Exam 1 – Fall 2019 (Johnston)

Section 2: Classification

```
R version 3.5.1 (2018-07-02) -- "Feather Spray"
Copyright (C) 2018 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

  Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

Microsoft R Open 3.5.1
The enhanced R distribution from Microsoft
Microsoft packages Copyright (C) 2018 Microsoft Corporation

Using the Intel MKL for parallel mathematical computing (using 4 cores).

Default CRAN mirror snapshot taken on 2018-08-01.
See: https://mran.microsoft.com/.

> ###
> #
> # BUAN 6357 2019 Fall (Johnston)
> #
> # Exam 1: section 2 - classification
> #
> #
> options(scipen=10)           # avoid exponential notation
> setwd("c:/data/exams/exam1") # change as needed
>
> require(data.table)
Loading required package: data.table
data.table 1.11.4  Latest news: http://r-datatable.com
> require(partykit)
Loading required package: partykit
Loading required package: grid
Loading required package: libcoin
Loading required package: mvtnorm
>
> classif    <- c(1, 2, 3)
> byCols     <- 2
> byRows     <- 1
>
> in1        <- fread(file="classif.dat")
>
```

```
> fitLogit   <- function(df,i) {
+               df$y            <- 0
+               df$y[df$grp==i] <- 1
+               t               <- glm(y~.-grp,family=binomial(),data=df)
+               return(t$fitted.values)
+               }
>
> (t         <- data.table(idx=1:3, i=1:3) )
   idx i
1:   1 1
2:   2 2
3:   3 3
> tLogit     <- t[,.(fitted=fitLogit(in1,i)), by=.(idx)]
Warning messages:
1: glm.fit: algorithm did not converge
2: glm.fit: fitted probabilities numerically 0 or 1 occurred
3: glm.fit: fitted probabilities numerically 0 or 1 occurred
> (mLogit    <- matrix(tLogit$fitted, ncol=length(classif),byrow=F) )
                [,1]        [,2]         [,3]
  [1,] 2.220446e-16 0.446561196 1.481064e-05
  [2,] 1.000000e+00 0.084913218 2.220446e-16
  [3,] 2.220446e-16 0.095661544 1.000000e+00
  [4,] 1.000000e+00 0.144643488 2.220446e-16
  [5,] 4.855499e-10 0.629082784 1.290424e-10
  [6,] 1.000000e+00 0.203055831 2.220446e-16
  [7,] 1.000000e+00 0.182719028 2.220446e-16
  [8,] 2.220446e-16 0.098468930 9.999932e-01
  [9,] 1.000000e+00 0.146615506 2.220446e-16
 [10,] 2.220446e-16 0.152688686 4.048381e-01
 [11,] 2.220446e-16 0.896097587 9.204923e-01
 [12,] 1.000000e+00 0.122779536 2.220446e-16
 [13,] 2.220446e-16 0.338799903 8.245440e-01
 [14,] 2.220446e-16 0.446220505 2.309662e-06
 [15,] 2.220446e-16 0.351802660 7.884147e-07
 [16,] 1.000000e+00 0.171982672 2.220446e-16
 [17,] 2.220446e-16 0.377468596 9.999992e-01
 [18,] 2.220446e-16 0.646776813 4.360614e-07
 [19,] 2.220446e-16 0.071180487 9.999952e-01
 [20,] 1.000000e+00 0.253822895 2.220446e-16
 [21,] 1.000000e+00 0.011737848 2.220446e-16
 [22,] 2.220446e-16 0.105652352 2.129823e-04
 [23,] 2.220446e-16 0.434128932 1.410660e-06
 [24,] 2.220446e-16 0.217987813 1.000000e+00
 [25,] 2.220446e-16 0.457234907 1.408470e-03
 [26,] 2.220446e-16 0.902922390 9.947107e-08
 [27,] 2.220446e-16 0.032661153 1.000000e+00
 [28,] 2.220446e-16 0.827614779 2.551360e-04
 [29,] 2.220446e-16 0.136952754 9.999824e-01
 [30,] 1.000000e+00 0.282917869 2.220446e-16
 [31,] 2.220446e-16 0.809798929 5.959820e-02
 [32,] 1.000000e+00 0.095100612 2.220446e-16
 [33,] 1.000000e+00 0.033536563 2.220446e-16
 [34,] 2.220446e-16 0.888692503 9.664047e-01
 [35,] 1.733438e-13 0.802088276 5.298820e-09
 [36,] 2.220446e-16 0.302108585 9.999990e-01
 [37,] 1.000000e+00 0.023403244 2.220446e-16
 [38,] 2.220446e-16 0.733465616 1.481153e-08
 [39,] 2.220446e-16 0.709205985 4.023809e-05
 [40,] 2.220446e-16 0.456463346 9.996139e-01
```

```
[41,] 2.220446e-16 0.088172089 9.999189e-01
[42,] 2.220446e-16 0.480922554 2.344150e-06
[43,] 2.220446e-16 0.456463346 9.996139e-01
[44,] 2.220446e-16 0.049851313 9.999956e-01
[45,] 2.220446e-16 0.610427722 1.018578e-04
[46,] 2.220446e-16 0.198302894 4.856237e-05
[47,] 1.000000e+00 0.044795194 2.220446e-16
[48,] 2.220446e-16 0.283298814 2.979719e-04
[49,] 2.220446e-16 0.489900110 1.000000e+00
[50,] 2.220446e-16 0.915132256 3.990780e-08
[51,] 2.220446e-16 0.322955404 7.060188e-06
[52,] 2.220446e-16 0.663812478 1.109268e-05
[53,] 2.220446e-16 0.795969041 9.999921e-01
[54,] 2.220446e-16 0.630511939 2.048741e-01
[55,] 2.220446e-16 0.519988582 1.458241e-05
[56,] 1.000000e+00 0.106951255 2.220446e-16
[57,] 1.000000e+00 0.037423490 2.220446e-16
[58,] 2.220446e-16 0.775502078 4.220049e-05
[59,] 2.220446e-16 0.443625290 2.541253e-07
[60,] 2.220446e-16 0.387028022 9.651525e-04
[61,] 1.000000e+00 0.234453540 2.220446e-16
[62,] 2.220446e-16 0.752251283 2.248338e-01
[63,] 2.220446e-16 0.711682917 1.000000e+00
[64,] 1.000000e+00 0.268014581 2.220446e-16
[65,] 2.220446e-16 0.387873714 9.995586e-01
[66,] 3.232718e-13 0.271250038 1.378280e-08
[67,] 1.000000e+00 0.094705717 2.220446e-16
[68,] 2.220446e-16 0.344944541 1.326003e-03
[69,] 5.071636e-10 0.505124507 6.163826e-11
[70,] 1.000000e+00 0.284463794 2.220446e-16
[71,] 1.000000e+00 0.671837566 2.220446e-16
[72,] 2.220446e-16 0.485235768 9.997429e-01
[73,] 2.220446e-16 0.268236915 1.171672e-05
[74,] 2.220446e-16 0.746512788 8.712675e-08
[75,] 2.220446e-16 0.679672890 9.999955e-01
[76,] 1.000000e+00 0.088657334 2.220446e-16
[77,] 2.220446e-16 0.614632483 9.999969e-01
[78,] 1.000000e+00 0.049565186 2.220446e-16
[79,] 2.220446e-16 0.356115348 2.169221e-03
[80,] 1.000000e+00 0.348040480 2.220446e-16
[81,] 2.220446e-16 0.328605388 1.198626e-03
[82,] 2.220446e-16 0.548318744 8.707382e-08
[83,] 1.000000e+00 0.289239940 2.220446e-16
[84,] 2.220446e-16 0.647905008 8.676299e-01
[85,] 2.220446e-16 0.318589723 9.776789e-01
[86,] 2.220446e-16 0.424127086 3.405812e-07
[87,] 2.220446e-16 0.208865263 9.989939e-01
[88,] 1.000000e+00 0.065667789 2.220446e-16
[89,] 1.000000e+00 0.235493474 2.220446e-16
[90,] 2.220446e-16 0.255011441 8.022990e-01
[91,] 2.220446e-16 0.573336389 7.124099e-04
[92,] 1.000000e+00 0.309920322 2.220446e-16
[93,] 2.220446e-16 0.248050604 3.744346e-05
[94,] 2.220446e-16 0.500015457 9.999673e-01
[95,] 1.000000e+00 0.125446695 2.220446e-16
[96,] 1.000000e+00 0.042484334 2.220446e-16
[97,] 2.220446e-16 0.588849176 1.502115e-05
[98,] 1.000000e+00 0.059409586 2.220446e-16
[99,] 1.000000e+00 0.281159026 2.220446e-16
```

```
[100,] 1.000000e+00 0.013971627 2.220446e-16
[101,] 1.000000e+00 0.093590656 2.220446e-16
[102,] 2.220446e-16 0.102853203 9.999996e-01
[103,] 2.220446e-16 0.048006808 9.999999e-01
[104,] 2.220446e-16 0.345893720 9.964973e-01
[105,] 2.220446e-16 0.709325560 1.000000e+00
[106,] 1.000000e+00 0.195330231 2.220446e-16
[107,] 2.220446e-16 0.307874353 2.760617e-01
[108,] 1.000000e+00 0.033477545 2.220446e-16
[109,] 2.220446e-16 0.136647611 9.999999e-01
[110,] 2.220446e-16 0.079536211 9.999999e-01
[111,] 2.220446e-16 0.151268800 9.998717e-01
[112,] 1.000000e+00 0.004211069 2.220446e-16
[113,] 1.000000e+00 0.069419306 2.220446e-16
[114,] 1.000000e+00 0.053204234 2.220446e-16
[115,] 1.000000e+00 0.142639277 2.220446e-16
[116,] 2.220446e-16 0.279742901 9.995130e-01
[117,] 2.220446e-16 0.592190618 8.908123e-01
[118,] 4.617163e-13 0.735197378 5.351876e-10
[119,] 1.000000e+00 0.068695913 2.220446e-16
[120,] 2.220446e-16 0.532624132 9.991067e-01
[121,] 2.220446e-16 0.514047617 7.988665e-04
[122,] 2.220446e-16 0.405640478 9.976994e-01
[123,] 2.220446e-16 0.429923968 9.484339e-01
[124,] 2.220446e-16 0.078715028 1.000000e+00
[125,] 1.000000e+00 0.014626994 2.220446e-16
[126,] 2.220446e-16 0.158802911 1.305727e-03
[127,] 1.000000e+00 0.085791654 2.220446e-16
[128,] 2.220446e-16 0.132543737 1.000000e+00
[129,] 2.220446e-16 0.249878252 9.999999e-01
[130,] 2.220446e-16 0.260298942 2.828836e-06
[131,] 2.220446e-16 0.597725020 9.712013e-01
[132,] 2.220446e-16 0.314720662 9.999999e-01
[133,] 2.220446e-16 0.116865184 9.902584e-01
[134,] 2.220446e-16 0.235251995 6.691425e-01
[135,] 1.000000e+00 0.067075197 2.220446e-16
[136,] 1.000000e+00 0.333623714 2.220446e-16
[137,] 1.000000e+00 0.039110729 2.220446e-16
[138,] 2.220446e-16 0.216000555 9.999800e-01
[139,] 2.220446e-16 0.049634005 1.000000e+00
[140,] 2.220446e-16 0.412215071 1.596216e-04
[141,] 2.220446e-16 0.769229473 3.969831e-05
[142,] 6.831500e-13 0.781815103 8.158121e-10
[143,] 2.220446e-16 0.519508925 9.997188e-01
[144,] 1.000000e+00 0.371053818 2.220446e-16
[145,] 1.000000e+00 0.024827392 2.220446e-16
[146,] 2.220446e-16 0.444075149 3.085679e-06
[147,] 1.000000e+00 0.144722026 2.220446e-16
[148,] 1.000000e+00 0.054453818 2.220446e-16
[149,] 2.220446e-16 0.777806218 8.469327e-08
[150,] 2.220446e-16 0.064498190 9.999440e-01
> (idxLogit  <- apply(mLogit,byRows,which.max) )
  [1] 2 1 3 1 2 1 1 3 1 3 3 1 3 2 2 1 3 2 3 1 1 2 2 3 2 2 3 2 3 1 2 1 1 3 2 3 1
 [38] 2 2 3 3 2 3 3 2 2 1 2 3 2 2 2 3 2 2 1 1 2 2 2 1 2 3 1 3 2 1 2 2 1 1 3 2 2
 [75] 3 1 3 1 2 1 2 2 1 3 3 2 3 1 1 3 2 1 2 3 1 1 2 1 1 1 1 3 3 3 3 1 2 1 3 3 3
[112] 1 1 1 1 3 3 2 1 3 2 3 3 3 1 2 1 3 3 2 3 3 3 3 1 1 1 3 3 2 2 2 3 1 1 2 1 1
[149] 2 3
```

```
> (classLogit<- classif[idxLogit] )
  [1] 2 1 3 1 2 1 1 3 1 3 3 1 3 2 2 1 3 2 3 1 1 2 2 3 2 2 3 2 3 1 2 1 1 3 2 3 1
 [38] 2 2 3 3 2 3 3 2 2 1 2 3 2 2 2 3 2 2 1 1 2 2 2 1 2 3 1 3 2 1 2 2 1 1 3 2 2
 [75] 3 1 3 1 2 1 2 2 1 3 3 2 3 1 1 3 2 1 2 3 1 1 2 1 1 1 1 3 3 3 3 1 2 1 3 3 3
[112] 1 1 1 1 3 3 2 1 3 2 3 3 3 1 2 1 3 3 2 3 3 3 3 1 1 1 3 3 2 2 2 3 1 1 2 1 1
[149] 2 3
> (rMargin   <- mLogit[,1]+mLogit[,2]+mLogit[,3] )
  [1] 0.4465760 1.0849132 1.0956615 1.1446435 0.6290828 1.2030558 1.1827190
  [8] 1.0984621 1.1466155 0.5575268 1.8165899 1.1227795 1.1633439 0.4462228
 [15] 0.3518034 1.1719827 1.3774678 0.6467772 1.0711757 1.2538229 1.0117378
 [22] 0.1058653 0.4341303 1.2179878 0.4586434 0.9029225 1.0326611 0.8278699
 [29] 1.1369351 1.2829179 0.8693971 1.0951006 1.0335366 1.8550972 0.8020883
 [36] 1.3021076 1.0234032 0.7334656 0.7092462 1.4560773 1.0880910 0.4809249
 [43] 1.4560773 1.0498469 0.6105296 0.1983515 1.0447952 0.2835968 1.4899001
 [50] 0.9151323 0.3229625 0.6638236 1.7959611 0.8353860 0.5200032 1.1069513
 [57] 1.0374235 0.7755443 0.4436255 0.3879932 1.2344535 0.9770851 1.7116829
 [64] 1.2680146 1.3874323 0.2712501 1.0947057 0.3462705 0.5051245 1.2844638
 [71] 1.6718376 1.4849787 0.2682486 0.7465129 1.6796684 1.0886573 1.6146294
 [78] 1.0495652 0.3582846 1.3480405 0.3298040 0.5483188 1.2892399 1.5155349
 [85] 1.2962686 0.4241274 1.2078592 1.0656678 1.2354935 1.0573104 0.5740488
 [92] 1.3099203 0.2480880 1.4999827 1.1254467 1.0424843 0.5888642 1.0594096
 [99] 1.2811590 1.0139716 1.0935907 1.1028528 1.0480067 1.3423910 1.7093256
[106] 1.1953302 0.5839361 1.0334775 1.1366475 1.0795361 1.1511405 1.0042111
[113] 1.0694193 1.0532042 1.1426393 1.2792559 1.4830029 0.7351974 1.0686959
[120] 1.5317308 0.5148465 1.4033398 1.3783579 1.0787150 1.0146270 0.1601086
[127] 1.0857917 1.1325437 1.2498782 0.2603018 1.5689263 1.3147205 1.1071236
[134] 0.9043945 1.0670752 1.3336237 1.0391107 1.2159805 1.0496340 0.4123747
[141] 0.7692692 0.7818151 1.5192278 1.3710538 1.0248274 0.4440782 1.1447220
[148] 1.0544538 0.7778063 1.0644422
> t1         <- apply(mLogit,byRows,max)
> (pLogit    <- t1/rMargin )
  [1] 0.9999668 0.9217327 0.9126906 0.8736345 1.0000000 0.8312166 0.8455094
  [8] 0.9103575 0.8721319 0.7261321 0.5067144 0.8906468 0.7087706 0.9999948
 [15] 0.9999978 0.8532549 0.7259692 0.9999993 0.9335492 0.7975608 0.9883983
 [22] 0.9979882 0.9999968 0.8210263 0.9969291 0.9999999 0.9683719 0.9996918
 [29] 0.8795422 0.7794731 0.9314488 0.9131581 0.9675516 0.5209456 1.0000000
 [36] 0.7679849 0.9771319 1.0000000 0.9999433 0.6865116 0.9189663 0.9999951
 [43] 0.6865116 0.9525156 0.9998332 0.9997552 0.9571254 0.9989493 0.6711859
 [50] 1.0000000 0.9999781 0.9999833 0.5568005 0.7547552 0.9999720 0.9033821
 [57] 0.9639265 0.9999456 0.9999994 0.9975124 0.8100750 0.7698933 0.5842204
 [64] 0.7886345 0.7204377 0.9999999 0.9134875 0.9961706 1.0000000 0.7785350
 [71] 0.5981442 0.6732372 0.9999563 0.9999999 0.5953529 0.9185627 0.6193352
 [78] 0.9527755 0.9939455 0.7418175 0.9963656 0.9999998 0.7756508 0.5724909
 [85] 0.7542255 0.9999992 0.8270781 0.9383787 0.8093932 0.7588112 0.9987590
 [92] 0.7634052 0.9998491 0.6666525 0.8885361 0.9592470 0.9999745 0.9439220
 [99] 0.7805432 0.9862209 0.9144189 0.9067390 0.9541923 0.7423301 0.5850261
[106] 0.8365889 0.5272398 0.9676069 0.8797801 0.9263237 0.8685922 0.9958066
[113] 0.9350869 0.9494835 0.8751668 0.7813237 0.6006814 1.0000000 0.9357199
[120] 0.6522730 0.9984483 0.7109464 0.6880897 0.9270289 0.9855839 0.9918447
[127] 0.9209870 0.8829681 0.8000779 0.9999891 0.6190229 0.7606178 0.8944425
[134] 0.7398790 0.9371411 0.7498367 0.9623613 0.8223651 0.9527130 0.9996129
[141] 0.9999484 1.0000000 0.6580441 0.7293660 0.9757741 0.9999931 0.8735745
[148] 0.9483583 0.9999999 0.9394066
```

```
> (brLogit   <- 1-pLogit )
  [1] 0.0000331648768604 0.0782672906850690 0.0873093963559064
  [4] 0.1263655364055221 0.0000000009769655 0.1687833813909168
  [7] 0.1544906468073792 0.0896425380101440 0.1278680648882337
 [10] 0.2738678968872413 0.4932855765394173 0.1093532005369025
 [13] 0.2912293526820108 0.0000051760274826 0.0000022410657894
 [16] 0.1467450641232390 0.2740307885033126 0.0000006742064892
 [19] 0.0664508076073812 0.2024391926624798 0.0116016696542289
 [22] 0.0020118226055312 0.0000032493933632 0.1789737253734673
 [25] 0.0030709484686395 0.0000001101656778 0.0316281418042432
 [28] 0.0003081837175790 0.1204578429548867 0.2205268753069153
 [31] 0.0685511767796582 0.0868418946818581 0.0324483563427732
 [34] 0.4790544241639278 0.0000000066064957 0.2320150656080736
 [37] 0.0228680576027908 0.0000000201938987 0.0000567336038194
 [40] 0.3134884121323780 0.0810337452108374 0.0000048742531449
 [43] 0.3134884121323780 0.0474843624932125 0.0001668350854757
 [46] 0.0002448299292033 0.0428746174011642 0.0010506886121168
 [49] 0.3288140650253466 0.0000000436087819 0.0000218607075074
 [52] 0.0000167102864457 0.4431994788553558 0.2452447859041402
 [55] 0.0000280429307471 0.0966178544161266 0.0360734936300182
 [58] 0.0000544140345583 0.0000005728374362 0.0024875502516765
 [61] 0.1899249604260091 0.2301066758605749 0.4157796468270698
 [64] 0.2113655355830747 0.2795622591871946 0.0000000508133301
 [67] 0.0865124900576869 0.0038293836551287 0.0000000011260628
 [70] 0.2214650151970440 0.4018557664228519 0.3267627864965194
 [73] 0.0000436785913812 0.0000001167116547 0.4046470681765758
 [76] 0.0814373185972522 0.3806647512508344 0.0472244946707981
 [79] 0.0060544651338261 0.2581825137300054 0.0036343574019821
 [82] 0.0000001588014353 0.2243491926397646 0.4275091310684829
 [85] 0.2457744706266046 0.0000008030160962 0.1729218660393298
 [88] 0.0616212576859515 0.1906068136538444 0.2411888025962498
 [91] 0.0012410267836660 0.2365947885932129 0.0001509281132401
 [94] 0.3333474747987986 0.1114639152446062 0.0407529711946575
 [97] 0.0000255086849659 0.0560780144464998 0.2194567731805618
[100] 0.0137791104727737 0.0855810676031672 0.0932610418545828
[103] 0.0458077308997861 0.2576698771646602 0.4149739385177700
[106] 0.1634111026682232 0.4727601734692577 0.0323931033216901
[109] 0.1202198638839994 0.0736762839718532 0.1314077646828800
[112] 0.0041934098103541 0.0649130844293543 0.0505165399338728
[115] 0.1248331643763420 0.2186762652195484 0.3993185720593083
[118] 0.0000000007285791 0.0642801304581881 0.3477269807934019
[121] 0.0015516596944093 0.2890536306749528 0.3119102646523909
[124] 0.0729711053578300 0.0144161292670995 0.0081552546513949
[127] 0.0790129978988517 0.1170318975423523 0.1999220880741408
[130] 0.0000108675235119 0.3809771190727832 0.2393821747314505
[133] 0.1055574837422687 0.2601210047097778 0.0628589222436522
[136] 0.2501633036950314 0.0376386534376877 0.1776348797088368
[139] 0.0472869638263163 0.0003870791223541 0.0000516052299030
[142] 0.0000000010443585 0.3419559155974097 0.2706340282819356
[145] 0.0242259252881312 0.0000069485036578 0.1264254747729904
[148] 0.0516417288895967 0.0000001088873597 0.0605934196133858
> table(in1$grp,classLogit)
   classLogit
     1  2  3
  1 50  0  0
  2  0 48  2
  3  0  1 49
>
>
```

```
> nmDat      <- in1
> nmDat$fac  <- as.factor(nmDat$grp)
> (mn        <- ctree(fac~.-grp,data=nmDat) )

Model formula:
fac ~ V1 + V2 + V3 + V4

Fitted party:
[1] root
|   [2] V3 <= 1.9: 1 (n = 50, err = 0.0%)
|   [3] V3 > 1.9
|   |   [4] V4 <= 1.7
|   |   |   [5] V3 <= 4.8: 2 (n = 46, err = 2.2%)
|   |   |   [6] V3 > 4.8: 2 (n = 8, err = 50.0%)
|   |   [7] V4 > 1.7: 3 (n = 46, err = 2.2%)

Number of inner nodes:    3
Number of terminal nodes: 4
> mnTree     <- as.matrix(predict(mn,type="prob"))
> attr(mnTree,"dimnames") <- NULL
> mnTree
       [,1]       [,2]       [,3]
  [1,]    0 0.97826087 0.02173913
  [2,]    1 0.00000000 0.00000000
  [3,]    0 0.02173913 0.97826087
  [4,]    1 0.00000000 0.00000000
  [5,]    0 0.97826087 0.02173913
  [6,]    1 0.00000000 0.00000000
  [7,]    1 0.00000000 0.00000000
  [8,]    0 0.02173913 0.97826087
  [9,]    1 0.00000000 0.00000000
 [10,]    0 0.02173913 0.97826087
 [11,]    0 0.50000000 0.50000000
 [12,]    1 0.00000000 0.00000000
 [13,]    0 0.02173913 0.97826087
 [14,]    0 0.97826087 0.02173913
 [15,]    0 0.97826087 0.02173913
 [16,]    1 0.00000000 0.00000000
 [17,]    0 0.02173913 0.97826087
 [18,]    0 0.97826087 0.02173913
 [19,]    0 0.02173913 0.97826087
 [20,]    1 0.00000000 0.00000000
 [21,]    1 0.00000000 0.00000000
 [22,]    0 0.97826087 0.02173913
 [23,]    0 0.97826087 0.02173913
 [24,]    0 0.02173913 0.97826087
 [25,]    0 0.97826087 0.02173913
 [26,]    0 0.97826087 0.02173913
 [27,]    0 0.02173913 0.97826087
 [28,]    0 0.97826087 0.02173913
 [29,]    0 0.02173913 0.97826087
 [30,]    1 0.00000000 0.00000000
 [31,]    0 0.97826087 0.02173913
 [32,]    1 0.00000000 0.00000000
 [33,]    1 0.00000000 0.00000000
 [34,]    0 0.50000000 0.50000000
 [35,]    0 0.97826087 0.02173913
 [36,]    0 0.02173913 0.97826087
 [37,]    1 0.00000000 0.00000000
```

```
[38,]    0 0.97826087 0.02173913
[39,]    0 0.97826087 0.02173913
[40,]    0 0.02173913 0.97826087
[41,]    0 0.02173913 0.97826087
[42,]    0 0.97826087 0.02173913
[43,]    0 0.02173913 0.97826087
[44,]    0 0.02173913 0.97826087
[45,]    0 0.97826087 0.02173913
[46,]    0 0.97826087 0.02173913
[47,]    1 0.00000000 0.00000000
[48,]    0 0.97826087 0.02173913
[49,]    0 0.02173913 0.97826087
[50,]    0 0.97826087 0.02173913
[51,]    0 0.97826087 0.02173913
[52,]    0 0.97826087 0.02173913
[53,]    0 0.02173913 0.97826087
[54,]    0 0.50000000 0.50000000
[55,]    0 0.97826087 0.02173913
[56,]    1 0.00000000 0.00000000
[57,]    1 0.00000000 0.00000000
[58,]    0 0.97826087 0.02173913
[59,]    0 0.97826087 0.02173913
[60,]    0 0.97826087 0.02173913
[61,]    1 0.00000000 0.00000000
[62,]    0 0.50000000 0.50000000
[63,]    0 0.02173913 0.97826087
[64,]    1 0.00000000 0.00000000
[65,]    0 0.02173913 0.97826087
[66,]    0 0.97826087 0.02173913
[67,]    1 0.00000000 0.00000000
[68,]    0 0.97826087 0.02173913
[69,]    0 0.97826087 0.02173913
[70,]    1 0.00000000 0.00000000
[71,]    1 0.00000000 0.00000000
[72,]    0 0.02173913 0.97826087
[73,]    0 0.97826087 0.02173913
[74,]    0 0.97826087 0.02173913
[75,]    0 0.02173913 0.97826087
[76,]    1 0.00000000 0.00000000
[77,]    0 0.02173913 0.97826087
[78,]    1 0.00000000 0.00000000
[79,]    0 0.97826087 0.02173913
[80,]    1 0.00000000 0.00000000
[81,]    0 0.50000000 0.50000000
[82,]    0 0.97826087 0.02173913
[83,]    1 0.00000000 0.00000000
[84,]    0 0.50000000 0.50000000
[85,]    0 0.02173913 0.97826087
[86,]    0 0.97826087 0.02173913
[87,]    0 0.02173913 0.97826087
[88,]    1 0.00000000 0.00000000
[89,]    1 0.00000000 0.00000000
[90,]    0 0.02173913 0.97826087
[91,]    0 0.97826087 0.02173913
[92,]    1 0.00000000 0.00000000
[93,]    0 0.97826087 0.02173913
[94,]    0 0.02173913 0.97826087
[95,]    1 0.00000000 0.00000000
[96,]    1 0.00000000 0.00000000
```

```
 [97,]    0 0.97826087 0.02173913
 [98,]    1 0.00000000 0.00000000
 [99,]    1 0.00000000 0.00000000
[100,]    1 0.00000000 0.00000000
[101,]    1 0.00000000 0.00000000
[102,]    0 0.02173913 0.97826087
[103,]    0 0.02173913 0.97826087
[104,]    0 0.02173913 0.97826087
[105,]    0 0.02173913 0.97826087
[106,]    1 0.00000000 0.00000000
[107,]    0 0.50000000 0.50000000
[108,]    1 0.00000000 0.00000000
[109,]    0 0.02173913 0.97826087
[110,]    0 0.02173913 0.97826087
[111,]    0 0.02173913 0.97826087
[112,]    1 0.00000000 0.00000000
[113,]    1 0.00000000 0.00000000
[114,]    1 0.00000000 0.00000000
[115,]    1 0.00000000 0.00000000
[116,]    0 0.02173913 0.97826087
[117,]    0 0.97826087 0.02173913
[118,]    0 0.97826087 0.02173913
[119,]    1 0.00000000 0.00000000
[120,]    0 0.02173913 0.97826087
[121,]    0 0.97826087 0.02173913
[122,]    0 0.02173913 0.97826087
[123,]    0 0.02173913 0.97826087
[124,]    0 0.02173913 0.97826087
[125,]    1 0.00000000 0.00000000
[126,]    0 0.97826087 0.02173913
[127,]    1 0.00000000 0.00000000
[128,]    0 0.02173913 0.97826087
[129,]    0 0.02173913 0.97826087
[130,]    0 0.97826087 0.02173913
[131,]    0 0.50000000 0.50000000
[132,]    0 0.02173913 0.97826087
[133,]    0 0.02173913 0.97826087
[134,]    0 0.02173913 0.97826087
[135,]    1 0.00000000 0.00000000
[136,]    1 0.00000000 0.00000000
[137,]    1 0.00000000 0.00000000
[138,]    0 0.02173913 0.97826087
[139,]    0 0.02173913 0.97826087
[140,]    0 0.97826087 0.02173913
[141,]    0 0.97826087 0.02173913
[142,]    0 0.97826087 0.02173913
[143,]    0 0.02173913 0.97826087
[144,]    1 0.00000000 0.00000000
[145,]    1 0.00000000 0.00000000
[146,]    0 0.97826087 0.02173913
[147,]    1 0.00000000 0.00000000
[148,]    1 0.00000000 0.00000000
[149,]    0 0.97826087 0.02173913
[150,]    0 0.02173913 0.97826087
> idxTr      <- apply(mnTree,byRows,which.max)
```

```
> (classTree <- classif[idxTr] )
  [1] 2 1 3 1 2 1 1 3 1 3 2 1 3 2 2 1 3 2 3 1 1 2 2 3 2 2 3 2 3 1 2 1 1 2 2 3 1
 [38] 2 2 3 3 2 3 3 2 2 1 2 3 2 2 2 3 2 2 1 1 2 2 2 1 2 3 1 3 2 1 2 2 1 1 3 2 2
 [75] 3 1 3 1 2 1 2 2 1 2 3 2 3 1 1 3 2 1 2 3 1 1 2 1 1 1 1 3 3 3 3 1 2 1 3 3 3
[112] 1 1 1 1 3 2 2 1 3 2 3 3 3 1 2 1 3 3 2 2 3 3 3 1 1 1 3 3 2 2 2 3 1 1 2 1 1
[149] 2 3
> (pTree     <- apply(mnTree,byRows,max) )
  [1] 0.9782609 1.0000000 0.9782609 1.0000000 0.9782609 1.0000000 1.0000000
  [8] 0.9782609 1.0000000 0.9782609 0.5000000 1.0000000 0.9782609 0.9782609
 [15] 0.9782609 1.0000000 0.9782609 0.9782609 0.9782609 1.0000000 1.0000000
 [22] 0.9782609 0.9782609 0.9782609 0.9782609 0.9782609 0.9782609 0.9782609
 [29] 0.9782609 1.0000000 0.9782609 1.0000000 1.0000000 0.5000000 0.9782609
 [36] 0.9782609 1.0000000 0.9782609 0.9782609 0.9782609 0.9782609 0.9782609
 [43] 0.9782609 0.9782609 0.9782609 0.9782609 1.0000000 0.9782609 0.9782609
 [50] 0.9782609 0.9782609 0.9782609 0.9782609 0.5000000 0.9782609 1.0000000
 [57] 1.0000000 0.9782609 0.9782609 0.9782609 1.0000000 0.5000000 0.9782609
 [64] 1.0000000 0.9782609 0.9782609 1.0000000 0.9782609 0.9782609 1.0000000
 [71] 1.0000000 0.9782609 0.9782609 0.9782609 0.9782609 1.0000000 0.9782609
 [78] 1.0000000 0.9782609 1.0000000 0.5000000 0.9782609 1.0000000 0.5000000
 [85] 0.9782609 0.9782609 0.9782609 1.0000000 1.0000000 0.9782609 0.9782609
 [92] 1.0000000 0.9782609 0.9782609 1.0000000 1.0000000 0.9782609 1.0000000
 [99] 1.0000000 1.0000000 1.0000000 0.9782609 0.9782609 0.9782609 0.9782609
[106] 1.0000000 0.5000000 1.0000000 0.9782609 0.9782609 0.9782609 1.0000000
[113] 1.0000000 1.0000000 1.0000000 0.9782609 0.9782609 0.9782609 1.0000000
[120] 0.9782609 0.9782609 0.9782609 0.9782609 0.9782609 1.0000000 0.9782609
[127] 1.0000000 0.9782609 0.9782609 0.9782609 0.5000000 0.9782609 0.9782609
[134] 0.9782609 1.0000000 1.0000000 1.0000000 0.9782609 0.9782609 0.9782609
[141] 0.9782609 0.9782609 0.9782609 1.0000000 1.0000000 0.9782609 1.0000000
[148] 1.0000000 0.9782609 0.9782609
> (brTree    <- 1-pTree )
  [1] 0.02173913 0.00000000 0.02173913 0.00000000 0.02173913 0.00000000
  [7] 0.00000000 0.02173913 0.00000000 0.02173913 0.50000000 0.00000000
 [13] 0.02173913 0.02173913 0.02173913 0.00000000 0.02173913 0.02173913
 [19] 0.02173913 0.00000000 0.00000000 0.02173913 0.02173913 0.02173913
 [25] 0.02173913 0.02173913 0.02173913 0.02173913 0.02173913 0.00000000
 [31] 0.02173913 0.00000000 0.00000000 0.50000000 0.02173913 0.02173913
 [37] 0.00000000 0.02173913 0.02173913 0.02173913 0.02173913 0.02173913
 [43] 0.02173913 0.02173913 0.02173913 0.02173913 0.00000000 0.02173913
 [49] 0.02173913 0.02173913 0.02173913 0.02173913 0.02173913 0.50000000
 [55] 0.02173913 0.00000000 0.00000000 0.02173913 0.02173913 0.02173913
 [61] 0.00000000 0.50000000 0.02173913 0.00000000 0.02173913 0.02173913
 [67] 0.00000000 0.02173913 0.02173913 0.00000000 0.00000000 0.02173913
 [73] 0.02173913 0.02173913 0.02173913 0.00000000 0.02173913 0.00000000
 [79] 0.02173913 0.00000000 0.50000000 0.02173913 0.00000000 0.50000000
 [85] 0.02173913 0.02173913 0.02173913 0.00000000 0.00000000 0.02173913
 [91] 0.02173913 0.00000000 0.02173913 0.02173913 0.00000000 0.00000000
 [97] 0.02173913 0.00000000 0.00000000 0.00000000 0.00000000 0.02173913
[103] 0.02173913 0.02173913 0.02173913 0.00000000 0.50000000 0.00000000
[109] 0.02173913 0.02173913 0.02173913 0.00000000 0.00000000 0.00000000
[115] 0.00000000 0.02173913 0.02173913 0.02173913 0.00000000 0.02173913
[121] 0.02173913 0.02173913 0.02173913 0.02173913 0.00000000 0.02173913
[127] 0.00000000 0.02173913 0.02173913 0.02173913 0.50000000 0.02173913
[133] 0.02173913 0.02173913 0.00000000 0.00000000 0.00000000 0.02173913
[139] 0.02173913 0.02173913 0.02173913 0.02173913 0.02173913 0.00000000
[145] 0.00000000 0.02173913 0.00000000 0.00000000 0.02173913 0.02173913
```

```
> table(in1$grp,classTree)
   classTree
      1  2  3
  1 50  0  0
  2  0 49  1
  3  0  5 45
>
```