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

- 2022 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 midterm 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 AM ~ 12:15 PM, June 9, 2022.
- Submission Deadline: 12:15 PM ~ 12:30 PM, June 9, 2022.
- No late submission is accepted.
- Round off all your answer to the nearest hundredth.
  (당신의 모든 답을 소수점 둘째자리에서 반올림하시오).
- 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. [10 pts.]

Explain the following schemes, in brief:

1-1. Weak second order stationarity

1-2. Intrinsic hypothesis

Problem 2. [20 pts.]

Draw five theoretical variogram models (i.e., nugget, linear, spherical, exponential, and Gaussian models) as a function of distance h with a range a and sill σ^2 in a single graph. Compare characteristics of these variogram models, in detail.

Problem 3. [5 pts.]

In the Cartesian coordinate system, calculate the semi-variogram at $(x, y) = (3, 4)$ when the isotropic semi-variogram model is given as $\gamma(h) = 3 + 4\text{Exp}_{10}(h)$. Distance h must be calculated from the origin $(x, y) = (0, 0)$.

Problem 4. [20 pts.]

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

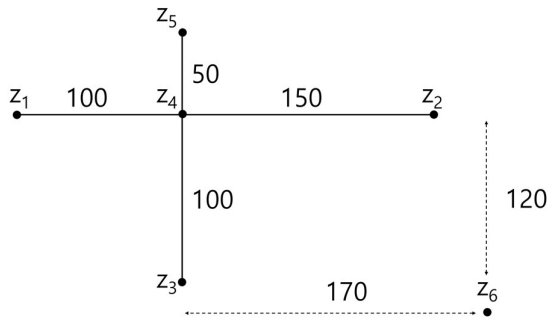
4-1. Show your work to derive the Kriging equation and error variance for simple kriging [10 pts.].

4-2. Show your work to derive the Kriging equation and error variance for ordinary kriging [10 pts.].

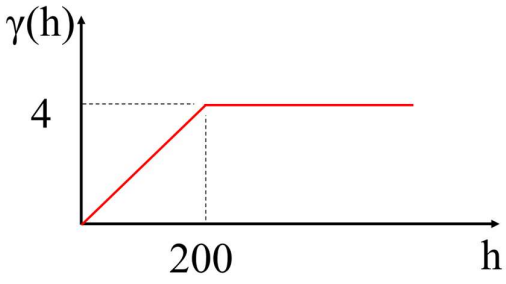
Problem 5. [20 pts.]

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 $z_3 = 15$.



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

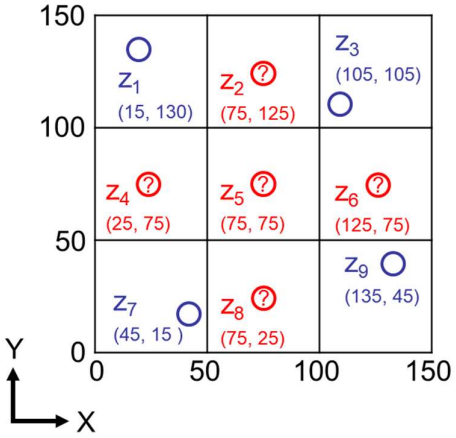


(b) Variogram model (linear)

Problem 6. [25 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 rock samples are collected from Z_1, Z_3, Z_7, and Z_9. Make a rational assumption, if needed.

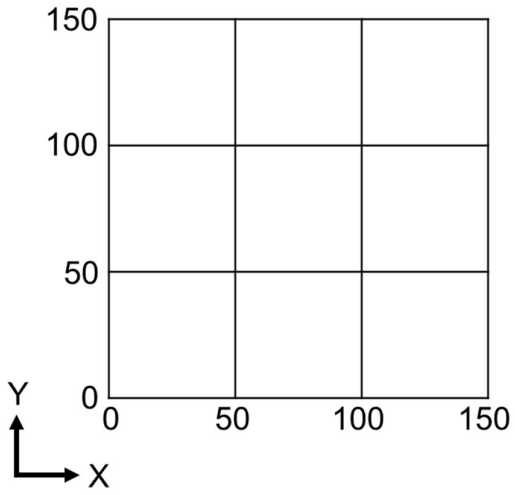
Variogram model
: $\gamma(h) = 1 + 3\text{Linear}_{120}(h)$



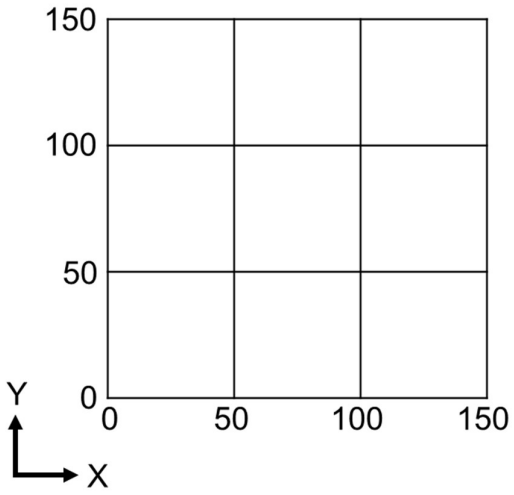
Data No.	X	Y	Z, g/ton
1	15	130	8
2	75	125	?
3	105	105	9
4	25	75	?
5	75	75	?
6	125	75	?
7	135	45	12
8	75	25	?
9	45	15	10

6-1. Show your work to draw a map of Z estimates using ordinary kriging, in detail. In other words, show your work how to estimate Z values from Z_1 to Z_9, in detail.

6-2. Show your work to draw a map of error variance σ^2_{OK} using ordinary kriging, in detail. In other words, show your work how to estimate error variance associated with Z values from Z_1 to Z_9.



6-1. Gold content map from ordinary kriging



6-2. Error variance map from ordinary kriging

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