Variogram models

This far, we used *experimental* variograms, which are derived from observed data to detect spatial structures in the data. This is already insightful, but if we want to utilize these functions for an interpolation we have to go one step further. We need to fit an **theoretical variogram function**, or variogram model to our data, that describes the covariance structure in a more mathematical notation. This can be done by any means suitable to fit a function to data. Most common approaches are least squares or maximum likelihood estimation.

Task 1

To get things started, calculate an experimental variogram for the given artificial data in `artificial.csv` , just like you did in in Task 6 of the previous exercise. Adjust the binning until you're happy with the vaiogram. Estimate the three variogram parameters nugget, sill and effective range by visual inspection and note them down. We will need these values later.

Task 2

The most common variogram model functions are:

- spherical model
- exponential model
- Gaussian model

Implement each one as a Matlab/Octave function and use the *test_* scripts for development. The definitions of the models can be found below

Spherical model

$$\gamma = \begin{cases} b + C_0 * \left(\frac{3*h}{2*a} - \frac{1}{2} * \left(\frac{h}{a} \right)^3 \right) & h <= r \\ b + C_0 & h > r \end{cases}$$

Exponential model

$$\gamma = b + C_0 * \left(1 - e^{-\frac{h}{a}} \right)$$

Gaussian model

$$\gamma = b + c_0 * \left(1 - e^{-\frac{h^2}{a^2}} \right)$$

Range vs effective range

Remember the difference between the model parameter *range*, denoted as **a** here, and the effective range of the variogram (and the data) itself *r*. As you know from the lectures, a := r for a spherical, a := r/3 for a exponential, and a := r/2 for a Gaussian model.

Task 3

Time for action. Apply each of the three models using different colors to your experimental variogram from Task 1. Use the parameters derived in that task as function arguments. How do the three models differ?

Task 4

Can you find better / other parameters for the three models by trial-and-error fitting? Copy your best guess for variogram parameters for each of the model into one table.

Task 5

Use the build-in Matlab / Octave least-squares function to find the best variogram parameter set for each of the functions. Plot the fitted models as they are your ultimate result. How much do they differ from your best guess? Did the machine beat you?