

# Conference Abstract

## 2023 13th International Conference on Software Technology and Engineering (ICSTE 2023)

### Workshops

2023 6th International Conference on Frontiers of Image  
Processing  
(ICFIP 2023)

2023 2nd International Conference on Video and Signal  
Processing  
(ICVSP 2023)

October 27-29, 2023

Osaka, Japan  
Virtual Conference

Technical Supporter



**AJEENKYA**  
D Y PATIL UNIVERSITY  
THE INNOVATION UNIVERSITY

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## Conference Chairs

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Chi Man Pun, University of Macau, China

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Branislav Vuksanovic, University of Portsmouth, UK

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Omar Portillo, Technological University Dublin, Ireland

William P. Rey, Mapua University, Philippines

Mahirah Jahari, Universiti Putra Malaysia, Malaysia

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Sirikan Chucherd, Mae Fah Luang University, Thailand  
Alessandro Bruno, IULM University, Italy  
Yahui Peng, Beijing Jiaotong University, China  
Bok-Min Goi, Universiti Tunku Abdul Rahman, Malaysia  
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Yuanyao Lu, North China University of Technology, China  
Qiu Chen, Kogakuin University, Japan  
P.J. Herrera, UNED, Spain  
Suraiya Jabin, Jamia Millia Islamia, India  
Narendra D. Londhe, National Institute of Technology, India  
Somkait Udomhunsakul, Rajamangala University of Technology Suvarnabhumi, Thailand  
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Houssain Kettani, Dakota State University, USA  
Kun Hua, Lawrence Technological University, USA  
Jun Qin, Southern Illinois University, USA  
Brian Kelley, The University of Texas at San Antonio, USA  
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Gautam Dasarathy, Arizona State University, USA  
Shenghui SONG, The Hong Kong University of Science and Technology, China

# Conference Committee



Chik Patrick YUE, The Hong Kong University of Science and Technology, China

B. Hunyadi, Technische Universiteit Delft, Netherlands

C. Varon, Technische Universiteit Delft, Netherlands

AHMED K. SULTAN SALEM, King Abdullah University of Science and Technology, Saudi Arabia

# Welcome Message



Welcome to attend 2023 13th International Conference on Software Technology and Engineering (ICSTE 2023) and its workshops 2023 6th International Conference on Frontiers of Image Processing (ICFIP 2023) and 2023 2nd International Conference on Video and Signal Processing (ICVSP 2023) virtually.

The conference aims to provide a forum for researchers, practitioners, and professionals from the industry, academia and government who are working in the fields of software technology and engineering, image processing and video and signal processing to have an active discourse on research and development, as well as professional practice in related fields.

This year, we have received a good number of high-quality submissions from both academia and industry. All submitted papers have been carefully peer-reviewed and highest-quality papers were accepted. Conference participants come from Austria, Kuwait, Germany, USA, Turkey, Japan, Thailand, Egypt, Pakistan, Philippines, and other countries.

The conference program features keynote session, technical and paper presentations. Distinguished speakers were invited to deliver keynote speeches on conference. Attendees will have the opportunity to interface with experts from all related fields. The conference serves as an international forum for exchanging ideas, presenting advances in the state of the art, identifying emerging research topics, and defining the future trends of these exciting research domains.

We are honored to have invited excellent world-class keynote speakers. They are all leading experts in the research areas close to our conference theme. We are sure that all the attendees will be inspired and benefitted by their speeches. We are also confident that today's conference will become a thought-provoking forum for attendees from both academia and industry to share ideas, exchange experiences, discuss challenges, and report the state-of-the-art contributions.

On behalf of the Program and Organizing committees, we thank the authors very much for submitting their papers to the conference and allowing us to build a program of high quality. We greatly appreciate the support of everyone including the keynote speakers, session chairs, committee members, reviewers, and staff members for their great effort in making this conference a successful scientific event.

With warmest regards,

**Conference Chair**

**Prof. Dr. habil. Sergei Gorlatch**

**University of Muenster, Germany**

## Time Zone

Tokyo Time, UTC/GMT+9



**ZOOM Download:** <https://zoom.us/>

ZOOM Using Instruction and silde template: <http://www.icste.org/kits.rar>

- ✧ ZOOM online conference room will be open 30 mins before scheduled time.
- ✧ It's suggested to use headset with microphone or earphone with microphone.
- ✧ Please choose right room to join in while test and presentation session.
- ✧ Prepare the PPT file of your presentation on your laptop in advance.
- ✧ Duration of Each Presentation: 15 Minutes in total including 12 Minutes Presentation and 3 Minutes Q&A.
- ✧ The regular oral presentation time arrangement is for reference only. In case any absence or some presentations are less than 15 minutes, please enter the room before session starts.

### **Please rename your screen name before entering the room**

<b>Rename screen name before entering the room</b>	<b>Examples</b>
<b>Authors: Paper ID-Name</b>	<b>RB001-John Smith</b>
<b>Listener: Listener- Name</b>	<b>Listener-John Smith</b>
<b>Keynote Speaker: Keynote-Name</b>	<b>Keynote-John Smith</b>
<b>Committee Member: Committee-Name</b>	<b>Committee-John Smith</b>

**October 28, 2023, Saturday, 9:35-10:15, Tokyo Time, GMT+9**

Zoom Link: <https://us02web.zoom.us/j/82384066616>

Zoom ID: 823 8406 6616

Password: 23102729



## **Prof. Witold Pedrycz**

IEEE Life Fellow

**University of Alberta, Canada**

### **Speech Title: Credibility, Data Privacy, and Energy Awareness: Advances in Machine Learning**

**Abstract:** Over the recent years, we have been witnessing spectacular achievements of Machine Learning with highly visible accomplishments encountered, in particular, in natural language processing and computer vision impacting numerous areas of human endeavours. Driven inherently by the technologically advanced learning and architectural developments, Machine Learning constructs are highly impactful coming with far reaching consequences; just to mention autonomous vehicles, control, health care imaging, decision-making in critical areas, among others.

We advocate that the design and analysis of ML constructs have to be carried out in a holistic manner by identifying and addressing a series of central and unavoidable quests coming from industrial environments and implied by a plethora of requirements of interpretability, energy awareness (being also lucidly identified on the agenda of green AI), efficient quantification of quality of ML constructs, their brittleness and conceptual stability coming hand in hand with the varying levels of abstraction. They are highly intertwined and exhibit relationships with the technological end of ML. As such, they deserve prudent attention, in particular when a multicriterial facet of the problem is considered.

The talk elaborates on the above challenges, offers definitions and identifies the linkages among them. In the pursuit of coping with such quests, we advocate that Granular Computing can play a pivotal role offering a conceptual environment and realizing algorithmic development. We stress and identify ways to effective assessments of credibility of ML constructs. As a detailed study, we discuss the ideas of knowledge transfer showing how a thoughtful and prudently arranged knowledge reuse to support energy-aware ML computing. We discuss passive and active modes of knowledge transfer. In both modes, the essential role of information granularity is identified. In the passive approach, information granularity serves as a vehicle to quantify the credibility of the transferred knowledge. In the active approach, a new model is constructed in the target domain whereas the design is guided by the loss function, which involves granular regularization produced by the granular model transferred from the source domain. A generalized scenario of multi-source domains is discussed. Knowledge distillation leading to model compression is also studied in the context of transfer learning.

**Bio:** Witold Pedrycz (IEEE Life Fellow) is Professor in the Department of Electrical and Computer Engineering, University of Alberta, Edmonton, Canada. He is also with the Systems Research Institute of the Polish Academy of Sciences, Warsaw, Poland. Dr. Pedrycz is a foreign member of the Polish Academy of Sciences and a Fellow of the Royal Society of Canada. He is a recipient of several awards including Norbert Wiener award from the IEEE Systems, Man, and Cybernetics Society, IEEE Canada Computer Engineering Medal, a Cajastur Prize for Soft Computing from the European Centre for Soft Computing, a Killam Prize, a Fuzzy Pioneer Award from the IEEE Computational Intelligence Society, and 2019 Meritorious Service Award from the IEEE Systems Man and Cybernetics Society.



# Keynote Speakers



His main research directions involve Computational Intelligence, Granular Computing, and Machine Learning, among others.

Professor Pedrycz serves as an Editor-in-Chief of Information Sciences, Editor-in-Chief of WIREs Data Mining and Knowledge Discovery (Wiley), and Co-editor-in-Chief of Int. J. of Granular Computing (Springer) and J. of Data Information and Management (Springer).

October 28, 2023, Saturday, 10:15-10:55, Tokyo Time, GMT+9

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## Prof. Shaoying Liu

IEEE Fellow, BCS Fellow, AAIA Fellow

Hiroshima University, Japan

### Speech Title: Agile Formal Engineering Method for High Productivity and Reliability

**Abstract:** With the rapid development and spreading applications of IoT systems and information systems, how to ensure software productivity and reliability has become a tremendous challenge to conventional software engineering. To overcome this challenge, we have developed the “Formal Engineering Methods” (FEM) as a research area since 1989 to study how formal methods can be effectively integrated into conventional software engineering technologies and process models so that formal techniques can be tailored, revised, or extended to fit the need for improving software productivity and reliability in practice (e.g., through the enhancement of the usability of formalism and the tool supportability of the relevant methods). As a result of our efforts, we have developed a specific FEM called Agile Structured Object-Oriented Formal Language (Agile-SOFL) that offers a Three-Step Specification Approach, Specification Animation for Validation, Incremental Specification-Based Implementation, and Specification-Based Testing techniques. In this talk, after reviewing the commonly used development methods, I will focus on the introduction of Agile-SOFL and explain how it can be used to improve software productivity and reliability. Finally, I will describe several important and new research directions and topics for future software engineering.

**Bio:** Shaoying Liu is a Professor of Software Engineering at Hiroshima University, Japan, IEEE Fellow, BCS Fellow, and AAIA Fellow. He received the Ph.D in Computer Science from the University of Manchester, U.K in 1992. His research interests include Formal Engineering Methods, Specification Verification and Validation, Specification-based Program Inspection, Automatic Specification-based Testing, Testing-Based Formal Verification, and Intelligent Software Engineering Environments. He has published a book entitled "Formal Engineering for Industrial Software Development" with Springer-Verlag, more than 13 edited books, and over 250 academic papers in refereed journals and international conferences. He proposed to use the terminology of "Formal Engineering Methods" in 1997 and has established Formal Engineering Methods as a research area based on his extensive research on the SOFL (Structured Object-Oriented Formal Language) method since 1989, and the development of ICFEM conference series since 1997. In recent years, he has served as the General Chair of QRS 2020 and ICECCS 2022 and PC member for numerous international conferences. He is an Associate Editor for IEEE Transactions on Reliability and Innovations of Systems and Software Engineering, respectively.

**October 28, 2023, Saturday, 11:10-11:50, Tokyo Time, GMT+9**

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## **Dr. Branislav Vuksanovic**

Associate Head of School for Research and Innovation

**University of Portsmouth, UK**

### **Speech Title: FER - Facial Expression Recognition - Advances and Challenges**

**Abstract:** Facial expression recognition stands at the intersection of computer vision, machine learning, and human-computer interaction, with applications ranging from emotion analysis to human-robot interaction. This talk will provide a journey through the dynamic landscape of facial expression recognition, from its foundational principles to current state-of-the-art techniques. It will also delve into unsolved problems that persist in this field such as adapting to diverse human expressions, robustness to variability and cross-database generalisation. Finally, it will try to shed a bit of light on the ongoing research efforts of the presenter in the problem of cross-database expression recognition, aiming to bridge the gap between training data and real-world scenarios.

**Bio:** Dr. Branislav Vuksanovic is an accomplished Electrical and Power Engineer, with a rich academic and professional background. He completed his undergraduate studies at the prestigious University of Belgrade, Serbia, and later earned his MSc degree in Measurement and Instrumentation from South Bank University in London, UK. He went on to earn his PhD in Active Noise Control from the University of Huddersfield, UK. Dr. Vuksanovic has an impressive career history, which includes working as a Project Engineer for the Croatian Electricity Board in Osijek, Croatia, and as a Research Fellow at Sheffield and Birmingham Universities. At the University of Derby, he served as a Lecturer and was a member of the Sensors and Controls Research Group. Currently, he holds the position of Associate Head of School for Research and Innovation at the University of Portsmouth, School of Energy and Electronic Engineering. He has authored numerous papers, including those in the areas of active noise control, biomedical signal processing, and pattern recognition for intrusion detection and knowledge-based authentication. He has also authored a book in the Digital Electronics and Microcontrollers field, and organized and chaired several international conferences and workshops. Dr. Vuksanovic currently serves as an Editor-In\_Chief for the Journal of Image and Graphics and is a member of the IET and ASR. His current research interests revolve around the application of pattern recognition techniques for power systems, acoustic noise analysis and the processing of ground-penetrating radar data.

October 28, 2023, Saturday, 13:30-14:10, Tokyo Time, GMT+9

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## Prof. Domenico Talia

Senior Member of ACM and IEEE Computer Society

University of Calabria, Italy

### Speech Title: Cloud Computing Frameworks for Data Science

**Abstract:** Cloud computing offers scalable services for addressing the computational and data storage needs of Big Data science applications and for implementing machine learning services. According to this approach, Cloud computing software frameworks can be efficiently used for supporting Data science applications and services. The three main service models, software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS), can be exploited for implementing Big Data analytics and machine learning tasks in the cloud for data science applications. This keynote discusses approaches, models, frameworks, and tools to be utilized in Cloud computing platforms for implementing Data science services. The talk presents the design of data analysis applications according to the data analytics as a service (DAaaS) model. Distributed data mining techniques and frameworks designed for developing service-oriented distributed data analysis applications on Clouds will be discussed. In particular, the talk discusses how to develop big data mining services using the Data Mining Cloud Framework. Data science software design and use-cases performance are illustrated. Open research issues and trends will be also outlined.

**Bio:** Domenico Talia is a full professor of computer engineering at the University of Calabria, Italy, an adjunct professor at Fuzhou University, China, and an Honorary professor at Noida University, India. He is a co-founder of the start-up DtoK Lab. His research interests include Big Data analysis, high-performance computing, parallel and distributed data mining algorithms, Cloud computing, distributed machine learning, social data analysis, peer-to-peer systems, and parallel programming models and languages. Domenico Talia has published 7 books and more than 400 papers in archival journals such as Communications of the ACM, IEEE TPDS, IEEE Computer, IEEE TKDE, IEEE TSE, IEEE TSMC-A, IEEE TSMC-B, IEEE Micro, ACM Computing Surveys, FGCS, Parallel Computing, IEEE Internet Computing, and highly reputed conference proceedings. He is a member of the editorial boards of IEEE Transactions on Parallel and Distributed Systems, IEEE Computer, ACM Computing Surveys, the Future Generation Computer Systems journal, the International Journal of Web and Grid Services, the Journal of Cloud Computing-Advances, Systems and Applications, the Scalable Computing Practice and Experience journal, the International Journal of Next-Generation Computing. He was guest editor of special issues of IEEE Transactions on Software Engineering, Parallel Computing, IEEE Transactions on Big Data, and Future Generation Computer Systems, and served as a program chair or program committee member of several international conferences. Talia is a Senior member of the Association for Computing Machinery (ACM) and the IEEE Computer Society and he has been a reviewer for several research agencies and public administrations.

October 28, 2023, Saturday, 14:10-14:50, Tokyo Time, GMT+9

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## Prof. Joan Lu

Research Group Leader of Information and System Engineering (ISE) in the Centre of High Intelligent Computing (CHIC)

University of Huddersfield, UK

### Speech Title: Smart Pervasive Sustainable Technology Benefit to Educational Society

**Abstract:** A direction of a man's education determines his future in life – Plato, Greek philosopher.

This talk will address three pillars in 1) smart pervasive sustainable technology applied in educational society, the modes and technologies developed, 2) the impacts on the real-world applications, the benefits to the end users and stakeholders, finally 3) the challenges are facing in Infrastructures, Information retrieval, User Experience, System maintenance and upgrading, costing and staffing.

**Bio:** Professor Joan Lu is in the Department of Computer Science and is the research group leader of Information and System Engineering (ISE) in the Centre of High Intelligent Computing (CHIC), having previously been team leader in the IT department of Charlesworth Group publishing company. She successfully led and completed two research projects in the area of XML database systems and document processing in collaboration with Beijing University. Both systems were deployed as part of company commercial productions.

Professor Lu has published 11 academic books and more than 200 peer reviewed academic papers. Her research publications have 35,606 reads and 700 citations by international colleagues, according to incomplete statistics from the researchgate, Scopus and Google Scholar.

Professor Lu has acted as the founder and a program chair for the International XML Technology Workshop for 11 years and serves as Chair of various international conferences. She is the founder and Editor in Chief of International Journal of Information Retrieval Research and serves as a BCS examiner of Database and Advanced Database Management Systems, and is an FHEA. She has been the UOH principle investigator for four recent EU interdisciplinary (computer science and psychology) projects: Edumecca (student responses system) (143545-LLP-NO-KA3-KA3MP), DO-IT (multilingual student response system) used by more than 15 EU countries (2009-1-NO1-LEO05-01046), and DONE-IT (mobile exam system) (511485-LLP-1-2010-NO-KA3-KA3MP), HRLAW2016 - 3090 / 001 - 001.

# Conference Schedule



## Day 1, October 27, 2023, Friday, Tokyo Time, GMT+9

Online Pretest Session		
Time	Presenters	ZOOM Information
10:00-18:00	Keynote Speakers, Session Chairs, Committee Members	<b>Zoom Link:</b> <a href="https://us02web.zoom.us/j/82384066616">https://us02web.zoom.us/j/82384066616</a>  <b>Zoom ID:</b> 823 8406 6616  <b>Password:</b> 23102729
10:00-12:00	Session 1: Visual Based Image Analysis and Application  RB027, RB2002, RB038, RB505, RB040, RB305, RB007-A, RE0010	
	Session 2: Mobile Applications and Human Machine Interaction Systems Design  RB018, RB020, RE0008, RB303, RB013, RB016, RB044, RB029	
14:00-18:00	Session 3: Information Management and Service Platform Construction Based on Code Design  RB003, RE2023, RB042, RB301-A, RB304, RB045, RE1001, RE0012	
	Session 4: AI based Data Analysis and Information Management  RB024, RB019, RB047, RB004, RB039, RB307, RB010, RE1004-A	
	Session 5: System Modeling, Resource Allocation, and Network Performance Analysis in Digital Communication  RE2005, RB015, RB306, RB502, RB025, RE2026, RB503, RB2001-A	

## Day 2, October 28, 2023, Saturday, Tokyo Time, GMT+9

Time	Schedule
<b>Zoom Link:</b> <a href="https://us02web.zoom.us/j/82384066616">https://us02web.zoom.us/j/82384066616</a> <b>Zoom ID:</b> 823 8406 6616 <b>Password:</b> 23102729	
9:30-9:35	<b>Welcome Message</b>  <b>Prof. Sergei Gorlatch</b> University of Muenster, Germany
9:35-10:15	<b>Keynote Speech 1</b>  <b>Speech Title: Credibility, Data Privacy, and Energy Awareness: Advances in Machine Learning</b>  <b>Prof. Witold Pedrycz</b> IEEE Life Fellow  University of Alberta, Canada

# Conference Schedule



<p><b>10:15-10:55</b></p>	<p><b>Keynote Speech 2</b>  <b>Speech Title: Agile Formal Engineering Method for High Productivity and Reliability</b>  <b>Prof. Shaoying Liu</b>                      IEEE Fellow, BCS Fellow, AIAA Fellow  <b>Hiroshima University, Japan</b></p>
<p><b>10:55-11:10</b></p>	<p><b>Break Time &amp; Group Photo</b></p>
<p><b>11:10-11:50</b></p>	<p><b>Keynote Speech 3</b>  <b>Speech Title: FER - Facial Expression Recognition - Advances and Challenges</b>  <b>Dr. Branislav Vuksanovic</b>                      Associate Head of School for Research and Innovation  <b>University of Portsmouth, UK</b></p>
<p><b>11:50-13:30</b></p>	<p><b>Break Time</b></p>
<p><b>13:30-14:10</b></p>	<p><b>Keynote Speech 4</b>  <b>Speech Title: Cloud Computing Frameworks for Data Science</b>  <b>Prof. Domenico Talia</b>                      Senior Member of ACM and IEEE Computer Society  <b>University of Calabria, Italy</b></p>
<p><b>14:10-14:50</b></p>	<p><b>Keynote Speech 5</b>  <b>Speech Title: Smart Pervasive Sustainable Technology Benefit to Educational Society</b>  <b>Prof. Joan Lu</b>                      Research Group Leader of Information and System Engineering (ISE) in the Centre of High Intelligent Computing (CHIC)  <b>University of Huddersfield, UK</b></p>
<p><b>14:50-15:00</b></p>	<p><b>Break Time</b></p>
<p><b>15:00-17:00</b></p>	<p><b>Session 1: Visual Based Image Analysis and Application</b>                      Session Chair: Prof. William P. Rey, Mapua University, Philippines                      RB027, RB2002, RB038, RB505, RB040, RB305, RB007-A, RE0010</p>
<p><b>17:00-17:10</b></p>	<p><b>Break Time</b></p>
<p><b>17:10-19:10</b></p>	<p><b>Session 2: Mobile Applications and Human Machine Interaction Systems Design</b>                      Session Chair: Prof. Sergei Gorlatch, University of Muenster, Germany                      RB018, RB020, RE0008, RB303, RB013, RB016, RB044, RB029</p>

# Conference Schedule



**Day 3, October 29, 2023, Sunday, Tokyo Time, GMT+9**

Time	Schedule
<b>Zoom Link:</b> <a href="https://us02web.zoom.us/j/82384066616">https://us02web.zoom.us/j/82384066616</a> <b>Zoom ID:</b> 823 8406 6616 <b>Password:</b> 23102729	
<b>09:30-11:30</b>	<b>Session 3: Information Management and Service Platform Construction Based on Code Design</b>  Session Chair: Prof. Rubita Sudirman, Department of Electronic & Computer Engineering Faculty of Electrical Engineering Universiti Teknologi Malaysia  RB003, RE2023, RB042, RB301-A, RB304, RB045, RE1001, RE0012
<b>11:30-13:00</b>	<b>Break Time</b>
<b>13:00-15:00</b>	<b>Session 4: AI Based Data Analysis and Information Management</b>  Session Chair: Asst. Prof. Sethapong Wong-In, Valaya Alongkorn Rajabhat University under the Royal Patronage, Thailand  Co-Session Chair: Dr. Sosrapak Pukdesree, Bangkok University, Thailand  RB024, RB019, RB047, RB004, RB039, RB307, RB010, RE1004-A
<b>15:00-15:10</b>	<b>Break Time</b>
<b>15:10-17:10</b>	<b>Session 5: System Modeling, Resource Allocation, and Network Performance Analysis in Digital Communication</b>  Session Chair: Assoc. Prof. Rogelio O. Badiang Jr., University of the Immaculate Conception, Davao City, Philippines  RE2005, RB015, RB306, RB502, RB025, RE2026, RB503, RB2001-A



## Session 1: Visual Based Image Analysis and Application

**Time:** 15:00-17:00, October 28, 2023, Tokyo Time, GMT+9

**Zoom Link:** <https://us02web.zoom.us/j/82384066616> **Zoom ID:** 823 8406 6616

**Password:** 23102729

**Session Chair:** Prof. William P. Rey, Mapua University, Philippines

### RB027

15:00-15:15

**Title:** Securing Dormitory Through Biometric Recognition System: A Case Study of Door2Dorm

**Authors:** Mary Jane C. Samonte, Francesca Jacinthe C. Navarro, Vladimir D. Beduya, Cloyd Van S. Secuya

**Presenter:** Mary Jane C. Samonte, Mapua University, Philippines

**Abstract:** The study presents Door2Dorm, an IoT-based Dormitory Management System (DMS) that integrates facial and fingerprint recognition biometrics. The system enhances dormitory security and management by providing robust identity verification and access control. Through functionality testing, cross-browser testing, usability testing, user acceptance testing, and user experience testing, the study demonstrates the effectiveness of Door2Dorm. The conclusion confirms the successful development of the management system with facial recognition and fingerprint security features. It highlights additional key features such as records management, payment management, direct messaging, and security logging for administrators, tenants, and visitors. The integration of the Silent-Face-Anti-Spoofing library enhances system security. The study's results show high user satisfaction, making Door2Dorm an efficient and credible solution for dormitory management with biometric security measures.

### RB2002

15:15-15:30

**Title:** Automatic Detection of Spine Region using Multiple Pseudo 3D U-Net Models with Weighted Average Voting and Attention Mechanisms

**Authors:** Kai Yang, Kanon Kobayashi, Masayuki Kikuchi

**Presenter:** Kai Yang, Tokyo University of Technology, Japan

**Abstract:** In the field of medical imaging, the U-Net architecture has emerged as a prominent deep learning model owing to its proficiency in handling segmentation tasks. A previous study by Shigeta et al. [2] exploited the U-Net for pseudo 3D feature extraction. In our present study, we used supervised learning aiming to automate CT image extraction. To this end, we deployed convolutional neural networks (CNNs), particularly specialized for medical image processing. Our approach adopted Shigeta's U-Net model, implementing a model that applies average calculations to data within a  $n \times n \times n$  range located three units distant from the coordinates, with the average output derived from the weights obtained from both range of  $1 \times 1 \times 1$  and  $7 \times 7 \times 7$  models. Furthermore, each of these models are added with attention gates, facilitating pseudo 3D feature extraction by assigning higher weights to the most pertinent features, thereby potentially enhancing model performance, and by utilizing ensemble learning, we succeeded in augmenting model diversity and mitigating the issue of overfitting.

### RB038

15:30-15:45

**Title:** Effectiveness of Using Fundus Image Data Containing Other Retinal Diseases in Identifying Age-Related Macular Degeneration using Image Classification

**Authors:** Joel De Goma, Froilan Divina, Mac Kristan Isaac, Randall Joseph Pajaro

**Presenter:** Joel De Goma, Mapua University, Makati City, Philippines

**Abstract:** This study aims to identify Age-Related Macular Degeneration on complex data (existence of other retinal diseases in fundus images containing AMD). With the

rise of artificial intelligence for automation of pattern recognition, image processing would become a viable way of aiding the detection of diseases for medical science. This study involves Image Data Gathering, application of CLAHE on the green channel for Image Preprocessing, the use of UNet for Image Segmentation, and the implementation of Resnet, InceptionV3, and CNN classification models. Upon testing, The inclusion of U-Net as an image segmentation method in the deep learning architectures showed consistent improvements in the metric scores across different models. Also, it was observed that InceptionV3 with U-Net exhibited the highest metric scores across Precision, Accuracy, and F1-score with a 98.25% accuracy. The researchers recommend adding more data since the researchers were limited to open source datasets along with using better segmentation method that does not erode or crop image features such as a deeper model similar to MSU-Net."

## RB505

Title: Leveraging 360° Camera in 3D Reconstruction: A Vision-based Approach  
Authors: Hoi Chuen Cheng, Babar Hussain, Ziyang Hong and C. Patrick Yue  
Presenter: Hoi Chuen Cheng, HKUST, Hong Kong

15:45-16:00

Abstract: In this paper, we present a novel vision-based approach for 3D reconstruction using a single 360° camera, aiming to offer a simplified and accessible solution for various consumer-oriented applications. Consumer-grade 360° cameras have gained significant popularity due to their affordability and ease of use. However, traditional methods for 3D reconstruction often require complex setups with multiple cameras or expensive hardware such as LiDAR. Our approach addresses the challenges associated with 360° cameras by converting the distorted equirectangular projection (ERP) into four perspective views resembling cube maps, allowing compatibility with deep learning models trained on undistorted perspective images. We leverage visual simultaneous localization and mapping (VSLAM) techniques for camera pose estimation and employ a standard 3D reconstruction pipeline for generating detailed 3D mesh representations of the indoor environment. Through experimental evaluation, we compare the performance of 360° cameras with traditional perspective cameras in 3D reconstruction, and analyze the accuracy and performance of our vision-based approach. Our findings demonstrate the potential of using 360° cameras for constructing high-quality models and facilitating efficient data collection for 3D reconstructions, opening up new possibilities for various consumer-oriented applications in multiple fields.

## RB040

Title: AcneCheck: An Acne Severity Grading in Teledermatology Through Computer Vision  
Authors: Mary Jane Samonte, Joshua A. Borja, Lance Michael A. Delariarte, Jeffrey Angelo A. Ebanen  
Presenter: Mary Jane Samonte, Mapua University, Philippines

16:00-16:15

Abstract: Telemedicine contributed to the availment of health services with time convenience, ease of commute, and avoiding contagious diseases for private practice worldwide. Software and electronic telecommunication technologies are used to seek clinical services remotely with expert advice. Computer vision in telemedicine advances medical practices in healthcare. With image processing technology integrated into a teledermatology web application, dermatologists can pre-diagnose a patient's skin lesion as acne as well as grade its severity. Teledermatology is the result of combining dermatology - a medical field specializing in skin problems - and telemedicine. Teledermatology is an excellent method for diagnosing skin lesions due to the visible aspect of the skin. It may also reduce unnecessary clinical referrals and triage dermatological patients. This study aims to develop a web-based teledermatology application with acne severity

grading using computer vision to assist dermatologists. Aside from the traditional telemedicine features like appointment scheduling and sending prescriptions, the developed system analyzed and graded the severity of facial acne using the Acne Grading API. Additionally, it includes a data repository for medical-related files of patients within a video conferencing tool. The developed system has undergone vulnerability assessment testing and penetration testing. Vulnerability testing detects security weaknesses of the developed system, while penetration testing provides the current security posture to ensure that configuration management standards have been followed in identifying potential breach points. Based on user acceptance testing results, patients and dermatologists efficiently communicate with this developed telemedicine tool with an SUS score of 69.125.

## RB305

Title: Real-World Implementation of IoT-based Temperature Detection Helmet Using Thermal Imaging Cameras in Manufacturing

Authors: Paniti Netinant, Kamontat Pattamasoot, Sorapak Pukdesree

Presenter: Kamontat Pattamasoot, Rangsit University, Thailand

16:15-16:30

Abstract: The use of Internet of Things-based thermal sensor cameras for temperature detection in manufacturing has gained popularity in recent years due to the potential of these cameras to increase the efficiency of manufacturing processes while simultaneously reducing the time wasted on downtime. On the other hand, there is a lack of implementation studies in the real world that offer valuable insights into the employment of these devices in manufacturing settings. This study aims to present a case study of an actual-world use of Internet of Things-based thermal sensor cameras for temperature detection in a manufacturing facility. The worker will wear a smart helmet with integrated Internet of Things-based temperature detection and a thermal sensor camera throughout the study. The data will then be collected, analyzed, and used to identify temperature anomalies that may occur during the manufacturing process. The study results show that an Internet of Things (IoT)-based thermal sensor camera-equipped smart helmet can detect temperature anomalies in manufacturing processes and can be integrated into preexisting systems. Nevertheless, the study draws attention to some of the challenges associated with data privacy and security, cost-effectiveness, and scalability of IoT-based thermal sensor cameras used in manufacturing.

## RB007-A

Title: AI-Based misbehavior detection framework in IoT

Authors: Hamid Al-Hamadi

Presenter: Hamid Al-Hamadi, Kuwait University, Kuwait

16:30-16:45

Abstract: Many modern misbehavior detection systems rely on AI classification methods with learning capability to classify if an IoT device (e.g., an embedded IoT device in a cyber physical system) is malicious. It is a well-known problem that AI-based systems can produce correct outputs most of the time but can fail miserably sometimes. In this paper, we devise a methodology to assess the effectiveness of AI-based misbehavior detection systems with learning capability. Our methodology consisting of two lightweight statistical analysis methods can allow a system designer to quantify the effect of learning capability on the effectiveness of AI-based detection code, measured by false negative probability and false positive probability. Moreover, it helps determine the amount of training time in the testing phase before the AI-based misbehavior detection code can be released for operational use.

## **RB0010**

16:45-17:00

Title: A fully embedded AI system for the detection of soft falls using accelerometer data in real time

Authors: Gamaliel Percino, Annie Bourgeois, Alexandre Fenneteau, Vincent Pitard

Presenter: MSc. Gamaliel Percino, Capgemini Engineering, France

Abstract: Fall detection has been widely studied given the incidence of falls in the elderly population, often resulting in physical injuries that require prolonged medical treatment. This paper proposes a detection system to detect falls, and more importantly “soft falls”. Soft falls do not necessarily produce physical injuries, but may be the consequence of a serious health issue such as a heart attack. Soft falls are more difficult to detect as they can be mistaken for daily activities. The detection system implements an artificial neuronal network model that reaches an AUC score of 98%. The model is reduced in size using a TinyML framework to be deployed in real time on a microcontroller, making it compatible with wearable systems that do not invade or restrict mobility and activities of users.

## **Session 2: Mobile Applications and Human Machine Interaction Systems Design**

**Time:** 17:10-19:10, October 28, 2023, Tokyo Time, GMT+9

**Zoom Link:** <https://us02web.zoom.us/j/82384066616> **Zoom ID:** 823 8406 6616

**Password:** 23102729

**Session Chair:** Prof. Sergei Gorlatch, University of Muenster, Germany

### **RB018**

**Title:** Assessing MABIS Mobile App Based on People at the Center of Mobile Application Development (PACMAD) Usability Model: Empirical Investigation

**Authors:** William P. Rey

**Presenter:** William P. Rey, Mapua University, Philippines

17:10-17:25

**Abstract:** This study aimed to assess the usability attributes of the MABIS mobile app among Philippine National Police (PNP) personnel, focusing on effectiveness, efficiency, learnability, memorability, errors, and cognitive load. A survey-based methodology was employed, following the dimensions of the PACMAD usability model. The findings revealed that the application exhibited consistently high efficiency, with task completion time, page duration, and interaction requirements meeting or exceeding expectations. The evaluated effectiveness categories performed at a highly acceptable level, indicating that the application effectively achieved its intended goals. Learnability was high, with users perceiving the application as easy to learn and quickly acquiring the necessary skills. The application demonstrated a relatively high level of memorability, enabling users to reuse it without assistance. Additionally, it excelled in error handling and recovery, providing practical aid and informative error messages. The application imposed a manageable cognitive load on users, allowing them to complete tasks within allocated time frames. Overall, the study concluded that the current usability of the MABIS mobile app was acceptable, acknowledging the subjective nature of usability influenced by user-specific factors. The research contributes to the literature on evaluating the usability of mobile applications in government institutions in the Philippines, offering insights to developers and designers. Future studies can expand the sample to include other government agencies and explore new evaluation methodologies for usability assessment.

### **RB020**

**Title:** CareForPaws: A Mobile Application for Pet Adoption and Other Services with Location based Technology Developed in React Native Framework

**Authors:** Eric Blancaflor, Midsi Shreya Delos Santos, Alejandro Reyes, Juan Miguel Romualdo

**Presenter:** Eric Blancaflor, Mapua University, Philippines

17:25-17:40

**Abstract:** The research centered on the utilization of a mobile app with location-based capabilities created in the React Native Framework for the purpose of pet adoption. The core inquiry revolved around assessing the efficacy of the CareForPaws mobile app's functionalities, which encompass pet adoption management, monitoring systems, and personality & locationbased matching. To gather data for the study, a selective sampling method was employed. This method entailed handpicking respondents from a specific subset within the Facebook community. This approach was chosen because it empowered the researchers to exercise their judgment in selecting participants who were most suited for the study's objectives. The chosen participants were granted the opportunity to engage with and evaluate the app, ensuring that all its features were accessible and functional. Subsequent to this testing phase, the researchers integrated necessary modifications to the app based



on feedback received from the testers. The study findings indicated the effectiveness of employing a mobile application equipped with location-based technology, developed using the React Native Framework, for the purpose of pet adoption. The app's features proved instrumental in identifying adoptable pets, and the questionnaire component facilitated the assessment of a pet's compatibility with potential adopters. Additionally, the inclusion of a community forum within the app was found to be beneficial in connecting individuals who share an interest in pets. This forum not only aided in finding like-minded individuals but also enabled the app users to extend invitations to fellow pet enthusiasts and organizations, encouraging broader adoption and use of the mobile application.

**RE0008** Title: Designing a summarization system on social comments using transformers  
Authors: A. papagiannopoulou - C. Angeli  
Presenter: Chrissanthi Angeli, University of West Attica, Athens, Greece

17:40-17:55

Abstract: Smart technology has radically changed our lives, giving a leading role to social media for communication, advertising, information and opinion exchange. Managing the massive amount of data available on social media by humans is an almost impossible task. AI techniques for automated text summarization, is a major undertaking. Due to the recent development of neural networks and deep learning models like Transformers we can create more efficient summaries. In this paper we introduce our work towards a system which creates abstractive summaries of social media comments by using transformers. We have started with a comparison of 3 transformer encoder-decoder architecture pre-trained models T5, BART, & PEGASUS. For the purposes of this work we have used a Facebook dataset of news posts and their corresponding comments. Since T5 exceeds the other models, we proceed to cluster the data so that T5 can be fed and fine-tuned with the desired text to be summarized.

**RB303** Title: WellnessWise: User Experience Design of the Proposed Mobile Application for Physical and Mental Health Self-Care  
Authors: Francesca Jacinthe C. Navarro, Vladimir D. Beduya, Leon Eduardo D. Man, Sean Ashley L. Calaguas, Grace Lorraine D. Intal  
Presenter: Grace Lorraine Intal, Mapua University, Philippines

17:55-18:10

Abstract: Each fitness app has its own method and effectiveness on how their users become physically active to improve their general health. This study proposes a prototype design of the "Wellness wise" app, a tracker, fitness, and mental health mobile application using the Design Thinking Methodology which includes Empathy, Define, Ideate, Prototype, and Test. The authors gather data through survey to determine their working routines, experiences in using the existing fitness applications and ideas on improving the existing fitness apps. The data were analyzed to come up with features of the app based on user requirements. The proposed design was tested in terms of ease of use, then, suggestions and feedback from the respondents were gathered and analyzed to improve and enhance the Wellness wise application using SWOT analysis. The results show that the majority of respondents were satisfied as to the design of the app which includes features such as gamification, social media feedback, and virtual coaches.

**RB013** Title: X-Mech: an On-Demand Vehicle Express Repair Service Mobile Application  
Authors: William P. Rey, Eduardo Jose Del Rosario, Marcus Keanu Lasquety, Kent Andrei Dominique Tan  
Presenter: William P. Rey, Mapua University, Philippines

18:10-18:25

Abstract: The study aims to develop a mobile application catering to motorists across

various locations in the Philippines. This app aims to provide motorists with high-quality vehicle services, including mechanical repairs to maintain their cars in good condition and other services focused on ensuring vehicle safety. The researchers also offer assistance in utilizing the mobile application, acting as a service that connects users with skilled mechanics to fulfill their automotive needs. To access these services, businesses, and consumers would need to create an account on the open platform provided by the mobile app. The development of this app holds the potential to expand the range of assistance offered by the business and bring benefits to the company. In today's world, where mobile and Internet usage is prevalent, services that utilize these technologies allow companies to gather information efficiently and deliver services that benefit both the business and the consumer. The assessment of the various attributes based on the PACMAD framework indicates that users have a highly positive perception of the application. The application scored well in efficiency, effectiveness, learnability, memorability, error resolution, satisfaction, and cognitive load. These findings highlight the application's strengths and provide valuable insights for further improvements, ensuring an enhanced user experience and continued user satisfaction.

## **RB016**

Title: A State Graph-Based Improved Framework for Monkey GUI Testing for EDA Desktop Applications

Authors: Sarah Ali, Magda Fayek

Presenter: Sarah Ali, Faculty of Engineering, Cairo University, Egypt

18:25-18:40

Abstract: Monkey Testing is an autonomous Graphical User Interface (GUI) automation testing technique. Due to the complex GUI of Electronic Design Automation (EDA) software applications, applying Monkey Testing in a timely manner is very challenging. By making use of the GUI regressions' knowledge about the application we can have a faster and improved Monkey Testing approach. Yet directing the improved Monkey flow to have better coverage needs enhancements so this paper addresses this by building a state graph while running to guide traversing new states using image processing and weighted random selection techniques. A state is represented as an image and the improved Monkey Testing flow is guided to avoid already hit windows and actions. The paper proves that the state graph-based Monkey Testing approach reaches higher coverage than the improved Monkey Testing approach.

## **RB044**

Title: Narrate: A User-Driven Web Application for Developing Speech Corpora in Endangered Philippine Languages and Dialects

Authors: Shane Francis Maglangit, Mico Magtira, Elcid Serrano, Jessica Nicole Dela Cruz, Lamar Clarence Cruz, Ramon Rodriguez

Presenter: Elcid Serrano, Mapua University, Philippines, Philippines

18:40-18:55

Abstract: Society gradually forgets the start of a language and starts to lose its culture and traditions with it; these languages are called endangered languages. Many languages in the Philippines fall under the endangered language that needs to be preserved so the next generation can savor its cultural richness. The preservation can be done with the help of technology. The use of digital repositories for the public can preserve endangered languages. A few online repositories contain files of endangered languages, such as audio files. However, some online repositories are coherently restricted to the public and cover only a specific group of countries of their endangered languages. With this premise, the researcher came up with the idea to develop an online repository of audio and text files of endangered languages that a website user can upload that the public can download. The student developers created a web application named Narrate with another functionality: a recording tool. The project author can record the endangered language's speech, which can be

immediately uploaded to the platform for the community to use. Narrate was developed through the agile software development cycle due to the short time allotted and the small team that designed the application. In the testing phase, the team utilized Agile testing, a core part of the agile development cycle, to fit the small team of student developers using the automated unit, integration testing, manual system, and usability testing. The Mean completion time metric measured the task for every given scenario during the test. The result shows it requires less than 30 seconds to perform most of the tasks in the system, but for more complex tasks, it requires an average of one (1) to two (2) seconds to finish the task.

## RB029

Title: Remote Access Penetration Testing Simulation on a Mobile Phone using CamPhish & Storm-Breaker

Authors: ERIC BLANCAFLOR, KESTER KANE FRANCIS DE MATA, JAN CARLO PERALTA, AARON CHRIS RAPSING, JUAN CARLOS TABIOS,

18:55-19:10

Presenter: AARON CHRIS RAPSING , Mapua University , Philippines

Abstract: As smartphones become an integral part of our daily lives, cybercriminals continue to devise new and sophisticated techniques to gain unauthorized access to these devices. Remote access attacks have become prevalent, with attackers exploiting vulnerabilities in the operating system or user behavior to gain access to sensitive information. In this study, we conducted penetration testing of remote smartphone access using CamPhish, Storm Breaker. CamPhish is a phishing tool that allows attackers to create fake websites that prompt victims to provide personal details that give access to the victim's smartphone front camera. Our tests were conducted on various smartphones running different operating systems, including Android and iOS. Our findings showed that all three frameworks successfully gained remote access to the target devices. Storm Breaker was the most effective regarding the range of malicious activities that could be performed. The results of this study underscore the need for smartphone users to remain vigilant and take proactive steps to secure their devices. Implementing security measures such as strong passwords, two-factor authentication, and avoiding clicking on suspicious links can help prevent remote access attacks. In conclusion, this study highlights the importance of regular security testing and the need for individuals and organizations to remain vigilant against potential cyber threats targeting smartphones. Users can protect themselves from unauthorized access and safeguard their sensitive information by taking proactive steps to secure their devices.



## Session 3: Information Management and Service Platform Construction Based on Code Design

**Time:** 09:30-11:30, October 29, 2023, Tokyo Time, GMT+9

**Zoom Link:** <https://us02web.zoom.us/j/82384066616> **Zoom ID:** 823 8406 6616

**Password:** 23102729

**Session Chair:** Prof. Rubita Sudirman, Department of Electronic & Computer Engineering Faculty of Electrical Engineering Universiti Teknologi Malaysia

### RB003

09:30-09:45

**Title:** Vulnerability Assessment on Cross-site scripting attack in a simulated E-commerce platform using BeEF and XSSStrike

**Authors:** ERIC BLANCAFLOR, EUGENIO EMMANUEL ARAULLO, JOSEPH ANGELO CORCUERA, JOHN RAY RIVERA, LAUREN NICOLE VELARDE,  
**Presenter:** EUGENIO EMMANUEL ARAULLO , Mapua University , Philippines

**Abstract:** The risk of cyberattacks increases along with the quantity of e-commerce websites. One of the frequent attacks that target and threaten said websites is cross-site scripting (XSS) attack. They take use of flaws in online applications to insert harmful code into a website, which can be exploited to steal confidential data or impair the performance of the website. XSS attacks can have significant effects on end users as well as the companies in charge of maintaining the websites. Websites can be edited or defaced, users can be tricked into giving up their information and login credentials, and websites or applications can even be taken over. This study is conducted to gauge the susceptibility of e-commerce websites to XSS attacks, enumerate as many vulnerabilities as our testing will allow us to find, and glean recommendations from the results to help improve the security of such websites. Additionally, this study also aims to demonstrate the severity of XSS attacks and their effects on the end-users and organizations affected by such attacks. Penetration testing using the freely available open-source XSS tools BeEF and XSSStrike are used to identify potential vulnerabilities in the two websites created and provided by the researchers' structure, features, and functionality.

### RE2023

09:45-10:00

**Title:** AI-based PdM Platform in Deciding Failure of Automobile SCU Equipment

**Authors:** Sung Hyun Oh, Jeong Gon Kim

**Presenter:** Jeong Gon Kim, Tech University of Korea, Republic of Korea

**Abstract:** Recently, factory automation have been implemented through the use of sensor networks. In general, the equipment deployed in automated factories is expensive. Due to the huge maintenance expenses associated with manufacturing plant equipment, there is a growing need for technology that can predict the lifespan of equipment consumables. Real-time fault prediction technology is essential because downtime in a process can lead to substantial financial losses for a factory. predictive maintenance (PdM), which predicts replacement cycles instead of relying on preventive maintenance (PM) following equipment failure, can enhance productivity. Hence, this paper developed a predictive maintenance technology based on industrial internet of things (IIoT). The developed platform can predict and verify the state of equipment in real time. To predict faults, we generated virtual voltage and frequency data for the inspection equipment of the shift-by-wire control unit (SCU). We then applied this data to three models: the recurrent neural network (RNN), the long short-term memory (LSTM), and the gated recurrent unit (GRU), and compared their performance. Among them, the GRU model achieved the highest prediction speed and accuracy, with an R2-score of 0.992. We utilized this platform to develop a real-time AI prediction management system with the goal of

## RB042

10:00-10:15

improving productivity.

Title: Comparison of Leading Language Parsers – ANTLR, JavaCC, SableCC, Tree-sitter, Yacc, Bison

Authors: Afshan Latif, Farooque Azam, Muhammad Waseem Anwar, and Amina Zafar

Presenter: Afshan Latif, Department of Computer and Software Engineering, College of Electrical and Mechanical Engineering, National University of Sciences and Technology (NUST), Islamabad, Pakistan

Abstract: Software engineering applications in domains like embedded systems and health care have increased exponentially during the last few years. Developing, analyzing, and customization of languages is one of the core software engineering aspects. This usually involves lexical, syntactical, and semantic operations, technically termed parsing. For this, several parsers have been introduced in state-of-the-art. However, due to diverse features, selecting a parser for a particular operation during software engineering applications is always problematic. In this article, we identified six leading parsers (i.e., ANTLR, JavaCC, SableCC, Tree-sitter, Yacc, and Bison) from the state-of-the-art. Furthermore, we also identified significant parser features to perform meaningful comparative analysis. Results indicate that ANTLR and JavaCC provide enhanced parsing features, such as the parsing algorithm and the extended grammar notation. However, JavaCC is suitable for simple grammar definition, whereas ANTLR allows specifying complex grammar with multiple alternative paths. The findings of this article are highly beneficial for researchers and practitioners while selecting the right parser to perform specific software engineering tasks.

## RB301-A

10:15-10:30

Title: Idea Grouping Support System

Authors: Naoki Kajitani, Yuji Oyamada, Mikihiro Mori, and Haruhiko Maenami

Presenter: Naoki Kajitani, Tottori University, Japan

Abstract: In general, grouping, which is the process of dividing sticky notes into several groups, is carried out at the end of the ideation process using imitation paper and sticky notes. The grouping process organizes the sticky notes on the paper, and sticky notes belonging to the same group are placed in close proximity. When looking back on the ideation from the completed imitation paper, the grouping may be restructured and examined. In this kind of reflection, a tool is expected to support the restructure and examination of the grouping. In this paper, we propose a web application that supports the examination of grouping. The system takes as input a photograph of a imitation paper on which sticky notes are pasted and the position of each sticky note on the imitation paper. First, the system crops all the stickies on the imitation paper from the photograph. Through the GUI, the user considers the groupings by adding, editing and deleting multiple groups formed on the imitation paper. Specifically, attributes corresponding to the groups and categories classifying these attributes are created, and the attributes to which each sticky note corresponds are managed using checkboxes. This makes it possible for a single sticky to have multiple attributes for a particular category that is difficult with the real imitation paper. We conducted a simple experiment in which screen recordings of the system in operation were shown to those who had experience in ideation. We confirmed that the GUI-based grouping enabled the users to achieve more flexible grouping. One of the users suggested to use the system in such a way that each participant first thinks of their own groupings and then shares them before grouping them on a imitation paper. The users also suggested more intuitive GUI and AI-based auto grouping as future direction. These results indicate that this system can help support grouping.

## RB304

Title: Design Travel Keywords for Improved Chatbot Information Communications and Services using Ontology

Authors: Paniti Netinant, Warinthorn Singhanatbanchorn, Meennapa Rukhiran

Presenter: Paniti Netinant, Rangsit University, Thailand

10:30-10:45

Abstract: Searching for a trip requires a great deal of information, including locations, travel, exercise, restaurants, coffee shops, interesting activities, and accommodation. The vast majority of digital information platforms may not provide sufficient information to support all users. Intelligent interactive systems or chatbots have been proposed to facilitate more convenient real-time responses in business and other extensive work. Intent recognition is crucial to a chatbot's ability to respond successfully to a user's needs. This study describes the ontology of tourism based on user surveys. By conducting a survey of users and analyzing the data collected, keywords are categorized into various groups. Thus, the ontological design is proposed that tourist ontology support four primary domains and subcategories. In addition, classes and properties have been used to represent the travel domain's concepts and relationships. Consequently, keywords can enhance the user experience and communication in tourist searches, tourist information, and chatbot development for further study.

## RB045

Title: A Performance Evaluation on the Blockchain-based Traceability Application of Pharmaceutical Supply Chain: A Case Study

Authors: Mary Jane C. Samonte, Danica Grace D. Advincula, Sofia Samantha S. Beltran, Aiko D. Obog

Presenter: Mary Jane Samonte, Mapua University, Philippines

10:45-11:00

Abstract: Blockchain is a disruptive technology known for its security features and continuous development. Despite blockchain's notable features, such as immutability, it is still a compelling solution for various industry use cases. Albeit technical hitches such as network overload are still of concern to use this technology in an enterprise context. Some factors to consider include high transaction throughput and low latency. This study focuses on developing a blockchain-based web application that focuses on a specific industry use case, in this case, the distribution and recall transactions of the pharmaceutical supply chain. Since the pharmaceutical supply chain suffers from frequent visibility problems, blockchain is a suitable solution for this use case. After developing the application, performance testing was done to determine the system's throughput, latency, and scalability performance. Three use cases were tested explicitly by different transaction rates (tps), the total number of transactions, and the number of simultaneous transactions in the simulated test environment. For every performance test, two transaction types were done: the invoke and query transactions. The study showed that a blockchain system's hardware configuration heavily impacted the system's overall performance through the blockchain's latency, throughput, and scalability. These factors depend on the configuration of the system, the network design of the blockchain, and the complexity of the operations of the smart contract.

## RE1001

Title: Adapting the CRISP-DM Data Mining Process to develop employee Net Promoter Score model based on NLP technique

Authors: Alex Kolokolov

Presenter: Alex Kolokolov, Russian, Georgia

11:00-11:15

Abstract: The purpose of this study is to describe the management of the machine learning project to explore employee Net Promoter Score (eNPS) for a large industrial company. As more than 100 000 employees' answers were up to be processed, the usual data processing methods are inapplicable. The output result of

the machine learning model is presented as an interactive report performed with Power BI software. All project stages are discussed according to CRISP-DM methodology and some encountered challenges are highlighted and ways to handle them are preferred.

## RE0012

Title: Enhancing Traffic Prediction with Interpretable Community Embeddings via Louvain Algorithm

Authors: Bartosz Durys, Israel Pineda

11:15-11:30

Presenter: Bartosz Durys, Institute of Applied Computer Science, Lodz University of Technology, Lodz, Poland

Abstract: Predicting traffic is a complex problem that involves both space and time. This study focuses on the spatial aspect of this challenge, specifically how groups of road sections behave and interact within a city. Leveraging the well-regarded Louvain algorithm, we partition the urban road network into distinct communities. To augment the predictive power of models, we implement a learnable embedding layer that integrates generated groups with the input. We test our idea with a classic and simple model called Temporal Graph Convolutional Network (T-GCN). The obtained results highlight the promise of this avenue of research and emphasize its value for further investigation. Notably, the interpretability of the generated embeddings is demonstrated. By extracting meaningful relationships and disparities among communities, we provide insights into the dynamics of the road network. This approach enhances traffic prediction and contributes to a deeper understanding of the spatial interactions within urban road systems.

## Session 4: AI based Data Analysis and Information Management

**Time:** 13:00-15:00, October 29, 2023, Tokyo Time, GMT+9

**Zoom Link:** <https://us02web.zoom.us/j/82384066616> **Zoom ID:** 823 8406 6616

**Password:** 23102729

**Session Chair:** Asst. Prof. Sethapong Wong-In, Valaya Alongkorn Rajabhat University under the Royal Patronage, Thailand

**Co-Session Chair:** Dr. Sosrapak Pukdesree, Bangkok University, Thailand

### RB024

**Title:** Utilizing Testing-Based Formal Verification in Neural Networks: A Theoretical Approach

**Authors:** Haiyi Liu; Shaoying Liu; Guangquan Xu; Ai Liu; Yujun Dai

**Presenter:** Haiyi Liu, Hiroshima university, Japan

13:00-13:15

**Abstract:** Neural networks are widely applied across various computer applications, including many safety-critical systems. However, understanding the decision-making behavior of neural networks and verifying their reliability through formal specifications continues to be a topic of ongoing discussion. The first difficulty is to give the precondition and post-condition for neural networks, and the second difficulty also exists in traditional software, i.e., the problem of exploding execution paths. Fortunately, the output range of a neural network is easier to give and when an input is given, we can obtain the activation order of neurons in the neural network. Based on the above facts, we propose DeepTBFV, a method for pre-trained neural networks, which uses a testing-based formal verification algorithm to derive the precondition of the neural network on a specified path by post-condition. Preconditions can be used to verify that a neural network meets a given formal specification, and the behavior of the neural network can also be interpreted by analyzing its preconditions.

### RB019

**Title:** Using Hybrid CNN-LSTM Model for Sentiment Analysis of COVID-19 Tweets

**Authors:** Mary Jane C. Samonte, Aderieyan Timothy G. Dela Rosa, Lance Joshua C. Rivera, John Shadrach E. Silo

**Presenter:** Mary Jane C. Samonte, Mapua University, Philippines

13:15-13:30

**Abstract:** The COVID-19 pandemic has affected many aspects of everyone's lives, causing problems in health and the economy. People often share their sentiments about the pandemic on social media, particularly on platforms like Twitter. Sentiment analysis involves using various pre-processed tweets and natural language processing (NLP) techniques to classify them as positive, neutral, or negative. It is a demanding task. Platforms with microblogging features have played a crucial role in disseminating information, such as news and emergencies. These data types are rich in sentiments that contribute to the necessary awareness of safety and preparedness. Previous studies have demonstrated that Twitter usage during disasters increases situational awareness and improves disaster response through the tweets of affected users. However, sometimes a single model is insufficient to achieve desired results, necessitating the creation of a hybrid model. This study aimed to develop a sentiment analysis model using a hybrid CNN-LSTM framework to analyze sentiments in tweets during the COVID-19 pandemic. The model utilized a hybrid CNN-LSTM architecture that focused on predicting whether the sentiment was positive or negative. The developed hybrid CNN-LSTM model achieved a testing accuracy of 84.72% and outperformed standalone CNN and LSTM models.



## RB047

Title: Towards the Automated Generation of the Optimal Rocket Self- Landing Control Solution using AI and Reinforcement Learning

Authors: Harry Xu, Yu Sun

Presenter: Harry Xu, Mission San Jose High School, USA

13:30-13:45

Abstract: In the dynamic domain of aerospace engineering, the drive for reusable aerospace launching systems has gained momentum, emphasizing the crucial nature of recycling rocket systems with robust landing control mechanisms. This study engages with the central challenge: optimizing self-landing control amidst unknown variables and environmental dynamics. Through a multi-faceted research approach, we introduced a synthesis of artificial intelligence and reinforcement learning, particularly employing the Unity ML-agents framework, to generate adaptive self-landing control solutions. Our research encapsulates six experiments ranging from analysing fuel efficiency and environmental factors, examining landing time dynamics, identifying hazard thresholds, assessing landing platform design, to comparing AI's ability to mimic physical behaviours. The findings underscore the potential of an AI-driven approach in tandem with fundamental physics to optimize rocket self-landing, envisioning a future with enhanced safety, efficiency, and reliability in aerospace launching systems.

## RB004

Title: Analyzing the Sentiments Of Filipino Commuters: An Application of Data Science Techniques through the Use of Machine Learning Algorithms

Authors: JOEL C. DE GOMA, Alfred Alexander M. Quiambao, Justin Gillian M. Pascua, Paul Bryan V. Bravo

Presenter: JOEL C. DE GOMA, MAPUA UNIVERSITY, PHILIPPINES

13:45-14:00

Abstract: Living in the 21st century, the rise of science and technology has brought upon various developments that help improve the quality of life for all humans. Diverse innovations are slowly being developed into better ideas, thus causing people to think outside the box. Various computer-related techniques are being applied in order to make life easier. This study is an application of data science techniques with regard to analyzing the Twitter sentiments of Filipino commuters. Moreover, this study also determines and compares which data science model obtained the most accurate result with regard to the prediction and analysis of Twitter sentiments. The algorithms used in this study are the Naïve-Bayes, Support Vector Machine, and Deep Learning (Artificial Neural Network) containing English and Filipino language datasets.

## RB039

Title: Accelerating Mutation-Based Fault Localization via Optimized Mutant Execution

Authors: Xia Li, Ryan Juza

Presenter: Xia Li, Kennesaw State University, US

14:00-14:15

Abstract: As modern software systems become more and more complex, bugs (also called faults) are prevalent and inevitable. Automated fault localization focuses on identifying faulty program elements that cause software failures. Mutation-based fault localization (MBFL) is one popular approach and has been proved to be more effective in real bugs. However, MBFL brings a problem of execution cost since it requires the execution of the whole test suite against a huge number of generated mutants. In this paper, we propose FastMBFL, a novel technique to improve the efficiency of MBFL by considering the importance of the impact information originated from failed test while maintaining the similar accuracy. The experimental results show that in terms of the widely used evaluation metric Mutant-Test Pair (MTP), FastMBFL can reduce the mutation cost by 24%- 40% compared with the state-of-the-art technique.

## RB307

Title: Local Outlier Reclassifier (LORec): a Method for Relocating Local Outliers Generated by K-means

Authors: Rogelio O. Badiang Jr.

14:15-14:30

Presenter: Rogelio O. Badiang Jr., University of the Immaculate Conception, Davao City, Philippines

Abstract: The occurrence of local outliers produced by the K-means algorithm remains challenging since they affect the clustering performance due to misclassification. While current algorithms can identify the local outliers in the clusters, they do not relocate them to their correct clusters. Also, modifications of K-means addresses problems including time complexity, identifying the initial centroids and number of clusters, and preventing the occurrence of outliers in every cluster, but only a few focused on relocating the local outliers to their correct clusters. Hence, this paper introduces a Local Outlier Reclassifier (LORec) method capable of relocating local outliers generated by K-means. Results of the study using the three datasets show that the LORec integrated into K-means improved its clustering performance. The generation of false-positive instances is reduced by an average of 25.01%. Additionally, the integration yielded an average improvement of 8.50 % accuracy, 5.39% in the rand index, and 8.9% in f-measure. These results indicate that integrating LORec into K-means is an effective method for relocating local outliers to their correct clusters.

## RB010

Title: Do Bad Smells Lead to Defects?

Authors: Fatma Neda Topuz, David A. Umphress

14:30-14:45

Presenter: Fatma Neda Topuz, Doctor at Osmaniye Korkut Ata University, TURKEY

Abstract: Code that disregards fundamental sound design practices is said to “smell.” While a code smell is not normally a bug, conventional wisdom suggests that it could lead to bugs when the software is later modified. This makes logical sense, but is there empirical evidence that supports this argument? If code smells can be shown to metastasize over time, are there some code smells that more virulent than others? We set out to address these questions by examining five popular Python open-source software projects to determine if recorded defects traced back to segments of code containing a smell. Our study focused on eight code smells: Large Class, Long Parameter List, Feature Envy, Parallel Inheritance Hierarchy, Data Class, Lazy Class, Refused Bequest, and Long Method. We analyzed GitHub change and defect logs for defects, then identified how the code as repaired. A smell was assumed to be the cause of the defect if changes resulted in removal of the smell. We counted the number of code smells in the project and used the ratio of the count of smells to the count of defects to quantify the influence of smells on defects. Our results indicate that the Long Parameter List code smell has the highest positive correlation, the Long Method and Large Class smells have a moderate correlation, and the Parallel Inheritance Hierarchy, Data Class, Lazy Class, Feature Envy and Refused Bequest smells have no significant correlation on the presence of defects.

## RE1004-A

Title: Feature Selection for Binary and Multi-Class Classification Problems

Authors: Ayman Alzaatreh, Luai Al-Labadi

14:45-15:00

Presenter: Ayman Alzaatreh, American University of Sharjah, United Arab Emirates

Abstract: Feature selection has become a critical step in most data mining applications to mitigate the curse of dimensionality in high-dimensional datasets.

Without direct input from the target variable, filter methods evaluate the importance of features as a pre-processing operation to the learning algorithm and select the best feature subsets through some information metrics. Filters are known to be more computationally efficient than wrapper and embedded methods. In this talk, a Bayesian approach namely, the relative belief ratio will be used as a filter method in binary and multi-class classification problems. The relative belief ratio is used as a filter method to rank features based on their importance in relation to a binary and multi-class target variables. Several benchmark data sets are used to demonstrate the applicability of the proposed method.



## **Session 5: System Modeling, Resource Allocation, and Network Performance Analysis in Digital Communication**

**Time:** 15:10-17:10, October 29, 2023, Tokyo Time, GMT+9

**Zoom Link:** <https://us02web.zoom.us/j/82384066616> **Zoom ID:** 823 8406 6616

**Password:** 23102729

**Session Chair:** Assoc. Prof. Rogelio O. Badiang Jr., University of the Immaculate Conception, Davao City, Philippines

### **RE2005**

15:10-15:25

**Title:** Performance Evaluation CSMA/CA in MAC Layer and Markov Gaussian Memory Impulse Noise Channels in PHY Layer

**Authors:** Yuri Bulatov, Andrey Kryukov and Konstantin Suslov

**Presenter:** Konstantin Suslov, Irkutsk National Research Technical University, Russia

**Abstract:** This paper develops computer models of ultra-high voltage long-distance electricity transmission lines (LDETL). The models provide an integrated simulation of modes and determine the conditions of electromagnetic safety. We used methods based on phase coordinates and lattice equivalent circuits with a fully connected topology. The simulation was carried out for a 1150 kV LDETL 900 km long, each phase of which was formed by eight 330 mm<sup>2</sup> steel reinforced aluminium wires. We used the Fazonord software package. Along with the calculations of the modes of the electric network incorporating the 1150 kV LDETL, we performed determination of the electromagnetic fields created by this line. The results obtained showed a significant asymmetry of the phase currents at full cycles of wire transposition. To maintain a symmetrical mode for such load, phase-wise regulation of reactive power sources is required.

### **RB015**

15:25-15:40

**Title:** Kubernetes-Based Edge System for Managing Intermittently Connected IoT Gateway on Rail Vehicle

**Authors:** Hitoshi Yabusaki, Hirotake Abe

**Presenter:** Hitoshi Yabusaki, Hitachi Ltd., Japan

**Abstract:** The rail industry is shifting from time-based maintenance to condition-based maintenance (CBM) to improve maintenance efficiency and reduce maintenance costs. For CBM, IoT gateways are installed in rail vehicles to collect and pre-process sensor data before sending them to an analysis system in the cloud. Containers make it easy to flexibly update CBM's application components in the gateway; Kubernetes is the de-facto standard for container management. However, Kubernetes is not designed for intermittently connected gateways; it causes node health issues and containers down when the gateway is disconnected. We propose an edge management system that enables the management of containers in intermittently connected IoT gateways via the Kubernetes API. The novelty of the proposed system is that it enables intermittently connected gateways managed by Kubernetes without modifying the Kubernetes control plane logic. We evaluated the system with both EKS and on-premises Kubernetes and showed that containers in a gateway managed by the proposed system successfully worked without any container downtime due to node health issues. The results showed that the edge node stayed in the Ready state and all the containers on the edge node kept running without down when the node was disconnected. Also, they showed that a container was restarted in 840 milliseconds on average if the container process was down while the edge node was disconnected. Based on these results, we concluded the self-healing

mechanism for pod failure worked on the Kubernetes cluster with intermittently connected edge nodes by applying the proposed edge management system. The contribution of this paper is the architecture of the Kubernetes-based edge system for intermittently connected gateways and a feasibility test with both AWS EKS, an AWS-managed Kubernetes service, and on-premises Kubernetes.

## RB306

15:40-15:55

Title: Real-Time IoT-Based Environmental Station for Hospital Safety and Efficiency  
Authors: Paniti Netinant, Tanawat Kanrai, Sorapak Pukdesree  
Presenter: Tanawat Kanrai, Rangsit University, Thailand

Abstract: The ecological monitoring situation demonstrates the capability of monitoring for a wide range of environmental parameters, thereby providing hospital staff with access to real-time environmental data that can aid in the early detection of environmental hazards and prompt remediation. This research aims to maintain a safe and healthy environment for patients and staff by observing humidity, temperature, UV indices, PM10, PM2.5, and pressures. Internet of Things (IoT)-based hospital environmental monitoring systems hold great promise for improving healthcare outcomes and patient safety. This study examines how the Internet of Things (IoT)-based technologies can be utilized to implement an effective solution for real-time hospital environmental monitoring. The research describes the design, implementation, and affirmation of an Internet of Things (IoT)-based hospital environmental monitoring system, including the software architecture, communication protocols, and Internet of Things (IoT) devices and sensors. The system was implemented in a real hospital and found to improve environmental monitoring and patient safety, thereby increasing hospital efficiency and patient safety and minimizing environmental exposure risk. The findings have significant implications for healthcare providers and policymakers, suggesting that Internet of Things-based systems could enhance hospital patient safety and environmental awareness.

## RB502

15:55-16:10

Title: Reduction of Computational Amount in Person Verification Based on SVM Using Evoked Brain Wave by Ultrasound  
Authors: Isao Nakanishi and Kouki Kawakami  
Presenter: Isao Nakanishi, Tottori University, Japan

Abstract: For realizing continuous authentication of users, we have studied to use an electroencephalogram (EEG) evoked by ultrasound as biometrics. Users are presented only the ultrasound of their memorable music and verified whether genuine or not using the induced components of EEG. In our previous studies, the verification error rate of 0 % was achieved using multiple quantities in EEG as individual features and a support vector machine (SVM) as a verification method; however, it required a large amount of computation for processing SVM models. Thus, we reduce the number of SVM models by applying two selection methods of features and electrodes, which have been previously introduced. Furthermore, we examine the usage rates of features and electrodes in the reduced SVM models. By using only the electrodes with high usage rates, the verification error rate of 0 % is guaranteed with a small amount of computation.

## RB025

16:10-16:25

Title: A Novel Model-driven Framework for the Development of Web-based Geographical Information Systems  
Authors: Zara Hayat, Farooque Azam, Muhammad Waseem Anwar, Yawar Rasheed  
Presenter: Zara Hayat, College of E&ME National University of Sciences and Technology (NUST) H-12 Islamabad, Pakistan

**Abstract:** Web-based Geographical Information Systems (Web-GIS) aim to store, analyze, and disseminate geospatial information, enabling effective decision-making. However, their development requires professional expertise and incurs high development costs, resulting in resource limitations for many organizations in developing their own GIS. To address these challenges, we propose a Geo-Location System (GLS) Framework with a Model-driven approach that will ease the developers to automatically develop their customized Web-GIS using Google Maps API. The framework incorporates a GLS meta-model encompassing essential concepts for Web-GIS development and proposes two novel features using OCL constraints to enhance the framework's capabilities. The framework also includes a customized tree editor and a graphical modeling tool that allows the easy modeling and visualization of any complex Web-GIS. Moreover, the framework provides an Aceleo transformation engine that automatically transforms models into executable Web code. The resulting source code is browser-ready without manual modifications. The proposed framework is validated with a real-world case study which demonstrates its effectiveness in reducing the overall development complexity, cost, and time.

## RE2026

**Title:** Comparison of Machine Learning approaches based on multiple channel attributes for authentication and spoofing detection at the physical layer

**Authors:** Andrea Stomaci, Dania Marabissi, Lorenzo Mucchi

**Presenter:** Andrea Stomaci, University of Florence, Italy

16:25-16:40

**Abstract:** The aim of this study is to assess the effectiveness of Physical Layer Authentication (PLA) in securing IoT nodes. Specifically, we present a PLA framework based on wireless fingerprinting, where the legitimated node is distinguished from potential attackers by exploiting the unique wireless channel features. To achieve this objective, we employ various machine learning approaches for anomaly detection, making use of a wide range of channel attributes in time-varying conditions. In particular, four different ML strategies in their one class version have been considered and compared: decision-tree, kernel-based, clustering and nearest neighbours. Our study highlights advantages and disadvantages of each method, considering parameters optimization, training requirements and time complexity. Results show that the use of multiple-attributes allows to achieve accurate detection performance. In particular, our results reveal that the kernel-based solution is the one that achieves best results in terms of accuracy, but the nearest neighbour solution has very similar performance with a significant advantage in terms of complexity and no need for training, making it more suitable for time-varying contexts, and a promising choice for securing IoT nodes through PLA based on wireless fingerprinting. The other two alternatives have somewhat lower performance but low complexity. This research contributes valuable insights into enhancing IoT security through PLA techniques.

## RB503

**Title:** A survey of manifold learning and its applications for multimedia

**Authors:** Hannes Fassold

**Presenter:** Hannes Fassold, JOANNEUM RESEARCH, Austria

16:40-16:55

**Abstract:** Manifold learning is an emerging research domain of machine learning and helps to overcome the limits of standard neural networks which are restricted to Euclidean spaces. In this work, we give an introduction into manifold learning and how it is employed for important application fields in multimedia like similarity search, image classification, synthesis & enhancement, video analysis, 3D data processing and nonlinear dimension reduction. Furthermore, we present available open source software frameworks for manifold learning.

## **RB2001-A**

Title: Remote 6 DoF Simultaneous Localization And Mapping for network-enabled low-compute devices

Authors: Piotr Wójcik

Presenter: Piotr Wójcik, 1000 realities sp. zo.o., Poland

16:55-17:10

Abstract: This paper presents a 6 DoF real time Simultaneous Localization and Mapping (SLAM) system operating entirely outside of the localized device, developed by 1000 realities as part of the "Edge Realities 2.0" project. The main novelty is the ability of our SLAM system to provide visual or visual-inertial inside-out tracking and mapping to a device from an entirely external server, based solely on the raw input from the device's single RGB camera and IMU transmitted over a network. The output is a 6 DoF pose that is in turn transmitted back to the device in real time. This manner of operation results in enabling a wide range of low-compute, network-enabled devices with various capabilities derived from SLAM (e.g. autonomous navigation, augmented reality etc.), as well as significant compute offload and battery life extension for devices already capable of running onboard SLAM. Our experiments indicate that the system is capable of robust and reliable operation over commercial networks with a wide variety of devices, providing state of the art accuracy, with the additional capabilities of mapping and tracking environments of unprecedented scale, as well as providing out of the box accurate shared SLAM for multiple devices.

## Universal Studios Japan



Universal Studios Japan (Japanese: ユニバーサル・スタジオ・ジャパン, English: Universal Studios Japan) is located in Osaka, Japan. It is one of the five Universal Studios theme parks in the world. Its design is similar to that of Universal Studios in Orlando, USA, and is partially mobile. The games are the same, including the classic facilities "Jurassic Park", "Terminator", "Spider-Man", "Jaws", and other parks such as "Super Nintendo World" and "The Wizarding World of Harry Potter". According to the "Global Theme Parks and Museums Report" released in 2022 by the Themed Entertainment Association (TEA) and the well-known international engineering consulting company AECOM, Universal Studios Japan ranks fifth among global theme parks.

Universal Studios Japan has a total of 10 parks. The tenth park, The Wizarding World of Harry Potter, opened on July 15, 2014. It is a park modeled on the Wizarding World of Harry Potter at Islands of Adventure in Florida and Universal Studios Hollywood.

## Osaka Castle



Osaka Castle, also known as "Jincheng" or "Jincheng". Located in the Osaka Castle Park in Chuo District, Osaka City, Japan (formerly part of Settsu Province Higashi-sei County), it is ranked among the three largest cities in Japan along with Nagoya Castle and Himeji Castle.

During the Momoyama period when the world was unified, it was the residence of Toyotomi Hideyoshi and the center of the Toyotomi regime. Later, Tokugawa Ieyasu destroyed the Toyotomi family with two battles of Osaka (Winter Formation and Summer Formation). After that, the Edo shogunate used Osaka Castle as an important base to control the daimyo of Western Japan.

The perimeter of the castle including the castle town is about 7.8 kilometers, which is equivalent to the early Edo Castle (inner castle) (the perimeter of the outer castle including the castle town in the late Edo period is about 15.8km). During the Toyotomi period, Osaka Castle was the largest castle in Japan.

**Thank You and**

**See You Next Year**

