

MONOGRAFÍAS MATEMÁTICAS "GARCÍA DE GALDEANO"

2026

N.º 44

Seventeenth International Conference Zaragoza-Pau on Mathematics and its Applications

É. Ahusborde
C. Amrouche
C.-E. Bréhier
G. Carbou
J. L. Gracia
E. Javierre
M. C. López de Silanes
(Editors)

MONOGRAFÍAS MATEMÁTICAS
GARCÍA DE GALDEANO

Número **44**, 2026

Comité Editorial

Manuel Alfaro. Departamento de Matemáticas. Universidad de Zaragoza.

Enrique Artal. Departamento de Matemáticas. Universidad de Zaragoza.

Antonio Elipe. Departamento de Matemática Aplicada. Universidad de Zaragoza.

Ángel Francés. Departamento de Informática e Ingeniería de Sistemas. Universidad de Zaragoza.

Juan Manuel Peña. Departamento de Matemática Aplicada. Universidad de Zaragoza.

Javier Tejel. Departamento de Métodos Estadísticos. Universidad de Zaragoza.

Comité Científico

Jesús Bastero. Universidad de Zaragoza.

José Antonio Cristóbal. Universidad de Zaragoza.

Eladio Domínguez. Universidad de Zaragoza.

José Luis Fernández. Universidad Autónoma de Madrid.

M^a Luisa Fernández. Universidad del País Vasco.

Sebastián Ferrer. Universidad de Murcia.

Mariano Gasca. Universidad de Zaragoza.

Josep Gascón. Universidad Autónoma de Barcelona.

Alberto Ibort. Universidad Carlos III de Madrid.

Manuel de León. Consejo Superior de Investigaciones Científicas.

M^a Teresa Lozano. Universidad de Zaragoza.

Francisco Marcellán. Universidad Carlos III de Madrid.

Consuelo Martínez. Universidad de Oviedo.

Javier Otal. Universidad de Zaragoza.

Leandro Pardo. Universidad Complutense de Madrid.

In memory of our dear colleague Manuel Palacios,
from the University of Zaragoza, whose commitment,
dedication and good work in organizing the Conferences
will always be remembered with great affection.

Seventeenth International Conference Zaragoza-Pau on Mathematics and its Applications

Jaca (Spain), September 4-6, 2024

Editors

É. AHUSBORDE

C. AMROUCHE

C.-E. BRÉHIER

G. CARBOU

Université de Pau et des Pays de l'Adour, France

J. L. GRACIA

E. JAVIERRE

M. C. LÓPEZ DE SILANES

Universidad de Zaragoza, Spain

Monografías Matemáticas García de Galdeano n.º 44

Febrero 2026

Universidad de Zaragoza

© Los autores

© De la presente edición, Prensas de la Universidad de Zaragoza

Imprime: Servicio de Publicaciones. Universidad de Zaragoza

D.L.: Z 82-2026

ISBN: 979-13-7014-073-1

The edition of this volume has been partially subsidized by the Vicerrectorado de Investigación de la Universidad de Zaragoza

XVII Journées Jornadas ZARAGOZA-PAU

Seventeenth International
Conference Zaragoza-Pau
on Mathematics and
its Applications

Jaca
September 4-6
Residencia
Universitaria
de Jaca
2024

PLENARY SPEAKERS

Amel BEN ABDA
(École Nationale d'Ingénieurs de Tunis, Tunisia)

Marco CANNONE
(Université Gustave Eiffel, France)

Matthieu DUPONCHEEL
(Université de Louvain, Belgium)

Ernesto ESTRADA
(IFISC, Universitat de les Illes Balears, Spain)

Šárka NEČASOVÁ
(Czech Academy of Sciences, Prague, Czech Republic)

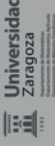
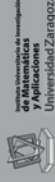
Joan PORTI
(Universitat Autònoma de Barcelona, Spain)

Justo PUERTO
(Universidad de Sevilla, Spain)

Maria Luisa RAPÚN
(Universidad Politécnica de Madrid, Spain)

Blas Manuel VINAGRE
(Universidad de Extremadura, Spain)

<http://pcmap.unizar.es/~jaca2024>



CONTENTS

Preface	xiii
Contributors	xv
List of participants	xvii
Other communications	xxv
Published articles	
Practical and didactic analysis of math tutoring <i>F. Abadie</i>	<i>1</i>
Vertex separator problem with and without packing <i>S. Anglada, C. Galé and J. J. Salazar-González</i>	<i>9</i>
Reducing model dependence in treatment effect estimation via matching <i>A. Aurensanz-Crespo, J. Castillo-Mateo, J. Asín, Z. Gracia-Tabuenca and J. M. Ramírez</i>	<i>19</i>
A selection algorithm of spatio-temporal models for the occurrence of temperature records <i>E. Barrio-Torres, Z. Gracia-Tabuenca, J. Castillo-Mateo, J. Asín, A. C. Cebrián and J. Abaurrea</i>	<i>29</i>
Well-posedness of a time discretization scheme for a stochastic p-Laplace equation with Neumann boundary conditions <i>C. Bauzet, K. Schmitz, C. Sultan and A. Zimmermann</i>	<i>37</i>
Modified equations and error analysis for a semi-implicit stochastic optimization scheme <i>C.-E. Bréhier, M. Dambrine and N. En-Nebbazi</i>	<i>47</i>
The facility location problem with ties in customers' preferences: a pessimistic bilevel approach <i>H. I. Calvete, C. Galé, A. Hernández and J. A. Iranzo</i>	<i>59</i>
Stability of singular self-similar flow <i>M. Cannone</i>	<i>69</i>
Flux-equilibrated based a posteriori error analysis for an interface problem with CutFEM <i>D. Copatina and A. Gouasmi</i>	<i>81</i>
From mathematical to didactical questions: model games <i>O. Delord</i>	<i>91</i>

On an analytical treatment of a problem of Radzievskij based on the true anomaly <i>L. Floría and C. Llorente</i>	111
Neural networks and ODE's <i>E. Javierre, J. I. Montijano, L. Rández and A. Selva</i>	123
On the high friction limit in the bi-fluid system <i>M. Kalousek, Y.-S. Kwon and Š. Nečasová</i>	133
A variance reduction technique to probabilistic domain decomposition <i>J. Morón-Vidal and F. Bernal</i>	149
Uniqueness results of a nonlinear stochastic diffusion-convection equation with reflection <i>N. Sapountzoglou</i>	157
On some Lewy–Stampacchia's inequalities <i>G. Vallet</i>	167

PREFACE

The *International Conference Zaragoza-Pau on Mathematics and its Applications* was organized by the *Departamento de Matemática Aplicada*, the *Departamento de Métodos Estadísticos*, *Departamento de Matemáticas* and the *Instituto Universitario de Matemáticas y Aplicaciones*, all of them from the *Universidad de Zaragoza* (Spain), and the *Laboratoire de Mathématiques et de leurs Applications*, from the *Université de Pau et des Pays de l'Adour* (France). This conference has been held every two years since 1989. The aim of this conference is to present recent advances in Applied Mathematics, Statistics and Pure Mathematics, putting special emphasis on subjects linked to energy and environment.

The Seventeenth Conference took place in Jaca (Spain) from 4th to 6th September 2024. The official opening ceremony was graced by the presence of the Vice-Chancellor for Internationalization and Cooperation of the University of Zaragoza, D. Francisco Beltrán Lloris, and the Chancellor of the University of Pau, M. le Président Laurent Bordes. During those three days, 121 mathematicians, coming from different universities, research institutes or the industrial sector, attended 9 plenary lectures, 75 contributed talks and a poster session with 3 posters. We note that in this edition there were 14 mini-symposia, one of them co-organized by colleagues from the *Universidad de Zaragoza* and the *Université de Pau et des Pays de l'Adour*.

The principal talks were about theoretical and numerical analysis of deterministic models described by partial differential equations, statistics and stochastic processes, surface approximation and image analysis. At the same time, there was also a discussion session about problems in algebra and geometry. These proceedings contain 16 refereed research papers.

We would like to thank the following institutions for their regular financial and material support in our cooperation programmes: *Université de Pau et des Pays de l'Adour*, *Universidad de Zaragoza* and *Gobierno de Aragón*. Thanks are also due to the *Institut Carnot ISIFoR*, the *Centre National de la Recherche Scientifique (CNRS)*, *Common Funds Aquitaine-Aragón* and *European Social Fund (ESF)* and the *Fédération IPRA of Pau (Institut Pluridisciplinaire de Recherche Appliquée)* for the grants specially allotted at the time of the Seventeenth Conference.

We wish to express our gratitude to Enrique Artal (U. Zaragoza), Carmelo Clavero (U. Zaragoza), Jacky Cresson (U. Pau), Marc Dambrine (U. Pau), Jacqueline Fleckinger (U. Toulouse I), Vincent Florens (U. Pau), Carmen Galé (U. Zaragoza), Jacques Giacomoni (U. Pau), Sophie Mercier (U. Pau), Pedro J. Miana (U. Zaragoza), Philippe Poncet (U. Pau), Luis Rández (U. Zaragoza), Carmen Sangüesa (U. Zaragoza), Peter Takáč (U. Rostock), who, together with us, formed the Scientific Committee. We would like also to express our special thanks to Pedro Mateo and Luis Rández (U. Zaragoza) and to Juan José Torrens (U. Pública de Navarra), for their invaluable help in organizing the web and editing these proceedings, respectively. We are also indebted to all the others who helped in the organization of the Conference, in particular, Begoña Álvarez, Paula Álvarez, Sergio Anglada, Adrián Aurenzanz, Elsa Carmen Barrio, Aitor Hernández, Lei Li, Pablo Solán-Fustero and Javier Zaratiegui.

We finally acknowledge the kind cooperation of the referees, as well as the assistance provided for the realization of the proceedings by the Servicio de Publicaciones of the University of Zaragoza.

The next Conference Zaragoza-Pau will be held in Jaca from 10th to 12th June 2026. All of you are cordially invited to participate in this event.

Pau and Zaragoza, December, 2025

The Editors

José Luis Gracia
Etelvina Javierre
María Cruz López de Silanes
Departamento de Matemática Aplicada
Universidad de Zaragoza

Étienne Ahusborde
Chérif Amrouche
Charles–Edouard Bréhier
Gilles Carbou
Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l’Adour

CONTRIBUTORS

ABADIE, F., 1
ABAURREA, J., 29
ANGLADA, S., 9
ASÍN, J., 19, 29
AURENSANZ-CRESPO, A., 19

BARRIO-TORRES, E., 29
BAUZET, C., 37
BERNAL, F., 149
BRÉHIER, C.-E., 47

CALVETE, H. I., 59
CANNONE, M., 69
CAPATINA, D., 81
CASTILLO-MATEO, J., 19, 29
CEBRIÁN, A. C., 29

DAMBRINE, M., 47
DELORD, O., 91

EN-NEBBAZI, N., 47

FLORÍA, L., 111

GALÉ, C., 9, 59
GOUASMI, A., 81
GRACIA-TABUENCA, Z., 19, 29

HERNÁNDEZ, A., 59

IRANZO, J. A., 59

JAVIERRE, E., 123

KALOUSEK, M., 133
KWON, Y.-S., 133

LLORENTE, C., 111

MONTJANO, J. I., 123
MORÓN-VIDAL, J., 149

NEČASOVÁ, Š., 133

RAMÍREZ, J. M., 19
RÁNDEZ, L., 123

SALAZAR-GONZÁLEZ, J. J., 9
SAPOUNTZOGLOU, N., 157
SCHMITZ, K., 37
SELVA, A., 123
SULTAN, C., 37

VALLET, G., 167

ZIMMERMANN, A., 37

LIST OF PARTICIPANTS

ABADIE, FRANÇOIS

Lycée Barthou

Université de Pau et des Pays de l'Adour, France

mathsabadie64@outlook.fr

AHMED KHAN, SHERAZ

Centre International de Méthodes Numériques en
Ingénierie

Universitat Politècnica de Catalunya, Spain

sheraz.ahmed@upc.edu

AIBECHE, AISSA

Ferhat Abbas University, Algeria

aibeche@univ-setif.dz

ÁLVAREZ, BEGOÑA

Departamento de Métodos Estadísticos & IUMA

Universidad de Zaragoza, Spain

balvarez@unizar.es

ÁLVAREZ, PAULA

Universidad de Oviedo, Spain

alvarezlompaula@uniovi.es

ALZIARY, BÉNÉDICTE

Institut de Mathématiques de Toulouse & TSE

Université Toulouse I Capitole, France

alziary@ut-capitole.fr

AMMARI, KAÏS

Department of Mathematics

University of Monastir, Tunisie

kais.ammari@fsm.rnu.tn

AMROUCHE, CHÉRIF

Laboratoire de Mathématiques et de leurs
Applications

Université de Pau et des Pays de l'Adour, France

cherif.amrouche@univ-pau.fr

ANGLADA, SERGIO

Departamento de Métodos Estadísticos & IUMA

Universidad de Zaragoza, Spain

sanglada@unizar.es

ARTAL, ENRIQUE

Departamento de Matemáticas & IUMA

Universidad de Zaragoza, Spain

artal@unizar.es

ASÍN, JESÚS

Departamento de Métodos Estadísticos & IUMA

Universidad de Zaragoza, Spain

jasin@unizar.es

AURENSANZ, ADRIÁN

Departamento de Métodos Estadísticos & IUMA

Universidad de Zaragoza, Spain

778099@unizar.es

BADÍA, FRANCISCO GERMÁN

Departamento de Métodos Estadísticos & IUMA

Universidad de Zaragoza, Spain

gbadia@unizar.es

BALTY, PIERRE

Institute of Mechanics, Materials and Civil
Engineering

Université catholique de Louvain, Belgium

pierre.balty@uclouvain.be

BARRIO, ELSA CARMEN

Departamento de Métodos Estadísticos & IUMA

Universidad de Zaragoza, Spain

elsa.barrio@unizar.es

BARRIO, ROBERTO

Departamento de Matemática Aplicada & IUMA

Universidad de Zaragoza, Spain

rbarrio@unizar.es

BELGRADE, RIDHA

Faculté des Sciences et Technologies, Institut

Élie Cartan de Lorraine, France

ridha.belgrade@univ-lorraine.fr

BEN ABDA, AMEL

École Nationale d'Ingénieurs de Tunis,

Université de Tunis, Tunisia

amel.benabda@enit.rnu.tn

BOUSSETOUAN, IMANE

École Nationale Supérieure de Technologie et
d'Ingénierie d'Annaba, Algeria

i.boussetouan@esti-annaba.dz

BRÉHIER, CHARLES-ÉDOUARD

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l'Adour, France
charles-edouard.brehier@univ-pau.fr

CABALLERO, CELIA

Departamento de Análisis Matemático,
Estadística e I.O. y Matemática Aplicada
Universidad de Málaga, Spain
celiacaba@uma.es

CALVETE, HERMINIA I.

Departamento de Métodos Estadísticos & IUMA
Universidad de Zaragoza, Spain
herminia@unizar.es

CANNONE, MARCO

Laboratoire d'Analyse et de Mathématiques
Appliquées
Université Gustave Eiffel, France
marco.cannone@univ-eiffel.fr

CARBOU, GILLES

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l'Adour, France
gilles.carbou@univ-pau.fr

CASANOVA, DANIEL

Centro Universitario de la Defensa & IUMA
Universidad de Zaragoza, Spain
casanov@unizar.es

CATTELL, OLIVER

School of Mathematical Sciences
University of Nottingham, United Kingdom
oliver.cattell@nottingham.ac.uk

CILDOZ, MARTA

Departamento de Estadística, Informática y
Matemáticas
Universidad Pública de Navarra, Spain
marta.cildoz@unavarra.es

CLAVERO, CARMELO

Departamento de Matemática Aplicada & IUMA
Universidad de Zaragoza, Spain
clavero@unizar.es

COGOLLUDO-AGUSTÍN, JOSÉ IGNACIO

Departamento de Matemáticas & IUMA
Universidad de Zaragoza, Spain
jicogo@unizar.es

DÁVILA, JOSÉ LUIS

Departamento de Matemática Aplicada
Universidad de Zaragoza, Spain
jdavila@unizar.es

DELORD, OLIVIER

Lycée Louis Barthou, France
olivier.delord@ac-bordeaux.fr

DÍAZ, PABLO

Departamento de Matemática Aplicada & IUMA
Universidad de Zaragoza, Spain
pablodiaz@unizar.es

DOUCE, VINCENT

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l'Adour, France
vincent.douce@univ-pau.fr

DUPONCHEEL, MATTHIEU

Institute of Mechanics, Materials and Civil
Engineering
Université catholique de Louvain, Belgium
matthieu.duponcheel@uclouvain.be

ELIPE, ANTONIO

Departamento de Matemáticas & IUMA
Universidad de Zaragoza, Spain
elipe@unizar.es

EN-NEBBAZI, NASSIM

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l'Adour, France
nenebbazi@univ-pau.fr

ESTRADA, ERNESTO

Instituto de Física Interdisciplinar y Sistemas
Complejos, CSIC
Universidad de las Islas Baleares, Spain
estrada@ifisc.uib-csic.es

FEHRENBACH, JÉRÔME

Institut de Mathématiques de Toulouse
Université Toulouse III – Paul Sabatier, France
jerome.fehrenbach@math.univ-toulouse.fr

FERREIRA, CHELO

Departamento de Matemática Aplicada &
IUMA,
Universidad de Zaragoza, Spain
cferrei@unizar.es

FLORENS, VINCENT

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l'Adour, France
vincent.florens@univ-pau.fr

FLORÍA, LUIS

Departamento de Física Teórica & IUMA
Universidad de Zaragoza, Spain
lfloria@unizar.es

GALÉ, CARMEN

Departamento de Métodos Estadísticos & IUMA
Universidad de Zaragoza, Spain
cgale@unizar.es

GARCÍA, DAVID

Departamento de Ingeniería Mecánica
Universidad de Zaragoza, Spain
david.garcian@unizar.es

GHANTOUS JOYCE

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l'Adour, France
joyce.ghantous@univ-pau.fr

GÓMEZ, IRENE

Departamento de Análisis Matemático,
Estadística e I.O. y Matemática Aplicada
Universidad de Málaga, Spain
igomezbueno@uma.es

GONZÁLEZ-VILLA, MANUEL

Departamento de Matemáticas
Universidad de Zaragoza, Spain
m.gonzalez@unizar.es
manuel.gonzalez@cimat.mx

GOUASMI, AIMENE

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l'Adour, France
agouasmi@univ-pau.fr

GRACIA, JOSÉ LUIS

Departamento de Matemática Aplicada & IUMA
Universidad de Zaragoza, Spain
jlgracia@unizar.es

HERNÁNDEZ, AITOR

Departamento de Métodos Estadísticos & IUMA
Universidad de Zaragoza, Spain
aitor.hernandez@unizar.es

IRANZO, JOSÉ ÁNGEL

Departamento de Métodos Estadísticos & IUMA
Universidad de Zaragoza, Spain
joseani@unizar.es

JAVIERRE, ETELVINA

Departamento de Matemática Aplicada & IUMA
Universidad de Zaragoza, Spain
etelvina@unizar.es

JODRÁ, PEDRO

Departamento de Métodos Estadísticos & IUMA
Universidad de Zaragoza, Spain
pjodra@unizar.es

JORGE, JUAN CARLOS

Departamento de Estadística, Informática y
Matemáticas
Universidad Pública de Navarra, Spain
jcjorge@unavarra.es

JOVER, JORGE ALBERTO

Departamento de Matemática Aplicada & IUMA
Universidad de Zaragoza, Spain
jorgejover@unizar.es

LABBÉ, STÉPHANE

Laboratoire Jacques-Louis Lions
Sorbonne Université, France
stephane.labbe@sorbonne-universite.fr

LALAUDE-LABAYLE, MARC

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l'Adour, France
marc.lalaude-labayle@univ-pau.fr

LANCHARES, ERNESTO

Departamento de Estadística, Informática y
Matemáticas
Universidad Pública de Navarra, Spain
elancha98@gmail.com

LANCHARES, VÍCTOR

Departamento de Matemáticas y Computación
Universidad de La Rioja, Spain
vlancha@unirioja.es

LASCORZ, LORIÉN

Departamento de Matemáticas & IUMA
Universidad de Zaragoza, Spain
lolascorz@unizar.es

LELOUP, GUILLAUME

Institut de Recherche Mathématique de Rennes
Université de Rennes, France
guillaume.leloup@univ-rennes.fr

LÉVI, LAURENT

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l'Adour, France
laurent.levi@univ-pau.fr

LEWANDOWSKI, ROGER

Département de Mathématiques,
Université de Rennes, France
Roger.Lewandowski@univ-rennes1.fr

LI, LEI

College of Computer Science and Technology
Engineering
Hunan University, China
aleilei@hnu.edu.cn

LISBONA, FRANCISCO J.

Universidad de Zaragoza, Spain
lisbona@unizar.es

LÓPEZ DE SILANES, MARÍA CRUZ

Universidad de Zaragoza, Spain
mcruz@unizar.es

MADAUNE-TORT, MONIQUE

Arros de Nay, France
monique.madaune-tort@wanadoo.fr

MAGANIN, JESIKA

Universidade Federal do Paraná, Brazil
jesikamaganin@ufpr.br

MALLOR, FERMÍN

Departamento de Estadística, Informática y
Matemáticas,
Universidad Pública de Navarra, Spain
mallor@unavarra.es

MANOURAS, MANOUSOS

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l'Adour
manousosmanouras@hotmail.com

MARTIN-MORALES, JORGE

Departamento de Matemáticas & IUMA
Universidad de Zaragoza, Spain
jorge.martin@unizar.es

MATEO, PEDRO

Departamento de Métodos Estadísticos
Universidad de Zaragoza, Spain
mateo@unizar.es

MAYORA-CEBOLLERO, ANA

Departamento de Matemática Aplicada & IUMA
Universidad de Zaragoza, Spain
amayora@unizar.es

MAYORA-CEBOLLERO, CARMEN

Departamento de Matemática Aplicada & IUMA
Universidad de Zaragoza, Spain
cmayora@unizar.es

MIANA, PEDRO J.

Departamento de Matemáticas & IUMA
Universidad de Zaragoza, Spain
pjmiana@unizar.es

MORA, FERNANDA

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l'Adour, France
fermora@alumnos.uai.cl

MORÓN-VIDAL, JORGE

Departamento de Matemáticas
Universidad Carlos III de Madrid, Spain
jmoron@math.uc3m.es

MUÑOZ, MARÍA LUZ

Departamento de Análisis Matemático,
Estadística e I.O. y Matemática Aplicada
Universidad de Málaga, Spain
mlmunoz@uma.es

NASR, NIAMI

Institut Camille Jordan
Université Jean Monnet, Saint-Étienne, France
niami.nasr@univ-st-etienne.fr

NEČASOVÁ, ŠÁRKA

Institute of Mathematics
Czech Academy of Sciences, Czech Republic
matus@math.cas.cz

NORIEGA, DIEGO

Departamento de Matemáticas
Universidad de Oviedo, Spain
noriegadiego@uniovi.es

NUDO, FEDERICO

Departamento di Matematica “Tullio
Levi-Civita”
Università degli Studi di Padova, Italy
federico.nudo@unipd.it

ORERA, HÉCTOR

Departamento de Matemática Aplicada & IUMA
Universidad de Zaragoza, Spain
hectororera@unizar.es

PALACIÁN, JESÚS F.

Departamento de Estadística, Informática y
Matemáticas
Universidad Pública de Navarra, Spain
palacian@unavarra.es

PAROISSIN, CHRISTIAN

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l’Adour, France
cparoiss@univ-pau.fr

PÉ DE LA RIVA, ÁLVARO

Departamento de Matemática Aplicada & IUMA
Universidad de Zaragoza, Spain
apedelariva@unizar.es

PEREDA VIVO, MAGDALENA

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l’Adour, France
mpvivo@univ-pau.fr

PEREZ, SARAH

The Lyell Centre
Heriot-Watt University, Scotland, United
Kingdom
s.perez@hw.ac.uk

PÉREZ SINUSÍA, ESTER

Departamento de Matemática Aplicada & IUMA
Universidad de Zaragoza, Spain
ester.perez@unizar.es

PIERRE, CHARLES

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l’Adour, France
charles.pierre@univ-pau.fr

PONCET, PHILIPPE

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l’Adour, France
philippe.poncet@univ-pau.fr

PORTI, JOAN

Departament de matemàtiques
Universitat Autònoma de Barcelona, Spain
joan.porti@uab.cat

POZO, MIGUEL A.

Departamento de Estadística e Investigacióm
Operativa – IMUS
Universidad de Sevilla, Spain
miguelpozo@us.es

PUERTO, JUSTO

Instituto de Matemáticas – IMUS CITIUS II
Universidad de Sevilla, Spain
puerto@us.es

PUIG, BÉNÉDICTE

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l’Adour, France
benedicte.puig@univ-pau.fr

RACOT, JÉRÉMIE

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l’Adour, France
jeremie.racot@etud-univ-pau.fr

RÁNDEZ, LUIS

Departamento de Matmática Aplicada & IUMA
Universidad de Zaragoza, Spain
randez@unizar.es

RAPÚN, MARÍA-LUISA

Departamento de Matemática Aplicada a la
Ingeniería Aeroespacial
Universidad Politécnica de Madrid, Spain
marialuisa.rapun@upm.es

RAZAFISON, ULRICH

Laboratoire de Mathématiques de Besançon
Université de Franche-Comté, France
ulrich.razafison@univ-fcomte.fr

RODAU, ADRIEN

Laboratoire Paul Painlevé
Université de Lille, France
adrien.rodau@univ-lille.fr

RODRÍGUEZ-BELLIDO, MARÍA ÁNGELES
Departamento de Ecuaciones Diferenciales y
Análisis Numérico
Universidad de Sevilla, Spain
angeles@us.es

ROYO-AMONDARAIN, EDUARDO
Departamento de Matemáticas & CAPA
Universidad de Zaragoza, Spain
eduroyo@unizar.es

SANGÜESA, CARMEN
Departamento de Métodos Estadísticos & IUMA
Universidad de Zaragoza, Spain
csangues@unizar.es

SAPOUNTZOGLU, NIKLAS
Institut für Mathematik
Technische Universität Clausthal, Germany
niklas.sapountzoglou@tu-clausthal.de

SCHINDLER, IAN
Institut de Mathématiques de Toulouse & TSE
Université Toulouse I Capitole, France
ian.schindler@tutanota.com

SCHMITZ, KERSTIN
Institut für Mathematik
Technische Universität Clausthal, Germany
kerstin.schmitz@tu-clausthal.de

SEBASTIÁN, MARÍA VICTORIA
Centro Universitario de la Defensa
Universidad de Zaragoza, Spain
msebasti@unizar.es

SEGOVIA-BURILLO, JOSÉ
Departamento de Ciencia y Tecnología de
Materiales y Fluidos & I3A
Universidad de Zaragoza, Spain
jsegovia@unizar.es

SOLÁN-FUSTERO, PABLO

Departamento de Ciencia y Tecnología de
Materiales y Fluidos & I3A
Universidad de Zaragoza, Spain
psolfus@unizar.es

STARK, JUSTINA

Max Planck Institute of Molecular Cell Biology
and Genetics
Center for Systems Biology Dresden
Technische Universität Dresden, Germany
justina.stark@tu-dresden.de

SULTAN, CÉDRIC

Laboratoire de Mécanique et d'Acoustique
Aix-Marseille Université, France
cedric.sultan@univ-amu.fr

TAKÁČ, PETER

Institut für Mathematik
Universität Rostock, Germany
peter.takac@uni-rostock.de

TRESACO, EVA

Departamento de Matemática Aplicada & IUMA
Universidad de Zaragoza, Spain
etresaco@unizar.es

TRIDON, JASON

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l'Adour, France
jason.tridon@univ-pau.fr

VALLET, GUY

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l'Adour, France
guy.vallet@univ-pau.fr

VIGARA, RUBÉN

Departamento de Matemática Aplicada & IUMA
Universidad de Zaragoza, France
rvigara@unizar.es

VINAGRE, BLAS M.

Departamento de Ingeniería Eléctrica,
Electrónica y Automática
Universidad de Extremadura, Spain
bvinagre@unex.es

VIU–SOS, JUAN

Departamento de Matemática e Informática
Aplicadas a las Ingenierías Civil y Naval
Universidad Politécnica de Madrid, Spain
juan.viu.sos@upm.es

WEYNANS, LISL

Institut de Mathématiques
Université de Bordeaux, France
lisl.weynans@math.u-bordeaux.fr

YASKOVETS, SERHI

Max Planck Institute of Molecular Cell Biology
and Genetics
Center for Systems Biology Dresden
Technische Universität Dresden, Germany
yaskovet@mpi-cbg.de

ZARATIEGUI, JAVIER

Departamento de Matemáticas
Universidad de Zaragoza, Spain
javierzu@unizar.es

ZELADA, RODRIGO

Laboratoire de Mathématiques et de leurs
Applications
Université de Pau et des Pays de l'Adour, France
rodrigo.zelada-mancini@univ-pau.fr

OTHER COMMUNICATIONS

The following contributions were also presented in the Conference Zaragoza-Pau, but they are not included in this book. Some will appear in other publications.

On the property of decreasing inverse failure rate for random sums and its applications in applied probability models

D. Adrián, G. Badía, A. Federgruen and C. Sangüesa

A posteriori error estimates for the finite element approximation of the convection-diffusion equation based on the variational multiscale concept

S. Ahmed Khan, R. Codina and H. Gravenkamp

Approaching the solution of the physician scheduling problem in the ER of the University Hospital of Navarra

B. Álvarez, M. Cildoz, F. Mallor and P. M. Mateo

High-order Melnikov functions through normalisation

M. Álvarez, J. F. Palacián and P. Yanguas

Unfolding of an unipotent fixed point: first steps

P. Álvarez Lombardero

Regularity of the semigroup associated with some interacting elastic systems

K. Ammari, S. Farhat and L. Tebou

Orbifolds and line arrangements

E. Artal Bartolo

Properties of Weighted Mean Residual Life in Distribution Mixtures

F. G. Badía, M. D. Berrade, J. H. Cha and H. Lee

A Multiresolution Vortex Particle-Mesh method

P. Balty, G. Poncelet, M. Duponcheel and P. Chatelain

On a Stationary Schrödinger Equation with Periodic Magnetic Potential

P. Bégout and I. Schindler

The Cauchy–Stokes problem

A. Ben Abda

Surface boundary layers through a scalar equation with an eddy viscosity vanishing at the ground

L. C. Berselli, F. Legeais and R. Lewandowski

On the inverse scattering problem with uncertainties

T. Bonnafont, F. Caubet and J. Tridon

Generalized and strong solutions for Stokes and Navier–Stokes equations with mixed boundary conditions

I. Boussetouan, C. Amrouche and N. Seloula

Histopolation via mock–Chebyshev points

L. Bruni Bruno, F. Dell’Accio, W. Erb and F. Nudo

A semi–implicit fully exactly well-balanced relaxation scheme for the shallow water system

C. Caballero–Cárdenas, M. J. Castro, C. Chalons, T. Morales de Luna and M. L. Muñoz–Ruiz

Domain Wall Dynamics in Notched Ferromagnetic Nanowires

G. Carbou, M. Jazar and M. Kassan

Lunar Orbits: Short and Long–Duration Paths for Different Mission Objectives

J. P. S. Carvalho, D. Casanova and E. Tresaco

Secondary Bifurcations in a Next Generation Neural Field Model

O. Cattell, R. D. O’Dea and S. Coombes

Shape optimization with discontinuities

F. Caubet, C. Conca, M. Dambrine and R. Zelada

Special time integrators for 2D evolutionary singularly perturbed systems

C. Clavero and J. C. Jorge

Mathematical modeling and numerical simulation of gas flow through a one-way valve

A. Corli, U. Razafison and M. D. Rosini

Imperfect condition–based maintenance for a gamma degradation process in presence of unknown parameters

F. Corset, M. Fouladirad and C. Paroissin

An immersed boundary method for the inverse problem of electrical impedance tomography (EIT)

J. Dardé, N. Nasr and L. Weynans

Total positivity and symmetric functions

P. Díaz, E. Mainar and B. Rubio

Creating fairy tales to teach maths

V. Douce

Bifurcations and Chaos in Linearly Coupled FitzHugh–Nagumo Systems

F. Drubi, S. Ibáñez and D. Noriega

Wake Characterization, Mitigation and Exploitation Scenarios using the Vortex Particle–Mesh Method

M. Duponcheel and P. Chatelain

An excursion through complex networks

E. Estrada

An hybrid computing implementation for remeshed particle method with operator splitting

J. M. Etancelin, J. B. Keck, F. Perignon, C. Mimeau, C. Picard, G. H. Cottet and N. Grima

Inverse Stefan problem - application to geology

J. Fehrenbach and O. Melnik

Asymptotic expansions of two new special functions: the H-function of communication theory and the Moench Integral Transform of Hydrology

C. Ferreira, J. L. López, P. Pagola and E. Pérez Sinusía

An integral from the elastodynamic theory: computation in terms of elementary functions

C. Ferreira, J. L. López and E. Pérez Sinusía

Incorporating noise in the inverse problem of the EIT complete electrode model

S. Fourcade and L. Weynans

Confined cell migration by an agent-based model

D. García-Navarro, J. Zhang-Zhou and J. M. García-Aznar

Preserving all non-moving stationary solutions of the Euler equations with gravity

I. Gómez-Bueno, M. J. Castro and C. Parés

Zeta functions for multiplicity 3 surfaces

M. González Villa, E. Artal Bartolo and E. León Cardenal

Solving POD-based ROMs combined with Augmented Riemannian solvers applied to 2D SWE

J. L. Gracia, P. Solán-Fustero, A. Navas-Montilla and P. García-Navarro

Numerical treatment of a SIS model with repulsive taxis

F. Guillén-González, M. A. Rodríguez-Bellido and D. A. Rueda-Gómez

A multiphysics model of the mechanical and biochemical interactions in tissue growth

E. Javierre, M. T. Sánchez, F. J. Gaspar and C. Rodrigo

A quantile regression model for a bounded response variable having the reflected LEEG distribution

P. Jodrá

Applications of control theory to dynamical systems with different timescales

J. A. Jover Galtier

High accuracy computations of the Newton form of the Lagrange interpolant

Y. Khia, E. Mainar, E. Royo–Amondarain and B. Rubio

Bachelor in Mathematics and primary education: an experiment

M. Lalaude-Labayle, L. Lévi and G. Vallet

The effect of Coriolis coupling in a Hénon–Heiles–like system

V. Lanchares, M. Iñarrea and J. P. Salas

Performing Delaunay normalisations for a wide class of functions and its applications

E. Lanchares and J. F. Palacián

Vorticity Leray– α model for Navier–Stokes equations with viscosity depending on the distance to the wall

G. Leloup

The Influence of Noise in Mean-Field Models of Neural Populations

L. Li, R. Barrio, A. Mayora–Cebollero, C. Mayora–Cebollero and L. Pérez

Dominant patterns in small directed bipartite networks

Á. Lozano, R. Vigara, C. Mayora–Cebollero and R. Barrio

Repeated Richardson Extrapolation for minimizing discretization error in tumor growth modeling

J. Maganin, M. A. Villela Pinto, N. M. Lopes Romeiro and S. Romero Franco

Effective methods for computing the Bernstein–Sato polynomial of a meromorphic function

J. Martín–Morales

Dynamical Study of the Influence of Adaptive Coupling in Mean-Field Models of Neural Populations

A. Mayora–Cebollero, R. Barrio, J. A. Jover–Galtier, C. Mayora–Cebollero, S. Serrano, L. Pérez and L. Li

Deep Learning to Quantify Chaos in a Dynamical System

C. Mayora–Cebollero, R. Barrio, A. Mayora–Cebollero and Á. Lozano

Accurate computations for Laplacian matrices

H. Orera and J. M. Peña

Statistical inference for the semi-parametric proportional reversed hazard model for leftcensored and zero-inflated data

C. Paroissin and M. Pereda Vivo

On the design of efficient numerical methods for the poroelastic Biot's equations

A. Pé de la Riva, C. Rodrigo Cardiel and F. J. Gaspar Lorenz

From Direct Numerical Simulation to Uncertainty Quantification in reactive microscale flows for CO₂ mineral storage applications

S. Perez, J. M. Etancelin and P. Poncet

Conductivity reconstruction using electric impedance tomography: a finite element implementation

C. Pierre

Varieties of representations and three manifolds

J. Porti

The biobjective minimum-cost perfect matching problem and Chinese postman problem

M. A. Pozo, J. Puerto and I. Roldán

Data Science and Location Theory in a nutshell

J. Puerto

Numerical solution of a linear elasticity equation in a saturated porous media in presence of fluid flow

J. Racot, J. M. Etancelin and P. Poncet

Topological derivatives for defect detection in non-destructive testing

M. L. Rapún

Well-posedness of stochastic evolution equations with Hölder continuous noise

K. Schmitz

A review on non-hydrostatic formulation for free surface flows

J. Segovia-Burillo, M. Morales-Hernández, S. Martínez-Aranda and P. García-Navarro

Prediction of solutions computed by POD-based reduced-order models beyond the training parameter set

P. Solán-Fustero, J. L. Gracia, A. Navas-Montilla and P. García-Navarro

Porous-media characteristics of embryo tissue regulate morphogen gradient formation

J. Stark, R- Krishnan Harish, I. F. Sbalzarini and M. Brand

Two positive solutions to a semilinear spectral problem with a convex/concave nonlinearity of variable $(q(x) - 1)$ -power-type $(\geq / \leq 1)$

P. Takáč, J. Benedikt, P. Girg and L. Kotrla

On Time and Control Theory: An Engineering Approach

B. M. Vinagre

Fast neighborhood iterators for particle and particle-mesh codes on parallel computers

S. Yaskovets and I. F. Sbalzarini

Multigrid methods for the Multipoint Flux Mixed Finite Element discretization of the Darcy flow model with double porosity

J. Zaratiegui, C. Rodrigo, A. Arrarás and L. Portero

PRACTICAL AND DIDACTIC ANALYSIS OF MATH TUTORING

François Abadie

Abstract. Based on a one year long observation of tutoring sessions led by L3 MIAHS PPPE students for both 1st year high school students and L1 MIAHS PPPE students, we will illustrate some of the contributions and difficulties of tutors from a didactic and professional point of view.

Keywords: mathematics tutoring, teacher education, peer learning.

AMS classification: Mathematics teaching methods and classroom techniques, Learning difficulties and student errors.

§1. General structure

This practical teaching unit is set up for 3rd year MIAHS Bachelor students in the PPPE stream (Maths Applied to Human and Social Sciences, preparatory course for elementary school teachers). This teaching unit represents 2 ECTS. Participants and time schedule are detailed as followed :

- 1.5h per week, during 26 weeks of 1 academic year
- 10 tutors (third year undergraduate students in L3)
- 30 pupils in 10th grade (15 yo) from Lycée Louis Barthou, volunteers "for tutoring"
- 15 first year undergraduate students in L1, volunteers "for tutoring"
- 1 referent teacher, organizing, helping and assessing tutors

Distribution of students :

- 2 groups of first year undergraduate students (called L1 students)
- 8 groups with no more than 4 pupils and one tutor per group

It should be noted that the 10th grade level is the level required for the written elementary school teacher recruitment exam.

§2. Tutors' objectives and evaluations.

2.1. During the sessions

The following main objectives were given to the tutors and then evaluated by the referent teacher :

- professional posture, supportive attitude
- putting pupils and students in active learning situations

- oral and written communication skills
- use of digital tools when necessary

2.2. Written report of each session

Student tutors were asked to fill up a report after each session in order to describe :

- mathematical topics and questions covered
- students and pupils difficulties
- proposed remediation
- self-evaluation

You'll find below an empty session report and a completed one.

Tuteur TUTOR	Elèves/étudiants (nom, prénom et classe) PUPILS/STUDENTS
Thème(s) abordé(s) TOPICS	
Exercices/questions traitées (énoncés succincts) EXERCISES MADE	
Difficultés rencontrées par l'élève ou l'étudiant DIFFICULTIES/MISTAKES IDENTIFIED	
Remédiations proposées REMEDATIONS	
Difficultés rencontrées par le tuteur (manque de maîtrise mathématique en profondeur de tel sujet, incompréhension de la difficulté de l'élève, manque d'outils et de leviers à disposition, analyse a posteriori, etc.) DIFFICULTIES FOR THE TUTOR	
Remarques éventuelles : REMARKS	

Figure 1: Session's report for student tutors

Thème(s) abordé(s) des équations et les inéquations
Exercices/questions traitées (énoncés succincts) $x^2 = 2 \cos 5,4 - \sqrt{x}; \sqrt{x}$ - résolution de $(x+2)^2 - 7 \rightarrow 3 = ?$ $(x-3)^2 - 0 \rightarrow 5 = ?$ $(x-2)(x+5) = 0 \rightarrow 5 = ?$ - résolution de $\frac{(x-1)^2 - 4}{x-1} = 0$ en déterminant la valeur interdite - résolution d'inéquations $-3 < x \leq 2$ et pour $x-1$; $x+1$, $3x$, $-5x$ etc. et pour $2x+3$; $-5x-2$ $x \leq 2$ alors $2x$? $y \leq 6$ alors $3y$? et $x+y$?
Difficultés rencontrées par l'élève ou l'étudiant - comprendre la valeur interdite $\rightarrow$ pourquoi elle est interdite ? - comprendre ses calculs comme $(x+2)^2 - 7 = (x+2-2)(x+2+2)$ $a^2 - b^2$ $-x = -1 \times x$
Remédiations proposées - recorriger les différentes identités remarquables - proposer des exercices en partant des bases (résolution équation 1^{er} degré) en allant vers des exercices plus difficiles (équation 2nd degré). - refaire des exercices similaires plusieurs fois pour vérifier que la notion est bien comprise
Difficultés rencontrées par le tuteur (manque de maîtrise mathématique en profondeur de tel sujet, incompréhension de la difficulté de l'élève, manque d'outils et de leviers à disposition, analyse a posteriori ("j'aurais peut-être pu faire ceci ou cela"), etc.) Pas de soucis pour cette séance.
Remarques éventuelles :

Figure 2: One example of session's report

§3. Difficulties encountered by tutors

3.1. Organizational difficulties

- finding time to fill out reports during every session
- new pupils joining tutoring sessions during the schoolyear
- finding content or activities when pupils don't really have any new work to do
- managing heterogeneous groups and different programs

To find exercises and activities to fill sessions without new notions studied in class, tutors made revision of old exercises, previous tests, and also pre-requisite exercises for the chapters to come. The access to exercise banks (in school books or online) wasn't so hard to find.

A simple answer to the heterogeneous groups difficulties was to limit groups with no more than 4 pupils, and to keep the same group as long as possible. This difficulty wasn't pointed out by tutors with L1 students, with a common organization based on personal or group research, then commented solutions at the board.

Another answer was found by tutors themselves with *tutoring within tutoring* in order to keep everybody active, peer learning as showed bellow.

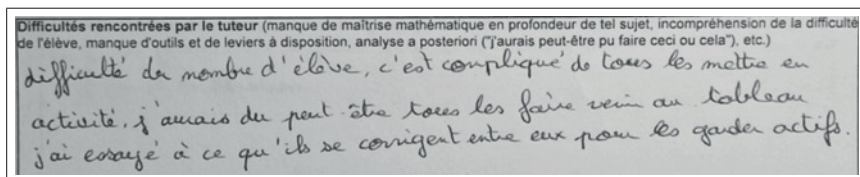


Figure 3: Extract of a report : *tutoring within tutoring*



Figure 4: A tutoring session of L1 students



Figure 5: A tutoring session of 10th grade pupils

3.2. Mathematical difficulties

For pupils tutors:

- adaption to the methods studied in class (for example with the resolution of quadratic equations without using discriminant)
- keeping rigorous writing requirements (for both pupils and tutors)
- make students express themselves orally using a rigorous vocabulary

For L1 tutors:

- sufficient understanding on the concepts and methods they faced
- necessity to prepare in advance with the teacher's corrections

Pupils tutors had to check the pupils lessons and keep closer as possible from the methods studied in class. For L1 tutors, program and corrections were sent in advance by university teachers, and in case of major difficulty, they could always ask the referent teacher for help.

3.3. Pedagogical difficulties and mistakes

For pupils tutors:

- identification of pupils' needs
- identification of main concepts in the lessons and key exercises
- make students express themselves orally using a rigorous vocabulary

While reading pupils lessons, tutors must point out the main results to be known by pupils, and question them because pupils are not always able to tell their own difficulties.

To ensure understanding of key exercises, repetition of those exercises are important, but tutors must also create similar exercises implicitly using the concept of didactic variables.

For all the tutors:

- main mistake observed : improvisation a lecture instead of getting pupils and students involved
- explanation of a difficulty
- pupils and students' oral expression remains underdeveloped

The main tools used by tutors to explain a difficulty were giving simple examples and managing different registers (mostly with graphics, including the use of digital tools).

Asking pupils and students to comment on their solutions at the board is essential to develop oral expression, and was also favored by tutors.

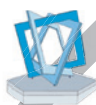
Most of the time, tutors were able to recognize when a student has made a mistake. However, the study of the causes of this error and its classification (modeling, classic trap, design error/automatic analogies, language, etc.) are rarely known or analyzed. Similarly, after a few explanations, the proposed remediation is poorly developed ("we've done other exercises"), and when the notion seems to have been understood, further elaboration is not always proposed. The length of the sessions may explain this last point, but the tutors don't always feel the need to go into greater depth.

ISBN 978-13-7014-073-1
9 791370 140731



Prensas de la Universidad
Universidad Zaragoza

 monografías
garcía de galdeano



Instituto Universitario de Investigación
**de Matemáticas
y Aplicaciones**
Universidad Zaragoza