Some comments on

# COVID-19

Berndt Mueller - May 19, 2020

# BASIC EPIDEMIOLOGY

The simplest infectious disease transmission model assumes exponential growth of the number of symptomatic cases:

$$n(t) = n_0 e^{rt} = n_0 R_0^{(t/\tau)}$$

$R_0$ is known as the basic reproduction number and $\tau$ is the mean infectious period.

$$R_0 = e^{r\tau}$$

For example, if τ = 5 days and $r$ = 0.2, then $R_0$ = 2.72. If τ = 5 days and $r$ = − 0.06, then $R_0$ = 0.74.

More sophisticated transmission models account for latent infectious periods, isolation of symptomatic people, etc. Such models are generally known as SEIR models as they distinguish four population segments: susceptible, exposed, infectious, recovered (assumed to be immune). They are usually described by differential equations.

It has been known that discrete models, not based on DGEs, have quantitatively different behavior for the same parameters (see e.g. Fodor, Katz & Kovacs, arxiv:2004.07208).

# OUR MODEL

Our model represents a generalization of the simplest infectious disease transmission in that it allows for two periods with different parameter, using a simple interpolation. Period 1 covers the uncontrolled epidemic; period 2 covers the controlled epidemic, e.g., by stay-at-home orders or just spontaneous public response to the presence of the epidemic:

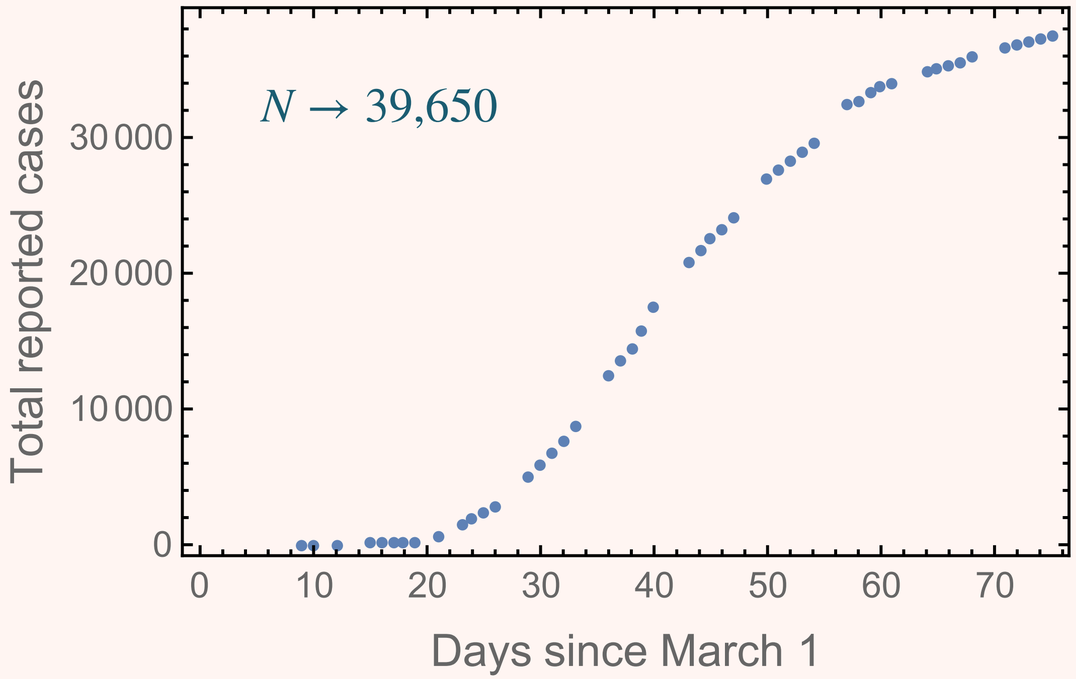
$$n(t) = n_0 \frac{e^{r_1(t-t_1)}}{1 + e^{(r_1-r_2)(t-t_2)}}$$

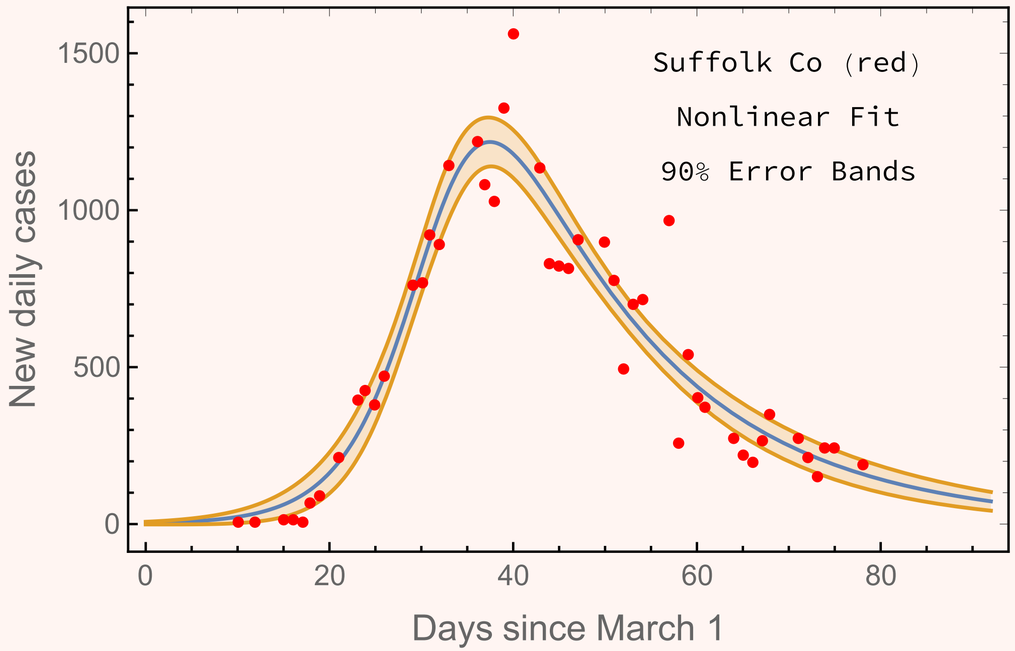
We also consider the case where the number of reported symptomatic cases is modulated by weekly modulations in reporting:

$$n(t) = n_0 \frac{e^{r_1(t-t_1)}}{1 + e^{(r_1-r_2)(t-t_2)}} \left(1 + a \sin[\omega(t - t_0)]\right)$$

# RESULTS

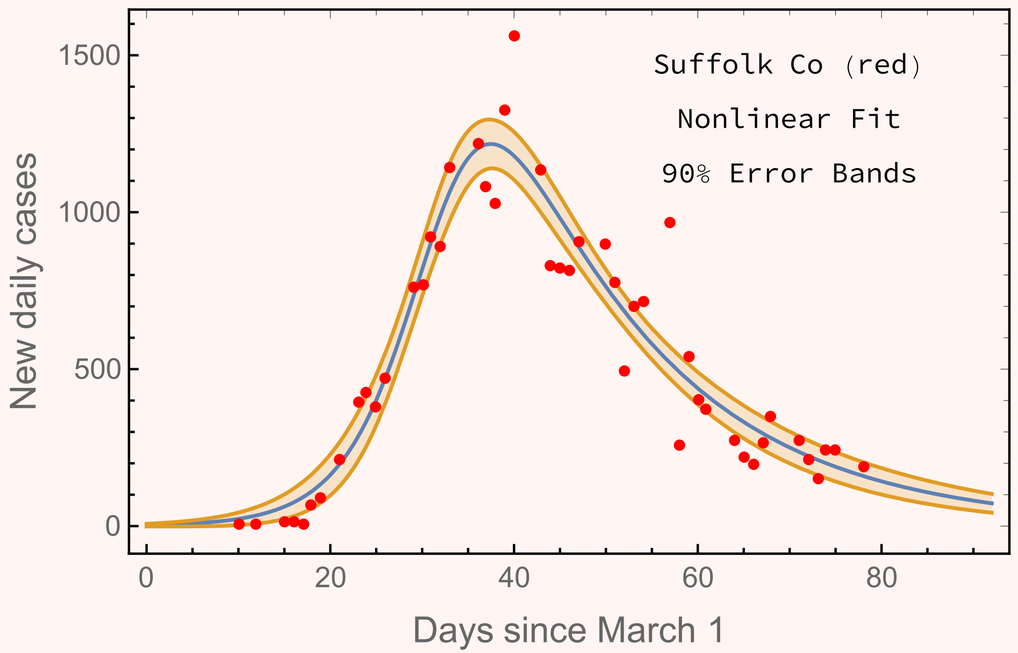
# SUFFOLK COUNTY (NY)

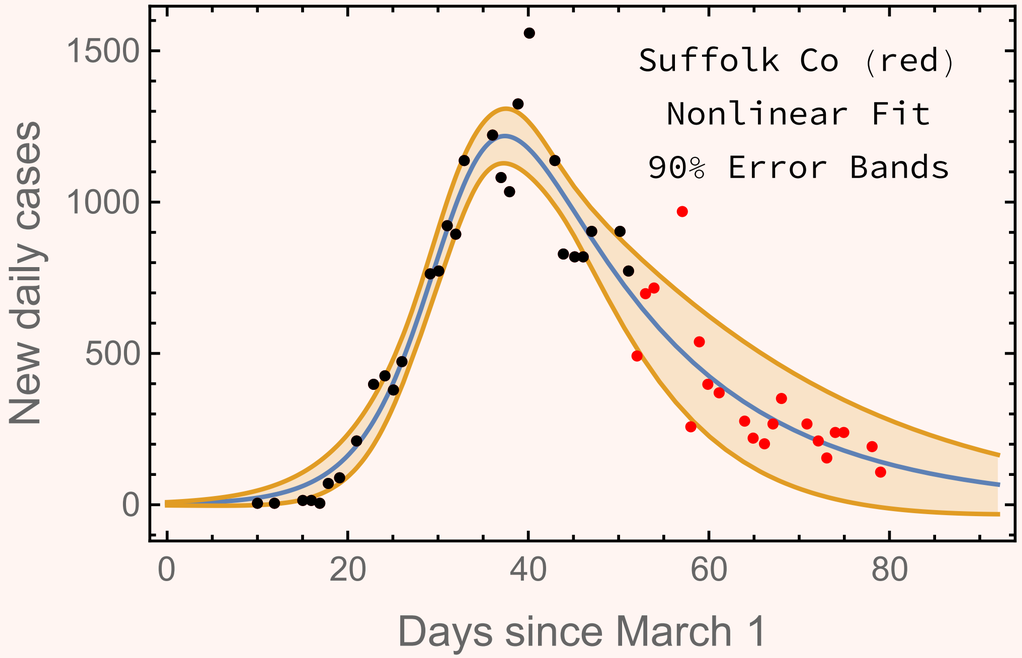



**$r_1 = 0.20$ $t_1 = -6$ $r_2 = -0.055$ $t_2 = 32.5$**

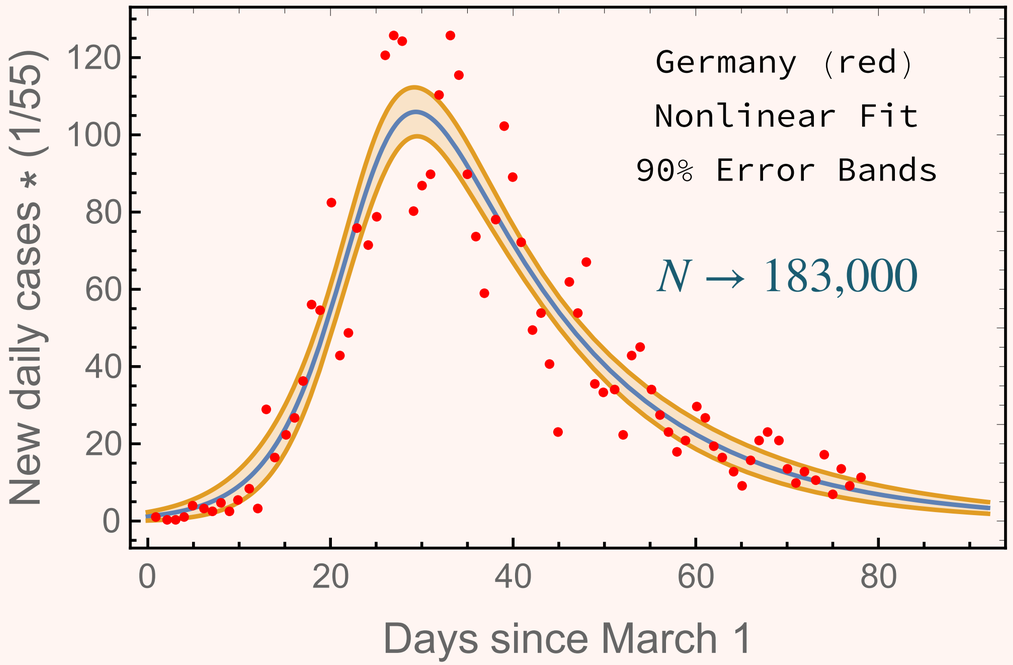
# SUFFOLK COUNTY (NY)

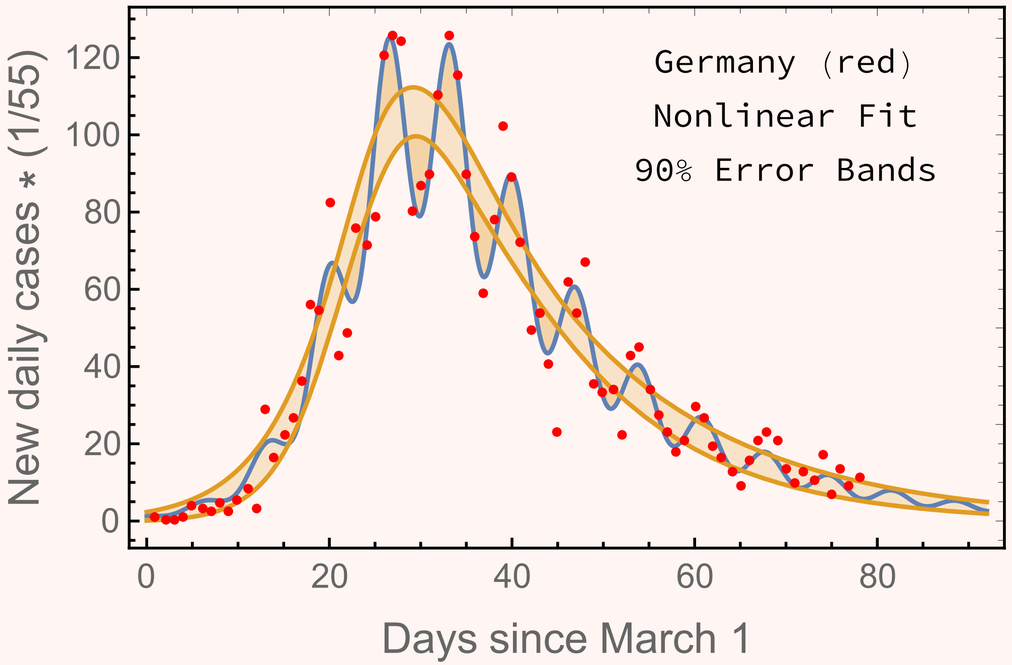



$r_1 = 0.20$ $t_1 = -6$ $r_2 = -0.055$ $t_2 = 32.5$

# GERMANY

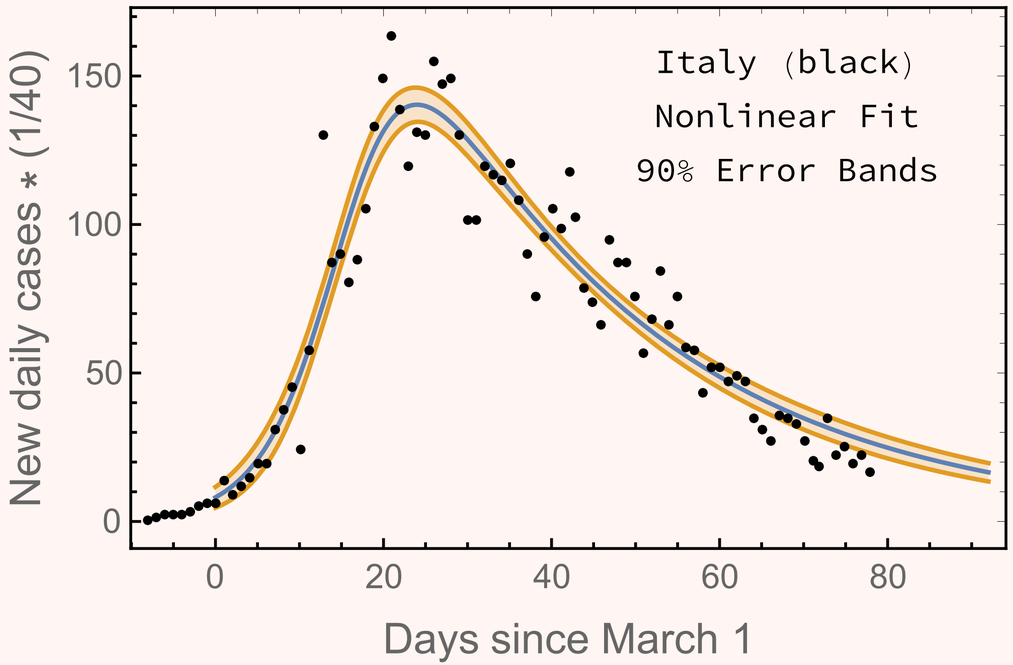


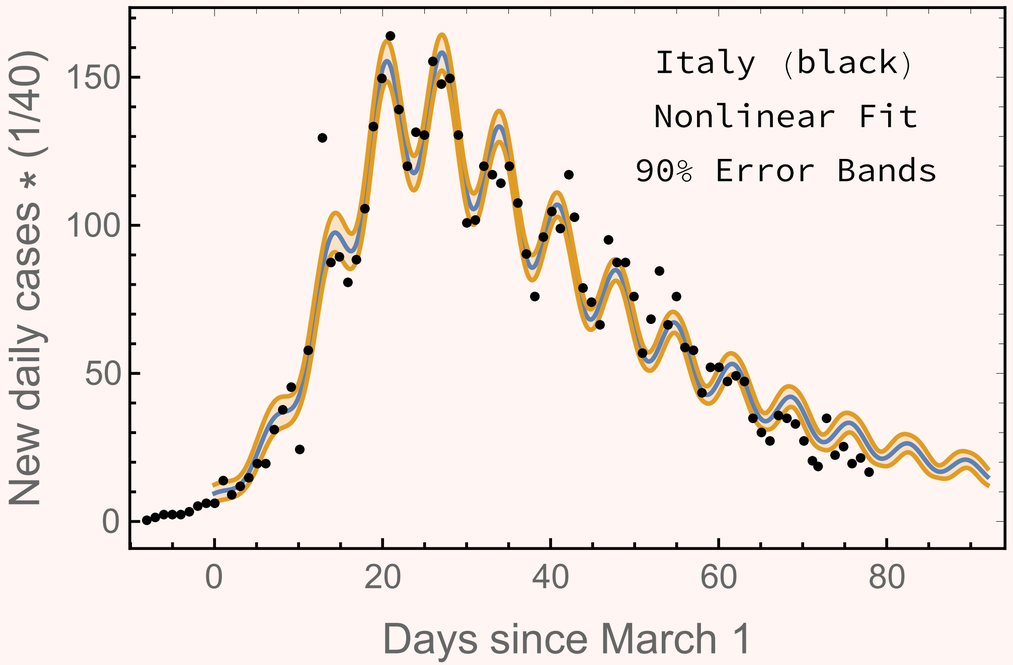




**$r_1 = 0.20$ $t_1 = -1$ $r_2 = -0.06$ $t_1 = 25$**

**T = 6.9 days**

# ITALY

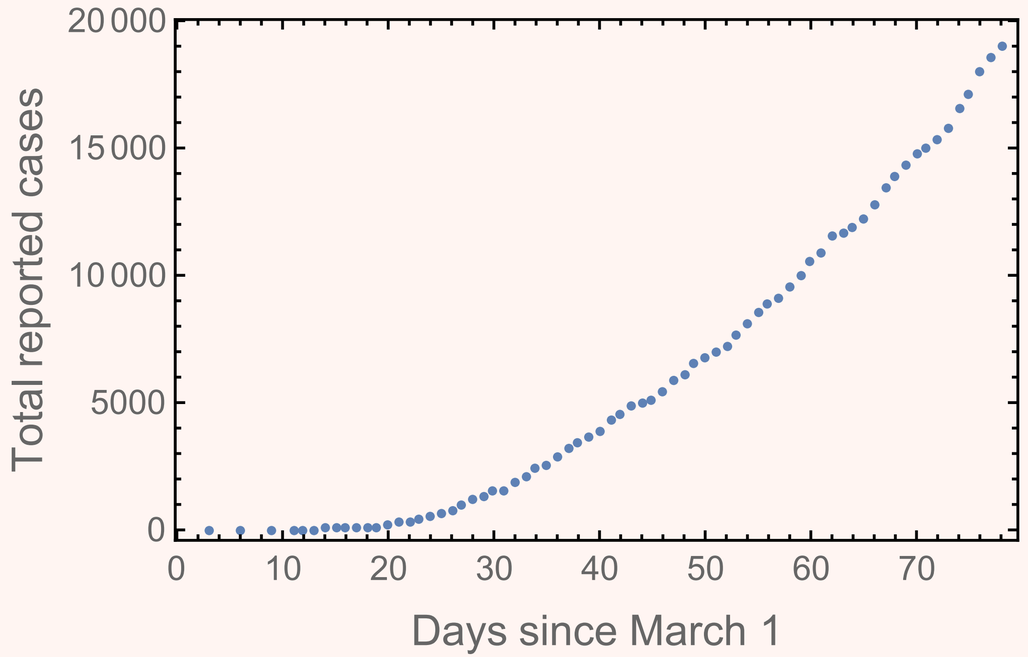


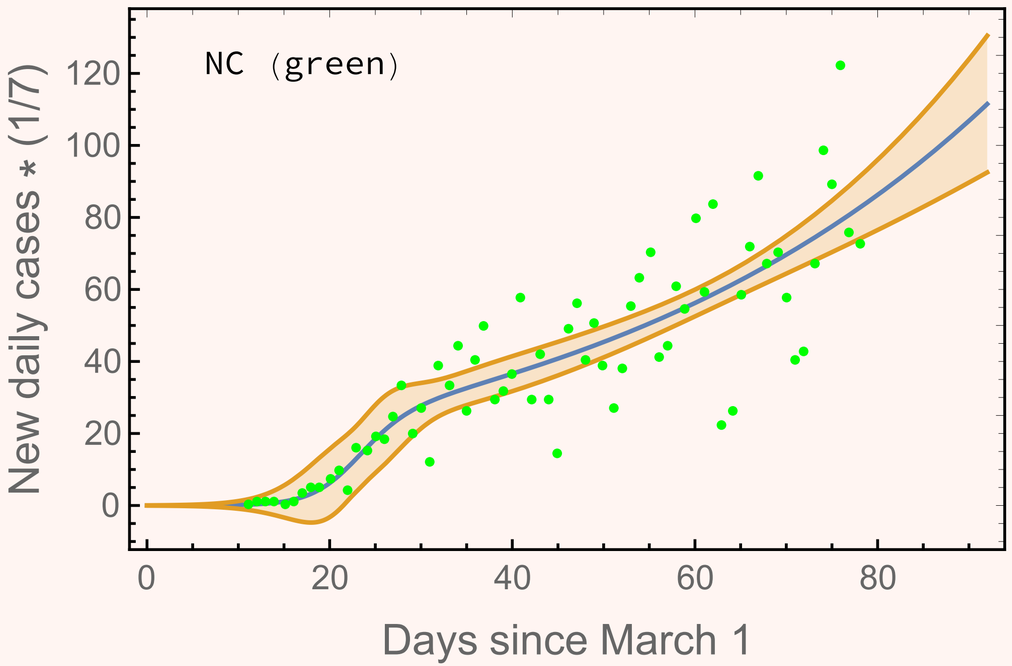




**$r_1 = 0.20$ $t_1 = -11$ $r_2 = -0.033$ $t_1 = 16$**

**T = 7.0 days**

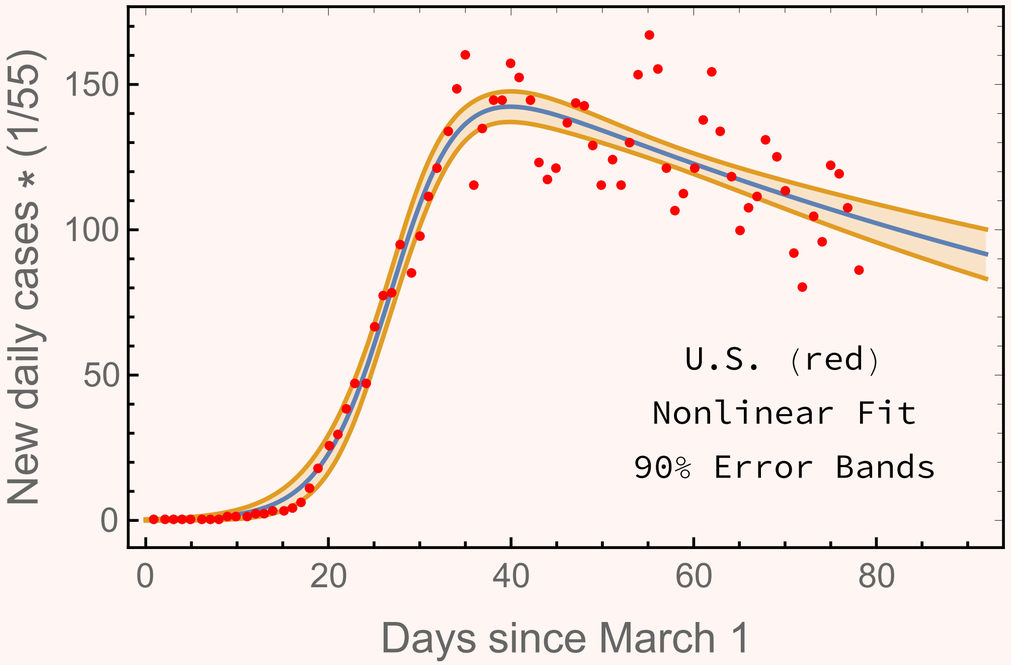
# NORTH CAROLINA

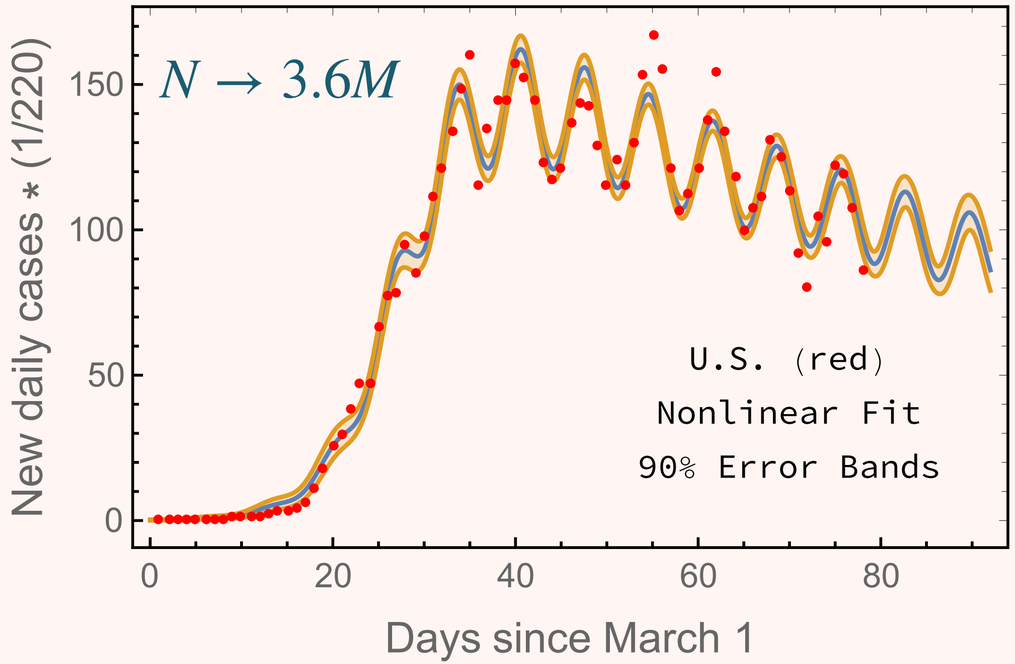



$r_1 = 0.36$ $t_1 = 14$ $r_2 = 0.019$ $t_2 = 23$

# UNITED STATES



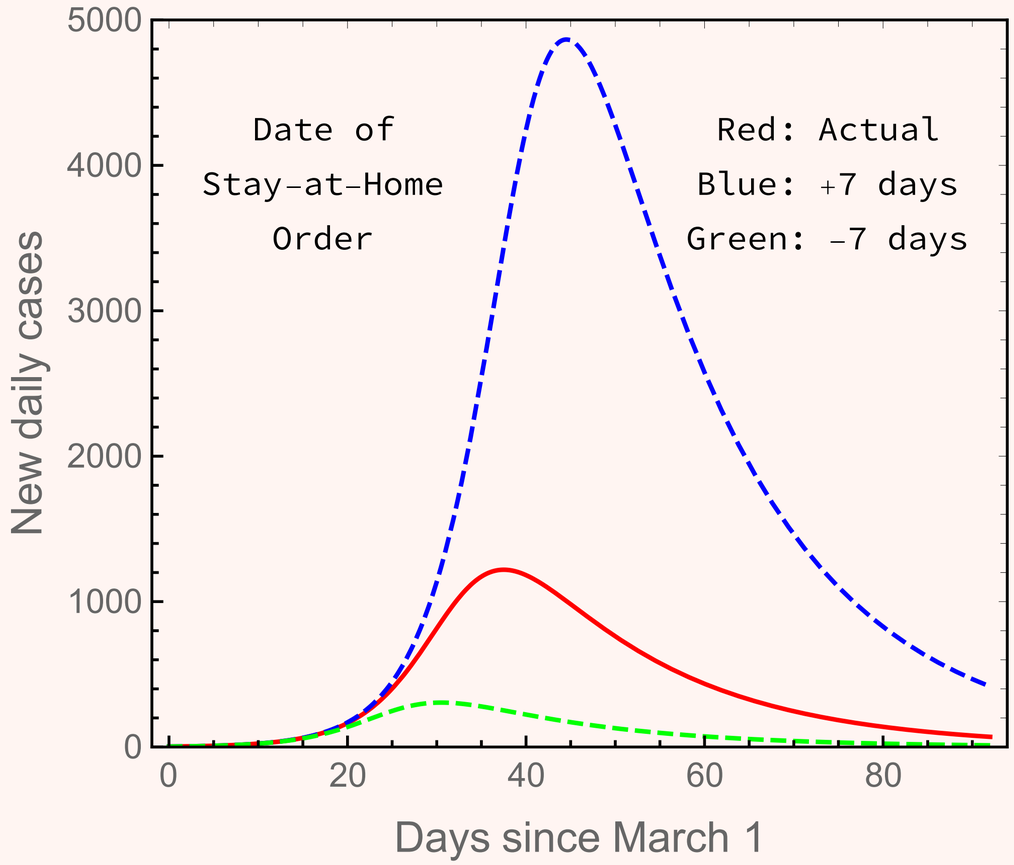




**$r_1 = 0.25$ $t_1 = 7$ $r_2 = -0.09$ $t_2 = 27$**

**T = 7.0 days**

# MITIGATION MATTERS

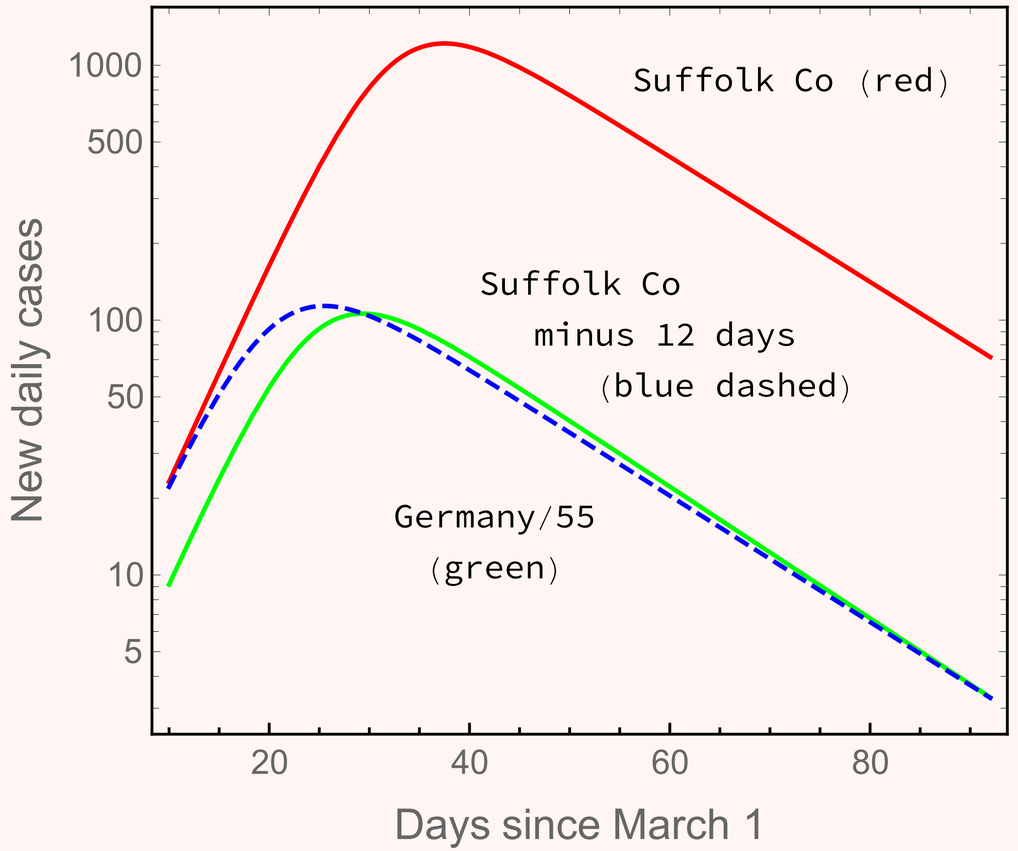
**Effect of data of onset of suppressed transmission phase (stay-at-home order) For Suffolk County, NY**



# SUFFOLK COUNTY

**Could have been like Germany**

**If the stay-at-home order**
**would have been issued 12 days earlier**

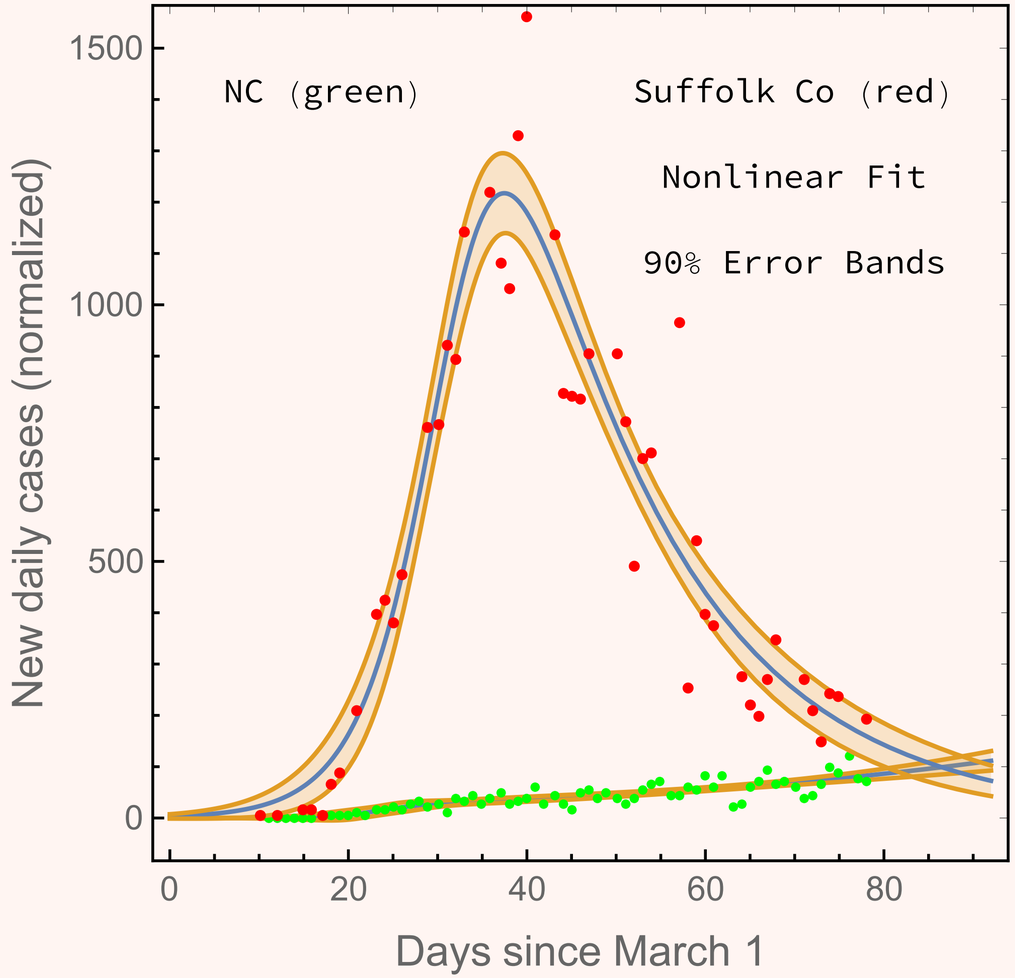


# SUFFOLK COUNTY VS. NORTH CAROLINA

**Normalized to the populations**

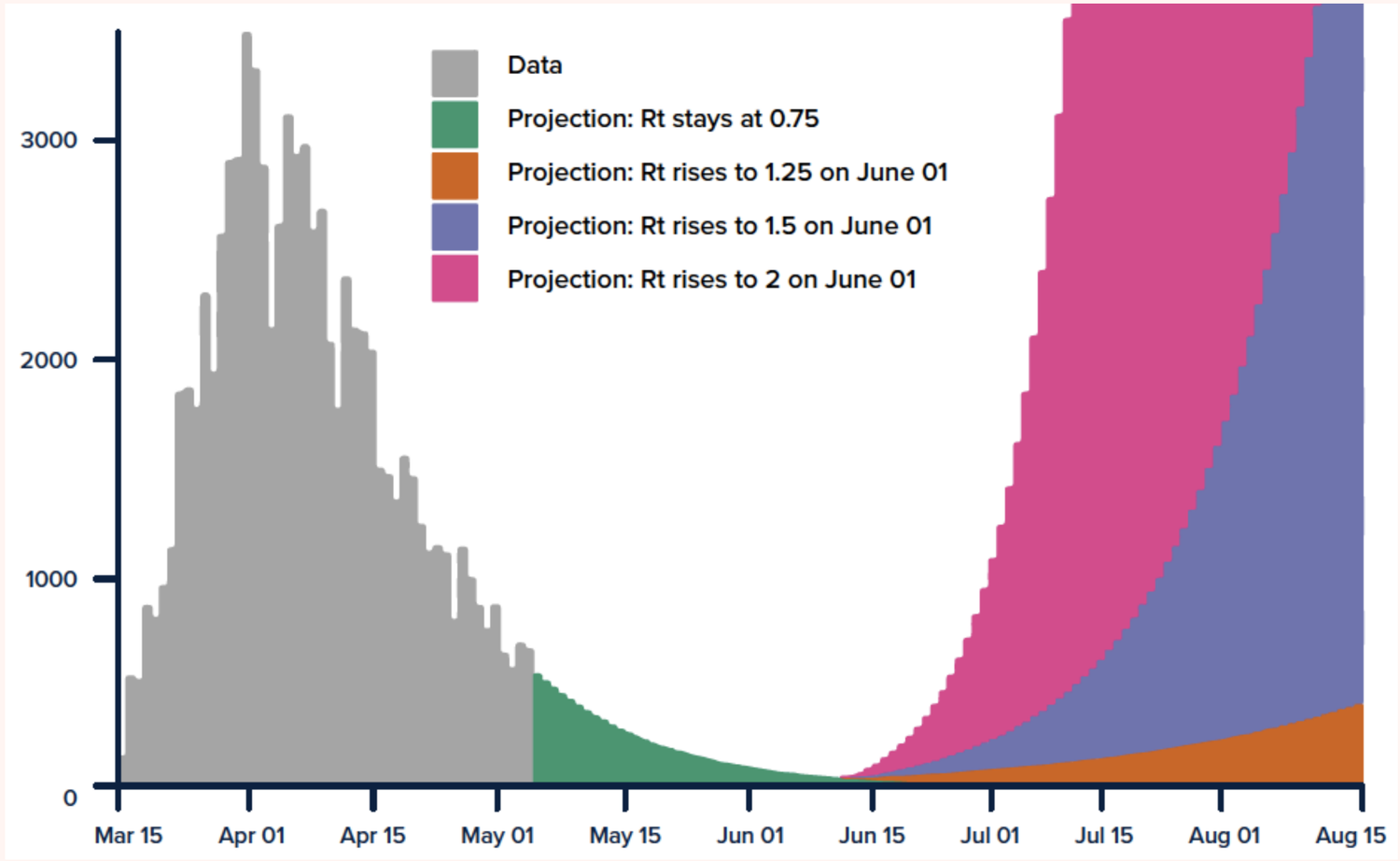
**(1.5M in Suffolk Co)**

**(10.5M in North Carolina)**



# NY STATE REOPENING SCENARIOS

From Governor Andrew Cuomo's "NY Forward" Guide




https://www.governor.ny.gov/sites/governor.ny.gov/files/atoms/files/NYForwardReopeningGuide.pdf

# HAPPY BIRTHDAY!