Tarea 3

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Pregunta 1

a)

$$P_{i,j} = \begin{bmatrix} \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ ... & 0 & q_i & 1-q_i-p_i & p_i & 0 & ... \\ ... & 0 & 0 & q_i & 1-q_i-p_i & p_i & ... \\ ... & 0 & 0 & 0 & q_i & 1-q_i-p_i & ... \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \end{bmatrix}$$

Para $X_1 = 0$, $q_i = 0.5$, $p_i = 0.2$

```r
x1 <- 0
x <- x1

for(i in 2:500){
  x[i] <- sample(c(x[i-1]-1,x[i-1],x[i-1]+1),1, prob = c(0.5,0.2,0.3))
}

table(x)
```

```
## x
## -98 -97 -96 -95 -94 -93 -92 -91 -90 -89 -88 -87 -86 -85 -84 -83 -82 -81
##   1   2   1   6  19  10   2   1   3  13  16  14   9   9  12  10   1   3
## -80 -79 -78 -77 -76 -75 -74 -73 -72 -71 -70 -69 -68 -67 -66 -65 -64 -63
##   4   4   3   5   5   4   1   2   4   7  11   5   1   3   1   1   4   3
## -62 -61 -60 -59 -58 -57 -56 -55 -54 -53 -52 -51 -50 -49 -48 -47 -46 -45
##   2   2   1   1   1   2   6  16  21  18  17  19   7   2   5   4   1   1
## -44 -43 -42 -41 -40 -39 -38 -37 -36 -35 -34 -33 -32 -31 -30 -29 -28 -27
##   1   1   1   1   1   2   6  11   5   2   3   3   2   1   1   1   1   5
## -26 -25 -24 -23 -22 -21 -20 -19 -18 -17 -16 -15 -14 -13 -12 -11 -10  -9
##   3   1   1   2   3   2   2   5   8   3   1   2   6  11  13  10   9   4
##  -8  -7  -6  -5  -4  -3  -2  -1   0   1
##   1   1   1   1   1   2   5  12  12   4
```

```r
x1 <- 0
x <- x1

for(i in 2:500){
  x[i] <- sample(c(x[i-1]-1,x[i-1],x[i-1]+1),1, prob = c(0.5,0.2,0.3))
}

table(x)
```

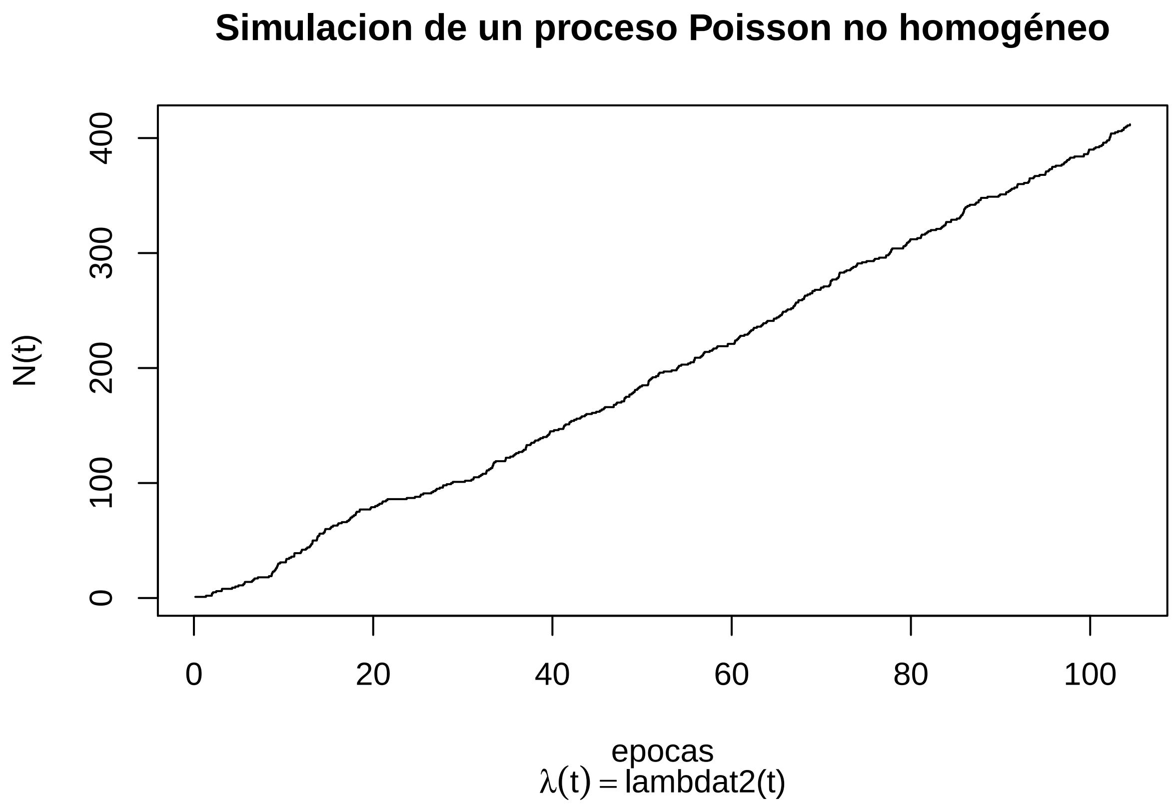
```
## x
## -116 -115 -114 -113 -112 -111 -110 -109 -108 -107 -106 -105 -104 -103 -102
##    2    4    8   13   15    7    2    2    2    1    3    5    4    2    2
## -101 -100  -99  -98  -97  -96  -95  -94  -93  -92  -91  -90  -89  -88  -87
```

```
##     5    5    9    5    5   13    8    9    7    2    2    3    2    1    3
##   -86  -85  -84  -83  -82  -81  -80  -79  -78  -77  -76  -75  -74  -73  -72
##     5    4    1    1    3    1    2    1    1    1    2    6    4    2    1
##   -71  -70  -69  -68  -67  -66  -65  -64  -63  -62  -61  -60  -59  -58  -57
##     4    3    5    3    3    3    2    9    8    3    3    6    5    5    8
##   -56  -55  -54  -53  -52  -51  -50  -49  -48  -47  -46  -45  -44  -43  -42
##     7    8    8    7    8    7    6    7   10    8    6    2    1    1    1
##   -41  -40  -39  -38  -37  -36  -35  -34  -33  -32  -31  -30  -29  -28  -27
##     1    4    9    8    7    9   10    9    8    2    3    5    1    5   10
##   -26  -25  -24  -23  -22  -21  -20  -19  -18  -17  -16  -15  -14  -13  -12
##     7    1    1    1    1    3    5    3    2    3    4    3    3    2    1
##   -11  -10   -9   -8   -7   -6   -5   -4   -3   -2   -1    0
##     2    2    1    1    1    2    1    4    5    4    2    1
```

Pregunta 2

a) Grafiquen una ejemplo del proceso considerando el intervalo de tiempo [0,100].

```r
lambdat2 <- function(t){
  x <- paste("","{",0,"<= t & t <",1,"}",sep="")
  for(i in seq(2,100,2)){
    x <- paste(x,paste("","{",i,"<= t & t <",i+1,"}",sep=""),sep="|")
    }
  return(ifelse(eval(parse(text=x)),3,5))
}
poissonnohomogeneo<-function(lambdat,n,pic=T){
  lambda <- 5
  TT <- rexp(n,lambda)
  s <- cumsum(TT)
  u <- runif(n)
  ss <- s[u <= lambdat(s)/lambda]
  Ns <- 1:length(ss)
  if(pic==T){
  plot(ss, Ns, type = "s", xlab = "epocas", ylab = "N(t)", main = "Simulacion de un proceso Poisson no h
  return(list(epocas = ss, cuenta= Ns))
  }
}
poissonnohomogeneo(lambdat2,510)
```



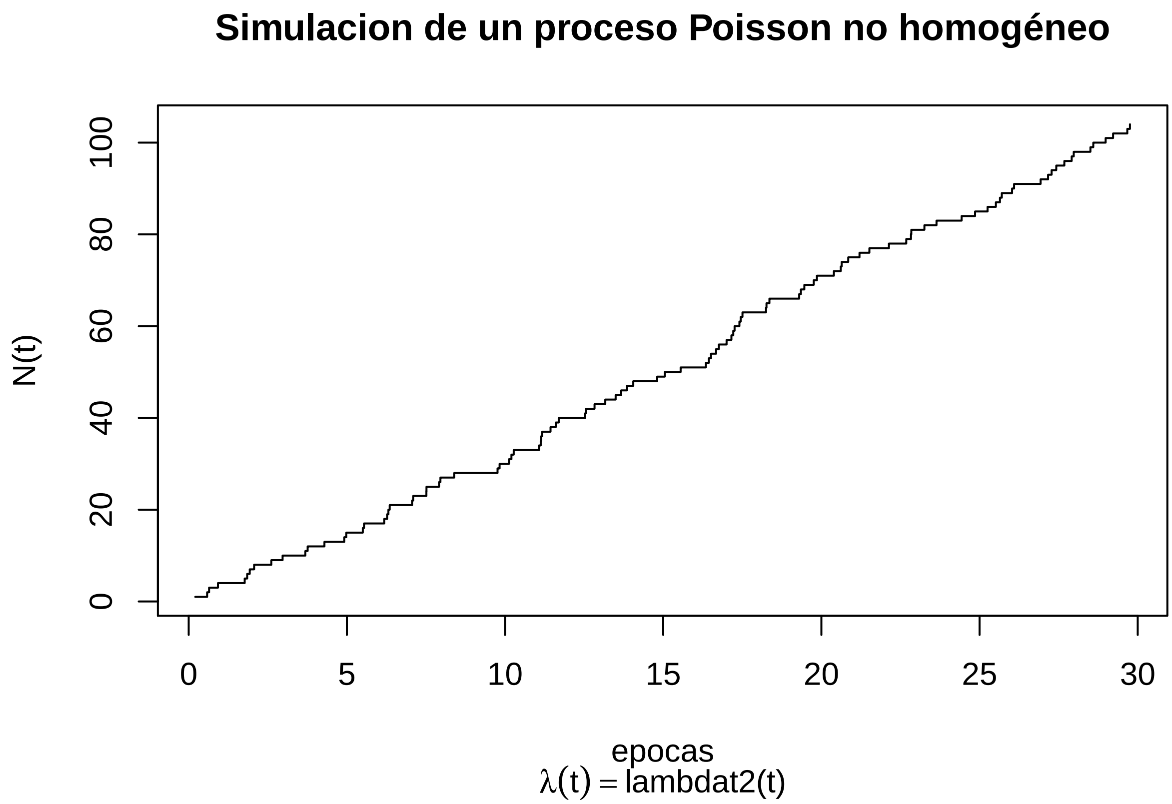

```
## $epocas
##   [1]  0.1473285  1.3434066  1.9958099  2.0068195  2.1241860
##   [6]  2.4852113  3.1003639  3.1263395  4.2618953  4.6161450
##  [11]  4.9599940  5.4973092  5.6271955  5.6819631  6.4832790
##  [16]  6.6243726  6.7506420  7.1314181  8.3607006  8.6657825
##  [21]  8.6810731  8.7355483  8.7959236  8.9799949  9.0902188
##  [26]  9.1576623  9.2494974  9.3000602  9.3573979  9.4047602
##  [31]  9.6138306 10.2667657 10.2782420 10.3148810 10.6266578
##  [36] 10.8577012 11.1916088 11.2002002 11.2167751 11.9165843
##  [41] 11.9910995 12.0414843 12.4945857 12.6468025 12.9130058
##  [46] 13.0137531 13.0928439 13.2107954 13.2385123 13.2431111
##  [51] 13.7131573 13.7529647 13.7611934 13.8368695 13.9895930
##  [56] 14.0145575 14.4588879 14.5882628 14.6178431 14.6605043
##  [61] 15.2169415 15.3234708 15.5200269 16.0310458 16.1225363
##  [66] 16.4937864 17.0802384 17.2772650 17.4126778 17.4765966
##  [71] 17.6627496 17.8407030 18.0392252 18.0748778 18.1485987
##  [76] 18.4784687 18.5039711 19.6842383 19.7683056 20.2177806
##  [81] 20.4923569 20.6869061 20.9874866 21.0575321 21.4284172
##  [86] 21.5891592 23.7417209 24.6555970 25.2466755 25.3179497
##  [91] 25.5903530 26.4956234 26.7047079 26.9550338 27.0814838
##  [96] 27.4235452 27.7822415 27.8065215 28.2020787 28.6918352
## [101] 28.8808582 30.2402669 30.9588496 31.1814263 31.2244607
## [106] 31.8162593 32.0109799 32.1943900 32.5957029 32.6326852
## [111] 32.6720124 32.9135539 33.1087403 33.2945071 33.3232800
## [116] 33.3838582 33.4132316 33.4838398 33.6627841 34.7406632
## [121] 34.7892348 34.8018956 35.2946524 35.6308983 35.7820462
```

```
## [126]  35.9439134  36.2358156  36.6629980  36.8045720  37.0322353
## [131]  37.0347562  37.0919999  37.1145069  37.5550553  37.6431121
## [136]  37.9676955  38.0734716  38.4497311  38.6460201  38.9432985
## [141]  39.3709461  39.5021936  39.6499955  39.6949951  39.7474091
## [146]  40.1671328  40.6910543  41.2175910  41.2665943  41.3076061
## [151]  41.4606335  41.8782985  41.9143742  42.0887696  42.4243261
## [156]  42.6820694  43.1123054  43.2622764  43.6122121  43.7763157
## [161]  44.4082108  44.8813514  45.2864426  45.4920130  45.7224043
## [166]  45.8437792  46.8436981  46.8438075  47.0937187  47.1933088
## [171]  47.7006876  48.0042751  48.0330082  48.0521460  48.1960111
## [176]  48.5885028  48.5936092  48.8398628  49.0158681  49.1695564
## [181]  49.2108424  49.4692883  49.5956225  49.7571572  49.9986236
## [186]  50.6559832  50.7086804  50.7100529  50.7429254  50.8554262
## [191]  51.0123227  51.1580079  51.5561248  51.8206598  51.8277626
## [196]  51.9369536  52.4123110  53.2982788  53.8471991  53.9193173
## [201]  54.0276751  54.1180730  54.3776329  55.1380149  55.4035640
## [206]  55.7858253  55.7929976  55.8849885  55.8935246  56.5277294
## [211]  56.6880381  56.8183115  56.8642747  56.9702101  57.5453840
## [216]  57.8315248  57.9607072  58.3144975  58.4111935  59.5612529
## [221]  59.5640358  60.3095427  60.3710864  60.3768747  60.5879685
## [226]  60.7271279  60.8291599  60.9496112  61.4201970  61.8000736
## [231]  61.9455289  62.0369323  62.1760804  62.4005717  62.4756986
## [236]  62.8172584  63.2876758  63.4370703  63.5359542  63.8564803
## [241]  63.9745983  64.6953266  64.7146842  65.0130838  65.2543935
## [246]  65.4141546  65.6060872  65.6527135  65.7239113  66.0737762
## [251]  66.2286802  66.6324416  66.8499528  66.9092540  67.0502279
## [256]  67.1036801  67.1747961  67.4405505  67.4525250  67.8864556
## [261]  68.0819982  68.1056662  68.1736869  68.4635261  68.7509892
## [266]  69.0036038  69.0070296  69.2687841  69.9172766  69.9683742
## [271]  70.2514658  70.8737455  71.0026544  71.0221264  71.0315008
## [276]  71.0665286  71.2209977  71.7106002  71.8841226  71.9647199
## [281]  71.9900353  72.0074861  72.0556833  72.5800960  72.8010270
## [286]  73.2437439  73.3741664  73.5639542  73.8674835  73.9843059
## [291]  74.0271959  74.5439446  75.0457043  75.8663275  75.9660834
## [296]  76.4450444  77.2119848  77.2379493  77.4942130  77.6140319
## [301]  77.6928332  77.7940509  77.8088142  77.9093342  79.1380131
## [306]  79.1707538  79.3907777  79.5080635  79.5604383  79.7315783
## [311]  79.8779482  79.9367479  80.7060763  81.1164258  81.1372401
## [316]  81.2045565  81.5817514  81.7686396  81.9261255  82.2164595
## [321]  82.8233062  83.3518454  83.4860340  83.6571884  83.8490430
## [326]  83.8923863  83.9294443  84.4788328  84.4961179  85.1213529
## [331]  85.4419949  85.5334214  85.6211747  85.7609571  85.8073163
## [336]  85.8835140  85.9255129  85.9309831  86.0138298  86.1098916
## [341]  86.3052015  86.5537153  87.1865799  87.3050127  87.5533508
## [346]  87.5605708  87.7851362  87.8175174  88.5410846  89.7865547
## [351]  89.9428561  90.6066428  90.6342409  90.8987163  91.0973728
## [356]  91.2460816  91.5492017  91.8542516  91.8648773  91.9200255
## [361]  92.6144504  93.0944552  93.1999873  93.2250129  93.2449848
## [366]  93.6860614  93.7979920  94.3449083  94.9943436  95.0271138
## [371]  95.0706357  95.3533878  95.4731914  95.7419294  95.7655243
## [376]  96.1548873  96.8183865  97.0403029  97.1455555  97.3409180
## [381]  97.4460422  97.6582007  97.7688039  98.2431839  99.2966319
## [386]  99.3030841  99.7473021  99.7988656  99.8447689  99.8670275
## [391] 100.4196639 100.6009118 101.0189099 101.2886138 101.4539273
```

```
## [396] 101.4546546 101.8045272 101.8982900 102.1243577 102.1776597
## [401] 102.1955615 102.2746214 102.2939833 102.3212197 102.7824864
## [406] 103.0942733 103.5409467 103.7344912 103.7735479 103.9806584
## [411] 104.1570088 104.4427747
##
## $cuenta
##   [1]   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17
##  [18]  18  19  20  21  22  23  24  25  26  27  28  29  30  31  32  33  34
##  [35]  35  36  37  38  39  40  41  42  43  44  45  46  47  48  49  50  51
##  [52]  52  53  54  55  56  57  58  59  60  61  62  63  64  65  66  67  68
##  [69]  69  70  71  72  73  74  75  76  77  78  79  80  81  82  83  84  85
##  [86]  86  87  88  89  90  91  92  93  94  95  96  97  98  99 100 101 102
## [103] 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119
## [120] 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136
## [137] 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153
## [154] 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170
## [171] 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187
## [188] 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204
## [205] 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221
## [222] 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238
## [239] 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255
## [256] 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272
## [273] 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289
## [290] 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306
## [307] 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323
## [324] 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340
## [341] 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357
## [358] 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374
## [375] 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391
## [392] 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408
## [409] 409 410 411 412
```

b) Grafiquen el proceso hasta obtener 100 eventos,

```
poissonnohomogeneo(lambdat2,140)
```




```
## $epocas
##   [1]  0.2080757  0.5835279  0.6447513  0.9246542  1.7705570  1.8498910
##   [7]  1.9294436  2.0686980  2.6141757  2.9683592  3.6894892  3.7609414
##  [13]  4.2913056  4.9193415  4.9834981  5.5040734  5.5416336  6.1836585
##  [19]  6.2737461  6.3142413  6.3542869  7.0622936  7.0984685  7.5141674
##  [25]  7.5170382  7.9145339  7.9579008  8.3953913  9.7630804  9.8282833
##  [31] 10.1252755 10.2021718 10.2746793 11.0744535 11.1297185 11.1425118
##  [37] 11.1747264 11.4389256 11.6047076 11.6984836 12.5311384 12.5538819
##  [43] 12.8293268 13.1690716 13.4973293 13.6715984 13.8569682 14.0540887
##  [49] 14.8106359 15.0490310 15.5513225 16.3483907 16.4420692 16.5103966
##  [55] 16.6720982 16.7578597 17.0037909 17.1561692 17.2154549 17.2569732
##  [61] 17.4091748 17.4486170 17.5063376 18.2508101 18.2652623 18.3582517
##  [67] 19.2988796 19.3524465 19.4614607 19.7571988 19.8589985 20.3955439
##  [73] 20.6122015 20.6403151 20.8494720 21.2052695 21.5174456 22.1352028
##  [79] 22.6841815 22.8330305 22.8436210 23.2571108 23.6397698 24.4324434
##  [85] 24.8595308 25.2534079 25.5166746 25.6454404 25.7039898 26.0290678
##  [91] 26.0925103 26.9302635 27.1666340 27.2777642 27.4255524 27.6808222
##  [97] 27.9122410 27.9771215 28.5047693 28.5953526 28.9858693 29.2219154
## [103] 29.6706686 29.7554069
##
## $cuenta
##   [1]   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17
##  [18]  18  19  20  21  22  23  24  25  26  27  28  29  30  31  32  33  34
##  [35]  35  36  37  38  39  40  41  42  43  44  45  46  47  48  49  50  51
##  [52]  52  53  54  55  56  57  58  59  60  61  62  63  64  65  66  67  68
##  [69]  69  70  71  72  73  74  75  76  77  78  79  80  81  82  83  84  85
```

```
## [86]  86  87  88  89  90  91  92  93  94  95  96  97  98  99 100 101 102
## [103] 103 104
```

c) Estimen la probabilidad de que el nÃºmero de eventos observados en el periodo de tiempo (1.25,3] es mayor que 2.

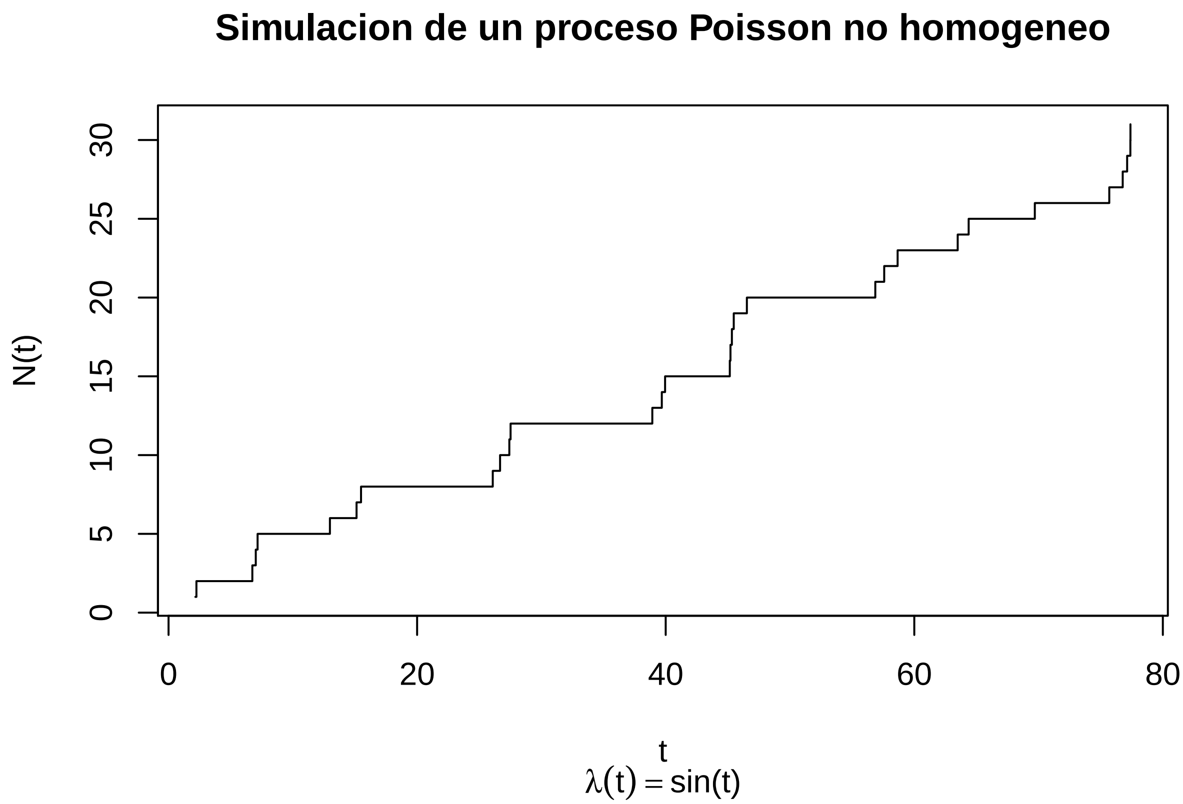
```
fr <- NULL
N <- 10000
for(i in 1:N){
x <- poissonnohomogeneo(lambdat2,10,pic=F);
fr <- c(fr,ifelse(1.25 < x$epocas[x$cuenta==2] & x$epocas[x$cuenta==2] <3,1,0))
}
sum(fr)/N
```

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

Pregunta 3

Simular un proceso Poisson no homogéneo con función de intensidad dada por $\lambda(t) = sin(t)$

```
lambdat <- function(t){sin(t)}
poisson.nohomogeneo<-function(lambdat,n){
  lambda <- 1 #mayoriza la función lambdat
  TT <- rexp(n,lambda) #genera variables exponenciales para los tiempos.
  s <- cumsum(TT) #acumula los tiempos en el vector s
  u <- runif(n) #obten n uniformes
  ss <- s[u <= lambdat(s)/lambda]
  Ns <- 1:length(ss) # Conteo
  plot(ss, Ns, type = "s", xlab = "t", ylab = "N(t)", main = "Simulacion de un proceso Poisson no homoge
  return(list(epocas = ss, cuenta= Ns))
}
x <- poisson.nohomogeneo(lambdat,100)
```



Pregunta 4

- $P(B_2 \leq 1)$
$$P(B_2 \leq 1) = P(\frac{B_2}{\sqrt{2}} \leq \frac{1}{\sqrt{2}}) = \Phi(\frac{1}{\sqrt{2}}) = 0.3106966$$

- $E[B_4|B_1 = x]$
$$E[B_4|B_1 = x] = E[B_4 - B_1 + B_1|B_1 = x] = E[B_4 - B_1|B_1 = x] + E[B_1|B_1 = x] = E[B_4 - B_1] + E[B_1|B_1 = x] = 0 + x = x$$

- $Corr(B_{t+s}, B_s)$
$$Corr(B_{t+s}, B_s) = \frac{Cov(B_{t+s}, B_s)}{\sqrt{Var(B_{t+s})}\sqrt{Var(B_s)}} = \frac{E[B_{t+s}B_s] - E[B_{t+s}]E[B_s]}{\sqrt{t+s}\sqrt{s}} = \frac{E[(B_{t+s} - B_s + B_s)B_s] - 0}{\sqrt{t+s}\sqrt{s}}$$
$$= \frac{E[(B_{t+s} - B_s)B_s + B_s^2]}{\sqrt{t+s}\sqrt{s}} = \frac{E[B_{t+s} - B_s]E[B_s] + E[B_s^2]}{\sqrt{t+s}\sqrt{s}} = \frac{0 + Var(B_s) + E[B_s]^2}{\sqrt{t+s}\sqrt{s}} = \frac{s+0}{\sqrt{t+s}\sqrt{s}} = \frac{s}{\sqrt{t+s}\sqrt{s}}$$

- $Var(B_4|B_1)$
$$Var(B_4|B_1) = Var(B_4 - B_1 + B_1|B_1) = Var(B_4 - B_1|B_1) + Var(B_1|B_1) + 2Cov(B_4 - B_1, B_1)$$
$$= Var(B_4 - B_1) + 0 + 2 * 0 = 3$$

- $P(B_3 \leq 5|B_1 = 2)$
$$P(B_3 \leq 5|B_1 = 2) = P(B_3 - B_1 \leq 5 - 2|B_1 = 2) = P(B_3 - B_1 \leq 3) = P(\frac{B_3 - B_1}{\sqrt{2}} \leq \frac{3}{\sqrt{2}}) = \Phi(\frac{3}{\sqrt{2}}) = 0.0420482$$

Pregunta 6

Sea $S(t)$ un movimiento Browniano geométrico con drift $\mu = -0.25$ y $\sigma = 0.5$
Calcular

$$P\{S(90+t) \geq 100|S(t) = 80\} = P\{\frac{S(90+t)}{S(t)} \geq \frac{100}{80}\} = P\{\ln[\frac{S(90+t)}{S(t)}] \geq \ln[\frac{100}{80}]\}$$

Como $\ln[\frac{S(90+t)}{S(t)}] \sim N(90(0.10), 90(0.5)^2)$
Entonces

$$P\{\frac{\ln[\frac{S(90+t)}{S(t)}] - 90(0.10)}{\sqrt{90(0.5)^2}} \geq \frac{\ln[\frac{100}{80}] - 90(0.10)}{\sqrt{90(0.5)^2}}\}$$

$$= P\{\frac{\ln[\frac{S(90+t)}{S(t)}] - 90(0.10)}{\sqrt{90(0.5)^2}} \geq -1.850324\} = 1 - \phi(-1.850324) = 0.9678666$$

Pregunta 7

Sea $S(t)$ un movimiento Browniano geométrico con drift $\mu = -0.25$ y $\sigma = 0.4$ Se busca el valor esperado del precio de esta acción en 6 meses.

$$E[S(t+6)|S(t) = 35] = E[\frac{S(t+180)}{S(t)}S(t)] = 35E[\frac{S(t+180)}{S(t)}] = 35e^{6(-0.25+\frac{0.4^2}{2})} = 12.62$$

Entonces la ganancia de la acción será $40 - 12.62 = 27.38$

Pregunta 12

Se asignan $\mu = 0.2$, $\sigma = 0.3$, $h = 1/52$

```r
s0<-100
mu<-0.2
sig<-0.3
h<-1/52
```

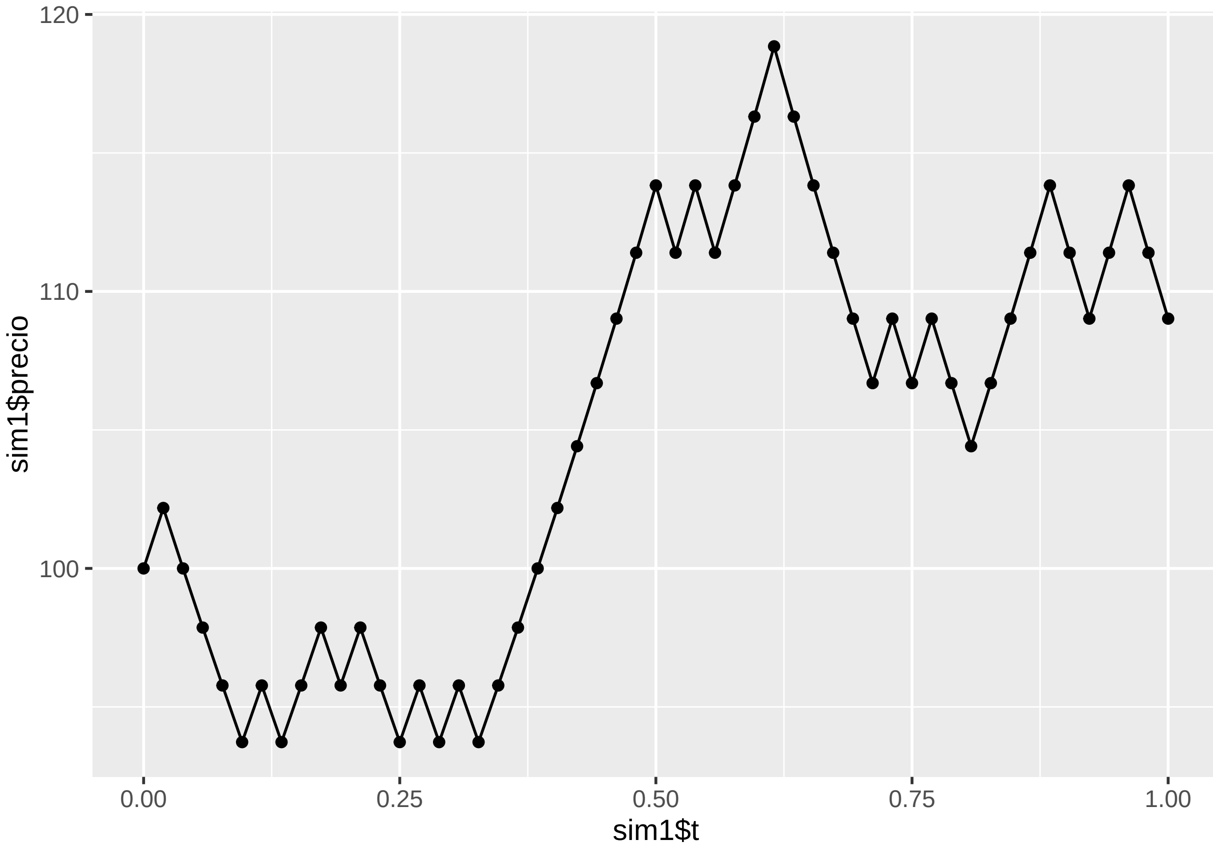
Se calculan u, v, p

```r
u <- (1/2)*(exp(-mu*h)+exp(mu*h+h*sig^2)+(1/2)*sqrt((exp(-mu*h)+exp(mu*h+h*sig^2))^2-4))
v <- 1/u
p <- (exp(mu*h)-v)/(u-v)
```

Se simula el modelo

```r
modelobinom <- function(u, v, p, m, anio, s0){
h <- 1/m
t <- seq(0,anio,h)
precio <- NULL
precio[1]<- s0
for (i in 2:(m*anio+1)){
  precio[i] <- precio[i-1]*sample(c(u,v),1,prob = c(p,1-p))
}
return(list(t=t,precio=precio))
}
```

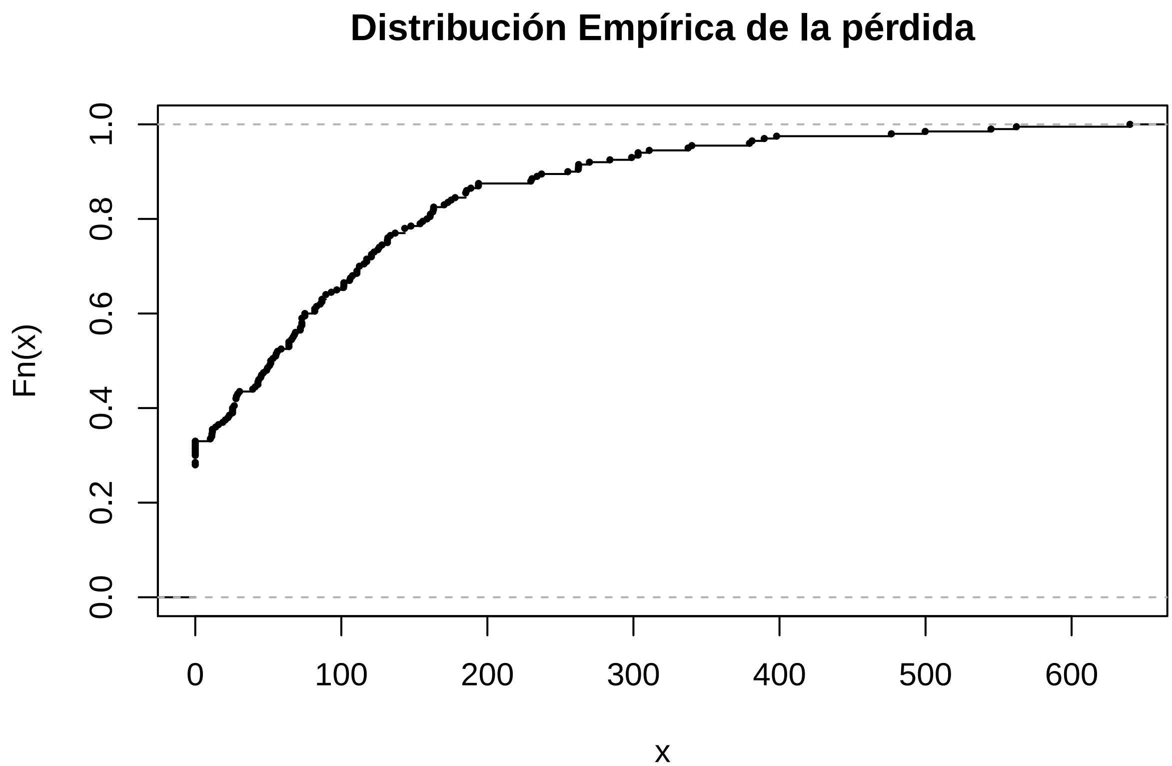
```r
sim1 <- modelobinom(u, v, p, 52, 1, 100)
ggplot(data=data.frame(sim1$precio, sim1$t), aes(x=sim1$t, y=sim1$precio, group=1)) +
  geom_line()+
  geom_point()
```



Ahora $h = 1/252$, y se define $S_{max} = \{S_j | j = 0, 1, ..., 759\}$

```r
perdida <- NULL
for (i in 1:200){
sim2 <- modelobinom(u,v,p,252,3,100)
smax <- max(sim2$precio)
perdida[i] <- smax - sim2$precio[757]
}

Fn <- ecdf(perdida)
plot(Fn, main ="Distribución Empírica de la pérdida", xlim= c(min(perdida), max(perdida)), pch = 16, ce
```



Pregunta 13

```
PPCompuesto <- function(lambda,alfa,beta,t){
  N <- rpois(1, lambda*t)
  Yis <- rgamma(n=N, shape=alfa, rate=beta)
  Xt <- sum(Yis)
  return(Xt)
}
```

Si se hace una muestra con los parámetros $\lambda = 10$, $\alpha = 1000$, $\beta = 1$ para X_{10}
$E[X_{10}] = \lambda * 10 * \alpha * \beta = 10 * 10 * 1000 * 1 = 100,000$
$Var(X_{10}) = \lambda * 10 * (\alpha\beta^2 + \alpha^2\beta^2) = 100,100,000$

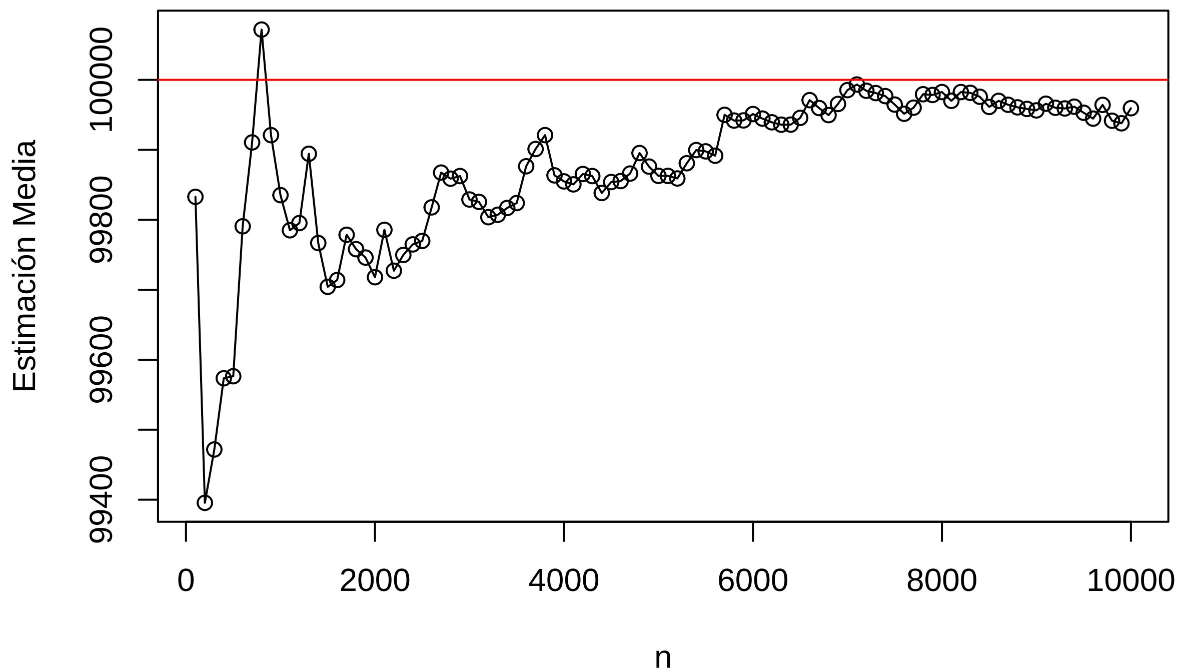
```
PPCompuesto(10,1000,1,10)
```

```
## [1] 97889.67
```

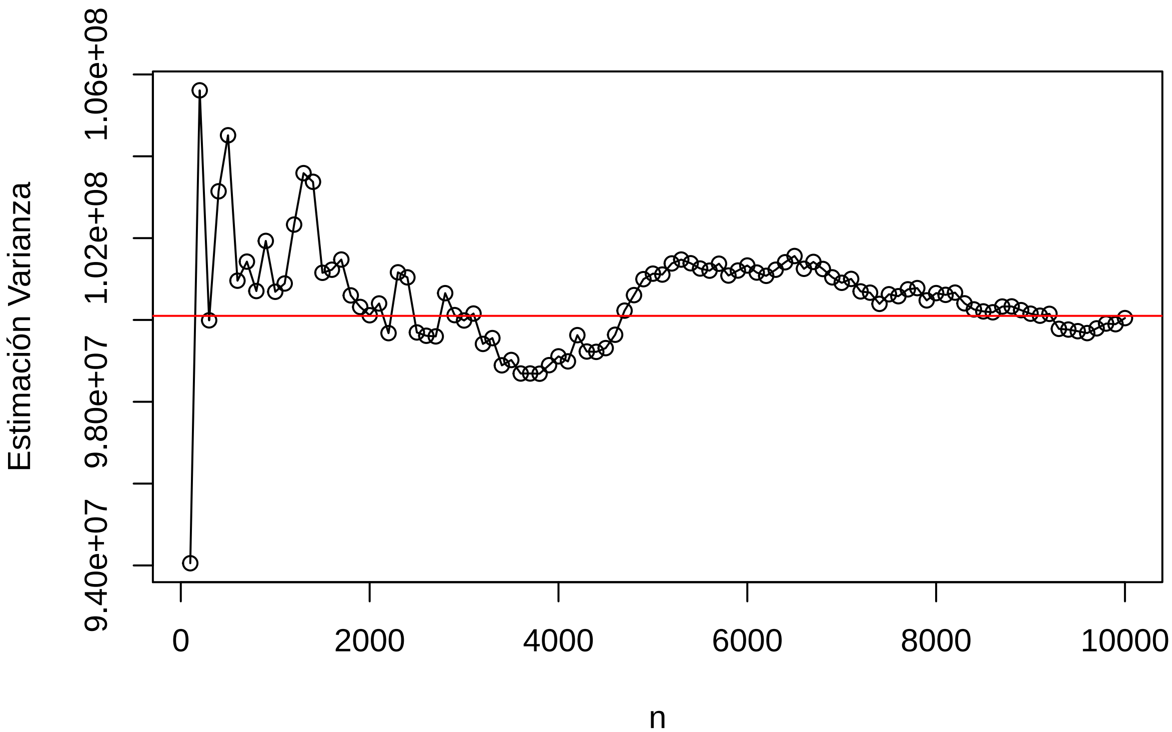
```
muestra <- NULL
for (i in 1:10000){
  muestra <- c(PPCompuesto(10,1000,1,10), muestra)
}

n <- seq(100,10000,by=100)
X <- NULL
Y <- NULL
```

```r
for(i in n) {
  X[match(i,n)] <- mean(muestra[1:n[match(i,n)]])
  Y[match(i,n)] <- var(muestra[1:n[match(i,n)]])
  }
plot(n,X[1:length(n)], type = "o", ylab = "Estimación Media")
abline(h = 100000, col="red")
```




```r
plot(n,Y[1:length(n)], type = "o", ylab = "Estimación Varianza")
abline(h = 100100000, col="red")
```



Estimación Varianza
9.40e+07
9.80e+07
1.02e+08
1.06e+08
0
2000
4000
6000
8000
10000
n