Scientific Methods for Health Sciences: Applied Inference (HS851): Fall 2014
http://www.socr.umich.edu/people/dinov/2014/Fall/HS851
Homework 1 Solutions

Problem 1: Suppose we have obtained the following measurements. Calculate the corresponding power, specificity and sensitivity.

		Actual Condition	
		Absent (Ho is true)	**Present (H1 is true)**
Test Result	**Negative(fail to reject Ho)**	0.983	0.0025
	Positive (reject Ho)	0.0085	0.0055

Power: 1−(*FN/(* TP+FN*))*= 0.6875
Specificity: TN/(TN+FP) = 0.983/(0.983+0.0085) = 0.9914271
Sensitivity: TP/(TP+FN) = 0.0055/(0.0055+0.0025) = 0.6875

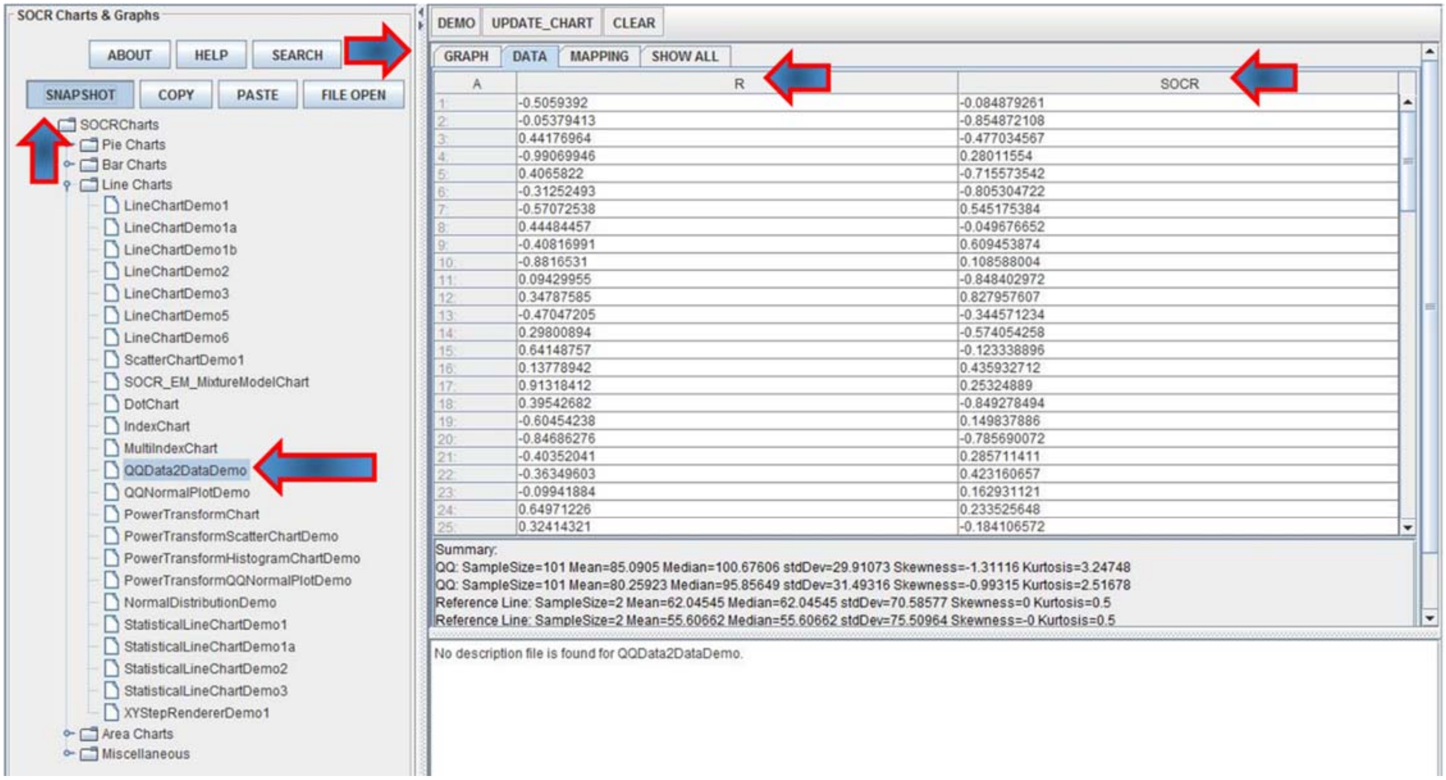
R calculations

```
dat <- matrix(c(0.983,  0.0025, 0.0085, 0.0055), byrow=T, nrow=2)
dat

colnames(dat) <- c('H0 true', 'H1 true')
rownames(dat) <- c('Neg test results', 'Pos test result')
power <- 1-dat[1,2]
specificity <- dat[1,1]/(dat[1,1]+dat[2,1])
sensitivity <- dat[2,2]/(dat[2,2]+dat[1,2])
```

Problem 2: Using R and SOCR, generate 100 random observations from uniform(-1,1), normal(0,1) and exponential(1) distributions. Then Use the SOCR QQ Data-Data Plot to compare the paired samples, i.e., for each distribution, plot the quantiles of the R-generated sample against the SOCR generated sample. What do you expect and what do you see? Explain.

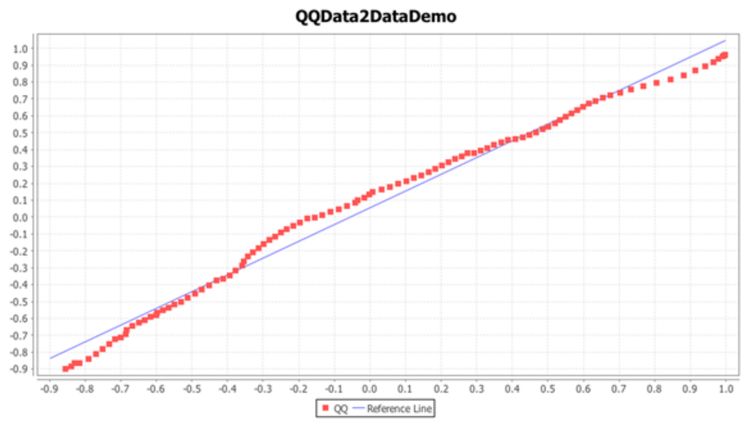
In all cases (uniform(-1,1), normal(0,1) and exponential(1) distributions) we expect to see the QQ plots to be Very linear with the scatter plot of the (R, SOCR) data evenly distributed over the range and close following the line bisecting the [0,1]x[0,1] domain. There should not be S-shape (snake) patterns emerging, which would be indicative of differences in the quantile distributions (which is not expected as both software tools sample from the same distributions, albeit using different sampling methods). See Appendix for random samples.

Using SOCR QQ Data to Data Plot (http://www.socr.umich.edu/html/cha/SOCR_Charts.html)
Copy-paste pairs of data (randomly generated samples from R and SOCR) for each of the 3 distributions.

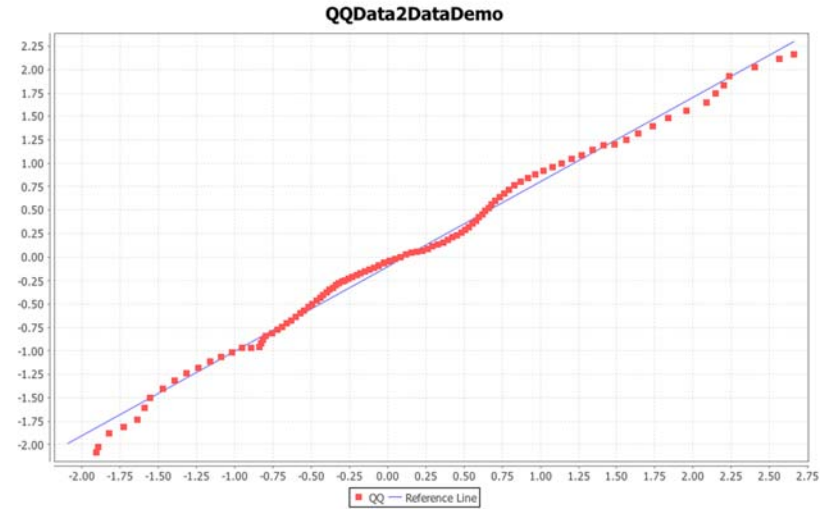


Then click the mapping tab and map the R and SOCR column headings into the 2 bins (X and Y axes). Finally click "Update Chart" to plot the QQ plot (quartiles of R and SOCR data are on the X and Y axes, respectively). We can change the Chart Titles and label the axes (using right-click and setting the chart properties), however we did not do that here to avoid possible confusion.

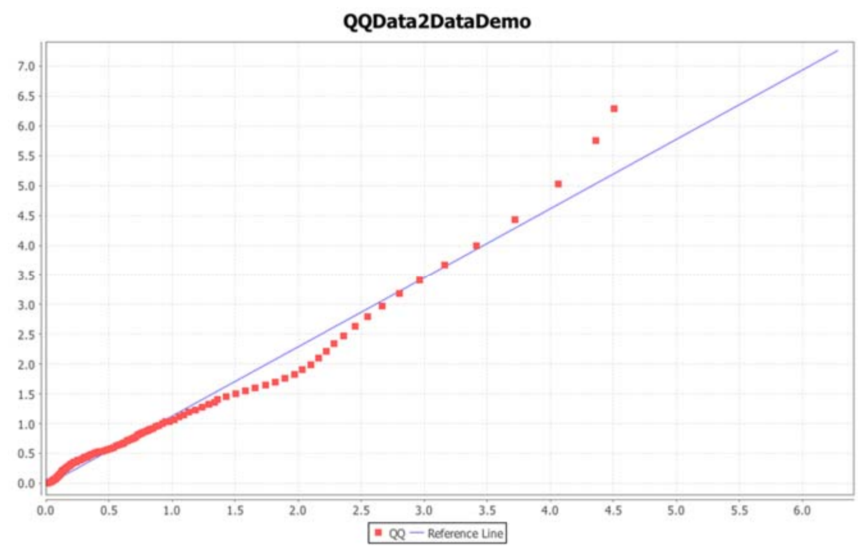
Uniform QQ Plot



Normal QQ plot



Exponential QQ plot

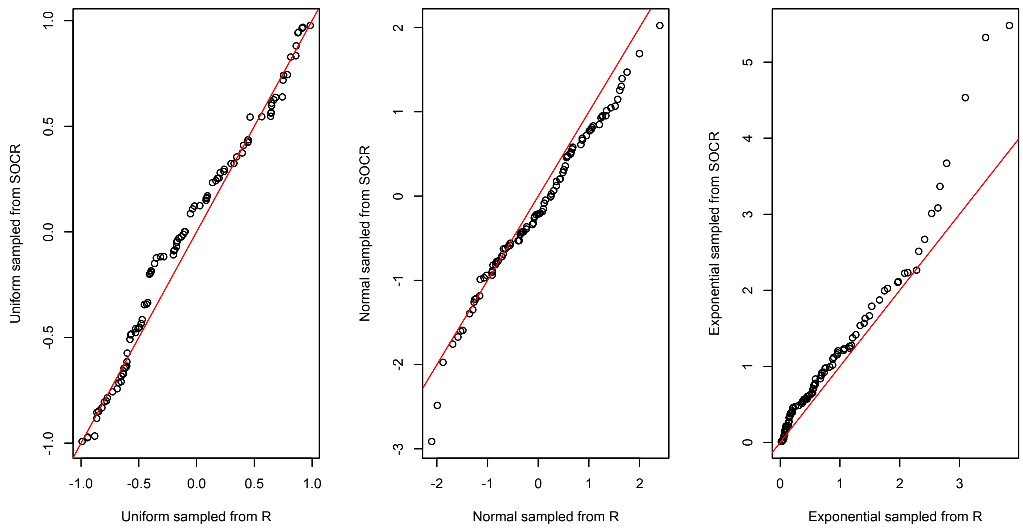


Notes:

- For SOCR RNG see this activity: http://wiki.socr.umich.edu/index.php/SOCR_EduMaterials_Activities_RNG
- For R random number generation:

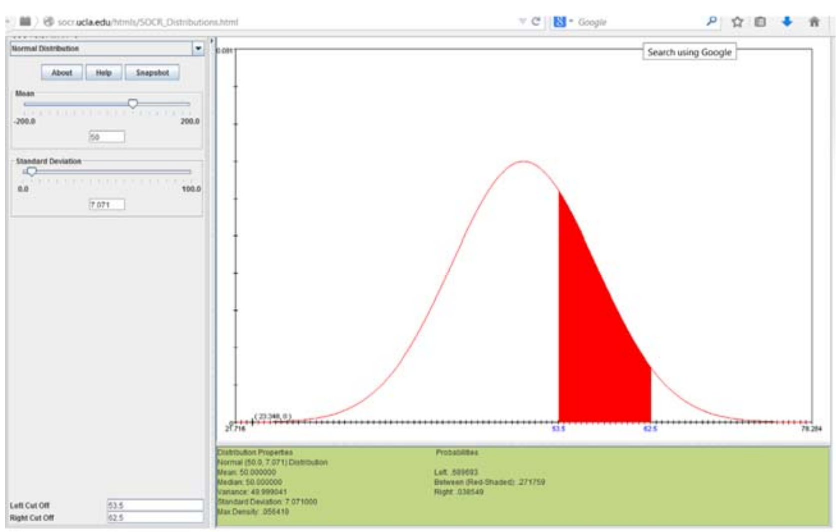
```
unif.gen <- runif(100, -1, 1)
norm.gen <- rnorm(100, 0, 1)
exp.gen <- rexp(100, 1)

dat.gen<-cbind(unif.gen, norm.gen, exp.gen)
write.csv(dat.gen, 'hw_dat_gen.csv')

# QQ plot in R
data <- read.csv("hw_dat_gen.csv',header=T)
attach(data)
```

```
colnames(data)=c('U_R','U_S','N_R','N_S','E_R','E_S')
par(mfrow=c(1,3))
qqplot(U_R,U_S,xlab='Uniform sampled from R',ylab='Uniform sampled from SOCR')
abline(0,1,col='red')
qqplot(N_R,N_S,xlab='Normal sampled from R',ylab='Normal sampled from SOCR')
abline(0,1,col='red')
qqplot(E_R,E_S,xlab='Exponential sampled from R',ylab='Exponential sampled from SOCR')
abline(0,1,col='red')
```

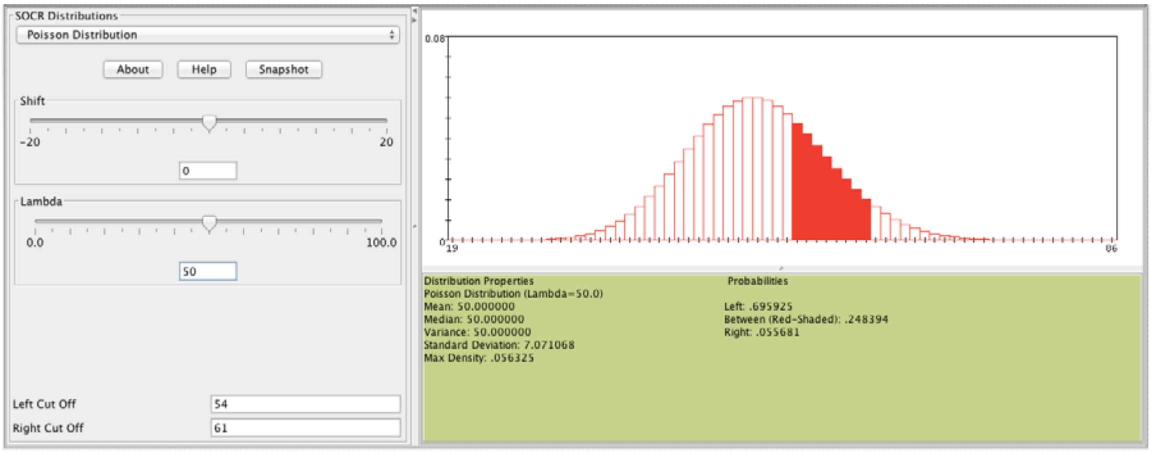


Problem 3: The Poisson distribution with parameter λ can be approximated with normal when λ is large. Suppose patients arrive at a hospital at a rate of 50 per day. Let's assume that the process is a Poisson random variable with λ=50. Compute the probability that in the next day the number of patients that arrive at this hospital will be between 54 and 62. Use the SOCR Normal (N(μ=50,σ=7.071)) and Poisson (Poisson(λ=50))distribution calculators.

Using the normal distribution, the probability is P(53.5<X<62.5| N(μ=50,σ=7.071))= **0.271759** (see the continuity correction section of the EBook).



Using the Poisson distribution, the probability is P(54≤X≤62| P(λ=50)) = **0.248**. I do not include 62 because in the continuous normal distribution we only include values up to 62.0

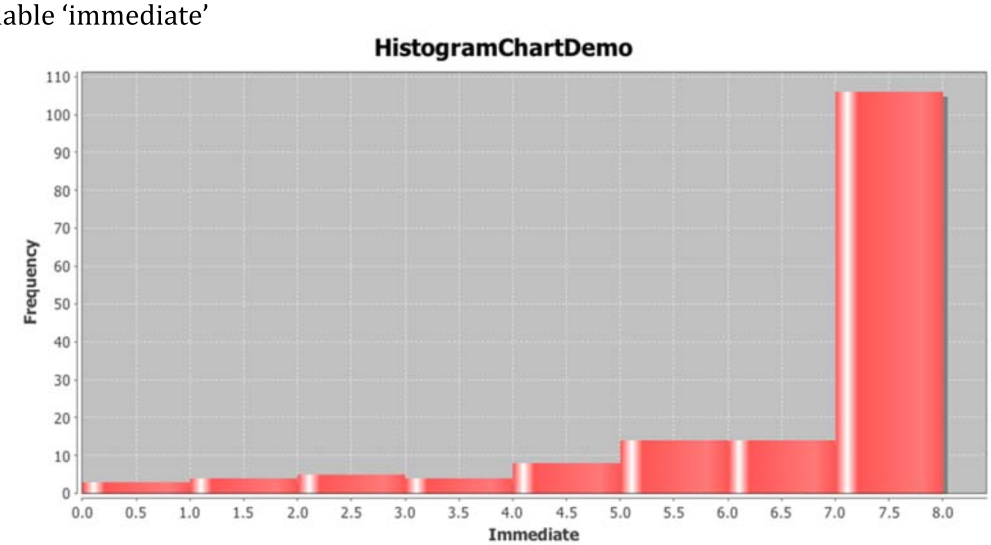


R Code:

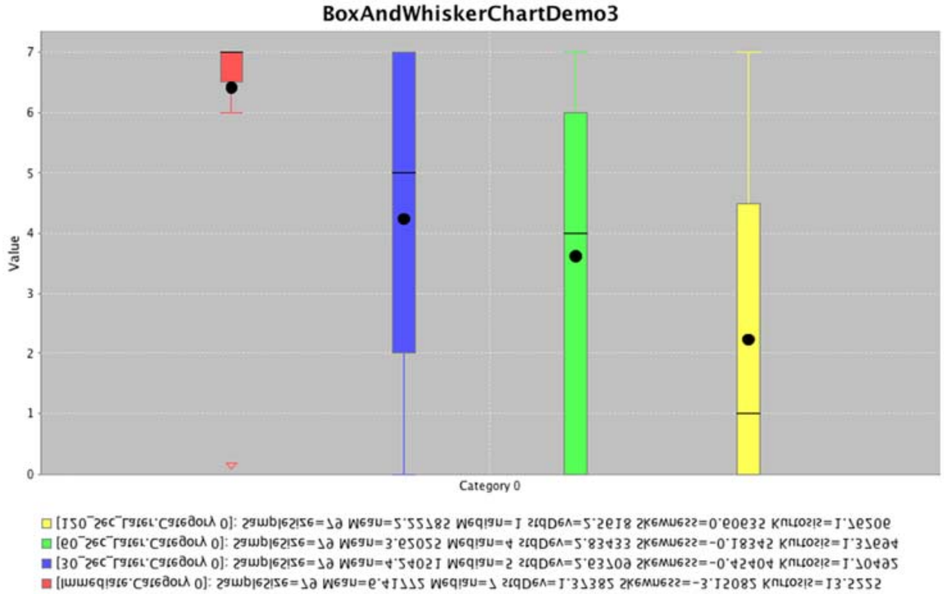
```
ppois(q=61, lambda=50, lower.tail=T) -
  ppois(q=53, lambda=50, lower.tail=T)
#I used 61 and 53 to match the results from SOCR.
#I'm not sure what values are being included here...

pnorm(q=62, mean=50, sd=7.071, lower.tail=T) -
  pnorm(q=54, mean=50, sd=7.071, lower.tail=T)
```

Problem 4: Use the Vitamin K shots Neonate Infant Pain Score (NIPS) dataset and SOCR Charts to generate a box plot, a scatter plot, a line plot, a dot plot, a boxplot, a histogram plot and a pie chart for some of the variables (Immediate, 30_Sec_Later, 60_Sec_Later, 120_Sec_Later, Total_Cry_Time).

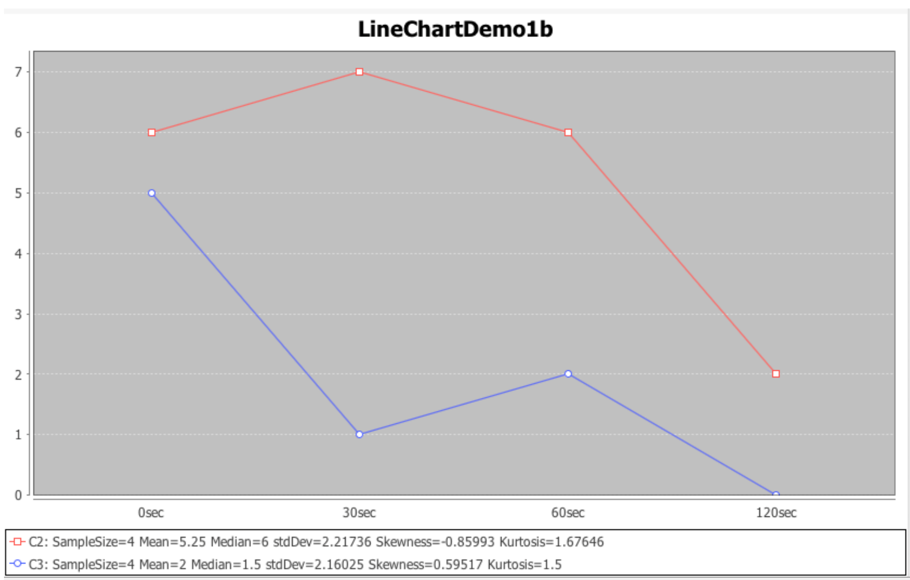
Histogram of variable 'immediate'

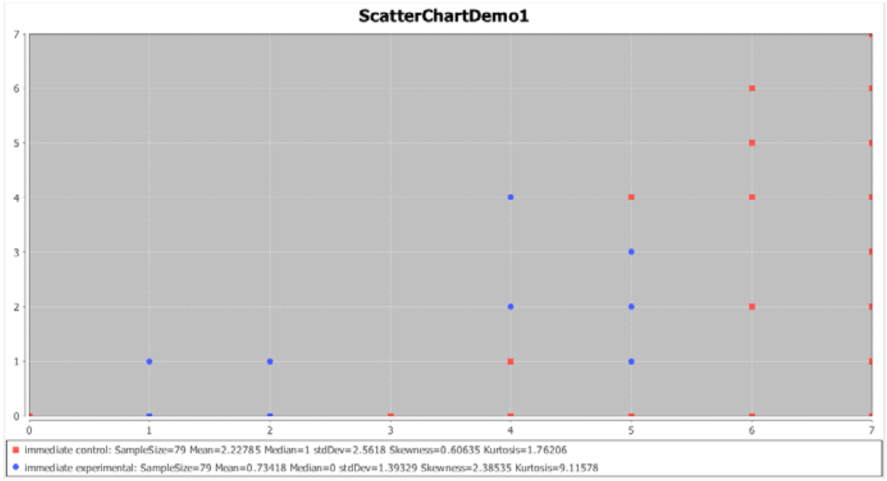


Boxplot of the control group for various variables.

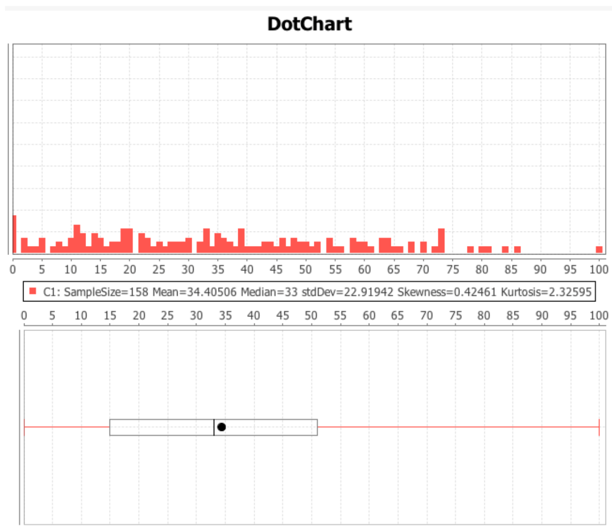

BoxAndWhiskerChartDemo3
Value
Category 0
0
1
2
3
4
5
6
7

Line chart

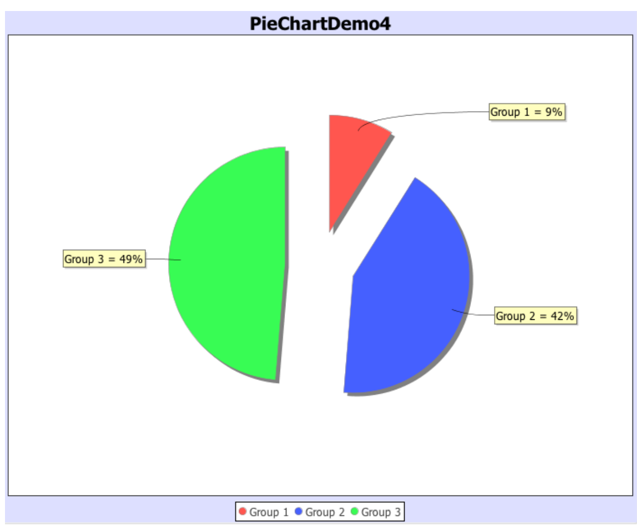

LineChartDemo1b
0
1
2
3
4
5
6
7
0sec
30sec
60sec
120sec
C2: SampleSize=4 Mean=5.25 Median=6 stdDev=2.21736 Skewness=-0.85993 Kurtosis=1.67646
C3: SampleSize=4 Mean=2 Median=1.5 stdDev=2.16025 Skewness=0.59517 Kurtosis=1.5



Dot chart of total cry time



Pie chart of clusters



R Code:

```
nips.dat<-read.csv('NIPS_data.csv')
head(nips.dat)
```

```
hist(nips.dat$Immediate)
boxplot(nips.dat[nips.dat$Group_NC1_Interv2==1,3:6])
plot(1:4,unlist(nips.dat[1,3:6]), col=1, type='b', ylim=c(0,7))
points(1:4, unlist(nips.dat[2,3:6]), col=2, type='b')

#calculate proportions for pie chart of variable 'cluster'
cluster.tab<-table(nips.dat$Cluster)
cluster.props<-cluster.tab/sum(cluster.tab)
pie(cluster.props, labels=paste('group',names(cluster.props)))
```

Appendix: Problem 2: Random Number generation results (SOCR and R)

Index	unif.gen.r	norm.gen.r	exp.gen.r	unif.gen.socr	norm.gen.socr	exp.gen.socr
1	-0.03421	2.146162	1.340007	0.460332	1.20057	1.041762
2	-0.72205	0.629507	1.099317	-0.86515	-0.22798	1.243426
3	-0.67383	-0.66391	0.312262	-0.05886	0.997939	0.589069
4	-0.83861	-0.36714	0.114022	0.654992	1.013191	0.771458
5	-0.12954	-0.31342	0.709416	-0.07565	0.774204	0.493172
6	0.547198	0.591664	0.894984	0.32987	1.547096	3.501474
7	0.20275	-0.72866	0.216729	0.45734	-0.65392	0.292094
8	0.689725	-0.25386	2.546228	-0.71675	0.549533	0.385044
9	0.932319	-0.50089	0.037871	0.449293	0.039298	0.101861
10	-0.23215	-0.37405	2.265916	0.005879	0.155565	0.450133
11	-0.05471	0.71512	0.070696	0.301959	-0.81355	0.633944
12	-0.60256	-0.07206	0.870941	-0.08382	1.665624	0.258207
13	0.309499	0.390936	0.151744	-0.52922	0.221251	4.207319
14	-0.88687	0.151597	2.180663	0.540384	-0.2561	2.889952
15	-0.70833	-0.35227	0.200772	-0.51099	-0.34571	0.084309
16	-0.55618	-1.27415	0.738722	0.734095	0.691379	0.510943
17	0.997966	-0.37241	0.723516	0.108784	-0.07839	2.84049
18	-0.31476	-0.74948	0.725648	0.753113	-0.21449	0.938006
19	0.648257	-1.48634	2.746657	0.399	-0.93579	0.872644
20	-0.2527	1.636721	0.711131	-0.53996	-1.57178	0.005215
21	0.488616	-0.23512	3.036433	-0.60762	0.274927	0.845941
22	-0.62573	0.613624	1.974556	0.229866	0.916813	5.327805
23	0.546316	0.092615	0.105033	-0.77381	-0.70757	0.466315
24	-0.17407	-0.43698	0.578787	-0.32124	-0.18651	1.501219
25	-0.3447	-1.88449	0.270065	0.737515	-1.6356	0.603368
26	0.308256	-0.73031	3.337005	-0.04694	-0.06189	1.905998
27	-0.26303	0.663724	0.219036	0.750205	0.232279	0.186334
28	0.531543	1.71799	0.407216	0.529095	0.073917	3.151731
29	0.602814	0.717651	4.511306	0.453735	1.249572	1.568328
30	0.978829	0.293492	0.114425	0.118894	-2.02146	0.081836
31	-0.85019	-1.4763	1.124781	-0.51768	-0.28394	0.340263
32	0.23253	1.475606	0.599163	0.963082	-2.97734	1.290559
33	-0.28099	1.494191	1.223023	0.745283	0.44355	0.923142
34	-0.30193	-0.28436	0.700383	-0.5863	0.064641	1.869083
35	0.548397	-0.20229	0.086656	-0.54248	0.093079	6.278972
36	0.995536	-0.70494	0.285405	0.939171	-0.40414	0.447815
37	-0.01905	-0.17924	0.071937	-0.07612	-0.31802	0.937193
38	-0.96642	-0.68723	2.111835	-0.523	2.167942	0.843612
39	0.107123	0.545174	0.974293	0.726575	0.941747	0.08351
40	-0.06	0.790998	0.68405	0.153013	-0.17526	0.39209
41	-0.70203	1.298077	0.969277	0.365026	-1.14691	0.034582
42	-0.4387	-0.21428	3.832193	-0.20345	0.156672	0.315035
43	-0.45316	0.332357	4.407625	0.948052	-1.34833	0.131123

Index	unif.gen.r	norm.gen.r	exp.gen.r	unif.gen.socr	norm.gen.socr	exp.gen.socr
44	0.655648	-1.86569	1.429922	0.208282	-0.28243	0.153636
45	0.3256	-1.34245	0.843509	0.116541	-0.25856	0.881637
46	0.983889	2.12348	0.857802	-0.13949	-0.85751	1.545764
47	0.300022	-1.83606	2.056815	-0.61146	-2.41567	0.071218
48	-0.73311	-0.38427	0.09266	0.491245	-0.81568	0.728199
49	0.509772	0.748845	2.212804	-0.99243	1.052579	3.929189
50	0.173622	2.657411	0.0562	-0.9653	-0.82528	0.968741
51	-0.76479	-2.28273	2.791011	0.109822	-0.27364	0.01077
52	-0.22208	0.472962	0.840846	-0.56335	-0.97879	0.402135
53	0.426459	-1.13678	0.115148	0.608226	-0.57152	0.770245
54	-0.34607	0.567162	3.128469	0.337765	-0.75563	1.20417
55	-0.34911	-0.61365	0.050545	-0.84481	0.649193	0.308639
56	0.927089	0.297586	1.114771	-0.64119	1.228224	0.355358
57	0.743263	-0.41333	2.130998	-0.54559	-0.50897	0.712986
58	-0.78684	-0.10762	1.592749	0.054734	0.528545	0.238807
59	-0.53026	1.182324	0.634011	-0.85744	-0.09481	0.362151
60	-0.75019	-1.67929	0.027767	0.570614	0.077227	1.966582
61	0.441064	-1.34327	0.203299	0.579498	1.803817	0.02477
62	0.115574	0.946397	0.356205	0.959642	-0.77776	1.339688
63	-0.72323	1.002117	0.280054	-0.1695	0.30471	0.229536
64	0.207033	1.174052	0.795948	-0.87549	0.276103	0.744773
65	0.922349	0.312329	0.636844	-0.41622	-1.11926	1.287061
66	0.555111	0.254074	1.743359	0.810238	-1.2959	0.401478
67	-0.21242	0.784066	2.296724	0.943708	1.687488	2.583519
68	-0.58894	-0.05484	0.169041	0.183287	-0.26602	0.368145
69	-0.56253	-0.86096	1.51277	0.224716	0.605233	0.645768
70	0.607497	2.554486	0.274575	-0.26691	0.978547	1.891233
71	-0.30391	0.590389	0.148642	-0.17202	-0.03424	1.640018
72	-0.11632	-2.20915	0.469799	-0.23503	-1.02101	0.052416
73	-0.5117	0.017043	0.212306	0.825396	1.275137	1.560863
74	-0.59448	-1.49431	0.277172	0.134829	-0.16892	1.63781
75	0.644255	-0.96206	0.517558	-0.64993	-1.72645	0.61451
76	-0.36739	-2.30136	0.751569	-0.59528	0.902601	0.564951
77	-0.57243	0.132685	0.772659	0.675575	-0.37315	2.474797
78	-0.42413	1.738395	2.428733	0.855513	-0.57194	0.259538
79	0.216546	1.358673	0.036986	0.866471	0.209621	0.394872
80	0.4865	-0.1048	0.392775	-0.86183	-0.22841	0.19988
81	0.307922	0.466571	0.43465	-0.96086	-0.04075	2.756624
82	0.83845	0.195562	0.024099	-0.57759	2.051262	0.812336
83	0.054557	-0.63174	0.029043	-0.94467	0.444667	0.013513
84	0.991523	-0.02751	0.698759	0.134421	1.801101	0.881565
85	0.237425	0.492225	0.240529	0.383753	0.742141	0.842572
86	0.222587	-0.56496	0.159572	0.467906	0.517282	0.466636
87	0.142296	-0.56339	1.770333	-0.06051	2.049387	1.304635
88	0.025827	-0.4032	1.077106	-0.70687	0.025195	1.042272

Index	unif.gen.r	norm.gen.r	exp.gen.r	unif.gen.socr	norm.gen.socr	exp.gen.socr
89	0.644079	0.820375	0.414582	0.012978	1.379224	1.554755
90	-0.93367	1.666928	0.531248	0.642531	0.378679	2.141496
91	-0.13577	0.570079	0.236922	0.523789	-1.9216	3.945831
92	0.47481	1.215485	2.132891	0.169072	-2.78431	0.476985
93	0.734987	0.964138	0.10621	0.407978	0.897581	1.821299
94	-0.41119	-0.92193	0.888887	0.684376	-0.60674	0.461348
95	0.393878	0.709595	1.286282	0.128438	-1.09462	0.024869
96	0.062104	-0.38311	0.428636	-0.30117	-0.61066	0.893323
97	0.332088	-0.81415	0.12951	0.275516	0.505129	1.127407
98	-0.93	0.624815	1.035004	-0.30138	-1.29674	0.784496
99	-0.33118	2.19848	0.328307	-0.27936	0.052262	0.533495
100	-0.59948	-1.3648	2.060017	0.378161	-1.26381	0.177867