CompProject2

Patrick Wong

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MATH 324 Computer Project 2

Algorithm 1: Generate 500 Sample Means from Sample Size n and for a Particular Distribution

I)

```
library(ggplot2)
a <- 0
b <- 5
sample_size <- 500
numList <- runif(sample_size, min = a, max = b)
```

II)

```
number_trials <- 15
p <- 0.2
rbinom(sample_size, size = number_trials, prob = p)
```

```
##   [1] 1 4 2 5 2 3 1 4 2 2 3 3 4 1 3 3 2 5 3 4 6 3 1 3 1 3 4 3 2 4 6 0 3 1 3
##  [36] 3 4 4 2 1 3 2 1 1 4 4 3 3 8 3 2 3 2 2 3 4 3 2 1 3 2 2 4 0 5 3 2 4 1 2
##  [71] 3 6 3 3 5 3 4 5 3 1 2 1 3 3 3 3 4 4 3 3 5 6 2 2 4 2 2 2 3 3 4 0 4 3 4
## [106] 4 3 2 2 3 2 3 4 3 2 3 2 4 4 3 3 3 1 3 2 1 2 1 1 5 2 6 1 3 3 2 2 6 4 4
## [141] 5 5 4 2 1 3 3 5 5 2 1 3 3 3 7 4 4 4 1 4 4 1 3 4 4 4 4 2 7 6 3 0 2 3 1
## [176] 2 2 3 2 3 3 1 3 5 3 7 3 3 2 4 5 3 2 2 3 2 1 4 2 4 4 3 4 3 0 0 4 4 1 1
## [211] 2 5 3 3 2 1 4 3 4 0 2 1 3 3 1 2 2 3 2 2 2 1 4 3 4 4 0 2 1 2 4 3 5 7 4
## [246] 5 3 2 4 3 2 3 6 4 4 4 2 3 4 3 3 3 7 4 3 4 2 4 4 3 0 1 6 6 3 4 4 5 3 3
## [281] 0 2 1 2 2 4 3 5 4 3 3 4 3 6 5 3 2 2 6 1 1 4 3 2 5 3 2 5 3 3 2 2 2 2 5
## [316] 2 3 2 5 3 4 5 5 1 4 4 3 2 5 5 3 1 0 2 3 3 3 4 1 3 2 3 5 2 6 3 1 3 2 3
## [351] 3 5 2 4 3 4 4 6 2 2 6 4 4 4 5 1 2 2 3 3 6 4 2 2 4 0 2 3 0 3 1 6 4 3 4
## [386] 5 6 3 1 1 3 5 3 1 2 2 4 4 3 2 4 3 3 4 2 2 2 2 0 4 3 2 4 3 3 2 3 3 4 5
## [421] 2 4 2 3 3 3 1 3 4 7 3 0 2 2 3 1 1 4 4 4 2 3 4 5 4 1 2 3 3 3 2 2 1 4 2
## [456] 4 7 3 6 0 4 3 2 6 3 1 2 5 4 4 4 4 4 3 2 3 4 3 4 7 5 1 5 5 3 6 3 1 4 4
## [491] 3 3 2 2 3 3 5 4 4 5
```

III)

```
lambda <- 5
rexp(sample_size, rate = lambda)
```

```
##   [1] 0.0019107054 0.4201690230 0.3318996612 0.0431219182 0.4009602088
##   [6] 0.0463301805 0.0910920604 0.2064009894 0.3478588424 0.0010544583
##  [11] 0.1155011185 0.2987908218 0.0118574449 0.0473160685 0.1882732377
##  [16] 0.1190376719 0.1882076705 0.2193167392 0.0029745582 0.1209280009
##  [21] 0.2126267802 0.1498052737 0.4731566768 0.3352276344 0.0444005596
```

```
##  [26] 0.0066862175 0.2129860578 0.3670530640 0.2481731163 0.3868758450
##  [31] 0.6841604367 0.4165272217 0.3498154968 0.3065300938 0.2996473456
##  [36] 0.2860962666 0.2096968247 0.1831967715 0.1582432572 0.0272152007
##  [41] 0.3023330301 0.0525609137 0.1866131280 0.1206402936 0.0559466835
##  [46] 0.0189363195 0.1653125708 0.0289699710 0.1708079820 0.1375477267
##  [51] 0.3974039998 0.0036131401 0.3949839555 0.0017857127 0.1710143318
##  [56] 0.1343683231 0.1064533355 0.1703844504 0.1148092755 0.1054663744
##  [61] 0.5311700616 0.0445968266 0.0414461050 0.2160095567 0.2421425074
##  [66] 0.6126809552 0.7025955390 0.3302360235 0.3953922640 0.1186891168
##  [71] 0.0249511294 0.1724238171 0.0352424822 0.0505403391 0.0039232573
##  [76] 0.0480371978 0.2123900577 0.5121587690 0.0217362154 0.2063517576
##  [81] 0.2187186317 0.0160211263 0.0357972632 0.3237105135 0.0112515298
##  [86] 0.1903222874 0.0157056183 0.0912172026 0.0013387285 0.0113645122
##  [91] 0.0540246963 0.0158809686 0.0846755264 0.1273769959 0.1780406540
##  [96] 0.3177399498 0.0848136266 0.9041144348 0.0276699775 0.1118453692
## [101] 0.6548083269 0.3314377650 0.1156929026 0.1155466737 0.7354299675
## [106] 0.2124318290 0.3594015762 0.1003094560 0.2244466178 0.3859127838
## [111] 0.2473626142 0.0189453590 0.0852761830 0.8756216186 0.5420659747
## [116] 0.5905803248 0.6356762205 0.0571492663 0.1398422690 0.0964908419
## [121] 0.0708351600 0.0164150864 0.1815793801 0.0262747132 0.0561153186
## [126] 0.0179825187 0.0626586455 0.0171554215 0.2725059885 0.0004615852
## [131] 0.1290806551 0.7321396618 0.0115759766 0.2259230321 0.2453789717
## [136] 0.7352554839 0.0372461653 0.0679151639 0.0374193113 0.0052371522
## [141] 0.1779598617 0.2223929198 0.0003580065 0.2463730583 0.0271421803
## [146] 0.0250354265 0.1430248881 0.0458751167 0.1428376466 0.2673511792
## [151] 0.4286758747 0.3272829614 0.0206323705 0.0418905756 0.1505908331
## [156] 0.4085279956 0.1279449984 0.2197185696 0.0715569418 0.0038842663
## [161] 0.1406502008 0.1977719562 0.0786669463 0.4044135880 0.3309170615
## [166] 0.1292011780 0.0380026428 0.2792357176 0.0501752011 0.0541876306
## [171] 0.4107179794 0.0757416633 0.0774169415 0.0269808934 0.1166872901
## [176] 0.3653823782 0.5221398385 0.0736918260 0.6213821296 0.0018710147
## [181] 0.0472204508 0.0006512695 0.2714276805 0.0400693468 0.1431355225
## [186] 0.0924657370 0.3085774600 0.3828989290 0.6154253221 0.1037740580
## [191] 0.2976604817 0.2412314430 0.0669854328 0.2159645801 0.0297015971
## [196] 0.1470686558 0.2139286823 0.0838392376 0.0858195789 0.7758866798
## [201] 0.6680598393 0.0549799888 0.6055252232 0.1235317126 0.0585746101
## [206] 0.5357005823 0.1243937614 0.1056475252 0.1989031538 0.0135780485
## [211] 0.3684097607 0.3158193212 0.2252874650 0.0202688460 0.1948038509
## [216] 0.2980390799 0.4283848777 0.2817259200 0.0866557649 0.1473665427
## [221] 0.6081723898 0.5600007210 0.1828213237 0.2358054953 0.0825652711
## [226] 0.3802435092 0.0444414482 0.0820031996 0.7940821718 0.3947457131
## [231] 0.1145934460 0.1943106826 0.0375734174 0.3757090855 0.0847482337
## [236] 0.0563536500 0.1999155389 0.5357739199 0.0331289450 0.0317612683
## [241] 0.2196450246 0.1139102989 0.1024517176 0.3461116873 0.0417871012
## [246] 0.6698093220 0.0102231760 0.2639271278 0.1643526343 0.0297413852
## [251] 0.0650223074 0.1377626624 0.0607223419 0.4417823272 0.1047229436
## [256] 0.1518801961 0.0964869276 0.1197815010 0.1952336825 0.0873161786
## [261] 0.0707066671 0.7105953178 0.2240696909 0.0703588725 0.1312245387
## [266] 0.0074438852 0.0114264123 0.2554966973 0.4222145584 0.0119362277
## [271] 0.0014172633 0.1246443911 0.2642471885 0.1122201241 0.1427946668
## [276] 0.1373886288 0.2282276772 0.2425608294 0.0054713217 0.0666004974
## [281] 0.2257128370 0.3103093549 0.3339200072 0.1319157072 0.0212699593
## [286] 0.3812151871 0.2822147328 0.0134013337 0.1552821333 0.0693282742
## [291] 0.0552843016 0.1506189041 0.0775945165 0.3789642405 0.0435015309
```

```
## [296] 0.0153393967 0.0458300352 0.0774377878 0.0152555746 0.5344570908
## [301] 0.0982940386 0.1253222813 0.0232479831 0.0872305406 0.1006433005
## [306] 0.0690980696 0.0135248936 0.0288338174 0.0394551047 0.1969959931
## [311] 0.2297012297 0.1131019364 0.3421438351 0.3979971796 0.5985183686
## [316] 0.4349977739 0.1185825028 0.4826541867 0.1503132196 0.2882184636
## [321] 0.3194972046 0.1213255178 0.0388862954 0.1130943870 0.2022047871
## [326] 0.3800270095 0.2311410628 0.0275176536 0.3853468355 0.1510600232
## [331] 0.1559868362 0.2152891412 0.0204857281 0.0632761868 0.0373260891
## [336] 0.0624380080 0.0381596228 0.3699015625 0.1258055411 0.1405666250
## [341] 0.0321962336 0.0193778477 0.5094316030 0.0342428171 0.0812629730
## [346] 0.2441098211 0.1197108405 0.1967247587 0.4951952729 0.3856261249
## [351] 0.0146866771 0.2391370645 0.0677833471 0.3545995809 0.0430113480
## [356] 0.5496323962 0.3247117650 0.1025679022 0.0059794069 0.2726840632
## [361] 0.0623976096 0.0523733722 0.5633120766 0.0660354545 0.2901746507
## [366] 0.2112591661 0.2014016937 0.0002599683 0.0541953941 0.2766939780
## [371] 0.3615551174 0.1633459392 0.3824830618 0.0394720240 0.5201362613
## [376] 0.3401486410 0.1510541864 0.5293260600 0.3719997968 0.5635354697
## [381] 0.2720041688 0.0961380968 0.2098754825 0.0433321815 0.1622643182
## [386] 0.0874829487 0.4029931836 0.2011015473 0.0980810396 0.0014022556
## [391] 0.0194795592 0.0300201469 0.1794087898 0.0280750406 0.2532090930
## [396] 0.1027547834 0.3929210864 0.0756304913 0.1958796009 0.4181230806
## [401] 0.1422897799 0.4269753027 0.1553290157 0.2863650978 0.2295399344
## [406] 0.0932689707 0.0447729519 0.0703338831 0.2511975318 0.6686558500
## [411] 0.2776444002 0.1407149846 0.0515552398 0.0311941634 0.4113012746
## [416] 0.0742701942 0.2962290115 0.6298585742 0.1382528624 0.0846420282
## [421] 0.1137250298 0.2672780236 0.0130405576 0.0388286845 0.2902954638
## [426] 0.0818166218 0.2120010883 0.0643278687 0.3769490715 0.7454344701
## [431] 0.0181119780 0.0984572365 0.0343218913 0.0536150911 0.1856909625
## [436] 0.0690081598 0.2611205092 0.4928464608 0.0841787277 0.1938034331
## [441] 0.2451026000 0.2717465937 0.2522711278 0.1966226153 0.5565143988
## [446] 0.2669047933 0.3495492711 0.2108405851 0.0720600978 0.0499177882
## [451] 0.1214882103 0.0291029158 0.1635672598 0.3258343205 0.1242483656
## [456] 0.0347745858 0.2653720606 0.0843945570 0.0888633075 0.2226639172
## [461] 0.0459567235 0.0455104889 0.0094497327 0.2954185309 0.0714671378
## [466] 0.0356239468 0.1115028374 0.4019631889 0.6736144334 0.0875883645
## [471] 0.1342169423 0.0532718225 0.1554787444 0.3712736688 0.2465470549
## [476] 0.1291863002 0.1240700356 0.0282561156 0.2433329826 0.1759871565
## [481] 0.1748112384 0.0060737679 0.0618006650 0.1307158185 0.2961407844
## [486] 0.0110022580 0.0014008479 0.2646045772 0.0139036551 0.6002461031
## [491] 0.2229730183 0.0741490341 0.2076208713 0.2861582726 0.0832385377
## [496] 0.0023872110 0.4449243067 0.1617381111 0.0049481697 0.1638831742
```

IV)

```
mu <- 2
rpois(sample_size, mu)
```

```
##   [1] 1 1 3 1 2 3 4 2 2 2 1 1 1 2 0 0 1 2 1 2 0 1 1 2 3 2 1 1 3 1 2 1 2 1 0
##  [36] 5 1 3 1 3 1 1 2 3 3 2 3 2 0 2 3 2 5 2 1 3 0 2 0 1 5 1 2 2 5 2 1 3 1 0
##  [71] 4 2 3 3 0 4 6 2 6 2 2 1 3 3 3 3 3 1 4 1 0 0 5 0 4 1 1 1 2 2 4 1 4 0 4
## [106] 3 3 1 3 3 3 1 3 0 1 1 2 1 1 3 1 1 3 3 3 1 0 3 2 2 4 2 3 2 1 2 2 3 3 1
## [141] 0 2 1 2 3 1 3 4 0 3 3 1 0 4 1 5 6 4 2 3 3 2 1 1 4 1 1 1 1 0 2 1 1 3 2
## [176] 2 3 2 0 2 2 3 2 1 3 2 2 0 0 0 1 0 1 3 2 1 2 2 3 1 1 2 3 2 0 2 0 1 2 2
```

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## [211] 1 2 3 3 2 2 2 4 2 2 0 4 4 3 2 2 3 3 2 1 2 0 2 1 3 3 3 4 0 1 2 2 2 0 3
## [246] 3 1 1 4 4 4 3 2 1 6 1 3 4 0 5 0 0 3 2 2 4 1 3 3 3 1 1 0 0 1 3 2 2 0 1
## [281] 1 2 4 2 3 2 6 2 1 3 1 2 4 0 2 5 3 2 3 4 2 3 1 0 3 2 2 2 1 0 1 1 2 2 0
## [316] 2 6 1 1 1 1 3 2 2 2 2 1 1 0 2 1 3 2 1 1 2 2 2 0 1 2 4 1 0 2 3 3 2 2 2
## [351] 1 4 1 0 4 4 1 3 2 0 3 2 3 4 1 0 2 1 0 0 0 1 1 4 3 5 4 0 2 1 3 1 2 3 5
## [386] 2 2 1 2 1 3 1 2 1 3 2 2 2 1 1 3 2 1 3 3 1 1 1 3 4 2 1 1 4 4 2 6 2 1 1
## [421] 4 0 3 1 5 1 2 1 2 3 3 1 2 2 3 0 2 1 5 5 2 1 0 1 3 1 2 2 1 0 1 0 0 2 4
## [456] 2 2 3 1 3 3 3 0 0 2 1 1 1 3 2 3 1 0 1 2 1 1 5 2 1 1 5 4 1 1 2 1 2 1 1
## [491] 1 2 4 5 4 2 1 2 2 3
```

Algorithm)

```
storedData = rep(NA, sample_size)
for (i in 1:sample_size){
  storedData[i] = i
  print(storedData[i])
}
```

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## [1] 1
## [1] 2
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```

Question 1)

```
# if the sample size is 5
n <- 5
simulatedData5 <- matrix(rexp(n*sample_size, lambda), nrow=sample_size, ncol=n)
simMeans5 <- apply(simulatedData5, 1, mean)
sampleMean5 <- round(mean(simMeans5),3);
paste0("sampleMean for n = 5: " , sampleMean5)
```

```
## [1] "sampleMean for n = 5: 0.203"
```

```
theoreticalMean5 <- round(1/lambda,3);
paste0("theoreticalMean for n = 5: ", theoreticalMean5)
```

```
## [1] "theoreticalMean for n = 5: 0.2"
```

```
# if the sample size is 50
m <- 50
simulatedData50 <- matrix(rexp(m*sample_size, lambda), nrow=sample_size, ncol=m)
simMeans50 <- apply(simulatedData50, 1, mean)
```

```
sampleMean50 <- round(mean(simMeans50),3);
paste0("sampleMean for n = 50: " , sampleMean50)
```

```
## [1] "sampleMean for n = 50: 0.199"
```

```
theoreticalMean50 <- round(1/lambda,3);
paste0("theoreticalMean for n = 50: ", theoreticalMean50)
```

```
## [1] "theoreticalMean for n = 50: 0.2"
```

Question 2)

```
## if the sample size is 5
simulatedData5 <- matrix(rexp(n*sample_size, lambda), nrow=sample_size, ncol=n)
simMeans5 <- apply(simulatedData5, 1, mean)
sampleVar5 <- round(var(simMeans5), 3)
paste0("sampleVariance for n = 5: ", sampleVar5)
```

```
## [1] "sampleVariance for n = 5: 0.008"
```

```
theoretcalVar5 <- round((1/lambda)^2/n,3);
paste0("theoreticalVariance for n = 5: ", theoretcalVar5)
```

```
## [1] "theoreticalVariance for n = 5: 0.008"
```

```
## if the sample size is 50
simulatedData50 <- matrix(rexp(m*sample_size, lambda), nrow=sample_size, ncol=m)
simMeans50 <- apply(simulatedData50, 1, mean)
sampleVar50 <- round(var(simMeans50), 3)
paste0("sampleVariance for n = 50: ", sampleVar50)
```

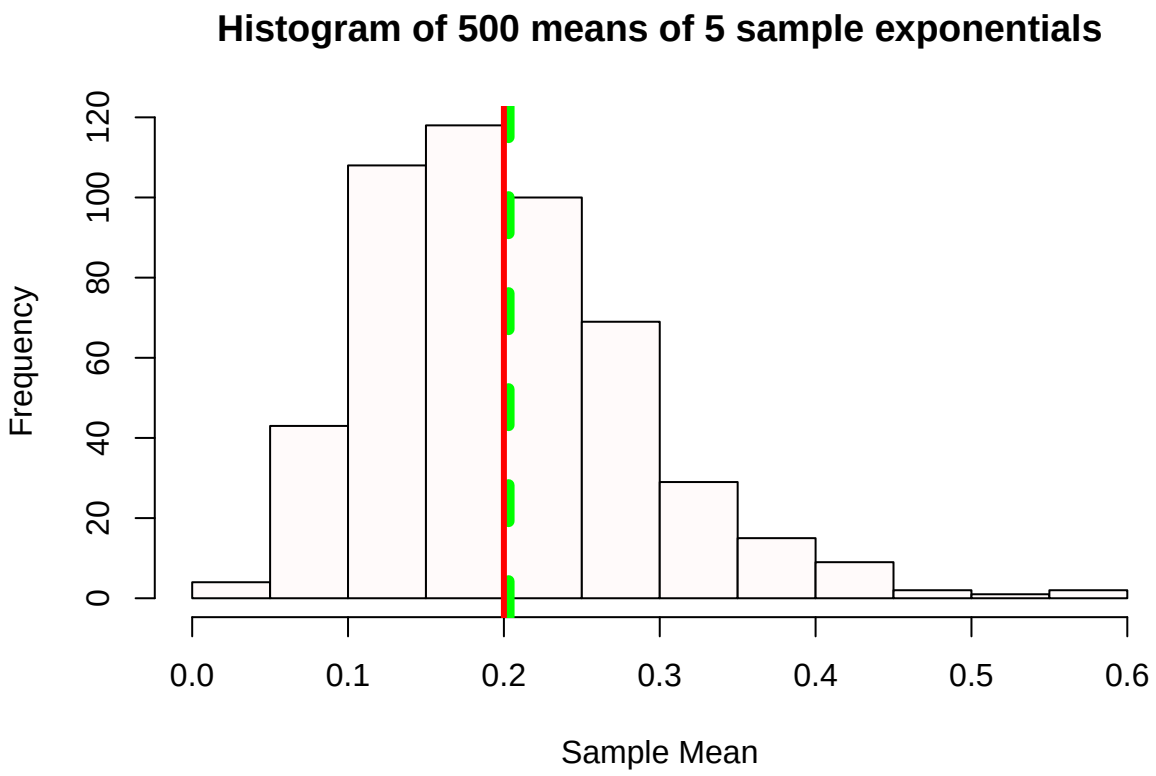
```
## [1] "sampleVariance for n = 50: 0.001"
```

```
theoretcalVar50 <- round((1/lambda)^2/n,3);
paste0("theoreticalVariance for n = 50: ", theoretcalVar50)
```

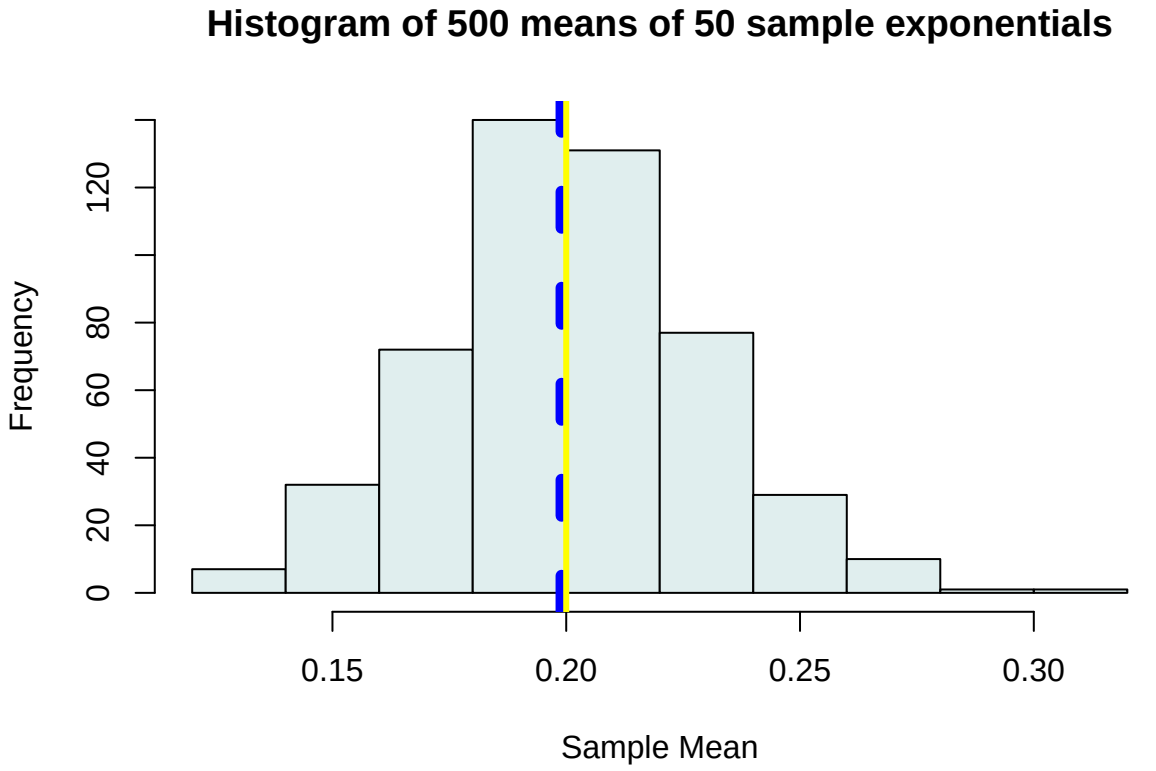
```
## [1] "theoreticalVariance for n = 50: 0.008"
```

Question 3)

```
hist(simMeans5, col="snow", main="Histogram of 500 means of 5 sample exponentials", xlab="Sample Mean",
abline(v=sampleMean5, col="green", lwd=6, lty=2)
abline(v=theoreticalMean5, col="red", lwd=3)
```

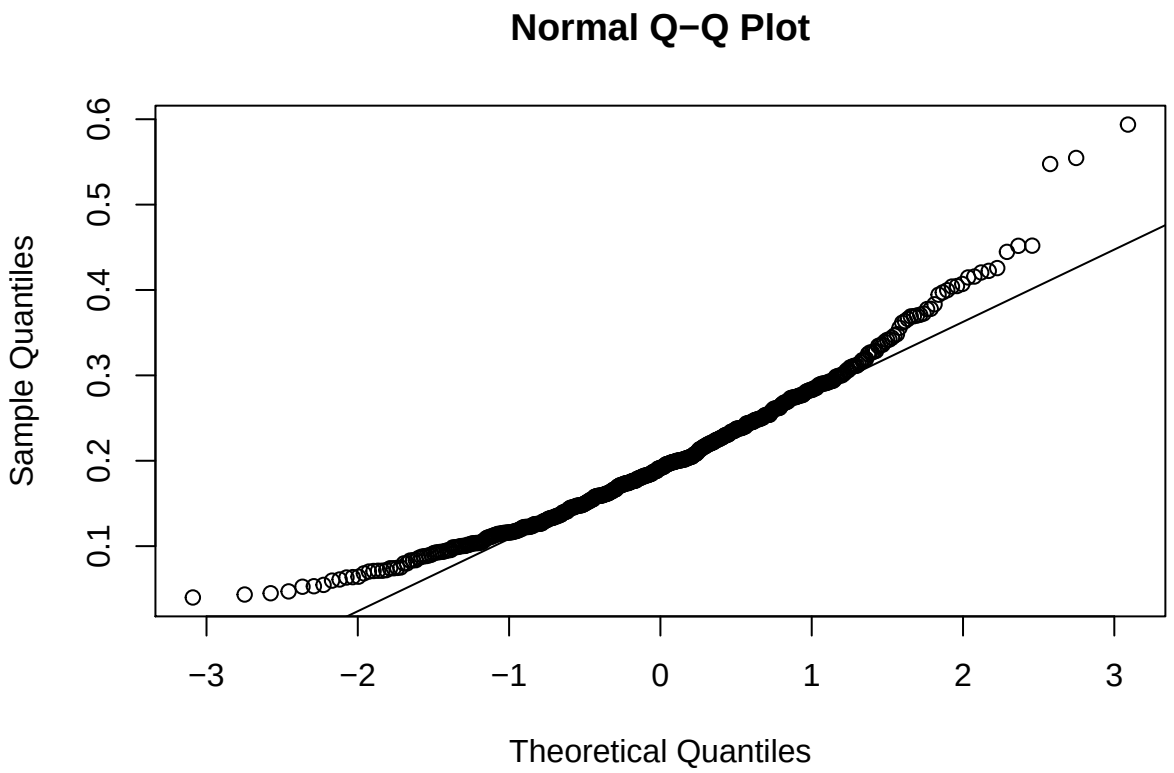



```
hist(simMeans50, col="azure2", main="Histogram of 500 means of 50 sample exponentials", xlab="Sample Mea
abline(v=sampleMean50, col="blue", lwd=6, lty=2)
abline(v=theoreticalMean50, col="yellow", lwd=3)
```

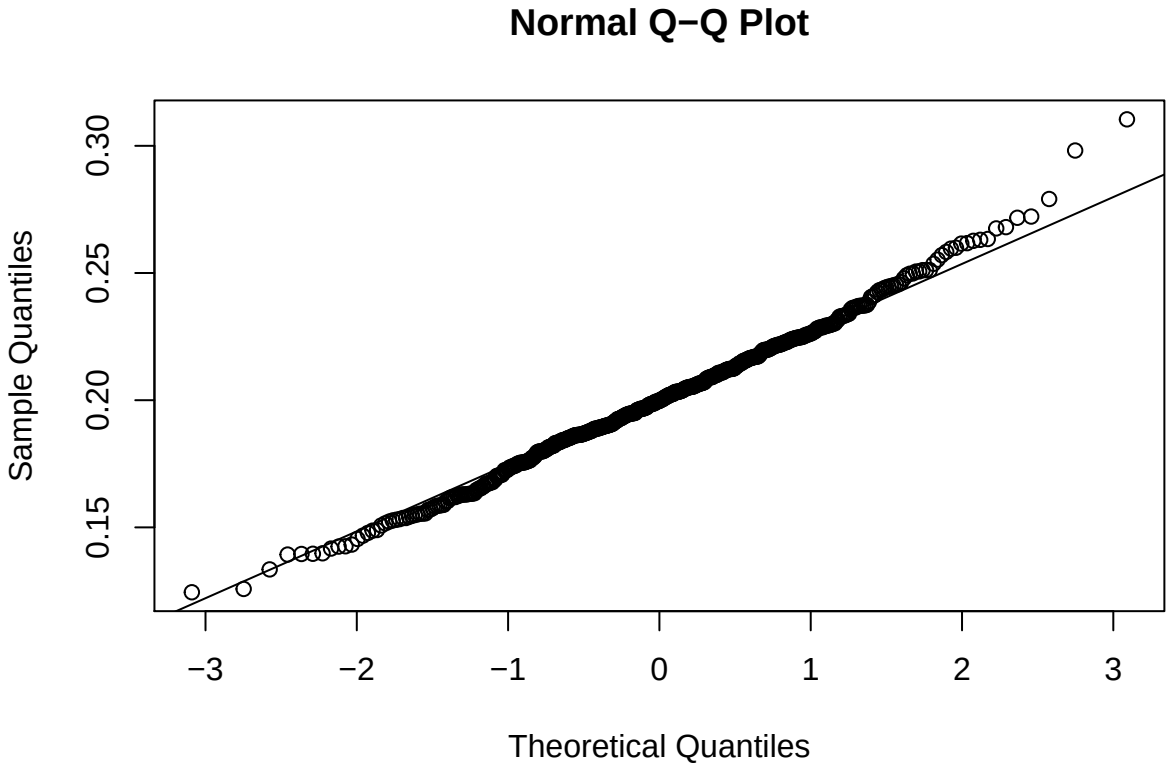


Question 4)

```
qqnorm(simMeans5)
qqline(simMeans5)
```




```
qqnorm(simMeans50)
qqline(simMeans50)
```


Normal Q−Q Plot
Sample Quantiles
0.15
0.20
0.25
0.30
−3
−2
−1
0
1
2
3
Theoretical Quantiles