

Explainable Multimodal Skin Lesion Classification

A transparent framework utilizing ResNet-18, TabNet, and LIME to bridge the gap between deep learning accuracy and clinical trust.

Master of Science in Artificial Intelligence Thesis Summary

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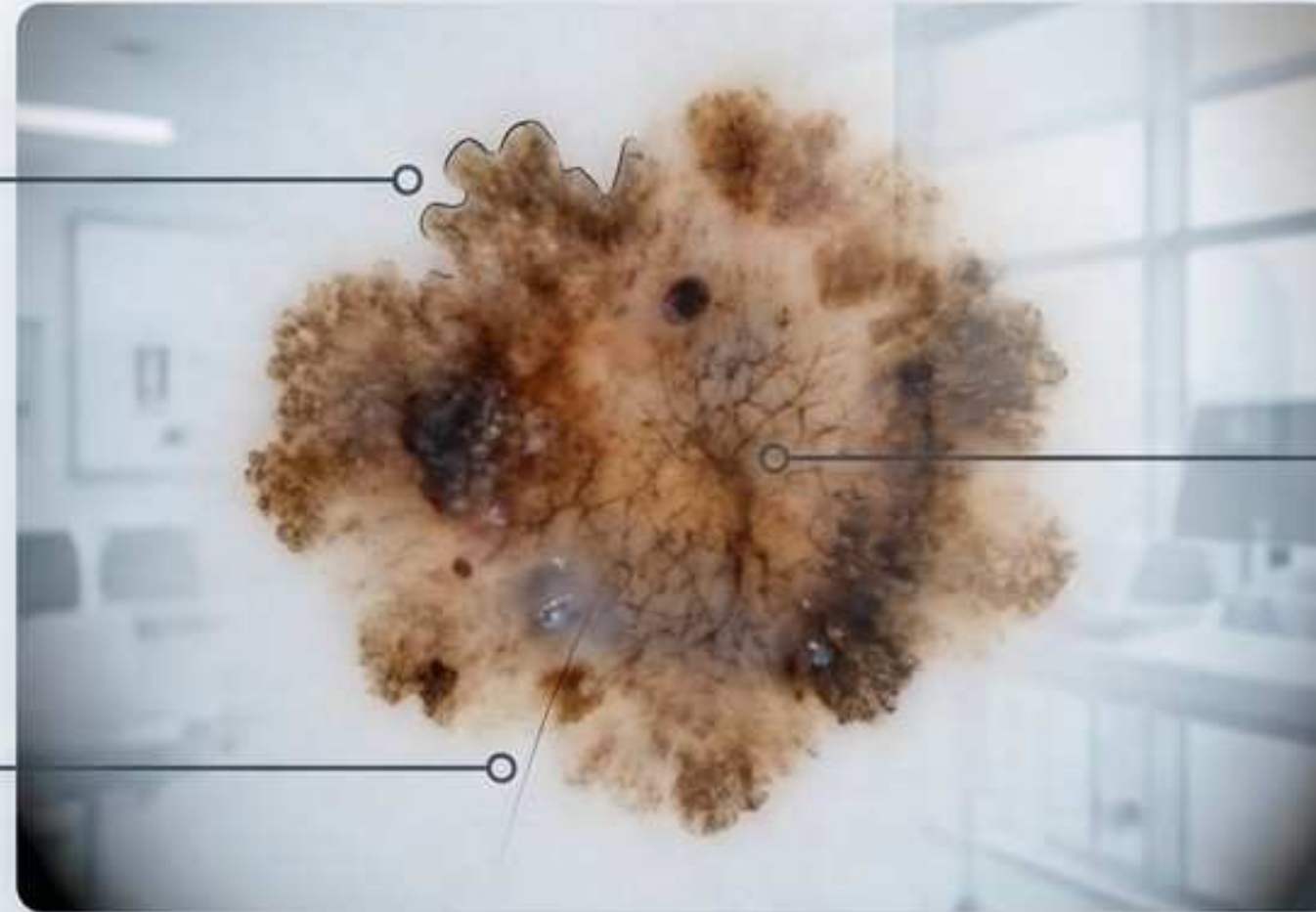
Visual assessment of skin lesions is highly subjective and prone to overlapping symptoms.

The ABCD Heuristic

Asymmetry, Border, Colour, Differential structures — describable, but difficult to grade consistently.

Dermoscope Artifacts

Extraneous visual clutter biases machine learning models if not properly handled.



Overlapping Pathologies

Early-stage malignant (melanoma) and benign (nevus) lesions frequently share identical visual structures.

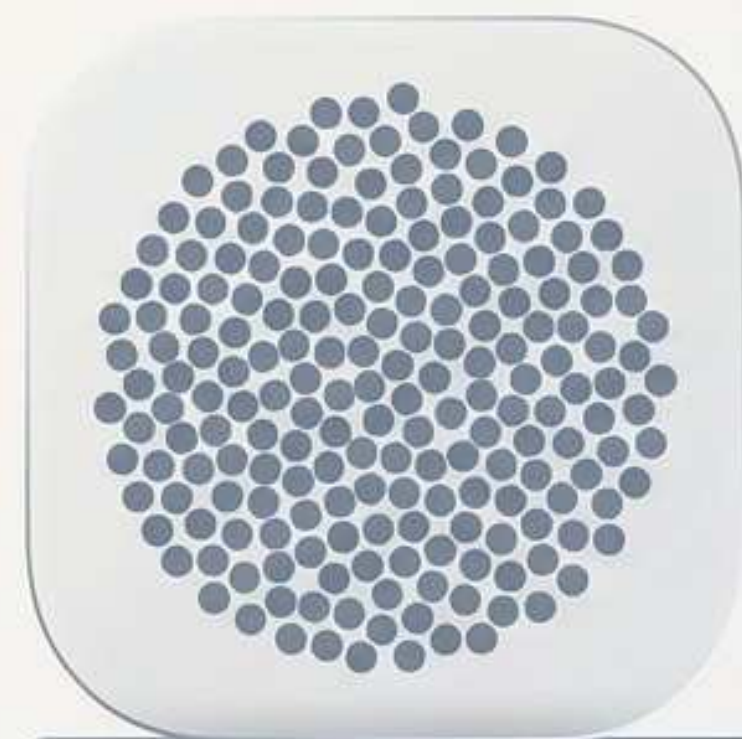
Predictive performance alone is insufficient; **clinicians cannot trust an unexplainable diagnosis** when assessing malignancy.

The evolution of Medical AI demands a shift from opaque accuracy to transparent reasoning.

Medical AI Paradigm Shift Matrix			While early models proved CNNs could match board-certified dermatologists, their black-box nature hindered clinical adoption. Accuracy and trust must be achieved together.
Architecture	The Status Quo	The Proposed Framework	
	Heavy Ensembles	Lightweight ResNet-18 + TabNet	
Interpretability	Black-Box & Confident Label	Glass-Box Visual LIME Heatmap	
Dataset Dependency	Requires 100k+ Images (e.g., Esteva 2017)	Data-Efficient Curated Dataset	
Clinical Output	Trust me	Here is my reasoning	

Curating a 10-class dataset requires active mitigation of major clinical imbalances.

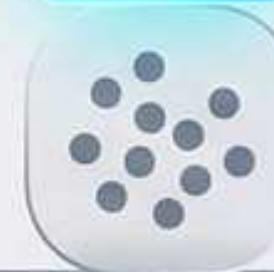
Balancing Act



Dominant Classes
(e.g., Atopic Dermatitis,
Vascular Lesions)

Data Augmentation
(Rotations, flips, color shifts)

Cost-Sensitive Weighting
(Inverse frequency loss penalty)

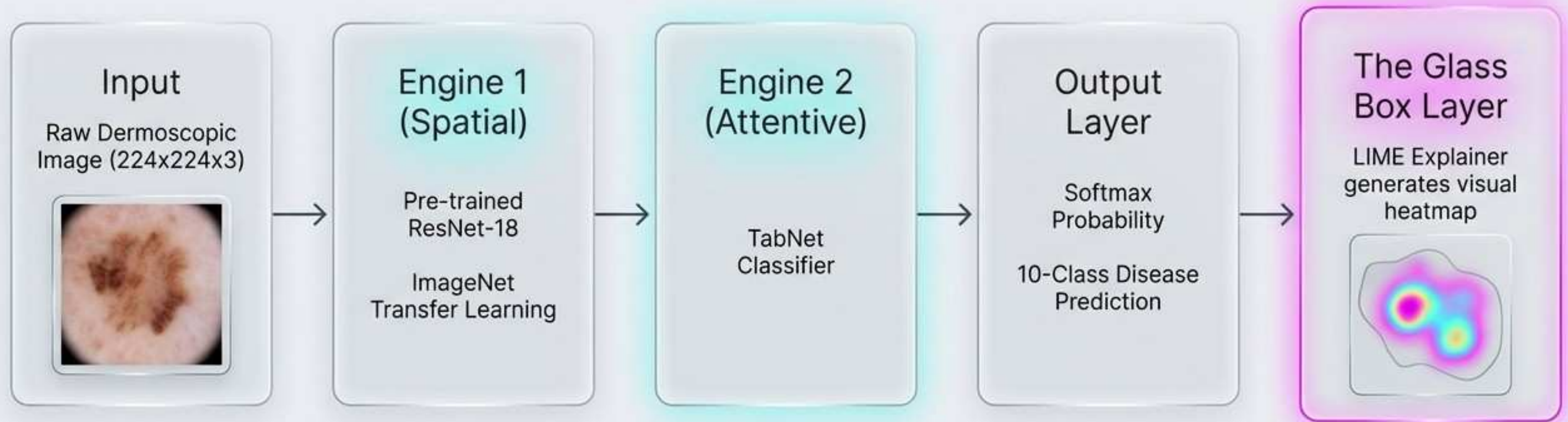


Rare Realities
(e.g., Tinea/Ringworm
with 76 examples)

Dataset Composition

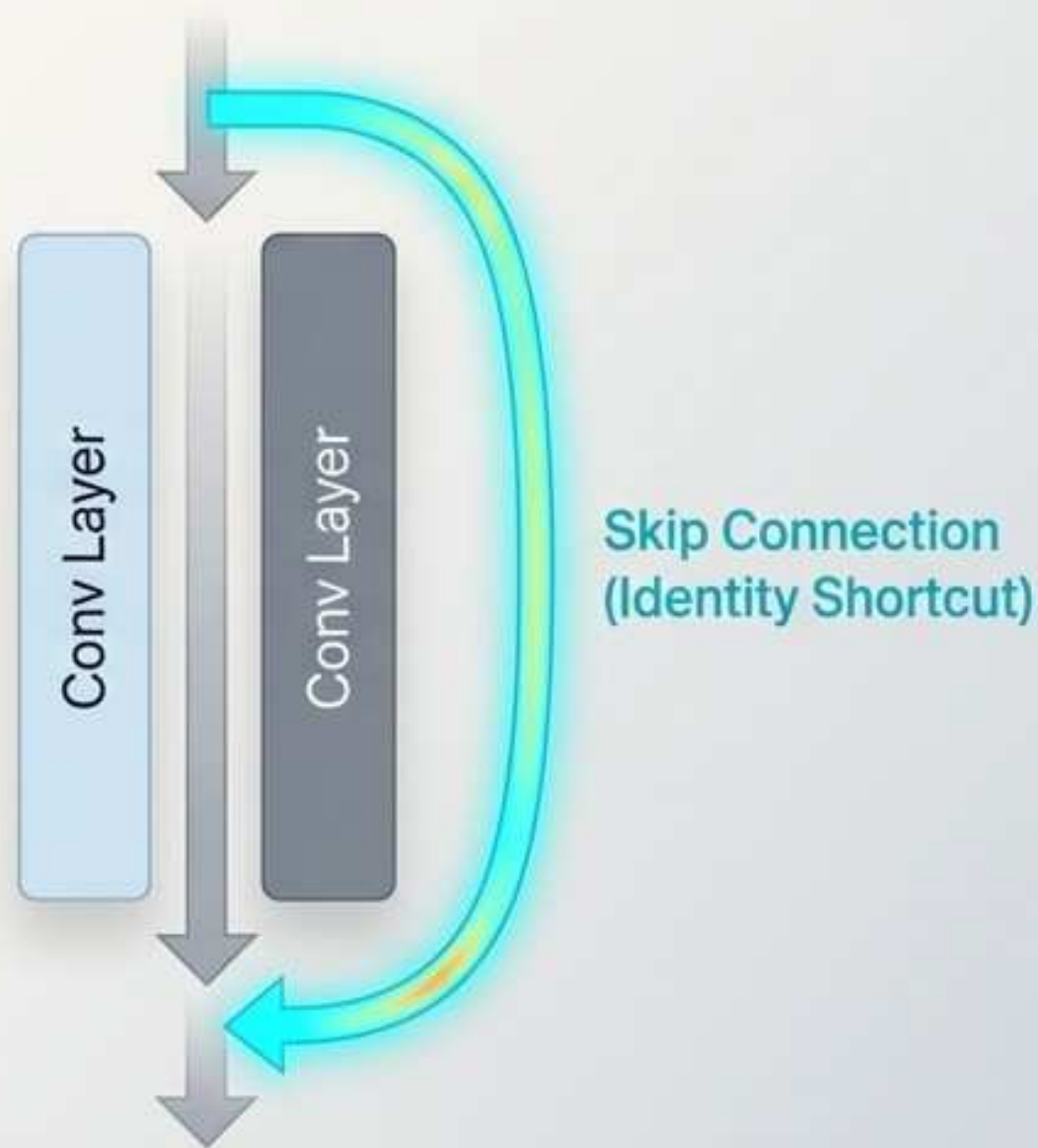
-  **Total Images:**
878
-  **Split:**
80% Train /
20% Validation
-  **Resolution:**
Standardized to
224x224 pixels
-  **Categories:**
Malignant,
Pre-malignant,
Benign, and
Non-neoplastic
conditions.

A sequential pipeline engineered for both high-fidelity extraction and clinical explainability



The framework deliberately selects lightweight components (ResNet-18's ~11M parameters) over computationally heavy ensembles, ensuring suitability for resource-constrained clinical hardware.

ResNet-18 distills complex lesion structures without the burden of vanishing gradients.



The Degradation Problem

Deep networks traditionally lose gradient flow during backpropagation, capping performance.

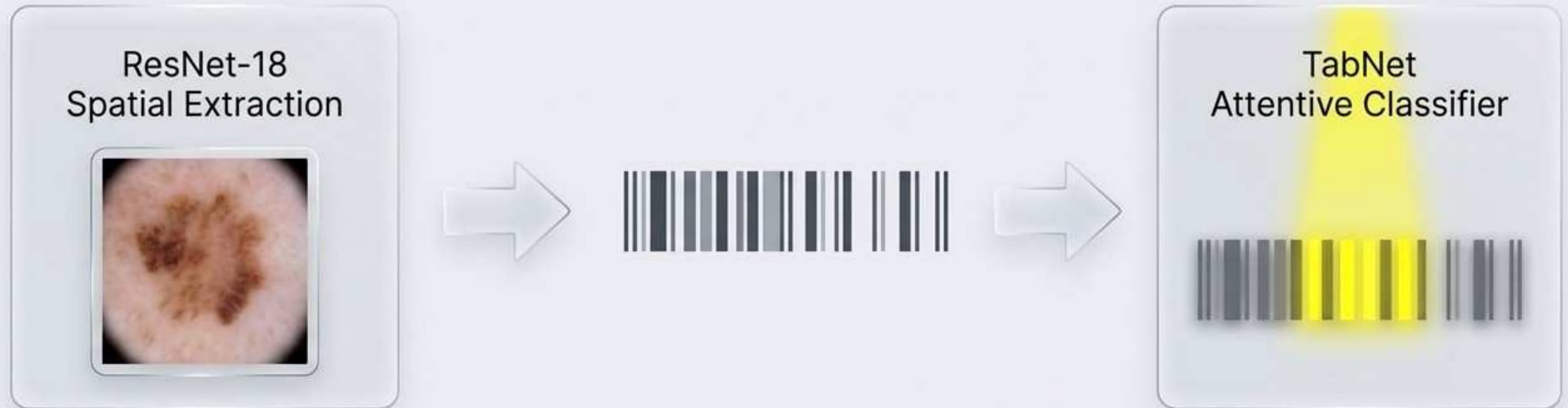
The Residual Solution

Skip connections preserve gradients, allowing the network to learn small functional corrections rather than entirely new transformations.

Transfer Learning Advantage

Initialized with ImageNet weights to leverage pre-learned generic visual primitives, fine-tuned specifically for dermatology via an Adam optimizer ($lr=1e-4$).

Connecting spatial features to precise clinical classification through attentive selection.



ResNet extracts a dense array of visual features. TabNet acts as a clinical filter, actively selecting only the most relevant diagnostic features to compute the final 10-class probability, ignoring redundant data.

Local Interpretable Model-Agnostic Explanations (LIME) mathematically justify the prediction.



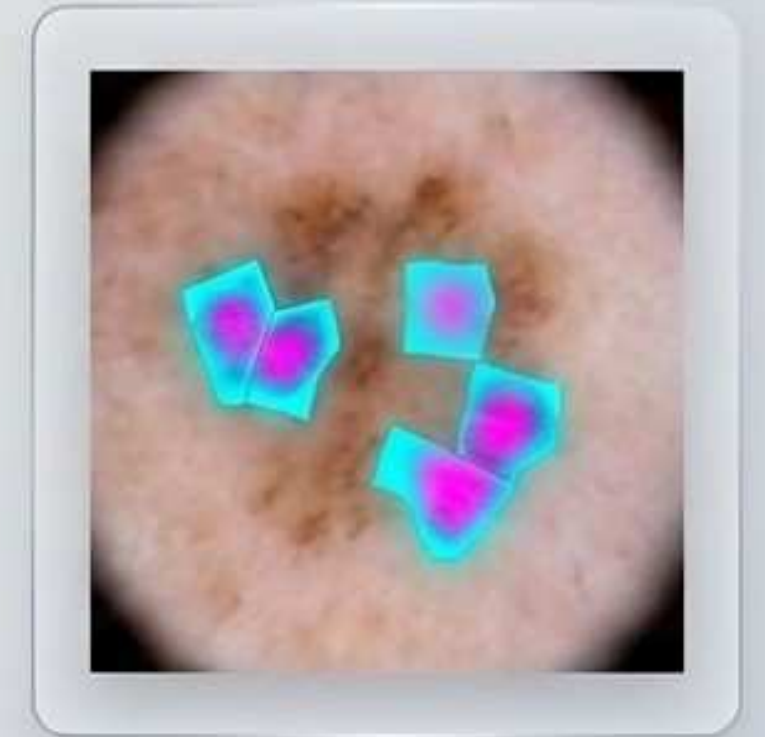
1. Segmentation



2. Perturbation



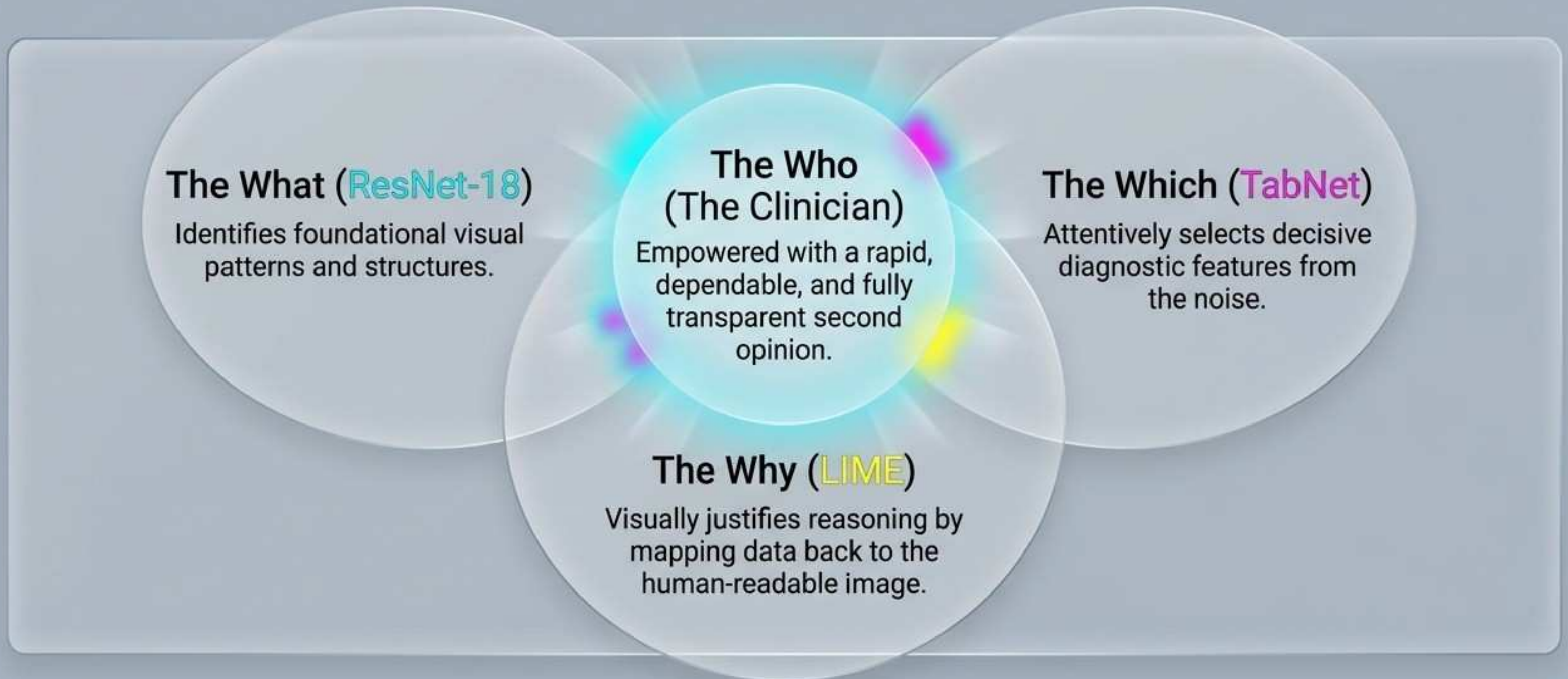
3. Observation



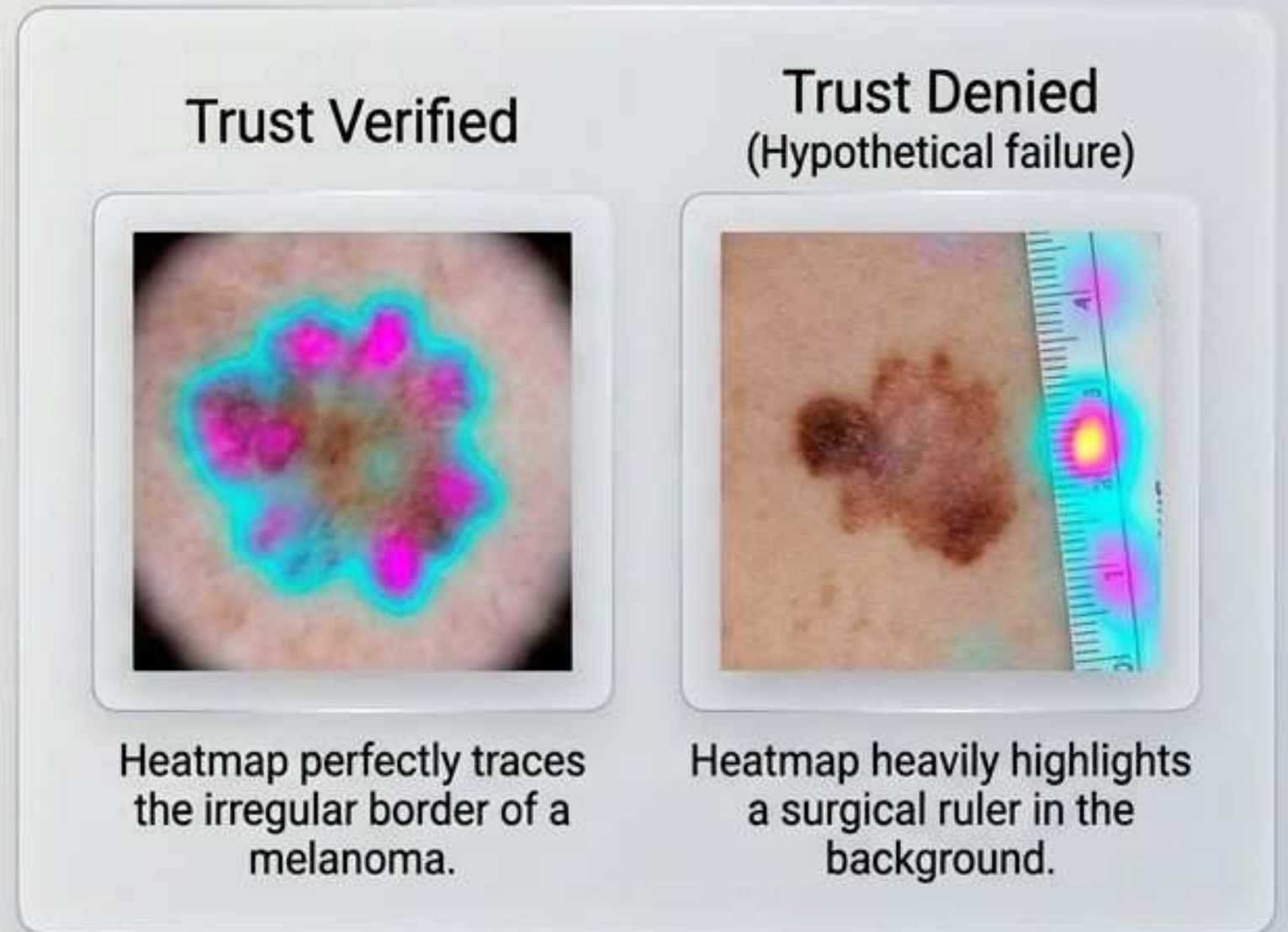
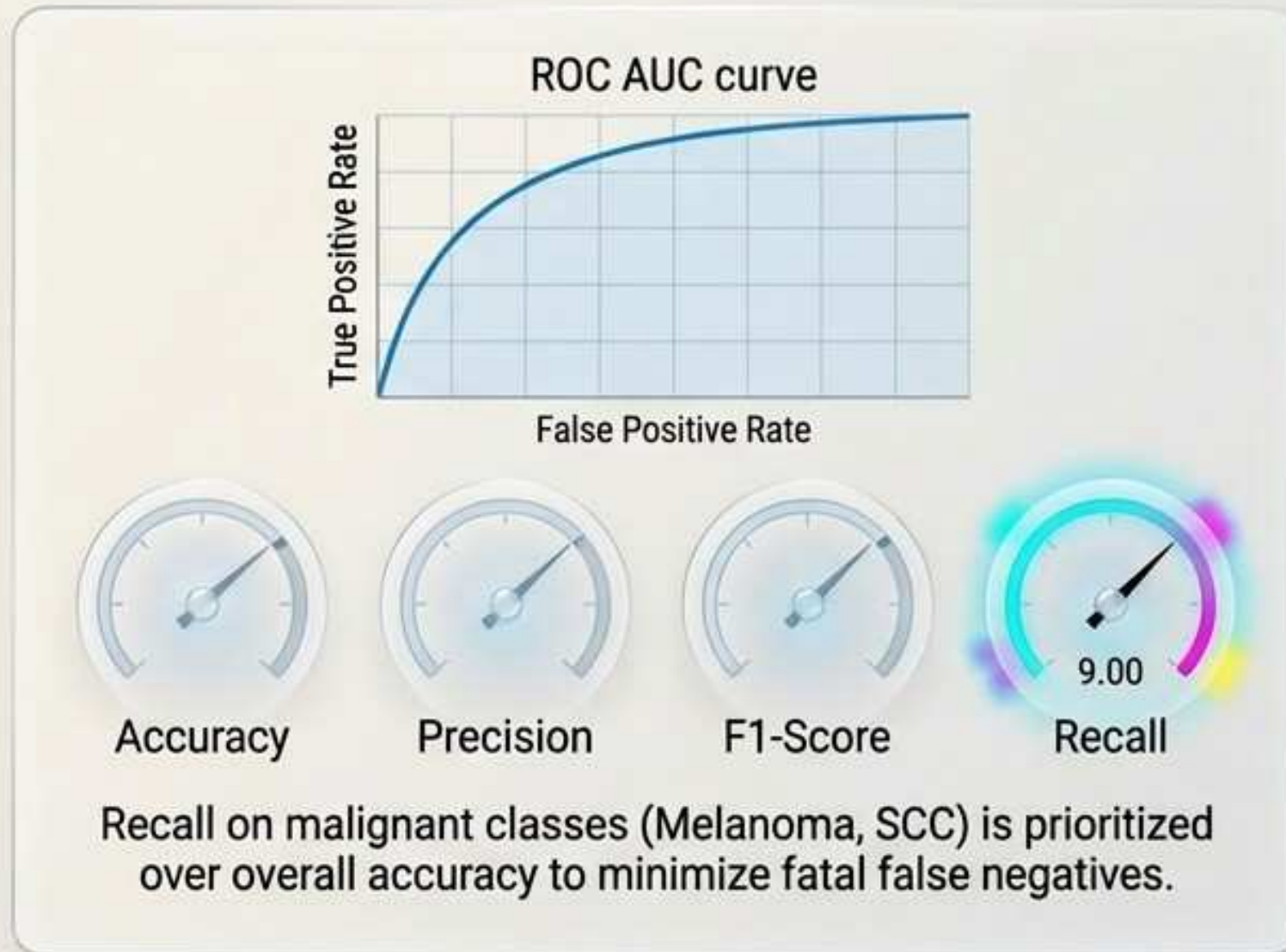
4. The Heatmap

LIME fits a simple, interpretable surrogate model to observe local behavior. It answers the clinician's ultimate question: "Which specific pixels drove this diagnosis?"

The Architecture of Trust: Accuracy and explainability are not opposing forces.



A dual-evaluation strategy prioritizing malignant recall and qualitative clinical alignment.



A model is only clinically viable if its LIME explanations consistently focus on pathological tissue rather than imaging artifacts.

Transforming deep learning from an opaque oracle into a transparent clinical partner

Diagnostic Glass Box



Prediction: Melanoma
Confidence: 94.2%

Efficiency

Achieved robust multi-class diagnosis on modest datasets via augmentation, class weighting, and transfer learning.

Performance

Leveraged the spatial power of ResNet-18 and the attentive precision of TabNet.

Transparency

Ensured clinical acceptability by mandating per-prediction visual justifications via LIME.

The future of computer-aided diagnosis in dermatology relies not just on artificial intelligence, but on explainable artificial intelligence.