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SPECTRUM

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Spectrum is an e-magazine with the comprehensive collection of all the papers that have been published in our journal over the last two months — Volume 12, Issue 1 (January-February, 2026). This edition brings together 16 papers by 34 authors from 20 institutions. Each entry links to the abstract and the full paper.

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ABSTRACTS

1 Neuroplasticity Beyond Childhood: Evidence, Influences, & Limitations

Paper ID V12I1-1141 · Pages 1-4 · Neuroplasticity

Aarav Lohchab, Student, Garth Webb Secondary School, Canada

This paper explores neuroplasticity in adults, focusing on scientific evidence that shows the adult brain can continue to change and adapt. It explains how neuroplasticity supports learning and cognitive function and may help protect against certain diseases. The paper also examines strategies to enhance neuroplasticity, while reviewing studies with negative results, thus offering a balanced perspective. In addition, the roles of social engagement and stress are discussed to show how the environment factors influence neuroplasticity. Finally, it reviews the modern advances as well as the current limitations in our understanding of the topic.

Keywords: Adult Neuroplasticity, Physical Exercise and Brain Health, Social Engagement and Stress, Enhancing Neuroplasticity, Environmental Influence on Neuroplasticity.

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2 How Do Upcoming Digital Payment System Innovations Affect Consumer Spending and Saving Behavior, and How Does It Affect Overall Economic Growth?

Paper ID V12I1-1142 · Pages 5-10 · Economics

Rayhan Taneja, Student, Shiv Nadar School, Haryana

By introducing tools that change saving behaviors and providing convenience that changes spending, the global transition to digital payment systems causes conflict. According to research, the "pain of paying" is lessened in digital transactions, which increases consumer spending by 40–48% and promotes impulsive purchases. On the other hand, automated digital budgeting tools successfully encourage financial resilience and savings. Macroeconomic research demonstrates that market formalization and GDP growth are positively correlated with digital adoption. According to this paper, new behaviorally-designed savings tools offer a necessary counterbalance to the convenience of payments, which drives consumption, but only if they are backed by robust financial literacy and regulatory oversight. Using case studies such as India's UPI and M-Pesa, this paper examines the relationship between payment convenience and spending, the dual impact of digital budgeting tools on saving, and the macroeconomic effects on growth. Innovations in digital payments will speed up formalities and economic activity, but their ability to serve as a strategic pillar for national development depends on how well they strike a balance between transactional convenience and instruments that encourage responsible consumer savings.

Keywords: Digital Payment Systems, Consumer Spending Behaviour, Payment Convenience, Digital Budgeting Tools, Cashless Economy.

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3 Empirical Atmospheric Attenuation Models for Free Space Optical Links using Nigerian Meteorological Data

Paper ID V12I1-1137 · Pages 11-13 · Telecommunication

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Dr. R. O. Okeke, Associate Professor, University of Port-Harcourt, Nigeria

Accurate prediction of atmospheric attenuation is critical for the reliable deployment of Free Space Optical (FSO) communication systems, particularly in regions with diverse climatic conditions. This paper presents a comparative validation of three widely used empirical attenuation models—Kruse, Kim, and Al Naboulsi—using real meteorological visibility data from Nigeria. Visibility records obtained from the Nigerian Meteorological Agency (NiMet) for Lagos, Port Harcourt, Abuja, Jos, and Kano were used to compute attenuation coefficients at an operating wavelength of 1550 nm. Simulation results were compared with attenuation values derived from measured visibility data using correlation and root mean square error (RMSE) metrics. Results show that the Kim model provides the highest correlation (0.93) and lowest RMSE (2.7 dB/km), demonstrating superior suitability for tropical atmospheric conditions. The findings offer validated guidelines for selecting appropriate attenuation models for FSO-based 5G backhaul and last-mile deployments in Nigeria.

Keywords: Free Space Optics, Atmospheric Attenuation, Visibility, Kim Model, Kruse Model, Al Naboulsi Model, 5G Backhaul.

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4 The Economic Analysis of Gender Pay Gap in Sports

Paper ID V12I1-1147 · Pages 14-18 · Gender Pay Gap

Advika Rao, Student, Heritage International Xperiential School, Haryana

This research paper examines the causes of the gender pay gap in the sports industry. It looks at the many factors affecting the wages of female athletes by highlighting the role of sponsors, industries, labour markets and media. It also reflects the presentation of women in sports using sexual connotations, the limited opportunities and reduced investment they receive, which restricts their skill development and therefore the wages they earn. This research paper emphasises how earnings are not due to lack of performance or athletic abilities, but due to institutional inequalities present in sports industries consisting of women, thus they are not a true reflection of the performance of female athletes.

Keywords: Gender Inequality, Sports Industry, Limited Sponsorships, Restricted Opportunities, Labour Market Economics.

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5 Growth of Small and Medium Enterprises in Asian Countries with Special Emphasis on India

Paper ID V12I1-1148 · Pages 19-26 · Economy

Daksh Singhal, Student, G.D. Goenka Public School, Haryana

This paper examines the growth trajectory of Small and Medium Enterprises (SMEs) across Asian countries, with an emphasis on India. SMEs constitute the backbone of economic development in Asia, contributing

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significantly to employment generation, poverty alleviation, and export growth, yet they face persistent structural challenges like limited access to finance and inadequate infrastructure. This paper also delves into various Government interventions and policies supporting MSMEs. It also draws a comparison of India with other Asian countries such as Indonesia, Malaysia, the Philippines, and Thailand.

Keywords: SMEs, MSMEs, Asian Economy, Financial Obstacles, Government Policies.

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6 Predicting Adolescent Psychological Outcomes of Therapeutic Chatbot Use by Integrating Neuroscience, Chatbot, and User Behaviour

Paper ID V12I1-1151 · Pages 27-34 · Psychology

Kavika Singhal, Student, Paul George Global School, New Delhi

As we find our lives more and more intertwined with Artificial Intelligence, we use it for a variety of purposes. Using an AI assistant means that many tasks previously done by us can now be outsourced. This has many implications, cognitive, sociological and emotional. Earlier research in neuroscience suggests that teenagers and young adults are more vulnerable to negative psychological impacts from external influences. A study shows an increase in cognitive decline in students who use AI for essay writing. (Kosmyna). Another preprint finding shows how AI can aid medical misinformation sometimes and enhance patient care other times. (Jedrzejczak et al.). This paper discusses the effects of AI usage for companionship or mental health-focused conversations on adolescents and youth. Drawing on neuroscience literature and understanding the reward circuitry of the brain, it assesses the potential downsides of long-term usage. Deploying a basic chatbot to engage in empathetic conversations and conducting a survey (n=90) post interaction, perceived empathy, validation and other emotional factors are assessed. Another experiment is conducted to quantitatively measure chatbot validation. This paper proposes that AI is over-validating by nature and that it fosters reliance.

Keywords: Artificial Intelligence, Therapeutic Chatbots, Adolescent Mental Health, Social Validation, Emotional Dependence, Human-AI Interaction, Reward Circuitry.

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7 A Survey on Modern Computational Methods for Drug Repurposing

Paper ID V12I1-1157 · Pages 35-41 · Computational Biology

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Drug repurposing, the process of identifying new therapeutic uses for existing drugs, offers a promising strategy to accelerate drug development by significantly reducing costs, time, and risks compared to de novo drug discovery. The increasing availability of large-scale biomedical data has catalysed the development of computational approaches to systematically identify and prioritise repurposing candidates. This survey reviews

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the state-of-the-art computational methodologies, with a particular focus on network medicine and machine learning-based techniques. We discuss key approaches such as pathway-based analysis, network proximity, matrix factorisation, and the growing application of deep learning, particularly Graph Neural Networks (GNNs), which leverage complex biomedical networks. The paper explores how these methodsutilisee heterogeneous data—including drug-target interactions, gene-disease associations, and molecular structures—to generate repurposing hypotheses. Furthermore, we outline the primary challenges in the field, including data integration, model generalizability, and the need for explainability, and discuss future directions, such as the integration of multi-modal data and the development of more sophisticated, interpretable AI models.

Keywords: Computational Drug Discovery, Graph Attention Networks, Network-Based Prediction, Heterogeneous Graphs, Machine Learning, Therapeutic Discovery.

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8 Tribal Health in India: Status, Challenges, and Strategies for Strengthening Healthcare Delivery

Paper ID V12I1-1159 · Pages 42-47 · Gender Studies

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Tribal health remains one of the most neglected domains within the Indian public health system despite constitutional safeguards and multiple targeted programmes. Scheduled Tribes (STs), constituting approximately 8.6% of India's population, continue to experience disproportionately high morbidity and mortality due to a complex interaction of socio-economic deprivation, geographical isolation, cultural barriers, and systemic inadequacies in healthcare delivery. Historical marginalisation, poverty, low literacy levels, and poor living conditions have collectively contributed to persistent health inequities among tribal communities. Conventional healthcare models, which largely follow a uniform national approach, have failed to adequately address the unique cultural, social, and environmental contexts of tribal populations, resulting in limited utilisation of health services and delayed care-seeking behaviour. This paper presents a detailed narrative analysis of the health status of tribal populations in India, drawing upon secondary data from national surveys, census reports, and published literature. The study examines key indicators related to maternal and child health, nutritional status, communicable and non-communicable diseases, and healthcare utilisation patterns among tribal communities. It further explores systemic barriers such as inadequate infrastructure, workforce shortages, accessibility issues, financial constraints, and discrimination within healthcare settings. By reviewing existing policy frameworks and community-based models, the paper proposes context-specific and culturally sensitive strategies to strengthen primary healthcare delivery in tribal areas. The findings emphasise the need for integrated, participatory, and rights-based approaches to reduce health disparities and improve overall health outcomes among tribal populations.

Keywords: Tribal Health, Scheduled Tribes, Health Inequity, Primary Healthcare, Indigenous Populations, India.

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9 Lightweight Machine Learning Models for Detecting DNS Data Exfiltration Attacks in Cloud and Enterprise Networks

Paper ID V12I1-1155 · Pages 48-70 · Cloud Computing

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Cloud and Enterprise Networks are the foundation of today's digital age, facilitating frictionless communication and service delivery. Cloud and Enterprise Network attacks increasingly depend on trusted protocols, and DNS Data Exfiltration Attacks in Cloud and Enterprise Networks have evolved as a devious and powerful means to evade classic defences. Detecting DNS Data Exfiltration Attacks in Cloud and Enterprise Networks is therefore a pressing challenge that requires efficient and accurate solutions. This study investigates Machine Learning Models for Detecting DNS Data Exfiltration Attacks in Cloud and Enterprise Networks, focusing on lightweight approaches such as Random Forest, Decision Tree, Multi-Layer Perceptron, Logistic Regression, and Gaussian Naïve Bayes. Both Random Forest and Decision Tree achieved perfect evaluation scores (100%) across standard metrics, but closer inspection of confusion matrices revealed Random Forest as the superior model, misclassifying only two malicious instances while generating no false positives. The significance of this research lies in demonstrating that lightweight models, particularly Random Forest, can provide highly accurate, resource-efficient, and practical real-time protection against DNS exfiltration threats, ensuring the resilience of cloud and enterprise infrastructures.

Keywords: DNS Attack, Cloud, Machine Learning, Data Exfiltration.

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10 An Intelligent AI-Based Framework for Handwritten Character Recognition

Paper ID V12I1-1166 · Pages 71-78 · Deep Learning

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Handwritten Character Recognition (HCR) remains a fundamental yet challenging problem in pattern recognition due to variations in writing styles, distortions, noise, and inter-class similarity. This study proposes an intelligent AI-based framework for robust handwritten character recognition using a Convolutional Neural Network (CNN). The model is trained and evaluated on a self-curated dataset comprising 13,640 grayscale images representing 62-character classes, including digits (0–9), lowercase letters (a–z), and uppercase letters (A–Z). Images are standardized to a resolution of 28×28 pixels and normalized to enhance learning efficiency.

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The proposed CNN architecture leverages hierarchical feature extraction through multiple convolutional and pooling layers, followed by dense layers for classification. Experimental results demonstrate a recognition accuracy of approximately 93%, indicating strong generalization capability despite handwriting variability. The proposed framework emphasizes automated feature learning, eliminating the dependency on handcrafted descriptors traditionally used in character recognition systems. The model exhibits strong adaptability across diverse handwriting patterns, demonstrating robustness to intra-class variations. Furthermore, the lightweight CNN architecture ensures computational efficiency, making the system suitable for real-time applications and deployment in resource-constrained environments. The study also highlights the critical role of dataset quality, preprocessing strategies, and normalization techniques in improving recognition performance. Overall, the findings confirm that deep learning-driven approaches offer a reliable, scalable, and efficient solution for handwritten character recognition.

Keywords: Handwritten Character Recognition, Convolutional Neural Network (CNN), Deep Learning, Image Classification, Pattern Recognition.

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11 Life Cycle Assessment of Electric Vehicles vs. Internal Combustion Engine Vehicles: A Post-2020 Comparative Analysis

Paper ID V12I1-1182 · Pages 85-90 · Automobile

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Harpreet Singh, Independent Researcher, Independent researcher

The rapid electrification of transportation after 2020 has increased discussions about whether electric vehicles (EVs) are more environmentally friendly than internal combustion engine vehicles (ICEVs). Although EVs do not produce tailpipe emissions, their total impact on the environment depends on the manufacturing process, battery production, the combination of electricity production, and end-of-life treatment. In this work, the LCA of EVs and ICEVs on the basis of cradle-to-grave life cycle analysis is provided under the conditions of technological progress and the grid in the post-2020 period, with references to the Indian electricity mix. Mathematical emission modeling, break-even analysis, and sensitivity analysis are conducted for a functional unit of 150,000 km. Results indicate that EVs exhibit higher manufacturing emissions but lower operational emissions. Compared to ICEVs, EVs exhibit 6–30% lower total life cycle emissions under current grid conditions (0.7 kg CO_2/kWh). The study also emphasizes how important grid decarbonization is to improving EV sustainability performance.

Keywords: Electric Vehicles, Life Cycle Assessment, Internal Combustion Engine Vehicles, Carbon Emissions, Battery Manufacturing, Well-to-Wheel Analysis

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12 Impact of Aging on the Endocrine System

Paper ID V12I1-1154 · Pages 91-97 · Biology

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The endocrine system plays a central role in maintaining homeostasis through hormonal regulation. Aging is associated with progressive dysregulation of several endocrine axes, resulting in widespread effects on metabolism, musculoskeletal integrity, immune function, mental health, etc. This paper examines the impact of aging on key systems, including the growth hormone–insulin-like growth factor-I axis (GH-IGF-I Axis), dehydroepiandrosterone (DHEA(S)), the hypothalamo–pituitary–adrenal axis (HPA Axis), menopause, and andropause. Understanding these hormonal changes is essential for addressing age-related morbidity and improving quality of life in older populations.

Keywords: Endocrine Aging, Growth Hormone–IGF-I Axis, Dehydroepiandrosterone (DHEA/DHEAS), Hypothalamic–Pituitary–Adrenal axis, Menopause, Andropause.

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13 The Impact of Digital Payments in the Modern Global World: A Comparison Between India, EU/US/UK and Italy

Paper ID V12I1-1163 · Pages 98-105 · Economics

Vedaansh Chaudhary, Student, Step by Step School, Noida

This study explores the rapid growth of digital payment systems and their impact on financial inclusion and literacy around the world. Over the past decade, these platforms have become increasingly integrated into the economies of many countries, changing the way people access and manage money. The research focuses on how digital payment systems have emerged in the modern global context and examines their influence on financial literacy across different populations. A comparative analysis is conducted for countries including the United States, India, the European Union, and Italy, highlighting differences in adoption, regulatory approaches, and accessibility. Using qualitative analysis of policy reports and secondary data from international financial institutions, the study identifies both opportunities and challenges associated with digital payment expansion. Findings suggest that while these systems make financial transactions easier and more efficient, gaps in digital skills, infrastructure, and access remain. The study emphasizes the need for targeted policies and education programs to ensure that digital payments contribute to inclusive and sustainable financial development.

Keywords: Digital Literacy, Italy, EU, Payment, Finance, Financial Inclusion, Digital Payment Systems, Economics, Youth, Fintech Education, India, USA.

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14 Loss Aversion, Nudges, and Mental Accounting: Understanding Decision-Making through Behavioral Economics

Paper ID V12I1-1169 · Pages 106-111 · Economics

Kapeesh Ahuja, Student, Shiv Nadar School, Gurugram

This research paper explores the principles of behavioral economics, placing special emphasis on loss aversion, the endowment effect, and the role of nudge theory in everyday decision-making. By analyzing foundational theories, this paper highlights how psychological factors influence human behaviour, and aims to prove how behavioural economics provides a more realistic approach to decision-making than traditional theories. Behavioral economics has emerged as a field that explains the deviations in pre-existing consumer theories and provides a more realistic rationale to explain consumer behaviour in making decisions. Special attention is given to Richard H. Thaler, whose contributions to mental accounting, prospect theory, and nudge theory provided the foundation for understanding real-world behaviour. Methodologically, this paper adopts an analytical approach. It reviews pioneering literature, including Thaler's original papers related to behavioural studies, and contrasts them with neoclassical assumptions. This paper draws connections between theoretical concepts and real-world practical examples—from consumer spending patterns to market behaviour. Overall, this paper discusses that integrating human behavioural insights into economic thinking leads to a more realistic model of human behaviour.

Keywords: Behavioural Economics, Neoclassical Economics, Expected Utility Theory (EUT), Efficient Market Hypothesis (EMH), Prospect Theory, Heuristics, Loss Aversion, Endowment Effect, Mental Accounting, Nudge Theory, Choice Architecture and Libertarian Paternalism.

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15 Advancements in Additive Manufacturing for Modern Industrial Applications

Paper ID V12I1-1158 · Pages 112-120 · Engineering

Riya Ghosh, Student, Paul George Global School, New Delhi

Additive manufacturing (AM), commonly known as 3D printing, has emerged as a transformative technology in modern manufacturing due to its ability to produce complex, customized components with reduced material waste and shorter production timelines. Driven by increasing consumer demand for personalization and rapid product development, AM enables layer-by-layer fabrication directly from digital CAD models, offering significant advantages over traditional manufacturing methods. This paper presents a comprehensive review of additive manufacturing technologies, examining their evolution, key processes, materials, and applications across various industrial sectors. The paper highlights the primary benefits of AM, including cost effectiveness, design flexibility, reduced tooling requirements, and the integration of advanced information technologies for automated process monitoring. At the same time, it critically analyzes the limitations that hinder widespread industrial adoption, such as restricted build volume, material and mechanical property constraints, regulatory challenges in the healthcare and food sectors, and ethical and security concerns related to misuse. Particular emphasis is placed on the lack of standardized regulatory frameworks for medical devices and implants, which contributes to industry hesitation despite the significant potential of AM in personalized healthcare solutions. Furthermore, the paper discusses current adoption trends and identifies key drivers such as prototyping,

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product development, and innovation that continue to fuel advancements in additive manufacturing. Finally, the scope for future research is outlined, focusing on large-scale printing systems, advanced material development, improved quality control through artificial intelligence, and the establishment of AM-specific regulatory standards. The findings suggest that while additive manufacturing is unlikely to fully replace conventional manufacturing in the near future, it will continue to play a critical complementary role in shaping the future of intelligent and sustainable manufacturing.

Keywords: Additive Manufacturing, Advancements, Regulatory Standards, Primary Benefits, Current Adoption Trends.

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16 AI-Based Video Clip Identifier for Movies and Streaming Platforms

Paper ID V12I1-1152 · Pages 121-122 · Dynamic Website

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With the rapid growth of movies and over-the-top (OTT) streaming platforms, managing and identifying video clips efficiently has become a challenging task. Traditional video identification systems rely on manual tagging and metadata-based search techniques, which are time-consuming and often inaccurate. This paper presents an AI-based video clip identifier that automatically recognizes and identifies video clips from movies and streaming platforms using machine learning and deep learning techniques. The proposed system extracts video frames, analyzes audio-visual features, and applies convolutional neural networks to accurately match and identify video clips.

Keywords: Artificial Intelligence, Video Clip Identification, Deep Learning, OTT Platforms.

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