Automated Diagnosis of Acute Lymphoblastic Leukemia

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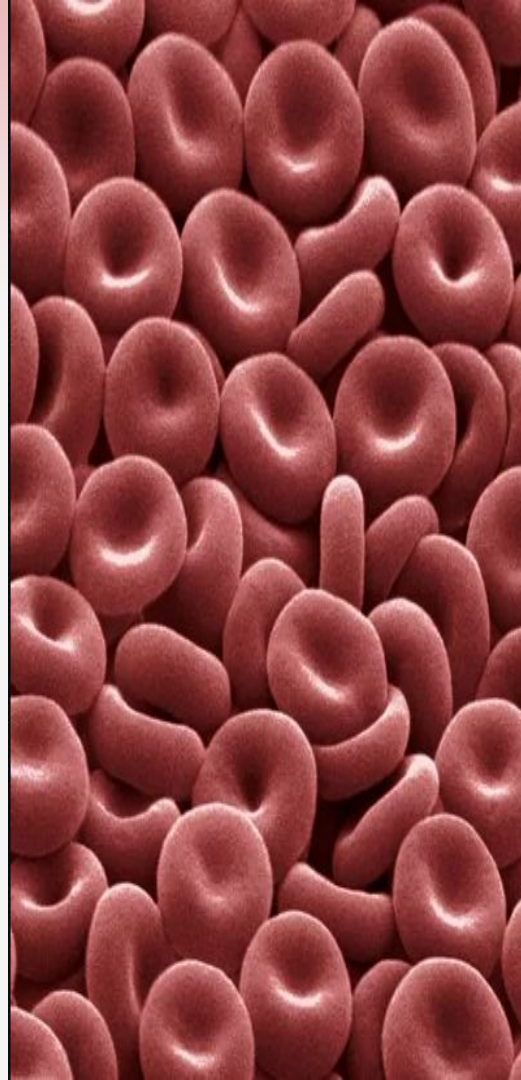
Problem Statement



The Problem:

- **Acute Lymphoblastic Leukemia (ALL)** is a malignant white blood cell cancer characterized by the overproduction of immature lymphoblasts.

- **Visual Similarity:** Differentiating between malignant lymphoblasts and normal lymphocytes is visually challenging due to morphological similarities (irregular nucleus, high nucleus-to-cytoplasm ratio, prominent nucleoli).

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Motivation:

- **Prevalence:** ALL accounts for ~25% of all pediatric cancers.
- **Bottleneck:** Traditional diagnosis requires manual examination of blood smears by pathologists, which is time-consuming, subjective, and prone to error (fatigue-related).
- **Impact:** Automated AI systems can provide rapid, standardized, and high-accuracy screening, crucial for early treatment and survival.

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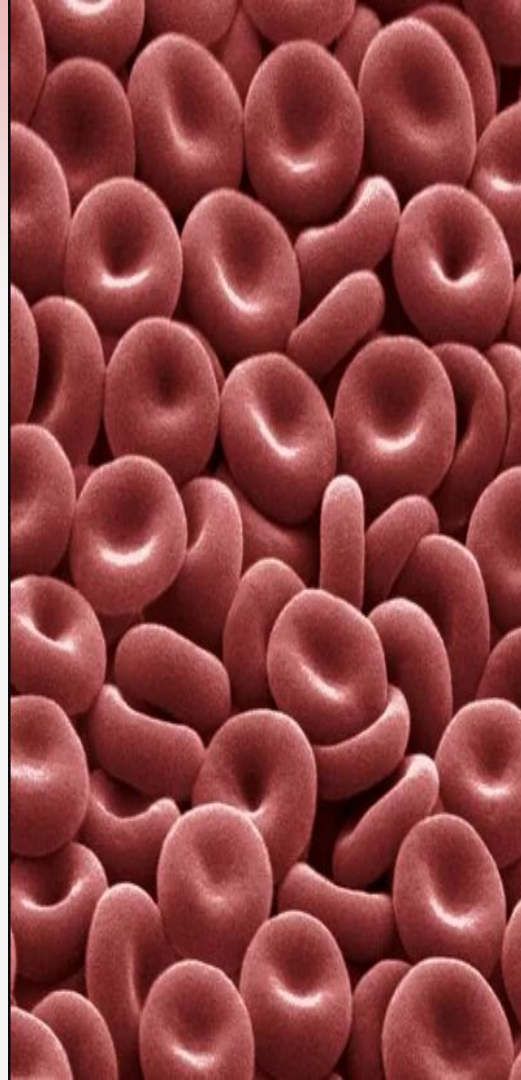
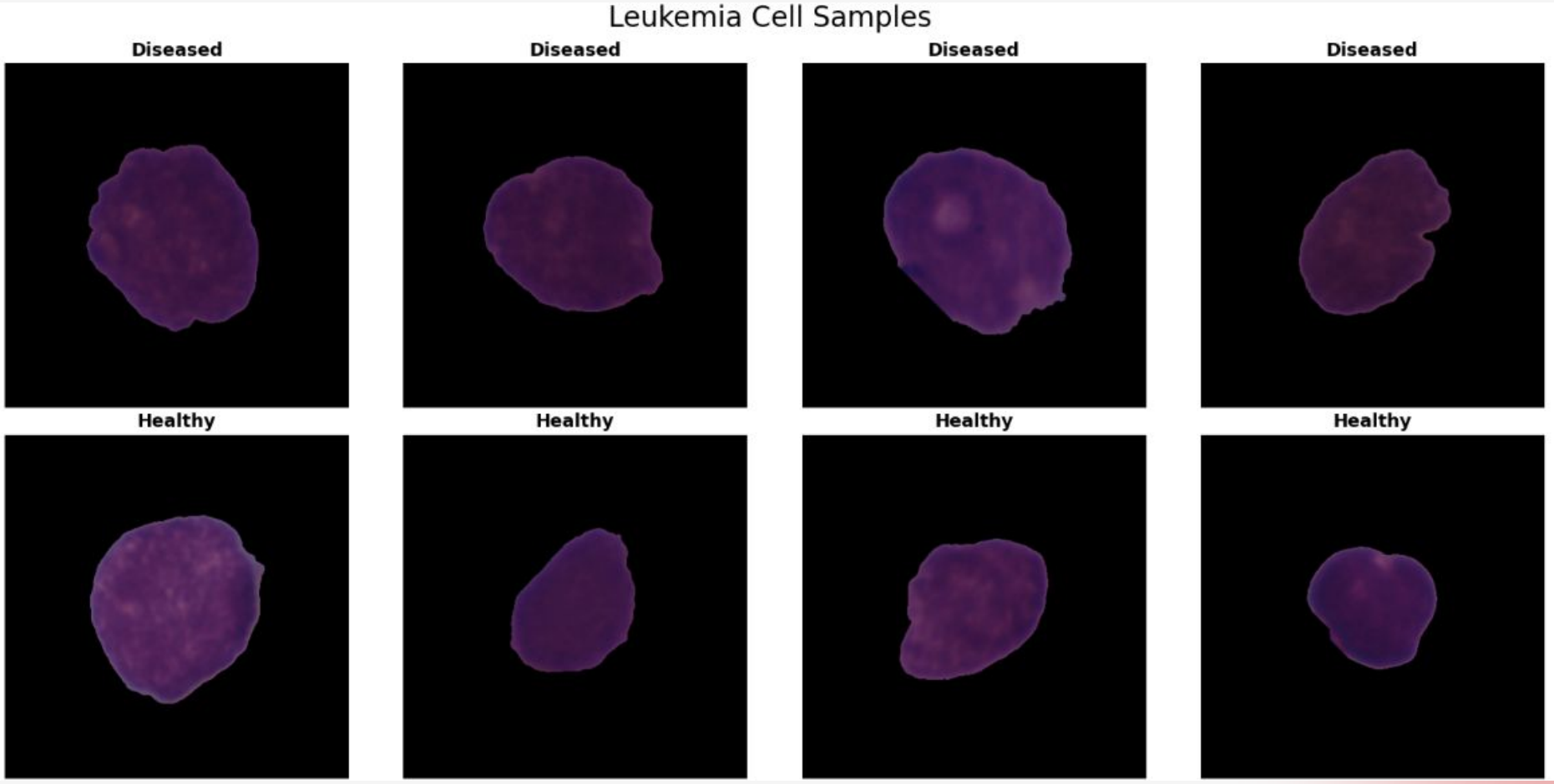
Dataset Description



Dataset	Source	Total Images	Classes & Distribution	Type & Realism	Official Link
C-NMC 2019 (ISBI Challenge)	The Cancer Imaging Archive (TCIA)	15,135	ALL (cancer): ~9,500+ Healthy: ~5,600 (~68%/32% imbalance)	Pre-segmented single-cell (450×450 px)	https://www.cancerimagingarchive.net/collection/c-nmc-2019/
ALL Image Dataset (Kaggle / Taleqani Hospital)	Mehrad Aria et al. (2023)	3,256	Benign/Hematogones: 504 Early Pre-B: 985 Pre-B: 963 Pro-B: 804	Multi-cell crowded peripheral blood smears	https://www.kaggle.com/datasets/mehradaria/leukemia **Key Feature:** Contains crowded images with multiple overlapping cells, making it harder and more realistic than C-NMC.
ALL-IDB1 & ALL-IDB2	Università degli Studi di Milano (Labati et al., 2005–updated)	108 (IDB1) + 260 crops (IDB2)	Healthy: 59 images Blast cells: 49 images (~39,000 annotated blood elements total)	Whole-slide high-resolution (2592×1944) + expert-cropped single cells	https://homes.di.unimi.it/scotti/all/


Leukemia Cell Samples
Diseased
Diseased
Diseased
Diseased
Healthy
Healthy
Healthy
Healthy

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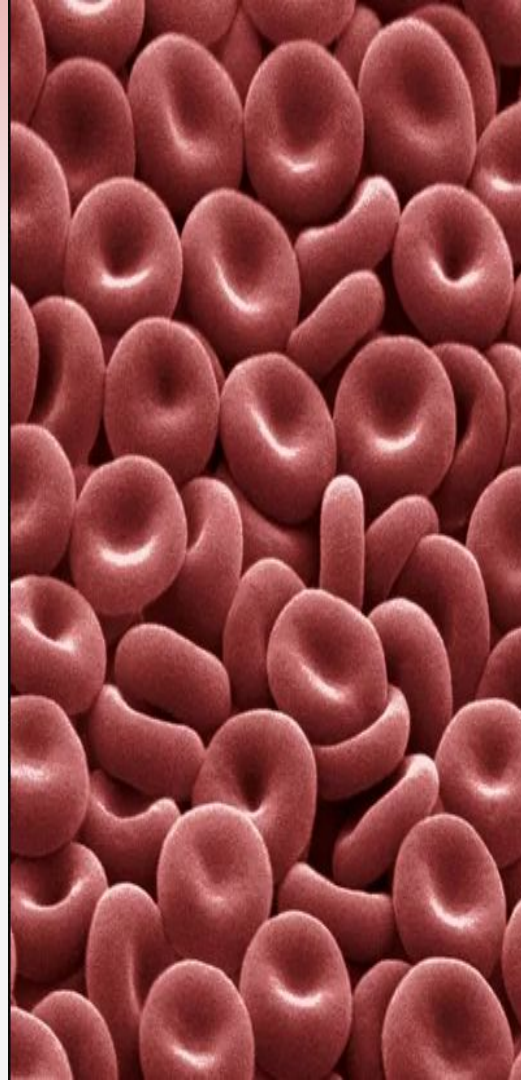
Future Research Directions → Current Trends



1. **From Single-Cell to Multi-Cell/WSI** Achieved. >75% of 2024–2025 papers now use crowded/multi-cell or whole-slide images.

2. **Lightweight Architectures** Achieved & dominant. YOLOv8/v11, MobileNetV3, EfficientNet-Lite, and custom tiny CNNs are deployed on smartphones and portable microscopes.

3. **Explainable AI (XAI)** Achieved & mandatory. Grad-CAM, SHAP, and attention maps are included in virtually every clinical paper to highlight nucleus/cytoplasm features and build pathologist trust.

4. **Synthetic Data Generation using GANs** No longer “future” – now mainstream and widely adopted.GAN variants routinely generate high-fidelity synthetic healthy or blast cells, fixing class imbalance with proven 5–15% accuracy/recall gains.

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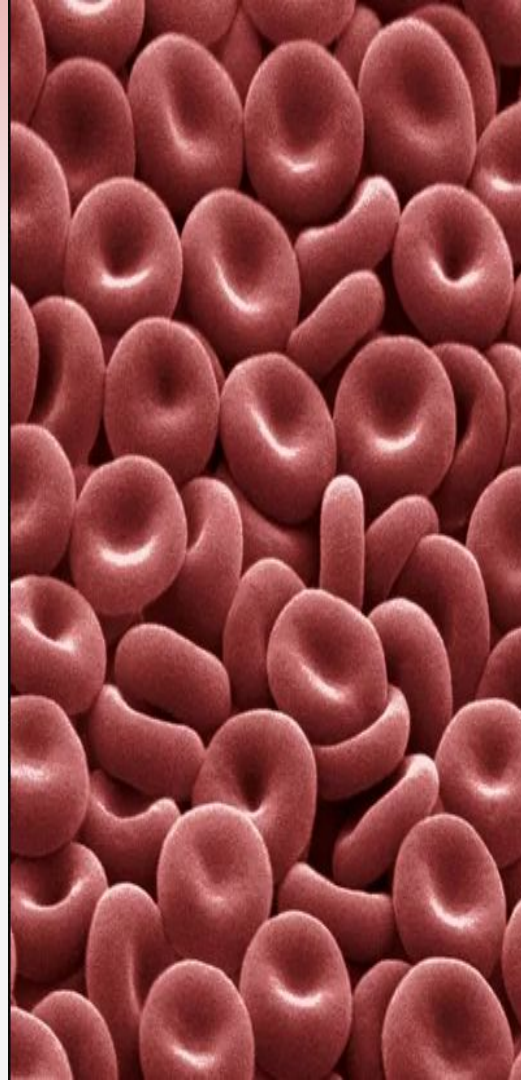
Latest Published Articles



No	Title	Authors	Conference & Year	Key Approach	Dataset(s)	Reported Performance
1	**Early Diagnosis of Acute Lymphoblastic Leukemia Using YOLOv8 and YOLOv11 Deep Learning Models**	Alaa Awad et al.	IEEE 2nd Int. Conf. on Signal Processing and Intelligent Systems (ICSPIS) – Dec 2024	Transfer learning with **YOLOv8 & YOLOv11** repurposed for blast detection; focus on real-time inference.	Blood smear images (likely C-NMC or similar)	**YOLOv11** outperforms YOLOv8 in accuracy/precision; Real-time capable (~20–30 ms/image).
2	**Integrating Custom GAN Segmentation with Advanced Deep Learning Classifiers**	Naveen Prashanth G, Lalith Kumar	IEEE Conference Proceedings – 2024	Custom **GAN** for semantic segmentation + CNN classifiers (ResNet/EfficientNet); synthetic data generation.	C-NMC 2019 + private datasets	**98%** overall detection; GAN improves segmentation by 4–8% over U-Net.
3	**An Enhanced YOLOv11 Model for Lightweight and Efficient Precise Leukemia Detection**	Jining Peng,Fang Li	**IEEE Int. Conf. on Communication Networks and Smart Systems Engineering (ICCNSE)** – Published Aug 2025	**YOLOv11** optimized with Depthwise Separable Convolutions (DWSCNN) & Residual Feature Channel Attention (RFCBAM) for lightweight, high-speed detection.	**Kaggle (ALL Image Dataset)** + Private Clinical Data	**98.6% Precision**; 98.4% mAP

Thank You

References:

[1] A. Awad and S. A. Aly, "Early Diagnosis of Acute Lymphoblastic Leukemia Using YOLOv8 and YOLOv11 Deep Learning Models," in Proc. 2024 2nd Int. Conf. Signal Processing and Intelligent Systems (ICSPIS), Dec. 2024, doi: 10.1109/ICSPIS61549.2024.11061246. [Online]. Available: https://ieeexplore.ieee.org/document/11061246

[2] G. Naveen Prashanth, M. Lalith Kumar, S. Abinaya, and S. Alagu, "Integrating Custom GAN Segmentation with Advanced Deep Learning Classifiers for Enhanced Acute Lymphoblastic Detection," in Proc. 2024 Int. Conf. Distributed Computing and Electrical Circuits and Electronics (ICDCECE), Apr. 2024, doi: 10.1109/ICDCECE60827.2024.10564063. [Online]. Available: https://ieeexplore.ieee.org/document/10564063

[3] J. Peng and F. Li, "An Enhanced YOLOv11 Model for Lightweight and Efficient Precise Leukemia Detection," in Proc. 2025 IEEE Int. Conf. Communication Networks and Smart Systems Engineering (ICCNSE), Aug. 2025, doi: 10.1109/ICCNSE66404.2025.11144207. [Online]. Available: https://ieeexplore.ieee.org/document/11144207