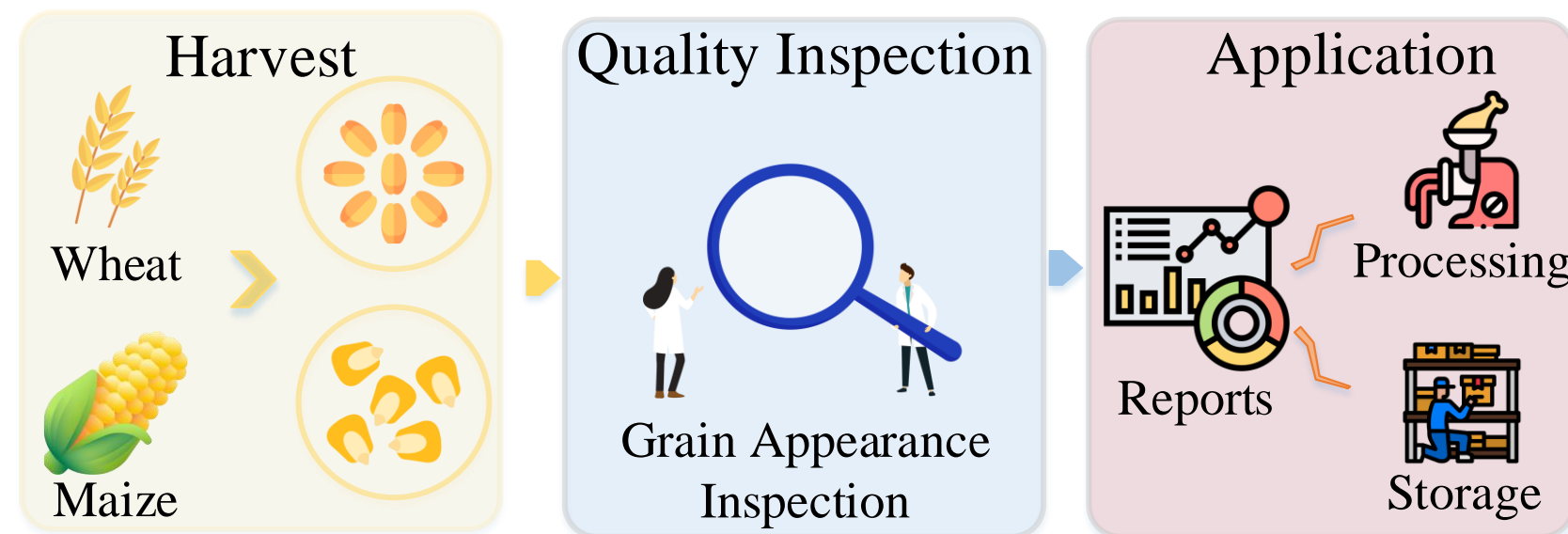


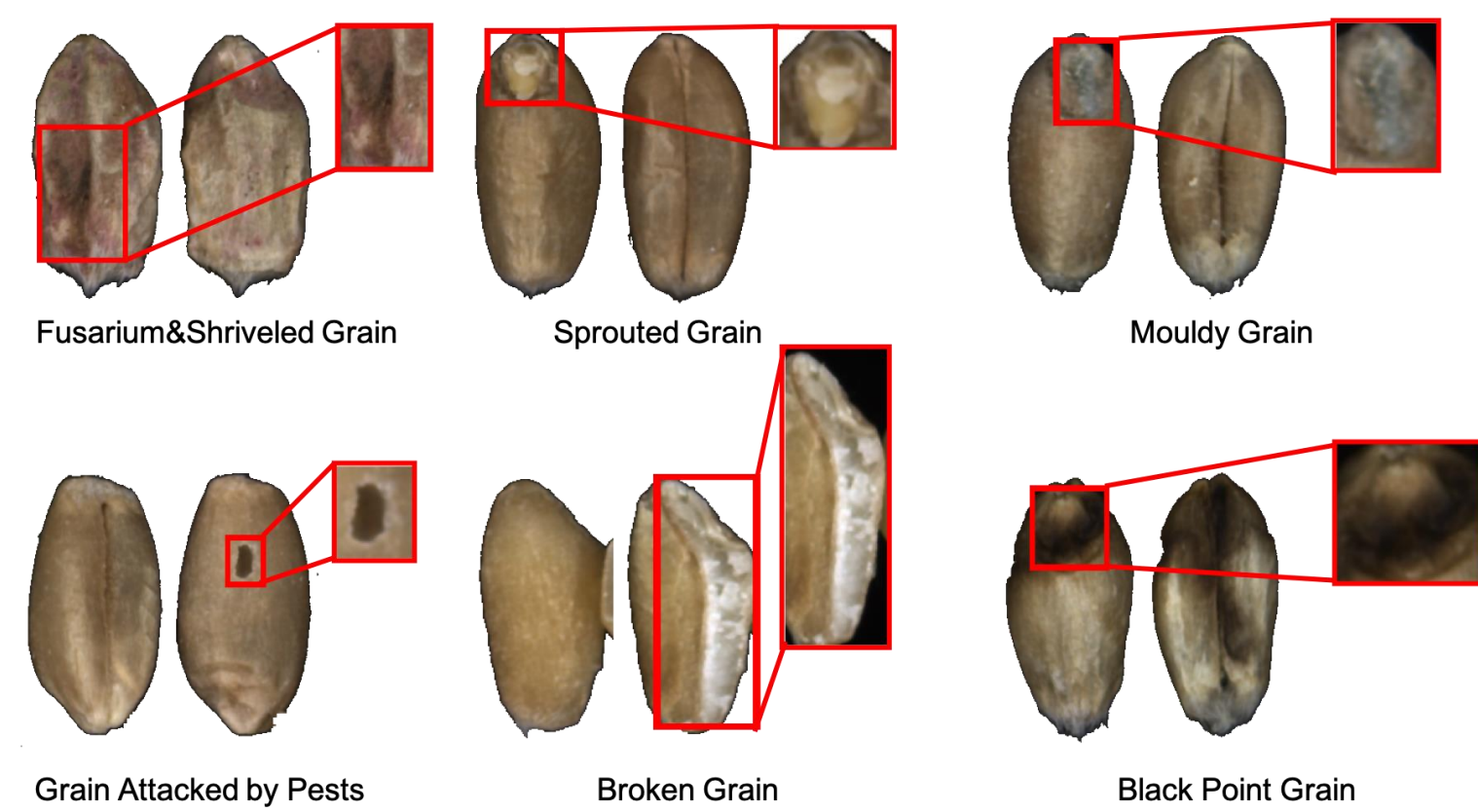
Backgrounds

Grain Appearance Inspection (GAI) serves as an essential process to determine grain quality and facilitate grain circulation and processing. However, GAI is routinely performed manually by inspectors with cumbersome procedures, which poses a significant bottleneck in smart agriculture.



In this paper, we endeavor to develop an automated GAI system: **AI4GrainInsp**, to identify defective grains under anomaly detection setting.

Defective Grains (Wheat)

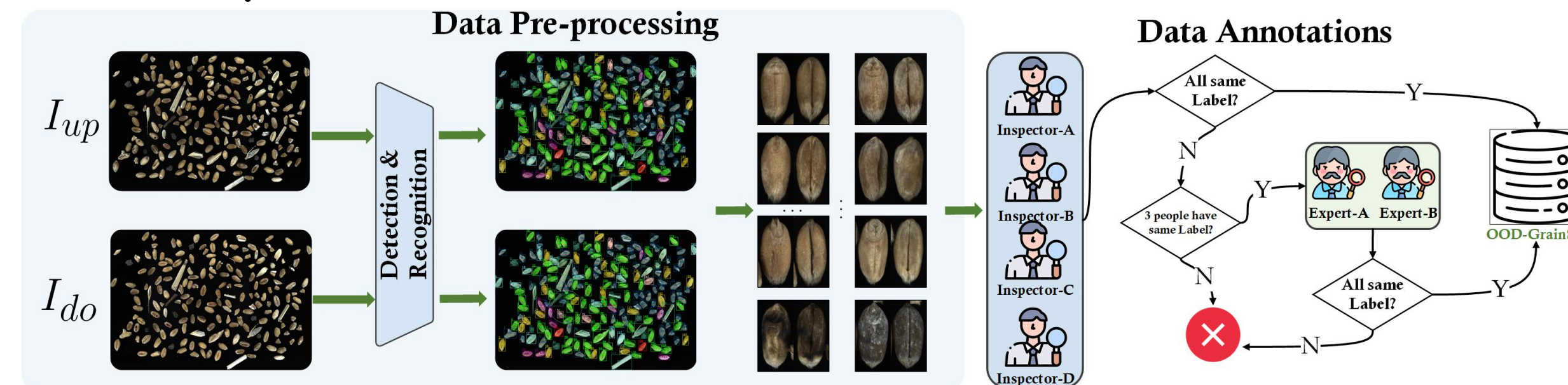


Defective grains refer to grains of decreased value and can be mainly categorized into six types:

- Sprouted (SD) grain,
- Fusarium & shriveled grain (FS),
- Black point (BP) grain for wheat or heated (HD) grain for maize,
- Moldy (MY) grain
- Broken (BN) grain
- Grain attacked by pests (AP)

And Healthy grains (HY), and Impurities (IM).

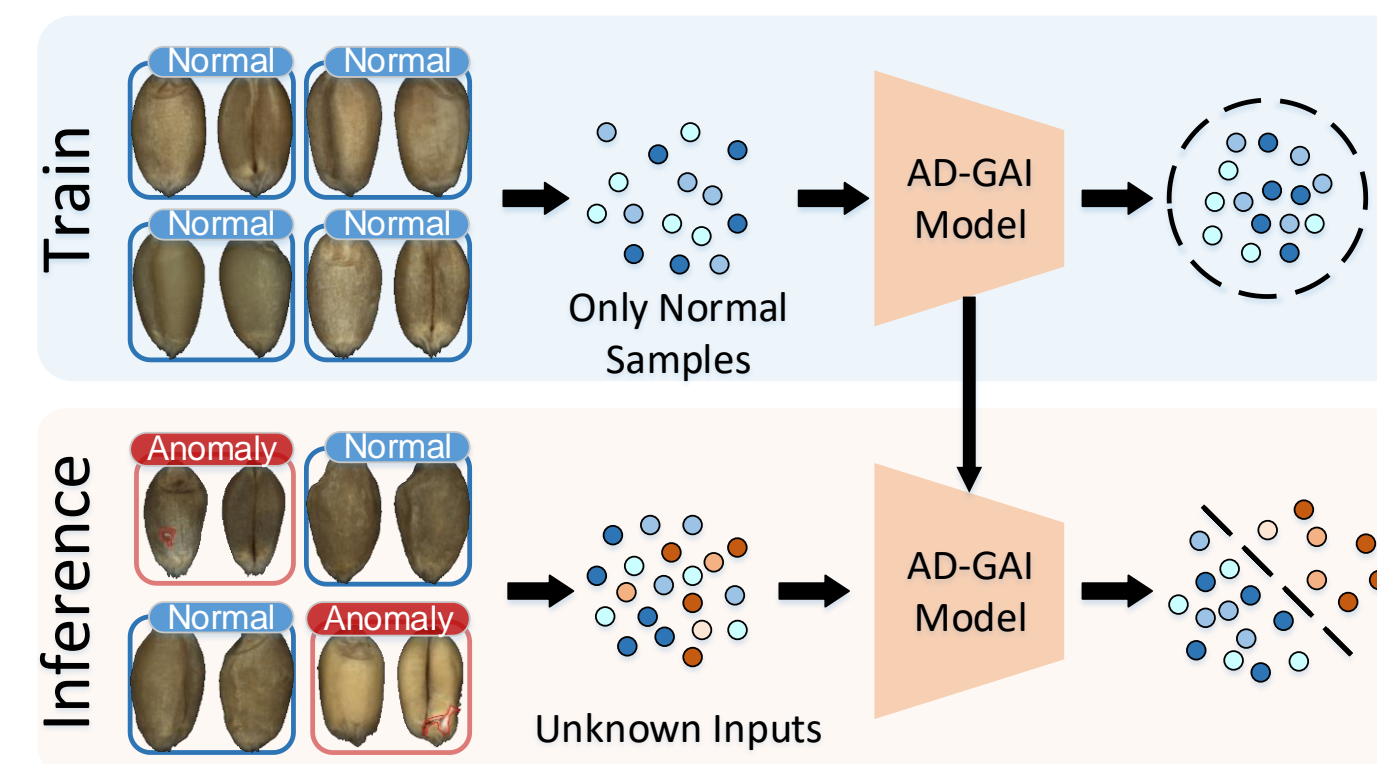
Data Acquisition



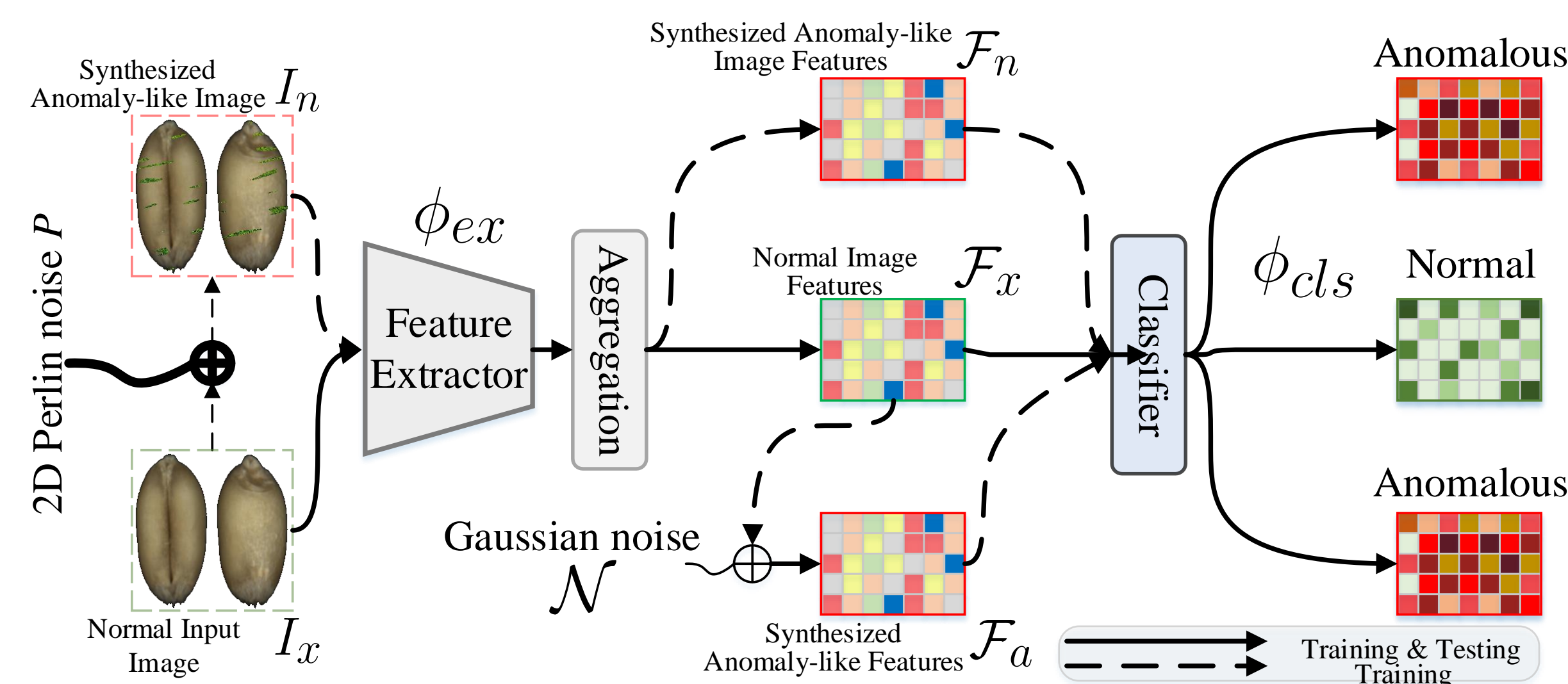
Dataset Distribution	Categories of Grains								Total
	HY	Defective Grains							
		SD	FS	BP/HD	MY	BN	AP	IM	
Wheat	135k	5k	5k	5k	5k	5k	5k	5k	180k
Maize	33k	1k	1k	1k	1k	1k	1k	1k	40k

Contributions

- Our proposed **AI4GrainInsp** is a complete pipeline from data acquisition to deep learning-based data analysis models.
- We formulate GAI as an AD problem and further propose data augmentation-based method: AD-GAI.
- We release a large-scale dataset, called **OOD-GrainSet**, including 220K images for wheat and maize with expert-level annotations



Anomaly Detection Method (AD-GAI)

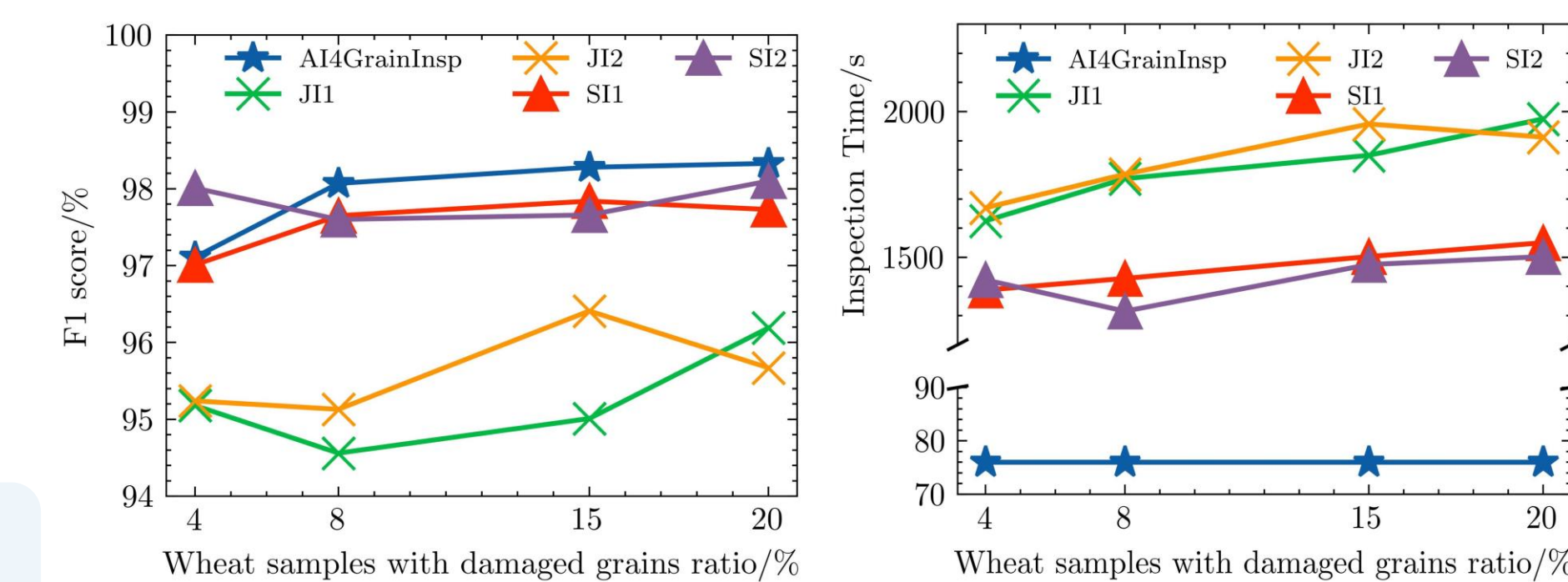


Overview of our proposed AD-GAI.

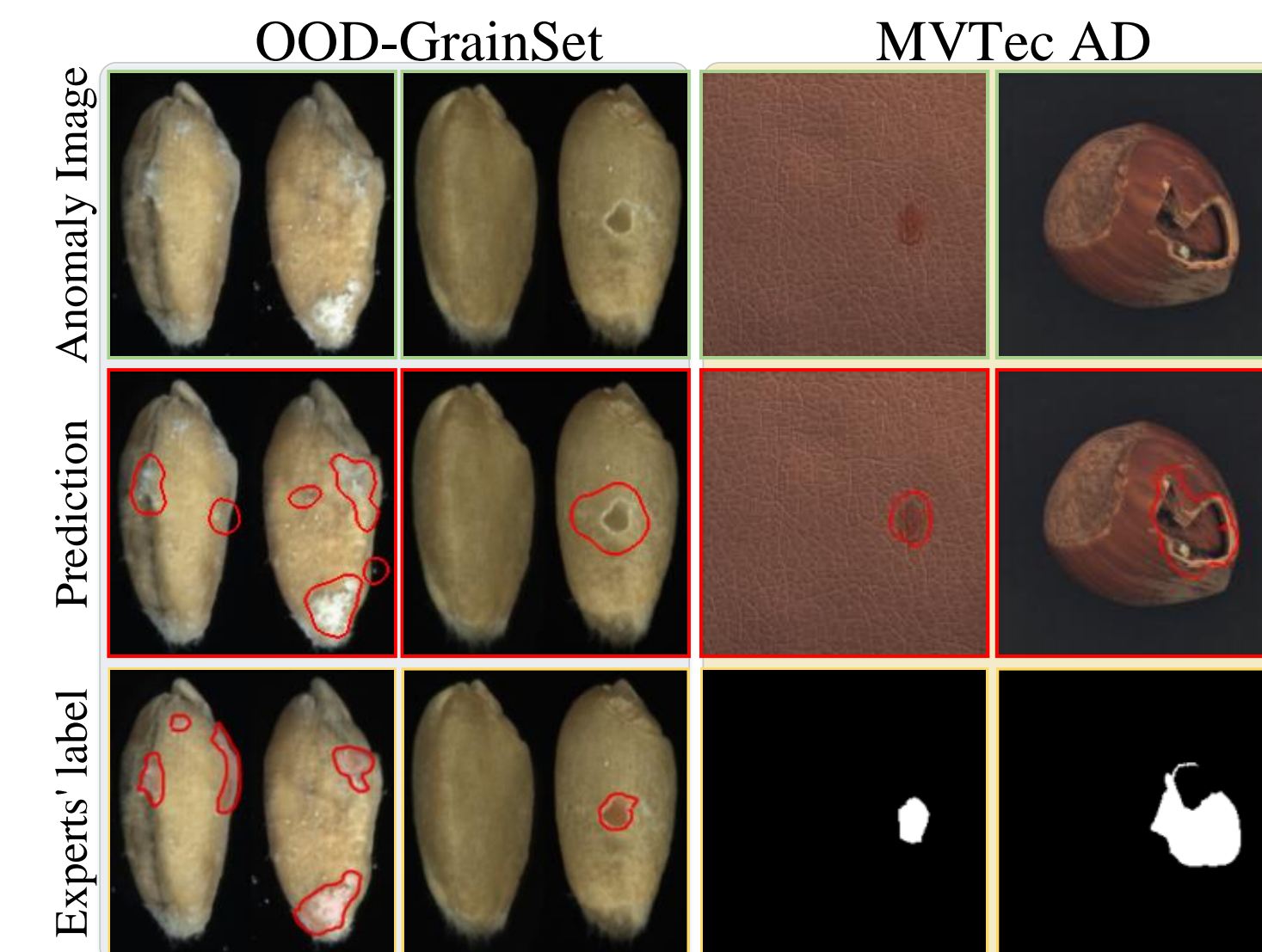
Comparison with the SOTA

Methods	MVTec AD	OOD-GrainSet					Average
		Wheat(set1)	Wheat(set2)	Maize(set1)	Maize(set2)		
Deep-SVDD (ICML-18 [32])	59.2	86.5	86.6	80.9	76.4	82.6	
PADiM (ICPR-21 [4])	95.8	73.1	67.5	67.2	59.4	66.8	
Mem-AE (ICCV-19 [17])	-	85.8	84.9	73.8	56.4	75.2	
DRAEM (ICCV-21 [45])	98.1	79.8	59.5	66.4	78.1	70.9	
RevDist (CVPR-22 [5])	98.4	90.1	89.2	86.5	81.9	86.9	
CSI (NeurIPS-20 [37])	-	83.6	77.3	84.7	78.6	81.1	
CutPaste (CVPR-21 [22])	96.1	76.7	77.5	75.1	71.3	75.2	
AD-GAI (single R50 model)	99.0	94.2	93.5	87.7	82.5	89.5	
AD-GAI (ensemble R50&R101)	99.1	95.9	94.1	88.2	82.8	90.2	

AI4GrainInsp vs. Human Experts



Qualitative Analysis



References

1. Fan, Lei and Ding, Yiwen and Fan, Dongdong and Di, Donglin and Pagnucco, Maurice and Song, Yang, 'GrainSpace: A Large-scale Dataset for Fine-grained and Domain-adaptive Recognition of Cereal Grains', in CVPR 2022
2. Liu, Zhikang and Zhou, Yiming and Xu, Yuansheng and Wang, Zilei, 'SimpleNet: A Simple Network for Image Anomaly Detection and Localization', in CVPR 2023.

GitHub Code:

