



# IMACS2023

*21<sup>st</sup> IMACS World Congress*

SEPTEMBER 11 - 15, 2023

University *La Sapienza*  
Civil and Industrial Engineering Faculty  
Via Eudossiana 18, Roma

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*IMACS2023*

Book of Abstracts of IMACS2023  
21<sup>st</sup> IMACS World Congress at  
University *La Sapienza*, Roma, Italy  
September 11 - 15, 2023

Edited by

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# About *IMACS*

*International Association for  
Mathematics and Computers in Simulation*



## *The history*

The beginnings of IMACS dated from 1955, when an International Conference on Analog Computation was held at the Brussels Free University (ULB), attended by scientists and managers of simulation laboratories from different countries of the world. Many of these laboratories were by-products of the enormous technological developments that had been brought about by World War II. The participation was truly international, with attendees coming from most European countries including Russia, the United States of America, Japan.

During the conference, it was realized that there was a need for establishing some permanent means of communication between the members of such a new scientific community. This resulted in the creation of AICA (the International Association for Analogue Computation) which was legally incorporated under the Belgian Law in 1956.

The birth of AICA exhibited the emergence, at that time, of disciplines spurred by new technologies, in particular those resulting in tools having to do with the mechanization of information and computation. The example was followed by other organizations in particular fields of applications, namely IFAC (Automatic Control, 1957), IFORS (Operations Research-1959), IMEKO (Measurement – 1959) and IFIP (Information Processing-1960).

In 1972, these five organizations decided to coordinate their activities with the creation of FIACC (the Five International Associations Coordinating Committee), which was created with the support of UNESCO.

It had been under Jean Hoffmann, Professor at the Brussels Free University (ULB), that the 1955 International Conference on Analog Computation, giving birth to AICA, was organized. He became President of the newborn association, a post he held until 1973.

The objectives of AICA remained pretty much unchanged during that period, objectives related to analog computation developed as a tool for applications to mostly industrial problems. This included hardware questions, mathematical and programming aspects with some consideration, beginning in the mid-

1960's, to what had emerged as hybrid computing, i.e. computing involving linked analog and digital machines.

After Hoffmann, Professor Robert Vichnevetsky was elected President at the AICA's 7th World Congress in Prague, August 1973. It was during Vichnevetsky's tenure that the Association grew, reaching the visibility it holds today in scientific computing and applied mathematics. Significant developments were taking place in the sciences at the time and the scope of what was still known as AICA began to expand to include numerical computing, subdisciplines in applied mathematics, and the introduction of mathematical modeling in many of the traditional fields of the applied sciences that had to change their ways to keep up with the new environment. In 1976, AICA changed its name to IMACS (International Association for Mathematics and Computers in Simulation) to reflect the widening of its areas of interests.

### *Disciplinary directions*

The post World War II years had been characterized by significant changes in sciences and industry, brought about by what has come to be called the 'computer revolution', the mechanization of computation and information processing. There had been modest beginnings in earlier times (to which the names of Pascal, Leibniz, Jacquard, Babbage, Kelvin, Hollerith and others are attached in historical reconstructions), but it was not until the middle of the 20th century that computers and the many ramifications related to the theoretical tools needed for their applications became a field of their own, with research, funding and industrial development to back it up. Significant communities of scientists, engineers, technicians engaged in these developments appeared in developed countries throughout the world.

One of the earliest class of scientific problems solved by machines was that of computing the dynamics of mechanical and similar systems, those described with differential equations. Analog computers achieving this had been built since the 1930's (Vannevar Bush at the MIT). ENIAC, the first significant digital computer— built at the University of Pennsylvania during the war years (Eckert, Mauchly, with a significant participation by von Neumann) was likewise intended for the solution of the differential equations, those describing the trajectory of projectiles above the Earth. And it is by no coincidence that it is the same class of problems that had led to the development of Calculus in the 17th century (Galileo, Huygens, Newton, Leibniz).

Two resulting communities — the analog and the digital — remained pretty much separated for a number of years, with some of the protagonists talking of a "war" between the two (which it was not). The digital side did gradually take over with the increasing power and decreasing cost of its hardware. Little analog computation was left by the middle 1970's.

What is today at the center of IMACS's disciplinary interests may be described in broad terms as the development of theoretical concepts and algorithmic

tools that use computers (digital computers : analog computers have become practically obsolete) and mathematics, in the abstract as well as in the context of specific applications. They are "tools" in the sense that they will -at least in theory- be used by others, members of some "end-use discipline" such as engineering and physics.

Those directions have changed and will by definition continue to change with time. New groups with particular interests appear, old ones become dormant although some have shown remarkably stubborn resilience to do so irrespectively of what was happening in the outside world. We have in our midst nice examples and counter-examples of the dynamics of what Thomas Kuhn called "Scientific Revolutions".

### *Working groups and technical committees*

New disciplinary groups appear in IMACS generally manifesting themselves at first by a few individuals having the intent of organizing a workshop or conference, then asking for or being offered our sponsorship -something that gives them recognition, status and the possibility of having the outcome of their work published in established journals .

Working groups after a while often become organized and administered as Technical Committees – IMACS TC's – which consist of individual members that generally belong to academia. What is possibly the most important role of IMACS's in this process is in recognizing new fields of research, establishing contact with representative members of those emergent communities. The connection with those groups works is often started at first informally – at the professional instead of administrative level (between professors, established researchers, etc. ...). It has been with the establishment and coordination of such connections that IMACS has been changed from an association with very little happening between the Triennial World Congresses (which is what it was up to the 1970's) and what it is now (we have about 13 "Technical Committees" in IMACS – generating jointly about one IMACS sponsored conference a month somewhere in the world).

### *The journals*

Since 1979 IMACS bylaw states that the association publishes a scientific journal, Mathematics and Computers in Simulation, besides an information bulletin, IMACS Newsletter, for promoting scientific activities, launching conferences and workshops conceived by the affiliated research groups.

Recently the collaboration of IMACS with Elsevier has been enriched with the inclusion also of the journal Applied Numerical Mathematics as a further reputable editorial site for submitting interesting results for publication and for the publication of Special Issues with the best papers from IMACS events.

(from the official website of IMACS <https://www.imacs-online.eu>)



## About IMACS2023

This booklet contains all the abstracts of the results which are going to be presented at the IMACS World Congress taking place in Rome at the Engineering Faculty of University 'La Sapienza', September 11-15, 2023.

This is the 21<sup>st</sup> one in a series of World Conferences whose complete list goes back to 1955 and covered the whole continents as it reads:

1955 Brussels, Belgium	1985 Oslo, Norway
1958 Strasbourg, France	1988 Paris, France
1961 Opatija, Yugoslavia	1991 Dublin, Ireland
1964 Brighton, Great Britain	1994 Atlanta, USA
1967 Lausanne, Switzerland	1997 Berlin, Germany
1970 Munich, Germany	2000 Lausanne, Switzerland
1973 Prague, Czechoslovakia	2005 Paris, France
1976 Delft, The Netherlands	2009 Cairns, Australia
1979 Sorrento, Italy	2013 Madrid Spain
1982 Montreal, Canada	2016 Xiamen, China

The subsequent World Conferences, usually, take place every three years. Unfortunately, due to the COVID pandemics, IMACS2023, initially scheduled in 2020, had to be postponed also in order to follow the spirit of the IMACS World Conference which prescribes to gather scientists in presence from all over the world. So, in the present occasion, the whole participants are expected to convene in Rome for exchanging their works, ideas and experiences.

This Book of Abstracts, reflecting the Congress structure, is organized in sections: Keynote Lectures, General Session, Mini-symposia, Special Sessions and Posters. According to the IMACS philosophy, different aspects of applied mathematics are represented with a special interest towards the numerical methods and solutions.

## **IMACS2023 FOREWORD**

This is the *Book of Abstracts* for the **IMACS 2023** Congress. This meeting, as the long series of the IMACS World Congresses, aims at giving the opportunity to a large number of researchers and scientists to meet, facing each other in Rome, and discuss scientific computing results and future trends to support strong multidisciplinary communities. The Congress attendees have the opportunity to compare ideas and match points of view, contributing to the IMACS knowledge community combining expertise in the area of simulation as well as in classical and new applications.

The world is changing fast, and research communities face a range of new problems, not only those traditionally linked to the hard sciences and industry, but also those attached to the social sciences, to the impact of climate change, urban pollution, crowd dynamics, transportation and so on.

In line with the general philosophy of IMACS, this Congress opens the mind on different aspects of multidisciplinary problems coming from the real world as well as from the development of new theoretical and computational tools. Representatives of several research Institutions join in the Congress General Sessions, and in Mini-symposia and Sessions organized by separate Committees, showing advanced research developments in crucial application areas. Special Issues of the IMACS Journals, APNUM and MATCOM, will be published.

The publication of this Book of Abstracts, volume 23 in the IMACS Series in Computational and Applied Mathematics, which is edited by the members of the Local Organizing and Scientific Committee, Sandra Carillo, Costanza Conti, Daniela Mansutti, Francesca Pitolli and Rosa Maria Spitaleri, presents the large international participation in the 21st IMACS World Congress, organized by the *International Association for Mathematics and Computers in Simulation (IMACS)* with the sponsorship of the *Istituto per le Applicazioni del Calcolo (IAC)* of the Consiglio Nazionale delle Ricerche (CNR), along with the *University of Rome La Sapienza* and *University of Florence*.

Special thanks are due to the Congress Organizers, in particular the IMACS President, Dr. Rosa Maria Spitaleri, Chair of IMACS 2023 for her generous efforts, being the main contributor to the success of this event. Further thanks are due to all the Organizing Committees, Congress Staff and all the Participants.

**Robert Vichnevetsky**  
**IMACS Honorary President**



# Bivariate Spline Quasi-interpolants on Criss-cross Triangulations for the Approximation of Piecewise Smooth Functions

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Spline quasi-interpolation is well known to be a powerful and useful tool for the approximation of bivariate functions and data, important problem in many mathematical and scientific applications. If the function to be approximated is smooth, a spline quasi-interpolant is able to well reconstruct it, but if the function has jump discontinuities, the approximating spline presents oscillations of magnitude proportional to the jump. Therefore, the aim of this talk is to apply Weighted Essentially Non-Oscillatory (WENO) techniques to modify classical quasi-interpolants in the space of  $C^1$  quadratic and  $C^2$  quartic splines on criss-cross triangulations, in order to avoid such oscillations. Using such a nonlinear modification we are able to avoid Gibbs phenomenon near discontinuities and, at the same time, maintain the high-order accuracy in smooth regions. We study the convergence properties of the proposed quasi-interpolants and we provide some numerical and graphical tests confirming the theoretical results.