SPIE. OPTICAL METROLOGY

Open-source framework for multimodal microscopy

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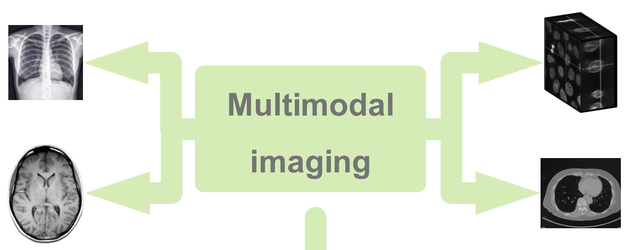
ABSTRACT

We present an open-source framework combining advanced AI and multimodal microscopy for biological imaging. By integrating electron microscopy (EM), label-free light microscopy (LM), and AI tools, our framework enhances imaging workflows with automated, artifact-free analysis. This platform empowers researchers to achieve scalable, reproducible, and high-resolution insights into biological systems.

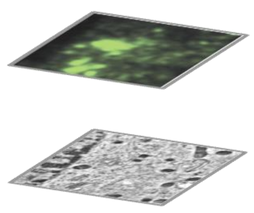
INTRODUCTION

Multimodal imaging is the integration of two or more imaging modalities, which provides a more comprehensive understanding of biological processes.



Microscopy: Correlative Light Electron Microscopy (CLEM)

Great potential for characterizing biological processes in its cellular domain (molecular mechanism in virus assembly)



AI in biomedical multimodal imaging

Enhancement in several tasks related to microscopy.

- Deep Learning + CLEM → **deepCLEM**

☒ Challenges in microscopy workflows

Growing demand for robust software frameworks

TensorFlow PyTorch MONAI

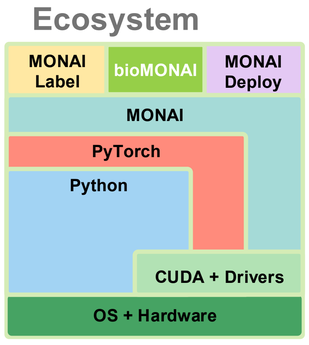
☒ Lack of biomedical imaging component focused on multimodal microscopy workflows

bioMONAI

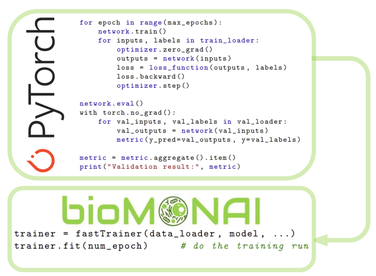
Deep learning for biomedical imaging

IMPLEMENTATION

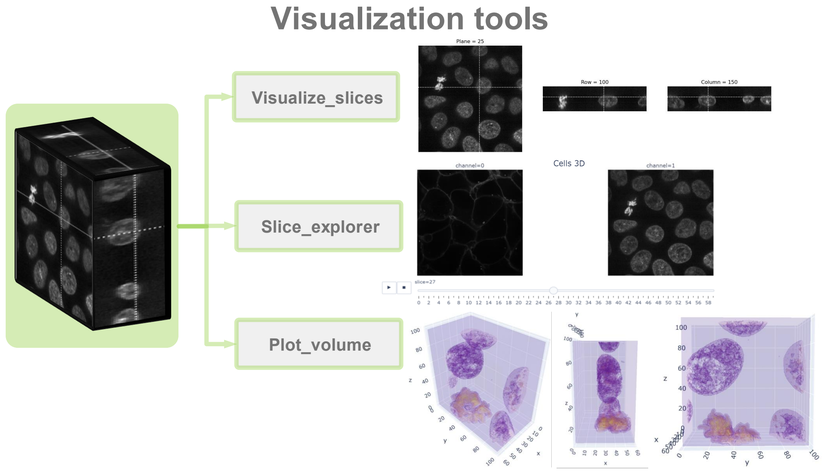
Ecosystem



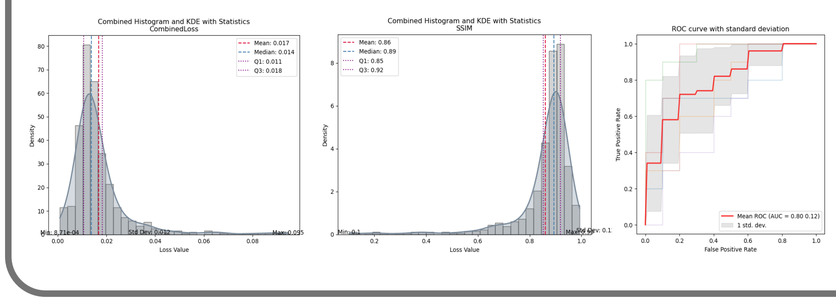
Low-code Platform



Visualization tools



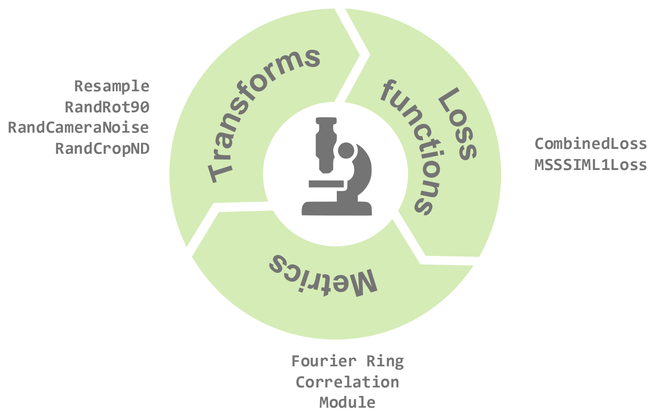
Model Evaluation Utilities



MICROSCOPY-SPECIFIC FEATURES

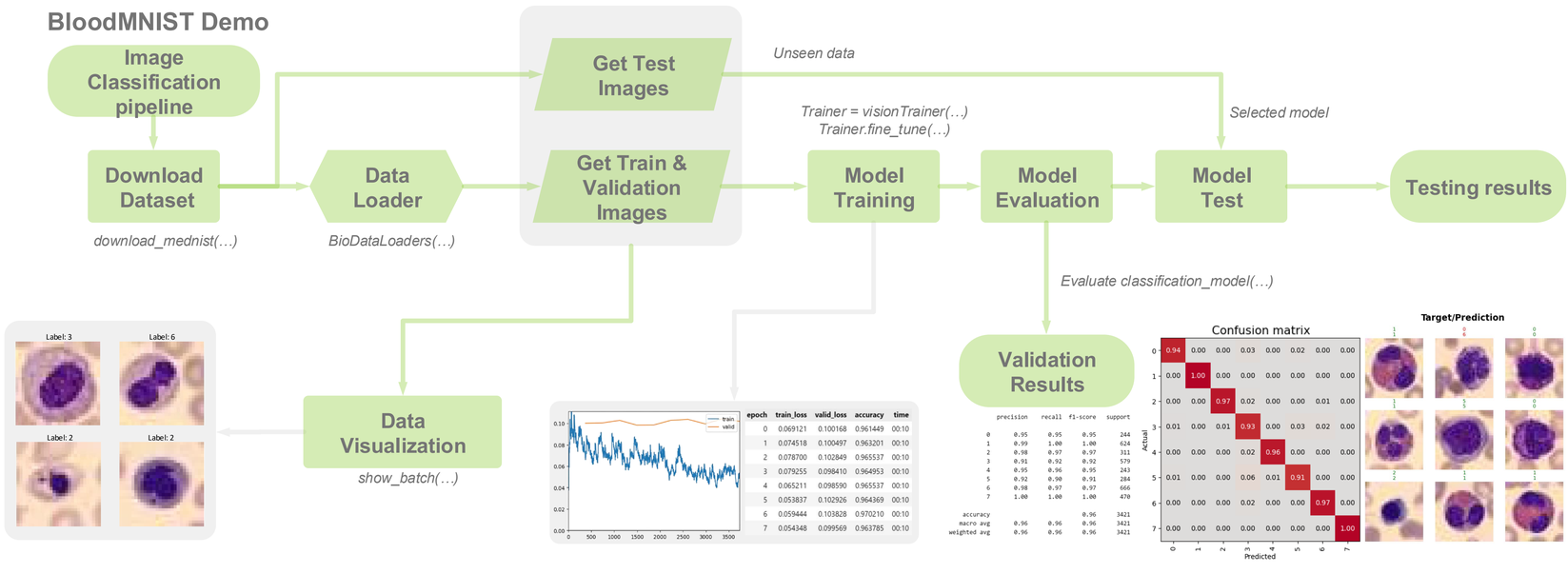
- Support for the most **common formats** used **in microscopy**
- **Specific** transforms, metrics and loss functions are fundamental for **field-based tasks**
- Integration of **image metadata** through the **BioImage class**

bioMONAI provides both general-purpose and domain-specific tools



Data & IO	Modeling & Training	Evaluation & Visualization
biomonai.data	biomonai.nets	biomonai.metrics
biomonai.io	biomonai.losses	biomonai.visualizer
biomonai.datasets	biomonai.callbacks	
biomonai.transform	biomonai.core	

WORKFLOW EXAMPLE: CLASSIFICATION



CONCLUSION

bioMONAI is an open-source framework that extends the MONAI ecosystem to meet the specific demands of biomedical imaging, especially in advanced microscopy workflows and Correlative Light Electron Microscopy (CLEM).

Available at: github.com/deepCLEM/bioMONAI

REFERENCES

[1] M. J. Cardoso *et al.*, "MONAI: An open-source framework for deep learning in healthcare", *arXiv [cs.LG]*, 2022.

[2] J. Bischof *et al.*, "Multimodal bioimaging across disciplines and scales: challenges, opportunities and breaking down barriers", *npj Imaging*, vol. 2, núm. 1, 2024.

[3] P. de Boer, J. P. Hoogenboom, y B. N. G. Giepmans, "Correlated light and electron microscopy: ultrastructure lights up!", *Nat. Methods*, vol. 12, núm. 6, pp. 503–513, 2015.

bioMONAI's docs!

bioMONAI's Github!

deepCLEM's docs!

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