Application structure for the exam

Research Methods and Statistics

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Designing Investigation Networks for Geological Process Analysis

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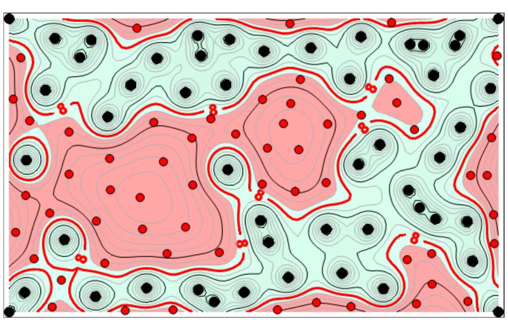
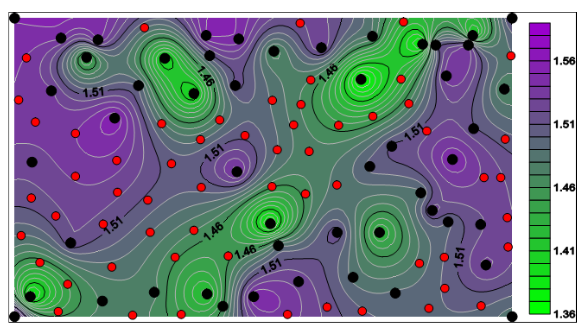




INTRODUCTION

The research methodology specific to each field of Earth Sciences provides an immense volume of data which, when skillfully and insightfully handled through STATISTICS, is transformed into representative ***conceptual models*** of the studied geological processes. The conceptual model serves as the foundation for modeling geological processes and is built upon the characteristic values of their determining ***factors***, measured within the spatial and temporal framework in which they are studied. Within the course dedicated to first-year doctoral students of the ***Doctoral School of Geology***, the research methodology is limited to methodologies for ***configuring investigation networks***, at micro and macro scales, for the volumes in which the studied geological processes take place. ***The responsibility*** for selecting the determining factors of the studied processes lies primarily with the researchers dedicated to the chosen processes, while the methodology presented to the doctoral students is applied to a ***database*** provided by the doctoral students themselves.

The introduction of the application for Research Methods and Statistics should include:

- Title of the Doctoral Thesis
- The geological process/processes that constitute the subject of the research
- The main (current) objective of the research
- The key factors that condition the development of the process, grouped according to the three components of the conceptual model of the process:
    - The spatial and temporal framework in which the geological process occurs
    - The parametric characteristics of the space in which the geological process takes place
    - The energy that drives the development of the geological process
- The data required to achieve the research objective, grouped into two categories:
    - Alphanumeric (qualitative)
    - Numeric (quantitative)

Note

The factors that condition the space in which the studied geological process takes place, as well as the time interval during which it is studied, should be listed, along with the parametric characteristics that determine the evolution of the geological process and the type of energy required for its development.

The introduction should include only an enumeration of the main categories of data that you currently have or expect to obtain. Consequently:

- For those who already have personal data, only the available data that can be processed using the methodology dedicated to the configuration of investigation networks should be selected and presented;
- For those who do not yet have data, a file with standard data will be provided for the analysis of the results of a preliminary investigation concerning the numerical variable V.

1. Methodology for Designing Investigation Networks

The research is based on an ***investigation network*** whose configuration aims to capture, with ***minimal errors***, the spatial and temporal variability of the regionalized variables of geological processes, using:

- a minimum number of observation points
- a minimum frequency of measurements over time at the investigation points

The configuration of the network depends on the number of regionalized variables and the acceptable error for evaluating the spatial distribution of all investigated regionalized variables. A concise presentation should be given of the sequence and operational options for designing investigation networks, with reference to the technologies used for data transmission and storage:

- The stages of monitoring network design;
- The entropy method and the fictitious point method.

2. The data required for optimizing the investigation network

The minimum data required for configuring an investigation network based on a preliminary investigation are:

- ***The coordinates*** of the initial observation points (N) of the investigation network (i = 1, 2, ..., N):
  - (X_i, Y_i)
- ***The values*** of the monitored variable/variables at the initial moment at all observation points:
  - $V(T_0)$
- ***Time series of values*** at each observation point (k: The number of moments at which the variable was measured):
  - $V(X_1, Y_1, T_1), V(X_1, Y_1, T_2), \dots, V(X_1, Y_1, T_k)$
  - $\dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots ....$
  - $V(X_N, Y_N, T_1), V(X_N, Y_N, T_2), \dots, V(X_N, Y_N, T_k)$
- **The maximum accepted standard deviation** (KSD) (KSD: Kriging Standard Deviation) imposed by the maximum ***allowable error (ε(α))*** for evaluating the spatial and temporal distribution in the investigated area, corresponding to an assumed risk (α).

3. The entropy method

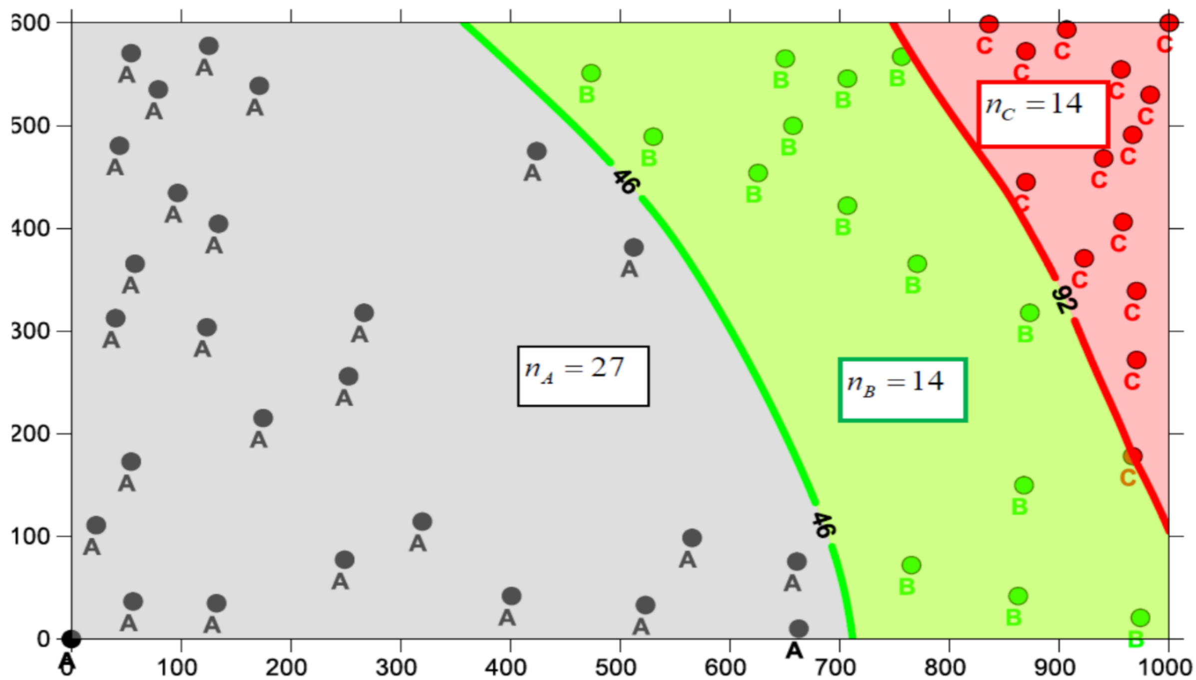
The application of the entropy method is carried out in two variants:

- 2D entropy for evaluating the variability of the studied variable at a given moment
- 1D entropy for evaluating the sampling interval of the time series

3.1. The 2D entropy of the investigation network

The evaluation of the 2D entropy of the investigation network must include:

- Presentation of the principle of the 2D entropy evaluation method
- Calculation of ***the average 2D entropy value*** for the monitored area, performed to separate the amplitude of variation of the studied variable into a ***minimum of three value groups***
- Graphical representation of the spatial distribution of the variable values at the initial moment ($V(T_0)$: contour map)

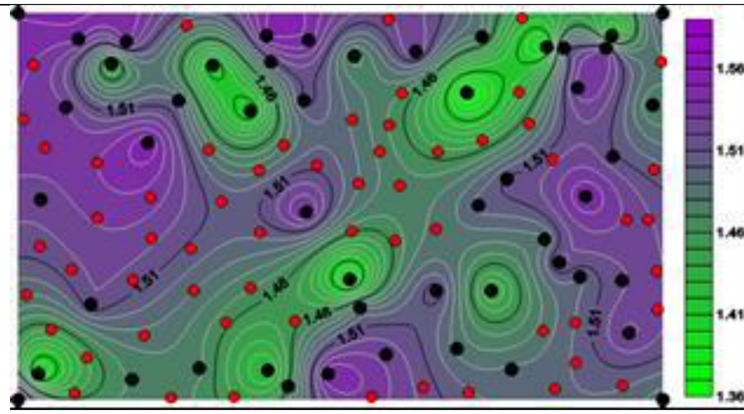


Example: Position of the observation values of the groups A, B, and C.

3.2. The 1D entropy of the investigation network

The 1D entropy will be calculated for each observation point of the investigation network, based on time series of 50 values from each observation point, and will include:

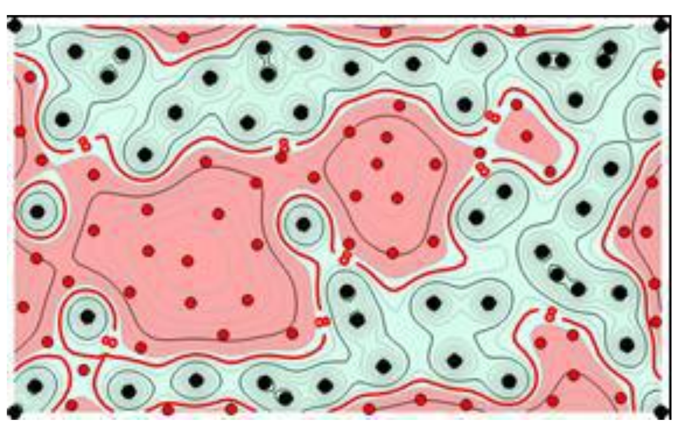
- Presentation of the ***principle of the 1D entropy*** evaluation method
- Calculation of ***the average 1D entropy value*** for the time series from the investigation points
- ***Zoning of the investigated area*** based on the 1D entropies from each observation point, to highlight the areas where it is necessary to reduce the time interval (Δt) between two successive measurements, in order to reduce the entropy of the time series.



4. The fictitious point method

The fictitious point method must determine the additional observation points that ensure the reduction of KSD over the entire monitored area, below the maximum allowable value (in the standard data files, the maximum KSD is specified in the header of the measured variable values at the initial moment: V(To): KSD <= ...). This chapter must include:

- Presentation of the fictitious point methodology
- The stages of applying the fictitious point method
- Illustration of the results with:
    - A map showing the position of the initial investigation points
    - A map of the initial KSD distribution highlighting the areas where the maximum allowable value is exceeded
    - A map showing the position of the fictitious points that reduce the KSD below the maximum allowable value



Note

Doctoral students who will process ***standard data*** should assume that the spatial distribution of the variable ***V*** is ***ISOTROPIC*** and will ***not conduct an analysis of the anisotropy of the surface variogram***. The implicit variogram model selected by the Surfer program will be used for an ISOTROPIC structure, typically a linear model.

Doctoral students processing their own data should aim to process the data as rigorously as possible (anisotropy study is mandatory) in order to obtain results that can be included in the thesis. If the effort is too great, the anisotropy analysis is not mandatory for the exam!

Conclusions

A synthesis of the interpretation of the three parameters that quantify the efficiency of the monitoring network for estimating the spatial distribution and temporal variability of the monitored variable V:

- 1D Entropy
- 2D Entropy
- KSD

Guidelines for writing the report

The report will necessarily contain the processed data in tabular form.
The text of application for exam, in PDF format, will be uploaded to the assignment created in the group on Teams: ***2025_SDG_MET_CERCETARII***.

Additional bibliography.

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