Instruction

- **Read this instruction very carefully.**
- You will name the filename as *[StudentIDNumber]*.cc (or .cpp, .c, etc).
  - Submit the file *[StudentIDNumber]*.cc (or .cpp, .c, etc) on iCampus before the deadline.
- You should submit the source code only.
- You may submit partial solution (and you'll receive partial credit).
- You may ask questions thru email at atang@skku.edu.
  - But please ask your questions early (otherwise, I may not reply in time before your deadline)
  - Do not ask question on iCampus. Ask question thru **email** only
- I will make clarifications about the problem on icampus.
- You may submit multiple versions.
  - I will grade the last version before the deadline you submitted only.
  - Work submitted after the deadline will not be graded
- Make backup!
- The deadline is Thursday 14th April 2022 23:59 pm.

Collaboration Policy

- The work you submit must be the work of your own.
- You are free to give or receive help when doing homework assignments, but you must follow the following restrictions:
- Only the helper can look at the code of others. Student who is receiving help must not look at the code of the helper;
- Student who is receiving help must do all the typing herself/himself. Helper must not touch the computer of the student who is receiving help; and
- All student can not post your code on the web, nor send your code to other students.

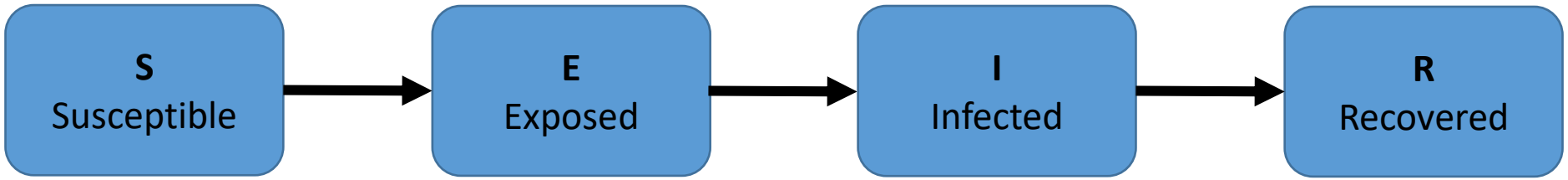
The problem

- In this assignment, you will write a program to conduct a simulation in transmissive diseases (such as COVID-19) in Korea.
- Your program will simulate the infection of a transmissive disease.
- Your program will first ask the user to enter 5 simulation parameters
    1. Number of infected people on Day 0
    2. Beta
    3. Sigma
    4. Gamma
    5. How many days should be simulation be run (max 80 days)

- Your program will display the simulation results in a table.
- Your program will plot the simulation results in a histogram.

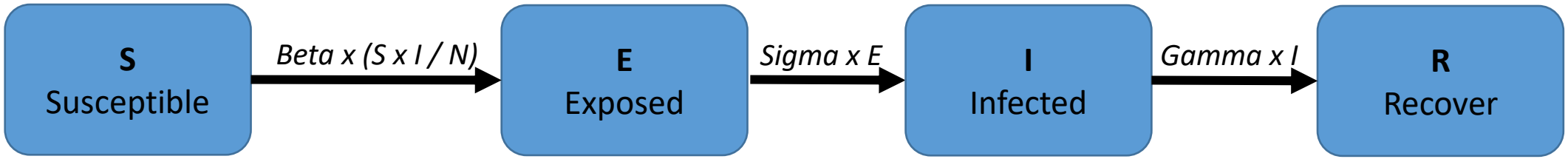
The transmission model (SEIR Model)

- The SEIR diagram below shows how individuals move through each compartment in the model.
- The model consists of 4 compartments.
- Each compartment represents the number of people in a location currently in the status:
  - Susceptible – People that are healthy
  - Exposed – People that are exposed to the disease, but not sick yet
  - Infected – People that are infected with the disease
  - Recovered – People that are recovered and immune



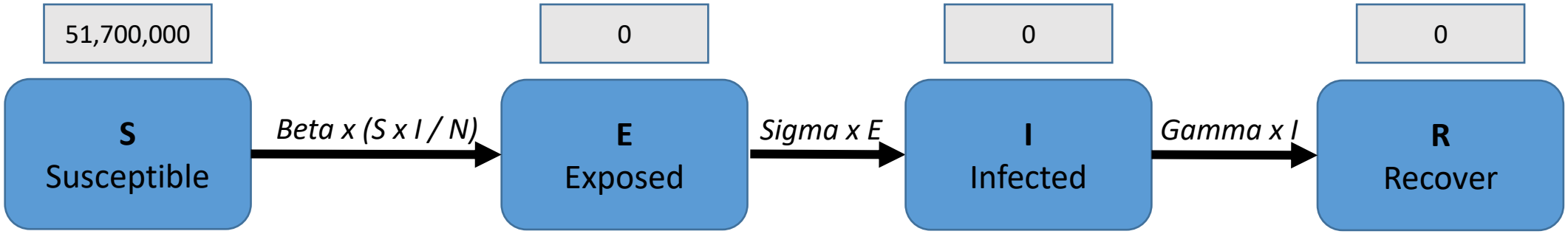
The transmission model (SEIR Model)

- Disease transmission on each day is defined with three equations:
  - **Beta x (S x I / N)** – Number of people moving from S to E each day
    - Beta: Transmission rate (one person infects *Beta* people per day)
    - N: Total population number
  - **Sigma x E** – Number of people moving from E to I each day
    - Sigma: Incubation rate (It takes *1/Sigma* days for a person get infected after exposed)
  - **Gamma x I** – Number of people moving from I to R each day
    - Gamma: Recovery rate (It takes *1/Gamma* days for a person to recover)



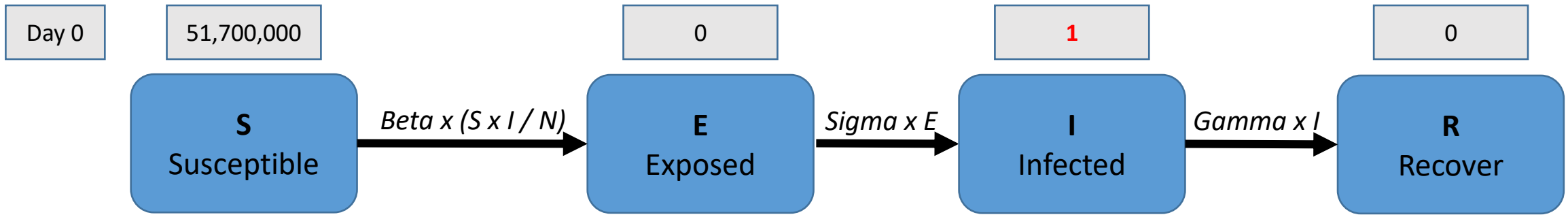
The transmission model (SEIR Model)

- Original state:
  - Population of Korea = 51,700,000
  - 51,700,000 people who are healthy, no one is sick



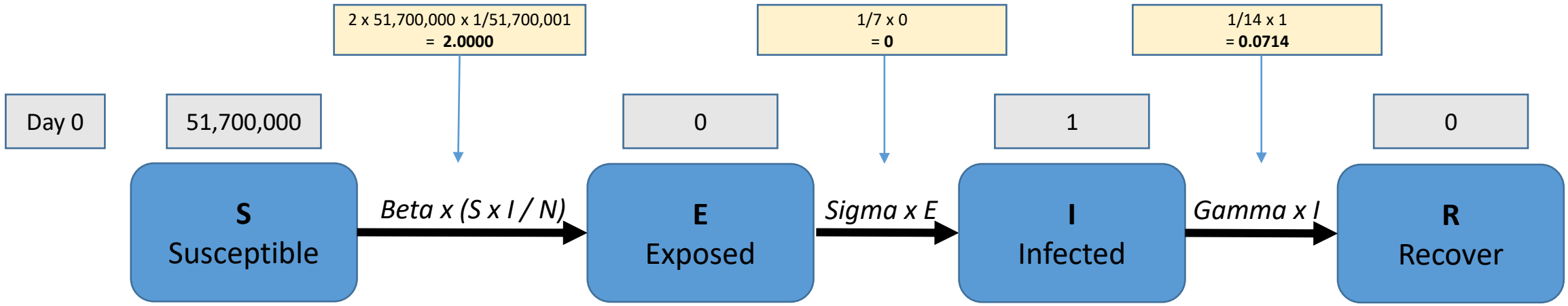
The transmission model (SEIR Model)

- Day 0:
  - 1 infected person entered the country
- Question:
  - How is the disease going to be transmitted in the country for the first 50 days?
  - Suppose Beta = 2, Sigma = 1/7, Gamma = 1/14



The transmission model (SEIR Model)

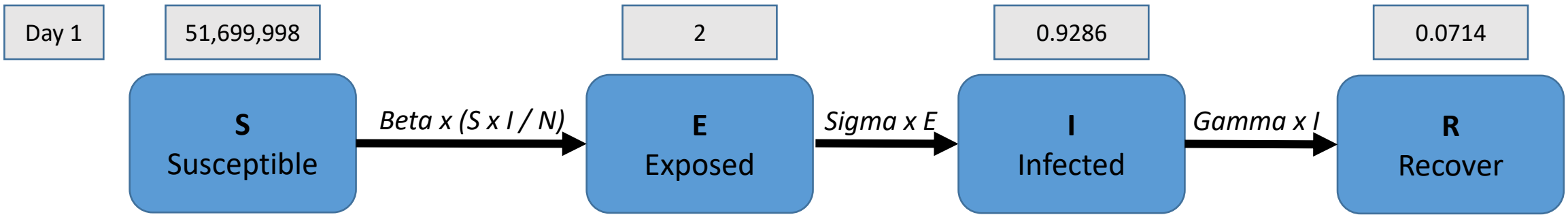
- Question:
  - How is the disease going to be transmitted in the country for the first 50 days?
  - Suppose Beta = 2, Sigma = 1/7, Gamma = 1/14
- Calculate the number of people in each of the 4 compartments in Day 1



The transmission model (SEIR Model)

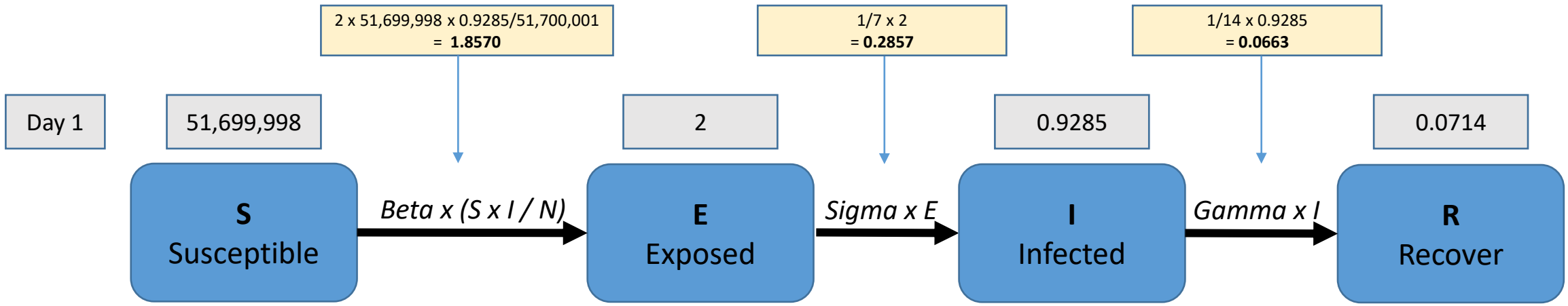
- Number of people in each compartment on Day 1

- Next, calculate the number of people in each compartment on Day 2 ……



The transmission model (SEIR Model)

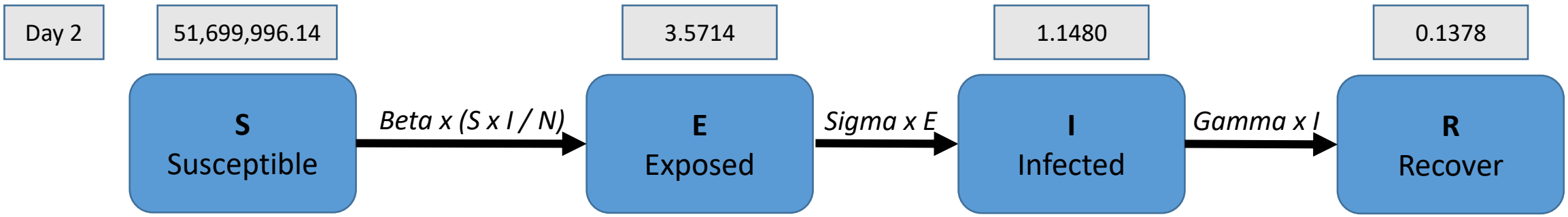
- Calculate Day 2:



The transmission model (SEIR Model)

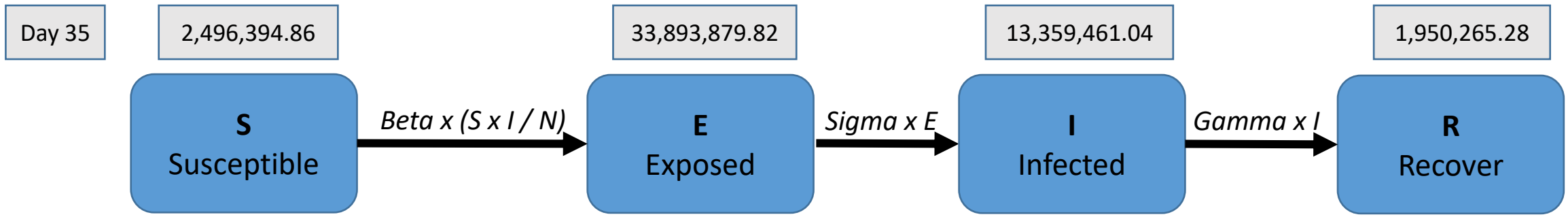
- Number of people in each compartment on Day 2

- Next, calculate the number of people in each compartment on Day 3 ……



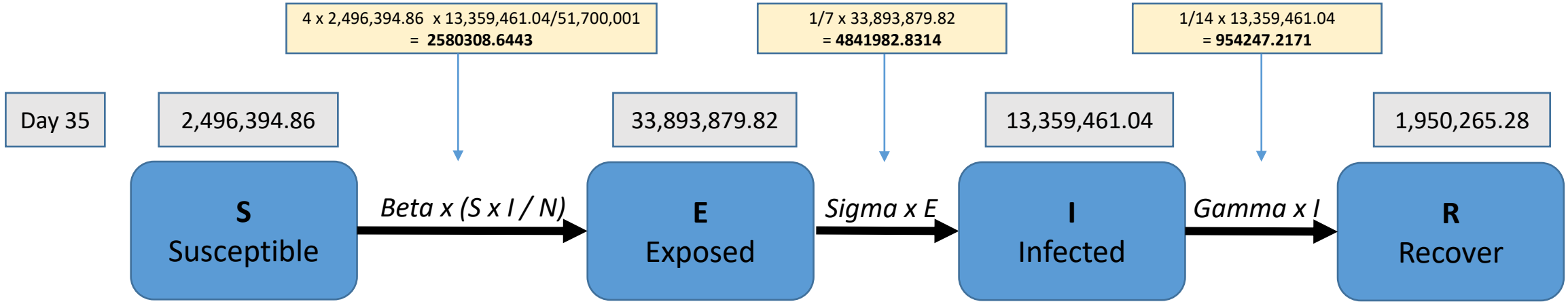
The transmission model (SEIR Model)

- Caution!!!
- The number of people in the 4 compartments should not be negative number
- Consider the following case:
  - Number of infected people in Day 0 = 1
  - Beta = 4
  - Sigma = 1/7
  - Gamma = 1/14



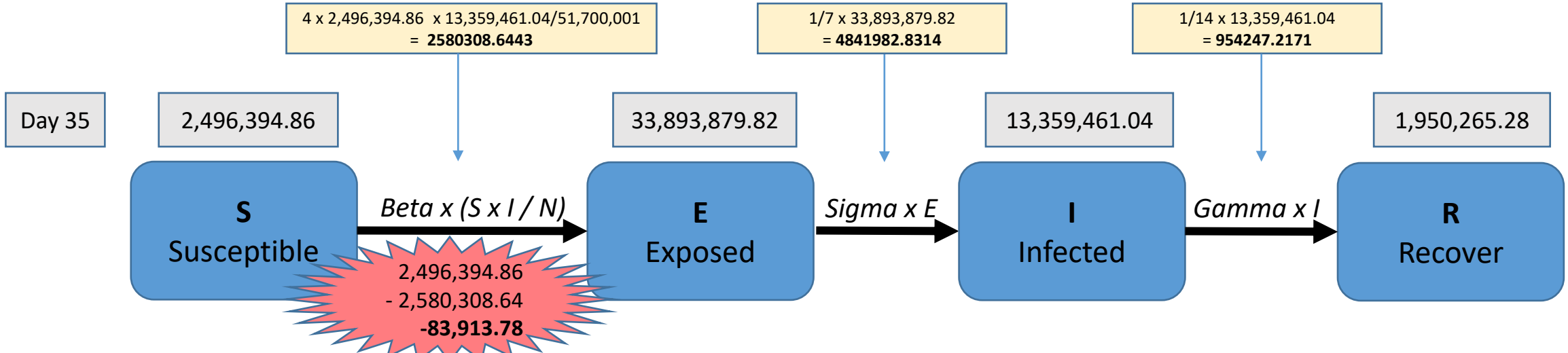
The transmission model (SEIR Model)

- Caution!!!
- **The number of people in the 4 compartments should not be negative number**
- Consider the following case:
  - Number of infected people in Day 0 = 1
  - Beta = 4
  - Sigma = 1/7
  - Gamma = 1/14



The transmission model (SEIR Model)

- Caution!!!
- **The number of people in the 4 compartments should not be negative number**
- Consider the following case:
  - Number of infected people in Day 0 = 1
  - Beta = 4
  - Sigma = 1/7
  - Gamma = 1/14



The simulation program

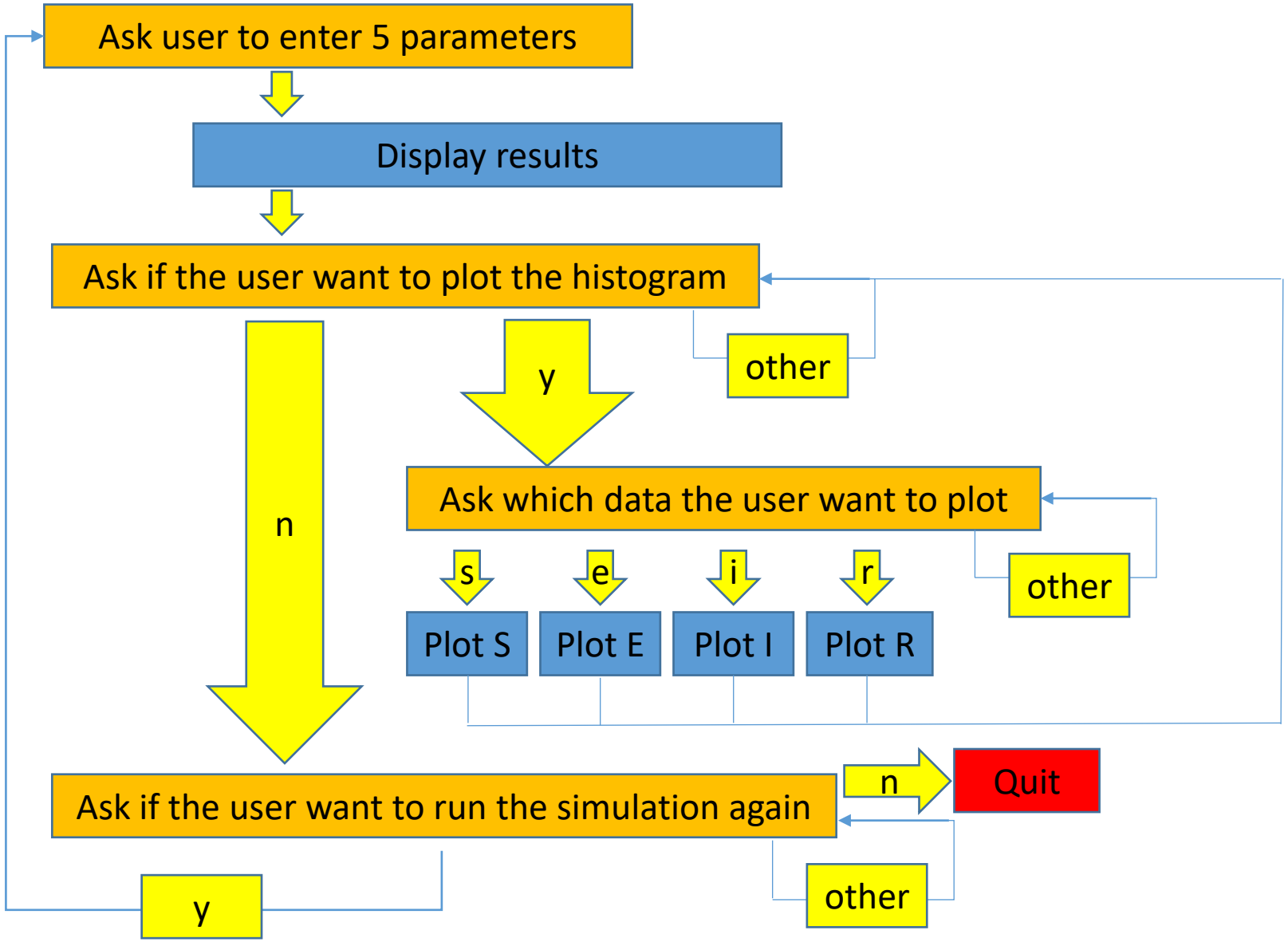
- Specifications for the program:
  - Your program should ask the user to enter the following:
    1. Number of infected people entering the country on Day 0
    2. Beta
    3. Sigma
    4. Gamma
    5. How many days should be simulation be run (max 80 days)

You may assume users always enter a positive float point numbers in these four input

You may assume users always enter one positive integer number smaller or equal to 80 in this input

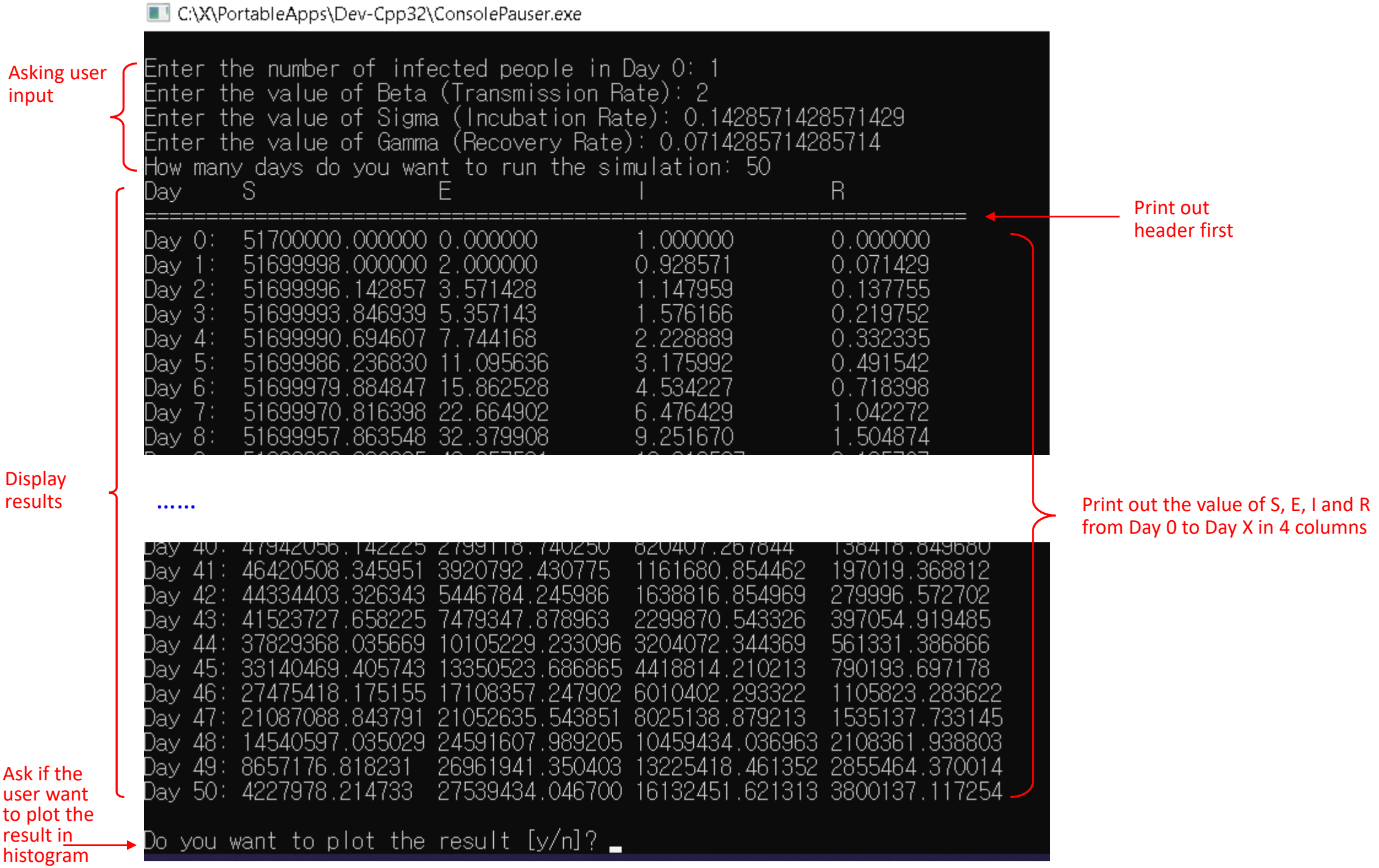
  - Your program will calculate the number of people in each of the 4 compartments from Day 0 to Day X (X is the 5^{th} parameter input by the user).
    - Your program will display these results in a table form.
  - Your program will also ask if the user want to plot the results in a histogram
  - Your program execution will following the flow diagram in the follow page.
  - You should avoid using external library, except the <stdio.h>, <conio.h>, <math.h> libraries

The simulation program (cont.)



The output table

- Specifications for the program:
  - Your program should ask the user to enter the following:
    1. Number of infected people entering the country on Day 0
    2. Beta
    3. Sigma
    4. Gamma
    5. How many days should be simulation be run (max 80 days)
  - Your program will calculate the number of people in each of the 4 compartments from Day 0 to Day X (X is the 5^{th} parameter input by the user).
    - Your program will display these results in a table form.
  - Your program will also ask if the user want to plot the results in a histogram
  - Your program execution will following the flow diagram in the follow page.


C:\X\PortableApps\Dev-Cpp32\ConsolePauser.exe
Enter the number of infected people in Day 0: 1
Enter the value of Beta (Transmission Rate): 2
Enter the value of Sigma (Incubation Rate): 0.1428571428571429
Enter the value of Gamma (Recovery Rate): 0.0714285714285714
How many days do you want to run the simulation: 50
Day S E I R
Day 0: 51700000.000000 0.000000 1.000000 0.000000
Day 1: 51699998.000000 2.000000 0.928571 0.071429
Day 2: 51699996.142857 3.571428 1.147959 0.137755
Day 3: 51699993.846939 5.357143 1.576166 0.219752
Day 4: 51699990.694607 7.744168 2.228889 0.332335
Day 5: 51699986.236830 11.095636 3.175992 0.491542
Day 6: 51699979.884847 15.862528 4.534227 0.718398
Day 7: 51699970.816398 22.664902 6.476429 1.042272
Day 8: 51699957.863548 32.379908 9.251670 1.504874
.....
Day 41: 46420508.345951 3920792.430775 1161680.854462 197019.368812
Day 42: 44334403.326343 5446784.245986 1638816.854969 279996.572702
Day 43: 41523727.658225 7479347.878963 2299870.543326 397054.919485
Day 44: 37829368.035669 10105229.233096 3204072.344369 561331.386866
Day 45: 33140469.405743 13350523.686865 4418814.210213 790193.697178
Day 46: 27475418.175155 17108357.247902 6010402.293322 1105823.283622
Day 47: 21087088.843791 21052635.543851 8025138.879213 1535137.733145
Day 48: 14540597.035029 24591607.989205 10459434.036963 2108361.938803
Day 49: 8657176.818231 26961941.350403 13225418.461352 2855464.370014
Day 50: 4227978.214733 27539434.046700 16132451.621313 3800137.117254
Do you want to plot the result [y/n]? _
Asking user input
Print out header first
Display results
Print out the value of S, E, I and R from Day 0 to Day X in 4 columns
Ask if the user want to plot the result in histogram

- Check user's input
- If user enter "y",
  - ask which data the user want to plot
- If user enter n,
  - Ask if user want to run another simulation
- If user enter anything else,
  - Display error message and ask again

```
Day 44: 37829368.035669 10105229.233096 3204072.344369  561331.386866
Day 45: 33140469.405743 13350523.686865 4418814.210213  790193.697178
Day 46: 27475418.175155 17108357.247902 6010402.293322  1105823.283622
Day 47: 21087088.843791 21052635.543851 8025138.879213  1535137.733145
Day 48: 14540597.035029 24591607.989205 10459434.036963 2108361.938803
Day 49: 8657176.818231  26961941.350403 13225418.461352 2855464.370014
Day 50: 4227978.214733  27539434.046700 16132451.621313 3800137.117254

Do you want to plot the result [y/n]? 1
Input Error! Please enter [y/n].
Do you want to plot the result [y/n]? s
Input Error! Please enter [y/n].
Do you want to plot the result [y/n]? l
Input Error! Please enter [y/n].
Do you want to plot the result [y/n]? i
Input Error! Please enter [y/n].
Do you want to plot the result [y/n]? o
Input Error! Please enter [y/n].
Do you want to plot the result [y/n]? y
Which data would you like to plot? [s/e/i/r]
```

```
Day 49: 8657176.818231  26961941.350403 13225418.461352
Day 50: 4227978.214733  27539434.046700 16132451.621313

Do you want to plot the result [y/n]? d
Input Error! Please enter [y/n].
Do you want to plot the result [y/n]? w
Input Error! Please enter [y/n].
Do you want to plot the result [y/n]? 0
Input Error! Please enter [y/n].
Do you want to plot the result [y/n]? n
Do you want to run the simulation again [y/n]?
```

The histogram

- The user select one of the 4 data set (S, E, I or R) to be plotted in the histogram
- The histogram is represented in percentage value
- Your program will plot one “*” for one percentage value

Some hints

- You may consider using double as the type for the population (Population of Korea is 51,700,000, the number is large)
- A sample code segment for taking double input by the user using the `scanf()` function is shown as follow:

```
double S;
scanf("%lf",&S);      // %lf stands for long float
```

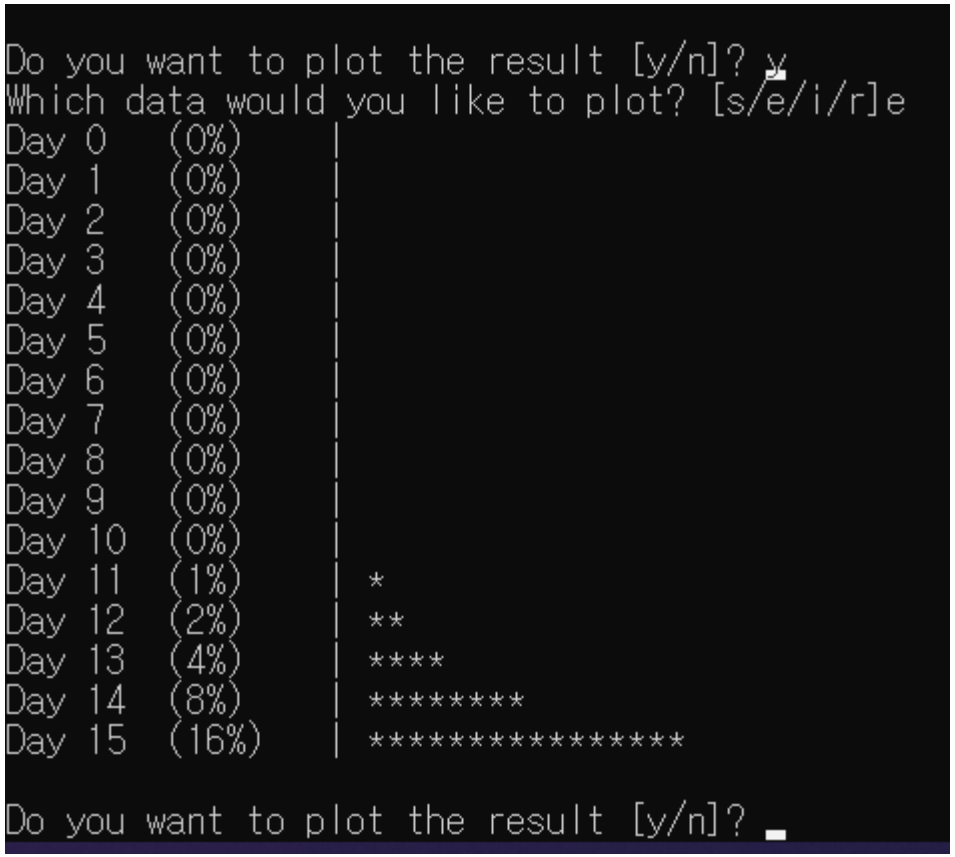
- You may use the `int()` function to convert a float point value to an integer value
- I suggest you to implement your program using functions

```
Enter the number of infected people in Day 0: 100
Enter the value of Beta (Transmission Rate): 8
Enter the value of Sigma (Incubation Rate): 0.1428571428571429
Enter the value of Gamma (Recovery Rate): 0.0714285714285714
How many days do you want to run the simulation: 15
Day     S                  E                  I                  R
================================================================
Day 0:  51700000.000000 0.000000        100.000000      0.000000
Day 1:  51699200.001547 799.998453      92.857143       7.142857
Day 2:  51698457.157336 1428.557171     200.509983      13.775510
Day 3:  51696853.128444 2828.506467     390.267437      28.097652
Day 4:  51693731.185023 5546.377535     766.463544      55.973897
Day 5:  51687600.232021 10884.990889    1504.055796     110.721293
Day 6:  51675570.694793 21359.529420    2951.621938     218.153850
Day 7:  51651968.922556 41909.940311    5792.153145     428.983989
Day 8:  51605674.835816 82216.892721    11365.562250    842.709213
Day 9:  51514916.402495 161230.055653   22299.006764    1654.535088
Day 10: 51337163.327463 315950.265591   43739.085660    3247.321286
Day 11: 50989707.042572 618270.798255   85750.617483    6371.541690
Day 12: 50313128.256199 1206525.184878  167949.973128   12496.585796
Day 13: 49005573.564645 2341719.135734  328314.287173   24493.012448
Day 14: 46515948.987152 4496812.408123  639394.571765   47944.032960
Day 15: 41913707.168217 8456652.454468  1236125.303514  93615.073801

Do you want to plot the result [y/n]? y
Which data would you like to plot? [s/e/i/r]s
Day 0   (99%)   | ********************************************************************************************** <-- 99 "*"
Day 1   (99%)   | **********************************************************************************************
Day 2   (99%)   | **********************************************************************************************
Day 3   (99%)   | **********************************************************************************************
Day 4   (99%)   | **********************************************************************************************
Day 5   (99%)   | **********************************************************************************************
Day 6   (99%)   | **********************************************************************************************
Day 7   (99%)   | **********************************************************************************************
Day 8   (99%)   | **********************************************************************************************
Day 9   (99%)   | **********************************************************************************************
Day 10  (99%)   | **********************************************************************************************
Day 11  (98%)   | ********************************************************************************************
Day 12  (97%)   | ******************************************************************************************
Day 13  (94%)   | **************************************************************************************
Day 14  (89%)   | ********************************************************************************
Day 15  (81%)   | ************************************************************************** <-- 81 "*"

Do you want to plot the result [y/n]?
```

Plot the percentage value from Day 0 to Day X in the histogram

Ask if the user want to plot the result in histogram again

Another example



Example results:

I on Day 0 = 1

Beta = 2

Sigma = 1/7

Gamma = 1/14

Number of day = 40

C:\X\PortableApps\Dev-Cpp32\ConsolePauser.exe

```
Enter the number of infected people in Day 0: 1
Enter the value of Beta (Transmission Rate): 2
Enter the value of Sigma (Incubation Rate): 0.1428571428571429
Enter the value of Gamma (Recovery Rate): 0.0714285714285714
How many days do you want to run the simulation: 40
Day     S               E               I               R
================================================================
Day 0:  51700000.000000 0.000000        1.000000        0.000000
Day 1:  51699998.000000 2.000000        0.928571        0.071429
Day 2:  51699996.142857 3.571428        1.147959        0.137755
Day 3:  51699993.846939 5.357143        1.576166        0.219752
Day 4:  51699990.694607 7.744168        2.228889        0.332335
Day 5:  51699986.236830 11.095636       3.175992        0.491542
Day 6:  51699979.884847 15.862528       4.534227        0.718398
Day 7:  51699970.816398 22.664902       6.476429        1.042272
Day 8:  51699957.863548 32.379908       9.251670        1.504874
Day 9:  51699939.360225 46.257531       13.216537       2.165707
Day 10: 51699912.927182 66.082355       18.880718       3.109746
Day 11: 51699875.165811 94.403389       26.972431       4.458368
Day 12: 51699821.221080 134.861922      38.532028       6.384971
Day 13: 51699744.157293 192.659720      55.045729       9.137258
Day 14: 51699634.066382 275.227814      78.636708       13.069096
Day 15: 51699476.794062 393.181855      112.338060      18.686004
Day 16: 51699252.120241 561.686859      160.482749      26.710151
Day 17: 51698931.159393 802.406728      229.260675      38.173204
Day 18: 51698472.647530 1146.289057     327.514445      54.548967
Day 19: 51697817.638004 1637.543004     467.876136      77.942856
Day 20: 51696881.925250 2339.321043     668.391127      111.362580
Day 21: 51695545.223645 3341.833928     954.837624      159.104803
Day 22: 51693635.712983 4773.939743     1364.039783     227.307491
Day 23: 51690907.969296 6819.692038     1948.599762     324.738904
Day 24: 51687011.455214 9741.964401     2783.655785     463.924601
Day 25: 51681445.542423 13916.167992    3976.532429     662.757157
Day 26: 51673495.331970 19878.354445    5680.518397     946.795188
Day 27: 51662140.119778 28393.801717    8114.532004     1352.546502
Day 28: 51645922.940618 40554.723488    11591.179963    1932.155931
Day 29: 51622764.829378 57919.302802    16556.770464    2760.097357
Day 30: 51589700.757755 82709.188311    23648.330117    3942.723818
Day 31: 51542505.003381 118089.344353   33774.762010    5631.890255
Day 32: 51475161.258460 168563.182938   48232.185345    8044.373256
Day 33: 51379116.404670 240527.582023   68867.483955    11489.529352
Day 34: 51242236.311588 343046.591959   98309.461104    16408.635349
Day 35: 51047358.302299 488917.945254   140294.012734   23430.739713
Day 36: 50770312.321751 696118.505051   200118.432575   33451.740623
Day 37: 50377272.665015 989712.661066   285269.759541   47745.914378
Day 38: 49821330.220856 1404267.582216  406280.871155   68122.325774
Day 39: 49038295.286515 1986692.861954  577870.463532   97142.387999
Day 40: 47942056.142225 2799118.740250  820407.267844   138418.849680
```

Example results:

I on Day 0 = 10

Beta = 2

Sigma = 1/7

Gamma = 1/14

Number of day = 40

C:\X\PortableApps\Dev-Cpp32\ConsolePauser.exe

```
Enter the number of infected people in Day 0: 10
Enter the value of Beta (Transmission Rate): 2
Enter the value of Sigma (Incubation Rate): 0.1428571428571429
Enter the value of Gamma (Recovery Rate): 0.0714285714285714
How many days do you want to run the simulation: 40
Day     S               E               I               R
================================================================
Day 0:  51700000.000000 0.000000        10.000000       0.000000
Day 1:  51699980.000004 19.999996       9.285714        0.714286
Day 2:  51699961.428586 35.714272       11.479591       1.377551
Day 3:  51699938.469425 53.571394       15.761659       2.197522
Day 4:  51699906.946150 77.441613       22.288883       3.323355
Day 5:  51699862.368474 110.956202      31.759907       4.915418
Day 6:  51699798.848841 158.624949      45.342228       7.183982
Day 7:  51699708.164754 226.648328      64.764205       10.422713
Day 8:  51699578.637101 323.797649      92.516523       15.048728
Day 9:  51699393.605600 462.572343      132.165007      21.657051
Day 10: 51699129.278738 660.817441      188.806412      31.097408
Day 11: 51698751.672346 944.021341      269.722732      44.583581
Day 12: 51698212.240013 1348.593483     385.317014      63.849490
Day 13: 51697441.632782 1926.544502     550.450582      91.372134
Day 14: 51696340.786310 2752.170331     786.353326      130.690033
Day 15: 51694768.191274 3931.598177     1123.352422     186.858127
Day 16: 51692521.714222 5616.418347     1604.769845     267.097586
Day 17: 51689312.639404 8023.147686     2292.488906     381.724004
Day 18: 51684728.610280 11461.012856    3274.903654     545.473211
Day 19: 51678180.738952 16371.596633    4678.269515     779.394901
Day 20: 51668828.150527 23385.385538    6682.906926     1113.557009
Day 21: 51655470.398005 33402.368698    9546.325794     1590.907504
Day 22: 51636394.194753 47706.804993    13636.212337    2272.787917
Day 23: 51609155.328241 68130.413649    19477.455026    3246.803084
Day 24: 51570268.875343 97283.950311    27819.124474    4638.049872
Day 25: 51514770.250527 138884.867940   39729.751342    6625.130191
Day 26: 51435595.449111 198218.973936   56732.607380    9462.969573
Day 27: 51322710.540888 282786.885882   80997.274558    13515.298672
Day 28: 51161898.205388 403201.094828   115609.881501   19300.818283
Day 29: 50933085.058586 574414.085226   164952.189227   27558.666962
Day 30: 50608074.526306 817365.462474   235229.045028   39340.966192
Day 31: 50147552.795592 1161120.698548  335193.465023   56143.040837
Day 32: 49497296.364928 1645502.743706  477125.460171   80085.431196
Day 33: 48583701.945688 2324025.342416  678116.890688   114165.821208
Day 34: 47309217.515162 3266506.152597  961683.590270   162602.741971
Day 35: 45549198.584688 4559881.346985  1359635.641336  231294.426991
Day 36: 43153442.226807 6304226.083869  1913930.430810  328411.258515
Day 37: 39958367.940667 8598696.643741  2677824.840590  465120.575001
Day 38: 35819045.326959 11509634.022629 3714936.872511  656393.777900
Day 39: 30671445.076079 15013000.841706 5093817.670565  921746.411651
Day 40: 24627548.801773 18912182.710053 6874687.957196  1285590.530977
```

Example results:

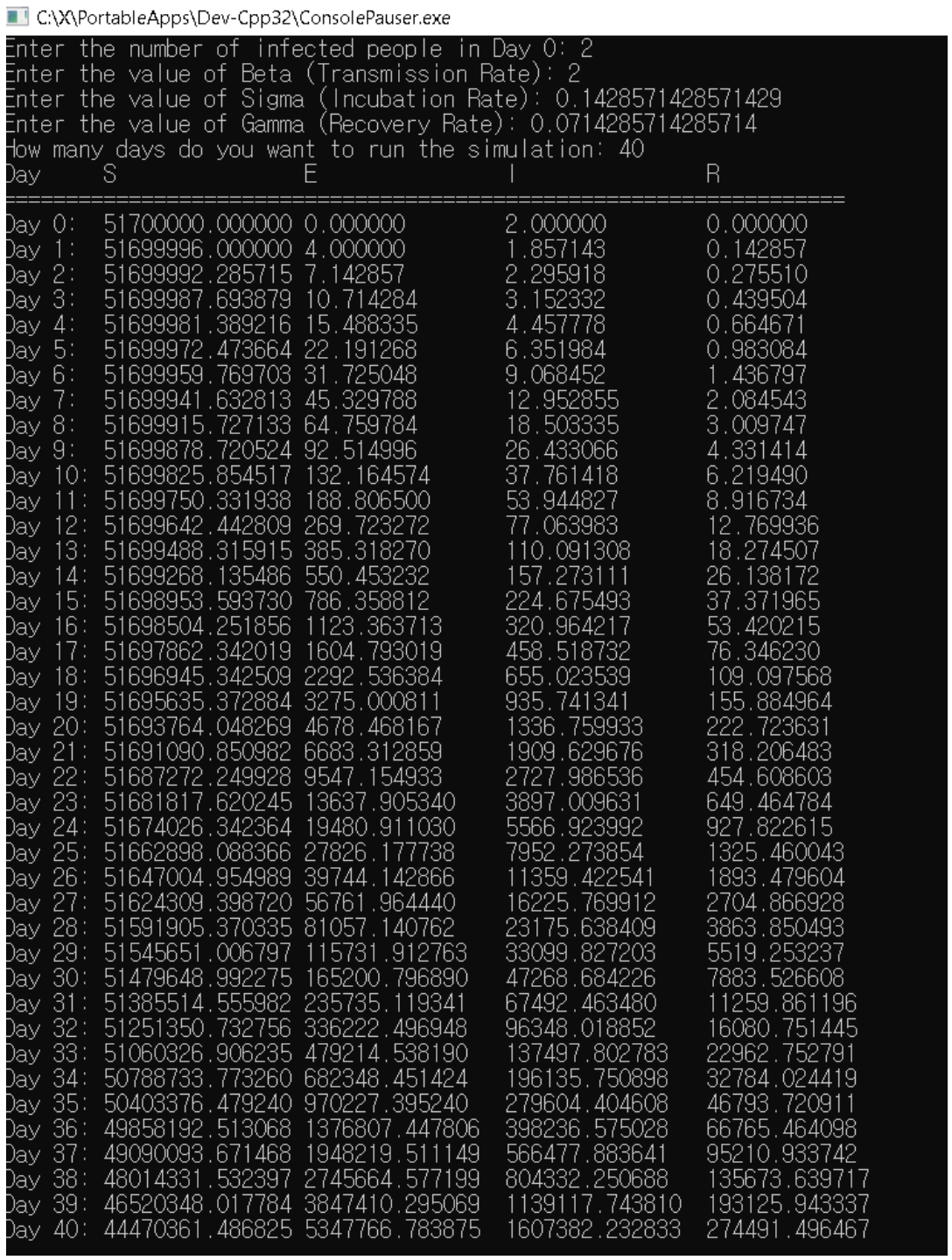
I on Day 0 = 2

Beta = 2

Sigma = 1/7

Gamma = 1/14

Number of day = 40



```
C:\X\PortableApps\Dev-Cpp32\ConsolePauser.exe
Enter the number of infected people in Day 0: 2
Enter the value of Beta (Transmission Rate): 2
Enter the value of Sigma (Incubation Rate): 0.1428571428571429
Enter the value of Gamma (Recovery Rate): 0.0714285714285714
How many days do you want to run the simulation: 40
Day     S                E                I                R
================================================================
Day 0:  51700000.000000 0.000000         2.000000         0.000000
Day 1:  51699996.000000 4.000000         1.857143         0.142857
Day 2:  51699992.285715 7.142857         2.295918         0.275510
Day 3:  51699987.693879 10.714284        3.152332         0.439504
Day 4:  51699981.389216 15.488335        4.457778         0.664671
Day 5:  51699972.473664 22.191268        6.351984         0.983084
Day 6:  51699959.769703 31.725048        9.068452         1.436797
Day 7:  51699941.632813 45.329788        12.952855        2.084543
Day 8:  51699915.727133 64.759784        18.503335        3.009747
Day 9:  51699878.720524 92.514996        26.433066        4.331414
Day 10: 51699825.854517 132.164574       37.761418        6.219490
Day 11: 51699750.331938 188.806500       53.944827        8.916734
Day 12: 51699642.442809 269.723272       77.063983        12.769936
Day 13: 51699488.315915 385.318270       110.091308       18.274507
Day 14: 51699268.135486 550.453232       157.273111       26.138172
Day 15: 51698953.593730 786.358812       224.675493       37.371965
Day 16: 51698504.251856 1123.363713      320.964217       53.420215
Day 17: 51697862.342019 1604.793019      458.518732       76.346230
Day 18: 51696945.342509 2292.536384      655.023539       109.097568
Day 19: 51695635.372884 3275.000811      935.741341       155.884964
Day 20: 51693764.048269 4678.468167      1336.759933      222.723631
Day 21: 51691090.850982 6683.312859      1909.629676      318.206483
Day 22: 51687272.249928 9547.154933      2727.986536      454.608603
Day 23: 51681817.620245 13637.905340     3897.009631      649.464784
Day 24: 51674026.342364 19480.911030     5566.923992      927.822615
Day 25: 51662898.088366 27826.177738     7952.273854      1325.460043
Day 26: 51647004.954989 39744.142866     11359.422541     1893.479604
Day 27: 51624309.398720 56761.964440     16225.769912     2704.866928
Day 28: 51591905.370335 81057.140762     23175.638409     3863.850493
Day 29: 51545651.006797 115731.912763    33099.827203     5519.253237
Day 30: 51479648.992275 165200.796890    47268.684226     7883.526608
Day 31: 51385514.555982 235735.119341    67492.463480     11259.861196
Day 32: 51251350.732756 336222.496948    96348.018852     16080.751445
Day 33: 51060326.906235 479214.538190    137497.802783    22962.752791
Day 34: 50788733.773260 682348.451424    196135.750898    32784.024419
Day 35: 50403376.479240 970227.395240    279604.404608    46793.720911
Day 36: 49858192.513068 1376807.447806   398236.575028    66765.464098
Day 37: 49090093.671468 1948219.511149   566477.883641    95210.933742
Day 38: 48014331.532397 2745664.577199   804332.250688    135673.639717
Day 39: 46520348.017784 3847410.295069   1139117.743810   193125.943337
Day 40: 44470361.486825 5347766.783875   1607382.232833   274491.496467
```

Example results:

I on Day 0 = 1

Beta = 4

Sigma = 1/7

Gamma = 1/14

Number of day = 40

This result has problem!!!
Number of susceptible
on Day 36, 38 and 40
are negative!

C:\X\PortableApps\Dev-Cpp32\ConsolePauser.exe

```
Enter the number of infected people in Day 0: 1
Enter the value of Beta (Transmission Rate): 4
Enter the value of Sigma (Incubation Rate): 0.1428571428571429
Enter the value of Gamma (Recovery Rate): 0.0714285714285714
How many days do you want to run the simulation: 40
Day     S               E               I               R
================================================================
Day 0:  51700000.000000 0.000000        1.000000        0.000000
Day 1:  51699996.000000 4.000000        0.928571        0.071429
Day 2:  51699992.285715 7.142857        1.433673        0.137755
Day 3:  51699986.551022 11.857141       2.351676        0.240160
Day 4:  51699977.144319 19.569967       3.877577        0.408137
Day 5:  51699961.634019 32.284557       6.396317        0.685107
Day 6:  51699936.048772 53.257724       10.551516       1.141987
Day 7:  51699893.842760 87.855491       17.406083       1.895666
Day 8:  51699824.218572 144.928894      28.713576       3.138958
Day 9:  51699709.364662 239.078676      47.366734       5.189928
Day 10: 51699519.898796 394.390446      78.137492       8.573266
Day 11: 51699207.351735 650.596014      128.897735      14.154515
Day 12: 51698691.768710 1073.236752     212.633042      23.361496
Day 13: 51697841.258082 1770.427844     350.764503      38.549571
Day 14: 51696438.258681 2920.508982     578.628159      63.604178
Day 15: 51694123.905541 4817.646553     954.513145      104.934761
Day 16: 51690306.286984 7947.029888     1574.568857     173.114271
Day 17: 51684009.192601 13108.834287    2597.389637     285.583475
Day 18: 51673622.847745 21622.488530    4284.552418     471.111307
Day 19: 51656493.382257 35663.027085    7067.439892     777.150765
Day 20: 51628247.412821 58814.278367    11657.340912    1281.967900
Day 21: 51581682.765305 96976.886116    19226.713471    2114.635108
Day 22: 51504951.916896 159853.893652   31707.217668    3487.971785
Day 23: 51378601.534704 263368.005321   52278.686928    5752.773047
Day 24: 51170786.774746 433558.764520   86168.495765    9486.964970
Day 25: 50829640.961347 712767.611559   141950.569570   15641.857525
Day 26: 50271397.530327 1169187.098070  233635.187680   25781.183923
Day 27: 49362680.534600 1910877.365502  383973.688285   42469.411614
Day 28: 47896222.496544 3104352.922772  629529.477050   69896.103634
Day 29: 45563372.723412 4993723.706936  1028042.074800  114862.494852
Day 30: 41939305.928562 7904401.400795  1667999.599019  188294.071624
Day 31: 36526946.615689 12187560.513555 2678056.970631  307436.900125
Day 32: 28958571.984514 18014855.071365 4227847.260380  498726.683742
Day 33: 19486044.567794 24913831.763604 6499408.894833  800715.773769
Day 34: 9687377.725289  31153379.782737 9594284.225717  1264959.266257
Day 35: 2496394.862577  33893879.819344 13359461.035700 1950265.282380
Day 36: -83913.783554   31632205.634140 17247196.650199 2904512.499215
Day 37: 28061.264695    27001344.066728 20534140.551490 4136455.117087
Day 38: -16520.084795   23188590.549543 22924751.093059 5603179.442193
Day 39: 12781.178233    19846633.493723 24599924.664918 7240661.663126
Day 40: -11545.012527   17035726.328237 25678020.545099 8997799.139191
```

Example results:

I on Day 0 = 1

Beta = 4

Sigma = 1/7

Gamma = 1/14

Number of day = 40

This is the correct result!!!

Example results:

I on Day 0 = 2

Beta = 8

Sigma = 1

Gamma = 1

Number of day = 40