





Adapting the orientation of the kriging neighbourhood to follow a surface like the topography or any geological horizon does not necessarily require an unfolding procedure, when the surface is varying gently. The use of local parameters at the kriging stage achieves that task by using a neighbourhood with rotations defining the orientation of the local dip of the surface.



1. Isatis workflow

The main steps to perform are:

- 1. Calculation of the gradient components of the 2D surface;
- 2. Transfer of the gradient information to all blocks of the domain to be estimated;
- 3. Calculation of the rotation angles corresponding to the surface dip;
- 4. Kriging with local neighborhood.

2. Gradient calculation

→ Isatis → Interpolate → Interpolation → Grid Operator

Two variables containing the gradients along Ox and Oy are stored in the 2D grid file containing the surface.

| 🚹 Grid Operator | |
|--|------------------------------------|
| Grid File SURFACES / 2D GRIDS [U] 1 Dit Variable: vb = None [U] 1 bit Variable: v7 = None [U] 1 bit Variable: v9 = None [U] 1 bit Variable: v9 = None [U] 1 bit Variable: v1 = None [U] Real Variable: v1 = SURF 3: S2 [U] Real Variable: v2 = gradx(SURF3) [U] Real Variable: v4 = grady(SURF3) [U] Real Variable: v4 = None | Z Z |
| Thresholds Add One Delete | Structural Elements Add One Delete |
|]w2=gradx(w1) w3=grady(w1) | Load Save Templates |
| Run | Close |

The gradient vector may be visualized on top of the surface by means of Gradients representation in Isatis Display menu.







3. Transfer of the gradient information to all blocks of the layer

We will assign to each block along the vertical the same gradients as the surface gradient.

Beforehand it is necessary to create a selection to mask blocks outside of the domain limited by a top and a bottom surface.

→ Isatis → File → Selection → From Surfaces

| Selection from Surfaces | |
|---|--|
| 3D Grid 3D GRIDS / STRUCT [W] New Selection Variable [W] New Proportion Variabl | FURE GRID [Selection = None] e = sel unit S2 Le = None |
| 2D Grid SURFACES / 2D GRI [R] Top Surface Variable = [R] Bottom Surface Variab] | IDS = SURF 3: S2 Le = SURF 4: S3 |
| Use 2D Polygon File | |
| Polyyon | lone |
| X Discretization Factor: 💌 🔺 | Automatic |
| Y Discretization Factor: 👿 🛓 | |
| Threshold on Proportion: | 0.5 |
| Run | Close |

Then the gradient is migrated from the 2D surface to the 3D grid.

→ Isatis → Tools → Migrate → Grid->Point

| Migrate Grid to Point | |
|--|---------|
| Number of Variables: | |
| Input Grid File SURFACES / 2D GRIDS [Selection = Non [R] Input Variable #1 = gradx(SURF3) [R] Input Variable #2 = grady(SURF3) | e] |
| Output File 3D GRIDS / STRUCTURE GRID [Selection [W] Migrated Variable #1 = gradx(SURF3) [W] Migrated Variable #2 = grady(SURF3) | Default |
| Loop on OUTPUT File Samples | |
| Run | Close |



4. Calculation of the rotation angles corresponding to the surface dip

A function available in Isatis Calculator ('gradxy2rotxyz') is used and stores the 3angles rotations around x,y,z using the mathematician convention.

→ Isatis → File → Calculator

| Calculator | | | | |
|--|----------------|-------------------------|---------------|-------------------|
| # of Float Variables: # of Selection Variables: # of Macro Variables: | VAD VAD | 12 2 2 | | |
| $\label{eq:response} \begin{array}{ c c c c } \hline Data File & 3D GRIDS / STRU \\ \hline U & vl = grady(SIRF3) \\ \hline U & vl = grady(SIRF3) \\ \hline U & vl = grady(SIRF3) \\ \hline U & vl = roty(SIRF3) $ | CTURE G | SRID [Selection - None] | | Ĩ |
| Transformations: Example: v1 = simulate_gaussiar | n(1, 1000 |) + v2 | Length | Variable Unit: m |
| Variables 💷 🛛 Logical | | Operators 💷 | Intervals 💷 | 5 |
| Constants 💷 🛛 Options | = | Mathematic 💷 | Trigonometric | - |
| Date | - | Statistics | = | Load |
| (v3,v4,v5)=gradxy2rotxyz(v) | L, v 2) | | | Save Templates |
| Run | | | | Close |

5. Kriging with local neighborhood.

The local parameters are recovered from the same grid as the interpolation grid. They could also be used as local parameters for the variogram anisotropy.

→ Isatis → Interpolate → Interpolation → (Co)-Kriging

| alculation: Punctual umber of Variables: TAE Full Set of Output Va laximum Number of External Drifts: TAE 1 | ariables |
|---|------------|
| Imput File WELLS / 3D Wells [Selection = None] [R] Variable #1 = PHT [R] Variable #2 = None | <u>ata</u> |
| Output File 3D GRIDS / STRUCTURE GRID [Selection = sel unit S [V] Estimation for PHI = Kriging Poro [V] St dev for PHI = None | 2] |
| riging Parameters Model Phi | Edit |
| No special Model Options No special model option | Talit |
| ocal Parameters Neighborhood Rotation Special Kriging Options No special kriging option | |

| Image: Section Protocol (manification of Convention) Image: Section of Z [R] Var = rotz(SURF3) Rotation / Y [R] Var = rotz(SURF3) Rotation / Y [R] Var = rotz(SURF3) J Use Local Radius |
|---|
| Rotation / Z [R] Var = rotz(SURF3) Rotation / Y [R] Var = roty(SURF3) Rotation / X [R] Var = rotx(SURF3) J Use Local Radius |
| Rotation / Y [R] Var = rotx(SURF3) Rotation / X [R] Var = rotx(SURF3) J Use Local Radius |
| Rotation / X [R] Var = rotx(SURF3) J Use Local Radius |
| 1 Use Local Radius If Projuntional Radius / X Radius / X [R] Var = Rome Radius / Z [R] Var = Rome |
| |
| |
| |



The neighborhood may be visualized by launching the Isatis 3D Viewer and asking in the Application menu of the Kriging test window "Link to 3D Viewer).



For more information, let us help you assessing the quality of your data and implementing this workflow.

Contact our consultants at consult-oil@geovariances.com, consult-mine@geovariances.com or consultenv@geovariances.com.