# Report

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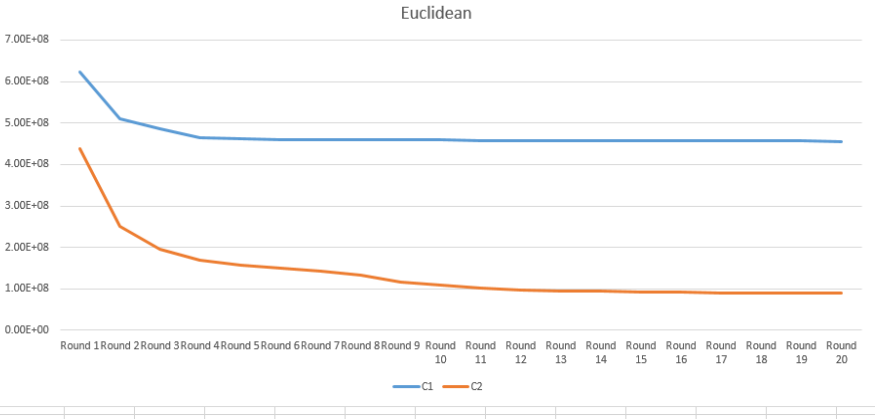
1.

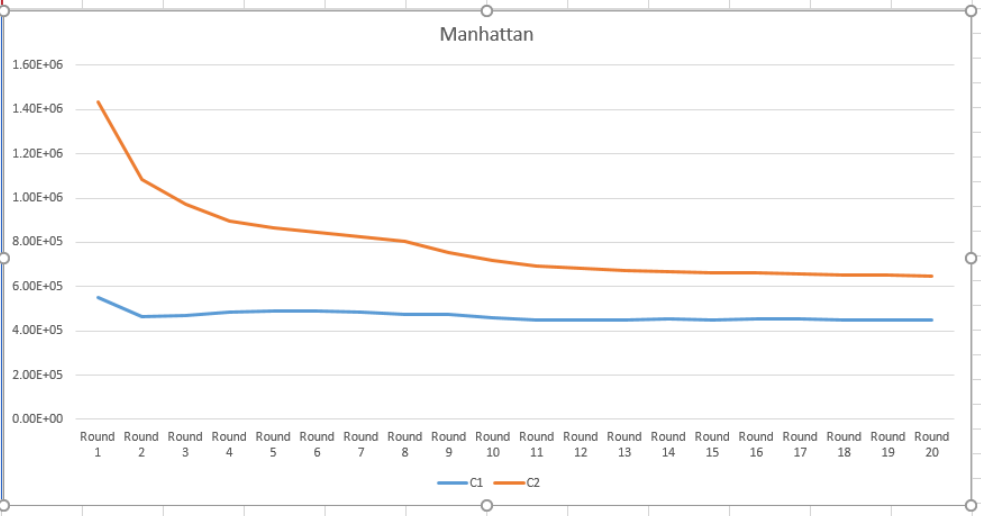
Euclidean Distance

| | C1 | C2 |
|---|---|---|
| Round 1 | 6.24E+08 | 4.39E+08 |
| Round 2 | 5.10E+08 | 2.50E+08 |
| Round 3 | 4.85E+08 | 1.94E+08 |
| Round 4 | 4.64E+08 | 1.70E+08 |
| Round 5 | 4.61E+08 | 1.56E+08 |
| Round 6 | 4.61E+08 | 1.49E+08 |
| Round 7 | 4.60E+08 | 1.43E+08 |
| Round 8 | 4.60E+08 | 1.32E+08 |
| Round 9 | 4.60E+08 | 1.17E+08 |
| Round 10 | 4.59E+08 | 1.09E+08 |
| Round 11 | 4.58E+08 | 1.02E+08 |
| Round 12 | 4.58E+08 | 9.83E+07 |
| Round 13 | 4.58E+08 | 9.56E+07 |
| Round 14 | 4.57E+08 | 9.38E+07 |
| Round 15 | 4.57E+08 | 9.24E+07 |
| Round 16 | 4.57E+08 | 9.15E+07 |
| Round 17 | 4.57E+08 | 9.10E+07 |
| Round 18 | 4.56E+08 | 9.08E+07 |
| Round 19 | 4.56E+08 | 9.05E+07 |
| Round 20 | 4.56E+08 | 9.02E+07 |




Manhattan

| | C1 | C2 |
|---|---|---|
| Round 1 | 5.50E+05 | 1.43E+06 |
| Round 2 | 4.65E+05 | 1.08E+06 |
| Round 3 | 4.71E+05 | 9.73E+05 |
| Round 4 | 4.84E+05 | 8.96E+05 |
| Round 5 | 4.89E+05 | 8.65E+05 |
| Round 6 | 4.88E+05 | 8.46E+05 |
| Round 7 | 4.84E+05 | 8.27E+05 |
| Round 8 | 4.75E+05 | 8.04E+05 |
| Round 9 | 4.75E+05 | 7.56E+05 |
| Round 10 | 4.57E+05 | 7.17E+05 |
| Round 11 | 4.47E+05 | 6.95E+05 |
| Round 12 | 4.51E+05 | 6.84E+05 |
| Round 13 | 4.51E+05 | 6.75E+05 |
| Round 14 | 4.52E+05 | 6.67E+05 |
| Round 15 | 4.52E+05 | 6.64E+05 |
| Round 16 | 4.53E+05 | 6.60E+05 |
| Round 17 | 4.53E+05 | 6.56E+05 |
| Round 18 | 4.51E+05 | 6.53E+05 |
| Round 19 | 4.50E+05 | 6.51E+05 |
| Round 20 | 4.49E+05 | 6.50E+05 |




2.

Euclidean：

$$C1 = \frac{623660345.3064231 - 459021103.3422894}{623660345.3064231} \cong 26.39886\%$$

$$C2 = \frac{438747790.02791643 - 108547377.1785701}{438747790.02791643} \cong 75.2597\%$$

從改變的幅度來看，C2 improve 的結果較好，而從 cost 的結果來看，C2 也比 C1 還要好，當兩者都趨近穩定時，C2 的 cost 明顯低於 C1。所以在 Euclidean 的情況下，C2 是比較好的 initialization。

Manhattan：

$$C1 = \frac{550117.1420000052 - 457232.92011507315}{550117.1420000052} \cong 16.8844\%$$

$$C2 = \frac{1433739.309999996 - 717332.9025432286}{1433739.309999996} \cong 49.9677\%$$

從改變的幅度來看，C2 improve 的結果比較好；但是若從 cost 的結果來看， C1 的結果會比較好，cost 明顯低於 C2。因此，若從 improvement 的角度來說，C2 是比較好的 initialization；若從 cost 來看，C1 則一直都是低於 C2，所以是比較好的選擇。

3.

C1 在經過 Euclidean 的 K-Means 後，任兩個 data 間的 Euclidean Distance：

```
0 - 1 692.1578865536187
0 - 2 3490.2586403239793
0 - 3 205.75027883457204
0 - 4 346.71882253414816
0 - 5 512.6122467083617
0 - 6 444.7310005470825
0 - 7 566.2019922936282
0 - 8 1282.7708445154385
0 - 9 307.66912835221507
1 - 2 2798.8010531589434
1 - 3 897.6589863450828
1 - 4 1038.8268882911389
1 - 5 1204.0781989863117
1 - 6 1136.3273438149283
1 - 7 1257.4495275592424
1 - 8 669.8902282318555
1 - 9 412.076077167744
2 - 3 3695.114191079636
2 - 4 3836.9066381524567
2 - 5 4002.6890825730284
2 - 6 3934.8715588311575
2 - 7 4056.1355729719103
2 - 8 2294.57964158953
2 - 9 3195.9239010108936
3 - 4 142.43887392408647
3 - 5 309.50632446700047
3 - 6 241.7301145044183
3 - 7 363.2628951046584
3 - 8 1474.9454213642691
3 - 9 504.63411599571515
4 - 5 167.1498001315246
4 - 6 99.54554331498562
4 - 7 220.90178372040566
4 - 8 1615.852353440387
4 - 9 646.9305638786212
5 - 6 67.91186107588504
5 - 7 53.78989116172683
5 - 8 1782.2030486002302
5 - 9 814.0761501339795
6 - 7 121.63372043718282
6 - 8 1715.2531997144126
6 - 9 746.3355586141014
7 - 8 1835.6396718448902
7 - 9 867.8230790917461
8 - 9 975.3204225971708
```

C1 在經過 Euclidean 的 K-Means 後，任兩個 data 間的 Manhattan Distance：

```
0 - 1 728.9243139995409
0 - 2 3797.8990780180675
0 - 3 212.18109038688195
0 - 4 374.8904224625678
0 - 5 577.4020758222025
0 - 6 499.1578939470968
0 - 7 645.7697774866793
0 - 8 1731.0643066429416
0 - 9 406.70122510554586
1 - 2 3072.8886904466503
1 - 3 935.8853379058191
1 - 4 1100.833091013825
1 - 5 1303.8957233218873
1 - 6 1225.351713180189
1 - 7 1372.0922054892176
1 - 8 1005.2930456989247
1 - 9 490.9280581546785
2 - 3 4001.0380519416276
2 - 4 4170.304532612548
2 - 5 4372.788718801669
2 - 6 4294.952834221333
2 - 7 4440.719767637059
2 - 8 2513.422660256411
2 - 9 3396.4200031055902
3 - 4 171.36515415561516
3 - 5 375.2479208943975
3 - 6 296.25472354226696
3 - 7 443.49844537759145
3 - 8 1934.086959807074
3 - 9 609.749321623295
4 - 5 204.5229236423925
4 - 6 125.59678617977005
4 - 7 272.93491284339433
4 - 8 2102.86492281106
4 - 9 779.3972267080745
5 - 6 79.40168444202222
5 - 7 69.58987631971816
5 - 8 2306.3802505970657
5 - 9 983.019680661424
6 - 7 147.86570909768562
6 - 8 2227.555856782107
6 - 9 904.3702500156849
7 - 8 2374.545430478822
7 - 9 1050.9162214834769
8 - 9 1327.5839795031056
```

C2 在經過 Euclidean 的 K-Means 後，任兩個 data 間的 Euclidean Distance：

```
0 - 1 15760.12247224593
0 - 2 14110.83439088334
0 - 3 9045.32023455239
0 - 4 5567.684524118405
0 - 5 1924.6240815733204
0 - 6 1100.8590503593277
0 - 7 402.89054961102914
0 - 8 2105.4425755929597
0 - 9 3169.003772849924
1 - 2 11524.505650179837
1 - 3 6743.88410019246
1 - 4 10192.525007384162
1 - 5 14455.11937212132
1 - 6 14682.450992891092
1 - 7 15362.417960805125
1 - 8 13674.707531226235
1 - 9 12597.039559531104
2 - 3 9545.879403387185
2 - 4 10883.382187801386
2 - 5 12233.959804503613
2 - 6 13208.002933714424
2 - 7 13786.484182516106
2 - 8 12508.95738096874
2 - 9 11938.376127029482
3 - 4 3494.2224155718104
3 - 5 7718.222009696623
3 - 6 7957.775949135465
3 - 7 8644.807041005524
3 - 8 6947.820636329124
3 - 9 5876.330199605868
4 - 5 4404.562590797219
4 - 6 4492.458214360271
4 - 7 5169.9372911256405
4 - 8 3488.1585187816186
4 - 9 2407.918794485802
5 - 6 1182.864189045907
5 - 7 1615.7882361392917
5 - 8 1313.3274934048693
5 - 9 2153.771471752397
6 - 7 698.4881359277906
6 - 8 1010.1976652126849
6 - 9 2085.4606764072964
7 - 8 1702.7926583344838
7 - 9 2768.6077191659247
8 - 9 1080.534943939508
```

C2 在經過 Euclidean 的 K-Means 後，任兩個 data 間的 Manhattan Distance：

```
0 - 1 15772.614899885255
0 - 2 20215.645980206544
0 - 3 9533.17084939759
0 - 4 5604.200489099255
0 - 5 3088.0543184882386
0 - 6 1311.039156985083
0 - 7 471.26571999995156
0 - 8 2369.4121590413606
0 - 9 3349.657086008631
1 - 2 16003.499
1 - 3 7219.196666666668
1 - 4 10221.031
1 - 5 16105.3475
1 - 6 14909.169510714286
1 - 7 15434.460040787624
1 - 8 13950.575945454546
1 - 9 12776.883065217391
2 - 3 10690.484333333334
2 - 4 14613.552
2 - 5 17509.90275
2 - 6 18912.605410714285
2 - 7 19748.93569338959
2 - 8 17851.806836363638
2 - 9 16873.243673913043
3 - 4 3935.2926666666663
3 - 5 8896.389208333332
3 - 6 8228.355075
3 - 7 9065.404333333334
3 - 8 7168.732963636363
3 - 9 6190.679311594203
4 - 5 5893.070125
4 - 6 4696.975382142857
4 - 7 5221.252805907173
4 - 8 3737.707
4 - 9 2564.1705434782607
5 - 6 1781.8226714285715
5 - 7 2619.8113862517584
5 - 8 2162.8021454545456
5 - 9 3337.7462608695655
6 - 7 840.7225236939923
6 - 8 1068.9399724025977
6 - 9 2137.7882566770186
7 - 8 1901.208756322721
7 - 9 2883.734536812817
8 - 9 1176.4504256916996
```

C1 在經過 Manhattan 的 K-Means 後，任兩個 data 間的 Euclidean Distance：

```
0 - 1 2219.1772770509865
0 - 2 9948.044077639335
0 - 3 528.6997575475606
0 - 4 413.3650612071161
0 - 5 827.7188856579816
0 - 6 681.0349895443137
0 - 7 917.127382961168
0 - 8 832.1474343052389
0 - 9 729.0563485517976
1 - 2 7767.945602579569
1 - 3 2734.0498544640413
1 - 4 2628.4908097297634
1 - 5 3044.4778721252733
1 - 6 2898.7128939326617
1 - 7 3133.460130173686
1 - 8 1812.4545744763466
1 - 9 1491.3573457511582
2 - 3 10433.061351319797
2 - 4 10361.367486044566
2 - 5 10773.530838116945
2 - 6 10626.48859681842
2 - 7 10862.965776276442
2 - 8 9340.275232170257
2 - 9 9236.840021697923
3 - 4 221.37279398782263
3 - 5 375.1561884837036
3 - 6 249.3791882654921
3 - 7 457.25965255434755
3 - 8 1156.5833757939854
3 - 9 1251.1583460671166
4 - 5 415.9899852468605
4 - 6 270.74879157775905
4 - 7 505.07106661337866
4 - 8 1171.964205896139
4 - 9 1137.135265913954
5 - 6 147.04697388149492
5 - 7 89.4909165524104
5 - 8 1529.4640115204097
5 - 9 1553.1238066646654
6 - 7 236.51462239245419
6 - 8 1391.550421146714
6 - 9 1407.404400267174
7 - 8 1613.555789411286
7 - 9 1642.1286873773308
8 - 9 709.4077855501387
```

C1 在經過 Manhattan 的 K-Means 後，任兩個 data 間的 Manhattan Distance：

```
0 - 1 2341.017218605991
0 - 2 11929.300151785714
0 - 3 651.187488095238
0 - 4 496.33152119047617
0 - 5 947.7432364650634
0 - 6 770.7373834915085
0 - 7 1056.7995006298163
0 - 8 1260.5105607142857
0 - 9 737.7135730519481
1 - 2 9597.441187096774
1 - 3 2778.9457620967737
1 - 4 2830.1445281720426
1 - 5 3280.3591681796074
1 - 6 3104.2857711482065
1 - 7 3388.9826482565923
1 - 8 2380.460958064516
1 - 9 1605.2701287064187
2 - 3 12323.287569444445
2 - 4 12421.263079999999
2 - 5 12871.483428978225
2 - 6 12695.554202097901
2 - 7 12979.13318018672
2 - 8 10775.939185714284
2 - 9 11196.78698181818
3 - 4 335.951213
3 - 5 558.4692581658292
3 - 6 382.4633301282051
3 - 7 667.5332295988935
3 - 8 1653.8258869047618
3 - 9 1379.165172979798
4 - 5 452.86133068676713
4 - 6 276.3264914965034
4 - 7 561.8492485408023
4 - 8 1755.105532761905
4 - 9 1226.6603546666668
5 - 6 177.59316237363976
5 - 7 110.21762404606017
5 - 8 2205.3073830102894
5 - 9 1677.666863534846
6 - 7 287.42970773365636
6 - 8 2028.901615784216
6 - 9 1500.9934102564105
7 - 8 2314.667454756965
7 - 9 1786.8113163428895
8 - 9 1006.3678264069263
```

C2 在經過 Manhattan 的 K-Means 後，任兩個 data 間的 Euclidean Distance：

```
0 - 1 15747.234225995131
0 - 2 14100.144687804226
0 - 3 9032.333022974994
0 - 4 5554.786693382845
0 - 5 2006.7026683699517
0 - 6 1338.161125522521
0 - 7 514.627037539365
0 - 8 1571.2434198098995
0 - 9 3022.6608840606823
1 - 2 11524.505650179837
1 - 3 6743.88410019246
1 - 4 10192.525007384162
1 - 5 14474.554115568231
1 - 6 14412.056615494355
1 - 7 15239.87707116475
1 - 8 14328.226191823098
1 - 9 12731.397634823861
2 - 3 9545.879403387185
2 - 4 10883.382187801386
2 - 5 12167.79387138704
2 - 6 13125.351004065811
2 - 7 13684.606757319763
2 - 8 12643.985638343242
2 - 9 12006.39461776129
3 - 4 3494.2224155718104
3 - 5 7742.6281172713425
3 - 6 7694.276701483224
3 - 7 8521.197863130883
3 - 8 7588.404540222487
3 - 9 6009.820222838373
4 - 5 4452.971684507903
4 - 6 4219.760574098205
4 - 7 5047.516256062294
4 - 8 4167.636533016605
4 - 9 2542.5693542004556
5 - 6 1405.1090803330765
5 - 7 1637.7294382123869
5 - 8 910.9943878357352
5 - 9 2124.2633623517277
6 - 7 827.840658014979
6 - 8 566.5510174100833
6 - 9 1684.516011855046
7 - 8 1081.3793348240201
7 - 9 2511.458858671225
8 - 9 1649.3891719444812
```

C2 在經過 Manhattan 的 K-Means 後，任兩個 data 間的 Manhattan Distance：

```
0 - 1 15757.691264458323
0 - 2 20200.259435786043
0 - 3 9517.668232509728
0 - 4 5588.853634537063
0 - 5 3281.488246764413
0 - 6 1430.2086778758846
0 - 7 602.9548488263027
0 - 8 2102.553977579326
0 - 9 3211.4557560606645
1 - 2 16003.499
1 - 3 7219.196666666668
1 - 4 10221.031
1 - 5 16325.2705
1 - 6 14506.48588961039
1 - 7 15335.957402597402
1 - 8 14980.056095890412
1 - 9 12922.931357142857
2 - 3 10690.484333333334
2 - 4 14613.552
2 - 5 17521.517666666663
2 - 6 18775.12146103896
2 - 7 19602.262814935064
2 - 8 18111.885424657536
2 - 9 16995.133535714285
3 - 4 3935.2926666666663
3 - 5 9116.0245
3 - 6 8090.510188311688
3 - 7 8918.813116883115
3 - 8 7771.22207762557
3 - 9 6312.5300119047615
4 - 5 6110.8325
4 - 6 4293.5019025974025
4 - 7 5123.066808441558
4 - 8 4768.923
4 - 9 2710.0564999999997
5 - 6 1855.5799090909088
5 - 7 2682.5692337662335
5 - 8 1358.795894977169
5 - 9 3413.0361785714285
6 - 7 833.4302824675323
6 - 8 674.8275699163852
6 - 9 1784.5120454545456
7 - 8 1500.824883695072
7 - 9 2613.9973051948054
8 - 9 2062.251068003914
```