
Contents

◆ Discovering the Possibilities ◆◆◆



Table of Contents

Table of Contents	iii
Preface	xvii
Preface to the First Edition	xvii
Preface to the Second Edition	xviii
Getting Started	1
Chapter Overview	1
Philosophy Behind this Book	1
Using this Book	2
Required Version of IDL	2
Working with Colors in the IDL Session	2
Style Conventions Used in the Book	2
Capitalization	3
Comments	3
Line Continuation Characters	4
IDL Programs and Data Files Used in the Book	4
Installing the Program Files	4
Determining Your IDL Home and Current Directory	4
Downloading the Program Files Used with the Book	5
Make Sure Your Coyote Directory is on the IDL Path	5
Copying the Data Files	5
Obtaining Additional Help	6
Working with IDL Commands	6
Anatomy of an IDL Command	6
Positional Parameters	6
Keyword Parameters	7
IDL Procedures and Functions	7

Table of Contents

Help with IDL Commands	8
Creating Command Journals	8
Creating Variables	9
Variable Attributes Change Dynamically	10
Be Careful With Integer Variables	11
Working with Vectors and Arrays	13
Creating Vectors	13
Using Array Subscripts	13
Creating Arrays	14
Accessing Elements in Arrays	14
Extracting Vectors and Subarrays	15
Working with IDL Graphics Windows	15
Creating Graphics Windows	15
Determining the Current Graphics Window	16
Making a Graphics Window the Current Graphics Window	16
Deleting Graphics Windows	17
Positioning and Sizing Graphics Windows	17
Bringing a Graphics Window Forward on the Display	17
Putting a Title on a Graphics Window	18
Erasing a Graphics Window	18

Simple Graphical Displays 19

Chapter Overview	19
Simple Graphical Displays in IDL	19
Creating Line Plots	20
Customizing Graphics Plots	22
Modifying Line Styles and Thicknesses	22
Displaying Data with Symbols Instead of Lines	23
Displaying Data with Lines and Symbols	23
Creating Your Own Plotting Symbols	24
Drawing Line Plots in Color	24
Limiting the Range of Line Plots	25
Changing the Style of Line Plots	26
Plotting Multiple Data Sets on Line Plots	28
Plotting Data on Multiple Axes	29
Creating Surface Plots	29
Customizing Surface Plots	31
Rotating Surface Plots	31
Adding Color to a Surface Plot	32
Modifying the Appearance of a Surface Plot	34
Creating Shaded Surface Plots	34
Changing the Shading Parameters	35
Using Another Data Set For the Shading Values	35

Creating Contour Plots	36
Selecting Contour Levels	38
Modifying a Contour Plot	39
Changing the Appearance of a Contour Plot	39
Adding Color to a Contour Plot	41
Creating a Filled Contour Plot	42
Positioning Graphic Output in the Display Window	44
Setting the Graphic Margins	45
Setting the Graphic Position	46
Setting the Graphic Region	47
Creating Multiple Graphics Plots	47
Leaving Room for Titles with Multiple Graphics Plots	48
Non-Symmetrical Arrangements with !P.Multi	49
Adding Text to Graphical Displays	51
Finding the Names of Available Fonts	52
Adding Text with the XYOutS Command	52
Using XYOutS with Vector Fonts	53
Aligning Text	54
Erasing Text	54
Orienting Text	54
Adding Lines and Symbols to Graphical Displays	55
Adding Color to Your Graphical Displays	56

Working with Image Data 59

Chapter Overview	59
Working with Images	59
Displaying Images	60
An Alternative Image Display Command	62
Scaling Image Data	62
Scaling Images into Different Portions of the Color Table	63
Displaying 8-Bit Images with Different Color Tables on 24-Bit Displays	64
Displaying 24-Bit Images	64
Displaying 24-Bit Images on 24-Bit Displays	65
Displaying 8-Bit Images on 24-Bit Displays	66
Automatic Updating of Graphic Displays When Color Tables are Loaded	66
Controlling Image Display Order	68
Changing Image Size	68
Changing Image Size in PostScript	69
Positioning an Image in the Display Window	69
Positioning Images with Normalized Coordinates	70
Reading Images from the Display Device	72
Obtaining Screen Dumps on 8-Bit Displays	72
Obtaining Screen Dumps on 24-Bit Displays	73
Reading a Portion of the Display	73
An Alternative to TVRD	73

- Basic Image Processing in IDL 74
 - Histogram Equalization 74
 - Smoothing Images 75
 - Removing Noise From Images 77
 - Enhancing the Edges of Images 77
- Frequency Domain Filtering of Images 78
 - Building Image Filters 78

Graphical Display Techniques81

- Chapter Overview 81
- Working with Colors in IDL 81
 - Using the Indexed versus the RGB Color Model 82
 - Static versus Dynamic Color Visuals 83
 - Specifying Colors on an 8-Bit Display 84
 - Specifying Decomposed Colors on a 24-Bit Display 84
 - Determining if Color Decomposition is On or Off 86
 - Obtaining Device Independent Colors 87
 - Loading Color Tables on a 24-Bit Display 88
 - Obtaining a Copy of the Color Table 89
 - Modifying and Creating Color Tables 89
 - Saving Your Own Color Tables 91
- Creating Your Own Axis Annotations 92
 - Adjusting Axis Tick Intervals 92
 - Formatting Axis Annotations 92
 - Writing a Tick Format Function 94
- Handling Missing Data in IDL 95
- Setting Up a 3D Coordinate System in IDL 97
 - Setting Up a 3D Scatter Plot 98
 - Positioning the 3D Axes Through the Origin of a Plot 99
- Combining Simple Graphical Displays 100
- Animating Data in IDL 102
 - Setting Up the Animation Tool 103
 - Loading the Animation Buffer 103
 - Running the Animation Tool 103
 - Controlling the Animation 103
 - Saving Animation Pixmaps 104
 - Animating Other Types of Graphic Data 104
 - Gridding Data for Graphical Display 106
 - Delaunay Triangulation Method of Gridding 106
 - Spherical Gridding of Data 108
- Using the Cursor with Graphical Displays 109
 - When Is the Cursor Position Returned? 110
 - Which Mouse Button Was Used with the Cursor? 111
 - Annotating Graphics Output with the Cursor 111
 - Drawing a Box 111

Using the Cursor with Images	112
Using the Cursor in Loops	113
Erasing Annotation From the Display	114
The “Exclusive OR” Method of Erasing Annotation	114
The Device Copy Method of Erasing Annotation	116
Drawing a Rubberband Box	118
Graphics Window Scrolling	119
Graphics Display Tricks in the Z-Graphics Buffer	120
The Z-Graphics Buffer Implementation	121
A Z-Graphics Buffer Example: Two Surfaces	121
Make the Z-Graphics Buffer the Current Device	121
Configure the Z-Graphics Buffer	122
Load the Objects into the Z-Graphics Buffer	122
Take a Picture of the Projection Plane	122
Display the Result on the Display Device	122
Some Z-Graphics Buffer Oddities	123
Warping Images with the Z-Graphics Buffer	123
Transparency Effects in the Z-Graphics Buffer	125
Combining Z-Graphics Buffer Effects with Volume Rendering	126

Reading and Writing Data in IDL 129

Chapter Overview	129
Opening a File for Reading or Writing	129
Locating and Selecting Data Files	130
Selecting File Names	130
Selecting Directory Names	131
Finding Files	131
Constructing File Names	131
Obtaining a Logical Unit Number	131
Using Logical Unit Numbers Directly	132
Allowing IDL to Manage Logical Unit Numbers	132
Determining Which Files are Attached to Which LUNs	133
Reading and Writing Formatted Data	133
Writing a Free Format File	133
Reading a Free Format File	134
Rules For Reading Free Format Data	134
Examples of Reading and Writing Free Format Files	136
Reading a Simple Data File	136
Writing a Column-Format Data File	137
Reading a Column-Format Data File	137
Creating a Template for Reading Column-Format Data	139
Writing with an Explicit File Format	140
A Few Common Format Specifiers	140
Writing a Comma Separated Explicitly Formatted Data File	141
Reading a Comma Separated Explicitly Formatted Data File	141
Reading Formatted Data From a String	141

- Reading and Writing Unformatted Data **142**
 - Reading an Unformatted Image Data File **142**
 - Writing an Unformatted Image Data File **143**
 - Reading Unformatted Data Files with Headers **144**
 - Problems with Unformatted Data Files **145**
 - Accessing Unformatted Data Files with Associated Variables **145**
 - Advantages of Associated Variables **146**
 - Defining Associated Variables **146**
- Reading and Writing Files with Popular File Formats **147**
 - Querying Image Files for Information **147**
 - Creating a Graphic Display Program **149**
 - Creating Color GIF Files **150**
 - If the Display Depth is Eight **151**
 - If the Display Depth is Greater than Eight **152**
 - Writing the GIF File **153**
 - Reading a GIF File **153**
 - Creating Color JPEG Files **154**
 - If the Display Depth is Eight **154**
 - If the Display Depth is Greater than Eight **155**
 - Writing the JPEG File **155**
 - Reading a JPEG File **155**
 - Creating Color TIFF Files **156**
 - Reading Dicom Image Files **157**
 - Using the IDLffDicom Object **157**

Reading and Writing HDF Data 161

- Chapter Overview **161**
- Why Use the HDF Format? **162**
- Primary HDF Data Objects **162**
- HDF Application Programming Interface **163**
- Working with HDF Files **165**
 - Opening HDF Files **165**
 - Closing HDF Files **166**
 - Determining the Number of Tags in an HDF File **166**
- Working with Scientific Data Set HDF Files **166**
 - Optional Dimension Scales **167**
 - Optional User-Defined Attributes **167**
 - Optional Predefined Attributes **167**
 - Opening HDF Files Containing Scientific Data Sets **169**
 - Closing HDF Files Containing Scientific Data Sets **169**
 - Creating or Selecting Scientific Data Sets **169**
 - Creating a New SDS **169**
 - Selecting an Existing SDS **170**
 - Adding Attributes to Scientific Data Sets and HDF Files **170**
 - Gathering Information about Scientific Data Sets **172**
 - Gathering SDS Attribute Information **173**

Adding Color Palettes to HDF Files 173
Examples of Reading and Writing HDF Files 174

Creating Hardcopy Graphics Output 175

Chapter Overview	175
Selecting the Graphics Hardcopy Output Device	175
Configuring the Graphics Hardcopy Output Device	176
Determining the Current Device Configuration	176
Common Device Command Keywords	177
Creating the PostScript File	178
Sending Graphics to the Hardcopy Device	179
Printing PostScript Files	180
Printing PostScript Files on Computers Running MacOS	181
Printing PostScript Files on a Windows Computer	181
Producing Encapsulated PostScript Output	181
Encapsulated PostScript Graphic Preview	182
Producing Color PostScript Output	182
Color and Gray Scale Images in PostScript	183
True-Color Images	183
Creating Quality Output on PostScript Devices	184
Similarities Between the Display and PostScript Devices	184
Differences Between the Display and PostScript Devices	185
Problem: PostScript Windows May Have a Different Aspect Ratio	185
Solution: Make the Aspect Ratios of Graphics Windows the Same Size	185
Problem: PostScript Devices Have a Higher Display Resolution	186
Solution: Don't Use Device Coordinates to Position Graphics	187
Problem: PostScript Devices Can Use Different Display Fonts	187
Solution: Take Care in Designing and Positioning Text	187
Problem: PostScript Devices Use Background and Plotting Colors Differently	189
Solution: Understand How PostScript Handles Background and Plotting Colors	190
Problem: PostScript Devices Often Have More Colors Than the Display Device	191
Solution: Be Sure to Scale Your Data Appropriately in PostScript	192
Problem: PostScript Devices Display Images Differently	193
Solution: Size Images with the TV Command	195
Calculating PostScript Offsets in Landscape Mode	198
Configuring the PostScript Device with PSConfig	198
Configuring and Using the Printer Device	200
Positioning Graphics with the Printer Device	202
Outputting Images with the Printer Device	203
Loading Colors in the Printer Device	204
Color Loading Work-Arounds	204

IDL Programming Fundamentals207

- Chapter Overview 207
- Writing an IDL Batch File 207
- Writing a Main-Level IDL Program 208
- Writing an IDL Procedure 209
 - Scope of Procedure and Function Variables 210
 - Creating a Positional Parameter 211
 - Defining Optional or Required Positional Parameters 212
 - Defining a Keyword Parameter 213
 - Using Keyword Abbreviations 213
 - Defining Optional Keyword Parameters 214
 - Is the Keyword Defined? 214
 - Handling Keywords with Binary Properties 215
 - Passing Undefined Keywords by Keyword Inheritance 216
 - Creating Output Parameters 217
 - Passing Information by Reference or by Value 217
 - Using Keyword Inheritance with Output Parameters 219
 - Is the Parameter Present? 220
 - Was the Parameter Used? 220
- Writing an IDL Function 221
 - Square Bracket Notation and Function Calls 222
 - Reserving Function Names with the Forward_Function Command 223
- Using Program Control Statements 223
 - True and False Expressions in IDL 223
 - Making Multiple Statements Appear As Single Statements 224
 - The IF...THEN...ELSE Control Statement 225
 - The Conditional Expression 226
 - The FOR Loop Control Statement 226
 - The WHILE Loop Control Statement 226
 - The REPEAT...UNTIL Loop Control Statement 227
 - The BREAK Control Statement 227
 - The CONTINUE Control Statement 227
 - The CASE Control Statement 227
 - The SWITCH Control Statement 228
 - The GOTO Control Statement 229
 - Error Handling Control Statements 229
 - The On_IOError Control Statement 229
 - The On_Error Control Statement 230
 - The Catch Control Statement 230
 - Error Handling Hierarchy 231
 - Reporting Errors 232
 - Generating Errors 233
 - Tracing Errors 234
- Compiling and Running IDL Program Modules 235
 - Rules for Compiling IDL Program Modules Automatically 236
 - Structuring Program Files 236
 - Special Compilation Commands 237

Writing an IDL Graphics Display Program 239

Chapter Overview 239

The HistoImage Program 240

Writing the Procedure Definition Statement 240

Writing the Error Handling Code 242

Checking for Positional and Keyword Parameters 242

Checking for the Image Positional Parameter 243

Checking for Keyword Parameters 243

Loading the Program Colors 246

Preparing to Draw the Graphics 246

Calculating Graphic Positions in the Window 246

Changing Character Size According To Window Size 247

Calculating the Image Histogram 248

Drawing the Graphics 248

Drawing the Histogram Plot 248

Drawing the Color Bar 251

Drawing the Image Plot 251

Working Around a Printer Device Bug 252

Compiling and Testing the Program 253

Reviewing the HistoImage Program's Advantages 253

The HistoImage Program is Device Independent 255

Using HistoImage in a "Smart" Resizeable Graphics Window 256

Writing a Widget Program 259

Chapter Overview 259

The Structure of Widget Programs 259

How Do Widget Programs Respond to Events? 261

Writing the Widget Definition Module 261

The Advantage of Mistakes 261

Typing the Code 262

Defining and Creating the Program's Widgets 263

Creating the Top-Level Base Widget 264

Creating Buttons for the Menu Bar 265

Creating the Graphics Window for the Program 265

Realizing the Widgets on the Display 266

Making the Draw Widget the Current Graphics Window 266

Displaying the Graphics in the Draw Widget Window 266

Storing Information Required to Run the Program 267

Using Pointer Variables 268

Using Pointers in the Info Structure 271

Using Widget User Values to Store Program Information 271

Practicing Good Memory Management 272

Creating the Event Loop and Registering the Program 275

Running the Program 276

Table of Contents

Writing the Event Handler Modules	276
Common Fields in Event Structures	277
Event Handler Functions	278
Associating Event Handlers with Widgets	279
Writing the Quit Button Event Handler	279
Writing the Resizable Graphics Window Event Handler	280
Writing the Cleanup Procedure	282
Running the Program	283
Recovering From Program Errors	283
Adding Color Protection	284
Saving the Color Vectors	285
Setting Up Keyboard Focus Events	285
Modifying the Histo_GUI_TLB_Events Event Handler	286
Buffering the Graphic Display for Smoother Output	287

Widget Programming Techniques293

Chapter Overview	293
Adding Image Processing Capability	294
Building the Pull-Down Menu Widgets	294
Writing the Event Handler for the Pull-Down Menu	295
Limitations of the Event Handler as Written	296
Implementing an Undo Capability	298
Adding Color Controls to the Program	301
Building the Pull-Down Menu Widgets	301
Writing the Drawing Colors Event Handler	301
Writing the Image Colors Event Handler	305
Communicating in XColors via Widget Events	306
Importance of Group Leaders	310
Adding File Output Functionality	312
Building the Pull-Down Menu Widgets	312
Writing the File Output Event Handler	313
Creating the GIF File	315
Creating the JPEG File	315
Creating the TIFF File	316
An Alternative Way of Creating GIF, JPEG, and TIFF Files	316
Creating the PostScript File	317
Adding Printer Functionality	320
Creating the Print Pull-Down Menu	320
Writing the Print Event Handler	320

Creating Dialog Form Widgets325

Chapter Overview	325
Creating a Modal Dialog Form Widget	325

A Blocking Widget Program	326
A Modal Widget Program	327
Writing a Modal Dialog Form Widget Definition Module	327
Defining a Modal Top-Level Base	328
Defining Other Widgets	329
Storing Collected Information in Modal Dialogs	330
Creating the Info Structure	331
Creating a Blocked Widget	331
Returning from the Block	331
Writing the Modal Dialog Event Handler Modules	332
Error Handling	333
Testing the Modal Dialog Form Widget Program	335
Using FSC_InputField for Program Input	335
Adding an Open Image Capability to the Histo_GUI Program	337
Adding an Open Button	337
Writing the Open Image Event Handler	338
Creating a Non-Modal Widget Dialog	340
Writing a Non-Modal Dialog Widget Definition Module	341
Notifying Widgets of Program Events	342
Writing the Non-Modal Dialog Event Handler Modules	343
Sending Events to Other Widgets	344
Testing the ReadImage Program	345
Writing the Read Image Event Handler	345

Creating Graphics Display Objects 349

Chapter Overview	349
A Quick Object Overview	349
The Idea of Data Encapsulation	350
Creating Objects	350
Invoking Object Methods	351
Destroying Objects	353
Creating a New Object Class	353
Defining the Object Class	353
Structure Review	353
Automatic Structure Definition	355
The BoxImage Class Definition	355
Creating Object Lifecycle Methods	356
Creating the Init Method	357
Creating the Cleanup Method	360
Creating the Specific Instance of the Object	360
Lifecycle Methods Must Be Defined When the Object is Created	361
Common Problems When Creating Objects	361
Initializing the Object Using Parameters	361
Creating the Display Method	362
Creating Methods to Set and Get Object Properties	364
Set Property Methods	365
Get Property Methods	367
Creating Methods to Work with Colors in Objects	370

- Creating Methods to Extend Object Functionality 372
- Object Inheritance 374
 - Defining the Subclass Object 374
 - Creating Subclass Lifecycle Methods 376
 - Attaching Methods to Superclass Objects 378
 - Overriding Superclass Methods 378
 - Creating New Methods for the SubClass Object 380
 - Object Polymorphism 380
 - Testing the HistoImage Object 386

Appendix A: Widget Event Structures389

- Event Structure Definition 389
 - Common Field Definitions 389
- Basic Widget Event Structures 389
 - Base Widget Event Structure 389
 - Button Widget Event Structure 390
 - Draw Widget Event Structure 390
 - Droplist Widget Event Structure 390
 - Label Widget Event Structure 390
 - List Widget Event Structure 390
 - Slider Widget Event Structure 390
 - Table Widget Event Structure 391
 - Character Insertion Event 391
 - String Insertion Event 391
 - Delete String Event 391
 - Text Selection Event 391
 - Cell Selection Event 391
 - Row Height Changed Event 391
 - Column Width Changed Event 392
 - Invalid Data Event 392
 - Text Widget Event Structure 392
 - Character Insertion Event 392
 - String Insertion Event 392
 - Delete String Event 392
 - Text Selection Event 392
- Compound Widget Event Structures 393
 - CW_Animate Event Structure 393
 - CW_Arcbal Event Structure 393
 - CW_BGroup Event Structure 393
 - CW_Clr_Index Event Structure 393
 - CW_Color_Set Event Structure 393
 - CW_DefROI Event Structure 393
 - CW_Field Event Structure 393
 - CW_Form Event Structure 393
 - CW_FSlider Event Structure 393
 - CW_Orient Event Structure 394
 - CW_PDMenu Event Structure 394
 - CW_RGBSlider Event Structure 394

CW_Zoom Event Structure	394
FSC_InputField Event Structure	394
Widget Program Event Structures	394
XColors Event Structure	394
ReadImage Event Structure	395
Other Widget Event Structures	395
Keyboard Focus Events	395
Kill Widget Request Events	395
Widget Timer Events	395
Widget Tracking Events	395
Appendix B: Data File Descriptions	397
Appendix C: IDL Program Code	399
IDL Example Programs	399
BoxImage__Define Object Program	399
HDFRead Program	406
HDFWrite Program	407
HistoImage Program	409
Histo_GUI Program	412
HistoImage__Define Object Program	423
OpenImage Program	428
ReadImage Program	431
Index	435