

Generating red cards

$$\lambda_k^*(t) = A_\lambda t$$

$$\mu_k^*(t) = A_\mu t$$

$$\hat{A}_\lambda = 0.00001973085$$

$$\hat{A}_\mu = 0.00003189517$$

$$\Lambda^*(t) = \int_0^t \lambda^*(y) dy = A_\lambda \frac{t^2}{2}$$

$$Y^*(t) = \int_0^t \mu^*(y) dy = A_\mu \frac{t^2}{2}$$

$$\Lambda^{*-1}(t) = \left(\frac{2t}{A_\lambda} \right)^{1/2}$$

$$Y^{*-1}(t) = \left(\frac{2t}{A_\mu} \right)^{1/2}$$

```
library(dplyr)
library(knitr)

A_lambda = 0.00001973085
A_mu = 0.00003189517

inv_lambda <- function(x) {
  (2*x/A_lambda)^(1/2)
}

inv_mu <- function(x) {
  (2*x/A_mu)^(1/2)
}
```

Generating for the home team in the first half

```
nit = 1000000

home_1st = list()
for(it in 1:nit) {
  t = 0
  s = 0
}
```

```

tmp = NULL
while(t < 48) {
  u = runif(1)
  s = s - log(u)
  t = inv_lambda(s)
  if(t < 48) {
    tmp = c(tmp, t)
  }
}
home_1st[[it]] = tmp
}

```

Generating for the away team in the first half

```

away_1st = list()
for(it in 1:nit) {
  t = 0
  s = 0
  tmp = NULL
  while(t < 48) {
    u = runif(1)
    s = s - log(u)
    t = inv_mu(s)
    if(t < 48) {
      tmp = c(tmp, t)
    }
  }
  away_1st[[it]] = tmp
}

```

Generating for the home team in the second half

```

home_2nd = list()
for(it in 1:nit) {
  t = 0
  s = (1/2)*A_lambda*45^2
  tmp = NULL
  while(t < (49+45)) {
    u = runif(1)
    s = s - log(u)
    t = inv_lambda(s)
    if(t < (49+45)) {
      tmp = c(tmp, t-45)
    }
  }
  home_2nd[[it]] = tmp
}

```

Generating for the away team in the second half

```
away_2nd = list()
for(it in 1:nit) {
  t = 0
  s = (1/2)*A_mu*45^2
  tmp = NULL
  while(t < (49+45)) {
    u = runif(1)
    s = s - log(u)
    t = inv_mu(s)
    if(t < (49+45)) {
      tmp = c(tmp, t-45)
    }
  }
  away_2nd[[it]] = tmp
}
```

Comparing the percentage of generated red cards with the real data

```
load("scrape/data/reds.RData")
load("2015-2020/data/input.RData")
Generated = c(length(unlist(home_1st))/nit, length(unlist(away_1st))/nit,
              length(unlist(home_2nd))/nit, length(unlist(away_2nd))/nit,
              length(unlist(home_1st))/nit + length(unlist(away_1st))/nit +
              length(unlist(home_2nd))/nit + length(unlist(away_2nd))/nit)
Real = c(reds %>% filter(Team == 1, Half == 1) %>% nrow() / N,
         reds %>% filter(Team == 2, Half == 1) %>% nrow() / N,
         reds %>% filter(Team == 1, Half == 2) %>% nrow() / N,
         reds %>% filter(Team == 2, Half == 2) %>% nrow() / N,
         nrow(reds)/N)
Team = c("Home", "Away", "Home", "Away", "Both")
Half = c("1st", "1st", "2nd", "2nd", "Both")
tib = tibble(Team, Half, Generated, Real)
kable(tib, digits = 4)
```

Team	Half	Generated	Real
Home	1st	0.0227	0.0176
Away	1st	0.0367	0.0259
Home	2nd	0.0675	0.0733
Away	2nd	0.1090	0.1202
Both	Both	0.2359	0.2369