

COURSE TITLE

PROGRAMMING FOR IMAGING SCIENCE (1051.211.01)

INSTRUCTOR INFORMATION

Carl Salvaggio, Ph.D.
Associate Professor
Office Address: 76/3136
Telephone Number: 585-475-6380
E-mail: salvaggio@cis.rit.edu
AIM: imagesci87
Office Hours: Open door

TEACHING ASSISTANT INFORMATION

May Arsenovic
Teaching Assistant
Office Address: 76/3227 (located in Room 76/3215)
E-mail: mva7609@rit.edu
AIM: MayTheTA
Office Hours: M 12-2 / T 12-4 / R 12-4

COURSE DESCRIPTION

This course will introduce the student to the IDL environment as a data visualization tool and a programming language. The student will learn the various capabilities of the package and how they can rapidly prototype solutions to various science and engineering problems. As these solutions are developed, fundamental concepts of programming and data structures will be introduced. Programming assignments will include fundamental imaging related problems and will work with scalar, vector and array processes. This course will emphasize the need for concrete problem definition, problem decomposition into smaller sub-problems, implementation/testing, and presentation/documentation of the algorithms and results. (Algebra and trigonometry) Class 4, Credit 4

LEARNING OUTCOMES/METHOD OF EVALUATION

- Ability to use the IDL environment as an interactive problem solving tool (HOMEWORK ASSIGNMENTS)
- Ability to use IDL as a programming language to solve scientific problems (HOMEWORK ASSIGNMENTS)
- Ability to produce user-friendly, robust, graphical-user interface-driven codes for scientific problem solving (HOMEWORK ASSIGNMENTS)
- Gain an understanding of computer/imaging science concepts
 - Binary, octal and hexadecimal numbering systems (EXAMS / QUIZZES)
 - Programming control statements (HOMEWORK ASSIGNMENTS / EXAMS / QUIZZES)
 - Data structures and arrays (HOMEWORK ASSIGNMENTS / EXAMS / QUIZZES)

- Image file formats (HOMEWORK ASSIGNMENTS)
- Basic image processing concepts (HOMEWORK ASSIGNMENTS)
- Vector and array-based processing (HOMEWORK ASSIGNMENTS)

MEETING TIMES

Tuesday, Thursday / 10:00-11:50AM / Room 76:2155 (enter through 76:2125)

READING MATERIALS

- Gumley, Liam E., Practical IDL Programming, Morgan Kaufmann Publishers, New York, 2002 (ISBN: 1-55860-700-5)
- Horton, K., J. Johnson and P. Lucey, Infrared measurements of pristine and disturbed soils 2 - Environmental effects and field data reduction, Remote Sensing of Environment, Volume 64, 1998, pp. 47-52.
- Bower, N., R. Knuteson and H. Revercomb, High spectral resolution land surface temperature and emissivity measurements in the thermal infrared, Publication from the Co-operative Institute for Meteorological and Satellite Studies and the University of Wisconsin, Madison.

COURSE MECHANICS

60% Programming Assignments

10% Quizzes

15% Programming Examination 1

15% Programming Examination 2

TOPICAL OUTLINE

Overview of UNIX / Scientific Problem Solving

- Obtain computer accounts on CIS network
- E-mail (LDAP, different RIT accounts, types of servers, forwarding)
- Discuss fundamental UNIX commands
 - ls
 - man
 - vi
 - rm
 - alias
 - mv
 - cp
- Discuss client/server relationships
- Web server/client
- Database server/client
- X Windows Server/client
- Mail server/client
- ssh vs. telnet
- ssh Concepts (key generation, pass phrases)
 - sftp

- srm
- Discuss fundamental UNIX commands
- Discuss the IDL language
- Introduction to IDL and the scientific problem-solving concept through the use of the regression example
 - Definition of data arrays (INPUT)
 - Use of the REGRESS function (PROCESSING)
 - Use of the PLOT function (OUTPUT)

READING:

Practical Programming in IDL, Section(s) 1.1 through 2.1, 3.1

Storage Concepts / Variable Types / Arrays

- Data Types
 - BYTE
 - INT
 - UINT
 - LONG
 - ULONG
 - LONG64
 - ULONG64
 - FLOAT
 - DOUBLE
 - COMPLEX
 - DCOMPLEX
 - STRING
 - STRUCT
- Conversion Functions
 - BYTE()
 - FIX()
 - UINT()
 - LONG()
 - ULONG()
 - LONG64()
 - ULONG64()
 - FLOAT()
 - DOUBLE()
 - COMPLEX()
 - DCOMPLEX()
 - STRING()
- Counting Systems
 - Decimal (base 10)
 - Binary (Base 2)
 - Octal (base 8)
 - Hexidecimal (base 16)

READING:

Practical Programming in IDL, Section(s) 2.2 through 2.5

Writing Simple Q&A Programs in IDL

- Arrays & Structures
- Simple Programs
- Program structure
- Input/output statements (READ, PRINT, HELP)
- Procedures vs. Functions (PRO, FUNCTION)
- Passing arguments between IDL procedures and functions (parameters, keywords, booleans keywords, RETURN)

READING:

Practical Programming in IDL, Section(s) 3.3, 4.1

Procedures vs. Functions / Data Structures

- The discussion of the differences between functions and procedures in IDL will continue. The concept of returning value using a RETURN statement in a FUNCTION or via the parameter list in a PROCEDURE will be looked at more closely. We will also look at optional parameters and how they could be used in a PROCEDURE or FUNCTION call.
 - Single input/single output
 - Multiple input/single output
 - Single input/multiple output
 - Multiple input/multiple output
- A discussion will take place describing how and where IDL looks for functions and procedure. A demonstration will occur on storing a function in a separate file for use by many different programs in the future.
- The last variable/data type will be introduced, the STRUCTURE.
- A discussion of GUI programming and the interface widgets available in IDL will begin. The objective will be for everyone to be able to write GUI based interfaces for the remaining programs in this class.

READING:

Practical Programming in IDL, Section(s) 2.7

Elements of GUI Development

- The discussion of GUI development will continue covering
- Differences between procedural and event driven programming
- Concept of widgets
- The GUI definition procedure (_gui)
 - WIDGET_BASE()
 - WIDGET_LABEL()
 - WIDGET_TEXT()
 - WIDGET_BUTTON()
 - WIDGET_CONTROL()

- Widget realization via WIDGET_CONTROL()

READING:

Practical Programming in IDL, Section(s) 9.1 through 9.3

Elements of GUI Development / Control Statements

- The introductory discussion of GUI development will continue by looking at
- The event manager / XMANAGER()
- The event procedure (_event)
- Two fundamental control statements will be discussed
 - IF () THEN ... ELSE
 - CASE

READING:

Practical Programming in IDL, Section(s) 9.4 through 9.5, 3.2 (pages 97-101), 2.6

Elements of GUI Development / Dealing with Images

- The introductory discussion of GUI development will conclude by looking at
 - /EXCLUSIVE bases (radio buttons)
 - /NONEXCLUSIVE bases (check boxes)
- Dealing with files specific to images will be considered with the following topics being covered
- Image file formats (raw, compressed, greyscale, color, multispectral, hyperspectral)
- QUERY_* routines
- READ_* routines
- WINDOW procedure
- TV and TVSCL procedures
- WRITE_* routines

READING:

Practical Programming in IDL, Section(s) 7.1 through 7.5

Dealing with ASCII and Binary Files / More Control Statements

The concept of files and how to deal with them will be discussed

- ASCII files
- Binary files
- OPENR/OPENW procedures
- READ/READF procedures
- PRINT/PRINTF procedures
- READU/WRITEU procedures
- Dealing with files specific to images will be considered with the following topics being covered
- Image file formats (raw, compressed, greyscale, color, multispectral, hyperspectral)
- QUERY_* routines

- READ_* routines
- WINDOW procedure
- TV and TVSCL procedures
- Review of READ_ASCII() and ASCII_TEMPLATE()

READING:

Practical Programming in IDL, Section(s) 4.2 through 4.4

PROGRAMMING EXAMINATION 1

Looping Mechanisms

- A look at the looping mechanisms in IDL will be taken. Mechanisms include
 - FOR
 - WHILE
 - REPEAT

READING:

Practical Programming in IDL, Section(s) 3.2 (pages 101-106)

Arrays, Data Structures, Strings and Associated Manipulation Routines

- A much closer look at arrays will be taken. Topics will include
 - Array formation
 - Array addressing
 - Dimensionality; N_ELEMENTS()
 - Size determination; SIZE()
 - The use of arithmetic operators with arrays
 - Array functions; MIN(), MAX(), MOMENT(), MEAN(), STDEV(), VARIANCE(), and others
 - Finding elements within arrays; WHERE()
 - Reordering array elements; REVERSE(), ROTATE(), TRANSPOSE(), SHIFT(), SORT(), UNIQ()

READING:

Practical Programming in IDL, Section(s) 2.9 through 2.11

Structures, Strings and Control Statements

- We will finish our closer look at arrays, and discuss structures and strings. Topics will include
 - Resizing and array; CONGRID()
 - Matrix operations
 - Forming structures
 - String manipulation functions and procedures
- We will conclude our introduction to control statements by discussing
 - SWITCH
 - BREAK

- CONTINUE

READING:

Practical Programming in IDL, Section(s) 2.12, 2.7, 3.2 (pages 106-109)

Advanced Imaging Applications and Concepts

- Some advanced image display functions will be examined including
 - TVSCL procedure
 - Displaying multiple images in a single window, TV procedure
 - ZOOM procedure
 - SLIDE_IMAGE procedure
 - Some useful image information routines will be examined including
 - CURSOR
 - Working with color using IDL Direct Graphics can be a little confusing. The following topics should remove some of this confusion
 - Indexed vs. RGB color
 - DEVICE, DECOMPOSED=0,1
 - LOADCT / XLOADCT
 - XPALETTE
 - Specifying RGB colors (color = red + 256L*green + (256L²)*blue)
 - COLOR keyword

PROGRAMMING EXAMINATION 2