The Blended Kriging Version of SAKWeb©

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ABSTRACT

Kriging describes the best linear unbiased estimator in the sense of least variance. Kriging is B.L.U.E. (best linear unbiased estimator) and B.U.E. (best unbiased estimator if data respects the 'bell' curve). When Kriging is compared with deterministic interpolators, there are major differences, e.g., the former provides uncertainty assessment, anisotropy detection or methodology assumptions. This poster tries to address the former combination issue when different Ordinary Kriging (OK) interpolations for the same region are available using a weighted quantification based on the smaller estimation variance.

Keywords: Geographic Information Systems, Ordinary Kriging, SAKWeb©, Spatial Interpolation, Spatial Statistics.

1. Preamble

SAKWeb© is a free Web software that provides access in an Internet environment. It is not a comprehensive statistical package in the traditional way for solving everyone's problems. Written with Active Server Pages® technology, it was developed with the philosophy that Kriging interpolation is needed as a learning tool by individuals with limited geostatistical knowledge.

Kriging seems to achieve better interpolation results than other methods. Mathematically, the difference between Inverse Distance Weighted (IDW), for instance, and Kriging derives from the computational process that minimizes the minimum squared error variance of the estimation. The equation system can be obtained from the following two algebraic expressions [Soares, 2000]: $\sum_j w_j \gamma(x_i,x_j) - \psi = \gamma(x_i,x_0)$, i=1,..,n and $\sum_i w_i = 1$, where w_i is the weights to be assigned to the i^{th} observation, Ψ represents the LaGrange multiplier or slack value required for forcing total weights to 1, $\gamma(x_i,x_j)$ is the variogram value between sample i and j while $j\gamma(x_i,x_0)$ equals the variogram value between sample i and the estimation x_0.

Kriging hold diverse adaptations such as simple (SK), ordinary (OK), external drift (KED), cokriging (CK) and indicator (IK). The presented research, supported by SAKWeb©, focuses on the possibility to merge several OK versions of the same area into a single one.

2. OK Blended Estimator

The combined Kriged estimates option of SAKWeb© is a weighted averaging of three exact OK models: OK with nugget-effect (model 1), without nugget-effect (model 2) and micro-scale structure for very short distances (model 3). See Negreiros *et al.* [2008] for further details. This blended approach is based on the variance of the Kriged estimates, giving more weight to those sites with smaller estimation variance. According to Bryan [1994], equation 1 shows the process of weighting the Kriging values for a certain block B(x1,y1) with three Kriging estimation variance, K_{m_1}, K_{m_2}, K_{m_3}, and three variances, V_{m_1}, V_{m_2}, V_{m_3}. The same methodology is used to calculate the estimated variance (see equation 2).

$$B(x1,y1)=K_{m\_1}\left(\frac{\frac{1}{V_{m\_1}}}{\frac{1}{V_{m\_1}}+\frac{1}{V_{m\_2}}+\frac{1}{V_{m\_3}}}\right)+K_{m\_2}\left(\frac{\frac{1}{V_{m\_2}}}{\frac{1}{V_{m\_1}}+\frac{1}{V_{m\_2}}+\frac{1}{V_{m\_3}}}\right)+K_{m\_3}\left(\frac{\frac{1}{V_{m\_3}}}{\frac{1}{V_{m\_1}}+\frac{1}{V_{m\_2}}+\frac{1}{V_{m\_3}}}\right) \quad \textbf{[1]}$$

$$V(x1,y1)=V_{m\_1}\left(\frac{\frac{1}{V_{m\_1}}}{\frac{1}{V_{m\_1}}+\frac{1}{V_{m\_2}}+\frac{1}{V_{m\_3}}}\right)^2+V_{m\_2}\left(\frac{\frac{1}{V_{m\_2}}}{\frac{1}{V_{m\_1}}+\frac{1}{V_{m\_2}}+\frac{1}{V_{m\_3}}}\right)^2+V_{m\_3}\left(\frac{\frac{1}{V_{m\_3}}}{\frac{1}{V_{m\_1}}+\frac{1}{V_{m\_2}}+\frac{1}{V_{m\_3}}}\right)^2 \quad \textbf{[2]}$$

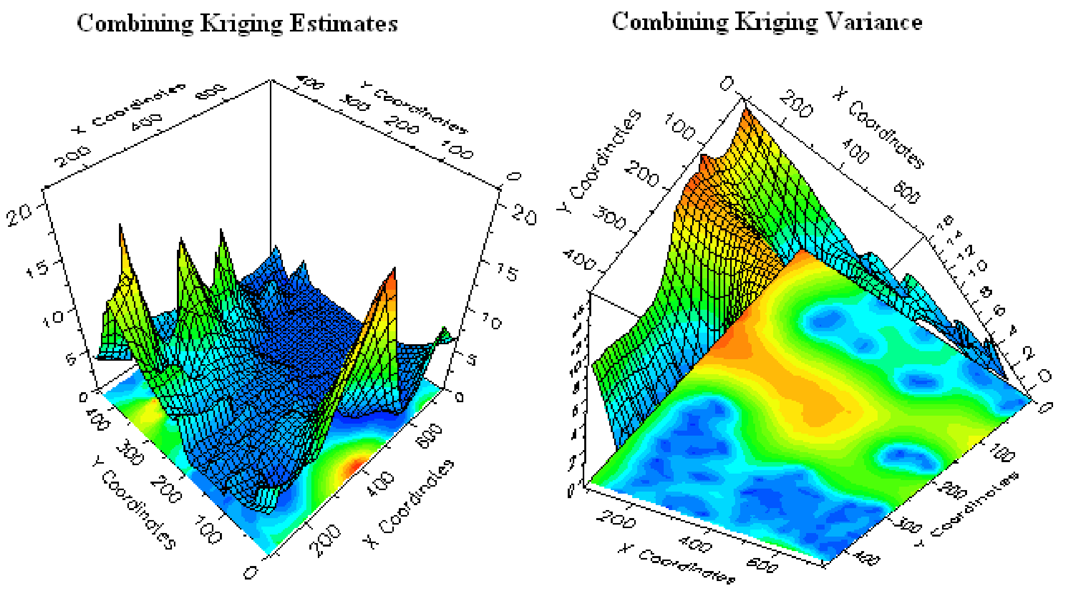

Figure 1: Combination of Kriging estimates from OK with C0 (model 1), OK without C0 (model 2) and with micro-scale structure (model 3) for the grasshopper 1993 infestation dataset of Colorado, USA.

For SAKWeb©, the difference between the blended and the three models is a two step process (see figure 2). Nevertheless, the possibility to cross-validate the combined Kriged estimates is not possible because the Kriging variance equals zero.

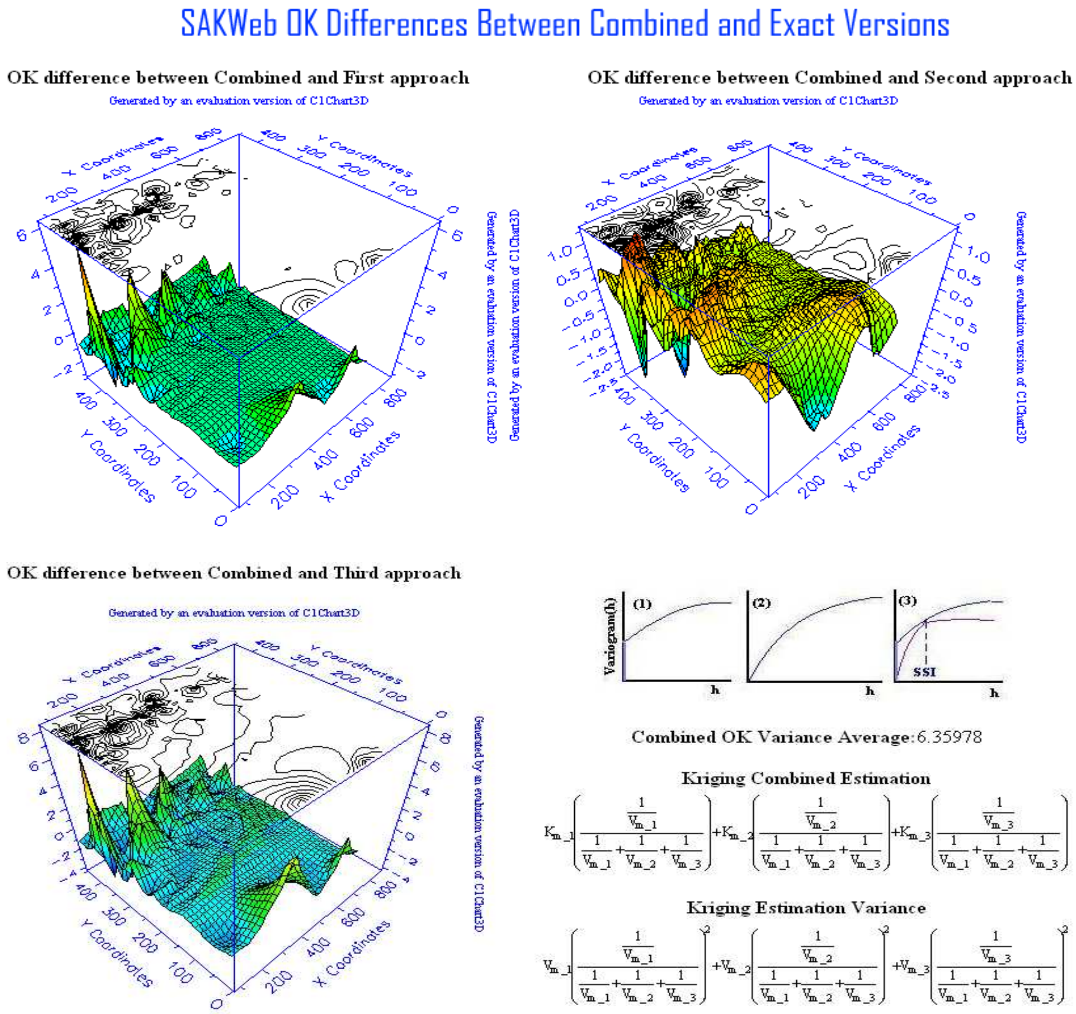

Figure 2: Notice that the OK variance of the combined version rounds 66% less when compared with the other three versions.

3. Final Thought

This poster concentrates on the basic geocomputation to produce a merged adaptation of three OK versions. Quite often, mathematical problems require graceful solutions. This is the case.

References

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