Applied Math Modeling Takehome, Final Exam (Spring 2020)

Name:

Directions: **All work should be your own**. Any cooperation or collusion between students will result for an F for the exam and an F for the course.

1. This first problem refers to an updated InsightMaker model of the Covid-19 virus. I've added total deaths into the model, as well, and I have updated the total cases (all through May 2nd). You should clone the insight, and then

   a. Evaluate our model of April 9th: how is it performing as of May 2nd?

   b. Adjust the model so at to obtain an improved fit to the data (total cases and total deaths, hopefully), and explain what your changes mean (in terms of properties of Covid-19 or the proposed intervention).

2. This second problem involves fitting a theoretical variogram model to the first twenty-nine lags of one of the empirical variograms (maximum – data appended to the end of the exam) from the Fletcher project.

   Two standard variogram models are the Gaussian,

   $$\gamma_G(h) = n + s\left(1.0 - e^{-\ln(20)\left(\frac{h}{r}\right)^2}\right) \qquad h > 0;$$

   and the Exponential,

   $$\gamma_E(h) = n + s\left(1.0 - e^{-\ln(20)\frac{h}{r}}\right) \qquad h > 0;$$

   where

n	is the "nugget",
s	is the "sill",
r	is the "range", and
h	is the distance (in time!) between two data values.

   These variogram models may be combined, as **positive** linear combinations, to produce a "nested model" (note that only one model should have a non-zero nugget): that is, you might create a theoretical variogram model which is a sum of both types,

   $$\gamma(h) = n + s_1\left(1.0 - e^{-\ln(20)\left(\frac{h}{r_1}\right)^2}\right) + s_2\left(1.0 - e^{-\ln(20)\frac{h}{r_2}}\right)$$

   so long as the nugget and sills are positive. You might even take a combination of two different Gaussians, etc.

You should

a. use these two model types to find the best theoretical variogram can to fit the empirical variogram data;

b. Make a solid mathematical and statistical argument for why your model is the best.

Good luck!

lag	variogram
0.002737851	0.3352083
0.005475702	0.6193353
0.008213552	0.7514369
0.010951403	0.8163598
0.013689254	0.8536704
0.016427105	0.8765450
0.019164956	0.8941746
0.021902806	0.9057704
0.024640657	0.9100563
0.027378508	0.9175279
0.030116359	0.9232952
0.032854209	0.9241713
0.035592060	0.9266196
0.038329911	0.9287303
0.041067762	0.9315528
0.043805613	0.9397256
0.046543463	0.9447636
0.049281314	0.9474760
0.052019165	0.9512294
0.054757016	0.9487390
0.057494867	0.9507847
0.060232717	0.9576104
0.062970568	0.9615994
0.065708419	0.9626555
0.068446270	0.9604158
0.071184120	0.9581537
0.073921971	0.9612405
0.076659822	0.9649029
0.079397673	0.9686055