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RADemics

Comparative Analysis of Machine Learning and Deep Learning Models for Multi- Cancer Diagnosis

A decorative graphic consisting of several thin, curved lines in shades of blue and grey, originating from the bottom left and extending upwards and to the right, resembling stylized grass or reeds.

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Comparative Analysis of Machine Learning and Deep Learning Models for Multi-Cancer Diagnosis

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Abstract

Cancer diagnosis represents a critical challenge in modern healthcare due to increasing incidence rates and the complexity of identifying diverse cancer types at early stages. Advances in artificial intelligence have introduced powerful computational approaches capable of improving diagnostic accuracy through data-driven analysis. Machine learning and deep learning models have demonstrated significant potential in analyzing clinical records, medical imaging, and molecular datasets for effective cancer detection. Machine learning techniques rely on structured data and engineered features to support predictive modeling, while deep learning architectures enable automated feature extraction from large-scale and high-dimensional datasets, particularly medical images. Comparative evaluation of these approaches highlights differences in computational complexity, interpretability, data requirements, and diagnostic performance in multi-cancer detection tasks. Integration of advanced algorithms with multimodal biomedical datasets contributes to improved screening efficiency and supports early disease identification. Analytical insights derived from this comparative study strengthen understanding of suitable AI frameworks for multi-cancer diagnosis and support future development of reliable clinical decision-support systems in oncology.

Keywords: Machine Learning, Deep Learning, Multi-Cancer Diagnosis, Artificial Intelligence in Healthcare, Medical Image Analysis, Cancer Detection.

Introduction

Cancer represents one of the most critical public health challenges across the world, with increasing incidence rates and growing complexity in diagnosis and treatment [1]. Rapid urbanization, environmental changes, genetic predispositions, and lifestyle-related factors have contributed to a steady rise in various cancer types [2]. Early and accurate detection plays a crucial role in improving survival outcomes and enabling timely therapeutic interventions. Conventional diagnostic approaches such as histopathological examination, radiological imaging, and laboratory-based biomarker testing have formed the foundation of cancer detection for decades [3]. Clinical specialists analyze tissue samples, imaging scans, and laboratory findings to identify abnormal cellular activity and determine disease progression. Diagnostic interpretation requires extensive medical expertise and careful evaluation of complex clinical evidence. Growing patient

populations and increasing volumes of medical data place substantial demands on healthcare professionals responsible for cancer screening and diagnosis [4]. Diagnostic variability across institutions and clinicians often affects consistency in medical decision-making. Rapid advancements in medical imaging technologies, genomic sequencing, and electronic health records generate enormous quantities of biomedical data that require sophisticated analytical methods [5]. Traditional analytical techniques struggle to efficiently process such large and heterogeneous datasets. Development of intelligent computational frameworks capable of extracting meaningful insights from complex medical data therefore represents a critical priority in modern oncology research.

Artificial intelligence has emerged as a transformative technological advancement that enhances analytical capabilities within healthcare and biomedical research [6]. Artificial intelligence refers to computational systems designed to perform complex analytical tasks through automated pattern recognition, data interpretation, and predictive modeling. In oncology research, artificial intelligence supports detection of subtle disease indicators that remain difficult to identify through conventional analytical approaches [7]. Medical datasets collected through imaging systems, genomic sequencing platforms, and clinical information systems contain complex multidimensional information that requires advanced computational processing. Artificial intelligence algorithms analyze large volumes of biomedical data and identify hidden relationships among clinical variables associated with cancer progression [8]. Pattern recognition capabilities within intelligent systems enable identification of tumor characteristics, abnormal tissue structures, and molecular markers linked to malignant conditions. Integration of artificial intelligence within diagnostic frameworks enhances efficiency of data analysis and supports evidence-based clinical decision-making [9]. Healthcare researchers increasingly adopt computational intelligence to accelerate discovery of disease biomarkers and improve diagnostic accuracy across multiple cancer types. Expansion of artificial intelligence applications within oncology strengthens interdisciplinary collaboration between computer science, biomedical engineering, and clinical medicine [10]. Continuous technological progress has positioned artificial intelligence as a central component in the development of next-generation cancer diagnostic systems.