



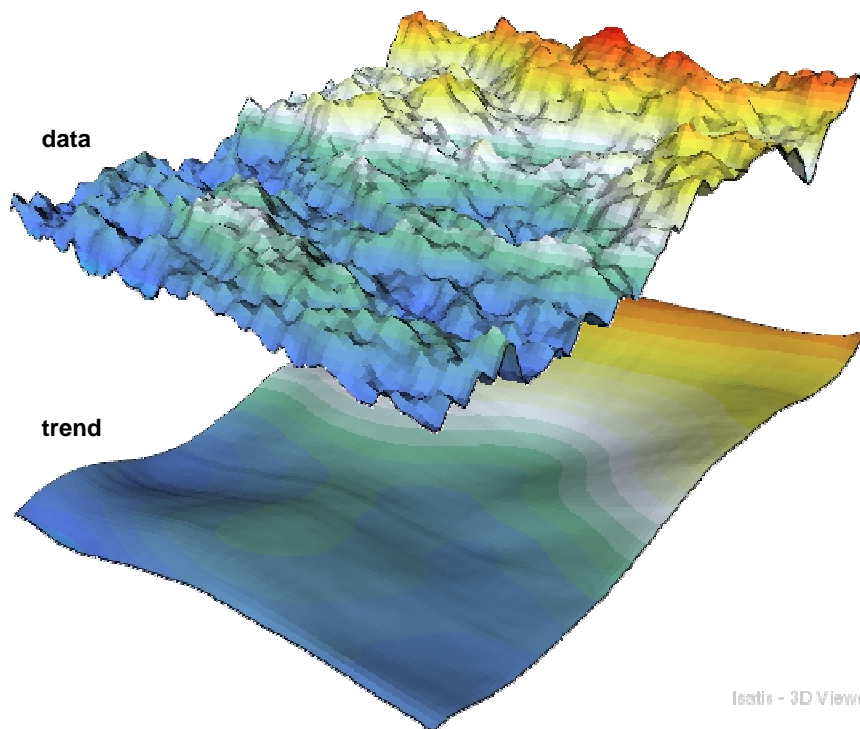
Geovariances
Where no one has gone before

isatis
SOFTWARE

HOW TO...

COMPUTE QUICKLY A RELIABLE TREND

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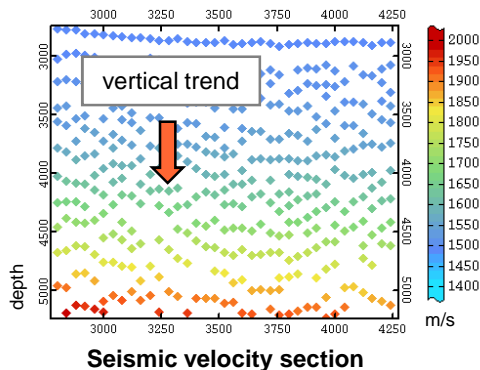


Keywords

Non-stationary geostatistics, trend, residuals, least square polynomial fit, data decimation.

Introduction

Spatial data sets show sometimes non-stationary properties, which can be explained by natural phenomena. For example, underground rock velocity increases with depth in consequence of sediments compaction.



Extracting a trend (low frequency component, very large scale variations) from a data set can be useful for many reasons: the trend can be used as input into a modeling process, it can be used to compute then work on stationary residuals, etc.

Here is described an **ISATIS solution for computing quickly a reliable trend** from any data set, 2D or 3D, dense or not, regularly or irregularly sampled (scatter).

The solution is based on a least squares polynomial fit process implemented in the *Quick Interpolation* panel of ISATIS.

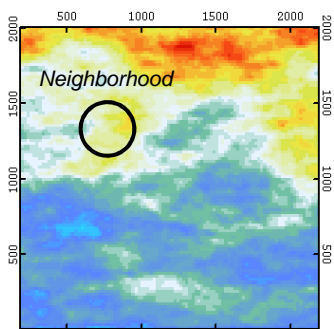
Description

Flowchart

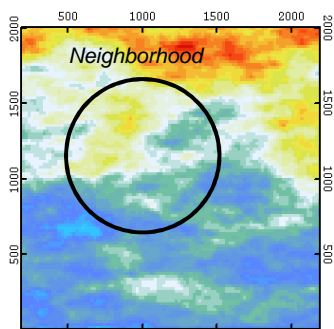
1. Neighborhood determination
2. Decimation (for dense data sets)
3. Trend computation
4. Validation

1. Neighborhood determination

The trend estimation solution presented here is based on polynomial fit by least squares method within a moving neighborhood. The dimensions of the neighborhood are set, more or less intuitively, by taking into account of the structural characteristics of the data. Estimating a trend is firstly a question of scale.



Neighborhood too small



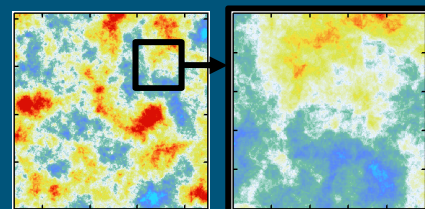
Neighborhood OK

In other words, dimensions of the neighborhood are set according to short scale variations we want to avoid.

Non-stationarity

Non-stationarity features observed on data sets can be of various types: mean, variance, structuration, etc.

Non-stationarity is firstly a question of observation scale:



Stationary

Not stationary

IRF-k

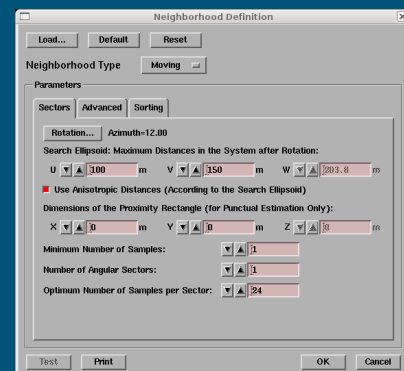
In 1973, Matheron has developed the theory of IRF-k (Intrinsic Random Function of order k) which allows to solve some non-stationary issues. IRF-k models are implemented in ISATIS.

G. Matheron - 1973 - The intrinsic random functions and their applications. Advances in Applied Probability, 5, 439-468.

ISATIS +

ISATIS implements a lot of options for defining **moving neighborhoods** involved in interpolation, estimation and simulation processes.

Dimensions, rotations, number of angular sectors, optimum number of points can be easily defined as well as some more advanced parameters.



Neighborhood definition window

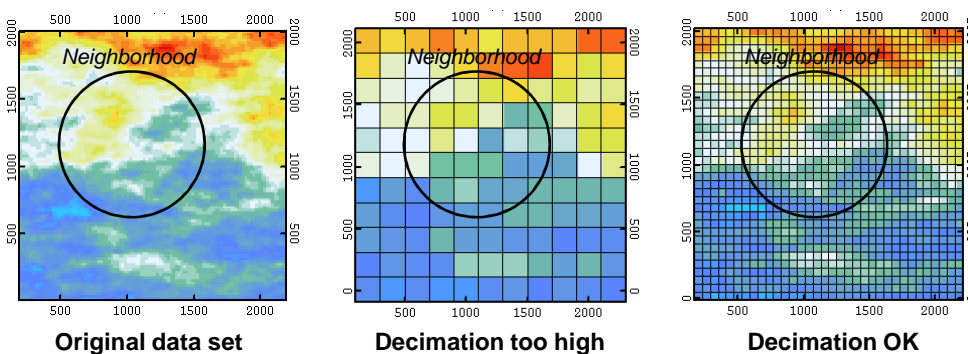
2. Decimation (for dense data sets)

2.1. Decimation rules

Once the dimensions of the neighborhood have been determined, it occurs sometimes that these dimensions would involve too many data samples in the least squares polynomial fit process, thus leading to very high computation time. It is in particular the case when processing dense data sets.

Then, decimating data set is necessary before running trend estimation process.

Decimation must be reasonable in the way that it must preserve a sufficient number of data samples within the neighborhood: at least around 15 in all directions. Otherwise strong numerical instabilities may be generated.



2.2. Decimation tools

In case of regularly sampled data (grid), decimation process is carried out by creating a coarse grid then migrating original data on it.

Grid data decimation

- Open File / Create Grid File
- Set the parameters of the decimation grid and save the grid
- Open Tools / Migrate / Point to Grid
- Input File: original grid file
- Output File: decimation grid
- Run

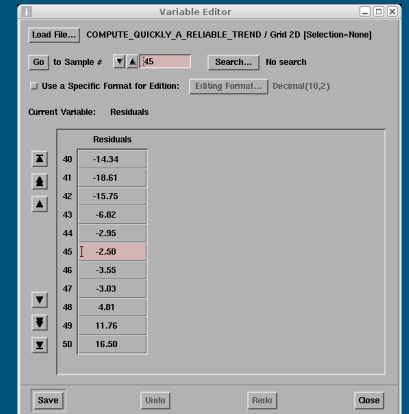
When facing with scatter data (irregular sampling), one decimation solution consists in using the *Look for Duplicate* option, which enables to select some samples separated by a given minimum distance.

Scatter data decimation

- Open Tools / Look for Duplicates
- Data File:
 - Variable Name: data
 - New Selection Name: selection decimation
- Inform Minimum Distance
- Masking Option: Mask all Duplicates but First
- Run

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ISATIS offers various and powerful tools for handling spatial data such as decimation tools but also edition, transformation, migration, selection tools, etc.



Variable Editor

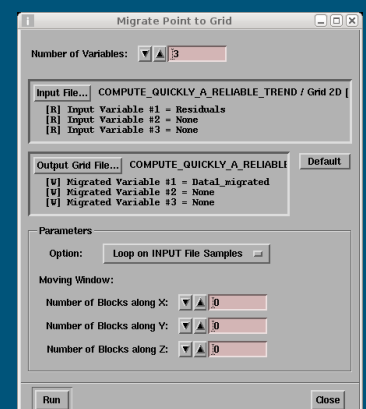
Large data sets

Large spatial data sets are more and more encountered and processed by geostatistical techniques. In the petroleum industry for example, several Go of data are sometimes processed in 3D. For the purpose of handling large data sets, **multi-threading** is developed in ISATIS.

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In ISATIS are available several useful tools for **migrating data** from one file to another one.

These tools give the user the flexibility necessary for carrying out any migration tasks. In particular, several variables can be migrated in the same time.



Migrate Point to Grid

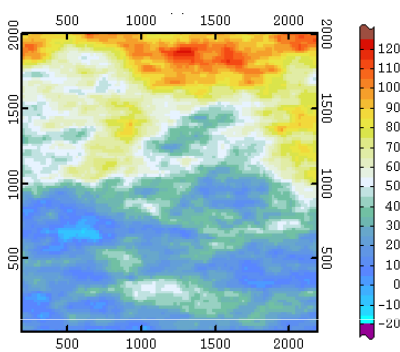
3. Trend computation

Estimation of a trend can be realized by least squares polynomial fit, which is a rather reliable and fast method.

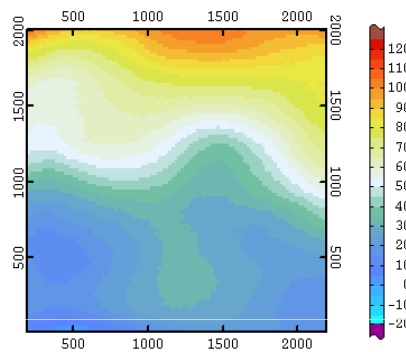
Least Squares Polynomial Fit

- Open Interpolate / Interpolation / Quick Interpolation
- Input File: data (eventually decimated)
- Output File: trend (original data support)
- Interpolation Method: Least Squares Polynomial Fit
 - Least Squares Degree: 2
 - Applied to X, Y (& Z)
- Neighborhood: set dimensions according to the neighborhood analysis conclusions (step 1)
- Optimum Number of Samples per Sector: 1 000 000*
- Run

* A high value ensures that the neighborhood is well filled.



Data



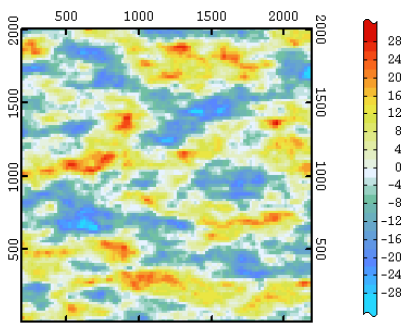
Trend

Please note that the Output File support may be decimated too, if necessary.

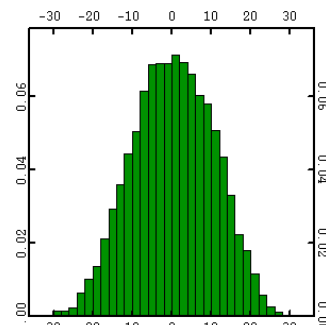
4. Validation

Visual comparative inspection of the data and of the trend is the first and the more intuitive step for validating the trend estimation process.

As a complement, residuals, which correspond to the difference between data and trend, can be analyzed. Residuals should be stationary and zero-centered. This can be checked within the *EDA* (*Exploratory Data Analysis*) application window.



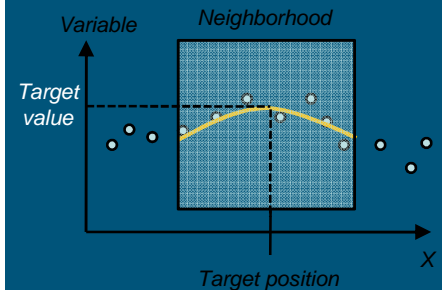
Residuals



Histogram of the residuals

What is Least Squares Polynomial Fit ?

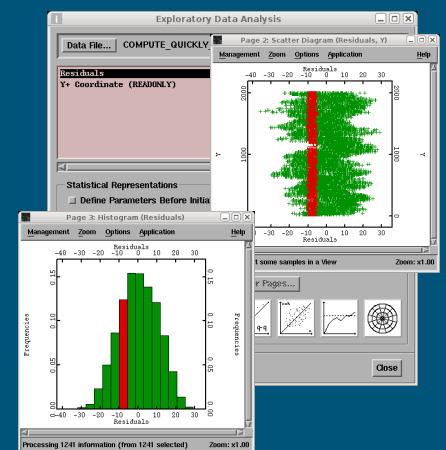
Least Squares Polynomial Fit consists in fitting, by least squares method, a polynomial to data contained within a given neighborhood centered on a target point.



Repeating the fit operation on all target positions (output file) leads to a polynomial trend estimation.

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The **Exploratory Data Analysis (EDA)** is a one of the main applications of ISATIS. It allows to compute statistics and get standard statistical representations of variables. A very useful option of EDA is that all graphic pages are linked together.



EDA

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