PROBABILITY AND STATISTICS

LAB ASSIGNMENT - 7
(Chi-square, t-distribution, F-distribution)

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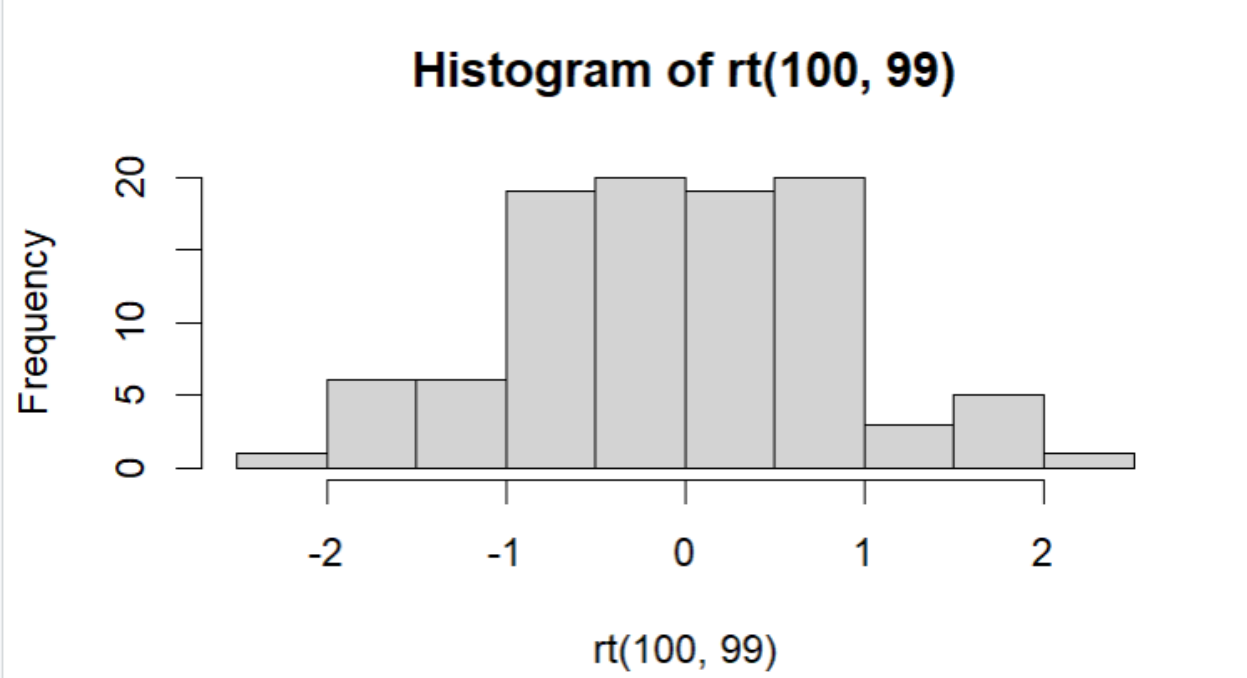
(1) Use the $rt(n, df)$ function in r to investigate the t-distribution for $n = 100$ and $df = n - 1$ and plot the histogram for the same.

```
# Q1
rt(100,99)
hist(rt(100,99))
```

Output :

```
> # Q1
> rt(100,99)
  [1] -0.17838656 -1.01866451  0.80424191  0.07187985  0.46358635 -0.72382645
  [7]  0.21907786 -0.67117184 -1.24001243  0.35773850  0.60653476 -0.30943324
 [13] -2.61781714  0.08940275 -1.07905470 -1.08501008  0.57832899 -0.86932499
 [19] -0.74046358  0.21168195 -1.49308476 -1.08842874  0.58524293 -0.81024473
 [25] -0.44299264  0.33388559  0.03985329  0.63389984 -1.00404024 -1.73217739
 [31]  0.51433683 -0.39153011 -0.32275688 -0.32973991  1.41840572  0.70049825
 [37] -0.91175143  0.43419592 -0.54998038 -0.34662754 -0.74194602 -0.08190506
 [43]  0.73878003 -1.21013822  0.46284316 -0.34293126 -2.89095064 -0.55998927
 [49] -0.78489703  0.87712754  0.37451871 -0.90450503  0.74422467  1.32315607
 [55]  0.89042624 -1.08855892  0.28879001  2.53069010  1.04349680 -0.02286470
 [61] -0.70028913 -0.12308857 -0.55380416 -0.29339999 -0.27702980 -0.22764696
 [67]  1.74103114 -0.86519284  0.51382010 -1.82329525 -1.46574211  0.01495561
 [73] -0.34686902 -0.10784361 -0.48151425  0.28728352  1.19690409  0.68793865
 [79]  1.15480880  0.06392285 -0.47994442  2.03666198  0.98366730  0.27550529
 [85] -0.76220844  0.13476395  2.04912911  0.27467346  0.83294749  0.23258120
 [91]  0.55768229  0.42902442 -1.44049744  1.56456160 -0.30302047 -2.05931993
 [97] -1.28629574 -2.03580703 -0.15336907 -1.58179101
> hist(rt(100,99))
>
```



(2) Use the $rchisq(n, df)$ function in r to investigate the chi-square distribution with $n = 100$ and $df = 2, 10, 25$.

```
# Q2
rchisq(100,2)
rchisq(100,10)
rchisq(100,25)
```

Output :

```
> # Q2
> rchisq(100,2)
  [1] 4.22733532 0.06312347 1.27276530 1.19926486 2.13704822 3.36184412 1.03512544
  [8] 0.87375013 0.56500820 1.36473074 2.25728312 0.68288552 0.45634133 1.40145705
 [15] 0.81217139 4.59062219 3.31514615 0.01415752 0.39944592 0.17027624 0.66979972
 [22] 0.85883448 1.33533336 1.46412295 1.03070444 1.40698420 2.20581234 2.08798008
 [29] 0.07211476 0.25423977 2.94094369 3.30236232 1.15863533 1.22802810 2.20613440
 [36] 1.97712042 2.73552201 3.21770767 1.02102750 0.22659235 2.54433313 0.64006291
 [43] 6.23205091 2.61705441 1.48431189 9.90090337 1.14407784 0.18214237 0.03461530
 [50] 0.52626165 4.41227560 1.85067509 0.48830582 3.70830470 3.32964925 3.51110755
 [57] 3.22166070 1.29127921 1.95352482 0.01179415 1.06333218 0.14444740 0.25812745
 [64] 3.33360404 0.46274164 0.11125827 1.62421877 2.32232255 1.47154426 2.44078131
 [71] 2.12502957 3.76241074 1.99243074 0.62060910 0.45940506 2.01079847 2.47547456
 [78] 1.93203731 0.06970010 2.90704276 0.97497302 0.33900158 1.80390487 2.72672425
 [85] 0.27538372 2.11942713 0.52405709 0.33714372 4.72584814 1.20043868 3.30085066
 [92] 0.31010479 1.15096420 0.68042155 1.22827781 1.43589188 0.83566966 0.28354290
 [99] 0.54584800 1.83324168
```

```
> rchisq(100,10)
  [1] 12.875722  4.848986 11.228291  9.979209  8.384646  9.631107 11.087591  4.968250
  [9]  6.246484  7.461309  8.227853 16.979886  6.782735  8.097739  6.307196  6.480529
 [17] 13.719311  5.163581  8.952022 16.908331 10.430591  2.493750  6.006655 10.280762
 [25]  6.497664  7.825539  5.850321 10.578772  1.492809  5.717715  6.902583  9.219575
 [33] 15.719402  6.164037  8.992209 18.204611  6.441620 10.871371  5.699950 11.471643
 [41]  4.521127 12.326147 11.671713 13.225229  1.536779 22.245234 11.832387  9.399109
 [49]  7.867932  6.565607  9.062542  5.968803  8.220575 14.176320 10.697871 13.823226
 [57]  9.601291 13.110903 15.118106  2.017419  9.140220 11.297472  6.467999 12.923874
 [65] 10.444225  5.514610  6.124410  9.817032  8.322296 12.333294 19.445705 12.857842
 [73]  7.813114 19.244650 11.729045 13.297498 15.451514  8.609232 11.718950 10.150232
 [81]  8.000902 10.692963 10.959302  9.293749  5.588426  4.950948  9.113337 18.631360
 [89]  9.638895  5.186185 10.382257  7.693364  4.881421 10.265921 16.281029 23.322302
 [97]  9.930419  9.374359 11.989373  4.987872
```

```
> rchisq(100,25)
  [1] 20.68750 28.20289 35.91108 26.51447 31.83146 26.52213 15.69831 29.85973 26.11680
 [10] 21.53901 26.27639 22.13858 23.44473 34.13436 19.53910 25.44374 13.76505 25.88752
 [19] 30.27737 15.23388 27.77696 25.46434 20.30380 40.63852 31.10885 20.73652 17.55045
 [28] 16.51507 19.92938 32.28824 29.80637 28.18034 39.96142 15.09588 32.12829 23.74261
 [37] 26.56402 23.91419 20.59569 32.69938 20.14835 15.72706 37.38378 12.86103 13.72260
 [46] 11.96265 22.23464 16.36176 13.28267 20.09460 34.01735 43.22653 31.94912 26.30212
 [55] 17.07238 17.99142 21.27224 26.52946 18.41659 15.93973 16.05971 37.38500 24.81167
 [64] 22.74806 31.77823 20.83425 30.56924 22.62030 16.84869 29.38138 18.54310 22.64831
 [73] 18.61936 32.70839 29.74954 17.32403 35.28264 28.77317 28.14996 18.78263 47.55841
 [82] 18.14660 34.35963 24.48468 24.12605 20.44713 26.78285 25.68517 22.57598 31.60279
 [91] 25.92629 21.03333 28.51805 17.19540 28.10992 17.39051 12.67563 24.23086 38.99438
[100] 37.02512
>
```

(3) Generate a vector of 100 values between -6 and 6. Use the $dt()$ function in r to find the values of a t-distribution given a random variable x and degrees of freedom 1,4,10,30. Using these values plot the density function for students t-distribution with degrees of freedom 30. Also shows a comparison of probability density functions having different degrees of freedom (1,4,10,30).

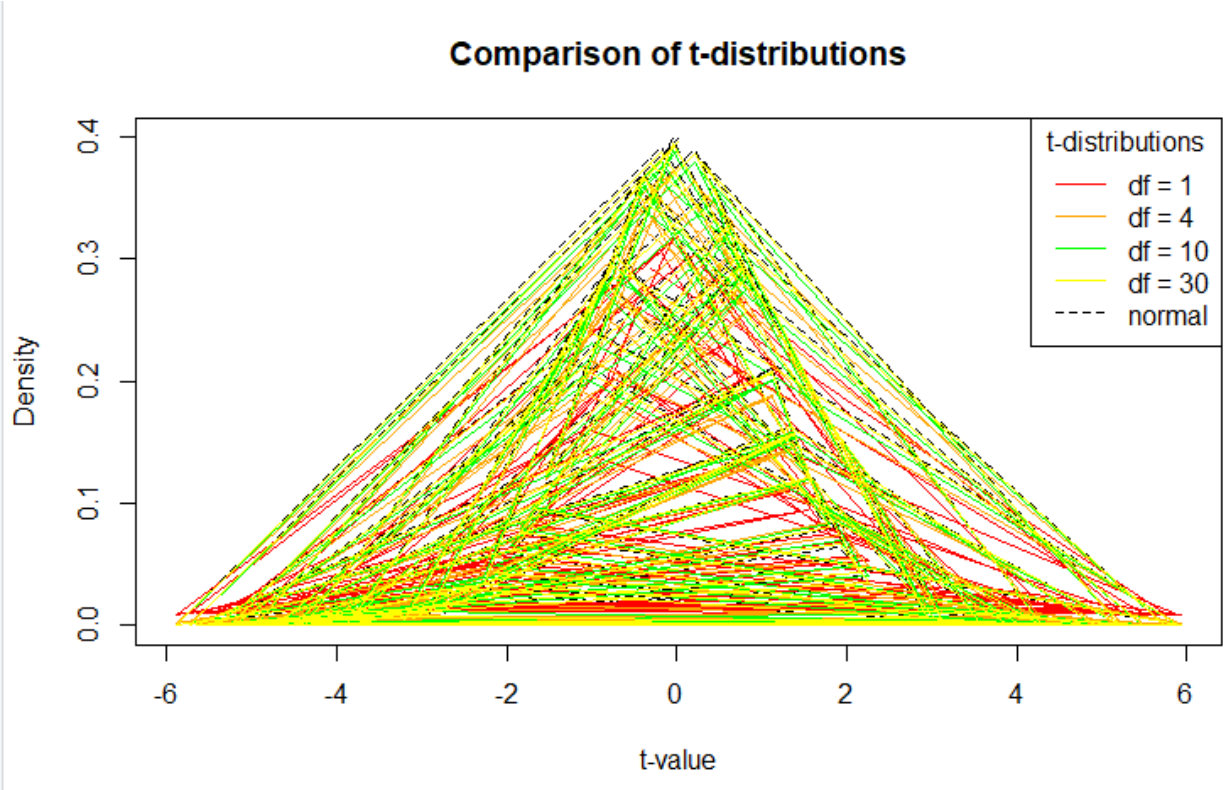
```
# Q3
x <- runif(100,-6,6)
dt(x,1)
dt(x,4)
dt(x,10)
dt(x,30)
df = c(1,4,10,30)
colour = c("red", "orange", "green", "yellow","black")

plot(x, dnorm(x), type = "l", lty = 2, xlab = "t-value", ylab = "Density",main = "Comparis
on of t-distributions", col = "black")
for (i in 1:4){
  lines(x, dt(x, df[i]), col = colour[i])
}
legend("topright", c("df = 1", "df = 4", "df = 10", "df = 30", "normal"),col = colour, tit
le = "t-distributions", lty = c(1,1,1,1,2))
```

Output :

```
> # Q3
> x <- runif(100,-6,6)
> dt(x,1)
  [1] 0.292379645 0.009373953 0.020425658 0.014791874 0.051399389 0.008922302
  [7] 0.306518324 0.192573520 0.265668881 0.188166580 0.082953542 0.018340828
 [13] 0.024640730 0.013934224 0.015655391 0.012850330 0.013258591 0.139290526
 [19] 0.080173220 0.019623513 0.012440037 0.318302613 0.009380058 0.111116296
 [25] 0.036804663 0.011010616 0.010990275 0.012285691 0.048814746 0.017435231
 [31] 0.016205142 0.018322151 0.009190774 0.020075485 0.013185736 0.072982804
 [37] 0.232912489 0.014899996 0.114207199 0.012651761 0.025849484 0.010211095
 [43] 0.052093121 0.068161453 0.015817185 0.278040688 0.056633634 0.009966839
 [49] 0.093722226 0.021841860 0.029952976 0.317397019 0.095353999 0.209007964
 [55] 0.033353504 0.304463984 0.011107844 0.032729847 0.201137871 0.019742458
 [61] 0.012168455 0.012746148 0.016826954 0.139883980 0.009649361 0.032045615
 [67] 0.010728180 0.013856383 0.141732186 0.016407651 0.293211107 0.011298717
 [73] 0.159769993 0.010490714 0.023162612 0.276832832 0.051481820 0.010285389
 [79] 0.260592848 0.197287048 0.028346942 0.201814337 0.008900413 0.009068943
 [85] 0.011332338 0.200752591 0.081926800 0.008773888 0.016906587 0.019801921
 [91] 0.075082330 0.209021178 0.031149204 0.065506418 0.192367693 0.019597143
 [97] 0.010897965 0.056662879 0.111835005 0.029956374
>
```

```
> dt(x,4)
  [1] 0.354994490 0.001445253 0.008060156 0.004031009 0.046833122 0.001289984 0.366133331 0.256960134 0.332305566 0.251692240
 [11] 0.098171284 0.006419327 0.011870183 0.003534212 0.004563394 0.002952702 0.003165610 0.186862862 0.093552665 0.007408841
 [21] 0.002746246 0.374994644 0.001447416 0.144070485 0.025911597 0.002086344 0.002077624 0.002670539 0.042904288 0.005760250
 [31] 0.004918913 0.006405400 0.001381150 0.007772798 0.003127071 0.081615901 0.301168990 0.004095911 0.148944287 0.002851841
 [41] 0.013075595 0.001757824 0.047900213 0.073654851 0.004666695 0.343094619 0.054998253 0.001663299 0.115973085 0.009269206
 [51] 0.017505787 0.374326760 0.118650043 0.275819770 0.021534389 0.364549987 0.002128287 0.020773284 0.266940345 0.007503861
 [61] 0.002613751 0.002899563 0.005336358 0.187722554 0.001544533 0.019949452 0.001966951 0.003490717 0.190388459 0.005053089
 [71] 0.355665481 0.002211883 0.215491121 0.001869391 0.010462535 0.342063115 0.046959650 0.001787117 0.327731725 0.262494472
 [81] 0.015712299 0.267714412 0.001282696 0.001339369 0.002226779 0.266498556 0.096466089 0.001241006 0.005390983 0.007551568
 [91] 0.085096778 0.275834449 0.018888385 0.069299975 0.256716120 0.007387850 0.002038287 0.055044548 0.145207354 0.017509659
> dt(x,10)
  [1] 3.706637e-01 1.283490e-04 2.763749e-03 8.412309e-04 3.899879e-02 1.034368e-04 3.809775e-01 2.747840e-01 3.493044e-01
 [10] 2.693563e-01 9.851053e-02 1.884952e-03 5.195907e-03 6.659440e-04 1.046328e-03 4.820699e-04 5.466104e-04 2.001082e-01
 [19] 9.307857e-02 2.401004e-03 4.226810e-04 3.891035e-01 1.287128e-04 1.519383e-01 1.710646e-02 2.552496e-04 2.532771e-04
 [28] 4.017125e-04 3.467745e-02 1.566632e-03 1.192638e-03 1.878007e-03 1.177750e-04 2.601550e-03 5.346848e-04 7.904569e-02
 [37] 3.191973e-01 8.653029e-04 1.575168e-01 4.526566e-04 6.059213e-03 1.855391e-04 4.018394e-02 6.971950e-02 1.088090e-03
 [46] 3.595207e-01 4.817001e-02 1.672779e-04 1.193883e-01 3.481366e-03 9.536205e-03 3.884934e-01 1.225145e-01 2.939768e-01
 [55] 1.303207e-02 3.795182e-01 2.648271e-04 1.235103e-02 2.849868e-01 2.452825e-03 3.862746e-04 4.664792e-04 1.373476e-03
 [64] 2.010563e-01 1.455128e-04 1.162413e-02 2.288153e-04 6.513749e-04 2.039915e-01 1.249719e-03 3.712882e-01 2.843605e-04
 [73] 2.312508e-01 2.081405e-04 4.241026e-03 3.585486e-01 3.913908e-02 1.913645e-04 3.449403e-01 2.804547e-01 8.076118e-03
 [82] 2.857738e-01 1.023266e-04 1.111010e-04 2.879029e-04 2.845374e-01 9.650534e-02 9.607846e-05 1.397838e-03 2.478987e-03
 [91] 8.313442e-02 2.939915e-01 1.070450e-02 6.464096e-02 2.745332e-01 2.389608e-03 2.444611e-04 4.822261e-02 1.532416e-01
[100] 9.539427e-03
```

```
> dt(x,30)
  [1] 3.779383e-01 4.050467e-06 8.519664e-04 1.227695e-04 3.331370e-02 2.667949e-06 3.878512e-01 2.833713e-01 3.572538e-01
 [10] 2.778816e-01 9.749781e-02 4.657318e-04 2.215422e-03 8.220102e-05 1.774748e-04 4.669068e-05 5.826420e-05 2.064965e-01
 [19] 9.157372e-02 6.837891e-04 3.695917e-05 3.956275e-01 4.072569e-06 1.553739e-01 1.171006e-02 1.479330e-05 1.458304e-05
 [28] 3.374405e-05 2.885318e-02 3.455315e-04 2.207605e-04 4.629853e-04 3.431841e-06 7.753628e-04 5.605022e-05 7.627417e-02
 [37] 3.277324e-01 1.288042e-04 1.613528e-01 4.175751e-05 2.774393e-03 8.164916e-06 3.454747e-02 6.613248e-02 1.894857e-04
 [46] 3.671737e-01 4.295389e-02 6.714690e-06 1.202236e-01 1.215460e-03 5.294314e-03 3.950447e-01 1.236168e-01 3.026627e-01
 [55] 8.136254e-03 3.864516e-01 1.583231e-05 7.563792e-03 2.936498e-01 7.071079e-04 3.145318e-05 4.404849e-05 2.786947e-04
 [64] 2.074909e-01 5.151567e-06 6.962093e-03 1.208288e-05 7.911067e-05 2.105662e-01 2.385369e-04 3.785399e-01 1.804278e-05
 [73] 2.389114e-01 1.012862e-05 1.638166e-03 3.662320e-01 3.345953e-02 8.653438e-06 3.530014e-01 2.890906e-01 4.190836e-03
 [82] 2.944404e-01 2.612472e-06 3.065402e-06 1.845660e-05 2.931982e-01 9.531117e-02 2.310247e-06 2.868519e-04 7.189727e-04
 [91] 8.072927e-02 3.026775e-01 6.215787e-03 6.062880e-02 2.831180e-01 6.786938e-04 1.365894e-05 4.300971e-02 1.567719e-01
[100] 5.296812e-03
> df = c(1,4,10,30)
> colour = c("red", "orange", "green", "yellow","black")
> plot(x, dnorm(x), type = "l", lty = 2, xlab = "t-value", ylab = "Density",main = "Comparison of t-distributions", col = "black")
> for (i in 1:4){
+   lines(x, dt(x, df[i]), col = colour[i])
+ }
> legend("topright", c("df = 1", "df = 4", "df = 10", "df = 30", "normal"),
+        col = colour, title = "t-distributions", lty = c(1,1,1,1,2))
> |
```



(4) Write a r-code

(i) To find the 95^{th} percentile of the F-distribution with $(10, 20)$ degrees of freedom.

(ii) To calculate the area under the curve for the interval $[0, 1.5]$ and the interval $[1.5, +\infty)$ of a F-curve with $v_1 = 10$ and $v_2 = 20$ (USE $pf()$).

(iii) To calculate the quantile for a given area (= probability) under the curve for a F-curve with $v_1 = 10$ and $v_2 = 20$ that corresponds to $q = 0.25, 0.5, 0.75$ and 0.999. (use the $qf()$)

(iv) To generate 1000 random values from the F-distribution with $v_1 = 10$ and $v_2 = 20$ (use $rf()$)and plot a histogram.

```
# Q4
# (i)
qf(.95, df1=10, df2=20)
# (ii)
pf(1.5,10,20,lower.tail = TRUE)
pf(1.5,10,20,lower.tail = FALSE)
# (iii)
qf(0.25,10,20,lower.tail = TRUE)
qf(0.5,10,20,lower.tail = TRUE)
qf(0.75,10,20,lower.tail = TRUE)
qf(0.999,10,20,lower.tail = TRUE)
# (iv)
rf(1000,10,20)
hist(rf(1000,10,20))
```

Output :

```
> # (i)
> qf(.95, df1=10, df2=20)
[1] 2.347878
> # (ii)
> pf(1.5,10,20,lower.tail = TRUE)
[1] 0.7890535
> pf(1.5,10,20,lower.tail = FALSE)
[1] 0.2109465
```

```
> # (iii)
> qf(0.25,10,20,lower.tail = TRUE)
[1] 0.6563936
> qf(0.5,10,20,lower.tail = TRUE)
[1] 0.9662639
> qf(0.75,10,20,lower.tail = TRUE)
[1] 1.399487
> qf(0.999,10,20,lower.tail = TRUE)
[1] 5.075246
```

```
> # (iv)
> rf(1000,10,20)
   [1] 1.08095431 1.27012538 0.67813428 1.96039370 1.40534388 1.14469833 0.77096887
   [8] 0.48630053 1.29664804 0.58914879 0.37147558 1.73370261 0.59859026 0.61668140
  [15] 1.28820863 0.91811925 1.58805438 0.60989463 0.76792302 3.04776609 0.20965125
  [22] 1.37733491 1.19658406 0.29508832 1.76737540 2.39304490 0.52532898 1.23533572
  [29] 0.83259524 0.41666629 0.70717553 0.52794523 2.63743378 0.29946380 0.61801700
  [36] 0.98969566 1.91496431 0.42178693 0.97328164 1.33646271 1.51975541 0.54531906
  [43] 0.93577593 0.95860493 0.85274833 1.20717909 0.99107353 1.29753479 1.19246457
  [50] 0.81501954 4.19456501 0.69924549 0.64505912 2.64879768 1.83814677 0.72634191
  [57] 0.46381746 1.24323363 0.88027207 0.49454169 1.79148635 1.96523211 0.27825589
  [64] 0.64981732 1.39903098 1.06215136 0.08235815 0.88651216 0.48887810 1.74930653
```