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Chapter 1 - Introduction

Welcome to Surfer, a powerful contouring, gridding, and surface mapping package for scientists, engineers, educators, or anyone who needs to generate maps quickly and easily. Producing publication quality maps has never been quicker or easier. Adding multiple map layers and objects, customizing the map display, and annotating with text creates attractive and informative maps. Virtually all aspects of your maps can be customized to produce the exact presentation you want.

Surfer is a grid-based mapping program that interpolates irregularly spaced XYZ data into a regularly spaced grid. Grids may also be imported from other sources, such as the United States Geological Survey (USGS). The grid is used to produce different types of maps including contour, color relief, and 3D surface maps among others. Many gridding and mapping options are available allowing you to produce the map that best represents your data.

An extensive suite of gridding methods is available in Surfer. The variety of available methods provides different interpretations of your data, and allows you to choose the most appropriate method for your needs. In addition, data metrics allow you to map statistical information about your gridded data. Surface area, projected planar area, and volumetric calculations can be performed quickly in Surfer. Cross-sectional profiles can also be computed and exported.

The grid files can be edited, combined, filtered, sliced, queried, and mathematically transformed. For example, grids can be sliced to create cross-sectional profiles, or the Grids | Calculate | Math command can be used to create an isopach map from two grid files. Grids can be edited with an intuitive user interface in the grid editor.

Scripter

The Scripter™ program, included with Surfer, is useful in creating, editing, and running script files that automate Surfer procedures. By writing and running script files, simple mundane tasks or complex system integration tasks can be performed precisely and repetitively without direct interaction. Surfer also supports ActiveX Automation using any compatible client, such as Visual BASIC. These two automation capabilities allow Surfer to be used as a data visualization and map generation post-processor for any scientific modeling system.

New Features

The new features in Surfer 14 are summarized:

- In the web help at http://surferhelp.goldensoftware.com/#t=topics%2Fnew_features.htm
- In the program, click the help button , and click on the New Features page in the Introduction book

Who Uses Surfer?

People from many different disciplines use Surfer. Since 1984, over 100,000 scientists and engineers worldwide have discovered Surfer’s power and simplicity. Surfer’s outstanding gridding and contouring capabilities have made Surfer the software of choice for working with XYZ data. Over the years, Surfer users have included hydrologists, engineers, geologists, archeologists, oceanographers, biologists, foresters, geophysicists, medical researchers, climatologists, educators, students, and more! Anyone wanting to visualize their XYZ data with striking clarity and accuracy will benefit from Surfer’s powerful features!
System Requirements

The system requirements for Surfer are:

- Windows Vista, 7, 8 (excluding RT), 10 or higher
- 512MB RAM minimum for simple data sets, 1GB RAM recommended
- At least 500MB free hard disk space
- 1024x768 or higher monitor resolution with a minimum 16-bit color depth

Installation Directions

Installing Surfer requires Administrator rights. Either an administrator account can be used to install Surfer, or the administrator's credentials can be entered before installation while logged in to a standard user account. If you wish to use a Surfer single-user license, the product key must be activated while logged in to the account under which Surfer will be used.

Golden Software does not recommend installing Surfer 14 over any previous versions of Surfer. Surfer 14 can coexist with older versions (e.g. Surfer 13) as long as both versions are installed in different directories. By default the program installation directories are different. For detailed installation directions see the Readme.rtf file.

To install Surfer from a download:

1. Log into the account for the individual who will be licensed to use Surfer. Log in at http://myaccount.goldensoftware.com.
2. Download Surfer according to the emailed directions you received.
3. Double-click on the downloaded file to begin the installation process.
4. Once the installation is complete, run Surfer.
5. License Surfer by activating a single-user license product key or connecting to a license server.

Updating Surfer

To update your version of Surfer, open the Surfer program and choose the File | Online | Check for Update command. This will launch the Internet Update program which will check Golden Software’s servers for any updates. If there is an update for your version of Surfer (e.g. Surfer 14.0 to Surfer 14.1), you will be prompted to download the update.

You can also email your registered Surfer 14 serial number to surferssupport@goldensoftware.com and request to download the full product update. See the Check for Update help topic for additional information.

Uninstalling Surfer

To uninstall Surfer, follow the directions below for your specific operating system.

Windows Vista

To uninstall Surfer when using the Regular Control Panel Home, click the Uninstall a program link. Select Surfer 14 from the list of installed applications. Click the Uninstall button to uninstall Surfer. To uninstall Surfer when using the Classic View, go to the Control Panel and double-click on Programs and Features. Select Surfer 14 from the list of installed applications. Click the Remove button to uninstall Surfer.
Windows 7
To uninstall Surfer go to the Windows Control Panel and click the Uninstall a program link. Select Surfer 14 from the list of installed applications. Click the Uninstall button to uninstall Surfer.

Windows 8
From the Start screen, right-click the Surfer 14 tile and click the Uninstall button at the bottom of the screen. Alternatively, right-click anywhere on the Start screen and click All apps at the bottom of the screen. Right-click the Surfer 14 tile and click Uninstall at the bottom of the screen.

Windows 10
Select Settings in the Start menu. In Settings, select System | Apps & features. Select Surfer 14 and then click Uninstall. To uninstall Surfer from the Windows Control Panel, click Programs | Programs and Features. Select Surfer 14 and click Uninstall.

Surfer Trial Functionality
The Surfer trial is a fully functioning time-limited trial. This means that commands work exactly as the command works in the full program for the duration of the trial. The trial has no further restrictions on use. Any data set or image can be used to create any project. All properties can be changed in the trial. The trial can be installed on any computer that meets the system requirements. The trial can be activated with a product key or licensed by connecting to a license server.

Three-Minute Tour
We have included several sample files with Surfer so that you can quickly see some of Surfer's capabilities. Only a few files are discussed here, and these examples do not include all of Surfer's many map types and features. The Contents window is a good source of information as to what is included in each file.

To see the example files:
1. Open Surfer.
2. Click the File | Open command.
3. In the Open dialog, navigate to the Surfer Samples folder. By default, the Surfer installation folder is located in C:\Program Files\Golden Software\Surfer 14\ by default.
4. Select the sample .SRF file of interest and click Open. The sample file is now displayed. Repeat as necessary to see the files of interest.
Overview of Sample Surfer .SRF Files
An image of the sample file and a brief explanation of what the sample file contains is displayed for each sample file.

Axes.SRF
The Axes.SRF file contains a contour map layer and color relief map layer overlaid. The grid file used for the two map layers is the same and includes dates as the X values. The X Axis is displayed using date formatting.

Base.SRF
The Base.SRF sample file displays three base map layers showing road transportation, stream hydrology, and a USGS urban area satellite image for Golden, Colorado, USA. The individual polygons and polylines that make up the base maps can be edited or deleted by expanding the base map layer in the Contents window.
BaseMapFromServer.SRF
The BaseMapFromServer.SRF file contains five base maps of South America, showing Distribution of various minerals, national boundaries, and generalized geology. All base maps were created by downloading images from online servers.

Classed Post.SRF
The Classed Post.SRF sample file displays two maps. The left map is a contour map with a classed post map layer displaying the sample location and assay results over a study area. The right map is a classed post map that displays the drill hole assay results by comparing the depth from surface to the Easting. A classed post map legend has been added to each map.

ColorRelief.SRF
The ColorRelief.SRF sample file displays a color relief map with a base map layer and a post map layer. The color relief map displays the elevation changes across the state of Colorado. A color scale has been added to show the elevation values. The base map layer displays the county boundaries. The post map layer displays the county names.
Contours.SRF
The Contours.SRF sample file displays a contour map of the Grand Canyon, USA. The left axis and bottom axis have the major and minor grid lines shown.

CoordinateSystems.SRF
The CoordinateSystem.SRF sample file displays two base map layers showing stream hydrology, and a land grid. An image map showing topography for the Mt. Diablo region is overlaid. The base map layers use a UTM coordinate system. The image map layer uses a state plane coordinate system. The final map is displayed in latitude and longitude coordinates.
Graticule.SRF
The Graticule.SRF file shows a contour layer overlaid on a downloaded base layer. The map also includes a graticule, scale bars, and grid lines.

GridValues.SRF
The GridValues.srf sample file displays a grid values, post, and filled contour layer overlaid in a single map. The grid values layer is used to visualize the grid geometry or post grid values on the map.
Logarithmic.SRF

The Logarithmic.SRF file contains the same data gridded in three different ways. The top map shows the data gridded in the normal Linear Z method. The bottom two maps show the data gridded in the Log Z method. The map on the left has the Z data saved in log form. The map on the right has the Z data saved in linear form, but the contour level method is set to logarithmic.

Map Layers.SRF

The MapLayers.SRF sample file displays a map with a contour layer, a shaded relief layer, and a base layer defining a national forest boundary. The contour map is semi-transparent, allowing the ability to see through the filled contours to the shaded relief map layer. The base map boundary was created from a blanking file .BLN. Blanking files can be created from known points, or by digitizing points. The color scale displays the elevation values for the contour map.

MapTypes.SRF

The MapTypes.SRF file contains a sample map for each of the map types. All grid based map types are created from the same Telluride.grd file. The classed post and post map are created from the same data file, which contains elevation of various locations in the same Telluride area.
Post.SRF
The Post.SRF sample file displays a post map with a contour map layer. The post map is using a symbol column from the worksheet and contains multiple labels. The contour map is using a gradational line color.

Profile.SRF
The Profile.SRF file contains a map with two base map layers, a contour layer, and a shaded relief layer. The base maps were created with the Map Tools | Add to Map | Profile command. At the bottom of the page, the two profiles lines are displayed, showing the elevation across the profile.
Chapter 1 - Introduction

Shaded Relief.SRF
The Shaded Relief.SRF sample file displays a shaded relief map of the Telluride Quadrangle, Colorado on an aerial image of the same area. A map scale has been added.

Stacked Maps.SRF
The Stacked Maps.SRF sample file displays two maps. The top map is a contour map, and the bottom map is a 3D surface of the same grid file. The two maps were aligned with the Map Tools | Map Tools | Stack Maps command and polylines were added. The top contour map has an index contour, where every fifth line is bold.
Surface.SRF
The Surface.SRF sample file displays three maps. The top map is a 3D surface gravity map for the state of Colorado. The bottom maps display the same 3D surface map from a different view, and a post map of some Colorado cities for reference. A color scale has been added to display the values for the Bouger anomaly.

Transparent.SRF
The Transparent.SRF file displays a contour map overlaid on a base map created from an aerial photograph. The contour map is filled with a partially transparent pattern.

Tutorial.SRF
The Tutorial.SRF file displays a sample contour map.
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Vectors.SRF
The Vectors.SRF sample file displays a vector map with contour and post layers. The vectors show barometric pressure patterns in the Northern Hemisphere. A legend has been added to show the reference vector sizes.

Viewshed.SRF
The Viewshed.SRF sample file shows a shaded relief layer with viewshed layers added. The transmitter location is represented by the blue triangle symbol. The visible regions are highlighted in green, and the invisible regions are highlighted in red. The viewshed radius is limited to 6000km.
Watershed.SRF
The Watershed.srf sample file displays a post map, two base maps, a contour map, a watershed map, and a surface map layer. The map shows roads, rivers, and the watershed delineation of a section of the Rocky Mountains in Colorado.

Wireframe.SRF
The Wireframe.SRF sample file displays a 3D wireframe map of the Colorado Front Range. A color scale has been added to show the elevation values.

Using Surfer
The most common application of Surfer is to create a grid-based map from an XYZ data file. The Home | Grid Data | Grid Data command uses an XYZ data file to produce a grid file. The grid file is then used by most of the Home | New Map commands to produce maps. Post maps and base maps do not use grid files. The general steps to progress from an XYZ data set to a finished grid-based map are as follows:

1. Create an XYZ data file. This file can be created in a Surfer worksheet window or outside of Surfer (using an ASCII text editor or Microsoft Excel, for example).

Start with irregular XYZ data in three columns.
2. To display the data points, click the **Home | New Map | Post** command.

3. Create a grid file .GRD from the XYZ data file using the **Home | Grid Data | Grid Data** command.

4. To create a map, select the map type from the **Home | New Map** commands. Select the grid file from step two. Grid-based maps include contour, 3D surface, 3D wireframe, color relief, shaded relief, vector, watershed, viewshed, and grid values maps.
5. Click on the map to display the map properties in the **Properties** window where you can customize the map to fit your needs.

6. Click the File | Save command to save the project as a Surfer .SRF file which contains all the information needed to recreate the map.
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Surfer Flow Chart

This flow chart illustrates the relationship between XYZ data files, grid files, vector files, image files, and various maps. This example displays only one of the grid based maps, a contour map.

Using Scripter

Tasks can be automated in Surfer using Golden Software’s Scripter program or any ActiveX Automation-compatible client, such as Visual BASIC. A script is a text file containing a series of instructions for execution when the script is run. Scripter can be used to perform almost any task in Surfer. You can do practically everything with a script that you can do manually with the mouse or from your keyboard. Scripts are useful for automating repetitive tasks and consolidating a sequence of steps. Scripter is installed in the same location as Surfer. Refer to the Surfer Automation help book for more information about Scripter. We have included several example scripts so that you can quickly see some of Scripter’s capabilities.

To run a sample script file:

1. Open Scripter by navigating to the installation folder, C:\Program Files\Golden Software\Surfer 14\Scripter. If you are running a 32-bit version of Surfer on a 64-bit version of Windows, navigate to C:\Program Files (x86)\Golden Software\Surfer 14\Scripter. Right-click on the Scripter.exe application file and select Run as administrator.
2. Choose the File | Open command.
3. Select a sample script .BAS file. These are located in the C:\Program Files\Golden Software\Surfer 14\Samples\Scripts folder or the C:\Program Files (x86)\Golden Software\Surfer 14\Samples\Scripts folder, if you are running a 32-bit version of Surfer on a 64-bit version of Windows.
4. Click the Script | Run command and the script is executed. Most sample scripts open Surfer and display a map in the plot window.

Surfer User Interface

Surfer contains three document window types: the plot document, worksheet document, and grid editor. Maps are created and displayed in the plot document. The worksheet document displays, edits, transforms, and saves data in a tabular format. The grid editor displays and edits Z values for the grid with various editing tools.
This is the **Surfer** plot window with the **Contents** and **Properties** windows on the left and the worksheet and grid editor tabs on the top of the horizontal ruler.

**Surfer Layout**

The following table summarizes the function of each component of the **Surfer** layout.

<table>
<thead>
<tr>
<th><strong>Component Name</strong></th>
<th><strong>Component Function</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Title Bar</td>
<td>The title bar lists the program name plus the saved Surfer .SRF file name (if any). An asterisk after the file name indicates the file has been modified.</td>
</tr>
<tr>
<td>Quick Access Toolbar</td>
<td>All window types in <strong>Surfer</strong> include the quick access toolbar to the left of the title bar. The quick access toolbar contains buttons for many common commands. The quick access toolbar can be customized to add or remove buttons with the <strong>Customize</strong> command.</td>
</tr>
<tr>
<td>Ribbon</td>
<td>The ribbon includes all of the commands in <strong>Surfer</strong>. Commands are grouped under the File menu and various tabs. Some commands and tabs are only available in specific views. For example, the **Features</td>
</tr>
</tbody>
</table>
Tabbed Documents

The plot, worksheet, and grid editor windows are displayed as tabbed documents. The tabs may be reordered by clicking and dragging. When more than one window is open, tabs appear at the top of the document, allowing you to click on a tab to switch to a different window. When a document contains unsaved changes, an asterisk (*) appears next to its tabbed name.

Contents

The **Contents** window contains a hierarchical list of all the objects in a Surfer plot document displayed in a tree view. The objects can be selected, added, arranged, and edited. Changes made in the **Contents** window are reflected in the plot document, and vice versa.

The **Contents** window is initially docked at the left side of the window, giving the window a split appearance; however, it can be dragged and placed anywhere on the screen. The **Contents** window can also be hidden as a tab or displayed as a floating dialog.

Properties

The **Properties** window contains all of the properties for the selected object or objects. Changes made in the **Properties** window are reflected in the plot document. The properties in the **Properties** window are grouped by page.

The **Properties** window is initially docked below the **Contents** window. The **Properties** window can also be hidden as a tab or displayed as a floating dialog.

Status Bar

The status bar displays information about the current command or activity in Surfer. The status bar is divided into five sections. The sections display basic plot commands and descriptions, the name of the selected object, the pointer map coordinates and units, the pointer page coordinates, and the dimensions of the selected object.

The status bar also indicates the progress of a procedure, such as gridding. The percent of completion and time remaining will be displayed.

Opening Windows

Selecting the **File | Open** command opens any of the three window types, depending on the type of file selected. The **File | New | Plot** command creates a new plot window. The **File | New | Worksheet** command creates a new worksheet window.

Ribbon

The Ribbon is the strip of buttons and icons located above the manager and view windows. The Ribbon replaces the menus and toolbars found in earlier versions of Surfer. The ribbon is designed to help you quickly find the commands that you need to complete a task.

Above the Ribbon are a number of tabs, such as **Home**, **Features**, and **Map Tools**. Clicking or scrolling to a tab displays the commands located in this section of the ribbon. The tabs have commands that are organized into a group. For instance, all the commands for adding drawn objects are on the **Features** tab in the **Insert** group.
Minimizing the Ribbon

The ribbon can be minimized to take up less space on the screen. To minimize the ribbon, right-click on the ribbon and select **Minimize the Ribbon** or click the button in the top right portion of the **Surfer** window. When displayed in a minimized mode, only the tabs at the top of the screen are visible. To see the commands on each tab, click the tab name. After selecting a command, the ribbon automatically minimizes again. Double-click any tab name to quickly minimize or maximize the ribbon.

Customizing the Ribbon

The ribbon is customizable in **Surfer**. To customize the commands in the ribbon, right-click on the ribbon and select **Customize the Ribbon**.

In the **Customize Ribbon** dialog, you can add new tabs, add groups, hide existing tabs or custom groups, and add commands to any custom group. You can also rearrange the tabs into an order that fits your needs better.

To customize the commands in the **Customize Ribbon** dialog, right-click on the ribbon and select **Customize the Ribbon**. In the **Customize Ribbon** dialog, use the following options.

Tab options:
1. To add a custom tab, set the **Customize the Ribbon** section to **All Tabs**. Click in the list on the right side of the dialog where the custom tab should be located and click the **New Tab** button.
2. To delete custom tab, right-click on the tab name in the list on the right side of the dialog and select **Delete**.
3. To rename a default or custom tab, click on the tab name in the list on the right side of the dialog. Click the **Rename** button. Type the new name and press OK to make the change.
4. To hide a default or custom tab, uncheck the box next to the tab name on the right side of the dialog. Only checked tabs will be displayed.
5. To change the order of default or custom tabs, click on the tab name that should be moved in the list on the right side of the dialog. Click the up and down arrow buttons on the far right
side of the dialog to move the selected tab up or down. Default tabs must remain in their major group.

Group options:
1. To add a custom group to a default or custom tab, click on the † next to the tab name. Click in the list of group names where the new group should be located and click the New Group button.
2. To delete a default or custom group on any tab, right-click on the group name in the list on the right side of the dialog and select Delete.
3. To rename a default or custom group on any tab, click on the group name in the list on the right side of the dialog. Click the Rename button. Type the new name and click OK to make the change.
4. To change the order of default or custom groups on any tab, click on the group name that should be moved in the list on the right side of the dialog. Click the up and down arrow buttons on the far right side of the dialog to move the selected group up or down in the list.
5. To replace a default group with a custom group, right-click on the default group name and select Delete. Click the New Group button. Add the desired commands to the new group that you want displayed. Rename the new group, if desired.

Command options:
Commands can only be added to or deleted from custom groups. Commands can only be rearranged or renamed in custom groups. If commands in default groups are desired to be edited, the default group should be hidden and a new custom group should be created with the same commands.
1. To add a command to a custom group, set the choose commands from list to All Tabs so that all commands are listed on the left side of the dialog. Select the desired command that should be added. On the right side of the dialog, click the † next to the custom group name. Click on the desired position in the list of commands. If no commands exist in the group yet, click on the group name. Click the Add>> button and the command is added to the custom group.
2. To delete a command from a custom group, right-click on the command name in the list on the right side of the dialog and select Delete. Only commands from custom groups can be deleted.
3. To rename a command in a custom group, click on the command name in the list on the right side of the dialog. Click the Rename button. Type the new name and click OK to make the change. Only commands in custom groups can be renamed.
4. To change the order of commands in a custom group, click on the command name that should be moved in the list on the right side of the dialog. Click the up and down arrow buttons on the far right side of the dialog to move the selected command up or down in the list.

Reset the Ribbon
To reset all customizations on the ribbon, click the Reset button at the bottom of the Customize Ribbon dialog.

Command and Help Search
The ribbon also includes a command search to the right of the last tab (View, Data, or Grid Editor depending on document type). Begin typing a command name to search for commands. Click on a command in the search results to use the command. Press ENTER to quickly use the top search result command. For example type post into the command search bar and the Home | New Map | Post command group, Map Tools | Add to Map | Layer command group, and Map Tools | Edit Layer | Post Labels commands are displayed in the search results. You can also click the Search help file at the bottom of the results list to search the help file for the search term.
Chapter 2 - Tutorial

The tutorial is designed to introduce basic Surfer features and should take less than an hour to complete. After you have completed the tutorial, you will have the skills needed to create maps in Surfer using your own data. The tutorial can be accessed in the program by clicking the button and navigating to the Tutorial book or by clicking Tutorials in the Welcome to Surfer dialog.

If you find you still have questions after you have completed the tutorial, you should consider reviewing the material in Surfer's extensive in-program help. The help is also available on the web. The Golden Software website contains a knowledge base of questions and answers, an interactive forum, and training videos. Usually, the answers to your questions are found in one of these locations. However, if you find you still have questions, do not hesitate to contact Golden Software's technical support team. We are happy to answer your questions before they become problems.

Tutorial Overview

The following is an overview of lessons included in the tutorial.

Starting Surfer shows you how to begin a new Surfer session and open a new plot window.

Lesson 1 - Viewing and Creating Data opens and edits an existing data file and creates a new data file.

Lesson 2 - Using the Map Wizard creates a grid file, the basis for most map types in Surfer, and a map with contour, post, and color relief layers.

Lesson 3 - Changing Layer Properties edits the contour, post, and color relief layer properties.

Lesson 4 - Modifying an Axis edits the axis tick labels and axis title properties.

Lesson 5 - Creating a Profile creates a profile line on the contour map and displays the profile.

Lesson 6 - Saving a Map saves your map and all the information it contains to a Surfer .SRF file.

Lesson 7 - Creating a 3D Surface Map creates and edits 3D surface map.

Lesson 8 - Adding Transparency, Color Scales, and Titles changes the transparency of various objects, adds a color scale, and adds a map title.

Lesson 9 - Creating Maps from Different Coordinate Systems loads multiple map layers from different coordinate systems and sets the target coordinate system for the entire map.

Advanced (optional) Lessons

Optional Advanced Tutorial Lessons are available to demonstrate additional features of Surfer.
Chapter 2 - Tutorial

A Note about the Documentation

Various font styles are used throughout the Surfer quick start guide and online help. Bold text indicates commands, dialog names, tab names, and page names. Italic text indicates items within a dialog or the Contents or Properties windows such as section names, options, and field names. For example, the Save As dialog contains a Save as type list. Bold and italic text may occasionally be used for emphasis.

Also, commands appear as Home | New Map | Contour. This means, "click or scroll to the Home tab at the top of the plot window, then click on the Contour command within the New Map command group." The first word is always the menu or ribbon tab name, followed by the command group, and finally the command name within the menu list or on the ribbon.

Sample File Location

The sample files used in the tutorial lessons are located in the Surfer SAMPLES folder. The SAMPLES folder is located by default at C:\Program Files\Golden Software\Surfer 14\Samples. Note, if you are running the 32-bit version of Surfer on a 64-bit version of Windows, the SAMPLES folder is located at C:\Program Files (x86)\Golden Software\Surfer 14\Samples, by default.

Starting Surfer

To begin a Surfer session:

1. Navigate to the installation folder, which is C:\Program Files\Golden Software\Surfer 14 by default.
3. The Welcome to Surfer dialog appears. Click New Plot to open a new blank plot window.
4. A new empty plot window opens in Surfer. This is the work area where you can produce grid files, maps, and modify grids.

If this is the first time that you have opened Surfer, you are prompted to license Surfer. Activate your Single-User product key, select a license server, or continue using the trial. Your product key is located in the download instructions email. You may also access your product key at your Golden Software My Account page.

If you have already been working with Surfer, open a new plot window before starting the tutorial. To open a new plot window, click the File | New | Plot command.

Lesson 1 - Viewing and Creating Data

An XYZ data file is a file containing at least three columns of data values. The first two columns are the X and Y coordinates for the data points. The third column is the Z value assigned to the XY point. Although it is not required, entering the X coordinate in column A, the Y coordinate in column B, and the Z value in column C is a good idea. Surfer looks for these coordinates in these columns by default. You can customize the default columns for XYZ data with the Assign XYZ Columns worksheet command. Surfer requires the use of decimal degree Latitude (Y) and Longitude (X) values when using Latitude and Longitude values.
A simple XYZ data file. Notice that the X, Y, and Z data are placed in columns A, B, and C, respectively.

Creating a New Data File - Tutorial

The Surfer worksheet can also be used to create a new data file. To open a worksheet window and begin entering data:

1. Click the File | New | Worksheet command, click the on the quick access toolbar, or press CTRL+W on the keyboard. A new empty worksheet window is displayed.

Data are entered into the active cell of the worksheet. Click on the text "A1" or "Active Cell" for the definition of the active cell, active cell location, and the active cell edit box.

2. Data is entered into the active cell. The active cell is selected by clicking on the cell or by using the arrow keys to move between cells. The active cell is indicated by a heavy border and the contents of the active cell are displayed in the active cell edit box. The active cell
Chapter 2 - Tutorial

The location box shows the location of the active cell in the worksheet. Letters are the column labels and numbers are the row labels.

3. When a cell is active, enter a value or text, and the information is displayed in both the active cell and the active cell edit box.

4. The BACKSPACE and DELETE keys can be used to edit data as you type.

5. To preserve the typed data in the active cell, move to a new cell. Move to a new cell by clicking a new cell with the pointer, pressing one of the arrow keys, or pressing ENTER. Press the ESC key to cancel without entering the data.

Opening an Existing Data File - Tutorial

To look at an example of an XYZ data file, you can open any sample data file in a worksheet window:

1. Click the File | Open command, click the button on the quick access toolbar, or press CTRL+O on the keyboard to open the Open dialog.

2. If you are not in the Samples folder, browse to it. By default, the Samples folder is located in C:\Program Files\Golden Software\Surfer 14. In the list of files, click TutorWS.dat.

3. Click Open to display the file in the worksheet window.

Notice that the X coordinate (Easting) is in column A, the Y coordinate (Northing) is in column B, and the Z value (Elevation) is in column C. Although it is not required, row 1 contains header text, which is helpful in identifying the type of data in the column. When a header row exists, the information in the header row is used in the Properties window when selecting worksheet columns.

When a data file is displayed, the name of the file is shown in the title bar and in the worksheet tab. In this file, row 1 contains descriptive information about each column of data.
Adding New Data - Tutorial

To edit any value, click in the cell to select it. Type information and the existing value is overwritten. Data can be transformed, sorted, or filtered in this window. New columns can be added. For instance, an ID column can be added which labels each row with a unique identifier. To do this,

1. Click in cell D1.
2. Type the text Name.
3. Press ENTER to save the text and move the active cell to cell D2.
4. Click the Data | Data | Transform command.
5. In the Transform dialog, set the Transform with to Column variables (e.g., C = A + B).
6. Set the Transform equation to $D = "MW" + \text{ITOA}(\text{ROW()} - 1)$. This equation will use a prefix of "MW" before a number. The number is the row number minus 1 for each row. The ITOA function converts the ROW() -1 number to text.
7. Set the First row to 2.
8. Set the Last row to 48 (the last row in the worksheet).
9. Leave the Empty cells, Text cells, and Number cells set to the defaults.
10. Click OK and each row will have a unique identifier.

Set the options in the Transform dialog as above to add a unique identifier to each row.

The worksheet should now have a unique identifier column:
The new column contains a unique identifier for each row. This can be used for labels later in the tutorial.

Saving the Data File - Tutorial

When you have completed entering all of the data, the file can be saved.

1. Click the **File | Save As** command. The **Save As** dialog is displayed.
2. Navigate to the folder in which you wish to save the tutorial, for example the **Documents** folder.
3. In the **Save as type** list, choose the **DAT Data (*.dat)** option.
4. Type **Tutorial** into the **File name** box.
5. Click the **Save** button and the **Data Export Options** dialog opens.
6. Accept the defaults in the **Data Export Options** dialog by clicking **OK**.

The file is saved in the **Data .DAT** format as **Tutorial.dat**. The name of the data file appears in the title bar and on the worksheet tab.

Lesson 2 - Using the Map Wizard

Now that we have saved the data file, we will use the **Map Wizard** to create a grid and a map with contour and post layers. The **Map Wizard** steps through the map creation process from raw data to a map with one or more layers. The **Map Wizard** is useful for creating multiple map types from a single data file. The **Map Wizard** can use a **data, grid, or boundary** file as an input file.

1. If you have the worksheet window open, click on the **Plot1** tab above the worksheet window. Alternatively, you can create a new plot window with the **File | New | Plot** command.
2. Click the **Home | Wizard | Map Wizard** command.

The **Map Wizard** opens to the first page, the **Select Your Data** page. The remaining topics in Lesson 2 will step through the pages of the Map Wizard.
Select Your Data - Tutorial

The first page in the Map Wizard is the Select Your Data page. Here you select the data, grid, base map, or image file you wish to use to create your map.

1. By default, the Map Wizard displays the sample files in the Select File list. Click Sample files and select Browse from the list. The Open dialog is displayed. You can also display Recent files and Project files in the Select File list. You can also display Recent files and Project files in the Select File list.
2. In the Open dialog, navigate to the Tutorial.dat file you saved in Lesson 1 - Saving the Data File.
3. Select the Tutorial.dat file and click Open. The Tutorial.dat file is loaded in the Data Preview section. The column letters and header row information is displayed in the Select Data Columns list. By default the X coordinate is column A, the Y coordinate is column B, and the Z coordinate is column C. Any other valid input files in the folder are also displayed in the Select File list.
4. Click Next in the Map Wizard.
Select Your Map Type - Tutorial

Now that you have selected a data file and specified the data columns, we can select which map layers will be included in the map on the **Map Wizard - Select Your Map Type** page.

**XYZ data files are the most flexible input file type.** All of the layers were available in the Select Your Map Type page. Some map types will be unavailable after choosing an image, vector, or grid file on the Select Your Data page. The data file type and the map type selections determine if a map is created after the Select Your Map Type page or if a grid must be created first.

For this tutorial we will include a contour and post layer in our map:

1. Click the Post map in the **Map types - check all desired** list to select it. Notice a description is displayed in the Description field.
2. Click the Contour map in the **Map types - check all desired** list to select it. The Finish button changes to Next. This is because we must create a grid from the XYZ data file before we can create a contour map.
3. Click Next.
Select Gridding Parameters - Tutorial

Grid files are required to produce a grid-based map. Grid-based maps include contour, color relief, shaded relief, vector, viewed, watershed, 3D wireframe, and 3D surface map layers. If necessary, grid files are created with the Map Wizard. Grid files can also be created at any time by using the Home | Grid Data | Grid Data command.

A grid must be created from the Tutorial.dat file to display a contour map. The Map Wizard - Select Gridding Parameters page controls the gridding options and output grid file name. The Select Gridding Parameters page displays a preview color relief map for you to quickly compare gridding methods. We will create a grid with the default gridding method and options.

![A map is created with default contour and post layers.](image)

1. Verify that the Gridding method is set to Kriging. If it is not, click the current gridding method and select Kriging from the list.
2. Verify that the Output grid file is named Tutorial.grd and in the desired directory, for example your Documents folder.
3. Click Finish.

The grid is created and saved, and a map is created in the plot window with a contour and post layer. The map uses the default display properties. The Map Wizard is a useful tool for quickly creating maps and grids. However, it is not necessary to use the Map Wizard. Grids can be created with the Grid Data command, and maps and layers can be created with the Home | New Map and Home | Add to Map | Layer commands.

Adding a Color Relief Layer - Tutorial

Map layers allow you to add multiple maps to an existing map to create one map object displaying a variety of map types. The map uses a single set of axes and the map layers are positioned according to the target coordinate system. For example, if you have a contour map of weather data created, you can add a post map layer displaying the location and station names of each data collection station.
Multiple map layers can be created at one time when using the **Map Wizard**. However, map layers can also be added to an existing map by selecting the map and using the **Home | Add to Map | Layer** command, by dragging an existing map layer from one map object to another, or by selecting all maps and using the **Map Tools | Map Tools | Overlay Maps** command. Now we will add a color relief layer to the map:

1. Click on the *Map* object in the **Contents** window, or click on the map in the plot window, to select it.
2. Click the **Home | Add to Map | Layer | Color Relief** command. The **Open Grid** dialog is displayed.
3. Navigate to the *Tutorial.grd* file you created in **Select Gridding Parameters** and select it.
4. Click **Open** to add the color relief layer to the map.

The color relief layer is added to the map and uses the default display properties. In Lesson 3, we will edit the appearance of the map by changing the color relief, contour, and post layer properties.

**Lesson 3 - Changing Layer Properties**

The map's appearance is mainly determined by the properties of the map layers. This lesson will demonstrate a few of the common properties for controlling the display of contour, post, and color relief layers. However, each map type has many properties and display options. A description and explanation is included for every property in the help.
This color relief layer uses the Rainbow colormap.

We will begin by changing the color relief layer’s colors:

1. Click the Color Relief-Tutorial.grd layer in the Contents window to select it. When multiple layers are overlaid in a single map, it is often easier to select the desired layer in the Contents window. When the color relief layer is selected, the color relief layer properties are displayed in the Properties window.
2. Click the General tab in the Properties window to display the General page.
3. If necessary, click the button next to General to expand the General section.
4. The Colors property determines the colormap used in the color relief map. The default colormap is Terrain. Click Terrain and select Rainbow from the Colors list.

Now the color relief layer is using the Rainbow colormap. You can click the button next to the Colors property to customize the colormap in the Colormap dialog.

Changing Contour Levels - Tutorial

Go to the Levels page to display the contour level properties.
You can easily modify any of the contour map features. For example, you might want to change the contour levels displayed on the map. To change the contour levels:

1. Click on the Contours-Tutorial.grd object in the Contents window. When the contour layer is selected, the contour properties are displayed in the Properties window.
2. In the Properties window, click the Levels tab to display the contour levels and contour line properties for the map. In this example, the contour levels begin at \( Z = 20 \). This is displayed next to Minimum contour. The Maximum contour level is \( Z = 105 \).
3. To change the contour range, click in the box next to Minimum contour or Maximum contour. Highlight the existing value and type a new value. The Data range of the grid file is displayed at the top of the Levels page, making selecting an appropriate range easier. For best results, select values for Minimum contour and Maximum contour that are in or near this Data range.
4. The Contour interval, or the frequency of contour lines, is five. This means that a contour line will be displayed every five \( Z \) units. We should see contour lines at 20, 25, 30, 35, etc. up to 105. Click in the Contour interval box, highlight the value 5, and type the value 10.
5. Press ENTER on the keyboard. The map automatically updates to show contour lines every 10 \( Z \) units. The minimum contour level is \( Z = 20 \), and the largest contour level is \( Z = 100 \).

The contour map is redrawn using new contour levels based on a contour interval of 10.

Changing Contour Line Properties - Tutorial

You can set any of the options in the list on the Levels page to customize the contour map. The Major contour every value allows the setting of two different line styles, the major and minor contour lines, for the contour map. By default, the major contour lines are black and labeled and the minor contour lines are gray and unlabeled. The number of minor contour lines and the line properties for both the major and minor contours can be changed.

Setting the Major Contour Value

1. Highlight the number in the box next to Major contour every and type in a new value of 3.
2. Press ENTER on the keyboard and every third line is a major contour line.

Changing the Major Contour Line Properties

1. Click the \( \mathbb{H} \) next to Major Contours, if it is not already open.
2. Click the \( \mathbb{H} \) next to Line Properties in the Major Contours section. The major line properties appear.
3. Click the Black color box next to Color. Select another color, such as Red, from the list. The map automatically updates.
4. Click the \( \) next to \textit{Width} and change the value to 0.03 inches. Thick red lines now appear at the major contours.


### Changing the Minor Contour Line Properties

1. Click the \( \) next to \textit{Minor Contours}, if it is not already open.
2. Click the \( \) next to \textit{Line Properties} in the \textit{Minor Contours} section. The minor line properties appear.
3. Click the 30\% \textit{Black} color box next to \textit{Color}. Select another color, such as 80\% \textit{Black}, from the list.
4. Click in the box next to \textit{Style} and select a dashed line from the list. Dashed gray lines now appear at the minor contours.

![The contour map should look similar to this example after changing the major and minor line properties.](image)

### Advanced Contour Level Properties - Tutorial

Contour map level properties can be set in one of three methods: \textit{Simple}, \textit{Logarithmic}, or \textit{Advanced}. As seen in the previous topic, the \textit{Simple} method is easy to use and quick to adjust. The \textit{Logarithmic} method is very similar to the \textit{Simple} method, but it uses a logarithmic scale rather than a linear scale. When using the \textit{Advanced} method, each contour line is individually controlled.

![The Levels for Map dialog is used to adjust level properties with](image)
Chapter 2 - Tutorial

*the Advanced level method.*

Control advanced settings for the *Level, Line, Fill, Label,* and *Hach* properties of the contour map in the **Levels for Map** dialog. Properties can be adjusted for all contours at once by clicking on the column buttons, or for individual contours by double-clicking on the specific contour level.

The changes that can be made by clicking the **Levels for Map** dialog header buttons include the following:

- Set the minimum, maximum, and contour interval by clicking the **Level** button.
- Set the line properties for all lines to a uniform or gradational color and style by clicking the **Line** button.
- Set the **Colormap** for the foreground and background color and the fill pattern between all contour lines by clicking the **Fill** button.
- Set the label properties for all contour labels or contour labels on a frequency basis by clicking the **Label** button.
- Set the hachure properties for all contours or on a frequency basis by clicking the **Hach** button.

Individual level changes that can be made include the following items:

- Set an individual level value by double-clicking on the level value to enter a new *Z value.*
- Set the individual line properties for a single level by double-clicking the line style for that level.
- Set the fill color or pattern for a single level by double-clicking on the fill pattern for that level.
- Set the label properties for a single contour label by double-clicking on the Yes or No under the **Label** column for that level.
- Set the hachure properties for a single contour level by double-clicking on the Yes or No under the **Hach** column for that level.

Now we will apply the Advanced level method and customize the contour levels with some bulk changes:

1. In the **Contents** window, click once on the **Contours-Tutorial.grd** contour layer to select it.
2. In the **Properties** window, click on the **Levels** tab.
3. Change the **Level method** by clicking on the word **Simple** next to **Level method** and selecting **Advanced** from the list.
4. Click the **Edit Levels** button next to **Contour levels** to open the advanced **Levels for Map** dialog.
5. Clicking the column header buttons makes bulk changes at regular intervals. Click on the **Label** button. The **Labels** dialog opens.
6. Change the **First** value to 2, the **Set** value to 1, and the **Skip** value to 2.
   - The **First** value tells **Surfer** which contour line to first change. This says to set the label format for the second contour line (Z=30).
   - The **Set** value tells **Surfer** how many lines to set with this style. This says to set only one line with the label format.
   - The **Skip** value tells **Surfer** how many lines to skip before setting the next contour line. This says to skip two contour lines. So, the Z=40 and Z=50 contours are not set. The next contour line Z=60 uses the label format. Z=70 and Z=80 are skipped. Z=90 is set. Z=100 is skipped.
7. Click the **Font** button. The **Font Properties** dialog opens.
8. Set the **Size (points)** to 12.
9. Set the Foreground color and opacity color to White.
10. Click **OK** in the **Font Properties** dialog.
11. Click **OK** in the **Labels** dialog. Notice how the label status is changed in the **Levels for Map** dialog.
12. Click on the **Hach** button. The **Hachures** dialog opens.
13. Set the *First* to 1, the *Set* to 1, and the *Skip* to 0.
   - The *First* value tells **Surfer** to set the hachure setting for the first contour line, \( Z=20 \).
   - The *Set* value tells **Surfer** to set only one contour line to the hachure style.
   - The *Skip* value tells **Surfer** how many contours to skip. In this case, no contours are skipped. This means that all of the contours will have the hachure style.

14. Check the *Hachure Closed Contours Only* box, if it is not already checked.
15. Change the Direction to Uphill.
16. Click **OK** in the **Hachures** dialog. This changes all of the items under *Hach* to **Yes**. All closed contours will have hachure marks.
17. Click **OK** in the **Levels for Map** dialog and the bulk changes are made to the contour map.

Now we will open the **Levels for Map** dialog again and set properties for individual contour levels:

1. In the **Contents** window, click once on the *Contours-Tutorial.grd* contour layer to select it.
2. In the **Properties** window, click on the **Levels** tab.
3. Make sure that the *Level method* is set to **Advanced**.
4. Click the **Edit Levels** button next to *Contour levels* to open the advanced **Levels for Map** dialog.
5. In the **Levels for Map** dialog, you can double-click an individual *Z* value in the list underneath the *Level* button to change the *Z* value for that particular contour level. Let's double-click on the number 60.
6. In the **Z Level** dialog, highlight the value 60 and type in 65.
7. Click **OK** in the **Z Level** dialog, and the contour line level changes to 65.
8. You can also double-click the line style for an individual level to modify the line properties for the selected level. This provides a way to emphasize individual contour levels on the map. Double-click on the line style next to the level 70.
9. In the **Line Properties** dialog, change the *Style* to a solid line by clicking on the dashed line and selecting the *Solid* line from the list.
10. Click **OK** in the **Line Properties** dialog.
11. Let's add a single contour line halfway between two existing values. Click on the number 65 under the *Level* column.
12. Click the **Add** button. The value 57.5 is added between the 50 and the 65.

Use the **Levels for Map** dialog to make bulk and individual changes to contour levels.

13. Click **OK** in the **Levels for Map** dialog and the individual settings are made to the contour map.
Adding, Deleting, and Moving Contour Labels - Tutorial

Contour label locations can be changed on an individual basis. Labels can be added, deleted, or moved. This section will demonstrate adding, deleting, and moving contour labels:

1. Select the contour layer by clicking the Contours-Tutorial.grd object in the Contents window.
2. Click the Map Tools | Edit Layer | Contour Labels command or right-click on the contour map and select Edit Contour Labels. The cursor changes to  to indicate that you are in edit mode. Contour labels have rectangular boxes around them in edit mode.
3. To delete a label, click on the label and press the DELETE key on the keyboard. For example, left-click on one of the 65 labels and press the DELETE key on your keyboard.
4. To add a label, press and hold the CTRL key on the keyboard and left-click the location on the contour line where you want the new label to be located. The cursor changes to a black arrowhead with a plus sign  to indicate you are able to add a new label. Add several contour labels to the red lines.
5. To move a contour label, left-click on the label, hold down the left mouse button, and drag the label. Release the left mouse button to complete the label movement.
6. To duplicate a label, hold the CTRL key while clicking and dragging an existing label. The duplicate label will be dragged to a new location along the line.
7. To exit the Edit Contour Labels mode, press the ESC key, click the Home | Selection | Select command, or click the Map Tools | Edit Layer | Contour Labels command.
Contour labels can be moved, added, or deleted with the **Contour Labels** command.

### Exporting 3D Contours - Tutorial

When you have completed a contour map in the plot window, you can export the contour lines with associated Z values to an AutoCAD DXF, 2D SHP, 3D SHP, or TXT file. To export contour lines to a DXF, 2D or 3D SHP, or TXT file:

1. Select the contour map layer by clicking `Contours-Tutorial.grd` in the **Contents** window.
2. Click the **Map Tools | Layer Tools | Export Contours** command.
3. In the **Save As** dialog, type `Tutorial contours` in the **File name** box.
4. Select AutoCAD DXF File (*.dxf), 2D Esri Shapefile (*.shp), 3D Esri Shapefile (*.shp), or Text format (*.txt) in the **Save as type** list.
5. Click **Save** and the file is exported to the current directory. This creates a file titled `Tutorial contours.dxf`, `Tutorial contours.shp`, or `Tutorial contours.txt` depending on what file type you selected. Additional files may also be created that accompany the DXF or SHP file.

The contours are exported as polylines or polygons. The labels and gaps are removed. The exported file can be used in **Surfer** as a base map, or used in other applications. The **File | Export** command can also be used to export 2D or 3D contours. A comparison between the **Export Contours** and **Export** commands is available on the **Export Contours** help topic.

### Changing the Post Layer Properties - Tutorial

Symbols in a post map can all be the same or can be selected with a worksheet column. Symbol sizes can all be the same or have proportional sizes. Symbol colors can all be the same or have color based on a column. Now we will edit the post map layer properties:

1. Click on the `Post-Tutorial.dat` layer in the **Contents** window.
2. In the **Properties** window, click on the **Symbol** tab.
3. Click the **Symbol** next to **Symbol** if the **Symbol** section is not already expanded.
4. Click the **Symbol Properties** next to **Symbol Properties** to open the **Symbol Properties** section.
5. Click the selected symbol next to the **Symbol** property. In the list, click on the filled diamond symbol (**Symbol set: GSI Default Symbols, Number: 6**) from the symbol palette.
6. Click the **Symbol Size** next to **Symbol Size** to open the **Symbol Size** section.
7. Highlight the value next to the **Symbol size** option and type 0.15 in.
8. Press ENTER on the keyboard. The symbols update with the new symbol size.
9. Click the **Symbol Color**.
10. To change the symbol colors based on a worksheet value, click on the **None** next to the **Color column** option and select **Column C: Elevation**.
11. Verify that the Color method is set to Numeric via colormap.
12. Click the colormap next to the **Symbol colors** and select the desired colormap, such as **Terrain**.

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Chapter 2 - Tutorial

If the post map is not visible, ensure that the post layer is on top of the contour layer in the **Contents** window. The order the layers are listed in a map object is the order the map layers are drawn in the plot window. To move the post layer in the **Contents** window, left-click and drag the post layer above the other layers in the map object. Alternatively, select the post layer and click the **Layout | Arrange | Bring to Front | Bring Forward** command, or right-click the post layer and select **Order Objects | Move Forward**.

The updated post map is displayed overlaid on the contour layer and color relief layer.

### Adding Labels to the Post Layer - Tutorial

You can add labels to the data points on **post maps** and **classed post maps**. Multiple labels can be added to display all of the information desired in the map. We will add labels showing the elevation and names for the data points:

1. Click on the **Post-Tutorial.dat** layer in the **Contents** window.
2. In the **Properties** window, click on the **Labels** tab.
3. Click the **Add** button next to **Label Set 1**, if the section is not already open.
4. Next to **Worksheet column**, click the word **None**. A list displaying all of the columns in **Tutorial.dat** are displayed. Select **Column C: Elevation** from the list.
5. For the **Position relative to symbol option**, click on the existing option and select **Below** from the list.
6. Click the **Add** button next to the **Add label set** option to add a second label to the post map.
7. Next to **Worksheet column**, click the word **None**. A list displaying all of the columns in **Tutorial.dat** are displayed. Select **Column D: Name** from the list.
8. For the **Position relative to symbol option**, click on the existing option and select **Above** from the list.
9. Click the **Add** button next to **Font Properties** to open the **Font Properties** section.
10. Change the **Background opacity** to 33%. This places a semi-transparent white box around the names.

The post map layer is automatically redrawn with labels on each of the data points.
Add labels to post maps in the **Properties** window on the **Labels** tab.

### Moving Individual Post Labels - Tutorial

You can move individual labels on **post maps** and **classed post maps** with the **Map Tools | Edit Layer | Post Labels** command. Alternatively, add labels, and then right-click the post map and select **Edit Post Labels** to enter edit mode. A customizable line is automatically added from the data point label to the actual X, Y data point location.

1. Select the **Post-Tutorial.dat** layer in the **Contents** window.
2. Click the **Map Tools | Edit Layer | Post Labels** command or right-click on the selected map and select **Edit Post Labels**. The cursor will change to \( \text{\textdegree} \) to indicate you are now in post label editing mode.
3. Left-click on a label, hold the left mouse button down, and drag the label to a new location. With the left mouse button held down, the arrow keyboard keys can be used to nudge the label location. Release the left mouse button to place the label in the new location. A leader line will be added from the point location to the new label location by default. The leader line visibility and line properties are controlled on the **Labels** page in the **Properties** window when the post layer is selected.
4. Press the ESC key to exit the post label editing mode.

Customize the post map labels with the **Edit Post Labels** command.
Lesson 4 - Modifying an Axis

Every map is created with four map axes: the bottom, right, top, and left axes. 3D maps also have an additional Z axis. You can control the display of each axis independently of the other axes on the map. Additional left, right, top, bottom, or Z axes can be added to a map with the Map Tools | Add to Map | Axis commands. You can control the display of each axis independently of the other axes on the map. In this example, we will change the axis label spacing and add an axis title:

1. Move the cursor over one of the axis tick labels on the bottom X axis and left-click the mouse. In the status bar at the bottom of the plot window, the words "Map: Bottom Axis" are displayed. The Bottom Axis object is selected in the Contents window. This indicates that you have selected the bottom axis of the map. Additionally, blue circle handles appear at each end of the axis, and green square handles appear surrounding the entire map. This indicates that the axis is a "sub-object" of the entire map.
2. The bottom axis properties are displayed in the Properties window. Click on the General tab.
3. Click the ▪ next to Title to open the Title section if it is not already open.
4. Click in the box next to Title text. Type Bottom Axis and press the ENTER key on the keyboard. This places a title on the selected axis. Alternatively, click the □ button. Type the text in the Text Editor and click OK.
5. If you cannot see the axis title, click the View | Zoom | Selected command. The map automatically increases its size to fill the plot window.

Changing the Tick Label Properties - Tutorial

All properties of the axis can be edited, including the tick label format and frequency. We will change both format and frequency in this example:

1. In the Properties window, click on the Scaling tab to display the axis scaling options.
2. In the Major interval field, highlight the value 1 and type the value 1.5.
3. Press ENTER on the keyboard to place 1.5 X map units between tick marks. This spacing automatically updates on the map axis.
4. Click on the General tab in the Properties window.
5. Click the ▪ next to Labels, if it is not already open.
6. Click the ▪ next to Label Format to open the Label Format section.
7. In the Label Format section, select Fixed for the Type.
8. Click in the box next to Decimal digits. Highlight the existing value and type the value 1.
9. Press ENTER on the keyboard. This indicates that only one digit follows the decimal point for the axis tick labels.

The map is updated immediately after every change, showing the axis tick spacing, labels, and the axis title.

Lesson 5 - Creating a Profile

The ability to slice a grid file in Surfer to create a file of data points along a specified line of section is a very powerful tool. The sliced data can be visually displayed as a profile in Surfer, or multiple profiles can be combined to display a cross section. However, if being able to quickly see the profile on the map and on a graph is the desire, the Map Tools | Add to Map | Profile command provides an excellent quick method. The profile line will be drawn directly on the map:

You can use the axis properties to change the tick mark and axis title properties.
Chapter 3 - Data Files and the Worksheet

Data files contain the raw information used to create a grid file, perform residual calculations, or produce post maps. Each record in a data file occupies a single row and is comprised of at least two values (X, Y) for post maps and at least three values for gridding (X, Y, Z). The X, Y, and Z values are each placed in separate columns. The X and Y coordinates define the position of the point on the map, and the Z value defines the value assigned to the specific X, Y location. Common examples of X, Y coordinates include longitude and latitude, easting and northing, or UTM (Universal Transverse Mercator) coordinates. The Z data might be topographic elevation, water depth, chemical concentration, temperature, or any other quantity amenable to mapping.

Data files can be created in the Surfer worksheet, a text editor, or any program that can produce files in one of the supported file formats. Regardless of the program used to create your data files, you must save the file on disk prior to performing any Surfer operation requiring a data file, including the gridding operation. Surfer reads data only from a data file in one of the recognized formats.

It is not necessary to open a data file in the worksheet in order to use the data file for a command (i.e. Grid | Data). If you want to view or alter the data in a data file, you can use the File | Open command to gain access to the worksheet data.

Surfer requires the use of decimal degree values when using Latitude and Longitude data.

XYZ Data Files

XYZ data files contain the raw data Surfer interprets to produce a grid file. Before you create a grid file in Surfer, you must create an XYZ data file. XYZ data files must be organized in column and row format. By default, Surfer expects the X data to be contained in column A, the Y data in column B, and the Z data in column C. However, the data can be placed in any order in any column.

Portions of two simple data files are shown below. The order of the data in the file is not important. These examples contain descriptive headers in Row 1 of each column. Such information is helpful but not required by Surfer to create a grid file. When text appears in Row 1 of a column, this text appears in list boxes in various Surfer dialogs as column titles. If a number resides in Row 1, it is not incorporated into the dialogs, and instead, the column heading (such as column B) is displayed.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.1</td>
<td>0</td>
<td>90</td>
</tr>
<tr>
<td>2</td>
<td>3.5</td>
<td>0</td>
<td>45</td>
</tr>
<tr>
<td>3</td>
<td>4.9</td>
<td>0</td>
<td>65</td>
</tr>
<tr>
<td>4</td>
<td>6.2</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>0</td>
<td>55</td>
</tr>
<tr>
<td>6</td>
<td>9</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>7</td>
<td>9</td>
<td>5</td>
<td>55</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>3</td>
<td>48</td>
</tr>
</tbody>
</table>

This is a simple XYZ data file.
Chapter 3 - Data Files and the Worksheet

This is another example of an XYZ data file with header information in row 1 of each column in the data file.

Missing Entries

Rows with non-numeric entries (empty cells or text) in any of the X, Y, or Z columns are excluded when performing various tasks, including gridding or transforming data in the worksheet. If there is no Z information for a particular XY location, you can leave the Z cell blank for that row. In the example shown here, there are two data records without Z values. These records are not considered during the gridding operation.

Multiple Columns of Information for Additional Maps

Data files can contain up to one billion columns. Since you can specify the columns to be gridded, your X, Y, and Z values can occupy any three columns. This allows you to have columns containing other information particular to each point. The data file can contain several Z columns, so you can produce several contour maps using the same XY coordinates. For example, you might have concentrations of different contaminants at each sample location. All the contaminant concentration data can be placed in the same data file.

This is an example of an XYZ data file containing several columns of Z data. You could use this file to create several different grid files,
Additional Information in Data Files

Data files may contain information in addition to the X, Y, and Z values. For example, when posting data with the Home | New Map | Post command, additional columns can be used to specify the symbol, the rotation angle, the symbol color, labels, etc. The following is an example of such a data file. Columns A, B, and C contain the X, Y, and Z data used to produce a contour map of depth to the water table. Columns D, E, and F contain information used to create an overlaying post map.

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>Y</td>
<td>C</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>1</td>
<td>Easting</td>
<td>Northing</td>
<td>Elevation</td>
<td>Symbol set: index</td>
<td>Color</td>
</tr>
<tr>
<td>2</td>
<td>0.1</td>
<td>0</td>
<td>90</td>
<td>Arial:65</td>
<td>Red</td>
</tr>
<tr>
<td>3</td>
<td>3.5</td>
<td>0</td>
<td>45</td>
<td>Arial:66</td>
<td>green</td>
</tr>
<tr>
<td>4</td>
<td>4.9</td>
<td>0</td>
<td>65</td>
<td>Arial:67</td>
<td>blue</td>
</tr>
<tr>
<td>5</td>
<td>6.2</td>
<td>0</td>
<td>40</td>
<td>GSI Default Symbols:4</td>
<td>purple</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>0</td>
<td>55</td>
<td>GSI Default Symbols:8</td>
<td>majestic pl</td>
</tr>
<tr>
<td>7</td>
<td>9</td>
<td>0</td>
<td>25</td>
<td>GSI Default Symbols:14</td>
<td>Red</td>
</tr>
</tbody>
</table>

A data file used to create a post map or a classed post map can contain several columns of data. Each column can have a different effect on the posted data points.

Data as Numbers or Text

Worksheet data are in one of two forms: numbers or text. Grid file creation, statistics, post maps, and other operations require data as numbers. Text data (even if it contains numeric digits) can be used for labels in Surfer, but it cannot be used to create grids or in any operation requiring numbers.

Numbers can consist of digits (0 - 9), decimal points (.), the letters "e," "d," "E," or "D" (indicating an exponent), and the plus (+) or minus (-) sign. If you type any characters other than these when entering a number (or type any of the special characters more than once), Surfer automatically converts the cell entry to text. For example, if your longitude data appears as 104.5 W in a worksheet cell, it is interpreted as text and cannot be used to grid data. To successfully read this data, use the -104.5 format to indicate a location 104.5 degrees west of the prime meridian. If a number has if formatted as text and should be formatted as a number, highlight the cell or group of cells to select them and click the Text to Number command.

You can also convert numeric data to text by typing a single quotation mark (') in front of the number. Surfer does not place the single quotation in the worksheet cell, however the single quotation is visible in the Active Cell Edit Box.

By default, numeric data is right justified in a cell, and text is left justified. Cell entries, whether numeric or text, can be justified by specifying the desired alignment using the options on the Alignment page of the Format Cells dialog. Use the Text to Number command to remove text formatting.
Notice that column B is left aligned. This means the numbers are formatted as text. When a cell is highlighted, an apostrophe appears in the active cell edit box, also indicating that the number is formatted as text.

Data File Formats

**Surfer** can import and export data in several data **file formats**. A variety of commands in the plot document, **worksheet document**, and grid editor can be used to import and export data. The commands are summarized below:

**Import Data File Formats**
- File | Import in the plot document
- Data | Edit | Merge in the worksheet document
- File | Open in the plot, worksheet, or grid editor

**Export Data File Formats**
- File | Export in the plot document
- File | Save As in the plot document
- Grids | Edit | Convert in the plot document
- File | Save As in the grid editor
- File | Save As in the worksheet document

Date/Time Formatting

In addition to numbers and text, **dates and times** are format types in **Surfer**. Dates and times can be used to create a grid, as axis and plot labels, and to set axis limits.

**Using Date/Time Formatting**

To use dates and times in **Surfer**, the data need to be formatted as dates and times. One way to format data in **Surfer** is to use the worksheet. The worksheet can be accessed with the File | New | Worksheet or File | Open command. Highlight the column containing dates and times and select Data | Format | Format Cells to set the column as date/time in the worksheet. On the Number tab, select Date/time as the Type. Next, type the appropriate Date/Time format option, or click the button and select or create a date/time format in the Date/Time Format Builder dialog.
Once the formatting is set to date/time, you can use the date/time information just as you would use numbers in Surfer:

- you can create a post map of the data using date/time values
- you can set the map limits using date/time values
- you can grid date/time values

Date/time information can also be used as labels anywhere in the map layer or as axis tick labels.

Date/Time formats are made of combinations of year, month, day, hours, minutes, seconds, BC/AD or BCE/CE designation, and AM/PM designation. Years are shown as yy or yyyy. Months are shown as M, MM, MMM, MMMM, or MMMMM. Days are shown as d, dd, ddd, or dddd. Hours are shown as h, hh, H, HH, or [h]. Minutes are shown as m, mm, or [mm]. Seconds are shown as ss, ss.0, ss.00, ss.000, or [ss]. AM/PM designation is shown as tt or TT. BC/AD designation is shown as gg or GG. BCE/CE designation is shown as g, G, ggg, or GGG. See the Date Time Formats help topic for examples of date/time formats.

Date/Time Formatting Tips

- In the worksheet, save data files containing date/time formatting as Excel files to preserve the date time formatting as seen in the worksheet.
- You can save date/time-formatted data files as ASCII files (.DAT, .CSV, .TXT, .BNA, or BLN). Sometimes this is necessary if you exceed the Excel row or column limits. When opening the file in Surfer's worksheet, you can make the serial numbers appear as dates by using Data | Format | Format Cells.
- If you have formatted the data as date/time in another spreadsheet program such as Excel, the data are formatted as date/time in Surfer.
- Whenever possible, enter and display dates and times in one of the many calendar formats, e.g., "6/14/2009" or "14-June-2009", and let the software handle converting to/from internal numeric representations.
- When the recognized format is ambiguous (i.e. 10/7/12), the month, day, and year order is determined by the Windows locale. In some countries, this will be recognized as M/d/yy, in others as d/M/yy, and in others as YY/M/d. It is important to use non-ambiguous date/time formats when the Windows locale may change.
- The year 0 is defined, according to the ISO 8601:2004 standard.
- If dates/times occur before 1/1/0000, use the BC or BCE suffix after the date. So, Alexander III of Macedon's birthday would be listed as 20-July-356 BCE in the worksheet. Using AD or CE is not necessary and the worksheet will automatically remove these in dates after 1/1/0000.
- When a two digit year is input in the worksheet (00 to 99), it means the year in the current century. For instance, inputting 11/4/13, indicates that the year is 2013, not 0013. In order to have the year 0013, the full four digits (0013) must be input for the date. So, the date would be input as 11/4/0013 CE for November 4, 0013 CE or 11/4/0013 BCE for November 4, 0013 BCE.

Date Time Formats

Date and time formats can be set from the worksheet, from labels, and from axes. In addition, date and time formats can be used for data columns when creating post maps or when gridding data. Date and time options are case sensitive.

When dates are parsed during input/import, the month and day of week names must match those of the local language as set in the Windows Control Panel, otherwise the entry will not be recognized as a valid date and will be treated as a text string.
Chapter 3 - Data Files and the Worksheet

Date/Time formats are made of combinations of locale, year, month, day, hours, minutes, seconds, BC/AD or BCE/CE designation, and AM/PM designation. Years are shown as yy or yyyy. Months are shown as M, MM, MMM, MMMM, or MMMMM. Days are shown as d, dd, ddd, or dddd. Hours are shown as h, hh, H, HH, or [h]. Minutes are shown as m, mm, or [mm]. Seconds are shown as ss, ss.0, ss.00, ss.000, ss.0000, or [ss]. AM/PM designation is shown as tt or TT. BC/AD designation is shown as gg or GG. BCE/CE designation is shown as g, G, ggg or GGG.

To add new date/time designations, use any combination of the following codes:

<table>
<thead>
<tr>
<th>Code</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>d</td>
<td>9</td>
<td>Single digit day, excluding leading zero</td>
</tr>
<tr>
<td>dd</td>
<td>09</td>
<td>Double digit day, including leading zero</td>
</tr>
<tr>
<td>ddd</td>
<td>Wed</td>
<td>Shortened day of week name</td>
</tr>
<tr>
<td>dddd</td>
<td>Wednesday</td>
<td>Full day of week name</td>
</tr>
<tr>
<td>M</td>
<td>7</td>
<td>Single digit month, excluding leading zero</td>
</tr>
<tr>
<td>MM</td>
<td>07</td>
<td>Double digit month, including leading zero</td>
</tr>
<tr>
<td>MMM</td>
<td>Jul</td>
<td>Shortened month name</td>
</tr>
<tr>
<td>MMMM</td>
<td>July</td>
<td>Full month name</td>
</tr>
<tr>
<td>MMMMM</td>
<td>J</td>
<td>First letter of month name</td>
</tr>
<tr>
<td>yy</td>
<td>98</td>
<td>Two digit year</td>
</tr>
<tr>
<td>yyyy</td>
<td>1998</td>
<td>Full year</td>
</tr>
<tr>
<td>g</td>
<td></td>
<td>Before Common Era designator - Includes space and bce or nothing if ce, lower case</td>
</tr>
<tr>
<td>gg</td>
<td>ad</td>
<td>BC/AD designator - Includes space and bc or ad, lower case</td>
</tr>
<tr>
<td>ggg</td>
<td>ce</td>
<td>Before Common Era designator - Includes space and bce or ce, lower case</td>
</tr>
<tr>
<td>G</td>
<td></td>
<td>Before Common Era designator - Includes space and BCE or nothing if CE, upper case</td>
</tr>
<tr>
<td>GG</td>
<td>AD</td>
<td>BC/AD designator - Includes space and BC or AD, upper case</td>
</tr>
<tr>
<td>GGG</td>
<td>CE</td>
<td>Before Common Era designator - Includes space and BCE or CE, upper case</td>
</tr>
<tr>
<td>h</td>
<td>6</td>
<td>Single digit hours - 1-12, excluding leading zero</td>
</tr>
<tr>
<td>hh</td>
<td>06</td>
<td>Double digit hours - 01-12, including leading zero</td>
</tr>
<tr>
<td>H</td>
<td>18</td>
<td>Hours - 0-23 military, excluding leading zero</td>
</tr>
<tr>
<td>HH</td>
<td>18</td>
<td>Hours - 00-23 military, including leading zero</td>
</tr>
<tr>
<td>[h]</td>
<td>1003914</td>
<td>Hours portion of total time, excludes leading zeros</td>
</tr>
<tr>
<td>m</td>
<td>45</td>
<td>Minutes - 0-60, excluding leading zero</td>
</tr>
<tr>
<td>mm</td>
<td>45</td>
<td>Minutes - 00 to 60, including leading zero</td>
</tr>
<tr>
<td>[mm]</td>
<td>45</td>
<td>Minutes portion of total time, includes leading zeros</td>
</tr>
<tr>
<td>ss</td>
<td>44</td>
<td>Seconds - 0-60, rounded to the nearest second</td>
</tr>
<tr>
<td>ss.0</td>
<td>44.1</td>
<td>Seconds - 0-60, rounded to the nearest tenth of a second</td>
</tr>
</tbody>
</table>
ss.00 44.12 Seconds - 0-60, rounded to the nearest hundredth of a second
ss.000 44.123 Seconds - 0-60, rounded to the nearest millisecond
ss.0000 44.12345 Seconds - 0-60, maximum precision
[ss] 44 Seconds portion of total time, includes leading zeros
tt pm am or pm designator, lower case
TT PM AM or PM designator, upper case
\ escape character - output next character verbatim
'...' output ALL characters between single quotes verbatim, including escape character
[$-xxxx] [$-409] xxxx is an up to four hex digit representation of a locale ID

Custom Date/Time Example

```
mm/dd/yy 9/7/98
```

Month double digits, Day double digits, Year double digits, separated with /

```
04/14/09 6:45:44 PM
```

When dates are parsed during input/import, the month and day of week names must match those of the local language as set in the Windows Control Panel, otherwise the entry will not be recognized as a valid date and will be treated as a text string.

When the recognized format is ambiguous (i.e. 10/7/12), the month, day, and year order is determined by the Windows locale. In some countries, this will be recognized as M/d/yy, in others as d/M/yy, and in others as YY/M/d. It is important to use non-ambiguous date/time formats when the Windows locale may change.

The tables below show many examples of date/time format strings.

Date Formats

All rows below use the date September 7, 1998 for the Example.

<table>
<thead>
<tr>
<th>Code</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(None)</td>
<td></td>
<td>Date not displayed</td>
</tr>
<tr>
<td>M/d/yy</td>
<td>9/7/98</td>
<td>Single digit month and day, two digit year,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>separated with /</td>
</tr>
<tr>
<td>MM/dd/yy</td>
<td>09/07/98</td>
<td>Double digit month, day, and year, separated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>with /</td>
</tr>
<tr>
<td>M/d/yyyy</td>
<td>9/7/1998</td>
<td>Single digit month and day, full year,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>separated with /</td>
</tr>
<tr>
<td>MMM dd, yyyy</td>
<td>Sep 07, 1998</td>
<td>Shortened month name, double digit day, full</td>
</tr>
<tr>
<td></td>
<td></td>
<td>year, separated with spaces and comma</td>
</tr>
<tr>
<td>MMMM dd, yyyy</td>
<td>September 07, 1998</td>
<td>Full month name, double digit day, full</td>
</tr>
<tr>
<td></td>
<td></td>
<td>year, separated with spaces and comma</td>
</tr>
<tr>
<td>Shortened Form</td>
<td>Expanded Form</td>
<td>Description</td>
</tr>
<tr>
<td>----------------</td>
<td>----------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>MMMM-d-yyyy</td>
<td>September-7-1998</td>
<td>Full month name, single digit day, full year, separated with -</td>
</tr>
<tr>
<td>d MMMM yyyy</td>
<td>7 September 1998</td>
<td>Single digit day, full month name, full year, separated with spaces</td>
</tr>
<tr>
<td>d-MMM-yy</td>
<td>7-Sep-98</td>
<td>Single digit day, shortened month name, two digit year, separated with -</td>
</tr>
<tr>
<td>dd-MMM-yy</td>
<td>07-Sep-98</td>
<td>Double digit day, shortened month name, two digit year, separated with -</td>
</tr>
<tr>
<td>d-MMM-yyyy</td>
<td>7-Sep-1998</td>
<td>Single digit day, shortened month name, full year, separated with -</td>
</tr>
<tr>
<td>d-MMM</td>
<td>7-Sep</td>
<td>Single digit day, shortened month name, separated with -</td>
</tr>
<tr>
<td>MMM-yy</td>
<td>Sep-98</td>
<td>Shortened month name, two digit year, separated with -</td>
</tr>
<tr>
<td>MMM-yyyy</td>
<td>Sep-1998</td>
<td>Shortened month name, full year, separated with -</td>
</tr>
<tr>
<td>MMMMM-yyyy</td>
<td>September-98</td>
<td>Full month name, two digit year, separated with -</td>
</tr>
<tr>
<td>MMMM-yyyy</td>
<td>September-1998</td>
<td>Full month name, full year, separated with -</td>
</tr>
<tr>
<td>MM-dd-yy</td>
<td>09-07-98</td>
<td>Double digit month and day, two digit year, separated with -</td>
</tr>
<tr>
<td>yyyy</td>
<td>1998</td>
<td>Full year</td>
</tr>
<tr>
<td>yyyy gg</td>
<td>1998 ad</td>
<td>Full year with lowercase bc/ad designation</td>
</tr>
<tr>
<td>yyyy GGG</td>
<td>1998 CE</td>
<td>Full year with uppercase BCE/CE designation</td>
</tr>
<tr>
<td>yy</td>
<td>98</td>
<td>Two digit year</td>
</tr>
<tr>
<td>MMMMMM</td>
<td>S</td>
<td>First letter of month name</td>
</tr>
<tr>
<td>MMMM</td>
<td>September</td>
<td>Full month name</td>
</tr>
<tr>
<td>MMM</td>
<td>Sep</td>
<td>Shortened month name</td>
</tr>
<tr>
<td>MM</td>
<td>09</td>
<td>Double digit month</td>
</tr>
<tr>
<td>M</td>
<td>9</td>
<td>Single digit month</td>
</tr>
<tr>
<td>MMMMM-yyyyy</td>
<td>S-98</td>
<td>First letter of month name, two digit year, separated with -</td>
</tr>
<tr>
<td>MMM-d</td>
<td>Sep-7</td>
<td>Shortened month name, single digit day, separated with -</td>
</tr>
<tr>
<td>M/d</td>
<td>9/7</td>
<td>Single digit month and day, separated with /</td>
</tr>
<tr>
<td>dddd</td>
<td>Monday</td>
<td>Full day of week name</td>
</tr>
<tr>
<td>ddd</td>
<td>Mon</td>
<td>Shortened day of week name</td>
</tr>
<tr>
<td>dd</td>
<td>07</td>
<td>Double digit day</td>
</tr>
<tr>
<td>d</td>
<td>7</td>
<td>Single digit day</td>
</tr>
<tr>
<td>d/M/yy</td>
<td>7/9/98</td>
<td>Single digit day and month, two digit year, separated with /</td>
</tr>
<tr>
<td>d.M.yy</td>
<td>7.9.98</td>
<td>Single digit day and month, two digit year, separated with .</td>
</tr>
</tbody>
</table>
dd/MM/yy  07/09/98  Double digit day and month, two digit year, separated with /

dd/MM/yyyy  07/09/1998  Double digit day and month, full year, separated with /

yy/MM/dd  98/09/07  Two digit year, double digit month and day, separated with /

yyyy-MM-dd  1998-09-07  Full year, double digit month and day, separated with -

**Time Formats**

All rows below use the time 2:45:44.12 PM for the *Example*.

<table>
<thead>
<tr>
<th><strong>Code</strong></th>
<th><strong>Example</strong></th>
<th><strong>Description</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(None)</td>
<td></td>
<td>Time not displayed</td>
</tr>
<tr>
<td>h:mm tt</td>
<td>2:45 PM</td>
<td>Hour in 0-12 (standard format), two digit Minutes 00 to 60, then a space and AM or PM</td>
</tr>
<tr>
<td>h:mm</td>
<td>14:45</td>
<td>Hour in 0-23 (military time), two digit Minutes 00 to 60</td>
</tr>
<tr>
<td>hh:mm</td>
<td>14:45</td>
<td>Two digit Hour 00-23 (military time), two digit Minutes 00 to 60</td>
</tr>
<tr>
<td>h:mm:ss tt</td>
<td>2:45:44 PM</td>
<td>Hour in 0-12 (standard format), two digit Minutes 00 to 60</td>
</tr>
<tr>
<td>h:mm:ss</td>
<td>14:45:44</td>
<td>Hour in 0-23 (military time), two digit Minutes 00 to 60, two digit Seconds 00 to 60</td>
</tr>
<tr>
<td>hh:mm:ss</td>
<td>14:45:44</td>
<td>Two digit Hour 00-23 (military time), two digit Minutes 00 to 60, two digit Seconds 00 to 60</td>
</tr>
<tr>
<td>m:ss</td>
<td>45:44</td>
<td>Single digit Minutes 0 to 60, two digit Seconds 00 to 60</td>
</tr>
<tr>
<td>mm:ss</td>
<td>45:44</td>
<td>Two digit Minutes 00 to 60, two digit Seconds 00 to 60</td>
</tr>
<tr>
<td>m:ss.0</td>
<td>45:44.1</td>
<td>Single digit Minutes 0 to 60, two digit Seconds 00 to 60, fractional seconds rounded to the nearest tenth of a second</td>
</tr>
<tr>
<td>mm:ss.0</td>
<td>45:44.1</td>
<td>Two digit Minutes 00 to 60, two digit Seconds 00 to 60, fractional seconds rounded to the nearest tenth of a second</td>
</tr>
<tr>
<td>h:mm:ss.000</td>
<td>14:45:44.12</td>
<td>Hour in 0-23 (military time), two digit Minutes 00 to 60, two digit Seconds, 00 to 60, fractional seconds with full precision</td>
</tr>
<tr>
<td>m:ss.000</td>
<td>45:44.12</td>
<td>Single digit Minutes 0 to 60, two digit Seconds 00 to 60, fractional seconds with full precision</td>
</tr>
<tr>
<td>mm:ss.000</td>
<td>45:44.12</td>
<td>Two digit Minutes 00 to 60, two digit Seconds 00 to 60, fractional seconds with full precision</td>
</tr>
<tr>
<td>[h]:mm:ss</td>
<td>865094:45:44</td>
<td>Total hours (day value plus hour value), two digit Minutes 00 to 60, two digit Seconds 00 to 60.</td>
</tr>
</tbody>
</table>
Example Explanation: Date value 865080 = September 7, 1998
Hour value = 14, added to 865080 = 865094

Worksheet Document
Worksheet windows are a view of the data file and are designed to display, edit, enter, and save data. The worksheet windows have several useful and powerful editing, transformation, and statistical operations available. In addition, a coordinate system can be assigned to the data file. Several import and export options are available for opening data files from other spreadsheet programs. The components of the worksheet window are displayed below.

Worksheet Commands
The worksheet commands include commands on the following tabs:

- **File**: Open and save files, import or export data, print, and set options and defaults
- **Home**: Contains clipboard and undo commands
- **Grids**: Perform grid operations
- **View**: Controls the display of status bar and windows and resets window positions
- **Data**: Edit, find, format data in the worksheet. Manipulate, transform, and perform calculations with worksheet data. Assign or project coordinates. Track the cursor between the plot, worksheet, and grid windows.

Not all of the **File**, **Home**, **Grids**, and **View** commands are available in the worksheet view.

The Application/Document Control menu commands control the size and position of the application window or the document window.

Tab View
The plot, worksheet, and grid node editor windows are displayed as **tabbed documents**. When more than one window is open, tabs appear at the top of the document, allowing you to click on a tab to switch to a different window. The tabs may be dragged to reorder them. When a document contains unsaved changes, an asterisk (*) appears next to its tabbed name. The asterisk is removed once the changes have been saved.
Worksheet Document
The image below contains the parts of the worksheet document.

Opening a Worksheet Window
You can view, enter, or modify data in the worksheet document.

To open a blank worksheet window:
- Click the File | New | Worksheet command in the plot document, grid editor, or worksheet document.
- Click the button in the toolbar.
- Press the CTRL + W keyboard command.

To view worksheet data:
- Click the File | Open command in the plot document, grid node editor, or worksheet document and then select a data file.
- Click the button in the toolbar. In the Open dialog, select a data file.
- Select the File | Open or File | Import command in the worksheet and then select a data file.
- If there is an open worksheet window, return to it at any time by clicking the desired worksheet tab.
To enter and modify worksheet data:
See Working with Worksheet Data for more information.

Worksheet Window
To enter data in a worksheet, click the File | Open command to open an existing data file or click the File | New | Worksheet command to create a blank worksheet. The components of the worksheet window are discussed below.

The components of a worksheet window shown above are described in the table below.

<table>
<thead>
<tr>
<th>Component Name</th>
<th>Component Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Column Letters</td>
<td>The letter that identifies a column of the worksheet.</td>
</tr>
<tr>
<td>Row Numbers</td>
<td>The number that identifies a row of the worksheet.</td>
</tr>
<tr>
<td><strong>Active Cell</strong></td>
<td>The cell highlighted with a bold outline. The active cell receives data input (numeric values or text strings) from the keyboard. Only one cell is active at a time.</td>
</tr>
<tr>
<td><strong>Active Cell Location</strong></td>
<td>The location of the active cell, specified by column letter and row number.</td>
</tr>
<tr>
<td><strong>Active Cell Edit Box</strong></td>
<td>The box displaying the data or text contained in the active cell. Data typed into an empty cell appears in both the edit box and the active cell.</td>
</tr>
<tr>
<td>Worksheet Name</td>
<td>The name of the data file displayed in the worksheet or the worksheet number prior to saving.</td>
</tr>
<tr>
<td><strong>Select Entire Worksheet Button</strong></td>
<td>The button used to select all cells in the worksheet. Located in the top left corner of the worksheet.</td>
</tr>
</tbody>
</table>

Row and Column Label Bars
The worksheet cells are located by column label bars (A, B, C...) or row label bars (1,2,3...). Click the label to select entire rows or columns, to change row height, to change column width, or to hide or unhide rows and columns. To select multiple rows or columns, drag the mouse over several adjacent labels.
Active Cell

The active cell is displayed with a heavy border surrounding the cell. The contents of this cell are displayed in the cell edit box. You can enter or edit data in the active cell. To edit existing data, activate the desired cell and press the F2 key or highlight the information in the cell edit box.

Special Key Functions when editing the active cell:

<table>
<thead>
<tr>
<th>Keyboard Command</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESC</td>
<td>ESC cancels edit mode and restores the original contents of the active cell.</td>
</tr>
<tr>
<td>ENTER</td>
<td>ENTER stores the contents of the cell edit box and then moves the active cell down one cell.</td>
</tr>
<tr>
<td>CTRL+ENTER</td>
<td>CTRL+ENTER completes the entry and keeps the current cell active.</td>
</tr>
<tr>
<td>ARROWS (left and right)</td>
<td>Left and right ARROWS move within the cell's text if the F2 key has been pressed. Otherwise, these keys store the contents of the cell edit box and then move the active cell to the left or right.</td>
</tr>
<tr>
<td>ARROWS (up and down)</td>
<td>Up and down ARROWS store the contents of the cell edit box in the active cell and move the active cell above or below.</td>
</tr>
<tr>
<td>DELETE</td>
<td>DELETE deletes the character to the right of the cursor if the F2 key has been pressed. Otherwise, pressing the delete key deletes the entire contents of the cell.</td>
</tr>
<tr>
<td>BACKSPACE</td>
<td>BACKSPACE deletes the character to the left of the cursor if the F2 key has been pressed. Otherwise, pressing the backspace key deletes the entire contents of the cell.</td>
</tr>
<tr>
<td>PAGE UP and PAGE DOWN</td>
<td>PAGE UP and PAGE DOWN store the contents of the cell edit box in the active cell and move one page up or down.</td>
</tr>
<tr>
<td>TAB and SHIFT+TAB</td>
<td>TAB and SHIFT+TAB store the contents of the cell edit box in the active cell and move the active cell to the right or left.</td>
</tr>
</tbody>
</table>

Active Cell Location Box

The active cell location box shows the location of the active cell in the worksheet. Letters are the column labels and numbers are the row labels.

<table>
<thead>
<tr>
<th>C5</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>x</td>
</tr>
<tr>
<td>1</td>
<td>Easting</td>
</tr>
<tr>
<td>2</td>
<td>0.1</td>
</tr>
<tr>
<td>3</td>
<td>3.5</td>
</tr>
<tr>
<td>4</td>
<td>4.9</td>
</tr>
<tr>
<td>5</td>
<td>6.2</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

*This example shows the active cell as cell C5. The name of the active cell "C5" is listed in the active cell location box in the upper left portion of the worksheet.*
Active Cell Edit Box

The cell edit box is located at the top of the worksheet window just above the column letter bar. The cell edit box shows the contents of the active cell and is used for editing cells. Use the cell edit box to see the contents of a worksheet cell when the column is too narrow to display all of the cell contents.

To begin editing the selected cell, press the F2 key. Alternatively, highlight the contents of the cell edit box to edit the cell. To overwrite the current cell contents, simply begin typing without pressing F2. If the mouse is clicked on a new cell, the new cell becomes the active cell.

Right-click in the active cell edit box to access the following commands in the context menu:

- **Right to left Reading order**: Toggles right to left reading order on or off.
- **Show Unicode control characters**: Toggles the display of Unicode control characters on or off.
- **Insert Unicode control character**: Select a Unicode control character from the list, and it is inserted in the active cell edit box at the cursor location.
- **Open/Close IME**: When a user types a phonetic representation of a word, the IME displays a candidate list on the screen. The user can select the intended word or phrase from among several different possible representations in the candidate list, and the user's selection then replaces the phonetic representation in the document. This command toggles the IME on or off.
- **Reconversion**: IME reconversion allows users who are typing in Japanese to convert back and forth between the phonetic spelling of a word (using the standard Western keyboard) and the Japanese character that represents the word.

Special Key Functions when Editing the Active Cell:

<table>
<thead>
<tr>
<th><strong>Keyboard Command</strong></th>
<th><strong>Action</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>ESC</td>
<td>ESC cancels edit mode and restores the original contents of the active cell.</td>
</tr>
<tr>
<td>ENTER</td>
<td>ENTER stores the contents of the cell edit box and then moves the active cell down one cell.</td>
</tr>
<tr>
<td>CTRL+ENTER</td>
<td>CTRL+ENTER completes the entry and keeps the current cell active.</td>
</tr>
<tr>
<td>ARROWS (left and right)</td>
<td>Left and right ARROWS move within the cell's text if the F2 key has been pressed. Otherwise, these keys store the contents of the cell edit box and then move the active cell to the left or right.</td>
</tr>
<tr>
<td>ARROWS (up and down)</td>
<td>Up and down ARROWS store the contents of the cell edit box in the active cell and move the active cell above or below.</td>
</tr>
<tr>
<td>DELETE</td>
<td>DELETE deletes the character to the right of the cursor if the F2 key has been pressed. Otherwise, pressing the delete key deletes the entire contents of the cell.</td>
</tr>
<tr>
<td>BACKSPACE</td>
<td>BACKSPACE deletes the character to the left of the cursor if the F2 key has been pressed. Otherwise, pressing the backspace key deletes the entire contents of the cell.</td>
</tr>
</tbody>
</table>
PAGE UP and PAGE DOWN store the contents of the cell edit box in the active cell and move one page up or down.

TAB and SHIFT+TAB store the contents of the cell edit box in the active cell and move the active cell to the right or left.

**Select Entire Worksheet**

Clicking on the small box above the row labels and to the left of the column labels selects the entire worksheet.

**Working with Worksheet Data**

There are three ways to enter data into the worksheet. Data are entered into the worksheet by using File | Open and opening a data file, by typing data directly into the worksheet, or by copying the data from another application and pasting it into the worksheet. Use the Data menu commands to sort the data, filter the data, view statistics, transform the data using mathematical functions, assign default columns for coordinate data, assign a coordinate system to the data, and project coordinates.

There are two basic modes in the worksheet. Normal mode is when the active cell can be moved throughout the worksheet, and edit mode allows the contents of a single cell to be edited in the active cell edit box. Only one mode may be active at a given time. ESC, ENTER, or clicking on another cell can be used to exit edit mode and return to normal mode.

**Entering Data Into a Cell**

Edit the contents of a cell by making it the **active cell**. The active cell is positioned by clicking on a cell with the mouse, by using the ARROW keys, PAGE UP, PAGE DOWN, TAB, HOME, END, and SHIFT+TAB. Press the F2 key or highlight the contents of the **cell edit box** to edit the contents of the cell.

To enter new data and delete the old, position the active cell and begin typing. Edit mode is entered automatically and the old data is deleted. Pressing the ENTER, Up or Down ARROWS, TAB, SHIFT+TAB, PAGE UP, or PAGE DOWN keys causes the edit changes to be recorded permanently in the cell. After pressing F2 or highlighting the cell edit box use the HOME, END, BACKSPACE, DEL,
and ARROW keys to edit the cell. Pressing ESC while editing a cell cancels the changes and restores the original data.

## Moving the Active Cell

You can designate any worksheet cell as the active cell by left-clicking on it with the mouse. The active cell can also be repositioned by using keyboard commands. The active cell is the cell with a thick border drawn around it.

<table>
<thead>
<tr>
<th>Keyboard Command</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARROW keys (Up, Down, Left, Right)</td>
<td>The ARROWS move the active cell to an adjacent cell.</td>
</tr>
<tr>
<td>PAGE UP/PAGE DOWN</td>
<td>Press the PAGE UP or PAGE DOWN to move the active cell up or down by the number of rows visible in the window.</td>
</tr>
<tr>
<td>HOME</td>
<td>Press HOME to move the active cell to the first occupied cell in the current column. Press HOME again to move the active cell to the top row in the current column.</td>
</tr>
<tr>
<td>END</td>
<td>Press END to move the active cell to the last occupied row in the current column. Press END again to move the active cell to the bottom row of the worksheet.</td>
</tr>
<tr>
<td>ENTER</td>
<td>Press ENTER to move the active cell down one row and end &quot;edit mode.&quot;</td>
</tr>
<tr>
<td>TAB</td>
<td>Press TAB to move the active cell right one column and end &quot;edit mode.&quot;</td>
</tr>
<tr>
<td>SHIFT + ENTER</td>
<td>Press SHIFT+ENTER to move the active cell up one row and end &quot;edit mode.&quot;</td>
</tr>
<tr>
<td>SHIFT + TAB</td>
<td>Press SHIFT+TAB to move the active cell left one column and end &quot;edit mode.&quot;</td>
</tr>
<tr>
<td>CTRL+HOME</td>
<td>Press CTRL+HOME to move the active cell to the top cell of the left most column in the worksheet (A1).</td>
</tr>
<tr>
<td>CTRL+END</td>
<td>Press CTRL+END to move the active cell to the bottom occupied row of the last occupied column in the worksheet.</td>
</tr>
<tr>
<td>CTRL+LEFT ARROW</td>
<td>The CTRL+LEFT ARROW behavior depends on the position of the active cell. If the active cell is to the right of the last occupied column in the current row, it moves the active cell to the last occupied column in the current row. If the active cell is in or to the left of the last occupied column in the current row, but to the right of the first occupied column in the current row, it moves the active cell to the first occupied column in the current row. Otherwise, CTRL+LEFT ARROW moves the active cell to the first column in the current row.</td>
</tr>
<tr>
<td>CTRL+RIGHT ARROW</td>
<td>The CTRL+RIGHT ARROW behavior depends on the position of the active cell. If the active cell is to the left of the first occupied column in the current row, it moves the active cell to the first occupied column in the current row. If the active cell is in or to the right of the first occupied column in the current row, but to the left of the last occupied column in the current row, it moves the active cell to the last occupied column. Otherwise, CTRL+RIGHT ARROW moves the active cell to the last column in the current row.</td>
</tr>
</tbody>
</table>
| CTRL+UP ARROW          | The CTRL+UP ARROW behavior depends on the position of the active cell. If the active cell is below the bottom occupied row in the current column, it moves the active cell to the bottom occupied row in the
current column. If the active cell is below the top occupied row in the current column, but in or above the bottom occupied row in the current column, it moves the active cell to the top occupied row in the current column. Otherwise, CTRL+UP ARROW moves the active cell to the first row in the current column.

CTRL+DOWN ARROW  The CTRL+DOWN ARROW behavior depends on the position of the active cell. If the active cell is above the top occupied row in the current column, it moves the active cell to the top occupied row in the current column. If the active cell is above the bottom occupied row in the current column, but below the top occupied row in the current column, it moves the active cell to the bottom occupied row in the current column. Otherwise, CTRL+DOWN ARROW moves the active cell to the last row in the current column.

ENTER, TAB, SHIFT+ENTER, and SHIFT+TAB  If a block of cells is selected, the ENTER, TAB, SHIFT+ENTER, and SHIFT+TAB keys move the active cell within a group of selected cells without canceling the selection.

Moving the Active Cell Within Selections
The ENTER, TAB, SHIFT+ENTER, and SHIFT+TAB keys move the active cell within a group of selected cells without canceling the selection.

Pasting Data
If data are copied to the clipboard from another software application, the contents of the clipboard can be pasted into the worksheet. If the source application is Microsoft Excel, some formatting information is retained. When pasting data into the worksheet, select a cell and use Home | Clipboard | Paste (CTRL+V). Any data to the right or below the active cell is overwritten, so be sure to locate the active cell carefully. When data are copied to the clipboard, special formatting information is also copied. The Home | Clipboard | Paste | Paste Special command determines the format in which the contents are pasted into the worksheet.

Opening Data Files
When you create a grid file or use another command that requires data, you do not need to open the data into the worksheet first. However, the worksheet is available if you would like to view or edit your data. The File | Open command loads a data file into a new worksheet.

If the worksheet already contains data, additional data can be imported into the worksheet using the File | Import command. The contents of the new file are merged into the worksheet at the active cell so it is imperative that the cell be positioned at the edge of the existing data. Any cells in the existing worksheet that lie to the right and below the active cell will be overwritten with the contents of the merging file. Multiple files can be opened at one time into the same worksheet with File | Import using the SHIFT or CONTROL keyboard keys while selecting files in the Import Data dialog.

Worksheet Input Modes
The worksheet has several special input modes that tracks the mouse position:
- Drag-Select Mode - for selecting cells with the mouse
- Drag-Row-Height Mode - for adjusting row heights with the mouse
- Drag-Column-Width Mode - for adjusting column widths with the mouse
Pressing the ESC key before releasing the mouse button cancels the mouse-tracking mode.
Selecting Cells

The keyboard and the mouse may be used to select cells. Selected cells are indicated by reverse video (white background becomes black, etc.). Hidden cells are selected if their columns or rows are within a selected block of cells. Single cells, a rectangular block of cells, one or more rows, one or more columns, or the entire worksheet can be selected.

Cells may be selected to:

- perform editing and clipboard functions,
- perform a transform function,
- sort the selected cells,
- compute statistics for selected cells, or to
- set column properties for several columns via the column width, row height, and cell format commands.

There are several ways to select cells:

- Clicking on the small box above the row labels and to the left of the column label bar selects the entire worksheet.
- To deselect all selected cells, click the left mouse button anywhere within the worksheet, or move the active cell with an ARROW key. Alternatively, the PAGE UP, PAGE DOWN, HOME, and END keys may also be used to deselect the cells.
- To rapidly select a large block, first select one corner of the block, and then use the scroll bars to scroll to the opposite corner. Hold down the SHIFT key and click on the cell at the opposite corner. The PAGE UP, PAGE DOWN, HOME, and END keys may also be used, but the SHIFT key must be held down while these keys are pressed. The SHIFT key is not needed while using the scroll bars.
- To select all cells in a column or row, click the column letter or row number. To select several adjacent columns or rows, press and hold the left mouse button and drag the pointer on the column letters or row numbers.
- While holding down the CTRL key, the active cell may be repositioned for selecting a new, discontinuous block.
- The CTRL key is used to select multiple blocks and the SHIFT key is used to resize the last selected block. Details and exceptions are given in separate help sections for selecting with the mouse and selecting with the keyboard.
- If entire rows or columns are selected by clicking on the headers, some operations, such as statistics, can take a long time. Rather than clicking on the headers, only select the cells containing data.
- Clicking and holding the left mouse button while dragging the mouse in the worksheet selects a block. Similarly, using the SHIFT key plus the ARROW keys selects a block.
- The keys used with SHIFT for selecting cells are the ARROW keys, PAGE UP, PAGE DOWN, HOME, and END. TAB and SHIFT+TAB cannot be used.
- While holding down the SHIFT key, the last selected block may be resized. Use the SHIFT key and the mouse or the SHIFT key and ARROW keys.
- The active cell is at one corner (or edge) of a selected block and must first be positioned before selecting multiple cells.
- The last block cannot be resized if the active cell has been moved.
- Once selected, a block of cells cannot be unselected unless all cells are unselected.
Selecting Cells with the Keyboard

The keyboard may be used to select cells. Selected cells are indicated by reverse video (white background becomes black, etc.).

<table>
<thead>
<tr>
<th>To Select</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single cells</td>
<td>Click in the cell to select it, or use the arrow keys to select a cell. The selected cell will have a thick outline around it.</td>
</tr>
<tr>
<td>A rectangular block of cells</td>
<td>Move the active cell to one corner of the block. While holding down the SHIFT key, use the movement keys to position the opposite corner of the block. The movement keys include the ARROW keys, PAGE UP, PAGE DOWN, HOME, and END, but not TAB and SHIFT+TAB. When the block has been sized, release the SHIFT key. To resize the block, see the instructions below.</td>
</tr>
<tr>
<td>Several adjacent rows</td>
<td>Select the first or last row. Then, while holding down the SHIFT key, use the vertical movement keys. These include up ARROW, down ARROW, page up, page down, HOME, and END.</td>
</tr>
<tr>
<td>Several adjacent columns</td>
<td>Select the first or last column. Then, while holding down the SHIFT key, use the right and left ARROW keys.</td>
</tr>
</tbody>
</table>

Resize the Last Selected Block

To resize the last selected block, hold down the SHIFT key while using the movement keys (as appropriate to the type of block). The last block cannot be resized if the active cell has been moved.

Deselect All Selected Cells

To deselect all selected cells, left-click anywhere within the worksheet or move the active cell with an ARROW key or other movement key.

Selecting Cells with the Mouse

The mouse may be used to select cells. Selected cells are indicated by reverse video (white background becomes black, etc.).

<table>
<thead>
<tr>
<th>To Select</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single cells</td>
<td>Click the left mouse button on the cell. The cell will have a thick outline around it.</td>
</tr>
<tr>
<td>A rectangular block of cells</td>
<td>Move the active cell to one corner of the block. Click and hold the left mouse button, and drag it to the opposite corner of the block. Then release the mouse button.</td>
</tr>
<tr>
<td>An entire row</td>
<td>Click the mouse on the row label.</td>
</tr>
<tr>
<td>Several adjacent rows</td>
<td>Click and hold the mouse on the first row label and drag it to the last row. Make sure the cursor is a normal arrow cursor not the double arrow cursor used for selecting column dividing lines.</td>
</tr>
</tbody>
</table>
### Chapter 3 - Data Files and the Worksheet

<table>
<thead>
<tr>
<th>Description</th>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>An entire column</td>
<td>Click the mouse on the column label.</td>
</tr>
<tr>
<td>Several adjacent columns</td>
<td>Click and hold the mouse on the first column label and drag it to the last column. Make sure the cursor is a normal arrow cursor not the double arrow cursor used for selecting column dividing lines.</td>
</tr>
<tr>
<td>The entire worksheet</td>
<td>Click on the small box above the row labels and to the left of the column label bar.</td>
</tr>
</tbody>
</table>

The worksheet will scroll automatically if the mouse is dragged past the visible limits of the worksheet.

**Select Additional Blocks**

To select additional blocks, hold down the CTRL key while clicking.

**Resize the Last Selected Block**

To resize the last selected block, hold down the SHIFT key while clicking and holding the left mouse button. Then, drag the edge of the last selected block to the new position. The last block cannot be resized if the active cell has been moved.

**Deselect All Selected Cells**

To deselect all selected cells, left-click anywhere within the worksheet or move the active cell with an arrow key or other movement key.

**Selecting a Column or Row Dividing Line**

The column or row dividing lines are the lines between the column letter labels and row number labels along the borders of the worksheet. These lines divide the columns or rows. When selecting a dividing line, the cursor must be within approximately a character's width of the dividing line and it must be on the label bar.

Change the column width or row height by dragging the dividing line. Rows or columns can be hidden or unhidden by using the mouse. The **Data | Format | Column Width** or **Data | Format | Row Height** commands can also be used to set column widths or row heights.

Move the cursor to the **label bar** near the dividing line until the cursor changes to a between columns, and a between rows. The cursor must be within approximately a character's width of the dividing line and it must be on the label bar. Click and hold the left mouse button and drag the dividing line.
This example shows the cursor being used to change the width of column A.

This example shows the cursor being used to change the height of row 3.

Hiding Columns or Rows
The mouse may be used to hide columns or rows.

To hide a column, first click on the vertical dividing line to the right of the column. Drag the vertical dividing line to the left as far as it will go and then release the mouse button. If there are hidden columns to the right of this column, grab the left side of the vertical dividing line. If the right side of the vertical dividing line is selected, the vertical dividing line for the adjacent hidden column is selected.

To hide a row, first click on the horizontal dividing line at the bottom of the row. Drag the horizontal dividing line up as far as it will go and then release the mouse button. If there are hidden rows above this row, grab horizontal dividing line just below the line. If the top side of the horizontal dividing line is selected, the horizontal dividing line for the adjacent hidden row is selected.

With the Format Menu
Columns and rows can also be hidden with the Data | Format | Column Width and Data | Format | Row Height commands. Select the columns or rows to hide, click the Data | Format | Column Width or Data | Format | Row Height command, and then set the Column Width or Row Height to zero.

Displaying Hidden Columns or Rows
The mouse may be used to display hidden columns or rows.

To display a hidden column, first click on the vertical dividing line at the right of the hidden column and then drag the vertical dividing line to the new position. If several adjacent columns are hidden, only the far right column is displayed after dragging the dividing line. If the cursor is to the left of the vertical dividing line when the line is selected, then the selected vertical dividing line is for the visible column to the left and not for the hidden column.

To display a hidden row, first click on the horizontal dividing line below the hidden row and then drag the horizontal dividing line to the new position. If several adjacent rows are hidden, only the bottom row is displayed after dragging the dividing line. If the cursor is above the horizontal
Chapter 4 - Creating Grid Files

Contour maps, color relief maps, shaded relief maps, vector maps, watershed maps, 3D surfaces, and 3D wireframes all require grids for their creation in Surfer. A grid is a regular, rectangular array of values. The Home | Grid Data | Grid Data command provides you with several methods for generating a Surfer .GRD grid file from your XYZ data. In addition to the grid files that Surfer creates, it can also read many common grid file formats directly. A grid with all blank nodes cannot be saved.

A Gridding Example

Consider the scenario of producing a contour map of water table depth given well data collected over a region. The well locations are not regularly spaced over the area of interest. If you provide Surfer with the locations of the wells (the XY coordinates) and the depth to the water table (the Z value) in the form of an XYZ data file, Surfer can produce a grid file from the original data and a grid-based map from the gridded data. The following series of figures show the normal progression from a data file, to a grid file, to a contour map.

1. In a worksheet window, define well locations (X and Y coordinates) and water table depth (Z value) at each location in an XYZ data file.

![XYZ data file](image)

*This is the XYZ data file that defines the well locations and water table depth at each location.*

2. In the plot window, click the Home | New Map | Post command. Select the data file created in step 1 and click Open to create a post map displaying the data locations with Z value labels. This step is to show the irregularly spaced data across the map.
3. Click the **Grids | New Grid | Grid Data** command to create a regularly spaced grid .GRD file from the irregularly spaced XYZ data file. Use the default values in the **Grid Data** dialog and click OK to create the .GRD file.
4. Click once on the post map to select it. Click the **Home | Add to Map | Layer | Contour** command to add a **contour map** of the grid file to the post map of the data file.

![Contour Map Example](image)

The irregularly spaced data points are used to interpolate grid node values. These interpolated values are written to a grid file. The grid file is used to produce the contour map. This figure shows the filled contour map, the posted data points, and the layout of the grid.

**Grid Data**

Grid files are necessary in **Surfer** to create grid-based maps. Data files are typically randomly spaced files, and this data must be converted into an evenly spaced grid before using many of **Surfer's** features. Grid files are produced from XYZ data using the **Home | Grid Data | Grid Data** or the **Grids | New Grid | Grid Data** command. With this command, you can specify the parameters for the particular gridding method and the extents of the grid. The gridding methods define the way in which the XYZ data are interpolated when producing a grid file. Refer to the **tutorial** for more information on data and gridding data.

When creating a grid file you can usually accept all of the default gridding parameters and generate a grid file that represents your data well. Under most circumstances, the recommended gridding method is kriging with the default linear variogram. This is the selected default gridding method because it gives good results for most XYZ data sets.

There are several gridding parameters you can set when producing a grid file. Refer to the **gridding method** for more information on specific parameters. All gridding methods require at least three non-collinear data points. Some methods require more data points. For example, a higher-order polynomial fit needs more than three data points; there must be at least as many data as there are degrees of freedom. When the **Z Transform** is set to **Log, save as log** or **Log, save as linear**, at least three non-collinear data points must contain Z data that are non-negative and non-zero. Click the **Grids | New Grid | Grid Data** or **Home | Grid Data | Grid Data** command to choose the data to be used in the gridding process.
Chapter 4 - Creating Grid Files

The Grid Data Dialog
Click the Grids | New Grid | Grid Data or Home | Grid Data | Grid Data command to display the Open Data dialog. Select a data file and click Open. The Grid Data dialog is displayed.

![Grid Data Dialog](image)

Gridding options are set in the Grid Data dialog.

Data Columns
Individually specify the columns for the X data, the Y data, and the Z data. Surfer defaults to X: Column A, Y: Column B, and Z: Column C. Your data can be in any three columns, however. Click the down arrow on each box and select the appropriate column for each variable. If the data file was selected from the Grid Info group in the Open Data dialog, assigned XYZ columns (if any) will populate the appropriate columns in the Data Columns group. Columns containing dates or numbers can be selected.

Note: When using date/time formats for any of the Data Columns, the values are stored in the grid as numbers, not in date/time format. To display date/time formats on the map, select the appropriate map part (axis, map layer, or map) and set the date/time label format.

Filter Data
You can filter the data before gridding based on a predefined filter or based on a user-defined equation by clicking the Filter Data button.
View Data
If you are unsure of which columns contain your XYZ data, click the View Data button to see the data file in a worksheet format. If you get an Insufficient data (3 or more XYZ triplets required) error, use View Data to check the layout of the data. One common reason for this warning is that the data is not numeric or date/time format. After clicking View Data, make sure that all three columns of data are right aligned. If one of the columns is left aligned, the data are text, not numbers. You can use the data view to determine the appropriate columns for the X, Y, and Z values.

Statistics
Click the Statistics button to display statistics based on the selected X, Y, and Z columns.

Grid Report
Check the box next to the Grid Report option to create a gridding report that includes all the gridding parameters used to generate a grid. This report also includes statistics about the grid. You can also access the grid statistics by creating a grid information report. Create a grid information report in the Grid Editor by clicking the Grid Editor | Options | Grid Info command or by clicking the Grids | Info | Grid Info command from any document window.

Gridding Method and Advanced Options
Surfer has several different gridding methods. These gridding methods define the way in which the XYZ data are interpolated when producing a grid file. Choose the Gridding Method and gridding options (Advanced Options button) in the Gridding Method group. Refer to the gridding methods for more information on the options.

Cross Validate
Click the Cross Validate button to perform cross validation on your data. Cross validation is an objective way of assessing the gridding parameters for your data set. Cross validation is always performed on the linear Z values, not the transformed Z values.

Output Grid Geometry
The Output Grid Geometry section defines the grid limits and grid density. The Output Grid Geometry section also controls whether grid nodes outside the data are automatically blanked.

Minimum and Maximum X and Y Coordinate (Grid Limits)
Grid limits are the minimum and maximum X and Y coordinates for the grid. Surfer computes the minimum and maximum X and Y values from the XYZ data file. These values are used as the default minimum and maximum coordinates for the grid.

Grid limits define the X and Y extent of contour maps, color relief maps, shaded relief maps, vector maps, 3D wireframes, and 3D surfaces created from grid files. When creating a grid file, you can set the grid limits to the X and Y extents you want to use for your map. Once a grid file is created, you cannot produce a grid-based map larger than the extent of the grid file. If you find you need larger grid limits, you must regrid the data. You can, however, read in a subset of the grid file to produce a map smaller than the extent of the grid file.

When either the X, Y, or Z value is in a date/time format, the date/time values are converted and stored in the grid as numbers.
Chapter 4 - Creating Grid Files

Spacing and # of Nodes (Grid Density)
Grid density is usually defined by the number of columns and rows in the grid, and is a measure of the number of grid nodes in the grid. The # of Nodes in the X Direction is the number of grid columns, and the # of Nodes in the Y Direction is the number of grid rows. The direction (X Direction or Y Direction) that covers the greater extent (the greater number of data units) is assigned 100 grid nodes by default. The number of grid nodes in the other direction is computed so that the grid nodes Spacing in the two directions are as close to one another as possible.

By defining the grid limits and the number of rows and columns, the Spacing values are automatically determined as the distance in data units between adjacent rows and adjacent columns.

Note on High Density Grid Files
Higher grid densities (smaller Spacing and a larger # of Nodes) increase the smoothness in grid-based maps. However, an increase in the number of grid nodes proportionally increases the gridding time, drawing time, and the grid file size. You can have up to 2,147,483,647 rows and columns in a grid file. It is likely your computer will run out of memory before reaching the maximum grid size. The primary use for the large grid size maximum is to allow grids with extreme aspect ratios to be created.

The larger the density of grid nodes in the grid, the smoother the map that is created from the grid. Contour lines and XY lines defining a wireframe are a series of straight-line segments. More X and Y grid nodes in a grid file result in shorter line segments for contours or wireframe maps. This provides a smoother appearance to contour lines on a contour map or smoother appearing wireframe.

Although highly dense grid files can be created, time and space are practical limits to the number of grid nodes you may want to create in a grid file. The grid density limit is based on the amount of available memory in your computer and the size of the data file used to create the grid. Limited memory, very large data files, very dense grids, or any combination of these factors can greatly increase gridding time. When gridding begins, the status bar provides you with information about the estimated gridding time to complete the task. If gridding time is excessive, click in the plot window to cancel the gridding operation.

Some examples of the amount of memory needed to grid large files:
- A 10,000 x 10,000 grid requires 10000*10000*8 = 763MB.
- A 15,000 x 15,000 grid requires 1.7GB.
- A 20,000 x 20,000 grid requires 3GB which is more than a 32-bit OS can address (although it is possible on an 64 bit OS)
- A 2,147,483,647 x 2 grid requires 32GB of contiguous RAM (most computers contain a maximum of 16GB RAM stored noncontiguously)

You can also increase or decrease the grid density by using the Grid | Spline Smooth, Grid | Extract, or Grids | Resize | Mosaic commands.

Output Grid Geometry Example
Consider these examples. The data range from 0 to 25 in the Y dimension and 0 to 10 in the X dimension. The two examples use different numbers of grid nodes, or grid spacing, during gridding.
Two different Grid Line Geometry examples are shown here. These are based on the same data file. The coordinates range from zero to 10 in the X direction and zero to 25 in the Y dimension.

In the example on the left above, the grid Spacing is set approximately equal in the X and Y dimensions (one unit each). This results in a different number of grid nodes in the X and Y dimensions.

In the example on the right above, the same # of Nodes are specified in the two dimensions. This results in an unequal spacing in data units in the two dimensions.

The Output Grid Geometry information specified in the Grid Data dialog for each of the examples is displayed below.

<table>
<thead>
<tr>
<th>Grid Line Geometry</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Spacing</th>
<th># of Nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>X Direction:</td>
<td>0</td>
<td>10</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Y Direction:</td>
<td>0</td>
<td>25</td>
<td>1</td>
<td>26</td>
</tr>
</tbody>
</table>

This shows the Output Grid Geometry information for the 11 by 26 grid. The grid node spacing values are set to one, resulting in a different number of grid nodes in the X and Y dimensions.
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This shows the Output Grid Geometry information for the 5 by 5 grid. The number of nodes is equal, resulting in different spacing in the X and Y dimensions.

### Grid Z Limits

In some cases, the gridding interpolation and extrapolation can result in undesired values, for example negative numbers in cases where negative values are physically impossible. The Grid Z Limits options clamp the grid output to specific minimum and maximum values.

The Grid Z Limits are applied after the interpolation operation. After the grid interpolation is performed, Surfer locates any grid values less than the Minimum and replaces them with the Data min or Custom value. Surfer locates any grid values greater than the Maximum and replaces them with the Data max or Custom value.

To clamp the output to a specific minimum value, click the current selection next to Minimum, and select None, Data min, or Custom from the list. If Data min is selected, the data minimum will be displayed in the field to the right of the Minimum list. Select Custom and type a value in the input box to use a user-defined Minimum.

To clamp the output to a specific maximum value, click the current selection next to Maximum, and select None, Data max, or Custom from the list. If Data max is selected, the data maximum will be displayed in the field to the right of the Maximum list. Select Custom and type a value in the input box to use a user-defined Maximum.

### Convex Hull of Data

The convex hull of a data set is the smallest convex polygon containing all the data. The convex hull can be thought of as a rubber band that encompasses all data points. The rubber band only touches the outside points. So, areas inside the convex hull without data are still gridded.

### Blank Grid Outside Convex Hull

Check the box next to the Blank grid outside convex hull of data to automatically blank the grid nodes outside the convex hull of the data. Leave the box unchecked to extrapolate the data to the minimum and maximum grid limits, regardless of whether data exists in these areas.

### Inflate Convex Hull

The Inflate convex hull by option expands or contracts the convex hull. When set to zero, the boundary connects the outside data points exactly. When set to a positive value, the area blanked is moved outside the convex hull boundary by the number of map units specified. When set to a negative value, the area blanked is moved inside the convex hull boundary by the number of map units specified. To change the value, highlight the existing value and type the desired value. Values are in horizontal (X) map units. When the value is set to too high of a positive value, the contours will extend all the way to the minimum and maximum X and Y limits of the grid. When the value is set to too low of a negative value, the entire grid will be blanked, resulting in no grid file being created.
Convex Hull Example

This example, with a data set such as the points on the left below, checking the **Blank grid outside convex hull of data** option will leave the outer edges blank. The three contour maps display the resulting grid file when the **Inflate convex hull by** option is set to 0, inflated by 1.5, and deflated by -1.5. Contours always extend to the same minimum and maximum X and Y coordinates. Contour lines align in all three situations. The only difference is how far the contours extend from the convex hull.

This data has an area near the top left corner with no data. When the **Blank grid outside convex hull of data** option is checked, no contours appear in this area. Setting the **Inflate convex hull by** value to a positive value (3rd image) creates a buffer around the outside of the data points. Setting the **Inflate convex hull by** value to a negative value (last image) brings the contours inside the convex hull of data.

Z Transform

The **Z Transform** option changes how the Z values are gridded. Available options are **Linear; Log, save as log**; and **Log, save as linear**. To change the **Z Transform** option, click on the existing option and select the desired option from the list.

**Linear** uses the Z values in the worksheet for gridding. No transformation is applied to the Z values. The **Linear** method is a good option for data that gradually increases over space. This is the default **Z Transform**.

Both **Log** options use take the log (base 10) of the Z values before gridding. The log (base 10) of the Z value is then used for gridding. The **Log, save as log** takes the log (base 10) of the Z values and uses the log value for gridding. The grid is then saved with the log (base 10) values. The **Log, save as linear** takes the log (base 10) of the Z values and uses the log value for gridding. The grid is then converted back to the linear Z values by taking the antilog of the gridded results. When **Log, save as log** or **Log, save as linear** is selected, at least three non-collinear data points must be positive Z values. Negative values are ignored for gridding. Both **Log** methods are good options when the data changes very quickly over a small area or when very high and very low values occur very closely to each other. This can be common with concentration values in ground water or geochemical data.
Chapter 4 - Creating Grid Files

The images above display the difference in gridding the posted data with linear (top right) and log (bottom contours). The log contours on bottom show the difference in Z values between the grid when Log, save as log (bottom left) and Log, save as linear (bottom right) are selected.

Output Grid
Choose a path and file name for the grid file in the Output Grid group. You can type a path and file name, or click the \( \text{\textbf{...}} \) button to browse to a new path and enter a file name in the Save Grid As dialog.

To Create a Grid File from an XYZ Data File
1. Create an XYZ data file. The data must be organized in columns: all X data in one column, all Y data in another column, and all Z data in a third column.
2. Click the Grids | New Grid | Grid Data command to display the Open Data dialog.
3. Specify the name of the XYZ data file, and click Open. To link to a database instead of a data file, click the Database button.
4. In the Grid Data dialog, specify the parameters for the type of grid file you want to produce.
5. Click OK and the grid file is created. During gridding, the status bar at the bottom of the Surfer window provides you with information about the progress of the gridding process.

Open Data Dialog

The Open Data dialog is used by some plot window grid commands (i.e. Grid Data).

Look In

The Look in field shows the current directory. Click the down arrow to see the directory structure and click on the folders to change directories.

Creating New Folders and Changing the View

The buttons to the right of the Look in field allow you to create new folders and change the view of the file list.
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File List
The File list displays files in the current directory. The current directory is listed in the Look in field. The Files of type field controls the display of the file list. For example, if DAT Data (*.dat) is listed in the Files of type field only *.DAT files appear in the files list.

Specify a File Name
The File name field shows the name of the selected file. Alternatively, type a path and file name into the box to open a file.

Files of Type
The Files of type field controls the display of the file list. For example, if DAT Data (*.dat) is listed in the Files of type field only *.DAT files appear in the files list.

The All Recognized Types (*.*) format type is selected by default. This displays all the common file formats in the navigation pane. If a different format type is selected, Surfer will remember the setting until the end of the current session. When Surfer is restarted, the default format type will be used.

To see all files in the directory, choose All Files (*.*) from the Files of type list. Double-click on a file to open it or single-click the file and then click the Open button. The All Files (*.*) option shows all of the file formats in the current directory, even if the file type is not appropriate for the action chosen. For example, a GRD file may be displayed, even though a GRD file cannot be imported into the worksheet.

Select a file type from the Files of type list. The following formats are supported:

- ACCDB Access Database (*.accdb)
- BLN Golden Software Blanking .BLN
- BNA Atlas Boundary .BNA
- CSV Comma Separated Variables .CSV
- DAT Data .DAT
- DBF Database .DBF
- DXF AutoCAD Drawing Data (*.dxf)
- LAS LiDAR Data (*.las)
- MDB Microsoft Access .MDB
- SEG-P1 Data Exchange Format (*.seg)
- P1 Data Exchange Format (*.sp1)
- SLK Sylk Spreadsheet .SLK
- TXT Text Data .TXT
- XLS Excel Spreadsheet .XLS
- XLSX Excel 2007 Spreadsheet .XLSX
- XLSM Excel 2007 Spreadsheet .XLSM
Open Worksheets

The Open worksheets group displays worksheets that are currently open to be selected. If a worksheet is selected from the Open worksheets group that has assigned XYZ coordinates, the following dialogs (i.e. Grid Data dialog) will have the X, Y, and Z columns populated to match the assigned XYZ coordinates.

Load Database

Click the Database button in the Open Data dialog to open the Data Link Properties dialog and import a database.

Data Filters

You can filter the data before gridding in the worksheet using the Data | Data | Spatial Filter command. Or, you can filter data directly in the Grid Data dialog based on a predefined filter or based on a user-defined equation. The Filter dialog provides methods for filtering data. Filtering is also available on the Data page in the New Variogram dialog. You can filter data by using one of the predefined data filtering methods (To Keep list), or you can generate a filtering method with the Data Exclusion Filter. When filtering data, the Data Exclusion Filter is applied first, then the Duplicate Data methods are applied next.

To open the Filter dialog, click the Grids | New Grid | Grid Data command. Select a data file and click Open. In the Grid Data dialog, click the Filter Data button to open the Filter dialog.

Filter data before gridding in the Filter dialog.

Duplicate Data

The Duplicate Data section contains methods for defining and handling duplicate data points. Duplicate data are two or more data points having nearly identical X and Y coordinates. The Z values may vary for these X and Y coordinates. Duplicate data present a problem for a number of gridding methods, including Kriging, Natural Neighbor, Radial Basis Function, and Triangulation with Linear Interpolation. Filtering the data reduces the duplicate points to allow a better gridding fit.

To Keep

Duplicates are determined by moving from the lowest X value to the highest X value. A datum only belongs to one set of duplicates. The To Keep options specify which duplicate data points to keep and which to delete in each set of duplicate points. A report containing the retained and deleted points can be generated.
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**All**  Do not delete any duplicates. This option is not available for Kriging, Nearest Neighbor, Natural Neighbor, Radial Basis Function, and Triangulation with Linear Interpolation.

**None**  Eliminate all of the duplicates.

**First**  Keep the first point, as defined by the order in the data file, from each set of duplicates.

**Last**  Keep the last point, as defined by the order in the data file, from each set of duplicates.

**Minimum X**  Keep the point with the minimum X coordinate.

**Maximum X**  Keep the point with the maximum X coordinate.

**Median X**  Keep the point with the median X coordinate.

**Minimum Y**  Keep the point with the minimum Y coordinate.

**Maximum Y**  Keep the point with the maximum Y coordinate.

**Median Y**  Keep the point with the median Y coordinate.

**Minimum Z**  Keep the point with the minimum Z value.

**Maximum Z**  Keep the point with the maximum Z value.

**Median Z**  Keep the point with the median Z value.

**Sum**  Create an artificial data point at the centroid of the duplicate points with a Z value equal to the sum of the duplicate set's Z values.

**Average**  Create an artificial data point at the centroid of the duplicate points with a Z value equal to the average of the duplicate set's Z values.

**Midrange**  Create an artificial data point at the centroid of the duplicate points with a Z value equal to the midrange of the duplicate observations' Z values halfway between the minimum Z and the maximum Z.

**Random**  Keep a single randomly selected representative point.

**X and Y Tolerance**

In addition to the To Keep options there are X Tolerance and Y Tolerance options. The Tolerance values specify how close two points are located before Surfer considers the points duplicates. For example, two points, A and B are duplicates if:

\[ |X_A - X_B| < X\text{Tolerance} \]

and

\[ |Y_A - Y_B| < Y\text{Tolerance} \]

Using this definition, it is possible for points A and B to be "duplicates," for points B and C to be "duplicates," but for points A and C to not be "duplicates."

**Data Exclusion Filter**

The Data Exclusion Filter allows a Boolean expression to specify how to exclude data. The Data Exclusion Filter can be used with any column in the worksheet that contains numbers. Columns in the worksheet that contain text or columns that are empty will not be excluded by the Data Exclusion Filter.

To use one of the X, Y, or Z columns, use X, Y, or Z in the Data Exclusion Filter. To use another column from the worksheet, use _A, _B, _C, etc. The underscore is required when specifying a worksheet column.
For example:

<table>
<thead>
<tr>
<th>Expression</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>X=-999 or Y=-999 or Z=-999</td>
<td>Excludes any data with a -999 value in either the X, Y, or Z columns.</td>
</tr>
<tr>
<td>X&lt;10 or X&gt;20 or Y&lt;10 or Y&gt;20</td>
<td>Excludes all data except for points in the range 10 to 20 for both the X and Y directions.</td>
</tr>
<tr>
<td>Z &lt; 0.0</td>
<td>Excludes any triplet with Z value less than 0.0.</td>
</tr>
<tr>
<td>_A &gt; 10</td>
<td>Excludes any row in the worksheet that contains a value greater than 10 in column A.</td>
</tr>
<tr>
<td>Z &lt; 0 AND _D = -999</td>
<td>Excludes any triplet with Z value less than 0.0 and whose row in the worksheet contains a value in column D equal to -999.</td>
</tr>
</tbody>
</table>

Boolean expressions, used by Grids | New Grid | Function, Grids | Calculate | Math, Grid | Data, and Grid | Variogram, include:

- logical operators (AND, OR, XOR, NOT)
- comparison operators (\(=\), \(<\), \(>\), \(\leq\), \(\geq\))
- the IF function - for example IF(condition, true_value, false_value)

The words AND, OR, XOR, NOT, and IF are reserved keywords and may not be used as variable names.

To use a stored function, click the next to the current function. This will display the ten most recent functions used. The functions are stored in the registry, so the equations are stored between Surfer sessions. You can also start typing the function in the function box. If the function is in the ten function history, the entire function will auto-complete.

For example, consider the case of ignoring data outside of a grid. The original grid X Maximum is 50, but the grid X Maximum is reset to 40. To limit the search to data with X values less than 40, use the Data Exclusion Filter by entering X > 40 into the Data Exclusion Filter text box. This tells Surfer to exclude all data with X values greater than 40.

Consider a second case where data contains a numerical identifier in column D. When the value in this column is equal to -999, the data point is considered inaccurate and should not be used when gridding. To grid only those data where column D is not equal to -999, exclude column D with the Data Exclusion Filter by entering _D = -999 into the Data Exclusion Filter text box. This excludes all rows of data where column D contains the value -999.

Cross Validate

Generally, cross validation can be considered an objective method of assessing the quality of a gridding method, or to compare the relative quality of two or more candidate gridding methods. In Surfer, cross validation can be used with all gridding methods. While cross validation can be used to select a gridding method, the results can also be used to assess the spatial variation in gridding quality and to guide data sampling. Cross validation is always performed on the linear Z values, not the transformed Z values.
A generalized discussion of cross validation is given here. Refer to one of the many geostatistics books for more information. In the listed references below, much of the discussion concerns kriging, but the generalized discussion applies to all of the gridding methods in Surfer.

The Cross Validation Process

Given the known values at N observation locations in the original data set, cross validation allows you to assess the relative quality of the grid by computing and investigating the gridding errors. In Surfer, these errors are calculated by removing the first observation from the data set, and using the remaining data and the specified algorithm to interpolate a value at the first observation location. Using the known observation value at this location, the interpolation error is computed as:

\[
\text{error} = \text{interpolated value} - \text{observed value}
\]

Then, the first observation is put back into the data set and the second observation is removed from the data set. Using the remaining data (including the first observation), and the specified algorithm, a value is interpolated at the second observation location. Using the known observation value at this location, the interpolation error is computed as before.

The second observation is put back into the data set and the process is continued in this fashion for the third, fourth, fifth observations, etc., all the way through up to and including observation N, the last observation in the data file. This process generates N interpolation errors. Various statistics computed for the errors can be used as a quantitative, objective measure of quality for the gridding method.

Thus, cross validation involves four steps:

1. Select a gridding method, along with all of the defining parameters.
2. For each observation location, interpolate the value using the neighboring data, but not the observation itself.
3. Compute the resulting interpolation errors.
4. Assess the quality of the selected gridding method using various summary statistics of the errors.

Using Cross Validation

To obtain cross validation information:

1. Click Grids | New Grid | Grid Data.
2. Select a data file in the Open Data dialog and click Open.
3. Click the Cross Validate button in the Grid Data dialog.
4. Select the number of random points, the validation limits, and exclusion limits you wish to use with cross validation.
5. Click the Report box to generate a Cross Validation Report.
6. Set the results path and file name in the Cross Validation Results File field.

The Cross Validation Dialog

Click the Cross Validate button in the Grid Data dialog to open the Cross Validation dialog.
Click the Cross Validate button in the Grid Data dialog to open the Cross Validation dialog.

Number of Random Points to Validate
For large and very large data sets the cross validation process of sweeping through each and every observation point can take a great deal of time and computational effort. A quicker alternative is to carry-out the cross validation procedure at a random subset of the observation locations.

*Number of random points to validate* allows you to specify the number of cross validation points. By default, this value is equal to the total number of observations. For large and very large data sets this values should be 1,000 or more to ensure a relatively stable set of error statistics. Note, the entire data set is used through out the cross validation process, not just the random subset. The random subset merely identifies the locations at which cross validation errors are computed. Also, note that the random subset is determined without replacement, using a random number generator that is randomly initialized for every execution; thus, the random subset may be different every time cross validation is run.

Select Validation Points Within These Limits
Set the X Direction, Y Direction, and Z Direction values for Minimum and Maximum in the Select validation points within these limits section. This restricts the cross validation to a subarea of the data extent. Data falling outside of these limits may be used during the interpolation, but they are not used as cross validation points. The limits in the Z Direction are useful to exclude cross validation at known anomalous observation locations.

Exclude Data Within this Distance of the Validation Point
Often observations come in relatively homogeneous clusters. In these circumstances, the standard cross validation approach may not generate useful results as the interpolated values are merely the values of the close-by adjacent observations. To counter this potential problem, the X Tolerance and Y Tolerance fields define a centered rectangular buffer zone around each of the observations at which cross validation is carried out. This buffer zone is two times the X Tolerance in the X direction, and two times the Y Tolerance in the Y direction. Any observations falling within a validation point’s buffer zone are not used in the interpolation of that validation point. When these values are zero, all points in the validation limits are used.
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Cross Validation Results File

Set a path and file name in the Cross Validation Results File field for the cross validation results. The results are presented in an ASCII data file, which can be used as a gridding data file. The first line in the file contains column titles. Each subsequent line is associated with a validation point. There are seven numeric values per line. The first three values are the X, Y, and Z values from the original data file of each validation point. The fourth column, titled ID is the line number from the original data file of the validation point. The next two columns are the estimated and residual values. The nData column contains the total number of original data points.

Statistics Note

Under most interesting statistical models, the cross validation errors are not statistically independent: the estimate at one observation location uses much of the same information as the estimate at a neighboring observation location. As such, standard hypothesis testing and test of statistical significance are not valid. A discussion of this point can be found in the cross validation reference, Kitanidis (1997).

Cross Validation References

The following references include extensive discussion of the theory and application of cross validation. Isaaks and Srivastava [1989], Kitanidis [1997], Olea [1999], and Chiles and Delfiner [1999] focus on cross validation with kriging, but the general discussion applies to all of the supported gridding methods in Surfer.


Reports

You can gather information about your data by

- clicking the Statistics button in the Grid Data dialog to obtain a Data Statistics Report,
- checking the Grid Report option in the Grid Data dialog to create a Gridding Report,
- checking the Generate Report option on the General page of the New Variogram dialog to create a Variogram Grid Report,
- clicking the Display Statistics button on the Statistics page in the Variogram Properties and clicking Report to create a Variogram Grid Report,
- clicking the button for a map layer in the Properties window to generate a Grid Information report,
- clicking the Grids | Info | Grid Info command to obtain a Grid Information report,
- clicking the Options | Grid Info command in the Grid Editor to create a Grid Information report,
- or checking the Report option in the Cross Validation dialog to create a Cross Validation Report.
All reports contain the name of the report and the name of the data file. For example, a Data Statistics Report for the file demogrid.dat will be named DataStatisticsReport-Demogrid. The Grid Data Report will be named GridDataReport-Demogrid.

If you make changes to the data selection (i.e. changing a data column or changing the data filtering method) generate a new report by repeating one of the processes listed above. All reports contain similar information and differences are noted below.

Report Types
There are 5 types of gridding reports. Each report contains different information. Some of the information is similar among the reports.

Data Statistics Report
Contains Time Stamp, Data Source, Filtered Data Counts, Exclusion Filtering, Duplicate Filtering, Breakline Filtering, Data Counts, Univariate Statistics, Inter-Variable Covariance, Inter-Variable Correlation, Inter-Variable Rank Correlation, Principal Component Analysis, Planar Regression: \( Z = AX+BY+C \), and Nearest Neighbor Statistics. See below for a list of the information contained in each section. The data statistics always refer to the pre-transformed \( Z \) values, even when the Log, save as log or Log, save as linear option is selected when gridding.

Gridding Report
Contains Time Stamp, Data Source, Filtered Data Counts, Exclusion Filtering, Duplicate Filtering, Breakline Filtering, \( Z \) Data Transform, Data Counts, Univariate Statistics, Inter-Variable Covariance, Inter-Variable Correlation, Inter-Variable Rank Correlation, Principal Component Analysis, Planar Regression: \( Z = AX+BY+C \), Nearest Neighbor Statistics, Gridding Rules, and Output Grid. See below for a list of the information contained in each section.

Grid Information Report
Contains Time Stamp, Grid Information, Grid Geometry, and Univariate Grid Statistics. See below for a list of the information contained in each section.

Cross Validation Report
Contains Time Stamp, Data Source, Gridding Rules, Data Counts at Validation Points, Univariate Statistics, Univariate Cross-Validation Statistics, Residual Regression at Validation Points: \( R = AX+BY+C \), Inter-Variable Correlation at Validation Points, and Rank Correlation at Validation Points. See below for a list of the information contained in each section.

Variogram Grid Report
Contains Data Source, Variogram Grid, Data Counts, Univariate Statistics, Inter-Variable Correlation, Inter-Variable Covariance, Planar Regression: \( Z = AX+BY+C \), Nearest Neighbor Statistics, Exclusion Filtering, and Duplicate Filtering. See below for a list of the information contained in each section.

Information Contained in Each Report Section
Each section of the report contains information about the grid, data, or variogram.

**Time Stamp**
- Time of report
- Date and time the report was created in....
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Data Source
- Source Data File Name: path and file name of the data used in gridding
- X Column: X data column
- Y Column: Y data column
- Z Column: Z data column

Data Counts and Filtered Data Counts
- Active Data: number of data after applying filters
- Original Data: number of original data points (excludes breakline data)
- Excluded Data: number of data excluded by the Data Exclusion Filter - the excluded data are listed in the Exclusion Filtering section
- Deleted Duplicates: number of duplicates deleted by the Duplicate Data filter - the deleted duplicates are listed in the Duplicate Filtering section
- Retained Duplicates: number of duplicates retained by the Duplicate Data filter (this statistic is not computed if the duplicate rule is ALL) - the retained duplicates are listed in the Duplicate Filtering section including any artificial data
- Artificial Data: number of artificial data created by the Sum, Average, and Midrange Duplicate Data filters
- Superseded Data: Superseded data are number of data eliminated by breaklines in the Data Statistics Report and the Gridding Report. Breakline data always supersede point data. If point data are on, or in the immediate vicinity of, breakline data the point data are eliminated.

Data Counts at Validation Points
The Data Counts at Validation Points section is only included in the Cross Validation Report.
- Active Results: locations at which the cross validation interpolation was successfully carried out
- Blanked Results: The blanked results are the locations at which cross validation interpolation was attempted, but was not successful. For example, the natural neighbor gridding algorithm can only interpolate at locations within the convex hull of the active data. As such, an observation that lies on the convex hull of the original, complete, data set will lie outside of the convex hull of the active data when that observation is the cross validation point. Cross validation is not possible using the natural neighbor algorithm at such a point, so it is blanked.
- Attempted Results: reports the number of locations at which cross validation interpolation was attempted
Requested Results contains the original number of random data

Z Data Transform
Includes the transformation method (if any) applied to the Z values. Lists the data that was unable to be transformed in a table.

The rest of the report information is calculated using the active data, including any artificial data generated by duplicate filtering. Excluded, deleted, or superseded data are not included in the following calculations.

Exclusion Filtering
Exclusion Filter String shows the Data Exclusion Filter string
Excluded Data number of data excluded by the Data Exclusion Filter -
Excluded Data Table the excluded data are listed in a table. The ID is equal to the line number in the original data file. This list is 100 data rows long by default.

Duplicate Filtering
Duplicate Points to Keep To Keep filter used
X Duplicate Tolerance maximum X spacing of points to be considered a duplicate
Y Duplicate Tolerance maximum Y spacing of points to be considered a duplicate
Deleted Duplicates number of duplicates deleted by the Duplicate Data filter - the deleted duplicates are listed in the Duplicate Filtering section
Retained Duplicates number of duplicates retained by the Duplicate Data filter (this statistic is not computed if the duplicate rule is ALL) - the retained duplicates are listed in the Duplicate Filtering section including any artificial data
Artificial Data number of artificial data created by the Sum, Average, and Midrange Duplicate Data filters
Duplicate Data Table the duplicate data table lists all of the duplicate points with X, Y, Z, ID, and Status. The ID is equal to the line number in the original data file. When the status is artificial, no ID is given since this data does not come from the original data file. The Status (Retained, Deleted, or Artificial) reports how the duplicate was handled. This list is 100 data rows long by default.

Breakline Filtering
When breaklines are used, data that is within the X Tolerance and Y Tolerance, as set in the Filter dialog, of the breakline are deleted due to breakline data superseding original data.
Anisotropy Angle the anisotropy angle reported for the default variogram
Anisotropy Ratio the anisotropy ratio reported for the default variogram
X Tolerance maximum X spacing of points to be considered a duplicate
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Y Tolerance maximum Y spacing of points to be considered a duplicate

Superseded Data Superseded data are number of data eliminated by breaklines in the Data Statistics Report and the Gridding Report. Breakline data always supersede point data. If point data are on, or in the immediate vicinity of, breakline data the point data are eliminated.

Breakline Data Table the breakline data table lists all of the superseded data points with X, Y, Z, ID, and Status. The ID is equal to the line number in the original data file. The Status (Retained, Deleted, or Artificial) reports how the duplicate was handled. This list is 100 data rows long by default.

Inter-Variable Correlation
The Inter-Variable Correlation table shows the correlation between the X, Y, and Z variables. The Cross Validation Report also contains Estimated Z and Residual Z columns and rows. The correlations are computed with

\[ \text{Correlation}(X, Y) = \frac{\text{covariance}(X, Y)}{\text{standard deviation}(X) \cdot \text{standard deviation}(Y)} \]

The correlation is positive when both variables increase or decrease together. The correlation is negative when one variable increases while the other variable decreases. A correlation of zero shows that there is no linear relationship between the variables.

Inter-Variable Covariance
The Inter-Variance Covariance table shows the covariance between the X, Y, and Z variables. The covariances are computed with

\[ \text{Covariance}(X, Y) = \frac{1}{N} \sum_{i=1}^{N} (X_i - \text{mean}(X))(Y_i - \text{mean}(Y)) \]

The covariance is positive if, on average, the variables are both above the mean. The covariance is negative if one variable is above the mean and the other variable is below the mean.

Inter-Variable Rank Correlation
The Inter-Variance Rank Correlation table shows the rank correlation between the X, Y, and Z variables. The data is ordered and then assigned a rank value from 1 to the count of values. Rank values range from -1 to +1. The correlation is positive when both variables increase or decrease together. The correlation is negative when one variable increases while the other variable decreases. A correlation of zero shows that there is no linear relationship between the variables.

Univariate Statistics
This group of statistics shows information for X, Y, and Z data. These statistics do not include breakline data.

<table>
<thead>
<tr>
<th>Count</th>
<th>total number of points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1%-%-tile</td>
<td>1 percent of the values are smaller than this number and 99 percent of the values are larger</td>
</tr>
<tr>
<td>5%-%-tile</td>
<td>5 percent of the values are smaller than this number and 95 percent of the values are larger</td>
</tr>
</tbody>
</table>
10%
tile  10 percent of the values are smaller than this number and 90 percent of the values are larger

25\%-tile  lower quartile; 25 percent of the values are smaller than this number and 75 percent of the values are larger

50\%-tile middle data value, 50 percent of the data values are larger than this number and 50 percent of the data are smaller than this number

75\%-tile upper quartile; 75 percent of the values are smaller than this number and 25 percent of the values are larger than this number

90\%-tile 90 percent of the values are smaller than this number and 10 percent of the values are larger

95\%-tile 95 percent of the values are smaller than this number and 5 percent of the values are larger

99\%-tile 99 percent of the values are smaller than this number and 1 percent of the values are larger

Minimum  minimum value

Maximum  maximum value

Mean  
\[
\text{Mean} = \frac{1}{N} \sum_{i=1}^{N} X_i
\]
arithmetic average of the data

Median  middle data value, 50 percent of the data values are larger than this number and 50 percent of the data are smaller than this number

Geometric Mean geometric mean of the data

Harmonic Mean harmonic mean of the data

Root Mean Square  square root of the mean square

Trim Mean (10\%) Trim Mean is the mean without the upper five percent and lower five percent of the data, therefore, extreme value influence is removed. If there are fewer than 20 data points, the minimum and maximum data points are removed instead of the upper and lower five percent.

Interquartile Mean interquartile mean, or midmean, is a truncated mean using only the data in the second and third quantiles (all data between the 25\%-tile and 75\%-tile)

Midrange  the value halfway between the minimum and maximum values

Midrange = (Minimum + Maximum) / 2

Winsorized Mean Winsorized mean is a truncated mean. This method replaces the extreme highs and lows values with a more central value. This mean is less sensitive to outliers.

TriMean the trimean, or Tukey’s trimean, is a measure of probability distribution location. This is equivalent to the the sum of (quartile 1, 2 times the quartile 2, and quartile 3) divided by four.

\[
\text{Variance} = \frac{1}{N} \sum_{i=1}^{N} (X_i - \text{Mean})^2
\]

Variance square root of the variance

Standard Deviation square root of the variance

Interquartile Range separation distance between the 25\%-tile and 75\%-tile
### Chapter 4 - Creating Grid Files

- **Range**
  - The separation between the minimum and maximum value
  - \( \text{Range} = \text{Maximum} - \text{Minimum} \)

- **Mean Difference**
  - The mean or average of the absolute difference of two random variables \( X \) and \( Y \).

- **Median Abs. Deviation**
  - Median Absolute Deviation is the median value of the sorted absolute deviations. It is calculated by:
    1. computing the data's median value
    2. subtracting the median value from each data value
    3. taking the absolute value of the difference
    4. sorting the values
    5. calculating the median of the values

- **Average Abs Deviation**
  - Average Absolute Deviation is the average value of the sorted absolute deviations. It is calculated by:
    1. computing the data's average mean value
    2. subtracting the mean value from each data value
    3. taking the absolute value of the difference
    4. calculating the average value

- **Quartile Dispersion**
  - Measures dispersion of the data using:
    - \( \frac{(\text{Quartile 3} - \text{Quartile 1})}{(\text{Quartile 3} + \text{Quartile 1})} \)

- **Relative Mean Difference**
  - The mean difference of the entire data set divided by the sample mean of the data set

- **Standard Error**
  - The standard error of the mean is the standard deviation of those sample means over all possible samples drawn from the population. This is calculated by dividing the standard deviation by the square root of the number of samples.

- **Coef. of Variation**
  - The Coefficient of Variation is calculated by dividing the standard deviation by the mean. If a "-1" is reported, the coefficient of variation could not be computed. The coefficient of variation is computed only for the Z values.

- **Skewness**
  - The Coefficient of Skewness is calculated by:
    \[ \gamma_1 = \frac{1}{N \sigma^3} \sum_{i=1}^{N} (x_i - \mu)^3 \]
  - If a "-1" is reported, the coefficient of skewness could not be computed. The coefficient of skewness is computed only for the Z values.

- **Kurtosis**
  - The Coefficient of Kurtosis is calculated by:
    \[ \gamma_2 = \left( \frac{1}{N \sigma^4} \sum_{i=1}^{N} (x_i - \mu)^4 \right) - 3 \]

- **Sum**
  - The sum of all \( X \), \( Y \), or \( Z \) values

- **Sum Absolute**
  - The absolute value of the sum of all \( X \), \( Y \), or \( Z \) values
Sum Squares  
the sum of all squared X, Y, or Z values

Mean Square  
\[
\text{Mean Square} = \frac{1}{M} \sum_{i=1}^{M} X_i^2
\]

Planar Regression

Planar regression is an ordinary least-squares fit where Z=AX+BY+C.

- The Parameter Values are the A, B, and C values.
- The Standard Error is the estimated standard deviation of the parameters.
- The Inter-Parameter Correlations are the correlation between A, B, and C coefficients.
- The ANOVA Table shows regression statistics on the planar fit where \(df\) are the degrees of freedom and \(F\) is the ratio of the mean squares.
- The Coefficient of Multiple Determination (\(R^2\)) is calculated with
  \[
  R^2 = 1 - \frac{\sum (Z_i - AX_i - BY_i - C)^2}{\sum (Z_i - Z)^2} = 1 - \frac{\text{SSE}}{\text{SST}}
  \]

For the Cross Validation Report, the planar regression is the residual regression at the validation points.

Nearest Neighbor Statistics

The nearest neighbor statistics represent aspects of the data values and of the data locations. The nearest neighbor to a data point uses a simple separation distance without taking anisotropy into account. If two or more points tie as the nearest neighbor, the tied data points are sorted on X, then Y, then Z, and then ID. The smallest value is selected as the nearest neighbor.

The Separation column shows the separation distances between the observation and its nearest neighbor. The \(|\text{Delta Z}|\) column shows the absolute values of the differences between the observation Z value and the nearest neighbor Z value.

The statistics are the same as the Univariate Statistics (see above).

The Nearest Neighbor Statistics also includes the Complete Spatial Randomness section. The Complete Spatial Randomness statistics measure how random locations are in space. Surfer does not correct for edge effects so the statistics may be biased.

\[
\lambda = \frac{N}{(\text{Range}(X))(\text{Range}(Y))}
\]

\[
\lambda = \frac{2\sqrt{\lambda}}{N} \sum S_i
\]
where
\(\lambda = \text{average spatial density}\)
$S_i = \text{separation distance between the observation and the nearest neighbor}$

The distribution of this statistic is normal, with a mean equal to one and a variance of

$$\frac{(4 - \pi)}{(N\pi)}$$

See Clark and Evans (1954) and Cressie (1991) for more information.

$$\sum S_i^2 = 2\pi\lambda$$

where

$\lambda = \text{average spatial density}$

$S_i = \text{separation distance between the observation and the nearest neighbor}$

The distribution is Chi-Squared with $2N$ degrees of freedom. See Skellam (1952) and Cressie (1991) for more information.

**Principal Component Analysis**

Principal component analysis (PCA) is a mathematical procedure that uses orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. The number of principal components is less than or equal to the number of original variables. The principal components are calculated for the $X$, $Y$, and $Z$ values. A $\lambda$ value is also reported for each principal component.

**Variogram Grid**

<table>
<thead>
<tr>
<th>Max Lag Distance</th>
<th>set on the General page in the New Variogram dialog</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angular Divisions</td>
<td>number of Angular Divisions set on the General page in the New Variogram dialog</td>
</tr>
<tr>
<td>Radial Divisions</td>
<td>number of Radial Divisions set on the General page in the New Variogram dialog</td>
</tr>
</tbody>
</table>

**Output Grid**

<table>
<thead>
<tr>
<th>Grid File Name</th>
<th>name of the output grid file</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grid Size</td>
<td>number of rows and columns in the grid</td>
</tr>
<tr>
<td>Total Nodes</td>
<td>number of columns times the number of rows</td>
</tr>
<tr>
<td>Filled Nodes</td>
<td>number of grid nodes containing interpolated values</td>
</tr>
<tr>
<td>Blanked Nodes</td>
<td>number of grid nodes containing blanked values</td>
</tr>
<tr>
<td>X Minimum</td>
<td>minimum X grid line value specified in the Output Grid Geometry group in the Grid Data dialog</td>
</tr>
</tbody>
</table>
X Maximum: maximum X grid line value specified in the Output Grid Geometry group in the Grid Data dialog.
X Spacing: X spacing set in the Grid Data dialog.
Y Minimum: Minimum Y grid line value specified in the Output Grid Geometry group in the Grid Data dialog.
Y Maximum: Maximum Y grid line value specified in the Output Grid Geometry group in the Grid Data dialog.
Y Spacing: Y spacing set in the Grid Data dialog.

Grid Information:
- Grid File Name: name of the output grid file.
- Grid Size: number of rows and columns in the grid.
- Total Nodes: number of columns times the number of rows.
- Filled Nodes: number of grid nodes containing interpolated values.
- Blanked Nodes: number of grid nodes containing blanked values.
- Blank Value: reports the Z value associated with blanked nodes.

Grid Geometry:
- X Minimum: minimum X grid line value specified in the Output Grid Geometry group in the Grid Data dialog.
- X Maximum: maximum X grid line value specified in the Output Grid Geometry group in the Grid Data dialog.
- X Spacing: X spacing set in the Grid Data dialog.
- Y Minimum: Minimum Y grid line value specified in the Output Grid Geometry group in the Grid Data dialog.
- Y Maximum: Maximum Y grid line value specified in the Output Grid Geometry group in the Grid Data dialog.
- Y Spacing: Y spacing set in the Grid Data dialog.

Gridding Rules:
This section displays the gridding method used, as well as the option settings for each gridding method.

Univariate Grid Statistics:
The Univariate Grid Statistics are the same as those reported in the Univariate Statistics and Nearest Neighbor Statistics sections.

Univariate Cross-Validation Statistics:
The Univariate Cross Validation Statistics section are the same as those reported in the Univariate Statistics. It also contains an additional column of data, called Data Used. This column shows the number of data points used in the calculation.