

Spatial Information Modeling for Climate and Energy Systems (기후에너지 공간정보모델링) (38541)

- 2024 Final Examination -

Student ID:

Name:

Notice

- Fill your name below and write the whole sentence in your answer sheet:
*“I, _____, swear I solve all problems by myself in this final examination.
I will take any disadvantages if any dishonesty such as cheating is acted on my solution.”*
5 points will be deducted from your total score if you do not fill in your name above.
- **You MUST solve each problem by hand.**
- Submission Deadline: 11:00~12:15, June 10, 2024.

Problem 1. [20 pts.]

Draw five theoretical variogram models (i.e., nugget, linear, spherical, exponential, and Gaussian models) with their formulae as a function of distance h with a unit range ($a = 1$) and a unit sill ($\sigma^2 = 1$) in a single graph. Compare characteristics of these variogram models near the origin and at the range of $a = 1$.

Problem 2. [20 pts.]

For Universal Kriging (UK), let us denote $z(x) = D(x) + R(x)$, where $D(x)$ is a drift term (i.e., trend) and $R(x)$ is a residual term.

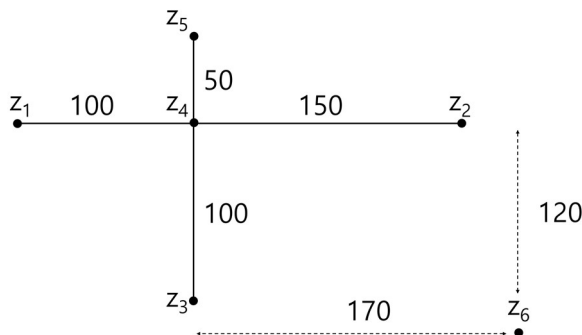
2-1. Derive Kriging equation in a matrix form.

2-2. Derive error variance in a general form.

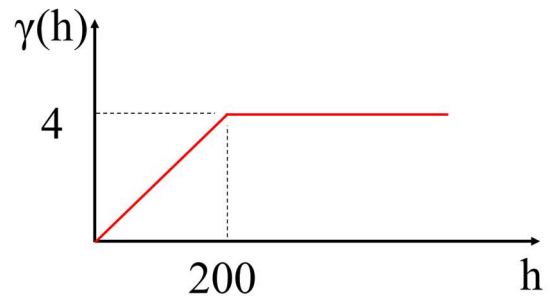
Problem 3. [20 pts.]

Estimate kriged values and its error variance values at z_4 , z_5 , and z_6 using Ordinary Kriging (OK) under the following conditions:

- Variogram model is linear with the range of 200 and sill of 4 (i.e., $\gamma(h) = 4\text{Linear}_{200}(h)$).
- Three sample values are as follows: $z_1 = 5$, $z_2 = 10$, and $z_3 = 15$.
- Round any number to the first decimal place (소수 첫째자리까지) for your own calculation.
- **CAUTION: For each z estimate, you MUST show your Kriging Equation in a matrix form. Every element in the matrix MUST be written to the second decimal place.**



(a) Distribution of sample data $z_1, z_2,$ and z_3

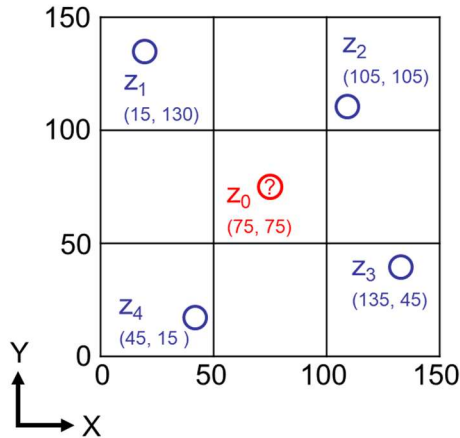


(b) Variogram model (linear)

Problem 4. [40 pts.]

In a two-dimensional domain, X and Y are coordinates and Z is the content of gold in rock sample. The unit of Z is gold karat (g/ton). Four rock samples are collected from $z_1, z_2, z_3,$ and z_4 . You may make rational assumptions, if necessary.

Variogram model
 $\gamma(h) = 1 + 3\text{Sph}_{120}(h)$



| Data No. | X | Y | Z, g/ton |
|----------|-----|-----|----------|
| 1 | 15 | 130 | 8 |
| 2 | 105 | 105 | 9 |
| 3 | 135 | 45 | 10 |
| 4 | 45 | 15 | 12 |
| 0 | 75 | 75 | ? |

- CAUTION: For each z estimate, you MUST show your Kriging Equation in a matrix form. Every element in the matrix MUST be written to the third decimal place.

6-1. Show your work to estimate z_0^* and its error variance σ_{SK}^2 using Simple Kriging (SK), in detail.

6-2. Show your work to estimate z_0^* and its error variance σ_{OK}^2 using Ordinary Kriging (OK), in detail.

6-3. Show your work to estimate z_0^* and its error variance σ_{BK}^2 using Block Kriging (BK), in detail. You may select

6-4. Show your work to estimate z_0^* and its error variance σ_{CK}^2 using Co-Kriging (CK), in detail. Here, the secondary variable $u_3 = 135$, $\gamma_u(h) = 5 + 200\text{Exp}_{100}(h)$, $\gamma_{zu}(h) = 5 + 200\text{Exp}_{100}$.

----- This is the End of the Final Examination -----