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Open AI and Computational Intelligence for Society 5.0

Rajiv Pandey, Nidhi Srivastava, Rajesh Prasad,
Jayashree Prasad, and Manuel B. Garcia

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Rajiv Pandey
Amity University, India

Nidhi Srivastava
Amity University, India

Rajesh Prasad
MIT Art, Design, and Technology University, India

Jayashree Prasad
MIT Art, Design, and Technology University, India

Manuel B. Garcia
FEU Institute of Technology, Philippines

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Table of Contents

Preface xx

Section 1
Introduction and Applications to AI, CI, and Society 5.0

Chapter 1
AI, CI, and Society 5.0: A Historical Overview 1
Nitesh Behare, Balaji Institute of International Business, Sri Balaji University, Pune, India
Vatsala Manjunath Keerthi, Global Business School and Research Centre, Dr. D.Y. Patil Vidyapeeth, Pune, India
Abhijit Vasmatkar, Symbiosis Law School, Symbiosis International University (Deemed), Pune, India
Shrikant Waghulkar, Ramachandran International Institute of Management, India
Shubhada Nitesh Behare, Sri Balaji University, India
Ashish Mohture, Institute of Management and Research, Sambhaji Nagar, India
Vinod N. Sayankar, Neville Wadia Institute of Management and Research Center, Pune, India
Suraj Sharma, Ramachandran International Institute of Management, India

Chapter 2
Advancements in Domain-Specific OpenAI and Computational Intelligence Solutions for Society 5.0 27
Leena Suresh More, JSPM Jayawant Institute of Management Studies, Pune, India
Binod Kumar, JSPM Jayawant Institute of Management Studies, Pune, India
Sheetal B. Prasad, New York University, USA

Chapter 3
Nurturing Digital Citizenship in Society 5.0 Through AI and Computational Intelligence Education 59
Muhammad Usman Tariq, Abu Dhabi University, UAE & University College Cork, Ireland
Rommel P. Sergio, Canadian University, Dubai, UAE

Chapter 4
AI's Cognitive Blueprint Through Human Brain Anatomy 85
Jyoti Nagnath Gavhane, MIT Art, Design, and Technology University, India
Reena Pagare, MIT Art, Design, and Technology University, India
Nirmal Govind Radhakrishnan, Qualitest Group, UK
Divya Midhunchakkaravarthy, Lincoln University College, Malaysia

Chapter 5
Agricultural Intelligence (AI)'s Impact on Society 5.0 Farming 109
Princy Rana, Lady Irwin College, India
Munir Ahmad, Survey of Pakistan, Pakistan
Taulu Stephen, David Livingstone College of Education, Zambia
Houssem Chemingui, Brest Business School France, France

Chapter 6
Unlocking the Potential of Society 5.0: AI and CI Applications in the Education Sector 129
Nitesh Behare, Balaji Institute of International Business, Sri Balaji University, Pune, India
Ashutosh Panchbhai, Symbiosis Law School, Symbiosis International University (Deemed), Pune, India
Puja Bhardwaj, Balaji Institute of Modern Management, India
Priyanka Jadhav, Arihant Institute of Business Management, India
Shubhada Nitesh Behare, Sri Balaji University, India
Shrikant Waghulkar, Ramachandran International Institute of Management, India
Suraj Sharma, Arihant Institute of Business Management, India

Chapter 7
Towards a Greener Tomorrow: Unpacking the Current and Future Outlook of Renewable Energy in Bangladesh..... 157
Shalini Puri, Manipal University Jaipur, India
Md. Mortuza Ahmmed, American International University - Bangladesh, Bangladesh
Anjali Dadhich, Bharati Vidyapeeth (Deemed to be University), Navi Mumbai, India
Ritu Punhani, Amity University, Noida, India
Tahsin Kabir, American International University - Bangladesh, Bangladesh
Mian Mohammad Rassel, American International University - Bangladesh, Bangladesh
Mst. Nadiya Noor, American International University - Bangladesh, Bangladesh

Chapter 8
Hydro Horizons: A Glimpse Into Bangladesh's Present and Future Hydro Energy Landscape..... 175
Md. Mortuza Ahmmed, American International University - Bangladesh, Bangladesh
Shalini Puri, Manipal University Jaipur, India
Ritu Punhani, Amity University, Noida, India
Moynul Islam, American International University - Bangladesh, Bangladesh
Mian Mohammad Rassel, American International University - Bangladesh, Bangladesh

Section 2
Ethical Consideration and Use of ML

Chapter 9
Bias in AI: A Societal Threat: A Look Beyond the Tech 197
Malobika Bose, Amity University, India

Chapter 10
Ethical Considerations and Social Impact of AI and Computational Intelligence in Society 5.0 225
Muhammad Usman Tariq, Abu Dhabi University, UAE & University College Cork, Ireland
Rommel P. Sergio, Canadian University, Dubai, UAE

Chapter 11
Ethical Implications of Open AI and Collaborative Development in Society 5.0 249
Shibli Akhtar, Suraj Singh Memorial College, Ranchi, India
Mohammad Amir Khusru Akhtar, Usha Martin University, Ranchi, India
Mohit Kumar, MIT Art, Design and Technology University, Pune, India

Chapter 12
An Exploration of Ethical Implications and Social Impact of Artificial Intelligence (AI) in the Indian Context 265
Sheeba Khalid, Amity University, India
Somarata Chakraborty, IQ City United World School of Business, India
Sweta Rani, The Neotia University, India

Chapter 13
Machine Learning Solutions in Smart Healthcare: Features, Applications, and Challenges 291
Vivek Patel, Maulana Azad National Institute of Technology, Bhopal, India
Vijayshri Chaurasia, Maulana Azad National Institute of Technology, Bhopal, India
Ebtasam Ahmad Siddiqui, Poornima Institute of Engineering & Technology, Jaipur, India
Shashikant P. Patole, Khalifa University of Science and Technology, Abu Dhabi, UAE
Rajesh Mahadeva, Manipal Institute of Technology, Karnataka, India

Chapter 14
QR Code-Integrated ML Analytics Library System 315
Rajiv Pandey, Amity University, Noida, India
Archana Sahai, Amity University, Noida, India
Guru Dev Singh, Amity University, Noida, India
Radhika Awasthi, Amity University, Noida, India

Chapter 15
Implementation of an AI-Based Chatbot Using Machine Learning Algorithms for Answering and Categorization in Medical Diagnosis and Treatments 331
Bharat Tripathi, Allenhouse Business School, Department of Computer application, India
Nidhi Srivastava, Amity Institute of Information Technology, Amity University, Lucknow, India
Rajiv Pandey, Amity Institute of Information Technology, Amity University, Lucknow, India
Madan Lal Saini, Department of CSE Apex Institute of Technology Chandigarh University, Punjab, India
Amod Kumar Tiwari, Department of Computer Science, Rajkiya Engineering College Sonbhadra, Uttar Pradesh, India

Chapter 16
Machine Learning-Based Allocation of Resources in Blockchain Network for Optimum Efficiency 347
Rahul Ganpatrao Sonkamble, Pimpri Chinchwad University, Pune, India
Swati Shirke-Deshmukh, Pimpri Chinchwad University, Pune, India
Gurunath Gagan Machhale, Sanjay Ghodawat University, Kolhapur, India
Sonali Patil, G.H. Raisoni College of Engineering and Management, Pune, India
Shraddha Phansalkar, MIT Art, Design, and Technology University, Pune, India
Sudeep Thepade, Pimpri Chinchwad College of Engineering, India
Faheem Ahmad Reegu, College of Engineering and Computer Science, Jazan University, Saudi Arabia
Abdoh Jabbari, College of Engineering and Computer Science, Jazan University, Saudi Arabia

Chapter 17
Advancements in Optic Disc Detection: A Comparative Study of Deep Learning Algorithms..... 373
Nilima Kulkarni, MIT SoC, MIT Art, Design, and Technology University, Pune, India
Nitish Das, MIT Art, Design, and Technology University, Pune, India
Pratik Kakade, MIT Art, Design, and Technology University, Pune, India
Ameya Kale, MIT Art, Design, and Technology University, Pune, India
Ishan Jawade, MIT Art, Design, and Technology University, Pune, India
Rushikesh Jadhav, MIT Art, Design, and Technology University, Pune, India

Section 3
Computational Intelligence and Use Cases

Chapter 18
Next Generation Smart Street Light Monitoring and Controlling System Using IoT 393
Singaravelan Shanmugasundaram, PSR Engineering College, India
Arun Ramaiah, PSR Engineering College, India
Arun Shunmugam Dhiraviyam, PSR Engineering College, India
Manohar Ethirajan, Francis Xavier Engineering College, India
RamaSubramanian PaperAnathaMurugesan, PSR Engineering College, India
Gopalsamy Pathalaveeran, PSR Engineering College, India
Balaganesh Subbiah, PSR Engineering College, India
Kasirajan Kasipandian, MAHSA University, Malaysia

Chapter 19
Improving Time Series Forecasting Accuracy With Hybrid Radial Basis Function Networks 419
S. David Samuel Azariya, Sona College of Technology, India
V. Mohanraj, Sona College of Technology, India
Sathiyamoorthi Velayutham, Government Polytechnic College, Dharmapuri, India
Sengathir Janakiraman, CVR College of Engineering, India
V. Vijayagopal, Dr. M.G.R. Educational and Research Institute, India

Chapter 20
Degree Immutability for Education: A Blockchain Approach..... 437
Rajiv Pandey, Amity Institute of Information Technology, Amity University Uttar Pradesh, Lucknow, India
Pratibha Maurya, Amity Institute of Information Technology, Amity University Uttar Pradesh, Lucknow, India
Guru Dev Singh, Amity Institute of Information Technology, Amity University, India

Chapter 21
Improving Autonomous Vehicle Technology Through Reinforcement Learning and Deep Learning Models 461
Shabanam Kumari, G.L. Bajaj Institute of Technology and Management, India
Sunil Kumar Rajak, G.L. Bajaj Institute of Technology and Management, India
Dhirendra Siddharth, G.L. Bajaj Institute of Technology and Management, India
Mohit Kumar, G.L. Bajaj Institute of Technology and Management, India

Chapter 22
Probabilistic Integration Random Forest Decision Tree Fusion Model: A Comprehensive Approach to Kidney Stone Prevention..... 475
Ayesha Butalia, MIT Art, Design, and Technology University, India
Debarshi Basu Bhattacharjee, MIT Art, Design, and Technology University, India
Keerti Satpute, MIT Art, Design, and Technology University, India

Compilation of References 495

About the Contributors 559

Index..... 569

Preface

The rapid evolution of computational intelligence and artificial intelligence technologies has paved the way for an era where machines are not just tools but active participants in addressing complex societal challenges. As editors of this volume, *Open AI and Computational Intelligence for Society 5.0*, we are excited to present a collection of insights and innovations that reflect the growing significance of these technologies in shaping our world.

Computational Intelligence (CI) refers to the theory, design, application, and development of computational paradigms inspired by biological and linguistic principles. It is at the forefront of intelligent systems design, equipping machines to tackle difficult tasks and solve critical societal issues. The emerging generation of intelligent machines—those capable of perception, reasoning, learning, and decision-making—marks a profound shift in the role of technology in our daily lives. These abilities, once exclusive to human intelligence, are now accessible through CI algorithms and models, such as neural networks and fuzzy logic systems. This transformation is further accelerated by open-source AI tools, enabling collaboration and innovation on an unprecedented scale.

This book is grounded in the vision of *Society 5.0*, a concept that represents a harmonious integration of technology and human society. In this future society, technology is leveraged to enhance the quality of life, while addressing global and local challenges. The systems depicted within these chapters demonstrate the potential for intelligent machines to collaborate with humans, amplifying our problem-solving abilities and elevating our overall standard of living. From IoT frameworks to AI-driven systems, the contributors to this book explore disruptive technologies that contribute to the realization of Society 5.0.

The chapters within this volume cater to a wide range of experts and enthusiasts: scientists, design engineers, system integrators, researchers in AI and machine learning, big data architects, cloud and physical layer architects, city planners, government agencies, and postgraduate students pursuing advanced degrees in computer science and related fields. Our aim is to present a comprehensive guide that not only delves into technical aspects but also discusses the societal implications and benefits of integrating AI and computational intelligence in the development of smart societies.

We hope that the insights shared in *Open AI and Computational Intelligence for Society 5.0* will inspire further research, innovation, and collaboration across fields. As we move toward this new era, it is our shared responsibility to harness these technologies for the greater good, ensuring a sustainable and equitable future for all.

Organization of the Book

Chapter 1, "AI, CI, and Society 5.0: A Historical Overview," provides a comprehensive review of the historical evolution of Artificial Intelligence (AI) and Computational Intelligence (CI) in relation to Society 5.0. It traces the development of AI and CI technologies, exploring their increasing influence on socio-economic systems. The chapter highlights key technological milestones and the vision of Society

5.0—a human-centered, technologically advanced society. In addition to outlining the technological progression, the authors delve into ethical and societal implications and discuss future opportunities, offering valuable insights for academics, practitioners, and decision-makers.

Chapter 2, "Advancements in Domain-Specific OpenAI and Computational Intelligence Solutions for Society 5.0," explores the role of OpenAI and CI in addressing the challenges of Society 5.0. Focusing on domain-specific applications in sectors such as healthcare, education, agriculture, and urban planning, the chapter emphasizes how AI innovations are revolutionizing these fields. Through case studies, it showcases AI-driven optimizations in resource allocation and decision-making, while also addressing ethical concerns and regulatory frameworks to ensure responsible deployment. The chapter highlights the transformative potential of OpenAI and CI in creating a more inclusive and sustainable future.

In Chapter 3, "Nurturing Digital Citizenship in Society 5.0 Through AI and Computational Intelligence Education," the authors focus on the need for digital literacy and AI education in the context of Society 5.0. The chapter highlights the importance of equipping individuals with the knowledge and skills to navigate an increasingly AI-driven world. Through innovative curricula and educational strategies, the authors promote the integration of AI and CI education across all levels of academia. Case studies, such as the AI4K12 initiative, demonstrate effective approaches to digital literacy and emphasize diversity, ethics, and inclusivity in AI education.

Chapter 4, "AI's Cognitive Blueprint Through Human Brain Anatomy," dives deep into the intersection of AI and human cognition. The chapter examines how AI systems simulate human cognitive processes, drawing parallels between AI architectures and the human brain. It explores cognitive architectures such as SOAR, ACT-R, and Hopfield Neural Networks (HNNs), and their applications in areas like mental health. The authors discuss ongoing research, including the Human Brain Project, and speculate on the future developments in AI's cognitive capabilities, revealing the growing symbiosis between machine intelligence and human cognition.

Chapter 5, "Agricultural Intelligence: AI's Impact on Society 5.0 Farming," explores the integration of AI in agriculture, or Ag-AI, within Society 5.0. The chapter highlights how AI is revolutionizing precision agriculture, resource optimization, and pest management. AI's ability to reduce downtime, optimize inputs like water and fertilizers, and automate labor-intensive tasks significantly boosts productivity. However, the authors also address the potential drawbacks, including data privacy, cybersecurity concerns, and the digital divide. The chapter offers a balanced view of Ag-AI's role in driving sustainable farming practices in Society 5.0.

Chapter 6, "Unlocking the Potential of Society 5.0: AI and CI Applications in the Education Sector," explores the transformative impact of AI and CI in the education system. The chapter begins with an introduction to Society 5.0 and its vision of a technology-empowered society. It then discusses how AI and CI are reshaping education through personalized learning, adaptive tutoring, and intelligent content creation. The chapter also addresses ethical concerns and the need for inclusive and accessible education. Through case studies and real-world applications, the authors illustrate AI's potential to revolutionize education in Society 5.0.

In Chapter 7, "Towards a Greener Tomorrow: Unpacking the Current and Future Outlook of Renewable Energy in Bangladesh," the authors provide an in-depth exploration of Bangladesh's renewable energy landscape. The chapter examines the country's dependency on fossil fuels and the environmental impact, while highlighting advancements in hydroelectric, solar, and wind power. Government policies promoting renewable energy are discussed, alongside societal benefits such as energy security and rural

electrification. The authors also address challenges like infrastructure limitations and insufficient funding, offering a comprehensive look at the future of sustainable energy in Bangladesh.

Chapter 8, "Hydro Horizons: A Glimpse into Bangladesh's Present and Future Hydro Energy Landscape," takes a focused look at Bangladesh's hydroelectric power potential. The chapter discusses the nation's existing hydroelectric infrastructure and its contributions to the national grid. It highlights challenges such as environmental impact and infrastructure limitations while exploring novel approaches like small-scale hydro projects and enhanced energy storage solutions. With a focus on sustainability, the chapter suggests ways to improve economic feasibility and reduce environmental effects, positioning hydroelectric power as a key player in Bangladesh's renewable energy future.

In Chapter 9, "Bias in AI - A Societal Threat: A Look Beyond the Tech," the author addresses the critical issue of AI bias and its far-reaching effects on society. The chapter examines how biases embedded in AI systems can exacerbate existing inequalities in areas such as employment, criminal justice, and economic opportunities. It highlights the societal consequences of AI bias, such as discrimination against certain demographic groups, and discusses potential mitigation strategies. The chapter calls for a comprehensive understanding of AI's societal impact, urging the development of solutions to minimize the negative effects of AI bias.

Chapter 10, "Ethical Considerations and Social Impact of AI and Computational Intelligence in Society 5.0," delves into the ethical dimensions of AI and CI within Society 5.0. The chapter explores the profound social, economic, and governance implications of deploying AI technologies, emphasizing the importance of ethical frameworks to guide their development. Key issues such as algorithmic bias, privacy, and societal disparities are critically analyzed. The chapter advocates for robust ethical guidelines to ensure that AI and CI technologies contribute positively to Society 5.0, highlighting the need for responsible innovation in the digital era.

Chapter 11, "Ethical Implications of Open AI and Collaborative Development in Society 5.0," explores the convergence of advanced AI technologies with Society 5.0, a future vision of a tech-integrated human-centric society. OpenAI, a suite of publicly accessible AI tools, stands at the core of this transformation. The authors highlight the transformative potential of AI, spanning personalized learning, precision medicine, sustainability solutions, and public safety enhancements. However, they also underscore pressing ethical challenges such as algorithmic transparency, bias, job displacement, and privacy concerns. The chapter calls for collaborative discourse among researchers, policymakers, and the public to ensure AI's responsible and ethical integration into society.

Chapter 12, "An Exploration of Ethical Implications and Social Impact of Artificial Intelligence (AI) in Indian Context," focuses on the ethical dimensions of AI development in India. With the nation's rapid AI adoption, concerns about privacy, autonomy, fairness, and accountability are growing. Rooted in ethical principles of respect, beneficence, and justice, this chapter examines AI's societal impact, stressing the need for ethical frameworks that respect human dignity and promote welfare. By exploring India's cultural and societal nuances, the chapter aims to inform the development of AI guidelines tailored to the unique context of the country, ensuring responsible AI implementation.

Chapter 13, "Machine Learning Solutions in Smart Healthcare: Features, Applications and Challenges," investigates the evolving role of machine learning (ML) in the healthcare sector. As healthcare systems struggle with inefficiencies, ML offers innovative solutions that can automate and improve healthcare frameworks. The authors explore the integration of Internet of Things (IoT) technology to create global healthcare platforms, though they acknowledge the challenges posed by limited medical

data for ML training. This chapter provides insights into current ML advancements and their potential to revolutionize healthcare systems.

Chapter 14, "QR-Code Integrated ML Analytics Library System," introduces a novel approach to library management that integrates QR codes and machine learning (ML) analytics. Prompted by the COVID-19 pandemic and the need for touchless technologies, this chapter critiques traditional library systems and proposes a new QR-code-based solution for student and book identification. This system addresses inefficiencies in Radio Frequency Identification (RFID) and introduces unique ID mapping for each book, offering benefits such as reduced staff, streamlined processes, and improved health and safety measures in libraries.

Chapter 15, "Implementation of an AI-Based Chatbot Using Machine Learning Algorithms for Answering and Categorization in Medical Diagnosis and Treatments," explores the development of an AI chatbot designed to answer frequently asked questions (FAQs) related to medical diagnoses and treatments. Using natural language processing (NLP) and machine learning, the chatbot can categorize questions into relevant topics and provide accurate responses. The chapter discusses the system's training pipeline, which continuously improves the chatbot's performance, demonstrating its utility in automating routine tasks in the medical field.

Chapter 16, "Machine Learning-Based Allocation of Resources in Blockchain Network for Optimum Efficiency," examines how integrating machine learning (ML) with blockchain technology can enhance resource allocation in sectors like healthcare, banking, and supply chain management. The chapter focuses on addressing transaction throughput, energy consumption, and interoperability issues, proposing a novel system that combines Non-Orthogonal Multiple Access (NOMA) and Mobile Edge Computing (MEC) to optimize performance. The proposed model is evaluated based on resource utilization, system performance, and blockchain-specific metrics.

Chapter 17, "Advancements in Optic Disc Detection: A Comparative Study of Deep Learning Algorithms," offers a comparative study of deep learning algorithms used in optic disc detection, a crucial step in diagnosing eye diseases such as diabetic retinopathy and hypertension. The chapter evaluates five deep learning methods, including YOLOv2, YOLOv3, and Mask RCNN, focusing on their computational requirements and processing times. The authors also propose a modified YOLOv3 algorithm, tested using datasets like MESSIDOR, DRIVE, and DIARET-DB1, offering potential improvements for low-computational devices.

Chapter 18, "Next Generation Smart Street Light Monitoring and Controlling System Using IoT," presents an IoT-based smart street lighting system designed to manage large-scale outdoor lighting networks. By integrating cloud-based solutions with central management software, the system allows municipalities to control and monitor streetlights remotely. The chapter details the system's ability to detect maintenance issues, adjust lighting levels, and schedule operations, offering a cost-effective solution for energy savings and real-time monitoring. The authors demonstrate its application across highways, urban spaces, and industrial areas.

Chapter 19, "Improving Time Series Forecasting Accuracy with Hybrid Radial Basis Function Networks," delves into the use of Hybrid Radial Basis Function Networks (RBFNs) for time series forecasting, crucial in industries such as energy and finance. By combining RBFNs with other techniques, this chapter demonstrates how hybrid models can address the challenges of nonlinearity, seasonality, and noise in time series data. The authors highlight the design and hybridization approaches, showing how these networks can enhance forecasting accuracy in practical scenarios.

Chapter 20, “Degree Immutability for Education: A Blockchain Approach,” proposes a blockchain-based platform for student certificate verification. This decentralized, tamper-resistant solution aims to address rising concerns about the authenticity of academic credentials. By creating a transparent system for validating student certificates, the authors argue that the platform offers increased trust, security, and efficiency for educational institutions and employers alike, eliminating the risks of fraud or manipulation in the verification process.

Chapter 21, “Improving Autonomous Vehicle Technology Through Reinforcement Learning and Deep Learning Models,” focuses on how reinforcement learning (RL) and deep learning (DL) models can enhance autonomous vehicle (AV) technology. As AVs grow in prominence, the decision-making processes driving their operations become critical. This chapter explains the theoretical foundations of RL and DL, while offering practical applications that improve AV performance in real-world scenarios, contributing to increased safety and efficiency in transportation.

Chapter 22, “Probabilistic Integration Random Forest Decision Tree Fusion Model: A Comprehensive Approach to Kidney Stone Prevention,” proposes an advanced model for kidney stone detection based on probabilistic methods and machine learning. By leveraging Random Forest and Decision Tree algorithms, the model uncovers key factors in kidney stone formation, aiming to improve early detection and healthcare outcomes. The chapter emphasizes the model's potential for practical use in clinical settings, providing a more efficient and accurate method for predicting and preventing kidney stones.

IN CONCLUSION

As we conclude this comprehensive exploration of ethical, technological, and societal advancements within the landscape of AI, machine learning, and emerging technologies, it becomes evident that the future we envision will be profoundly shaped by these innovations. The diverse range of chapters included in this volume reflects the interdisciplinary nature of the challenges and opportunities ahead. From the ethical dilemmas posed by AI in Society 5.0 to the cutting-edge applications of machine learning in healthcare, blockchain, and autonomous systems, each contribution underscores the need for responsible, informed, and forward-thinking development.

The synergy between technology and human-centered values emerges as a crucial theme throughout the book. While the chapters celebrate the potential of AI and machine learning to revolutionize industries and improve lives, they also serve as a reminder of the ethical imperatives we must navigate. The responsible use of technology requires collaboration among policymakers, researchers, developers, and society at large to ensure that innovation promotes fairness, accountability, and transparency.

As editors, we hope that this book not only provides valuable insights but also sparks ongoing discussions and research that will guide the ethical and sustainable deployment of these powerful technologies. By addressing both the technical intricacies and the broader societal implications, we aim to contribute to the shaping of a future where technology and humanity coalesce harmoniously in Society 5.0 and beyond.

Open AI and Computational Intelligence for Society 5.0

As technology rapidly advances, the complexity of societal challenges grows, necessitating intelligent solutions that can adapt and evolve. However, developing such solutions requires a deep understanding of computational intelligence (CI) and its application in addressing real-world problems. Moreover, ethical considerations surrounding AI, such as bias and accountability, are crucial to ensure responsible development and deployment of intelligent systems.

Open AI and Computational Intelligence for Society 5.0 offers a comprehensive exploration of CI, providing insights into intelligent systems' theory, design, and application. This book is a practical guide for scientists, engineers, and researchers seeking to develop thoughtful solutions for complex societal issues. Integrating disruptive technologies and frameworks illuminates the path toward creating intelligent machines collaborating with humans to enhance problem-solving and improve quality of life.

This extensive research book is tailored for professionals and postgraduate students in fields like IoT, AI/ML, and city planning. It delves into domain-specific applications of AI and CI in areas such as healthcare, smart cities, and finance, directly relevant to your interests. It also addresses ethical considerations, ensuring that advancements in AI are made responsibly. With a blend of theoretical insights and real-world use cases, this book equips you with the knowledge and tools needed to navigate the complexities of AI and CI, contributing to the advancement of Society 5.0.

Topics Covered

- Adaptive Intelligent Tutoring Systems
- Advances in AI
- Agriculture
- Bias in AI
- Climate Change Mitigation
- Cognitive Computing Systems
- Computational Intelligence
- Deep Learning Models
- Domain-Specific Applications
- Education
- Ethical Considerations
- Evolutionary Computation
- Finance
- Fuzzy Systems

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