Statisical Programming Assignment

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1. Summing Distributions and Testing for Normality

This program will serve to sum up distributions, specifically binomial, and then explore how many distributions can be summed before the tests for Normality passes. This is because the binomial distribution is one of the simpler distributions and are easier to sum.

I will specifically use the Shapiro test to conduct these tests.

Code:

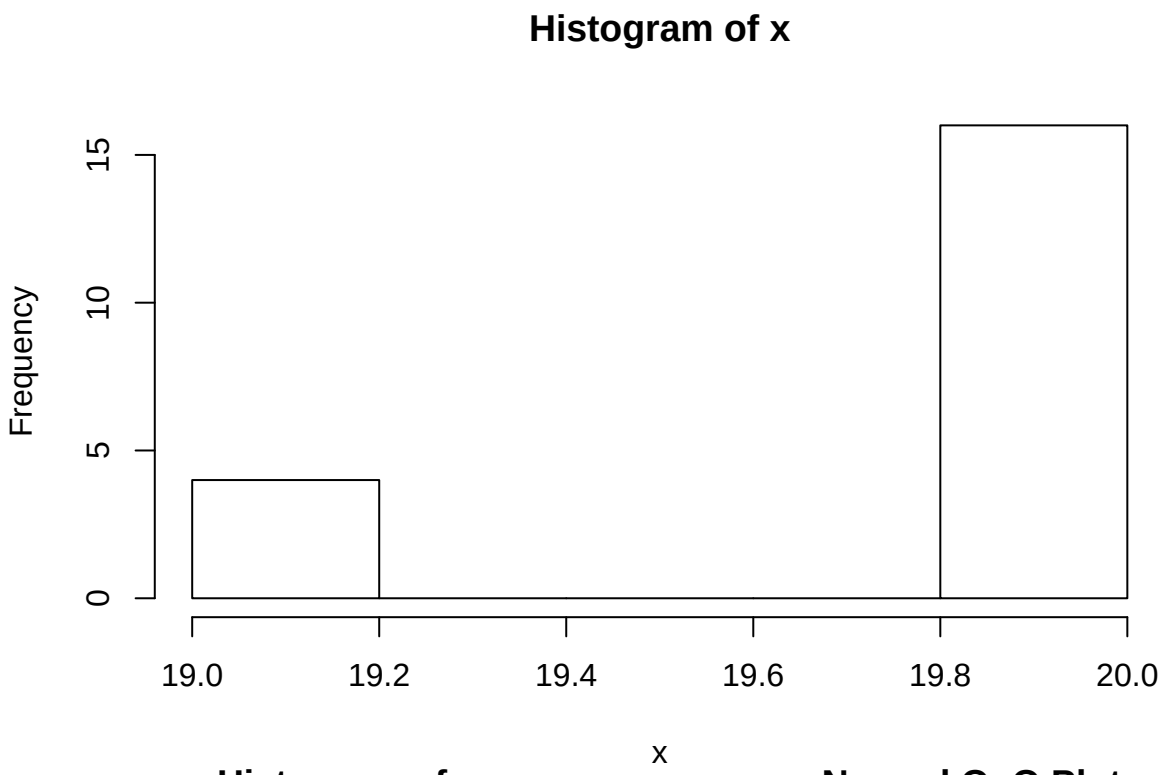
```
bin_test <- function(num){
  x = rbinom(num, n = num, prob = 0.99)

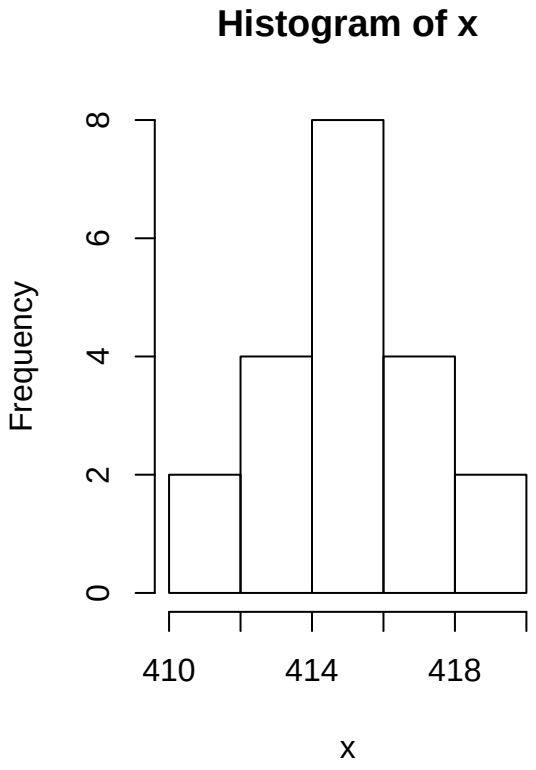
  t=0
  hist(x)

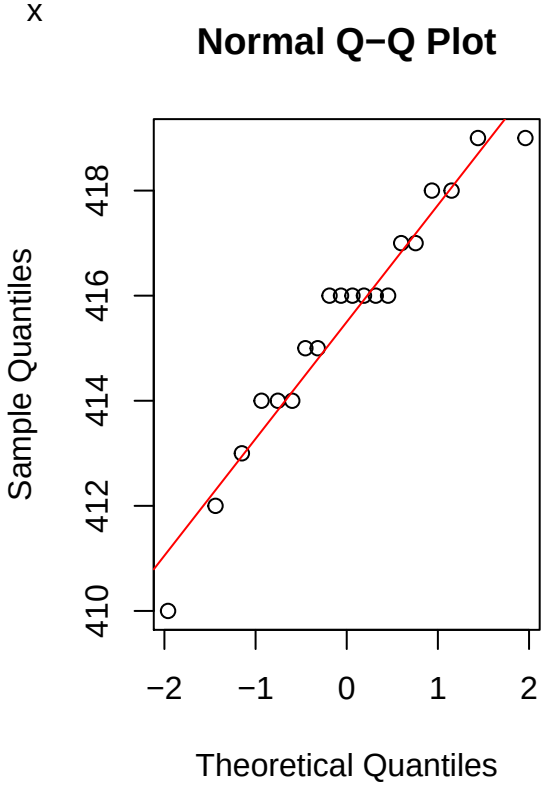
  while (t<0.2){
    x = x + rbinom(num, n = num, prob = 0.99)
    k = shapiro.test(x)
    t = k$p.value #to store the p values from the test summary
  }
  par (mfrow=c(1,2))
  hist(x)
  print(qqnorm(x))
  qqline(x, col = 2)
}
```

We will attempt to combine 20 binomial observations.

```
bin_test(20)
```





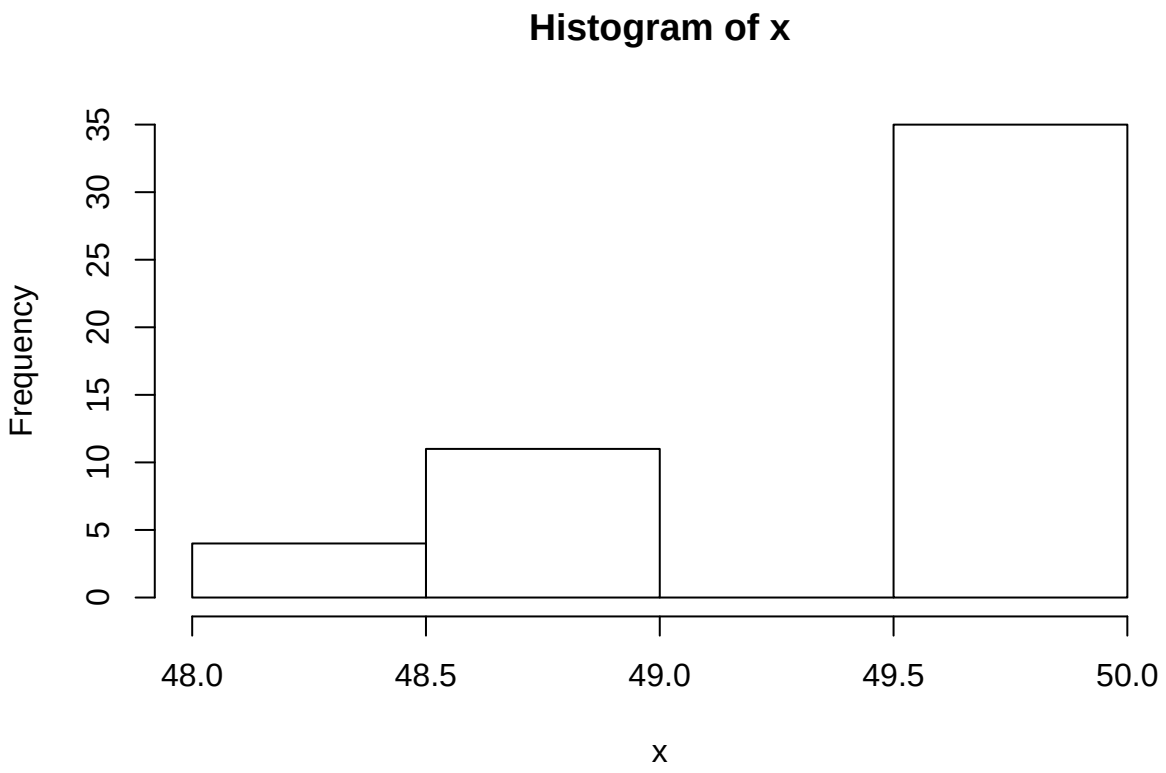


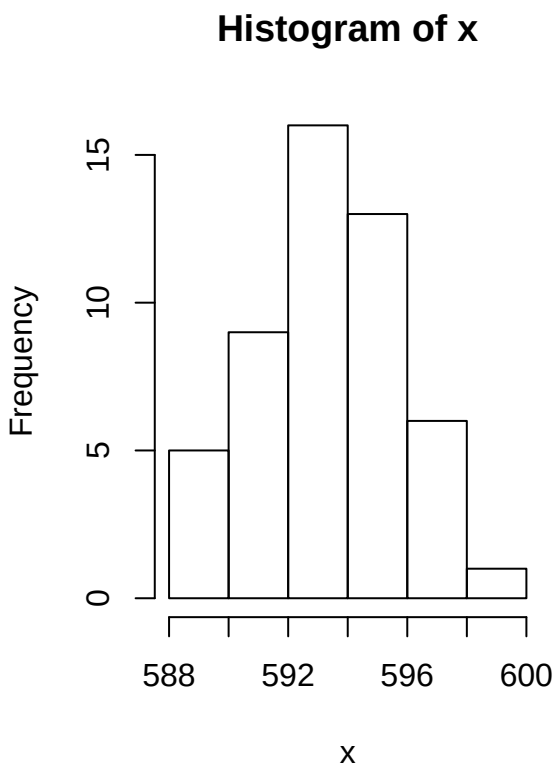

```
## $x
##  [1] -1.15034938 -0.93458929 -0.45376219 -0.18911843 -1.43953147
##  [6]  0.93458929  1.43953147  0.59776013  0.75541503 -1.95996398
## [11] -0.06270678  1.15034938  0.06270678  0.18911843  1.95996398
## [16] -0.75541503  0.31863936 -0.59776013  0.45376219 -0.31863936
```

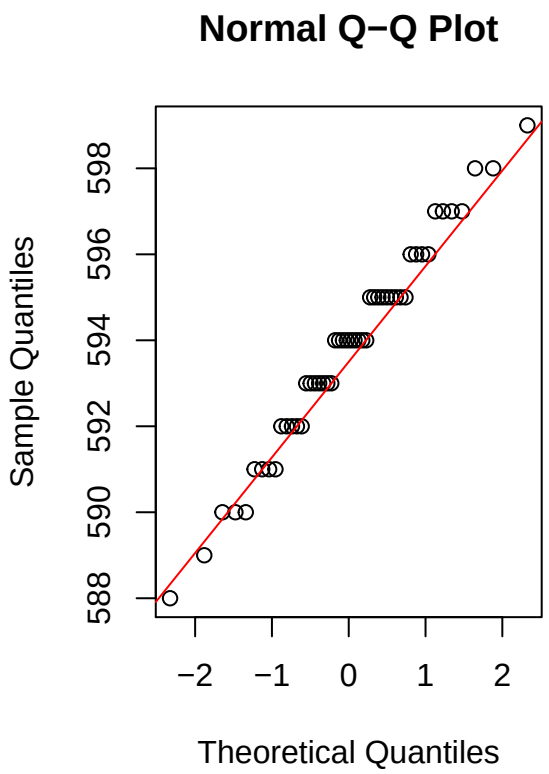
```
##
## $y
##  [1] 413 414 415 416 412 418 419 417 417 410 416 418 416 416 419 414 416
## [18] 414 416 415
```

We will now try 50 observations.

```
bin_test(50)
```



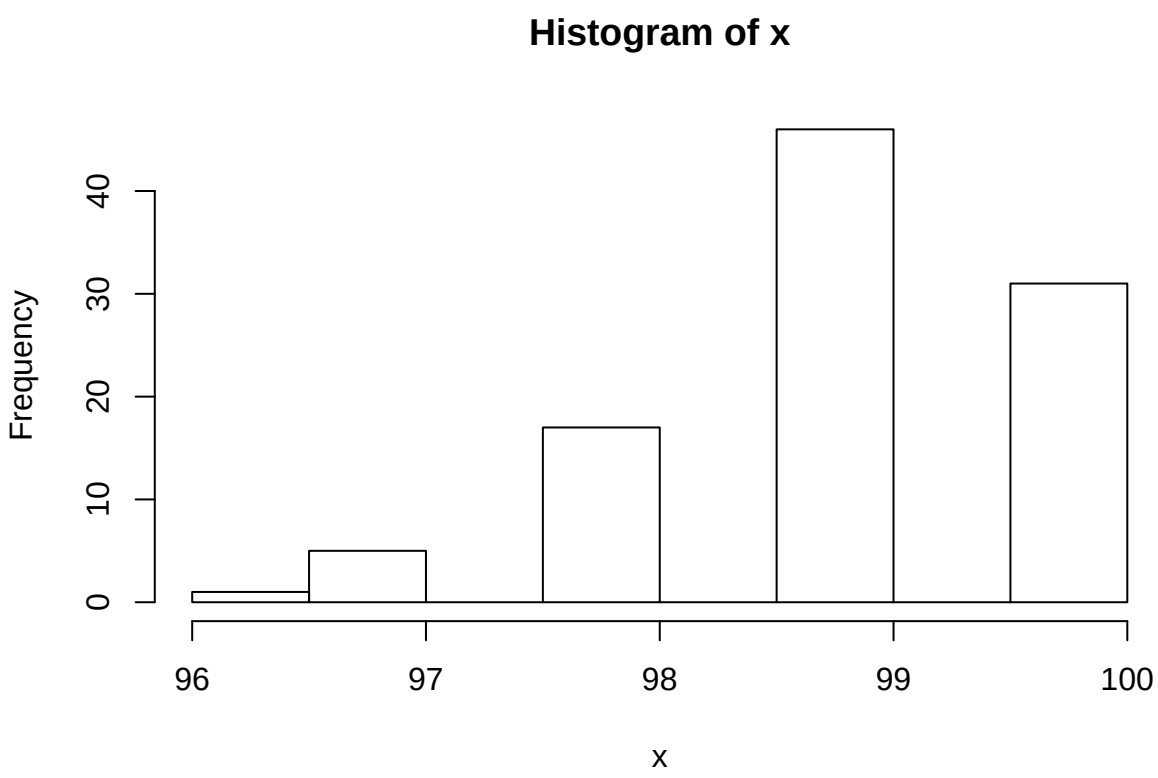





```
## $x
##  [1]  0.80642125  0.27931903  0.33185335  2.32634787  0.38532047
##  [6] -0.87789630 -0.17637416  0.43991317  0.49585035 -1.64485363
## [11] -0.12566135 -0.07526986 -1.47579103 -0.55338472 -0.02506891
## [16]  0.55338472  0.02506891 -2.32634787  1.12639113 -0.80642125
## [21]  1.22652812  0.61281299 -1.22652812  1.34075503 -1.88079361
## [26] -1.12639113 -0.49585035  1.64485363 -0.73884685 -1.03643339
## [31]  0.07526986  0.67448975  0.87789630  0.12566135  0.95416525
## [36] -0.67448975 -0.61281299  0.17637416 -0.43991317  1.03643339
## [41]  1.47579103 -0.38532047  0.73884685 -0.33185335 -0.27931903
## [46]  1.88079361  0.22754498 -0.95416525 -1.34075503 -0.22754498
##
## $y
##  [1] 596 595 595 599 595 592 594 595 595 590 594 594 590 593 594 595 594
## [18] 588 597 592 597 595 591 597 589 591 593 598 592 591 594 595 596 594
## [35] 596 592 592 594 593 596 597 593 595 593 593 598 594 591 590 593
```

We will also try 100 observations.

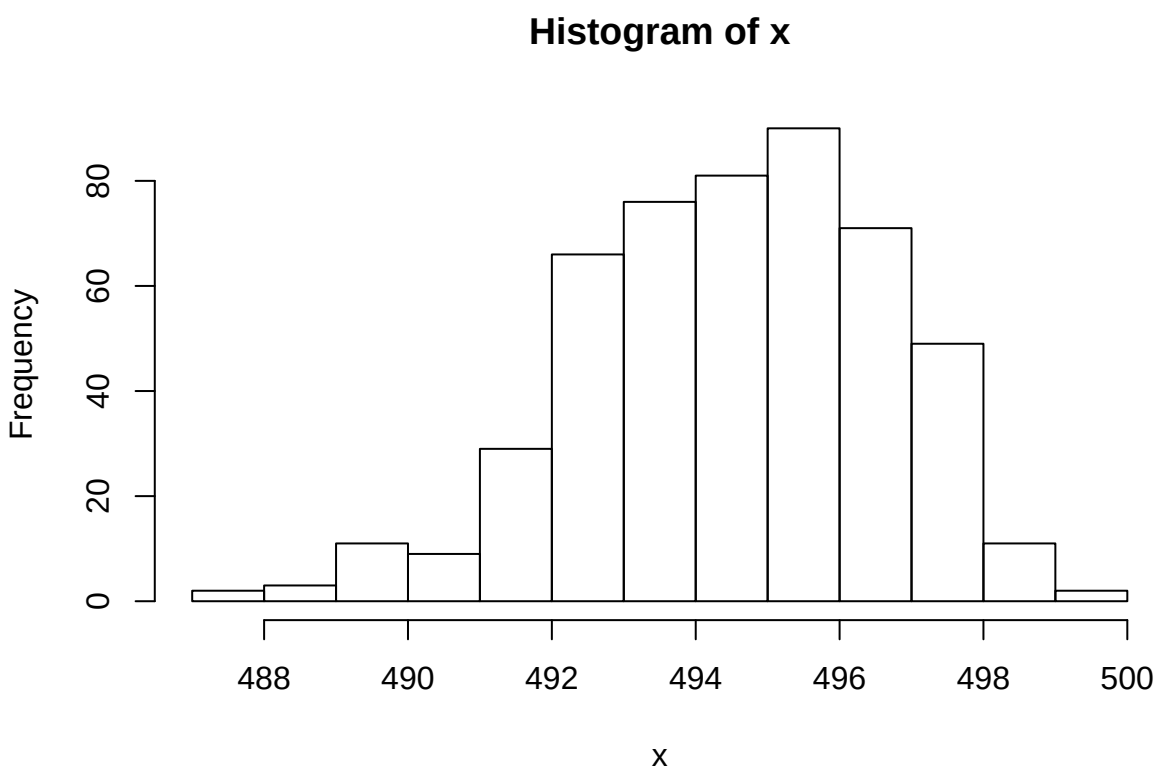
```
bin_test(100)
```

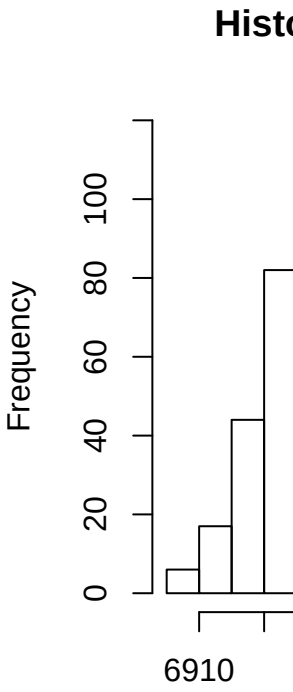



```
## $x
##   [1]  0.53883603  0.56805150 -0.62800601 -1.20035886 -0.89647336
##   [6] -0.59776013 -1.15034938 -2.57582930  1.15034938  0.59776013
##  [11]  0.82389363 -1.10306256 -0.08784484 -0.56805150  1.81191067
##  [16] -0.26631061 -0.06270678  0.85961736  1.20035886  0.21470157
##  [21]  0.62800601 -0.85961736  0.24042603 -0.53883603  2.17009038
##  [26]  2.57582930 -1.43953147 -1.05812162 -0.51007346  0.89647336
##  [31] -0.03760829  1.25356544 -1.59819314  0.26631061 -1.37220381
##  [36]  1.31057911 -0.24042603 -0.01253347 -2.17009038 -0.21470157
##  [41] -1.95996398  0.01253347 -1.01522203  1.37220381 -1.81191067
##  [46]  0.65883769  0.93458929 -1.69539771 -1.31057911 -0.82389363
##  [51]  0.29237490  0.31863936  0.34512553 -0.78919165  0.03760829
##  [56] -0.18911843 -0.48172685  0.69030882  0.37185609 -0.45376219
##  [61]  0.72247905  1.43953147 -0.16365849  0.97411388  1.95996398
##  [66]  0.06270678 -0.42614801  1.51410189 -0.39885507  0.39885507
##  [71] -0.13830421  0.08784484  1.01522203  1.05812162 -0.75541503
##  [76]  0.42614801 -1.25356544 -1.51410189 -0.72247905 -0.37185609
##  [81] -0.69030882 -0.11303854  0.75541503 -0.34512553  0.45376219
##  [86]  0.48172685  0.11303854 -0.97411388  0.13830421  1.59819314
##  [91]  1.10306256  0.78919165 -0.65883769  0.16365849  0.18911843
##  [96]  1.69539771 -0.31863936  0.51007346 -0.93458929 -0.29237490
##
## $y
##   [1] 992 992 988 986 987 988 986 982 994 992 993 986 990 988 996 989 990
##  [18] 993 994 991 992 987 991 988 997 997 985 986 988 993 990 994 984 991
##  [35] 985 994 989 990 983 989 983 990 986 994 983 992 993 983 985 987 991
##  [52] 991 991 987 990 989 988 992 991 988 992 994 989 993 996 990 988 994
##  [69] 988 991 989 990 993 993 987 991 985 984 987 988 987 989 992 988 991
##  [86] 991 990 986 990 994 993 992 987 990 990 995 988 991 986 988
```

Let's also try 500 and 1000 observations.

```
bin_test(500)
```






```
## $x
##   [1]  0.823893630 -0.318639364 -0.037608288  0.067730713 -0.527278791
##   [6] -0.189118426  0.204452382 -1.103062556 -0.634123849 -0.431644239
##  [11]  0.603764838 -0.866894167 -1.200358858  1.598193140 -0.628006014
##  [16]  2.120071690 -0.426148008 -0.184017151 -1.093897353 -0.420664620
##  [21] -1.546433122 -0.313369439  1.170002408 -1.895697924 -0.415193851
##  [26] -0.308108202 -0.621911596 -0.178920660 -1.190118042 -0.998576271
##  [31] -1.346938626  0.072756358  0.609791399  0.615840189 -0.521526572
##  [36] -1.530067588  0.209574223 -0.032591937 -0.990356294 -1.674664889
##  [41] -0.859617364 -2.457263390 -0.302855481 -0.515791557 -0.510073457
##  [46]  1.298836633  0.729002718  0.077783842 -0.409735480  0.830953321
##  [51] -0.852385798 -1.180000540 -0.982202695  1.838423669 -0.615840189
##  [56]  1.180000540  2.033520149  0.339809491 -0.173828813  1.190118042
##  [61]  2.170090378  0.214701568 -0.762100541 -1.170002408 -0.027576406
##  [66] -1.762410298 -1.334622287  2.575829304  0.470496968 -0.022561568
##  [71] -2.170090378  0.082813292  0.838054670  1.200358858  0.219834564
##  [76] -2.120071690  1.498513068  0.087844838  0.224973358  0.735557557
##  [81] -0.017547298  0.621911596 -1.322505137  1.514101888  0.230118101
##  [86]  1.310579112 -1.310579112  0.235268941 -1.084823128 -0.168741468
##  [91]  1.322505137  0.476104403 -0.163658486  0.481726850  1.334622287
##  [96]  0.845198535  0.628006014  1.616436371  0.487364565  1.926836573
## [101] -1.075837361 -0.504371986 -0.609791399 -0.755415026 -0.498686864
## [106] -0.404289290  1.346938626 -1.160119883  1.075837361 -0.158579730
## [111]  0.634123849  0.493017814  0.982202695  0.240426031 -1.654627902
## [116] -0.748763107  0.245589523  1.084823128 -0.153505060  0.250759572
```

```
## [121]  0.498686864 -1.453806359  0.990356294  0.092878609  0.255936332
## [126]  1.093897353  0.742144154 -0.148434341  1.635234015  1.739197665
## [131]  0.097914734  0.852385798 -0.742144154 -1.298836633  0.102953344
## [136] -0.143367435 -0.603764838  0.261119960 -0.297611102 -0.845198535
## [141] -0.493017814  0.504371986 -0.292374896 -0.287146694  0.345125531
## [146]  0.640265509  1.762410298  1.786613365 -0.597760126 -0.012533470
## [151] -1.635234015 -0.281926330 -0.398855066 -1.066937632 -1.439531471
## [156]  0.350451343 -0.735557557  0.107994569 -1.425544037  0.355787114
## [161] -1.514101888 -0.007519956  0.510073457 -1.287270563 -0.974113877
## [166] -1.411830078  0.113038541 -1.866295743 -0.138304208 -0.729002718
## [171] -0.487364565  0.266310613  0.748763107  1.210727133  0.271508452
## [176] -2.074854734  2.074854734  0.755415026 -0.133244524  0.515791557
## [181]  0.361133034  1.359462745 -0.591776891 -0.838054670 -0.585814766
## [186]  1.221227222  1.654627902 -0.128188248  1.103062556  0.118085389
## [191]  0.762100541 -0.393432594 -0.276713637  0.859617364  0.276713637
## [196]  0.646431416 -0.722479052 -2.747781385 -0.002506631 -0.123135248
## [201] -0.481726850 -0.579873392 -1.275874179  0.366489294 -0.118085389
## [206] -2.033520149  0.371856089  0.281926330 -0.388021666 -1.150349380
## [211]  0.866894167  0.998576271 -0.573952419  0.002506631  1.372203809
## [216] -0.715985990  1.112321367  0.768820293  0.652621998 -1.058121618
## [221]  0.521526572 -0.113038541  0.287146694  1.006864279 -0.709522974
## [226] -1.049387085  0.377233617 -0.107994569 -0.102953344  0.123135248
## [231]  0.775574943  1.015222033  0.658837693  0.382622075  0.527278791
## [236]  0.533048511  0.292374896  1.385171608 -1.995393310  1.231863709
## [241] -0.568051498 -0.966088297 -1.264641136  0.388021666 -0.271508452
## [246] -1.838423669  0.538836030  1.959963985 -1.253565438  0.544641655
## [251]  0.393432594  0.550465695 -0.958124465  1.242641419 -0.097914734
## [256] -0.266310613 -0.092878609  0.556308467 -0.830953321 -0.261119960
## [261]  0.562170292  0.665078946  1.995393310 -0.087844838  0.874217165
## [266]  1.023651312  0.297611102  0.881587347  0.128188248 -0.950220942
## [271]  1.530067588  0.671346215  0.889005731  1.866295743  1.398376621
## [276] -0.942376333  0.302855481  0.133244524 -0.255936332 -0.934589291
## [281] -0.082813292  1.546433122 -0.926858513  0.568051498  0.398855066
## [286]  1.032153958 -0.823893630 -0.077783842  0.308108202  3.090232306
## [291]  0.138304208  0.007519956  0.573952419  1.811910673  0.677639965
## [296] -0.703089460  0.143367435 -0.072756358 -0.696684917  0.148434341
## [301]  0.683960672 -0.067730713 -1.242641419 -1.040731886  0.690308824
## [306]  0.404289290  1.674664889  0.409735480  0.896473364  1.040731886
## [311] -1.498513068  0.153505060 -0.690308824  1.049387085 -0.816874766
## [316]  0.415193851 -0.562170292 -0.683960672 -0.382622075  0.696684917
## [321] -0.377233617 -1.959963985 -1.616436371 -0.809895915  0.903991328
## [326] -0.677639965 -0.802956288  0.420664620  0.426148008  0.158579730
## [331]  0.313369439 -0.919182735  0.012533470 -0.671346215 -0.062706778
## [336] -1.140687476  0.318639364 -1.032153958 -1.926836573  1.253565438
## [341]  0.911560735 -1.398376621 -1.023651312 -0.476104403 -0.250759572
## [346]  0.017547298  0.163658486  1.411830078  0.703089460 -1.598193140
## [351]  0.431644239 -0.245589523  0.022561568 -0.556308467  0.437153541
## [356] -0.911560735 -0.240426031  1.121676528  0.919182735 -0.371856089
## [361] -0.665078946  0.926858513 -1.739197665 -2.365618127 -0.903991328
## [366] -1.015222033 -0.235268941  1.131130901 -0.470496968  0.934589291
## [371] -3.090232306 -0.366489294 -1.006864279  1.425544037 -0.230118101
## [376]  2.747781385  0.442676144 -0.224973358  0.027576406 -0.658837693
## [381] -0.219834564  0.323918153 -1.811910673  0.942376333 -0.550465695
## [386] -0.652621998 -0.214701568  1.140687476 -1.483280127 -0.209574223
```

```
## [391]  1.563223647  2.365618127  0.032591937  0.579873392  0.782365165
## [396] -0.057684425  1.264641136  0.585814766  1.058121618  0.168741468
## [401] -0.361133034 -0.796055117  0.448212281  1.439531471  0.173828813
## [406]  1.275874179  0.789191653  1.895697924  0.950220942  0.453762190
## [411]  0.459326111  1.580466818 -0.464904288 -0.355787114  0.796055117
## [416]  0.709522974 -0.459326111 -1.131130901 -0.350451343  0.464904288
## [421] -0.544641655 -0.345125531  0.037608288  1.695397710 -0.789191653
## [426]  0.178920660 -0.896473364  1.453806359  0.184017151 -1.468383798
## [431] -0.339809491 -0.204452382  0.042625585 -0.453762190 -1.121676528
## [436] -0.199335898  0.047643956 -1.716886018 -1.385171608 -1.695397710
## [441]  2.226211769  1.716886018  0.591776891  0.189118426 -0.782365165
## [446] -1.112321367  0.802956288 -0.334503036  0.715985990  0.052663527
## [451] -0.329205984 -0.052663527 -1.231863709 -0.775574943  0.958124465
## [456]  1.150349380 -0.448212281  2.290367878  0.809895915 -0.323918153
## [461] -1.372203809 -0.194224628  0.722479052 -2.226211769 -1.359462745
## [466] -0.442676144 -0.646431416 -0.437153541  1.468383798 -0.538836030
## [471] -1.580466818  0.329205984 -1.221227222 -2.290367878 -0.533048511
## [476] -0.640265509  0.057684425  0.062706778 -1.786613365 -0.889005731
## [481]  2.457263390  0.597760126  0.334503036  1.287270563  1.483280127
## [486] -1.563223647  0.966088297 -0.047643956 -0.768820293 -2.575829304
## [491]  0.816874766  1.160119883  0.194224628 -0.881587347 -0.042625585
## [496]  1.066937632  0.199335898  0.974113877 -0.874217165 -1.210727133
##
## $y
##   [1] 6937 6928 6930 6931 6926 6929 6932 6921 6925 6927 6935 6923 6920 6943
##  [15] 6925 6948 6927 6929 6921 6927 6917 6928 6940 6914 6927 6928 6925 6929
##  [29] 6920 6922 6919 6931 6935 6935 6926 6917 6932 6930 6922 6916 6923 6909
##  [43] 6928 6926 6926 6941 6936 6931 6927 6937 6923 6920 6922 6945 6925 6940
##  [57] 6947 6933 6929 6940 6948 6932 6924 6920 6930 6915 6919 6950 6934 6930
##  [71] 6912 6931 6937 6940 6932 6912 6942 6931 6932 6936 6930 6935 6919 6942
##  [85] 6932 6941 6919 6932 6921 6929 6941 6934 6929 6934 6941 6937 6935 6943
##  [99] 6934 6946 6921 6926 6925 6924 6926 6927 6941 6920 6939 6929 6935 6934
## [113] 6938 6932 6916 6924 6932 6939 6929 6932 6934 6918 6938 6931 6932 6939
## [127] 6936 6929 6943 6944 6931 6937 6924 6919 6931 6929 6925 6932 6928 6923
## [141] 6926 6934 6928 6928 6933 6935 6944 6944 6925 6930 6916 6928 6927 6921
## [155] 6918 6933 6924 6931 6918 6933 6917 6930 6934 6919 6922 6918 6931 6914
## [169] 6929 6924 6926 6932 6936 6940 6932 6913 6947 6936 6929 6934 6933 6941
## [183] 6925 6923 6925 6940 6943 6929 6939 6931 6936 6927 6928 6937 6932 6935
## [197] 6924 6908 6930 6929 6926 6925 6919 6933 6929 6913 6933 6932 6927 6920
## [211] 6937 6938 6925 6930 6941 6924 6939 6936 6935 6921 6934 6929 6932 6938
## [225] 6924 6921 6933 6929 6929 6931 6936 6938 6935 6933 6934 6934 6932 6941
## [239] 6913 6940 6925 6922 6919 6933 6928 6914 6934 6946 6919 6934 6933 6934
## [253] 6922 6940 6929 6928 6929 6934 6923 6928 6934 6935 6946 6929 6937 6938
## [267] 6932 6937 6931 6922 6942 6935 6937 6945 6941 6922 6932 6931 6928 6922
## [281] 6929 6942 6922 6934 6933 6938 6923 6929 6932 6956 6931 6930 6934 6944
## [295] 6935 6924 6931 6929 6924 6931 6935 6929 6919 6921 6935 6933 6943 6933
## [309] 6937 6938 6917 6931 6924 6938 6923 6933 6925 6924 6927 6935 6927 6913
## [323] 6916 6923 6937 6924 6923 6933 6933 6931 6932 6922 6930 6924 6929 6920
## [337] 6932 6921 6913 6940 6937 6918 6921 6926 6928 6930 6931 6941 6935 6916
## [351] 6933 6928 6930 6925 6933 6922 6928 6939 6937 6927 6924 6937 6915 6909
## [365] 6922 6921 6928 6939 6926 6937 6905 6927 6921 6941 6928 6952 6933 6928
## [379] 6930 6924 6928 6932 6914 6937 6925 6924 6928 6939 6917 6928 6942 6949
## [393] 6930 6934 6936 6929 6940 6934 6938 6931 6927 6923 6933 6941 6931 6940
## [407] 6936 6945 6937 6933 6933 6942 6926 6927 6936 6935 6926 6920 6927 6933
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## [421] 6925 6927 6930 6943 6923 6931 6922 6941 6931 6917 6927 6928 6930 6926
## [435] 6920 6928 6930 6915 6918 6915 6948 6943 6934 6931 6923 6920 6936 6927
## [449] 6935 6930 6927 6929 6919 6923 6937 6939 6926 6948 6936 6927 6918 6928
## [463] 6935 6911 6918 6926 6924 6926 6941 6925 6916 6932 6919 6910 6925 6924
## [477] 6930 6930 6914 6922 6949 6934 6932 6940 6941 6916 6937 6929 6923 6908
## [491] 6936 6939 6931 6922 6929 6938 6931 6937 6922 6919
```

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bin_test(1000)
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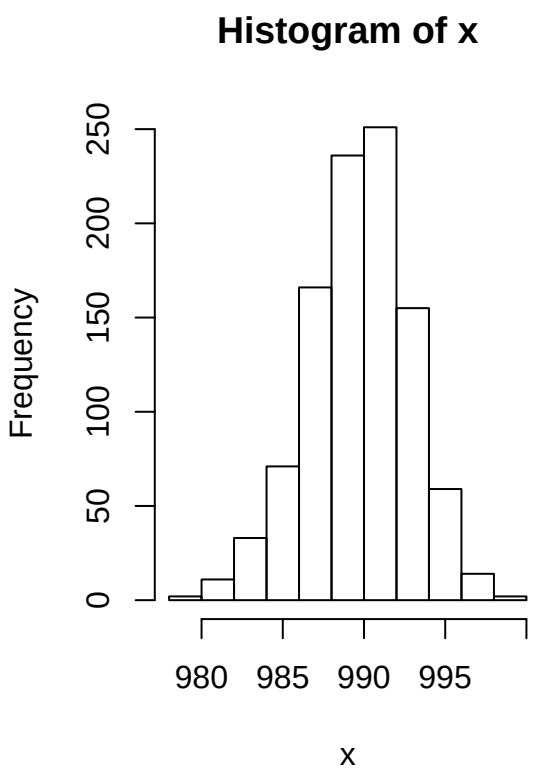

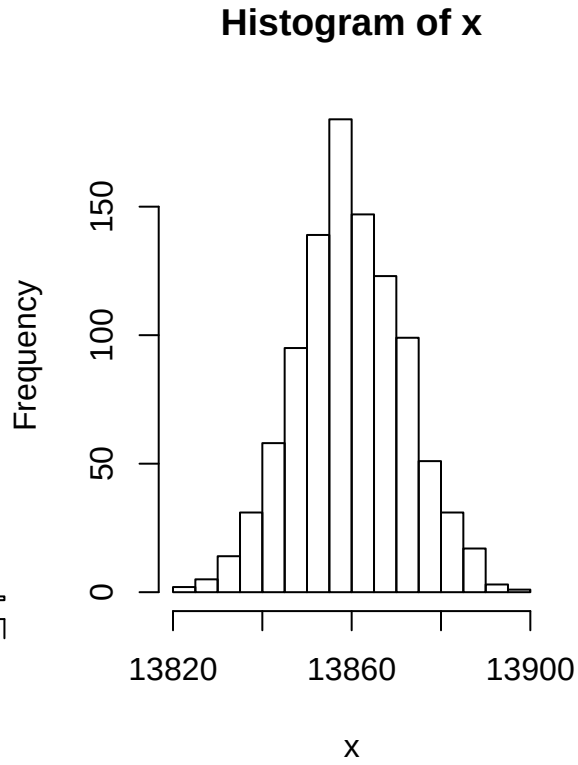

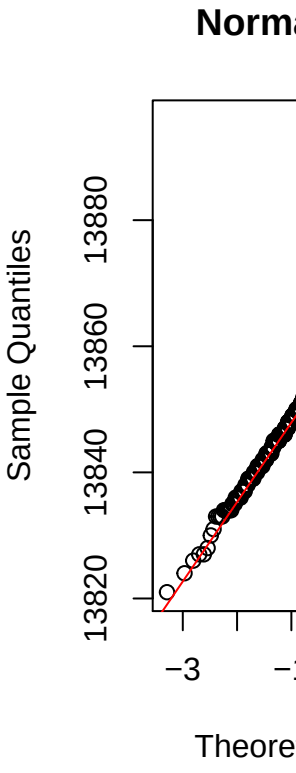


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##    [6]  0.392078788  0.666643306 -1.918876226  0.836275381  1.381907841
##   [11]  0.455151847 -1.457421739 -2.023709991 -1.223873372  0.740494495
##   [16]  0.226258980  1.472077317 -0.773882972 -0.605269415 -0.669776933
##   [21] -0.018800820 -0.096655475 -0.285840875  1.187577263 -0.471897434
##   [26]  0.228831349  0.669776933 -0.980174479 -0.770505658  0.172556560
##   [31]  0.304167872  0.071499780 -0.602261626 -1.060317897  0.839836616
##   [36] -0.283230695 -0.280622444  1.630480421 -0.192947608 -2.241402728
##   [41] -1.325516200 -1.218589596 -0.016293805 -0.599259276  0.457933804
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##   [51] -0.666643306  1.388450197 -0.469097424 -1.845258117 -0.397498354
##   [56] -0.190394509 -1.450209883  1.008947110  0.672917151  0.743795835
##   [61] -0.013786892 -1.362627301 -0.011280066  2.183486528 -0.187842651
##   [66]  1.192666527  0.528719569 -1.055930431 -1.208122880  1.479525205
##   [71] -1.611825121  2.386707734 -1.831674030  1.487056080 -0.094137414
##   [76]  1.640024851  0.747105302  0.463508393 -1.792830694  0.466301088
##   [81]  0.469097424  1.649721064  1.096180023  0.074013052 -0.185292016
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##   [91]  0.843408535 -1.319506017 -0.822135119 -2.696844261  0.076526791
##   [96]  0.394787122 -0.394787122 -0.392078788  0.079041015  0.397498354
##  [101]  1.576111974 -0.463508393 -0.182742585  1.267434417  0.750422972
##  [106] -0.976130094 -0.089103067 -0.460719309 -0.972101613  1.100762584
##  [111] -0.457933804 -0.389373327 -0.008773312 -0.180194342  0.753748922
##  [116] -1.356311745 -1.119328551  1.831674030 -0.590284394  0.676064019
##  [121]  1.273050845 -0.763777244  0.306794231  0.400212512 -0.663516212
##  [126] -0.386670714  1.700696461  1.968591669  0.175101347 -2.211517809
##  [131] -1.602704091 -0.278016100 -0.006266612 -0.003759951  2.483769293
##  [136]  0.846991247 -1.051563198 -0.905878812 -0.587303338 -0.177647269
##  [141] -0.086586748 -0.084070977 -0.968088846  0.177647269  1.278707720
##  [146]  1.013125960  0.471897434 -1.313543123 -1.593714478  1.986300204
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##  [166]  0.309422707 -0.383970921  0.001253314 -0.760425978 -0.584327491
##  [171]  1.888193337  2.807033768 -2.004654462  0.312053322  0.003759951
##  [176]  0.314686099 -0.818625699 -0.964091607 -0.815126333 -0.172556560
##  [181] -0.581356810  0.006266612 -3.290526731  1.109997741 -0.170012889
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##  [271]  0.760425978  1.021537187 -0.743795835 -1.903310819 -1.114651015
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##  [861] -2.612054141  0.061451046 -1.234544702  0.651072016 -0.614325886
##  [866] -1.934920925  1.934920925  0.288453004  0.988311735  0.291067102
##  [871]  1.534120544 -0.488776411  0.992405002  0.063962608  0.818625699
##  [876] -1.388450197 -0.205732334  0.444058900  1.542302919  0.215984281
##  [881]  0.293683191  1.319506017  0.996514964  0.720852939 -1.534120544
##  [886] -1.381907841 -1.069154627  0.066474574 -0.992405002  1.550589875
##  [891] -0.109255300 -0.485953691  0.913461259  1.091620367  0.654173550
##  [896] -0.203172764  0.296301291  0.218550777  0.383970921  1.162579875
```

```
##  [901]  0.221118713 -1.472077317  0.596262318 -1.375424105 -0.483134837
##  [906]  1.780464342 -2.542698819  1.000641829  1.167521081 -0.832724719
##  [911]  0.822135119  1.611825121  0.599259276  0.724107077 -0.296301291
##  [916]  0.386670714  0.657281391  0.446826965 -1.133510343 -0.917272240
##  [921]  1.792830694  0.154773352  0.727368901 -1.464710203  0.917272240
##  [926] -1.229191540  0.449598458  0.068986959 -0.780664237  1.464710203
##  [931] -0.480319817  0.157310685 -1.859191494  1.172490959 -1.630480421
##  [936]  2.023709991  0.730638483 -0.611301497  0.159849030 -1.064725869
##  [941]  0.660395592  0.825654693 -0.106734011 -0.405649708 -0.676064019
##  [946]  0.162388406 -0.913461259  0.733915893  1.325516200  0.298921424
##  [951]  0.164928830  1.690146138 -0.672917151 -0.777269137 -0.477508598
##  [956]  0.301543611 -0.104213400 -0.909663498  1.558984706  0.737201206
##  [961]  1.004785806 -1.368997680 -0.200614525 -0.101693452  0.223688108
##  [966] -0.293683191 -0.402929621  0.520091217  1.805477457  0.452373409
##  [971]  0.167470319  0.829184525 -0.099174149 -0.829184525  1.177489966
##  [976]  1.567490864 -0.825654693  0.170012889  0.663516212  1.951479773
##  [981]  0.602261626 -0.198057597 -0.023815220  1.621082251 -0.608282689
##  [986] -0.021307953  0.522963002  1.818419763 -0.988311735  0.921096591
##  [991] -1.128757845  1.261857687  0.525839108 -0.195501964 -0.291067102
##  [996] -0.984234960  0.832724719  3.290526731  0.389373327 -1.124030705
##
## $y
##    [1] 13875 13857 13878 13855 13856 13865 13869 13837 13871 13878 13866
##   [12] 13843 13836 13846 13870 13863 13879 13852 13854 13853 13860 13859
##   [23] 13857 13875 13855 13863 13869 13849 13852 13862 13864 13861 13854
##   [34] 13848 13871 13857 13857 13881 13858 13834 13845 13846 13860 13854
##   [45] 13866 13846 13841 13866 13854 13854 13853 13878 13855 13838 13856
##   [56] 13858 13843 13873 13869 13870 13860 13844 13860 13887 13858 13875
##   [67] 13867 13848 13846 13879 13841 13888 13838 13879 13859 13881 13870
##   [78] 13866 13839 13866 13866 13881 13874 13861 13858 13859 13867 13855
##   [89] 13852 13863 13871 13845 13851 13827 13861 13865 13856 13856 13861
##  [100] 13865 13880 13855 13858 13876 13870 13849 13859 13855 13849 13874
##  [111] 13855 13856 13860 13858 13870 13844 13847 13883 13854 13869 13876
##  [122] 13852 13864 13865 13853 13856 13882 13885 13862 13834 13841 13857
##  [133] 13860 13860 13889 13871 13848 13850 13854 13858 13859 13859 13849
##  [144] 13862 13876 13873 13866 13845 13841 13885 13868 13860 13858 13887
##  [155] 13857 13857 13865 13866 13839 13874 13888 13855 13861 13870 13861
##  [166] 13864 13856 13860 13852 13854 13884 13892 13836 13864 13860 13864
##  [177] 13851 13849 13851 13858 13854 13860 13821 13874 13858 13839 13875
##  [188] 13845 13883 13884 13865 13855 13848 13859 13868 13862 13833 13865
##  [199] 13857 13861 13855 13856 13861 13851 13863 13860 13864 13859 13856
##  [210] 13867 13878 13892 13857 13846 13866 13851 13841 13856 13855 13868
##  [221] 13867 13843 13852 13852 13872 13864 13886 13854 13871 13854 13842
##  [232] 13848 13853 13857 13879 13871 13866 13849 13863 13840 13882 13842
##  [243] 13871 13878 13877 13863 13859 13877 13856 13859 13853 13868 13859
##  [254] 13882 13875 13836 13852 13863 13857 13845 13862 13873 13852 13860
##  [265] 13867 13877 13857 13857 13854 13860 13870 13873 13852 13837 13847
##  [276] 13847 13865 13858 13852 13863 13872 13845 13852 13858 13838 13870
##  [287] 13846 13848 13857 13863 13859 13886 13870 13874 13854 13858 13869
##  [298] 13882 13856 13874 13873 13851 13863 13863 13840 13871 13853 13857
##  [309] 13871 13878 13874 13866 13874 13867 13861 13841 13864 13882 13841
##  [320] 13852 13856 13863 13859 13857 13847 13848 13881 13861 13864 13856
##  [331] 13848 13875 13850 13870 13853 13877 13873 13850 13869 13839 13865
##  [342] 13831 13878 13871 13853 13858 13863 13855 13864 13849 13853 13858
```

```
##   [353] 13856 13835 13859 13872 13881 13855 13856 13866 13889 13840 13850
##   [364] 13860 13869 13855 13861 13861 13856 13862 13861 13852 13857 13856
##   [375] 13871 13852 13840 13845 13856 13861 13886 13868 13868 13852 13870
##   [386] 13876 13867 13871 13863 13860 13856 13858 13869 13856 13845 13864
##   [397] 13849 13845 13847 13870 13852 13876 13843 13859 13872 13856 13864
##   [408] 13846 13856 13859 13862 13851 13853 13868 13867 13865 13854 13860
##   [419] 13852 13867 13854 13866 13858 13877 13842 13854 13834 13861 13867
##   [430] 13878 13849 13850 13874 13859 13871 13865 13858 13869 13839 13866
##   [441] 13857 13837 13855 13873 13860 13849 13860 13880 13847 13833 13859
##   [452] 13871 13864 13878 13860 13869 13849 13852 13852 13855 13870 13830
##   [463] 13864 13854 13864 13861 13848 13854 13853 13844 13868 13859 13850
##   [474] 13853 13850 13871 13848 13864 13854 13861 13852 13858 13833 13845
##   [485] 13835 13859 13861 13850 13859 13842 13858 13869 13872 13855 13850
##   [496] 13865 13839 13852 13840 13858 13839 13868 13856 13866 13861 13857
##   [507] 13850 13876 13871 13863 13867 13858 13846 13875 13863 13833 13847
##   [518] 13872 13862 13865 13872 13850 13873 13845 13854 13865 13855 13859
##   [529] 13873 13834 13848 13834 13870 13864 13854 13864 13850 13847 13857
##   [540] 13875 13843 13846 13840 13860 13870 13843 13836 13845 13869 13880
##   [551] 13842 13852 13853 13860 13856 13864 13868 13858 13852 13862 13851
##   [562] 13864 13842 13867 13875 13851 13875 13862 13864 13887 13844 13850
##   [573] 13872 13859 13855 13858 13860 13861 13859 13884 13860 13859 13862
##   [584] 13864 13863 13866 13872 13867 13858 13858 13858 13857 13854 13870
##   [595] 13857 13857 13865 13865 13846 13873 13872 13824 13846 13856 13872
##   [606] 13870 13861 13856 13826 13845 13887 13878 13846 13841 13864 13861
##   [617] 13864 13843 13863 13856 13866 13887 13848 13872 13874 13860 13843
##   [628] 13873 13858 13867 13857 13855 13866 13863 13855 13850 13870 13850
##   [639] 13863 13875 13861 13891 13854 13864 13836 13854 13869 13854 13864
##   [650] 13876 13861 13887 13857 13870 13862 13879 13886 13876 13843 13856
##   [661] 13845 13879 13850 13844 13861 13858 13856 13858 13856 13870 13868
##   [672] 13859 13872 13867 13875 13861 13866 13850 13850 13860 13854 13875
##   [683] 13846 13883 13856 13878 13854 13857 13856 13872 13854 13870 13873
##   [694] 13846 13839 13854 13869 13868 13861 13862 13852 13861 13875 13848
##   [705] 13873 13868 13846 13841 13856 13868 13849 13837 13885 13872 13882
##   [716] 13858 13859 13865 13853 13861 13856 13843 13878 13864 13855 13849
##   [727] 13859 13867 13847 13871 13871 13856 13875 13858 13849 13848 13863
##   [738] 13852 13869 13841 13852 13864 13862 13880 13849 13857 13866 13855
##   [749] 13854 13860 13851 13842 13852 13869 13839 13849 13848 13882 13877
##   [760] 13851 13846 13874 13867 13854 13835 13855 13845 13860 13853 13876
##   [771] 13853 13858 13881 13874 13865 13873 13867 13879 13890 13854 13886
##   [782] 13867 13857 13845 13854 13854 13879 13854 13863 13848 13860 13856
##   [793] 13862 13860 13870 13861 13857 13863 13871 13857 13870 13855 13868
##   [804] 13861 13873 13867 13851 13883 13854 13864 13854 13869 13886 13866
##   [815] 13859 13846 13853 13853 13878 13844 13873 13863 13867 13873 13873
##   [826] 13874 13854 13854 13874 13854 13867 13860 13873 13838 13871 13834
##   [837] 13862 13852 13877 13847 13857 13861 13850 13861 13866 13866 13860
##   [848] 13871 13857 13872 13846 13862 13865 13850 13847 13856 13864 13852
##   [859] 13856 13867 13827 13860 13845 13868 13853 13836 13884 13863 13872
##   [870] 13863 13879 13854 13872 13860 13870 13843 13857 13865 13879 13862
##   [881] 13863 13876 13872 13869 13841 13843 13847 13860 13848 13879 13858
##   [892] 13854 13871 13873 13868 13857 13863 13862 13864 13874 13862 13842
##   [903] 13867 13843 13854 13882 13828 13872 13874 13850 13870 13880 13867
##   [914] 13869 13856 13864 13868 13865 13846 13849 13882 13861 13869 13842
##   [925] 13871 13845 13865 13860 13851 13878 13854 13861 13837 13874 13840
##   [936] 13885 13869 13853 13861 13847 13868 13870 13858 13855 13852 13861
```

```
##  [947] 13849 13869 13876 13863 13861 13881 13852 13851 13854 13863 13858
##  [958] 13849 13879 13869 13872 13843 13857 13858 13862 13856 13855 13866
##  [969] 13882 13865 13861 13870 13858 13850 13874 13879 13850 13861 13868
##  [980] 13884 13867 13857 13859 13880 13853 13859 13866 13882 13848 13871
##  [991] 13846 13875 13866 13857 13856 13848 13870 13896 13864 13846
```

Small note: I am unsure how exactly to ensure the plots do not end up outside of the paper margins. The par(mfrow) method worked until the larger distribution (100,500) summations. Would be nice to know how to ensure it is always in line.

2. Delta Method calculation

unknown distribution -> random number generation

```
vec_xbar <- NULL
vec_yn <- NULL

delta <- function(n){
  for (i in 1:n){
    x = runif(1000)
    xbar = mean(x)
    vec_xbar = c(vec_xbar, xbar)

    yn = 1/xbar
    vec_yn = c(vec_yn, yn)

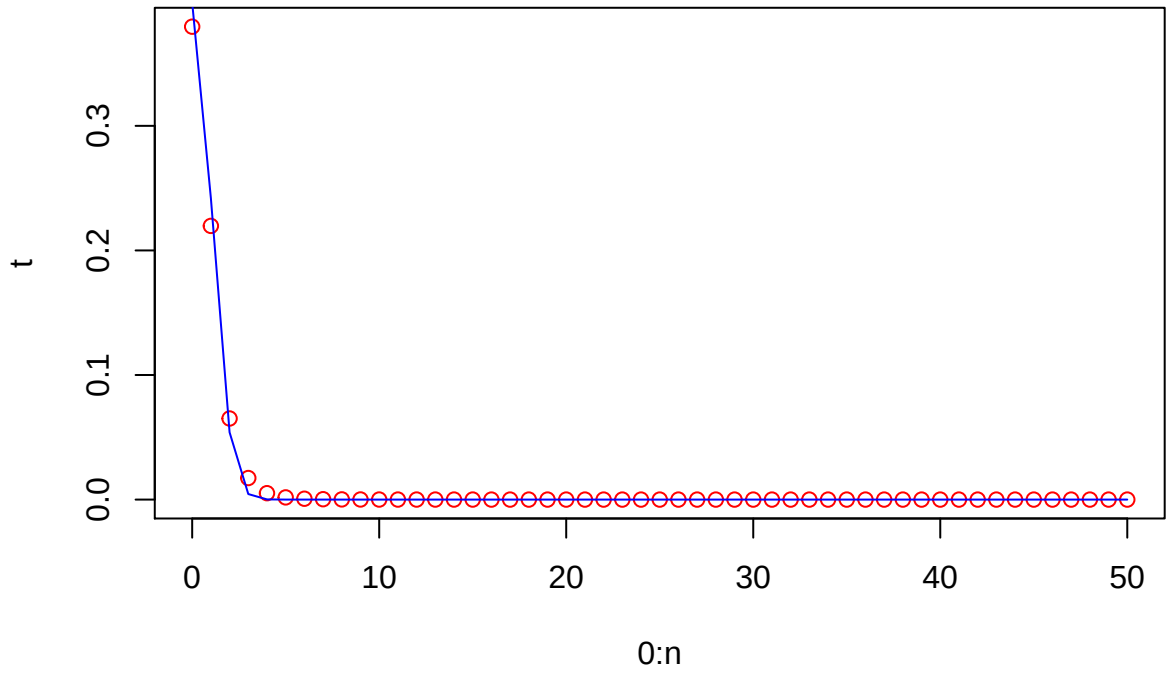
    plot(xbar, yn)
  }
  final = as.data.frame(matrix(c(vec_xbar, vec_yn), nrow = 2, byrow = TRUE))
  return(final)
}
```

3. T distribution versus Normal Distribution

```
TvN <- function(n, df){
  t = dt(0:n, df)
  N = dnorm(0:n, mean = 0 , sd =1)
  plot(0:n, t, col = "red")
  lines(0:n, N, col = "blue")
}
```

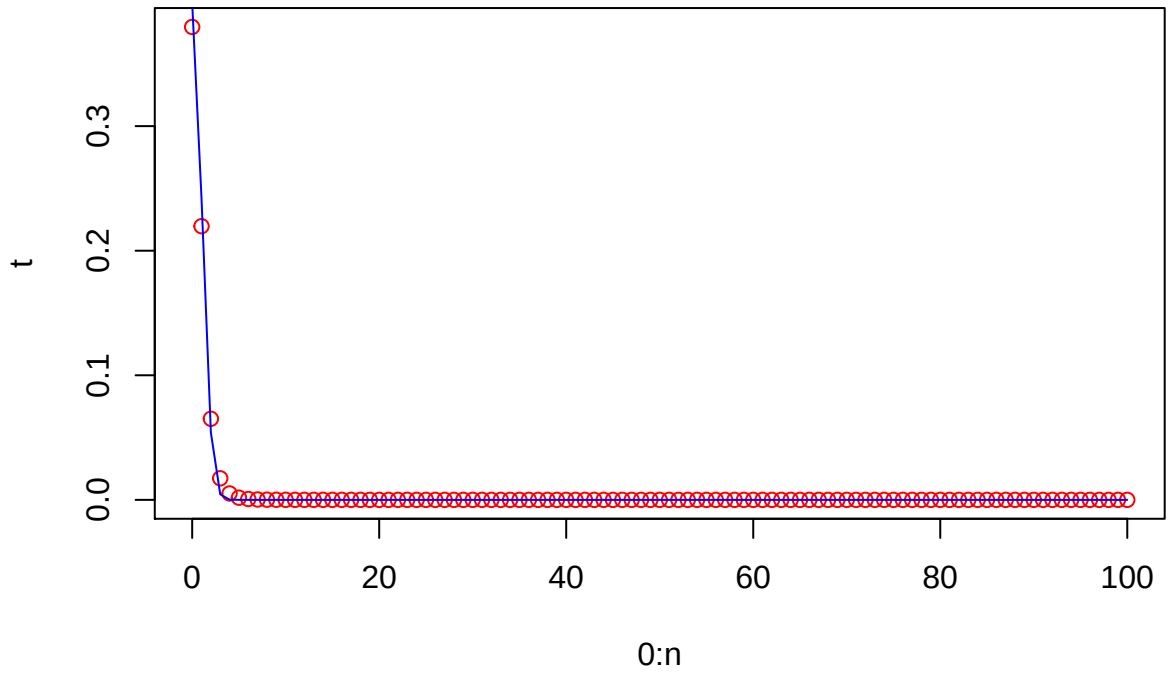
Testing the program out at n = 50 and df = 5 (randomly picked df)

```
TvN(50, 5)
```



Now at n = 100

```
TvN(100, 5)
```



Looking at both plots, it seems like both the T distribution and Normal distribution tend towards each other and can be said to be the same.

4 MSE of median

```
x <- read.table("productsales.dat")
x <- unlist(x)
x <-as.numeric(x)

x_len <- length(x)

size <- 500

sample1 <- sample(x, x_len*size, replace = TRUE)
matrixform <- matrix(sample1, size, x_len)

mean_matrix <- apply(matrixform, 1, mean)
Mean <- mean(mean_matrix)
Mean
```

```
## [1] 88054.86
```

```
median_matrix <- apply(matrixform, 1, median)
Median <- median(median_matrix)
Median
```

```
## [1] 87037.5
```

```
sd_matrix <- apply(matrixform, 1, sd)
SD <- sd(sd_matrix)
SD
```

```
## [1] 1312.256
```

MSE is the average of the squared of the errors, however, just taking from the Product Sales table does not provide us with a prediction and true value to compute the errors from. Thus, I am unsure how exactly to calculate this value.