Lab2 oskhi827

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Question 1

```
#, out.width='.49\\linewidth', fig.width=5, fig.height=5,fig.show='hold',fig.align='center'
library(HMM)

states = c("1", "2", "3", "4", "5", "6", "7", "8", "9", "10")
symbols = c("1", "2", "3", "4", "5", "6", "7", "8", "9", "10")
#start_prob = rep(0, 10)
#start_prob[1] = 1
start_prob = NULL
sur_state = function(x){
  state = x%%10
  if (state ==0) {
    state=10
  }
  return(state)
}
trans_prob = matrix(data=0, nrow = 10, ncol=10)
for (i in 1:10) {
  trans_prob[i,i] = 0.5
  trans_prob[i,sur_state(i+1)] = 0.5
}
emmis_prob = matrix(data=0, nrow = 10, ncol=10)
for (i in 1:10) {
  for (j in -2:2) {
    emmis_prob[i,sur_state(i+j)] = 0.5
  }
}
HMM = initHMM(states, symbols, start_prob, trans_prob, emmis_prob)
print(HMM)
```

```
## $States
##  [1] "1"  "2"  "3"  "4"  "5"  "6"  "7"  "8"  "9"  "10"
##
## $Symbols
##  [1] "1"  "2"  "3"  "4"  "5"  "6"  "7"  "8"  "9"  "10"
##
## $startProbs
##   1   2   3   4   5   6   7   8   9  10
## 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1
```

```
##
## $transProbs
##     to
## from   1   2   3   4   5   6   7   8   9  10
##   1  0.5 0.5 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
##   2  0.0 0.5 0.5 0.0 0.0 0.0 0.0 0.0 0.0 0.0
##   3  0.0 0.0 0.5 0.5 0.0 0.0 0.0 0.0 0.0 0.0
##   4  0.0 0.0 0.0 0.5 0.5 0.0 0.0 0.0 0.0 0.0
##   5  0.0 0.0 0.0 0.0 0.5 0.5 0.0 0.0 0.0 0.0
##   6  0.0 0.0 0.0 0.0 0.0 0.5 0.5 0.0 0.0 0.0
##   7  0.0 0.0 0.0 0.0 0.0 0.0 0.5 0.5 0.0 0.0
##   8  0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.5 0.5 0.0
##   9  0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.5 0.5
##   10 0.5 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.5
##
## $emissionProbs
##       symbols
## states   1   2   3   4   5   6   7   8   9  10
##     1  0.5 0.5 0.5 0.0 0.0 0.0 0.0 0.0 0.5 0.5
##     2  0.5 0.5 0.5 0.5 0.0 0.0 0.0 0.0 0.0 0.5
##     3  0.5 0.5 0.5 0.5 0.5 0.0 0.0 0.0 0.0 0.0
##     4  0.0 0.5 0.5 0.5 0.5 0.5 0.0 0.0 0.0 0.0
##     5  0.0 0.0 0.5 0.5 0.5 0.5 0.5 0.0 0.0 0.0
##     6  0.0 0.0 0.0 0.5 0.5 0.5 0.5 0.5 0.0 0.0
##     7  0.0 0.0 0.0 0.0 0.5 0.5 0.5 0.5 0.5 0.0
##     8  0.0 0.0 0.0 0.0 0.0 0.5 0.5 0.5 0.5 0.5
##     9  0.5 0.0 0.0 0.0 0.0 0.0 0.5 0.5 0.5 0.5
##     10 0.5 0.5 0.0 0.0 0.0 0.0 0.0 0.5 0.5 0.5
```

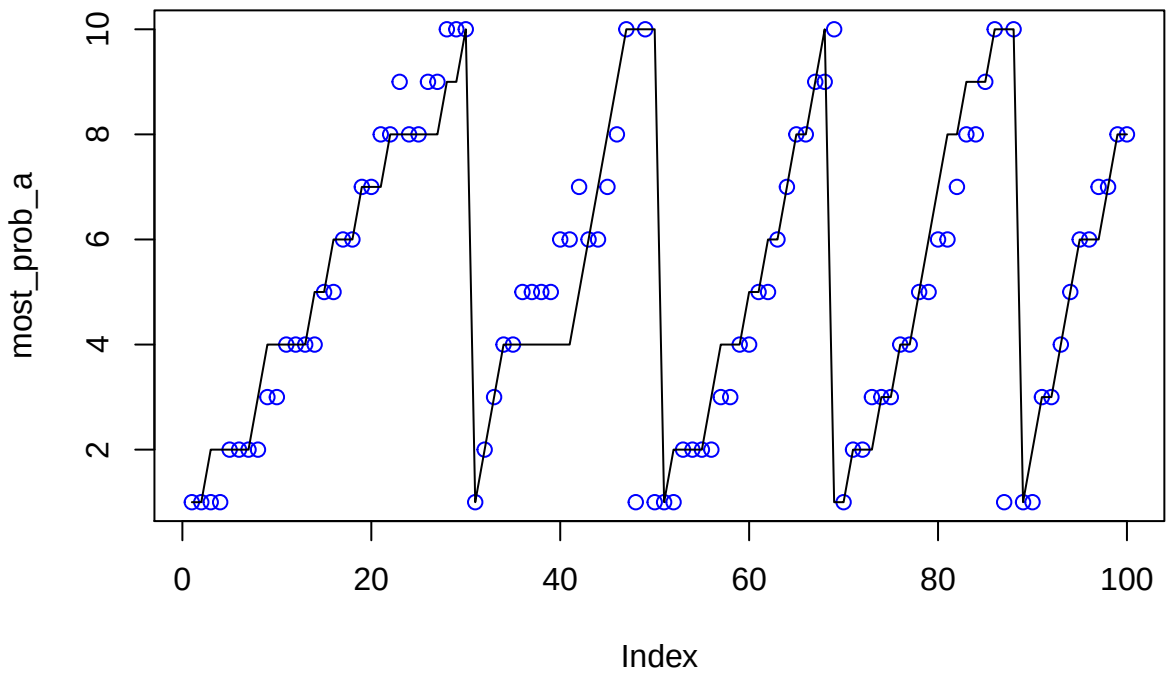
Question 2

```
N = 100
sim = simHMM(HMM, N)
sim
```

```
## $states
##   [1] "1"  "1"  "2"  "2"  "2"  "2"  "2"  "3"  "4"  "4"  "4"  "4"  "4"  "5"  "5"
##  [16] "6"  "6"  "6"  "7"  "7"  "7"  "8"  "8"  "8"  "8"  "8"  "8"  "9"  "9"  "10"
##  [31] "1"  "2"  "3"  "4"  "4"  "4"  "4"  "4"  "4"  "4"  "4"  "5"  "6"  "7"  "8"
##  [46] "9"  "10" "10" "10" "10" "1"  "2"  "2"  "2"  "2"  "3"  "4"  "4"  "4"  "5"
##  [61] "5"  "6"  "6"  "7"  "8"  "8"  "9"  "10" "1"  "1"  "2"  "2"  "2"  "3"  "3"
##  [76] "4"  "4"  "5"  "6"  "7"  "8"  "8"  "9"  "9"  "9"  "10" "10" "10" "1"  "2"
##  [91] "3"  "3"  "4"  "5"  "6"  "6"  "6"  "7"  "8"  "8"
##
## $observation
##   [1] "10" "9"  "2"  "1"  "2"  "4"  "10" "4"  "2"  "2"  "5"  "2"  "2"  "3"  "5"
##  [16] "4"  "5"  "6"  "6"  "7"  "8"  "9"  "7"  "6"  "10" "9"  "8"  "10" "8"  "1"
##  [31] "3"  "10" "5"  "6"  "5"  "3"  "5"  "3"  "5"  "4"  "6"  "6"  "4"  "6"  "8"
##  [46] "10" "2"  "1"  "8"  "9"  "10" "1"  "10" "2"  "10" "1"  "2"  "2"  "3"  "3"
##  [61] "3"  "7"  "8"  "5"  "10" "10" "9"  "8"  "2"  "3"  "3"  "2"  "1"  "2"  "3"
##  [76] "3"  "5"  "3"  "7"  "6"  "7"  "9"  "7"  "9"  "7"  "2"  "9"  "8"  "1"  "3"
##  [91] "5"  "3"  "5"  "7"  "5"  "7"  "6"  "6"  "6"  "9"
```

Question 3

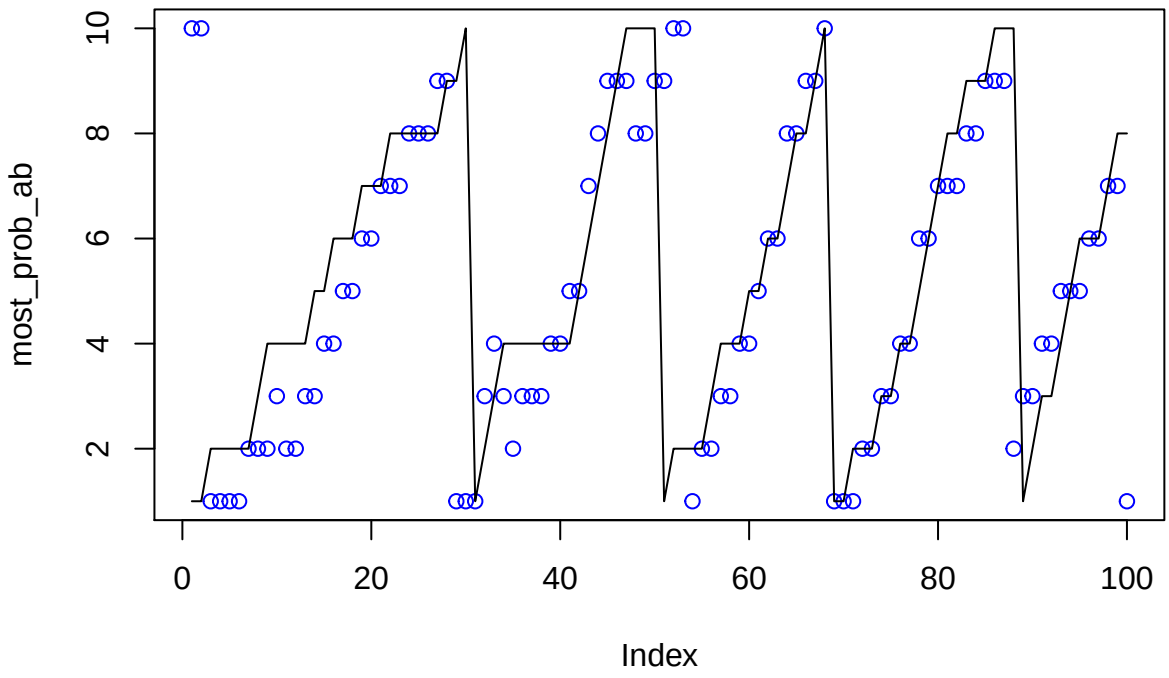
```
observed = sim$observation

miss_class = function(table){
  return(1-(sum(diag(table))/sum(table)))
}

# filterd alpha --Alpha uses all observations up to point t to estimate Zt
alpha_log = forward(HMM, observed)
alpha = exp(alpha_log)
most_prob_a = apply(alpha, MARGIN = 2, which.max)
plot(most_prob_a, col="blue")
lines(sim$states)
```




```
sum(sim$states==most_prob_a)/100
```

```
## [1] 0.57
```

```
# smoothed alpha*beta  -- Alpha beta uses all observations (to T) to estimate Zt. "which is better"
alpha_beta_log = backward(HMM, observed)
alpha_beta = exp(alpha_beta_log)
most_prob_ab = apply(alpha_beta, MARGIN = 2, which.max)
plot(most_prob_ab, col="blue")
lines(sim$states)
```




```
sum(sim$states==most_prob_ab)/100
```

```
## [1] 0.34
```