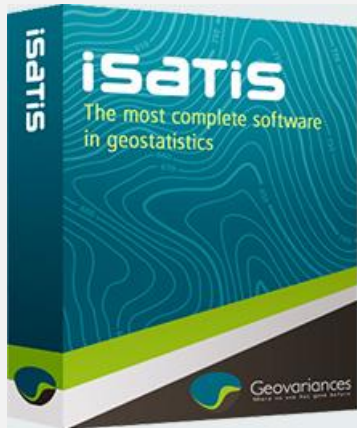


ISATIS 2016 FEATURES



Isatis is the **Reference geostatistics-dedicated software solution**. It offers, in a single integrated package, an exclusive range of proven geostatistical techniques for in-depth data analysis, estimation and simulations. Using **Isatis**, you can be sure of the reliability of your results: robust techniques, well researched algorithms, exclusive agreement with Fontainebleau Geostatistics Group (from Mines ParisTech), professional expertise confirmed by nearly 30 years of experience in geostatistics.

Isatis numerous interfaces with professional standard software packages allow to load a wide variety of data and output the results in a format best suited to your needs.

Isatis batch functionalities enable automatic procedures for updating and easy reproduction of workflows.

1. DATA HANDLING

1.1. Data Integration

- **Import:** ASCII, Binary, Arcview Shapefile and grids, Boreholes with Deviation Survey Data, Datamine STUDIO (parent blocks, sub-blocks), DXF (Autocad), Excel, Gslib, Handvel, Image files (PNG, GIF and BMP), Irap Classic, LAS, NetCDF files, ODBC, RML – Heresim 3D, SEG-Y, Vulcan, Z-Map Plus.
- **Export:** ASCII, Binary, Arcview, CMG, Datamine STUDIO (parent blocks, sub-blocks), Eclipse, Gslib, Handvel, Irap Classic, NetCDF files, RML – Heresim 3D, SEG-Y, TIFF, Vulcan, VIP, Whittle Four-D, Z-Map Plus.
- **Direct link** to ISATIS in Gocad® (Paragdim), Petrel® (Schlumberger), the RML® (Beicip-Franlab), Gems® (Gemcom).
- **Direct link** to acquire® and RMS® (Roxar) in Isatis.

1.2. Data Management

- File Manager. Variable Editor.
- Selection utilities to build **masks on samples** (interactive selection of samples from a graphical basemap, intervals on numerical variables, patterns on alphanumeric variables, convex hull, polygons, wireframes, surfaces and macro-selections to handle domainning).

- Various tools for data manipulation between files.
- Management of **boreholes/wells data** (extraction, merging, point data conversion)
- Management of **polygons** (2D/3D) and **wireframes**.
- **Split** and **Merge** of big files to save computation time.

1.3. Data Manipulation

- Advanced **scientific calculator** to modify or create new variables: mathematical, boolean and interval operators; mathematical, trigonometric, date and statistical functions.
- **Grid operator** (for morphological operations on grids).
- **Alphanumeric encoding/decoding**.
- **Variable transformation** (normalization, truncation, normal score, Gaussian, PCA/MAF)
- **Cross-files statistics**.
- **Compositing** of drillholes (by benches, by length, by domains).
- **Declustering** (weighted variable).
- **Service variables** (Probable Ore and Probable Metal estimation).
- **Discretization** and **flattening** to work in homogeneous geological units.

- **Unfolding** and **folding** of geological units (3D lines and grids).
- **Velocity Calculator** (Dix velocity).

1.4. Exploratory Data Analysis

- Classical statistics (univariate, multivariate). Boxplots, swathplots.
- Computation and display of different statistics (possibly weighted): **basemaps, histograms, cross-plots, grade-tonnage curves**, standard **QQ-plots** and **PP-plots, normal probability plots, experimental variograms** and related functions (covariances, 1st order variograms, variogram cloud) in any direction of the space (3D, 2D or 1D), statistics on the distances between samples, **variogram maps** (2D and 3D), **H-scatter plots**.
- Average experimental variogram. Refined experimental variogram lags at small distances. Dynamic lag definition.
- Unique ability of picking data in the **linked graphic windows** for identifying spatial variability and masking possible outliers or anomalous data.

1.5. Statistics

- **Principal Component Analysis**.
- **Minimum/ Maximum Autocorrelation Factors**.
- **Multilinear regression**.
- **Cloud transform** simulation.
- **Proportion curves**.
- **Gibbs Sampler** to compute new Gaussian variables from variables affected by a strong **Zero Effect**.
- Estimation of **Mining Production Variability** on different support size.

1.6. Domaining

- **Border effect** to characterize the relationships between domains and grades.
- **Contact analysis** to illustrate the grade behavior at the contact between two domains.

2. VARIOGRAM MODELING

- **Stationary variables:**
 - **2D-3D variogram modeling** with geometrical and/or zonal anisotropies.

- Multi-directional display of experimental variograms.
- Exhaustive set of variogram models.
- **Interactive graphical fitting** of variograms.
- **Automatic sill fitting** of simple and cross variograms.
- **Automatic variogram fitting** of multivariate, multi-directional and multi-structure variograms starting from a given combination of basic structures in each direction and for each variable with possible automatic **sill normalization**.
- **Truncated Gaussian variogram modeling:** fit the underlying Gaussian random functions of zero-effect variables or indicators.
- Fitting of a punctual model using an experimental regularized variogram.
- Variograms on large grids. Algorithm based upon FFT.

- **Non-stationary variables:**

- **Automatic drift identification** (IRF-k, external drift functions, automatic covariance recognition).
- **Global trend modeling**.
- **Variogram Fitting for Universal Kriging:** identify the global trend and fit the residual variogram in one run.

- **Variogram regularization**.

- **Histogram modeling** (multivariate): anamorphosis function, weighted histograms, global support correction including information effect with grade-tonnage curve calculations, modeling of indicators and zero-effect variables. Gaussian support correction.
- **Cross-validation** (can be applied with local parameters).
- **Local Geostatistics:** estimation of local variogram and local neighborhood parameters to be used as input in kriging, cross-validation and SGS.
- Possible use of **2D or 3D faults** in variogram calculations.

3. ESTIMATION

3.1. Interpolation

- Polygons of influence, moving average, moving median and moving dip average, inverse distance,



least squares polynomial fit, discrete splines, linear model kriging, spline model kriging.

- Definition of the **data search neighborhood** for estimation (unique, ellipsoidal, sequential). Powerful search neighborhood optimization. **Neighbor statistics**.
- Interpolation of directions and anisotropy systems.
- Filling of blank areas in grids (reproducing property variability in case of seismic grids).

3.2. Kriging & Cokriging

- Definition of the data search neighborhood for estimation and simulation techniques (unique, ellipsoidal, sequential). **Powerful search neighborhood optimization**.
- Simple kriging, ordinary kriging, IRF-k kriging.
- Point or block estimate, 2D and 3D polygon estimate (global estimation), estimation of the drift, first and second order derivatives. **Ordinary kriging rescaling** to reduce the risk of getting negative estimates.
- Possible use of **2D or 3D faults** in estimation procedures.
- **Advanced techniques** such as kriging with variance of measurement error, factorial kriging analysis, deconvolution, residual kriging, kriging with Bayesian drift, kriging with external drift, collocated cokriging (with one or several collocated variables), kriging with inequalities, kriging with local parameters.
- Possible integration of different support size data in the estimation through **Mixed Support Kriging Pre-processing**.
- **Automatic factorial** kriging (MAAFK) for extracting common/different components from two grid datasets.
- **Non-linear techniques**:
 - Disjunctive Kriging, **Uniform Conditioning** (multivariate), Indicator kriging,
 - Lognormal kriging, macro kriging for clustered data.
 - **Localized Uniform Conditioning**: post-processing to UC which assigns within each Panel a grade value to each SMU.
- **Confidence intervals** estimation.
- **Kriging Efficiency** calculation.

4. SIMULATIONS

4.1. Non-conditional simulations

- Exhaustive set of non-conditional simulations: **Turning Bands**, **Sequential Gaussian**, **Truncated Gaussian**, **Sequential Indicator**, **Boolean**, **LU Decomposition**, **Substitution**, **Dilution**, **Dead Leaves**, **Fractals**, **Poisson**, **Voronoi**, **Object based simulations**.

4.2. Conditional simulations

- **Turning Bands** method: univariate and multivariate simulations, allowing stationary, intrinsic and non-stationary models, with kriging or cokriging (including collocated) conditioning, in unique or ellipsoidal neighborhood. Point or block simulations.
- **Direct Block Simulations** which bypasses the point scale models to directly build block scale models.
- **Sequential Gaussian Simulations** (standard ellipsoidal neighborhood, sequential neighborhood, with kriging or cokriging (including collocated) conditioning and local parameters).
- Simulation with Bayesian drift, external drift simulations, **Collocated Cosimulations**, **LU decomposition**.
- **Truncated Gaussian Simulations**, **Plurigaussian Simulations**, **Boolean Simulations**, **Sequential Indicator Simulations** (standard ellipsoidal neighborhood, sequential neighborhood).
- Possible use of **2D or 3D faults** in simulation procedures.

4.3. Advanced simulations

- **Multiple-point Simulations** (Impala-based).
- **Flumy**, advanced geological model for meandering channelized systems (modeling of fluvial and turbiditic environments).

4.4. Risk Assessment and resource estimation

- **Grade-tonnage curves and Metal Quantity, Tonnage and Mean Grade values** from kriging or simulation results. **QTM Validation** for checking grade-tonnage variable consistency.
- **Selectivity Coefficient**.

- **Simulation Reduction:** to identify the subset of grade realizations which best capture the space of uncertainty as the full set of realizations would do (for grade variables only).
- **Post-processing of simulation results:** expectation curves on surfaces & volumes, mean and variance maps, probability and quantile maps, histogram of realizations for interactively selected points.
- **Post-processing of facies simulations:** mapping of the local probability for each facies, the local most and least probable facies.
- **Volumetrics processing. Spill Point** calculations.

5. DISPLAY

5.1. Standard display

- Display of 2D/3D set of isolated points, 2D/3D regular grids, regular 2D surfaces, 3D lines, fence sections on 3D grids or 2D surfaces.
- Color scale and palette management.
- Graphic editor.

5.2. 3D Viewer

Sophisticated visualization abilities for in-depth data exploration and control in 3D:

- Representation of 2D/3D point data, wells/boreholes data, 3D models, 2D surfaces, 2D/3D polygons, 2D/3D faults, 3D wireframes, grid sections.
- Visualisation of grids, directions, rotations, ellipsoid of anisotropy, 3D neighbourhoods.
- Many features such as clipping, slicing, zooming, filtering, database inquiry.
- Easy export of graphics to standard image formats.
- Direct link to Isatis database for automatic refresh.

6. WORKFLOW CUSTOMIZATION AND BATCH PROCEDURES

- Parameter files and journaling file system for automatic batch procedures and auditing.
- Workflows for standard geostatistical processing.

7. ON-LINE DOCUMENTATION / REFERENCE GUIDE

- Easy access to the user's guide and technical references through standard browsers.
- Various case studies dedicated to basic and advanced workflows.