
An Introduction to Programming with IDL

Interactive Data Language

Kenneth P. Bowman

Department of Atmospheric Sciences

Texas A&M University



AMSTERDAM • BOSTON • HEIDELBERG • LONDON
NEW YORK • OXFORD • PARIS • SAN DIEGO
SAN FRANCISCO • SINGAPORE • SYDNEY • TOKYO

Academic Press is an imprint of Elsevier



Contents

	Preface	xi
	Acknowledgments	xiii
Part I	IDL BASICS	1
Chapter 1	Introduction	3
	1.1 What Is IDL?	3
	1.2 IDL Resources	4
	1.3 The IDL Software System	5
Chapter 2	IDL Manuals and Books	9
	2.1 Features of This Book	9
	2.2 IDL Documentation from Research Systems	10
	2.3 Other IDL Books	11
Chapter 3	Interactive IDL	13
	3.1 IDL Commands	13
	3.2 Setting Up IDL	13
	3.3 Starting and Exiting IDL	18
	3.4 Interrupting and Restarting IDL Calculations	19
	3.5 Simple IDL Statements	20
	3.6 Getting Information	22
	3.7 Variables	23
	3.8 Arrays	24
	3.9 Graphics	27
	3.10 Summary	30
	3.11 Exercises	31
Chapter 4	IDL Scripts (Batch Jobs)	33
	4.1 IDL Commands and Notation	33
	4.2 A Note on Files and File Names	33
	4.3 Making a Script	34

	4.4	Journaling	36
	4.5	Summary	37
	4.6	Exercises	38
Chapter 5		Integer Constants and Variables	39
	5.1	IDL Commands and Notation	39
	5.2	Decimal and Binary Notation	39
	5.3	BYTE Constants and Variables	40
	5.4	INT Constants and Variables	44
	5.5	LONG Constants and Variables	45
	5.6	Other Integer Types	46
	5.7	Converting One Integer Type to Another	46
	5.8	Summary	47
	5.9	Exercises	47
Chapter 6		Floating-Point Constants and Variables	49
	6.1	IDL Commands and Notation	49
	6.2	Development of Floating-Point Methods	49
	6.3	Limitations of Floating-Point Arithmetic	50
	6.4	Single-Precision Constants and Variables	51
	6.5	Double-Precision Constants and Variables	53
	6.6	Type Conversion	54
	6.7	Rounding	55
	6.8	Infinities and Not-a-Numbers	55
	6.9	Summary	57
	6.10	Exercises	58
Chapter 7		Using Arrays	59
	7.1	IDL Procedures and Functions	59
	7.2	Creating Arrays	59
	7.3	Arithmetic with Arrays	60
	7.4	Index Arrays	63
	7.5	Generating a Coordinate Array	64
	7.6	Changing the Shape of an Array	66
	7.7	Using Part of an Array	69
	7.8	Expanding or Shrinking (Rebinning) an Array	70
	7.9	Reversing an Array	72
	7.10	Rotating or Transposing an Array	74
	7.11	Shifting an Array	74
	7.12	Summary	75
	7.13	Exercises	75

Chapter 8	Searching and Sorting	77
8.1	IDL Procedures and Functions	77
8.2	Finding Values in an Array That Satisfy a Logical Condition	77
8.3	Sorting an Array	79
8.4	Finding a Value in a Sorted Array	80
8.5	Summary	81
8.6	Exercises	82
Chapter 9	Structures	83
9.1	IDL Commands and Keywords	83
9.2	Named Structures	83
9.3	Anonymous Structures	87
9.4	Hierarchical Structures	89
9.5	Additional Topics	90
9.6	Summary	90
9.7	Exercises	90
Part II	INPUT AND OUTPUT	91
Chapter 10	Printing Text	93
10.1	IDL Commands and Keywords	93
10.2	Free-Format Output	93
10.3	Formatted Output	95
10.4	Printing a Table	97
10.5	Output to Files	98
10.6	Summary	99
10.7	Exercises	100
Chapter 11	Reading Text	101
11.1	IDL Commands and Keywords	101
11.2	Reading Text from the Terminal	101
11.3	Reading Text from Files	102
11.4	Summary	104
11.5	Exercises	105
Chapter 12	Writing and Reading Binary Files	107
12.1	IDL Commands and Keywords	107
12.2	Writing Binary Files	108
12.3	Reading Binary Files	110
12.4	Exchanging Files with Fortran Programs	113
12.5	Summary	113
12.6	Exercises	114

Chapter 13	Reading NetCDF Files	115
	13.1 IDL Procedures and Functions	115
	13.2 NetCDF Basics	116
	13.3 Reading Attributes	119
	13.4 A Real Data File	122
	13.5 Summary	124
	13.6 Exercises	124
Chapter 14	Writing NetCDF Files	127
	14.1 IDL Procedures and Functions	127
	14.2 Writing a NetCDF File	127
	14.3 Writing Parts of an Array	131
	14.4 Summary	132
	14.5 Exercises	133
Part III	PROGRAM STRUCTURE AND CONTROL	135
Chapter 15	Procedures and Functions	137
	15.1 IDL Commands and Keywords	137
	15.2 Built-in Procedures and Functions	137
	15.3 Writing Procedures	139
	15.4 Writing Functions	144
	15.5 Keyword Parameters	147
	15.6 Optional Parameters	149
	15.7 Summary	149
	15.8 Exercises	150
Chapter 16	Program Control	153
	16.1 IDL Commands and Keywords	153
	16.2 BEGIN...END Statements	153
	16.3 IF...THEN...ELSE Statements	154
	16.4 FOR Loops	155
	16.5 WHILE Loops	156
	16.6 Other Control Structures	157
	16.7 Summary	157
Part IV	GRAPHICS	159
Chapter 17	Line Graphs	161
	17.1 IDL Commands for Plotting Line Graphs	161
	17.2 Plotting Styles	161
	17.3 Titles and Labels	165
	17.4 Axes	167

	17.5 Multiple Plots Per Page	169
	17.6 Summary	170
Chapter 18	Contour and Surface Plots	171
	18.1 IDL Commands and Keywords	171
	18.2 Contour Plots	171
	18.3 Surface Plots	175
	18.4 Shaded Surface Plots	177
	18.5 Summary	179
Chapter 19	Mapping	181
	19.1 IDL Commands and Keywords	181
	19.2 Drawing Maps	181
	19.3 Contour Plots on Maps	189
	19.4 Other Plots on Maps	191
	19.5 Summary	191
Chapter 20	Printing Graphics	193
	20.1 IDL Commands and Keywords	193
	20.2 Device Drivers	193
	20.3 The PostScript Device	194
	20.4 The PRINTER Device	196
	20.5 Some Limitations of the PRINTER and PS Devices	200
	20.6 Summary	200
	20.7 Exercises	200
Chapter 21	Color and Image Display	201
	21.1 IDL Commands and Keywords	201
	21.2 Color Basics	201
	21.3 24-Bit Devices	205
	21.4 8-Bit Devices	215
	21.5 Printing Color Output	216
	21.6 Summary	217
Chapter 22	Animation	219
	22.1 IDL Commands and Keywords	219
	22.2 Background	219
	22.3 Using XINTERANIMATE	220
	22.4 Summary	224
	22.5 Exercises	224

Part V	APPLICATIONS	225
Chapter 23	Statistics and Pseudorandom Numbers	227
	23.1 IDL Commands and Keywords	227
	23.2 Pseudorandom Numbers	228
	23.3 Basic Statistics	231
	23.4 Regression and Correlation	233
	23.5 Curve Fitting	233
	23.6 Significance Tests	234
	23.7 Summary	235
Chapter 24	Interpolation	237
	24.1 IDL Commands and Keywords	237
	24.2 Background	237
	24.3 1-D Interpolation	237
	24.4 Bilinear Interpolation	239
	24.5 Higher Dimensions	242
	24.6 Irregular Grids	243
	24.7 Summary	246
Chapter 25	Fourier Analysis	247
	25.1 IDL Commands and Keywords	247
	25.2 Background	247
	25.3 The IDL FFT	252
	25.4 Fourier Filtering	257
	25.5 Summary	262
	25.6 Exercises	262
Appendix A	An IDL Style Guide	263
	A.1 IDL Style Rules	263
	A.2 Examples of Good and Bad Style	266
	A.3 IDL Reserved Words	269
Appendix B	Example Procedures, Functions, Scripts, and Data Files	271
	B.1 Example Procedures, Functions, Scripts	271
	B.2 Data Files	275
	Bibliography	277
	Index	279
