Appendix: R code of the Monte Carlo simulation model for representing the dynamics of the COVID-19 spread processes.

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#-------------------------------------------------------------------------------------------------------------------
TransSimu = function(days = 300, nd = 30, Rt = rr, muT = 4, sizeV = 1,limit=1000000,
pp=0.001,n0=1)
            {                  # beginning of the function
# days: observation period
# nd: simulation period
# Rt = rr  # infection rate pattern
#  muT  is the mean time an infected person will transmit the virus to (i.e., infect) another
person.
# We assume that the independence among those ones being infected.  The default value is
set as muT = 4 (days).
# sizeV: the dispersion parameter so that variance = mu + mu^2/size. The default value is
set as sizeV =1.
# limit: the target/study population size
# pp: the proportion of people with immunity in the population
# n0: the initial number of infectious persons.
# The default setting assumes one virus carrier/infectious person in the beginning, i.e., n0=1.
#
kk = atrisk = rep(0,days); nn = length(kk)
# kk: daily new cases; atrisk: number of active cases each day; simulation period of nn days
 tt = 0   # the cumulative total number of confirmed cases.

  if(nd > length(Rt)) stop("The length of Rt should not be smaller than nd.")
   stoplimit = limit*(1-pp)

  nk = n0   # The initial number of existing infectious persons.
          # there must be a first patient to kick off the transmission process!
 for(k in 1:nk) {
 #
  if(tt>stoplimit)  Rt[1]=0.001
  ni = rpois(1,Rt[1])    # how many people will be infected by this existing virus carrier person.
    imuind = sample(c(0,1), 1, prob=c((1-pp),pp))
    if(imuind==1) ni=0
  tt=tt+ni
    if(ni > 0) {
  tk = rep(0,ni)
  for (i in 1:ni) {
   tk[i] = rnbinom(1,size=sizeV,mu=muT)+1  # this is the nth day on which a new case occurs
       kk[tk[i]] = kk[tk[i]] + 1
                   }
  #
        pastevent = c(rep(1,(max(tk)-1)),rep(0, (days-max(tk)+1)))
          atrisk = atrisk + pastevent
                  } # end of  if(ni > 0)
                    }  # end of k loop
#
```

```
 for(j in 2:nd) {
     nk = kk[j-1]    # this is the number of people newly infected (i.e., new cases) on (j-1)th day
   if(nk > 0) {
         for(k in 1:nk) {
 #
  if(tt>stoplimit)  Rt[j]=0.001
  ni = rpois(1,Rt[j])    # how many people will be infected by this existing virus carrier person.
    imuind = sample(c(0,1), 1, prob=c((1-pp),pp))
    if(imuind==1) ni=0
  tt=tt+ni
    if(ni > 0) {
  tk = rep(0,ni)
  for (i in 1:ni) {
     tk[i] = rnbinom(1,size=sizeV,mu=muT)+1+j  # this is the nth day on which a new case
occurs
       kk[tk[i]] = kk[tk[i]] + 1
                      }
  #
        pastevent = c(rep(0, (j-1) ), rep(1,(max(tk)+1-j)),rep(0, (days-max(tk))))
           atrisk = atrisk + pastevent
                      } # end of  if(ni > 0)
                         }  # end of k loop
                      }  #  end of  if(nk > 0)
 #
                      }     # end of j loop

     list(riskpopu = atrisk, dailynew = kk, total=tt)     # output information

                 }  # end of the function
#------------------------------------------------------------------------
# observed number of confirmed infection cases in Australia and UK over the period of 1
March to 18 April 2020
# oz = Australia; uk = United Kingdom
oz = c(26,   29,   33,   41,   52,   59,   63,   74,   80,  100,  112,  126,  156,  197,  249,
        298,  375,  454,  565,  709,  874, 1098, 1709, 1823, 2423, 2799, 3166, 3378, 3809,
        4093, 4557, 4707, 4976, 5224, 5548, 5687, 5744, 5844, 5956, 6052, 6152, 6238, 6289,
        6322, 6366, 6416, 6458, 6497, 6533)
uk = c(23, 36, 40, 51, 85, 115, 163, 206, 273, 321, 373, 456, 590, 707, 1140, 1391, 1543,
       1950,  2630,  3277, 3983, 5018, 5683, 6650, 8077, 9529, 11658, 14543, 17089, 19522,
       22141,  25150,  29474,  33718,  38168,  41903,  47806,  51608,  55242,  60733,
       65077,  70272,  78991,  84279,  88621,  93873,  98476, 103093, 108692)
#---------------------------------
rr = c(rep(2.5,5), rep(2.3,5),rep(2.9,5), rep(3,5),rep(2.1,5), rep(0.9,5), rep(0.3,5), rep(0.2,15),
rep(0.1,50))  # estimated/assumed infection rate over time pattern for Australia
rr = c(rep(3.4,10), rep(3.1,10),rep(2,5),rep(1.8,5),rep(1.6,5),rep(1.5,5),rep(0.7,5),
rep(0.6,5),rep(0.3,10),rep(0.1,40))
#  estimated/assumed infection rate over time pattern for UK
#---------------------------------
# A bootstrap procedure for the point estimates and interval estimates:
set.seed(10)
  outMA = newMA = NULL; gtotalA = NULL
  for(m in 1:1000) {
#     runi = TransSimu(nd=100, muT=4.3,sizeV=1,n0=10)  #oz  18April
     runi = TransSimu(nd=100, muT=3.95,sizeV=1,n0=9)   #uk  18April
   this = runi$riskpopu[1:150]
```

```
   outMA = rbind(outMA, this)
   thisnew = runi$dailynew[1:150]
   newMA = rbind(newMA, thisnew)
   gtotalA = c(gtotalA, runi$total)
        }
#--------------------------------------------------------------------------
```