



# IEOM Society

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## **2024 IEOM Awards – 7<sup>th</sup> European Conference on Industrial Engineering and Operations Management Augsburg, Germany, July 16-18, 2024**

### **Distinguished Academic Leadership Award**

Prof. Dr. Nadine  
Vice President  
Technical University of Applied Sciences Augsburg

### **Distinguished Industry Leadership Award**

Roland Jenning  
Senior Vice President  
Digital Solutions  
Grenzebach

Heike Homann  
Vice President of Operations Strategy  
Airbus Helicopters  
Donauwörth, Germany

### **Distinguished Industry Achievement Award**

Dr. Vasko Isakovic  
Head of KUKA Simulation Business in the KUKA Robotics Group  
Kuka AG  
Augsburg, Bavaria, Germany

Dr. Max Dinkelmann  
Senior Inhouse Consultant  
TRUMPF Laser- und Systemtechnik GmbH

### **Outstanding Professor Award in Digitalization of Forming Technology**

Dr.-Ing. Philipp Frey  
Researcher  
Technische Hochschule Nürnberg Georg Simon Ohm  
Nürnberg, Germany

### **Outstanding Professor Award in production technology and operations**

Dr.-Ing. Stefan Braunreuther  
Faculty of Mechanical and Process Engineering  
Technical University of Applied Science Augsburg  
Augsburg, Bavaria, Germany

### **Outstanding Professor Award in production automation**

Dr. Florian Kerber  
Faculty of Electrical Engineering  
Technical University of Applied Science Augsburg  
Augsburg, Bavaria, Germany

### **Outstanding Professor in Reliability and Maintainability Engineering**

Dr. Pardeep Gupta  
Professor  
Department of Mechanical Engineering  
Sant Longowal Institute of Engineering and Technology  
Longowal, Sangrur (Punjab), India

**Outstanding Professor in Supply Chain and Logistics**

Dr. Anthony Afful-Dadzie  
Head  
Department of Operations Management and Information Systems  
University of Ghana Business School  
Accra, Ghana

**Outstanding Teaching and Learning Award**

Imad Amine  
Head of Industrial Engineering Technology Program  
American College of the Middle East  
Eqaila, Kuwait

**Outstanding Research Award**

Prof. Dr. Carsten Hahn  
Senior Director of SAP  
Research Professor of Karlsruhe University of Applied Science

**Outstanding Researcher in Operations Management Award**

Dr. Emmanuel Innocents Edoun  
Associate Professor  
Department of Quality & Operations Management  
Faculty of Engineering and the Built Environment  
University of Johannesburg, South Africa

**Data Analytics Award**

Dr. Semir Maslo  
Head of Product Management  
Big Data in Manufacturing GmbH  
Germany

**Global Supply Chain Management Award**

Simon Heck  
Manufacturing Engineering Director EMEA  
TI Fluid Systems  
Rastatt, Germany

**Global AI in Manufacturing Award**

Dr. Steffen Klarmann  
Advanced Development Director Manager  
Valeo SA  
Wemding, Germany

**Global AI and Machine Learning Award**

Klaus Spindler  
Director of Artificial Intelligence  
Forvia  
Nuremberg, Bavaria, Germany

**Global Lean Six Sigma Award**

Dr.-Ing. Roman Ungern-Sternberg  
Team Lead Operational Excellence  
Fraunhofer Institute for Manufacturing Engineering and Automation  
Stuttgart, Germany

**Innovation Award**

Felix Georg Müller  
CEO and Co-Founder  
Plus10 GmbH  
Augsburg, Bavaria, Germany

**Rising Star Award**

C. Vigneshkumar, PhD (IIT Guwahati)  
Postdoc Fellow  
The Hong Kong Polytechnic University, Hong Kong

**IEOM Society Appreciation Award**

Dr. Takaaki Kawanaka  
Associate Professor  
Graduate School of Engineering  
The University of Tokyo  
Tokyo, Japan

Dr. Laoucine Kerbache  
Professor  
Division of Logistics and Supply Chain Management  
College of Science and Engineering  
Hamad bin Khalifa University  
Qatar

**Outstanding Leadership Award**

Prof. Dr. Jürgen H. Lenz  
Research Professor  
Department of Mechanical Engineering  
Technical University of Applied Sciences Augsburg  
Germany

**Outstanding Conference Service Award**

Teresa Herzgsell, Technical University of Applied Sciences Augsburg, Germany  
Alexandra Klein, Technical University of Applied Sciences Augsburg, Germany  
Jessica Hövelborn, Technical University of Applied Sciences Augsburg, Germany

**Outstanding Student Research Award**

WANG Nannan  
IESEG School of Management  
Univ. Lille, CNRS  
LEM – Lille Economie Management,  
Lille, France

**Faculty Advisor Award:**

Dr. Simone Kubowitsch  
Professor for Personnel Psychology  
School of Business  
Technical University of Applied Sciences Augsburg  
Augsburg, Germany

**Outstanding Student Award**

President: Joshua Braun  
Director of Social Media: Kathrin Polly  
Director of Program/Activities: Natalie Hogh  
Director of Membership: Sabrina Meyer  
Director of Communication: Erik Bußjäger

## Competition Winners

### Undergraduate Student Paper Competition sponsored by Siemens - Online

#### First Place

**ID 156 Mental Health Chatbot for University Students Support and Encouragement**

Tauro Tapiwa, Sibusisiwe Dube and Belinda Mutunhu Ndlovu, National University of Science and Technology, Bulawayo, Zimbabwe

#### Second Place

**ID 190 Optimization of Inventory Management in the Peruvian Pharmaceutical Industry through Lean Supply Chain Management Methodology in the Post-Pandemic Context**

Daniela Nicoll Contreras-Alva, Bachelors in Industrial Engineering, Faculty of Engineering, Universidad de Lima, Peru  
Pedro Gustavo Buleje-Castañeda, Bachelors in Industrial Engineering, Faculty of Engineering, Universidad de Lima, Peru  
Martín Fidel Collao-Díaz, Research Professor, Faculty of Engineering, Universidad de Lima, Peru

#### Third Place

**ID 216 Optimizing Operational Efficiency in Automotive Maintenance SMEs through PDCA Integration and Systematic Layout Planning**

Daniel García Calderón-Mendoza-del-Solar, Bachelors in Industrial Engineering, Faculty of Engineering, Universidad de Lima, Peru  
Miguel Caleb Montoya-Nunez, Bachelors in Industrial Engineering, Faculty of Engineering, Universidad de Lima, Peru  
Martín Fidel Collao-Díaz, Research Professor, Faculty of Engineering, Universidad de Lima, Peru

### Undergraduate Student Paper Competition sponsored by Siemens - Onsite

#### First Place

**ID 173 Evaluating Team Workload Through Physiological Synchrony: An Exploratory Study Using MdrQA Data to Assess Teams in Action**

Joshua Braun, Natalie Hogh and Simone Kubowitsch, Department of Business Psychology, Technical University of Applied Sciences Augsburg, Augsburg, Bavaria, Germany

### Undergraduate Research Competition sponsored by Daikin Applied - Online

#### First Place

**ID 215 Optimization of the Clothing Production Line in Peruvian SMEs through the Implementation of Lean Manufacturing: A Case Study**

Santiago Bravo de Rueda-Alarcon, Bachelors in Industrial Engineering, Faculty of Engineering, Universidad de Lima, Peru  
Martín Fidel Collao-Díaz, Research Professor, Faculty of Engineering, Universidad de Lima, Peru

#### Second Place

**ID 219 Enhancing Operational Efficiency in Craft Beer Production: Implementation of Lean Manufacturing and TPM Methodologies in SMEs**

Ronald Wilmer Perez-Peralta, Bachelors in Industrial Engineering, Faculty of Engineering, Universidad de Lima, Peru  
Adonis Meza-Estrada, Bachelors in Industrial Engineering, Faculty of Engineering, Universidad de Lima, Peru  
Martín Fidel Collao-Díaz, Research Professor, Faculty of Engineering, Universidad de Lima, Peru

#### Third Place

**ID 79 Loan Eligibility System Using Machine Learning**

Alpha Zimkhulu Mnkandla, Belinda Ndlovu, Sibusisiwe Dube, Martin Muduva and Fungai Jacqueline Kiwa, Department of Informatics and Analytics, National University of Science and Technology, Bulawayo, Zimbabwe

### Graduate Student Paper Competition sponsored by Eaton - Online

#### First Place

**ID 269 Manufacturing Defect Mitigation with Cognitive Intelligent Case-based Reasoning Using Generative Artificial Intelligence and Knowledge Graphs**

Shu Wang, Chenxi Tao, Mulang Song, Yiyun (Cindy) Fei and Liuyang Shan, School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA, USA  
Jianxin (Roger) Jiao, Associate Professor of School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA 30332, USA

**Second Place**

**ID 277 The Sustainability Triangle for Urban Forest Development in the Capital City of the Indonesian Archipelago**

Yenita, Roesdiman Soegiarso and Oei Fuk Jin, Faculty of Engineering, Universitas Tarumanagara, Letjen S. Parman No. 1, West Jakarta, Indonesia

**Third Place**

**ID 196 Bloque en Sistema Braille**

Brenda Cotrina, Industrial Engineering Students, University of Lima, Lima, Perú, University of Lima, Lima, Av. Javier Prado Este 4600, Peru  
Andrea Reyes, Industrial Engineering Students, University of Lima, Lima, Perú, University of Lima, Lima, Av. Javier Prado Este 4600, Peru  
Dr. Fabricio Paredes, Researcher at the Fablab Manufacturing Laboratory, University of Lima, Lima, Perú

## **Graduate Student Paper Competition sponsored by Eaton - Onsite**

**First Place**

**ID 214 The Benefits of Adopting Fourth Industrial Revolution (4IR) Technologies in Higher Education Institutions (HEIs)- a Case of South African Institutions**

Thalente Nkosi, Department of Construction Management, Nelson Mandela University of Technology, Gqeberha, RSA  
Bogolo Ntombela and Morena Nkomo, Department of Construction Management and Quantity Surveying, University of Johannesburg, Johannesburg, RSA  
Sibongile Dlamini, Department of Civil Engineering, Durban University of Technology, Pietermaritzburg, RSA  
Lungisile Hlophe, Department of Construction Management and Quantity Surveying, Mangosuthu University of Technology, Durban, RSA

**Second Place**

**ID 265 Process Mining: Crane Efficiency at Webcor**

Jacob Odisho, Nick Amireh, Phil Sites, Willem Holzrichter, and Sagit Kedem-Yemini, Industrial and Manufacturing Engineering Department, California Polytechnic State University, San Luis Obispo, CA 93407, USA

**Third Place**

**ID 161 Estimation of Global Horizontal Irradiance in Tustin, California, Using several Deep-learning Approaches**

Fathy Alkhatib, Maher Maalouf and Mohammad Omar, Department of Industrial and Systems Engineering, Khalifa University, Abu Dhabi, United Arab Emirates

## **Doctoral Dissertation Competition sponsored by Airbus**

**First Place**

**ID 209 Innovative Approaches to Knowledge Management: The Role of Novices in Knowledge-Intensive Maintenance Environments**

Hamid Roham and Jorge F.S. Gomes, Lisbon School of Economics and Management, University of Lisbon, Portugal

**Second Place**

**ID 225 Designing a Knowledge-based System to Facilitate the Process of Fall Risk Assessment in Construction**

Vigneshkumar Chellappa, Postdoctoral Researcher, School of Design, The Hong Kong Polytechnic University, Kowloon, Hong Kong  
Urmi Ravindra Salve, Associate Professor, Department of Design, Indian Institute of Technology, Guwahati 781039, India

**Third Place**

**ID 11 Reasons why people start small scale mining companies in South Africa**

Zandisile Mkubukeli, University of Johannesburg, South Africa  
Emmanuel Edoun, University of Johannesburg, South Africa

## **Masters Thesis Competition - Online**

**First Place**

**ID 76 Investigating the factors driving the adoption of smart helmets in mining operations by artisanal miners in Zimbabwe**

Kwanele Ruth Ndlovu, Philip Nyoni, Belinda Mutunhu Ndlovu, Sibusisiwe Dube and Samukeliso Sukoluhle Dube, National University of Science and Technology, Bulawayo, Zimbabwe

**Second Place**

**ID 271 GAI-based Intelligent Cognitive Assistant for Urban Rideshare Safety Recommendation Services**

Chenxi Tao, Roosan Liyons, Roger J. Jiao and Seung-Kyum Choi, School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA, USA

**Third Place**

**ID 155 A Framework for adopting AI Chatbots: A case Zimbabwe's Non-Governmental Organizations**

Macdonald Dube, Sibusisiwe Dube and Belinda Mutunhu Ndlovu, National University of Science and Technology, Bulawayo, Zimbabwe

## **Masters Thesis Competition - Onsite**

**First Place**

**ID 227 Leveraging Blockchain to Track and Improve the Sustainability of Shared Economy Models. A Platform for Shared Last-Mile Delivery**

Omar S. Abdulkarim, Department of Industrial Engineering, American University of Sharjah, Sharjah, UAE

Malick Ndiaye, Department of Industrial Engineering, American University of Sharjah, Sharjah, UAE

**Second Place**

**ID 139 Integration of Social Media into Supply Chain Management: Antecedents and Value Outcomes from a Case Study Perspective**

Emmanuel Doe Oposika Aggudey and Joshua Ofori-Amanfo, MPhil Candidate and Senior Lecturer, Department of Operations and

Management Information Systems, University of Ghana Business School, PO Box LG 78, Legon, Accra, Ghana

Yaa Amponsah Twumasi, Lecturer, Faculty of Management Studies, Dept. of Marketing, University of Professional Studies, Accra, Ghana

**Third Place**

**ID 176 Predicting Glass Forming Ability (GFA) of Metallic Glasses Using Machine Learning Techniques**

Abu-Salah S. Fahid and Dr. Maalouf. Elsa, Maroun Semaan Faculty of Engineering and Architecture, American University of Beirut (AUB),

Beirut, Lebanon

## **Simulation Competition**

**First Place**

**ID 266 An Integrated Approach to Formulate Win-Win Strategies in Retail Banking, A Simulation-Machine Learning-Optimization Approach to Make Portfolio of Loan-Based Products**

Mahdi Bastan, Graduate School of Management and Economics, Sharif University of Technology, Tehran, Iran

Ali Ghazizadeh, School of Industrial Engineering, Iran University of Science and Technology, Tehran, Iran

Mahdi Hamid, School of Industrial Engineering, College of Engineering, University of Tehran, Tehran, Iran

**Second Place**

**ID 107 Designing a Smart System for Predicting Carbon Dioxide Emissions from Traditional Wood-Fired Heating in Homes During the Winter Season**

Rasha A Al-Shamrani, Mona H Alfweah, Doha A Al-Alatiq, Tasnim M Adi, Almaha B AlKhabti and Wejdan H Alkhathami, Undergraduate

Student in Industrial Engineering Department, College of Engineering, University of Bisha, Bisha 61922, Saudi Arabia

Khaled Ali Abuhasel, Full Professor in Industrial Engineering, Department, College of Engineering, University of Bisha, Bisha, Saudi Arabia

**Third Place**

**ID 220 Manufacturing Facility Simulation Using Tecnomatix PLM by Siemens**

Abbas Jamal, Abdullah Malallah and Mahmoud AlShatti, Student, American College of the Middle East, Eqaila, Kuwait

Imad Amine, Head of Industrial Engineering Technology Program, American College of the Middle East, Eqaila, Kuwait

## **Human Factors and Ergonomics Competition sponsored by CINTAS - Online**

**First Place**

**ID 228 Prevalence of Musculoskeletal Disorders and Postural Analysis in Puffed Rice Industry**

Qutubuddin Syed Mohammed, P.D.A. College of Engineering, India

**Second Place**

**ID 218 Design of an Ergonomic Back Support to Prevent Lumbar Injuries**

Gino Leonardo Solis-Sparrow, Facultad de Ingeniería, Carrera de Ingeniería Industrial, Universidad de Lima, Lima, Perú

Jair Dario Angeles-Morales, Facultad de Ingeniería, Carrera de Ingeniería Industrial, Universidad de Lima, Lima, Perú

Marcos Fernando Ruiz-Ruiz, Associate Professor, Facultad de Ingeniería, Carrera de Ingeniería Industrial, Universidad de Lima, Lima, Perú  
Óscar Eduardo Sakay-Rodríguez, Advisor, Kansei Analytics, 10833 Hillrose Ave, Baton Rouge, LA 70810, USA

#### **Third Place**

**ID 175 A framework to incorporate Health 4.0 in an operating theatre: Case study of Zimbabwe's Central Hospitals**

Winnie Mutenhabundo, Department of Industrial and Mechatronics Engineering, University of Zimbabwe, Mt Pleasant, Harare, Zimbabwe.  
Tawanda Mushiri, Executive Director – Technical, Scientific and Industrial Research and Development Centre (SIRDC), Harare, Zimbabwe  
Biomedical Engineering and Healthcare Technology (BEAHT) Research Centre, Faculty of Health Sciences, University of Johannesburg, South Africa

Patson Zvandasara, Department of Physics, University of Zimbabwe, P.O Box MP167, Mt Pleasant, Harare, 263, Zimbabwe  
Timothy Gutu, Department of Obstetrics & Gynecology, University of Zimbabwe, P.O Box MP167, Mt Pleasant, Harare, 263, Zimbabwe  
Charles Mbohwa, Distinguished Professor, University of South Africa, College of Science, Engineering and Technology, Roodepoort

## **Human Factors and Ergonomics Competition sponsored by CINTAS - Onsite**

#### **First Place**

**ID 109 The Potential of Integrated Workload Measures in Production**

Simone Kubowitsch, School of Business, Technical University of Applied Sciences Augsburg, Augsburg, Bavaria, Germany  
Peter Cocron, Faculty of Liberal Arts and Sciences, Technical University of Applied Sciences Augsburg, Augsburg, Bavaria, Germany

#### **Second Place**

**ID 35 Unlocking the SME Advantage: Prioritising Optimisation Before Automation for Small-Scale Manufacturers**

Joshua Denning and Kapila Liyanage, College of Science of Engineering, University of Derby, United Kingdom

#### **Third Place**

**ID 212 Human Reliability Analysis for Multi-Unit Small Modular Reactors: Challenges and Insights**

Ibrahim A. Alrammah, Research, Development and Innovation Authority, Riyadh, Saudi Arabia

**ID 150 The Voice of the Patient: Exploring How VOC and CTQ Enhance Healthcare Service Quality**

Michael Osei, MBA (TQM), Michael Harnar, Ph.D., Akorfa Wuttor DBA and Michelle Rincones-Rodríguez B.S., Organisational and Social Psychology, London School of Economics and Political Science, Houghton Street, London WC2A 2AE, United Kingdom

## **Lean Six Sigma Competition sponsored by Tooling Tech Group**

#### **First Place**

**ID 268 Using Lean Tools in Warehouse Improvement: A Case Study from Electronics Retail Sector**

Noha A. Mostafa, Associate Professor, The British University in Egypt, Shorouk, Cairo, Egypt and Zagazig University, Zagazig, Sharkia, Egypt  
Youssef Essam, Graduate, The British University in Egypt, Shorouk, Cairo, Egypt

#### **Second Place**

**ID 251 Application of Lean Six Sigma in Inventory Optimization at a Water and Electricity Company**

Mohamed A. Allam, Afnan Al Hemeiri, Roda Al Marzooqi, Maryam Al Ameri and Saed Amer, Department of Management Science and Engineering, College of Engineering, Khalifa University, Abu Dhabi, UAE

#### **Third Place**

**ID 193 Six Sigma in Revolutionising and Improving Revenue Collection; Case of Hare Polytechnic in Zimbabwe**

Wilson Takavadii Nyamanhindi, Head of School of Office Management, Harare Polytechnic, Zimbabwe  
Dorcas Mutizhe, Accounting Assistant, Harare Polytechnic, Zimbabwe

**ID 267 Process Optimization in Industrial Engineering through the Implementation of Lean Manufacturing: A Comprehensive Approach to Efficiency and Continuous Improvement**

Héctor Vega, Facultad de Ingeniería, Universidad Ricardo Palma, Lima, Surco 15039, PERÚ  
Mario Chauca, Grupo de Investigación en Ingeniería para la Ciencia y la Tecnología, (ERSTECH) Universidad Ricardo Palma, Lima, PERÚ

## **High School STEM Competition**

#### **First Place**

**ID 272 Design of a Situation-Aware Intelligent Cognitive Assistant for Urban Rideshare Safety Using Deep Visual Learning and Ambient Data Analytics**

Roosan Liyons, Chenxi Tao and Roger J. Jiao, School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA, USA

**Second Place**

**ID 92 Sci-fi Skylines: Investigating the influence of Dune on Dubai's Urban Landscape**  
Alexander Wong, St Patrick's School, Singapore, Singapore

**Third Place**

**ID 243 Application of artificial intelligence in healthcare field Cases and Trends**  
Kim See You and Shin Dong Ho, Graduate and Professor, My Paul School, 12-11, Dowontongmi-gil, Cheongcheon-myeon, Goesan-gun, Chungcheongbuk-do, Republic of Korea  
Jeongwon Kim, Department of Economics, College of Economics, Nihon University, 1-chome, Chiyoda-ku, Tokyo, Japan

## **Supply Chain and Logistics Competition - Online**

**First place**

**ID 135 Robust Optimization for Cost Validation in Designing Service Networks**  
Ashish Chandra, College of Business, Illinois State University, Normal, IL 61761, USA

**Second Place**

**ID 157 Strengthening National Defense: Military Supply Chains with PARDS Integration in the Philippine Army's Requisition Process**  
LTC Alan P. Sillacay (OS) PA, LTC Erasto Gallardo (INF) PA and MAJ Carlo Dendiego (FS) PA, Master of Logistics and Supply Chain Management, Graduate Studies, Technological Institute of the Philippines, Quezon City Philippines, Military Servicemen, Philippine Army Fort Bonifacio, Taguig City, Philippines  
Cherry D. Casuat, Julius S. Cansino and Arvin De La Cruz, Professor, Computer Engineering, Polytechnic University of the Philippines, Professor, Graduate School of Engineering, Polytechnic University of the Philippines, Sta. Mesa, Manila, Philippines

**Third Place**

**ID 195 Risk Management in The Corn Commodity Supply Chain as a Raw material For Sustainable Poultry Feed: a Systematic Literature Review**  
Kulsum, Research Student, Graduate Program of Agro-industrial Engineering, Faculty of Agricultural Engineering and Technology IPB University, Bogor, Indonesia  
Anas Miftah Fauzi, Illah Sailah, Ono Suparno and Hoetomo Lembito, Research Professor, Department of Agro-industrial Technology, Faculty of Agricultural Engineering and Technology IPB University, Bogor, Indonesia

## **Supply Chain and Logistics Competition - Onsite**

**First Place**

**ID 132 Inventory Flow of Subscription-Based Business Models with Circular Economy Practices**  
Behzad Maleki Vishkaei, Department of Management and Technology, Bocconi University, Milan, Italy  
Pietro De Giovanni, SDA Bocconi School of Management, Milan, Italy

**Second Place**

**ID 201 Uncertain Supply of Recycled Plastic in Closed-Loop Supply Chain: Challenges and Mitigation Strategies for Plastic Circular Economy**  
Muhammad Omair and Brian Vejrum Wæhrens, Department of Materials and Production, Aalborg University | Fibigerstræde, Aalborg, Denmark

**Third Place**

**ID 163 Disruptive Innovation in Space Economy Supply Chains: Analyzing Advanced Manufacturing for Sustainability and Resilience**  
Janne Heilala, Dept. of Mech and Mat Eng., Faculty of Tech, University of Turku, Turku, Finland

## **Poster Competition**

**First Place**

**ID 3 Evaluating AI-based Automatic Replenishment for Medical Devices in Vendor Managed Inventory**  
Nai-Chuan Fang, Taichung Veterans General Hospital, Taiwan

**Second Place**



**ID 222 Used products reuse or material recovery? Interactions between OEMs and TPRs under environmental regulations**

Nannan WANG and Linda L. ZHANG, IESEG School of Management, Univ. Lille, CNRS, LEM – Lille Economie Management, Lille, France

**Third Place**

**ID 221 Towards Enabling MQTT for Real-Time Internet of Things**

Abdelmajid Khelil, Michael Deller and Lobna Badraoui, Landshut University of Applied Sciences, Institute for Data and Process Science, Am Lurzenhof 1, D-84036 Landshut, Germany

**ID 134 Strong Perturbation Bounds for Markov Chains**

Nabil Ait Yala, Faculté des Sciences et Sciences Appliquées, University of Bouira, Bouira, Algeria

Badredine Issaadi, Ecole Supérieure en Sciences et Technologies de l'Informatique et du Numérique, Campus Amizour, Bejaia, Algeria

Karim Abbas, Faculté des Sciences Exactes, University of Bejaia, Bejaia, Algeria