The Institute for Research in Applied Mathematics and Systems

Historical overview

The Institute for Research in Applied Mathematics and Systems (IIMAS by its Spanish acronym) is one of the 20 institutes that make up the Subsystem for Scientific Research of the Universidad Nacional Autónoma de México, within the area dedicated to Physical and Mathematical Sciences. The Institute's mission is to create, develop and foster original scientific research in the disciplines of Applied Mathematics, Computer Sciences and Engineering, and Systems.

IIMAS is composed of an academic staff of 60 scientists and 45 research assistants across six different departments, within two academic areas: Applied Mathematics and System, and Computer Science and Engineering. It also has one of the best specialized libraries in applied mathematics and computer science in the country and in Latin America. The Institute grants great importance to teaching undergraduate courses and plays a key role in the following UNAM graduate studies programs: "Mathematical Sciences", "Computer Science and Engineering", "Earth Sciences", and other branches of Engineering. The Institute supports additional human resource development through courses, workshops, seminars, research projects and continuing education programs, as well as other forms of dissemination of knowledge.

Mission

Our mission is to guarantee the existence of research groups in applied mathematics, computer science and engineering, and systems, ensuring that the study of these disciplines is kept up-to-date, thus contributing to scientific knowledge of universal value. In addition, we aim to provide both the university community and the society at large the means to access such knowledge.

Objectives

- Carry out original research in applied mathematics, computer science and engineering, and systems.
- Participate in the following graduate programs: Mathematical Sciences; Computer Science and Engineering; Engineering; and Earth Sciences. Participate in the undergraduate programs of the Faculty of Science and the Faculty of Engineering, among others.
- Train high-level human resources through research projects.
- Disseminate scientific knowledge.

Functions

Research in the areas that are studied at the Institute. Train human resources in research and teaching in higher education through the provision of courses, tutoring and direction of theses. Organize and participate in seminars, conferences, congresses, symposia, among others, both national and international. Develop outreach activities through collaborations with academic units and related national and international institutions, and with the productive sectors. Disseminate the results of research and technological developments produced by the Institute.

Areas

Applied Mathematics and Systems

Applied mathematics is concerned with the formulation and further study of mathematical methods towards the design and testing of mathematical models used for the advancement of science, engineering, business, industry and education.

At IIMAS research is pursued in dynamical complex systems, both as models of natural phenomena or as theoretical constructs, in mathematical physics, control theory, biology, probability and statistics and the social sciences. The departments within this area are:

- Mathematical Physics
- Mathematics and Mechanics
- Mathematical Modeling of Social Systems
- Probability and Statistics

Computer Science and Engineering

Electronic computers were developed to automatize mathematical calculations. This capability has allowed the exploration of complex phenomena which was not possible beforehand. In this way, the use of computers has permeated to all sciences and has found engineering applications in every domain.

Theory and applications of computer science coexist at IIMAS, contributing to robotics, biomedical imaging and signal processing, pattern recognition, telecommunications, control, artificial intelligence, artificial life, high performance computing, optimization, model checking, combinatorial design, and complex systems. The departments within this area are:

- Computer Science
- Computational Systems Engineering and Automatization

Departments

Mathematical Physics

The main purpose of this Department is to carry out research on mathematical-physics, mathematical analysis, control theory and combinatorial analysis, with special emphasis on the generation of new problem solving processes in physics, chemistry and engineering, as well as the study of those significant mathematical aspects of existing empirical methods. This body of research extends itself from the deduction of theoretical results to the development and implementation of algorithms. The lines of investigation in this Department are functional analysis and mathematical-physics, upgradeability and problems with mixed constraints in optimal control, combinatory and combinatorial optimization, remote perception and tectonic of plates, quantum gravity, homeomorphism groups, quantum optics and information, and tectonics with emphasis on the Jalisco Block.

Mathematics and Mechanics

This Department is dedicated to the application of mathematics in different fields of science. Differential equations are used as a common language and special emphasis is placed on the study of nonlinear problems.

The main lines of investigation address nonlinear phenomena described by differential equations and nonlinear dynamical systems in finite and infinite dimensions, using analytical, topological, asymptotic and numerical techniques. These areas of research cover very diverse applications including the following: the mechanics of solids and fluids, nonlinear optics, composite materials, quantitative aspects of biology, propagation of waves, coherent structures with nonlinear diffusion and solitons. In addition, recent work has also been carried on mathematics and prehispanic surveying.

This Department has a computer laboratory used by researchers and students, and has developed a hybrid cluster of computers working in parallel and GPU servers with 1800 processors.

From its beginnings, the Department has demonstrated a vocation for an horizontal approach to science, leading it to develop the University Project on Nonlinear Phenomena and Mechanics (FENOMEC by its acronym in Spanish; see www.fenomec.unam.mx), which operates as a "center without walls". At this time, FENOMEC has 32 participating members from 10 different UNAM Departments, including all of the members from this Department.

Mathematical Modeling of Social Systems

This Department studies social processes from the perspective of social systems and networks, as well as the history of science. A systems approach permits a holistic vision of social problems, allowing for the formulation of alternative solutions to complex problems. The lines of investigation call for the integration of transdisciplinary teams; to this end, this Department is made up of researchers from different fields of science –systems science, anthropology, sociology, history and engineering– who collaborate with specialists from other disciplines both within the Institute and elsewhere.

The Department runs a Network Laboratory to analyze large social networks (with over a thousand nodes) and which also permits experimentation with different organizational models.

The lines of investigation developed in this Department include the following: social networks analysis, development and use of a text-mining platform for research in knowledge management, the impact of technology on web users in different contexts and the impact of technological convergence, transnational corporations and professionals, alternative ways of learning and research for development, history of statistics, history of probability, sociocultural history of the university, the training and acquisition of the identity of artists in Mexico, participatory strategic planning, planning process and implementation of plans, and historical networks.

Probability and Statistics

Research in this Department covers different areas of statistics and probability. Basic research is carried out but models are also developed to describe phenomena in other disciplines. Some of this work has to do with concrete applications to problems of national significance.

In recent years, the academic staff in this Department have worked mainly in the following lines of research: Multivariate distributions with rational Laplace transform, Bayesian statistics, spatial statistics, statistical inference, statistics in science, sampling theorem, space measurement optimization, Markov decision processes, stochastic processes, time series, theory of copulas and mathematical finance.

Computer Science

This Department is a national leader in research, education and dissemination of computer science. Its researchers have conducted theoretical and contributions applied to cognitive science, artificial intelligence, pattern recognition, combinatorial design, verification models, complex systems, artificial life and image processing. Some studies have contributed to the development of solutions in the areas of health, education, mobility, urban planning, engineering, anthropology, linguistics, and basic biomedical research. While these lines of research will continue the department department's development, we seek to extend them and increase their applications to other fields of study such as: graphing, visualization, computation theory and information theory.

The internal structure of the department is constituted as follows:

- Image Processing Group.
- Pattern Recognition Laboratory.
- Golem Laboratory: Design and Construction of Service Robots.
- Self-organizing Systems Laboratory.
- Model Checking Laboratory.

Computational Systems Engineering and Automatization

This Department integrates two sections: Computational Systems Engineering (CSE) and Electronics and Automation (EA). CSE conducts basic and applied research in high performance and reliability of computer systems engineering, trains high level specialist and promotes dissemination of research activities and products. EA develops technologies in the areas of electronics and automation focusing on the study and use of emerging technologies in the design of digital systems for instrumentation, automation, communications and signal and image processing. Teaching activities are also promoted such as teaching courses, social services activities, undergraduate and graduate theses supervision, resulting on high quality technological developments, theses dissertation, peer-review journal papers, conference papers and technical reports.

The research interests in the Department include: high performance architecture and algorithms, bio-inspired algorithms in bioinformatics, evolutionary computation, computer networks control, fault detection and isolation, ultrasonic imagery, local and global optimization (oil field modeling), real-time image processing, process automation, digital communications, electronic instrumentation, supervisory control systems and data acquisition, and robotic vision in manufacturing.

The IIMAS Library

The IIMAS Library is recognized as one of the best libraries in Applied Mathematics and Computer Sciences in Mexico and Latin America. Since its creation, the Library has sought to disseminate the library's services and informational resources. Its mission is to serve as a dynamic and avant-garde entity that plays a decisive, timely and efficient role in processes that generate, share and disseminate knowledge.

In order to facilitate the use of its collection, the library operates with open shelf stacks. The collection includes scientific journals and specialized books. In addition, the library also has a microfiche and compact disc collection that are support materials.

As a part of the UNAM's Library System, the IIMAS Library provides access to the electronic and digital resources that the University puts at the disposition of its academic community. These resources specialized in applied mathematics and computer sciences are also

accessible via the library's website. The IIMAS Library offers the following services: specialized consults, citation analysis, journal alerts, new acquisitions bulletin, selective dissemination of information, borrowing from the IIMAS collection, interlibrary loans, document requests, on line access to the library's catalogue, among others.