Appendix

Problem 4 Part (c)

```
prob <- data.frame()
for(i in 1:4){
  for(j in 1:4){
    if(j==1){
        n <- i*8
        counter <- c(0)
        for(k in 1:10000){
          code <- sample( c(0,1), size = n, replace = TRUE, prob= c(0.01, (1-0.01)))
          error <- c(0)
          for(l in 1:(n-1)){
            if(code[l]==0 && code[l+1]==0){
            error = error + 1
            }
          }
          if(error>0){
            counter <- counter + 1
          }
        }
        prob[i,j] <- (10000-counter)/10000
    }
    if(j==2){
        n <- i*8
        counter <- c(0)
        for(k in 1:10000){
          code <- sample( c(0,1), size = n, replace = TRUE, prob= c(0.05, (1-0.05)))
          error <- c(0)
          for(l in 1:(n-1)){
            if(code[l]==0 && code[l+1]==0){
            error = error + 1
            }
          }
          if(error>0){
            counter <- counter + 1
          }
        }
        prob[i,j] <- (10000-counter)/10000
    }
    if(j==3){
        n <- i*8
        counter <- c(0)
        for(k in 1:10000){
          code <- sample( c(0,1), size = n, replace = TRUE, prob= c(0.1, (1-0.1)))
```

```
          error <- c(0)
          for(l in 1:(n-1)){
            if(code[l]==0 && code[l+1]==0){
            error = error + 1
            }
          }
          if(error>0){
            counter <- counter + 1
          }
        }
        prob[i,j] <- (10000-counter)/10000

    }
    if(j==4){
        n <- i*8
        counter <- c(0)
        for(k in 1:10000){
          code <- sample( c(0,1), size = n, replace = TRUE, prob= c(0.15, (1-0.15)))
          error <- c(0)
          for(l in 1:(n-1)){
            if(code[l]==0 && code[l+1]==0){
            error = error + 1
            }
          }
          if(error>0){
            counter <- counter + 1
          }
        }
        prob[i,j] <- (10000-counter)/10000

    }
  }
}
row.names(prob) <- c("n = 8","n = 16", "n = 24", "n = 32")
colnames(prob) <- c("p = 0.01", "p = 0.05","p =0.10","p = 0.15")
prob
```

```
##        p = 0.01 p = 0.05 p =0.10 p = 0.15
## n = 8    0.9995   0.9828  0.9378   0.8670
## n = 16   0.9988   0.9653  0.8746   0.7425
## n = 24   0.9975   0.9499  0.8139   0.6332
## n = 32   0.9971   0.9300  0.7511   0.5242
```

Problem 4 Part (d)

```
prob <- data.frame()
for(i in 1:4){
  for(j in 1:4){
    if(j==1){
        n <- i*8
        counter <- c(0)
```

```
    for(k in 1:10000){
      code <- sample( c(0,1), size = n, replace = TRUE, prob= c(0.01, (1-0.01)))
      error <- c(0)
      for(l in 1:(n-2)){
        if(code[l]==0 && code[l+1]==0 && code[l+2]==0){
        error = error + 1
        }
      }
      if(error>0){
        counter <- counter + 1
      }
    }
    prob[i,j] <- (10000-counter)/10000
}
if(j==2){
    n <- i*8
    counter <- c(0)
    for(k in 1:10000){
      code <- sample( c(0,1), size = n, replace = TRUE, prob= c(0.05, (1-0.05)))
      error <- c(0)
      for(l in 1:(n-2)){
        if(code[l]==0 && code[l+1]==0 && code[l+2]==0){
        error = error + 1
        }
      }
      if(error>0){
        counter <- counter + 1
      }
    }
    prob[i,j] <- (10000-counter)/10000
}
if(j==3){
    n <- i*8
    counter <- c(0)
    for(k in 1:10000){
      code <- sample( c(0,1), size = n, replace = TRUE, prob= c(0.1, (1-0.1)))
      error <- c(0)
      for(l in 1:(n-2)){
        if(code[l]==0 && code[l+1]==0 && code[l+2]==0){
        error = error + 1
        }
      }
      if(error>0){
        counter <- counter + 1
      }
    }
    prob[i,j] <- (10000-counter)/10000

}
if(j==4){
    n <- i*8
    counter <- c(0)
    for(k in 1:10000){
```

```
          code <- sample( c(0,1), size = n, replace = TRUE, prob= c(0.15, (1-0.15)))
          error <- c(0)
          for(l in 1:(n-2)){
            if(code[l]==0 && code[l+1]==0 && code[l+2]==0){
            error = error + 1
            }
          }
          if(error>0){
            counter <- counter + 1
          }
        }
        prob[i,j] <- (10000-counter)/10000

    }
  }
}
row.names(prob) <- c("n = 8","n = 16", "n = 24", "n = 32")
colnames(prob) <- c("p = 0.01", "p = 0.05","p =0.10","p = 0.15")
prob
```

```
##        p = 0.01 p = 0.05 p =0.10 p = 0.15
## n = 8         1   0.9991  0.9936   0.9827
## n = 16        1   0.9980  0.9856   0.9608
## n = 24        1   0.9975  0.9785   0.9417
## n = 32        1   0.9957  0.9718   0.9156
```

Problem 5 (b)

```
for(i in 1:6){
  prob <- as.data.frame(matrix(0, nrow = (5+1), ncol = 1))
  for(j in 0:5){
    row.names(prob)[j+1] <- paste("Cell",j)
  }
  for(j in 1:1000){
      path <- sample((0:1), size = 5, replace = TRUE)
      prob[(sum(path)+1), 1] <- prob[(sum(path)+1), 1] + 1
  }
  colnames(prob) <- paste("Number of Balls")
  prob[i, 2] <- choose(5,(i-1))*((0.5)^(i))*((0.5)^(5-i))
}
for (i in 1:6) {
  prob[i, 2] <- choose(5,(i-1))*((0.5)^(i))*((0.5)^(5-i))
}
colnames(prob) <- c("Number of Balls","Theoretical Probabilities")
prob
```

```
##        Number of Balls Theoretical Probabilities
## Cell 0              30                   0.03125
## Cell 1             152                   0.15625
## Cell 2             299                   0.31250
## Cell 3             310                   0.31250
```

```
## Cell 4             175                   0.15625
## Cell 5              34                   0.03125
```

Problem 5 (d)

```r
for(i in 1:6){
  prob <- as.data.frame(matrix(0, nrow = (100+1), ncol = 1))
  for(j in 0:100){
    row.names(prob)[j+1] <- paste("Cell",j)
  }
  for(j in 1:1000){
      path <- sample((0:1), size = 100, replace = TRUE)
      prob[(sum(path)+1), 1] <- prob[(sum(path)+1), 1] + 1
  }
  colnames(prob) <- paste("Number of Balls")
  prob[i, 2] <- choose(5,(i-1))*((0.5)^(i))*((0.5)^(5-i))
}
for (i in 1:101) {
  prob[i, 2] <- round(choose(100,(i-1))*((0.5)^(i))*((0.5)^(100-i)), digits = 4)
}
colnames(prob) <- c("Number of Balls","Theoretical Probabilities")
prob
```

```
##          Number of Balls Theoretical Probabilities
## Cell 0                 0                     0.0000
## Cell 1                 0                     0.0000
## Cell 2                 0                     0.0000
## Cell 3                 0                     0.0000
## Cell 4                 0                     0.0000
## Cell 5                 0                     0.0000
## Cell 6                 0                     0.0000
## Cell 7                 0                     0.0000
## Cell 8                 0                     0.0000
## Cell 9                 0                     0.0000
## Cell 10                0                     0.0000
## Cell 11                0                     0.0000
## Cell 12                0                     0.0000
## Cell 13                0                     0.0000
## Cell 14                0                     0.0000
## Cell 15                0                     0.0000
## Cell 16                0                     0.0000
## Cell 17                0                     0.0000
## Cell 18                0                     0.0000
## Cell 19                0                     0.0000
## Cell 20                0                     0.0000
## Cell 21                0                     0.0000
## Cell 22                0                     0.0000
## Cell 23                0                     0.0000
## Cell 24                0                     0.0000
## Cell 25                0                     0.0000
## Cell 26                0                     0.0000
## Cell 27                0                     0.0000
```

```
## Cell 28              0                0.0000
## Cell 29              0                0.0000
## Cell 30              0                0.0000
## Cell 31              0                0.0001
## Cell 32              0                0.0001
## Cell 33              2                0.0002
## Cell 34              0                0.0005
## Cell 35              1                0.0009
## Cell 36              4                0.0016
## Cell 37              4                0.0027
## Cell 38              2                0.0045
## Cell 39              2                0.0071
## Cell 40             12                0.0108
## Cell 41             12                0.0159
## Cell 42             22                0.0223
## Cell 43             24                0.0301
## Cell 44             49                0.0390
## Cell 45             43                0.0485
## Cell 46             64                0.0580
## Cell 47             68                0.0666
## Cell 48             68                0.0735
## Cell 49             69                0.0780
## Cell 50             72                0.0796
## Cell 51             87                0.0780
## Cell 52             83                0.0735
## Cell 53             72                0.0666
## Cell 54             60                0.0580
## Cell 55             58                0.0485
## Cell 56             38                0.0390
## Cell 57             26                0.0301
## Cell 58             19                0.0223
## Cell 59             15                0.0159
## Cell 60             12                0.0108
## Cell 61              6                0.0071
## Cell 62              0                0.0045
## Cell 63              1                0.0027
## Cell 64              3                0.0016
## Cell 65              2                0.0009
## Cell 66              0                0.0005
## Cell 67              0                0.0002
## Cell 68              0                0.0001
## Cell 69              0                0.0001
## Cell 70              0                0.0000
## Cell 71              0                0.0000
## Cell 72              0                0.0000
## Cell 73              0                0.0000
## Cell 74              0                0.0000
## Cell 75              0                0.0000
## Cell 76              0                0.0000
## Cell 77              0                0.0000
## Cell 78              0                0.0000
## Cell 79              0                0.0000
## Cell 80              0                0.0000
## Cell 81              0                0.0000
```

```
## Cell 82              0                   0.0000
## Cell 83              0                   0.0000
## Cell 84              0                   0.0000
## Cell 85              0                   0.0000
## Cell 86              0                   0.0000
## Cell 87              0                   0.0000
## Cell 88              0                   0.0000
## Cell 89              0                   0.0000
## Cell 90              0                   0.0000
## Cell 91              0                   0.0000
## Cell 92              0                   0.0000
## Cell 93              0                   0.0000
## Cell 94              0                   0.0000
## Cell 95              0                   0.0000
## Cell 96              0                   0.0000
## Cell 97              0                   0.0000
## Cell 98              0                   0.0000
## Cell 99              0                   0.0000
## Cell 100             0                   0.0000
```