

# Rlab2 Random number generation

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I. Pareto(2,2) 1)

```
ppareto <- function(x, a, b){  
  1-(b/x)^2  
}  
ppareto(2,2,1)
```

```
## [1] 0.75
```

```
ppareto(4,2,1)
```

```
## [1] 0.9375
```

```
ppareto(6,2,1)
```

```
## [1] 0.9722222
```

2)

```
qpareto <- function(p, a, b){  
  b*(-(p-1))^{(-1/a)}  
}  
qpareto(.25,2,1)
```

```
## [1] 1.154701
```

```
qpareto(0.5,2,2)
```

```
## [1] 2.828427
```

```
qpareto(0.99,2,1)
```

```
## [1] 10
```

3)

```

ppareto <- function(x,a,b){
  1-(b/x)^2
}
ppareto(sample(1:1000),2,2)

## [1] 0.9999913 0.9999846 0.9999257 0.9999866 0.9999944 0.9999889
## [7] 0.9999868 0.9991598 0.9999946 0.9999789 0.9999823 0.9999567
## [13] 0.9999514 0.9999953 0.9998937 0.9999722 0.9999941 0.9999950
## [19] 0.9999859 0.9999941 0.9999210 0.9999955 0.9967347 0.9999954
## [25] 0.9999439 0.9940828 0.9909297 0.9999684 0.9999955 0.9999923
## [31] 0.9999951 0.9999941 0.9999920 0.9999901 0.9999926 0.9999742
## [37] 0.9999826 0.9999950 0.9999870 0.9999703 0.9999925 0.9999933
## [43] 0.9999537 0.9999550 0.9999841 0.9999951 0.9999762 0.9999953
## [49] 0.9999166 0.9998856 0.9999714 0.9999675 0.9999110 0.9999711
## [55] 0.9999924 0.9999918 0.9999672 0.9999944 0.9999380 0.9999952
## [61] 0.9999945 0.9999944 0.9999890 0.9999945 0.9999928 0.9999769
## [67] 0.9999020 0.9999905 0.9999888 0.9993425 0.9999217 0.9997596
## [73] 0.9999737 0.9669421 0.9999945 0.9999561 0.9999730 0.9999677
## [79] 0.9917355 0.9992284 0.9999929 0.9999604 0.9999949 0.9999732
## [85] 0.9999958 0.9999668 0.9999486 0.9999010 0.9993591 0.9999851
## [91] 0.9994715 0.9999482 0.9995274 0.9999942 0.9999825 0.9999929
## [97] 0.9999943 0.9999639 0.9999808 0.9999907 0.9999914 0.9997313
## [103] 0.9999471 0.9999896 0.9994835 0.9999646 0.9958377 0.9999959
## [109] 0.9997805 0.9999949 0.9999872 0.9999948 0.9979339 0.9999837
## [115] 0.8400000 0.9999930 0.9998071 0.9999727 0.9989250 0.9998291
## [121] 0.9997988 0.9999955 0.9999939 0.9999666 0.9945130 0.9999943
## [127] 0.9999039 0.9999946 0.9999876 0.9999633 0.9999855 0.9999892
## [133] 0.9930556 0.9999899 0.9999948 0.9999902 0.9999869 0.9999490
## [139] 0.9999426 0.9999915 0.9999740 0.9999937 0.9999670 0.9999250
## [145] 0.9999910 0.9999564 0.9999899 0.9999933 0.9998335 0.9999833
## [151] 0.9999497 0.9999784 0.9999188 0.9999947 0.9999957 0.9999937
## [157] 0.9999690 0.9999931 0.9998765 0.9999943 0.9999932 0.9999886
## [163] 0.9999959 0.9999791 0.9999925 0.9999578 0.9981892 0.9999912
## [169] 0.9991089 0.9999867 0.9999767 0.9999816 0.9999889 0.9999877
## [175] 0.9999443 0.9822222 0.9999946 0.9999780 0.9999796 0.9999935
## [181] 0.9999949 0.9999451 0.9999953 0.9999862 0.9999904 0.9999783
## [187] 0.9999493 0.9998844 0.9999955 0.9999955 0.9996230 0.9999923
## [193] 0.9999840 0.9999842 0.9999911 0.9998599 0.9999350 0.9999918
## [199] 0.9999947 0.9999959 0.9999960 0.9983340 0.9999952 0.9999957
## [205] 0.9999893 0.9997222 0.9999955 0.9999771 0.9999949 0.9999954
## [211] 0.9999614 0.9995473 0.9999747 0.9999323 0.9999048 0.9999952
## [217] 0.9999946 0.9997772 0.9999934 0.9990817 0.9999795 0.9999746
## [223] 0.9999768 0.9999531 0.9999846 0.9999695 0.9999723 0.9998868
## [229] 0.9999829 0.9999799 0.9981096 0.9999942 0.9999934 0.9999288
## [235] 0.9999576 0.9994592 0.9999929 0.9999896 0.9999755 0.9999360
## [241] 0.9999818 0.9999939 0.9999884 0.9997869 0.9999612 0.9998198
## [247] 0.9999835 0.9763314 0.9999951 0.9999269 0.9999949 0.9999501
## [253] 0.9991349 0.9999782 0.9999394 0.9999953 0.9999939 0.9999203
## [259] 0.9999955 0.9999075 0.9999781 0.9999143 0.9999949 0.9999911
## [265] 0.9998831 0.9985760 0.9999942 0.9999786 0.9994051 0.9996975
## [271] 0.9999931 0.9999914 0.9999931 0.9998892 0.9999644 0.9999630
## [277] 0.9999955 0.9999885 0.9999882 0.9999696 0.9998269 0.9999950
## [283] 0.9999952 0.9999849 0.9999660 0.9999734 0.9999890 0.9999547

```

```

## [289] 0.9987689 0.9999824 0.9999903 0.9994331 0.9999778 0.9999892
## [295] 0.9999891 0.9999852 0.9997356 0.9999945 0.9997633 0.9998959
## [301] 0.9999790 0.9999805 0.9936000 0.9999930 0.9995835 0.9999938
## [307] 0.9999916 0.9999939 0.9999857 0.9999933 0.9998738 0.9991837
## [313] 0.9999599 0.9998016 0.9999719 0.9995170 0.9999679 0.9999897
## [319] 0.9999698 0.9999925 0.9999933 0.9999736 0.9999181 0.9999897
## [325] 0.9999940 0.9999909 0.9999929 0.9999553 0.9999960 0.9999915
## [331] 0.9999894 0.0000000 0.9999860 0.9999231 0.9999624 0.9999584
## [337] 0.9999919 0.9999831 0.9999686 0.9999947 0.9999947 0.9999938
## [343] 0.9963269 0.9998123 0.9999883 0.9999858 0.9999897 0.9998969
## [349] 0.9997669 0.9996372 0.9999940 0.9997268 0.9999521 0.9993903
## [355] 0.9999688 0.9999923 0.9999921 0.9999708 0.9999937 0.9998457
## [361] 0.9999888 0.9999940 0.9998377 0.9999942 0.9998806 0.9999717
## [367] 0.9999913 0.9999928 0.9999934 0.9999941 0.9999923 0.9999459
## [373] 0.9999936 0.9999706 0.9999810 0.9999635 0.9999936 0.9999887
## [379] 0.9998648 0.9976205 0.9999853 0.9999306 0.9999282 0.9999956
## [385] 0.9999904 0.9999841 0.9999586 0.9999915 0.9999960 0.9999528
## [391] 0.9999648 0.9999900 0.9999956 0.9999933 0.9999917 0.9999828
## [397] 0.9999385 0.9999960 0.9999752 0.9995919 0.9999882 0.9999738
## [403] 0.9999959 0.9999926 0.9999935 0.9999877 0.9960938 0.9999370
## [409] 0.9999908 0.9999951 0.9993253 0.9999817 0.9506173 0.9999928
## [415] 0.9999745 0.9999750 0.9999856 0.9999911 0.9999869 0.9998313
## [421] 0.9999826 0.9999954 0.9999884 0.9998752 0.9999741 0.9999937
## [427] 0.9999776 0.9999763 0.9999870 0.9999947 0.9999916 0.9999808
## [433] 0.9980247 0.9999936 0.9999879 0.9996000 0.9999936 0.9999907
## [439] 0.9998990 0.9999430 0.9999775 0.9999950 0.9999884 0.9999815
## [445] 0.9999817 0.9999881 0.9988509 0.9999903 0.9998513 0.9999811
## [451] 0.9996506 0.9992065 0.9999798 0.8888889 0.9999941 0.9999237
## [457] 0.9999916 0.9999334 0.9999853 0.9999943 0.9999744 0.9999960
## [463] 0.9999919 0.9999957 0.9996694 0.9999927 0.9999592 0.9999602
## [469] 0.9843750 0.9999863 0.9999958 0.9999878 0.9999942 0.9999910
## [475] 0.9999573 0.9999943 0.9999619 0.9999873 0.9999597 0.9999764
## [481] 0.9992695 0.9999641 0.9999948 0.9999940 0.9999683 0.9999837
## [487] 0.9999467 0.9999893 0.9999959 0.9999928 0.9999813 0.9999830
## [493] 0.9999875 0.9999934 0.9997175 0.9999681 0.9999953 0.9999479
## [499] 0.9999951 0.9999880 0.9998948 0.9992494 0.9999733 0.9999936
## [505] -3.0000000 0.9999956 0.9999404 0.9999724 0.9995375 0.9999951
## [511] 0.9999945 0.9999895 0.9999000 0.9999944 0.9999950 0.9999196
## [517] 0.9999823 0.9999720 0.9999867 0.9995568 0.9999857 0.9999875
## [523] 0.9999899 0.9999751 0.9999838 0.9999556 0.9999902 0.9999821
## [529] 0.9999898 0.9999831 0.9999952 0.9999868 0.9996922 0.9952438
## [535] 0.9998548 0.9999906 0.9999908 0.9999906 0.9999959 0.9999540
## [541] 0.9999920 0.9999943 0.9999244 0.9999832 0.9997559 0.9999294
## [547] 0.9999890 0.9999691 0.9999958 0.9999923 0.9999957 0.9999933
## [553] 0.9993750 0.5555556 0.9999843 0.9999914 0.9999957 0.9999887
## [559] 0.9999952 0.9999959 0.9999958 0.9999774 0.9999801 0.9999930
## [565] 0.9999915 0.9999945 0.9999860 0.9999422 0.9999656 0.9999954
## [571] 0.9998398 0.9999953 0.9998709 0.9999932 0.9999959 0.9999916
## [577] 0.9999700 0.9998149 0.9999518 0.9999800 0.9999948 0.9978367
## [583] 0.9998926 0.9999931 0.9999865 0.9999956 0.9999874 0.9998044
## [589] 0.9998819 0.9996811 0.9999957 0.9999709 0.9999955 0.9999765
## [595] 0.9998222 0.9999754 0.9969136 0.9999894 0.9999793 0.9999912
## [601] 0.9999910 0.9999947 0.9999861 0.9999939 0.9999834 0.9999375
## [607] 0.9999895 0.9997127 0.9997900 0.9999844 0.9999813 0.9999355

```

```

## [613] 0.9999956 0.9999534 0.9999917 0.9999311 0.9999849 0.9999959
## [619] 0.9999885 0.9998880 0.9999543 0.9999328 0.9999935 0.9999952
## [625] 0.9999626 0.9999803 0.9999880 0.9999938 0.9985207 0.9999895
## [631] 0.9999317 0.9993075 0.9997837 0.9999772 0.9999662 0.9999757
## [637] 0.9999900 0.9998694 0.9999861 0.9999819 0.9999919 0.9999904
## [643] 0.9999927 0.9999953 0.9999954 0.9999957 0.9999093 0.9999455
## [649] 0.9999911 0.9999504 0.9999935 0.9999770 0.9999909 0.9999792
## [655] 0.9998904 0.9999859 0.9999652 0.9999617 0.9999820 0.9999922
## [661] 0.9999447 0.9999924 0.9999806 0.9999927 0.9999872 0.9999956
## [667] 0.9999847 0.9999942 0.9999925 0.9999926 0.9999300 0.9999224
## [673] 0.9999854 0.9999950 0.9999879 0.9999628 0.9999917 0.9999637
## [679] 0.9999957 0.9999701 0.9998679 0.9999929 0.9999855 0.9999589
## [685] 0.9990234 0.9999931 0.9999958 0.9999581 0.9999881 0.9999878
## [691] 0.9998246 0.9999908 0.9999891 0.9965398 0.9999922 0.9999797
## [697] 0.9999263 0.9999925 0.9999839 0.9999820 0.9999951 0.9999594
## [703] 0.9999873 0.9999901 0.9999905 0.9999127 0.9999621 0.9999939
## [709] 0.9999918 0.9999559 0.9999920 0.9999948 0.9999958 0.9999664
## [715] 0.9999876 0.9999940 0.9998418 0.9998583 0.9999960 0.9987245
## [721] 0.9999417 0.9986777 0.9995749 0.9999885 0.9999903 0.9999954
## [727] 0.9996440 0.9999937 0.9999827 0.9999944 0.9999954 0.9999949
## [733] 0.9999276 0.9999809 0.9999932 0.9999802 0.9999946 0.9999902
## [739] 0.9998792 0.9999901 0.9999937 0.9999908 0.9999872 0.9999788
## [745] 0.9999934 0.9999947 0.9900000 0.9999712 0.9984000 0.9999883
## [751] 0.9999135 0.9999876 0.9999958 0.9999938 0.9999791 0.9999958
## [757] 0.9999928 0.9999912 0.9999927 0.9999365 0.9998616 0.9999871
## [763] 0.9998779 0.7500000 0.9183673 0.9999929 0.9996867 0.9999839
## [769] 0.9992889 0.9997739 0.9999940 0.9999879 0.9999915 0.9999029
## [775] 0.9999922 0.9999749 0.9999390 0.9988109 0.9998723 0.9999934
## [781] 0.9999944 0.9999932 0.9999084 0.9999802 0.9999850 0.9889197
## [787] 0.9999953 0.9999904 0.9999435 0.9999773 0.9999943 0.9996754
## [793] 0.9999570 0.9999956 0.9999953 0.9999906 0.9999955 0.9999935
## [799] 0.9999729 0.9984621 0.9998356 0.9982639 0.9999930 0.9999726
## [805] 0.9999948 0.9998494 0.9999946 0.9999935 0.9999945 0.9999919
## [811] 0.9999891 0.9973702 0.9999874 0.9999952 0.9999912 0.9999151
## [817] 0.9999957 0.9999942 0.9999938 0.9999779 0.9999673 0.9996155
## [823] 0.9999864 0.9999959 0.9955556 0.9999926 0.9999887 0.9999463
## [829] 0.9999865 0.9999654 0.9999118 0.9996302 0.9600000 0.9999939
## [835] 0.9998174 0.9997480 0.9999408 0.9999913 0.9998098 0.9996079
## [841] 0.9995660 0.9999948 0.9722222 0.9999804 0.9970782 0.9999835
## [847] 0.9999102 0.9994950 0.9999941 0.9999894 0.9999886 0.9999829
## [853] 0.9999658 0.9999954 0.9999955 0.9999958 0.9999956 0.9999938
## [859] 0.9999848 0.9996571 0.9999524 0.9999959 0.9999918 0.9999946
## [865] 0.9999922 0.9999948 0.9999787 0.9999607 0.9999906 0.9999836
## [871] 0.9999900 0.9999960 0.9999913 0.9999951 0.9998476 0.9998566
## [877] 0.9999693 0.9999941 0.9999930 0.9999822 0.9999921 0.9999893
## [883] 0.9997959 0.9999924 0.9999942 0.9999956 0.9999716 0.9994194
## [889] 0.9999882 0.9999858 0.9999864 0.9999066 0.9999951 0.9997027
## [895] 0.9999921 0.9999952 0.9999957 0.9999814 0.9999174 0.9999862
## [901] 0.9975000 0.9999910 0.9999344 0.9997078 0.9999399 0.9999958
## [907] 0.9999871 0.9999950 0.9999953 0.9999898 0.9986283 0.9972299
## [913] 0.9999957 0.9998438 0.9999945 0.9999807 0.9998915 0.9999158
## [919] 0.9999944 0.9999905 0.9997440 0.9989922 0.9375000 0.9999948
## [925] 0.9999844 0.9999413 0.9999951 0.9999936 0.9999922 0.9999896
## [931] 0.9999889 0.9999927 0.9999854 0.9988889 0.9999850 0.9999932

```

```

## [937] 0.9977324 0.9999947 0.9998632 0.9999609 0.9999900 0.9999511
## [943] 0.9999938 0.9999954 0.9999950 0.9999475 0.9999759 0.9999508
## [949] 0.9999843 0.9994464 0.9999924 0.9997520 0.9999931 0.9948980
## [955] 0.9861592 0.9999650 0.9999920 0.9999956 0.9999756 0.9999917
## [961] 0.9997704 0.9999957 0.9924386 0.9999339 0.9999794 0.9876543
## [967] 0.9999760 0.9999812 0.9999950 0.9999833 0.9998664 0.9999761
## [973] 0.9999847 0.9999958 0.9999920 0.9999705 0.9795918 0.9999863
## [979] 0.9998980 0.9999907 0.9990533 0.9999921 0.9999954 0.9998531
## [985] 0.9999866 0.9989594 0.9999845 0.9999949 0.9995062 0.9999785
## [991] 0.9999057 0.9999926 0.9999959 0.9999898 0.9997399 0.9999909
## [997] 0.9999852 0.9997930 0.9996633 0.9999946

```

4)

```

u=runif(1000,0,1)
pt=qpareto(u,2,2)
ecdf(pt)

```

```

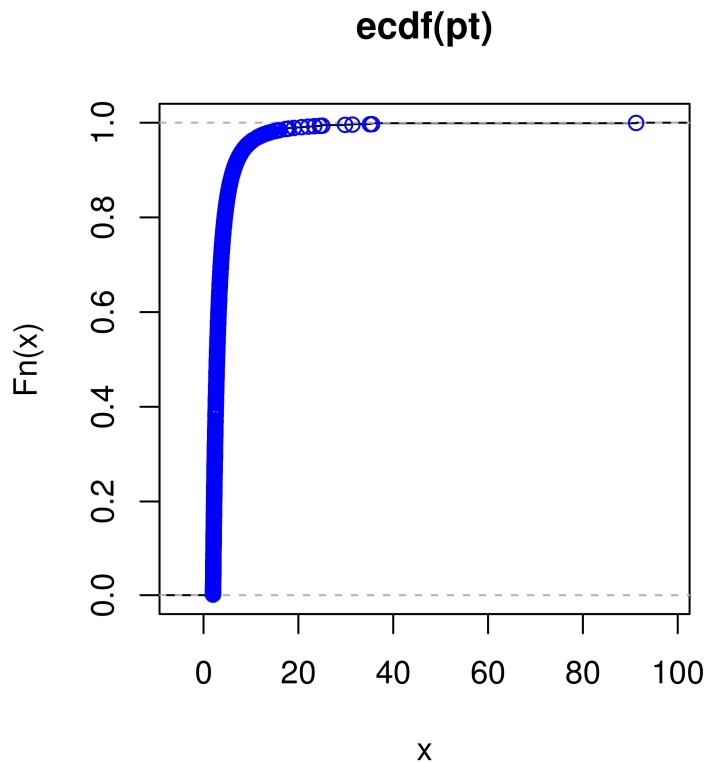
## Empirical CDF
## Call: ecdf(pt)
## x[1:1000] = 2.0011, 2.0027, 2.003, ..., 35.557, 91.22

```

```

ft=ppareto(pt,2,2)
plot(ecdf(pt))
points(pt,ft,col="blue")

```



## II. Beta(2,2)

- 5) The smallest possible c for an acceptance/rejectance approach based on a Unif(0,1) proposal distribution is 1.5

6

```
n <- 1000
k <- 0
j <- 1500
y <- numeric(n)
while (k < n) {
  u <- runif(1)
  j <- j + 1
  x <- runif(1)
  if (x * (1-x) > u) {

    k <- k + 1
    y[k] <- x
  }
}
j
```

```
## [1] 7422
```

Rizzo uses a c value of 6 which is 6000 iterations, and since 1.5 is the smallest value for C, we get 1500 iterations instead. This is more efficient because its the same but with less iterations.

7)

```
set.seed(20)
n <- 1000
k <- 0
j <- 0
y <- numeric(n)
while (k < n) {
  u <- runif(1)
  j <- j + 1
  x <- runif(1)
  if ((6/1.3) * (x * (1-x) > u)) {

    k <- k + 1
    y[k] <- x
  }
}
j
```

```
## [1] 5923
```

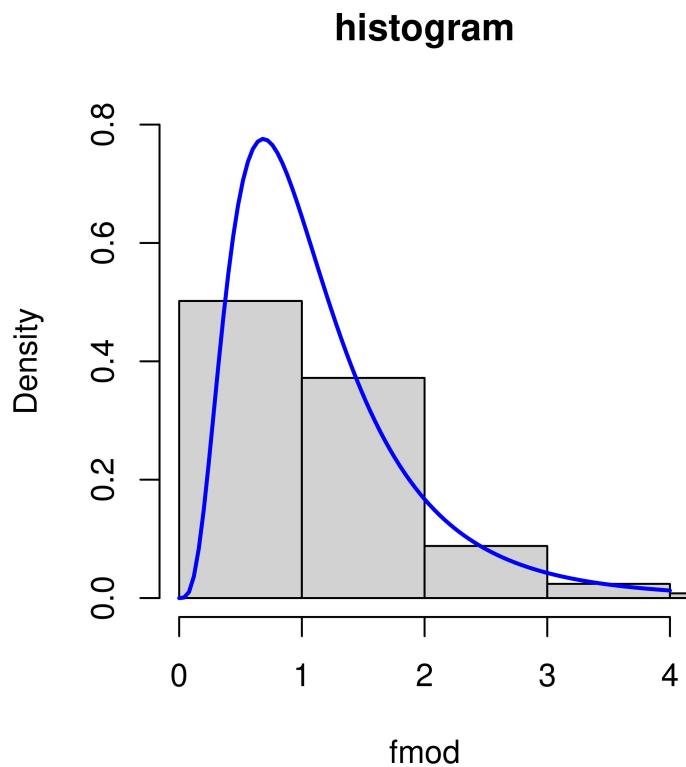
- 8) Guassian and normal is the best algorithm fo rthis scenario since normal and beta(2,2) are similar in density.

9)

```
a = rchisq(1000, df=10)
b = rchisq(1000, df=12)
fmod = (a/10)/(b/12)
```

10)

```
x <- seq(0,1000)
hist(fmod, freq=FALSE, xlim = c(0,4), ylim = c(0,.8), main = 'histogram')
curve(df(x, df1=10, df2=12), from=0, to=4, col='blue', lwd=2, add = T)
```



11)

```
numbobs <- 1000
mix <- sample(c(0,1), size = numbobs, replace=TRUE, prob = c(.75,.25))
a <- rnorm(1000,0,1)
b <- rnorm(1000,3,1)
mixture_sim <- ifelse(mix, a,b)
head(cbind(mix,a,b,mixture_sim))
```

```
##      mix          a          b mixture_sim
## [1,] 0 -0.09850228 4.431357    4.431357
```

```

## [2,] 0 1.19782408 4.488353 4.488353
## [3,] 0 -0.33207820 4.607240 4.607240
## [4,] 0 0.34653841 5.141011 5.141011
## [5,] 0 1.65836073 1.649214 1.649214
## [6,] 0 -0.65015498 1.788871 1.788871

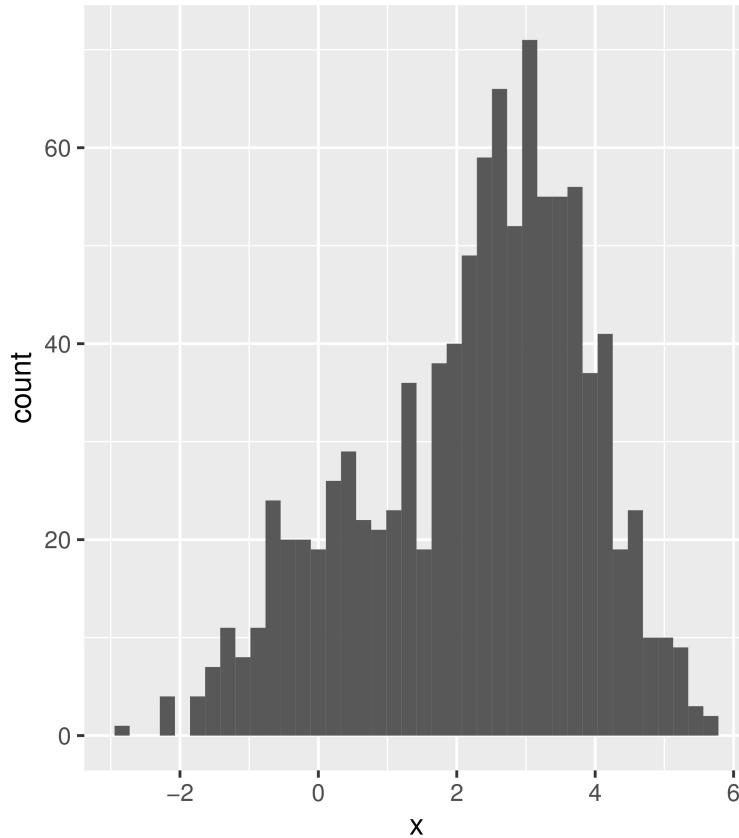
```

12)

```

library(ggplot2)
mixture_sim <- data.frame(x=mixture_sim)
ggplot(mixture_sim) + geom_histogram(aes(x=x, ..count..), bins=40)

```



13) When  $p_1$  is below .5, the graph is right skewed, greater than .5 it is left skewed.

14)

```

set.seed(1234)
rzip <- function(n, lambda,p){
for(i in seq_len(n))
u <- sample(0:1, size = n, replace = TRUE, prob = c(1-p,p))
pick <- c(n)
pick[which(u==1)] <- rpois(sum(u), lambda)
pick[which(u==0)] <- 0
return(pick)
}
rzip(100,1,.2)

```

} 16) The best guess for the maximum number of squirrels across all sites will be 4

17) The max for number of squirrels at one site will be 3