# Venue

**Genova** is one of Italy's most beautiful and historic cities, elongated between the mountains and the sea, in the middle of the Riviera Ligure.
The heart of Genova is the historical center, one of the widest in Europe, a maze of stone steps, narrow streets, churches, squares and dark lanes. You will find plenty to do in the evenings from sampling the delights of Genoese cuisine to visiting one of the many galleries or museums.

**The International School on Computational Methods for Shape Modelling and Analysis** will be held at the CNR in Genova, Italy (http://www.ge.cnr.it)

**Genova Cristoforo Colombo International Airport (GOA)** is located a few km from the city center. Connections to/from downtown by bus or by taxi (approx. 20€).
**http://www.airport.genova.it**

**Railways:** Genova Brignole or Genova Piazza Principe stations.

**Highway:** Genova Ovest exit.

For more information visit: **http://www.apt.genova.it**

# General Info

The School is organized within and sponsored by the following projects:

**MACROGeo**: *Metodi Algoritmici e Computazionali per la rappresentazione di Oggetti Geometrici*

**AIM@SHAPE**: *Advanced and Innovative Models And Tools for the development of Semantic-based systems for Handling, Acquiring, and Processing knowledge Embedded in multidimensional digital objects*

**SPEAKERS:**
Pierre Alliez, *INRIA Sophia-Antipolis*
Marco Attene, *IMATI, CNR, Genova*
Silvia Biasotti, *IMATI, CNR, Genova*
Paolo Cignoni, *ISTI, CNR, Pisa*
Leila De Floriani, *DISI, UNIGE, Genova*
Bianca Falcidieno *IMATI, CNR, Genova*
Patrizio Frosini, *ARCES, Bologna*
Simone Marini, *IMATI, CNR, Genova*
Michela Mortara *IMATI, CNR, Genova*
Giuseppe Patanè, *IMATI, CNR, Genova*
Nicholas Patrikalakis, *MIT, Boston*
Enrico Puppo, *DISI, UNIGE, Genova*
Takis Sakkalis, *MIT, Boston*
Roberto Scopigno, *ISTI, CNR, Pisa*
Michela Spagnuolo *IMATI, CNR, Genova*
Remco Veltkamp, *Utrecht University*, *Utrecht*

The number of participants to the School is limited to 80 participants.

## Registration fees:

200 € regular registration
150 € reduced registration for AIM@SHAPE and MACROGeo fellows

The registration fee includes school material, lunch coupons, coffee breaks, and social dinner. Registration fees can be paid either by money order or cash at the registration desk. Please note that payment by **credit card will not be accepted**.

## Details for money order payment:

Bank account N°: c/c 218155
holder: Consiglio Nazionale delle Ricerche,
Piazzale Aldo Moro 7, 00185 Roma, ITALY
description: "Incassi Giornalieri da Altre Dipendenze"
Payment reference: IMATI-GE 050002 REGISTRATION TO THE SUMMER SCHOOL

Bank details:
Bank name: Banca Nazionale del Lavoro, Sportello CNR 6392
Bank/Sort/Swift code: ABI: 01005 CAB: 03392
SWIFT:BNLIITRARBE
Street name: Piazzale Aldo Moro 7
PostCode: 00185
City: Rome
Country: Italy

# International Summer School on Computational Methods for Shape Modelling and Analysis

**Genova, 14-18 June 2004,**
Area della Ricerca, CNR, Genova

# Computational Methods for Shape Modelling and Analysis

## SHAPE MODELLING AND ANALYSIS: PROBLEMS AND PERSPECTIVES

Speaker: *Bianca Falcidieno* (IMATI, CNR, Genova)
Duration: 1 hour

**Abstract.** This talk will give an introductory overview of the main issues related to shape modelling and reasoning, focusing on how they are approached and studied within the scope of two projects: the MACROGeo national project and the AIM@SHAPE international Network of Excellence. The main future challenges in this field and how the school will address them will be described.

## SHAPE MATCHING

Speaker: *Remco Veltkamp* (Utrecht University, Utrecht)
Duration: 4 hours

**Abstract.** The tutorial will give a general overview of several issues related to shape matching, both in 2D and in 3D. It will in particular survey matching in different classes of applications, highlighting the vairous matching problems which arise. Shape features will be discussed in relation to matching problems and several similarity measures will be discussed. Algorithms for matching will be described and discussed. Also, perceptual issues will be addressed, as well as formal properties of features, similarity measures, and algorithms.

## SHAPE SIMILARITY: AMBIENT ISOTOPY AND FREE-FORM OBJECT MATCHING

Speakers: *Nicholas Patrikalakis, Takis Sakkalis* (MIT, Boston)
Duration*:* 1,5 hours

**Abstract.** This talk will address problems of similarity of 2D and 3D objects. The first part of the talk will consist of the notion of ambient isotopy as a means of similarity of two shapes, usually taken as two-dimensional manifolds. The second part will present problems of free-form matching for the point vs. NURBS surface and the NURBS surface vs. NURBS surface cases, and its application to copyright protection.

## SHAPE ACQUISITION AND RECONSTRUCTION

Speaker: *Roberto Scopigno* (ISTI, CNR, Pisa)
Duration: 4 hours

**Abstract.** These lectures relate to the pipeline of acquisition of the shape and colour of 3D objects, and for the creation of digital models to be efficiently used in local and/or remote graphics applications. The shape acquisition process, based on the adoption of optical 3D scanning approaches, implies the analysis, design, and implementation of efficient algorithms for the registration and alignment of the multiple scans into a common reference system, for the fusion of the scans into a unique digital model, the geometric simplification of the generated models, the editing and interactive corrections of small acquisition flaws, the acquisition of the colour and of the original texture, the efficient use of the models in local and/or distributed applications. Applications in the field of 3D Cultural Heritage will be shown.

## LEVEL-OF-DETAIL IN MESH-BASED REPRESENTATIONS

Speakers*: Leila De Floriani* (DISI, UNIGE, Genova), *Enrico Puppo* (DISI, UNIGE, Genova), *Paolo Cignoni* (ISTI, CNR, Pisa)
Duration: 5 hours

**Abstract.** We will introduce the basic concepts of Level-Of-Detail modeling by presenting a general framework which encompasses existing models proposed in the literature and allows for their analysis and comparison. Level-Of-Detail models can be divided into two broad classes: those designed for regularly-spaced data, and those for scattered data. We define the basic queries on a Level-Of-Detail model, and identify algorithms for answering such queries as well as primitives involved in such algorithms which must be supported by data structures. We will then present a survey of data structures for encoding Level-Of-Detail models, according to the classification into regular and irregular meshes.

## REMESHING TECHNIQUES

Speaker: *Pierre Alliez* (INRIA Sophia-Antipolis)
Duration: 2 hours

**Abstract.** Despite a recent effort to make digital geometry tools robust to arbitrarily irregular meshes, most scanned surfaces need to undergo complete remeshing (alteration of the sampling and of the connectivity) before any further processing: results of finite element computations, compression, or editing rely heavily on an good description of the original geometry. In the first part of this course, three different approaches for remeshing will be presented (isotropic, anisotropic and efficient remeshing), while in the second part of the course applications of remeshing to model compression will be described and methods for post-processing remeshed models will be discussed.

## REMESHING APPLICATIONS

Speaker: *Marco Attene, Michela Spagnuolo* (IMATI, CNR, Genova)
Duration*:* 1,5 hours

**Abstract.** Remeshing-based compression techniques for manifold triangle meshes will be discussed, and the SwingWrapper algorithm will be described in details. Automatic methods for restoring most of the sharp edges and corners lost by feature-insensitive (re)meshing techniques will be presented, as well as a method to to preserve the sharpness of the recovered sharp edges while bending their polyline approximations into smooth curves (EdgeSharpener and Bender algorithms).

## SIZE THEORY AS A GEOMETRIC-TOPOLOGICAL METHOD FOR SHAPE COMPARISON

Speaker: *Patrizio Frosini* (ARCES, Bologna)
Duration: 6 hours

**Abstract**. In the first part, basic notions will be given concerning the concept of natural pseudodistance for comparing shapes. In the second part, size functions will be introduced, with a detailed review of their properties. Finally, the use of size functions as a tool for evaulating the natural pseudodistance and computational aspects related their computation will be discussed

## MORSE THEORY AND REEB GRAPHS FOR SHAPE UNDERSTANDING AND CODING

Speakers: *Silvia Biasotti, Michela Spagnuolo* (IMATI, CNR, Genova)
Duration: 1,5 hours

**Abstract**. An introduction to basic concepts of homology and Morse theory will be given in the first part of the tutorial, in theoretical and computational settings. Then, Reeb graphs will be introduced and their relations to Morse theory will be detailed. Properties of Reeb graphs obtained with different mapping functions will be discussed together with their applications to terrain modelling, shape simplification and matching.

## SKELETAL STRUCTURES FOR SHAPE CODING AND MATCHING

Speaker: *Michela Mortara*, *Giuseppe Patané, Simone Marini* (IMATI, CNR, Genova)
Duration: 2 hours

**Abstract.** A skeletal structure is a lower-dimensional representation, which encodes the decomposition of a shape into relevant parts that may have either a geometric or an application-dependent meaning. Several skeletal descriptors of shapes will be introduced, such as the medial axis transformation, a curvature-based skeleton, and the Reeb graph, with their properties and limits. We will show how each representation has peculiarities that makes it more feasible for certain applications and unfeasible for others. Applications of skeletal structures will be described mainly for matching and parametrization.

## SHAPE INTERROGATION

Speakers: *Nicholas Patrikalakis, Takis Sakkalis* (MIT, Boston)
Duration: 1,5 hours

**Abstract.** Shape interrogation is the process of extraction of information from a geometric model. It is a fundamental component of CAD/CAM systems. In this lecture, we focus on shape interrogation of geometric models bounded by free-form or sculptured surfaces. Such surfaces are widely used in the bodies of ships, automobiles, aircraft, propeller and turbine blades, and various consumer devices. Our basic thesis is that shape interrogation problems can usually be recast in terms of the solution of a nonlinear system of equations, typically a polynomial system. Much of our work is based on the Interval Projected Polyhedron (IPP) Algorithm, which reduces a continuous shape interrogation problem into the discrete problem of computing convex hulls and their intersections.