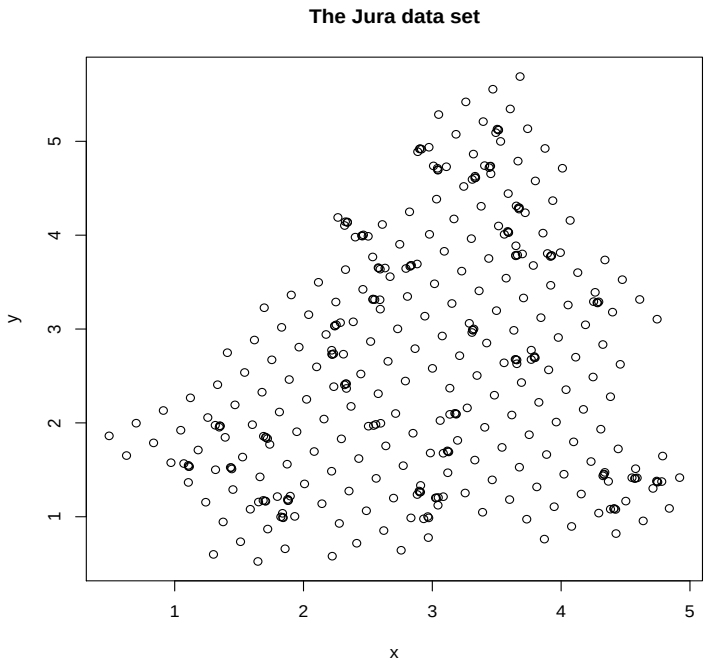
University of California, Los Angeles
Department of Statistics

Statistics C173/C273 **Instructor: Nicolas Christou**

Lab 1

Exercise 1

These Jura data were collected by the Swiss Federal Institute of Technology at Lausanne. See Goovaerts, P. 1997, "Geostatistics for Natural Resources Evaluation", Oxford University Press, New-York, 483 p. for more details. Data were recorded at 359 locations scattered in space (see figure below).



Concentrations of seven heavy metals (cadmium, cobalt, chromium, copper, nickel, lead, and zinc) in the topsoil were measured at each location. The type of land use and rock type was also recorded for each location. The data can be accessed here:

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

```
> names(a)
 [1] "x"       "y"       "Landuse" "Rock"    "Cd"
 [6] "Co"      "Cr"      "Cu"      "Ni"      "Pb"
[11] "Zn"
```

The variables x, y are the coordinates. Landuse and Rock represent type of land use (forest, pasture, meadow, tillage) and rock type (Argovian, Kimmeridgian, Sequanina, Portlandian, and Quaternary). The other variables are concerntrations in ppm of the following chemical elements:
`Cd`: Cadmium
`Co`: Cobalt
`Cr`: Chromium
`Cu`: Copper
`Ni`: Nickel
`Pb`: Lead
`Zn`: Zinc
Answer the following questions:

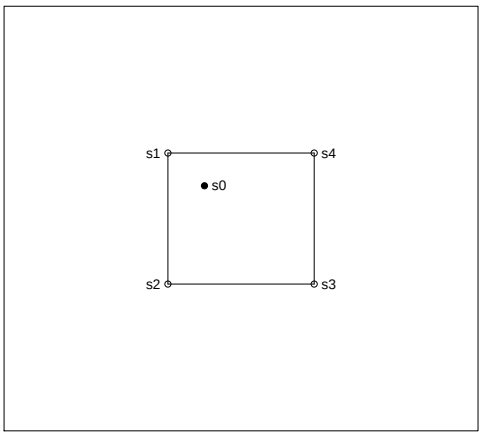
a. Construct histograms, boxplots, and empirical cumulative distribution functions for `Cd`, `Co`, `Cr`, `Cu`, `Ni`, `Pb`, `Zn`.

b. Compute the distance matrix (359×359).

c. Construct h-scatterplots using `Cu`, .

Exercise 2

Let $Z(s)$ be a stationary random function, and let $\hat{Z}(s_0) = 0.5Z(s_1), +0.2Z(s_2) + 0.2Z(s_3) + 0.1Z(s_4)$ be a weighted average of the four values $Z(s_1), Z(s_2), Z(s_3), Z(s_4)$ as shown on the $2m \times 2m$ square below.



Answer the following questions:

a. Use `R` to compute the distance matrix .

b. Assume that the spatial covariance is given by $C(h) = 2.5e^{-\frac{h}{2}}$. Use `R` to compute the 4×4 variance covariance matrix of the vector $\mathbf{Z} = \begin{pmatrix} Z(s_1) \\ Z(s_2) \\ Z(s_3) \\ Z(s_4) \end{pmatrix}$.

c. Use matrix and vector notation to compute $var(Z(s_0))$. Note: Write $Z(s_0) = \mathbf{a}'\mathbf{Z}$, where $\mathbf{a} = \begin{pmatrix} 0.5 \\ 0.2 \\ 0.2 \\ 0.1 \end{pmatrix}$. Then use $var(Z(s_0)) = \mathbf{a}'\mathbf{\Sigma}\mathbf{a}$.