



**SHINAWATRA
UNIVERSITY**
FOSTERING INNOVATION

ICIRD -2025

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(ICIRD – 2025)**

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**SHINAWATRA
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Dr. Pratikshya Bhandari
Dr. Sarana Photchanachan
Prof. Dr. Parin Somani

**ESN Publications, India
Shinawatra University, Thailand**

About Conference

It is a great privilege for us to present the 5th INTERNATIONAL CONFERENCE ON INNOVATIVE RESEARCH AND DEVELOPMENT (ICIRD – 2025) to the authors and delegates of the event. We hope you will find it useful, exciting and inspiring. The aim of ICIRD – 2025 is to present the latest research and findings of professors, students, PhD students, engineers, researchers and scientists related to Multidisciplinary topics. ICIRD – 2025 promises to be both stimulating and informative with an array of prominent and distinguished keynote speakers. This conference is a culmination of efforts of a large number of individuals from various parts of the world.

We wish all attendees of ICIRD – 2025 an enjoyable scholarly gathering at Cordelia Cruises.

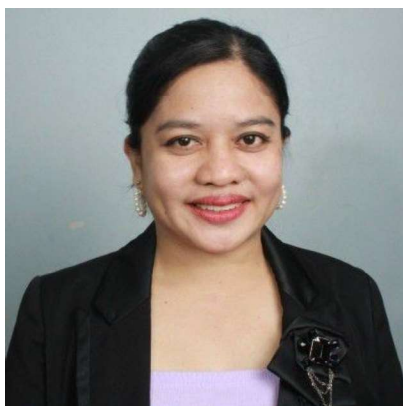
About ESN PUBLICATIONS

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About Shinawatra University

Metharath University (MRU), formerly Shinawatra University (SIU), is a private international university in Thailand, established by Thaksin Shinawatra and his colleagues. The campus was designed and developed by Soontorn Boonyatikarn in 1997. The Ministry of University Affairs granted the license for operation in 1999. The first Shinawatra University Council Meeting was held on 19 May 2000, and the first batch of students was admitted in September 2002. As of 2018, the university had students and faculty members of over 30 nationalities. The university changed its name in 2022[1] amidst concerns regarding Chinese investment.

About Editors



Julie Simon Macariola
Manager, International Affairs
Shinawatra University, Pathum Thani, Thailand

Ms. Julie Simon Macariola is an accomplished educator, guidance counselor, and international speaker with extensive experience in education, training, and global collaboration. Currently serving as Manager of International Affairs at Shinawatra University, she leads initiatives that strengthen international partnerships, foster academic exchange, world ranking, and enhance the university's global presence. With over fifteen years of professional experience, Ms. Julie has worked in diverse educational settings across Thailand and the Philippines. At Shinawatra University, she oversees academic networking and international affairs. In addition to her profile in higher education, she served as adjunct lecturer at the Asian Institute of Technology and Panyapiwat Institute of Management. Prior to this, she taught English and Science at the BMA English Program in Bangkok, served as an EAL Specialist at KPIS International School, and taught at Wat Muang School and Kewin School. Earlier in her career, Ms. Julie worked as a Guidance Counselor and High School Filipino Teacher at Our Lady of Pilar Montessori in the Philippines, where she supported students' academic and emotional development. She also managed MY English Learning Center in Muntinlupa City, serving as Headmaster and ESL instructor, and began her career as an ESL teacher at English Cultural Center. Beyond formal institutions, Ms. Julie has also worked as a

freelance language coach, helping learners develop English fluency and confidence in communication.

An international speaker, Ms. Julie has presented in numerous conferences around the world, both onsite and online, on topics related to Education, Artificial Intelligence in Education, and Well-being. As a certified trainer, she designs and conducts professional development programs on pedagogy, communication, public speaking, and mental health, empowering university students, educators and professionals to teach and lead with empathy and effectiveness.

Ms. Julie Simon Macariola holds a Master of Arts in Education, Major in Guidance and Counseling from Far Eastern University Roosevelt, where her study was recognized among the Top Ten Outstanding Theses, and a Bachelor of Secondary Education, Major in Filipino from Philippine Normal University. She is currently completing her dissertation for PhD in Education (Major in English) at University of Perpetual Help Dalta. She also holds international certifications in TESOL, TEFL, SPED (Supporting Diverse Learners in Inclusive Classrooms), EnterTrainer Certification as well as Diploma in Peace Mediation.

Recognized for excellence and leadership, she has received multiple distinctions, including Outstanding Global Educator, Eminent International Educationist, Noble Asian Educator, Jose Rizal Achievement Award, Leadership Excellence Award, and Distinguished Toastmaster. In addition, she has co-published research papers in Education and Educational Leadership, contributing to scholarly discourse on innovation, pedagogy, and effective leadership.

Dedicated to inclusive and transformative education, Ms. Julie Simon Macariola continues to inspire learners, educators, and professionals through teaching, research, training, and global engagement, championing lifelong learning, intercultural understanding, and mental well-being.



Dr. Pratikshya Bhandari
Faculty of Management
Shinawatra University, Thailand.

Dr. Pratikshya Bhandari serves as a distinguished lecturer at the Faculty of Management and holds the position of Director of International Affairs at Shinawatra University, Thailand. With a strong foundation in management education, she has played a crucial role in fostering academic growth and international collaboration within the institution. Dr. Bhandari's commitment to expanding global partnerships and enhancing educational opportunities is evident in her dynamic leadership role in international affairs, where she facilitates connections between students, and faculty. In addition to her academic and administrative responsibilities, Dr. Bhandari is deeply passionate about research, with a particular focus on entrepreneurship. Her research interests revolve around exploring innovative entrepreneurial practices, strategies for business development, and the role of entrepreneurship in driving economic growth.



Dr. Sarana Photchanachan
Dean of the Faculty of Management
Shinawatra University, Thailand

Dr. Sarana Photchanachan is the Dean of the Faculty of Management and the Director of the Research and Innovation Center at Shinawatra University. In his dual leadership roles, Dr. Photchanachan has been instrumental in fostering a research-driven culture within the institution, focusing on advancing the fields of management. His work as the Director of the Research and Innovation Center has promoted collaboration between academic scholars and industry professionals, encouraging innovative approaches. He is highly regarded in the research field, particularly for his innovative contributions to entrepreneurship and social entrepreneurship.



Prof. Dr. Parin Somani
CEO: London Organisation of Skills Development

Prof. Dr. Parin Somani is an internationally acclaimed academician, educator, humanitarian, and visionary leader, serving as the **CEO and Director of the London Organisation of Skills Development (LOSD)**. She is also the **Chief Editor of the Global Research Journal**, a four-time **TEDx Speaker, Skills Live Speaker, International Motivational Speaker, Philanthropist, Author, and Multi-International Award Winner**.

Her academic journey is distinguished by a remarkable depth of scholarship and contribution to global education. Prof. Dr. Somani holds two academic doctorate degrees and has been honoured with **six Honorary Doctorate Degrees**. They recognise her exceptional humanitarian, academic, and philanthropic contributions worldwide, reflecting her lifelong dedication to advancing education and human welfare.

As a prolific author, Prof. Dr. Somani has written **23 books** and published numerous academic papers, inspiring readers to embrace self-growth, education, and compassion. Her literary and educational contributions continue to shape contemporary academic and leadership discourse globally.

In recognition of her humanitarian impact and commitment to social development, Prof. Dr. Somani has travelled to over **127 countries**, empowering communities through initiatives in **education, women**

empowerment, youth development, mental health, and skills advancement. Her work through LOSD has transformed countless lives, bridging the gap between learning and leadership by fostering platforms such as *Global Research Conferences (GRC)*, *Global Research Journal (GRJ)*, and *Skills Live*.

Beyond academia, Prof. Dr. Parin Somani has gained international recognition in the field of pageantry, symbolising the harmony between intellect and grace. She was crowned Mrs Universe 2022, Winner of Enigma Mrs World 2022 in Thailand, Winner of Mrs BritAsian 2021 in London, Winner of Mrs India 2021, Winner of Mrs Universe International 2021, Winner of Mrs India Global 2021 and runner up of Mrs Queen of India 2021 and many more.

Prof. Dr. Parin Somani has been recognised in the Guinness World Records and was one of the Lead Editor of ‘The Thickest Book in the World’. Recognised 5 times in World Book of Records, twice in India Book of Records, Asia Book of Records, twice in Karnataka Book of Records, Golden World Book of Records and Scholars Book of World Records.

Fondly known as the **“Iron Lady of the 21st Century”** and the **“New Era of Mother Teresa”**, Prof. Dr. Parin Somani continues to serve as a beacon of resilience and compassion. Her strength stems from overcoming life-threatening challenges; battling cancer twice, temporary vision loss, and a stroke, transforming adversity into a mission to uplift humanity.

Prof. Dr. Parin Somani lives her life guided by two powerful mottos:

1. *“It is my aim in life to serve humanity until my last breath.”*
2. *“By working together, we can create positive global change.”*

Through her leadership, academic brilliance, and boundless compassion, Prof. Dr. Parin Somani continues to illuminate the path toward a more empowered, educated, and equitable world.

Keynote Speech



Dr.T.Gowtham Raj
MDS, FAAC

Dr. T. Gowtham Raj is a highly accomplished and dedicated **Prosthodontist, Chief Consultant, and academician**, currently serving as **Assistant Professor** at the **Mahatma Gandhi Postgraduate Institute of Dental Sciences (MGPIDS)**, Government of Puducherry. He holds a distinguished record in **advanced clinical care, academic teaching, and cutting-edge research**.

With an **MDS in Prosthodontics** and an **FAC in Clinical Cosmetology and Aesthetic Science**, Dr. Gowtham Raj possesses multidisciplinary expertise spanning **complex dental rehabilitation, implantology, digital dentistry, and facial aesthetics**. He is particularly specialized in **digitalized full-mouth rehabilitation**, integrating **CAD/CAM technology, digital smile design, and 3D-printing workflows** to deliver precision-driven, minimally invasive, and highly aesthetic restorative outcomes.

In addition to his academic role, he serves as the **President of the Council of Cosmetology, Trichology, Regenerative, and Aesthetic Science (COCTRASI)** and functions as **Chief Consultant Prosthodontist** at several leading dental centres. His clinical philosophy emphasizes **comprehensive, patient-focused care** grounded in technological innovation and long-term oral health.

Dr. Gowtham Raj's pioneering contributions to research and innovation have earned notable recognition—particularly his **award-winning design and 3D printing of a highly precise robotic arm** for a congenitally missing patient. His published works, including those on

Artificial Intelligence in Dentistry, reflect his deep commitment to **integrating emerging technologies** with evidence-based clinical practice.

As an educator and mentor, he is devoted to **nurturing future dental professionals**, fostering innovation, and promoting interdisciplinary learning. His active participation in **community health camps and outreach initiatives** demonstrates his belief in socially responsible dentistry.

Outside academia, he exemplifies creativity and endurance—a **world-record holder for performing 15 continuous hours of blindfolded drumming**—and is also a **digital artist**, channelling his artistic sensibility into both music and digital design.

Dr. T. Gowtham Raj is widely regarded as a **visionary professional** whose multidisciplinary expertise, innovative spirit, and compassionate leadership continue to inspire students, clinicians, and researchers alike.

‘The AI Transformation: From Everyday Life to Precision Dentistry’

Dr. T. Gowtham Raj

MDS Assistant Professor,
Department of Prosthodontics,
Mahatma Gandhi Postgraduate Institute of Dental Sciences,
Government of Puducherry, India

Artificial Intelligence (AI) has transitioned from being a futuristic concept to an indispensable force shaping our daily lives — from virtual assistants and smart wearables to predictive algorithms that guide our decisions. This same transformative power is revolutionizing modern dentistry, particularly in the realm of precision and prosthodontic rehabilitation.

This keynote explores the dynamic evolution of AI from its integration in everyday applications to its pivotal role in digital dentistry. It highlights how machine learning, image recognition, and predictive analytics are enhancing diagnostic accuracy, treatment planning, and digital workflows. Real-world clinical examples will demonstrate how AI-driven technologies such as CAD/CAM, 3D printing, and digital occlusion analysis are redefining patient care and prosthodontic outcomes.

Through this 30-minute session, attendees will gain insights into the seamless synergy between human expertise and artificial intelligence — a partnership driving dentistry toward precision, personalization, and predictability. The session will conclude with a forward-looking perspective on ethical integration, future research, and how AI is set to empower clinicians in creating truly intelligent smiles.



Dr. R. RAVANAN, M.Sc., M.Phil., Ph.D., FSMS.

“Tamil Nadu Scientist Awardee”

Joint Director (P&D) (Retd), Directorate of Collegiate Education

**Former Joint Director (Finance), Directorate of Collegiate
Education, Chennai**

**Former Joint Director of Collegiate Education, Chennai Region,
Chennai**

Former Principal, Presidency College, Chennai

Former Head, Department of Statistics, Presidency College, Chennai

**Former Secretary, Indian Society for Probability and Statistics (ISPS),
India**

**Former General Secretary, Tamil Nadu Statistical Association
(TNSA), Tamil Nadu**

I joined Tamil Nadu Government Collegiate Service in 1990 as a Lecturer of Statistics in S.S. Government Arts College, Tirutani. Later got transferred to Presidency College, Chennai where I served as Lecturer, Senior Lecturer, Reader, Head of the Department of Statistics and Principal of Presidency College. Before being posted as Principal of Presidency College, I served as Principal of Government Arts and

Science Colleges in Nagercoil and Tindivanam.

As Head, Department of Statistics, Presidency College, I organized several workshops and conferences inviting eminent Scholars like Professor S.R.S. Varadhan, Abel Prize laureate (Equivalent to Nobel Prize) in Mathematics.

As Principal of Presidency College, I created a positive visibility by inviting distinguished personalities to the College campus and the Honourable Vice President of India Shri. M.Venkaiah Naidu graced the occasion of the graduation day of Presidency College. During my tenure Presidency College was conferred 3rd Rank in All India Ranking – 2019 by NIRF.

As a research supervisor, I had successfully guided 19 M.Phil and 15 Ph.D Scholars are pursuing research under my guidance. I have authored 6 books and have 35 research publications in national and international journals with 25 citations. I had delivered more than 410 lectures on the applications of Statistics using SPSS and AMOS for the benefit of Scientists in the field of Medicine, Engineering, Social Science, etc., I had served as an EC member of Indian Society for Probability and Statistics (ISPS), a reputed Professional Society for Statistics and the Secretary of the Society.

Recently in recognition of my research work in the field of Mathematical Sciences the Tamil Nadu State Council for Science and Technology has conferred me the Tamil Nadu Scientists Award (TANSA) in Mathematical Sciences for the year 2019. I retired as the Joint Director (Planning and Development), Directorate of Collegiate Education, Chennai

Dr. R. RAVANAN, M.Sc., M.Phil., Ph.D., FSMS.

It is a great honour to be here with you today at this International Conference on Innovative Research and Development. I would like to thank the organizers for giving me the opportunity to address such a dynamic gathering of minds dedicated to progress and discovery. At a time when the world demands creative solutions to complex problems, this conference stands as a beacon of progress and collaboration.

Innovation is no longer a luxury—it is a necessity. The future belongs to those who not only think differently but also act boldly. In this spirit, I commend the efforts of ESN Publications, a reputed name in the academic world, for consistently promoting quality research, knowledge dissemination, and global academic collaboration. Through their journals, conferences, and academic platforms, ESN Publications has empowered countless researchers to share their work with the world. Equally commendable is the role of Shinawatra University, a leading institution committed to academic excellence and innovation, in co-hosting this conference.

This conference is more than just a series of technical sessions—it is an opportunity to connect, exchange ideas, and inspire innovation. It brings together researchers, academicians, professionals, and students from across the globe to explore new frontiers in knowledge.

I urge all participants to make the most of this opportunity—ask questions, challenge ideas, share knowledge, and build collaborations that go beyond borders.

Let this conference ignite new thoughts, strengthen academic networks, and pave the way for meaningful contributions to the world of research and innovation.

I wish the event grand success and congratulate both ESN Publications and Shinawatra University for organizing such a globally relevant initiative.



Prof. C. Ragavan

Associate Professor & Head
Department of Mathematics

Dr. C. Ragavan is an accomplished Associate Professor and Head of the Research Department of Mathematics at Sri Vidya Mandir Arts and Science College (Autonomous), Uthangarai, Krishnagiri District, Tamil Nadu, India, with over 23 years of teaching experience. Born on 15th June 1978 in Krishnagiri, Tamil Nadu, he holds a Ph.D. in Mathematics from Manonmaniam Sundaranar University, specializing in algebras, with a thesis titled “A Study on Various Types of Fuzzy Ideals in BCI-Algebras,” along with M.Sc., B.Ed., and M.Phil. degrees. He has supervised numerous Ph.D. and M.Phil. scholars, served as a Senate member for Periyar University, and chaired the Board of Studies at his college. Dr. Ragavan has actively participated in national and international conferences, workshops, and seminars, delivering invited talks and presenting research papers in areas including fuzzy logic, algebraic structures, and applications of mathematics in fluid dynamics. He has published over 60 research articles in reputed journals, including the *International Journal of Fuzzy Mathematics and Systems* and other Scopus-indexed journals, earning multiple awards for teaching and research excellence, such as the Best Teacher Award (2008) and Best Researcher Awards (2021, 2025). Additionally, he has contributed to faculty development programs, refresher courses, and e-content development initiatives, reflecting his dedication to advancing mathematical research and education.

Deep Learning Approaches for Disease Prediction: A Survey of Techniques and Applications in Healthcare

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Deep learning (DL) is revolutionizing two fundamental aspects of disease: early diagnosis and prediction. Some of these models such as AIs for medical imaging (for example, CNNs), electronic health records (for example, RNNs/LSTMs) and medical natural language processing and multimodal learning (for example, transformers) are presented in the following survey papers. Though these models have great potential to spot diseases like COVID-19, cancer and heart disease, there are still questions about a shortage of data, interpretability by researchers and ethical concerns. This article shares an overview of the future of predictive healthcare by exploring the latest technologies including wearable tight integration, federated learning and explainable AI.

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1. Introduction

Favoring better patient results and decreased health costs, early disease prediction is a necessity. When medical data is exploding in volume and complexity, from EHRs to imaging, genomics etc. traditional ML often do not capture subtle patterns. Deep learning (DL) has emerged as a powerful alternative tool, due to its ability to automatically extract features from raw high-dimensional data. Advancements in computing power, easily accessible large annotated datasets and the development of open-source libraries such as TensorFlow or PyTorch have all been responsible for its growth. This comprehensive review of DL techniques for disease prediction addresses main models, applications, challenges, and future trends in clinical practices.

2. Core Deep Learning Concepts

2.1 Neural Networks

Deep learning has its roots in the artificial neural network (ANN), which is a computational model inspired by human brain. An input layer, one or more hidden layers, and an output layer constitute the basic structure of a neural network [1]. Interconnected nodes (neurons) consisting of each layer are used to apply weight connections and the activation functions for processing and transforming input data.

This layered architecture allows the network to identify complex, non-linear relationships in the data. As the number of hidden layers increases, the network becomes a deep (or DNN) network [11] that is particularly suitable for medical applications in which high-level features can be learned from large unstructured databases.

Because of this layered construction, the network is able to find more complex, non-linear relationships in the data. As the hidden layers increase, the network turns to a deep neural network (DNN), and will be well applied in challenging medical applications by extracting high-level features from large-scale unstructured datasets.

2.2 Common Deep Learning Models in Healthcare

- Convolutional Neural Networks (CNNs):

CNNs excel in detecting diseases from images, particularly pathology and radiology. They are ideal for analyzing X-rays, CT scans, and MRIs to detect diseases such as tumors, fractures, pneumonia, and more due to the fact that they employ convolutional layers to learn automatically about spatial hierarchies within images.

- Recurrent Neural Networks (RNNs) and LSTMs

To represent time-dependent clinical data, such as genetic information, electronic health records (EHRs), and patient monitoring signals, RNNs need to be capable of handling sequential data. One type of RNN most useful for identifying long-term dependencies in patient history is the Long Short-Term Memory (LSTM) network, which is used to forecast the path of chronic diseases.

- Transformers:

Transformer models originated in natural language processing (NLP), but recently gained traction in medicine [3]. They are beneficial for medical NLP applications such as prediction of diagnosis codes, summarization of clinical notes, and detection of drug interactions due to their self-attention mechanism, which allows them to learn contextual relationships in clinical texts.

2.3 Training Techniques

- Supervised learning:

Supervised learning, the most widely used method in disease prediction, entails training models on labeled datasets with known correct diagnoses or outcomes. When there is access to high-quality annotated medical data, this method works well.

- Transfer learning:

Transfer learning enables pre-trained models that already have access to large datasets (such as ImageNet) to be fine-tuned for specific healthcare tasks in medical situations where there is limited medical data. Performance is improved and training is significantly reduced, especially in medical imaging settings.

- Fine-tuning Pre-trained Models

Fine-tuning is the process of changing the weights of a previously trained model to fit a new, domain-specific task, as opposed to training deep networks from scratch. This method is particularly helpful in the healthcare industry, where it can be difficult to gather and label large datasets.

3. Applications in Disease Prediction

Deep learning has shown great promise in many medical applications, especially in early disease diagnosis and prediction. Deep learning models are able to recognize subtle patterns that may be hard for conventional techniques or even skilled clinicians to notice by automatically learning from complex and high-dimensional datasets. Key applications in a number of important disease categories are listed below:

3.1 Cardiovascular Disorders

Cardiovascular diseases (CVDs) are among the leading causes of death globally. Deep learning models, particularly Convolutional

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Neural Networks (CNNs) and Long Short-Term Memory (LSTM) networks, have been able to effectively analyze ECG signals and electronic health records (EHRs) for the early diagnosis of arrhythmias, heart failure, and coronary artery disease[2]. Real-time detection and risk stratification are facilitated by these models' capacity to learn both spatial and temporal patterns.

3.2 Detection of Cancer

Deep learning has revolutionized cancer diagnostics, especially in the examination of medical images. Scans of tumors taken from modalities such as mammograms, CT scans, and histopathology images are often classified based on CNN-based architectures. For instance, CNNs can easily and rapidly identify nascent lung nodules or identify benign and malignant lesions in the case of breast cancer, often better than traditional diagnostic procedures.

3.3 Prediction of Diabetes

Early detection is critical in diabetes management and preventing complications [5]. Tabular datasets that include demographic, clinical, and lifestyle information have been applied to deep learning models, namely deep feedforward neural networks (DNNs). From patient profiles, the models help in identifying risk factors, type 2 diabetes onset prediction, and tailoring treatment regimens.

3.4 Neurological Disorders

Due to their insidious initial symptoms, neurological disorders such as Parkinson's disease and Alzheimer's disease are often diagnosed late. To detect structural and functional anomalies, brain MRI and PET scans are examined on the basis of deep learning models, especially CNNs. These models aid in clinical decision-making and early diagnosis through cognitive decline prediction and detection of disease markers.

3.5 COVID-19 Detection

Deep learning was critical for rapid screening and diagnosis in the time of the COVID-19 pandemic. CNNs were employed to screen CT scans and chest X-rays to facilitate rapid, accurate detection of pneumonia associated with COVID-19[4]. Especially in instances where testing facilities were limited, these technologies provided priceless help to overwhelmed healthcare systems.

4. Datasets

The availability of high-quality datasets from sources such as genomics, EHRs, and medical imaging is crucial to the efficacy of deep learning in disease prediction. The NIH Chest X-ray Dataset is a popular tool for CNN-based thoracic disease classification and provides more than 100,000 annotated X-rays from more than 30,000 patients for imaging purposes [6]. The BraTS dataset supports neuro-oncology research by offering multi-modal MRI scans with tumor annotations. Clinically speaking, MIMIC-III contains de-identified intensive care unit data from more than 60,000 patients, which makes it perfect for temporal modeling using transformers and LSTMs. Similar to this, the eICU Collaborative Database, which is used for treatment planning, length-of-stay estimation, and mortality prediction, includes information from 200,000 ICU admissions across US hospitals.

5. Evaluation Metrics

To guarantee the dependability and clinical utility of deep learning models for disease prediction, evaluation is crucial. The task, dataset, and error trade-offs all influence the choice of metrics. Metrics that are frequently used include:

5.1 Accuracy

With unbalanced medical datasets, accuracy—which quantifies the percentage of accurate predictions—can be deceptive.

$$\text{Accuracy} = \frac{TP + TN}{TP + FP + FN + TN}$$

5.2 precision and Recall

Recall (sensitivity) tells us the number of actual cases detected, while precision tells us the number of correctly identified positives among those predicted. Recall needs to be high for disease prediction to avoid missing diagnoses.

$$\text{Precision} = \frac{TP}{FP + TP}$$

5.3 F1 Score

To balance datasets where precision and recall separately are not sufficient, the F1 score is a useful measure by balancing the two.

$$F1 = 2 \times \left(\frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} \right)$$

5.4 Confusion Matrix

The confusion matrix serves as the foundation for numerous evaluation metrics that highlight model errors and provides information on prediction outcomes, including true positives, true negatives, false positives, and false negatives.

6. Challenges

Although there are issues with data quality, model limitations, and ethical implementation, deep learning has enormous potential for disease prediction.

6.1 Data Issues

- Training strong deep learning models is hampered by a lack of labeled data because of expert labeling, privacy concerns.
- When rare disease cases occur, class imbalance can skew models in favor of the majority class, decreasing sensitivity.
- Tight privacy laws restrict data exchange, making it difficult to collaborate and obtain extensive datasets.

7. Recent Trends & Future Directions

Rapid advancements are being made in deep learning for disease prediction, with multimodal learning combining various data sources such as labs, notes, and images to increase accuracy. In order to ensure security and wider applicability, federated learning allows hospitals to work together to train models without sharing raw data. Instead, they only exchange encrypted updates.

8. Conclusion

By untangling complex medical data, deep learning has the potential to enable earlier, tailored disease prediction. But to tackle concerns such as data scarcity, explainability, ethics, and anonymity, research, collaboration, and regulation are needed. To better meet the needs of diverse populations, hybrid models that integrate data modalities, enhance explainability, and utilize privacy-preserving methods such as federated learning are the future.

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