APPLICATION OF TWO METHODS FOR THE INTERPRETATION OF THE UNDERLYING VARIOGRAM

R. Sabourin
Coal Division, Mine Planning, Cape Breton Development Corporation, Canada.

ABSTRACT. The Universal Kriging (U.K.) is an estimation procedure which takes into account the trend effect (drift) of a regionalized variable. This forecasting technique is applied in an increasing number of problems. In this article we are interested in describing and applying two methods which are concerned with the interpretation of parameters needed in the U.K. system. In fact, an optimum efficiency can be obtained in the interpretation of the underlying variogram if both methods are used in a complementary manner.

1. INTRODUCTION

The interpretation of the characteristics of a variogram is very important in a geostatistical study. The work involved in it must be as objective as possible, and it should be standard for every problem. For example, in the simple kriging system, we have to find the parameters of a mathematical model which will best fit the experimental variogram of the real values. This step of the study can be entirely computerized. Indeed, by using the least square method, we can obtain the parameters' model automatically.

In our case, we will try to deal with a more complicated problem. The U.K. technique requires parameters which are not readily available from the real data, e.g. the underlying variogram. The interpretation of this function is not easy to undertake. Furthermore, because of the nature of the problem, this interpretation can give ground for subjectivity.

For these reasons automatic methods of interpretation are greatly needed in this field of research.

1.1 Description of data

A group of 71 channel samples will constitute our basic data. Each of these samples were taken across the seam of a coal mine (Lingan Mine, Cape Breton). The unit sample is a six inches section which is chemically analyzed for ash and sulfur content. They are taken from top to bottom of the seam (Harbour Seam) which has an average height of seven feet. The geological horizon or zero level for the Z coordinate is considered to be the bottom of the seam.

In our case we will only analyze the vertical variation of the sulfur, thus, the channel samples will be considered as parallel lines.

1.2 The basic theory

To be able to apply the U.K. system, we must know two parameters which represent the important characteristics of the regionalized variable.

They are: the underlying variogram \( \gamma(h) \) or variogram of the residuals; and the analytical expression of the drift which best characterizes the trend effect inside a neighbourhood. The difficulty in finding these parameters is that one cannot be calculated without the other. The definition of an estimated residual is: \( R(x) = Z(x) - M(x) \): the real value \( z(x) \) of our variable can be considered as a realization of a random function \( Z(x) \): \( M(x) \) is an optimal estimation of the drift at the point \( x \).

The variogram of the (estimated) residuals is expressed as:

\[
2\gamma_R(x,x+h) = E\{R(x) - R(x+h)\}^2
\]

We can easily verify that the experimental variogram of the residuals stated as:

\[
2\gamma^*(h) = \frac{1}{K(h)} \int_S k(x) k(x+h) \{Z(x) - Z(x+h) - M(x) + M(x+h)\}^2 dx
\]

where \( k(x) = 1 \) if \( x \in S \) and \( k(x) = 0 \) if \( x \notin S \); \( K(h) = \int_S k(x) k(x+h) dx \),

is an unbiased estimate of the mean variogram of the residuals.

\[
\gamma_R(h) = \frac{1}{K(h)} \int_S k(x) k(x+h) \gamma_R(x,x+h) dx
\]