1. Give two examples of each of the three types of spatial data: geospatial data, lattice data and spatial point patterns. You examples could be those in the literature (books and papers) but cannot be those given in the class or those in the handouts. If your examples are from the literature, please provide the citation of the literature. You can also construct your own examples.

2. Suppose we observe a process \( Y(s) \) for \( s \) in the interval \([0, 1]\). Suppose this process has a constant unknown mean and an exponential covariogram

\[
C(Y(s), Y(s + h)) = 2 \exp(-5|h|).
\]

We observe \( Y(0) = 1.5, Y(1) = 0.5 \), and predict \( Y(s) \) for \( s = 0.02, 0.04, \ldots, 0.98 \) using the BLUP or the ordinary kringing predictor.

- Plot the ordinary kriging prediction \( \hat{Y}(s) \) versus \( s \).
- Plot the ordinary kriging variance \( \sigma^2(s) \) versus \( s \).

You can use some existing \( R \) packages or the following methods.

One method is to use the formula (2.13) and (2.14)

\[
\begin{align*}
\lambda &= V^{-1}(k + m1) \\
m &= (1 - 1'V^{-1}k)/(1'V^{-1}1). \\
\hat{Y}(s) &= \lambda Y(s_1) + (1 - \lambda)Y(s_2).
\end{align*}
\]

Another method is to following the following steps:

(a) For any \( s \in [0, 1] \), find the \( \lambda \) that minimizes the MSE

\[
E[(\hat{Y}(s) - Y(s))^2].
\]

(Hint: Write

\[
MSE = \lambda^2 E(Y(s_1) - Y(s_2))^2 + 2\lambda Cov(Y(s_1) - Y(s_2), Y(s_2) - Y(s)) + E(Y(s_2) - Y(s))^2.
\]

Then express the covariance and mean squared difference in terms of the covariogram. For example, \( E(Y(s_1) - Y(s_2))^2 = 4(1 - \exp(-5)) \).

(b) For any \( s \), express the prediction variance in terms of the covariance and the optimal \( \lambda \). The prediction variance is the minimal MSE.

3. The data set \textit{conono2} has measures of \( CO, NO \) and \( NO_2 \) at 68 monitoring locations in California. Please calculate a semivariogram cloud for each variable and see if spatial autocorrelation exists for each of the three variables. Also plot the sample semivariogram. You can use the function \textit{variog} in \( R \) package \textit{geoR} or \textit{vgram} function in the package \textit{fields}. 