```
R version 3.5.1 (2018-07-02) -- "Feather Spray"
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Platform: x86_64-w64-mingw32/x64 (64-bit)

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Microsoft R Open 3.5.1
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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/.

[Previously saved workspace restored]

> ###
```

```
> #
> #
> # use mahalanodis distance to check cluster membership probability
in new data
> #
> ###
> #
> # keep down use of "scientific notation"
> options(scipen=100)
>
> ###
> # convenience definitions
> #
> byRows             <- 1  # for use with apply()
> byCols             <- 2  # for use with apply()
>
> # switches
> #
> verbose            <- T
>
> ###
> #
> # (1) set path and load data (support and "new" observations)
> # (2) assign cluster memberships
> # (3) generate report (listing) of all calculated data / plots
> #
> ###
> #
> # prep for mahalanobis distance [ updated ]
> # uses scale() to get means and std.dev; no loops
> #
```

```
> ###
> #
> #variability <- function(df) {
> #     df$cluster <- NULL                          # cleanup
> #     df$grps    <- NULL                          # cleanup
> #     n          <- nrow(df)
> #     df2        <- scale(df, center=T, scale=T)  # convert to Z w/
local mean and std.dev
> #     sscp       <- t(df2) %*% df2                # X'X
> #     vcvinv     <- solve((1/(n-1)) * sscp)       # inverse of
variance-covariance matrix
> #     return( list(n      = n,
> #                  avg    = attr(df2, "scaled:center"),
> #                  sdev   = attr(df2, "scaled:scale"),
> #                  vcvinv = vcvinv )
> #            )
> #     }
> ###
> # calculate and retain summary information for each existing cluster
> #mhWork   <- trn2                       %>%
> #            group_by(cluster)          %>%
> #            do( desc=variability(.) )
> #
> ###
> #
> # fetch the Mahalanobis Distance supporting data (scale info and
var-covar matrix inverse)
> #
> ###
> setwd("c:/data/BUAN6357/mahalanobis")
> load(file="exam1_mhd_support.Rdata")     # mhWork
```

```
>
> if(verbose) str(mhWork)
Classes ‘rowwise_df’, ‘tbl_df’, ‘tbl’ and 'data.frame': 3 obs. of  2
variables:
 $ cluster: int  1 2 3
 $ desc   :List of 3
  ..$ :List of 4
  .. ..$ n     : int 998
  .. ..$ avg   : Named num  -2.0113 -0.0231 1.012 2.0184
  .. .. ..- attr(*, "names")= chr  "v1" "v2" "v3" "v4"
  .. ..$ sdev  : Named num  1.04 1.03 1.03 1.04
  .. .. ..- attr(*, "names")= chr  "v1" "v2" "v3" "v4"
  .. ..$ vcvinv: num [1:4, 1:4] 1.00275 0.00385 -0.04773 -0.0211
0.00385 ...
  .. .. ..- attr(*, "dimnames")=List of 2
  .. .. .. ..$ : chr  "v1" "v2" "v3" "v4"
  .. .. .. ..$ : chr  "v1" "v2" "v3" "v4"
  ..$ :List of 4
  .. ..$ n     : int 900
  .. ..$ avg   : Named num  0.987 1.98 4.995 -1.021
  .. .. ..- attr(*, "names")= chr  "v1" "v2" "v3" "v4"
  .. ..$ sdev  : Named num  0.991 0.982 1.026 1.007
  .. .. ..- attr(*, "names")= chr  "v1" "v2" "v3" "v4"
  .. ..$ vcvinv: num [1:4, 1:4] 1.002 -0.0317 -0.0181 -0.0255 -0.0317
...
  .. .. ..- attr(*, "dimnames")=List of 2
  .. .. .. ..$ : chr  "v1" "v2" "v3" "v4"
  .. .. .. ..$ : chr  "v1" "v2" "v3" "v4"
  ..$ :List of 4
  .. ..$ n     : int 802
  .. ..$ avg   : Named num  1.97 3.993 -0.986 1.002
```

```
  .. .. ..- attr(*, "names")= chr  "v1" "v2" "v3" "v4"
  .. ..$ sdev  : Named num  1.028 0.949 0.991 0.937
  .. .. ..- attr(*, "names")= chr  "v1" "v2" "v3" "v4"
  .. ..$ vcvinv: num [1:4, 1:4] 1.0083 -0.0552 0.0383 -0.0648 -0.0552
...
  .. .. ..- attr(*, "dimnames")=List of 2
  .. .. .. ..$ : chr  "v1" "v2" "v3" "v4"
  .. .. .. ..$ : chr  "v1" "v2" "v3" "v4"
 - attr(*, "vars")= chr "cluster"
 - attr(*, "drop")= logi TRUE
>
> # get number of defined clusters
> (clusters <- mhWork$cluster )
[1] 1 2 3
> desc      <- mhWork$desc
>
> (mhDf     <- length(desc[[1]]$avg) )     # degrees-of-freedom for
chi-sq
[1] 4
>
> ###
> #
> # fetch testing set
> #
> ###
> setwd("c:/data/BUAN6357/exam_1")
> load(file="new_data.Rdata")              # newData
>
> if(verbose) newData
              v1           v2          v3          v4
1   -1.06024229 -0.713646912 -0.41152188  1.31779221
```

156	2	-0.14773505	-0.845835956	2.08386966	0.92663347
157	3	-1.00950701	0.688466496	2.17022235	1.74891717
158	4	-3.10890953	1.264535001	1.29475454	1.98721712
159	5	-1.91727831	0.500523295	0.44557234	4.42519305
160	6	-2.33256491	-0.333285590	0.59655931	0.59670373
161	7	-1.66503363	-0.614730753	-0.26812322	1.94233564
162	8	-1.76129265	-1.952227384	0.99086156	1.86196529
163	9	-2.48222423	0.019353632	1.34175932	-0.68798010
164	10	-2.82584685	0.615678185	1.39403967	1.41400623
165	11	-3.57526183	0.240481804	0.23700449	2.36585290
166	12	-2.06495676	0.781534408	2.49032802	2.45535954
167	13	-3.43093758	-0.614579071	2.15453963	0.01287483
168	14	-1.35865622	1.099336184	0.14374600	0.60479813
169	15	-2.78877936	0.141408861	1.57106872	1.71820196
170	16	-0.46469585	1.206212611	1.12753262	0.50113405
171	17	-2.05222585	1.465578498	1.84700163	3.88901902
172	18	-3.14091003	-0.143225888	0.22250805	2.18319833
173	19	-2.04091759	1.346826600	1.86156113	3.07345263
174	20	-1.05807171	-0.070148975	1.89080585	1.51297026
175	21	-2.39090359	-0.764480444	-0.90134247	2.54092770
176	22	-1.19488668	0.180046340	0.52260904	3.06327546
177	23	-1.65827774	-0.010070707	1.36965516	0.45207908
178	24	-2.47735940	0.447616446	0.60394365	1.73404854
179	25	-2.24984430	1.127515004	-1.45172007	1.40397483
180	26	-1.80093214	0.338964170	0.32443971	1.80891745
181	27	-2.95174106	-1.218882131	0.74612311	2.40489742
182	28	-4.01925614	1.111360006	-1.54709060	1.37817951
183	29	-1.24924680	0.435495936	0.68636725	3.44331486
184	30	-1.56419122	0.772647497	0.06768102	2.71634418
185	31	-2.67433556	-0.797009651	0.41522418	0.41414043

186	32	-1.58899772	0.344037024	1.15120896	0.11561793
187	33	-0.79162999	1.164680984	-0.28381753	2.51535362
188	34	-2.91936266	0.556720598	0.49064091	2.34754482
189	35	-1.20855154	-0.823519892	-1.33802589	2.62638435
190	36	-2.20792257	-0.005606915	1.17707364	1.34529136
191	37	-1.45318681	-0.600108622	-1.01603388	2.90997525
192	38	-2.36952224	0.068891556	1.05301409	0.51638990
193	39	-2.45386013	-1.209657277	3.02071503	1.71620544
194	40	-6.30278144	-0.539722084	0.07948742	0.88623024
195	41	-2.80034109	0.420146452	1.56864245	3.50338014
196	42	-2.26120018	-0.836423273	-0.84223681	2.15560954
197	43	-3.34820461	0.055588694	1.05708625	3.18260388
198	44	-2.80622748	0.120176237	2.51595627	1.56519922
199	45	-3.98779449	-1.552660807	1.34377912	1.98754926
200	46	-2.93900723	-0.642175197	1.99447305	1.68093911
201	47	-0.95294435	-0.775505237	0.56276767	3.35403835
202	48	-1.15375207	-0.425495160	0.51136522	0.67129399
203	49	-1.62579822	-0.191617637	1.71733627	3.90065680
204	50	-2.38360931	0.438519652	2.60664291	2.66219664
205	51	-1.77321797	0.315181743	0.31278654	2.30006191
206	52	-1.45518784	-0.607686766	0.77427771	2.04669077
207	53	-1.49231623	-1.380010431	1.36729237	3.01696410
208	54	-3.95200858	0.816648549	2.01079921	2.58576572
209	55	-2.68815967	-0.129798084	1.99103678	3.06300695
210	56	-2.27988509	-0.370551634	0.41352447	1.10501909
211	57	-2.53570453	1.227320326	1.71587861	2.45132011
212	58	-1.63662318	-1.693343781	0.24359946	2.38037923
213	59	-1.70984789	2.138272621	-0.39417058	3.99446499
214	60	-2.31042647	-0.809044704	-1.01114292	0.94209150
215	61	-2.51822476	0.247767650	0.72443642	2.72799761

216	62	-3.24160971	1.852442141	0.46169111	-0.10372510
217	63	-2.44042249	0.258657589	-0.81697925	2.35223739
218	64	-2.64037018	1.766286343	1.52821412	1.35475113
219	65	-1.12739819	-1.291165438	0.24014212	0.81541217
220	66	-2.86465731	0.738614816	-0.24525188	2.92767762
221	67	-2.22440839	0.014277952	2.98807872	1.80287829
222	68	-2.71179398	-0.163585457	1.33235963	1.39719162
223	69	-0.88659735	2.539018502	1.22944421	1.78125827
224	70	-2.13505388	-0.032931605	1.34619271	2.32679603
225	71	-1.20826553	0.071516951	-0.26861958	3.34134519
226	72	-2.33832395	0.558826363	2.58230106	1.67413393
227	73	-1.15221962	0.215565317	0.45914551	2.14427786
228	74	-1.61819863	0.449204686	1.55920817	2.60780995
229	75	-1.59983500	0.691037729	0.25769867	1.86609429
230	76	-0.86282874	-0.719290805	1.77970127	0.73141714
231	77	-1.58026835	1.406298329	0.27590165	1.28005556
232	78	-1.98528026	-0.985056891	-1.01843092	1.94741128
233	79	-1.88681827	0.076955455	1.85525106	2.69808667
234	80	-1.81439400	-0.757094120	1.64894955	0.57787129
235	81	-1.44176799	1.901652716	0.28971001	2.30471546
236	82	-2.07864577	-1.300575153	1.15336263	2.77564504
237	83	-1.25191392	-0.839590596	-0.42545598	3.83764492
238	84	-2.34911152	-1.606637026	2.51011398	2.04872471
239	85	-1.05350214	-0.926419759	2.59253064	1.51275830
240	86	-0.39371910	0.946257560	1.28927361	2.53324390
241	87	-2.53901870	0.180529597	2.70342241	0.68177643
242	88	-2.13099663	1.088752626	2.29083169	2.34207154
243	89	-0.96440655	-2.322119902	1.84832749	3.04901616
244	90	-1.23249833	-1.236367181	1.35041437	2.26683040
245	91	-2.76056107	1.665937977	0.99516056	1.10616642

246	92	-2.01092758	-0.749260196	0.94008980	2.77120349
247	93	-2.15474244	-1.103950542	1.06346228	2.77955261
248	94	-0.65748137	1.751381502	2.26821101	2.23471789
249	95	-3.04266363	-0.703589894	2.06734303	0.94534485
250	96	-0.78786603	-0.046169018	-0.10691095	3.19077441
251	97	-3.22506236	0.150780705	-0.20167254	0.01729599
252	98	-1.40810263	-0.508006164	1.44519615	1.65159110
253	99	-0.27008560	-1.726610376	0.51910162	1.82395750
254	100	-1.15014369	-0.395426223	1.30843720	1.67771357
255	101	-0.17494094	4.151130770	2.91848923	-3.39681431
256	102	-0.41277045	3.550375801	3.40280305	-4.01003894
257	103	1.45162606	1.729675706	2.66788678	-3.06220231
258	104	0.47470165	1.856337513	3.32767099	-2.71369977
259	105	0.56642405	4.267804158	3.78243727	-2.94295548
260	106	2.47993336	4.200629358	4.19474410	-2.64360227
261	107	-1.13498697	2.428188594	3.36920232	-3.35279527
262	108	1.39766880	2.033221410	4.53908965	-3.20184075
263	109	2.20676568	1.725881982	4.14633113	-4.26830360
264	110	0.73377417	2.627912670	5.61684983	-4.42500666
265	111	1.70250788	6.149895822	3.64382157	-3.19913530
266	112	0.96030713	3.315350557	3.43720393	-4.54253779
267	113	3.33158792	1.439962673	2.94970477	-4.00933709
268	114	0.03650002	2.286518417	5.89203823	-2.71927476
269	115	0.26224060	3.325298904	4.18632255	-3.44137293
270	116	1.82453956	3.721850142	3.40650814	-3.21314103
271	117	-0.26706613	1.798292317	3.88030575	-3.41732243
272	118	1.82991765	3.129532116	4.99230880	-3.40094527
273	119	1.94346842	2.333193150	3.37847638	-4.33383064
274	120	3.08551174	3.555187351	3.71984156	-2.91656490
275	121	-0.24271016	3.015780659	5.12854666	-2.87841945

276	122	-0.73039023	2.127261895	4.69346424	-1.92380154
277	123	1.80900763	4.609022815	4.69972562	-1.35054214
278	124	1.87045785	5.251660998	1.36957659	-3.98129321
279	125	-0.32166064	2.677925496	3.76007516	-3.53028403
280	126	1.46768927	4.088357588	3.83730076	-3.56735840
281	127	0.21034256	4.175836184	4.06552103	-3.90658300
282	128	-0.03776821	3.927540217	3.64604429	-3.37292157
283	129	0.37586508	4.867103433	2.40508553	-4.00156345
284	130	2.29657736	2.499868005	3.14988365	-3.32537716
285	131	2.28521478	2.033062845	2.14903280	-3.51202883
286	132	3.03857606	3.084212121	4.63981997	-3.15442037
287	133	0.85692614	1.793543596	3.92015888	-2.26260600
288	134	1.26537732	2.927131003	5.20860990	-2.31058146
289	135	-0.53658471	1.312760367	3.88752211	-1.81503471
290	136	1.25834289	3.230229402	4.88960489	-2.50899654
291	137	0.30454747	2.112301843	4.18085935	-3.83038879
292	138	-0.19675080	3.649083280	5.93062849	-3.49827009
293	139	1.83749050	4.076509722	3.82340545	-4.86763451
294	140	-1.15929042	2.183924339	2.89549580	-4.12046970
295	141	-0.51441697	4.075341387	4.28387220	-1.53932676
296	142	2.75376677	3.606950779	3.81204928	-2.58562078
297	143	1.13386434	3.363563780	3.79775665	-2.37777676
298	144	1.00289214	5.060410258	3.10456690	-1.66585883
299	145	2.41701767	1.725808082	5.54730669	-3.83391674
300	146	1.71165502	5.114285165	5.36385589	-4.36041428
301	147	2.14442872	2.768785220	2.69411689	-1.41734983
302	148	0.81803665	3.271308135	2.95538241	-2.41029675
303	149	-0.35369156	2.993869565	5.63893104	-2.79018111
304	150	1.89661181	1.942930235	5.75235760	-3.28286738
305	151	1.38158954	3.170216525	4.43098153	-1.03813682

306	152	1.60826014	1.848697559	4.44273572	-3.05804577
307	153	-0.15441642	2.005511025	2.31945882	-2.34885096
308	154	2.06102413	2.053485092	3.65125559	-2.93370761
309	155	1.47158654	2.901454427	4.66617017	-3.27629997
310	156	0.31729017	4.147303180	2.60102295	-1.43757210
311	157	0.61643442	2.920124071	2.45354919	-2.03869099
312	158	0.40888510	4.108614335	5.31417680	-2.23914711
313	159	1.50659516	3.871724791	3.97313414	-1.89721765
314	160	0.19560391	2.225650996	4.98439896	-2.67244598
315	161	2.73908791	3.724068011	5.46438013	-1.51198355
316	162	-0.01608558	1.981456043	3.97825625	-3.03567655
317	163	0.60165802	2.767681133	4.26366420	-3.20600917
318	164	-1.26665029	3.824070665	1.75275164	-4.67867813
319	165	1.16427483	3.786321962	3.52759258	-3.97622165
320	166	1.95195263	2.152291218	4.80558862	-3.05568929
321	167	1.05452539	4.541492491	4.02938334	-2.20021422
322	168	-0.28736873	2.287573334	4.18731789	-3.07097549
323	169	-0.39435043	2.779965430	1.82568388	-0.46870036
324	170	0.41557456	1.790548412	2.96023433	-2.27525515
325	171	-1.01107220	1.534616295	5.50173225	-3.05641742
326	172	1.12751943	2.899742749	5.03789611	-3.88647601
327	173	-0.63487251	2.612794329	4.37147768	-4.14422532
328	174	0.62957133	2.029317870	4.25275863	-3.40582774
329	175	3.15677054	2.443019383	3.65515736	-3.02627587
330	176	0.19492017	1.231682195	3.20680260	-2.28764984
331	177	1.25123438	2.997854557	3.41802527	-1.54822389
332	178	0.71341994	1.788661706	3.91151438	-4.36320423
333	179	1.60186643	3.604086999	4.96572994	-3.21232458
334	180	0.29382660	2.025068374	2.10011165	-1.63286163
335	181	-0.60524023	2.727948658	3.93124370	-2.81786706

182	1.50216845	2.278276221	3.88296547	-3.94296369
183	3.17085977	4.747629047	4.98694357	-1.55706987
184	0.73553093	3.651021891	5.25038189	-3.18462458
185	0.49563175	4.572957992	4.60568915	-2.19510122
186	-0.12306450	1.284853054	5.11100632	-2.88682589
187	0.54023719	3.479378795	4.08326863	-3.20630748
188	1.52372579	3.497287298	5.51409193	-1.88879592
189	3.20512344	2.534715189	3.39246021	-5.46891914
190	1.38015895	3.257866699	4.51748246	-3.98446054
191	1.62327188	2.689690879	3.62896266	-4.60588011
192	1.41362618	2.101244773	4.47372949	-3.65833592
193	-0.25503415	3.045425057	5.49885604	-2.19483447
194	0.60648634	2.267041048	3.65178880	-2.09841261
195	-0.26185045	3.618666451	3.01128778	-4.24498022
196	1.87283478	2.679276530	5.52595245	-1.14946063
197	0.58109948	3.134102894	4.43497239	-2.64903059
198	0.58238368	3.114263550	4.33109746	-2.91477421
199	0.40607044	3.280857184	4.37737586	-4.03281831
200	0.82099224	2.164393349	4.70237314	-3.26702870
201	3.34801366	4.404109335	-3.03718632	2.94010267
202	1.06486733	3.359378013	-2.17315475	0.45634563
203	2.39417223	4.616814196	-1.95910916	2.04003046
204	2.64203952	4.197829090	-1.70300752	1.55328441
205	3.14098911	3.344880503	1.35894599	2.76665219
206	2.32124271	4.725349219	-0.32292739	0.85393629
207	1.30363031	2.535069455	-2.15947932	-0.83815264
208	0.97466212	2.994586970	-1.62318380	0.77094023
209	1.33357426	4.846622584	-1.58502287	1.18936858
210	0.94106512	4.438273492	-2.33062346	0.18785870
211	2.80127158	3.834686467	-1.47897264	1.01480971

212	2.37631791	4.635772173	2.17593168	1.71261821
213	3.03740048	3.811206464	-1.45359861	1.42713198
214	1.46767226	3.190032879	-1.05855025	-0.46938668
215	1.80445435	4.246218091	-1.08468713	1.68506092
216	2.58642467	4.289510918	-0.32828172	0.22413464
217	2.16897412	3.544214690	-2.61517517	0.76103044
218	1.76278556	4.902470798	-0.50717617	2.40260357
219	1.49349840	3.782397835	-1.54511979	-0.05187558
220	2.41636643	4.796241229	-1.20941401	1.28739300
221	3.64696359	3.332384189	-1.73041467	1.77337681
222	2.26187993	4.575123956	-0.20917434	-1.03600252
223	-0.77372141	5.212667141	-2.96918124	0.22160415
224	0.91772902	4.120063958	0.01492361	0.30874358
225	1.89077248	4.311810158	-0.96066859	1.90240246
226	2.82297252	2.574112813	-0.14402262	1.43992096
227	3.04938912	3.449345772	0.28731154	1.06311488
228	2.14488452	3.845179894	-1.07310797	0.05076507
229	2.92576587	5.596176955	0.16344164	2.10030204
230	2.40343737	3.862963815	0.04535601	0.25431413
231	1.63002747	5.863057613	-0.41780717	1.57826149
232	1.18986651	2.561057567	-2.17515997	0.62952468
233	0.48466688	4.924547535	0.10427400	-0.27206553
234	2.99021911	5.313996392	0.14794258	0.74107755
235	3.08703361	3.295722427	0.33855771	1.27807728
236	0.70981003	4.559696925	-1.40175875	0.82300337
237	2.33993123	2.778466578	-0.34721572	1.74003439
238	0.94458722	5.197706369	-1.71264813	-0.41446813
239	-0.28959203	2.470663598	-0.61971176	1.84464882
240	2.78493778	3.500878254	-1.34820736	-0.20238430
241	2.68220703	3.666301214	-1.37219186	0.99799939

242	0.71771352	3.338794438	-1.72734450	-0.49673736
243	-0.19066748	2.790770009	-0.09745129	-0.15842737
244	1.35335863	3.212252721	-3.12479034	2.80539432
245	0.69531483	4.274730875	-1.17782452	1.22172076
246	1.58543845	4.788786578	0.83262515	-0.10880342
247	0.08731260	3.368118133	-2.81860328	1.00093288
248	4.60630379	4.187890823	-0.86913804	1.09872108
249	1.91882959	3.359345026	-1.11902863	0.86509612
250	1.12117487	6.516012164	-2.51660621	1.88553118
251	1.58799752	4.180799348	-1.96707501	-0.11036519
252	2.45542878	2.679501840	-1.71436271	1.90673891
253	2.80011390	4.923230695	-2.66602588	1.40918161
254	2.66473144	4.563180778	-1.30350006	1.85322610
255	3.07512915	3.425600644	-1.60108930	-0.13146708
256	2.28423162	3.381603188	1.30836785	0.68606177
257	3.50025424	2.160044454	-0.58729053	1.28668881
258	2.24070024	3.454895720	-1.52900261	1.74177161
259	2.94616421	4.429634989	-3.19503905	0.76286911
260	1.39312113	5.101034332	-1.50702931	0.64663204
261	2.40506179	5.026938448	-1.42830392	2.48738319
262	3.79604684	3.288648799	-0.19168272	1.47760496
263	3.32210611	3.454589707	-0.69182041	3.49909962
264	2.08656685	2.725547503	-0.66418901	0.83915116
265	-0.13182669	4.156584881	0.44549887	-0.53147015
266	1.35107371	2.139838280	-1.04012313	1.19180245
267	2.06901922	3.731058518	-1.72910016	-0.15433362
268	2.51613675	2.927189802	-1.99550282	-0.25575051
269	2.48525542	2.215923420	-2.03034877	1.04215066
270	1.36944159	5.479808021	-2.81659748	1.83660775
271	2.88364654	3.119242141	-0.76153763	1.47027461

272	2.79643073	2.757402577	-0.11233148	2.08424900
273	2.04071360	2.656059367	-1.24374526	-0.08389985
274	0.07356046	3.726862009	-0.56550577	1.20396270
275	2.93833742	2.425172386	0.81419120	2.62710621
276	3.67976325	4.448622467	-1.07418960	0.89275877
277	2.13729364	7.247952623	-2.04127201	-0.76144512
278	1.91311192	3.646796112	-0.89738744	0.93592718
279	3.73263529	5.463826881	-1.65655900	3.20376967
280	1.13953616	2.568585450	-0.17460619	1.08943632
281	1.50433819	3.912627182	-1.61511468	1.40537212
282	2.22512034	4.076898845	-0.18995896	1.70062343
283	1.30893441	3.553561358	0.08313798	-1.00611146
284	1.42076407	3.608855395	0.65702714	0.58664399
285	0.69406088	4.934921500	-2.70972166	2.54135407
286	0.69709800	3.517079214	-1.68654277	1.03873169
287	1.82318685	3.705244042	1.10864337	0.33644659
288	1.50424306	3.751616137	-1.05615713	2.29457431
289	3.73170166	2.912049047	0.04332301	0.38149546
290	2.79353127	4.124494685	-2.41551712	1.06361308
291	1.07849477	2.801409099	-1.36039928	1.03222931
292	3.10239070	3.974819635	-0.79936400	0.27379286
293	2.64633434	4.312717578	-1.88208903	1.05974700
294	3.90352857	4.827424871	-0.45356511	-0.33023557
295	1.43536086	5.474116326	-0.78223667	1.25521929
296	2.11510769	3.849692213	0.35190682	0.18109651
297	3.22758461	2.757631270	-1.27498798	1.55401422
298	0.19270435	3.784232489	-0.75197773	0.52181630
299	1.96594414	2.804745701	-2.42133903	0.24663878
300	1.69602691	3.959232352	-1.77973315	0.64296070
301	3.06089337	6.111499379	8.19975081	9.38795443

456	302	5.39366493	6.127961556	6.78243755	8.32541786
457	303	5.62581486	6.078208515	6.20608419	7.49037203
458	304	4.40900106	6.732601014	6.06341112	9.82950163
459	305	3.90744144	6.579836367	9.12260768	7.13741890
460	306	4.20609871	5.351364693	6.64133598	7.83129998
461	307	3.90839711	5.725154577	6.84049162	7.34469670
462	308	3.53999864	5.563980565	6.45552841	7.79635215
463	309	4.56749428	5.631117012	6.81415514	7.29124909
464	310	2.53981303	5.861830254	7.95699586	8.23558139
465	311	3.24942684	5.609779817	6.76468348	7.32683226
466	312	3.71286448	6.257959506	6.99182910	7.97103391
467	313	4.83163408	5.406710297	8.17966287	6.24062551
468	314	3.47301326	5.380923388	7.03720845	7.94290645
469	315	2.16735610	6.990078148	5.86820969	9.06352184
470	316	5.04643156	6.794095067	6.80502179	9.17249947
471	317	3.48031161	4.377043922	6.26442627	8.63399065
472	318	5.05350591	6.465637487	7.58602709	9.00075314
473	319	5.36152726	5.366892993	6.17630867	6.78081255
474	320	4.05590213	6.914717990	6.50794874	8.75976691
475	321	4.11657351	7.066993201	7.45063322	9.24110029
476	322	5.46795185	5.462238878	6.04879304	9.49157260
477	323	4.37774173	4.077852992	8.69196079	7.28794665
478	324	3.86923401	6.567620305	7.12001530	8.21209220
479	325	4.65319738	7.743189597	7.13087446	7.98681783
480	326	5.28436952	6.552121796	7.55365934	6.29680606
481	327	4.96315288	5.310953722	7.29140398	7.70131300
482	328	2.15473608	7.191213093	7.37052042	6.30660295
483	329	3.17877779	5.553002945	7.21275799	7.66204526
484	330	3.59294738	6.268362222	7.04099811	7.33425514
485	331	2.43882924	6.566100355	8.88768492	9.22674471

486	332	3.46833277	6.271452495	8.20928259	8.17833962
487	333	6.41230794	7.393766280	5.91343697	9.88190996
488	334	3.90509141	6.120269884	7.36672525	6.94106428
489	335	4.30332243	6.170557095	6.23255130	9.06439333
490	336	4.90751405	5.393228507	5.78106002	8.75899504
491	337	3.73255676	5.908894916	6.21854645	7.62026744
492	338	5.33177863	5.602857028	7.11176076	9.58264994
493	339	3.80666491	6.082255078	7.27356731	8.41695333
494	340	4.74112306	6.023688358	7.50019317	7.45660701
495	341	5.57845361	5.115400479	5.95428728	6.86271252
496	342	3.09526610	4.146917799	6.20146812	7.94867649
497	343	4.61654356	6.752692523	6.26277112	9.58510965
498	344	2.46554682	6.583708353	6.43722558	6.93288071
499	345	5.16377253	4.146100816	7.79419853	7.53376513
500	346	4.88728162	5.294063777	6.64137065	10.21102975
501	347	3.63741080	6.081124507	6.39957886	6.62594782
502	348	3.98984143	6.524233067	5.47792207	8.38873149
503	349	4.20446238	7.104828200	6.77083814	9.71295906
504	350	4.35407175	6.803166297	6.98751455	7.54505445
505	351	2.85385815	6.048945500	7.96479803	6.78857670
506	352	1.34352975	5.890747626	7.18416983	6.80530155
507	353	5.93085558	7.283295049	6.79316445	10.67036693
508	354	4.62276498	4.050976148	6.92967005	7.65058189
509	355	3.38165955	7.357896811	6.93803865	7.82283940
510	356	3.63470599	4.801247713	6.21550198	9.05803629
511	357	2.64009600	5.604284692	6.56033149	9.26329213
512	358	2.96769784	5.580411738	7.07073037	8.02717441
513	359	1.42594264	6.373773825	6.87549255	7.43184138
514	360	4.95396963	6.951233717	6.03039281	7.01968557
515	361	3.56560196	5.315250015	8.44360007	7.06969037

516	362	4.44829726	5.772978400	5.73579416	9.01281515
517	363	2.60890619	7.572037881	6.26553595	8.33707942
518	364	2.87091137	5.885112809	7.18990096	6.54636522
519	365	4.45994708	6.645006921	7.14185766	10.22964071
520	366	6.21101667	5.794880745	6.22532834	7.20847321
521	367	4.67674303	7.316629411	7.39330379	8.05231549
522	368	2.82074638	3.838853570	6.50769534	7.03542542
523	369	4.87756011	4.975473501	7.63817991	8.21453477
524	370	3.10337226	4.604623378	5.98437208	7.82834586
525	371	3.16000517	6.495248870	6.36147851	8.23288591
526	372	4.35770048	5.441489883	8.04680557	7.67281602
527	373	4.83664797	6.658583048	6.20133886	8.64743290
528	374	3.23405622	5.698425179	6.26284704	7.37212429
529	375	4.70968630	5.650512942	7.31755760	7.45940949
530	376	4.78494249	6.738204101	9.30597631	10.00830511
531	377	3.16306880	5.352913146	7.44123203	9.12110727
532	378	4.00851771	5.321614340	8.15265065	7.63252172
533	379	3.32152020	6.502920041	7.96621395	6.44224441
534	380	5.68915969	5.891727294	8.55021131	8.04980648
535	381	3.12810782	3.787853964	6.09225864	8.28299252
536	382	2.97366689	5.491653543	7.66168759	7.10189399
537	383	3.52802735	5.015972930	6.74844122	7.90177933
538	384	4.72402779	6.342011997	6.86473457	6.37542058
539	385	3.68694634	5.273851536	5.94565971	8.46673527
540	386	3.41937493	6.045573495	6.61642083	8.55626076
541	387	5.45430777	6.476566093	6.22934622	9.55566523
542	388	3.58360139	5.067341050	6.15344866	6.74740362
543	389	5.59991831	5.277541146	6.68871164	6.76066621
544	390	4.27514462	7.110931879	7.00750629	8.82579784
545	391	2.95549171	5.257331385	6.56507033	8.12444450

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392  3.45116675  5.279474272  6.35282769  6.90789864
393  1.96704474  3.792126955  7.37264576  7.91614420
394  4.70923855  5.699363190  7.52401867  8.15220499
395  4.95353167  6.881202280  5.35332348  9.41417349
396  5.40517178  5.391644861  7.45683521  6.49549628
397  5.08529851  5.785020616  5.61587232  7.93941817
398  3.96738879  6.200330661  8.00923707  7.62182717
399  2.73608228  4.932904668  8.90966414  8.22130588
400  1.85767733  8.036119827  5.54876030  7.28838824
> 
> ###
> # calculate mahalanobis distances for testing set to compare
behavior
> ###
> # storage space for distances
> dtst     <- matrix( -1,
+                     nrow=nrow(newData),
+                     ncol=length(clusters) )
> 
> # collect Mahalanobis distance for test data across clusters [
updated ]
> for ( i in seq_along(clusters) ) {
+     t         <- desc[[i]]
+     tdf       <- scale(newData, center=t$avg, scale=t$sdev)
+     dtst[, i] <- mahalanobis(tdf, center=F, cov=t$vcvinv,
inverted=T)
+     }
> 
> if (verbose) dtst
               [,1]       [,2]        [,3]
  [1,]   3.7277736  44.156232  32.2994463
```

```
      [2,]   6.0065746  20.993589  38.7644007
      [3,]   2.6389225  20.849992  29.8978270
      [4,]   2.7615063  39.538463  37.4167782
      [5,]   5.9869578  59.977394  42.7157752
      [6,]   2.1708332  36.768183  38.6901782
      [7,]   2.0043530  48.361641  36.0967697
      [8,]   3.5870735  46.140094  54.8946346
      [9,]   7.1298648  27.993334  42.3297013
     [10,]   1.4904585  34.530455  38.2775858
     [11,]   2.9435633  56.636887  46.6637697
     [12,]   2.7930888  28.926261  39.6965398
     [13,]   7.2957451  34.446856  58.6850949
     [14,]   4.3137131  31.004183  19.9888867
     [15,]   0.9980324  36.125103  42.8681107
     [16,]   5.9444037  19.088835  18.1429198
     [17,]   5.8461423  43.372009  38.9842669
     [18,]   1.7436962  53.102141  44.8995186
     [19,]   3.3804304  35.915064  34.8370471
     [20,]   1.7751293  23.784525  34.1645603
     [21,]   4.3041724  64.057421  44.4638115
     [22,]   1.9197598  43.518285  31.7547337
     [23,]   2.5508115  25.224142  34.3107969
     [24,]   0.6306025  40.027111  34.1562399
     [25,]   7.4831456  56.233837  25.5086980
     [26,]   0.6807480  38.917487  29.3698920
     [27,]   2.3786665  54.200280  55.9028140
     [28,]  11.1560609  71.867384  42.5064430
     [29,]   2.7156549  44.864570  32.5643692
     [30,]   2.1541306  44.893004  26.9992750
     [31,]   3.5549713  42.310661  45.4871155
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607    [32,]   3.7375398  24.230018  30.4995629
608    [33,]   4.7454339  42.736299  18.7000192
609    [34,]   1.4221470  47.814421  38.5213635
610    [35,]   6.9073062  63.547620  37.5561643
611    [36,]   0.4853999  33.287802  37.1211123
612    [37,]   5.3438357  61.926619  37.8022157
613    [38,]   2.2169231  31.582849  37.1192203
614    [39,]   5.6364754  33.128183  62.4662321
615    [40,]  18.7578615  85.270025  84.4481767
616    [41,]   3.1429409  48.568059  47.8779575
617    [42,]   3.8689702  60.287517  42.8018934
618    [43,]   2.9908201  54.932774  51.8839915
619    [44,]   3.0507613  30.345152  48.4727195
620    [45,]   6.0428091  58.488487  70.7665330
621    [46,]   2.2914950  37.917936  53.3807057
622    [47,]   3.4384478  48.914860  40.8584339
623    [48,]   2.8026163  31.859737  31.6822420
624    [49,]   3.8643388  45.934953  47.0972607
625    [50,]   3.1231828  32.866025  46.1037977
626    [51,]   0.7269364  42.022123  30.6657208
627    [52,]   0.6671405  38.666689  37.3526631
628    [53,]   3.0484583  46.032860  51.7316815
629    [54,]   5.5442534  47.617461  54.1589998
630    [55,]   2.4314087  43.253795  51.1071830
631    [56,]   1.2418228  40.118653  38.1040624
632    [57,]   2.3497822  35.469396  35.9844226
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>
> # which cluster for each testing observation?
> newClust        <- apply(dtst, byRows, which.min)
>
> # chi-squared cdf value for each testing observation
> minStat         <- apply(dtst, byRows, min)
> chiSq           <- pchisq(minStat,df=mhDf, lower.tail=F)
> summary(chiSq)
      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
0.0000000 0.0000008 0.1720895 0.2835496 0.5042738 0.9973757
>
> # new results
> newData2        <- data.frame(cluster=newClust,
+                               minStat=minStat,
+                               probChi=chiSq)
>
> if (verbose) newData2
    cluster     minStat                                              probChi
1         1   3.7277736 0.444099309546605092169357931197737343609333304
2         1   6.0065746 0.198657814964282808389839374285656958818435 67
3         1   2.6389225 0.619943890385263207676302954496350139379501 34
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997	4	1	2.7615063	0.59849551354670782465916545334039255976676941
998	5	1	5.9869578	0.20012439225019248989489994983159704133868217
999	6	1	2.1708332	0.70437248246422579089909277172409929335117340
1000	7	1	2.0043530	0.73495818955447000941916257943375967442989349
1001	8	1	3.5870735	0.46476271008128505757284187893674243241548538
1002	9	1	7.1298648	0.12918255916047866049822800960100721567869186
1003	10	1	1.4904585	0.82833026706272339101388979543116874992847443
1004	11	1	2.9435633	0.56731393323463696898301122928387485444545746
1005	12	1	2.7930888	0.59302630222336394361093425686703994870185852
1006	13	1	7.2957451	0.12106073168303525811051457594658131711184978
1007	14	1	4.3137131	0.36521107902539340361869335538358427584171295
1008	15	1	0.9980324	0.91009419918294609530562411237042397260665894
1009	16	1	5.9444037	0.20333889177064953801554736401158152148127556
1010	17	1	5.8461423	0.21093687877401642860597519302245927974581718
1011	18	1	1.7436962	0.78276568913727118115275516174733638763427734
1012	19	1	3.3804304	0.49629041691227870902736185598769225180149078
1013	20	1	1.7751293	0.77702932207928587793333008448826149106025696
1014	21	1	4.3041724	0.36640291859420459630314326204825192689895630
1015	22	1	1.9197598	0.75051420380978028923379952175309881567955017
1016	23	1	2.5508115	0.63556089368971757647130971236038021743297577
1017	24	1	0.6306025	0.95960309221329098683384017931530252099037170
1018	25	1	7.4831456	0.11245480081138782557648170268294052220880985
1019	26	1	0.6807480	0.95368169638613697891571518994169309735298157
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1021	28	1	11.1560609	0.02486497579158027104728745371176046319305897
1022	29	1	2.7156549	0.60647800455957701082354560639942064881324768
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1034	41	1	3.1429409	0.53419595414820741918759949840023182332515717
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1078	85	1	4.1933632	0.38046902016736294793730621677241288125514984
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1080	87	1	4.7896379	0.30957077885581762988209675313555635511875153
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1115	122	2	3.8362215	0.428624359543534116934182520708418451249599 46
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1191	198	2	5.4472977	0.24440104530734255150470346507063368335366249
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1205	212	3	11.1462622	0.02496848597351971135727133344062167452648282
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1219	226	3	4.0017167	0.4057735735679675603826410679175751283764839 2
1220	227	3	3.2727339	0.5132638976429498844922250100353267043828964 2
1221	228	3	1.1151274	0.8918647105660397755855228751897811889648437 5
1222	229	3	6.0773989	0.1934421587811000209367051638764678500592708 6
1223	230	3	2.1022723	0.7169549414044257273914695360872428864240646 4
1224	231	3	4.7552313	0.3133465182993933062505220732418820261955261 2
1225	232	3	4.2890857	0.3682937905336083339591368712717667222023010 3
1226	233	3	6.0327897	0.1967128661120102484094473993536666966974735 3
1227	234	3	4.2872050	0.3685300319479645203557538479799404740333557 1
1228	235	3	3.7509253	0.4407625122537855988369415172201115638017654 4
1229	236	3	2.1705349	0.7044271789783734805112658250436652451753616 3
1230	237	3	2.7987024	0.5920567223683805835321436461526900529861450 2
1231	238	3	5.3328731	0.2548152930201368904228331757622072473168373 1
1232	239	3	8.1622281	0.0858131085255047915127946112079371232539415 4
1233	240	3	2.8120688	0.5897512244570070061300270936044398695230484 0
1234	241	3	0.7582985	0.9439496703547853861948624398792162537574768 1
1235	242	3	4.7118913	0.3181564461154820500077278211392695084214210 5
1236	243	3	7.8068537	0.0989151833359199900153058138130290899425745 0

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1238	245	3	1.8341313	0.766232260823347388623005826957523822784423 83
1239	246	3	5.7392665	0.219484534454985669160720362924621440470218 66
1240	247	3	7.3440580	0.118785546584091059041377036464837146922945 98
1241	248	3	6.6255645	0.157048748000769206045745818300929386168718 34
1242	249	3	0.4828758	0.975146463630073623285454686993034556508064 27
1243	250	3	11.8067167	0.018847965175907435697588709899719106033444 40
1244	251	3	2.4366286	0.656018210581691518790137251926353201270103 45
1245	252	3	3.6424091	0.456557511618428391031443425163161009550094 60
1246	253	3	4.5858134	0.332493150248790114709152021532645449042320 25
1247	254	3	1.6600108	0.797968236702390143477714445907622575759887 70
1248	255	3	3.4952085	0.478607282798199029638652746143634431064128 88
1249	256	3	6.2190395	0.183376554670350494502528704288124572485685 35
1250	257	3	6.5350967	0.162592393759034808953245487828098703175783 16
1251	258	3	1.3306899	0.856147445424416897452601915574632585048675 54
1252	259	3	5.9613117	0.202056227484579686848320534409140236675739 29
1253	260	3	2.1611911	0.706140271401240804394205952121410518884658 81
1254	261	3	4.0634640	0.397485063553867146168840918107889592647552 49
1255	262	3	4.7418996	0.314819682371174802693047922730329446494579 32
1256	263	3	8.8567412	0.064781734253952574786872276035865070298314 09
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1259	266	3	4.1170969	0.390390398653811476759045717699336819350719 45
1260	267	3	2.0985961	0.717630311112515517635301875998266041278839 11
1261	268	3	4.3749393	0.357635039448321034871725032644462771713733 67
1262	269	3	4.9046898	0.297217458336336337598737600274034775793552 40
1263	270	3	7.5505791	0.109499536994861160210668060699390480294823 65
1264	271	3	1.9843937	0.738629467675567918938384082139236852526664 73
1265	272	3	4.4224405	0.351843342846601070394996213508420623838901 52
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1267	274	3	3.6618124	0.45370442424663837144294120662380009889602661
1268	275	3	9.7616098	0.04464061174322397212987922898719261866062880
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1275	282	3	1.2025507	0.87767847901291085044306328200036659836769104
1276	283	3	6.4280054	0.16938353017223803376190005565149476751685143
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1282	289	3	6.4003144	0.17118075380563343990125702021032338961958885
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1311	318	2	138.7543057	0.00000000000000000000000000005215753178166295
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1326	333	3	159.0369641	0.00000000000000000000000000000000235210990455

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1329	336	3	118.1636236	0.000000000000000000000001317765648948669340 18
1330	337	2	96.4162604	0.000000000000000000056952388554947675635038 72
1331	338	2	143.7177667	0.000000000000000000000000000004514046137898 35
1332	339	2	115.3804556	0.000000000000000000000005176285292149020811 87
1333	340	2	104.5799174	0.000000000000000000001040890076637341366667 08
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1336	343	3	143.7425131	0.000000000000000000000000000004459294209141 88
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1343	350	2	108.4950858	0.000000000000000000000152371740012424022837 55
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1345	352	2	80.1651537	0.000000000000000160699948344108101017796430 55
1346	353	3	183.1135604	0.000000000000000000000000000000000000015988 36
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1349	356	2	114.7479179	0.000000000000000000000007063588238404473773 97
1350	357	1	121.0018594	0.000000000000000000000003263335852726134103 4
1351	358	2	100.2364709	0.000000000000000000008759972831285773724706 30
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1353	360	2	103.1125185	0.000000000000000000021380878723080718678897 8
1354	361	2	91.4481067	0.000000000000000000648390211752964549206390 55
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1379	386	2	113.7180388	0.00000000000000000000001171689905413567621851
1380	387	3	145.3637866	0.00000000000000000000000000002004543982428 03
1381	388	2	75.6441308	0.00000000000001456009919243941096817993030 58
1382	389	2	91.9384417	0.00000000000000000510075440175221692150689 39
1383	390	2	134.1882445	0.00000000000000000000000000049488303973667802
1384	391	2	98.0930591	0.00000000000000000025045910144763843599435 84
1385	392	2	79.2853771	0.00000000000000246820676404913459407036713 24
1386	393	2	87.4373401	0.00000000000000000461011459723445714883188762

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394       2 113.9109505 0.00000000000000000000001065726723971180946561
395       3 130.9706223 0.00000000000000000000000024144400323247748
396       2  89.8391519 0.00000000000000001424537563403633104192752 56
397       3 105.2918508 0.00000000000000000000734009771016956409899 62
398       2 106.5809540 0.00000000000000000000389909269061431942929 31
399       2 108.6575449 0.00000000000000000000140690559996194630471 18
400       3 102.3862140 0.00000000000000000000305301737602195340541208
>
> # distribution of p-value (tail area) by group for testing sample
>
> hist(chiSq)
>
```