

Uebung 11

Multivariate Statistik

SoSe 2019

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Aufgabe 1 a)

```
clust <- read.csv("Ex11.csv")  
library('VIM')
```

```
clust <- format(clust, scientific = FALSE)
```

```
clust[c(1:40)] <- lapply(clust[c(1:40)], as.numeric)
```

Skalieren der Daten

```
scaled_data = t(as.matrix(scale(clust)))
```

```
#Let us apply kmeans for k=3 clusters
```

```
kmm = kmeans(scaled_data,5,nstart = 60,iter.max = 15) #we keep number of iter.max=15 to ensure the algo  
kmm
```

```
#> K-means clustering with 5 clusters of sizes 4, 20, 5, 4, 7
```

```
#>
```

```
#> Cluster means:
```

```
#>           1           2           3           4           5           6  
#> 1 -0.78319049 -0.490905861 -1.0648990  0.51260323 -0.54926363  0.05930680  
#> 2 -0.37161784 -0.130358987 -0.1191583 -0.27118251  0.09177602 -0.28814260  
#> 3  0.03702825  0.423730506 -0.1989750 -0.76928647  0.10145425 -0.05902151  
#> 4  0.89936710 -0.886482523 -0.4615916 -0.83505160  0.50537771 -0.26890651  
#> 5 -0.60257950  0.003687544  0.1084238 -0.01207629 -0.27916426 -0.32204246  
#>           7           8           9          10          11          12  
#> 1 -0.39487671 -0.1335777 -0.2372000  0.2735966  0.6870592  0.2779988  
#> 2 -0.12113998 -0.3758642 -0.3708198  1.6266369  1.7205980  1.6640746  
#> 3  0.54893370  0.7813757  0.3964986  0.6993071 -0.6314771  0.1629065  
#> 4 -0.06507313 -0.3327903  0.8609246 -0.3699414  0.3863596  0.6372845  
#> 5  0.38967844 -0.7004420  0.5342694 -0.2155363 -0.2602016 -0.1120106  
#>          13          14          15          16          17          18  
#> 1 -0.4819270 -0.2432016 -0.5271636  0.3573333  0.22185577  0.98873225  
#> 2  1.5375534  1.3451297  1.3942105  1.2634387  1.43957792  1.36123116  
#> 3  0.9113076 -0.1156746 -0.3424716  0.9084775  0.73365870 -0.21850362  
#> 4  0.8098699 -0.3860585  0.0205460  0.1730230 -0.06545958  0.34741768  
#> 5 -0.1185366 -0.3738859  0.2937372 -1.1420786 -0.37968330 -0.02035012  
#>          19          20          21          22          23          24  
#> 1 -0.6681783  1.1072158  0.2276142  0.94218789 -0.06738606 -0.49508852  
#> 2  1.4899759 -0.1229951 -0.2710697 -0.09074504 -0.09921251 -0.21186056  
#> 3  0.4475429 -0.2588835 -0.1567175  0.03364029  0.68532996  0.07316028  
#> 4 -0.5243921  0.6494378 -0.1156610  0.16968059  0.60072607 -0.81896302  
#> 5  0.5141695 -0.4658189  0.2163942 -0.53545219  0.45162831 -0.39463007  
#>          25          26          27          28          29          30  
#> 1 -0.52013622 -0.44397290 -0.4517606 -0.36028324 -0.57687231  0.5015907  
#> 2 -0.06460533 -0.13208107 -0.3669125  0.02543079 -0.21630879 -0.3471511
```

```

#> 3 -0.04761121 0.29692884 -0.2837121 -0.12370361 -0.42241011 -0.1949301
#> 4 0.27940209 0.01358927 0.1174558 0.35364984 0.54884580 0.3468985
#> 5 -0.17254591 0.40080397 0.4707122 0.06491765 -0.09214554 0.2607259
#>          31          32          33          34          35          36
#> 1 0.25472249 -0.7221197 0.004067165 0.87426310 0.3446951 0.3958152
#> 2 -0.26477050 -0.3687968 -0.105633410 0.07017628 -0.3253538 -0.2707660
#> 3 0.04559362 1.0624812 1.139961063 -0.43105209 0.1067249 -0.5576055
#> 4 0.01646702 0.3669387 -0.551271931 0.35127099 0.5371995 -1.2224206
#> 5 0.49711679 -0.3005947 0.175787416 -0.81855961 0.5509812 0.8543058
#>          37          38          39          40          41          42
#> 1 0.2704832 0.07022468 -0.06312819 -0.83725421 0.0247484214 -0.7335332
#> 2 -0.4575193 0.10645029 -0.14171386 -0.21895146 -0.5596232477 -0.2133864
#> 3 0.4245240 -0.38187188 0.56026033 -0.07384852 0.1709814400 0.1093972
#> 4 0.0169071 0.63986631 0.88099370 -0.22389973 -0.1950955800 -0.4292593
#> 5 0.2140117 0.08689231 -0.30190670 0.46809414 -0.0005607525 -0.4985573
#>          43          44          45          46          47          48
#> 1 0.60943720 0.87873084 -0.3116950 0.278828806 -0.09055204 0.79385306
#> 2 -0.28840940 0.27153837 0.1678662 -0.468286990 -0.03957990 0.37349399
#> 3 -0.08829451 -0.16063630 -0.1821624 -0.132270893 -0.01619105 -0.43353607
#> 4 0.61073608 -0.06383615 0.5150996 -0.604720107 -0.65857955 -0.60662434
#> 5 -0.31058999 -0.30264605 -0.1089855 -0.002363227 0.26386913 0.03379864
#>          49          50          51          52          53          54
#> 1 0.67799384 -0.2726834 0.4434038 0.281835704 -0.58060013 0.76978840
#> 2 0.16897893 -0.1973227 -0.1096104 -0.390645446 0.06101166 0.10154772
#> 3 -0.22809365 -0.3805828 -1.0178979 -0.200541916 -0.74920512 0.54258470
#> 4 -0.70520045 0.2909689 -0.7154054 0.246142740 -0.45745103 0.75539019
#> 5 0.08616386 -0.3052436 -0.2715040 0.008048417 -0.18964785 -0.07267809
#>          55          56          57          58          59          60
#> 1 0.7143900 -0.06877729 0.03029892 0.5050880 1.33557834 -0.73307169
#> 2 -0.2237806 -0.19949061 -0.28284603 -0.3253625 -0.02415848 -0.07723587
#> 3 0.1691613 -0.38815574 -0.61552503 0.1245877 -0.59907441 -0.82420937
#> 4 0.7742004 -0.11880494 -0.16762984 -0.2887009 -0.08102975 -0.22021091
#> 5 0.1857365 0.56783154 1.02010508 -0.5684191 0.10255646 -0.29005727
#>          61          62          63          64          65          66
#> 1 -0.7439120 -0.52931438 -1.0429400 0.5393907 0.007869601 -0.2978932
#> 2 -0.1716111 0.05565590 -0.1743188 -0.2410408 0.003959843 -0.5425985
#> 3 -0.1112320 0.04993868 -0.2731030 0.4645122 0.412764636 0.4379449
#> 4 -0.4506184 -0.44153805 0.2769826 0.5161701 0.558551012 -0.4066479
#> 5 -0.1263218 0.01281362 0.3007801 -0.5776088 0.194398358 0.4192999
#>          67          68          69          70          71          72
#> 1 -0.07667129 0.42463312 0.07883907 -0.09155771 -0.07671349 -0.31775849
#> 2 0.06912834 -0.05795774 -0.20241258 -0.17327019 -0.39225824 -0.27524147
#> 3 -0.66518627 -0.76179051 -0.83642418 -0.36087681 0.40541631 -0.61064502
#> 4 -1.21130113 0.19614305 -0.07921860 0.21516244 -0.16653874 -0.42441137
#> 5 0.64287100 0.16087391 -0.18516472 0.34123087 -0.32798440 0.08448288
#>          73          74          75          76          77          78
#> 1 0.36263196 -0.02847437 -0.29489093 0.90374261 0.18491478 -0.8488177
#> 2 -0.43799840 -0.18168741 -0.37088891 -0.48893654 -0.76899089 -0.1778989
#> 3 -0.01878502 0.07400974 -0.17324538 0.04104825 -0.08904429 0.3713913
#> 4 0.77825893 1.04405293 0.06517628 0.57236468 -0.44827230 0.3683654
#> 5 -0.34669917 0.55322198 1.15798140 0.30114732 -0.39616205 -0.4629424
#>          79          80          81          82          83          84
#> 1 -0.1208858 0.73538695 -0.06788379 -0.8345237 0.30032278 1.47121663

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#> 2 -0.3008811 -0.13918443 0.08066834 -0.2406257 -0.27338927 -0.07868906
#> 3 -0.7853967 0.15534807 -0.03604641 0.4211628 1.18372354 -0.83169212
#> 4 -1.1991009 0.07575408 0.03190997 0.3204938 -0.02830591 -0.60074608
#> 5 -0.1382745 -0.17985533 0.39347616 0.4478669 -0.09494545 0.40052385
#>      85      86      87      88      89      90
#> 1 -0.16395288 -0.85655827 -1.099193232 0.28350738 0.38691686 -0.1134014
#> 2 -0.28508312 -0.02402128 -0.385837141 -0.03740294 -0.08604632 -0.4574942
#> 3 -0.01600066 -0.35980119 0.657459720 0.69289823 -0.00906176 0.0528955
#> 4 0.11594148 -0.45794949 0.290534409 0.81395907 -0.36037796 0.6964196
#> 5 -0.25613557 0.26865930 -0.008919284 -0.12538386 -0.38962834 -0.3568768
#>      91      92      93      94      95      96
#> 1 -0.44601228 -0.3565933 -0.2100048 0.15435173 -0.1903605 0.2258969
#> 2 -0.11113014 -0.2107736 -0.2856978 0.22069225 -0.3817440 -0.5200555
#> 3 -0.01632339 -0.1829915 -0.7954900 0.52777005 0.5607689 0.6251881
#> 4 -0.65795524 0.7831772 -0.5708544 0.56172795 -0.2821855 -0.2977616
#> 5 0.28202300 -0.4553339 -0.2474893 0.01959613 0.3073819 -0.6309792
#>      97      98      99      100      101      102
#> 1 0.06090514 0.1679564 0.33668665 0.1987313 -0.31713962 0.11908894
#> 2 -0.38868732 -0.1842695 -0.04823037 -0.2101826 -0.60903738 0.06862975
#> 3 0.24841885 0.1724229 -0.17583257 0.1275149 0.10328421 -0.40392214
#> 4 -0.06477453 -0.2851845 -0.44305405 -0.6438540 0.38261767 0.15830626
#> 5 0.78759061 0.3526806 -0.47058507 -0.2796540 0.01732605 0.10608407
#>      103      104      105      106      107      108
#> 1 -0.3420998 0.57121002 0.56128863 0.32416558 0.46074442 0.1774898
#> 2 -0.4199700 0.03628597 -0.33782185 -0.09043603 -0.39731476 -0.3198139
#> 3 1.3448524 0.69942133 0.35148298 -0.45828920 -0.21850482 -0.6044132
#> 4 0.4590923 0.68110914 0.08844670 1.14608218 0.03920111 0.9598172
#> 5 0.1131651 0.04225576 0.06305415 -0.18512968 -0.14359554 0.1754803
#>      109      110      111      112      113      114
#> 1 0.46605682 -0.0575877 0.07936352 -0.39001276 -0.44369862 0.5067358
#> 2 -0.18713798 -0.1828621 -0.41536508 -0.28570623 -0.15815029 -0.6940744
#> 3 0.09290962 -0.3503827 -0.21609216 -0.15212597 -0.17740626 -0.5049232
#> 4 0.07900613 0.2755472 0.02449221 -0.45533273 0.01489629 -1.1029775
#> 5 0.35435511 0.1548455 0.15313573 0.09361641 -0.04451963 -0.7793607
#>      115      116      117      118      119      120
#> 1 -0.4311119 0.04180792 0.1682408 -0.02377467 -0.65666646 0.6590055
#> 2 -0.6548391 -0.28193948 -0.0248672 -0.16917252 -0.46087125 -0.1799984
#> 3 0.3539199 0.92622652 0.3167594 0.27955687 0.04582231 -0.7592796
#> 4 0.9265978 0.86698324 -1.3565611 -0.30484286 -0.57273684 0.2835622
#> 5 0.1103892 -0.68626534 -0.3635829 0.01494635 -0.56794132 -0.7830810
#>      121      122      123      124      125      126
#> 1 -0.99588094 0.65262779 0.1431587 0.34448214 -0.4285678 -0.1140092
#> 2 -0.28478555 -0.12802134 -0.6209063 0.14749476 -0.2707339 -0.3693148
#> 3 0.33189204 -0.07728675 0.4949111 -0.45983800 0.3212993 -0.1555801
#> 4 -0.07017453 0.19610431 -1.0721976 0.30525313 -0.6272918 0.3729804
#> 5 -0.17365393 0.42011493 0.1678794 0.03719224 0.1166024 0.4035677
#>      127      128      129      130      131      132
#> 1 -1.07589491 -0.46488600 1.14166708 -0.24816891 0.92626262 -0.17280460
#> 2 -0.01486872 -0.04566675 -0.37258822 -0.59444011 0.01843100 -0.12154245
#> 3 -0.01957660 0.92651838 0.08352838 0.73736443 -0.55938237 0.04834005
#> 4 -0.06261193 0.25621554 0.64060517 -1.03706551 0.09823987 -0.21000660
#> 5 -0.20045935 -0.35322913 0.22287757 -0.03528913 -0.10060242 0.25084324
#>      133      134      135      136      137      138

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#> 1 1.64119959 0.6320004 0.10916596 -0.38459669 -0.79952701 -0.18998675
#> 2 -0.31082629 -0.5052728 0.09234226 -0.35540065 -0.24239649 -0.45992170
#> 3 -0.53074720 0.3990826 0.35102607 0.99075756 0.27878688 -0.03966262
#> 4 0.05212207 0.8204540 0.98242612 0.31282913 -0.41041826 -0.48491513
#> 5 0.09238298 0.5598242 -0.08686416 0.01947662 0.02268627 -0.85705472
#>      139      140      141      142      143      144
#> 1 0.74610899 -0.09379896 -0.5642678 -0.47319445 -0.1859028 -0.6810929
#> 2 0.03507214 -0.59107106 0.1049791 -0.18441081 -0.1877522 -0.1874742
#> 3 0.61429970 -0.25260242 -0.6775036 0.84955351 0.6622943 -0.5576952
#> 4 0.42563242 0.27362557 0.3653238 -0.09656491 1.0341049 0.5994019
#> 5 -0.13592138 -0.38648221 -0.4361075 -0.87508398 0.2383186 -0.4179083
#>      145      146      147      148      149      150
#> 1 -0.1638914 0.06551669 0.3956722 0.06161988 -0.03001500 0.2994339
#> 2 0.0273816 -0.20573727 -0.4051609 -0.52708075 -0.04983021 -0.1545578
#> 3 1.0043703 0.59038817 -0.6427747 -0.42992986 0.13715207 -0.4033692
#> 4 -0.6986928 -0.96579433 -0.7547006 -0.34956143 -0.68223123 0.6145225
#> 5 0.1925044 -0.22933210 -0.2175024 0.30322227 0.62191895 0.3030380
#>      151      152      153      154      155      156
#> 1 0.1634228 -0.1315224 -0.52381821 0.07497978 -1.45190328 0.4451738
#> 2 -0.1998927 -0.0248404 -0.33435454 -0.10711989 0.18935530 -0.3908296
#> 3 0.2088469 0.3367777 -0.14166261 -0.84113460 -0.76121773 -0.1619682
#> 4 -0.7780430 -1.5389609 -0.04884868 0.91687489 -0.76938465 -0.5787112
#> 5 0.6307117 -0.6832642 0.28338788 -0.41845877 0.07204854 -0.1129728
#>      157      158      159      160      161      162
#> 1 -0.003566287 0.4984736 0.68412281 -0.438972246 0.66048564 -0.6591514
#> 2 -0.149268758 -0.4070264 -0.04287047 -0.136501894 -0.19811885 -0.3636744
#> 3 -0.509939705 0.2374345 -0.82615830 -0.143255899 0.22359490 -0.5565352
#> 4 -0.246266527 0.3018726 0.46158681 -0.415286370 0.85854065 -0.2297885
#> 5 -0.098293775 0.2038413 0.84065483 0.004465456 -0.03857659 0.2723712
#>      163      164      165      166      167
#> 1 -0.944913305 0.04471201 -0.01262969 0.50623115 -0.29404154
#> 2 -0.214363686 -0.08253502 -0.01422696 0.01501698 -0.24345103
#> 3 -0.003856017 0.12164814 -0.17654210 -0.46553276 -0.35246431
#> 4 -0.020230235 0.36793412 -0.10892877 -0.32350773 -0.01116698
#> 5 0.626847387 0.78741362 0.38775943 0.60959543 -0.18749869
#>      168      169      170      171      172      173
#> 1 -0.324615962 0.02904725 0.12550014 -0.1892354 0.025702365 0.01872816
#> 2 -0.332565488 -0.09039814 -0.33426566 -0.6903169 -0.476215285 -0.31287627
#> 3 -0.008771016 0.56472586 -0.21658343 0.6693724 -0.563360074 -0.07228283
#> 4 0.035884965 -1.16392063 0.09822182 -0.1732114 -0.241641026 -0.41615442
#> 5 0.687567332 -0.01203657 0.58756100 0.4381306 -0.008153906 -0.09173515
#>      174      175      176      177      178      179
#> 1 0.28399307 -0.1241269 0.55564689 0.16528210 0.06335519 -0.42210989
#> 2 -0.17482762 0.0331164 0.01718515 0.06853988 -0.44442226 -0.06689367
#> 3 0.07529012 0.4530830 -0.50742180 -0.32582973 0.36484028 -0.18994898
#> 4 -0.21300637 -0.2414962 -0.24626536 0.23136465 0.66982775 0.02155075
#> 5 -0.44075626 0.1412306 0.41348304 -0.13689179 -0.31880869 -0.27238859
#>      180      181      182      183      184      185
#> 1 0.33945918 -0.05306831 -0.009699505 -0.05494839 -0.11863998 -0.6723188
#> 2 -0.34657703 -0.20360180 -0.055260829 0.04141384 -0.04641734 -0.3724033
#> 3 -0.07931529 0.76747295 -0.342524081 0.61894952 -0.54552151 -0.8772323
#> 4 0.69454433 -0.12922965 -0.895039039 0.32433287 0.56067851 -0.1786226
#> 5 0.06411402 0.12255023 -0.214403781 0.14638787 0.44479542 -0.3944338

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#>          186          187          188          189          190          191
#> 1 -0.1308761  0.1820566344 -1.43672269 -0.7931617 -0.009340915  0.50418100
#> 2 -0.1648925 -0.4662335164 -0.19450330 -0.2765365 -0.437107682 -0.02824591
#> 3 -0.1716809  0.0007245839 -0.10657545  0.7486885  0.127645689 -1.16047060
#> 4 -0.2920132 -0.3917533732  0.46484282 -0.5721441  0.299278495  0.29250463
#> 5  0.1902300 -0.0702088630 -0.02747061 -0.5228911 -0.015303180 -0.23120340
#>          192          193          194          195          196
#> 1  0.296240364 -0.1316477 -0.48136477 -0.186579852 -0.37784695
#> 2 -0.013719797 -0.2295993  0.03871662 -0.008145671 -0.05858679
#> 3  0.164225772  1.2179206  0.47112904  0.474065677 -0.49551791
#> 4 -0.574731085 -0.2937810 -0.53659313 -0.388445854  0.15915305
#> 5 -0.004181992 -0.2507696 -0.60632940  0.293638957  0.01380123
#>          197          198          199          200          201
#> 1 -0.2981152803  0.17481905  0.46786942 -0.74620114  0.40077326
#> 2 -0.2263358103 -0.05257738 -0.20729998 -0.05471169 -0.29813812
#> 3 -1.0837088929  0.05119780 -0.03766335  0.06962379 -0.31009826
#> 4 -0.2155062140 -0.07449045 -0.40002232 -0.27756480 -0.27322258
#> 5 -0.0002529404 -0.21557151 -0.49016444 -0.27383758 -0.04537234
#>          202          203          204          205          206          207
#> 1  0.28049117  0.06989101  1.11890002 -0.19947071  0.35767464 -0.79637225
#> 2 -0.47920679 -0.11496417 -0.15887606 -0.02950543 -0.29732272 -0.10165337
#> 3  0.02710330  0.29364789  0.10247114 -0.78886119  0.01510548  0.03628103
#> 4 -0.29560537  0.39387294 -0.84916103  0.33365416 -0.17906162 -0.04043877
#> 5 -0.01241565  0.15320155  0.03560888  0.24982700  0.46816146  0.64633951
#>          208          209          210          211          212          213
#> 1 -0.2264914 -0.4595265  0.03204052  0.23877756 -0.77338759 -0.6087988
#> 2 -0.1573904 -0.3568093 -0.28051747 -0.08381073 -0.10372380  0.1112912
#> 3  0.2592052  0.2572658 -0.15248932 -0.04943063 -0.03265631  0.1476702
#> 4  0.7450872 -0.2799220 -0.13722361 -1.23632639  0.37896421 -0.2394464
#> 5 -0.4289289  0.5083443 -0.19468727 -0.21357937  0.20394085 -0.7725812
#>          214          215          216          217          218          219
#> 1 -0.17067634  0.02476100  0.22214465  0.44570752  0.8641705 -0.5112934
#> 2 -0.09024021 -0.04638255 -0.25158235 -0.07630523 -0.2811819 -0.4373923
#> 3  0.25383914 -0.66970708 -0.15009582  0.19949513  0.2730318 -0.9976671
#> 4  0.77022228 -0.74398811 -0.07078981 -0.53404364 -0.8919359  0.6238815
#> 5  0.29892625  0.48862026  0.73856982  0.27964841  0.9062737  0.3840088
#>          220          221          222          223          224          225
#> 1 -0.9541388  1.0622774 -0.71897773  0.5455919  0.4170486 -0.1203765
#> 2 -0.1759834 -0.3960632 -0.07066302 -0.6015252 -0.2032386 -0.2298713
#> 3 -0.3999141 -0.3913652 -0.11742526 -0.8717464  0.2649626  0.5435255
#> 4 -0.5566918  0.4658233  0.31099044 -0.3943600 -0.2721998 -0.4570579
#> 5  0.1292045  0.1800003 -0.15950083  0.6502578 -0.3795136  0.3745273
#>          226          227          228          229          230          231
#> 1  0.3542746 -0.8212967  0.26843993  1.14341767 -0.13249192  0.44256694
#> 2  0.2212300 -0.3419037 -0.06864663 -0.09308773 -0.32472983 -0.04280057
#> 3 -0.0678005 -0.1850524 -0.62208340  0.29606390 -0.07805446 -0.48465490
#> 4  0.2648356  0.5033328  0.13233778 -0.84231642  1.16681543 -0.91107873
#> 5 -0.2324581  0.3152065  0.19061435 -0.77065317  0.66697194  0.39077531
#>          232          233          234          235          236          237
#> 1  0.1858946  0.36959315  0.61467929 -0.24822058 -0.16427799 -0.7446304
#> 2 -0.3929308 -0.32400254 -0.12082307 -0.26343321 -0.11857208 -0.4379556
#> 3  0.3468832  0.05046548  0.39869891  0.96559455  0.03328685  0.5187517
#> 4 -0.5513142  0.04038679  0.56031153  0.06584341 -0.14973117 -0.7744570

```



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#> 5 -0.3679888 -0.82314938 0.04865439 -0.35516239 -0.42146017 -0.4661391
#>      238      239      240      241      242      243
#> 1 1.0378009 0.4161627 -0.53807222 -0.7436213 -0.4805238 0.02799714
#> 2 -0.1459399 -0.2161600 -0.20130498 -0.3089057 0.1601684 0.03920476
#> 3 -0.3118578 -0.4112022 -0.06929313 -0.2431546 -0.2437638 -0.61196425
#> 4 0.9410025 -0.5726428 0.15424684 -0.4781627 -0.5377578 0.44867130
#> 5 0.1210851 -0.1023701 -0.21490378 0.2777816 -0.4459685 0.44493831
#>      244      245      246      247      248      249
#> 1 0.27710936 0.07369758 -0.7705080 0.08363008 -0.222435057 0.17973221
#> 2 -0.44501823 -0.16336883 -0.2708567 0.10481967 -0.142031867 0.03639378
#> 3 0.31406700 0.30339352 -0.3374556 -0.46699953 -0.004375853 0.60983631
#> 4 -0.63315506 0.11257103 -0.2595357 0.67463222 0.122960279 0.36131963
#> 5 0.01129367 0.46267055 -0.1806227 -0.02938150 0.405628381 0.27446116
#>      250      251      252      253      254      255
#> 1 0.24871080 -1.04194850 0.93602017 -0.2894260 0.1794442 0.04932595
#> 2 -0.54103175 -0.32408773 -0.04088518 -0.1988928 -0.1105994 -0.24760256
#> 3 0.18260785 0.07539887 0.07905145 0.8366328 -0.2736586 -0.91518007
#> 4 -0.03359202 -0.64842887 -0.13169675 0.3386403 -0.4237869 0.56336441
#> 5 -0.08257602 -0.14125264 -0.66089106 0.1155751 0.6222840 0.45797379
#>      256      257      258      259      260      261
#> 1 0.03477383 -0.87984830 0.40434173 1.5239140 -0.002196145 -0.36086655
#> 2 -0.33944795 0.05478381 -0.07562479 -0.4515204 -0.115031076 -0.25062325
#> 3 0.48251214 -0.03303544 0.01947692 -0.9591814 -0.416524299 0.30052738
#> 4 0.23565256 -0.30957957 1.06966037 -0.6025135 -0.053340209 -0.72057457
#> 5 -0.36156726 -0.21237582 0.16512121 -0.5308487 0.691027097 -0.03049815
#>      262      263      264      265      266      267
#> 1 0.2339480 1.1881637 -0.41690605 0.14355225 -0.38514991 -0.5458770
#> 2 -0.4279321 -0.0402355 0.04769223 0.06554644 -0.09646024 -0.3496827
#> 3 0.4132686 0.2042736 0.11240105 -0.76827500 -0.28956870 -0.4405369
#> 4 0.2218653 0.7575626 -0.19911222 0.51931534 0.64207356 -0.5213245
#> 5 0.6573086 0.3566815 -0.40558404 -0.49190639 -0.56148601 0.3646223
#>      268      269      270      271      272      273
#> 1 -0.16788794 -0.677954245 -0.3253811 0.11916978 0.2604933 -0.6204638
#> 2 0.06494382 0.002909401 -0.2027082 -0.25075130 -0.2314319 0.3381160
#> 3 0.26523381 -0.188022859 0.2864859 -0.34826332 -0.2699968 -0.6398033
#> 4 -0.70375883 1.462917829 -1.6003485 0.02161089 0.2886306 0.4289054
#> 5 -0.01728366 0.555947273 -0.1403526 -0.23821127 0.3877383 0.8578023
#>      274      275      276      277      278      279
#> 1 0.24226107 -0.38123253 -0.84288409 -0.34060213 -0.5145170 -0.39517984
#> 2 -0.33674018 -0.05484301 -0.15554869 0.04224552 0.0387671 0.04702720
#> 3 0.07165287 -0.25318661 -0.26178472 -0.18181792 0.4381262 -0.76035065
#> 4 0.35731161 1.07211253 -0.01027216 0.05621291 -0.4504898 0.31291046
#> 5 -0.06305001 0.15931874 -0.43454086 0.12453023 0.2167145 -0.03487937
#>      280      281      282      283      284      285
#> 1 -0.97496722 -0.7847612 -0.01579165 -0.2225745 -0.13406296 -0.10324950
#> 2 -0.41011517 -0.2832606 -0.06664182 0.1157681 -0.15034506 0.04149202
#> 3 0.93335589 0.2640518 0.78949722 0.1487492 0.01427416 0.04584291
#> 4 -0.09567964 -0.1996855 -0.52039707 -1.1104042 -0.67565488 0.10080301
#> 5 0.13565148 0.1219156 -0.75257171 0.2351882 0.42904601 -0.48572758
#>      286      287      288      289      290      291
#> 1 -0.262402798 0.5978507 0.006875303 0.04214186 -1.05950601 -0.5268225
#> 2 -0.247258927 -0.3642095 -0.265870988 -0.01491961 -0.24217600 -0.1473592
#> 3 0.008539938 -0.4328292 0.165660403 -0.12430016 -0.17395338 0.1874795

```

```

#> 4 -0.430255896 -0.3775761 -0.531150996 0.79663857 0.84098630 -0.5545888
#> 5 0.560631080 0.3246904 -0.599223492 -0.16718959 -0.01614746 -0.1404405
#>      292      293      294      295      296      297
#> 1 0.33252897 -0.2525349 -0.33154454 0.15130182 0.46741308 0.1813776
#> 2 -0.58905953 -0.2297312 -0.25714851 -0.23782320 -0.31711644 -0.3028338
#> 3 0.67759437 0.2709382 0.01195682 -0.25277207 -0.24387621 0.1272075
#> 4 0.19966888 0.5866494 0.12768882 -0.07959866 0.19670781 -0.8366950
#> 5 -0.03070189 -0.4693222 -0.03497585 0.16669478 0.04431829 0.3103002
#>      298      299      300      301      302      303
#> 1 -0.4701671 -0.39564346 0.23185385 -0.3110922 0.7439579 -0.53397962
#> 2 -0.1451964 -0.18407702 -0.03907029 -0.1778240 -0.2214404 -0.03069261
#> 3 0.4147837 0.85795055 0.49734716 1.0817143 0.6284931 -0.56512063
#> 4 0.9694702 0.50386914 -0.69390026 0.2696656 -0.6501822 0.25098592
#> 5 -0.5974186 -0.09536663 -0.12482276 0.2436195 0.4252598 -0.10586664
#>      304      305      306      307      308      309
#> 1 -0.05304700 -0.341541176 -0.63943446 -0.85220806 -0.32272989 0.14425971
#> 2 -0.39330553 -0.128477272 -0.23837485 -0.25225570 -0.12461752 -0.32541250
#> 3 0.87582842 0.747959947 -0.09789844 -0.34975599 -0.19425254 1.03416519
#> 4 -0.28535071 -0.004958041 1.03055437 0.97386127 -0.63833202 0.24933279
#> 5 0.07880777 0.179944880 0.08958325 -0.05664419 0.03798823 -0.07228931
#>      310      311      312      313      314      315
#> 1 -0.70821440 0.30005875 -0.2493317 0.13675384 -0.3639423 0.6374543
#> 2 -0.18944727 -0.16876405 -0.1653466 -0.04097014 -0.2481535 -0.2592501
#> 3 -0.26784255 -0.42454943 0.9792883 -0.02372959 0.2412043 -0.3553563
#> 4 -0.04557877 0.70256474 -0.8566840 -0.22284129 0.6405672 -0.2789590
#> 5 0.74374905 -0.03656166 0.8117475 -0.47955603 -0.3194781 -0.4691381
#>      316      317      318      319      320
#> 1 0.2223656 -0.34211941 -0.828927030 -0.140623355 0.575562860
#> 2 -0.3146802 -0.18400773 -0.137916482 0.047753526 0.006345852
#> 3 0.9004006 0.08630752 0.179946820 0.003227859 0.461031810
#> 4 0.3953488 -0.35727268 0.004913409 -0.250990301 0.451564525
#> 5 -0.2921420 0.29676398 0.792132156 0.537049977 -0.049833702
#>      321      322      323      324      325
#> 1 0.119711621 -0.709501690 0.04548457 0.4026670 -0.587450186
#> 2 0.001958132 0.003370876 -0.14369827 -0.1064390 -0.001195293
#> 3 -0.243563301 0.150717712 -0.39439455 0.3696635 0.001534561
#> 4 0.388025406 0.712971215 -0.36992640 -0.1643650 -1.049509746
#> 5 -0.054752385 0.333219903 -0.23336660 -0.4409084 -0.038759436
#>      326      327      328      329      330      331
#> 1 0.09924276 -0.04531448 -0.26472306 0.25104815 -0.41389479 -0.1769660
#> 2 0.04353154 -0.01745769 -0.19870906 -0.27051534 0.05846314 -0.4936190
#> 3 -0.77302678 -0.06660898 -0.14582233 -0.04018509 -0.67820224 -1.0310421
#> 4 -0.62347152 0.41886163 -0.03864065 0.37924442 -0.11442262 0.3618453
#> 5 0.03956489 0.33032072 0.48178558 -0.36112209 -0.73250688 0.3778858
#>      332      333      334      335      336      337
#> 1 -0.2920346 -0.88586877 0.41449245 -0.09969756 1.42235326 -0.04107408
#> 2 -0.1503602 -0.07860417 -0.06975969 -0.10062988 -0.40539145 -0.27236425
#> 3 0.9889065 -0.20864125 0.46759835 -0.47206400 0.33018811 -0.88639979
#> 4 -0.7412410 -0.05084770 -0.13206321 0.64350893 0.22149348 -0.05291229
#> 5 -0.4502054 0.03656155 -0.08379353 0.08488375 0.09403319 0.34923113
#>      338      339      340      341      342      343
#> 1 0.80773454 -0.5996987 0.25268863 0.1476692 -1.03644678 0.16091365
#> 2 -0.11237753 -0.2911199 -0.27427107 0.2414119 -0.01759022 0.09583896

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#> 3 -0.03833185 0.2139996 0.39144537 -0.3113817 0.71011817 -0.13585685
#> 4 0.65440712 -0.7133311 1.30596992 0.4845319 0.54265747 0.11150413
#> 5 0.13224253 0.5792889 -0.07551028 0.1436556 0.45534317 0.17447723
#>      344      345      346      347      348      349
#> 1 -0.37176652 -0.4228240 -0.23409827 -0.1710362 0.46529874 0.09994455
#> 2 -0.09698348 -0.1572625 -0.06172079 -0.2623966 -0.09999711 -0.19624252
#> 3 0.85622337 -0.2552288 -0.68163560 0.1388101 0.70765168 -0.21759576
#> 4 -0.30278369 -1.0136874 0.18893868 0.2745440 -0.16293237 0.40872734
#> 5 -0.14129002 -0.3932199 0.21841404 -0.3832533 0.12783800 0.11729302
#>      350      351      352      353      354      355
#> 1 0.1855504 -0.54945308 0.03860849 0.1298864 -0.2008702 -0.02056044
#> 2 -0.3284257 -0.05405561 -0.31294779 -0.4502637 -0.1579265 -0.29107030
#> 3 0.2085815 0.47041559 0.02132755 0.6019723 0.5316094 -0.07523944
#> 4 -0.6309554 0.64636481 0.42841413 -0.1042415 -0.3580303 0.30346647
#> 5 -0.9179963 0.10792505 0.33043762 -0.2721016 -0.2120456 0.25024670
#>      356      357      358      359      360      361
#> 1 0.99517526 -0.56057616 -0.06962256 0.3515926 0.16077494 -0.32466019
#> 2 -0.16708591 -0.13013313 -0.33794069 -0.3091052 -0.45904091 -0.20875168
#> 3 -0.09905788 -0.16890124 -0.09646622 -0.4654250 -0.46147520 -0.09541277
#> 4 0.71975639 -0.55651632 0.17987517 0.1125971 -1.00365607 0.48928733
#> 5 -0.17624073 0.07514806 0.21732787 0.4899055 -0.04716185 -0.41250038
#>      362      363      364      365      366      367
#> 1 -0.05922967 -0.4646089 -0.1785681 0.46027876 -0.65281112 0.36082525
#> 2 -0.07006777 -0.1393705 -0.1542747 -0.25620489 0.01542249 -0.38631902
#> 3 0.54083391 0.5594272 -0.3330348 -0.01739434 0.53144556 0.51108613
#> 4 0.32441793 1.3130142 -0.0940888 -0.60988379 0.31034869 0.07031398
#> 5 -0.49038101 -0.5842797 0.2991317 0.17397919 0.40380038 -0.14546477
#>      368      369      370      371      372      373
#> 1 0.18317938 -0.13160696 0.69274209 0.1806447 0.5773552 -0.75429855
#> 2 -0.36712460 -0.24027709 -0.49149346 -0.2708552 -0.6737554 -0.33842763
#> 3 -0.29105158 -0.62139525 0.01370683 -0.1900159 0.1529820 0.25597655
#> 4 0.38629462 -0.09080183 -0.51035873 0.5410262 0.1502805 0.07979357
#> 5 -0.03728689 -0.10251314 -0.45012348 -0.1784819 -0.3514918 0.11029479
#>      374      375      376      377      378      379
#> 1 -0.4069402 -0.87638664 0.6704236 -0.199121588 -0.2394319 -0.1515465
#> 2 -0.5355013 -0.31583914 -0.5327149 -0.221536710 -0.3636887 -0.1813889
#> 3 -0.4011867 -0.22720508 0.6700846 -1.005188877 0.4209129 0.0195178
#> 4 0.7405085 1.08340643 -0.9715184 -0.224578184 -0.1178642 0.3378584
#> 5 0.3318547 -0.01264365 -0.5582406 -0.008133706 0.1677135 0.4032372
#>      380      381      382      383      384      385
#> 1 0.42771746 -0.5072783 0.6025567 0.59242461 -0.8203269 0.3141775
#> 2 -0.25646959 -0.3060971 -0.4081535 -0.37485496 -0.2736635 -0.1785327
#> 3 -0.52265621 -0.8057297 -0.8151382 -0.38244210 0.3307753 -0.7194329
#> 4 -0.08106084 -0.1823275 -0.3878171 0.46517849 0.1076852 -0.1290640
#> 5 -0.28132884 0.8205995 0.6313904 -0.01557146 0.5597264 0.4052606
#>      386      387      388      389      390      391
#> 1 -0.6769798 -0.12788030 0.8919974 0.2949708 -0.18042174 -0.3924494
#> 2 -0.5832506 -0.33211130 -0.2824488 -0.2438087 -0.36787504 -0.3123191
#> 3 0.3501657 -0.75921776 0.4640110 -0.3585379 -0.06654572 0.4165018
#> 4 0.4352784 1.31733958 0.1803132 0.1350609 1.44203681 0.1940563
#> 5 -0.4828357 0.09135947 0.5476052 0.3044188 0.35649986 -0.2786432
#>      392      393      394      395      396      397
#> 1 0.9753885 0.211874225 1.20023173 -0.2424197 0.26477857 0.54819208

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#> 2 -0.2975324 -0.306680702 0.06409153 -0.5742639 -0.08934538 0.02065623
#> 3 0.6662049 0.546848689 -0.09583335 0.2746839 0.11573568 0.04180138
#> 4 0.4152580 0.307405500 -0.16403233 -0.5701874 0.28619579 0.02508277
#> 5 0.2434140 0.004148762 -0.70276684 -0.2411100 0.48518124 -0.35853858
#>      398      399      400      401      402      403
#> 1 0.1158466 0.428822792 -0.5596434 0.45262523 0.37316434 0.67681765
#> 2 -0.2940273 0.069844184 -0.6542466 -0.36605872 -0.09253658 -0.19291976
#> 3 -0.1958533 0.587830801 0.1349960 -0.47218751 0.05819614 -0.60063461
#> 4 0.1966767 0.008641107 -1.4355137 1.25571204 -0.81793726 0.02975207
#> 5 -0.2110634 -0.239684632 0.5284955 0.07484189 -0.43230207 0.30762263
#>      404      405      406      407      408      409
#> 1 -0.20151842 -0.04247271 -0.6268045 0.58015434 0.48245525 -0.3657118
#> 2 -0.28613375 -0.15010200 -0.1686094 0.01137207 -0.18227131 -0.4122705
#> 3 0.12531745 -0.01729958 0.1823735 0.30715326 -0.19935850 0.2199596
#> 4 0.39913923 0.56652129 -0.6807854 -0.12641051 -0.36917155 0.4147116
#> 5 0.06276683 -0.15912653 0.6988902 0.45839435 0.02322228 0.6587007
#>      410      411      412      413      414      415
#> 1 0.10636764 0.058301912 0.68555670 0.25945030 1.27439211 -1.02362228
#> 2 -0.08372707 -0.002538823 -0.03598376 -0.34680987 -0.44714677 -0.37552233
#> 3 0.28727605 -0.336954505 -0.03204302 -0.28544004 -0.26001039 0.05558587
#> 4 -0.56772381 0.118307745 0.62089055 0.04725894 -0.02630517 -0.26169073
#> 5 -0.33203267 -0.081155314 -0.53259576 -0.19635993 -0.88359528 -0.76569823
#>      416      417      418      419      420      421
#> 1 0.37962244 0.5386123 0.17522030 -0.52949880 0.07827378 0.24159622
#> 2 -0.26240783 -0.1413251 -0.09062592 -0.17284778 -0.07375267 -0.33212074
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#> 4 0.49062355 -0.6012888 0.36118465 -0.56302389 -0.05714889 -0.57852355
#> 5 0.23613427 0.2215923 -0.37465818 -0.06244950 0.21983158 -0.07841564
#>      422      423      424      425      426      427
#> 1 -0.005229472 -0.299820048 -0.28578761 -0.70873747 0.7297806 -0.2823974
#> 2 -0.267680985 -0.021916430 -0.09298312 -0.44861305 -0.2467827 -0.1111693
#> 3 -0.571267242 -0.618948819 -0.23981438 -0.01944948 0.8300803 0.9083199
#> 4 0.339245721 -0.003307715 0.23092327 -1.19076642 0.7771500 0.6176845
#> 5 0.400784990 -0.496072711 -0.22958629 0.50882800 0.0975385 -0.1026508
#>      428      429      430      431      432      433
#> 1 0.15537317 -0.13018269 -0.14579196 -0.1052613 0.1909620 0.8565839189
#> 2 0.08872618 -0.38322810 -0.10487494 -0.2593596 -0.4259408 -0.0002521077
#> 3 -0.45319014 0.14360191 -0.07806591 -0.1969430 -0.6568690 -0.8844086816
#> 4 -0.29428196 0.12400194 -0.51022166 0.5566151 -0.2495756 0.3938010806
#> 5 0.17236478 0.07163089 -0.31952992 -0.2635459 -0.1002015 -0.0269607080
#>      434      435      436      437      438      439
#> 1 0.52445277 -0.17676614 0.51675535 -0.7231504 -0.53369534 -0.0571556
#> 2 -0.09250613 -0.11746306 0.01878174 -0.4360929 -0.34285640 -0.1937728
#> 3 0.72798237 0.13853584 -1.10335551 0.3929360 -0.05996675 0.1839056
#> 4 -0.54534597 -0.01484509 -0.09921647 -0.3790672 0.11831357 -0.1159084
#> 5 -0.56509154 -0.13578323 -0.04458835 0.1110423 -0.21844676 -0.2638713
#>      440      441      442      443      444      445
#> 1 -0.93596861 -0.30199466 -0.50382351 0.1495253 0.05660391 -0.422254154
#> 2 0.10009186 0.10490384 -0.02943465 -0.3664160 -0.04114866 -0.001734693
#> 3 -0.04471938 0.85138036 -0.12074261 0.2780692 0.21042710 -0.164135553
#> 4 0.34223744 0.40526484 -0.35166654 0.1945876 -0.57454557 0.379287713
#> 5 -0.03417180 0.01054663 0.52817125 0.4169894 -0.09146260 0.368957209
#>      446      447      448      449      450      451

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#> 1 -0.26468162 -0.2165981 -0.40413175 -0.11926934 0.5173956 -0.1529362
#> 2 -0.43929242 0.2986382 -0.34385216 -0.24731768 -0.3679577 -0.4643532
#> 3 -0.03122875 -0.1907304 -0.36082873 0.08663955 0.4767729 -0.4188516
#> 4 0.64056899 0.2196603 0.08204993 -1.15780231 -0.8501747 -0.3396465
#> 5 -0.60384303 -0.9210548 0.10222505 0.56023090 0.1677438 0.3070068
#>      452      453      454      455      456      457
#> 1 0.4177025 0.21341059 -0.11039574 -0.4617551 -0.6022680 0.20616634
#> 2 -0.3151017 -0.01194468 -0.59435062 -0.3623187 0.1153119 -0.04620186
#> 3 1.7221393 -0.13846549 -0.20383845 0.2098309 0.3276072 -0.18915101
#> 4 -0.9293458 0.14671245 0.08551173 0.4902468 -0.1997303 0.74289406
#> 5 0.5658953 -0.38513227 0.08391665 -0.2250990 -0.7188385 -0.18959252
#>      458      459      460      461      462      463
#> 1 0.7859190 0.15082357 0.01462283 0.1785230 1.40877475 0.07717735
#> 2 -0.2170649 0.21037835 0.04166292 -0.8364788 -0.05836868 -0.38873229
#> 3 -0.1136719 -0.54827652 -0.14919429 0.2351770 0.03798641 0.18567141
#> 4 0.2438137 0.07313056 0.30328623 -0.4203141 -0.20831467 0.79250083
#> 5 1.2839891 -0.02198250 0.27783397 0.1508458 0.03703431 -0.63159147
#>      464      465      466      467      468      469
#> 1 -0.8440678 -0.4983956 0.04729106 0.59329778 0.1763340 0.46213125
#> 2 -0.3228051 0.1010995 -0.13361619 -0.29098626 -0.2683078 -0.29742281
#> 3 -1.0830148 0.5516264 0.21032032 -0.83916920 1.0161191 0.10364484
#> 4 0.4232838 1.4609113 0.16601997 0.06694808 1.0167968 -0.08207232
#> 5 0.1080584 -0.1881601 -0.55394826 -0.77359324 0.6462494 0.10849269
#>      470      471      472      473      474      475
#> 1 0.01732972 0.3802164 -0.1952438 0.7622597 0.37242666 0.10047930
#> 2 -0.13648942 -0.2245483 -0.1083608 -0.3168872 -0.10136342 -0.05327698
#> 3 -0.10099857 0.2257554 0.8001902 0.3907499 0.36347327 0.32213856
#> 4 -0.83521901 -0.7388429 -0.3123499 0.6140113 -0.03344613 -0.44025496
#> 5 -0.09304531 -0.1105153 0.2258077 -0.5536466 0.31297481 -0.07401753
#>      476      477      478      479      480      481
#> 1 -0.571779490 0.84393047 0.4964697 0.4508960 0.6321876 -0.3202651
#> 2 -0.195056381 -0.23994858 -0.1893485 -0.3722569 -0.3026113 0.2169076
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#> 4 0.007937774 0.06577704 0.4499839 -0.3831534 0.7362858 -0.6682704
#> 5 -0.465149349 0.13695373 0.1673992 0.2737296 -0.4142727 0.1609890
#>      482      483      484      485      486      487
#> 1 -0.1867254 0.7950097 0.497964799 -0.42134970 0.43190217 -0.19284489
#> 2 -0.1454142 -0.0906823 -0.279315574 -0.05678101 -0.15822770 0.03711207
#> 3 -0.4294837 -0.3099406 0.003973287 -0.55790660 0.05877029 -0.12089076
#> 4 -0.5956793 -0.6038399 -0.691949499 -0.40101960 -0.16124575 -0.16881817
#> 5 0.3250473 0.3905028 -0.062877562 -0.30752794 0.23449597 0.72721726
#>      488      489      490      491      492      493
#> 1 -0.08987509 0.1853687 -0.12354350 -0.06330394 -0.49845968 -0.4478343
#> 2 -0.12372008 -0.2484519 -0.08492515 -0.38761921 0.12294725 -0.7367763
#> 3 -0.43326090 -1.3462085 0.13777912 -0.02929217 -0.01113723 -0.7050809
#> 4 0.25545463 -0.2441930 0.21335266 0.05198864 0.50653619 -0.5474732
#> 5 -0.45308409 -0.6579099 -0.29027556 0.01062389 -0.42254698 0.1685931
#>      494      495      496      497      498      499
#> 1 0.2786129 0.49606524 -0.9147054 1.3165209 0.51789914 0.0611995566
#> 2 -0.1277114 0.05164898 -0.4289807 -0.1578162 0.07362897 -0.0003274374
#> 3 -0.4443128 0.39953227 0.3747079 0.7766565 0.05139764 -0.2238802672
#> 4 1.0162637 0.77860710 0.4758349 -0.4117801 0.52753678 0.1797240827
#> 5 0.1640952 -0.22190427 -0.1668797 -0.3230103 -0.03216461 -0.1172581580

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#>	500	501	502	503	504	505
#> 1	0.07111883	-0.2863167	0.42106490	0.8632818	1.1182051	0.91472906
#> 2	1.40456267	1.7518977	1.69711663	1.2419118	1.6470960	1.54380721
#> 3	0.50805822	-0.3292576	-0.37979619	-0.2949293	0.2089479	-0.28039223
#> 4	0.53767158	0.2856222	0.23775230	-1.1155342	-0.3011684	0.43573242
#> 5	-0.13107196	-0.4123177	-0.01281975	-0.1756702	-0.4899308	0.01079503
#>	506	507	508	509	510	511
#> 1	-0.46086625	-0.2787639	0.19107343	0.4064875	-0.26476026	0.1121307
#> 2	1.28571572	1.8528533	1.80178763	1.2003172	1.81109212	1.4792762
#> 3	0.10232216	0.4927130	0.94771068	-0.3878430	-0.16861671	0.3641264
#> 4	-0.33184551	1.1532511	-0.05544254	0.3316130	0.95857358	0.1666057
#> 5	-0.06722221	0.1522405	-0.67152225	0.2359092	-0.07484621	-0.0593605
#>	512	513	514	515	516	517
#> 1	-0.6060397	0.04097193	0.757174583	0.64013855	0.01862849	-1.1016273
#> 2	1.4622884	1.52935766	1.524880161	1.55596188	1.55896838	0.9514437
#> 3	-1.0169763	-0.16518368	0.288489227	-0.11286867	0.24290761	0.6594552
#> 4	-0.7261144	0.54546626	0.007188037	0.06850513	-0.37604992	-0.7243013
#> 5	0.2196741	-0.28413499	0.266655401	-0.84545888	0.29143948	0.1831472
#>	518	519	520	521	522	523
#> 1	0.2096767	-0.3137832	0.09324847	-0.5095456	0.1330409	-0.1350190
#> 2	1.2921855	1.5536766	1.61736671	1.5975176	1.5324968	1.4368595
#> 3	0.7621286	0.5325185	0.27606488	0.6055405	0.2118735	-0.7825823
#> 4	0.2848031	-0.1413627	0.13583283	-0.1348727	-0.7608462	-0.4278928
#> 5	0.1029425	0.3653540	0.02632672	-0.1242094	-0.4395087	0.3872300
#>	524	525	526	527	528	529
#> 1	0.09448719	0.05082684	0.4668918	-0.4742186	-0.1686239	-0.48356212
#> 2	1.14485742	1.60852329	1.4969632	1.1416396	1.5170490	1.47116568
#> 3	0.50829943	0.65447439	-0.7731548	-0.6449729	-0.1390035	0.77932595
#> 4	-0.56988509	-0.12121544	-0.4704581	0.1210400	-0.6036427	-0.04481908
#> 5	0.06135171	0.07820141	0.7246046	-0.4684908	-0.4095513	-0.03893401
#>	530	531	532	533	534	535
#> 1	0.1659317	-0.1234020	-0.3492770	-0.09297852	-1.3191741	-0.1951218
#> 2	1.3995933	1.1143836	1.4742794	1.74672549	1.5174088	1.4683968
#> 3	0.2982503	-0.5356788	-0.1335862	0.14798222	0.3125371	-0.5675948
#> 4	-0.4418723	0.4638518	0.5168275	0.38390495	0.3961850	-0.4544616
#> 5	0.1317764	-0.1230892	-0.1074967	0.77376517	-0.2633075	-0.0401968
#>	536	537	538	539	540	541
#> 1	0.6817900	-0.02217292	-0.7939106	-0.3562951	0.4235008	0.6979044
#> 2	1.5041989	1.65671952	1.4586037	1.7832946	1.5866890	1.4969298
#> 3	0.3548434	-0.45659717	0.3943691	0.6389420	-0.2188437	-0.2965263
#> 4	0.2374804	0.07853836	0.3053681	0.6594037	-0.1056998	-0.4857282
#> 5	0.7382150	-0.21199029	0.3262759	-1.1621049	0.2133632	0.2912287
#>	542	543	544	545	546	547
#> 1	-0.2095406	0.1505243	0.2251811	0.4624722	-0.35303979	0.68339808
#> 2	1.4424795	1.4690633	1.6410311	1.5515175	1.30506255	1.81634975
#> 3	-0.1294628	0.4306865	0.1323487	0.1058797	-0.28698914	0.05034177
#> 4	0.5386767	0.2186951	-0.3137020	-0.6474111	-0.08936502	0.32328328
#> 5	0.3689191	-0.1123954	0.2154258	-0.4797276	-0.09722892	-0.23198147
#>	548	549	550	551	552	553
#> 1	-0.63860307	0.001634641	0.06244802	0.05435737	0.55150901	0.3099623
#> 2	1.68647279	1.625985598	1.94061734	1.22568109	1.31728614	1.6505580
#> 3	0.04577635	-0.058646923	0.18526140	0.35991320	0.04618584	-0.2154819
#> 4	-0.70317375	0.976574889	0.26240521	0.35714042	0.13375207	-0.3848446

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#> 5 -0.14141162 0.233397318 0.23320104 -0.30654831 -0.03400416 -0.4992064
#>      554      555      556      557      558      559
#> 1 0.8303239 0.20331216 0.3196292 0.84938983 0.63833256 -0.0009207093
#> 2 1.5802521 1.50256650 1.2358365 1.73024094 1.57494048 1.5913168344
#> 3 0.1670767 0.54490475 -0.3703036 0.79749240 -0.33918335 0.7450449095
#> 4 0.2759966 0.04847735 0.1973862 -0.05995545 0.52546930 0.2861137641
#> 5 -0.5805537 -0.04499848 0.2153615 0.07843756 0.09476516 -0.0628314403
#>      560      561      562      563      564      565
#> 1 0.18022183 -0.04452153 0.4964256 -0.09497711 0.03097238 -0.0183718
#> 2 1.75745771 1.52481737 1.4058075 1.51072908 1.78406743 1.7867569
#> 3 0.39947040 -1.24573934 0.3979741 -0.58729087 -0.16144320 0.8107932
#> 4 -0.07170321 -0.46674601 -0.5388460 -1.06654042 0.36803196 -0.5478114
#> 5 -0.55392716 -0.03431250 -0.2889257 0.72450272 -0.44612721 0.4144785
#>      566      567      568      569      570      571
#> 1 -0.3600169 0.8083770 -0.2799513 -0.26258186 0.5448299 0.0507760
#> 2 1.4454094 1.7113705 1.4419683 1.58246904 1.5467432 1.6619796
#> 3 0.2683509 -0.6666283 -0.1985718 -0.45739279 0.6568711 0.2814515
#> 4 -0.5030784 0.4775830 0.5637970 -0.06768282 -0.3201159 0.2996791
#> 5 0.3030332 -0.9838342 -0.1101984 0.08128005 -0.7858459 0.1692143
#>      572      573      574      575      576      577
#> 1 -0.1663153 -0.484090275 -0.10646694 0.59321849 0.06093792 0.1044598
#> 2 1.2223396 1.345872234 1.49711124 1.54213003 1.20447941 1.7034082
#> 3 -0.8497688 -0.200504565 -0.03718371 -0.74293407 -0.07597246 0.8100905
#> 4 0.6429577 0.002940139 -0.65017387 0.67070053 -0.07170875 1.2406209
#> 5 0.5556865 -0.580619140 0.33939091 0.07813195 -0.33094523 0.6852672
#>      578      579      580      581      582      583
#> 1 -0.5070787 1.1913064 0.6586431 -1.0510220 0.2864017 -1.0808397
#> 2 1.4527622 1.3075129 1.3765522 1.7017904 1.4281791 1.7395391
#> 3 -0.4240904 -0.3976540 0.3652271 -0.4839861 -1.0432735 -0.2314182
#> 4 0.1961984 -0.1042774 -0.3848520 0.2275191 -0.2716495 -0.1444318
#> 5 0.4382467 0.3306781 0.5691289 0.1319321 0.2976336 0.0330684
#>      584      585      586      587      588      589
#> 1 0.10513547 0.2705651 0.31053594 0.01821627 -0.148451395 0.1732367338
#> 2 1.37440276 1.7323401 1.63504939 1.40340087 1.899091288 1.5767420761
#> 3 0.62880323 0.2278982 -0.11823495 -0.17536502 0.610056335 -0.4243226305
#> 4 0.51113469 0.2802533 0.08149583 0.11307289 -0.008840132 -0.1368134487
#> 5 0.07317537 0.2282277 0.20629529 -0.24992189 0.067317355 0.0006092487
#>      590      591      592      593      594      595
#> 1 -0.81259307 -0.3298299 0.2576952 0.09696444 0.307078372 -0.53183412
#> 2 1.50443415 1.3857247 1.7467402 1.45882776 1.484530419 1.52339500
#> 3 -0.20395365 0.4901308 -1.0398716 0.77404828 0.519522908 0.06980342
#> 4 -0.03480752 -0.3177120 -0.1642498 0.79607574 -0.189697599 0.06607883
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#>      596      597      598      599      600      601
#> 1 0.878773768 -0.8329163 -1.3524148 -0.7376680 -0.27420850 0.04900825
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#> 3 -0.007499043 0.1918776 0.1394186 -0.8108206 -0.03166123 -0.20968618
#> 4 0.427273065 -0.2902212 -0.4186486 -0.8674599 0.15703647 -0.20869947
#> 5 0.194942810 0.3920132 -0.2598890 -0.3122502 0.07419277 0.07650939
#>      602      603      604      605      606      607
#> 1 0.7914306 0.12635620 -0.0238759 0.76572675 0.3058640 0.18609242
#> 2 -0.1975115 0.01489423 -0.1580870 -0.25135295 -0.2392276 -0.03185414
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#> 4 0.1521167 0.33983632 0.5773382 -0.22081187 0.8131217 0.22523327
#> 5 -0.1327803 0.45721217 0.1053996 -0.01482619 0.6634622 0.14620254
#>      608      609      610      611      612      613
#> 1 0.65799923 -0.18778931 -0.07365719 -0.49848413 -0.2099471 -0.53922053
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#> 3 0.51943101 0.14881502 -0.03962198 0.27194061 -0.3615011 0.57050562
#> 4 -0.09096711 0.28924752 0.62240032 -0.05950258 -1.3113048 0.23758539
#> 5 0.20238330 -0.04263232 0.43463799 0.05237434 0.4755862 0.10636272
#>      614      615      616      617      618      619
#> 1 0.5953518 0.1971690 -0.91917202 0.02976190 -0.1004828 -0.41463397
#> 2 0.3928630 -0.2455006 -0.05202011 -0.18741144 0.0429536 0.19820379
#> 3 -0.3958236 -0.1865562 0.39545845 -0.07337524 0.2890863 -0.11581924
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#>      620      621      622      623      624      625
#> 1 -1.0193304 0.10966261 -0.3233167 0.87841288 0.7233614 0.236513520
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#> 3 0.5500808 -0.11091303 0.2015030 0.32486341 -0.6422944 -0.605025309
#> 4 -0.2881611 -0.01887711 -0.2971456 1.76652483 -0.5961369 -0.007263279
#> 5 -0.6406357 0.72904662 -0.3703216 0.05559945 -0.1645103 0.009949337
#>      626      627      628      629      630      631
#> 1 0.25386036 -0.4494797 -0.58803042 -0.03009723 -0.32441588 0.1278640
#> 2 -0.17608002 0.1220793 -0.00774676 0.07788059 -0.33295553 -0.2199141
#> 3 0.22148295 0.6780076 -0.45030891 0.62794699 -0.08296229 -0.6120962
#> 4 -0.02564614 0.4054940 0.44986909 -0.60315607 -0.96009976 -0.3290594
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#>      632      633      634      635      636      637
#> 1 0.04749958 0.67512192 0.4743874 -0.13130291 0.50155283 -0.56929412
#> 2 -0.16095068 0.13657483 -0.2713199 -0.11031296 -0.35805827 0.09684187
#> 3 -0.05933556 -0.13910332 -0.6688913 0.70180295 -0.35845477 0.35436980
#> 4 -0.11919773 -0.06501447 0.5634770 0.22238834 0.49120268 -0.51119761
#> 5 0.95562330 -0.88058418 0.4197082 -0.03071179 0.01498011 -0.03732817
#>      638      639      640      641      642      643
#> 1 -0.8723628 -0.2781045 0.11191824 -0.8162324 0.4787585 -0.8401758
#> 2 -0.2469841 0.1449250 -0.53321178 -0.1547314 -0.1544980 -0.1034184
#> 3 0.4182009 -0.1303482 0.02422882 -0.1659166 -0.7245298 -0.3095754
#> 4 -0.3330312 -0.2323731 0.51106649 0.5354731 -0.9194235 0.2733954
#> 5 0.2246644 0.1717084 -0.11616742 -0.1530405 0.5353685 0.2856662
#>      644      645      646      647      648      649
#> 1 -0.75818793 -0.7550176 -0.5973837 -0.02594651 -0.67796449 0.3316787
#> 2 -0.22041450 -0.2824935 -0.3037970 -0.09845102 -0.09671321 -0.1008213
#> 3 0.04139395 0.3212715 0.6840516 -0.32742288 0.03766026 -0.3319749
#> 4 -0.04733667 0.2970168 -0.2635305 1.08991722 0.81930982 -0.3650937
#> 5 0.37653062 -0.1860294 0.1496849 -0.38318878 -0.68855414 0.6951554
#>      650      651      652      653      654      655
#> 1 -0.6451957 0.40995790 -0.81541612 0.44307761 -0.6273584 -0.90144886
#> 2 0.1657179 -0.02686991 -0.006628834 -0.18802533 -0.1372751 -0.35572284
#> 3 0.1955770 -0.36174030 0.520350357 -0.52345710 -0.1588285 0.19156701
#> 4 0.1919937 -0.18861322 -0.105041759 -0.35380138 -0.4751043 -0.71131421
#> 5 -0.1512397 0.45594271 -0.221390262 0.08566998 0.3000805 -0.07841268
#>      656      657      658      659      660      661
#> 1 0.03306812 -0.4019955 0.92256054 0.5161954 -0.78472508 -0.30146050
#> 2 0.04991135 -0.5278061 -0.05520837 -0.4021425 -0.37506414 0.07549421

```



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#> 3 -0.11919243 -0.2189065 0.63936792 -0.6283086 -0.01252666 0.30733415
#> 4 0.02979424 -0.5401871 -0.20941615 -0.2733654 -0.74284346 -0.15500357
#> 5 0.45120187 -0.3999969 0.01370616 0.9805620 0.43523113 -0.19219605
#>      662      663      664      665      666      667
#> 1 0.21637296 0.2284269 -0.7792670 1.1405268 0.484637010 -0.16907579
#> 2 0.04004293 0.1354282 -0.1279531 0.1715344 -0.417567074 -0.31426715
#> 3 -0.12328218 0.8217307 -0.2938563 0.1360534 0.493014871 0.28094119
#> 4 0.66351174 0.1906362 -0.2853676 0.1369349 -0.243712551 -0.03631988
#> 5 -0.30830141 -0.3895533 -0.4005695 0.3947441 -0.005062882 0.17294183
#>      668      669      670      671      672      673
#> 1 -0.03862069 0.06819288 0.21542127 0.39134700 0.5738671 0.26070481
#> 2 -0.45618066 -0.36665408 -0.21684955 -0.32375570 -0.4983792 0.02875551
#> 3 -0.54423584 0.48265765 -0.11595892 0.18771229 -0.8540904 -0.21667989
#> 4 0.89100000 0.65503279 0.04894025 -0.24631393 0.4049745 0.13990890
#> 5 0.32118778 -0.28544779 -0.41040128 0.09784549 -0.4515075 0.25921450
#>      674      675      676      677      678      679
#> 1 -0.82890985 -0.07207794 0.59370354 0.6765826 0.18253173 0.372963077
#> 2 -0.08116334 -0.03197162 0.07921775 -0.3490365 -0.32517011 0.271364893
#> 3 0.11539990 0.51413960 -0.02880544 0.1230124 0.04563101 -0.066333986
#> 4 -0.23461907 -0.35188057 -0.79879534 -0.4213100 0.07797576 0.004025683
#> 5 -0.68535136 0.15126682 0.28155177 0.7212366 -0.33819113 -0.298766031
#>      680      681      682      683      684      685
#> 1 -0.7376649 0.26089873 0.42186943 -0.03434275 0.1634847 -0.64493879
#> 2 -0.1633882 -0.06302492 -0.05329993 0.22701621 -0.3278823 -0.04318309
#> 3 -0.4816124 -0.55644404 -0.27829847 -0.14186878 -0.2778691 -0.15750127
#> 4 0.9791349 1.55573235 -0.78297761 0.16351883 0.2926203 0.22255146
#> 5 0.1434497 0.04404559 0.40433985 -0.47898547 -0.1903288 -0.82847985
#>      686      687      688      689      690      691
#> 1 -0.74514297 -0.4353818 -0.3463873 -0.3439567 -0.9761569 0.03993129
#> 2 0.00311837 -0.2906127 -0.8549816 -0.2722705 -0.2281551 -0.39516080
#> 3 -0.65270622 -0.2416112 0.3281545 0.2616976 0.6432600 0.58053070
#> 4 -0.19555896 -0.4533566 -0.1041303 -0.1356800 0.4148138 0.32508220
#> 5 0.26712872 0.1545440 -0.3636197 -0.3521782 -0.3408093 -0.96235506
#>      692      693      694      695      696      697
#> 1 -0.2742084 0.5706896 -0.1946953 -0.1197391 0.006736103 0.005600253
#> 2 -0.2053871 -0.1392215 -0.2854024 -0.1730843 0.029438464 -0.123884412
#> 3 -0.1970876 0.5180189 -0.5452395 -0.1995023 -0.381338367 0.603908770
#> 4 0.6636647 -0.8919831 -0.1560283 0.8411816 -0.599818299 0.043273940
#> 5 -0.3377940 -0.2138556 0.1284227 0.7783996 0.007540417 0.144980950
#>      698      699      700      701      702      703
#> 1 -0.04509849 -0.25771697 -0.2835010 -0.2223465 0.04973261 -0.52996344
#> 2 -0.31594219 0.03361934 -0.2108541 -0.4827319 0.18918093 0.03341905
#> 3 0.11183916 0.46698148 0.7861663 0.2381989 -0.23296632 -0.82090810
#> 4 0.34458507 0.05990218 -0.2264275 0.3803395 1.13269731 -0.04663370
#> 5 0.08522969 0.19505020 -0.2982987 0.2620118 0.06269250 0.06827924
#>      704      705      706      707      708      709
#> 1 0.51948711 -0.4183856 0.1021773 0.85714697 0.9159266 -0.3599615
#> 2 0.01082181 0.1205428 -0.4532698 -0.28624003 -0.3673289 -0.4308675
#> 3 0.56841282 -0.4047001 0.4154842 0.34113626 -0.4975752 0.2504577
#> 4 0.18322692 1.0537069 0.6705157 -0.36623061 0.5218670 -0.2115982
#> 5 -0.48563959 0.3209743 -0.4505057 -0.01672857 0.6393977 0.1859901
#>      710      711      712      713      714      715
#> 1 -0.5569998 0.591642317 -0.2497281 -0.51256549 -0.11754422 0.23133304

```

```

#> 2 -0.1570977 0.196409606 -0.1102558 -0.23159521 -0.06044923 -0.48733508
#> 3 -0.2250433 -0.381284532 -0.3285417 -0.65303914 -0.60848721 0.40294256
#> 4 -1.0699361 0.334878100 0.6872343 0.17781133 -1.01047843 -0.05493838
#> 5 0.1219199 0.005415081 -0.4846126 0.09040336 -0.71096683 0.10522060
#>          716          717          718          719          720          721
#> 1 -0.66637257 1.0155255 0.06261742 0.77750522 0.3550789 0.1279315
#> 2 -0.04815252 -0.2554630 -0.16659214 -0.31167677 -0.2681751 -0.2746189
#> 3 0.39041170 -0.6117601 0.18023562 0.13677370 0.2786458 0.3261700
#> 4 0.70227764 -0.3718416 -0.27884236 0.21465870 0.2761764 -0.6454151
#> 5 -0.19402034 -0.3498539 0.43907046 -0.05728036 -0.2289625 -0.5698302
#>          722          723          724          725          726          727
#> 1 -0.77689323 -1.0461801 0.44140501 -0.55911945 -0.4542465 -0.19271824
#> 2 -0.06196019 -0.1167712 0.03848801 -0.32281946 -0.3745494 0.02705018
#> 3 -0.07858392 0.1583933 0.28435336 -0.09906481 0.5737624 -0.13783047
#> 4 0.92607366 -1.1088873 -0.05963266 -0.19111445 -0.6849666 -0.19984071
#> 5 0.43200857 0.2334210 -0.66501186 0.46447015 -0.2412476 0.23194246
#>          728          729          730          731          732          733
#> 1 -0.3017795 0.2674124 0.31365238 0.5694941 -0.6051393 0.48296560
#> 2 -0.2271431 -0.1287634 -0.02936578 -0.3978503 -0.3200450 -0.05286793
#> 3 -0.6603332 0.2920768 -0.34699637 0.3247218 0.2494458 -0.26454910
#> 4 0.4260747 -0.5668188 -0.22471483 0.3989090 0.4429404 0.23231208
#> 5 0.4456188 0.6608856 0.45803604 0.3665830 0.5645989 -0.25961736
#>          734          735          736          737          738          739
#> 1 0.1367838 0.03077847 -0.007713943 0.5439873 0.1904630 0.3224925
#> 2 -0.3656345 -0.58610503 -0.044137990 -0.1860757 -0.2375712 -0.1273673
#> 3 0.5947154 -0.62480610 -0.011437858 -1.1001841 -0.5389739 0.4019868
#> 4 -0.1199934 -0.15998974 -0.759998833 0.3787147 -0.3592389 -0.1756570
#> 5 0.3294171 0.72016514 -0.329163402 -0.1683104 -1.0157485 -0.2174441
#>          740          741          742          743          744          745
#> 1 0.029053033 0.21263772 0.96025255 -0.798994899 -0.5047170 1.3767690
#> 2 -0.461914846 0.02778418 -0.04747412 0.042896368 -0.2327061 -0.2932020
#> 3 0.001481269 0.68063087 -0.51284869 -0.244206563 0.3516270 -0.5063077
#> 4 1.052432527 -0.64100212 0.84861432 -0.007499401 -0.3792545 0.7704553
#> 5 -0.292427910 0.11477809 0.16323244 0.278614803 0.4231900 0.2627418
#>          746          747          748          749          750          751
#> 1 0.1170576 0.06932312 -0.11901909 -0.46844331 0.6562701 -0.3033275
#> 2 -0.4650988 -0.16476901 0.04751925 -0.22481411 -0.2036347 0.1960953
#> 3 -0.4806777 0.34529264 0.71512243 -0.65550343 0.6687325 0.1072519
#> 4 0.7465634 0.14436874 -0.39826587 -0.55061620 0.9561729 -0.2038388
#> 5 0.1017506 -0.27505971 0.08978050 0.09702494 0.3398703 -0.5119346
#>          752          753          754          755          756          757
#> 1 -0.1485494 -0.13410947 0.29256362 0.5901337 -0.5655443 -0.17848338
#> 2 -0.5483752 -0.24738812 -0.05066223 -0.4164422 -0.1542149 -0.33397461
#> 3 -0.6637936 0.11003668 -0.14555459 -0.2199348 -0.1379034 0.09619385
#> 4 -0.3378481 -1.61171260 0.06441016 -0.1420786 0.0820767 0.44357590
#> 5 0.4591719 -0.08356481 0.04598752 -0.5978820 0.4560032 -0.23600243
#>          758          759          760          761          762          763
#> 1 -0.76162503 -0.97245535 0.5253020 -0.3563170 -0.43614166 -0.65882871
#> 2 -0.03410466 -0.18740150 -0.3866756 -0.2997781 0.06359542 -0.56859454
#> 3 0.50338733 0.07779602 -0.0321857 0.5149076 -0.40294750 -0.64006214
#> 4 0.03286225 -0.22891504 0.1938222 0.1741100 -0.11529033 0.09464144
#> 5 0.15540697 0.34370673 -0.2760366 0.2918274 0.30375222 -0.18328053
#>          764          765          766          767          768          769

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```

#> 1 -0.2271637 0.476256201 -0.72729075 0.3586778 -0.51605643 0.9327132
#> 2 -0.6214794 0.004776885 -0.09423559 -0.5770387 0.06172349 -0.5340129
#> 3 -0.5332853 0.106303778 0.28823278 0.1664672 -0.27137728 -0.9870794
#> 4 0.1185480 -0.036347285 -0.01759887 0.4012410 0.28610568 -0.4323499
#> 5 0.2541132 0.361366890 0.32596385 0.2442816 0.12185123 -0.5040138
#>      770      771      772      773      774      775
#> 1 -0.44349239 -0.15380438 -0.1385837 -0.1499774 -0.4723680 -0.4413517
#> 2 -0.40640138 -0.03070465 -0.0575740 -0.1368262 -0.2345637 -0.3483941
#> 3 0.27064685 -0.79642066 0.3030222 -0.3761496 0.1615977 1.1563718
#> 4 0.18135924 -0.15901367 -1.0425542 0.3723856 -0.5461600 0.3396432
#> 5 -0.08947963 0.68136093 0.5486178 -0.5819887 -0.1137890 -0.6648298
#>      776      777      778      779      780      781
#> 1 0.8941945 0.42030247 1.03669791 0.55172175 0.64971337 -0.27364456
#> 2 -0.2322941 -0.32992470 -0.08923046 -0.06949418 -0.18933635 0.01323172
#> 3 0.4799514 0.64220582 -0.13326421 -0.80246227 0.10026367 0.33332940
#> 4 -0.4601956 -0.29630684 -0.28355578 0.22921594 -0.06415509 -0.78901248
#> 5 0.2908594 0.07066432 -1.22115780 0.32173941 -0.12426407 -0.04842855
#>      782      783      784      785      786      787
#> 1 -0.1824620 0.76456424 0.45556580 1.286441873 -0.5761655 -0.3043940
#> 2 -0.1257239 -0.06621611 -0.16633513 0.008883771 -0.3778296 -0.2330477
#> 3 0.3258105 0.21235557 -0.08098279 0.343177635 -0.4738083 -0.7124170
#> 4 -0.0300054 0.89824978 -0.76358889 -0.189849711 0.8382663 0.3262475
#> 5 -0.1943532 0.04412327 0.45164372 0.327351887 0.0678282 -0.6598554
#>      788      789      790      791      792      793
#> 1 0.3793404 -0.3283243 0.6420398 -0.69538227 -0.09802471 -0.1305552
#> 2 -0.2719596 -0.2865668 -0.2869630 -0.30074163 0.34236438 -0.1331582
#> 3 -0.6837730 0.3679137 -0.1311327 -0.46023426 0.57974772 0.1282992
#> 4 0.3051092 0.4882545 -0.3397571 0.25359281 0.37409676 0.9292887
#> 5 0.2554339 0.2495839 -0.1945262 -0.05324586 0.32904699 -0.6000654
#>      794      795      796      797      798      799
#> 1 -0.3152001 -0.79981358 0.41791910 0.2002993 0.07564006 2.05008659
#> 2 -0.2173737 -0.01100633 0.01906554 -0.2008655 -0.14746600 -0.21788625
#> 3 -0.5674139 -0.06650055 -0.65356837 -0.4911723 -0.05465414 -0.36466331
#> 4 -0.6234368 0.86218395 0.02199693 0.2436766 0.75818896 -0.04351351
#> 5 -0.2742674 -0.32772467 -0.49864614 0.8399166 0.31612730 -0.16784303
#>      800      801      802      803      804      805
#> 1 0.62022847 -0.19985602 -0.34244435 0.3228096 -0.7275175805 0.22913547
#> 2 -0.08788291 -0.02340793 -0.36179200 -0.3369655 -0.0004163018 -0.34819658
#> 3 0.74970897 -0.82495992 -0.06977456 -0.1800873 0.2304193189 1.15486843
#> 4 -0.66679347 -0.38460744 -0.60098547 -0.8867472 0.3124122969 -0.02905405
#> 5 0.23371275 -0.33825302 0.51879272 -0.5331370 -0.5639578214 0.28030542
#>      806      807      808      809      810      811
#> 1 0.06758725 0.64511111 -0.109004327 -0.20944662 0.4621416 0.3230224
#> 2 0.08451213 -0.27434480 -0.006235752 -0.30733981 -0.2951776 -0.1699731
#> 3 -0.18757573 0.03880085 -0.258063901 -0.08741600 0.5026630 -1.1226097
#> 4 0.13139299 -0.97447673 0.915700890 0.47606258 -0.7027147 -0.2290441
#> 5 0.17108817 0.29779687 -0.233486887 0.07717832 -0.1500005 -0.2506605
#>      812      813      814      815      816      817
#> 1 -0.633414187 0.3308226 -0.7229289 0.3611662 -0.12708042 -0.6661614
#> 2 0.112397898 -0.2371181 -0.1097228 -0.2030742 -0.32886502 -0.1852719
#> 3 -0.171190830 0.2381508 -0.8989834 0.5147113 0.07964728 0.2475239
#> 4 0.009389146 0.6226795 -0.1333140 0.3264324 -0.03876508 0.2203449
#> 5 0.048522413 0.1480816 0.2004710 -0.3332577 -0.22454455 -0.3877516

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```

#>      818      819      820      821      822      823
#> 1 0.02586141 0.3919226 0.1240226 0.1622295 1.09088226 0.66855409
#> 2 -0.23018677 -0.1235977 -0.1747192 -0.1351410 -0.26384798 -0.27225394
#> 3 0.44785986 0.3134591 -0.2146810 0.4639324 1.35665679 0.01280969
#> 4 -0.09467367 -0.6859235 0.7145133 -0.7289202 0.03852003 0.01527166
#> 5 -0.43699899 -0.1333767 0.5175301 0.2738808 -0.17445076 -0.28788625
#>      824      825      826      827      828      829
#> 1 0.38972035 0.93271854 0.07899116 0.1579410 0.4150498 -1.07046636
#> 2 0.05116985 0.09096116 -0.11598551 -0.3045434 -0.3390843 -0.12821232
#> 3 0.65398959 -0.31368498 -0.22430610 0.7771410 -0.2360817 -0.51248107
#> 4 -0.06248708 0.49272543 0.37241598 -0.7259660 -0.3500801 -0.92638534
#> 5 -0.22535042 -0.09442711 -0.19804654 -0.1411587 0.5812637 0.06608121
#>      830      831      832      833      834      835
#> 1 0.9144812 0.094861148 0.1160273 0.84739293 -0.3700056 3.268897e-01
#> 2 -0.4855275 -0.126915064 -0.3331462 0.01347359 -0.2420884 -9.235255e-05
#> 3 -0.3637749 -0.492371576 0.4175618 -0.10494296 -0.2397548 8.856214e-02
#> 4 0.1075120 0.677026432 -0.1324737 -0.87120520 0.1430129 -3.971384e-01
#> 5 -0.1728118 -0.004263926 -0.6931754 -0.29526964 -0.2509703 -7.553047e-01
#>      836      837      838      839      840      841
#> 1 -0.138525345 -0.00981995 0.779034550 0.71908494 0.4309698 0.20966815
#> 2 0.005421612 -0.30751212 -0.002357671 -0.44992216 -0.4266049 0.02551043
#> 3 -0.690390773 -0.05807532 0.116122307 -0.01855515 0.5546779 -0.35418431
#> 4 -0.512498826 0.03537305 0.752563393 -0.48427430 -0.2249533 0.45192033
#> 5 0.164481474 -0.16539365 0.253269642 -0.67825997 0.1733622 -0.79513818
#>      842      843      844      845      846      847
#> 1 0.5004006 0.36153819 -0.2657065 0.1057673 -0.10067409 -0.49599042
#> 2 -0.2422559 -0.08862137 -0.3662263 -0.3334672 0.11805051 -0.41922973
#> 3 -0.1451352 0.50015467 0.1817680 -0.2149791 0.08166239 0.46742999
#> 4 -0.8398077 0.39921320 -0.2211957 -0.9436933 0.64182091 1.04772522
#> 5 0.4507631 0.15034463 0.2896972 0.8184687 -0.65134044 0.04865934
#>      848      849      850      851      852      853
#> 1 -0.37735986 0.87804096 -0.18787272 -0.8771883 -0.3068408 -0.6953335
#> 2 -0.08880614 -0.09474761 -0.33138033 0.1729763 0.4184833 -0.1776955
#> 3 0.19261981 0.19621669 -0.31131141 -0.1810001 -0.2869783 -0.1780897
#> 4 -0.21731732 -0.39270996 0.16186030 -0.5289082 -0.2649179 -0.6669936
#> 5 -0.15517243 0.05733686 0.06561609 0.2316618 -0.1654836 -0.5192415
#>      854      855      856      857      858      859
#> 1 0.7443467 -0.36886053 0.6582869 0.38580287 0.41718772 -0.47628109
#> 2 -0.2526549 -0.09502200 -0.0685519 0.06861395 -0.17488470 0.02532586
#> 3 0.4556086 0.08700410 -0.4631689 0.69525924 -0.13249344 -0.90891838
#> 4 -0.2126043 -0.09460227 -0.3860810 0.03292558 -0.13093423 0.69544938
#> 5 -1.2064415 0.01006581 0.2700984 -0.25575882 0.09440559 -0.64779165
#>      860      861      862      863      864      865
#> 1 -0.27980981 0.40057251 0.11255203 0.749127380 0.5008604 -1.12171793
#> 2 0.09229224 -0.49485652 -0.35795045 -0.002755344 -0.1000324 -0.27694398
#> 3 -0.20414362 1.01900136 0.37124926 -0.182974708 -0.3881067 -0.14090840
#> 4 -0.46310087 -0.08773558 0.04935898 -0.719964360 -0.5785238 0.50412762
#> 5 0.04998766 -0.34653708 0.09002599 0.296668433 0.6839981 -0.08265082
#>      866      867      868      869      870      871
#> 1 -0.13910812 0.62612603 0.03690793 0.2515496 -0.4590444 -0.2113320
#> 2 0.03525046 -0.46955111 -0.50779892 0.1861691 -0.4660202 -0.3102743
#> 3 0.51073185 -0.56152053 0.59521161 0.2463708 0.1892512 0.3795448
#> 4 0.28315618 -0.64773963 -0.27976938 -0.1180198 0.9132708 0.4470480

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#> 5 -0.06186844 0.09207077 -0.28610322 0.6230802 0.4938372 -0.3641037
#>      872      873      874      875      876
#> 1 -0.08048723 -0.1493317245 0.56130413 0.437593674 0.386234477
#> 2 0.01066211 0.0389764867 -0.07038718 -0.499817531 -0.051069137
#> 3 0.05913867 0.4685624230 0.81903001 -0.649772042 0.116457389
#> 4 0.30450687 0.4214313099 0.08978815 -0.001762203 0.705085161
#> 5 -0.22256275 0.0004770352 -0.28500008 0.296459642 -0.004979687
#>      877      878      879      880      881      882
#> 1 -0.31086788 0.03958836 0.50869576 0.05321147 0.3743545 0.01603005
#> 2 0.00593532 -0.06793132 -0.50894940 -0.60056105 -0.3980324 -0.48852242
#> 3 -0.08308360 -0.30483729 -0.41155499 0.35237006 -0.1254756 0.62084021
#> 4 0.29911757 -1.00329309 0.01594382 -0.19188054 -0.5564362 -1.24257913
#> 5 0.27144234 -0.07465133 -0.23941169 -0.12555031 0.2326800 0.03765357
#>      883      884      885      886      887      888
#> 1 -0.3546641 -0.43002404 -0.9457595 -0.9331361 -0.2558326639 -0.54171791
#> 2 -0.3606020 0.08706226 -0.3820139 -0.2434753 0.2183142744 -0.27961189
#> 3 0.1365479 -0.21628526 0.2373969 0.3220362 0.7669248431 -0.17350321
#> 4 -0.2064658 0.83438075 -0.1589967 0.8361191 0.1192682270 -0.33537887
#> 5 -0.9572056 -0.28027218 0.1616487 -0.2721760 -0.0003980947 0.08784904
#>      889      890      891      892      893      894
#> 1 0.08436273 0.4808880 -0.12875828 -0.20817937 -0.153610314 -0.6235001
#> 2 -0.09181601 -0.5060207 -0.01713622 0.02855613 -0.178064042 -0.4777918
#> 3 0.59912627 -0.7874663 0.05105522 -0.13482622 -0.296875131 -0.3105203
#> 4 0.33194983 -0.3945991 -1.19023729 0.78235651 0.006748591 0.1115081
#> 5 0.28303252 -0.5763110 -0.02323331 0.05573237 0.661076393 0.7437463
#>      895      896      897      898      899      900
#> 1 -0.12198566 -0.279500631 -0.62100321 0.56623220 -0.2068409 -0.2812690
#> 2 0.19704915 0.001879772 -0.06209988 -0.21983174 0.0168379 -0.1872877
#> 3 -0.01109515 -0.042163684 -0.65150508 -0.21009345 -0.1513093 -0.2201011
#> 4 -0.33823744 -0.779467834 -0.07827332 -0.00333141 -0.3008498 -0.4345396
#> 5 -0.01184774 0.420298702 -0.44347628 -0.11866466 -0.5249652 0.6998592
#>      901      902      903      904      905      906
#> 1 -0.6304459 -0.45102715 0.187211214 -0.3038926 0.7487273 0.1813533
#> 2 -0.2748914 -0.01419353 -0.249991777 -0.2918445 -0.2357016 -0.0447524
#> 3 0.2739311 -0.65713768 -0.448962163 0.1014562 -0.6791512 0.4874801
#> 4 -0.2855388 0.29147283 0.428284337 0.3861042 -0.3549140 -0.7180310
#> 5 -0.4702334 -0.06286179 -0.009171061 0.3234240 -0.0240298 0.6522296
#>      907      908      909      910      911      912
#> 1 0.4109582 -0.3702743 -0.75402286 -0.01253961 0.025432387 -0.1435224
#> 2 -0.2248324 -0.4847065 -0.06466259 -0.13073557 -0.428669328 -0.2216384
#> 3 0.1350306 0.3176191 0.15839434 -0.09007996 0.217368840 0.2026493
#> 4 0.8208870 0.1890872 0.75887691 -0.03648739 0.006208877 -0.3962428
#> 5 0.3159157 -0.1721366 -0.20248892 0.23718697 0.033363659 0.4494812
#>      913      914      915      916      917      918
#> 1 -0.3332395 -0.07713992 0.8058535 -0.41644672 -0.5578503 -1.07481441
#> 2 0.1270801 -0.17090345 -0.1115031 -0.08149816 -0.3359158 -0.07038508
#> 3 -0.1519157 0.58005917 -0.1233401 -0.80222758 0.1943359 -0.71841140
#> 4 0.1240636 0.94583061 0.7373727 -0.12795671 0.1092541 0.07001787
#> 5 0.7522076 0.14073346 -0.9757967 0.06763811 -0.2748847 0.11557255
#>      919      920      921      922      923      924
#> 1 -0.8587315 -0.9453349 0.64586869 -0.05930989 -0.52040914 0.3077301
#> 2 -0.2384565 -0.3231424 -0.07543868 0.02842824 -0.50565007 -0.1758806
#> 3 -0.8308118 0.5713272 -0.21388601 0.05157633 0.05663348 -0.5053143

```



```

#> 4 -0.2188765 0.4897840 0.23621452 0.60886835 -0.79721959 -0.6153848
#> 5 -0.3011484 0.6291601 -0.28922458 -0.31805793 0.36136238 0.2518870
#>          925          926          927          928          929          930
#> 1 0.84866841 0.6002481 -0.2468977 -0.43404141 0.371612477 -0.2444907
#> 2 0.01263115 -0.5382058 -0.2145030 -0.18059279 -0.230575748 -0.2516704
#> 3 0.04855175 -0.5568205 -0.4613276 -0.35579301 -0.076273033 -0.2107523
#> 4 -0.50070231 -0.3572626 0.0558407 -0.02962356 0.005285005 -0.4485422
#> 5 -0.13113797 -0.4388269 0.2175911 0.14937083 -0.550394273 0.7311262
#>          931          932          933          934          935          936
#> 1 0.04591207 -0.7886644 -0.99205131 0.1237920 -0.07039423 -0.30220562
#> 2 0.02780574 -0.1872114 -0.09000613 -0.4790011 -0.16989772 -0.03780131
#> 3 0.71117714 -0.3412825 0.68613044 -0.2217237 0.36533820 0.75010680
#> 4 -0.12108849 0.1802585 -0.43570346 -0.9620213 -0.15710602 0.85744059
#> 5 -0.80058147 -0.1034868 0.65859169 0.5377970 -0.42816536 -0.24013675
#>          937          938          939          940          941          942
#> 1 -1.1321238 -0.3420790 -0.1363565 0.24902087 0.3759461 0.5334722
#> 2 -0.2483854 0.1290663 -0.1515867 -0.22270464 -0.1801101 -0.2177702
#> 3 -0.7519345 -0.3652874 -0.2032828 0.01850937 -0.2407702 -0.3411952
#> 4 -0.7700593 0.1571295 0.5217639 -0.00611363 -0.1343953 -0.1454564
#> 5 0.3560271 -0.6602366 0.3778288 -0.51260000 -0.1683220 0.1779950
#>          943          944          945          946          947          948
#> 1 0.04516103 0.34700871 -1.1855156 -0.01559563 1.478496995 0.39745236
#> 2 0.05833538 -0.01546944 -0.2760283 0.05793133 -0.009277419 -0.05987117
#> 3 0.11474587 -0.89783944 0.5000407 0.37193783 0.152828051 0.53856468
#> 4 -0.13777564 -0.53818471 -0.4218741 0.07982394 0.650218587 0.21875731
#> 5 0.21393494 0.50286233 -0.1326163 0.23370360 0.237716774 -0.20822326
#>          949          950          951          952          953          954
#> 1 -0.1783053 0.38157813 0.2128019 0.06521681 -0.13598112 1.40677852
#> 2 -0.2027654 -0.10656315 0.0154074 -0.27738068 -0.56022726 -0.24046236
#> 3 -1.1300451 0.14895835 -0.4254832 0.19750795 -0.01564583 -0.05399519
#> 4 -0.6005760 0.05524641 -0.8574807 -0.51681724 -1.04649439 0.03762805
#> 5 -0.2683228 0.05170100 -0.2050941 -0.47638424 0.96027175 -0.70069322
#>          955          956          957          958          959          960
#> 1 -0.29236799 0.5170009 0.19456702 -0.4383396 0.63591851 0.49578812
#> 2 -0.05131833 -0.5298076 -0.26531408 -0.1710295 -0.03697572 -0.27363341
#> 3 0.03730141 -0.3453849 -0.51310161 0.2234710 -0.03611338 -0.26313893
#> 4 -0.16746527 0.2476647 -0.12743553 0.7236531 -0.38804703 0.11396380
#> 5 -0.01953645 0.4496567 0.05121458 -0.1805673 -0.62440227 0.06686561
#>          961          962          963          964          965          966
#> 1 -0.84900868 0.2947275 1.1604714 -0.06825133 -0.25154210 -0.7539070
#> 2 -0.24364831 -0.4599659 -0.3605081 -0.23856302 -0.46812316 0.2806135
#> 3 -0.07494199 -0.4981764 -0.6270087 -0.24831359 0.17256173 -0.6460807
#> 4 0.27509973 0.7179181 0.3931114 0.08296127 0.06064456 -0.2715134
#> 5 1.04592049 -0.4445711 0.3319211 -0.13223254 0.07965834 -0.1086562
#>          967          968          969          970          971          972
#> 1 -0.51091926 -0.3862390 -0.2678973 0.34715472 -0.3537663 0.4710499
#> 2 -0.25558911 -0.4698696 -0.1698527 -0.03827192 -0.2622173 -0.2149532
#> 3 0.22641922 -0.2708356 -0.6536129 -0.05220790 0.1507415 0.8900265
#> 4 0.07301291 1.5854646 -0.2897068 -0.03470577 -0.6583049 -0.3238652
#> 5 0.23335499 -0.2586735 0.3177551 -0.02247834 -0.4056628 -0.1053866
#>          973          974          975          976          977          978
#> 1 0.44753342 0.1980659 -0.42386379 -0.20316345 0.48070025 -0.15223062
#> 2 -0.05656158 -0.1150551 -0.34627070 -0.25724103 -0.34777541 0.08644216

```

```

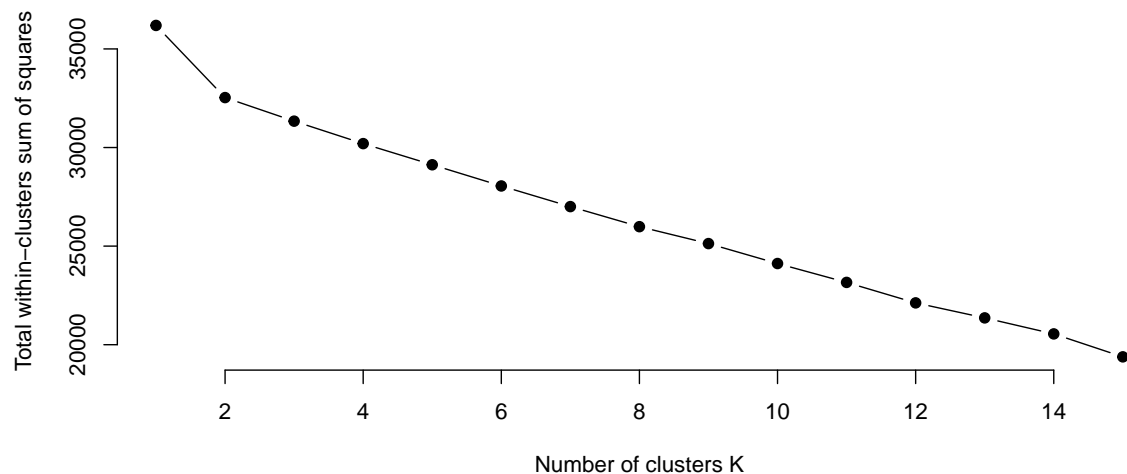
#> 3 0.93709770 -0.1949217 0.02409844 -0.06810831 -0.01307385 -0.34215085
#> 4 -0.26607491 0.3020294 0.31725536 1.07849536 -0.90142438 -0.06579537
#> 5 -0.19299942 -0.5434200 -0.50051586 0.54794056 0.28211830 0.52413168
#>          979          980          981          982          983          984
#> 1 -0.9464626 -1.36823719 0.53148902 -0.91204050 -0.1061298 0.004624396
#> 2 -0.2673652 -0.43104875 -0.21156964 0.01731834 -0.3589901 -0.012474619
#> 3 0.1019480 0.38937700 0.84865681 0.45853683 0.1408300 0.730091799
#> 4 1.0399011 -0.85293307 -0.51318521 0.01418099 -1.1964435 -0.594574847
#> 5 -0.2784783 0.09411387 -0.07981137 -0.09071290 -0.3113317 -0.799791445
#>          985          986          987          988          989          990
#> 1 -0.43981548 0.08970725 0.3287097 0.44429793 -0.32141041 -0.16357853
#> 2 -0.00349239 -0.21470386 -0.1416711 -0.05977998 -0.43172593 -0.14560705
#> 3 -0.57785374 -0.43668802 0.1137881 -0.20478486 0.09390983 0.03354041
#> 4 0.47222975 -0.86073690 -0.8688942 0.45727879 -0.20736417 0.57161781
#> 5 -0.44415229 0.06508487 -0.1304423 -0.63814815 0.69290756 -0.46670382
#>          991          992          993          994          995          996
#> 1 -0.045666626 -0.05267257 0.62398628 1.63328452 0.13056290 0.07934175
#> 2 -0.003537708 -0.26031019 -0.32712730 -0.03168406 -0.23624319 -0.33453575
#> 3 0.270546406 -0.42135611 -0.07762101 -0.23580073 0.12874047 -0.37912622
#> 4 0.550913388 0.46557552 0.34995551 0.30228586 0.34736731 -0.32268958
#> 5 0.145432657 0.18235081 -0.09022613 0.04245718 -0.05924426 -0.39912477
#>          997          998          999
#> 1 0.6496092 -0.3212383 -0.01658663
#> 2 -0.2623600 -0.3079115 -0.41400480
#> 3 0.4227699 0.1991706 -0.65264424
#> 4 -0.2215555 0.3727847 -0.01778748
#> 5 -0.7543713 0.1722276 0.38435187
#>
#> Clustering vector:
#> X.0.9619334 X0.4418028 X.0.9750051 X1.417504 X0.8188148
#>          5          1          5          5          1
#> X0.3162937 X.0.02496682 X.0.063966 X0.03149702 X.0.3503106
#>          4          1          3          5          4
#> X.0.7227299 X.0.2819547 X1.337515 X0.7019798 X1.007616
#>          3          3          4          3          3
#> X.0.4653828 X0.6385951 X0.2867807 X.0.2270782 X.0.2200452
#>          5          1          4          5          5
#> X.1.242573 X.0.1085056 X.1.864262 X.0.5005122 X.1.325008
#>          2          2          2          2          2
#> X1.063411 X.0.2963712 X.0.1216457 X0.08516605 X0.6241764
#>          2          2          2          2          2
#> X.0.5095915 X.0.2167255 X.0.05550597 X.0.4844491 X.0.5215811
#>          2          2          2          2          2
#> X1.949135 X1.324335 X0.4681471 X1.0611 X1.65597
#>          2          2          2          2          2
#>
#> Within cluster sum of squares by cluster:
#> [1] 2889.281 13540.079 3916.534 2854.316 5927.410
#> (between_SS / total_SS = 19.5 %)
#>
#> Available components:
#>
#> [1] "cluster"          "centers"          "totss"            "withinss"

```

```
#> [5] "tot.withinss" "betweenss"      "size"          "iter"
#> [9] "ifault"
```

Elbow-Method

```
#Elbow Method for finding the optimal number of clusters
set.seed(42)
# Compute and plot wss for k = 2 to k = 15.
k.max <- 15
data <- scaled_data
wss <- sapply(1:k.max,
              function(k){kmeans(data, k, nstart=60, iter.max = 15 )$tot.withinss})
wss
#> [1] 36190.83 32531.95 31337.21 30197.84 29125.14 28050.54 27003.94
#> [8] 25985.95 25128.65 24116.89 23159.64 22120.76 21359.88 20547.72
#> [15] 19384.38
plot(1:k.max, wss,
     type="b", pch = 19, frame = FALSE,
     xlab="Number of clusters K",
     ylab="Total within-clusters sum of squares")
```



Kriterium: Beim Elbow-Kriterium werden die Fehlerquadratsummen in ein Diagramm abgetragen. Zeigt sich im Kurvenverlauf ein Knick („Ellbogen“), so kann dieser Wert als Entscheidungskriterium für die Clusteranzahl verwendet werden.

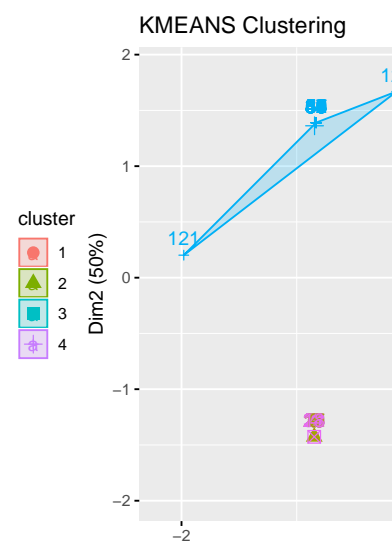
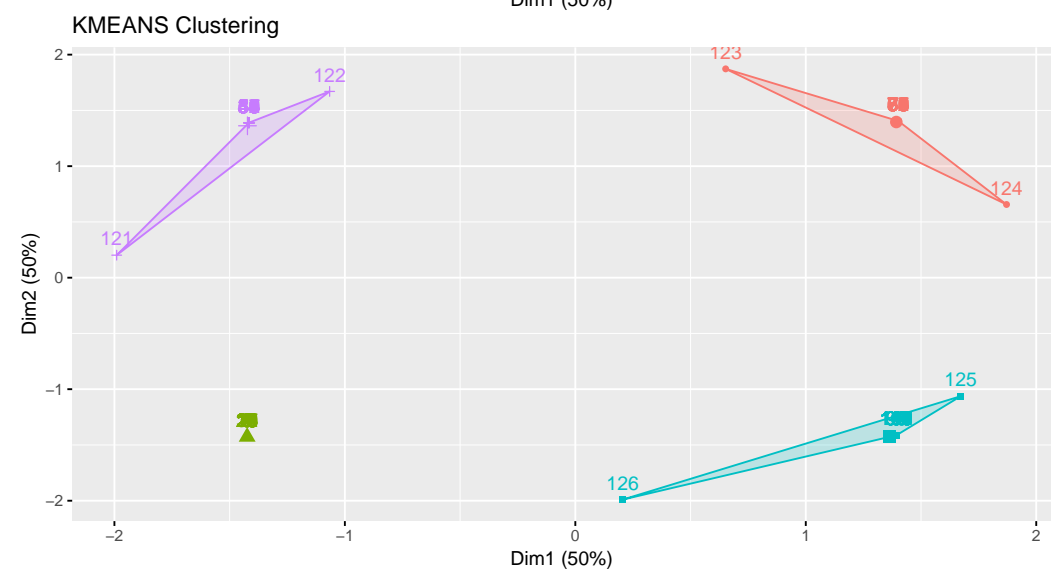
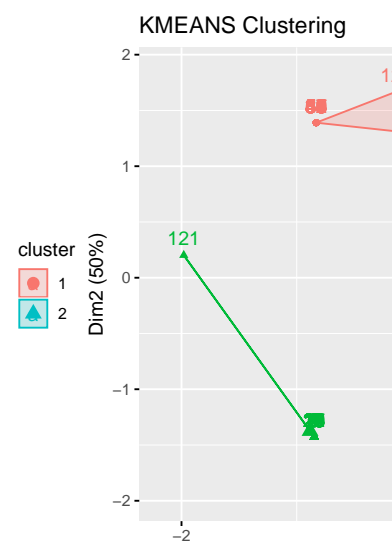
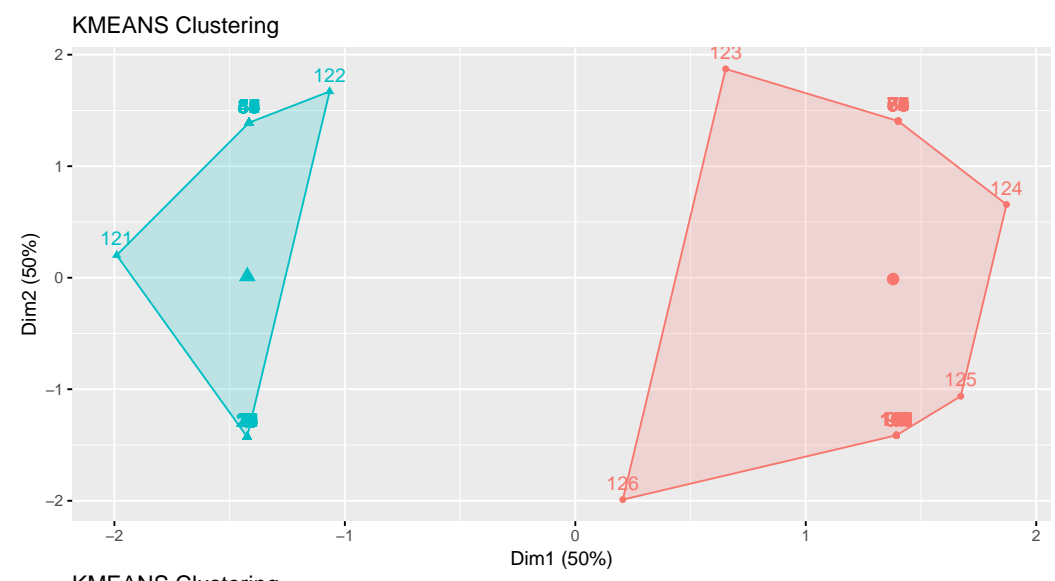
Optimale Anzahl der Cluster $K=4$.

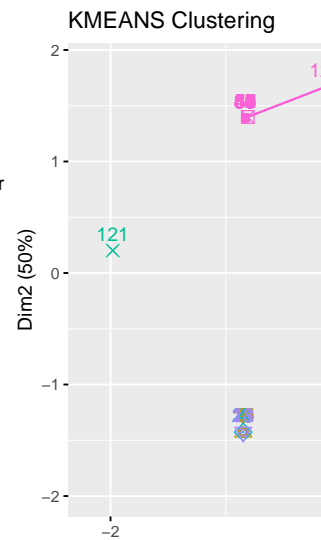
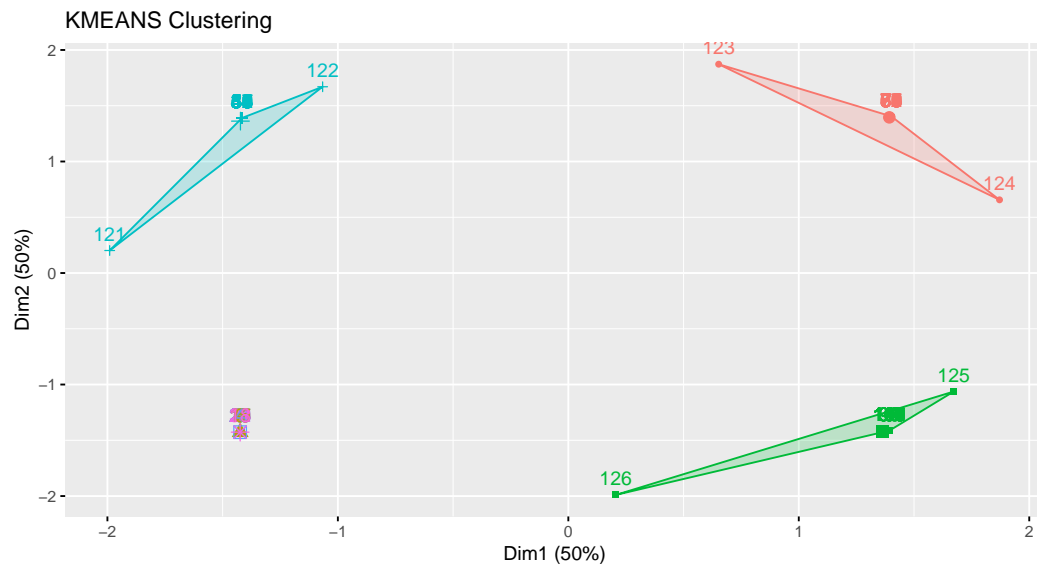
Aufgabe 2 a)

In diesem Aufgabenteil führen wir den Kmeans Algorithmus auf den clust Datensatz durch fuer die Werte $k=\{2, \dots, 7\}$ und visualisieren anschliessend die Cluster.

```
load("clust.RData")
packageTest("cluster")
packageTest("factoextra")
data <- clust
colnames(data) <- c("x1", "x2", "x3", "x4")
data <- scale(data)
for(i in 2:7) {
  par(mfrow=c(6,1))
```

```
eclust(data, "kmeans", k=i)
}
```





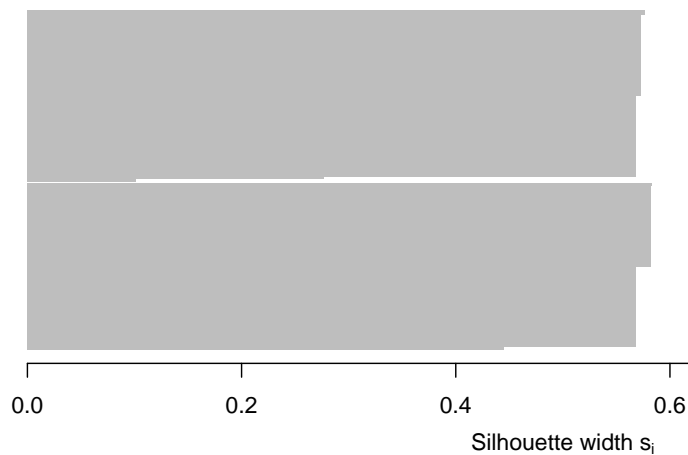
b)

Nun berechnen wir die Silhouetten sowie die Silhouetten-Koeffizienten fuer die Clusterungen aus a) und visualisieren anschliessend die Silhouetten inkl der Koeffizienten.

```
for(i in 2:7){
  km.res <- eclust(data, "kmeans", k=i, graph=FALSE)
  sil <- silhouette(km.res$cluster, dist(data))
  plot(sil, main=sprintf("Silhouette (k=%d)",i))
}
```

Silhouette (k=2)

n = 126



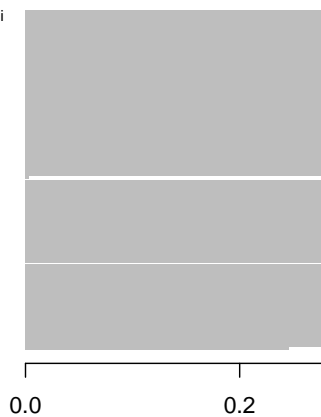
Silhouette (k=3)

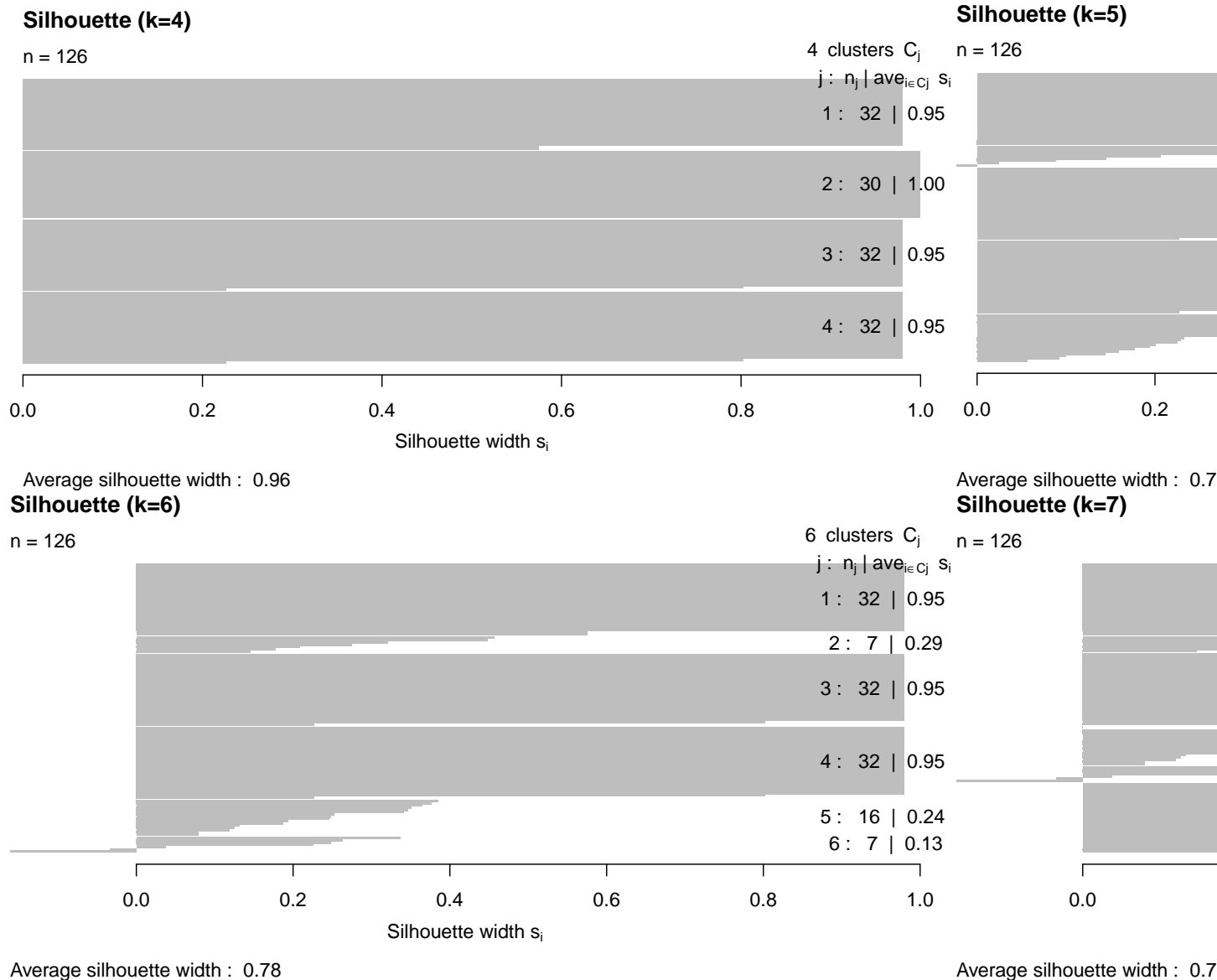
n = 126

2 clusters C_j
 $j : n_j \mid \text{ave}_{i \in C_j} s_i$

1 : 64 | 0.56

2 : 62 | 0.57





c)

Die Silhouette eines Datenpunktes entspricht einem Gütekriterium der Cluster. Sie gibt an, wie ähnlich bzw. unähnlich ein Datenpunkt zu seinen Nachbarn im Mittel ist. Dabei werden die Vergleiche zwischen dem Datenpunkt und den Nachbarn innerhalb des eigenen Clusters gemacht sowie zwischen dem Datenpunkt und den Nachbarn des nächsten Nachbar-Clusters.

Die Silhouette kann Werte aus dem Intervall $[-1,1]$ annehmen.

1 bedeutet dabei, dass der Datenpunkt im Mittel relativ zentral innerhalb des eigenen Clusters liegt und somit weiter entfernt zu den Nachbarclustern ist. Diese Eigenschaft entspricht einem guten Clustering.

-1 bedeutet, dass der Datenpunkt im Mittel näher zum Nachbar-Cluster liegt als zum eigenen Cluster.

0 wird einem Datenpunkt zugeordnet, wenn ein Cluster ausschließlich diesen Datenpunkt enthält.

maximieren wir den Wert der Silhouette, so erhalten wir den Silhouetten-Koeffizienten.

Vergleichen wir die Modelle mit unterschiedlichen Anzahl an Cluster, so wählen wir das Modell mit $k=4$, da dieser die höchste Silhouette besitzt sowie niedrigste Komplexität. Alle Cluster sind ähnlich gefüllt.

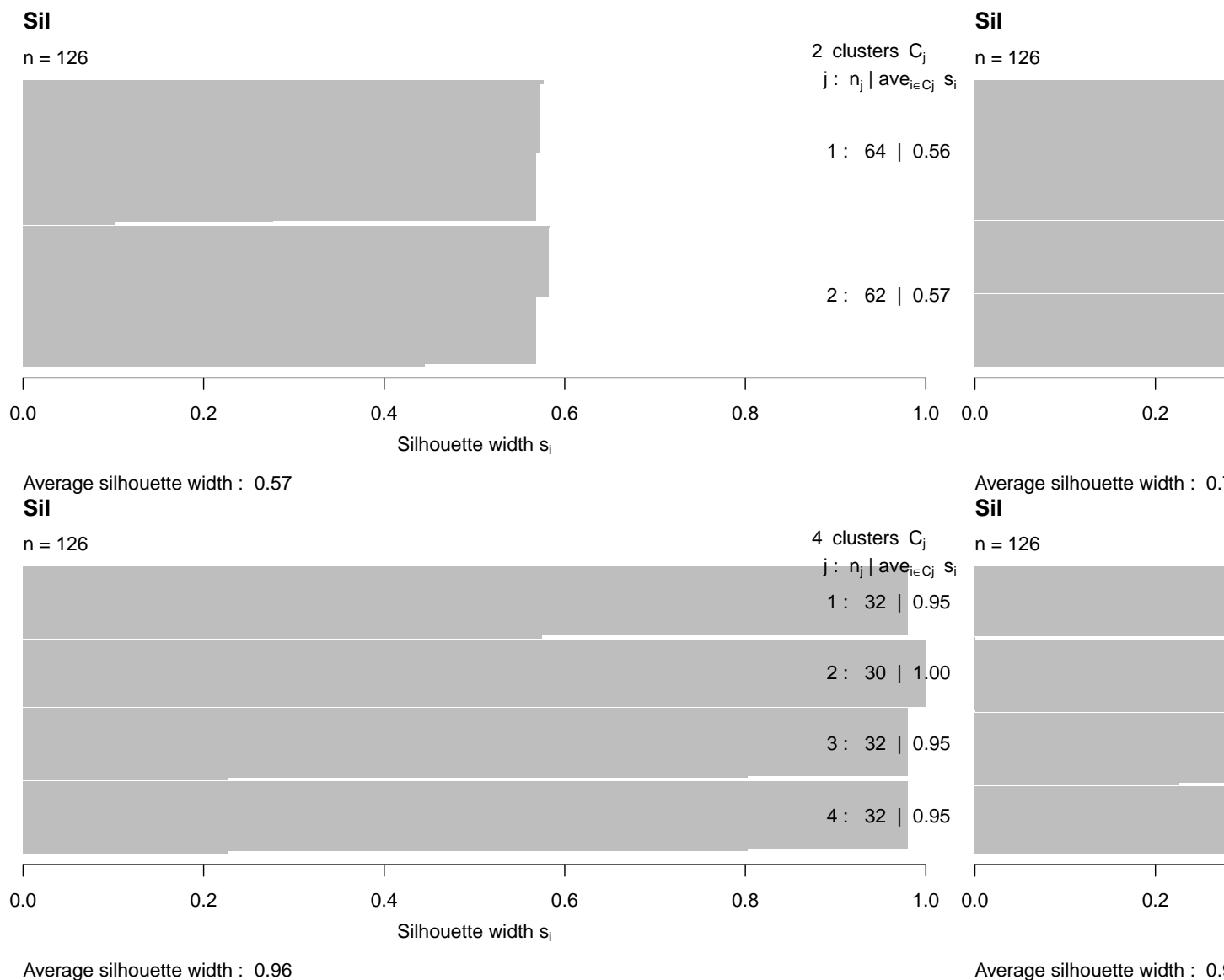
Erhöhen wir die Anzahl der Cluster, so bleibt der Wert der Silhouette gleich, jedoch erhalten wir Silhouetten

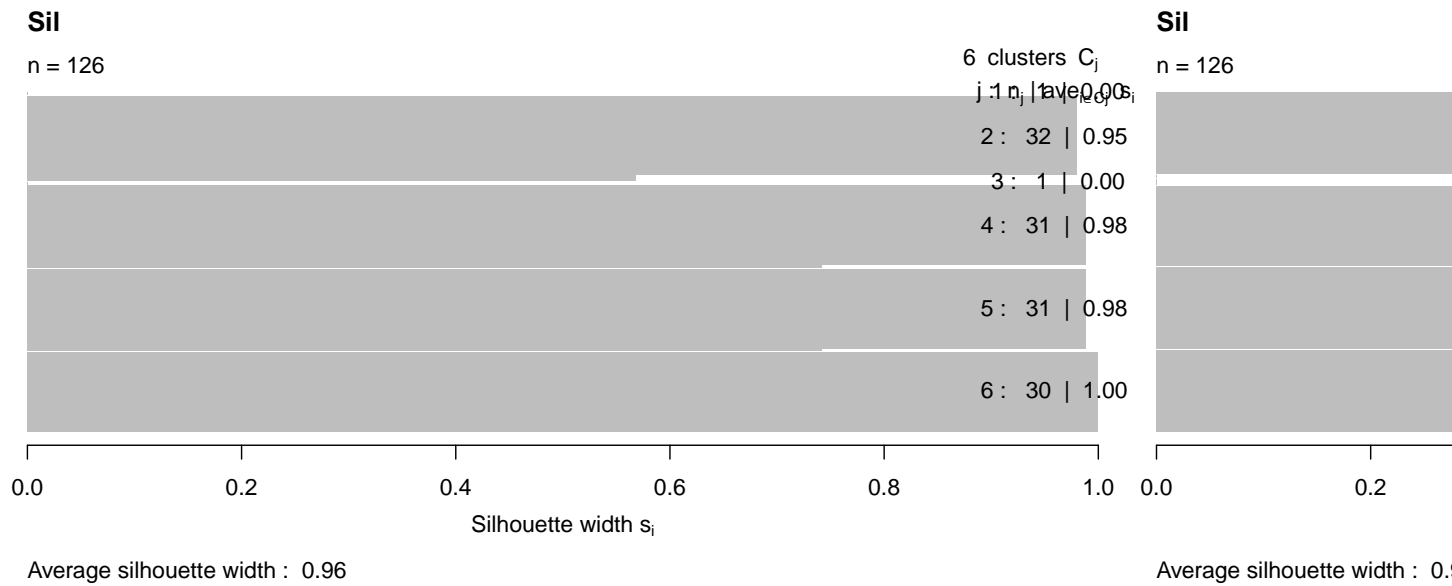
Werte gleich 0, diese entsprechen einem Cluster von einem Datenpunkt.

d)

Da das Ergebnis des K-Means-Verfahrens sehr stark von dem Initialzustand abhaengt, wiederholen wir im Folgenden den Algorithmus und setzen dabei fuer jeden Wert $k \in \{2, \dots, 7\}$ zufaellig einen Startzustand. Diese Option wird mit dem parameter *nstart* erreicht, den wir z.B. auf 25 setzen, so dass der Algorithmus 25 Mal durchlaeuft mit jeweils zufaelligem Startzustand. Im default betraegt dieser Parameterwert 1.

```
for(i in 2:7) {
  km.res <- eclust(data, "kmeans", k=i, graph=FALSE, nstart=25)
  sil <- silhouette(km.res$cluster, dist(data))
  plot(sil, main="Sil")
}
```





In unserem Fall erkennen keine signifikanten Unterschiede zu unserer Beobachtung auf Aufgabenteil b).