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

- 2021 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 write down your answer sheets by your own hand.**
- **You may use a software or a calculator to solve a matrix equation, if needed.**
- You **MUST** write down all matrix equations that are used to provide your own estimates and their error variance on your answer sheets if you solve the problems using a matrix solver.
- Submission Deadline: 10:45~11:00 AM, June 14, 2021.
- No late submission is accepted.
- Submit your solution as *.pdf or *.word file on the cyber campus.
- Please follow the format that gives a name to your solution file:
  (Final)-(Student ID)-(Last name)-(First name)
  For example, the file name must be Final-XXXXXXX-Min-Baehyun.

Problem 1. [20 pts.]

In the Cartesian coordinate system, calculate semi-variogram at $(x, y) = (3, 4)$. Distance h must be calculated from the origin $(x, y) = (0, 0)$.

1-1. Isotropic model [5 pts.].

$$\gamma(h) = 3 + 4\mathrm{Exp}_{10}(h)$$

1-2. Anisotropic geometric model with a major direction N45E [5 pts.].

$$\gamma_x(h) = 3 + 4\mathrm{Exp}_{10}(h)$$

$$\gamma_y(h) = 3 + 4\mathrm{Exp}_{5}(h)$$

1-3. Anisotropic model [5 pts.].

$$\gamma_x(h) = 2 + 3\mathrm{Gauss}_{10}(h) + 4\mathrm{Sph}_{15}(h)$$

$$\gamma_y(h) = 2 + 3\mathrm{Gauss}_{5}(h) + 4\mathrm{Sph}_{10}(h)$$

1-4. Anisotropic zonal model [5 pts.].

$$\gamma_x(h) = 2 + 3\mathrm{Sph}_{10}(h) + 4\mathrm{Exp}_{15}(h)$$

$$\gamma_y(h) = 2 + 4\mathrm{Sph}_{5}(h) + 5\mathrm{Exp}_{10}(h)$$

Problem 2. [30 pts.]

Let us estimate a spatial random variable z at any location using n sample data points. The estimate can be denoted as z^*.

2-1. Show your work to derive the Kriging equation and error variance for ordinary kriging [10 pts.].

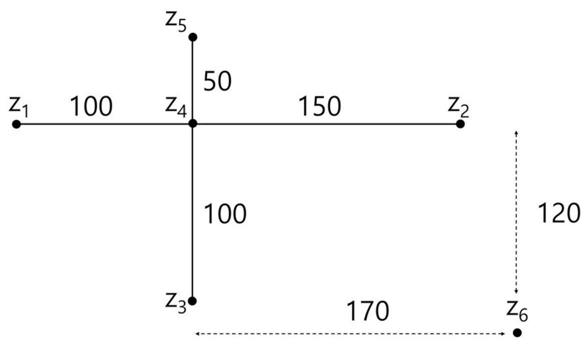
2-2. Show your work to derive the Kriging equation and error variance for block kriging [10 pts.].

2-3. Show your work to derive the Kriging equation and error variance for co-kriging [10 pts.].

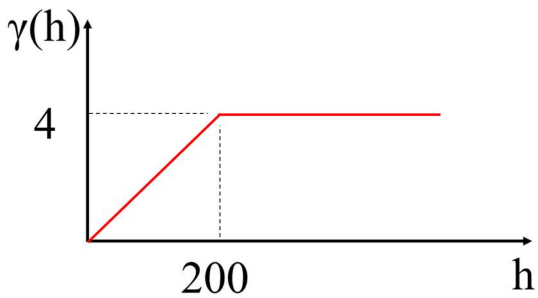
Problem 3. [20 pts.]

Estimate kriged values and its error variance values at z_4, z_5, and z_6 using ordinary kriging 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 for your own calculation.



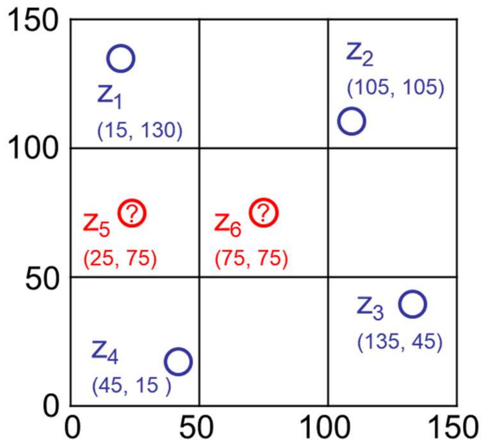
(a) Distribution of sample data z_1, z_2, and z_3



(b) Variogram model (linear)

Problem 4. [30 pts.]

In the 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 samples are collected from Z_1 to Z_4.



Data No.	X	Y	Z, g/ton
1	15	130	8
2	105	105	9
3	135	45	12
4	45	15	10
5	25	75	?
6	75	75	?

4-1. Estimate gold karat and its error variance at the gridblock including Z_5 using block kriging with four quasi-point measurements [10 pts.].

4-2. Estimate gold karat and its error variance at the gridblock including Z_6 using block kriging with four quasi-point measurements [10 pts.].

4-3. Estimate gold karat at the gridblock including Z_6 using block co-kriging with four quasi-point measurements under the following additional conditions: [10 pts.].

$U_3 = 135$, $\gamma_{\mathrm{U}}(h) = 5 + 200EXP_{100}(h)$, $\gamma_{\mathrm{ZU}}(h) = 5 + 200EXP_{100}(h)$,

where U is the secondary variable of the primary variable Z.

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