



## Modelação Estocástica - Trabalho 3

Ciência de Dados - PL - 3º ano | Professora: Catarina Marques

Catarina Castanheira, 92478

João Martins, 93259

Joel Paula, 93392

14/11/2021

```
knitr::opts_chunk$set(echo = TRUE)
library(simmer)
# Package que contém geradores para a Distribuição Triangular:
library(extraDistr)
# ver https://search.r-project.org/CRAN/refmans/extraDistr/html/Triangular.html
library(simmer.plot)

set.seed(42)
```

Condições:

- Os voos são de 170 passageiros, contudo a ocupação dos voos pode não ser completa;
- O Check-in abre 2h antes da partida do voo e fecha 40 min antes da hora da partida;
- Chegada de passageiros – os passageiros chegam ao check-in de acordo com uma distribuição de Poisson com média diferente consoante o tipo de passageiro:
  - Economy (média - 1,7);
  - Business (média - 0,85);
- Os passageiros Business, assim como os passageiros que sejam membros Gold/Premium são 20% do total dos passageiros. São considerados no sistema como passageiros Vip e são servidos por apenas um balcão de passageiros – o balcão Vip;
- Os passageiros Vip fazem o check-in entre os 80 e 40 minutos antes do voo;
- Os passageiros podem fazer o check-in individualmente ou em grupo; no entanto, por uma questão de simplicidade, vamos considerar que os grupos de passageiros fazem o check-in individualmente, pelo que são considerados como passageiros individuais;
- A empresa de viação disponibiliza dois balcões para passageiros Economy e um para passageiros Vip. Existe ainda uma máquina que pode ser utilizada por passageiros Economy que não tenham que despachar bagagem;
- A fila do check-in para os passageiros Economy que tenham bagagem para despachar pode ser única ou por balcão;
- 75% dos passageiros Economy despacham a bagagem. Neste caso, o tempo de atendimento no check-in demora mais 30 segundos;
- O tempo de atendimento no check-in (tempo de serviço) tem distribuição triangular com parâmetros apresentados na tabela seguinte (em segundos):

	Min	Moda	Max
Balcão	60	103	120
Máquina	40	60	90

- Os voos podem ser servidos por mais de um balcão; Do mesmo modo, os balcões podem servir um único voo ou vários voos. Contudo, iremos considerar que apenas estamos a servir um voo.

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Analise o tempo total do processo de check-in nos dois cenários seguintes:

# Análise do impacto da estratégia de fila dos balcões não VIP na distribuição do tempo total do check-in

- 1) Analise o impacto da estratégia da fila dos balcões não VIP na distribuição do tempo total do processo de check-in. Ou seja, analise o impacto de uma fila única para estes dois balcões ou uma fila por balcão.

Decidimos converter todos os tempos em segundos, já que achamos que seria melhor ter essa resolução, para cumprir todas as premissas do problema.

```
# Notas:
# se checkin esta aberto entre os 120min (2h00) e os 40min antes do voo, significa estar aberto durante
# se checkin para vip esta aberto entre os 80min e os 40min antes do voo, significa estar aberto durant

# definicao de tempos (em segundos) e outros parametros necessarios:
overall_checkin_time <- 4800 # tempo total do processo de checkin (80min = 4800s)
close_checkin_all <- overall_checkin_time # t_i em que se da fecho de checkin para todos os passageiros
begin_checkin_economy <- 1 # t_i em que se da abertura do checkin para passageiros economy
begin_checkin_vip <- 2400 # t_i em que se da abertura do checkin para passageiros vip (40min = 2400s)
dur_checkin_vip <- begin_checkin_vip
dur_checkin_economy <- overall_checkin_time

triang_counter_min <- 60 # parametro para distribuicao triangular do atendimento do checkin
triang_counter_mode <- 103 # parametro para distribuicao triangular do atendimento do checkin
triang_counter_max <- 120 # parametro para distribuicao triangular do atendimento do checkin

triang_machine_min <- 40 # parametro para distribuicao triangular do atendimento do checkin
triang_machine_mode <- 60 # parametro para distribuicao triangular do atendimento do checkin
triang_machine_max <- 90 # parametro para distribuicao triangular do atendimento do checkin

vip_passenger_lambda <- 51 # parametro lambda para gerador Poisson de passageiros VIP (0,85 min = 51s)
economy_passenger_lambda <- 102 # parametro lambda para gerador Poisson de passageiros Economy (1,7 min

extra_time_luggage <- 30 # tempo de atendimento extra no caso de passageiro economy ter bagagem

n_max <- 170 # maximo de passageiros por voo
prop_economy <- 0.8 # proporcao de passageiros economy
n_max_economy <- n_max * prop_economy # maximo de passageiros da class economy por voo
n_max_vip <- n_max - n_max_economy # maximo de passageiros vip por voo

# Definicao da trajetoria dos passageiros VIP
vip_passenger <-
  trajectory("VIP passenger's path") %>%
  log_("Arrived at Check-In Area.") %>%
  seize("vip_counter") %>%
  log_("Making Check-In...") %>%
  timeout(function() rtriang(
    n = 1,
    a = triang_counter_min,
    b = triang_counter_max,
    c = triang_counter_mode)) %>% # a=min, b=max, c=moda
  release("vip_counter") %>%
  log_("Check-in completed! Leaving VIP Counter and going to Security Checkpoint.")
```

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# Definicao da trajetoria dos passageiros Economy

economy_passenger <-
  trajectory() %>%
  log_("Arrived at Check-In Area.") %>%
  branch(
    function() (runif(1) > 0.75) + 1, continue = c(FALSE, FALSE), # 75% tem bagagem, 25% nao tem ba
    trajectory() %>% # trajetoria do passageiro se tiver bagagem
      log_("I have luggage to check.") %>%
      select(c("standard_counter1", "standard_counter2"), policy = "shortest-queue") %>% # cada b
      seize_selected() %>%
      log_("Making Check-In...") %>%
      timeout(function() rtriang(
        n = 1,
        a = triang_counter_min,
        b = triang_counter_max,
        c = triang_counter_mode) + extra_time_luggage) %>% # a=min, b=max, c=moda; tem tempo ex
      release_selected() %>%
      log_("Check-in completed! Leaving Standard Counter and going to Security Checkpoint."),
    trajectory() %>% # trajetoria do passageiro sem bagagem
      log_("I just have carry-on.") %>%
      seize("sc_machine") %>%
      log_("Making Check-In...") %>%
      timeout(function() rtriang(
        n = 1,
        a = triang_machine_min,
        b = triang_machine_max,
        c = triang_machine_mode)) %>% # a=min, b=max, c=moda
      release("sc_machine") %>%
      log_("Check-in completed! Leaving Self Check-In and going to Security Checkpoint.")
  )

# horarios de funcionamento do checkin para passageiros VIP
vip_checkin_schedule <-
  schedule(
    c(1, begin_checkin_vip, close_checkin_all),
    c(0, 1, 0), period = overall_checkin_time) # capacidade de atender 1 passageiro de cada vez

# horarios de funcionamento do checkin para passageiros Economy
# no nosso caso concreto nao seria necessario definir porque:
# tempo checkin para economy = tempo total em que checkin esta aberto;
# deixamos aqui definido para poder ser manipulado
economy_checkin_schedule <-
  schedule(
    c(1, begin_checkin_economy, close_checkin_all),
    c(0, 1, 0), period = overall_checkin_time) # capacidade de atender 1 passageiro de cada vez

# Ambiente de Simulacao
checkin_env <-
  simmer("Check-In") %>%
  add_resource("vip_counter", capacity = vip_checkin_schedule) %>% # so 1 balcao vip, sujeito ao hora
  add_resource("standard_counter1", capacity = economy_checkin_schedule) %>% # 2 balcoes para passage
  add_resource("standard_counter2", capacity = economy_checkin_schedule) %>%

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    add_resource("sc_machine", 1, capacity = economy_checkin_schedule) %>% # temos uma maquina self-che
add_generator("VIP Passenger",
              vip_passenger,
              function() { c(0, rpois(n = n_max_vip + 1, lambda = vip_passenger_lambda), -1) }
              ) %>% # "gerador" de passageiros VIP chegam ao check-in com uma distribuicao Poisson
add_generator("Economy Passenger",
              economy_passenger,
              function() { c(0, rpois(n = n_max_economy + 1, lambda = economy_passenger_lambda), -1)
              } # "gerador" de passageiros Economy chegam ao check-in com uma distribuicao Poisson (

# Simulador do check-in (desenrola-se por 1h20):
checkin_env %>% run(until = close_checkin_all)

```

```

## 0: VIP Passenger0: Arrived at Check-In Area.
## 0: Economy Passenger0: Arrived at Check-In Area.
## 0: Economy Passenger0: I have luggage to check.
## 1: Economy Passenger0: Making Check-In...
## 60: VIP Passenger1: Arrived at Check-In Area.
## 98: Economy Passenger1: Arrived at Check-In Area.
## 98: Economy Passenger1: I have luggage to check.
## 98: Economy Passenger1: Making Check-In...
## 106: VIP Passenger2: Arrived at Check-In Area.
## 128.856: Economy Passenger0: Check-in completed! Leaving Standard Counter and going to Security Checkp
## 157: VIP Passenger3: Arrived at Check-In Area.
## 193.959: Economy Passenger1: Check-in completed! Leaving Standard Counter and going to Security Checkp
## 200: VIP Passenger4: Arrived at Check-In Area.
## 201: Economy Passenger2: Arrived at Check-In Area.
## 201: Economy Passenger2: I have luggage to check.
## 201: Economy Passenger2: Making Check-In...
## 250: VIP Passenger5: Arrived at Check-In Area.
## 289: Economy Passenger3: Arrived at Check-In Area.
## 289: Economy Passenger3: I have luggage to check.
## 289: Economy Passenger3: Making Check-In...
## 311: VIP Passenger6: Arrived at Check-In Area.
## 346.9: Economy Passenger2: Check-in completed! Leaving Standard Counter and going to Security Checkp
## 361: VIP Passenger7: Arrived at Check-In Area.
## 395: Economy Passenger4: Arrived at Check-In Area.
## 395: Economy Passenger4: I have luggage to check.
## 395: Economy Passenger4: Making Check-In...
## 400.289: Economy Passenger3: Check-in completed! Leaving Standard Counter and going to Security Checkp
## 426: VIP Passenger8: Arrived at Check-In Area.
## 476: VIP Passenger9: Arrived at Check-In Area.
## 488: Economy Passenger5: Arrived at Check-In Area.
## 488: Economy Passenger5: I have luggage to check.
## 488: Economy Passenger5: Making Check-In...
## 523.407: Economy Passenger4: Check-in completed! Leaving Standard Counter and going to Security Checkp
## 536: VIP Passenger10: Arrived at Check-In Area.
## 596: Economy Passenger6: Arrived at Check-In Area.
## 596: Economy Passenger6: I have luggage to check.
## 596: Economy Passenger6: Making Check-In...
## 603: VIP Passenger11: Arrived at Check-In Area.
## 609.064: Economy Passenger5: Check-in completed! Leaving Standard Counter and going to Security Checkp
## 644: VIP Passenger12: Arrived at Check-In Area.

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## 698: Economy Passenger7: Arrived at Check-In Area.  
## 698: Economy Passenger7: I have luggage to check.  
## 698: Economy Passenger7: Making Check-In...  
## 704: VIP Passenger13: Arrived at Check-In Area.  
## 726.275: Economy Passenger6: Check-in completed! Leaving Standard Counter and going to Security Check  
## 761: VIP Passenger14: Arrived at Check-In Area.  
## 799.454: Economy Passenger7: Check-in completed! Leaving Standard Counter and going to Security Check  
## 803: Economy Passenger8: Arrived at Check-In Area.  
## 803: Economy Passenger8: I have luggage to check.  
## 803: Economy Passenger8: Making Check-In...  
## 818: VIP Passenger15: Arrived at Check-In Area.  
## 872: VIP Passenger16: Arrived at Check-In Area.  
## 897: Economy Passenger9: Arrived at Check-In Area.  
## 897: Economy Passenger9: I have luggage to check.  
## 897: Economy Passenger9: Making Check-In...  
## 929: VIP Passenger17: Arrived at Check-In Area.  
## 943.669: Economy Passenger8: Check-in completed! Leaving Standard Counter and going to Security Check  
## 974: VIP Passenger18: Arrived at Check-In Area.  
## 1014: Economy Passenger10: Arrived at Check-In Area.  
## 1014: Economy Passenger10: I have luggage to check.  
## 1014: Economy Passenger10: Making Check-In...  
## 1022: VIP Passenger19: Arrived at Check-In Area.  
## 1028.89: Economy Passenger9: Check-in completed! Leaving Standard Counter and going to Security Check  
## 1086: VIP Passenger20: Arrived at Check-In Area.  
## 1122: Economy Passenger11: Arrived at Check-In Area.  
## 1122: Economy Passenger11: I have luggage to check.  
## 1122: Economy Passenger11: Making Check-In...  
## 1141.16: Economy Passenger10: Check-in completed! Leaving Standard Counter and going to Security Check  
## 1149: VIP Passenger21: Arrived at Check-In Area.  
## 1202: VIP Passenger22: Arrived at Check-In Area.  
## 1224: Economy Passenger12: Arrived at Check-In Area.  
## 1224: Economy Passenger12: I have luggage to check.  
## 1224: Economy Passenger12: Making Check-In...  
## 1231.58: Economy Passenger11: Check-in completed! Leaving Standard Counter and going to Security Check  
## 1255: VIP Passenger23: Arrived at Check-In Area.  
## 1303: VIP Passenger24: Arrived at Check-In Area.  
## 1328: Economy Passenger13: Arrived at Check-In Area.  
## 1328: Economy Passenger13: I have luggage to check.  
## 1328: Economy Passenger13: Making Check-In...  
## 1341: VIP Passenger25: Arrived at Check-In Area.  
## 1355.18: Economy Passenger12: Check-in completed! Leaving Standard Counter and going to Security Check  
## 1385: VIP Passenger26: Arrived at Check-In Area.  
## 1435.53: Economy Passenger13: Check-in completed! Leaving Standard Counter and going to Security Check  
## 1436: Economy Passenger14: Arrived at Check-In Area.  
## 1436: Economy Passenger14: I have luggage to check.  
## 1436: Economy Passenger14: Making Check-In...  
## 1439: VIP Passenger27: Arrived at Check-In Area.  
## 1495: VIP Passenger28: Arrived at Check-In Area.  
## 1538: Economy Passenger15: Arrived at Check-In Area.  
## 1538: Economy Passenger15: I have luggage to check.  
## 1538: Economy Passenger15: Making Check-In...  
## 1553: VIP Passenger29: Arrived at Check-In Area.  
## 1578.84: Economy Passenger14: Check-in completed! Leaving Standard Counter and going to Security Check  
## 1599: VIP Passenger30: Arrived at Check-In Area.

## 1609: Economy Passenger16: Arrived at Check-In Area.  
 ## 1609: Economy Passenger16: I have luggage to check.  
 ## 1609: Economy Passenger16: Making Check-In...  
 ## 1644: VIP Passenger31: Arrived at Check-In Area.  
 ## 1664.97: Economy Passenger15: Check-in completed! Leaving Standard Counter and going to Security Checkpoint.  
 ## 1689: VIP Passenger32: Arrived at Check-In Area.  
 ## 1720: Economy Passenger17: Arrived at Check-In Area.  
 ## 1720: Economy Passenger17: I have luggage to check.  
 ## 1720: Economy Passenger17: Making Check-In...  
 ## 1728.47: Economy Passenger16: Check-in completed! Leaving Standard Counter and going to Security Checkpoint.  
 ## 1744: VIP Passenger33: Arrived at Check-In Area.  
 ## 1792: VIP Passenger34: Arrived at Check-In Area.  
 ## 1819: Economy Passenger18: Arrived at Check-In Area.  
 ## 1819: Economy Passenger18: I just have carry-on.  
 ## 1819: Economy Passenger18: Making Check-In...  
 ## 1830.14: Economy Passenger17: Check-in completed! Leaving Standard Counter and going to Security Checkpoint.  
 ## 1844: VIP Passenger35: Arrived at Check-In Area.  
 ## 1866: Economy Passenger18: Check-in completed! Leaving Self Check-In and going to Security Checkpoint.  
 ## 1926: Economy Passenger19: Arrived at Check-In Area.  
 ## 1926: Economy Passenger19: I just have carry-on.  
 ## 1926: Economy Passenger19: Making Check-In...  
 ## 1999.76: Economy Passenger19: Check-in completed! Leaving Self Check-In and going to Security Checkpoint.  
 ## 2042: Economy Passenger20: Arrived at Check-In Area.  
 ## 2042: Economy Passenger20: I have luggage to check.  
 ## 2042: Economy Passenger20: Making Check-In...  
 ## 2136: Economy Passenger21: Arrived at Check-In Area.  
 ## 2136: Economy Passenger21: I have luggage to check.  
 ## 2136: Economy Passenger21: Making Check-In...  
 ## 2181.1: Economy Passenger20: Check-in completed! Leaving Standard Counter and going to Security Checkpoint.  
 ## 2240: Economy Passenger22: Arrived at Check-In Area.  
 ## 2240: Economy Passenger22: I have luggage to check.  
 ## 2240: Economy Passenger22: Making Check-In...  
 ## 2263.75: Economy Passenger21: Check-in completed! Leaving Standard Counter and going to Security Checkpoint.  
 ## 2357: Economy Passenger23: Arrived at Check-In Area.  
 ## 2357: Economy Passenger23: I just have carry-on.  
 ## 2357: Economy Passenger23: Making Check-In...  
 ## 2368.41: Economy Passenger22: Check-in completed! Leaving Standard Counter and going to Security Checkpoint.  
 ## 2400: VIP Passenger0: Making Check-In...  
 ## 2428.39: Economy Passenger23: Check-in completed! Leaving Self Check-In and going to Security Checkpoint.  
 ## 2461: Economy Passenger24: Arrived at Check-In Area.  
 ## 2461: Economy Passenger24: I have luggage to check.  
 ## 2461: Economy Passenger24: Making Check-In...  
 ## 2472.11: VIP Passenger0: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
 ## 2472.11: VIP Passenger1: Making Check-In...  
 ## 2550: Economy Passenger25: Arrived at Check-In Area.  
 ## 2550: Economy Passenger25: I have luggage to check.  
 ## 2550: Economy Passenger25: Making Check-In...  
 ## 2575.54: VIP Passenger1: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
 ## 2575.54: VIP Passenger2: Making Check-In...  
 ## 2601.36: Economy Passenger24: Check-in completed! Leaving Standard Counter and going to Security Checkpoint.  
 ## 2641: Economy Passenger26: Arrived at Check-In Area.  
 ## 2641: Economy Passenger26: I have luggage to check.  
 ## 2641: Economy Passenger26: Making Check-In...  
 ## 2651.48: VIP Passenger2: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.

## 2651.48: VIP Passenger3: Making Check-In...  
## 2675.76: Economy Passenger25: Check-in completed! Leaving Standard Counter and going to Security Checkpoint.  
## 2740.94: Economy Passenger26: Check-in completed! Leaving Standard Counter and going to Security Checkpoint.  
## 2750: Economy Passenger27: Arrived at Check-In Area.  
## 2750: Economy Passenger27: I have luggage to check.  
## 2750: Economy Passenger27: Making Check-In...  
## 2755.19: VIP Passenger3: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
## 2755.19: VIP Passenger4: Making Check-In...  
## 2856.5: VIP Passenger4: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
## 2856.5: VIP Passenger5: Making Check-In...  
## 2861: Economy Passenger28: Arrived at Check-In Area.  
## 2861: Economy Passenger28: I just have carry-on.  
## 2861: Economy Passenger28: Making Check-In...  
## 2888.2: Economy Passenger27: Check-in completed! Leaving Standard Counter and going to Security Checkpoint.  
## 2914.01: Economy Passenger28: Check-in completed! Leaving Self Check-In and going to Security Checkpoint.  
## 2929.94: VIP Passenger5: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
## 2929.94: VIP Passenger6: Making Check-In...  
## 2979: Economy Passenger29: Arrived at Check-In Area.  
## 2979: Economy Passenger29: I have luggage to check.  
## 2979: Economy Passenger29: Making Check-In...  
## 3017.93: VIP Passenger6: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
## 3017.93: VIP Passenger7: Making Check-In...  
## 3070: Economy Passenger30: Arrived at Check-In Area.  
## 3070: Economy Passenger30: I just have carry-on.  
## 3070: Economy Passenger30: Making Check-In...  
## 3088.61: Economy Passenger29: Check-in completed! Leaving Standard Counter and going to Security Checkpoint.  
## 3122.53: VIP Passenger7: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
## 3122.53: VIP Passenger8: Making Check-In...  
## 3130.49: Economy Passenger30: Check-in completed! Leaving Self Check-In and going to Security Checkpoint.  
## 3179: Economy Passenger31: Arrived at Check-In Area.  
## 3179: Economy Passenger31: I have luggage to check.  
## 3179: Economy Passenger31: Making Check-In...  
## 3223.26: VIP Passenger8: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
## 3223.26: VIP Passenger9: Making Check-In...  
## 3285: Economy Passenger32: Arrived at Check-In Area.  
## 3285: Economy Passenger32: I have luggage to check.  
## 3285: Economy Passenger32: Making Check-In...  
## 3316.72: Economy Passenger31: Check-in completed! Leaving Standard Counter and going to Security Checkpoint.  
## 3324.62: VIP Passenger9: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
## 3324.62: VIP Passenger10: Making Check-In...  
## 3378: Economy Passenger33: Arrived at Check-In Area.  
## 3378: Economy Passenger33: I have luggage to check.  
## 3378: Economy Passenger33: Making Check-In...  
## 3404.48: VIP Passenger10: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
## 3404.48: VIP Passenger11: Making Check-In...  
## 3420.05: Economy Passenger32: Check-in completed! Leaving Standard Counter and going to Security Checkpoint.  
## 3484: Economy Passenger34: Arrived at Check-In Area.  
## 3484: Economy Passenger34: I just have carry-on.  
## 3484: Economy Passenger34: Making Check-In...  
## 3498.93: VIP Passenger11: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
## 3498.93: VIP Passenger12: Making Check-In...  
## 3499.75: Economy Passenger33: Check-in completed! Leaving Standard Counter and going to Security Checkpoint.  
## 3539.6: Economy Passenger34: Check-in completed! Leaving Self Check-In and going to Security Checkpoint.  
## 3587: Economy Passenger35: Arrived at Check-In Area.



## 3587: Economy Passenger35: I have luggage to check.  
 ## 3587: Economy Passenger35: Making Check-In...  
 ## 3601.14: VIP Passenger12: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
 ## 3601.14: VIP Passenger13: Making Check-In...  
 ## 3680: Economy Passenger36: Arrived at Check-In Area.  
 ## 3680: Economy Passenger36: I have luggage to check.  
 ## 3680: Economy Passenger36: Making Check-In...  
 ## 3695.69: Economy Passenger35: Check-in completed! Leaving Standard Counter and going to Security Che  
 ## 3705.49: VIP Passenger13: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
 ## 3705.49: VIP Passenger14: Making Check-In...  
 ## 3771.67: VIP Passenger14: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
 ## 3771.67: VIP Passenger15: Making Check-In...  
 ## 3780: Economy Passenger37: Arrived at Check-In Area.  
 ## 3780: Economy Passenger37: I just have carry-on.  
 ## 3780: Economy Passenger37: Making Check-In...  
 ## 3801.62: Economy Passenger36: Check-in completed! Leaving Standard Counter and going to Security Che  
 ## 3859.09: Economy Passenger37: Check-in completed! Leaving Self Check-In and going to Security Checkp  
 ## 3869: Economy Passenger38: Arrived at Check-In Area.  
 ## 3869: Economy Passenger38: I have luggage to check.  
 ## 3869: Economy Passenger38: Making Check-In...  
 ## 3875.79: VIP Passenger15: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
 ## 3875.79: VIP Passenger16: Making Check-In...  
 ## 3955.62: VIP Passenger16: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
 ## 3955.62: VIP Passenger17: Making Check-In...  
 ## 3961.73: Economy Passenger38: Check-in completed! Leaving Standard Counter and going to Security Che  
 ## 3968: Economy Passenger39: Arrived at Check-In Area.  
 ## 3968: Economy Passenger39: I have luggage to check.  
 ## 3968: Economy Passenger39: Making Check-In...  
 ## 4051.61: VIP Passenger17: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
 ## 4051.61: VIP Passenger18: Making Check-In...  
 ## 4068: Economy Passenger40: Arrived at Check-In Area.  
 ## 4068: Economy Passenger40: I have luggage to check.  
 ## 4068: Economy Passenger40: Making Check-In...  
 ## 4101.47: Economy Passenger39: Check-in completed! Leaving Standard Counter and going to Security Che  
 ## 4157.78: VIP Passenger18: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
 ## 4157.78: VIP Passenger19: Making Check-In...  
 ## 4179: Economy Passenger41: Arrived at Check-In Area.  
 ## 4179: Economy Passenger41: I have luggage to check.  
 ## 4179: Economy Passenger41: Making Check-In...  
 ## 4188.77: Economy Passenger40: Check-in completed! Leaving Standard Counter and going to Security Che  
 ## 4219.22: VIP Passenger19: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
 ## 4219.22: VIP Passenger20: Making Check-In...  
 ## 4289: Economy Passenger42: Arrived at Check-In Area.  
 ## 4289: Economy Passenger42: I have luggage to check.  
 ## 4289: Economy Passenger42: Making Check-In...  
 ## 4297.71: Economy Passenger41: Check-in completed! Leaving Standard Counter and going to Security Che  
 ## 4330.19: VIP Passenger20: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
 ## 4330.19: VIP Passenger21: Making Check-In...  
 ## 4403.21: Economy Passenger42: Check-in completed! Leaving Standard Counter and going to Security Che  
 ## 4405: Economy Passenger43: Arrived at Check-In Area.  
 ## 4405: Economy Passenger43: I have luggage to check.  
 ## 4405: Economy Passenger43: Making Check-In...  
 ## 4449.67: VIP Passenger21: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.  
 ## 4449.67: VIP Passenger22: Making Check-In...

```

## 4502: Economy Passenger44: Arrived at Check-In Area.
## 4502: Economy Passenger44: I just have carry-on.
## 4502: Economy Passenger44: Making Check-In...
## 4531.12: Economy Passenger43: Check-in completed! Leaving Standard Counter and going to Security Che
## 4552.89: VIP Passenger22: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.
## 4552.89: VIP Passenger23: Making Check-In...
## 4572.7: Economy Passenger44: Check-in completed! Leaving Self Check-In and going to Security Checkpo
## 4610: Economy Passenger45: Arrived at Check-In Area.
## 4610: Economy Passenger45: I have luggage to check.
## 4610: Economy Passenger45: Making Check-In...
## 4641.86: VIP Passenger23: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.
## 4641.86: VIP Passenger24: Making Check-In...
## 4720: Economy Passenger46: Arrived at Check-In Area.
## 4720: Economy Passenger46: I have luggage to check.
## 4720: Economy Passenger46: Making Check-In...
## 4729.22: Economy Passenger45: Check-in completed! Leaving Standard Counter and going to Security Che
## 4740.05: VIP Passenger24: Check-in completed! Leaving VIP Counter and going to Security Checkpoint.
## 4740.05: VIP Passenger25: Making Check-In...

```

```

## simmer environment: Check-In | now: 4800 | next: 4800
## { Monitor: in memory }
## { Resource: vip_counter | monitored: TRUE | server status: 1(1) | queue status: 10(Inf) }
## { Resource: standard_counter1 | monitored: TRUE | server status: 0(1) | queue status: 0(Inf) }
## { Resource: standard_counter2 | monitored: TRUE | server status: 1(1) | queue status: 0(Inf) }
## { Resource: sc_machine | monitored: TRUE | server status: 0(1) | queue status: 0(1) }
## { Source: VIP Passenger | monitored: 1 | n_generated: 36 }
## { Source: Economy Passenger | monitored: 1 | n_generated: 138 }

```

```
get_mon_arrivals(checkin_env)
```

		name	start_time	end_time	activity_time	finished	replication
## 1	Economy Passenger0	0	128.8559	127.85589	TRUE	1	
## 2	Economy Passenger1	98	193.9586	95.95862	TRUE	1	
## 3	Economy Passenger2	201	346.9002	145.90025	TRUE	1	
## 4	Economy Passenger3	289	400.2891	111.28911	TRUE	1	
## 5	Economy Passenger4	395	523.4072	128.40718	TRUE	1	
## 6	Economy Passenger5	488	609.0639	121.06389	TRUE	1	
## 7	Economy Passenger6	596	726.2754	130.27537	TRUE	1	
## 8	Economy Passenger7	698	799.4539	101.45386	TRUE	1	
## 9	Economy Passenger8	803	943.6694	140.66937	TRUE	1	
## 10	Economy Passenger9	897	1028.8862	131.88621	TRUE	1	
## 11	Economy Passenger10	1014	1141.1583	127.15834	TRUE	1	
## 12	Economy Passenger11	1122	1231.5828	109.58280	TRUE	1	
## 13	Economy Passenger12	1224	1355.1776	131.17757	TRUE	1	
## 14	Economy Passenger13	1328	1435.5344	107.53439	TRUE	1	
## 15	Economy Passenger14	1436	1578.8364	142.83643	TRUE	1	
## 16	Economy Passenger15	1538	1664.9661	126.96605	TRUE	1	
## 17	Economy Passenger16	1609	1728.4703	119.47029	TRUE	1	
## 18	Economy Passenger17	1720	1830.1434	110.14342	TRUE	1	
## 19	Economy Passenger18	1819	1866.0012	47.00125	TRUE	1	
## 20	Economy Passenger19	1926	1999.7620	73.76204	TRUE	1	
## 21	Economy Passenger20	2042	2181.1002	139.10022	TRUE	1	
## 22	Economy Passenger21	2136	2263.7528	127.75277	TRUE	1	

## 23	Economy Passenger22	2240	2368.4052	128.40518	TRUE	1
## 24	Economy Passenger23	2357	2428.3870	71.38697	TRUE	1
## 25	VIP Passenger0	0	2472.1103	72.11026	TRUE	1
## 26	VIP Passenger1	60	2575.5392	103.42889	TRUE	1
## 27	Economy Passenger24	2461	2601.3629	140.36293	TRUE	1
## 28	VIP Passenger2	106	2651.4768	75.93769	TRUE	1
## 29	Economy Passenger25	2550	2675.7598	125.75984	TRUE	1
## 30	Economy Passenger26	2641	2740.9375	99.93745	TRUE	1
## 31	VIP Passenger3	157	2755.1876	103.71072	TRUE	1
## 32	VIP Passenger4	200	2856.4999	101.31238	TRUE	1
## 33	Economy Passenger27	2750	2888.1981	138.19814	TRUE	1
## 34	Economy Passenger28	2861	2914.0117	53.01169	TRUE	1
## 35	VIP Passenger5	250	2929.9392	73.43927	TRUE	1
## 36	VIP Passenger6	311	3017.9259	87.98669	TRUE	1
## 37	Economy Passenger29	2979	3088.6107	109.61073	TRUE	1
## 38	VIP Passenger7	361	3122.5296	104.60367	TRUE	1
## 39	Economy Passenger30	3070	3130.4873	60.48735	TRUE	1
## 40	VIP Passenger8	426	3223.2554	100.72584	TRUE	1
## 41	Economy Passenger31	3179	3316.7150	137.71500	TRUE	1
## 42	VIP Passenger9	476	3324.6162	101.36081	TRUE	1
## 43	VIP Passenger10	536	3404.4788	79.86255	TRUE	1
## 44	Economy Passenger32	3285	3420.0489	135.04889	TRUE	1
## 45	VIP Passenger11	603	3498.9310	94.45223	TRUE	1
## 46	Economy Passenger33	3378	3499.7520	121.75197	TRUE	1
## 47	Economy Passenger34	3484	3539.6012	55.60117	TRUE	1
## 48	VIP Passenger12	644	3601.1423	102.21128	TRUE	1
## 49	Economy Passenger35	3587	3695.6944	108.69438	TRUE	1
## 50	VIP Passenger13	704	3705.4901	104.34777	TRUE	1
## 51	VIP Passenger14	761	3771.6694	66.17938	TRUE	1
## 52	Economy Passenger36	3680	3801.6192	121.61921	TRUE	1
## 53	Economy Passenger37	3780	3859.0870	79.08696	TRUE	1
## 54	VIP Passenger15	818	3875.7868	104.11733	TRUE	1
## 55	VIP Passenger16	872	3955.6234	79.83658	TRUE	1
## 56	Economy Passenger38	3869	3961.7322	92.73218	TRUE	1
## 57	VIP Passenger17	929	4051.6121	95.98877	TRUE	1
## 58	Economy Passenger39	3968	4101.4696	133.46956	TRUE	1
## 59	VIP Passenger18	974	4157.7801	106.16794	TRUE	1
## 60	Economy Passenger40	4068	4188.7749	120.77490	TRUE	1
## 61	VIP Passenger19	1022	4219.2237	61.44359	TRUE	1
## 62	Economy Passenger41	4179	4297.7128	118.71279	TRUE	1
## 63	VIP Passenger20	1086	4330.1909	110.96725	TRUE	1
## 64	Economy Passenger42	4289	4403.2074	114.20742	TRUE	1
## 65	VIP Passenger21	1149	4449.6659	119.47497	TRUE	1
## 66	Economy Passenger43	4405	4531.1200	126.12005	TRUE	1
## 67	VIP Passenger22	1202	4552.8920	103.22615	TRUE	1
## 68	Economy Passenger44	4502	4572.7035	70.70349	TRUE	1
## 69	VIP Passenger23	1255	4641.8569	88.96487	TRUE	1
## 70	Economy Passenger45	4610	4729.2190	119.21903	TRUE	1
## 71	VIP Passenger24	1303	4740.0510	98.19413	TRUE	1

```
get_mon_resources(checkin_env)
```

##	resource	time	server	queue	capacity	queue_size	system	limit
## 1	vip_counter	0.0000	0	1	0	Inf	1	Inf

## 2	standard_counter1	0.0000	0	1	0	Inf	1	Inf
## 3	standard_counter1	1.0000	1	0	1	Inf	1	Inf
## 4	standard_counter2	1.0000	0	0	1	Inf	0	Inf
## 5	sc_machine	1.0000	0	0	1	1	0	2
## 6	vip_counter	60.0000	0	2	0	Inf	2	Inf
## 7	standard_counter2	98.0000	1	0	1	Inf	1	Inf
## 8	vip_counter	106.0000	0	3	0	Inf	3	Inf
## 9	standard_counter1	128.8559	0	0	1	Inf	0	Inf
## 10	vip_counter	157.0000	0	4	0	Inf	4	Inf
## 11	standard_counter2	193.9586	0	0	1	Inf	0	Inf
## 12	vip_counter	200.0000	0	5	0	Inf	5	Inf
## 13	standard_counter1	201.0000	1	0	1	Inf	1	Inf
## 14	vip_counter	250.0000	0	6	0	Inf	6	Inf
## 15	standard_counter2	289.0000	1	0	1	Inf	1	Inf
## 16	vip_counter	311.0000	0	7	0	Inf	7	Inf
## 17	standard_counter1	346.9002	0	0	1	Inf	0	Inf
## 18	vip_counter	361.0000	0	8	0	Inf	8	Inf
## 19	standard_counter1	395.0000	1	0	1	Inf	1	Inf
## 20	standard_counter2	400.2891	0	0	1	Inf	0	Inf
## 21	vip_counter	426.0000	0	9	0	Inf	9	Inf
## 22	vip_counter	476.0000	0	10	0	Inf	10	Inf
## 23	standard_counter2	488.0000	1	0	1	Inf	1	Inf
## 24	standard_counter1	523.4072	0	0	1	Inf	0	Inf
## 25	vip_counter	536.0000	0	11	0	Inf	11	Inf
## 26	standard_counter1	596.0000	1	0	1	Inf	1	Inf
## 27	vip_counter	603.0000	0	12	0	Inf	12	Inf
## 28	standard_counter2	609.0639	0	0	1	Inf	0	Inf
## 29	vip_counter	644.0000	0	13	0	Inf	13	Inf
## 30	standard_counter2	698.0000	1	0	1	Inf	1	Inf
## 31	vip_counter	704.0000	0	14	0	Inf	14	Inf
## 32	standard_counter1	726.2754	0	0	1	Inf	0	Inf
## 33	vip_counter	761.0000	0	15	0	Inf	15	Inf
## 34	standard_counter2	799.4539	0	0	1	Inf	0	Inf
## 35	standard_counter1	803.0000	1	0	1	Inf	1	Inf
## 36	vip_counter	818.0000	0	16	0	Inf	16	Inf
## 37	vip_counter	872.0000	0	17	0	Inf	17	Inf
## 38	standard_counter2	897.0000	1	0	1	Inf	1	Inf
## 39	vip_counter	929.0000	0	18	0	Inf	18	Inf
## 40	standard_counter1	943.6694	0	0	1	Inf	0	Inf
## 41	vip_counter	974.0000	0	19	0	Inf	19	Inf
## 42	standard_counter1	1014.0000	1	0	1	Inf	1	Inf
## 43	vip_counter	1022.0000	0	20	0	Inf	20	Inf
## 44	standard_counter2	1028.8862	0	0	1	Inf	0	Inf
## 45	vip_counter	1086.0000	0	21	0	Inf	21	Inf
## 46	standard_counter2	1122.0000	1	0	1	Inf	1	Inf
## 47	standard_counter1	1141.1583	0	0	1	Inf	0	Inf
## 48	vip_counter	1149.0000	0	22	0	Inf	22	Inf
## 49	vip_counter	1202.0000	0	23	0	Inf	23	Inf
## 50	standard_counter1	1224.0000	1	0	1	Inf	1	Inf
## 51	standard_counter2	1231.5828	0	0	1	Inf	0	Inf
## 52	vip_counter	1255.0000	0	24	0	Inf	24	Inf
## 53	vip_counter	1303.0000	0	25	0	Inf	25	Inf
## 54	standard_counter2	1328.0000	1	0	1	Inf	1	Inf
## 55	vip_counter	1341.0000	0	26	0	Inf	26	Inf

## 56	standard_counter1	1355.1776	0	0	1	Inf	0	Inf
## 57	vip_counter	1385.0000	0	27	0	Inf	27	Inf
## 58	standard_counter2	1435.5344	0	0	1	Inf	0	Inf
## 59	standard_counter1	1436.0000	1	0	1	Inf	1	Inf
## 60	vip_counter	1439.0000	0	28	0	Inf	28	Inf
## 61	vip_counter	1495.0000	0	29	0	Inf	29	Inf
## 62	standard_counter2	1538.0000	1	0	1	Inf	1	Inf
## 63	vip_counter	1553.0000	0	30	0	Inf	30	Inf
## 64	standard_counter1	1578.8364	0	0	1	Inf	0	Inf
## 65	vip_counter	1599.0000	0	31	0	Inf	31	Inf
## 66	standard_counter1	1609.0000	1	0	1	Inf	1	Inf
## 67	vip_counter	1644.0000	0	32	0	Inf	32	Inf
## 68	standard_counter2	1664.9661	0	0	1	Inf	0	Inf
## 69	vip_counter	1689.0000	0	33	0	Inf	33	Inf
## 70	standard_counter2	1720.0000	1	0	1	Inf	1	Inf
## 71	standard_counter1	1728.4703	0	0	1	Inf	0	Inf
## 72	vip_counter	1744.0000	0	34	0	Inf	34	Inf
## 73	vip_counter	1792.0000	0	35	0	Inf	35	Inf
## 74	sc_machine	1819.0000	1	0	1	1	1	2
## 75	standard_counter2	1830.1434	0	0	1	Inf	0	Inf
## 76	vip_counter	1844.0000	0	36	0	Inf	36	Inf
## 77	sc_machine	1866.0012	0	0	1	1	0	2
## 78	sc_machine	1926.0000	1	0	1	1	1	2
## 79	sc_machine	1999.7620	0	0	1	1	0	2
## 80	standard_counter1	2042.0000	1	0	1	Inf	1	Inf
## 81	standard_counter2	2136.0000	1	0	1	Inf	1	Inf
## 82	standard_counter1	2181.1002	0	0	1	Inf	0	Inf
## 83	standard_counter1	2240.0000	1	0	1	Inf	1	Inf
## 84	standard_counter2	2263.7528	0	0	1	Inf	0	Inf
## 85	sc_machine	2357.0000	1	0	1	1	1	2
## 86	standard_counter1	2368.4052	0	0	1	Inf	0	Inf
## 87	vip_counter	2400.0000	1	35	1	Inf	36	Inf
## 88	sc_machine	2428.3870	0	0	1	1	0	2
## 89	standard_counter1	2461.0000	1	0	1	Inf	1	Inf
## 90	vip_counter	2472.1103	1	34	1	Inf	35	Inf
## 91	standard_counter2	2550.0000	1	0	1	Inf	1	Inf
## 92	vip_counter	2575.5392	1	33	1	Inf	34	Inf
## 93	standard_counter1	2601.3629	0	0	1	Inf	0	Inf
## 94	standard_counter1	2641.0000	1	0	1	Inf	1	Inf
## 95	vip_counter	2651.4768	1	32	1	Inf	33	Inf
## 96	standard_counter2	2675.7598	0	0	1	Inf	0	Inf
## 97	standard_counter1	2740.9375	0	0	1	Inf	0	Inf
## 98	standard_counter1	2750.0000	1	0	1	Inf	1	Inf
## 99	vip_counter	2755.1876	1	31	1	Inf	32	Inf
## 100	vip_counter	2856.4999	1	30	1	Inf	31	Inf
## 101	sc_machine	2861.0000	1	0	1	1	1	2
## 102	standard_counter1	2888.1981	0	0	1	Inf	0	Inf
## 103	sc_machine	2914.0117	0	0	1	1	0	2
## 104	vip_counter	2929.9392	1	29	1	Inf	30	Inf
## 105	standard_counter1	2979.0000	1	0	1	Inf	1	Inf
## 106	vip_counter	3017.9259	1	28	1	Inf	29	Inf
## 107	sc_machine	3070.0000	1	0	1	1	1	2
## 108	standard_counter1	3088.6107	0	0	1	Inf	0	Inf
## 109	vip_counter	3122.5296	1	27	1	Inf	28	Inf

## 110	sc_machine	3130.4873	0	0	1	1	0	2
## 111	standard_counter1	3179.0000	1	0	1	Inf	1	Inf
## 112	vip_counter	3223.2554	1	26	1	Inf	27	Inf
## 113	standard_counter2	3285.0000	1	0	1	Inf	1	Inf
## 114	standard_counter1	3316.7150	0	0	1	Inf	0	Inf
## 115	vip_counter	3324.6162	1	25	1	Inf	26	Inf
## 116	standard_counter1	3378.0000	1	0	1	Inf	1	Inf
## 117	vip_counter	3404.4788	1	24	1	Inf	25	Inf
## 118	standard_counter2	3420.0489	0	0	1	Inf	0	Inf
## 119	sc_machine	3484.0000	1	0	1	1	1	2
## 120	vip_counter	3498.9310	1	23	1	Inf	24	Inf
## 121	standard_counter1	3499.7520	0	0	1	Inf	0	Inf
## 122	sc_machine	3539.6012	0	0	1	1	0	2
## 123	standard_counter1	3587.0000	1	0	1	Inf	1	Inf
## 124	vip_counter	3601.1423	1	22	1	Inf	23	Inf
## 125	standard_counter2	3680.0000	1	0	1	Inf	1	Inf
## 126	standard_counter1	3695.6944	0	0	1	Inf	0	Inf
## 127	vip_counter	3705.4901	1	21	1	Inf	22	Inf
## 128	vip_counter	3771.6694	1	20	1	Inf	21	Inf
## 129	sc_machine	3780.0000	1	0	1	1	1	2
## 130	standard_counter2	3801.6192	0	0	1	Inf	0	Inf
## 131	sc_machine	3859.0870	0	0	1	1	0	2
## 132	standard_counter1	3869.0000	1	0	1	Inf	1	Inf
## 133	vip_counter	3875.7868	1	19	1	Inf	20	Inf
## 134	vip_counter	3955.6234	1	18	1	Inf	19	Inf
## 135	standard_counter1	3961.7322	0	0	1	Inf	0	Inf
## 136	standard_counter1	3968.0000	1	0	1	Inf	1	Inf
## 137	vip_counter	4051.6121	1	17	1	Inf	18	Inf
## 138	standard_counter2	4068.0000	1	0	1	Inf	1	Inf
## 139	standard_counter1	4101.4696	0	0	1	Inf	0	Inf
## 140	vip_counter	4157.7801	1	16	1	Inf	17	Inf
## 141	standard_counter1	4179.0000	1	0	1	Inf	1	Inf
## 142	standard_counter2	4188.7749	0	0	1	Inf	0	Inf
## 143	vip_counter	4219.2237	1	15	1	Inf	16	Inf
## 144	standard_counter2	4289.0000	1	0	1	Inf	1	Inf
## 145	standard_counter1	4297.7128	0	0	1	Inf	0	Inf
## 146	vip_counter	4330.1909	1	14	1	Inf	15	Inf
## 147	standard_counter2	4403.2074	0	0	1	Inf	0	Inf
## 148	standard_counter1	4405.0000	1	0	1	Inf	1	Inf
## 149	vip_counter	4449.6659	1	13	1	Inf	14	Inf
## 150	sc_machine	4502.0000	1	0	1	1	1	2
## 151	standard_counter1	4531.1200	0	0	1	Inf	0	Inf
## 152	vip_counter	4552.8920	1	12	1	Inf	13	Inf
## 153	sc_machine	4572.7035	0	0	1	1	0	2
## 154	standard_counter1	4610.0000	1	0	1	Inf	1	Inf
## 155	vip_counter	4641.8569	1	11	1	Inf	12	Inf
## 156	standard_counter2	4720.0000	1	0	1	Inf	1	Inf
## 157	standard_counter1	4729.2190	0	0	1	Inf	0	Inf
## 158	vip_counter	4740.0510	1	10	1	Inf	11	Inf
##	replication							
## 1	1							
## 2	1							
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## 4	1							

## 5	1
## 6	1
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## 153	1
## 154	1
## 155	1
## 156	1
## 157	1
## 158	1

- 
- 2) Analise o impacto da segmentação dos passageiros na distribuição do tempo total do processo. Ou seja, analise o impacto de os passageiros Vip serem servidos por um balcão que lhes é dedicado ou não existir este balcão e estes passageiros serem servidos pelos outros dois balcões com uma prioridade maior da dos outros passageiros.