HOMEWORK 3 ANSWERS

3.1.

```
#
# Chapter 3 -- Bayesian Computation With R
#              Cauchy Problem
#
#  Remove all objects just to be safe
#
rm(list=ls(all=TRUE))
#
library(LearnBayes)
library(lattice)
#
#
# Observed Data
#
y <- c(0, 10, 9, 8, 11, 3, 3, 8, 8, 11)
#
#  Theta
#
theta <- seq(-2, 12, .1)
#
#  Posterior Distribution
#
post <- NULL
kk <- length(theta)
i <- 0
j <- 0
while(i < kk){
   i <- i + 1
   j <- 0
   sum <- 1.0
      while (j < 10){
         j <- j + 1
         sum <- sum*(1.0/(1.0 + (y[j]-theta[i])*(y[j]-theta[i])))
      }
   post[i] <- sum
}
#
#  Normalize Posterior
#
post <- post/sum(post)
yy <- cbind(theta,post)
#
plot(theta, post, type = "h", col = "blue",
lwd=3,xlab="",ylab="",main="",font=2)
#
#
# Main title:   which side of the plot (1=bottom, 2=left, 3=top, 4=right).
mtext("Posterior Distribution for Theta",side=3,line=1.00,cex=1.2,font=2)
# x-axis title
mtext("Theta",side=1,line=2.75,cex=1.2)
# y-axis title
mtext("Density",side=2,line=2.5,cex=1.2)
#
#  Compute E(X)
#
thetamean <- sum(theta*post)
#
#  Compute E(X*X)
#
```

```
thetaXX <- sum(theta*theta*post)
#
#  VAR(X)=E(X*X) - E(X)*E(X)
#
thetavar <- thetaXX - thetamean*thetamean
thetasd <- sqrt(thetavar)


&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
post <- NULL
for(j in 1:length(theta))
{
post[j] <- prod(1/(1+(y-theta[j])^2))
}
post <- post/sum(post)
&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
```

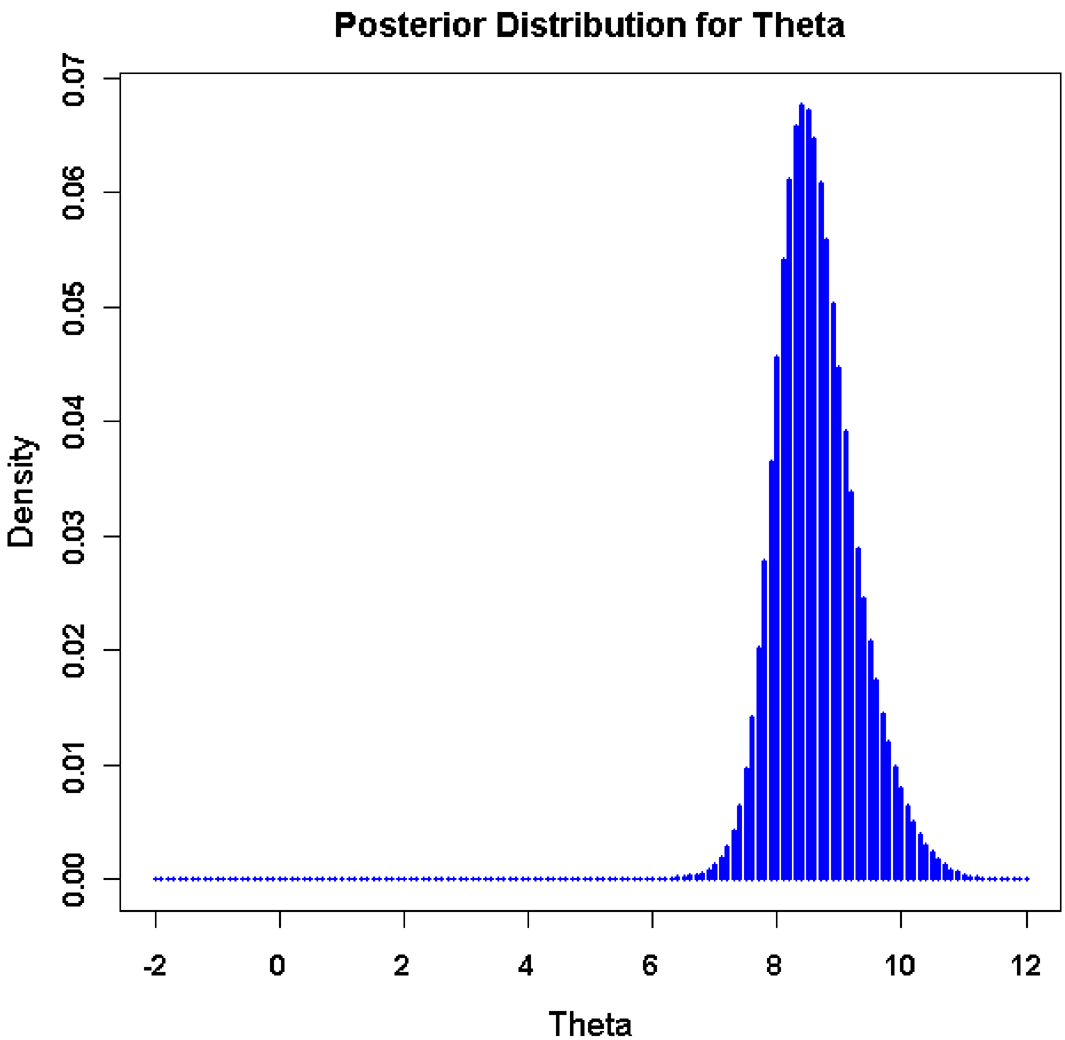
a) and b)

```
      theta    post
  [1,]  -2.0   1.126701e-12
  [2,]  -1.9   1.496731e-12
  [3,]  -1.8   1.998369e-12
  [4,]  -1.7   2.681960e-12
  [5,]  -1.6   3.618341e-12
  [6,]  -1.5   4.907571e-12
  [7,]  -1.4   6.691425e-12
  [8,]  -1.3   9.171224e-12
  [9,]  -1.2   1.263306e-11
 [10,]  -1.1   1.748306e-11
 [11,]  -1.0   2.429564e-11
 [12,]  -0.9   3.387761e-11
 [13,]  -0.8   4.734937e-11
 [14,]  -0.7   6.624058e-11
 [15,]  -0.6   9.259000e-11
 [16,]  -0.5   1.290277e-10
 [17,]  -0.4   1.788063e-10
 [18,]  -0.3   2.457439e-10
 [19,]  -0.2   3.340655e-10
 [20,]  -0.1   4.481838e-10
 [21,]   0.0   5.925432e-10
 [22,]   0.1   7.716980e-10
 [23,]   0.2   9.907641e-10
 [24,]   0.3   1.256265e-09
 [25,]   0.4   1.577282e-09
 [26,]   0.5   1.966808e-09
 [27,]   0.6   2.443283e-09
 [28,]   0.7   3.032471e-09
 [29,]   0.8   3.769918e-09
 [30,]   0.9   4.704408e-09
 [31,]   1.0   5.902894e-09
 [32,]   1.1   7.457609e-09
 [33,]   1.2   9.496316e-09
 [34,]   1.3   1.219707e-08
 [35,]   1.4   1.580947e-08
 [36,]   1.5   2.068510e-08
 [37,]   1.6   2.732094e-08
 [38,]   1.7   3.642051e-08
 [39,]   1.8   4.897829e-08
 [40,]   1.9   6.639260e-08
 [41,]   2.0   9.060846e-08
 [42,]   2.1   1.242817e-07
 [43,]   2.2   1.709331e-07
```

[44,]	2.3	2.350204e-07
[45,]	2.4	3.217946e-07
[46,]	2.5	4.367471e-07
[47,]	2.6	5.844460e-07
[48,]	2.7	7.667233e-07
[49,]	2.8	9.805828e-07
[50,]	2.9	1.216761e-06
[51,]	3.0	1.460147e-06
[52,]	3.1	1.692662e-06
[53,]	3.2	1.897806e-06
[54,]	3.3	2.064831e-06
[55,]	3.4	2.190700e-06
[56,]	3.5	2.279372e-06
[57,]	3.6	2.339409e-06
[58,]	3.7	2.381300e-06
[59,]	3.8	2.415471e-06
[60,]	3.9	2.451242e-06
[61,]	4.0	2.496573e-06
[62,]	4.1	2.558281e-06
[63,]	4.2	2.642503e-06
[64,]	4.3	2.755231e-06
[65,]	4.4	2.902879e-06
[66,]	4.5	3.092862e-06
[67,]	4.6	3.334235e-06
[68,]	4.7	3.638441e-06
[69,]	4.8	4.020242e-06
[70,]	4.9	4.498945e-06
[71,]	5.0	5.100067e-06
[72,]	5.1	5.857626e-06
[73,]	5.2	6.817372e-06
[74,]	5.3	8.041376e-06
[75,]	5.4	9.614637e-06
[76,]	5.5	1.165467e-05
[77,]	5.6	1.432560e-05
[78,]	5.7	1.785902e-05
[79,]	5.8	2.258530e-05
[80,]	5.9	2.898085e-05
[81,]	6.0	3.774050e-05
[82,]	6.1	4.988895e-05
[83,]	6.2	6.695444e-05
[84,]	6.3	9.124112e-05
[85,]	6.4	1.262594e-04
[86,]	6.5	1.774089e-04
[87,]	6.6	2.530649e-04
[88,]	6.7	3.663029e-04
[89,]	6.8	5.376134e-04
[90,]	6.9	7.991090e-04
[91,]	7.0	1.200852e-03
[92,]	7.1	1.819899e-03
[93,]	7.2	2.772146e-03
[94,]	7.3	4.225372e-03
[95,]	7.4	6.408220e-03
[96,]	7.5	9.603697e-03
[97,]	7.6	1.410919e-02
[98,]	7.7	2.014539e-02
[99,]	7.8	2.771668e-02
[100,]	7.9	3.647081e-02
[101,]	8.0	4.565149e-02
[102,]	8.1	5.422549e-02
[103,]	8.2	6.116538e-02
[104,]	8.3	6.574884e-02
[105,]	8.4	6.771668e-02
[106,]	8.5	6.723693e-02

```
[107,]   8.6   6.474535e-02
[108,]   8.7   6.077250e-02
[109,]   8.8   5.582661e-02
[110,]   8.9   5.034240e-02
[111,]   9.0   4.467224e-02
[112,]   9.1   3.909187e-02
[113,]   9.2   3.380540e-02
[114,]   9.3   2.894759e-02
[115,]   9.4   2.458832e-02
[116,]   9.5   2.074307e-02
[117,]   9.6   1.738861e-02
[118,]   9.7   1.448031e-02
[119,]   9.8   1.196713e-02
[120,]   9.9   9.801610e-03
[121,]  10.0   7.944263e-03
[122,]  10.1   6.363233e-03
[123,]  10.2   5.031358e-03
[124,]  10.3   3.923044e-03
[125,]  10.4   3.012578e-03
[126,]  10.5   2.274241e-03
[127,]  10.6   1.683455e-03
[128,]  10.7   1.217945e-03
[129,]  10.8   8.581987e-04
[130,]  10.9   5.871043e-04
[131,]  11.0   3.891602e-04
[132,]  11.1   2.498625e-04
[133,]  11.2   1.556626e-04
[134,]  11.3   9.443623e-05
[135,]  11.4   5.606765e-05
[136,]  11.5   3.275997e-05
[137,]  11.6   1.894430e-05
[138,]  11.7   1.089840e-05
[139,]  11.8   6.264988e-06
[140,]  11.9   3.611696e-06
[141,]  12.0   2.093835e-06
```

c)




```
d) > thetamean
[1] 8.629341
> thetasd
[1] 0.6453798
>
```

2) RATS EXAMPLE FROM WINBUGS

First Prior:

node	mean	sd	MC error	2.5%	median	97.5%	start	sample	
	alpha0	106.6	3.644	0.04122	99.41	106.5	113.8	1001	10000
	beta.c	6.185	0.1103	0.001337	5.966	6.184	6.404	1001	10000
	sigma	6.072	0.4665	0.0075	5.246	6.042	7.068	1001	10000

Second Prior:

node	mean	sd	MC error	2.5%	median	97.5%	start	sample
alpha0	106.6	3.655	0.04103	99.44	106.5	113.8	1001	10000
beta.c	6.185	0.1061	0.001313	5.975	6.185	6.395	1001	10000
sigma	6.086	0.4606	0.007422	5.255	6.061	7.049	1001	10000

Missing Data:

node	mean	sd	MC error	2.5%	median	97.5%	start	sample
Y[26,2]	204.5	8.723	0.1142	187.2	204.6	221.9	1001	10000
Y[26,3]	249.7	10.38	0.1729	229.3	249.7	270.4	1001	10000
Y[26,4]	295.0	12.97	0.2346	269.3	295.0	320.5	1001	10000
Y[26,5]	340.5	16.02	0.3137	308.6	340.6	371.8	1001	10000
beta.c	6.577	0.1509	0.003632	6.282	6.574	6.88	1001	10000

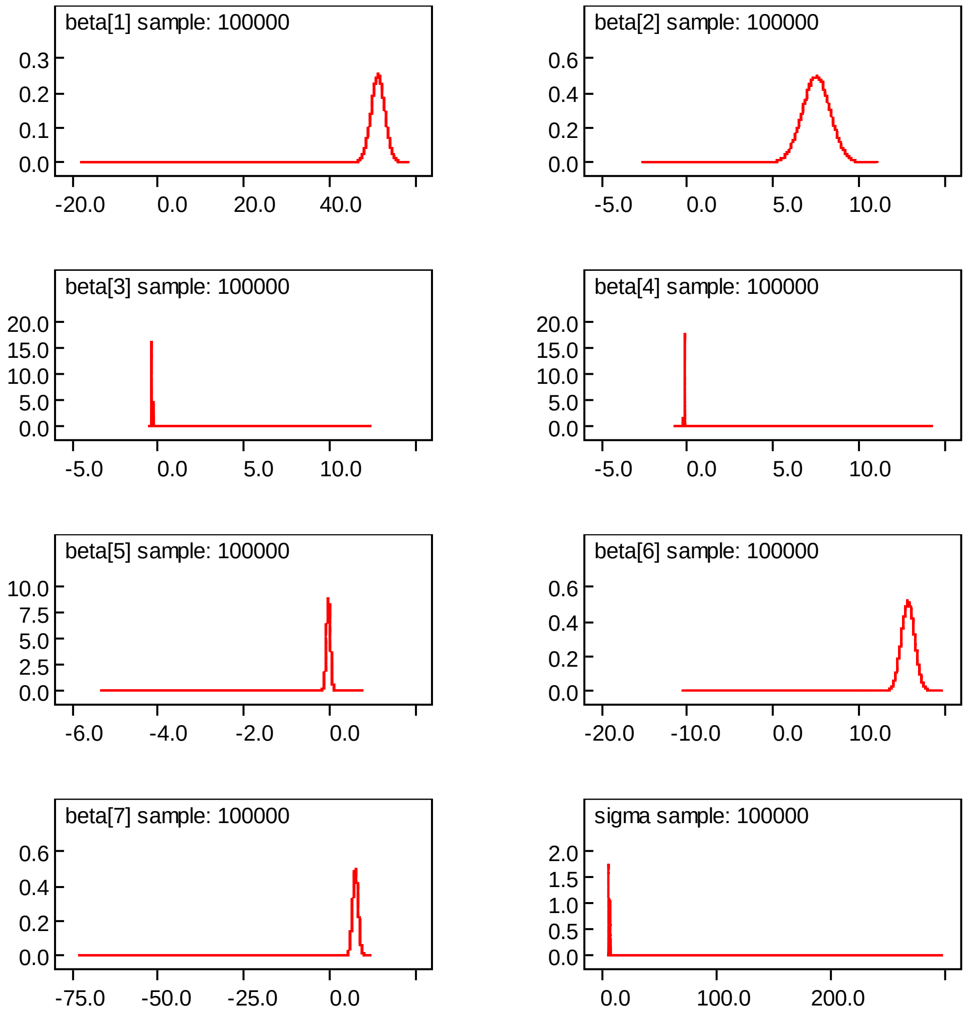
3) 106th House Regression Example

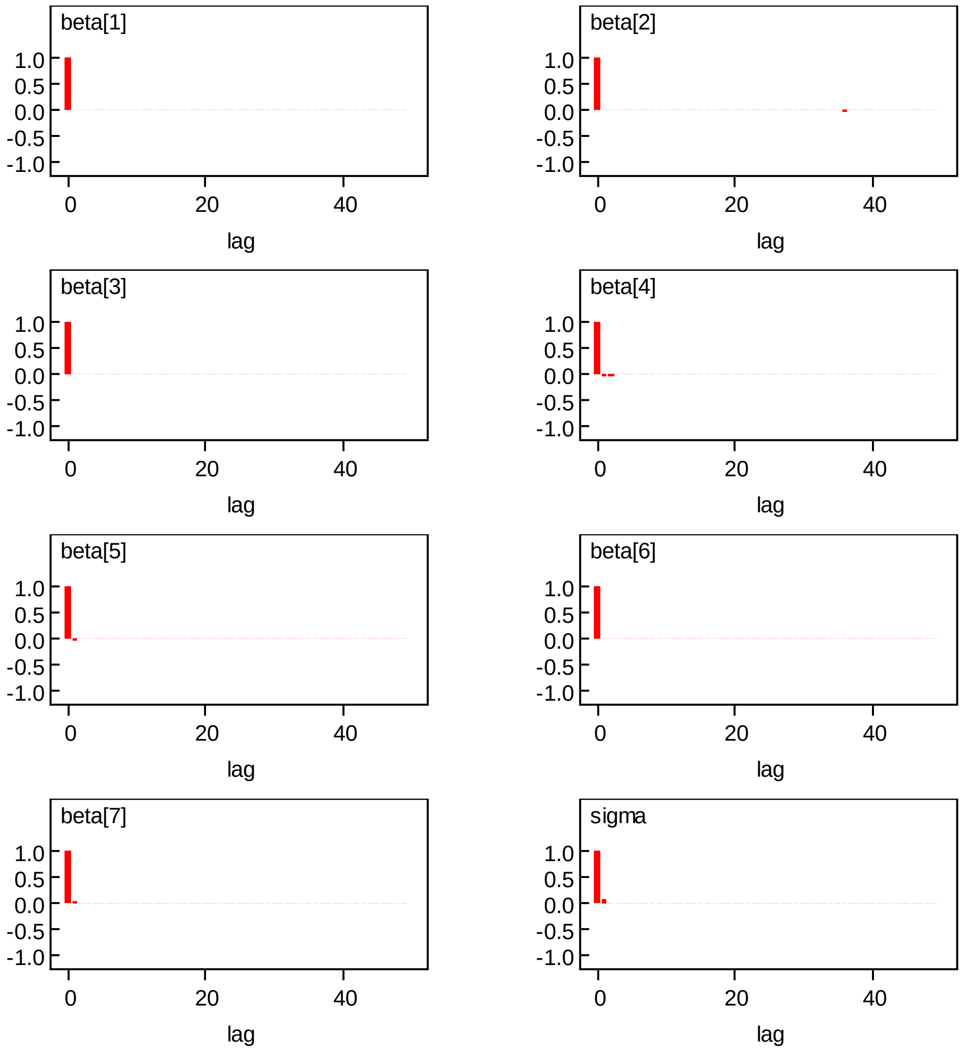
node	mean	sd	MC error	2.5%	median	97.5%	start	sample
beta[1]	51.0	3.183	0.1612	47.8	51.15	54.29	1	1000
beta[2]	7.514	0.8713	0.02519	5.918	7.54	9.171	1	1000
beta[3]	-0.3737	0.4041	0.01325	-0.4331	-0.386	-0.3393	1	1000
beta[4]	-0.1681	0.4553	0.01377	-0.2254	-0.1823	-0.1353	1	1000
beta[5]	-0.04338	0.1758	0.003721	-0.1308	-0.03974	0.05951	1	1000
beta[6]	15.63	1.217	0.04865	14.11	15.7	17.25	1	1000
beta[7]	7.247	2.921	0.1219	5.72	7.383	8.841	1	1000
sigma	6.856	9.211	0.3243	6.125	6.527	7.018	1	1000

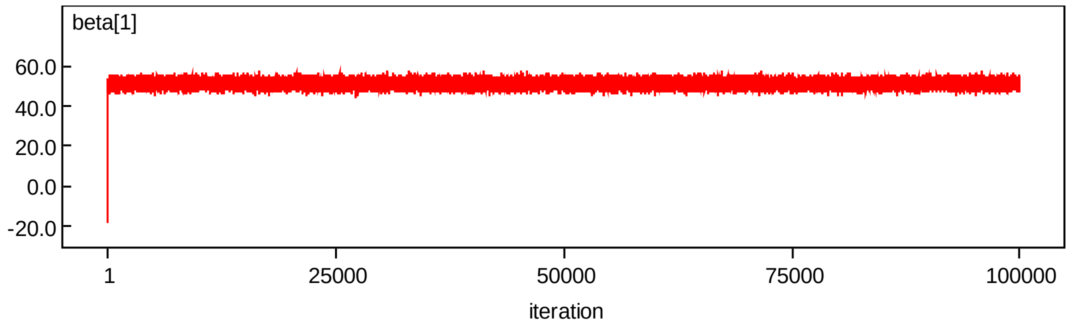
node	mean	sd	MC error	2.5%	median	97.5%	start	sample
beta[1]	51.15	1.795	0.02053	48.03	51.19	54.29	1	10000
beta[2]	7.486	0.8148	0.008027	5.894	7.489	9.093	1	10000
beta[3]	-0.3845	0.1242	0.001223	-0.4345	-0.3857	-0.3377	1	10000
beta[4]	-0.1801	0.139	0.001263	-0.2258	-0.1812	-0.1374	1	10000
beta[5]	-0.04063	0.06875	5.179E-4	-0.1293	-0.0408	0.05047	1	10000
beta[6]	15.67	0.8283	0.008754	14.16	15.68	17.18	1	10000
beta[7]	7.346	1.176	0.01323	5.759	7.35	8.929	1	10000
sigma	6.559	2.787	0.02932	6.109	6.522	6.994	1	10000

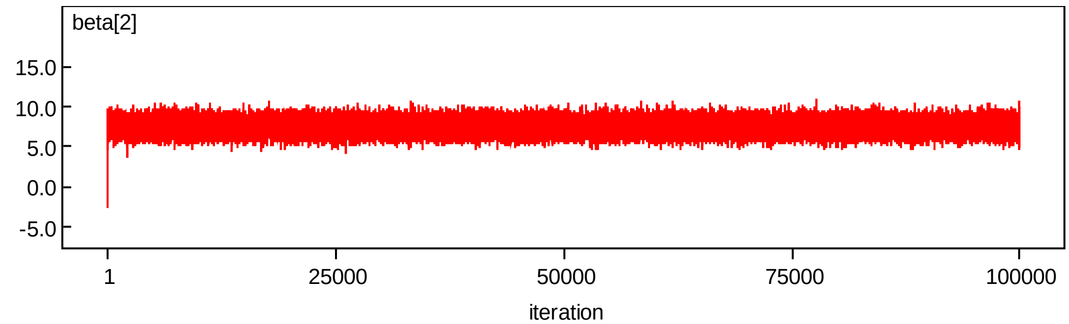
node	mean	sd	MC error	2.5%	median	97.5%	start	sample
beta[1]	51.15	1.624	0.005082	48.0	51.16	54.29	1	100000
beta[2]	7.496	0.8092	0.002412	5.908	7.497	9.085	1	100000
beta[3]	-0.3855	0.0472	1.488E-4	-0.4336	-0.3856	-0.3377	1	100000
beta[4]	-0.181	0.05084	1.519E-4	-0.2255	-0.181	-0.1367	1	100000
beta[5]	-0.03994	0.04899	1.487E-4	-0.1295	-0.04001	0.05032	1	100000
beta[6]	15.67	0.7886	0.00239	14.14	15.67	17.21	1	100000
beta[7]	7.359	0.8621	0.002776	5.77	7.361	8.958	1	100000
sigma	6.53	0.9482	0.003283	6.104	6.521	6.981	1	100000

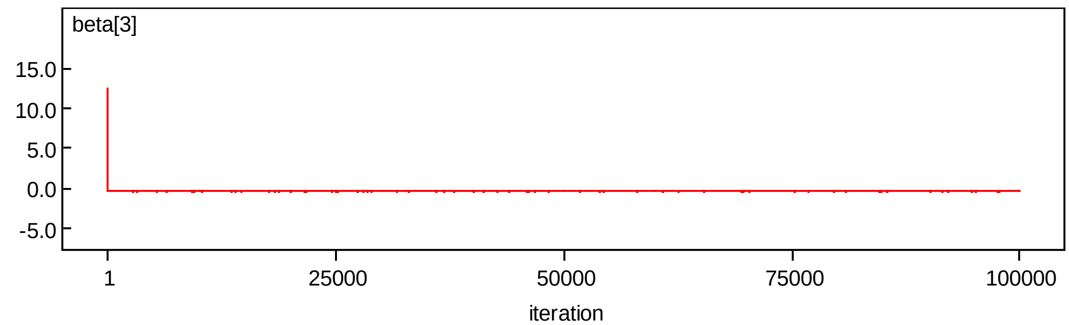
The means remain basically the same but the standard deviations drop a bit and the MC error drops a lot which is to be expected.

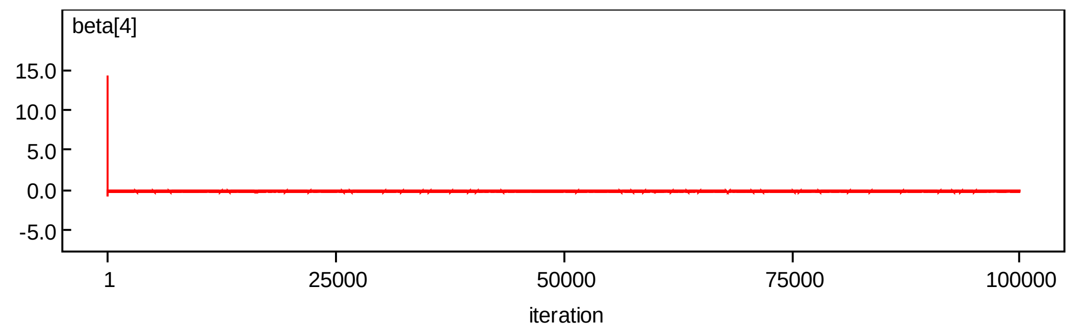

beta[1] sample: 100000
0.3
0.2
0.1
0.0
-20.0
0.0
20.0
40.0
beta[2] sample: 100000
0.6
0.4
0.2
0.0
-5.0
0.0
5.0
10.0
beta[3] sample: 100000
20.0
15.0
10.0
5.0
0.0
-5.0
0.0
5.0
10.0
beta[4] sample: 100000
20.0
15.0
10.0
5.0
0.0
-5.0
0.0
5.0
10.0
beta[5] sample: 100000
10.0
7.5
5.0
2.5
0.0
-6.0
-4.0
-2.0
0.0
beta[6] sample: 100000
0.6
0.4
0.2
0.0
-20.0
-10.0
0.0
10.0
beta[7] sample: 100000
0.6
0.4
0.2
0.0
-75.0
-50.0
-25.0
0.0
sigma sample: 100000
2.0
1.5
1.0
0.5
0.0
0.0
100.0
200.0

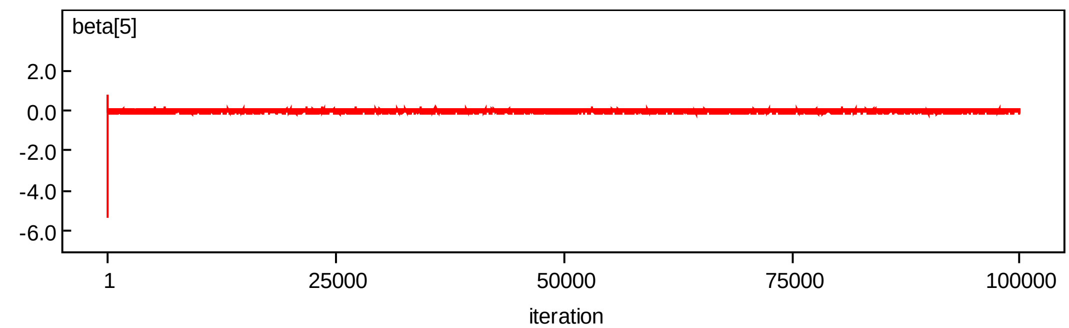

beta[1]
1.0
0.5
0.0
-0.5
-1.0
0
20
40
lag
beta[2]
beta[3]
beta[4]
beta[5]
beta[6]
beta[7]
sigma

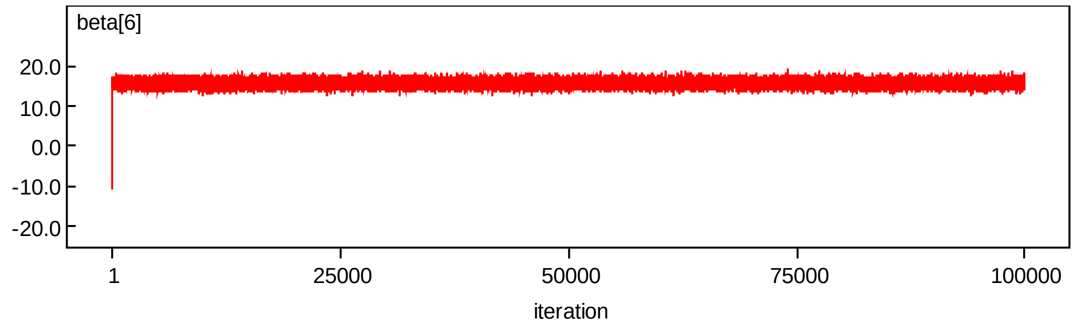

beta[1]
60.0
40.0
20.0
0.0
-20.0
1
25000
50000
75000
100000
iteration

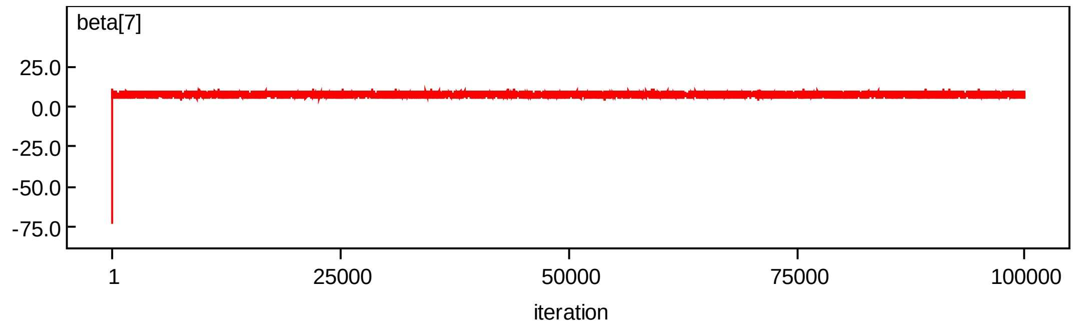

beta[2]
15.0
10.0
5.0
0.0
-5.0
1
25000
50000
75000
100000
iteration

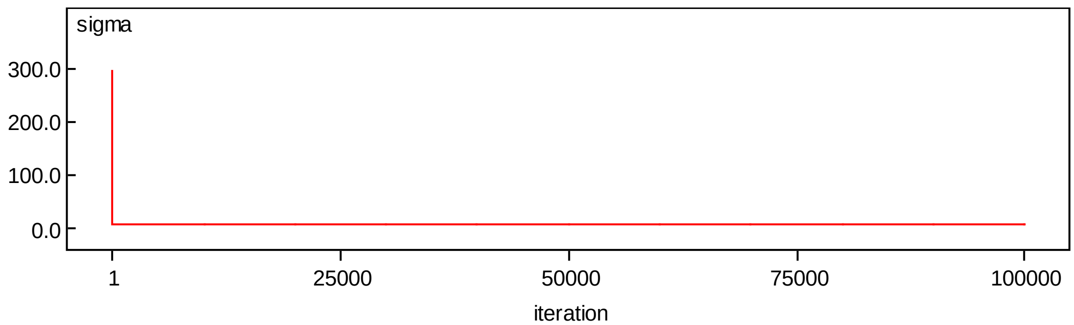

beta[3]
15.0
10.0
5.0
0.0
-5.0
1
25000
50000
75000
100000
iteration


beta[4]
15.0
10.0
5.0
0.0
-5.0
1
25000
50000
75000
100000
iteration


beta[5]
2.0
0.0
-2.0
-4.0
-6.0
1
25000
50000
75000
100000
iteration







All of these plots show convergence – densities are unimodal, very little autocorrelation, and the history plots are stable.