# Workshop 3D Slicer – SOFA

## Program of activities

- **DAY 1: 3D Slicer**

10:00 – 11:30. *Welcome and Introduction to 3D Slicer.* Alicia Pose Díez de la Lastra and Mónica Sevilla García, Universidad Carlos III de Madrid

In this session, we will cover the basic principles of 3D Slicer, including a brief introduction on how to use the tool, navigate between modules, and load and analyze medical images from patients. We will then learn basic segmentation techniques to delineate anatomical structures of interest, which will serve as the foundation for generating 3D models of the patient. This process is known as Surface Rendering. Finally, we will explore Volume Rendering methods as an alternative approach for 3D visualization.

12:00 – 13:30. *Segmentation with AI.* Lucía Cubero Gutiérrez and Sergio Carreras Salinas, Universidad Carlos III de Madrid.

In this session, we will begin with a concise introduction to machine learning, with a particular focus on deep learning and convolutional neural networks. Following this, we will demonstrate traditional manual segmentation techniques using 3D Slicer. Finally, we will explore how to integrate and apply AI-based models such as TotalSegmentator, nnInteractive, and medSAM within the 3D Slicer platform.

15:00 – 17:00. *Design your own module in 3D Slicer.* Alicia Pose Díez de la Lastra and Mónica Sevilla García, Universidad Carlos III de Madrid

This hands-on session will guide participants through the process of designing their own custom module in 3D Slicer. During the session, we will learn how to create a user interface for the module and gain basic knowledge on how to link each UI element to specific functions using Python scripting.

This workshop is organized by Alicia Pose Díez de la Lastra and Javier Pascau, as part of the project PID2023-149604OB-I00 (funded by AEI/10.13039/501100011033/FEDER, EU) and MAGERIT-CM (TEC-2024/COM-44, funded by the Comunidad de Madrid under programas de actividades de I+D en Tecnologías 2024).

- **DAY 2: SOFA**

10:00 – 11:30. *Introduction to SOFA*. Erik Pernod, InfinyTech3D.

This talk presents SOFA (Simulation Open Framework Architecture), an open-source engine for real-time physics-based simulation. We'll explore its modular design, key simulation features (such as soft-body dynamics and real-time interaction), and how its architecture fosters collaboration and rapid prototyping in fields like robotics, medical simulation, and digital twins. The session will also provide insight into the SOFA community and governance model and include live demonstrations of real-time simulations developed with SOFA.

12:00 – 13:30. *SOFA in 3D Slicer*. Rafael Palomar, Oslo University Hospital.

This session offers an introduction to simulations in the context of image-guided therapies, focusing on the integration between 3D Slicer and SOFA. Participants will gain hands-on experience with the SliceSOFA module, explore how data is structured in both platforms, and learn how to establish communication between them using NumPy arrays. The session will also cover how to control the execution flow of simulations and will conclude with practical examples to illustrate the full pipeline.

15:00 – 17:00. *SOFA hackathon.* Erik Pernod, InfinyTech3D; and Rafael Palomar, Oslo University Hospital.

This Slicer–SOFA Hackathon will guide participants through a complete pipeline: from the segmentation of a patient CT scan of the liver and internal anatomy in Slicer3D, to mesh reconstruction, and finally to the creation of an interactive simulation scene using the Slicer–SOFA plugin. The simulation will include key anatomical structures such as vessels, vena cava, and tumors. Several entry points along the pipeline will be provided, giving you a solid foundation—what you build next is up to you!

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- **DAY 3: Outreach talks and Applications**

10:00 – 10:30. *A data-driven approach to the clinical management of craniosynostosis.* Antonio Porras, Colorado School of Public Health.

In this talk, Dr. Porras will present his team's work towards objectifying the diagnosis and treatment of children with craniosynostosis by leveraging pre- and post-surgical imaging data and data science methods.

10:30 – 11:00. *Human femur fracture: experimental and numerical analysis.* Miguel Marco, Universidad Carlos III de Madrid.

Human femur fractures are a prevalent disease, especially among the elderly population. From a mechanical point of view, it is exciting the different kinds of fractures that can appear and their relationship with the mechanical state of the bone. Through experimental tests and numerical models, it is possible to understand why a fracture occurs and its trajectory. This kind of study can also be applied to specific clinical complications, such as the cut-out phenomenon, and analyze the best position for the implant, focusing on the mechanical optimization of the bone-implant structure.

11:00 – 11:30. *Virtual and Augmented Reality.* Alicia Pose Díez de la Lastra, Universidad Carlos III de Madrid.

In this session, we will explore the fundamentals of Augmented Reality (AR) and Virtual Reality (VR), including the key differences between the two technologies and the technical advantages each of them offers. We will also present how these tools are being used at Universidad Carlos III de Madrid to enhance surgical planning, support the training of novice clinicians, and assist in intraoperative guidance.

12:30 – 13:30. Demos VR and AR. Alicia Pose Díez de la Lastra and Mónica Sevilla García, Universidad Carlos III de Madrid.

During this session, we will set up several demo stations featuring different AR and VR devices (including Microsoft HoloLens 2, Magic Leap, and Meta Quest 3) to showcase the application examples discussed in the previous session. Participants will have the opportunity to try out the technologies themselves and experience these tools firsthand.

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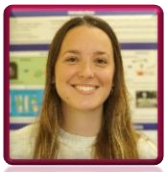
## Speakers, instructors and Organizers

**Dr. Javier Pascau** is a Full Professor from the Department of Bioengineering at Universidad Carlos III de Madrid since 2011. He leads the Image-Guided Treatments research group, working on surgical planning and guidance with tracking systems and augmented reality for orthopedic and maxillofacial surgery, developing simulation and training tools for maternal-fetal health, and applying machine-learning methods for medical image analysis.

**Dr. Alicia Pose Díez de la Lastra** is a postdoctoral researcher in Biomedical Engineering at Universidad Carlos III de Madrid (UC3M), Spain. Her main research interests include augmented reality, biomedical 3D printing, and computer-assisted interventions. Collaborating closely with surgeons from several hospitals in Madrid, she addresses clinical needs using cutting-edge technologies



**Dr. Mónica Sevilla García** is an Assistant Professor at Universidad Carlos III de Madrid. She also worked as a researcher at Instituto Universitario de Investigaciones Biomédicas y Sanitarias (IUIBS) from Universidad de Las Palmas de Gran Canaria. Her research interests are computer-assisted surgery, 3D printing, augmented and virtual reality, and surgical skills assessment.

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**Dr. Lucía Cubero Gutiérrez** did a joint PhD in the program of Biomedical Science and Technology at Universidad Carlos III de Madrid, and in the specialty of Signals, Images and Vision at Ecole Doctorale Mathisse at Université de Rennes. She currently works at Universidad Carlos III de Madrid on artificial intelligence and medical imaging.

**Mr. Sergio Carreras Salinas** is a PhD student at the department of Bioengineering under the tutorship of Dr. Javier Pascau in the IGT Group, at Universidad Carlos III de Madrid. His work focuses on the applications of FAIR and open artificial intelligence in medical imaging.

**Dr. Erik Pernod** is an engineer specializing in physics-based simulation and the founder of InfinyTech3D. With over 15 years of experience as a core developer of SOFA framework, he now leads R&D projects at the intersection of Virtual-Reality, haptics, and real-time simulation, aiming to improve healthcare training and safety through high-fidelity surgical simulators and the development of digital twins.

**Prof. Rafael Palomar** is a Senior Research Scientist at Oslo University Hospital (OUH) and an Associate Professor at the Norwegian University of Science and Technology (NTNU). He leads the Medical Software Research Group (MESH|Lab) at the Intervention Centre, OUH. His research focuses on medical software development, computer graphics, and image-guided therapies, with a track record of contributions in the field of surgical planning. In addition, he leads the development of SlicerLiver and SlicerSOFA.

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**Dr. Antonio Porras** is an Assistant Professor at the Department of Biostatistics and Informatics in the Colorado School of Public Health, where he teaches courses on machine learning and biomedical image analysis. He also directs the Medical Imaging and Machine Intelligence lab and serves as Director of Research in the Department of Pediatric Plastic and Reconstructive Surgery at Children's Hospital Colorado. His research interest is the development of computational and machine learning methods and tools to improve the understanding, diagnosis and treatment of pathology.

**Dr. Miguel Marco** is an Associate Professor in the Department of Mechanical Engineering at UC3M (February 2023). His career spans 12 years of research and academic experience, focusing on the mechanical behavior of various biological tissues, including bones and soft tissues, through experimental testing and numerical modeling. This includes fractures, damage, and interactions between biological tissues, personal protections, and 3D-printed implantable elements.

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