Exercise 1
Access the Maas river data at:

```r
a <- read.table("http://www.stat.ucla.edu/~nchristo/statistics_c173_c273/soil1.txt", header=TRUE)
```

a. Perform cokriging predictions on a grid (use by=50), using `log(lead)` as the target variable and co-located variables `log(cadmium)`, `log(copper)`, and `log(zinc)`.

b. Use cross-validation to compare ordinary kriging with cokriging of question (a). Note: Cross-validation for ordinary kriging can be done with the `krige.cv` function, while cross-validation for cokriging can be done using the `gstat.cv` function.

Exercise 2
Read the following data in R:

```r
a <- read.table("http://www.stat.ucla.edu/~nchristo/statistics_c173_c273/jura.txt", header=TRUE)
```

Use `log(Pb)` as the target variable. Answer the following questions:

a. Create a `gstat` object using the target variable. Compute the sample omnidirectional variogram and fit a model to it.

b. Create a dense grid for kriging predictions (use by=0.05).

c. Construct the raster map using the back-transformed values $\hat{Z}(s_0)$. Note: See handout #58.

d. Assign NA values to the region outside the observed points. Finally add contours to the map. Note: See handout #58.

Exercise 3
Consider the data shown on the rectangle of the previous page. Our goal is to estimate the average of the variable $Z(s)$ of the rectangle $ABCD$. The rectangle is descritized by the points $a,b,c,d,e,f$, and the observed data points are $z(s_1), z(s_2), z(s_3), z(s_4), z(s_5)$ (see the coordinates and figure below). Assume that the process $Z$ is second order stationary with variogram function:

$$\gamma(h) = \begin{cases} 
0 & h = 0 \\
3(1 - e^{-h/\pi}) & h > 0 
\end{cases}$$

a. Write the system of the kriging equations in terms of the variogram that will give you the weights for the estimation of the average of the rectangle $ABCD$. Explain what each part of the equations represent.

b. Compute the covariance between the observed data point $s_1$ and point $a$ of the rectangle $ABCD$.

c. Write the expression that computes the covariance between the observed data point $s_1$ and the average of the rectangle $ABCD$.

Coordinates of the observed data points $s_1, s_2, s_3, s_4, s_5$ and the points $a, b, c, d, e, f$:

```
\begin{array}{ccc}
  \text{Point} & x & y \\
  s_1 & 1.0 & 10 \\
  s_2 & 2.0 & 30 \\
  s_3 & 5.0 & 40 \\
  s_4 & 6.0 & 20 \\
  s_5 & 4.0 & 12 \\
  a & 3.5 & 28 \\
  b & 3.5 & 30 \\
  c & 3.5 & 32 \\
  d & 4.0 & 28 \\
  e & 4.0 & 30 \\
  f & 4.0 & 32 \\
\end{array}
```
Exercise 4
Consider the covariance function given by
\[
C(h) = \begin{cases} 
  c_1(1 - \frac{h}{\alpha}), & h \leq \alpha \\
  0, & h > \alpha
\end{cases}
\]
Suppose we want to predict point \(s_0\) at \(s_0 = 0\) using points \(s_1 = -\frac{\alpha}{2}\), \(s_2 = \frac{\alpha}{2}\) and \(s_3 = \frac{\alpha}{2} + \alpha f\), with \(0 < f \leq 1\). Note that when \(\frac{1}{2} < f \leq 1\), point \(s_3\) is located beyond the range of \(s_0\).

Show that when \(0 < f \leq \frac{1}{2}\) the ordinary kriging weights are \(w_1 = \frac{2}{3-f}\), \(w_2 = \frac{3-f}{3-f}\), and \(w_3 = -\frac{1}{3-f}\). See handout #70 for the case when \(\frac{1}{2} < f \leq 1\).