Statistical Analytical Review of Deep Learning Paradigms for Cancer Classification and Prognostic Modeling

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Deep learning has transformed cancer diagnosis, but statistical understanding of model behavior, repeatability, and generalizability remains limited. This study presents a statistical examination of 100 deep learning frameworks for cancer classification, prognostic modeling, and radiomic feature extraction across malignancies. Iterative comparison study measures CNN, transformer topology, multimodal fusion model, and metaheuristic optimization framework accuracy, precision, recall, F1-score, and AUC metrics. Ensemble and hybrid models incorporating radiomics or genomic correlations outperform single-stream CNNs with mean accuracies above 96% and AUCs above 0.98.

Additional Key Words and Phrases: Deep Learning, Cancer Classification, Radiomics, Statistical Analysis, Explainable AI

ACM Reference Format:
First Author and Second Author. 2024. Statistical Analytical Review of Deep Learning Paradigms for Cancer Classification and Prognostic Modeling. *J. ACM* 1, 1, Article 1 (January 2024), **??** pages. https://doi.org/XXXXXXX.XXXXXXX

1 Introduction

Digital clinical data and high-resolution medical imaging have altered cancer diagnosis. Automated, data-driven diagnostic methods are in high demand as healthcare companies pursue precision oncology. Traditional statistical models cannot find complex patterns in histology slides, radiological scans, and genetic data, but deep learning's hierarchical feature extraction and adaptive learning can for different scenarios. Deep learning cancer detection research is growing rapidly, but interpretive and statistical consistency is lacking.

2 Literature Review

2.1 Brain Cancer Analysis

Deep learning in cancer categorization has improved computational medicine and diagnostics. Many brain cancer detection investigations use iterative analytical methods to maximize convolutional structures, transfer learning, and statistical generalizability.

2.2 Statistical Analysis

Quantitative evaluation is needed to assess deep learning architecture cancer classification reliability. The linked works provide empirical or statistically simulated cancer domain comparison accuracy, precision, recall, F1-score, AUC, and sensitivity.

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ACM 1557-735X/2024/1-ART1
https://doi.org/XXXXXXX.XXXXXXX

Table 1. Representative Brain Cancer Analysis Techniques

Reference	Method	Strengths	Limitations
	CNN with Transfer Learning	Robust transfer adaptability	Limited dataset diversity
	Hybrid CNN Architecture	Versatile architecture	High computational load
	Fine-tuned Deep Models	Effective fine-tuning strategy	Sensitive to hyperparameter tur

Table 2. Performance Metrics Summary

Cancer Type	Best Method	Accuracy	Precision	Recall	AUC
Brain	Deep Residual Learning	98.1%	97.5%	97.9%	0.990
Liver	HCCNet Fusion	98.3%	97.8%	97.9%	0.993
Breast	Ensemble Deep Learning	97.2%	96.5%	96.6%	0.988
Skin	Attention-based Multi-class DL	97.5%	96.9%	97.1%	0.989
Lung	CNN + Transformer	97.8%	97.2%	97.4%	0.992

3 Conclusion

Due to exponential medical imaging data expansion and precision oncology, automated, scalable, and statistically verified cancer categorization systems are needed. Current research was scattered, and single contributions, if methodologically sound, lacked iterative validation, statistical harmonization, and interpretability across data sources. This review presents a robust quantitative and theoretical underpinning for deep learning-driven cancer classification systems.

References

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