How to Flatten the Curve Using Exponential Function?

Part 1

For illustration assume that our artificial and infectious disease called *Newvird*[1] spreads exponentially[2] at rate of 20% with 75 infections recorded at a certain time, (*time zero- days*) according to the following formula

$$P = P_0 * a^t = P_0 * (1 + r)^t$$

$$P_0 \; initial\ number\ of\ infections\ when\ t = 0$$

$$a\ is\ the\ factor\ by\ which\ P\ changes\ when\ t\ increases\ by\ 1$$

$$t \; - \; time\ [days]$$

$$r \; - \; rate\ in\ percent\ expressed\ in\ decimal\ notation$$

Example 1 (Exponential growth of Newvird with no intervention[3])

$$P_0 = 75 \;\; ; \; r = 0.20 \; ; \; t = 1\ to\ 30$$

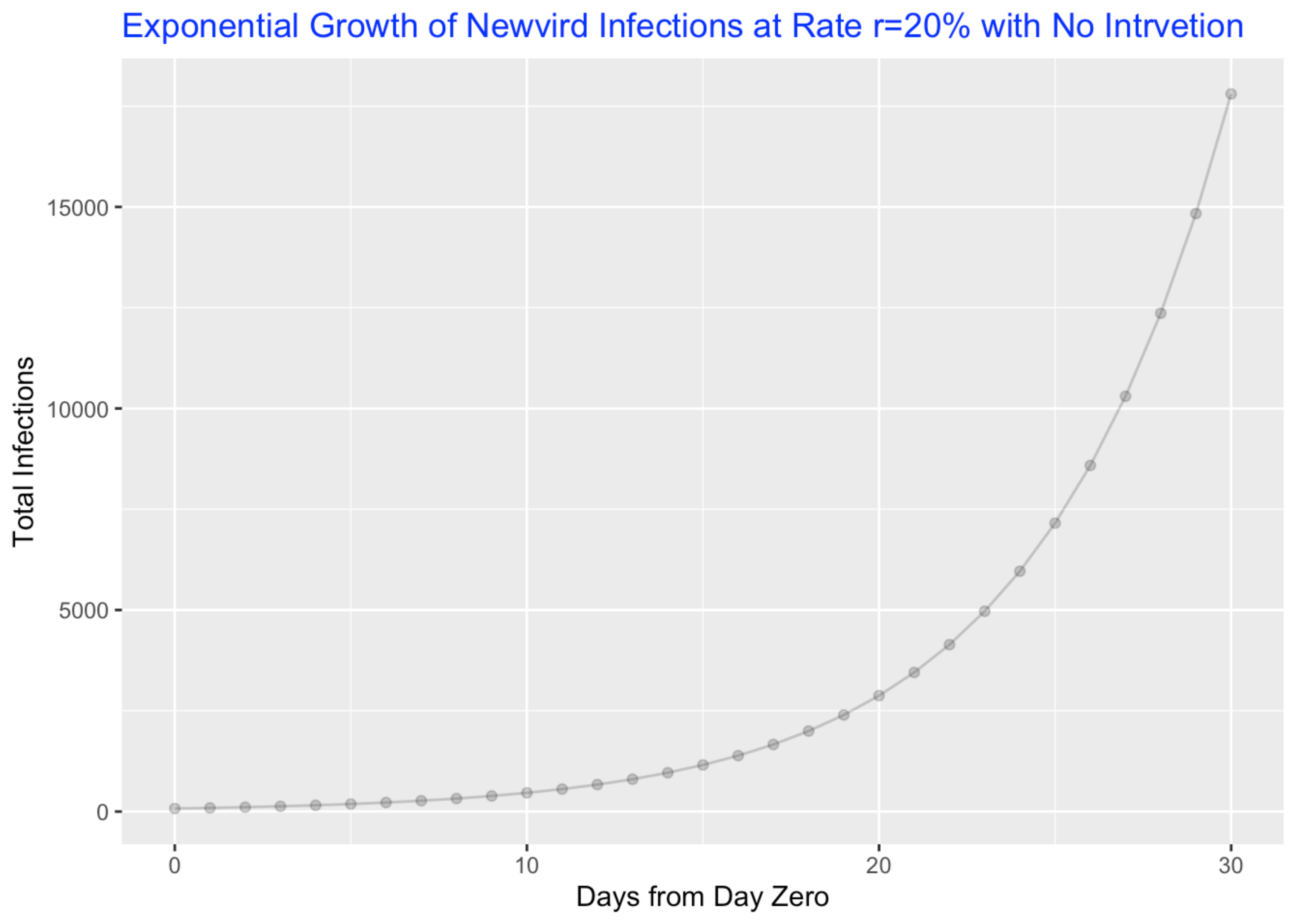
$$P = 75 * (1 + 0.20)^{time}$$

Here are the numbers of *new* infections for each day of the 1 to 30-day range.

```
##  [1]    75    90   108   130   156   187   224   269   322   387   464   557
## [13]   669   802   963  1156  1387  1664  1997  2396  2875  3450  4140  4969
## [25]  5962  7155  8586 10303 12363 14836 17803
```

The doubling time is constant and equal to four days, (number of *new* infections almost doubles every four days).

Here is the graphical illustration of exponential growth of Newvird infections.



Example 2 (Exponential growth of Newvird with new rate r=10% or r=0.10)

$$P_0 = 75 \;\; ; \; r = 0.10 \; ; \; t = 1\ to\ 30$$

$$P = 75 * (1 + 0.10)^{time}$$

Here are the numbers of *new* infections for each day of the 1 to 30-day range.

```
##  [1]   75   82   91  100  110  121  133  146  161  177  195  214  235  259  285
## [16]  313  345  379  417  459  505  555  611  672  739  813  894  983 1082 1190
## [31] 1309
```

The doubling time is constant and equal this time to eight days, (number of *new* infections almost doubles every eight days) at rate r=10%.

Here is the graphical illustration of exponential growth of Newvird infections when intervention is not activated.

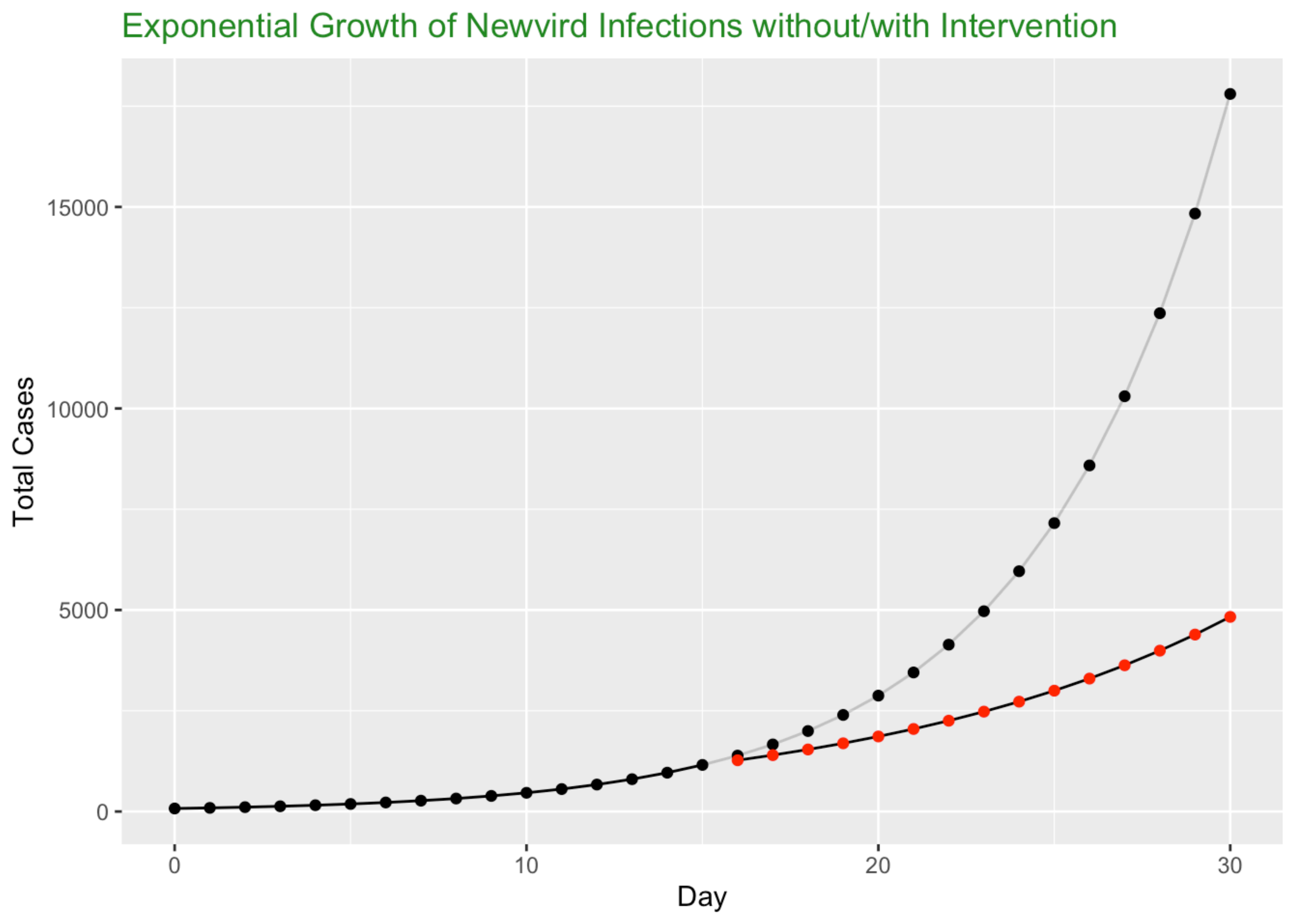
At rate, r=10% the number of infection is considerably smaller for each day of the 1 to 30-day range.

Assume that from past experiences we learned that the certain intervention(s)[4] may help to contain the spread of Newvird sizably for selected days of the 1 to 30-day range.

Example 3 (Exponential growth of Newvird without/with intervention illustration)

We will use the arbitrary range of 30-day periods in the following way. For the first 15-day period we will observe the spread of Newvird at the rate of 20% and introduce **no intervention**. After the 15th day and before the 16th day we will introduce *social distancing* intervention and **observe** the rate of infection for each day.

The effect of flattening the curve is visible on the graphical display below.



Here we have numbers of new infections after the intervention.

```
##  [1] 1272 1399 1539 1692 1862 2048 2253 2478 2726 2998 3298 3628 3991 4390 4829
```

Some Questions to Ponder/Extra Credit - Assignments

1. How appropriate is this *model* of the exponential spread of any infectious disease?
2. How to create and interpret a logarithmic representation of the above examples?
3. In reality, the spread of any infectious disease cannot increase forever; when the increase starts to level off and why?
4. Are there other possibly simpler explanations of the “flattening” of the curve?

References

A COVID-19: https://youtu.be/TIsXHxLNw6k

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1. New Viral Disease↩
2. Number of infections doubles at constant rate in time.↩
3. No measures to contain spread of infections are taken↩
4. Intervention(s) may include: social-distancing, self-quarantine, isolation and many more.↩