Taller Markov 1

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SOLUCIÓN

1 ECONOMÍA Y FINANZAS

a) MATRIZ DE TRANSICIÓN

```
Estados <- c("Sube","Constante","Baja")
library(matrixcalc)
P<-matrix(c(0.9,0.025,0.075,0.25,0.5,0.25,0.15,0.05,0.8),nrow = 3,byrow = TRUE)
row.names(P) <- Estados
colnames(P) <-Estados
knitr::kable(P, caption = "MATRIZ DE TRANSICIÓN")
```

Table 1: MATRIZ DE TRANSICIÓN

	Sube	Constante	Baja
Sube	0.90	0.025	0.075
Constante	0.25	0.500	0.250
Baja	0.15	0.050	0.800

b) a. SEMANA SIGUIENTE

```
x<-c(0,0,1);x #vector inicial
```

```
## [1] 0 0 1
```

```
x1=x %*% P;x1
```

```
##      Sube Constante Baja
## [1,] 0.15      0.05  0.8
```

```
knitr::kable(x1, caption = "SEMANA SIGUIENTE")
```

Table 2: SEMANA SIGUIENTE

Sube	Constante	Baja
0.15	0.05	0.8

b) b. DENTRO DE 5 SEMANAS

```
#b. DENTRO DE 5 SEMANAS
p5<-matrix.power(P,5)
p5
```

```
##              Sube Constante     Baja
## Sube      0.70683  0.054865 0.238305
## Constante 0.54865  0.086975 0.364375
## Baja      0.47661  0.072875 0.450515
```

```
x5 = x %*%p5
knitr::kable(x5, caption = "DENTRO DE 5 SEMANAS")
```

Table 3: DENTRO DE 5 SEMANAS

Sube	Constante	Baja
0.47661	0.072875	0.450515

b) c. DENTRO DE 52 SEMANAS

```
p52<-matrix.power(P,52)
p52
```

```
##                Sube  Constante      Baja
## Sube      0.6250001 0.06249999 0.3124999
## Constante 0.6249999 0.06250000 0.3125001
## Baja      0.6249999 0.06250001 0.3125001
```

```
x52 = x %*%p52
knitr::kable(x52, caption = "DENTRO DE 52 SEMANAS")
```

Table 4: DENTRO DE 52 SEMANAS

Sube	Constante	Baja
0.6249999	0.0625	0.3125001

b) d. DENTRO DE 99 SEMANAS

```
p99<-matrix.power(P,99)
p99
```

```
##            Sube Constante   Baja
## Sube      0.625    0.0625 0.3125
## Constante 0.625    0.0625 0.3125
## Baja      0.625    0.0625 0.3125
```

```
x99 = x %*%p99
knitr::kable(x99, caption = "DENTRO DE 99 SEMANAS")
```

Table 5: DENTRO DE 99 SEMANAS

Sube	Constante	Baja
0.625	0.0625	0.3125

a) ESTADO ESTABLE

El estado estable se encuentra en la semana 55

```
library(matrixcalc)
for(i in 1:60)  {
  print(paste('i = ', i, sep = ''))
  print(matrix.power(P,i))
  print('')
}
```

```
## [1] "i = 1"
##           Sube Constante  Baja
## Sube      0.90     0.025 0.075
## Constante 0.25     0.500 0.250
## Baja      0.15     0.050 0.800
## [1] ""
## [1] "i = 2"
##             Sube Constante    Baja
## Sube      0.8275   0.03875 0.13375
## Constante 0.3875   0.26875 0.34375
## Baja      0.2675   0.06875 0.66375
## [1] ""
## [1] "i = 3"
##             Sube Constante    Baja
## Sube      0.7745   0.04675 0.17875
## Constante 0.4675   0.16125 0.37125
## Baja      0.3575   0.07425 0.56825
## [1] ""
## [1] "i = 4"
##              Sube Constante     Baja
## Sube      0.73555  0.051675 0.212775
## Constante 0.51675  0.110875 0.372375
```

```
## Baja      0.42555  0.074475 0.499975
## [1] ""
## [1] "i = 5"
##              Sube Constante     Baja
## Sube      0.70683  0.054865 0.238305
## Constante 0.54865  0.086975 0.364375
## Baja      0.47661  0.072875 0.450515
## [1] ""
## [1] "i = 6"
##               Sube Constante      Baja
## Sube      0.685609 0.0570185 0.2573725
## Constante 0.570185 0.0754225 0.3543925
## Baja      0.514745 0.0708785 0.4143765
## [1] ""
## [1] "i = 7"
##                Sube Constante      Baja
## Sube      0.6699086 0.0585181 0.2715733
## Constante 0.5851810 0.0696855 0.3451335
## Baja      0.5431466 0.0690267 0.3878267
## [1] ""
## [1] "i = 8"
##                Sube  Constante      Baja
## Sube      0.6582833 0.05958543 0.2821313
## Constante 0.5958543 0.06672895 0.3374168
## Baja      0.5642626 0.06748335 0.3682540
## [1] ""
## [1] "i = 9"
##                Sube  Constante      Baja
## Sube      0.6496710 0.06035636 0.2899727
## Constante 0.6035636 0.06513167 0.3313047
## Baja      0.5799453 0.06626094 0.3537938
## [1] ""
## [1] "i = 10"
##                Sube  Constante      Baja
## Sube      0.6432889 0.06091859 0.2957925
## Constante 0.6091859 0.06422016 0.3265940
## Baja      0.5915851 0.06531879 0.3430961
## [1] ""
## [1] "i = 11"
##                Sube  Constante      Baja
## Sube      0.6385585 0.06133114 0.3001103
## Constante 0.6133114 0.06366943 0.3230191
## Baja      0.6002207 0.06460383 0.3351755
## [1] ""
## [1] "i = 12"
##                Sube  Constante      Baja
## Sube      0.6350520 0.06163505 0.3033129
## Constante 0.6163505 0.06331846 0.3203310
## Baja      0.6066259 0.06406621 0.3293079
## [1] ""
## [1] "i = 13"
##                Sube  Constante      Baja
## Sube      0.6324525 0.06185947 0.3056880
## Constante 0.6185947 0.06308454 0.3183207
```

```
## Baja      0.6113760 0.06366415 0.3249598
## [1] ""
## [1] "i = 14"
##                Sube  Constante      Baja
## Sube      0.6305253 0.06202545 0.3074492
## Constante 0.6202545 0.06292318 0.3168223
## Baja      0.6148984 0.06336446 0.3217371
## [1] ""
## [1] "i = 15"
##                Sube  Constante      Baja
## Sube      0.6290965 0.06214832 0.3087551
## Constante 0.6214832 0.06280907 0.3157077
## Baja      0.6175103 0.06314155 0.3193482
## [1] ""
## [1] "i = 16"
##                Sube  Constante      Baja
## Sube      0.6280372 0.06223933 0.3097234
## Constante 0.6223933 0.06272700 0.3148797
## Baja      0.6194469 0.06297594 0.3175772
## [1] ""
## [1] "i = 17"
##                Sube  Constante      Baja
## Sube      0.6272519 0.06230677 0.3104414
## Constante 0.6230677 0.06266732 0.3142650
## Baja      0.6208827 0.06285300 0.3162643
## [1] ""
## [1] "i = 18"
##                Sube  Constante      Baja
## Sube      0.6266696 0.06235675 0.3109737
## Constante 0.6235675 0.06262360 0.3138089
## Baja      0.6219474 0.06276178 0.3152909
## [1] ""
## [1] "i = 19"
##                Sube  Constante      Baja
## Sube      0.6262379 0.06239380 0.3113683
## Constante 0.6239380 0.06259143 0.3134706
## Baja      0.6227367 0.06269412 0.3145692
## [1] ""
## [1] "i = 20"
##                Sube  Constante      Baja
## Sube      0.6259178 0.06242126 0.3116610
## Constante 0.6242126 0.06256770 0.3132197
## Baja      0.6233219 0.06264394 0.3140341
## [1] ""
## [1] "i = 21"
##                Sube  Constante      Baja
## Sube      0.6256805 0.06244162 0.3118779
## Constante 0.6244162 0.06255015 0.3130336
## Baja      0.6237558 0.06260672 0.3136374
## [1] ""
## [1] "i = 22"
##                Sube  Constante      Baja
## Sube      0.6255045 0.06245672 0.3120388
## Constante 0.6245672 0.06253716 0.3128956
```

```
## Baja      0.6240776 0.06257913 0.3133433
## [1] ""
## [1] "i = 23"
##                Sube  Constante      Baja
## Sube      0.6253740 0.06246791 0.3121580
## Constante 0.6246791 0.06252754 0.3127933
## Baja      0.6243161 0.06255867 0.3131253
## [1] ""
## [1] "i = 24"
##                Sube  Constante      Baja
## Sube      0.6252773 0.06247621 0.3122465
## Constante 0.6247621 0.06252042 0.3127175
## Baja      0.6244929 0.06254350 0.3129636
## [1] ""
## [1] "i = 25"
##                Sube  Constante      Baja
## Sube      0.6252056 0.06248236 0.3123120
## Constante 0.6248236 0.06251514 0.3126613
## Baja      0.6246240 0.06253225 0.3128437
## [1] ""
## [1] "i = 26"
##                Sube  Constante      Baja
## Sube      0.6251524 0.06248692 0.3123606
## Constante 0.6248692 0.06251122 0.3126196
## Baja      0.6247213 0.06252391 0.3127548
## [1] ""
## [1] "i = 27"
##                Sube  Constante      Baja
## Sube      0.6251130 0.06249030 0.3123967
## Constante 0.6249030 0.06250832 0.3125886
## Baja      0.6247933 0.06251773 0.3126889
## [1] ""
## [1] "i = 28"
##                Sube  Constante      Baja
## Sube      0.6250838 0.06249281 0.3124234
## Constante 0.6249281 0.06250617 0.3125657
## Baja      0.6248468 0.06251314 0.3126401
## [1] ""
## [1] "i = 29"
##                Sube  Constante      Baja
## Sube      0.6250621 0.06249467 0.3124432
## Constante 0.6249467 0.06250457 0.3125487
## Baja      0.6248864 0.06250975 0.3126039
## [1] ""
## [1] "i = 30"
##                Sube  Constante      Baja
## Sube      0.6250461 0.06249605 0.3124579
## Constante 0.6249605 0.06250339 0.3125361
## Baja      0.6249158 0.06250723 0.3125770
## [1] ""
## [1] "i = 31"
##                Sube  Constante      Baja
## Sube      0.6250342 0.06249707 0.3124688
## Constante 0.6249707 0.06250251 0.3125268
```

```
## Baja      0.6249376 0.06250536 0.3125571
## [1] ""
## [1] "i = 32"
##                Sube  Constante      Baja
## Sube      0.6250253 0.06249783 0.3124768
## Constante 0.6249783 0.06250186 0.3125199
## Baja      0.6249537 0.06250397 0.3125423
## [1] ""
## [1] "i = 33"
##                Sube  Constante      Baja
## Sube      0.6250188 0.06249839 0.3124828
## Constante 0.6249839 0.06250138 0.3125147
## Baja      0.6249657 0.06250294 0.3125314
## [1] ""
## [1] "i = 34"
##                Sube  Constante      Baja
## Sube      0.6250139 0.06249881 0.3124873
## Constante 0.6249881 0.06250102 0.3125109
## Baja      0.6249745 0.06250218 0.3125233
## [1] ""
## [1] "i = 35"
##                Sube  Constante      Baja
## Sube      0.6250103 0.06249911 0.3124906
## Constante 0.6249911 0.06250076 0.3125081
## Baja      0.6249811 0.06250162 0.3125173
## [1] ""
## [1] "i = 36"
##                Sube  Constante      Baja
## Sube      0.6250077 0.06249934 0.3124930
## Constante 0.6249934 0.06250056 0.3125060
## Baja      0.6249860 0.06250120 0.3125128
## [1] ""
## [1] "i = 37"
##                Sube  Constante      Baja
## Sube      0.6250057 0.06249951 0.3124948
## Constante 0.6249951 0.06250042 0.3125044
## Baja      0.6249896 0.06250089 0.3125095
## [1] ""
## [1] "i = 38"
##                Sube  Constante      Baja
## Sube      0.6250042 0.06249964 0.3124962
## Constante 0.6249964 0.06250031 0.3125033
## Baja      0.6249923 0.06250066 0.3125070
## [1] ""
## [1] "i = 39"
##                Sube  Constante      Baja
## Sube      0.6250031 0.06249973 0.3124971
## Constante 0.6249973 0.06250023 0.3125024
## Baja      0.6249943 0.06250049 0.3125052
## [1] ""
## [1] "i = 40"
##                Sube  Constante      Baja
## Sube      0.6250023 0.06249980 0.3124979
## Constante 0.6249980 0.06250017 0.3125018
```

```
## Baja      0.6249958 0.06250036 0.3125039
## [1] ""
## [1] "i = 41"
##                Sube  Constante      Baja
## Sube      0.6250017 0.06249985 0.3124984
## Constante 0.6249985 0.06250013 0.3125013
## Baja      0.6249969 0.06250027 0.3125029
## [1] ""
## [1] "i = 42"
##                Sube  Constante      Baja
## Sube      0.6250013 0.06249989 0.3124988
## Constante 0.6249989 0.06250009 0.3125010
## Baja      0.6249977 0.06250020 0.3125021
## [1] ""
## [1] "i = 43"
##                Sube  Constante      Baja
## Sube      0.6250009 0.06249992 0.3124991
## Constante 0.6249992 0.06250007 0.3125007
## Baja      0.6249983 0.06250015 0.3125016
## [1] ""
## [1] "i = 44"
##                Sube  Constante      Baja
## Sube      0.6250007 0.06249994 0.3124994
## Constante 0.6249994 0.06250005 0.3125005
## Baja      0.6249987 0.06250011 0.3125012
## [1] ""
## [1] "i = 45"
##                Sube  Constante      Baja
## Sube      0.6250005 0.06249996 0.3124995
## Constante 0.6249996 0.06250004 0.3125004
## Baja      0.6249991 0.06250008 0.3125009
## [1] ""
## [1] "i = 46"
##                Sube  Constante      Baja
## Sube      0.6250004 0.06249997 0.3124996
## Constante 0.6249997 0.06250003 0.3125003
## Baja      0.6249993 0.06250006 0.3125006
## [1] ""
## [1] "i = 47"
##                Sube  Constante      Baja
## Sube      0.6250003 0.06249998 0.3124997
## Constante 0.6249998 0.06250002 0.3125002
## Baja      0.6249995 0.06250004 0.3125005
## [1] ""
## [1] "i = 48"
##                Sube  Constante      Baja
## Sube      0.6250002 0.06249998 0.3124998
## Constante 0.6249998 0.06250002 0.3125002
## Baja      0.6249996 0.06250003 0.3125004
## [1] ""
## [1] "i = 49"
##                Sube  Constante      Baja
## Sube      0.6250002 0.06249999 0.3124999
## Constante 0.6249999 0.06250001 0.3125001
```

```
## Baja      0.6249997 0.06250002 0.3125003
## [1] ""
## [1] "i = 50"
##                Sube  Constante      Baja
## Sube      0.6250001 0.06249999 0.3124999
## Constante 0.6249999 0.06250001 0.3125001
## Baja      0.6249998 0.06250002 0.3125002
## [1] ""
## [1] "i = 51"
##                Sube  Constante      Baja
## Sube      0.6250001 0.06249999 0.3124999
## Constante 0.6249999 0.06250001 0.3125001
## Baja      0.6249998 0.06250001 0.3125001
## [1] ""
## [1] "i = 52"
##                Sube  Constante      Baja
## Sube      0.6250001 0.06249999 0.3124999
## Constante 0.6249999 0.06250000 0.3125001
## Baja      0.6249999 0.06250001 0.3125001
## [1] ""
## [1] "i = 53"
##                Sube  Constante      Baja
## Sube      0.6250000 0.06250000 0.3125000
## Constante 0.6250000 0.06250000 0.3125000
## Baja      0.6249999 0.06250001 0.3125001
## [1] ""
## [1] "i = 54"
##                Sube  Constante      Baja
## Sube      0.6250000 0.06250000 0.3125000
## Constante 0.6250000 0.06250000 0.3125000
## Baja      0.6249999 0.06250001 0.3125001
## [1] ""
## [1] "i = 55"
##            Sube Constante   Baja
## Sube      0.625    0.0625 0.3125
## Constante 0.625    0.0625 0.3125
## Baja      0.625    0.0625 0.3125
## [1] ""
## [1] "i = 56"
##            Sube Constante   Baja
## Sube      0.625    0.0625 0.3125
## Constante 0.625    0.0625 0.3125
## Baja      0.625    0.0625 0.3125
## [1] ""
## [1] "i = 57"
##            Sube Constante   Baja
## Sube      0.625    0.0625 0.3125
## Constante 0.625    0.0625 0.3125
## Baja      0.625    0.0625 0.3125
## [1] ""
## [1] "i = 58"
##            Sube Constante   Baja
## Sube      0.625    0.0625 0.3125
## Constante 0.625    0.0625 0.3125
```

```
## Baja      0.625    0.0625 0.3125
## [1] ""
## [1] "i = 59"
##            Sube Constante   Baja
## Sube      0.625    0.0625 0.3125
## Constante 0.625    0.0625 0.3125
## Baja      0.625    0.0625 0.3125
## [1] ""
## [1] "i = 60"
##            Sube Constante   Baja
## Sube      0.625    0.0625 0.3125
## Constante 0.625    0.0625 0.3125
## Baja      0.625    0.0625 0.3125
## [1] ""
```

2 DISTRIBUCIÓN DE INGRESOS

a) DIAGRAMA DE MARKOV

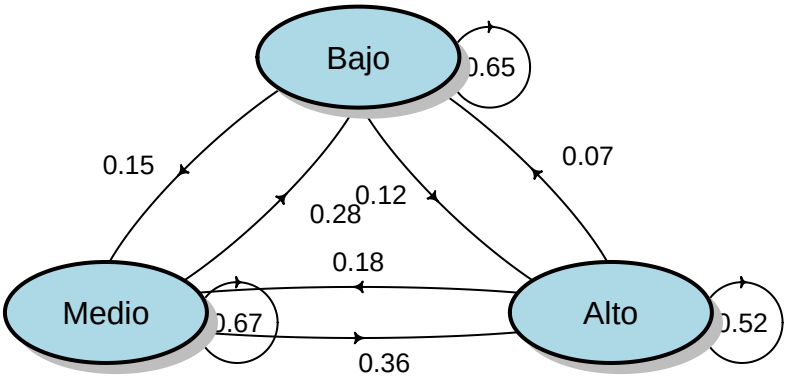
```
P1<-matrix(c(0.65,0.28,0.07,0.15,0.67,0.18,0.12,0.36,0.52),nrow = 3,byrow = TRUE);P1
```

```
##      [,1] [,2] [,3]
## [1,] 0.65 0.28 0.07
## [2,] 0.15 0.67 0.18
## [3,] 0.12 0.36 0.52
```

```
#diagrama de Markov
nombres_estados <- c("Bajo","Medio","Alto")
row.names(P1) <- nombres_estados;
colnames(P1) <- nombres_estados
library(diagram)
```

```
## Loading required package: shape
```

```
plotmat(P1,pos = c(1,2),
        lwd = 1, box.lwd = 2,
        cex.txt = 0.8,
        box.size = 0.1,
        box.type = "circle",
        box.prop = 0.5,
        box.col = "light blue",
        arr.length=.1,
        arr.width=.1,
        self.cex = .4,
        self.shifty = -.01,
        self.shiftx = .13,
        main = "Cadena de Markov estado de generacion")
```



b) SEPTIMA GENERACIÓN

```
x<-c(0.21,0.68,0.11);x #vector inicial
```

```
## [1] 0.21 0.68 0.11
```

```
x1=x %*% P1;x1
```

```
##        Bajo Medio   Alto
## [1,] 0.2517 0.554 0.1943
```

```
#b. DENTRO DE LA 7 GENERACION
p7<-matrix.power(P1,7)
p7
```

```
##            Bajo     Medio      Alto
## Bajo  0.2933709 0.4858094 0.2208197
## Medio 0.2842097 0.4895435 0.2262468
## Alto  0.2827296 0.4897564 0.2275141
```

```
x7 = x %*%p7
knitr::kable(x7, caption = "SEPTIMA GENERACIÓN")
```

Table 6: SEPTIMA GENERACIÓN

Bajo	Medio	Alto
0.2859707	0.4887828	0.2252465

c) GENERACIÓN DE DISTRIBUCIÓN ESTABLE

La distribución estable se encuentra en la generación 27

```
library(matrixcalc)
for(i in 1:35)  {
  print(paste('i = ', i, sep = ''))
  print(matrix.power(P1,i))
  print('')
}
```

```
## [1] "i = 1"
##       Bajo Medio Alto
## Bajo  0.65  0.28 0.07
## Medio 0.15  0.67 0.18
## Alto  0.12  0.36 0.52
## [1] ""
## [1] "i = 2"
##         Bajo  Medio   Alto
## Bajo  0.4729 0.3948 0.1323
## Medio 0.2196 0.5557 0.2247
## Alto  0.1944 0.4620 0.3436
## [1] ""
## [1] "i = 3"
##           Bajo    Medio     Alto
## Bajo  0.382481 0.444556 0.172963
## Medio 0.253059 0.514699 0.232242
## Alto  0.236892 0.487668 0.275440
## [1] ""
## [1] "i = 4"
##            Bajo     Medio      Alto
## Bajo  0.3360516 0.4672139 0.1967345
## Medio 0.2695622 0.4993120 0.2311258
## Alto  0.2601828 0.4922257 0.2475915
## [1] ""
## [1] "i = 5"
##            Bajo     Medio      Alto
## Bajo  0.3121238 0.4779522 0.2099241
## Medio 0.2778473 0.4932217 0.2289309
## Alto  0.2726637 0.4917753 0.2355610
## [1] ""
## [1] "i = 6"
##            Bajo     Medio      Alto
```

```
## Bajo  0.2997642 0.4831953 0.2170406
## Medio 0.2820557 0.4906709 0.2272733
## Alto  0.2792650 0.4906373 0.2300977
## [1] ""
## [1] "i = 7"
##           Bajo     Medio      Alto
## Bajo  0.2933709 0.4858094 0.2208197
## Medio 0.2842097 0.4895435 0.2262468
## Alto  0.2827296 0.4897564 0.2275141
## [1] ""
## [1] "i = 8"
##           Bajo     Medio      Alto
## Bajo  0.2900608 0.4871312 0.2228079
## Medio 0.2853174 0.4890217 0.2256608
## Alto  0.2845394 0.4892061 0.2262545
## [1] ""
## [1] "i = 9"
##           Bajo     Medio      Alto
## Bajo  0.2883462 0.4878058 0.2238480
## Medio 0.2858889 0.4887713 0.2253398
## Alto  0.2854820 0.4888907 0.2256272
## [1] ""
## [1] "i = 10"
##           Bajo     Medio      Alto
## Bajo  0.2874577 0.4881521 0.2243902
## Medio 0.2861843 0.4886480 0.2251677
## Alto  0.2859722 0.4887176 0.2253102
## [1] ""
## [1] "i = 11"
##           Bajo     Medio      Alto
## Bajo  0.2869971 0.4883305 0.2246723
## Medio 0.2863371 0.4885861 0.2250768
## Alto  0.2862268 0.4886247 0.2251485
## [1] ""
## [1] "i = 12"
##           Bajo     Medio      Alto
## Bajo  0.2867584 0.4884227 0.2248189
## Medio 0.2864162 0.4885547 0.2250290
## Alto  0.2863589 0.4885755 0.2250656
## [1] ""
## [1] "i = 13"
##           Bajo     Medio      Alto
## Bajo  0.2866346 0.4884704 0.2248950
## Medio 0.2864573 0.4885387 0.2250041
## Alto  0.2864275 0.4885497 0.2250228
## [1] ""
## [1] "i = 14"
##           Bajo     Medio      Alto
## Bajo  0.2865705 0.4884950 0.2249345
## Medio 0.2864785 0.4885304 0.2249911
## Alto  0.2864631 0.4885362 0.2250007
## [1] ""
## [1] "i = 15"
##           Bajo     Medio      Alto
```

```
## Bajo  0.2865372 0.4885078 0.2249550
## Medio 0.2864895 0.4885261 0.2249843
## Alto  0.2864815 0.4885292 0.2249893
## [1] ""
## [1] "i = 16"
##           Bajo     Medio      Alto
## Bajo  0.2865199 0.4885145 0.2249656
## Medio 0.2864952 0.4885239 0.2249808
## Alto  0.2864911 0.4885255 0.2249834
## [1] ""
## [1] "i = 17"
##           Bajo     Medio      Alto
## Bajo  0.2865110 0.4885179 0.2249711
## Medio 0.2864982 0.4885228 0.2249790
## Alto  0.2864960 0.4885236 0.2249803
## [1] ""
## [1] "i = 18"
##           Bajo     Medio      Alto
## Bajo  0.2865064 0.4885197 0.2249740
## Medio 0.2864997 0.4885222 0.2249781
## Alto  0.2864986 0.4885226 0.2249788
## [1] ""
## [1] "i = 19"
##           Bajo     Medio      Alto
## Bajo  0.2865040 0.4885206 0.2249754
## Medio 0.2865005 0.4885219 0.2249776
## Alto  0.2864999 0.4885221 0.2249779
## [1] ""
## [1] "i = 20"
##           Bajo     Medio      Alto
## Bajo  0.2865027 0.4885211 0.2249762
## Medio 0.2865009 0.4885217 0.2249773
## Alto  0.2865006 0.4885219 0.2249775
## [1] ""
## [1] "i = 21"
##           Bajo     Medio      Alto
## Bajo  0.2865021 0.4885213 0.2249766
## Medio 0.2865011 0.4885217 0.2249772
## Alto  0.2865010 0.4885217 0.2249773
## [1] ""
## [1] "i = 22"
##           Bajo     Medio      Alto
## Bajo  0.2865017 0.4885214 0.2249768
## Medio 0.2865013 0.4885216 0.2249771
## Alto  0.2865012 0.4885217 0.2249772
## [1] ""
## [1] "i = 23"
##           Bajo     Medio      Alto
## Bajo  0.2865016 0.4885215 0.2249769
## Medio 0.2865013 0.4885216 0.2249771
## Alto  0.2865013 0.4885216 0.2249771
## [1] ""
## [1] "i = 24"
##           Bajo     Medio      Alto
```

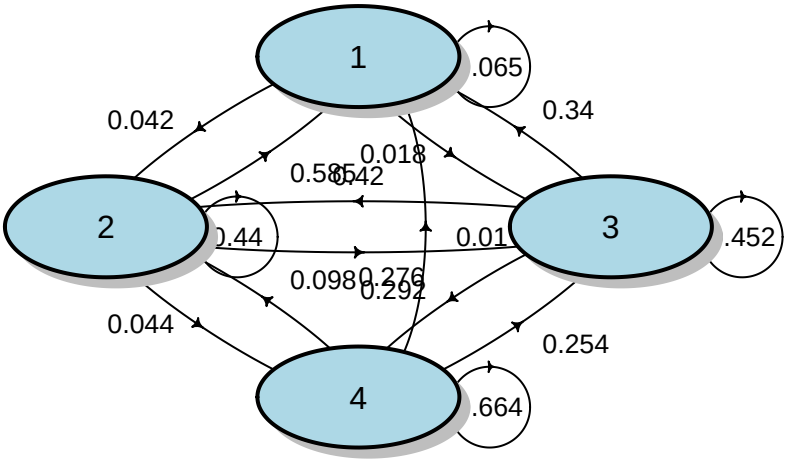
```
## Bajo  0.2865015 0.4885215 0.2249770
## Medio 0.2865013 0.4885216 0.2249771
## Alto  0.2865013 0.4885216 0.2249771
## [1] ""
## [1] "i = 25"
##            Bajo     Medio      Alto
## Bajo  0.2865014 0.4885216 0.2249770
## Medio 0.2865014 0.4885216 0.2249771
## Alto  0.2865013 0.4885216 0.2249771
## [1] ""
## [1] "i = 26"
##            Bajo     Medio      Alto
## Bajo  0.2865014 0.4885216 0.2249770
## Medio 0.2865014 0.4885216 0.2249770
## Alto  0.2865014 0.4885216 0.2249771
## [1] ""
## [1] "i = 27"
##            Bajo     Medio     Alto
## Bajo  0.2865014 0.4885216 0.224977
## Medio 0.2865014 0.4885216 0.224977
## Alto  0.2865014 0.4885216 0.224977
## [1] ""
## [1] "i = 28"
##            Bajo     Medio     Alto
## Bajo  0.2865014 0.4885216 0.224977
## Medio 0.2865014 0.4885216 0.224977
## Alto  0.2865014 0.4885216 0.224977
## [1] ""
## [1] "i = 29"
##            Bajo     Medio     Alto
## Bajo  0.2865014 0.4885216 0.224977
## Medio 0.2865014 0.4885216 0.224977
## Alto  0.2865014 0.4885216 0.224977
## [1] ""
## [1] "i = 30"
##            Bajo     Medio     Alto
## Bajo  0.2865014 0.4885216 0.224977
## Medio 0.2865014 0.4885216 0.224977
## Alto  0.2865014 0.4885216 0.224977
## [1] ""
## [1] "i = 31"
##            Bajo     Medio     Alto
## Bajo  0.2865014 0.4885216 0.224977
## Medio 0.2865014 0.4885216 0.224977
## Alto  0.2865014 0.4885216 0.224977
## [1] ""
## [1] "i = 32"
##            Bajo     Medio     Alto
## Bajo  0.2865014 0.4885216 0.224977
## Medio 0.2865014 0.4885216 0.224977
## Alto  0.2865014 0.4885216 0.224977
## [1] ""
## [1] "i = 33"
##            Bajo     Medio     Alto
```

```
## Bajo  0.2865014 0.4885216 0.224977
## Medio 0.2865014 0.4885216 0.224977
## Alto  0.2865014 0.4885216 0.224977
## [1] ""
## [1] "i = 34"
##           Bajo     Medio     Alto
## Bajo  0.2865014 0.4885216 0.224977
## Medio 0.2865014 0.4885216 0.224977
## Alto  0.2865014 0.4885216 0.224977
## [1] ""
## [1] "i = 35"
##           Bajo     Medio     Alto
## Bajo  0.2865014 0.4885216 0.224977
## Medio 0.2865014 0.4885216 0.224977
## Alto  0.2865014 0.4885216 0.224977
## [1] ""
```

3 EVALUACIÓN DE DESEMPEÑO

a) DIAGRAMA DE MARKOV

```
library(matrixcalc)
P2<-matrix(c(0.065,0.585,0.34,0.01,0.042,0.44,0.42,0.098,0.018,0.276,0.452,0.254,0,0.044,0.292,0.664),
           nrow = 4,byrow = TRUE)
nombres_estados <- c("1","2","3","4")
row.names(P2) <- nombres_estados;
colnames(P2) <- nombres_estados
library(diagram)
plotmat(P2,pos = c(1,2,1),
        lwd = 1, box.lwd = 2,
        cex.txt = 0.8,
        box.size = 0.1,
        box.type = "circle",
        box.prop = 0.5,
        box.col = "light blue",
        arr.length=.1,
        arr.width=.1,
        self.cex = .4,
        self.shifty = -.01,
        self.shiftx = .13,
        main = "Cadena de Markov de resultados del examen")
```



b) PREDICCIÓN A LARGO PLAZO

```
library(markovchain)
```

```
## Package:  markovchain
## Version:  0.8.6
## Date:     2021-05-17
## BugReport: https://github.com/spedygiorgio/markovchain/issues
```

```
cadena <- new("markovchain",
              transitionMatrix = P2 , name = "Ejemplo",
              byrow = TRUE)
equilibrio <- steadyStates(cadena)
knitr::kable(equilibrio, caption = "PREDICCIÓN A LARGO PLAZO")
```

Table 7: PREDICCIÓN A LARGO PLAZO

1	2	3	4
0.018043	0.2367865	0.3847318	0.3604387

c) RREPETICIONES REQUERDAS DE EXAMENES PÁRA QUE EL 70% ALCANCE EL DOMINO DE LOS TEMAS

Debido a los resultados obtenidos en el punto anterior, por más que se repita el examen nunca se va a lograr que el 70% de los estudiantes alcance el dominio de los temas.

```
library(matrixcalc)
for(i in 1:40)  {
  print(paste('i = ', i, sep = ''))
  print(matrix.power(P2,i))
  print('')
}
```

```
## [1] "i = 1"
##       1     2     3     4
## 1 0.065 0.585 0.340 0.010
## 2 0.042 0.440 0.420 0.098
## 3 0.018 0.276 0.452 0.254
## 4 0.000 0.044 0.292 0.664
## [1] ""
## [1] "i = 2"
##          1        2        3        4
## 1 0.034915 0.389705 0.424400 0.150980
## 2 0.028770 0.338402 0.417536 0.215292
## 3 0.020898 0.267898 0.400512 0.310692
## 4 0.007104 0.129168 0.344352 0.519376
## [1] ""
## [1] "i = 3"
##            1         2         3         4
## 1 0.02627628 0.3156730 0.4114622 0.2465886
## 2 0.02359858 0.2904401 0.4035022 0.2824591
## 3 0.01981930 0.2543122 0.3913760 0.3344925
## 4 0.01208515 0.1788835 0.3639708 0.4450606
## [1] ""
## [1] "i = 4"
##            1         2         3         4
## 1 0.02237254 0.2786812 0.3995014 0.2994449
## 2 0.02099543 0.2653936 0.3948694 0.3187415
## 3 0.01901413 0.2462291 0.3881234 0.3466333
## 4 0.01485011 0.2058171 0.3737125 0.4056202
## [1] ""
## [1] "i = 5"
##            1         2         3         4
## 1 0.02034985 0.2591456 0.3926653 0.3278392
## 2 0.01961888 0.2520641 0.3901573 0.3381597
## 3 0.01856376 0.2418380 0.3865298 0.3530685
## 4 0.01633640 0.2202388 0.3788514 0.3845734
## [1] ""
## [1] "i = 6"
##            1         2         3         4
## 1 0.01927483 0.2487293 0.3889739 0.3430220
## 2 0.01888475 0.2449477 0.3876311 0.3485365
## 3 0.01832138 0.2394858 0.3856911 0.3565018
```

```
## 4 0.01713122 0.2279461 0.3815909 0.3733318
## [1] ""
## [1] "i = 7"
##           1         2         3         4
## 1 0.01870102 0.2431664 0.3869984 0.3511342
## 2 0.01849267 0.2411463 0.3862807 0.3540802
## 3 0.01819173 0.2382286 0.3852442 0.3583355
## 4 0.01755590 0.2320637 0.3830539 0.3673264
## [1] ""
## [1] "i = 8"
##           1         2         3         4
## 1 0.01839453 0.2401948 0.3859427 0.3554680
## 2 0.01828322 0.2391156 0.3855593 0.3570419
## 3 0.01812246 0.2375569 0.3850055 0.3593151
## 4 0.01778278 0.2342635 0.3838355 0.3641182
## [1] ""
## [1] "i = 9"
##           1         2         3         4
## 1 0.01823079 0.2386073 0.3853787 0.3577832
## 2 0.01817133 0.2380308 0.3851739 0.3586240
## 3 0.01808545 0.2371981 0.3848780 0.3598385
## 4 0.01790399 0.2354387 0.3842530 0.3624044
## [1] ""
## [1] "i = 10"
##           1         2         3         4
## 1 0.01814332 0.2377592 0.3850774 0.3590201
## 2 0.01811156 0.2374512 0.3849680 0.3594692
## 3 0.01806568 0.2370064 0.3848099 0.3601180
## 4 0.01796874 0.2360665 0.3844760 0.3614888
## [1] ""
## [1] "i = 11"
##           1         2         3         4
## 1 0.01809660 0.2373061 0.3849164 0.3596808
## 2 0.01807963 0.2371416 0.3848580 0.3599208
## 3 0.01805512 0.2369040 0.3847736 0.3602674
## 4 0.01800333 0.2364018 0.3845952 0.3609997
## [1] ""
## [1] "i = 12"
##           1         2         3         4
## 1 0.01807163 0.2370641 0.3848305 0.3600338
## 2 0.01806257 0.2369762 0.3847992 0.3601620
## 3 0.01804947 0.2368492 0.3847541 0.3603472
## 4 0.01802181 0.2365810 0.3846588 0.3607384
## [1] ""
## [1] "i = 13"
##           1         2         3         4
## 1 0.01805830 0.2369348 0.3847845 0.3602224
## 2 0.01805345 0.2368878 0.3847678 0.3602909
## 3 0.01804646 0.2368200 0.3847437 0.3603898
## 4 0.01803168 0.2366767 0.3846928 0.3605988
## [1] ""
## [1] "i = 14"
##           1         2         3         4
## 1 0.01805117 0.2368657 0.3847600 0.3603231
```

```
## 2 0.01804859 0.2368406 0.3847511 0.3603597
## 3 0.01804485 0.2368044 0.3847382 0.3604126
## 4 0.01803695 0.2367279 0.3847110 0.3605242
## [1] ""
## [1] "i = 15"
##           1         2         3         4
## 1 0.01804737 0.2368288 0.3847469 0.3603769
## 2 0.01804598 0.2368154 0.3847421 0.3603965
## 3 0.01804399 0.2367961 0.3847352 0.3604247
## 4 0.01803977 0.2367552 0.3847207 0.3604844
## [1] ""
## [1] "i = 16"
##           1         2         3         4
## 1 0.01804533 0.2368091 0.3847399 0.3604057
## 2 0.01804459 0.2368020 0.3847373 0.3604161
## 3 0.01804353 0.2367916 0.3847336 0.3604312
## 4 0.01804127 0.2367698 0.3847259 0.3604631
## [1] ""
## [1] "i = 17"
##           1         2         3         4
## 1 0.01804425 0.2367986 0.3847361 0.3604211
## 2 0.01804385 0.2367948 0.3847348 0.3604266
## 3 0.01804328 0.2367892 0.3847328 0.3604347
## 4 0.01804208 0.2367776 0.3847287 0.3604517
## [1] ""
## [1] "i = 18"
##           1         2         3         4
## 1 0.01804367 0.2367930 0.3847341 0.3604293
## 2 0.01804346 0.2367909 0.3847334 0.3604322
## 3 0.01804315 0.2367880 0.3847323 0.3604365
## 4 0.01804251 0.2367817 0.3847301 0.3604456
## [1] ""
## [1] "i = 19"
##           1         2         3         4
## 1 0.01804336 0.2367900 0.3847331 0.3604336
## 2 0.01804324 0.2367889 0.3847327 0.3604352
## 3 0.01804308 0.2367873 0.3847321 0.3604375
## 4 0.01804274 0.2367840 0.3847309 0.3604424
## [1] ""
## [1] "i = 20"
##           1         2         3         4
## 1 0.01804319 0.2367883 0.3847325 0.3604360
## 2 0.01804313 0.2367878 0.3847323 0.3604368
## 3 0.01804304 0.2367869 0.3847320 0.3604381
## 4 0.01804286 0.2367851 0.3847313 0.3604407
## [1] ""
## [1] "i = 21"
##           1         2         3         4
## 1 0.01804310 0.2367875 0.3847322 0.3604372
## 2 0.01804307 0.2367872 0.3847321 0.3604377
## 3 0.01804302 0.2367867 0.3847319 0.3604383
## 4 0.01804293 0.2367858 0.3847316 0.3604397
## [1] ""
## [1] "i = 22"
```

```
##           1         2         3         4
## 1 0.01804306 0.2367870 0.3847320 0.3604379
## 2 0.01804304 0.2367869 0.3847320 0.3604381
## 3 0.01804301 0.2367866 0.3847319 0.3604385
## 4 0.01804296 0.2367861 0.3847317 0.3604392
## [1] ""
## [1] "i = 23"
##           1         2         3         4
## 1 0.01804303 0.2367868 0.3847319 0.3604383
## 2 0.01804302 0.2367867 0.3847319 0.3604384
## 3 0.01804301 0.2367866 0.3847319 0.3604386
## 4 0.01804298 0.2367863 0.3847318 0.3604390
## [1] ""
## [1] "i = 24"
##           1         2         3         4
## 1 0.01804302 0.2367867 0.3847319 0.3604384
## 2 0.01804301 0.2367866 0.3847319 0.3604385
## 3 0.01804300 0.2367865 0.3847318 0.3604386
## 4 0.01804299 0.2367864 0.3847318 0.3604388
## [1] ""
## [1] "i = 25"
##           1         2         3         4
## 1 0.01804301 0.2367866 0.3847319 0.3604385
## 2 0.01804301 0.2367866 0.3847318 0.3604386
## 3 0.01804300 0.2367865 0.3847318 0.3604386
## 4 0.01804300 0.2367864 0.3847318 0.3604388
## [1] ""
## [1] "i = 26"
##           1         2         3         4
## 1 0.01804301 0.2367865 0.3847318 0.3604386
## 2 0.01804300 0.2367865 0.3847318 0.3604386
## 3 0.01804300 0.2367865 0.3847318 0.3604387
## 4 0.01804300 0.2367865 0.3847318 0.3604387
## [1] ""
## [1] "i = 27"
##          1         2         3         4
## 1 0.018043 0.2367865 0.3847318 0.3604386
## 2 0.018043 0.2367865 0.3847318 0.3604386
## 3 0.018043 0.2367865 0.3847318 0.3604387
## 4 0.018043 0.2367865 0.3847318 0.3604387
## [1] ""
## [1] "i = 28"
##          1         2         3         4
## 1 0.018043 0.2367865 0.3847318 0.3604386
## 2 0.018043 0.2367865 0.3847318 0.3604387
## 3 0.018043 0.2367865 0.3847318 0.3604387
## 4 0.018043 0.2367865 0.3847318 0.3604387
## [1] ""
## [1] "i = 29"
##          1         2         3         4
## 1 0.018043 0.2367865 0.3847318 0.3604387
## 2 0.018043 0.2367865 0.3847318 0.3604387
## 3 0.018043 0.2367865 0.3847318 0.3604387
## 4 0.018043 0.2367865 0.3847318 0.3604387
```

```
## [1] ""
## [1] "i = 30"
##          1         2         3         4
## 1 0.018043 0.2367865 0.3847318 0.3604387
## 2 0.018043 0.2367865 0.3847318 0.3604387
## 3 0.018043 0.2367865 0.3847318 0.3604387
## 4 0.018043 0.2367865 0.3847318 0.3604387
## [1] ""
## [1] "i = 31"
##          1         2         3         4
## 1 0.018043 0.2367865 0.3847318 0.3604387
## 2 0.018043 0.2367865 0.3847318 0.3604387
## 3 0.018043 0.2367865 0.3847318 0.3604387
## 4 0.018043 0.2367865 0.3847318 0.3604387
## [1] ""
## [1] "i = 32"
##          1         2         3         4
## 1 0.018043 0.2367865 0.3847318 0.3604387
## 2 0.018043 0.2367865 0.3847318 0.3604387
## 3 0.018043 0.2367865 0.3847318 0.3604387
## 4 0.018043 0.2367865 0.3847318 0.3604387
## [1] ""
## [1] "i = 33"
##          1         2         3         4
## 1 0.018043 0.2367865 0.3847318 0.3604387
## 2 0.018043 0.2367865 0.3847318 0.3604387
## 3 0.018043 0.2367865 0.3847318 0.3604387
## 4 0.018043 0.2367865 0.3847318 0.3604387
## [1] ""
## [1] "i = 34"
##          1         2         3         4
## 1 0.018043 0.2367865 0.3847318 0.3604387
## 2 0.018043 0.2367865 0.3847318 0.3604387
## 3 0.018043 0.2367865 0.3847318 0.3604387
## 4 0.018043 0.2367865 0.3847318 0.3604387
## [1] ""
## [1] "i = 35"
##          1         2         3         4
## 1 0.018043 0.2367865 0.3847318 0.3604387
## 2 0.018043 0.2367865 0.3847318 0.3604387
## 3 0.018043 0.2367865 0.3847318 0.3604387
## 4 0.018043 0.2367865 0.3847318 0.3604387
## [1] ""
## [1] "i = 36"
##          1         2         3         4
## 1 0.018043 0.2367865 0.3847318 0.3604387
## 2 0.018043 0.2367865 0.3847318 0.3604387
## 3 0.018043 0.2367865 0.3847318 0.3604387
## 4 0.018043 0.2367865 0.3847318 0.3604387
## [1] ""
## [1] "i = 37"
##          1         2         3         4
## 1 0.018043 0.2367865 0.3847318 0.3604387
## 2 0.018043 0.2367865 0.3847318 0.3604387
```

```
## 3 0.018043 0.2367865 0.3847318 0.3604387
## 4 0.018043 0.2367865 0.3847318 0.3604387
## [1] ""
## [1] "i = 38"
##          1         2         3         4
## 1 0.018043 0.2367865 0.3847318 0.3604387
## 2 0.018043 0.2367865 0.3847318 0.3604387
## 3 0.018043 0.2367865 0.3847318 0.3604387
## 4 0.018043 0.2367865 0.3847318 0.3604387
## [1] ""
## [1] "i = 39"
##          1         2         3         4
## 1 0.018043 0.2367865 0.3847318 0.3604387
## 2 0.018043 0.2367865 0.3847318 0.3604387
## 3 0.018043 0.2367865 0.3847318 0.3604387
## 4 0.018043 0.2367865 0.3847318 0.3604387
## [1] ""
## [1] "i = 40"
##          1         2         3         4
## 1 0.018043 0.2367865 0.3847318 0.3604387
## 2 0.018043 0.2367865 0.3847318 0.3604387
## 3 0.018043 0.2367865 0.3847318 0.3604387
## 4 0.018043 0.2367865 0.3847318 0.3604387
## [1] ""
```

4 REPRODUCIÓN DE DATOS DEL ARTICULO

```
P3 = matrix(c(0.7,0,0.1,0.05,0.1,0.05,0,0.8,0.1,0,0,0.2,0.1,0,0.4,0.05,0.2,0,0,0.15,0,0.8,0.05,0.05,0.2
cadena2=new("markovchain",transitionMatrix=t(P3),name="ejemplo", byrow=TRUE)
equilibrio2=steadyStates(cadena2)
knitr::kable(equilibrio2, caption = "PREDICCIÓN A LARGO PLAZO DEL ARTICULO")
```

Table 8: PREDICCIÓN A LARGO PLAZO DEL ARTICULO

1	2	3	4	5	6
0.1401274	0.2253185	0.0843949	0.2452229	0.1218153	0.183121