Fall 2002, ESM4714; CRN 95629;
T,Th 5:00-6:15PM; Norris Hall Room 206
Approved for Graduate Credit

Engineering Science and Mechanics 4714
SCIENTIFIC VISUAL DATA ANALYSIS AND MULTIMEDIA
(ADP TITLE: SCI VISUAL DATA ANALY)
http://www.sv.vt.edu/classes/ESM4714/ESM4714.html

I. Catalog Description:

4714 SCIENTIFIC VISUAL DATA ANALYSIS

Classical and advanced methods of visual data analysis within scientific applications context; emphasis on examples of scientific investigation with visual tools, and new visual methods with computer graphics; visual data analysis of numerical experimental and analytical results including: gradients, function-extraction, chaos, nth-order tensor glyph representations, molecular synthesis.

(3H, 3C). II.

Pre: Math 1015-1016 or Math 1205-1206, any course in C, Fortran, or Pascal, working knowledge of Unix.

Co: Senior or graduate project that demonstrates a need for visual data analysis.

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II. Learning Objectives:

Upon successful completion of this course, the student will be able to:

- interpret and analyze complex analytic expressions, large experimental or computer simulation data sets,

- visually quantify multidimensional physical properties such as eigenvalues-eigenvectors with glyphs,

- apply principles of graphical excellence to complex ideas associated with large data sets or complex analytical functions with clarity, precision, and efficiency,

- compose a final project in a well organized and well designed visual format using multimedia or web software.

III. Justification:

Computer graphics have become increasingly useful for many disciplines, including art and architecture, as well as for engineering and science. Engineers and scientists use graphics software for analysis and interpretation in addition to presentation. The introduction of computer graphics as an analytical research tool was largely motivated by the National Science Foundation which created four supercomputing centers in the late 80s. Scientists and engineers have increasingly used supercomputers to simulate complex phenomena, typically three dimensional, that resulted in massive data sets. Similarly, computer-controlled experiments in the laboratory have also created massive three dimensional data sets such as MRI and X-Ray CAT scans. These massive data sets created a new problem in that traditional graphical techniques designed for presentation were inadequate for analysis and interpretation. Hence the name "visualization", short for visual data analysis, was coined to emphasize analysis and interpretation.

The need for visual data analysis has penetrated almost every discipline that encounters these large data sets. Because large data sets are encountered in the course of a senior project or graduate level research project, this course is oriented as a problem solving class project. Students are required to define a research problem as their class project that can benefit from implementing visual methods and techniques introduced in the class. Because of the emphasis on research, this course is suited for both 4000 level undergraduate class and 5000 level graduate class where senior projects, M.S. and Ph.D. research projects can encounter large complex data sets. As a special study this class was taken mostly by graduates and the Department of Computer Science also independently approved this class for graudate credit.

No credit is given for developing or programming visual interfaces although it is expected that students must demonstrate proficiency in programing as a prerequisite.

With resources provided in the ACITC: 1) Scientific Visualization and Modeling Classroom and 2) University Visualization and Animation Laboratory, students learn how to use state-of-the-art visual tools in a systematic and rational way, independent of the source of data (experimental, numerical, or analytical) to gain insight into their data or complex analytic functions. Access to NSF supercomputer time is also available from the NCSA for class projects that require numerical solutions to complex boundary value problems.

IV. Prerequisites & Corequisites:

Prerequisites: Undergraduate calculus, e.g., Math 1015--1016, or Math 1205-1206. Working Knowledge of UNIX, and either C, Fortran, or Pascal.

Corequisites: Existing project (e.g. Senior Design Project, Masters Thesis or Ph.D. dissertation) that will benefit from their class project.

V. Text and Special Teaching Aids:

1. Required Text/s: Robert Wolff and Larry Yaegar, VISUALIZATION OF NATURAL PHENOMENA, New York: Springer-Verlag, 1993, 374.

2. Optional Texts:
    1. Fortner B., THE DATA HANDBOOK. II, New York: Springer-Verlag, 1995, 349.
    2. Tufte E. R., ENVISIONING INFORMATION, Cheshire Connecticut: Graphics Press, 1990, 129.

3. Class notebook: "Three Visual Methods", lectures, exercises, assignments, and data sets accessed at http://www.sv.vt.edu/classes/ESM4714/ESM4714.html.

VI. Syllabus:

	Percent of Course
1. Historical perspective on visual tools and methods in scientific research: general principles for using graphical methods for visual insight	5 %
2. Scientific visual data analysis	
A. General principles and methods	15 %
1. Data compression into 4-D space: gradients of scalar functions	
2. N-dimensional space for extracting new relationships	
3. Visual representation of N-th order tensors	
B. Introduction to visual tools	25 %
1. Constructing scientific data sets and data types and conversions	
2. General visual tools	
3. Interactive data languages and visual programming systems	
C. Examples	5 %
1. Fluid mechanics	
2. Solid mechanics	
3. Dynamics	
3. Multimedia development	
A. Foundations of multimedia	13 %
1. Introduction to multimedia	
2. Introduction to layout and design	
B. Authoring tools	12 %
1. Macromedia director	
2. Macromedia authorware professional	
C. Technical Labs	25 %
1. Tour of the multimedia lab	
2. Interface design and image scanning	
3. Digital audio, digital video, navigation and scripting	
4. Final project production	
4. Final Class Presentations	