Lab_assignment_1

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1.

Read data

```
markov100 <- read.delim("~/Desktop/MSIA/Courses/MSIA 400 Everything starts with data/Lab Assignment 1/ma
```

(a)

```
library(expm)
```

```
## Loading required package: Matrix
```

```
##
## Attaching package: 'expm'
```

```
## The following object is masked from 'package:Matrix':
##
##     expm
```

```
a = rep(0,100)
a[1]= 1
p = a %*%(as.matrix(markov100) %^% 10)
p[5]
```

```
## [1] 0.045091
```

(b)

```
b = rep(0,100)
b[1:3]=1/3
p_b = b %*%(as.matrix(markov100) %^% 10)
p_b[10]
```

```
## [1] 0.08268901
```

(c)

```
Q <- t(as.matrix(markov100))-diag(100)
Q[100,]<-rep(1,100)
rhs = c(rep(0,99),1)
pi = solve(Q)%*%rhs
pi[1]
```

```
## [1] 0.01256589
```

(d)

```
b = as.matrix(markov100)[-100,-100]
Q = diag(99)-b
e = rep(1,99)
m = solve(Q) %*% e
m[1]
```

```
## [1] 254.9395
```

2.

read data

```
web <- read.delim("~/Desktop/MSIA/Courses/MSIA 400 Everything starts with data/Lab Assignment 1/webtraf
```

(a)

```
traffic <- matrix(colSums(web),nrow = 9,byrow = T)
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/colSums(traffic)
p
```

```
##       [,1]       [,2]       [,3]       [,4]      [,5]       [,6]
##  [1,]    0 0.44700000 0.55300000 0.00000000 0.0000000 0.00000000
##  [2,]    0 0.03610675 0.36106750 0.50392465 0.0000000 0.00000000
##  [3,]    0 0.20217918 0.05205811 0.62953995 0.0000000 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 0.0000000
##  [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 <- t(p)-diag(9)
Q[9,]<-rep(1,9)
rhs = c(rep(0,8),1)
pi = solve(Q)%*%rhs
pi
```

```
##             [,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)

```
w <- c(0.1,2,3,5,5,3,3,2)
B = p[-9,-9]
Q = diag(8)-B
e = rep(1,8)
m = solve(Q) %*% e
m
```

```
##          [,1]
## [1,] 5.316000
## [2,] 4.401776
## [3,] 4.246666
## [4,] 3.392390
## [5,] 2.429794
## [6,] 2.749343
## [7,] 2.940475
## [8,] 2.100010
```

```
avg_time = w %*% pi[-9]
# average time
m[1,1] * avg_time
```

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

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

(e)

```
traffic[2,6] = 0.3*traffic[2,3]
traffic[2,3] = 0.7*traffic[2,3]
traffic[2,7] = 0.2*traffic[2,4]
traffic[2,4] = 0.8*traffic[2,3]

p <- traffic/colSums(traffic)
Q <- t(p)-diag(9)
Q[9,]<-rep(1,9)
rhs = c(rep(0,8),1)
pi_2 = solve(Q)%*%rhs
pi_2
```

```
##              [,1]
##  [1,] 0.16160310
##  [2,] 0.10294118
##  [3,] 0.12233355
##  [4,] 0.11195863
##  [5,] 0.08225598
##  [6,] 0.08855850
##  [7,] 0.06596639
##  [8,] 0.10277957
##  [9,] 0.16160310
```

```
var(pi)
```

```
##              [,1]
## [1,] 0.001410675
```

```
var(pi_2)
```

```
##              [,1]
## [1,] 0.001092624
```