Lab13

Ising Model

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Today, we are going to do 5.3 from lecture notes.

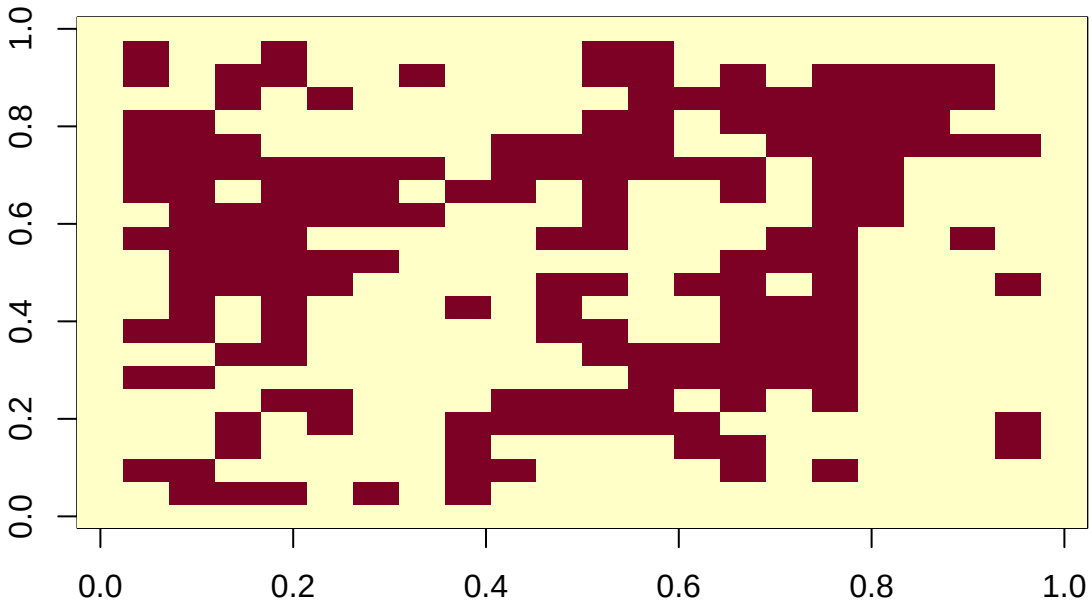
```
d <- 20
map <- matrix(0, d+2, d+2)
alpha0 <-4
alpha1 <- -2
beta <- 1/2
n_sim <- 50000
results <- array(0, dim = c(n_sim, d + 2, d + 2))
burnin <- 1000


## Gibbs
for (sim in (1:n_sim)){
for (i in (2:(d+1))){
  for (j in(2:(d+1))){
    eta <- (beta* (alpha0 +alpha1*(map[i+1, j] + map[i, j+1] + map[i-1, j] + map[i, j-1]) ))
    map[i, j] <- rbinom(1, 1, 1 / (1 + exp(eta)) )
  }
}
results[sim, ,] <- map
}


neighbor_sum <- function(matrix){
  d <- length(matrix[1,])
  sum_all <- 0
  for (i in (2:(d-1))){
    for (j in (2:(d-1))){
      neighbors <- matrix[i+1, j] + matrix[i, j+1] + matrix[i-1, j] + matrix[i, j-1]
      sum_all <- sum_all + neighbors*matrix[i, j]
    }
  }
  return(sum_all)
}

mean(apply(results[burnin:length(results[,1,1]), , ], 1, sum))
```

```
## [1] 174.2553
```

```r
mean(apply(results[burnin:length(results[,1,1]), , ], 1, neighbor_sum))
```

```
## [1] 404.9382
```

```r
image(results[1000,,])
```



Let's pack it into function

```r
gibbs_simulation <- function(n_sim, d, alpha0, alpha1, beta, burnin){
  map <- matrix(0, d+2, d+2)
  for (sim in (1:n_sim)){

    for (i in (2:(d+1))){
      for (j in(2:(d+1))){
        eta <- (beta* (alpha0 +alpha1*(map[i+1, j] + map[i, j+1] + map[i-1, j] + map[i, j-1]) ))
      map[i, j] <- rbinom(1, 1, 1 / (1 + exp(eta)) )
    }
    }

  results[sim, ,] <- map
  }
  return (results[burnin:length(results[,1,1]), , ])
}
```