Lab14

Boltzmann Machines

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Today, we are going to investigate Boltzmann Machines.

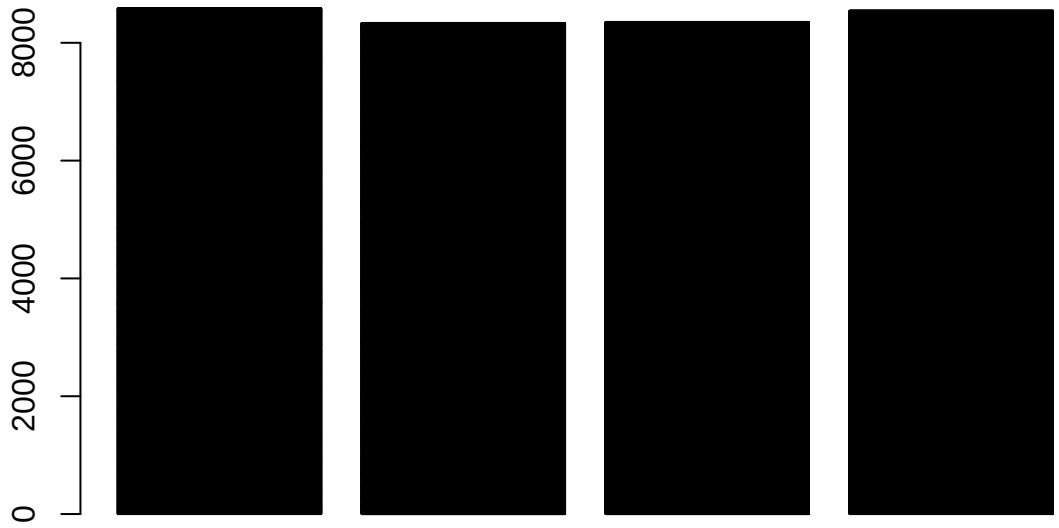
```
W  = matrix(c(1,0,0,1,-1,0,0,-1,1,0,0,1), nrow = 4, byrow = TRUE)

v_init = rep(0, 4)
h_init = rep(0, 3)

b_i = c(0,0,0,0)
c_j = c(0,0,0)

beta = 2

n_sim = 10000

h = h_init
v = v_init
h_trajectory = matrix(0, ncol = length(h), nrow = n_sim)
v_trajectory = matrix(0, ncol = length(v), nrow = n_sim)


for(n in 1:n_sim){
  eta = -beta*(-W %*% h - b_i)
  v = ( runif(length(v)) < (exp(eta) / (1 + exp(eta))) )
  v = as.integer(v)
  v_trajectory[n,] = v

  theta = -beta*(-t(W) %*% v - c_j)
  h = ( runif(length(h)) < (exp(theta) / (1 + exp(theta))) )
  h = as.integer(h)
  h_trajectory[n, ] = h
}



apply(v_trajectory, 2, mean)
```

```
## [1] 0.8584 0.8337 0.8354 0.8544
```

```r
apply(h_trajectory, 2, mean)
```

```
## [1] 0.9436 0.0618 0.9429
```

```r
barplot(v_trajectory)
```

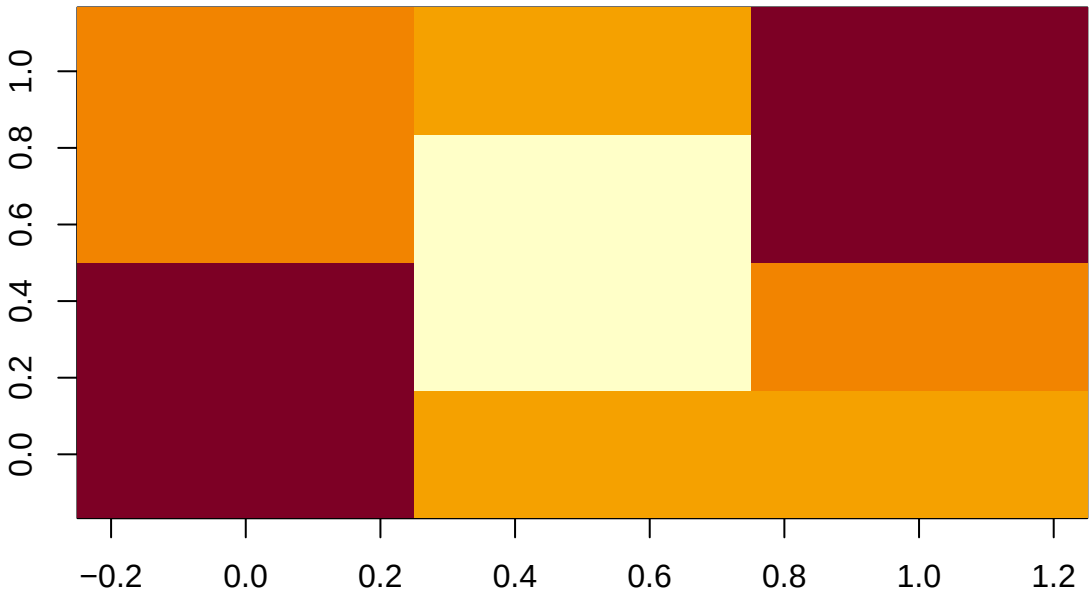



```r
barplot(h_trajectory)
```


```
cor(h_trajectory, v_trajectory)
```

```
##              [,1]        [,2]        [,3]         [,4]
## [1,]  0.246352457  0.23889508  0.02591098 -0.002603533
## [2,] -0.014879411 -0.25343477 -0.28029618 -0.023571839
## [3,] -0.004763644  0.03014284  0.27429863  0.238103549
```

```
#h_trajectory
image(cor(h_trajectory, v_trajectory))
```


0.0
0.2
0.4
0.6
0.8
1.0
−0.2
0.0
0.2
0.4
0.6
0.8
1.0
1.2