Course guide
270673 - SV - Scientific Visualization

Last modified: 29/07/2025

Unit in charge: Barcelona School of Informatics
Teaching unit: 723 - CS - Department of Computer Science.

Degree: MASTER'S DEGREE IN INNOVATION AND RESEARCH IN INFORMATICS (Syllabus 2012). (Optional subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: IMANOL MUÑOZ PANDIELLA

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEE1.1. Capability to understand and know how to apply current and future technologies for the design and evaluation of interactive graphic applications in three dimensions, either when priorizing image quality or when priorizing interactivity and speed, and to understand the associated commitments and the reasons that cause them.
CEE1.3. Ability to integrate the technologies mentioned in CEE1.2 and CEE1.1 skills with other digital processing information technologies to build new applications as well as make significant contributions in multidisciplinary teams using computer graphics.

Generical:
CG3. Capacity for mathematical modeling, calculation and experimental designing in technology and companies engineering centers, particularly in research and innovation in all areas of Computer Science.

Transversal:
CTR1. ENTREPRENEURSHIP AND INNOVATION: Capacity for knowing and understanding a business organization and the science that rules its activity, capability to understand the labour rules and the relationships between planning, industrial and commercial strategies, quality and profit. Capacity for developping creativity, entrepreneurship and innovation trend.
CTR4. INFORMATION LITERACY: Capability to manage the acquisition, structuring, analysis and visualization of data and information in the area of informatics engineering, and critically assess the results of this effort.

TEACHING METHODOLOGY

The professor provides theoretical lectures where the most important concepts are introduced; moreover supplement material will be provided.
During the laboratory class, the students will receive the guidelines for the analysis and implementation of their programming assignments and will have time to work in their assignments with the teacher supervision when needed.

LEARNING OBJECTIVES OF THE SUBJECT

1.By the end of the course, students should be able to know the main concepts behind visualization and representation of volume models in scientific applications (mainly in medical applications). More specifically they will be able to undestand and program algorithms for:

STUDY LOAD

Type	Hours	Percentage
Self study	96,0	64.00
Hours large group	24,0	16.00
Guided activities	6,0	4.00
Hours small group	24,0	16.00

Total learning time: 150 h

CONTENTS

Introduction to Visualization. Perception in Visualization

Description:
Basic concepts of visualization: goals, tasks, users.
Elements of perception and its application in Visualization: pre-attentive variables, visual channels...

Multi-dimensional data visualization

Description:
Techniques for visualization of multiple-dimensional data.

Multiple Views Visualization

Description:
Multiple Views. Common designs, examples, analysis of advantages and inconvenients.

Molecular visualization

Description:
Introduction to Molecular Visualization: motivation, data, and rendering algorithms.

GPU-based Volume Rendering

Description:
Presentation of the main algorithms of direct volume rendering, including 3D textures and ray-casting. Transfer fuctions. GPU-based ray-casting.

Advanced Scientific Visualization Techniques

Description:
Introduction to Molecular Visualization: motivation, data, and rendering algorithms.
Introduction to DTI rendering: data, applications, measures, algorithms.

ACTIVITIES

Lectures

Description:
Material will be presented in lectures along the term. You are expected to conduct complementary readings to be presented at a later date or turned in.

Full-or-part-time: 60h
Self study: 30h
Theory classes: 30h

Implementation of selected algorithms

Description:
A selection of relevant algorithms will be assigned to implement in Lab sessions and on your own, in VTK and C++. You may be required to present your solution in class.

Full-or-part-time: 60h
Self study: 45h
Laboratory classes: 15h

Lab project(s)

Description:
The students will have to complete a lab project that includes two or more practical works that consist in implementing some of the techniques developed in the lectures. This project will be either be presented and discussed at a later date or turned in for grading.

Full-or-part-time: 23h
Self study: 20h
Laboratory classes: 3h

Final Exam

Description:
At the end of the term, the students will have a final exam, which may be a take-home,

GRADING SYSTEM

The students will be marked for their attendance and participation in class (including the presentation of papers and their discussion), yielding a mark "Paper".

Another grade will stem from the student's implementations of selected algorithms (which may include the presentation of their solution in a laboratory class), yielding a mark "Lab".

Finally, students will receive a third mark based on their performance in the final exam, yielding "Exam".

The final grade for the course will be computed as:

Final Grade = 0.2 Paper+ 0.6 Lab + 0.2 Exam

BIBLIOGRAPHY

Basic:
- Engel, K. [et al.]. Real-time volume graphics. A K Peters, 2006. ISBN 1568812663.
- Preim, B.; Botha, C. Visual computing for medicine: theory, algorithms and applications. 2nd ed. Elsevier, 2014. ISBN 9780124158733.
- Hansen, C.D.; Johnson, C.R. [et al.]. The visualization handbook. Elsevier-Butterworth Heinemann, 2005. ISBN 012387582X.
- The VTK user's guide. 11th ed. Kitware, 2010. ISBN 9781930934238.
- Few, S. Show me the numbers: designing tables and graphs to enlighten. 2nd ed. Burlingame, Calif: Analytics Press, 2012. ISBN 9780970601971.
- Munzner, Tamara. Visualization analysis and design [on line]. Boca Raton: CRC Press, Taylor & Francis Group, 2015 [Consultation: 05/03/2025]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=1664615. ISBN 9781466508934.

Complementary:
- Computer Graphics Forum.
- Schroeder, W.; Martin, K.; Lorensen, B. The visualization toolkit: an object-oriented approach to 3D graphics. 4th ed. Kitware, 2006. ISBN 193093419X.

RESOURCES

Hyperlink:
- http://www.real-time-volume-graphics.org- http://www.siggraph.org/s2006/main.php?f=conference&p=courses&s=6