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Preface

It gives us great pleasure to welcome you to Lahore for the 4th International Conference on Innovative Computing (ICIC) 2021 being organized by the University of Management and Technology. Already in its fifth year, ICIC is a young multi-topic conference that seeks to bring together academics and practitioners from industry to exchange novel ideas and share observations in the field of Information and Communication Technology. This year ICIC received a total of 259 research articles. After a rigorous review process, 148 high quality papers were accepted that corresponds to an acceptance rate of 55 %. We are pleased to share that scholars from 18 different countries have opted to present their research through this platform.

The invited foreign speakers include Professor Yangquan Chen from University of California, Dr. Omer Hussein Alhazmi from Taibah Un1iversity, Dr. Marton Gergely from United Arab Emirates University, Dr. Hoshang Kolivand from Liverpool John Moores University, Dr. Ameena Saad Al-Sumaiti from Khalifa University, Dr. Sunny Joseph Kalayathankal from Jyothi Engineering College India, Prof. Dr. Gerassimos Barlas from American Univeristy of Sharjah, Prof. Dr. Imran Zualkernan from American Univeristy of Sharjah, Dr. Mohd Shafry Mohd Rahim from Universiti Teknologi Malaysia.

The national keynote speakers include Dr. Muhammad Atif Tahir from National University of Computer and Emerging Sciences, Karachi, Pakistan, Dr. Arif Mehmood from Information Technology University, Dr. Safee ullah Ch. From Lahore University of Management Sciences, Dr. Riaz ul Amin from Balochistan University of Information Technology, Engineering and Management Sciences, Dr. Khurram Shahzad from Punjab University College of Information Technology, Dr. Yasir Niaz Khan from University of Lahore, Dr. Kifayat Ullah Khan from National University of Computer & Emerging Sciences, Dr. Usama Ijaz Bajwa from COMSATS University Islamabad (CUI), Lahore Campus, and Dr. Syed Waqar ul Qounain Jaffry from Punjab University College of Information Technology.

The conference is made possible due to the efforts of many people. We would like to express our gratitude to the members of the Technical Program Committee and the external reviewers for their efforts in reviewing submissions, as well as to the Organizing Committee for their behind the scene efforts. The conference chairs Dr. Malik Tahir Hassan, Dr Khurram Shahzad, Dr. Shahzia Saqib, Dr. Adnan Khan, Dr. Usama Bajwa, Dr. Atif Alvi, Dr. Sajid Mahmood, Dr. Asim Qureshi, Dr. Ghulam Rasool, and Dr. Mubasher Baig also helped us in many ways, which we appreciate. We would also like to acknowledge the role of sponsors (UMT) and collaborators for their generous support. Finally, the conference would not be possible without the excellent contributions by the authors.

We thank the authors for being a part of ICIC 2021. We hope that this program will further stimulate research in the exciting field of Information and Communication Technology. It is our great privilege to serve recent developments in the field through this program.

November 9-10, 2021

Muzammil Hussain
Alisha Younas

Table of Contents

A Comprehensive DCell Network Topology Model for a Data Center……..…1
Antonio Cortés Castillo

Analysis of Corpus Development for Urdu Language……..…...….7
Asma Naseer, Tanzeela Shakeel, Kinza Arshad, Zeenia Ather

Artificial Intelligence and Criminal Culpability……..……...…12
Khushboo Farid Khan, Atif Ali, Zulqarnain Farid Khan, Hajra Siddiqua

Autonomous object detection and tracking robot using Kinect v2…….…….19
Syed Mujtaba Mehdi, Rizwan Ali Naqvi, Syed Zin Mehdi

An Integrated Framework for Sentiment Analysis of Giant Cold Drinks Companies…….....31
Tahir Mohammad Ali, Ali Nawaz, Attique Ur Rehman

Modeling the Strategies to Control the Impact of Photochemical Smog on Human Health……..….36
Aqsa Chaudary, Mian Muhammad Mubasher, Syed Waqar ul Qounain

Vehicle Tracking System and Speed Estimation Utilizing Optimal Technique……..……46
Waheed Javed, Muhammad Danish, Hassan Tahir, Hina Bashir

Heuristic and think aloud method to Evaluate the low fidelity prototype Of game-based language learning Application……..……..….53
Kashif Ishaq, Fadhilah Rosdi, Nor Azan Mat Zin, Adnan Abid

A Systematic Literature Review on Cognitive Radio Networks……...…...…...64
Tanzeela Shakeel, Shanzay Gul, Shahista Habib, Ateeqa Naseer

Implementation of Blockchain in Healthcare: A Systematic Review……..……...75
Ammara Karim Noon, Omer Aziz, Insia Zahra, Muhammad Anwar

Requirements Elicitation for Game-based Language Learning Application…….…….86
Kashif Ishaq, Fadhilah Rosdi, Nor Azan Mat Zin, Adnan Abid

Blockchain and Its Implementation for Charitable Organizations……..……96
Iqra khalil, Omer aziz, Numan asif

Usability Evaluation of Blind and Visually Impaired Interface in Solving the Accessibility Problems……....106
Azeem Shera, Muhammad Waseem Iqbal, Muhammad Raza Naqvi, Syed Khuram Shahzad, Muhammad Hasnain Sajjad, Abdul Rehman Shafqat, Muhammad Mohsin Saeed

DarkNet-19 based Decision Algorithm for the Diagnosis of Ophthalmic Disorders……..…..…....113
Zainoor Ahmad Choudhry, Hira Shahid, Syed Zohaib Hassan Naqvi, Sumair Aziz, Muhammad Umar Khan

Genome Scale Phylogenetic Analysis Differentiates SARS-CoV-2 Strains in Pakistani and Indian COVID-19 Patients with and without Travel History……..……120
Hafiz Abdul Rehman, Farheen Ramzan, Zarrin Basharat, Muhammad Shakeel, Muhammad Usman Ghani Khan, Ishtiaq Ahmad Khan

China-Pakistan Economic Corridor (CPEC): Exploring the breakthrough of different Social Media Platforms in CPEC…….…...130
Ayesha Siddiqua, Tayyaba Anees, Ateeqa Naseer, Afifa Wajid, Nosheen Manzoor, Tayaba Anjum

Role of Blockchain Technology in Healthcare: A Systematic Review……..…...137
Waheed Javed, Fatima Aabid, Muhammad Danish, Hassan Tahir, Rida Zainab

A Survey on Phishing Emails Detection Techniques……..…….....144
Amgad Muneer, Rao Faizan Ali, Abdo Ali Al-Sharai, Suliman Mohamed Fati

Design and Development of Low Cost, Wireless Controlled, 3D Prosthetic Hand using Flex Sensors……150
Syed Ammad Ali Hiader, Ali Nasir, Muhammad Ameen, Ali Raza, Aashir Waleed, Zeeshan Ali

EPS: An earthquake prediction system using Federated Learning……..…..157
Rabia Tehseen, Muhmmad Shoaib Farooq, Adnan Abid

VQ Based Comparative Analysis of MFCC and LPC Speaker Recognition System……..…….165
Iqra Naveed, Farwa Saher, Muhammad Nadeem Ali, Muhammad Sajid Farooq, Taimoor Hasan, Aqsa Iftikhar

Development of Time and Energy Efficient, Smart Parking System……..…..172
Mussarat-ul-Ain, Muhammad Talha Usman, Ahmad Hassan, Ali Akbar, Aashir Waleed, Abdullah Hasham

Basic Structure of Natural Language Processing Applied on Multiple Domains: Review……...…….180
Taimoor Hassan, Abrar Ahmad, Mehmood Anwar, Muhammad Nadeem Ali, Farva Saher, Muhammad Sajid Farooq

A Model Driven Framework for Standardizing Requirement Elicitation by Quantifying Software Quality Factor…….…….....187
Sadia Khalid, Uzair Rasheed, Muhammad Abbas

Issues and Algorithm of Distributed Shared Memory……...……...…….194
Mian Basam Ahmad, Sundas Sagheer

Heart Attack Disease Data Analytics and Machine Learning……..……..…...203
Muhammad Nabeel, Mazhar Javed Awan, Mohsin Raza, Hooria Muslih-ud-Din, Shumaila Majeed

An Analysis of Requirement Engineering Practices in Pakistani Software Houses……..……209
Ateeqa Naseer, Sadia Khalid, Tayyaba Anees, Tanzeela Shakeel, Mehr-un-Nisa, Fasiha Ashraf

Comparative Study of Comparison-based Sorting Algorithms…….…….…..215

Zainab Inayat, Rabia Sajjad

A Systematic Literature Review: Usage of Logistic Regression for Malware Detection……..……223
Zeeshan Akram, Mamoona Majid, Shaista Habib

Role of Data Mining and Machine Learning in Software Reusability……...……231
Rabia Qayyum, Joveria Rubaab, Umer Riaz, Dr. Fahim Arif

Application of Generalized Relevance Linear Vector Quantization for Diabetes Diagnosis……...…239
Alaa Ali Hameed, Akhtar Jamil, Zeynep Orman, Syed Attique Shah

Comparison of Machine Learning Classifiers for Breast Cancer Diagnosis……...……244
Muhammad Asad Arshed, Wajeeha Qureshi, Muhammad Rumaan, Muhammad Talha Ubaid, Abdul Qudoos, Muhammad Usman Ghani Khan

Modified Nominal Group Technique (NGT) for Evaluating HyTEE Model (Hybrid Software Change Management Tool with Test Effort Estimation)……..……..250
Mazidah Mat Rejab, Nurulhuda Firdaus Mohd Azmi, Suriayati Chuprat

A Textile Image Classification based on Texture and Shape Features……...……...258
Muhammad Kashif Nazir, M. Ahmad Nawaz Ul Ghani, Aysha Ashraf, Syed Mudassar Alam, Rao Umer Farooq, Zohaib Latif

Comparison of Ensemble Techniques for Prediction of Pedestrian Desired Direction……...…..……264
Ahmad Ali, Shaharyar Kamal, Waqas Nawaz

Influential Factors for Tourist Profiling for Personalized Tourism Recommendation Systems– A Compact Survey…….…….270
Maryam Kamal, Ioannis Chatzigiannakis.

Automatic Helmet Detection using EfficientDet……..……..…….276
Muhammad Talha Ubaid, Amara Kiran, Muhammad Tayyab Raja, Umme Aliza Asim, Abdou Darboe

Internet of Everything: Applications, and Security Challenges…….…...284
Muhammad Sajid, Ali Harris, Shaista Habib

Comparative Analysis of Data Driven Prediction Modeling Strategies for Aquaculture Healthcare……...….293
Shahzad Amin, Francesca Cuomo, Maryam Kamal

An Effective Technique for Detecting Defecting Parts of Fabric in Digital Image……...……299
Muhammad Arslan Rauf, Muhammad Abubakar, Ubaid Ullah, Nazeef Ul Haq

Multi-criteria Dual-View Attention Network for Rating Prediction……...…305
Salem Moqa, Muhammad Ismail, Ali Zakir, Jianfeng Lu

Detection of Phishing Websites through Computational Intelligence…….….313

Muhammad Taseer Suleman, Amir Ali

A Novel Bio-Inspired Path Planning for Autonomous Underwater Vehicle for Search and Tracing of Underwater Target……...320
Adnan Elahi Khan Khalil, Shahzad Anwar, Ghassan Husnain, Atif Elahi, Zhang Dong

Implementation and Comparative Analysis of Semi-Automated Surveillance Algorithms in Real Time using Fast-NCC……..…….…….…….…….……327
Omer Khan, Raheel Muzzammel, Umair Tahir, Omar Azeem, Rabia Arshad and Muhammad Umer

Kett Mangoes Detection in the Gambia using Deep Learning Techniques…….....…….333
Muhammad Talha Ubaid, Abdou Darboe, Fred Sangol Uche, Adama Daffeh, Muhammad Usman Ghani Khan

Comparative Analysis of Low Complexity Signal detection methods in Uplink Massive MIMO……...…….341
Muhammad Masoom Ul Hussan Rehan

Automated And Dynamic Access Control Management in OSN…….……348
Sohail Abid, Imran Daud

A Majority Voting based Ensemble Approach of Deep Learning Classifiers for Automated Melanoma Detection……..…….…..354
Khadija Safdar, Shahzad Akbar, Ayesha Shoukat

COVID-19 SOP's Violations Detection in Terms of Face Mask Using Deep Learning…….…...……360
Muhammad Talha Ubaid, Muhammad Zeeshan Khan, Muhammad Rumaan, Muhammad Asad Arshed, Muhammad Usman Ghani Khan, Abdou Darboe

Exploiting Temporal Information of Videos for Facial Landmark Detection: A Modified SDM…….....367
Iqra Rashid, Sana Basharat, Faria Ferooz, Syed Fawad Raza

Effect of Lean Software Development on the Small Organizations Using LSD Approach……...……377
Zaeem Anwaar, Farasat Ullah Khan, Mehwish Naz, Muhammad Usman Farooq

Machine learning in the prediction of nonsyndromic Orofacial Cleft in Pakistan……...……..385
Javaria Qadeer, Faisal Bukhari, Waheed Iqbal

A Deep Learning-based Automatic Method for Early Detection of the Glaucoma using Fundus Images…….391
Ayesha Shoukat, Shahzad Akbar, Khadija Safdar

Assessment of Critical Challenges Faced by Students and Significance of Cutting Edge Technologies in Pakistan Education during COVID-19 Pandemic……..……..397
Muhammad Sohail, Muhammad Bilal, Abid Bashir, Muhammad Farooq, Muhammad Ali Hussain

Factors Effecting Businesses due to Distributed Denial of Service (DDoS) Attack……..……404
Hafsa Mateen, Malik Shahzad Kaleem Awan

A Study on Detection of Chronic Renal Failure Based on Machine Learning……..……411
Usama Pervaiz, Dr. Faisal Bukhari, Dr. Waheed Iqbal

Energy Efficient Millimeter Wave Backhauling in 5G Heterogeneous Network……..……...421
Abdul Qahar, Kartinah Zen, Muhammad Anwar, Awais Khan

IoT Based Smart Environmental Monitring System Using ESP32/We-Mos D1 Mini & ThingSpeak…….....427
Muhammad Afzal, Hafiz Ali Hamza Gondal, Muhammad Najeeb Ullah, Saad Akbar

Smart city technologies, key components, and its aspects…….....433
Usama Tariq Khan, Muhammad Fahad Zia

An Embedded Solution of Gaze Estimation for Driver Assistance using Computer Vision……..…...443
Hafiz Umer Draz, Muhammad Ikram Ali, Muhammad Usman Ghani Khan, Muneeb Ahmad, Salman Mahmood, Muhammad Abdullah Javaid

IoT Based Smart Gloves for Women Safety……...…….…….450
Zahid Ali, Majid Ali Khan, Omar Bin Samin, Musadaq Mansoor, Maryam Omar

A Seamless Handoff Scheme for Mobility Management in MPLS based Wireless Network……..…....456
Zubair Hussain, Peer Azmat Shah, Sohail Abid

Indication of Health Status Using Machine Learning Linear Regression and Random Forest…….....464
Arslan Asif, Muhammad Nabeel, Mazhar Javed Awan, Muhammad Ahsan, Abdul Hannan, Shahroz Abbas

Fast Village Finder…….....470
Tayaba Anjum, Kashif Murtaza, Tayyaba Anees, Ahsan Ali

An Analysis of Initialization Techniques of Particle Swarm Optimization
Algorithm for Global Optimization…….…….…476
Waqas Haider Bangyal, Zahra Aman Malik, Iqra Saleem, Najeeb Ur Rehman

Evaluation of Activation Functions in CNN Model for Detection of Malaria Parasite using Blood Smear Images……...…….……..482
Ehsan ullah Khadim, Syed Attique Shah, Raja Asif Wagan

Predicting Article Sentiment Analysis Impact in Twitter: A Case Study in the Field of Information Sciences…….……...……488
Asma Ahmad, Faisal Bukhari, Kamran Malik

Traits Measuring Metrics for the Members of Semantic Social Network……..……..….494
Rizwan Pervez Mir, Muhammad Shoaib Farooq

Innovative Computational Moulding Approach for Genomics……...…….……500
Mehnaz Sarwar, Hassaan Malik, Insia Zahra

A Study of Image Processing Methods for Investigation of Radiographs……...……..…507
Jahangir Jabbar, Hassaan Malik, Ali Haider Khan, Muhammad Umair Ahmad, Adnan Ali

Variable Generalization Evaluation of Supervised Learning Models for Detection of Spam Messages…....512
Muhammad Saad Shahbaz khan, Muhammad Osama Akbar, Hassaan Malik, Ali Haider Khan, Zubair Akbar

Reinforcement Learning for Dialogue Generation: A Systematic Literature Review……...……..……..519
Sameera Kanwal, Muhammad Shoaib Farooq

Deep Learning Approach to Diagnose Alzheimer's Disease through Magnetic Resonance Images…..…..…529
Muhammad Faraz Ahmad, Shahzad Akbar, Syed Al E Hassan, Amjad Rehman, Noor Ayesha

Sliding Mode Control of Quadrotor UAV Using Parabolic Sliding Surface…….....535
Abdul Rehman, Naveed Mazhar, Abid Raza, Fahad Mumtaz Malik

Symptoms Based Covid-19 Disease Diagnosis Using Machine Learning Approach…….…..…541
Muhammad Asad Arshed, Wajeeha Qureshi, Muhammad Usman Ghani Khan

Survey on Sentiment Analysis of User Reviews…….……..…547
Saba Naseem, Toqeer Mahmood, Muhammad Asif, Junaid Rashid, Muhammad Umair, Mohsin Shah

A survey on computational parametric analysis of incompressible nanofluids applications in solar energy systems…….553
Usman Inayat, Shaukat Iqbal, Tareq Manzoor

Optical Handwritten with Character Recognition……...…….…….562
Syeda Binish Zahra, Shanza Moaen, Sundus Munir, Arfa Hassan, Afrozah Nadeem, Muhammad Sajid Farooq

FLOSSC:A Computer Aided Tool for Detecting Corona Virus Infections through Chest X-Ray Images…....570
Umair Bin Ahmad, Farwa Javed, M. Omer Aftab, Ayesha Nasir, Arfa Hassan, Muhammad Sajid Farooq

Sentiment Analysis of Customer for Ecommerce by Applying AI……..……..…579
M. Omer Aftab, Umer Ahmad, Shahid Khalid, Amina Saud, Arfa Hassan, Muhammad Sajid Farooq

Facebook Marketing Analytics……..……..……586
Afifa Wajid, Mazhar Javed Awan, Faria Ferooz, Saba Shoukat, Maria Anwar, Maha Mazhar

Control of Grid-tied PV Powered Charging Station for Electric Vehicles……..……..…….592
Muhammad Waqas Naeem, Jameel Ahmad, Muhammad Adnan, Khalid Ijaz, Zawar Hussain, Faran Awais Butt

Applying Multidimensional Framework in Agile Software Development (MDFA)……..……..……599
Muhammad Ahsan Arshad, Anees Ur Rahman, Yasir Hafeez, Sajid Mahmood, Muhammad Islam, Muhammad Khateeb Khan

A Comprehensive Survey on Mobile Communication Generation…….…..……606
Farhan Nisar, Samad Baseer

Diverse Dynamic Routing Protocols Distribution in the Large Network with Route Redistribution Techniques using GNS3……..…..……..……612
Mehboob Nazim Shehzad, Dr.Usman Rauf Kamboh, Muhammad Danish Taqdees, Zain Waheed, Muhammad Usman, Ahmed Mateen Buttar

Measurements of deterministic propagation models through field assessments for long-term evaluation…...619
Zain Waheed, Usman Rauf Kamboh, Mehboob Nazim Shehzad, Muhammad Danish Taqdees, Muhammad Usman, Aroosa Fatima

The best path selection using ant colony optimization and message trust in IoV……..……...….625
Abdul Rehman, Mohd Fadzil Hassan, Bushra Naeem, Yew Kwang Hooi, Muhammad Shoaib Ali

A Deep Transfer Learning Approach for Automated Detection of Brain Tumor Through Magnetic Resonance Imaging……..……..……631
Sahar Gull, Shahzad Akbar, Ijaz Ali Shoukat

Comparative Study of Open Source Automation Testing Tools: Selenium, Katalon Studio & Test Project….637
Bismal Majeed, Saba Khalil Toor, Kanwal Majeed, Moazzama Nadeem Ahmad Chaudhary

Drone-Based Campus Throughput Measurement for Ground-to-Air Channel at 2.4 GHz…….…..……643
Muhammad Danish Taqdees, Usman Rauf Kamboh, Mehboob Nazim Shehzad, Zain Waheed, Muhammad Usman, Ahmed Mateen Buttar

Multi-Step Forecasting of Global Horizontal Irradiance Using Long Short-Term Memory Network for Solving Economic Dispatch Problem……....650
Qizal Ashfaq, Abasin Ulasyar, Haris Sheh Zad, Shibli Nisar, Abraiz Khattak, Kashif Imran

Usability Evaluation of FinTech Mobile Applications: A Statistical Approach……....…..659
Abdul Wahab, Talha Mahboob Alam, Muhammad Mehdi Raza

Adoption Barriers of E-Learning in Heigher Education Institutes (HEI's) of Developing Countries - A Systematic Literature Review…….…….669
Maila Mushtaq, Aster Noor, Nosheen Sabahat

Comprehensive review of malware detection techniques……..…677
Usman Inayat, Muhammad Fahad Zia, Fahad Ali, Syed Moshin Ali, Hafiz Muhammad Ashja Khan, Wafa Noor

Computational Optimization of Energy Storage System in Managing Distribution Feeder Overloading……683
Muhammad Fahad Zia, Usman Inayat, Sajid Mahmood, Ali Harris

Wireless Sensor Networks: Security, Threats, and Solutions……..……..…689
Usman Inayat, Fahad Ali, Hafiz Muhammad Ashja Khan, Syed Moshin Ali, Kiran Ilyas, Habiba Habib

Voice Over Internet Protocol: Vulnerabilities and Assessments ……...……..…695
Hafiz Muhammad Ashja Khan, Usman Inayat, Muhammad Fahad Zia, Fahad Ali, Taila Jabeen, Syed Moshin

Personality Based E-Recruitment and CV Ranking System Using Support Vector Machine Model Classification……..……..701
Muhammad Saad Shafiq, Faran Haider, Nosheen Sabahat

Web Usability and User Experience for Pakistani E-commerce websites……..……..……707
Urooj Arshad, Tahreem Yasir, Tanzeela Shakeel

Smartphone Interface Design Issues for Pakistani Older Adults..……..…..714
Anam Riaz, Tahreem Yasir, Tanzeela Shakeel

Availability Testing of IoT-Based Health Care Devices: A Survey..…….……..…….720
Saqlain Abbas, Mehwish Naz, Zaeem Anwaar, Muhammad Usman Farooq, Farasat Ullah Khan

Using kNN Algorithm for classification of Distribution transformers Health index……..……...…726
Jahanzaib Javid, Muhammad Ali Mughal, Mustansir Karim

Quality of Service Characterization for ZigBee Networks……..…..……733
Jawad Khan, Suhail Yousaf

Classification of Sentiments of the Roman Urdu Reviews of Daraz Products using Natural Language Processing Approach...……..…739
Muneeba Talat, Hira Asim, Ayesha Asmat

An Attribute Weight Estimation Using Particle Swarm Optimization and Machine Learning Approaches for Customer Churn Prediction…….…….……745
Samina Kanwal, Junaid Rashid, Jungeun Kim, Muhammad Wasif Nisar, Amir Hussain, Saba Batool, Rabia Kanwal

Classification of CT/MR Images using Convolution Neural Network……...……..…751
Syed M. Haider Shah, Noor Badshah

New local region-based model for inhomogeneous images with the simplex constraints of landmarks…...…758
Maryum Saeed, Noor Badshah, Hadia Atta

Digital Polio Vaccination System – A Proposal to Make Polio Free Pakistan……...…..…764
Samia Asloob Qureshi, Nosheen Sabahat

Teaching English and Science to the Deaf Students……..……771
Afnan Zafar, Hira Gull, Uzma Farooq, Mohd Shafry Mohd Rahim, Adnan Abid

Enhance Neighbor Discovery Protocol Security by Using Secure Hash Algorithm……...……..……777
Muhammad Usman, Usman Rauf Kamboh, Muhammad Danish Taqdees, Zain Waheed, Mehboob Nazim Shehzad, Hamza Zafar

Learning Based Approach for Facial Fiducial Points Prediction of Non Frontal Faces……..…..…785
Sana Basharat, Iqra Rashid, Syed Fawad Raza, Numan Asif, Ali Haider Khan, Muhammad Umair Ahmad

A Corpus for Measuring Retrieval Performance of Process Matching Methods……...…794
Ayesha Asmat, Afnan Iftikhar

Identification of factors effecting Covid 19…….…….800
Afifa Wajid, Faria Ferooz, Iqra Rashid

Covid-19 Detection by using Deep learning- based Custom Convolution Neural Network (CNN)…….…..…..806
Mazhar Javed Awan, Muhammad Wasif Imtiaz, Muhammad Usama, Amjad Rehman, Noor Ayesha, Hafiz Muhammad Faisal Shehzad

Role of Statistical Moments and Various Sequence- based Features in Predicting Protein Functions…...…...813
Muhammad Taseer Suleman

Analysis of Machine Learning Techniques for Detection Framework for DNA Repair Genes to help Diagnose Cancer: A Systematic Literature Review…….……..…819
Muhammad Ayaz Farid Shah, Sami Ud Din, Asghar Ali Shah

Analysis of Machine Learning Techniques for Detection of Tumor Suppressor Genes for Early Detection of Cancer: A Systematic Literature Review…….……..…829
Sami Ud Din, Muhammad Ayaz Farid Shah, Asghar Ali Shah

Predicting PTMs through Statistical Moments and Various Sequence-based Features……..……...…839
Muhammad Taseer Suleman

Mutation Detection in Genes Sequence Using Machine Learning…….……...…845
Syed Muhammad Shehryar, Muhammad Ammar Shahid, Asghar Ali Shah

Analysis of Machine Learning techniques for identification of post translation modification in protein sequencing: A Review…….……..…….…..851
Asghar Ali Shah, Muhammad Khurram Ehsan, Ali Sohail, Sheeba Ilyas

Encoder decoder based CNN for single image dehazing with a semi-supervised approach…….……...……..857
Muhammad Ismail, Ali Zakir, Salem Moqa, Jianfeng Lu

PAT-PseAAC: Prediction of acetyl threonine in protein sites with statistical moments and chou's 5 step rule…….……..864
Sawabia Naseem

HIV-1 Protease Cleavages……..…….…873
Muhammad Abdullah, Seher Ansar Khawaja, Muhammad Farooq

E-Challan System Implemented in Lahore Using Digital Image Processing……..…..……879
Muhammad Zunnurain Hussain, Muhammad Zulkifl Hasan, Nadeem Sarwar, Junaid Nasir, Naila Aslam

Code Vision: Learning Mobile Application…….……885
Muhammad Zunnurain Hussain, Muhammad Zulkifl Hasan, Nadeem Sarwar, Junaid Nasir, Naila Aslam

A Review on Fog Computing for the Internet of Things……..……..……..…..892
Waheed Javed, Muhammad Danish, Fatima Aabid, Syeda um e Rubab, Sidra Ikram, Khawaja Ubaid ur Rehman

Cloud application importance and challenges: A Systematic Review…….……...…..898
Muhammad Zunnurain Hussain, Muhammad Zulkifl Hasan, Nadeem Sarwar3, Junaid Nasir, Naila Aslam

Detection of Genetic Colon Cancer……..……904
Jabar Saleem, Amna Arsahd

Prediction model for IcRNA aubcellular localization using machine learning…….....……913
Zareen Kalim, Amna Arshad

Protien-DNA binding sites Prediction…….……..…….……..923
Sania Srhar, Amna Arshad, Ahsan Raza

Two class weather classification with bagging technique…..……..…..……..…..…933
Haider Ali Baig, Amna Arshad, Ahsan Raza

Classification of lncRNA and mRNA using k-mers and random forest……..…...…939
Rana M. Nadir, Hafsa Mateen, Saif u Din

Recent advancements in predicting protein phosphorylation sites using machine learning methods……947
Adil Yousaf, Muhammad Rashid Rasheed, Muhammad Arif, Abdullah Yousafzai, Muhammad Kabir, Saeed Ahmed

Deep Learning Approach For Facial Age Recognition……..…….……..…953
Amgad Muneer, Rao Faizan Ali, Abdo Ali Al-Sharai

Design of a predictor for COVID-19 misinformation prediction……...……...…959
Muhammad Anzer Chughtai, Jun Hou, Huaqiu Long, Qianmu Li, Muhammad Ismail

A Fuzzy Expert System Design for Diagnosis of Prostate Cancer…….……..…969
Muhammad Sheharyar Liaqat, Ihtisham ul Haq, Faisal Riaz, Mubashar Hussain

Body-worn Hybrid-Sensors based Motion Patterns Detection via Bag-of-features and Fuzzy Logic Optimization…….…….…….…….…….…….…….…….…….…….…….…….975
Madiha Javeed, Ahmad Jalal

A Novel Deep Learning Model for Understanding Two-Person Interactions Using Depth Sensors…….....…982
Manahil Waheed, Madiha Javeed, Ahmad Jalal

Crowd Anomaly Detection in Public Surveillance via Spatio-temporal Descriptors and Zero-Shot Classifier……..…990
Faisal Abdullah, Madiha Javeed, Ahmad Jalal

Agent based Model for Zakat Distribution…….…….…998
Alisha Younas, Muzammil Hussain, Marrium Anam, Syed Waqar Jaffry

Green Awareness Rating Scale (GARS) Development to Extend TAM……....……1004
Sultana Ashiq

Internet of Things: Security Challenges and its Preclusion Methods…….……...……..……1010
Rabia Sajjad, Kamran Arshad

Intelligent Analytical String Search Algorithm…….…..……1017
Kamran Arshad

Comprehensive analysis of machine learning based predictors for identifying DNase I hypersensitive sites…….…….…….…….…….…….…….…….……1023
Muhammad Rashid Rasheed, Mehwish Gill, Muhammad Asif Subhani, Muhammad Arif, Saeed Ahmed, Muhammd Kabir

IoT Based Fish Stress Factor Monitoring System……...……..……..1029
Abdul Razzaq, Mohsin Raza, Fahad Saif, M. Salman Sajid, Naheed Bano, Ali Haider Khan

Rheumatoid Arthritis Genes Classification Using ML Classifiers……...…….….1035
Anam sana, Seher Ansar Khawaja, Muhammad Farooq

Blending Project Centric Approach With Gamification For Teaching Computing Courses…….....…..……1041
Muhammad Ishaq, Adnan Abid, Kamran Abid

Experience Report on Improving Software Engineering Education…….…….…..……1046
Affan Yasin, Rubia Fatima, Lin Liu, Ziqi Wei, Wang Jianmin

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KEYNOTE SPEAKERS

1. Dr. Omer Hussein Alhazmi, *Associate Professor of Computer Science*

Taibah University

Omar H. Alhazmi received the Ph.D. degree from Colorado State University, in 2007. He is currently a Professor with the Department of Computer Science, Taibah University, Medina, Saudi Arabia. He has worked as a consultant to several organizations and the e-government national program. His research interests include software vulnerabilities, security, reliability of software, and the Internet of Things.

Title: *Secure IoT Resources with Access Control over RESTful Web Services*

Abstract: With the Internet of Things (IoT), the number of connected devices on the internet has increased to billions, and this number is expected to grow exponentially in the coming years. Services and applications based on the IoT are expected to expand to cover more areas in the near future. Performance, connectivity and security are very important aspects of such an expansive environment. In order to enhance the performance and security of the IoT, a secure and cost-effective model for IoT applications that is based on Message Queue Telemetry Transport (MQTT) is proposed. This model addresses the IoT security challenges primarily by moving access control and data management from the MQTT broker to a fog server. The performance of the proposed model is validated by multiple metrics; and the obtained results show that it can be deployed successfully in the implementation of IoT applications to enhance both the IoT's security and performance.

2. Dr. Marton Gergely, *Assistant Professor Information Systems and Security-(CIT)*

United Arab Emirates University

Marton Gergely holds a PhD in Business Administration, with an emphasis in Information Technology, from The University of Texas at San Antonio. Prior to his doctoral studies, Marton earned an MS in Management of Technology from the same establishment, and completed his BS in Engineering Science, with a specialization in Mechanical Engineering, at Trinity University. His current research interests include Digital Piracy, Social and Cognitive Psychology in Technology Use, Cyber Law and Ethics, as well as Research Methods and Social Desirability Bias

Title: *Dynamic-informed consent: A potential solution for ethical dilemmas in population sequencing initiatives*

Abstract: While the majority of population-level genome sequencing initiatives claim to follow the principles of informed consent, the requirements for informed consent have not been-well defined in this context. In fact, the implementation of informed consent differs greatly across these initiatives - spanning broad consent, blanket consent, and tiered consent among others. As such, this calls for an investigation into the requirements for consent to be "informed" in the context of population genomics. One particular strategy that claims to be fully informed and to continuously engage participants is called "dynamic consent". Dynamic consent is based on a personalized communication platform that aims to facilitate the consent process. It is oriented to support continuous two-way communication between researchers and participants. In this paper, we analyze the requirements of informed consent in the context of population genomics,

review various current implementations of dynamic consent, assess whether they fulfill the requirement of informed consent, and, in turn, enable participants to make autonomous and informed choices on whether or not to participate in research projects.

3. Professor Yangquan Chen, *Mechanical Engineering, University of California, Merced*

YangQuan Chen earned his Ph.D. from Nanyang Technological University, Singapore, in 1998. He was a faculty of Electrical Engineering at Utah State University from 2000-2012. He joined the School of Engineering, University of California, Merced in 2012 teaching "Mechatronics", "Engineering Service Learning" and "Unmanned Aerial Systems" for undergraduates and "Fractional Order Mechanics" and "Nonlinear Controls" for graduates. His current research interests include mechatronics for sustainability, cognitive process control, small multi-UAV based cooperative multi-spectral "personal remote sensing" and applications, applied fractional calculus in controls, modeling and complex signal processing; distributed measurement and distributed control of distributed parameter systems using mobile actuator and sensor networks. He has been the Co-Chair for IEEE RAS Technical Committee (TC) on Unmanned Aerial Vehicle and Aerial Robotics (2012-2018).

Title: *Stability analysis of nonlinear Hadamard fractional differential system*

Abstract: The stability of the zero solution of a class of nonlinear Hadamard type fractional differential system is investigated by utilizing a new fractional comparison principle. The novelty of this paper is based on some new fractional differential inequalities along the given nonlinear Hadamard fractional differential system. A comparison principle employing the new fractional differential inequality for scalar Hadamard fractional differential system is presented. Based on the new comparison principle, some sufficient conditions for the (generalized) stability and the (generalized) Mittag-Leffler stability are given.

4. Dr. Hoshang Kolivand, *Assoc Prof in Intelligent Mixed Reality*

University: Liverpool John Moores University, UK Computer Science

Hoshang Kolivand is Senior Lecturer in Computer Graphics at the Department of Computer Science, Liverpool John Moores University, UK. He received his MSc degree in Applied Mathematics and Computer Science from Amirkabir University of Technology, Tehran, Iran, and his PhD from Universiti Teknologi Malaysia (UTM) in 2013. His background is in 3D maths & Computer Graphics in particular Augmented and Virtual Reality. Over 150 international publications in the area of 3D visualisation, immersive technology & human Computer Interaction. A global leader in this field invited to address the current & future advances of immersive technology in several high ranked international events.

Title: *Current and Future of Directions of Augmented and Virtual Reality*

Abstract: There is no doubt that Augmented and Virtual Reality (AR/VR) has changed the world recently and has the potential to become a fascinating widespread requirement in daily life. In about two decades, AR/VR has turned into one of the most attractive topics involved in a variety of topics attempting to obtain satisfactory results. In this speech, I am going to present what I have done so far with AR and VR and new technologies. Current advances and future directions of AR/VR and wearable devices will be discussed with an eye on revenue of this technology. How to engage our current research with new technology to enhance our current research will be the next part of my speech.

5. Dr. Kashif Nisar, *SMIEEE, Associate Professor, Former Vice-Chair IEEE Sabah Subsection, Malaysia*

Currently, he is serving as an Associate Professor at the Faculty of Computing and Informatics at University Malaysia Sabah, KK, and Sabah, Malaysia. He has completed his Ph.D. as a candidate with full funding at the Universiti Teknologi PETRONAS, Malaysia, majoring in Computer Networks and Information Technology. He has done Post-Doctoral at Auckland University of Technology, Auckland, New Zealand. In 2014, He served as a Guest Professor at Fernuniversität Hagen, Germany, fully funded by DAAD. He holds several visiting professor positions at well-known universities such as McMaster University, Hamilton, ON, Canada, University of Auckland, New Zealand, Panevezys University of Applied Sciences, Lithuania, Waseda University, Tokyo, Japan and Hanyang University, Seoul, South Korea.

Title: *Future industry 4.0 & iot: current status, future trends & open issues*

Abstract*:* Industry 4.0 will allow to exploit pillars such as the Internet of Things (IoT), Big Data and data analytics, augmented reality (a virtual representation of the real world), cyber security, collaborative robots, additive manufacturing, cloud computing, artificial intelligence, and finally, 5G networks. The physical systems become Internet of Things (IoT), communicating and cooperating both with each other and with humans in real time via the wireless web. According to The World Economic Forum (WEF), an estimated 65% of kids enrolling in primary education today will end up working in jobs that haven't been created yet. With an exponential growth of the following technologies that will drive Industry 4.0 additive manufacturing or 3D printing, sensor technologies, nanotechnology, artificial intelligence, robotics and drones. There is no doubt that 5G will be of great help but it will be important to add that new technologies will appear and Industry 4.0 needs a communication network technology that satisfies the industry over time, heterogeneity, security, and protection of industries. Future trends: Industry 4.0 makes a great change of perspective; the core of Society 5.0 focuses on people as fundamental axis of the production sector. Both production and marketing fields agree that beyond the focus of Industry 5.0 is the Society 5.0. In Society 5.0, the products or services offered will be customized to the customer needs. Industry 4.0 is a name for the current trend of automation and data exchange in manufacturing technologies. It includes cyber-physical systems, the IoT Communication, cloud computing, games, tangible technologies, mobile media and social and object-oriented research. The Internet represents one of the most successful examples of the benefits of sustained investment and commitment to research and development of information infrastructure. Information Centric Networking (ICN) is a new paradigm where future Internet network communications are accomplished by requesting named content, instead of sending packets to destination addresses. Named Data Networking (NDN) and Content-Centric Networking (CCN) are two prominent ICN architectures. ICN can provide tangible benefits to most stakeholders in an Internet that will be engineered according to its prevailing use over network. The ICN is an approach to evolve the Internet infrastructure to directly support accessing Named Data Objects (NDOs) as a first-order network service.

6. Dr. Ameena Saad Al-Sumaiti, *Associate Professor, Khalifa University, Electrical Engineering and Computer Science*

Dr. Ameena Al-Sumaiti received her Bachelor's degree in Electrical Engineering (Communication Track) from the United Arab Emirates University in 2008. She obtained her Master of Applied Science and Ph.D. in Electrical and Computer Engineering (Power and Energy) from the University of Waterloo in 2010 and 2015, respectively. She was a Visiting Professor at Massachusetts Institute of Technology in 2017. Dr. Al-Sumaiti is a recipient of a number of awards including the University of Waterloo Graduate Scholarship Award, UW Faculty of Engineering Graduate Scholarship Award, Provost Doctoral Entrance Award for

Women, UW/NSERC Graduate Scholarship Award, Masdar Scholarship Award, Her Highness Sheikha Fatima Bint Mubarak Award, United Arab Emirates University Award, UAEU Honor Student Program Award, Creativity Club Award, Al-Maktoum Institute Award, Abu Dhabi Education Council Award and Photography Competition Award, etc.

Title: *The power of computation in planning Renewable Energy Integration in Smart Grid*

Abstract: Smart grid is undergoing a transition into renewable energy era. With The United Nations' sustainable development goal (SDG 7) aiming for "affordable, reliable, sustainable and modern energy for all", the revolution into "100% renewable energy"; would facilitate meeting this target. One of the greatest challenges with the penetration of renewable energy systems into the smart grid is their uncertainty in power generation adding further uncertainty to the power system operation. To mitigate this challenge, innovative computing can be deployed to utilize such uncertainty in planning such systems integration into the grid. In this keynote speech, renewable energy advanced data modelling method will be presented first. Next, the power of computation in generating data resembling the behavior of renewable energy will be discussed. Then, the size and suitability of data in planning renewable energy systems into the grid will be discussed.

7. Dr. Sunny Joseph Kalayathankal, *Principal (Professor &Dean of Research), Jyothi Engineering College*

He is a professor and Dean (Research) in Jyothi Engineering College, Cheruthuruthy, Thrissur, Kerala, India Approved by AICTE & Affiliated to APJ Abdul Kalam Technological University. He is also the former Head of the Department and Associate Professor in the Department of Mathematics, K.E.College, Mannanam, Kottayam, Kerala, India. He has completed 33 years of Teaching service included 16 years of research experiences. He graduated from University College, Thiruvananthapuram, Kerala University in 1986. He took his B.Ed. degree from Calicut university in 1989, MPhil degree from Kerala University in 1993, the area of study was: Non- Negative Matrices. He has also completed M.Tech IT. He has completed his second Ph.D. from Bharathiar University, Coimbatore in 2018, the thesis was titled "Fuzzy Logic & Decision Making".

Title: *Fuzzy computing and decision making applications in the real world*

Abstract: The thought process involved in the act of decision making is a complex array of streaming possibilities in which a person selects or discards information made available from diverse sources. In doing so one is led by a meaningful analysis of available information and optimal selection out of several apparently equi-efficient decisions. Since Zadeh (1965) published the fuzzy set theory as an extension of classic set theory, it has been widely used in many fields of application, such as pattern recognition, data analysis, system control, etc. The unique characteristic of this theory, in contrast to classic mathematics, is its operation on various membership functions (MF) instead of the crisp real values of the variables. Molodtsov (1999) initiated the concept of soft set theory as a new mathematical tool for dealing with uncertainties. Pabitra Kumar Maji et al. (2001) introduced fuzzy soft set theory which also deals with uncertainties. Out of the several higher order fuzzy sets, intuitionistic fuzzy sets by Atanassov (1985) and Ordered intuitionistic fuzzy sets proposed by Kalayathanal et al. (2010) have been found to be highly useful to deal with vagueness. Intuitionistic fuzzy set is described by two functions: a membership function and a non - membership function. We develop and apply similarity measures between ordered intuitionistic fuzzy sets to multiple attribute decision making (MADM) under fuzzy environment.

8. Dr. Mohd Shafry Mohd Rahim, *Universiti Teknologi Malaysia.*

Prof. Dr. Mohd Shafry Mohd Rahim B. Comp. Sci. (UTM), M. Comp. Sci. (UTM), Ph.D (Spatial Modelling) (UPM) Title/Position: Director, UTMSpace College, Universiti Teknologi Malaysia, UTM Skudai, 81310 Johor Bahru. Researcher, UTM ViCubeLab Research Group, Faculty of Computing, Universiti Teknologi Malaysia, UTM Skudai, 81310, Johor Bahru. Telephone: +607553233/ +60193713662 Fax: +6075565044 E-mail: shafry@utm.my shafryr@gmail.com Website: www.gmm.cs.utm.my/~shafry Address of correspondence: UTM ViCubeLab Research Group, Faculty of Computing, Universiti Teknologi Malaysia (UTM), UTM Skudai, 81310, Johor Bahru.

Title: *Medical Image Diagnostic Analytics*

Abstract: Humans have a strong ability to process millions of data and information to assist in the decision-making process. With new disruptive technology, a trillion of medical data has been flooded into cloud computing and require an analytical process to produce valuable diagnosis information. Images are one of the data collected using a variety of sensors that carry a lot of valuable information for the diagnosis process. Therefore, Medical Image Diagnostic Analytics is a very significant research area to be strengthened in the new era of Big Data to improve healthcare industries by providing reliable information. In this discussion, several image analytics process, methods and techniques will be presented. The advantages and disadvantages of each method are described besides examination of each algorithm with its application in Magnetic Resonance Imaging and Computed Tomography image analysis. In this keynote, the discussion also focuses on experiences in Medical Image Diagnostic Analytics and discussing key challenges in various types of data for further research including semantic gaps.

9. Dr. Muhammad Atif Tahir, *Professor & Director, National University of Computer and Emerging Sciences, Karachi, Pakistan*

Muhammad Atif Tahir has over 14 years research experience in data analysis, computer vision, and machine learning. Before joining NUCES, he worked as a Senior Lecturer with Northumbria University, U.K. He is currently a Professor and the Director of the Video Surveillance Laboratory, which is one of the affiliated Laboratory of the National Centre for Big Data and Cloud Computing, sponsored by the Planning Commission of Pakistan and HEC. He has more than 50 publications in top quality international journals and conferences, such as IEEE Transactions on Pattern Analysis and Machine Intelligence, Journal of Machine Learning Research, and Pattern Recognition. His research interests include image analysis and classification for medical and security applications, face recognition, multi-label classification, and event detection. Dr. Tahir's method on image retrieval, using kernel discriminant analysis ranked first in many international competitions on concept detection in multimedia data, such as the Pascal 2009 and the ImageCLEF 2010.

Title: *Smart city big data analytics: An advanced review*

Abstract: With the increasing role of ICT in enabling and supporting smart cities, the demand for big data analytics solutions is increasing. Various artificial intelligence, data mining, machine learning and statistical analysis-based solutions have been successfully applied in thematic domains like climate science, energy management, transport, air quality management and weather pattern analysis. In this paper, we present a systematic review of the literature on smart city big data analytics. We have searched a number of different repositories using specific keywords and followed a structured data mining methodology for selecting material for the review. We have also performed a technological and thematic analysis of the shortlisted literature, identified various data mining/machine learning techniques and presented the results. Based on

this analysis we also present a classification model that studies four aspects of research in this domain. These include data models, computing models, security and privacy aspects and major market drivers in the smart cities domain. Moreover, we present a gap analysis and identify future directions for research. For the thematic analysis we identified the themes smart city governance, economy, environment, transport and energy. We present the major challenges in these themes, the major research work done in the field of data analytics to address these challenges and future research directions.

10. Dr. Arif Mehmood, *Professor, Information Technology University, Lahore, Pakistan*

Dr Arif Mahmood is currently a Professor of Computer Science, Director Computer Vision Lab and Controller of Examination at Information Technology University, Lahore, Pakistan. He has also worked as "Computer Vision Consultant" with King Abdulaziz University, Jeddah, Saudi Arabia and Huazhong University of Science and Technology, China in 2021. Before joining ITU, he served as a Research Assistant Professor at the School of Computer Science and Software Engineering, and later at the School of Mathematics and Statistics in University of the Western Australia from 2012-2015. Previously, he was an Assistant Professor at the Punjab University College of Information Technology from 2008-2012. He also worked as a Postdoctoral Researcher at the College of Engineering in Qatar University from 2015-2018. In 2015 he successfully authored Linkage Project grant from Australian Research Council (ARC): "Machine Learning for Fracture Risk Assessment from Simple Radiography" with industry partners.

Title: *Hierarchical Spatiotemporal Graph Regularized Discriminative Correlation Filter for Visual Object Tracking*

Abstract: Visual object tracking is a fundamental and challenging task in many high-level vision and robotics applications. It is typically formulated by estimating the target appearance model between consecutive frames. Discriminative correlation filters (DCFs) and their variants have achieved promising speed and accuracy for visual tracking in many challenging scenarios. However, because of the unwanted boundary effects and lack of geometric constraints, these methods suffer from performance degradation. In the current work, we propose hierarchical spatiotemporal graph-regularized correlation filters for robust object tracking. The target sample is decomposed into a large number of deep channels, which are then used to construct a spatial graph such that each graph node corresponds to a particular target location across all channels. Such a graph effectively captures the spatial structure of the target object. In order to capture the temporal structure of the target object, the information in the deep channels obtained from a temporal window is compressed using the principal component analysis, and then, a temporal graph is constructed such that each graph node corresponds to a particular target location in the temporal dimension. Both spatial and temporal graphs span different subspaces such that the target and the background become linearly separable. The learned correlation filter is constrained to act as an eigenvector of the Laplacian of these spatiotemporal graphs. We propose a novel objective function that incorporates these spatiotemporal constraints into the DCFs framework. We solve the objective function using alternating direction methods of multipliers such that each subproblem has a closed-form solution. We evaluate our proposed algorithm on six challenging benchmark datasets and compare it with 33 existing state-of-the art trackers. Our results demonstrate an excellent performance of the proposed algorithm compared to the existing trackers.

11. Prof. Dr. Gerassimos Barlas, *Professor, American Univeristy of Sharjah*

Gerassimos Barlas' research interests include parallel computation, high-performance computing, and grid computing, multimedia systems, compression of biomedical signals and images, and medical informatics. Dr. Barlas is a member of the Institute of Electrical and Electronics Engineers (IEEE) Computer Society.

Title: *High Performance Computing pushing the boundaries with hybrid execution*

Abstract: GPUs have been at the forefront of our push to achieve Exaflop computing. Six of the current Top 10 supercomputers in the world, rely on the massive parallelism of GPUs to offer raw computing power, while at the same time consuming the least amount of energy possible. However, CPUs can still provide competitive performance, especially with recent architectural advances that seem to borrow some tricks from the GPU' s cookbook. In this presentation we explore how combining all the computing resources in a system, can push the performance envelope beyond what CPUs or GPUs can accomplish alone. A sample application illustrates both the potential and the challenges involved in mastering such a paradigm shift.

12. Prof. Dr. Imran Zualkernan, *Professor, American Univeristy of Sharjah*

Imran Zualkernan has taught at the University of Minnesota and Pennsylvania State University. He has held C-Level positions in various startup companies. His current research interests include ubiquitous tangible learning systems, wearable learning, and adoption and alignment models for learning technologies. He has published over 170 papers in refereed conference proceedings and journals.

Title: *Educational Analytics: Issues, Prospects, and Opportunities*

Abstract: Today the world is awash with data. Thanks to pervasive networks and affordable end-devices, there are ample opportunities to collect data a multiple level. Educational systems have not fully utilized the power of data-driven decision-making. Pakistan is no exception. In this talk we will present a framework and a discussion of opportunities in using learning analytics at various levels of an educational system of a resource-constrained country like Pakistan. Various case studies showing the use of advanced Artificial Intelligence techniques to help improve education will be presented. Future opportunities will be discussed.

Author Index

Aashir Waleed	150, 172
Abasin Ulasyar	650
Abdo Ali Al-Sharai	144, 953
Abdou Darboe	276, 333, 360
Abdul Hannan	464
Abdul Qahar	421
Abdul Qudoos	244
Abdul Razzaq	1029
Abdul Rehman	535, 625
Abdul Rehman Shafqat	106
Abdul Wahab	659
Abdullah Hasham	172
Abdullah Yousafzai	947
Abid Bashir	397
Abid Raza	535
Abraiz Khattak	650
Abrar Ahmad	180
Adama Daffeh	333
Adil Yousaf	947
Adnan Abid	53, 86, 157, 771, 1041
Adnan Ali	507
Adnan Elahi Khan Khalil	320
Affan Yasin	1046
Afifa Wajid	130, 586, 800
Afnan Iftikhar	794
Afnan Zafar	771
Afrozah Nadeem	562
Ahmad Ali	264
Ahmad Hassan	172
Ahmad Jalal	975, 982, 990
Ahmed Mateen Buttar	612,643
Ahsan Ali	470
Ahsan Raza	923,933
Akhtar Jamil	239
Alaa Ali Hameed	239

Ali Akbar	172
Ali Haider Khan	5,075,127,851,029
Ali Harris	284,683
Ali Nasir	150
Ali Nawaz	31
Ali Raza	150
Ali Sohail	851
Ali Zakir	305,857
Alisha Younas	998
Amara Kiran	276
Amgad Muneer	144,953
Amina Saud	579
Amir Ali	313
Amir Hussain	745
Amjad Rehman	529,806
Ammara Karim Noon	75
Amna Arsahd	904,913,923,933
Anam Riaz	714
Anam sana	1035
Anees Ur Rahman	599
Antonio Cortés Castillo	1
Aqsa Chaudary	36
Aqsa Iftikhar	165
Arfa Hassan	562,570,579
Aroosa Fatima	619
Arslan Asif	464
Asghar Ali Shah	819,829,845,851
Asma Ahmad	488
Asma Naseer	7
Aster Noor	669
Ateeqa Naseer	64,130,209
Atif Ali	12
Atif Elahi	320
Attique Ur Rehman	31
Awais Khan	421
Ayesha Asmat	739
Ayesha Asmat	794

Ayesha Nasir	570
Ayesha Shoukat	354,391
Ayesha Siddiqua	130
Aysha Ashraf	258
Azeem Shera	106
Bismal Majeed	637
Bushra Naeem	625
Ehsan ullah Khadim	482
Fadhilah Rosdi	53,86
Fahad Ali	677,689,695
Fahad Mumtaz Malik	535
Fahad Saif	1029
Fahim Arif	231
Faisal Abdullah	990
Faisal Bukhari	411,385,488
Faisal Riaz	969
Faran Awais Butt	592
Faran Haider	701
Farasat Ullah Khan	377,720
Farhan Nisar	606
Farheen Ramzan	120
Faria Ferooz	367,586,800
Farva Saher	180
Farwa Javed	570
Farwa Saher	165
Fasiha Ashraf	209
Fatima Aabid	137,892
Francesca Cuomo	293
Fred Sangol Uche	333
Ghassan Husnain	320
Habiba Habib	689
Hadia Atta	758
Hafiz Abdul Rehman	120
Hafiz Ali Hamza Gondal	427
Hafiz Muhammad Ashja Khan	677,689,695
Hafiz Muhammad Faisal Shehzad	806
Hafiz Umer Draz	443

Hafsa Mateen	404,939
Haider Ali Baig	933
Hajra Siddiqua	12
Hamza Zafar	777
Haris Sheh Zad	650
Hassaan Malik	500,507,512
Hassan Tahir	46,137
Hina Bashir	46
Hira Asim	739
Hira Gull	771
Hira Shahid	113
Hooria Muslih-ud-Din	203
Huaqiu Long	959
Ihtisham ul Haq	969
Ijaz Ali Shoukat	631
Imran Daud	348
Insia Zahra	75,500
Ioannis Chatzigiannakis	270
Iqra khalil	96
Iqra Naveed	165
Iqra Rashid	367,785,800
Iqra Saleem	476
Ishtiaq Ahmad Khan	120
Jabar Saleem	904
Jahangir Jabbar	507
Jahanzaib Javid	726
Jameel Ahmad	592
Javaria Qadeer	385
Jawad Khan	733
Jianfeng Lu	305,857
Joveria Rubaab	231
Jun Hou	959
Junaid Nasir	879,885,898
Junaid Rashid	547,745
Jungeun Kim	745
Kamran Abid	1041
Kamran Arshad	1010, 1017

Kamran Malik	488
Kanwal Majeed	637
Kartinah Zen	421
Kashif Imran	650
Kashif Ishaq	53,86
Kashif Murtaza	470
Khadija Safdar	354,391
Khalid Ijaz	592
Khawaja Ubaid ur Rehman	892
Khushboo Farid Khan	12
Kinza Arshad	7
Kiran Ilyas	689
Lin Liu	1046
M. Ahmad Nawaz Ul Ghani	258
M. Omer Aftab	570,579
M. Salman Sajid	1029
Madiha Javeed	975,982,990
Maha Mazhar	586
Maila Mushtaq	669
Majid Ali Khan	450
Malik Shahzad Kaleem Awan	404
Mamoona Majid	223
Manahil Waheed	982
Maria Anwar	586
Marrium Anam	998
Maryam Kamal	270,293
Maryam Omar	450
Maryum Saeed	758
Mazhar Javed Awan	203,464,586,806
Mazidah Mat Rejab	250
Mehboob Nazim Shehzad	612,619,643,777
Mehmood Anwar	180
Mehnaz Sarwar	500
Mehr-un-Nisa	209
Mehwish Gill	1023
Mehwish Naz	377,720
Mian Basam Ahmad	194

Mian Muhammad Mubasher	36
Moazzama Nadeem Ahmad Chaudhary	637
Mohd Fadzil Hassan	625
Mohd Shafry Mohd Rahim	771
Mohsin Raza	203, 1029
Mohsin Shah	547
Mubashar Hussain	969
Muhammad Abbas	187
Muhammad Abdullah	873
Muhammad Abdullah Javaid	443
Muhammad Abubakar	299
Muhammad Adnan	592
Muhammad Afzal	427
Muhammad Ahsan	464
Muhammad Ahsan Arshad	599
Muhammad Ali Hussain	397
Muhammad Ali Mughal	726
Muhammad Ameen	150
Muhammad Ammar Shahid	845
Muhammad Anwar	75,421
Muhammad Anzer Chughtai	959
Muhammad Arif	947, 1023
Muhammad Arslan Rauf	299
Muhammad Asad Arshed	244, 360, 541
Muhammad Asif	547
Muhammad Asif Subhani	1023
Muhammad Ayaz Farid Shah	819, 829
Muhammad Bilal	397
Muhammad Danish	46, 137
Muhammad Danish	892
Muhammad Danish Taqdees	612, 619, 643, 777
Muhammad Fahad Zia	433, 677, 683, 695
Muhammad Faraz Ahmad	529
Muhammad Farooq	397, 873, 1035
Muhammad Hasnain Sajjad	106
Muhammad Ikram Ali	443
Muhammad Ishaq	1041

Muhammad Islam	599
Muhammad Ismail	305, 857, 959
Muhammad Kabir	947
Muhammad Kashif Nazir	258
Muhammad Khateeb Khan	599
Muhammad Khurram Ehsan	851
Muhammad Masoom Ul Hussan Rehan	341
Muhammad Mehdi Raza	659
Muhammad Mohsin Saeed	106
Muhammad Nabeel	203, 464
Muhammad Nadeem Ali	165, 180
Muhammad Najeeb Ullah	427
Muhammad Osama Akbar	512
Muhammad Rashid Rasheed	947, 1023
Muhammad Raza Naqvi	106
Muhammad Rumaan	244, 360
Muhammad Saad Shafiq	701
Muhammad Saad Shahbaz khan	512
Muhammad Sajid	284
Muhammad Sajid Farooq	165, 180, 562, 570, 579
Muhammad Shakeel	120
Muhammad Sheharyar Liaqat	969
Muhammad Shoaib Ali	625
Muhammad Shoaib Farooq	494, 519
Muhammad Sohail	397
Muhammad Talha Ubaid	244, 276, 333, 360
Muhammad Talha Usman	172
Muhammad Taseer Suleman	313, 813, 839
Muhammad Tayyab Raja	276
Muhammad Umair	547
Muhammad Umair Ahmad	507, 785
Muhammad Umar Khan	113
Muhammad Umer	327
Muhammad Usama	806
Muhammad Usman	612, 619, 643, 777
Muhammad Usman Farooq	377, 720
Muhammad Usman Ghani Khan	120, 244, 333, 360, 443, 541

Muhammad Waqas Naeem	592
Muhammad Waseem Iqbal	106
Muhammad Wasif Imtiaz	806
Muhammad Wasif Nisar	745
Muhammad Zeeshan Khan	360
Muhammad Zulkifl Hasan	879, 885, 898
Muhammad Zunnurain Hussain	879, 885, 898
Muhammd Kabir	1023
Muhmmad Shoaib Farooq	157
Muneeb Ahmad	443
Muneeba Talat	739
Musadaq Mansoor	450
Mussarat-ul-Ain	172
Mustansir Karim	726
Muzammil Hussain	998
Nadeem Sarwar	898, 879, 885
Naheed Bano	1029
Naila Aslam	879, 885, 898
Najeeb Ur Rehman	476
Naveed Mazhar	535
Nazeef Ul Haq	299
Noor Ayesha	529, 806
Noor Badshah	751, 758
Nor Azan Mat Zin	53, 86
Nosheen Manzoor	130
Nosheen Sabahat	669, 701, 764
Numan asif	96, 785
Nurulhuda Firdaus Mohd Azmi	250
Omar Azeem	327
Omar Bin Samin	450
Omer Aziz	75, 96
Omer Khan	327
Peer Azmat Shah	456
Qianmu Li	959
Qizal Ashfaq	650
Rabia Arshad	327
Rabia Kanwal	745

Rabia Qayyum	231
Rabia Sajjad	215, 1010
Rabia Tehseen	157
Raheel Muzzammel	327
Raja Asif Wagan	482
Rana M. Nadir	939
Rao Faizan Ali	144, 953
Rao Umer Farooq	258
Rida Zainab	137
Rizwan Ali Naqvi	19
Rizwan Pervez Mir	494
Rubia Fatima	1046
Saad Akbar	427
Saba Batool	745
Saba Khalil Toor	637
Saba Naseem	547
Saba Shoukat	586
Sadia Khalid	187, 209
Saeed Ahmed	947, 1023
Sahar Gull	631
Saif u Din	939
Sajid Mahmood	599, 683
Salem Moqa	305, 857
Salman Mahmood	443
Samad Baseer	606
Sameera Kanwal	519
Sami Ud Din	819, 829
Samia Asloob Qureshi	764
Samina Kanwal	745
Sana Basharat	367, 785
Sania Srhar	923
Saqlain Abbas	720
Sawabia naseem	864
Seher Ansar Khawaja	873, 1035
Shaharyar Kamal	264
Shahid Khalid	579
Shahista Habib	64

Shahroz Abbas	464
Shahzad Akbar	354, 391, 529, 631
Shahzad Amin	293
Shahzad Anwar	320
Shaista Habib	223, 284
Shanza Moaen	562
Shanzay Gul	64
Shaukat Iqbal	553
Sheeba Ilyas	851
Shibli Nisar	650
Shumaila Majeed	203
Sidra Ikram	892
Sohail Abid	348, 456
Suhail Yousaf	733
Suliman Mohamed Fati	144
Sultana Ashiq	1004
Sumair Aziz	113
Sundas Sagheer	194
Sundus Munir	562
Suriayati Chuprat	250
Syed Al E Hassan	529
Syed Ammad Ali Hiader	150
Syed Attique Shah	239, 482
Syed Fawad Raza	367, 785
Syed Khuram Shahzad	106
Syed M. Haider Shah	751
Syed Moshin Ali	677, 689, 695
Syed Mudassar Alam	258
Syed Muhammad Shehryar	845
Syed Mujtaba Mehdi	19
Syed Waqar Jaffry	998
Syed Waqar ul Qounain	36
Syed Zin Mehdi	19
Syed Zohaib Hassan Naqvi	113
Syeda Binish Zahra	562
Syeda um e Rubab	892
Tahir Mohammad Ali	31

Tahreem Yasir	707, 714
Taila Jabeen	695
Taimoor Hasan	165, 180
Talha Mahboob Alam	659
Tanzeela Shakeel	7, 64, 209, 707, 714
Tareq Manzoor	553
Tayaba Anjum	130, 470
Tayyaba Anees	130, 209, 470
Toqeer Mahmood	547
Ubaid Ullah	299
Umair Bin Ahmad	570
Umair Tahir	327
Umer Ahmad	579
Umer Riaz	231
Umme Aliza Asim	276
Urooj Arshad	707
Usama Pervaiz	411
Usama Tariq Khan	433
Usman Inayat	553, 677, 683, 689, 695
Usman Rauf Kamboh	612, 619, 643, 777
Uzair Rasheed	187
Uzma Farooq	771
Wafa Noor	677
Waheed Iqbal	411, 385
Waheed Javed	46, 137, 892
Wajeeha Qureshi	244, 541
Wang Jianmin	1046
Waqas Haider Bangyal	476
Waqas Nawaz	264
Yasir Hafeez	599
Yew Kwang Hooi	625
Zaeem Anwaar	377, 720
Zahid Ali	450
Zahra Aman Malik	476
Zain Waheed	612, 619, 643, 777
Zainab Inayat	215
Zainoor Ahmad Choudhry	113

Zareen Kalim	913
Zarrin Basharat	120
Zawar Hussain	592
Zeenia Ather	7
Zeeshan Akram	223
Zeeshan Ali	150
Zeynep Orman	239
Zhang Dong	320
Ziqi Wei	1046
Zohaib Latif	258
Zubair Akbar	512
Zubair Hussain	456
Zulqarnain Farid Khan	12

Keyword Index

AAM	785
Academic Process	1046
Accessibility	707
Acetyl threonine	864
Acetylation	851
Acoustic communication	320
Activating Functions	482
Active Contour	758
Adaptivity	215
ADASYN	113
AdWords, Brand Image	586
Age estimation.	953
Age progression	953
Agent based model	998
Agile framework Agile development	599
Aging	714
Air Quality	427
Altmetrics	488
Alzheimer Disease Detection	529
amino acids	813
Android Studio	172
ANFIS	592
ANN	864
Annotations	120
Anomaly Detection	990
Anomaly-based detection.	677
ANOVA	720
Aquaculture	293, 1029
AR	643
Arduino	1029
Artificial intelligence	12, 113
Artificial Intelligence (AI)	231
Artificial Intelligence in software engineering application levels (AI-SEAL)	231
Attacks on Internet of Things system	1010

Autonomous vehicles	320
Availability testing	720
Avatar.	771
B2C e-commerce,	707
Background subtraction	19
bag-of-features	975
bagging technique	933
Batik	258
Behavior	106
Benchmark Queries	794
Big Data	194
Binary Cross Entropy (BCE)	570
Bioinformatics.	947
Bisection bandwidth	1
Blind	106
Blockchain	75, 96, 137
BMI	464
Bone Fracture	507
Brain tumor	631
Brain Tumor Classification (BTC)	751
Brand Image	586
Breast Cancer Diseasel	244
Business Process Model	794
CACD	953
CAD	507
Cancer	819
Case Study	1046
changes with age	714
Charging Station	592
Charitable Organization	96
churn	745
CLAHE	113
Classification	144, 813
Classifiers	1035
Cleft	385
Cloud Computing component	892
Cloud Computing,	284

Cloud seeding	36
Clustering classification	231
CNN	482, 806, 933, 500
cognitive radio	64
Collaborative filtering	305
Color based object detection	19
component	829
Component based software engineering (CBSE)	231
Compressive Sensing	64
Computational methods	553
Computer-Aided Diagnosis (CAD)	529
Computing Course	1041
Consensus	137
Continuous data	31
Convergency behavior	239
Convolution Neural Network	46, 857, 982
Convolutional layers	360
Corpus	7
COVID-19	120, 360, 570, 806
COVID-19 Disease Diagnosis	541
COVID-19 Pandemic	397
COVID-19 Symptoms	541
CPEC	130
Criminology	12
Curriculum Design	1046
Curriculum Vitae (CV)	701
Cyber risk	404
Cybercrime	12
DAD.	643
Daraz	739
Data Center Network	1
Data Enhancement	385
Data Mining.	579
Data Science	293
DDoS	404
Deep features	113
Deep Learning	276

Deep Learning Face Mask Detection	360
Defect detection	299
Denial of Service	777, 695
depth videos	982
Dermoscopy	354
Development	885
Digital image	299
Digital Image Processing	879, 562
Digital Learning	53
Digital signal processing	165
dinucleotide-based spatial autocorrelation	913
Discrete Wavelet Transform	258
Distributed Memory	194
Distributed Protocols	137
Distribution system	683
Distribution transformers	726
DNA	819
DNA repair genes.	819
DNA RNA.	500
DNA training	904
DNase I Hypersensitive sites	1023
Dry Run	885
Dual-view	305
E-Challan	879
E-learning	669
E-learning barriers in developing countries	669
Early detection of cancer	819
Earthquake prediction	157
Economic Corridor	130
Economic dispatch	650
EfficientDet	276
EfficientNet	391
Electromyography	150
Electronic Health Record(EHR)	75
Email filtering	144
Energy Consumption	421
Energy storage system	683

ensemble models 264
Environment Monitoring 427
ESRD 411
Ethnicity 969
Evaluation module (EVM) 327
Evolutionary Computing 320
External memory interface (EMIF) 327
eye tracking 443
Face detection 367
face detection 443
Face detection 785
face verification 953
Facebook Marketing 586
Facial fiducial points 367, 785
Feature extraction 19, 165
Feature Selection. 959
FFP 785
Field-programmable gate array (FPGA) 327
Fintech 659
Fish Stress 1029
Flex Sensors 150
Focal Loss (FL) 570
Fog as a Service 892
Fog challenges 892
Fog Computing 892, 284
Forecasting solar irradiance 650
Formatting 829
Fundus images 391
Fuzzy 969
Fuzzy Based Enhancement Technique 751
Gamification 86, 1041
Gaussian Distribution 758
gaze estimation 443
general population 800
Generalized Linear Model 244
Generative Adversarial Network 953
genes sequence 845

Genomic 1035
Glaucoma classification 391
Gleason 969
Global data model 157
Google AdSense 586
Google Firebase 172
GPS technology 764
Green Awareness 1004
Green Literacy 1004
GRLVQ 239
Ground truth 19
Hacking 313
Hand Written Character Recognition 562
Handicapped 150
HCCloud (heterogeneous computing cloud) 898
HCI 714
Health Care Solution. 570
Health care. 529
Health index 726
Health Status by BMI 464
Healthcare 75, 137
Heart Attack Prediction 203
Helmet Detection 276
Heterogeneous Cellular Network 421
Heuristic Evaluation 53
hidden Markov models 975
HIV-1 Protease Cleavages 873
human interaction recognition 982
hybridsensors 975
Hydroxylation 851
Image classification 354
Image dehazing 857
Image processing 507
Image Segmentation 758
Import Export 130
Improved path planning 320
insert 829

Internet of Everything	284
Invariant Moments	258
IoT smart gadget	450
IoT with Fog Computing	892
Islamic wealth distribution	998
ISO 9126	187
Jackknife	1023
Joint application design (JAD)	209
k-fold	1023
K-means	904
K-mers	939
Katalon studio	637
Kidney Disease	411
Kinase	851
Kinect v2	19
kNN algorithm	726
Label switched path	456
Lambda iteration technique	650
Land analysis	470
LEAR	785
Legal personality	12
linear vector quantization	239
Literature review	1046
LLSG	53
lncRna	939
lncRNA subcellular localization	913
Local Binary Pattern	258
Local data model	157
Logistic regression	223
Low Discrepancy Sequences	476
Low fidelity	53
LSTM	547, 650
LSVM method	873
LWF	785
Machine Learning	203, 31, 244, 562
Machine Learning Predictors	1023
Malaria Detection	482

Malware	223
Mangoes Detection	333
Manual Annotations	794
Markov Decision Process (MDP)	519
Massive MIMO	341
Medical equipment	720
Medical Reasoning Images	529
Melanoma	354
Meta-Heuristic Algorithms	320
Metastasis	969
Metrics for Semantic Social Network	494
Millimeter Wave	421
Misinformation	959
Mixed integer linear programming	683
ML, Genomics	500
MLP	923
Mobile Application	172, 659
Mobility management	456
Modified Nominal Group Technique	250
motion patterns detection	975
MPLS	456
MPPT	592
mRna	939
MSDM	367
Multi-criteria	305
Multidimensional framework	599
mutation	845
naïve bayes	904
Nanofluids	553
narrowband sensing	64
Natural language processing	31, 180, 7
NDP	777
Neighbor Advertisement	643
Neighbor Solicitation	777
Network diameter degree	1
Network topology	1
Neural Network	180

NLP	959
nonlinear sliding surfaces	535
Normalized cross-correlation (NCC)	327
Nucleated Villages	470
Obesity Level.	464
Object-Oriented Programming	885
OETMAP encoding	873
Online Advertisement	579
Online Education	397
Ontologies	180
Ontology as a package OAAS	898
Open source Automation testing tools	637
opinion mining	547
Optical Character Recognition (OCR)	562
Optimal Stream	46
Organization	106
OSNs.	348
Ozone (O3)	36
Packet loss	733
PakChina Relations	130
Pakistan sign language	771
Pakistani software organization	209
Pandemic	120
Parking	172
Particle Swarm Optimization	476, 745, 990
Pattern Search	1017
Peak load demand	683
pedestrian direction prediction	264
pH	1029
Phase alternation line (PAL)	327
Phishing attacks	144
Phosphate	851
Phosphoralytion protein	947
Photochemical Smog	36
Phylogenetics	120
Polio Vaccination	764
Post Translation Modification (PTM)	851, 947

Prediction Modeling 293
Prediction of Health 464
Presentation 106
Programable Logic Controller 879
Programming Language 885
Project Centric 1041
Pronunciation 86
Prostate cancer 969
Prostate specific antigen 969
Prosthetic hand 150
protein 813
Protien-DNA 923
Pseudo-random numbers 476
PTM 839
quadrotor 535
Quality metrics 187
Quasi-random number 476
Radiographs 507
Random sampling technique 209
raspberry pi 443
RBF 923
Real Time Advertising 586
Real time tracking (RTT) 327
Recommendation System 270, 305
Recruitment 701
Region wise impact 800
Regression techniques 223
Reinforcement Learning(RL) 519
Remote sensing 470
Renal failure 411
Renewable energy. 650
Requirement elicitation 86
Requirement Engineering 209
Requirement Engineering practices 209
Requirements. 885
Retinal diseases 113
review analysis, 547

RFID	879
RGB-D sensor	19
Rheumatoid Arthritis	1035
Risk analysis	720
Roman Urdu	739
RT-PCR	806
RT-PCR Test	541
SARS	806
SARS-CoV-2	120, 806
Satellite imagery	470
Science	771
Scrum Process	599
Security	137, 1010
Security goals	689
Security measures.	689
security vulnerabilities	689
segmentation	631
Selenium tool	637
Semantic Segmentation	990
Semantic Social Network	494
Semantic Technology	180
semi-supervised learning.	857
Sensor nodes	689
Sentiment analysis	31, 180, 488, 547, 739
Serious game	86
Server – centric	1
Session initiation Protocol (SIP)	695
SGD Classifier	512
SHA	777
Signature-based detection	677
Similarity between Process Models,	794
site UCI Machine Learning	873
SLA (Service Level Agreement)	898
sliding mode control	535
Small Cells.	421
smart city	433
Smart gloves	450

smart greenhouse farms.	433
Smart Stress Monitoring System	1029
SMOTE	385, 913
Social Media	130
Social Media Real Time Bidding	586
Social Media.	579
Social Network	348
softmax classifier	982
Software Development Life Cycle	377, 209
Software Engineering	1046
software quality factors	187
Software Traceability	250
Solar PV	592
Sorting Algorithm	215
Spam Classification	512
Spatio-temporal descriptors	990
Speaker recognition	165
spectrum sensing	64
Statistical Analysis	377
statistical moments	813, 839, 864
Strength	377
String Pattern Search	1017
String Search	1017
style	829
Support Vector Machine	1023, 933
Swish	333
Symmetrical encoding	873
Systematic literature review	669
Tampered image	299
Teaching, Deaf students	771
Technology Acceptance Model	1004
Telecom	745
Temperature Humidity	427
Test Effort Estimation	250
Test project tool	637
Texture and Shape Features	258
Thermophoresis	553

Think-Aloud	53
Time complexity	215
Tourism	270
Tracking	46
Traffic Violation Challans	879
transfer learning	631, 570
Translation	839
Transparency	75, 96
Tree plantation	36
Trend, clustering	800
Twitter	488
Two Weather	933
UAV's,	535
Urdu	7
Urdu language processing (ULP)	7
Usability	106, 659
Variants	120
Variational Models	758
Vector-quantization	165
Vehicle	46, 172
Virtual Memory	1023
virtualization	1023
Visually Impaired	106
VKontakte	130
VOC	36
Voice Over Internet Protocol (VoIP)	695
Vulnerability	695
Water Quality Monitoring	1029
Wavelet Transform	299
Wealth distribution	998
web phishing	313
wideband sensing	64
Windows NT	1023
Wireless Control	150
Wireless sensor network	689
women safety device	450
women safety gadget	450

Women Security IoT	450
WSN	733
Yolov4	360
Yolov5	333
Zakat System	998