exercise4

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```
rm(list = ls())
setwd("E:/RStudio/workspace/ecology")
data <- read.csv("exercise4/percep_data.csv")
mydata <- data[1:1000,c(1, 2, 3)]
names(mydata) <- c("X1","X2","y")
str(mydata)
```

```
## 'data.frame':    1000 obs. of  3 variables:
##  $ X1: num  -0.58 -0.7 0.617 -0.384 0.103 ...
##  $ X2: num  -0.52 0.217 0.256 -0.716 0.527 ...
##  $ y : int  -1 -1 1 -1 1 -1 -1 -1 1 -1 ...
```

Sort the data by "y" from small to large

```
mydata <- mydata[order(mydata$y),]
for (i in 1:1000){
  if (mydata[i,3] > 0){
    num = i
    break
  }
}
```

```
g1_x = mydata[1:num-1,1]
g1_y = mydata[1:num-1,2]
g2_x = mydata[num:1000,1]
g2_y = mydata[num:1000,2]
g_x = c(g1_x, g2_x)
g_y = c(g1_y, g2_y)
group = mydata$y
print(g_x)
```

```
##    [1] -0.580332229 -0.700408393 -0.383554021 -0.669665385 -0.924211684
##    [6] -0.893007390 -0.747517828 -0.969455949  0.212477822 -0.067018274
##   [11] -0.845380255 -0.070843342 -0.161002714 -0.847237288 -0.538870153
##   [16] -0.796104809  0.312884902 -0.952179132 -0.555047904  0.027254277
##   [21] -0.201685828  0.614560655 -0.303915638 -0.745993299 -0.594036328
##   [26] -0.661723996  0.655322408 -0.012181714 -0.300574421  0.177990529
##   [31]  0.164390196 -0.082830399 -0.679185029 -0.207624209 -0.029622243
##   [36] -0.653184939 -0.727843930 -0.932441863 -0.709648260 -0.262066213
##   [41] -0.128924456 -0.652841405  0.133513165  0.309207475  0.471734496
##   [46]  0.168329255 -0.679675893  0.498291621  0.021842169 -0.662531914
##   [51] -0.969802656  0.172361911  0.520983047  0.009372056 -0.028214697
##   [56]  0.235774269 -0.130581330 -0.955704043 -0.491060224 -0.891019150
```

```
##   [61]  0.178745360 -0.212209630  0.041795839  0.111030995 -0.124411177
##   [66]  0.283784857 -0.166099959 -0.315088346 -0.830380953  0.129859228
##   [71]  0.052712458 -0.031044246 -0.599721087  0.464988472 -0.035812174
##   [76] -0.739608680 -0.209620364  0.311338193 -0.493997291  0.252401895
##   [81] -0.671518746 -0.686676425 -0.936032108 -0.510550155  0.367339595
##   [86] -0.826208770  0.217190416  0.504245621  0.296146520 -0.794670000
##   [91]  0.741823995  0.336200786 -0.654568986 -0.246696351 -0.444534361
##   [96] -0.863172337 -0.526602338 -0.919577098 -0.774254259 -0.371410395
##  [101]  0.259062315 -0.782329143 -0.329103272  0.037174952 -0.922831454
##  [106] -0.499206846  0.466347251  0.699940872 -0.046789649 -0.974437356
##  [111] -0.169687034 -0.204699697 -0.223160031 -0.202537509  0.620094142
##  [116]  0.043000923  0.348489683 -0.379673912  0.419640260  0.182189302
##  [121]  0.241317721 -0.742440020  0.113006205 -0.641043318 -0.403210716
##  [126] -0.994074475 -0.063866402 -0.019371397  0.364074961 -0.027474417
##  [131]  0.180817684 -0.936607894 -0.328059698 -0.735465886 -0.514475176
##  [136] -0.686662948 -0.816306446 -0.211106422  0.345657145 -0.957116118
##  [141] -0.947068227 -0.140775172 -0.896823365 -0.848902832 -0.206187144
##  [146]  0.165387341 -0.260593829 -0.565067444  0.391064555 -0.201906139
##  [151] -0.247436375 -0.155606141 -0.645391389  0.095639043 -0.914976891
##  [156] -0.089692972 -0.445442307 -0.092253339 -0.412230505  0.280022554
##  [161] -0.772558860 -0.317060656 -0.427522399 -0.845484805 -0.819221074
##  [166]  0.456802012 -0.209790305 -0.689747316 -0.119930612 -0.253897336
##  [171] -0.641686664 -0.570967958 -0.545758299 -0.115310044  0.053186549
##  [176] -0.323417496 -0.141921432 -0.364992660 -0.821142353 -0.655381416
##  [181]  0.304634633 -0.365465459 -0.728927127  0.385169975  0.188504144
##  [186]  0.124964156 -0.352389164  0.434121532 -0.768223628 -0.036338809
##  [191] -0.832893942 -0.217558372 -0.445880481 -0.377475702 -0.044101676
##  [196] -0.852990613 -0.798988577 -0.835976070 -0.448127987 -0.686201458
##  [201]  0.297108687 -0.158558780 -0.416690049 -0.822917893 -0.067795461
##  [206] -0.839224492  0.190852643 -0.178901900 -0.456978573  0.108187420
##  [211] -0.607726229 -0.253882249 -0.195342080 -0.042486992 -0.193772476
##  [216] -0.856056809  0.026147165 -0.653958161  0.416520590  0.308608411
##  [221] -0.972264203 -0.748728958 -0.870237883  0.300926180  0.551333887
##  [226]  0.696451934 -0.467352808 -0.172944556 -0.015172399 -0.211980343
##  [231] -0.307366263  0.401981569  0.494755397 -0.627593298 -0.646065289
##  [236] -0.802083119 -0.673365920 -0.344081173 -0.107657734 -0.129669155
##  [241]  0.175481335 -0.842352185 -0.307359297 -0.009464754 -0.697997046
##  [246]  0.038687191 -0.399294488  0.369750724  0.412766828 -0.154997888
##  [251] -0.795236657 -0.165362463  0.000334154 -0.113829067 -0.253295537
##  [256] -0.266737649  0.575917895 -0.355796588 -0.946214764 -0.757178127
##  [261]  0.012263365 -0.678252286 -0.180667686 -0.716173588 -0.895842977
##  [266] -0.928286566  0.035431514  0.015473441 -0.361613856  0.223643867
##  [271] -0.974288764 -0.900005416 -0.166460627 -0.802627985  0.658867585
##  [276] -0.054149183 -0.107479451 -0.254147325 -0.596835584 -0.768822022
##  [281] -0.392734643 -0.811788584 -0.166963488  0.265736505 -0.645530737
##  [286] -0.601138547  0.389303598  0.232397514 -0.806690948  0.182137072
##  [291] -0.409485518 -0.564986074  0.035444822  0.471500428 -0.573094180
##  [296] -0.432867255  0.191168467 -0.594515572  0.093331449 -0.208790140
##  [301] -0.967117591 -0.559325628 -0.924592285  0.234079776 -0.858373559
##  [306]  0.112455057 -0.518298279 -0.970944117 -0.377414336  0.070039710
##  [311] -0.037824427 -0.213020124  0.067258903 -0.724717168  0.688810281
##  [316]  0.087264478 -0.158909296 -0.769724817  0.055806912  0.095415584
##  [321] -0.658431144 -0.628058108 -0.314984113 -0.144179220 -0.314583454
##  [326]  0.441003655 -0.158952710 -0.315962978  0.345497573 -0.687195288
```

```
##  [331] -0.126628440 -0.179661683 -0.088183258  0.181202901  0.282010744
##  [336]  0.153671760  0.620897359 -0.549778792 -0.888157069  0.321892867
##  [341] -0.461256960 -0.264689643 -0.284150278  0.765190511 -0.741085878
##  [346] -0.748162873 -0.483040136  0.445254738  0.045465385 -0.860957781
##  [351] -0.416511309 -0.718017798 -0.064132224  0.117409077 -0.881507226
##  [356] -0.326711051 -0.750778860 -0.571088917 -0.906473081 -0.286386711
##  [361] -0.641660280 -0.781221180  0.397195697 -0.558807834  0.193122434
##  [366] -0.387582598 -0.420757418 -0.966231763  0.116030682 -0.350187365
##  [371]  0.062884708 -0.682551017 -0.401300504 -0.159472918  0.692469806
##  [376] -0.827573081  0.285814634 -0.170037101 -0.235924248 -0.789530714
##  [381] -0.913625308 -0.882604131 -0.123552807 -0.115001661 -0.729208708
##  [386] -0.625490915 -0.601441060  0.187301796 -0.625599968  0.330187223
##  [391] -0.749915121 -0.708846171 -0.290408871 -0.530922749  0.746768342
##  [396] -0.944784558 -0.349192686 -0.184933668  0.306502727 -0.419161390
##  [401] -0.662244672  0.245345186 -0.924199512 -0.520749620  0.141922093
##  [406] -0.558310262 -0.718951023 -0.353766682  0.083370241  0.165908242
##  [411] -0.902190282 -0.833461824 -0.401139818 -0.935742204 -0.773890657
##  [416]  0.155522502 -0.267749361 -0.656409097 -0.548493402  0.005637744
##  [421] -0.623664577  0.193454072 -0.709607192  0.622961145 -0.587941859
##  [426] -0.772632896 -0.106580826 -0.282237823 -0.420275256  0.675568823
##  [431] -0.332328035 -0.010200853 -0.339268897 -0.697159376  0.063798551
##  [436] -0.149303484  0.071928496 -0.273868570 -0.443125974  0.199992094
##  [441] -0.466650018 -0.405830210 -0.663891094  0.081889824 -0.196830544
##  [446]  0.249348830 -0.404209675 -0.297410359 -0.376978803  0.217374588
##  [451] -0.925128179 -0.771201064  0.499127375 -0.780692267 -0.305354987
##  [456] -0.080387612 -0.791710288 -0.004393333 -0.616765269 -0.179444063
##  [461]  0.200991023 -0.385387314 -0.190839613  0.277464658 -0.489161934
##  [466] -0.815507501  0.023013493 -0.403525979 -0.634905955 -0.732205941
##  [471] -0.915674248 -0.902312712 -0.559450231 -0.712596677  0.447495591
##  [476]  0.132552444 -0.036978606 -0.424367876 -0.314046890 -0.712853417
##  [481] -0.241534478 -0.568683981 -0.414000700 -0.239742117 -0.324528561
##  [486] -0.208028026  0.840509628  0.141464219 -0.422471884 -0.094710995
##  [491] -0.932614278 -0.477744627 -0.165755649  0.101332703 -0.963075801
##  [496] -0.864184003 -0.175750089 -0.375405491 -0.370674771 -0.250561224
##  [501] -0.976006721 -0.949363505 -0.191098937 -0.787015597 -0.859230338
##  [506] -0.249137735 -0.700804804 -0.390214302 -0.293462123  0.298451326
##  [511]  0.314188981 -0.285026094 -0.691558615 -0.239902932 -0.174967562
##  [516] -0.703233708 -0.369599388 -0.223754765 -0.514713384 -0.155804209
##  [521]  0.792885573 -0.302076167 -0.615199013  0.093260398 -0.482591934
##  [526] -0.365064777  0.109752625 -0.697287773 -0.856599043 -0.880615717
##  [531] -0.822679487 -0.320862388 -0.251871119  0.564032251  0.102640499
##  [536] -0.554506344 -0.850256227 -0.479235939 -0.271657098  0.214704994
##  [541] -0.402360349 -0.494843251  0.407675811 -0.004288866  0.357268584
##  [546] -0.092123169  0.574561055 -0.365274219 -0.423066940 -0.166714074
##  [551]  0.922230838 -0.193874396 -0.444780488  0.100524891  0.312744911
##  [556]  0.263368541 -0.998518443  0.090781895 -0.545345797 -0.327256690
##  [561] -0.961206979  0.950067932 -0.519171910  0.351340038 -0.886740738
##  [566]  0.297438289  0.056049726 -0.652629828  0.253545141 -0.522627722
##  [571] -0.734579715 -0.163512648 -0.853652426  0.060748849 -0.040044416
##  [576] -0.543203233  0.297929912 -0.233382013  0.259712565 -0.253748919
##  [581] -0.192967595 -0.543764659 -0.615920154 -0.296641224  0.098852753
##  [586] -0.618308517 -0.693263447 -0.876938911  0.756681340  0.712198121
##  [591] -0.813686469  0.197707428 -0.561940813 -0.961478478 -0.865332700
##  [596] -0.805343785 -0.509284019  0.613209374 -0.530029545  0.158138046
```

```
##  [601] -0.122007295 -0.549008537 -0.866411627 -0.399490101 -0.155724308
##  [606] -0.458632750 -0.421568671 -0.588181201  0.518976761 -0.047392850
##  [611] -0.883109126 -0.511075464  0.285739308 -0.928251764 -0.807711298
##  [616] -0.183885921  0.422554926 -0.027609547  0.597560266 -0.359902762
##  [621] -0.850962342 -0.679619643  0.310512355  0.879252173  0.260837032
##  [626]  0.066803083 -0.887660014 -0.744614456 -0.755401384 -0.427124362
##  [631]  0.081702865  0.626338821 -0.572181598 -0.605421676 -0.359128957
##  [636] -0.452135180 -0.167388875 -0.675963644 -0.502464008 -0.082102047
##  [641]  0.291148275 -0.824148617 -0.408202096 -0.753623002 -0.385308473
##  [646] -0.610716824 -0.335364092  0.311873815 -0.606699381  0.439094439
##  [651]  0.913315999  0.015714832 -0.869335719  0.410711158 -0.622861284
##  [656] -0.071611420 -0.073301136 -0.584423991 -0.425665190  0.586914383
##  [661]  0.268797752 -0.227074812 -0.738260977 -0.738537821 -0.717623139
##  [666]  0.108787790 -0.659649092 -0.585486952  0.617452960  0.102860314
##  [671]  0.495805302  0.717524145  0.590579726  0.731425554  0.483921118
##  [676]  0.665881643  0.713695913  0.932679267  0.550222915  0.192508432
##  [681]  0.652458721  0.582303554  0.815841476  0.224820658  0.369213326
##  [686]  0.476629192  0.475745307  0.216011198  0.964336313  0.250117260
##  [691]  0.233915106  0.678698656  0.568139121  0.821559003  0.919404368
##  [696]  0.417619857  0.392067277  0.524906655  0.894747502  0.428347597
##  [701]  0.810716338 -0.081888004  0.905405383  0.739087285  0.970142080
##  [706]  0.892603375  0.919931365  0.725802282  0.658469780  0.821923941
##  [711]  0.816940960  0.722909905  0.908834677  0.742041501  0.772651761
##  [716]  0.464171179  0.723530638  0.891825687  0.864651679  0.801288861
##  [721]  0.987301196 -0.467118425  0.688494379  0.608086800  0.398938740
##  [726]  0.927521297  0.939185260  0.642987972  0.804794711  0.613654878
##  [731]  0.729745180  0.295689749  0.346240358  0.682439948  0.587901326
##  [736] -0.004112198  0.749939844  0.540782292  0.926566520  0.803408851
##  [741]  0.505890977  0.455412403  0.859034390  0.288439938  0.506295346
##  [746]  0.176569473  0.909958834  0.443776780  0.257965944  0.636095771
##  [751]  0.634709449  0.641266505  0.838697677  0.258704986  0.445580781
##  [756]  0.798803652  0.864364909  0.853916025  0.916603066  0.881752174
##  [761]  0.867052207 -0.391734914  0.865338917  0.799224332  0.606619583
##  [766]  0.984023750  0.865926477  0.964862464  0.785717427  0.259316275
##  [771]  0.285496207  0.720984917  0.705606468  0.775837755  0.843479035
##  [776]  0.829673521  0.238637483  0.978575439  0.913979881  0.583926806
##  [781] -0.050259219 -0.029360380  0.991417036 -0.060254995  0.692808133
##  [786] -0.035165094  0.782367188  0.133189930  0.854801175  0.619836284
##  [791]  0.841352789  0.582125020  0.969806652  0.676268001  0.804554337
##  [796]  0.436217048  0.555555487  0.489192200  0.894542849  0.777457165
##  [801]  0.591089583  0.663318397  0.427442965  0.699602025  0.876730374
##  [806]  0.881163103  0.291357895  0.145928355  0.997131149  0.341296653
##  [811]  0.703390837  0.984792263 -0.344307624  0.721074105  0.294930345
##  [816]  0.474986978 -0.019181719  0.175069337  0.659952105  0.356974509
##  [821]  0.409245794  0.906489435  0.864253255  0.575288488  0.755117604
##  [826]  0.547547050  0.940818330  0.962734676  0.254520348  0.960789610
##  [831]  0.432844357  0.654123909  0.871460822  0.075991365  0.651641415
##  [836]  0.579835237  0.075459165  0.267797037  0.148971590  0.492552690
##  [841]  0.762729859  0.735864696 -0.133472593  0.529953276  0.372720274
##  [846]  0.885861657  0.467847235  0.175147638  0.666771272  0.706905389
##  [851]  0.921012893  0.862954224  0.820175318  0.598397850  0.838917051
##  [856]  0.512478007  0.793667857 -0.358524807  0.286051426  0.503908926
##  [861]  0.766913780  0.395648678  0.330393946  0.734578698  0.830322354
##  [866]  0.587589887  0.848788150  0.577934735  0.758437932  0.950971244
```

```
##  [871]  0.679835126  0.303365529  0.766944304  0.726523405  0.686285680
##  [876]  0.739346062  0.713007276  0.706848277  0.676630160  0.157903188
##  [881]  0.620536485  0.630384073  0.433166596  0.623042396  0.960544850
##  [886]  0.715408551  0.698854843  0.710342670  0.820727269  0.485013281
##  [891]  0.926851451  0.704234743  0.231711307  0.809317084  0.666857583
##  [896]  0.785270240  0.130067189  0.618908106  0.894779993  0.020842439
##  [901]  0.997732540  0.363069845  0.620408148  0.997525715  0.720659013
##  [906]  0.834827844  0.780129303  0.384541863  0.932570448  0.100769422
##  [911]  0.662887472  0.555710516  0.430679534  0.357212817  0.753994210
##  [916]  0.598761067  0.103908985  0.935290516  0.025553748  0.988902126
##  [921]  0.618051430  0.789193399  0.863632367  0.702681357  0.714228435
##  [926]  0.934796846  0.308086152  0.719759024  0.859053405  0.645949415
##  [931]  0.778692973  0.350962407  0.898676416  0.435821219  0.713049050
##  [936]  0.408234312  0.796753211  0.753026501  0.860338372  0.890994592
##  [941]  0.910200815  0.670767310  0.803446386 -0.681976813  0.462360063
##  [946]  0.916078371  0.867017545  0.601604638  0.232870690  0.617103974
##  [951]  0.065653211  0.824116913  0.918424270  0.829126610  0.539831813
##  [956]  0.597670494 -0.164067451  0.015252130  0.428780785  0.767178330
##  [961]  0.685353305  0.731710804  0.767946739  0.875615617  0.349175095
##  [966]  0.530546459  0.820267855  0.514998773  0.038780489  0.699823687
##  [971]  0.486799459  0.289754946  0.492070521  0.589714910  0.702352426
##  [976]  0.793462679  0.799033222  0.390658394  0.976742982  0.432787957
##  [981]  0.908759137  0.072954751  0.756588583  0.784670779  0.563193537
##  [986]  0.179956783  0.737284963  0.906559011  0.543397749  0.982478278
##  [991]  0.852748033  0.825467063  0.810363557  0.558737156  0.605552093
##  [996]  0.247469838  0.353707701  0.893961554 -0.005746083  0.715176346
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```
print(g_y)
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##    [6] -0.323050076  0.062956920 -0.821005984 -0.617250544  0.708718831
##   [11]  0.441071621 -0.309760052  0.290165307  0.377097876  0.886014835
##   [16] -0.772537561 -0.927682457  0.997913483  0.351738875 -0.341957527
##   [21] -0.085584627 -0.563663018 -0.610270385  0.652445398  0.317142254
##   [26] -0.953728724 -0.659164949 -0.449630272 -0.289391624  0.345849612
##   [31] -0.159522624  0.769028173  0.901361422 -0.761267025 -0.094095234
##   [36]  0.383359080 -0.660654874 -0.234250428 -0.599675439  0.752041644
##   [41] -0.927357809 -0.771892901 -0.599314685 -0.848098769 -0.724804531
##   [46] -0.496791888 -0.405263997 -0.598412670  0.132584007  0.570253959
##   [51]  0.152975575 -0.126105250 -0.341313754  0.111416987  0.155469950
##   [56] -0.924622848  0.217333102  0.038740327 -0.714546081  0.054238233
##   [61] -0.007466067 -0.978235774 -0.980159899 -0.671638325 -0.575068205
##   [66] -0.096313593  0.708060191 -0.750110808 -0.069231309 -0.433443991
##   [71]  0.287919428  0.593763679 -0.088547132 -0.105426550 -0.831066536
##   [76]  0.422413770 -0.722316766 -0.773726776  0.120430437  0.262260016
##   [81]  0.709359418 -0.018582785 -0.766173352  0.676493261 -0.103150035
##   [86]  0.365086977 -0.173133398 -0.207925170 -0.355308134 -0.812184219
##   [91] -0.855777129  0.083173679 -0.740702314 -0.653083731  0.161457065
##   [96]  0.989769892 -0.330085462 -0.965743032 -0.406270306 -0.382525466
##  [101] -0.424145212  0.232438799 -0.812559372 -0.244977412 -0.612597878
##  [106] -0.062963386 -0.448496379 -0.702935595  0.639594230  0.710988346
##  [111]  0.562042688  0.678850454  0.610470320 -0.290204390 -0.952392993
##  [116] -0.801764287 -0.181618974 -0.674107848 -0.913138151 -0.194113619
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##  [141] -0.516470019  0.863714326  0.334231469  0.764701757  0.582640084
##  [146] -0.764356225 -0.767649134 -0.923463350 -0.045693598 -0.869716426
##  [151]  0.582324159  0.566384295 -0.666216328  0.362926513  0.949280849
##  [156] -0.014390260  0.387874366  0.202615178  0.938324279 -0.328267295
##  [161]  0.071361611 -0.728153464 -0.951042099  0.209286518  0.326196240
##  [166] -0.551229243  0.411146770 -0.884010727 -0.671782435  0.895880357
##  [171]  0.631297373 -0.482557816 -0.353511550 -0.756514497 -0.845201435
##  [176] -0.307402492 -0.226861500  0.283244786  0.197494596  0.342223645
##  [181] -0.505160580 -0.772818503  0.106565239 -0.431940146 -0.060733335
##  [186]  0.409873865 -0.168140640 -0.916418225 -0.414114292  0.084915406
##  [191] -0.589107262 -0.143876802  0.283357498  0.172616706 -0.658929796
##  [196]  0.202303560  0.083915259 -0.655727615 -0.990391262 -0.610556596
##  [201] -0.370625117  0.617959608 -0.879279390  0.213561094  0.054433805
##  [206]  0.620531506 -0.361102588 -0.425615058  0.554640601  0.410347131
##  [211] -0.893931500  0.783421200  0.292845446  0.672564700 -0.769523880
##  [216]  0.534206151 -0.252451876 -0.579375592 -0.605703144 -0.339221471
##  [221]  0.748846428 -0.783082269  0.591666664 -0.867652726 -0.729311740
##  [226] -0.649059686  0.481239292 -0.648989767 -0.683693818  0.538125131
##  [231] -0.318835299 -0.064043046 -0.761064664  0.751569792 -0.075466470
##  [236]  0.833005759 -0.697198773  0.745998460 -0.719416423  0.004023034
##  [241]  0.180165666 -0.429355889  0.526685929  0.199487293  0.328477544
##  [246] -0.930719255  0.656180692 -0.376392154 -0.728298162 -0.181941509
##  [251]  0.301373281 -0.414402606  0.693786849 -0.142026964  0.087607881
##  [256] -0.566450160 -0.734079350  0.442903016 -0.413117812 -0.948840608
##  [261] -0.634203561 -0.781103690 -0.442369479  0.557816038  0.544817847
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##  [271] -0.269122283 -0.419971390  0.738944774  0.199879512 -0.624685050
##  [276] -0.631257358  0.698073226  0.288735889 -0.097865291  0.346911546
##  [281] -0.009207899  0.063637936  0.864107000 -0.586582379  0.269280910
##  [286] -0.695414256 -0.556715629 -0.620521015 -0.048055083 -0.041951894
##  [291]  0.977477302  0.478162456  0.086894040 -0.533493872 -0.620806346
##  [296]  0.748284173  0.301548383 -0.014514755  0.415719844  0.551635928
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##  [306] -0.898424545 -0.467001120  0.303373742  0.812139847  0.067211342
##  [311]  0.469065018  0.194724473 -0.573093642 -0.681836430 -0.890288390
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##  [321]  0.115934507  0.299166942  0.661561299  0.907220517  0.449384138
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##  [361] -0.235792196 -0.759554832 -0.794673699  0.899984079 -0.356438163
##  [366]  0.527985592  0.130551429 -0.865081300 -0.831664692  0.517772024
##  [371]  0.052056197  0.748945046  0.803937409  0.026167244 -0.721598880
##  [376] -0.681856413  0.190140767  0.134132754 -0.550150942  0.106454452
##  [381]  0.798414711  0.299762661  0.408342604  0.596745259  0.149431527
##  [386]  0.842409122 -0.118171861 -0.477047730 -0.443953117 -0.080836532
##  [391] -0.857855645 -0.930649952  0.152563525  0.039231640 -0.771724355
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##  [421] -0.583352374 -0.832595489  0.141511798 -0.794133502  0.967051591
##  [426]  0.207390213  0.870055406 -0.784702050  0.526973811 -0.543551269
##  [431]  0.206631222  0.442826434 -0.843089239 -0.779921411  0.163431576
##  [436]  0.568432718  0.240252638  0.483841428 -0.650827363 -0.930843802
##  [441]  0.849519045 -0.324390720 -0.991447533 -0.962698838  0.349233351
##  [446]  0.092743610 -0.835722716 -0.927149856  0.296065167 -0.570797003
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##  [456] -0.557231711 -0.447642085 -0.609768188 -0.014644058 -0.932347761
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##  [486]  0.021919340 -0.921384491 -0.128247601 -0.047464745 -0.603329102
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##  [526] -0.274948350  0.290640282 -0.536283298 -0.238803929  0.502385751
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##  [536]  0.850668418 -0.268299395 -0.017714991 -0.451069576  0.286721797
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##  [551] -0.975356469 -0.901149884 -0.203119242 -0.915411273 -0.976451682
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##  [566] -0.984494309  0.177570626 -0.952438512 -0.473423618 -0.849857398
##  [571]  0.303689008 -0.081190330 -0.902269883  0.494104412  0.686587843
##  [576]  0.947255619 -0.269996460 -0.973330177 -0.616127939  0.079151423
##  [581] -0.437315500 -0.481738363 -0.408397489 -0.652219400  0.246450698
##  [586] -0.947375703  0.985263408  0.128268208 -0.966647105 -0.800806875
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##  [596]  0.845828617 -0.739326060 -0.540344152 -0.037294973 -0.869983333
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##  [606] -0.705438885 -0.868209101 -0.594339342 -0.388232179 -0.281331698
##  [611] -0.532217966  0.250505430 -0.477818662 -0.912607899  0.929122651
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##  [621] -0.193293332  0.171808304 -0.289992425 -0.822937844 -0.148387702
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##  [891] -0.658000898 -0.470168019  0.925997048 -0.023902066 -0.202867223
##  [896] -0.216340049  0.637359911 -0.331724546  0.699055102  0.844656488
##  [901]  0.219557220  0.579903816  0.150328055  0.379149677  0.183646823
##  [906] -0.476220626 -0.232361719  0.051394356  0.226864411  0.968912669
##  [911]  0.308394417  0.869250764  0.783861426  0.927254533  0.894979039
##  [916]  0.821052843  0.910478256 -0.508277486  0.771791840 -0.933615211
##  [921] -0.021498451  0.078903731  0.448218092  0.316143179  0.574156435
##  [926] -0.498768267  0.309079474  0.762135282 -0.393938632 -0.109420694
##  [931] -0.437783598  0.167571427  0.355459576  0.993208495  0.614604194
##  [936]  0.517470724 -0.106448260  0.278844422 -0.403630945  0.595760830
```

```
##  [941] -0.768536740 -0.015899629  0.476982128 -0.137629990 -0.079218015
##  [946] -0.389105304 -0.354539033  0.447458206  0.997812058  0.994181517
##  [951]  0.840927554 -0.513583505  0.587781134  0.857035448  0.086215791
##  [956]  0.950977972  0.997553027  0.916786597  0.298661910  0.989902428
##  [961] -0.284839513  0.094149063  0.007195421 -0.429885716  0.158199611
##  [966]  0.297186636 -0.115286239  0.910834371  0.993983089 -0.195010530
##  [971]  0.750727096  0.261477361  0.443947403 -0.031126470 -0.116524510
##  [976] -0.476734445  0.594195400  0.204504129  0.631474056  0.777222957
##  [981]  0.009108269  0.713585841  0.618203951  0.162588359  0.062317627
##  [986]  0.584534413 -0.136514551  0.518319314  0.636010607 -0.013855288
##  [991]  0.137555285  0.951856345  0.661778382  0.923314955 -0.278932694
##  [996]  0.772786298  0.439182365 -0.422119606  0.849554409 -0.429342357
```

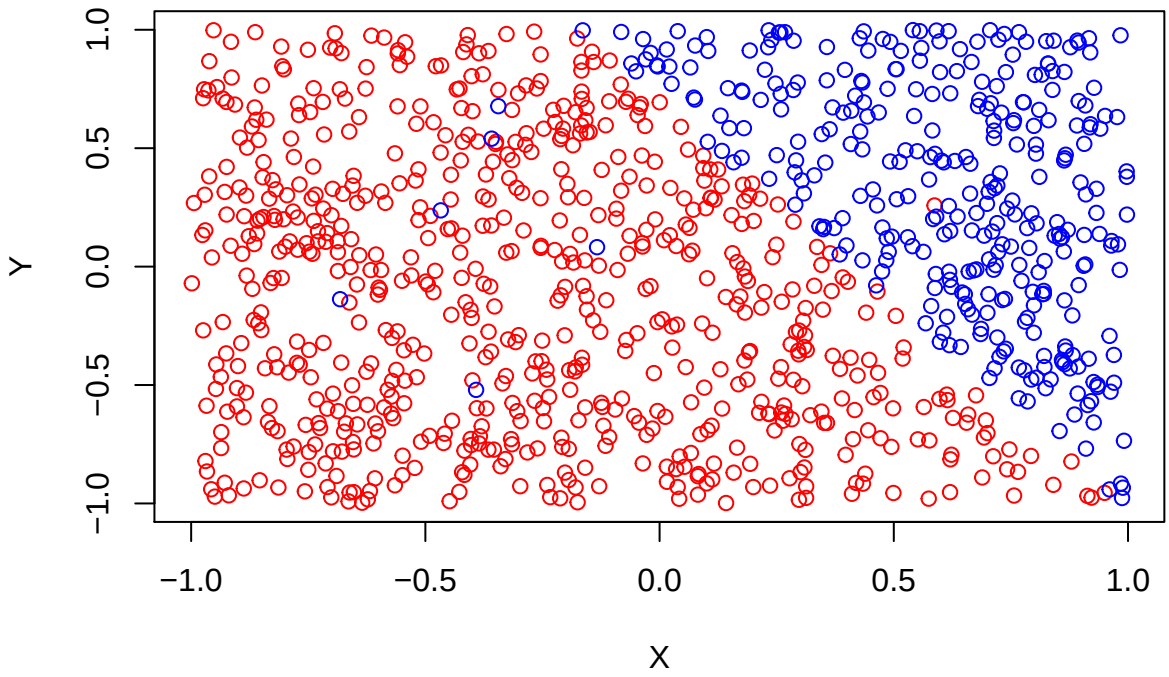
```
print(group)
```

```
##    [1] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##   [25] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##   [49] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##   [73] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##   [97] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [121] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [145] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [169] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [193] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [217] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [241] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [265] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [289] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [313] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [337] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [361] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [385] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [409] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [433] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [457] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [481] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [505] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [529] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [553] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [577] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [601] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [625] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [649] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1  1  1
##  [673]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [697]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [721]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [745]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [769]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [793]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [817]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [841]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [865]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [889]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [913]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [937]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
```

```
##  [961]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [985]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
```

Color points based on the value of "y"

```
plot(g_x, g_y, type='n',xlab='X', ylab='Y')
points(g1_x, g1_y, col='red')
points(g2_x, g2_y, col='blue')
```



Initial weitht

```
theta0 = 0.1
theta1 = 0.2
theta2 = 0.3
```

```
M = 15             # number of epochs to run
eta = 0.005        # learning rate
th = 0.9           # threshold to stop
verbose = F    # whether detailed weight update info is printed
```

Iteration

```
for (i in 1:M){
  print(paste('Epoch starts: ', i))

  ## We reshuffle the order of the datapoint for each epoch.
```

```
  index = 1:1000
  index = sample(index)

  for (j in index){
    y_j = theta0 + theta1*g_x[j] + theta2*g_y[j]

    if (y_j >= 0){
      pred_j = 1

    }else{
      pred_j = -1}

    theta0 = theta0 + eta*(group[j] - pred_j)*1.0
    theta1 = theta1 + eta*(group[j] - pred_j)*g_x[j]
    theta2 = theta2 + eta*(group[j] - pred_j)*g_y[j]

    if (verbose == T){
      print(paste('  -> updating data point ', j, ' : '))
      print(paste('     -> theta0: ' ,theta0))
      print(paste('     -> theta0: ' ,theta1))
      print(paste('     -> theta0: ' ,theta2))
    }
  }

  y_all = theta0 + theta1*g_x + theta2*g_y
  y_pred = y_all
  y_pred[y_all >= 0] = 1
  y_pred[y_all< 0] = -1

  acc = sum(y_pred == group)/length(group)
  print(paste('Epoch ends: ', i, ' WITH accuracy: ', acc))

  if (acc >= th){
    break
  }
}
```

```
## [1] "Epoch starts:  1"
## [1] "Epoch ends:  1  WITH accuracy:  0.985"
```

```
y_all = theta0 + theta1*g_x + theta2*g_y
print(y_all)
```

```
##    [1] -0.3132087894 -0.2430225552 -0.2913138649 -0.3543922006 -0.2977032351
##    [6] -0.3634981320 -0.2754506375 -0.4497048660 -0.1312442962 -0.0205776858
##   [11] -0.2483624435 -0.1593573087 -0.1003540538 -0.2574775140 -0.1127100310
##   [16] -0.4004819568 -0.1485462180 -0.1992851314 -0.1889990207 -0.1395720973
##   [21] -0.1612195472 -0.0250355932 -0.2573888330 -0.1952956253 -0.2032766481
##   [26] -0.3919315269 -0.0279287270 -0.1638498044 -0.2131396457 -0.0093885106
##   [31] -0.0811314203 -0.0163070894 -0.1451658550 -0.2541261064 -0.1200249084
##   [36] -0.2088720589 -0.3685404153 -0.3611854116 -0.3558094970 -0.0627175951
##   [41] -0.2572356558 -0.3651362597 -0.1482508379 -0.1386806210 -0.0819948998
##   [46] -0.1258071116 -0.3221218895 -0.0583534052 -0.0766808711 -0.1858785774
##   [51] -0.3179741056 -0.0746468884 -0.0179737478 -0.0826145699 -0.0859030064
##   [56] -0.1671097795 -0.1027239875 -0.3299646027 -0.3175592457 -0.3119476059
```

```
##   [61] -0.0570195492 -0.2846185976 -0.2223659053 -0.1635719983 -0.2084469528
##   [66] -0.0431927454 -0.0450517447 -0.2790641729 -0.3137340253 -0.1267016047
##   [71] -0.0480607220 -0.0272818706 -0.2595806484  0.0001698190 -0.2212880546
##   [76] -0.2248561836 -0.2493459536 -0.1280909227 -0.2052785716 -0.0023879791
##   [81] -0.1692641551 -0.2715123727 -0.4340580458 -0.1340963128 -0.0235543765
##   [86] -0.2539277243 -0.0699788433 -0.0040405252 -0.0752020618 -0.4054945108
##   [91] -0.0332488577 -0.0060013671 -0.3613401818 -0.2491008816 -0.1875528511
##   [96] -0.1784818669 -0.2742746058 -0.4570175481 -0.3455346925 -0.2431775228
##  [101] -0.0936450562 -0.2610807953 -0.2909649995 -0.1240054950 -0.4100247441
##  [106] -0.2313807263 -0.0459259362 -0.0228715132 -0.0249543745 -0.2435947757
##  [111] -0.0656961797 -0.0585046663 -0.0723023119 -0.1891218513 -0.0762834374
##  [116] -0.1979257326 -0.0388132931 -0.2846732393 -0.1203043478 -0.0814323492
##  [121] -0.0352264915 -0.2437420315 -0.1099916652 -0.2512369779 -0.2977033604
##  [126] -0.3083098352 -0.0981687781 -0.1159448543 -0.0027996449 -0.0604145102
##  [131] -0.0181172990 -0.3935456701 -0.2432645921 -0.3826310522 -0.2000637223
##  [136] -0.2607838459 -0.3584193678 -0.1683553619 -0.0139567477 -0.4627789408
##  [141] -0.4029799482 -0.0177532611 -0.2754825329 -0.2054301357 -0.0718915978
##  [146] -0.1627425935 -0.2680261582 -0.3640474186 -0.0099394419 -0.2673960915
##  [151] -0.0820861720 -0.0616431600 -0.3490007538 -0.0273448314 -0.1967111275
##  [156] -0.1240218108 -0.1571335864 -0.0952829988 -0.0744634189 -0.0755106835
##  [161] -0.2804759987 -0.2765779278 -0.3339287441 -0.2797573571 -0.2574713571
##  [166] -0.0621787020 -0.0959878206 -0.3893928762 -0.2204332923 -0.0412404078
##  [171] -0.1724869142 -0.3058286009 -0.2821594900 -0.2307635409 -0.2012976245
##  [176] -0.2211990813 -0.1656310142 -0.1514944738 -0.2753623417 -0.2149797932
##  [181] -0.0933936923 -0.2945356464 -0.2649734592 -0.0636637389 -0.0618268733
##  [186] -0.0137739190 -0.2094819464 -0.1171842892 -0.3451120827 -0.0974510910
##  [191] -0.3847111316 -0.1730150361 -0.1713864615 -0.1695387778 -0.2000316467
##  [196] -0.2825496610 -0.2852816193 -0.3944858942 -0.3443253818 -0.3515116489
##  [201] -0.0770382236 -0.0553897653 -0.3215506273 -0.2736249212 -0.1093181636
##  [206] -0.2225598271 -0.1019000662 -0.2016310307 -0.1374030671 -0.0178387786
##  [211] -0.3705493782 -0.0564566196 -0.1084425669 -0.0194333146 -0.2518345276
##  [216] -0.2383854614 -0.1277311097 -0.3393563202 -0.0794646867 -0.0699579486
##  [221] -0.2379363299 -0.3902494140 -0.2340990012 -0.1433651052 -0.0630147462
##  [226] -0.0164387502 -0.1498902014 -0.2303958155 -0.1962633810 -0.0793418937
##  [231] -0.2187960101 -0.0097360294 -0.0812365934 -0.1527410552 -0.2692160835
##  [236] -0.1846632878 -0.3600786272 -0.0837201048 -0.2238594813 -0.1313683132
##  [241] -0.0324292735 -0.3654185645 -0.1043636890 -0.0753312810 -0.2273282554
##  [246] -0.2164398063 -0.1094643122 -0.0599408410 -0.0969802078 -0.1627698983
##  [251] -0.2549280435 -0.1967813863 -0.0060224844 -0.1472359413 -0.1504817586
##  [256] -0.2423084722 -0.0576096299 -0.1276235127 -0.3887824887 -0.4147621279
##  [261] -0.1828133049 -0.3726366766 -0.2043331060 -0.2007636055 -0.2467410470
##  [266] -0.2857873125 -0.2069704850 -0.2105049057 -0.2003692408 -0.0595286469
##  [271] -0.3762037861 -0.3783374853 -0.0409606707 -0.2704830161 -0.0223898078
##  [276] -0.1987593167 -0.0319763042 -0.1234712589 -0.2601315944 -0.2422641289
##  [281] -0.1979018056 -0.2911760989 -0.0241453048 -0.1139862928 -0.2224273267
##  [286] -0.3420612899 -0.0795331998 -0.1267844925 -0.3050377612 -0.0608520381
##  [291] -0.0684889856 -0.1743350633 -0.0795166915 -0.0561610275 -0.3250620743
##  [296] -0.1052618395 -0.0121409092 -0.2482801769 -0.0207678419 -0.0767282397
##  [301] -0.4175016977 -0.1460748273 -0.2334789682 -0.1266842376 -0.2850237264
##  [306] -0.1939141707 -0.2907607030 -0.2979005396 -0.0829723046 -0.0736663734
##  [311] -0.0458269229 -0.1260727302 -0.1610079388 -0.3706375460 -0.0509666865
##  [316] -0.1742862705 -0.2540320435 -0.2028656924 -0.1436831179 -0.1456733065
##  [321] -0.2463557330 -0.2140824544 -0.0879865509 -0.0127030161 -0.1166034408
##  [326] -0.0177801084 -0.2195311464 -0.1688806767 -0.0978248657 -0.2546218725
```

```
##  [331] -0.1684137737 -0.0559868847 -0.0590376331 -0.1090821110 -0.1178248360
##  [336] -0.0327307692 -0.0573303552 -0.2434085134 -0.4046557342 -0.1056861456
##  [341] -0.3143143916 -0.2193043638 -0.0937013437 -0.0289771919 -0.2750558364
##  [346] -0.3317682187 -0.2335375678 -0.0839517919 -0.0089408369 -0.2279727997
##  [351] -0.3076867220 -0.2435353084 -0.0643919655 -0.0328152824 -0.3220956358
##  [356] -0.0475128871 -0.1608787857 -0.2812957327 -0.2304999050 -0.1008941299
##  [361] -0.2898300297 -0.3950619096 -0.1097954970 -0.1157263184 -0.1007101787
##  [366] -0.1239314934 -0.1858838123 -0.4548764006 -0.1839990743 -0.1161104575
##  [371] -0.0774783429 -0.1666218850 -0.0899610080 -0.1357063565 -0.0272360514
##  [376] -0.3959540432 -0.0039252230 -0.1236945332 -0.2325191158 -0.2799035569
##  [381] -0.2167963145 -0.2766479651 -0.0751434821 -0.0475410488 -0.2592413489
##  [386] -0.1399296846 -0.2640132822 -0.1184656714 -0.3140493867 -0.0296780689
##  [391] -0.4006609706 -0.4004053106 -0.1508247688 -0.2253554992 -0.0206565280
##  [396] -0.2299332812 -0.1146312746 -0.0761827780 -0.0554556239 -0.0805633904
##  [401] -0.2835379026 -0.1332655138 -0.2704794154 -0.1789987245 -0.2001588351
##  [406] -0.1137282270 -0.1828407092 -0.2916287186 -0.1980182528 -0.0565628998
##  [411] -0.3914480174 -0.2662965114 -0.2280403596 -0.4248711780 -0.3333393399
##  [416] -0.0540671130 -0.0316287913 -0.3293594703 -0.3430292728 -0.1287240271
##  [421] -0.3324389958 -0.1650704326 -0.2554890694 -0.0541594205 -0.1138197321
##  [426] -0.2620844685 -0.0084795309 -0.2756608422 -0.1321143910 -0.0072990471
##  [431] -0.1538240842 -0.0425795660 -0.2975986854 -0.3771298801 -0.0621801885
##  [436] -0.0598147895 -0.0497825744 -0.1019197723 -0.2971386601 -0.1767580317
##  [441] -0.0998752306 -0.2437807553 -0.3975696337 -0.2101352704 -0.1011775018
##  [446] -0.0260812687 -0.3125842466 -0.2986734531 -0.1527092981 -0.1237522574
##  [451] -0.3772725830 -0.1966186981 -0.1065215747 -0.2294909189 -0.1301469343
##  [456] -0.1951984018 -0.3554299300 -0.1836056537 -0.2537735329 -0.2703443258
##  [461] -0.0244563276 -0.0729367128 -0.2173383878 -0.1526779866 -0.1914150404
##  [466] -0.3947312172 -0.0493625283 -0.2239986208 -0.3911689326 -0.3560519310
##  [471] -0.3134240441 -0.4019704838 -0.2746844317 -0.2612146461 -0.0431470319
##  [476] -0.0214819410 -0.0956544746 -0.1437838241 -0.2551861439 -0.3878934340
##  [481] -0.2183554244 -0.3265560962 -0.2222485934 -0.2837595593 -0.1157487192
##  [486] -0.1482311183 -0.0178405363 -0.0825410367 -0.2103979964 -0.2049622180
##  [491] -0.2334985954 -0.1030683267 -0.1928728076 -0.0817278063 -0.2363150578
##  [496] -0.2217515451 -0.0129357124 -0.2021923054 -0.1385673239 -0.2039673459
##  [501] -0.3221448359 -0.4650759295 -0.1397811298 -0.2205211909 -0.2925056763
##  [506] -0.2421392367 -0.4043530171 -0.2769593130 -0.1300886098 -0.1279444052
##  [511] -0.0703315055 -0.0666165348 -0.1455122745 -0.2235270864 -0.2777202307
##  [516] -0.1479144406 -0.2720301486 -0.1455970232 -0.1710901791 -0.1552626576
##  [521] -0.0130534653 -0.0753860476 -0.1194112227 -0.0136746870 -0.1362968656
##  [526] -0.2270566051 -0.0336543755 -0.3441881419 -0.3431360499 -0.2487361249
##  [531] -0.3525722283 -0.1284490608 -0.2160281655 -0.0414176263 -0.1682236978
##  [536] -0.1213419330 -0.3455668625 -0.2203419030 -0.2279038911 -0.0083549428
##  [541] -0.3010220293 -0.2319606395 -0.0517114829 -0.1327856055 -0.1013927086
##  [546] -0.0895990956 -0.0911930094 -0.0666915808 -0.1135141636 -0.0290057215
##  [551] -0.0050326145 -0.2696735263 -0.2369542184 -0.1991492339 -0.1551809690
##  [556] -0.1232552700 -0.3552963562 -0.1101650874 -0.3123183067 -0.1725726632
##  [561] -0.2191722683  0.0045348577 -0.1461486848 -0.1028385698 -0.2894335916
##  [566] -0.1600365383 -0.0621737045 -0.3895187541 -0.1016720929 -0.3436409751
##  [571] -0.2396864040 -0.1512300616 -0.4322025876 -0.0181783614 -0.0169343189
##  [576] -0.1054882764 -0.0632172962 -0.2891654067 -0.1194674581 -0.1517378148
##  [581] -0.2066762354 -0.2990227145 -0.3068550902 -0.2612758011 -0.0423174363
##  [586] -0.3803867744 -0.1372756111 -0.2984633077 -0.0445971768 -0.0331005309
##  [591] -0.4264827848 -0.0039019108 -0.2973019217 -0.2850684328 -0.3000776626
##  [596] -0.1837303562 -0.3253979473 -0.0222122423 -0.2354925828 -0.1788220056
```

```
##  [601] -0.2102042604 -0.3542894195 -0.3437225318 -0.2633119364 -0.0476134929
##  [606] -0.3083460003 -0.3212530777 -0.3251931555 -0.0248173290 -0.1497385072
##  [611] -0.3893703066 -0.1918776626 -0.0943436239 -0.4519612953 -0.1730402288
##  [616] -0.1429323635 -0.0582215084 -0.2029298327 -0.0285046795 -0.2371471599
##  [621] -0.3355895218 -0.2440086069 -0.0628268415  0.0050178716 -0.0558879898
##  [626] -0.1900373670 -0.4452364880 -0.3464925630 -0.3763623454 -0.1033433446
##  [631] -0.1996367703 -0.0323160770 -0.3150729133 -0.2420821435 -0.1648863092
##  [636] -0.1898273112 -0.0605524263 -0.2247857700 -0.2733325618 -0.0768514939
##  [641] -0.0656939803 -0.3093800451 -0.1251427668 -0.2721072573 -0.2958558979
##  [646] -0.3513606291 -0.2492836582 -0.0468915285 -0.3389717721 -0.1102789706
##  [651] -0.0062108319 -0.2190942358 -0.3266469820 -0.1287256667 -0.3862848483
##  [656] -0.0234719793 -0.1662144823 -0.2801220937 -0.1967546716  0.0793852168
##  [661] -0.1180494495 -0.0662930010 -0.2555475868 -0.1798046492 -0.3202122920
##  [666] -0.0340045309 -0.2625725496 -0.2076638390  0.0866123879 -0.0033816165
##  [671]  0.0391445585  0.0774308558  0.0738851766  0.0608782098  0.0226877206
##  [676]  0.1808171073  0.1491541110  0.1740246528  0.1013258996  0.0708622561
##  [681]  0.0392465280  0.1210893612  0.2104476357  0.0678225360  0.0818402119
##  [686]  0.1473818380  0.0394499296  0.0484297979  0.1493732675  0.0252513892
##  [691]  0.0077513085  0.1955400985  0.0074377416  0.0448157443  0.2486657205
##  [696]  0.1004464930  0.0844688889  0.0956285932  0.1096329747  0.0826027258
##  [701]  0.1508297146  0.0139222728  0.1232990397  0.0349542799  0.0724084457
##  [706]  0.0471312687  0.2077647855  0.0270535544  0.0376932205  0.1054808091
##  [711]  0.0852633540  0.0863183036  0.2157479289  0.1157767745  0.0820379256
##  [716]  0.0491985584  0.2076995122  0.2486236657  0.0570613967  0.2067498163
##  [721]  0.0107634480 -0.1828340194  0.1750758719  0.0681314777  0.0102615328
##  [726]  0.2304658488  0.1498048017  0.0123432623  0.1227969972  0.0223489725
##  [731]  0.1675764418  0.0441328852  0.0609351513  0.1632405612  0.1091159949
##  [736]  0.0133686129  0.0960250522  0.1682268628  0.0620810055  0.1674474296
##  [741]  0.1373345199  0.0561936617  0.1282127789  0.0248675071  0.0631048057
##  [746]  0.0433006461  0.1652029862  0.0950113923  0.0973606249  0.0851671888
##  [751]  0.1679005650  0.1820779543  0.2073896997  0.0623860943  0.1330852637
##  [756]  0.0587964523  0.0934363752  0.0161957523  0.2560868995  0.0664315710
##  [761]  0.1773231628 -0.2668410421  0.1748911638  0.0745795453  0.1088745920
##  [766]  0.2743535763  0.0674685091  0.1520920507  0.0163356603  0.0536549774
##  [771]  0.0711727775  0.1237661695  0.2087567144  0.1849156214  0.1252470089
##  [776]  0.2202063817  0.0882901216  0.1535477267  0.0458118884  0.0708876015
##  [781] -0.0007918654  0.0111919230  0.0444761240  0.0012436136  0.0881888321
##  [786]  0.0213615407  0.2210365882 -0.0011111871  0.1263256557  0.0449784386
##  [791]  0.2361549198  0.1419133778  0.0882008229  0.0648371289  0.0345053509
##  [796]  0.1011881953  0.1712385002  0.0288474690  0.2481656092  0.1851842388
##  [801]  0.1803496016  0.1220368778  0.1356670215  0.1623593681  0.2411362193
##  [806]  0.0889757848  0.0324209110  0.0378801110  0.1998104308  0.0070315169
##  [811]  0.0772819727  0.0183710398 -0.0930607371  0.0369658826  0.0777647888
##  [816]  0.0141379230  0.0173906192  0.0436446961  0.0595543807  0.0943059876
##  [821]  0.0898134685  0.1411903224  0.2239366152  0.0913358297  0.1678497955
##  [826]  0.1360967628  0.2103438345  0.0654612581  0.0963538812  0.0091450999
##  [831]  0.0735180831  0.1236195543  0.1354911907  0.0450200968  0.0445575905
##  [836]  0.0201766899  0.0140350026  0.0998647227  0.0158094992  0.1496355655
##  [841]  0.1574982592  0.2140330991 -0.1217473535  0.0472159235  0.0137603070
##  [846]  0.0334928481  0.1032079272  0.0053174065  0.0847605956  0.1673142379
##  [851]  0.0497559573  0.1210216741  0.0879808496  0.0042971750  0.2182113688
##  [856]  0.0859533967  0.1257859034 -0.1151247014  0.0994740658  0.1368632998
##  [861]  0.0135091863  0.1097876036  0.0334441036  0.0323471966  0.1879900282
##  [866]  0.0323912653  0.1342856272  0.1048092395  0.1164797828  0.2201407435
```

```
##  [871]  0.1590268446  0.0239177950  0.0311045512  0.1320675047  0.0333396729
##  [876]  0.1930888936  0.0736995798  0.1223184396  0.0971540650 -0.0015349537
##  [881]  0.1517274533  0.1155125466  0.0101596010  0.0418124872  0.0967995644
##  [886]  0.1208486033  0.1078827165  0.0948357668  0.0509630265  0.0355127888
##  [891]  0.0390546248  0.0096873963  0.0823482900  0.0959455874  0.0366643138
##  [896]  0.0639833887  0.0182693444  0.0074242941  0.2148219118  0.0194430923
##  [901]  0.1752655119  0.0678375001  0.0730331924  0.1968134314  0.1022151327
##  [906]  0.0410084241  0.0605498261  0.0015948901  0.1602174535  0.0559303660
##  [911]  0.1048800309  0.1544076040  0.1120799542  0.1134055586  0.2066890542
##  [916]  0.1584797641  0.0487946826  0.0613947275  0.0107412804  0.0170249585
##  [921]  0.0491986374  0.1049064268  0.1732085750  0.1157223715  0.1534830459
##  [926]  0.0625601832  0.0176528538  0.1802847351  0.0581063865  0.0441654261
##  [931]  0.0323950782  0.0090537725  0.1692795478  0.1416778491  0.1586668811
##  [936]  0.0705033641  0.0816819183  0.1230648625  0.0571108967  0.1999107160
##  [941]  0.0199971206  0.0629302335  0.1622890963 -0.2864672886  0.0030699370
##  [946]  0.0727948886  0.0653986726  0.1086182832  0.0923528784  0.1864249003
##  [951]  0.0299667743  0.0333157716  0.2055814628  0.2200446484  0.0445258259
##  [956]  0.1757950874 -0.0053723309  0.0278291637  0.0459470353  0.2227804686
##  [961]  0.0301223694  0.0928226907  0.0899726140  0.0573175169  0.0073455417
##  [966]  0.0707928505  0.0862729813  0.1500158824  0.0440672798  0.0458408814
##  [971]  0.1214072749  0.0066990302  0.0811857798  0.0409217268  0.0570853178
##  [976]  0.0307585350  0.1770663100  0.0238216967  0.2258475224  0.1117004238
##  [981]  0.1248867290  0.0145296603  0.1698695450  0.1151190243  0.0470410482
##  [986]  0.0233983724  0.0629771394  0.1932605337  0.1198112120  0.1399218653
##  [991]  0.1284855570  0.2319768094  0.1890013124  0.1624693927  0.0112819653
##  [996]  0.0654914727  0.0464885207  0.0628836667  0.0135622825  0.0179054632
```

```
y_pred = y_all
y_pred[y_all >= 0] = 1
y_pred[y_all< 0] = -1
print(y_pred)
```

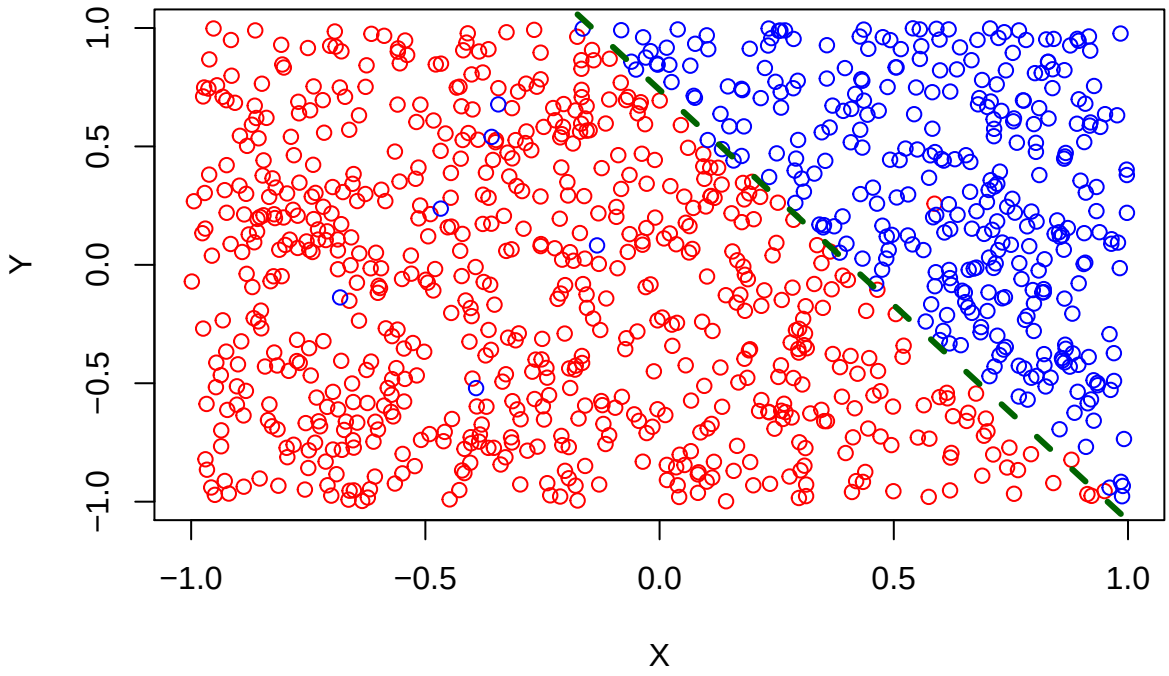
```
##    [1] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##   [25] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##   [49] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##   [73] -1  1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##   [97] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [121] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [145] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [169] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [193] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [217] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [241] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [265] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [289] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [313] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [337] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [361] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [385] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [409] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [433] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [457] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [481] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [505] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [529] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
```

```
##  [553] -1 -1 -1 -1 -1 -1 -1 -1 -1  1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [577] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [601] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1  1
##  [625] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
##  [649] -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1  1 -1 -1 -1 -1 -1 -1 -1 -1  1 -1  1  1
##  [673]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [697]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [721]  1 -1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [745]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 -1  1  1  1  1  1  1
##  [769]  1  1  1  1  1  1  1  1  1  1  1  1 -1  1  1  1  1  1  1 -1  1  1  1  1
##  [793]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 -1  1  1  1
##  [817]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [841]  1  1 -1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 -1  1  1  1  1  1  1
##  [865]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 -1  1  1  1  1  1  1  1  1
##  [889]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [913]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [937]  1  1  1  1  1  1  1 -1  1  1  1  1  1  1  1  1  1  1  1  1 -1  1  1  1
##  [961]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
##  [985]  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
```

```
acc = sum(y_pred == group)/length(group)
print(acc)
```

```
## [1] 0.985
```

```
plot(g_x, g_y, type='n', xlab='X', ylab='Y')
points(g1_x, g1_y, col='red')
points(g2_x, g2_y, col='blue')
abline(a = -1.0*theta0/theta2, b = -1.0*theta1/theta2, col='dark green', lwd=3, lty=2)
```


Y
1.0
0.5
0.0
−0.5
−1.0
−1.0
−0.5
0.0
0.5
1.0
X