

Enrique Alba · Gabriel Luque ·  
Francisco Chicano · Carlos Cotta ·  
David Camacho · Manuel Ojeda-Aciego ·  
Susana Montes · Alicia Troncoso ·  
José Riquelme · Rodrigo Gil-Merino (Eds.)

LNAI 12882

# Advances in Artificial Intelligence

19th Conference of the Spanish Association  
for Artificial Intelligence, CAEPIA 2020/2021  
Málaga, Spain, September 22–24, 2021  
Proceedings



 Springer

# Lecture Notes in Artificial Intelligence

12882

Subseries of Lecture Notes in Computer Science

## Series Editors

Randy Goebel

*University of Alberta, Edmonton, Canada*

Yuzuru Tanaka

*Hokkaido University, Sapporo, Japan*

Wolfgang Wahlster

*DFKI and Saarland University, Saarbrücken, Germany*

## Founding Editor

Jörg Siekmann

*DFKI and Saarland University, Saarbrücken, Germany*

More information about this subseries at <http://www.springer.com/series/1244>


Enrique Alba · Gabriel Luque ·  
Francisco Chicano · Carlos Cotta ·  
David Camacho · Manuel Ojeda-Aciego ·  
Susana Montes · Alicia Troncoso ·  
José Riquelme · Rodrigo Gil-Merino (Eds.)

# Advances in Artificial Intelligence

19th Conference of the Spanish Association  
for Artificial Intelligence, CAEPIA 2020/2021  
Málaga, Spain, September 22–24, 2021  
Proceedings


*Editors*


Enrique Alba   
University of Malaga  
Málaga, Spain

Francisco Chicano   
University of Malaga  
Málaga, Spain

David Camacho   
Technical University of Madrid  
Madrid, Spain

Susana Montes   
University of Oviedo  
Oviedo, Spain

José Riquelme   
University of Seville  
Seville, Spain

Gabriel Luque   
University of Malaga  
Málaga, Spain

Carlos Cotta   
University of Malaga  
Málaga, Spain

Manuel Ojeda-Aciego   
University of Malaga  
Málaga, Spain

Alicia Troncoso   
Pablo de Olavide University  
Seville, Spain

Rodrigo Gil-Merino   
University of Malaga  
Málaga, Spain

ISSN 0302-9743 ISSN 1611-3349 (electronic)  
Lecture Notes in Artificial Intelligence  
ISBN 978-3-030-85712-7 ISBN 978-3-030-85713-4 (eBook)  
<https://doi.org/10.1007/978-3-030-85713-4>

LNCS Sublibrary: SL7 – Artificial Intelligence

© Springer Nature Switzerland AG 2021

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG  
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Preface

This volume contains a selected and peer-reviewed set of papers explicitly submitted to CAEPIA 20/21, the XIX Conference of the Spanish Association for Artificial Intelligence, held in Málaga, Spain, during September 22–24, 2021. This series of conferences is a well-established biennial Spanish event on Artificial Intelligence (AI) that started back in 1985. Previous editions took place in Alicante, Málaga, Murcia, Gijón, San Sebastián, Santiago de Compostela, Sevilla, La Laguna, Madrid, Albacete, Salamanca, and Granada.

CAEPIA is a national forum open to researchers from all over the world to present and discuss their latest scientific and technological advances in AI. Authors were kindly requested to submit unpublished original papers describing relevant achievements on AI topics for evaluation to appear in this volume. The conference welcomed theoretical, methodological, technical, and applied research.

Several federated congresses and workshops related to relevant AI tracks took place within CAEPIA: XX Spanish Congress on Fuzzy Logic and Technologies (ESTYLF); XIV Spanish Congress on Metaheuristics, Evolutionary and Bioinspired Algorithms (MAEB); X Symposium of Theory and Applications of Data Mining (TAMIDA); and six workshops.

Within CAEPIA 20/21 we also had a Doctoral Consortium (DC) for students. This is a forum for doctoral students to interact with other researchers by discussing their PhD advances and working plans. As an additional AI activity, we ran the 4th Competition on Mobile Apps with AI Techniques, side by side with a new edition of the AI Dissemination Videos Competition.

All the above activities endorse AI, and we strove to reach a high quality in the scientific papers, the DC, and the competitions. The scientific program of CAEPIA 20/21 also offered a track to disseminate outstanding recently published papers (Key Works: KW) appearing in renowned journals and fora. CAEPIA has always aimed to be recognized as a flagship conference in AI, and thus the peer reviewed papers, especially for this LNAI volume, went through a strict evaluation process. The total number of submissions to CAEPIA 20/21 was 186 (neither DC nor competitions nor KW submissions (83 additional contributions) were included in this number, since they went through a different evaluation process). Only 25 outstanding manuscripts were selected for this volume after a thorough double-blind review process that involved at least three reviews per submission, for which we are grateful to the area experts and the Program Committee. The reviewers judged the overall quality of the submitted manuscripts, together with the quality of the methodology employed, the soundness of the conclusions, the significance of the topic, the clarity, and the organization, among other evaluation criteria. On the basis of these reviews, the area experts proposed a final number of articles that were analyzed and approved by the editors of this LNAI volume.

CAEPIA 20/21 invited two internationally renowned researchers for a plenary talk. Our conference was held as a big event within the still larger Spanish Conference on Computer Science (CEDI), itself having very interesting plenary talks too. Our two

plenary speakers were Óscar Cordón (Artificial Intelligence for Forensic Anthropology and Human Identification) and Yaochu Jin (Data-Driven Evolutionary Optimization).

AEPIA and the organizers of CAEPIA 20/21 recognized the best PhD theses and all the original articles in federated events written by both, seniors and students. CAEPIA 20/21 also aimed to promote the presence of women in AI research. As in previous editions, the Frances Allen award recognized the two best PhD theses defended by a woman during the last two years.

The editors of this volume would like to thank the many people that contributed to the success of CAEPIA 20/21: authors, members of the Scientific and Program Committees, invited speakers, event organizers, electronic media managers, etc. We would like to especially thank the tireless work of the Organizing Committee, our sponsors (like VRAIN in Valencia), the Springer team, and AEPIA for their support.

Last but not least, on behalf of the CAEPIA 20/21 participants, Enrique Alba (General Chair), and Gabriel Luque (LNAI volume responsible) really thank the University of Malaga (local premises for the conference) and the whole Spanish community working in AI (and their many foreign collaborators) for making this event a real success.

July 2021

Enrique Alba  
Gabriel Luque  
Francisco Chicano  
Carlos Cotta  
David Camacho  
Manuel Ojeda-Aciego  
Susana Montes  
Alicia Troncoso  
José Riquelme  
Rodrigo Gil-Merino

# Organization

## General Chair

Enrique Alba

University of Malaga, Spain

## Awards Committee Chair

Eva Onaindia

Polytechnic University of Valencia, Spain

## Tutorials and Workshops Chairs

Rodrigo Gil-Merino

University of Malaga, Spain

Araceli Sanchís

University Carlos III of Madrid, Spain

## General Session Chair

Francisco Chicano

University of Malaga, Spain

## Competitions Chairs

Alberto Bugarín

University of Santiago de Compostela, Spain

José Antonio Gámez

University of Castilla-La Mancha, Spain

## Responsible for the LNAI Proceedings of CAEPIA

Gabriel Luque

University of Malaga, Spain

## Doctoral Consortium Chairs

José Riquelme

Universidad de Sevilla, Spain

María José Del Jesús Díaz

Universidad de Jaén, Spain

## Conferences and Workshop Chairs

### XX ESTYLF

Manuel Ojeda-Aciego

University of Malaga, Spain

Susana Montes

University of Oviedo, Spain



#### **XIV MAEB**

Carlos Cotta  
David Camacho

University of Malaga, Spain  
Technical University of Madrid, Spain

#### **X TAMIDA**

Alicia Troncoso  
José C. Riquelme

Universidad Pablo de Olavide, Spain  
Universidad de Sevilla, Spain

#### **IABiomed 20/21**

Mar Marcos  
David Riaño  
José M. Juárez

Universitat Jaume I, Spain  
Universitat Rovira i Virgili, Spain  
Universidad de Murcia, Spain

#### **IA-SIT 20/21**

Paz Sesmero  
Pablo Marín  
Juan Pedro Llerena

University Carlos III of Madrid, Spain  
University Carlos III of Madrid, Spain  
University Carlos III of Madrid, Spain

#### **AI4D 20/21**

Agapito Ledezma Espino  
José Antonio Iglesias Martínez  
David Camilo Corrales Muñoz

University Carlos III of Madrid, Spain  
University Carlos III of Madrid, Spain  
Institut national de la recherche agronomique  
(INRA), France

Elias Said Hung

International University of La Rioja, Spain

#### **QUARTI 20/21**

Javier Echanobe  
Enrique Alba

University of the Basque Country, Spain  
University of Malaga, Spain

#### **AGM 20/21**

Carlos González Val  
Juan Manuel Fernández Montenegro  
Andrea Fenández Martinez  
Santiago Muiños Landin  
Omar A. Mures  
José A. Iglesias-Guitián

AIMEN Technological Center, Spain  
AIMEN Technological Center, Spain  
AIMEN Technological Center, Spain  
AIMEN Technological Center, Spain  
University of A Coruña (UDC), Spain  
University of A Coruña (UDC), CITIC - Centre  
for ICT Research, Spain

**SCAI 20/21**

Jamal Toutouh  
Enrique Alba

University of Malaga, Spain  
University of Malaga, Spain

**Organizing Committee****Publicity**

Rubén Saborido

University of Malaga, Spain

**Visual Concepts**

Christian Cintrano  
José Ángel Morell

University of Malaga, Spain  
University of Malaga, Spain

**Web**

José Ángel Morell

University of Malaga, Spain

**IT Hybrid Format**

Francisco Chicano  
Andrés Camero

University of Malaga, Spain  
German Aerospace Center, Germany

**Area Chairpersons**

Óscar Corcho  
Javier del Ser  
Juan Manuel Fernández Luna  
Jesús García Herrero  
Pedro Larrañaga  
Patricio Martínez Barco  
Miguel Molina Solana  
Serafín Moral Callejón  
Eva Onaindia  
Juan Pavón Mestras  
David Pearce  
José Luis Pérez de la Cruz Molina  
Petia Radeva

Universidad Politécnica de Madrid, Spain  
Tecnalia, Spain  
University of Granada, Spain  
Universidad Carlos III de Madrid, Spain  
Universidad Politécnica de Madrid, Spain  
Universidad de Alicante, Spain  
University of Granada, Spain  
University of Granada, Spain  
Polytechnic University of Valencia, Spain  
Universidad Complutense de Madrid, Spain  
Universidad Politécnica de Madrid, Spain  
University of Malaga, Spain  
Universitat de Barcelona and Computer Vision  
Center, Spain

## Program Committee

Maedeh Aghaei	Universitat de Barcelona, Spain
Amparo Alonso-Betanzos	University of A Coruña, Spain
Jaume Bacardit	Newcastle University, UK
Antonio Bahamonde	Universidad de Oviedo at Gijon, Spain
Javier Bajo	Universidad Politécnica de Madrid, Spain
Emili Balaguer-Ballester	Bournemouth University, UK
Ana M. Barbancho	University of Malaga, Spain
Álvaro Barreiro	University of A Coruña, Spain
Eduarne Barrenechea	Public University of Navarra, Spain
Senén Barro	University of Santiago de Compostela, Spain
José Ángel Bañares	University of Zaragoza, Spain
Ana M. Bernardos	Universidad Politécnica de Madrid, Spain
Concha Bielza Lozoya	Universidad Politécnica de Madrid, Spain
Daniel Borrajo	JPMorgan & Chase AI Research Lab, Spain
Juan Botia	King's College London, UK
Vicent Botti	Universitat Politècnica de València, Spain
Humberto Bustince	UPNA, Spain
Pedro Cabalar	University of A Coruña, Spain
José M. Cadenas	Universidad de Murcia, Spain
Zoraida Callejas	University of Granada, Spain
Iván Cantador	Universidad Autónoma de Madrid, Spain
Robert Castelo	Universitat Pompeu Fabra, Spain
Francisco Chicano	University of Malaga, Spain
Óscar Corcho	Universidad Politécnica de Madrid, Spain
Rafael Corchuelo	University of Seville, Spain
Carlos Cotta	University of Malaga, Spain
Zakaria Abdelmoiz Dahi	University of Malaga, Spain
Sergio Damas	University of Granada, Spain
Luis M. de Campos	University of Granada, Spain
André de Carvalho	University of Sao Paulo, Brazil
Luis De La Ossa	University of Castilla-La Mancha, Spain
Juan José Del Coz	University of Oviedo at Gijón, Spain
Javier del Ser	Tecnalia, Spain
Natalia Díaz-Rodríguez	ENSTA Paris, Institut Polytechnique de Paris, France
José Dorronsoro	Universidad Autónoma de Madrid, Spain
Jorge Fandinno	Potsdam University, Germany
Juan Manuel Fernández Luna	Universidad de Granada, Spain
Mariano Fernández López	Universidad San Pablo CEU, Brazil
Antonio Fernández-Caballero	Universidad de Castilla-La Mancha, Spain
Francesc J. Ferri	University of Valencia, Spain
José Manuel Galán	Universidad de Burgos, Spain
José Gámez	University of Castilla-La Mancha, Spain
Jesús García Herrero	University Carlos III of Madrid, Spain

Raúl García-Castro	Universidad Politécnica de Madrid, Spain
Rafael M. Gasca	University of Seville, Spain
Lluís Godo	IIIA - CSIC, Spain
Juan Gómez Romero	University of Granada, Spain
Antonio González	University of Granada, Spain
Manuel Graña	University of the Basque Country, Spain
Carlos Gómez-Rodríguez	Universidade da Coruña, Spain
César Hervás	University of Córdoba, Spain
Iñaki Inza	University of the Basque Country, Spain
Luis Jiménez Linares	University of Castilla-La Mancha, Spain
Kaisar Kushibar	University of Barcelona, Spain
Pedro Larrañaga	Universidad Politécnica de Madrid, Spain
Jordi Levy	IIIA - CSIC, Spain
Adolfo López	INSISOC - University of Valladolid, Spain
Gabriel Luque	University of Malaga, Spain
Victoria López	CUNEF University, Spain
Lawrence Mandow	University of Malaga, Spain
Felip Manyà	IIIA - CSIC, Spain
Eugenio Martínez-Cámara	University of Granada, Spain
Luis Martínez	University of Jaén, Spain
Patricio Martínez Barco	Universidad de Alicante, Spain
José Massa	Universidad de Buenos Aires, Argentina
Rafael Medina-Carnicer	University of Córdoba, Spain
Marcos Mejía	Universitat de Barcelona, Spain
Belén Melián	Universidad de La Laguna, Spain
Pedro Meseguer	IIIA - CSIC, Spain
Eva Millán	University of Malaga, Spain
José M. Molina	Universidad Carlos III de Madrid, Spain
Miguel Molina Solana	University of Granada, Spain
Susana Montes	University of Oviedo, Spain
Serafín Moral Callejón	Universidad de Granada, Spain
Rafael Morales-Bueno	University of Malaga, Spain
Bhalaji Nagarajan	Universitat de Barcelona, Spain
José Fernando Núñez	Universitat de Barcelona, Spain
Manuel Ojeda-Aciego	University of Malaga, Spain
José Ángel Olivas	UCLM, Spain
Eva Onaindia	Polytechnic University of Valencia, Spain
Sascha Ossowski	University Rey Juan Carlos, Spain
Francisco Parreño	Universidad de Castilla-La Mancha, Spain
Miguel Ángel Patricio	Universidad Carlos III de Madrid, Spain
Juan Pavón Mestras	Universidad Complutense de Madrid, Spain
David Pearce	Universidad Politécnica de Madrid, Spain
Antonio Peregrín	University of Huelva, Spain
Giuseppe Pezzano	Universitat de Barcelona, Spain
Filiberto Pla	University Jaume I, Spain
Héctor Pomares	University of Granada, Spain

José M. Puerta	Universidad de Castilla-La Mancha, Spain
José Luis Pérez de la Cruz Molina	University of Malaga, Spain
Camino R. Vela	University of Oviedo, Spain
Petia Radeva	Universitat de Barcelona and Computer Vision Center, Spain
José C. Riquelme	University of Seville, Spain
Ramón Rizo	Universidad de Alicante, Spain
Javier Rodenas	University of Barcelona, Spain
Rosa Rodríguez	University of Jaén, Spain
Paolo Rosso	Universitat Politècnica de València, Spain
Antonio Salmerón	University of Almería, Spain
Luciano Sánchez	Universidad de Oviedo, Spain
José Salvador Sánchez	Universitat Jaume I, Spain
Estela Saquete	University of Alicante, Spain
Encarna Segarra	Universitat Politecnica de Valencia, Spain
Emilio Soria	University of Valencia, Spain
Estefanía Talavera	University of Groningen, The Netherlands
Alicia Troncoso	Pablo de Olavide University, Spain
L. Alfonso Ureña-López	University of Jaén, Spain
Rafael Valencia-García	Universidad de Murcia, Spain
Sebastián Ventura	University of Córdoba, Spain
José Luis Verdegay	University of Granada, Spain
Mourad Zaied	RTIM-Lab, University of Gabes, Tunisia

# Contents

## Machine Learning

Prediction of Epiretinal Membrane from Retinal Fundus Images Using Deep Learning .....	3
<i>Ángela Casado-García, Manuel García-Domínguez, Jónathan Heras, Adrián Inés, Didac Royo, and Miguel Ángel Zapata</i>	
LabelDetection: Simplifying the Use and Construction of Deep Detection Models .....	14
<i>Ángela Casado-García and Jónathan Heras</i>	
A Proposal to Integrate Deep Q-Learning with Automated Planning to Improve the Performance of a Planning-Based Agent .....	23
<i>Carlos Núñez-Molina, Ignacio Vellido, Vladislav Nikolov-Vasilev, Raúl Pérez, and Juan Fdez-Olivares</i>	
ReLU-Based Activations: Analysis and Experimental Study for Deep Learning .....	33
<i>Víctor Manuel Vargas, David Guijo-Rubio, Pedro Antonio Gutiérrez, and César Hervás-Martínez</i>	
Studying the Effect of Different $L_p$ Norms in the Context of Time Series Ordinal Classification .....	44
<i>David Guijo-Rubio, Víctor Manuel Vargas, Pedro Antonio Gutiérrez, and César Hervás-Martínez</i>	
STree: A Single Multi-class Oblique Decision Tree Based on Support Vector Machines .....	54
<i>Ricardo Montañana, Jose A. Gámez, and Jose M. Puerta</i>	
Deep Reinforcement and Imitation Learning for Self-driving Tasks .....	65
<i>Sergio Hernández-García and Alfredo Cuesta-Infante</i>	
Human Activity Recognition with Capsule Networks .....	75
<i>Laura Llopis-Ibor, Alfredo Cuesta-Infante, Cesar Beltran-Royo, and Juan José Pantrigo</i>	
Towards Fairness in Classification: Comparison of Methods to Decrease Bias .....	86
<i>Maitane Martinez-Eguiluz, Oier Irazabal-Urrutia, and Olatz Arbelaitz-Gallego</i>	

Hypothesis Scoring and Model Refinement Strategies for FM-Based RANSAC .....	96
<i>Alberto Ortiz, Esaú Ortiz, Juan José Miñana, and Óscar Valero</i>	
Evaluation of the Transformer Architecture for Univariate Time Series Forecasting .....	106
<i>Pedro Lara-Benítez, Luis Gallego-Ledesma, Manuel Carranza-García, and José M. Luna-Romera</i>	
<b>Optimization and Search</b>	
Automatic Generation of Interrelated Organisms on Virtual Environments .....	119
<i>Santiago Pacheco, Nicolas Ottonello, and Sergio Nesmachnow</i>	
Asynchronous Vector Iteration in Multi-objective Markov Decision Processes .....	129
<i>Ekaterina Sedova, Lawrence Mandow, and José-Luis Pérez-de-la-Cruz</i>	
Influence of the Alternative Objective Functions in the Optimization of the Cyclic Cutwidth Minimization Problem .....	139
<i>Sergio Cavero, Eduardo G. Pardo, and Abraham Duarte</i>	
A Similarity Measure of Gaussian Process Predictive Distributions .....	150
<i>Lucía Asencio Martín and Eduardo C. Garrido-Merchán</i>	
Towards Automatic Bayesian Optimization: A First Step Involving Acquisition Functions .....	160
<i>Luis C. Jariego Pérez and Eduardo C. Garrido Merchán</i>	
Solving the Permutation Heijunka Flow Shop Scheduling Problem with Non-unit Demands for Jobs .....	170
<i>Joaquín Bautista-Valhondo</i>	
<b>Real-World Applications</b>	
Nearest Neighbors-Based Forecasting for Electricity Demand Time Series in Streaming .....	185
<i>L. Melgar-García, D. Gutiérrez-Avilés, C. Rubio-Escudero, and A. Troncoso</i>	
Towards Combining Object Detection and Text Classification Models for Form Entity Recognition .....	196
<i>María Villota, Gonzalo Santamaría, César Domínguez, Jónathan Heras, Eloy Mata, and Vico Pascual</i>	

<b>A Collaborative Platform for the Detection of Non-inclusive Situations in Smart Cities</b> .....	206
<i>Alfonso González-Briones, Iván García-Magariño, Jorge J. Gómez-Sanz, Rubén Fuentes-Fernández, and Juan Pavón</i>	
<b>Electricity Consumption Time Series Forecasting Using Temporal Convolutional Networks</b> .....	216
<i>J. F. Torres, M. J. Jiménez-Navarro, F. Martínez-Álvarez, and A. Troncoso</i>	
<b>Recognition of Teaching Activities from University Lecture Transcriptions</b> ....	226
<i>Daniel Diosdado, Alberto Romero, and Eva Onaindia</i>	
<b>Train Route Planning as a Multi-agent Path Finding Problem</b> .....	237
<i>Mauricio Salerno, Yolanda E-Martín, Raquel Fuentetaja, Alba Gragera, Alberto Pozanco, and Daniel Borrajo</i>	
<b>Citizen Centric Optimal Electric Vehicle Charging Stations Locations in a Full City: Case of Malaga</b> .....	247
<i>Christian Cintrano, Jamal Toutouh, and Enrique Alba</i>	
<b>Modeling Administrative Discretion Using Goal-Directed Answer Set Programming</b> .....	258
<i>Joaquín Arias, Mar Moreno-Rebato, Jose A. Rodríguez-García, and Sascha Ossowski</i>	
<b>Author Index</b> .....	269