10842230518537904 0.42459098845649
16.884078297955863][0.3783527862254871 0.0997070953284722 244.50680575308022
1.633417327876617 0.020126677794800266 0.32078293279674386
0.3652573571444904][3.9065408842897544 0.19541049858889908 237.60726999059287
16.563732831608565 0.7456255879586077 31.708410159924743
17.621411100658513][5.945868478524619 0.17600630914826532 235.47456199951492
25.31710749818006 3.312060179568066 69.07279786459597
12.032759039068187][0.34826254570234905 0.11018509055293822 242.46480998179214
1.5397587283044953 0.019330328083270978 0.37512699310739206
0.47348201412589197][0.3301178401455734 0.11161782534478094 240.58848641129362
1.4784379635504294 0.019306733675613984 0.3911044306815902
0.47454438410861766][4.002599767391134 0.19846034745947536 237.17313785709112
16.966010031257035 37.10614596205568 2.4470269680889727 11.158519299265828]]

[282872 101937 87111 64499 20062 51049 140743 119268 244553 218665 26575 4121 328758 304039
55028]

After 89 times iteration, the loss is: 8.96388110752302

_____k = 16_____

[[1.616640402305902 0.10498591929350717 243.31619336440625 6.613766711641004
0.11482276462651785 0.36884582362320617 18.518539188028946][3.924038381937907
0.19731352775164615 237.2595507055504 16.628726246472535 37.10873000940734
1.2590780809031044 11.12793979303857][0.35261337347531313 0.10703046022729541
242.93702086042117 1.5492111709278924 0.01943397204338391 0.3586699086666411
0.4288611611257462][3.0449419706446776 0.170291447327676 238.0790959104864
12.861532586032226 0.7326231910984496 0.6033834974505068
17.606717450093928][2.266453636902445 0.16663868053710384 237.85963130249783
9.663091418177462 0.6872815712563102 0.5287457336140121
0.2314578266467739][0.41384927298429314 0.10569879034369582 235.9592093595666
1.8532842255929813 0.03699663111592103 0.3625390563633507
0.16513641362216133][1.5936266631614155 0.11099700594429535 234.75151499218566
6.770769253238801 0.134425798536564 0.4317136222231959
17.041128101768685][2.665183342509622 0.18886701036087872 238.7605325591868
11.381320386405687 0.30126632964612843 30.448671104659894
0.38255167926322636][0.3417788262607173 0.1143246183058151 240.25309165415385

1.5312892920478747 0.022134885710640404 0.4053000642932372
0.43684627912271][1.0574857294634588 0.26266933887091476 240.84089317622252
4.600738880571889 0.06258753078669049 0.44859226348577774
11.00731636644613][1.3560069877385017 0.15330597253875272 241.33381924170615
5.736208163034694 0.19902812046785828 0.5642080876951764
0.3728551786487861][2.337705256905263 0.2686424710424712 238.99799881199914
9.833406593406568 0.2551826551826552 0.4754380754380754
28.374398574398576][3.883354846074824 0.19470718063853215 237.63938886563392
16.461448304729903 0.46858708474447275 31.635260093610867
17.613303398150613][6.017132443047909 0.19584351924587584 235.2308279654362
25.637957580518453 14.574234092694423 57.63519245875884
12.100549882168107][0.40459514997888196 0.09413141811011996 246.29150530910977
1.7192463033377368 0.01723700887198986 0.29785100690043653
0.30659343754400786][1.5659799653564188 0.11210408846504992 239.53166957868382
6.5130965397778855 0.11415839091602509 0.41885255449220143 17.965273785503065]]

[163060 53150 443759 96882 48929 114578 68469 19979 399731 41414 106186 16835 26279 6365
177525 266139]

After 61 times iteration, the loss is: 10.290797492982705

_____k = 17_____

[[0.3078463268140033 0.10396000384843662 241.70398944431406 1.3705474387341348
0.014368376925931526 0.3481781821680388 0.4278626111576893][4.368545536301056
0.1912394590294342 237.0809380512615 18.5418076164781 2.2986060668949535
38.443499014216044 16.76469163986026][2.337488785541891 0.26848660740566277
238.99532407134907 9.833590392653166 0.255548360510979 0.5148643080002355
28.338965090951906][3.9621387995118003 0.19811646140759656 237.21970635008697
16.790924220570574 37.12822219756648 1.8830393135840822
11.071322903953549][0.36374570494297737 0.10299201024240129 243.93581010050752
1.5820654336582982 0.019460544300074396 0.33685011851416113
0.3808162770982197][1.4913435227386147 0.12811362889513908 239.63896161649788
6.217935163092185 0.10221671357745996 0.4117707991027418
17.25579717392236][2.639265760664408 0.17415288788221975 237.99945564363946
11.274918837297328 1.1821442053605133 0.5136277840694602
0.24733861834654586][0.8422520196512865 0.1749246661273106 241.18607853482922
3.6736524910009143 0.09827992542825988 0.7337812327787353
1.1512422760795902][1.5944183258286624 0.11473796994520698 234.9128674117065
6.774225573699438 0.1360060760592416 0.43076276243693373
16.954131177778983][0.3277252605399183 0.11239730294920082 239.3700763762797
1.4760070911610195 0.022048003029233827 0.39266873779055256
0.3844717343224241][1.6014641148325575 0.1463749104081528 242.85507545086534
6.708788718206946 0.23129225345291826 0.44137303140073225
0.3036049822753424][1.6173340452037932 0.10912421565081332 243.23232259212648

6.623963625718038 0.11637933509004587 0.37599389169235714
18.42890768073759][3.0117250517598357 0.1709213732004411 238.16118946506427
12.72019259473249 0.7063026626221773 1.0287447638307092
17.61335644470124][2.6688291985203305 0.19060350184956829 238.75785499383477
11.398392108507965 0.35842170160295933 30.340369913686807
0.5709987669543773][0.39335888789238854 0.09162204484304685 247.0234330941734
1.665813452914642 0.013183856502242153 0.285067264573991
0.3056502242152466][0.3501656275615167 0.10115526962915228 235.33301671675528
1.58833055962634 0.030117489257060533 0.3316773889068283
0.12700265779080455][1.4698482160179085 0.1520187657630649 238.0312291222075
6.270988906329964 0.16723399001746062 0.560256794652463 0.3313638688513025]]

[363785 28911 16987 54078 288995 279964 26490 85287 73732 232402 51623 174189 103845 20275
111500 80518 56699]

After 67 times iteration, the loss is: 7.865821542789085

_____k = 18_____

[[1.5915458715596171 0.11459013215377839 234.90337469964996 6.762057667103628
0.13585353866317168 0.43520642201834864 16.960244648318042][2.8825805652290644
0.19490503616394153 238.64333210554548 12.309931690329483 0.35474149477631933
28.40801634074471 6.0472810072327885][1.487349675439862 0.1285763442093483
239.6342929750971 6.202540565533676 0.10168355478452865 0.4163186889993656
17.226898165903805][4.409980469429158 0.2000190089829038 236.6480515792516
18.7079223413506 36.93459866705303 2.6028977108084614
17.629324833381627][0.3928991580260534 0.10206338192874244 234.43154985576996
1.7774382162626658 0.03525765962423014 0.3413697668979496
0.11058704295626413][1.6171949764521367 0.10914290281147258 243.217569630369
6.623737405452945 0.11647780790637934 0.37573283858998147
18.434559725988297][2.33738779353776 0.2684077452769108 238.99520746277477
9.832734977340909 0.22947442763816137 0.5450532634924372
28.33835560002354][3.303184256920936 0.19671529994758694 238.06647353123302
13.997770048125025 37.008481440891984 2.182684518987945
0.397341211225997][0.46881138221129126 0.11679014047918769 237.64622644526068
2.080852466878572 0.044801470735167756 0.41727114681374017
0.29311791859001257][0.3352173326695968 0.11363481920623349 239.88234801104724
1.505722948816476 0.021604742725256823 0.39857899262343305
0.4653029823052903][4.61346202376877 0.18528282877683716 236.75826722746723
19.53499290849508 1.469604342935394 43.16770186335404
16.383674866728615][3.005714897135344 0.16933158893049688 238.1526567773905
12.691993580078831 0.6922134137444677 0.6660181897767619
17.61164340255824][0.4113882085953604 0.09070773643484058 247.84910737080764
1.733563424896875 0.0111893842686713 0.2853450585472712
0.30710919893464456][0.39481929627015794 0.09742875864393663 245.1385785445737

1.691881850741945 0.02103173845830868 0.30987143029817227
0.3290646411054068][2.258120225015733 0.1659326577445611 237.8757395260027
9.616855872139237 0.5090270303202615 0.525700127942162
0.2587884080339554][0.35544901107607185 0.10601756633543254 243.2130683378562
1.5582586013878648 0.0188166768617584 0.3479411685498732
0.44407126561484095][0.3429544340509334 0.11292994567215435 241.56913456694954
1.5276963087016346 0.01986234222458233 0.398227196601446
0.49167381506746727][1.3746943275844883 0.15474632638819646 241.52342827235316
5.818755856843932 0.22452397567540625 0.551400657960323 0.512122420496461]]

[73248 29864 278993 34510 51308 175175 16991 20987 100086 220970 20447 102805 63453 157191
49241 259929 293772 100310]

After 180 times iteration, the loss is: 7.957186617686649

_____k = 19_____

[[1.4902399608016796 0.1282224932404355 239.63999095149285 6.213309537774635
0.1020049784695498 0.4167036236963706 17.256659418320197][2.663289110518388
0.17208829100467746 238.00266341953727 11.339966755576407 0.6789980285283544
0.5057018052495265 0.2409834164443929][3.303666746126326 0.19670588796185967
238.06674326579193 13.999265792610252 37.018784266984504 2.183694874851013
0.39737783075089395][0.29176549665976453 0.07695768535756954 241.7018593595946
1.2738712901109226 0.01388812835395904 0.042656883145329096
0.4191524750848757][0.3938400892455562 0.09191688540572637 247.0906500300016
1.6675978701062562 0.012964976751162443 0.28737625618719065
0.30597532623368834][2.8874867914509768 0.19484163016062464 238.65044271870474
12.328932696136969 0.3542745254214788 28.360779238019383
6.187441922208947][0.3495946498938881 0.10120359704961196 235.30393301000038
1.5860614327573066 0.029945943215115692 0.3329165403657674
0.12419167424472062][1.6167210744395544 0.10916698753498139 243.2333210158209
6.621474998133399 0.1164206037688139 0.3756860356192567
18.42912641445459][1.5903774382181595 0.11472922317789586 234.90889753690504
6.757084633943627 0.1359131987514142 0.4357237299456129
16.953205294221885][4.409980469429158 0.2000190089829038 236.6480515792516
18.7079223413506 36.93459866705303 2.6028977108084614
17.629324833381627][2.3374742170944245 0.268436425712267 238.99551036025463
9.833093948669614 0.22927949140569814 0.5463268189310101
28.33953378855663][1.5994947097795136 0.1472659744882836 242.90329140710074
6.704776030851392 0.29840798971620686 0.4148521704736478
0.29241570256106003][0.3277560670378977 0.11089602643342562 239.30665031083555
1.4746573153329132 0.022080371652494116 0.35680620141080294
0.37963383946376883][1.4874740595669143 0.15324266499150116 237.94500369521933
6.351163993792059 0.22757002438844134 0.564573941319932
0.3121905254600547][0.36323113888957087 0.09857020184104587 244.02991581117243

1.5742679193811475 0.01922225920060856 0.2699674143208757
0.37518514590411545][3.0078386170524327 0.1693245824787556 238.14440765699413
12.701269655239802 0.6935931243285477 0.6304521925969333
17.611592928996973][0.905665233663064 0.1598390583914182 241.0009132267616
3.926168315316454 0.10394145554210665 0.3840032277362717
1.2889658722539894][0.41233492102866487 0.19952989332671872 241.795125692546
1.9070569751097701 0.027247167783014968 1.5653105102125195
0.46707185975357646][4.617207476635515 0.18508844072798772 236.75041367437376
19.5506246925725 1.4759468765371373 43.240727988194784 16.37196261682243]]

[279604 25869 20975 292192 106672 30132 79176 174007 73363 34510 16988 50565 222143 54124
273433 102390 71877 120930 20330]

After 100 times iteration, the loss is: 7.844914371576529

_____k = 20_____

[[6.017132443047909 0.19584351924587584 235.2308279654362 25.637957580518453
14.574234092694423 57.63519245875884 12.100549882168107][2.560062023768445
0.1716859301997426 238.20272616098435 10.914339468815514 0.9887429055219341
0.5149415195509705 0.21507635383023424][1.384064053862054 0.15323070508662953
238.4980581549771 5.9055993081936755 0.16688285617221038 0.5975323512152939
0.32542697427344885][0.3420041561881476 0.11075125566192291 238.5353197799307
1.5381249251536897 0.027550596307332503 0.38361616545855437
0.32934621047218526][0.3437592664342264 0.10824022327012099 242.55212793300896
1.5161747983226948 0.01872974173368235 0.3658883082437953
0.4330425907901078][0.34599128211474833 0.11545498253170862 240.71844984289226
1.5456615508724052 0.021898807471357844 0.4149811004053166
0.43978803828062485][2.6677566089791704 0.1889440682217203 238.76421319287633
11.392194632555762 0.3018811136192626 30.480461499874593
0.38204163531477303][3.924499247101335 0.19730496160216832 237.2594357024545
16.63030040656556 37.11551347688601 1.2592794759825328
11.132133714801988][2.337705256905263 0.2686424710424712 238.99799881199914
9.833406593406568 0.2551826551826552 0.4754380754380754
28.374398574398576][1.5936288912922583 0.11089202303352659 234.75019408961973
6.770684867440409 0.1344596767121686 0.43176171406857444
17.044020928940984][3.045004419661273 0.170228851714167 238.07861813300016
12.861716232961328 0.7329202808756712 0.6031908302354398
17.609128459314334][1.616709812364674 0.1049883272301202 243.31599218543985
6.6139742009101505 0.11482006268823339 0.36888529034711615
18.519508799048022][0.36683757313964727 0.09830226074688199 244.5816826837039
1.583425376992715 0.018998197780322468 0.31662052404489605
0.34400653244237006][1.0966574645840876 0.2730902232529568 240.7775296878938
4.7263181424461544 0.06356701779876499 0.45410601022660596
11.606862443767637][0.39772069655970443 0.09118179722104214 247.47501814210608

1.6799004914747806 0.011637643346884292 0.2828590498149384
0.29408409683878406][1.3872649952939344 0.14930732152534035 242.67735147314795
5.835535210062487 0.19768403639371382 0.5237585921679359
0.32775733721228717][0.36858433153916487 0.10226859774120355 234.8573057776661
1.6709467658131474 0.03305746554245356 0.33703058398929714
0.10752621262561837][1.566078961808161 0.11210078999391128 239.53134032126414
6.513441171385634 0.11417704582866678 0.418839588391374
17.966021241891475][0.774134763948498 0.18485064377682378 241.30676824034427
3.6702789699570784 0.05504291845493562 0.4253218884120172
6.376931330472103][3.8833155251141673 0.19471727549467224 237.6394044901063
16.46133181126321 0.46856925418569256 31.634779299847793 17.613013698630137]]

[6365 31891 64758 141957 317463 307414 19935 53128 16835 68422 96840 163029 206967 35789
82405 70122 64282 266078 9320 26280]

After 73 times iteration, the loss is: 8.880410161530161

Process finished with exit code 0