# CSI 703
# Scientific and Statistical Visualization
Syllabus

**Instructor:** Dr. Fernando Camelli
**Contact Info:** fcamelli@gmu.edu

**Date:** Tuesday 4:30 pm – 7:10 pm
**Place:** Research Hall, room 301, Fairfax Campus
**Office Hour:** Tuesdays from 3:00 pm to 4:00 pm or by appoitment
**Prerequisites:** Fluency with at least one of the following computer languages: C/C++, or FORTRAN. Fluency with Unix/Linux operating system, or Permission of Instructor

**Description:**

This course brings together material from many disciplines to provide an overview of scientific visualization. The scope is interpreted broadly to include contributions from the fields of information visualization and the emerging field of visual analytics.

The goals of visualization include data description and analysis, discovery, hypothesis generation, analysis, understanding, presentation and education. In this class the active agent is the analyst not passive user. A graphics design challenge is to engage the analyst. Toward this end the class begins by stressing human cognition and perception as a foundation for graphics that are useful for analysts. This is followed by topics from several disciplines. Topics from computer graphics cover some of the basics of image transformations and rendering. Topics from geography, cartography and earth systems address visualization in a geospatial and temporal contexts.

The course will present basic algorithms used to visualize scientific data sets. These algorithms can be interpreted as operators that transform the data into different forms and at the end of the process it can be rendered. The class will cover scalar field visualization (isosurfaces, volume rendering), vector field visualization, tensor visualization, large scale data visualization. The class stresses the importance of data (observational data or/and simulation data) and data models in driving the graphics. Student final project presentations and sometimes guest lecturers help to provide coverage of different domains.

**Topics:**

- Quantitative Graphics Design Guidelines, R, and basic graphics: human perception and cognition; introduction to R syntax.
- Computer Graphics and Interaction: introduction to OpenGL, OpenGL drawing techniques, GLUT, event managements, and mouse control.
- Advanced Computer Graphics: color perception review, graphic pipeline, shading, illumination, texture, GPU programming.

- Data Structures: tree structures, quadtree, octree, interval tree, segment tree, Kd-tree, range tree, structured and unstructured grids.
- Contouring, Iso-surfaces, Volume Rendering: marching cubes, examples of contouring, iso-surfaces, and volume rendering.
- Vector and Tensor Fields: mathematical description of a vector and tensor field, arrow plots, streamlines, line integration convolution (LIC), particle tracing methods, vortex visualization, and medical images.

**Grades:**

- Homework assignment: 35%
- Paper presentation: 10%
- Final project: 35%
- Final exam: 20%

**Class URL:** http://www.cds.gmu.edu/~fcamelli/academics/csi703.html
https://mymasonportal.gmu.edu/webapps/portal/frameset.jsp
Note: Presentations in PDF format will be posted on ***Blackboard*** after lectures for students.

**Text Book (not required but suggested):**

- **Visual Perception from a Computer Graphics Perspective,** by W. Thompson, R. Fleming, S. Creem-Regehr, and J.K. Stefanucci
- **The Visualization Handbook,** edited by C. D. Hansen and C. R. Johnson
- **Information Visualization, Perception for Design,** by C. Ware
- **The VTK User's Guide,** by Kitware, Inc.
- **The Visualization Toolkit: An Obejct-Oriented Approach to 3D Graphics,** by W. Schroeder, K. Matin, and B. Lorensen
- **Python Scripting for Computational Science,** by H. P. Langtangen
- **OpenGL Programming Guide: The Official Guide to Learn OpenGL, Version 2.1,** by OpenGL Architecture Review Board, D. Shreiner, M. Woo, J. Neider, and T. Davis
- **OpenGL SuperBible: Comprehensive Tutorial and Reference,** by R. S. Wright, B. Lipchak, and N. Haemel
- **Visualization and Processing of Tensor Fields,** edited by J. Weickert and H. Hagen
- **Scientific Visualization: The Visual Extraction of Knowledge from Data,** edited by G-P. Bonneau, T. Ertl and G. M. Nielson
- **Geometric Data Structures for Computer Graphics,** by E. Langetepe, and G. Zachmann
- **Computer Graphics: Principles and Practice (2nd edition),** by J. D. Foley, A. Van Dam, S. K. Feiner, and J. F. Hughes

**Honor Code:**
As in any class, you are allowed to study with other students. However, tests and homework assignments (unless otherwise specified) must be completed on your own. SPECIFICALLY - YOU MAY NOT COPY ANY TEXT OR MATERIAL AND REPRESENT IT AS YOUR OWN WORK. For both papers and for code, you may reference or link to other peoples work (if it is consistent with the assignment), but you MUST cite the source it came from. Failure to follow these guidelines will be considered a violation of GMU's academic honor code and will be treated as such.
Student members of the George Mason University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work. http://academicintegrity.gmu.edu/honorcode/
***Plagiarism will not be tolerated.***

**Academic Integrity:**
GMU is an Honor Code university; please see the University Catalog for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form. Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind) please ask for guidance and clarification.

**GMU e-mail Accounts:**
Students must use their Mason email accounts—either the existing "MEMO" system or a new "MASONLIVE" account to receive important University information, including messages related to this class. See http://masonlive.gmu.edu for more information.

**Office of Disability Services:**
If you are a student with a disability and you need academic accommodations, please see me and contact the Office of Disability Services (ODS) at 993-2474. All academic accommodations must be arranged through the ODS. http://ods.gmu.edu

**Other Useful Campus Resources:**

**Writing Center:** A114 Robinson Hall; (703) 993-1200; http://writingcenter.gmu.edu

**University Libraries** "Ask a Librarian" http://library.gmu.edu/mudge/IM/IMRef.html

**University Policies**
The University Catalog, http://catalog.gmu.edu, is the central resource for university policies affecting student, faculty, and staff conduct in university academic affairs. Other policies are available at http://universitypolicy.gmu.edu/. All members of the university community are responsible for knowing and following established policies.