

# EE 583 Pattern Recognition Project Presentation

- Evaluating ConvNeXt for Satellite Image Classification: The “Glass Cannon” Effect

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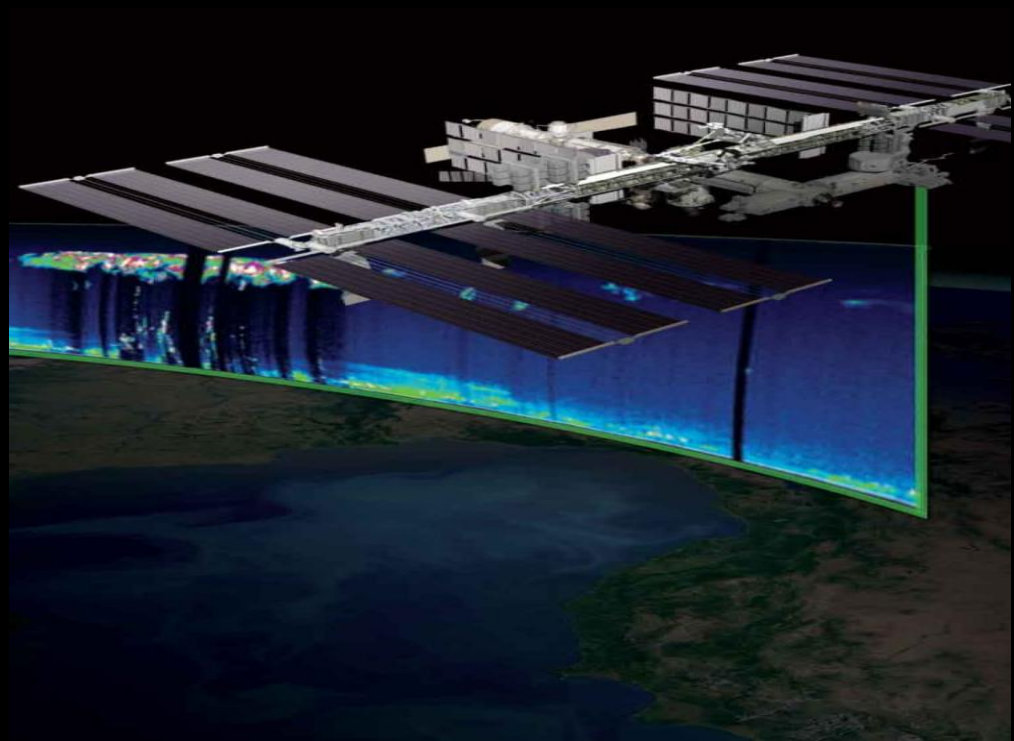
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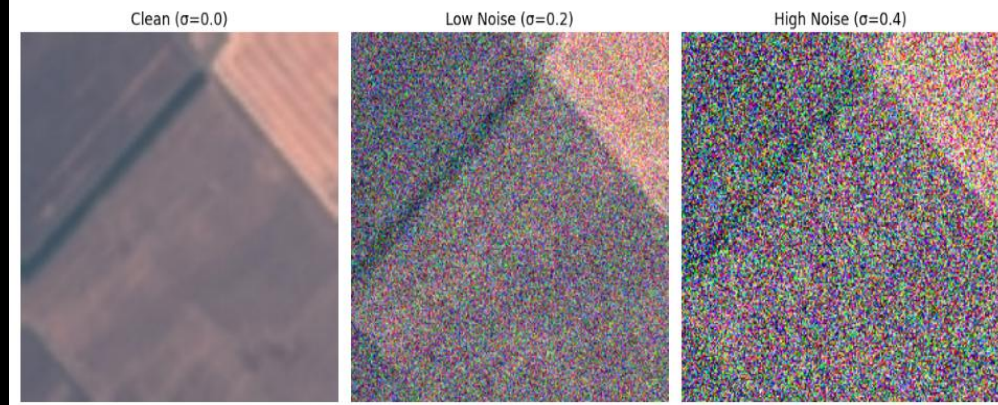


# The Challenge Of Remote Sensing

- What are the challenges of Remote Sensing?
- If I train a State-of-the-Art model on the clean data today, is it robust enough to trust in the noisy reality of orbit tomorrow?

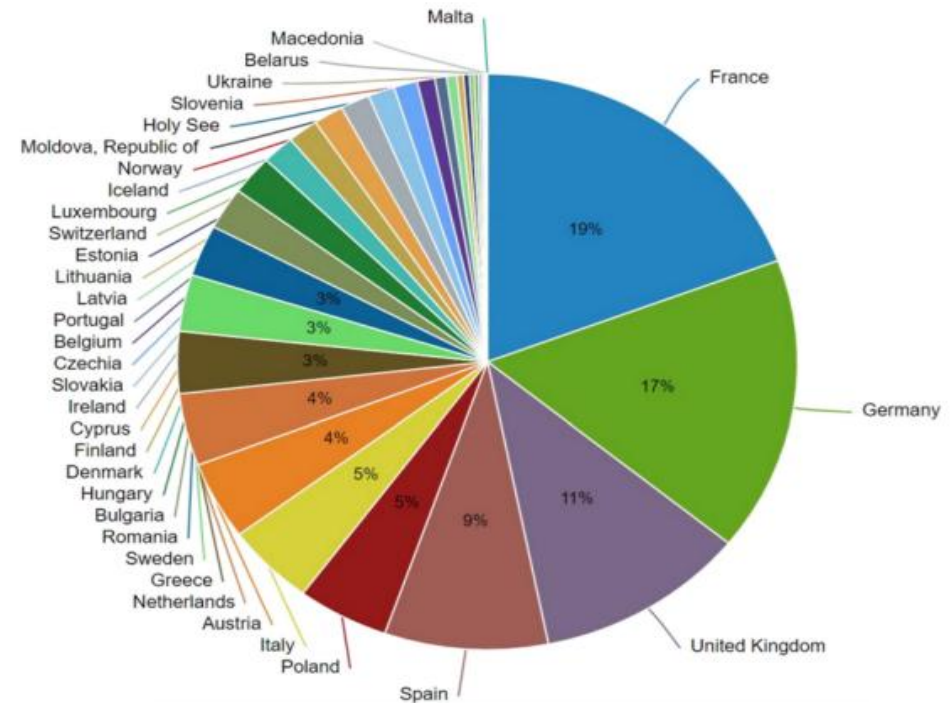
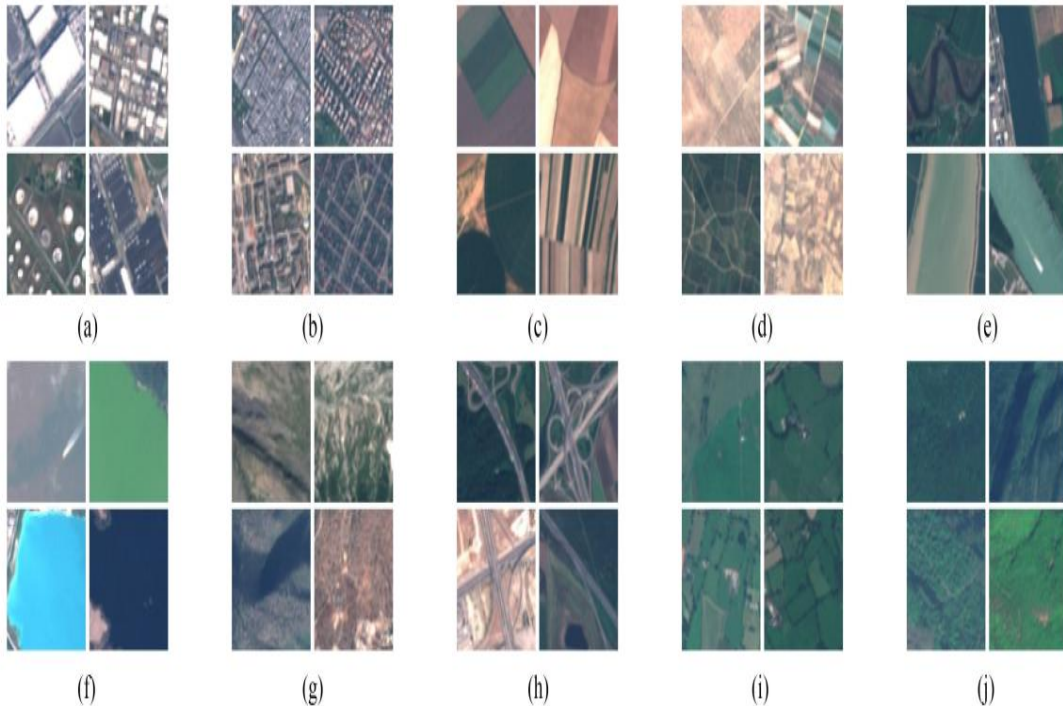


Effect of Sensor Noise on AnnualCrop (EuroSAT)



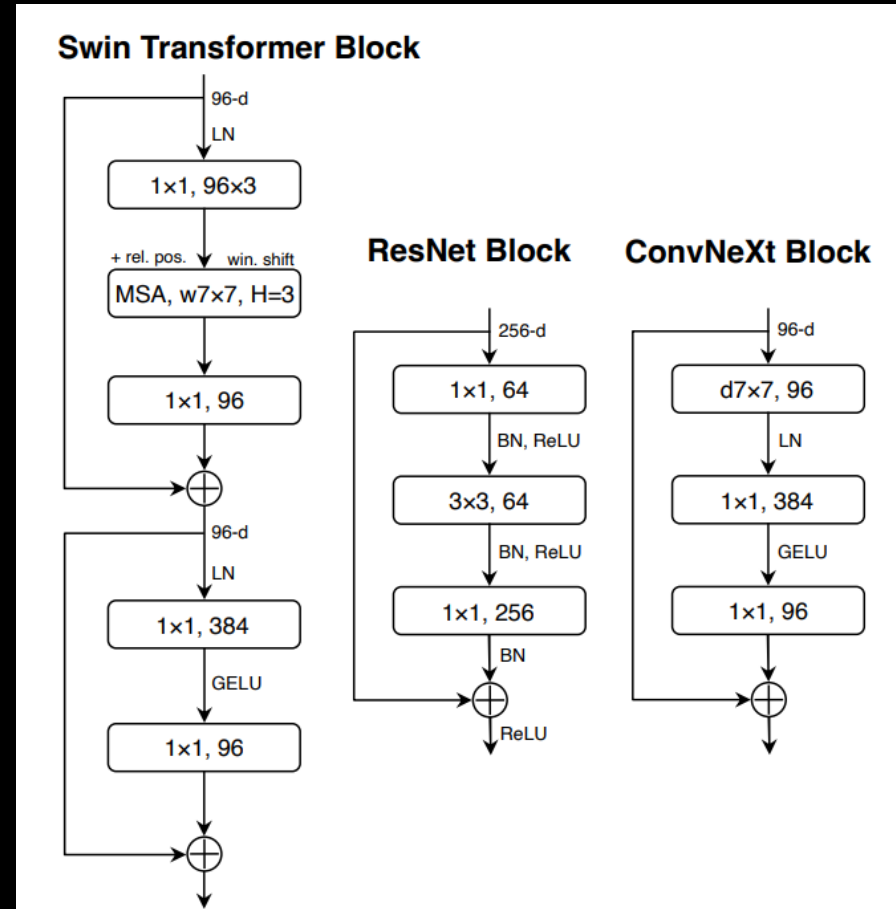
# The Dataset (EuroSAT)

- Consist of 27,000 satellite images derived from the Sentinel-2 satellite program.
- It includes 10 land use classes, such as Forests, Highways, Rivers, and Industrial zones.



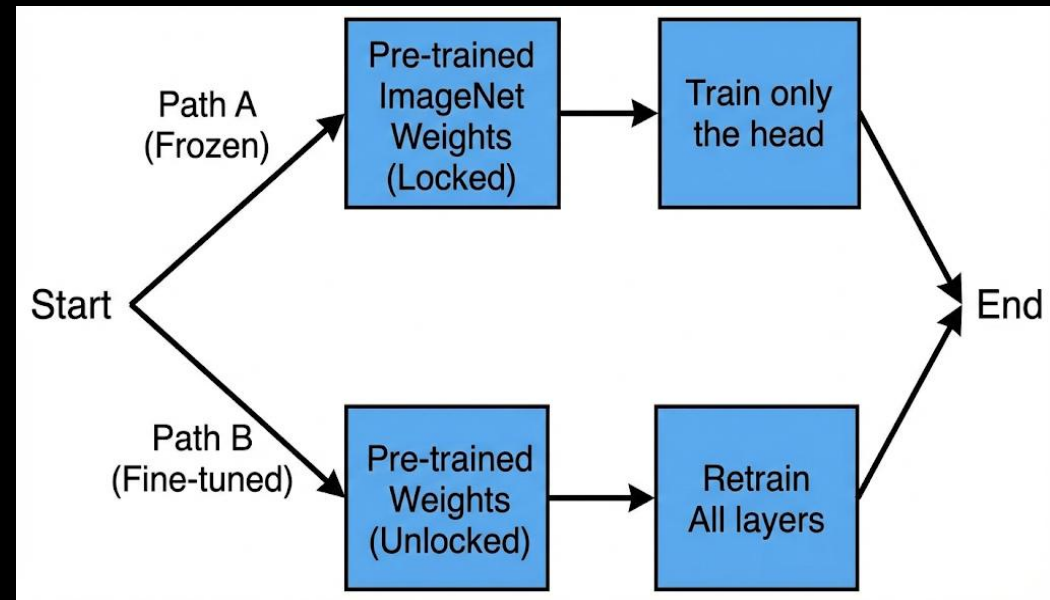
# ConvNeXt&Baselines

- It is a 'modernized' pure Convolutional Neural Network proposed by Facebook AI Research in 2022.
- I compared two variants: ConvNeXt-Tiny(29M parameters), ConvNeXt-Small (50M parameters)
- Baselines: K-Nearest Neighbors, Random Forest, Linear SVM

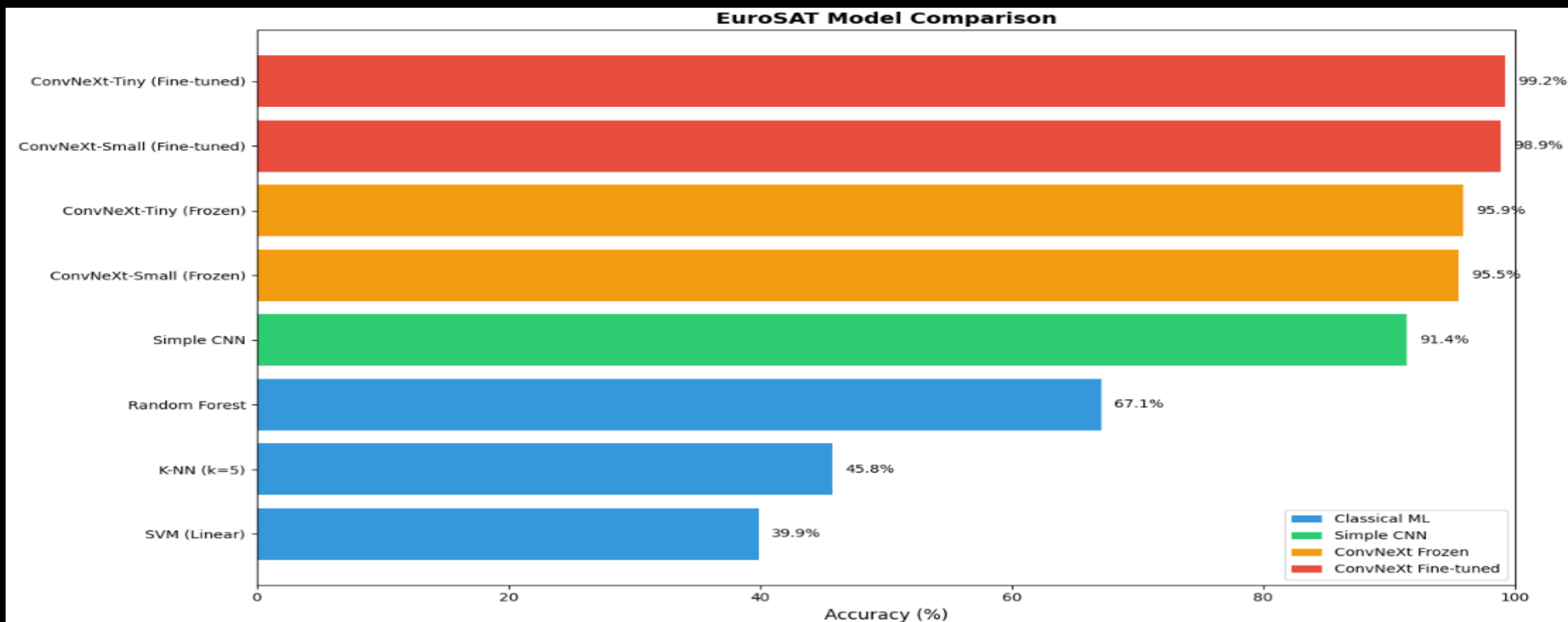


# Experimental Setup: Frozen vs Fine-Tuned

- Frozen: Pre-trained ImageNet Weights are locked, only the final classification head is trained.
- Fine-Tuned: Allowing the entire network to update its weights for satellite data.

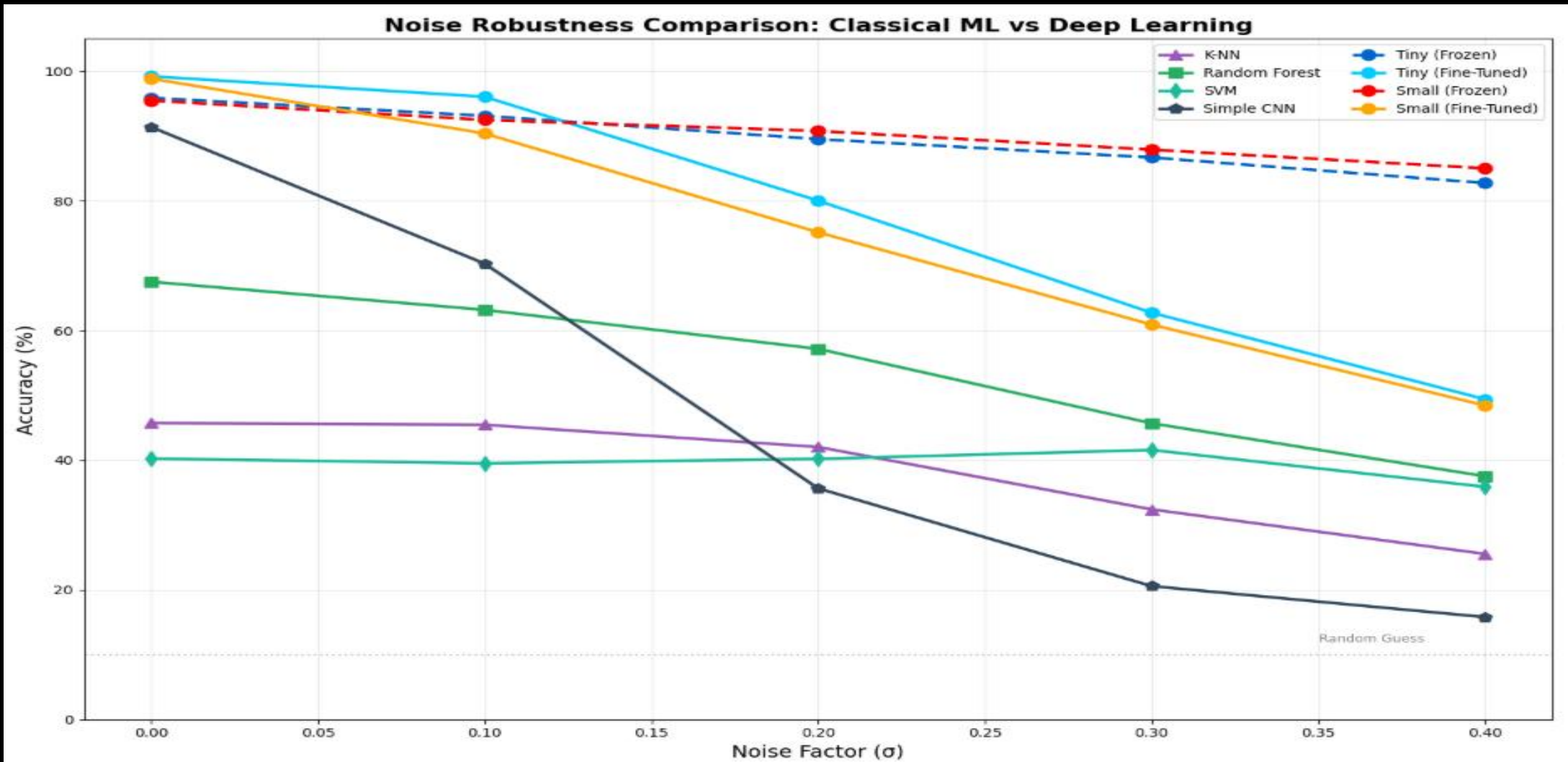


# Baseline Performance (Clean Data)





# Robustness Analysis: The Crash



# Why did the SOTA model fail?

- Overfitting to Domain-Specific Textures
- The Frozen Model retained its 'general' knowledge from ImageNet.

Model	$\sigma=0.0$	$\sigma=0.1$	$\sigma=0.2$	$\sigma=0.3$	$\sigma=0.4$	Drop	Type
Tiny (Fine-Tuned)	99.2%	96.1%	80.0%	62.7%	49.4%	-49.8%	ConvNext
Small (Fine-Tuned)	98.9%	90.4%	75.1%	60.9%	48.4%	-50.4%	ConvNext
Tiny (Frozen)	95.9%	93.1%	89.5%	86.7%	82.7%	-13.1%	ConvNext
Small (Frozen)	95.5%	92.5%	90.8%	87.9%	85.0%	-10.5%	ConvNext
Simple CNN	91.4%	70.3%	35.6%	20.6%	15.8%	-75.6%	CNN
Random Forest	67.5%	63.2%	57.2%	45.7%	37.5%	-30.0%	Classical
K-NN	45.7%	45.5%	42.0%	32.4%	25.5%	-20.2%	Classical
SVM	40.2%	39.5%	40.2%	41.6%	35.9%	-4.4%	Classical



# Conclusion

- Fine-Tuning Trade-off: Gains in accuracy came at the cost of robustness (~50% drop).
- The “Safe” Middle Ground: Frozen Embeddings offer the best balance (96% acc, low drop).
- Recommendation: For safety-critical systems, blindly trusting high accuracy metrics is dangerous.