

# MSiA400\_LabAssignment1

```
setwd("~/Desktop/Everything Starts With Data/Lab Assignment 1")
```

## Problem 1

a)

```
markov = read.table("markov100.txt", header=FALSE)
P = as.matrix(markov)
a <- c(1,rep(0,99))
library(expm)

## Loading required package: Matrix
##
## Attaching package: 'expm'
## The following object is masked from 'package:Matrix':
##
##      expm
p_10 <- a %*% (P %^% 10)
p_10[1,5]

##      V5
## 0.045091
```

b)

```
a1 <- c(rep(1/3,3),rep(0,97))
p1_10 <- a1 %*% (P %^% 10)
p1_10[1,10]

##      V10
## 0.08268901
```

c)

```
Q <- t(P) - diag(100)
Q[100,] <- c(rep(1,100))
rhs <- c(rep(0,99),1)
Pi = solve(Q) %*% rhs
Pi[1,1]

## [1] 0.01256589
```

d)

```
B <- P[1:99,1:99]
Q <- diag(99) - B
e <- c(rep(1,99))
m <- solve(Q) %*% e
m[1,1]
```

```
##          V1
## 254.9395
```

## Problem 2

a)

```
webtraffic = read.table("webtraffic.txt", header=TRUE)
sum <- colSums(webtraffic)
Traffic <- t(matrix(sum, nrow = 9, ncol = 9))
Traffic
```

```
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9]
## [1,]    0  447  553    0    0    0    0    0    0
## [2,]    0   23  230  321    0    0    0    0   63
## [3,]    0  167   43  520    0    0    0    0   96
## [4,]    0    0    0   44  158  312  247    0  124
## [5,]    0    0    0    0   22   52   90  127  218
## [6,]    0    0    0    0   67   21    0  294   97
## [7,]    0    0    0    0    0   94    7  185   58
## [8,]    0    0    0    0  262    0    0   30  344
## [9,]    0    0    0    0    0    0    0    0    0
```

b)

```
Traffic[9,1] <- 1000
P_traffic <- Traffic/rowSums(Traffic)
P_traffic
```

```
##      [,1]      [,2]      [,3]      [,4]      [,5]      [,6]
## [1,]    0 0.44700000 0.55300000 0.00000000 0.00000000 0.00000000
## [2,]    0 0.03610675 0.36106750 0.50392465 0.00000000 0.00000000
## [3,]    0 0.20217918 0.05205811 0.62953995 0.00000000 0.00000000
## [4,]    0 0.00000000 0.00000000 0.04971751 0.1785311 0.35254237
## [5,]    0 0.00000000 0.00000000 0.00000000 0.0432220 0.10216110
## [6,]    0 0.00000000 0.00000000 0.00000000 0.1398747 0.04384134
## [7,]    0 0.00000000 0.00000000 0.00000000 0.0000000 0.27325581
## [8,]    0 0.00000000 0.00000000 0.00000000 0.4119497 0.00000000
## [9,]    1 0.00000000 0.00000000 0.00000000 0.0000000 0.00000000
##      [,7]      [,8]      [,9]
## [1,] 0.00000000 0.00000000 0.00000000
## [2,] 0.00000000 0.00000000 0.0989011
## [3,] 0.00000000 0.00000000 0.1162228
```

```
## [4,] 0.27909605 0.00000000 0.1401130
## [5,] 0.17681729 0.24950884 0.4282908
## [6,] 0.00000000 0.61377871 0.2025052
## [7,] 0.02034884 0.53779070 0.1686047
## [8,] 0.00000000 0.04716981 0.5408805
## [9,] 0.00000000 0.00000000 0.0000000
```

c)

```
Q_traffic = t(P_traffic) - diag(9)
Q_traffic[9,] = c(1,1,1,1,1,1,1,1,1)
rhs_traffic = c(0,0,0,0,0,0,0,0,1)
Pi_traffic = solve(Q_traffic) %*% rhs_traffic
Pi_traffic
```

```
##          [,1]
## [1,] 0.15832806
## [2,] 0.10085497
## [3,] 0.13077897
## [4,] 0.14012033
## [5,] 0.08058898
## [6,] 0.07583914
## [7,] 0.05446485
## [8,] 0.10069664
## [9,] 0.15832806
```

d)

```
B_traffic = P_traffic[1:8,1:8]
Q_traffic1 = diag(8) - B_traffic
e_traffic = c(1,1,1,1,1,1,1,1)
m_traffic = solve(Q_traffic1) %*% e_traffic
time <- c(0.1,2,3,5,5,3,3,2,0)
avg_time <- time %*% Pi_traffic
spend_time = m_traffic[1,1] * avg_time
spend_time
```

```
##          [,1]
## [1,] 12.25727
```

e)

```
new_traffic <- Traffic
new_traffic[2,6] = new_traffic[2,3] * 0.3
new_traffic[2,7] = new_traffic[2,4] * 0.2
new_traffic[2,3] = new_traffic[2,3] * 0.7
new_traffic[2,4] = new_traffic[2,4] * 0.8
new_traffic[9,1] = 1000
P_newtraffic <- new_traffic/rowSums(new_traffic)
Q_newtraffic = t(P_newtraffic) - diag(9)
```

```

Q_newtraffic[9,] = c(1,1,1,1,1,1,1,1,1)
rhs_newtraffic = c(0,0,0,0,0,0,0,0,1)
Pi_newtraffic = solve(Q_newtraffic) %*% rhs_newtraffic
Pi_newtraffic

```

```

##           [,1]
## [1,] 0.16162840
## [2,] 0.10034341
## [3,] 0.12104331
## [4,] 0.12275720
## [5,] 0.08164613
## [6,] 0.08250884
## [7,] 0.06003218
## [8,] 0.10841213
## [9,] 0.16162840

```

```

Pi_newtraffic - Pi_traffic

```

```

##           [,1]
## [1,] 0.0033003475
## [2,] -0.0005115633
## [3,] -0.0097356600
## [4,] -0.0173631313
## [5,] 0.0010571466
## [6,] 0.0066696974
## [7,] 0.0055673326
## [8,] 0.0077154832
## [9,] 0.0033003475

```

Compared to Pi, chances to visit Page 2 and Page 3 in Pi2 decreases. The link works.