# Learning Biomarkers in Oncology from Histological Slide Images in the AI Era

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**Method 2: UNI vs H-OPTIMUS**

# Project Introduction

## Objective

Compare two foundation models for Whole Slide Image (WSI) analysis in oncology

**Approach**

- WSI $\rightarrow$ small patches
- Extract embeddings
- Aggregation for classification

**Models Compared**

- **UNI** (Mahmood Lab)
- **H-OPTIMUS** (Bioptimus)

**9 aggregation methods tested**

# 9 Aggregation Methods Tested

1. Mean Pooling + Logistic Regression

2. Max Pooling + Logistic Regression

3. Multi-Feature Aggregation (Mean + Max + Std)

4. Random Forest

5. SVM with Normalization

6. SMOTE + Logistic Regression

7. Gradient Boosting

8. Simple Attention MIL (Single Model)

9. Improved Attention MIL Ensemble

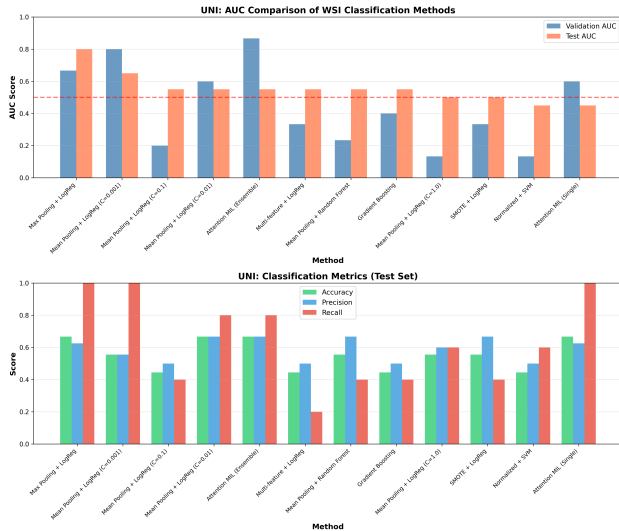**Each method tested on both UNI and H-OPTIMUS embeddings**

# UNI Model

## UNI - Universal Pathology Foundation Model

- ▶ Developed by Mahmood Lab
- ▶ Pre-trained on large histopathological datasets
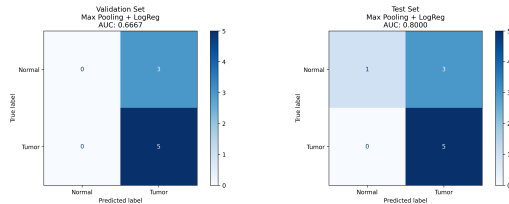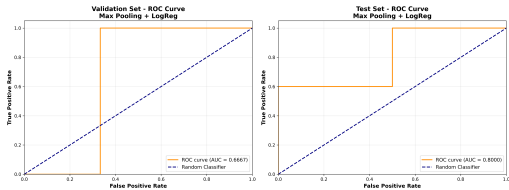- ▶ High-quality embeddings for pathological tissues

| Top 3 Methods | Val AUC | Test AUC |
|---|---|---|
| **Max Pooling + LogReg** | 0.67 | **0.80** |
| Attention MIL (Ensemble) | 0.87 | 0.55 |
| Mean Pooling + LogReg (C=0.001) | 0.80 | 0.65 |

# UNI - Detailed Results



Complete comparison of 9 methods with UNI

# UNI - Best Method



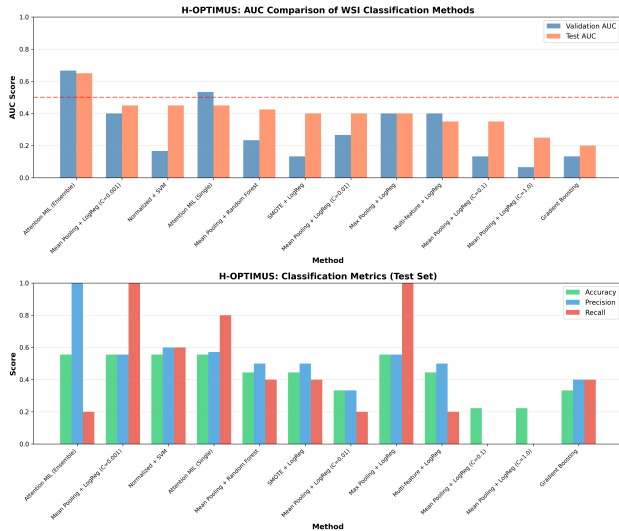**Max Pooling + LogReg**: Test AUC = 0.80, Accuracy = 0.67

# H-OPTIMUS Model

## H-OPTIMUS - Bioptimus Foundation Model

▶ Developed by Bioptimus

▶ Recent foundation model for computational pathology

▶ Architecture optimized for histological images

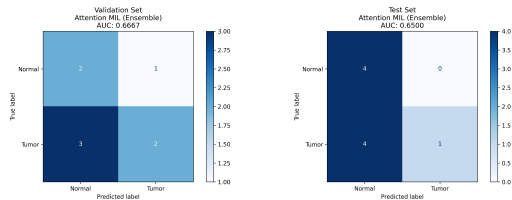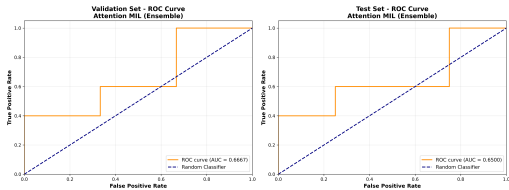| Top 3 Methods | Val AUC | Test AUC |
|---|---|---|
| **Attention MIL (Ensemble)** | 0.67 | **0.65** |
| Mean Pooling + LogReg (C=0.001) | 0.40 | 0.45 |
| Normalized + SVM | 0.17 | 0.45 |

# H-OPTIMUS - Detailed Results



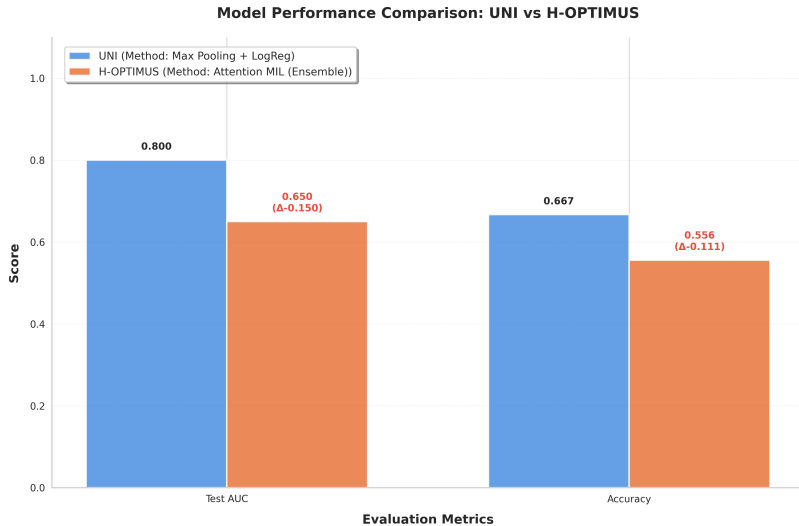Complete comparison of 9 methods with H-OPTIMUS

# H-OPTIMUS - Best Method



**Attention MIL (Ensemble)**: Test AUC = 0.65, Accuracy = 0.56

# UNI vs H-OPTIMUS Comparison



Model Performance Comparison: UNI vs H-OPTIMUS

Legend:
- UNI (Method: Max Pooling + LogReg)
- H-OPTIMUS (Method: Attention MIL (Ensemble))

Test AUC: UNI 0.800, H-OPTIMUS 0.650 (Δ-0.150)

Accuracy: UNI 0.667, H-OPTIMUS 0.556 (Δ-0.111)

Performance comparison on test set

# Results Summary

| Model | Best Method | Test AUC | Accuracy |
|-------|-------------|----------|----------|
| **UNI** | Max Pooling + LogReg | **0.80** | **0.67** |
| H-OPTIMUS | Attention MIL (Ensemble) | 0.65 | 0.56 |
| **Difference** | – | **+15%** | **+11%** |

## Key Observations

▶ **UNI** outperforms H-OPTIMUS on all metrics

▶ Optimal methods differ depending on the model

▶ Simple pooling effective for UNI vs MIL for H-OPTIMUS

# Conclusion & Perspectives

## Conclusions

- ▶ **UNI** is the best-performing foundation model for this dataset
- ▶ Choice of aggregation method depends on the embedding model
- ▶ Simple approaches (Max Pooling) can outperform complex methods

## Perspectives

- ▶ Test on larger datasets
- ▶ Combine strengths of both models (ensemble)
- ▶ Explore other aggregation architectures
- ▶ Analysis of prediction interpretability

**Thank you for your attention**