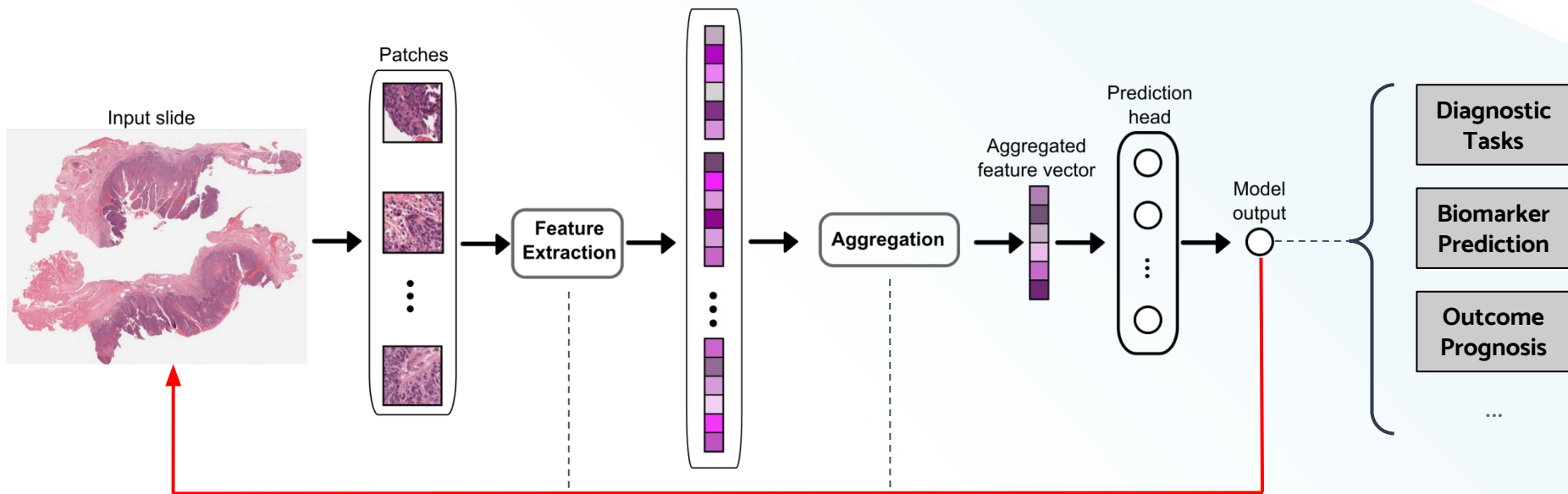


# **xMIL: Insightful Explanations for Multiple Instance Learning in Histopathology**

**Julius Hense\***, **Mina Jamshidi Idaji\***, Oliver Eberle, Thomas Schnake, Jonas Dippel,  
Laure Ciernik, Oliver Buchstab, Andreas Mock, Frederick Klauschen, Klaus-Robert Müller

# Multiple Instance Learning (MIL) in Histopathology



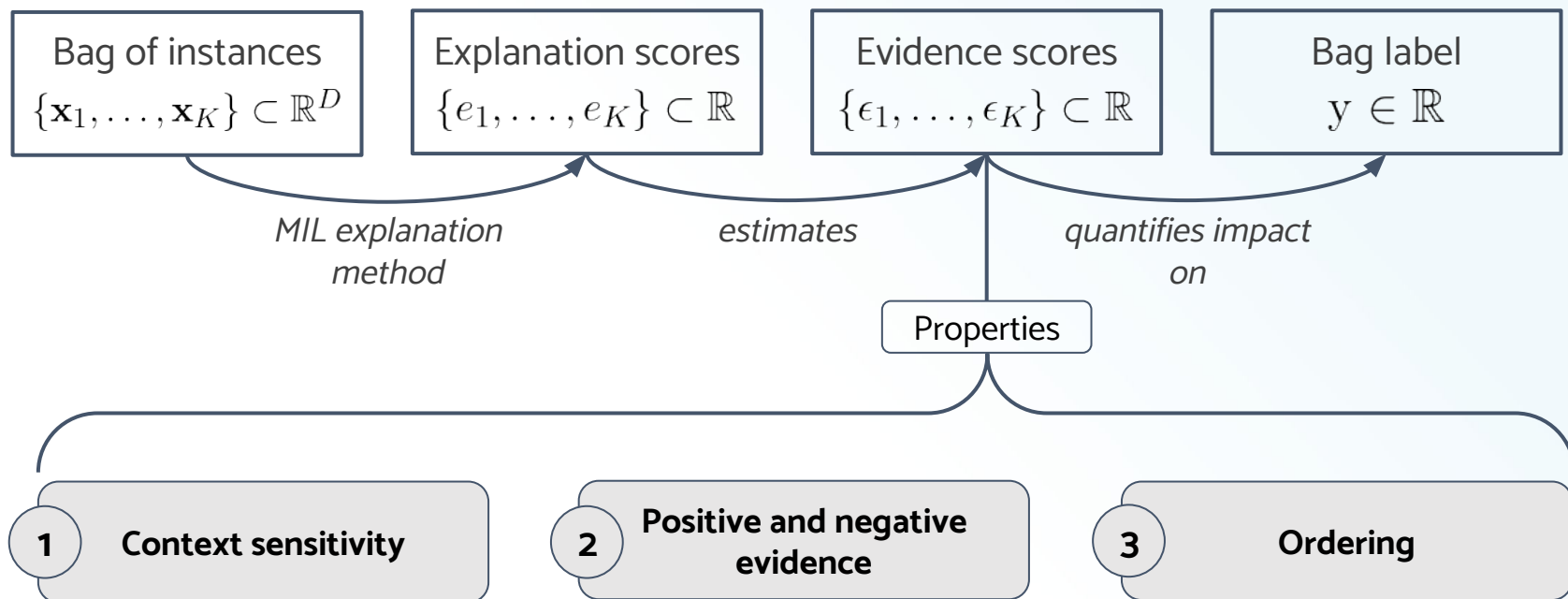
- Attention maps
- Additive models
- Perturbation methods
- Integrated gradients

**MIL Explanations**

**Foundation Model**

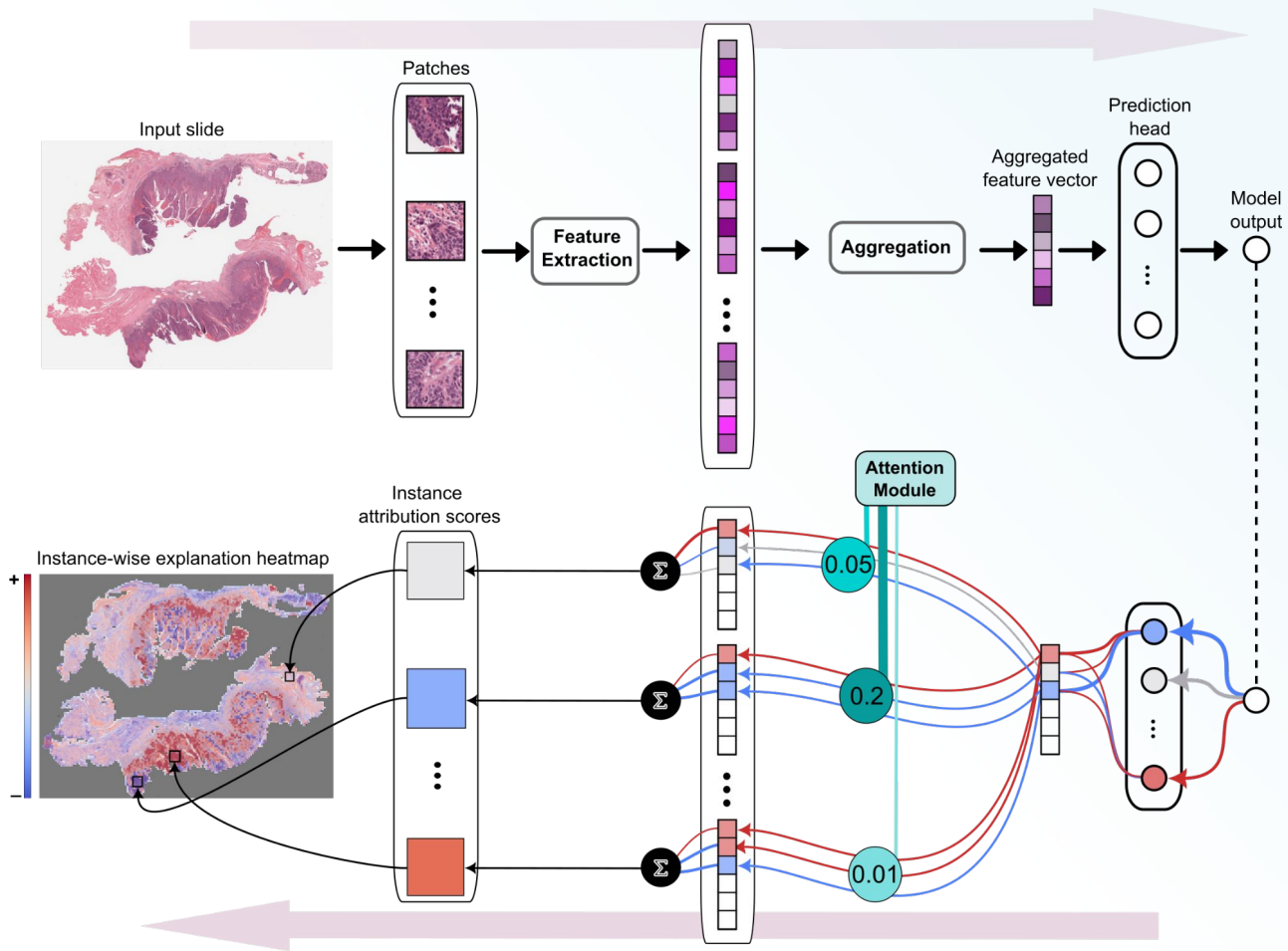
**MIL Model**

- Attention-based MIL
- Transformer-based MIL
- State-space MIL models
- ....



xMIL enables a structured **interpretation** and **evaluation** of MIL explanations.

# The xMIL-LRP Method



## 1 Toy experiments

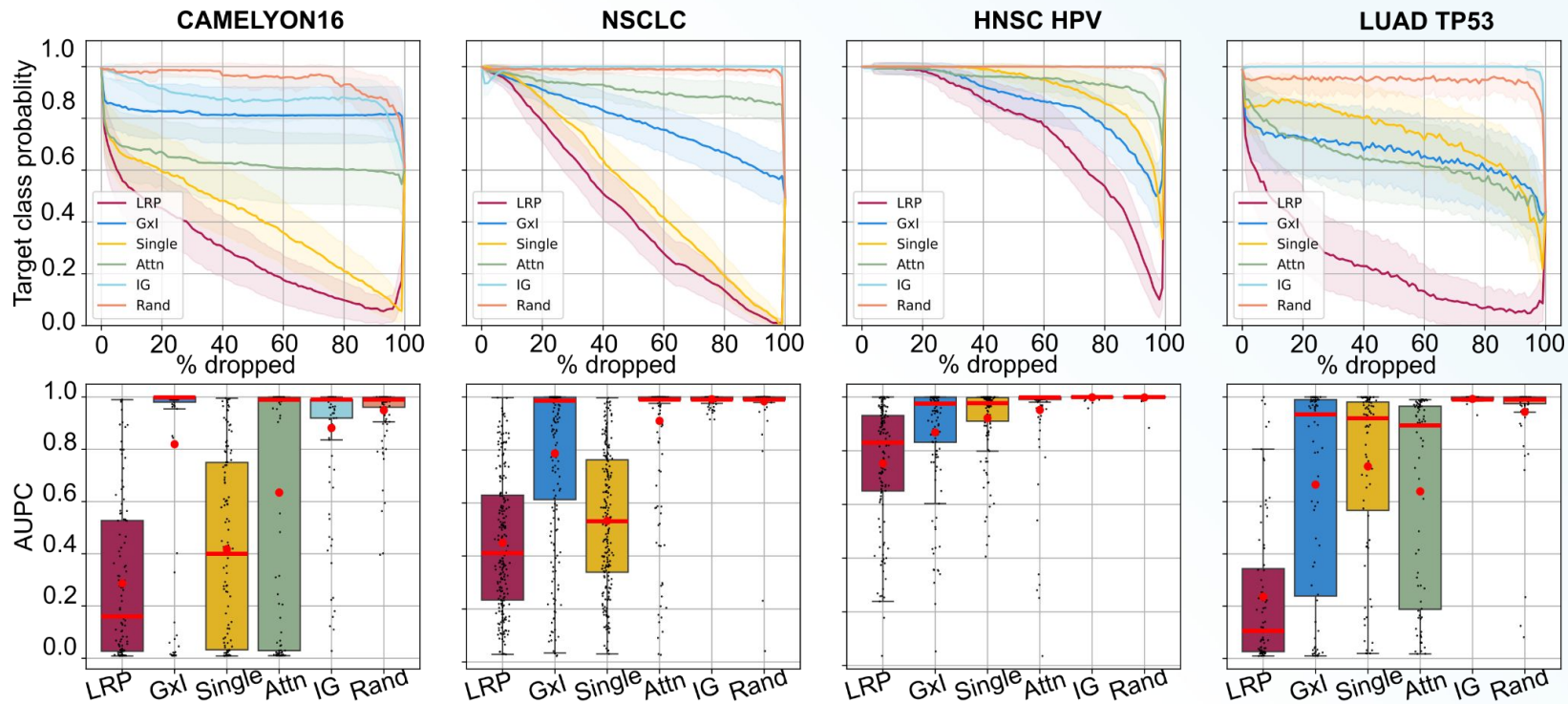
- 3 tasks x 3 MIL models
- Ground-truth explanations known: measure **explanation quality**
- **Focus:** (1) *context sensitivity*, (2) *positive and negative evidence*

## 2 Histopathology experiments

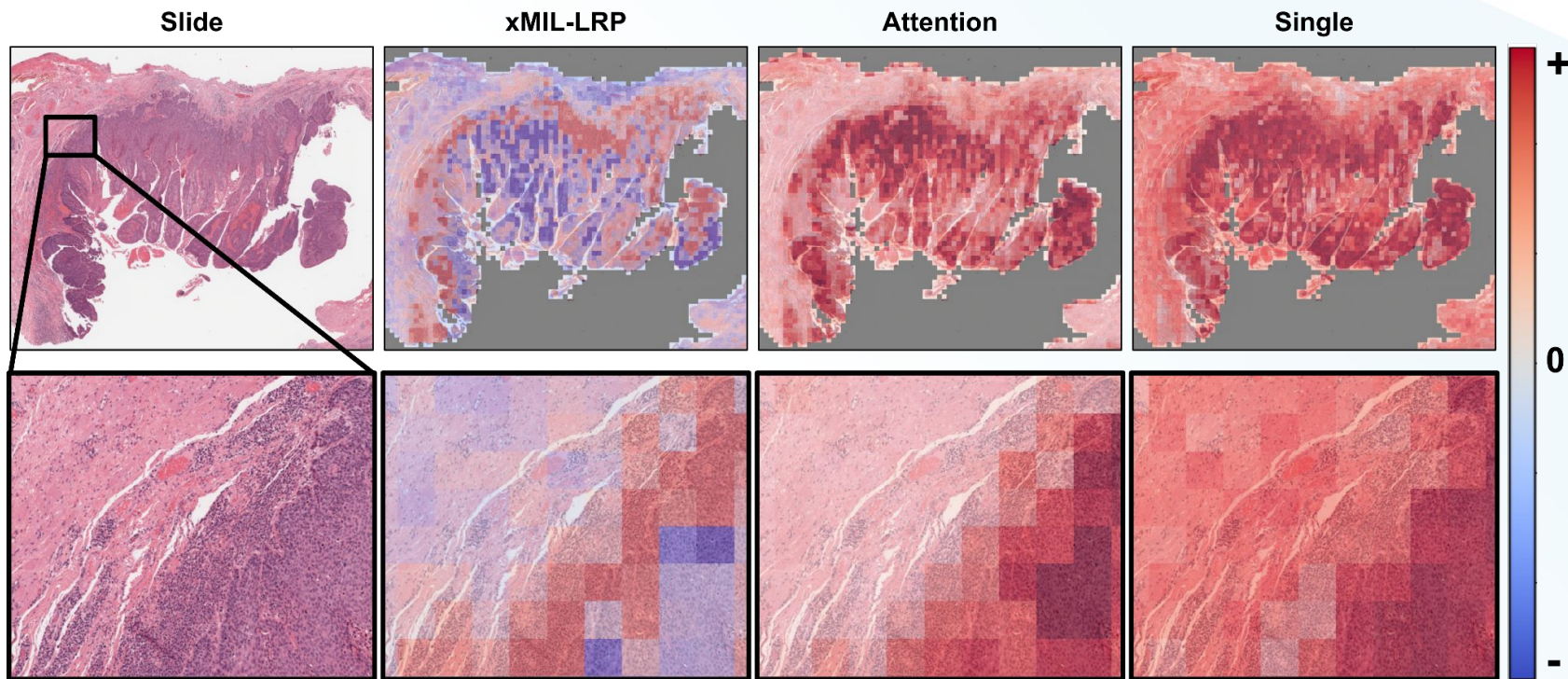
- 4 tasks x 2 MIL models
- Ground-truth explanations unknown: measure explanation **faithfulness**
- **Focus:** (2) *positive and negative evidence*, (3) *ordering*

**xMIL-LRP** outperformed all baselines in 13/14 settings.  
It excelled for **MIL Transformers** and **difficult prediction tasks**.

# Extensive Evaluation of MIL Explanations



# Insight Generation via xMIL-LRP



**xMIL & xMIL-LRP enable insight generation in histopathology.**



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**tubml-pathology/xMIL**