Module04: Sampling Distributions

2023-06-07

Create a function to compute the statistic. Here we are using the example $T = \frac{X_1 + X_2}{2}$. You can change this part of the program to any other function as you need.

```
fun <- function(x) {
mean(x)
}</pre>
```

Generating a large number of samples, each of the sample size as specified. The default simulation size (M) used here is 1000, and the default sample size (n) used here is 2.

The population is assumed to a Normal distribution with $\mu = 20$ and $\sigma = 6$. We will consider a sample size of n = 2. That is,

sampsize <- 2

```
simsize <- 10000
sampsize <- 4
set.seed(2)
Samples <- as.data.frame(matrix(rnorm(simsize*sampsize, mean=10,sd=2),ncol=sampsize))
rownames(Samples) <- paste("sample", 1:simsize, sep="")
colnames(Samples) <- paste("obs", 1:sampsize, sep="")
#Samples</pre>
```

Compute the statistic for each of the generated simsize samples. We are using a useful R function called apply, which can implement the same function for each row. This is a handy tool when we have to do the same operation on each row for a very large matrix of data.

```
results <- apply(Samples,FUN=fun,1)
Samples</pre>
```

```
##
                    obs1
                              obs2
                                        obs3
## sample1
                8.206171 12.680935 11.361322 13.593792
## sample2
               10.369698 7.768576 9.901487
                                              7.757519
## sample3
               13.175691 13.013077 10.435338
                                              5.848047
## sample4
                7.739249 6.780068 13.398548
                                              7.544363
## sample5
                9.839496 11.965986 10.491754 13.859439
## sample6
               10.264841 8.944097 10.948149
                                              9.452818
## sample7
               11.415909 8.786996 9.906710 8.501274
## sample8
                9.520604 7.526258 10.154599 8.320104
## sample9
               13.968948 11.445593 10.360214 14.077048
## sample10
                9.722426 8.782361 13.115886 11.981500
## sample11
               10.835302 13.827428 8.789254 12.394631
## sample12
               11.963506 8.363559 15.626885 13.694091
## sample13
                9.214609 11.437307 10.405898 8.221810
```

```
## sample14
               7.920662 9.387709
                                    9.911941 8.889357
## sample15
               13.564458 8.528656
                                   8.656647
                                              8.350453
## sample16
               5.377862 12.521905
                                    9.326361
                                              9.626713
## sample17
               11.757209 10.903882 12.659176
                                              7.973287
## sample18
               10.071613 7.539273 11.065492
                                              8.147835
## sample19
               12.025657 11.922825
                                  9.210898 11.026455
## sample20
               10.864530
                         9.031150 8.609237 13.518682
## sample21
               14.181638
                         9.965304 11.648909 12.710429
## sample22
               7.600148 8.600230 11.516036 11.736015
## sample23
               13.179276 14.018912
                                  9.263967
                                             7.020427
## sample24
               13.909303
                         8.608029 11.425218 9.142657
## sample25
               10.009876
                         6.072226
                                   9.015667 14.301823
## sample26
               5.096587
                         9.969588 12.706495 10.045992
## sample27
               10.954475 12.095144
                                   7.919523 10.424814
## sample28
                         8.071885 7.061290 10.264595
               8.806884
## sample29
               11.584407
                          4.784127 11.292463 12.153269
## sample30
               10.579273
                         9.311455 12.898891 8.152884
## sample31
                         9.292967
                                    9.285325 12.163863
               11.477877
## sample32
               10.637921 9.974897 11.973773 10.656022
                                             7.885823
## sample33
               12.152329 10.271555
                                   9.214648
## sample34
               9.431685
                         8.641131 13.709118 10.114157
## sample35
                        8.754400 11.872397 10.827483
               8.446649
## sample36
               8.808679 10.840511
                                  7.257965 10.869671
## sample37
                6.548040 8.784272 11.418678 13.433031
## sample38
                8.194831 10.380362 10.337658 10.432975
## sample39
                8.881876 12.144146 11.383129 10.509193
                         8.698625
## sample40
                9.506975
                                    8.286521 10.936823
## sample41
               9.232828
                          6.096802 9.143940
                                             9.359276
## sample42
               6.081794 8.894025 12.570011 10.213047
## sample43
               8.316590 13.049332 12.564282
                                              7.245948
## sample44
               13.807095 10.349630
                                    9.324950
                                              7.413582
## sample45
               11.244988 14.694868
                                    6.869657
                                              9.795707
## sample46
               13.981841
                         8.339522 10.428053 11.330116
## sample47
               9.389033
                         9.585911 11.390009
                                              9.332152
## sample48
                9.818312 12.593163
                                    4.922264
                                              9.117977
## sample49
               9.631677
                         8.990195
                                   9.426834
                                              7.371670
## sample50
               7.602464
                         9.770972 7.114105 11.026222
## sample51
               8.323426 8.321784 9.779656 10.216063
## sample52
               14.132603 10.685024 10.893688
                                              8.397069
               8.875506 12.590026
## sample53
                                   8.922586 10.423194
## sample54
               12.551431
                         8.926840 10.236892
                                              9.455632
               7.904855 13.425983 11.156406
## sample55
                                              9.416458
## sample56
                6.068244 8.915597
                                   7.180708 10.741500
## sample57
               9.354058 11.618924 10.029953
                                              7.901985
## sample58
               11.871725
                         9.081681 12.964555
                                              6.758876
## sample59
               12.278460
                         8.723434 10.382206
                                              9.996456
                                              6.807781
## sample60
               13.343238 10.437054 9.858875
## sample61
               6.423516 5.422895 10.514347
                                              8.603508
## sample62
               14.062485 9.566751
                                    9.223208 12.717940
## sample63
               8.593711 12.197974 13.193394
                                              9.441609
## sample64
               10.316330 8.524846 9.296384 10.559890
## sample65
               11.012470 10.222034 9.240726 11.483929
## sample66
               8.360010 9.539071 11.159304 10.302407
## sample67
               6.002306 8.869756 11.590961 11.406651
```

```
## sample68
               9.041415 8.654111 8.216319 9.801612
## sample69
               10.168360 10.617178 8.684831 11.321437
               8.209027 10.524511 11.827607 11.814128
## sample70
## sample71
                8.157449 12.670691
                                    8.640750
                                              8.563921
## sample72
               10.660899 10.849583
                                    9.967669
                                              7.051243
## sample73
               9.716678 8.504600
                                  7.022027
                                              9.766620
## sample74
              10.869696 14.247877 6.212315 10.905161
## sample75
               9.892555 12.151807 11.837489 10.504506
## sample76
               8.185779 11.864126 10.899805
                                              8.413107
## sample77
               12.607024 9.565880 10.569988
                                             8.291749
## sample78
               11.543580 10.561857
                                    8.185007 11.810443
## sample79
               12.105051
                         8.820523 12.097173
                                             8.205821
## sample80
               7.179923 7.908880 9.661089 10.266460
## sample81
              11.991969 11.991206 7.352608 8.573899
               6.608470 12.614094 10.441021 10.735380
## sample82
## sample83
               8.933256 10.985161 16.612083 10.829745
## sample84
               7.255461
                         9.851131
                                   8.669484
                                             7.578328
## sample85
                         9.449273 12.246718 11.487787
                5.584160
## sample86
               13.644245 10.051996
                                   7.231575
                                             4.771713
## sample87
               8.693213 13.822095
                                  7.324492 11.453146
## sample88
               9.430638 13.842605 10.021300 9.043301
## sample89
                        8.987966 11.993617 12.297401
               9.226101
## sample90
               10.773390 11.625990 8.293410 9.324637
## sample91
               13.200782 11.104168 10.244335
                                              8.283370
               13.362310
## sample92
                         8.654795 12.662763 10.827927
## sample93
               7.632787 11.140089
                                    9.800302 8.316557
               7.283085 11.077047
## sample94
                                    8.806583 11.863116
## sample95
                6.974658 13.791645
                                    7.765918 11.634961
## sample96
               7.493790 11.784297
                                    9.291032 9.958560
## sample97
              13.918714 10.371922 8.243926 13.701697
## sample98
               10.015292 10.338209 10.023741
                                              9.948995
## sample99
               8.314770 11.066372 10.572840 10.623352
## sample100
               8.797680 7.531665
                                   7.752056 14.118175
## sample101
               12.148919 12.114030 10.967460
                                              6.719492
## sample102
               10.521196 10.577421
                                    7.212131
                                              8.202981
## sample103
               9.371456
                         7.813234
                                   9.923242
                                              9.417392
## sample104
                8.500740
                         7.494824
                                   6.416724
                                              9.208500
## sample105
               8.275603 9.549998 13.821582
                                              7.440723
## sample106
               14.096081 12.168898
                                   7.886026 12.092617
## sample107
               11.879840 13.673663 8.455326 11.306536
## sample108
               14.017374 13.851986 11.008966 11.838084
## sample109
               9.157253 10.392192 11.907337 13.997537
## sample110
               9.298331 11.634055
                                   8.841308
                                              8.089493
## sample111
               7.945239 11.172933 11.647714 8.986546
## sample112
               9.498962 13.694863 9.953097 10.031988
               10.943719 10.901946 11.260466 10.327738
## sample113
## sample114
               12.717880 11.051775 10.153224
                                              9.665897
## sample115
               11.128337
                         7.493091 11.494655
                                             7.800145
## sample116
               10.911960 9.752625
                                   7.211930 10.922548
## sample117
               12.461907 13.096503 8.902893 13.344907
## sample118
               12.294274 7.621167 11.090343 10.880499
## sample119
               10.213196 11.442830 11.151816 10.977778
## sample120
               8.433367 12.269803 12.221506 8.160521
## sample121
               12.482400 9.735186 9.548793 10.973415
```

```
## sample122
               10.277717 7.972380 9.436528 9.156976
## sample123
               13.421263 10.987008 10.634034 12.763389
## sample124
               9.138718
                         8.232022
                                    6.655736 8.528407
## sample125
               7.911541 12.174706
                                   8.816698 11.016352
## sample126
              11.075159 12.939691 10.168534 10.980494
## sample127
               8.660828 10.293102 13.347058
                                             9.850157
## sample128
              11.277611 14.173720
                                    9.923772 9.718383
## sample129
               6.552020 11.534609
                                    9.931388 13.088247
## sample130
               6.515140 10.496032
                                   8.762766
                                              7.391101
## sample131
               11.379608 11.439569 10.106948
                                              9.665169
## sample132
               10.661926 10.570248
                                    9.175303 8.429338
## sample133
               11.742135 10.232788
                                    9.700984 11.753991
## sample134
               5.967509 8.307487
                                    9.698554 12.137864
## sample135
               12.425158 10.491837
                                    6.987352 11.568949
## sample136
               12.400989 12.365090
                                    9.743513 12.728540
## sample137
               12.064137 12.639240 11.415262
                                             8.735764
## sample138
               11.572821 11.661957 11.019909 9.003481
## sample139
               14.220147 11.702569
                                    9.881063 11.790351
## sample140
               7.092380 10.807748
                                    9.318420 11.364582
                                             7.916583
## sample141
               8.833792 6.632826
                                    8.889646
## sample142
              10.819448 11.563053
                                   9.532859 10.392243
## sample143
                         9.426558 14.330248 12.076208
               8.386037
## sample144
               10.171101 6.477424 12.322115 9.570511
## sample145
               11.492486 10.506010 7.057852 10.471692
## sample146
               8.692654 7.161751 12.710177
                                             6.884406
## sample147
               11.314212
                         9.552993
                                    8.842051
                                              8.159394
              11.099818 9.393218
                                    9.454279
## sample148
                                              9.215275
## sample149
               8.386541 16.389470
                                    9.502200
                                              7.371343
## sample150
               8.005241 10.237818
                                    8.953401 10.108062
## sample151
              11.951781 13.646234
                                    8.941022
                                             8.498831
## sample152
               9.661154 6.124707
                                    9.576655 11.124034
## sample153
               11.444384 12.142091 10.328014
                                              8.628279
## sample154
               8.311163
                         9.207701
                                    8.656341
                                              9.869673
## sample155
              12.554587 10.342163
                                    9.808233
                                              9.968404
## sample156
               7.313779 10.818326
                                    9.493025 10.336915
                                             8.527947
## sample157
              11.530681 5.678559
                                    8.912151
## sample158
               10.928405 11.311184 13.838324
## sample159
               10.535987 10.560122 12.017543 11.737003
## sample160
               11.335045 7.484839 13.868133 11.049587
                         2.901450 10.611789 9.306744
## sample161
               10.796935
## sample162
               8.723858
                         8.915725 10.480748 13.484951
## sample163
               9.464574 9.520244 10.302812 9.076260
## sample164
              10.719759 10.243815
                                  7.384487 10.414158
## sample165
               7.374268 10.959531 11.689392 10.334201
## sample166
               8.232061
                         8.328805 13.212305 13.370368
## sample167
                         8.969221 7.664919 10.747059
               14.154190
## sample168
                5.801549 10.442244 10.589144 6.778989
## sample169
               7.522988
                         9.919250 10.528816 11.881364
## sample170
               11.980866 11.119537
                                    7.866073
                                              9.464287
## sample171
               12.177324 12.669683 6.046896
                                              7.133029
## sample172
               11.679705 11.647936 10.520755
                                              9.222663
## sample173
               10.113717 10.994053 10.157533
                                              7.761774
## sample174
               10.647756 7.285285
                                   9.012038
                                              9.823566
## sample175
               8.190663 13.294420 7.016836
                                             8.141688
```

```
## sample176
               8.695632 11.428483 11.141612 10.489365
## sample177
               9.475091 9.160523 7.660672 11.070940
                8.130674 13.731483 7.382938
## sample178
                         8.874369 11.210206
## sample179
               11.642322
                                              4.497777
## sample180
                6.751482
                         8.923129
                                    9.339235 10.515248
               7.939193 7.864615 11.701319 10.272259
## sample181
## sample182
               7.476141
                         5.574187 9.689495 10.840240
## sample183
               10.784369
                         9.676111 13.477224 12.904912
## sample184
               7.737123 12.808712 7.172564 13.159588
## sample185
               11.088289 11.355085
                                   8.869450 10.922658
## sample186
               12.353218 10.420602 11.868839 11.736338
## sample187
               10.050457
                         7.812177 11.318950
                                             8.277273
## sample188
              11.030266
                         9.623177 10.831034
                                             7.309004
## sample189
               8.691780
                         9.387258 11.145238 12.580345
## sample190
                         9.097071 9.654992 11.144609
               11.007284
## sample191
               7.455762
                          9.325146 10.478872 10.329857
## sample192
               9.846458
                         9.297951 10.480011 7.947785
## sample193
               7.309361 10.970518
                                    9.020981 12.390174
                                             9.028912
## sample194
               9.467365 11.105106
                                    9.061887
## sample195
               12.175126 10.460035
                                    9.953058 11.100816
## sample196
               11.401136
                         8.275927
                                    6.382671
                                             7.707087
## sample197
                         8.244147
                                    9.985697
               9.114481
                                              9.272777
## sample198
               8.422960 11.300055 13.097207
                                              8.739621
## sample199
               8.286449 10.155237 13.338221
                                              7.937725
## sample200
               8.507162 9.328001
                                    9.989662
                                             7.787507
## sample201
              10.595967 12.340912 10.852324 13.211159
## sample202
               7.960896 10.656340
                                    8.279039 10.140220
## sample203
              15.741795
                         9.539178
                                    6.215181 7.511988
## sample204
                                    7.580373 10.284212
              10.437420 15.325744
## sample205
               8.066891 11.380820
                                    9.501796
                                             9.210879
## sample206
               10.767676
                          9.065627
                                    9.871540
                                              8.580675
## sample207
               9.756208
                         9.149472
                                    9.148547 11.209306
## sample208
               9.298905 10.676896
                                    8.866793 10.793417
## sample209
               11.198927
                         7.876942 13.190964 11.809232
## sample210
               10.462548
                         8.157372 13.193170
                                              9.685650
## sample211
              12.052492 6.606083 11.280921 8.199489
## sample212
               8.951102 10.271329
                                   6.854616 9.893995
## sample213
               13.592412 7.457496 9.522992 10.458767
## sample214
                          8.993695 13.311793
               7.131607
                                              6.822107
## sample215
               10.277372 9.183627 12.651167 10.494291
## sample216
               10.902927 10.612261 11.552067 13.432596
## sample217
              12.429548 9.135590 11.346294 8.109570
## sample218
               7.351038 9.007366
                                    8.739112 13.464604
## sample219
               7.720744 10.892598 8.862615 11.776326
## sample220
              13.351297
                         8.876108
                                   7.118378 10.622398
## sample221
                         8.019378 9.607425
               10.796292
                                             9.700063
## sample222
               11.431038
                         6.212833 11.493024 10.893978
## sample223
               8.413610 10.892421 12.188170 9.393953
## sample224
               13.847703 10.075547 11.794754 13.258680
## sample225
               10.140880 12.081450 11.816243 13.137562
## sample226
               10.938560 10.039592 14.494696 8.048315
## sample227
                         9.109261 10.507646 10.810075
## sample228
              11.788303 8.691365 13.631358 11.294766
## sample229
               9.252580 13.851251 8.587333 10.461857
```

```
## sample230
               14.516504 9.938620
                                    9.618925 8.401675
## sample231
               13.146204 8.489628
                                   6.847413 10.094425
                6.091357 11.984456 10.149718 15.269535
## sample232
## sample233
                8.761355
                         8.845260 11.999331 11.308373
## sample234
               9.940105 11.095841
                                    9.004626
                                              6.218554
## sample235
               6.556683 13.415158 10.229307
                                              9.776394
## sample236
               7.893086 11.104204
                                    9.986676
                                              9.159470
## sample237
               8.858675 9.792147
                                   5.090871
                                              8.198603
## sample238
               10.965429 12.191385 11.418362 10.393063
## sample239
               10.191848 10.369029 12.554501
                                              8.343395
## sample240
               8.824320
                         7.852568 11.852406
                                              9.339570
## sample241
               9.836440 11.222997
                                   8.923163
                                              7.888012
## sample242
              15.776837 11.525995 11.033780 11.020255
## sample243
               12.345651 13.455058 12.940175 9.001915
## sample244
               11.099286 11.340000 10.517621 10.622236
## sample245
               11.558209 10.835867 10.856104 10.021949
## sample246
               8.869737 8.949977 10.744310 9.925776
## sample247
               10.205909 10.845580 11.472071 8.227186
## sample248
              10.563043 9.977021
                                   6.410791 11.343868
## sample249
               9.051138 11.814145 11.096911 12.623842
## sample250
               9.083992 10.171227 13.360239 9.792191
## sample251
              11.003086 10.879446 9.652102 10.032623
## sample252
               9.189741 11.881427 14.254401
                                             8.666838
## sample253
               9.645229 12.761213 10.524308
                                              7.779700
## sample254
               9.360911 10.776556 8.215885 11.635333
## sample255
              11.686901
                          8.835174 12.314731 11.891083
## sample256
                          7.716481
               10.967313
                                    9.344325
                                              8.992855
## sample257
               9.392660 10.026336 15.169904
                                              7.193031
## sample258
               9.429808
                         9.894950 10.722988 10.888914
## sample259
              11.960873
                          9.667232 14.149427 10.196300
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## sample1201 10.937105 12.821687 12.720106 9.104273
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## sample1309 12.311802 11.284933 10.798341 12.750848
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## sample1957
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## sample2009
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## sample2011 10.886926 11.093040 7.476314 6.632323
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## sample2065 11.442402 11.657874 9.889964 8.940701
```

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## sample2066
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## sample2113
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## sample2114 10.939266 11.199124 12.057405
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## sample2119
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## sample2121
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## sample2389 10.988957 11.927092 13.066817 11.530791
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## sample2441 12.163690 10.773361 7.788946 10.207894
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## sample2443 10.905991 10.072260 7.931568 10.607606
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## sample2657
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## sample2659
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```

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## sample2682
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## sample2876
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## sample2921
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## sample2923
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## sample2927
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## sample2928
## sample2929
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## sample2939
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## sample3199
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## sample3253 10.555270 9.338301 10.644988 10.423330
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## sample3739 11.670162 7.844508 10.482831 4.041136
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## sample3974
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## sample3975
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## sample4009
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## sample4117 10.194036 8.865874 9.067768 11.095443
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## sample4123
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## sample4145
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## sample4156
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## sample4162
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## sample4168
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## sample4169
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## sample4170
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## sample4171
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## sample4172
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## sample4173
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## sample4174
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## sample4175
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## sample4176
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## sample4177
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## sample4178
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## sample4180
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## sample4190
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## sample4192
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## sample4211
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## sample4212
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## sample4213
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## sample4214
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## sample4223
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## sample4224 10.564100 11.585552 12.358894 6.682691
## sample4225
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## sample4226
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## sample4228
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## sample4229
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## sample4279 13.597811 12.389468 10.222414 12.081473
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## sample4387
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## sample4439
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## sample4440 14.381074 10.934125 8.944383 6.845173
## sample4441 10.128519 9.153360 8.132112 10.690647
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## sample4495
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## sample4759
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## sample4760
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## sample4761
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## sample4762
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## sample4763
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## sample4764
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## sample4771
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## sample4787
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## sample4812
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```

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## sample4823
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## sample4843
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## sample4844
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## sample4873
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```

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## sample4874
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## sample4876
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## sample4909
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## sample4910
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## sample4911
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## sample4914
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## sample4915
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## sample4924
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## sample4926
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## sample4927
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```

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## sample4928
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## sample4929
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## sample4946
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## sample4947
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## sample4949
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## sample4951
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## sample4966
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## sample4980
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## sample4981
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```

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## sample5035
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## sample5551
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## sample5574
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## sample5575
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## sample5629 10.421559 8.710450 14.341703 11.788700
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## sample5682
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## sample5793
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## sample5810
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## sample5813
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## sample5843
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## sample5844
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## sample5845 11.389545 9.242269 13.883788 9.385566
```

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## sample5899
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```

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## sample6007
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## sample6058
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## sample6060
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## sample6061
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## sample6317
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## sample6318
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## sample6319
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## sample6321
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## sample6329
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## sample6330
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## sample6331 12.929443 7.900786 8.921776 5.468005
```

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## sample6332
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## sample6358
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## sample6361
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## sample6371
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## sample6383
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## sample6384
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## sample6385 10.902439 10.170296 9.215160 5.638804
```

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## sample6387
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## sample6389
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                8.128574 10.777988
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## sample6421
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## sample6424
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## sample6430
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## sample6432
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## sample6434
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## sample6435
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## sample6436
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## sample6437
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## sample6438
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## sample6439
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## sample6443
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##
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## sample6469
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## sample6477
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## sample6478
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## sample6479
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## sample6482
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## sample6484
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## sample6486
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## sample6488
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## sample6492
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## sample6493
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```

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## sample6512
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## sample6516
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## sample6599
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## sample6621
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## sample6622
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## sample6739
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## sample6753
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## sample6764
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## sample6774
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## sample6776
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## sample6785
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## sample6788
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## sample6979
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## sample7008
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## sample7897 11.677863 12.430747 10.495765 11.427813
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## sample8384
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## sample8436
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## sample8437
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```

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## sample8491
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## sample8506
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##
##
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## sample8637
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## sample8638
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##
  sample8642
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## sample8644
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## sample8645
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## sample8650
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## sample8651
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## sample8652
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## sample8653
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```

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##
  sample8673
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                                               9.186609
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## sample8676
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## sample8683
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##
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## sample8691
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## sample8692
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## sample8705
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## sample8706
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## sample8707
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```

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## sample8710
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## sample8711
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                                              9.165709
## sample8712
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                                    6.636137 12.824485
## sample8713
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## sample8753
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## sample8755
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## sample8756
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## sample8757
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## sample8759
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## sample8761
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```

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## sample8786
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## sample8787
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## sample8799
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## sample8803
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## sample8806
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## sample8808
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## sample8809
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## sample8811
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## sample8812
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## sample8813
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## sample8814
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## sample8815 13.839433 10.437307 11.107384 9.780953
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## sample8817
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## sample8823
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## sample8853
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## sample8860
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## sample8868
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## sample8869
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## sample8876
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## sample9139
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## sample9416
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## sample9463 11.658694 10.629327 12.492970 8.735085
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## sample9678
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## sample9733
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## sample9787 10.218206 11.958651 10.017858 12.888565
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## sample9841 11.669603 9.530083 11.342339
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## sample9844
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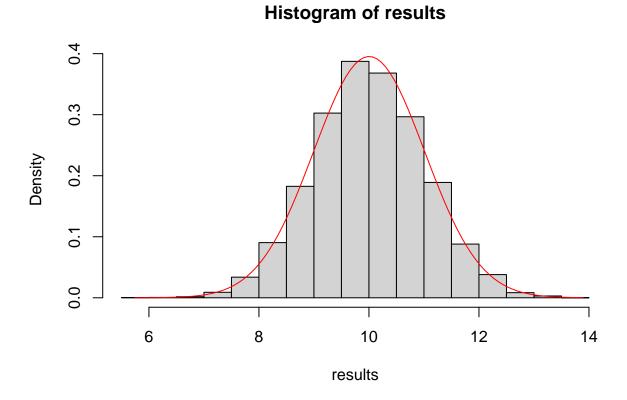
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## sample9914
                9.372445
                          6.420436 11.770023 11.465625
## sample9915
               7.470794
                         7.967420
                                    9.766042
                                              9.534459
## sample9916
               9.721193 11.526972
                                   8.636767 12.976708
                9.775862
                          9.398448 10.804613 8.455384
## sample9917
                          7.772552 12.214912 11.444653
## sample9918
                9.046171
## sample9919
                9.046158
                          9.824718 13.315581 10.200364
## sample9920
                9.509004 10.773616 11.952620 9.255665
  sample9921
              11.850408 14.138463
                                    9.358637 10.047606
               8.928332 11.093315
                                    9.489149 10.151676
## sample9922
  sample9923
              10.120078 12.851809 10.249665 11.123001
               7.817962
                                   9.709198 10.322280
  sample9924
                         9.179222
## sample9925
                9.303312 9.707654
                                    9.343876 10.800596
  sample9926
                9.273424 11.966501
                                    7.972986 13.150602
  sample9927
               13.377471
                          8.646893 10.255329 10.971598
   sample9928
               13.393819
                          8.098551
                                    7.853402
  sample9929
               11.165443 10.205362 13.946562
                                              9.543341
   sample9930
              11.776497 10.544397 12.548153 12.486796
## sample9931
               8.598590 13.110653 8.365040 10.528883
## sample9932
                8.393407 10.186227 13.711713
              12.889714
                          9.079223 8.368105 12.247160
## sample9933
## sample9934
                9.221255
                          8.623478 12.047211
                                              9.434289
## sample9935
              11.274071
                         8.962497
                                    9.473583 10.984625
## sample9936
              10.948198 11.873227
                                    9.469045
## sample9937
               7.989302 9.595354 10.940102 7.987004
## sample9938
                8.898191 11.997427
                                    8.180264 10.531107
## sample9939
                9.151210 11.193250
                                   8.367434 14.710621
## sample9940
              12.504856 11.915177 10.361269 8.814690
               10.684108 5.586188 13.840189 10.961045
## sample9941
## sample9942
                8.357209 15.037579
                                    9.454194 13.272439
## sample9943
                7.336661
                         8.115344 12.820841 13.113578
## sample9944
              10.761435
                          9.100173 11.643215 13.063206
## sample9945
               10.300385
                          8.161395
                                    7.186519 11.025969
## sample9946
              10.938562
                          7.621188
                                    9.143428
                                             8.972411
## sample9947
               12.773696
                          9.698823
                                   8.881589 8.088536
## sample9948
               9.049509
                          7.653228 11.415353 14.792095
## sample9949
               7.898732 11.410737 10.337753 11.719021
```

```
## sample9950
              10.320965
                         6.373275
                                    8.981975
                                             7.264294
## sample9951
              12.416116 9.640348
                                    6.613622
                                             7.620852
## sample9952
               7.725601
                          9.735605
                                    6.080355 11.104286
                9.234518
## sample9953
                         7.493255
                                    8.159515
                                              6.843760
## sample9954
              11.588670 7.460014
                                    9.605008
                                              9.022906
## sample9955
              11.783722 10.234697
                                    7.790611 11.513611
## sample9956
              11.410966 14.561692 12.241989 11.934953
## sample9957
               5.905247 7.424678 11.656470 9.771411
  sample9958
               9.845590 10.773224 13.741247 13.412960
  sample9959
              12.307688 10.087843 10.060621
                                             7.420372
## sample9960
               9.882170
                         7.520119
                                   7.414591
                                              9.285396
## sample9961
              10.404678
                         9.949073 12.551608 10.889957
## sample9962
               8.989707
                         8.158518 14.726527 10.001338
                                              9.265060
  sample9963
              10.081312
                         8.334097 11.750028
               9.553802
## sample9964
                         9.395645
                                   9.619400
                                              8.413705
  sample9965
                6.244178 13.719472
                                   8.884139
                                              7.206985
  sample9966
               7.373929
                         9.438070 11.626935
                                              8.388097
  sample9967
              11.203709
                         7.959452 11.472906
                                              8.164647
## sample9968
              10.264008 12.639881
                                   8.624979 10.590830
## sample9969
               7.473319 10.301186 13.711433 12.774950
## sample9970
              12.457319 8.627836 10.107086 10.548775
                7.971799 11.260980
## sample9971
                                   8.532605 13.295404
## sample9972
                7.762344
                         9.663060
                                  9.936081 8.509586
## sample9973
               8.958382 9.110415 10.609835 11.269445
## sample9974
              10.324185 11.192851 10.105899 12.822379
## sample9975
              10.607556
                         4.069958
                                    9.962182 10.436127
## sample9976
               9.094220
                         8.802446 10.751152
                                              9.212446
## sample9977
              10.447859
                         8.666864 11.237513 10.078869
## sample9978
              10.354057
                         9.957588
                                   5.737143
                                             8.773540
               9.226495
## sample9979
                          9.241657 10.716446
                                              9.193381
## sample9980
              12.097335
                          7.232543 14.980725
                                              8.534894
  sample9981
               9.347496 10.913492
                                    9.426995
                                              9.413466
  sample9982
              11.284318 11.943651
                                    9.583113 10.309751
## sample9983
              10.296183 13.300511
                                    8.184909 10.481445
  sample9984
              11.761166
                         7.578351 12.451225
                                              6.266290
## sample9985
               9.212494 12.424991 11.831889
                                              9.266417
## sample9986
              10.615061
                         9.402955 10.199225
## sample9987
               8.093441
                          9.674394 14.121277
                                              8.260769
## sample9988
              11.730305
                         7.048927
                                    9.212849
                                              8.856163
## sample9989
               9.996216 8.297766
                                   9.789038 10.928316
## sample9990
              11.736572 13.437268 13.769424 10.864478
## sample9991
              12.284348
                                   8.484461 8.860422
                         9.851792
## sample9992
               9.155983
                         8.612766 11.754726 13.321761
## sample9993
              10.693374
                                   7.529571 6.670083
                         8.175817
## sample9994
                9.319551
                         9.603022 10.118413 10.407712
                                   8.727024 10.571160
## sample9995
                8.059074 10.186582
## sample9996
              10.436107 10.295781 10.214301 11.376600
## sample9997
               10.968402 11.096099
                                    9.257123 11.400166
## sample9998
               7.735811 10.659523
                                    9.695602 14.370347
## sample9999
                9.877047
                          9.414189
                                    6.446423 10.925600
## sample10000 9.182387 9.908098
                                    8.886603 10.938417
```

#results

Now, we plot the histogram of all simulated values of the test statistic T, and compare it to a Normal distribution, with μ and σ approximated by the average and standard deviation of all simulated values of T}\$.

```
hist(results,prob=T)
curve(dnorm(x,mean=mean(results),sd=sd(results)), from = min(results), to = max(results),add=T,col="red"
red
```



#curve(dnorm(x,mean=mean(results),sd=sd(results)), from = 4.5, to = 12.5,add=T,col="red")