# SKIN CANCER DETECTION

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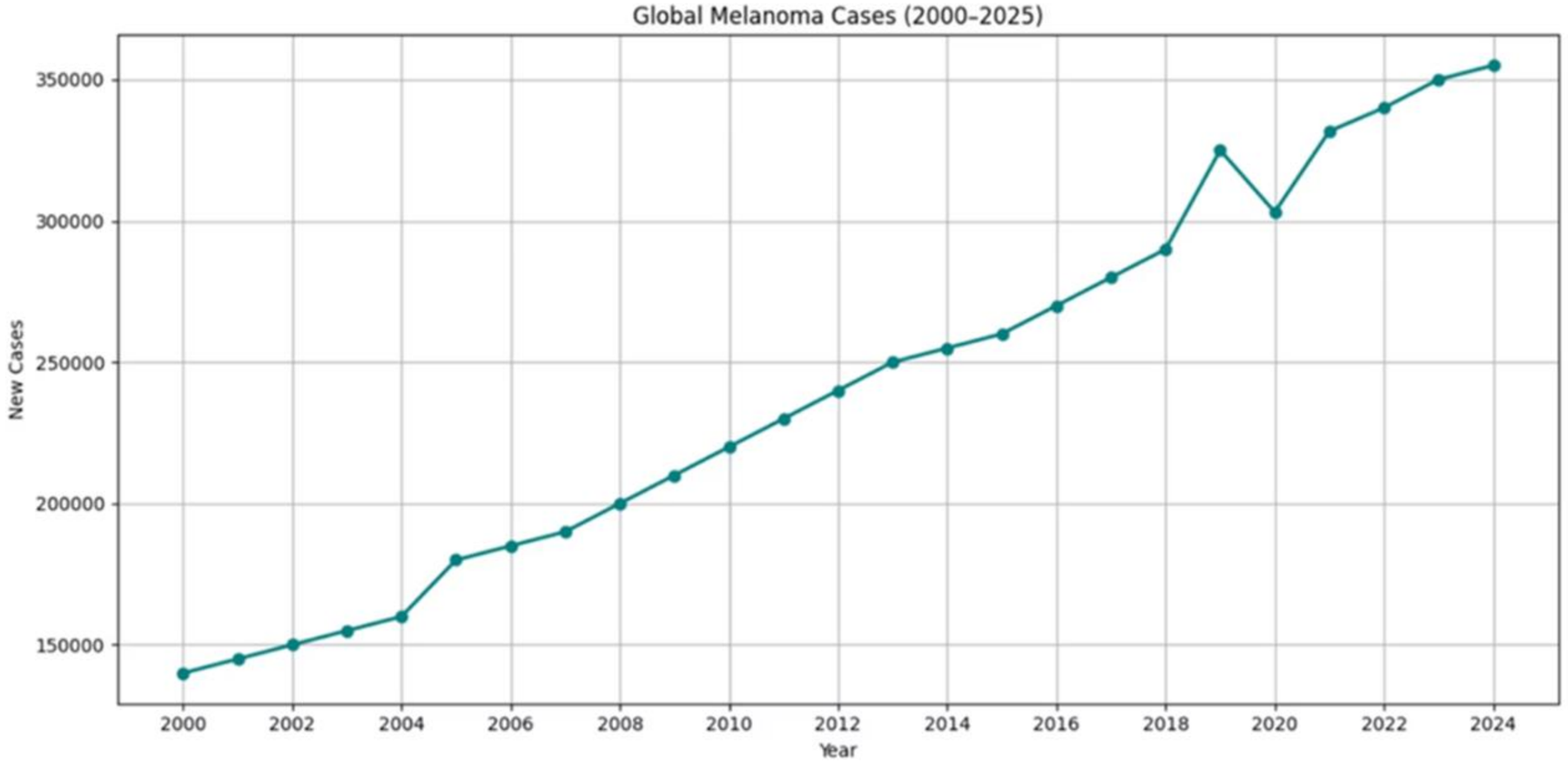
# The Problem

## CASES

Skin cancer is one of the most common cancers globally, with millions of new cases diagnosed every year. melanoma stands out as the most dangerous form, capable of being life-threatening if not detected early. more than 350,000 cases of melanoma were detected worldwide last year.



# The Problem

## DEATHS

| Rank | Country | Number | ASR/100,000 |
|---|---|---|---|
| | World | 58,667 | 0.53 |
| 1 | US | 7,368 | 1.0 |
| 2 | China | 5,385 | 0.20 |
| 3 | Russia | 3,928 | 1.5 |
| 4 | Germany | 3,303 | 1.4 |

# The Problem

## Causes

### Melanoma Risk Factors Pyramid

**Weakened Immunity**

Compromised immune system hinders cancer defense

**Moles**

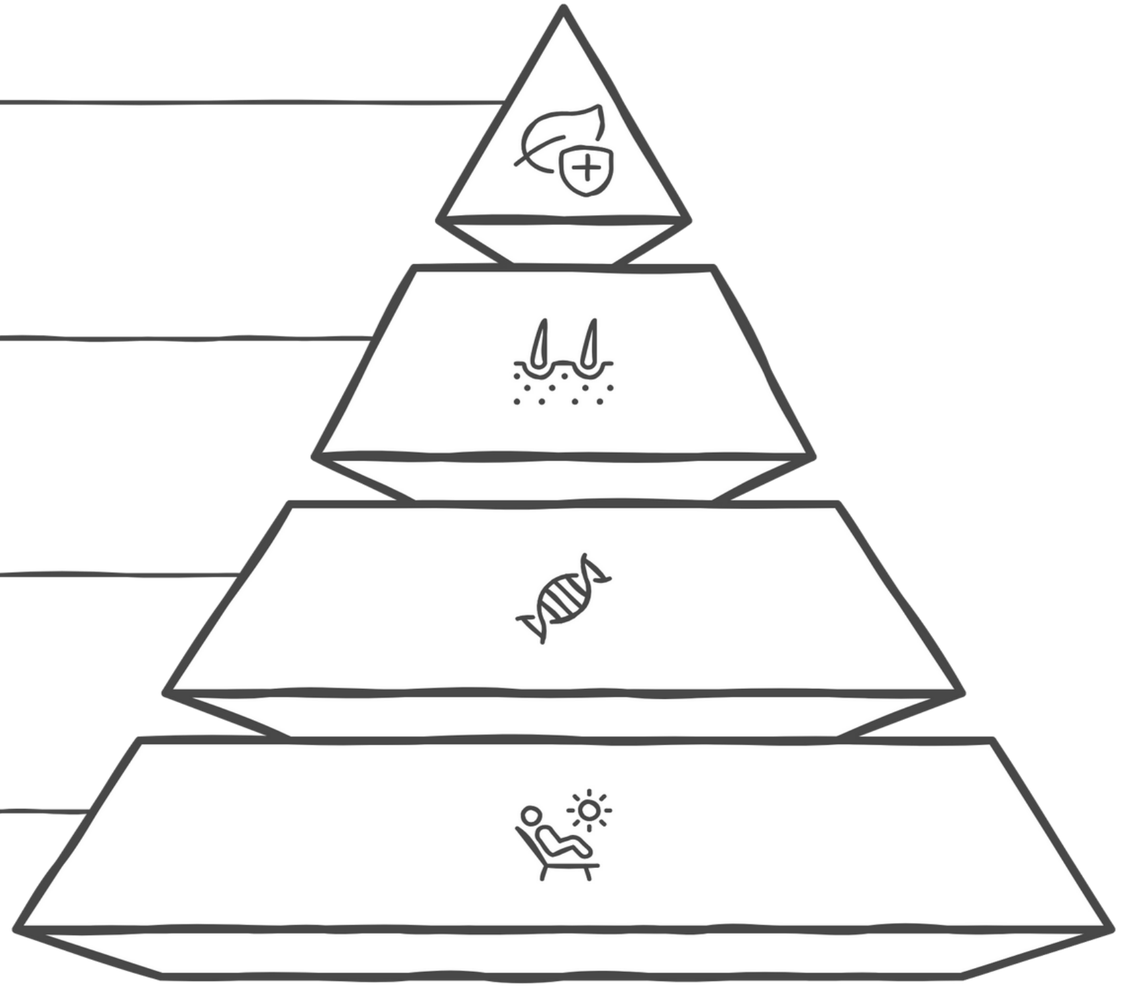
High number or atypical moles increase risk

**Genetic Factors**

Inherited mutations increase susceptibility

**UV Radiation**

Damages skin cell DNA, leading to mutations



# Motivation

## ✓ EARLY DETECTION IS KEY

Early detection is critical in the fight against melanoma. When caught in its early stages, the survival rate for melanoma exceeds 95%.

## ✓ SPECIALIST SHORTAGE

There is a significant shortage of dermatology specialists in many regions, resulting in delayed diagnoses and treatment.

## ✓ IMPORTANT NOTE

Primary care physicians can perform initial screening, but dermatologists are the specialists for comprehensive skin cancer evaluation.

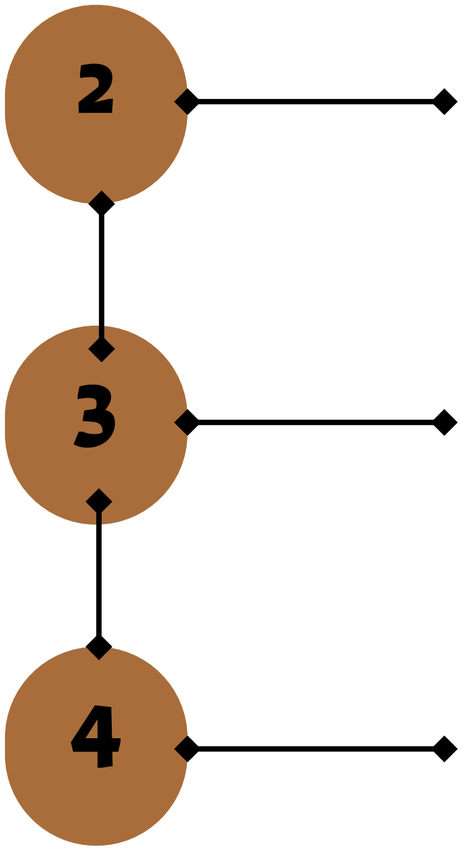
# Motivation

## Diagnostic Challenge

| Who | Diagnostic Method | Sensitivity | Specificity | False Negative Rate | False Positive Rate | Accuracy |
|---|---|---|---|---|---|---|
| Dermatologists | Clinical exam & images | ~76.9% | ~89.1% | ~23.1% | ~10.9% | ~89.1% |
| Dermatologists | Dermoscopy & images | **~85.7%** | ~81.3% | **~14.3%** | ~18.7% | ~81.3% |
| Primary Care Physicians | Clinical exam & images | ~37.5% | ~84.6% | ~62.5% | ~15.4% | ~84.6% |
| Primary Care Physicians | Dermoscopy & images | ~49.5% | **~91.3%** | ~50.5% | **~8.7%** | **~91.3%** |

# Motivation

## Diagnostic Delays




### Wait time

USA- 26 Days

ISRAEL - 111 Days

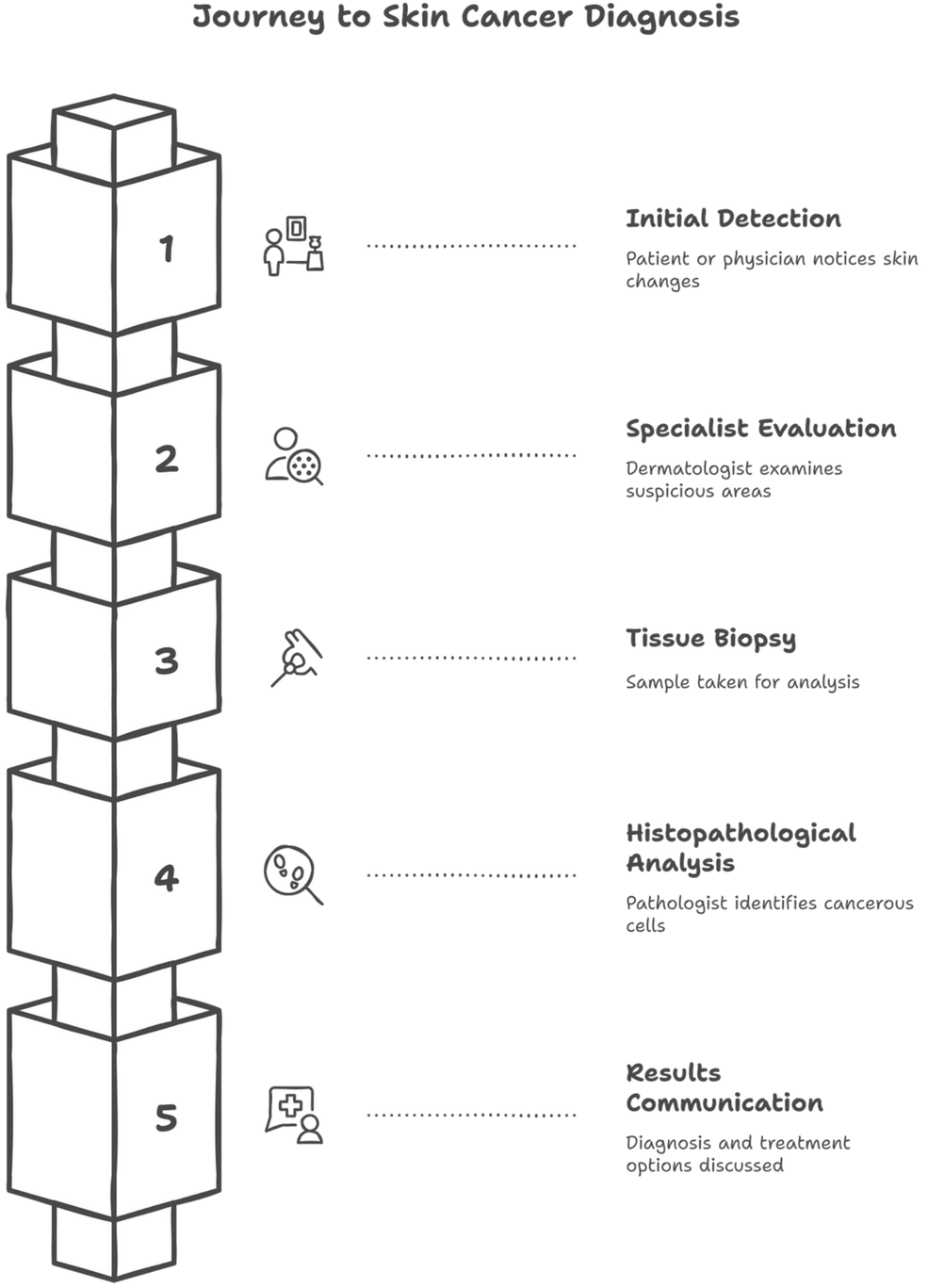
### Result time

7-14 Days

### Analysis time

7-14 Days

- FROM INASIVE TO METASTIC - WITHIN MONTHES IF NOT DETECTED



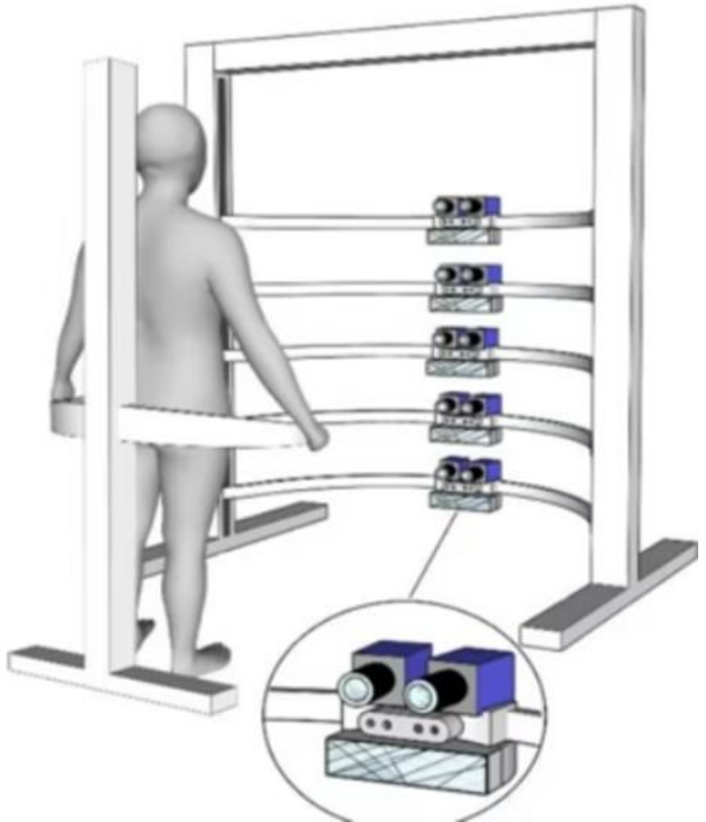
# 2024-2025 Major Breakthroughs

## DERMASENSOR

First FDA-authorized AI device for primary care skin cancer detection (Jan 2024)


## FRAUNHOFER INSTITUTE

Full-body scanner with 6-minute automated assessment (2025)



# The International Skin Imaging Collaboration


## 🎯 PRIMARY MISSION

REDUCE MELANOMA-RELATED DEATHS AND UNNECESSARY BIOPSIES BY IMPROVING THE ACCURACY AND EFFICIENCY OF EARLY MELANOMA DETECTION THROUGH AI-ENHANCED DIGITAL IMAGING.

- SUPPORT EARLY DIAGNOSIS WHEN MELANOMA IS MOST TREATABLE
- MINIMIZE UNNECESSARY BIOPSIES (E.G., 500,000+ PEDIATRIC BIOPSIES ANNUALLY FOR ~400 MELANOMAS)
- ADDRESS DIAGNOSTIC CHALLENGES IN TELEDERMATOLOGY

### GLOBAL COLLABORATION

ISIC IS A GLOBAL INITIATIVE TO IMPROVE MELANOMA DIAGNOSIS.

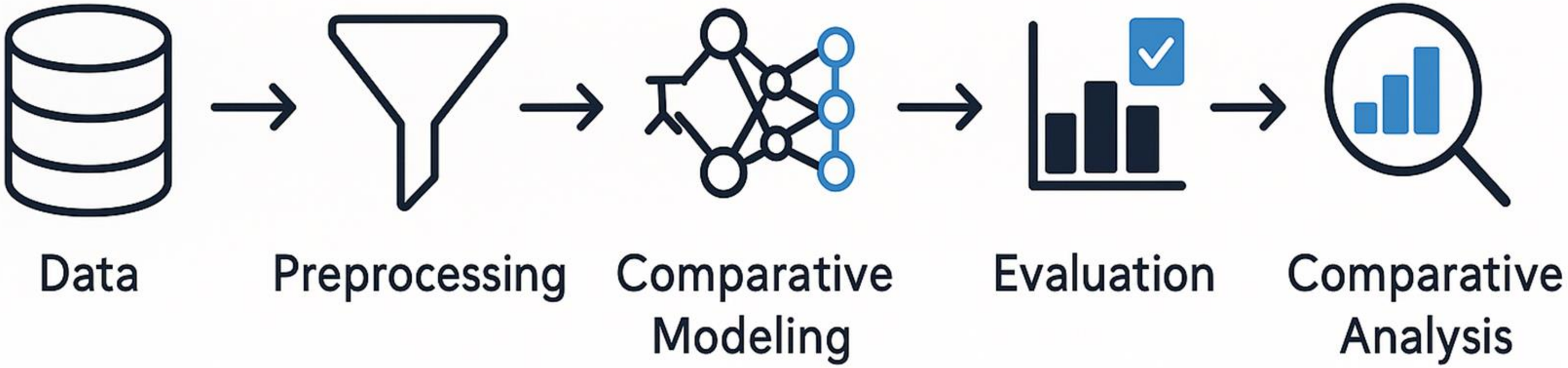
### DATA SHARING

THEY PROVIDE A LARGE DATASET OF DERMOSCOPIC IMAGES FOR RESEARCH.

### INNOVATION

ENCOURAGES DEVELOPMENT OF AI ALGORITHMS FOR DETECTION.

# Project Workflow



# Data

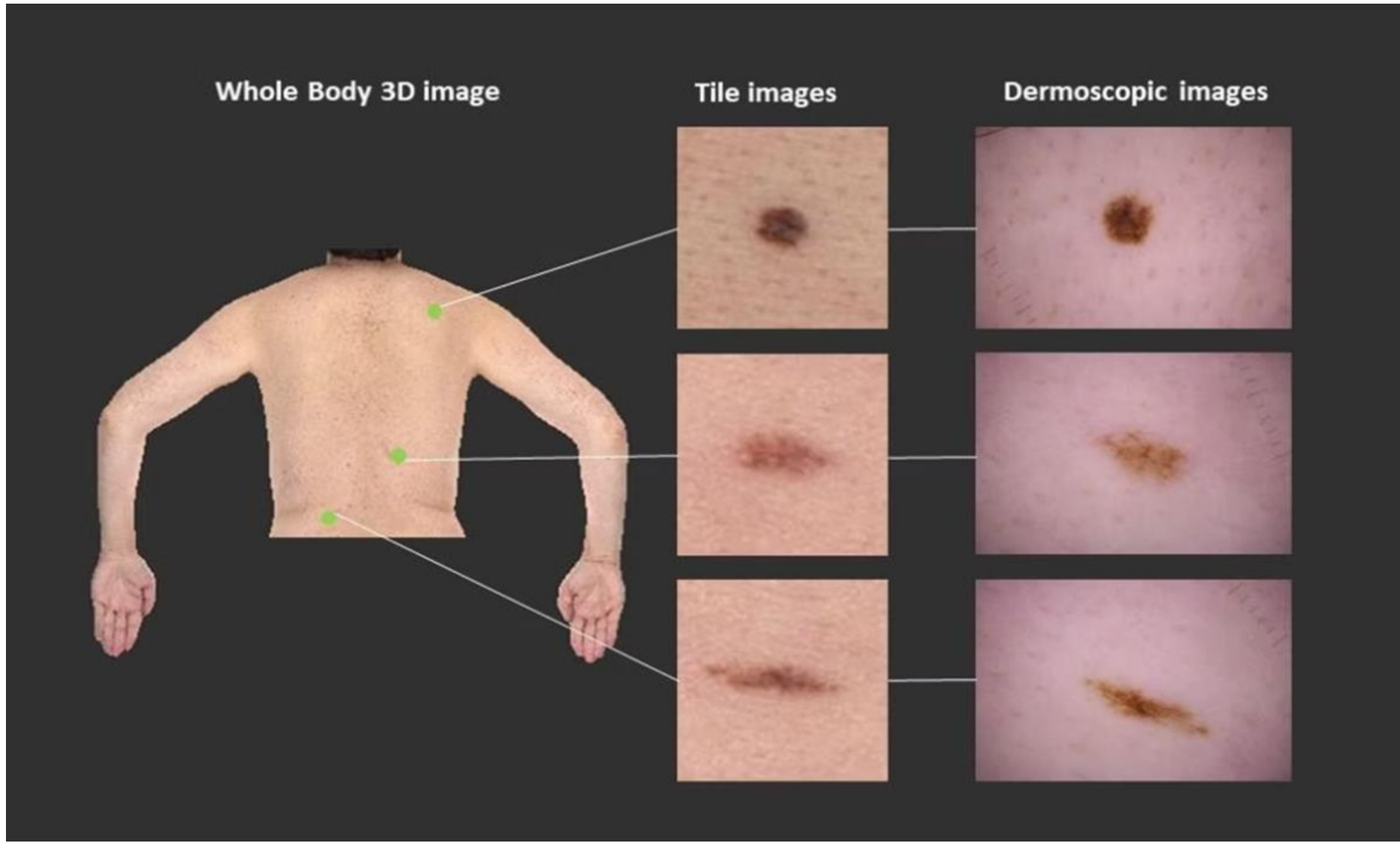
## ISIC - Dataset

### TILES

The location of each lesion on the patient is detected automatically and exported as individual 15x15 mm field-of-view cropped images.

### DERMOSCOPY

Dermoscopy refers to the examination of the skin using skin surface microscopy. Dermoscopy requires a high-quality magnifying lens and a powerful lighting system, which illuminate morphologic features not otherwise visible to the naked eye.

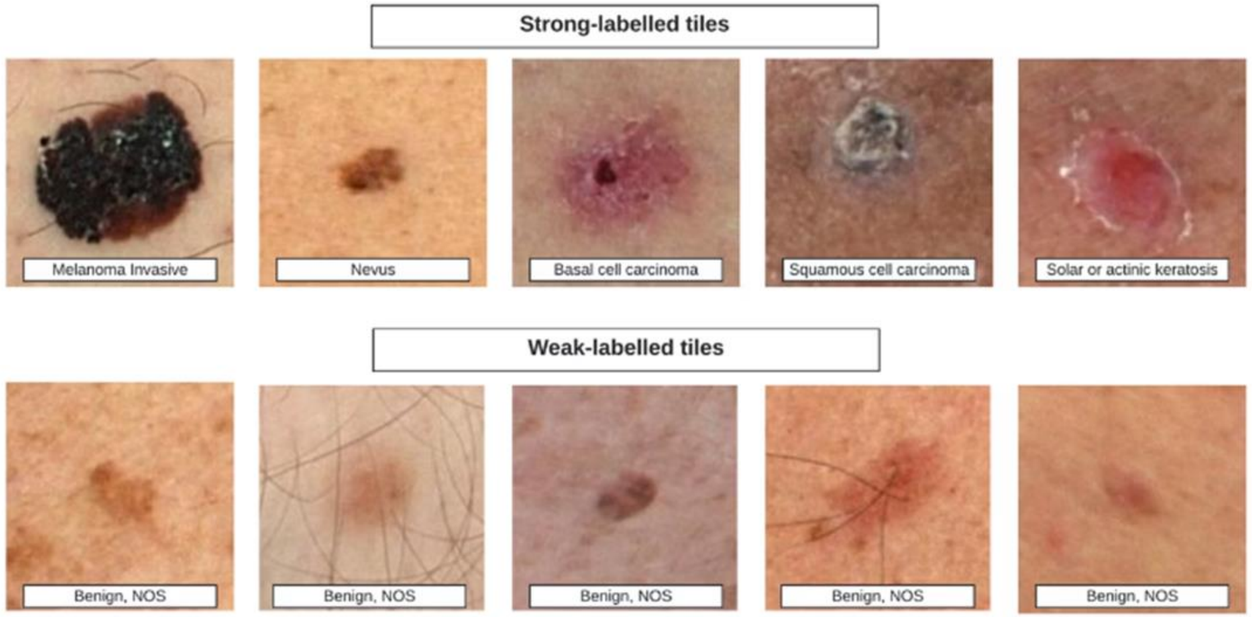


# Data

## ISIC - Metadata

### DERMOSCOPIC AND 3D IMAGES

These images provide detailed visual information for analysis.




### METADATA

Additional data points that accompany the images, such as patient age, gender, and lesion location.

# EDA

# Data Preparation

## DATA SPLITTING:

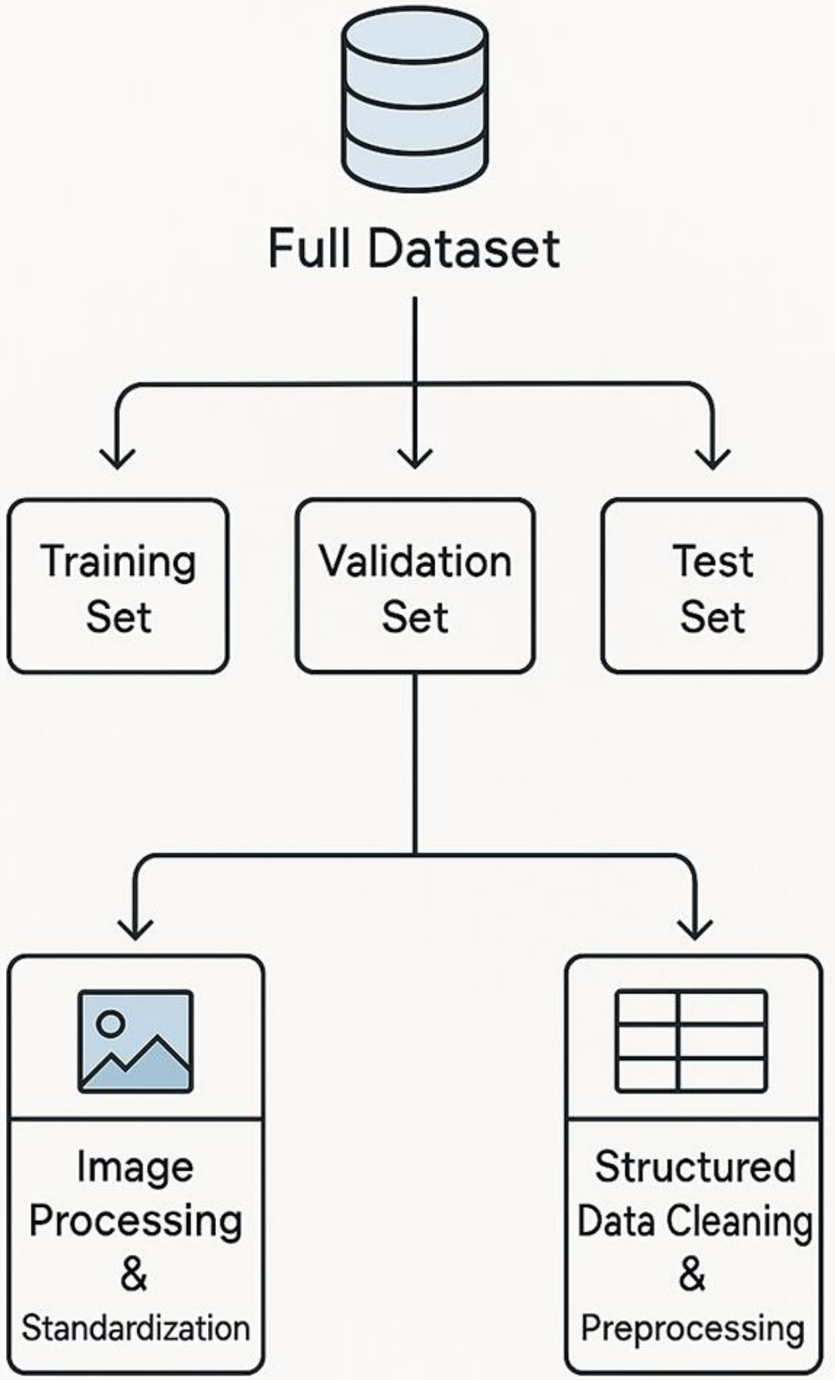
THE DATA WAS DIVIDED INTO TRAINING, VALIDATION, AND TEST SETS WHILE PRESERVING THE ORIGINAL CLASS DISTRIBUTION.

## STRUCTURED DATA PREPROCESSING:

A PIPELINE WAS BUILT TO HANDLE MISSING VALUES, NORMALIZE NUMERICAL FEATURES, AND HANDLE CATEGORICAL VALUES.

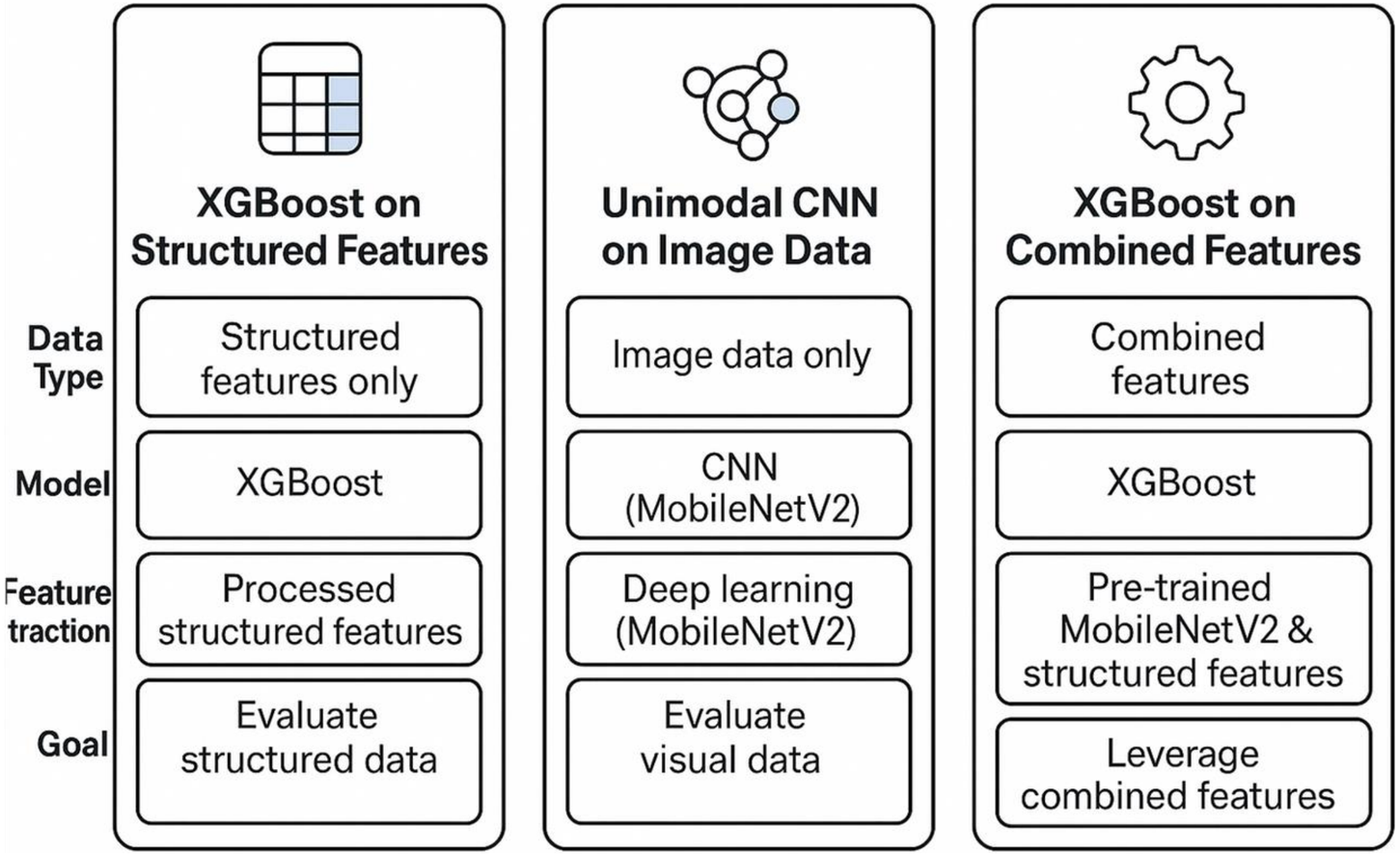
## IMAGE PROCESSING:

ALL IMAGES WERE STANDARDIZED TO A UNIFORM SIZE AND THEIR PIXEL VALUES WERE NORMALIZED.

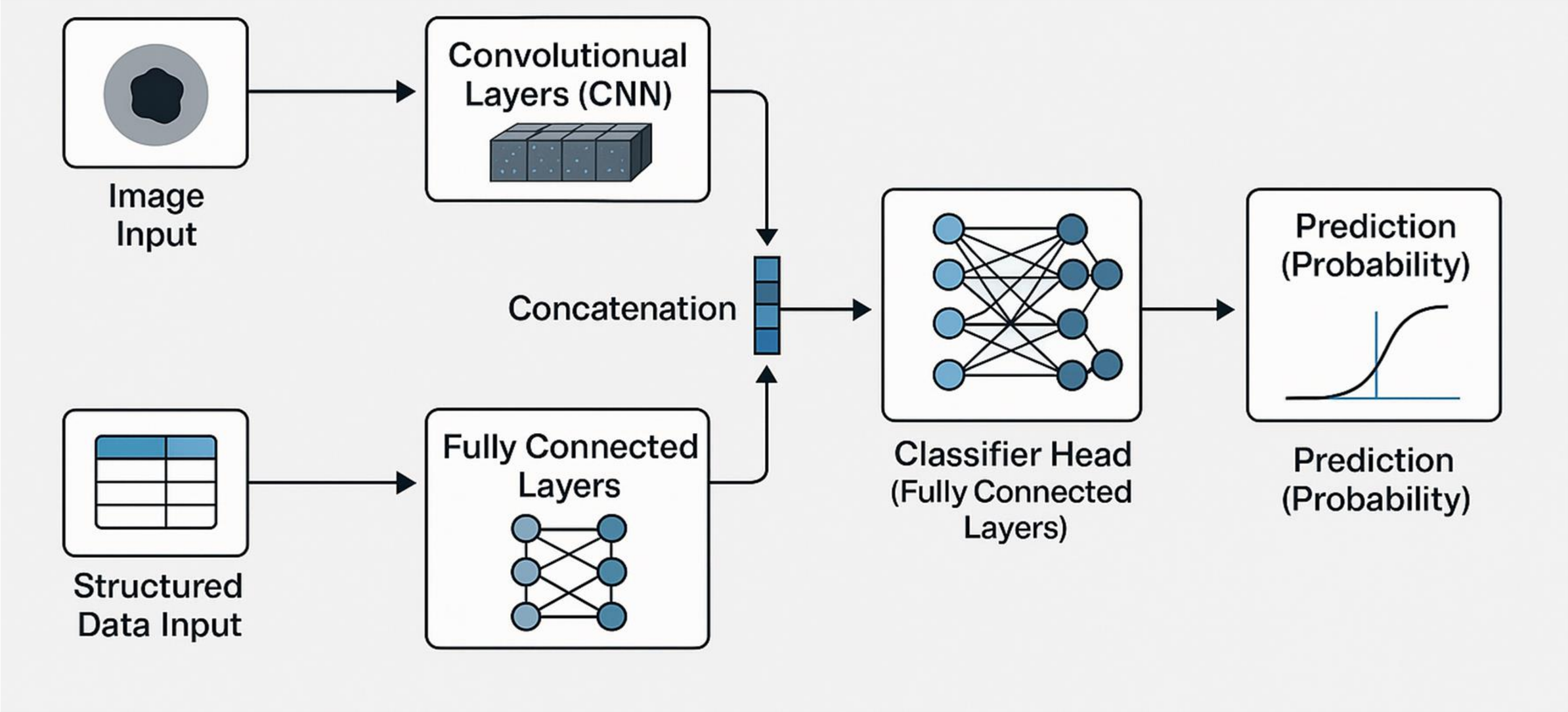


# Building a Comparative Baseline

To rigorously evaluate our main model, a comparative methodology was adopted. Three distinct baseline models were developed to establish performance benchmarks and isolate the contribution of each data modality.

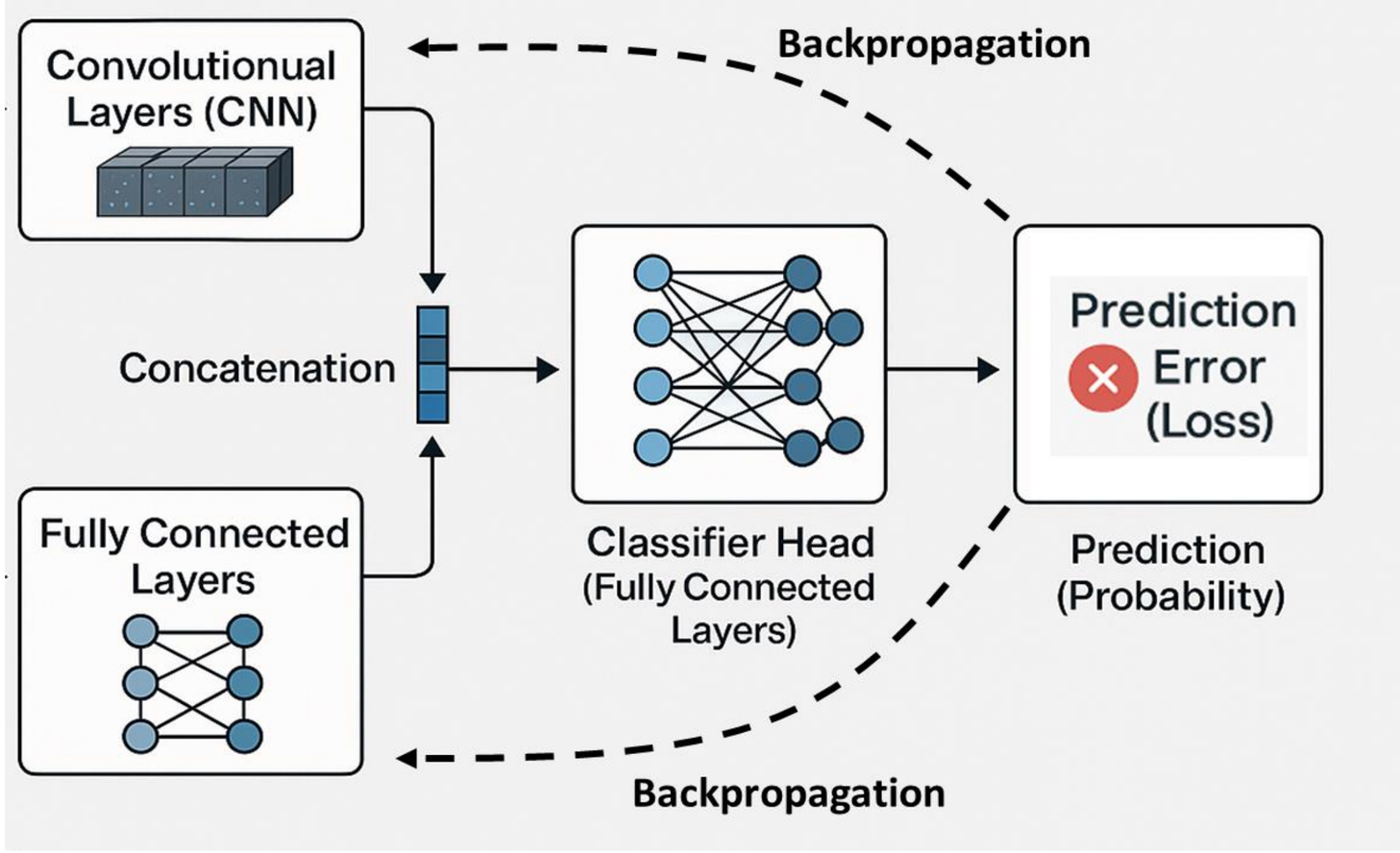


# Main Model Architecture



# Learning from Combined Features

By combining visual features with structured data, the model learns complex patterns that are not apparent from a single data type. This integrated structure allows the training error to propagate back to both branches, enabling each one to learn and adapt in the context of the complete data picture.



# Advanced Training Strategy

## Class Weights

To address the severe data imbalance and improve detection of cancer cases, weights were added to the loss calculation to focus learning on the rare class.

## Dropout

The use of high class weights can increase the risk of overfitting. Therefore, Dropout rates of 0.3-0.5 were used to mitigate this.

## Early Stopping

Prevents overfitting by stopping training when validation AUC no longer improves, restoring the best model.

## Threshold Optimization

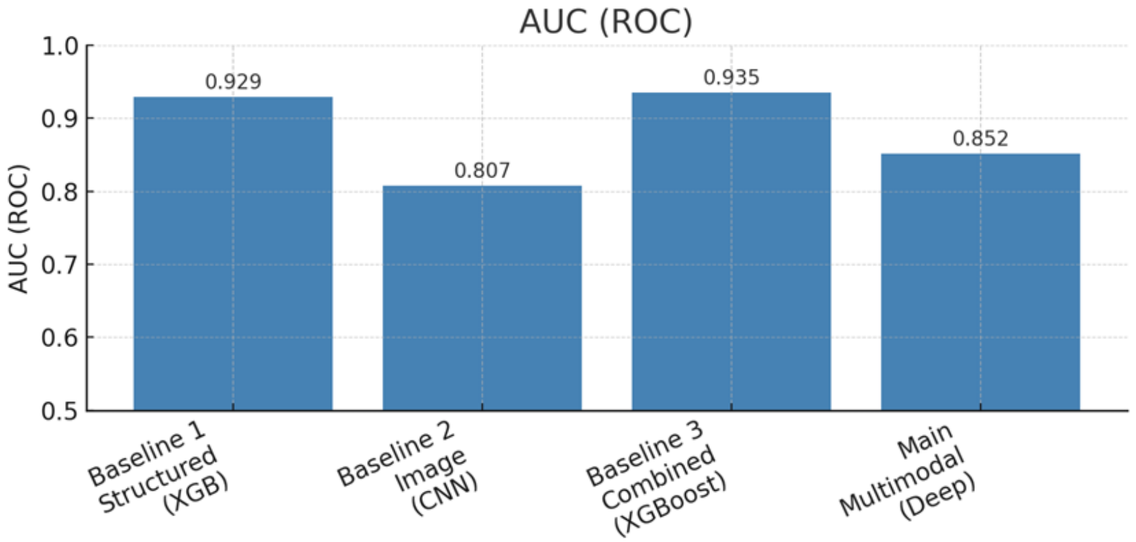
Optimizes the final decision boundary post-training to maximize Balanced Accuracy.

# Results

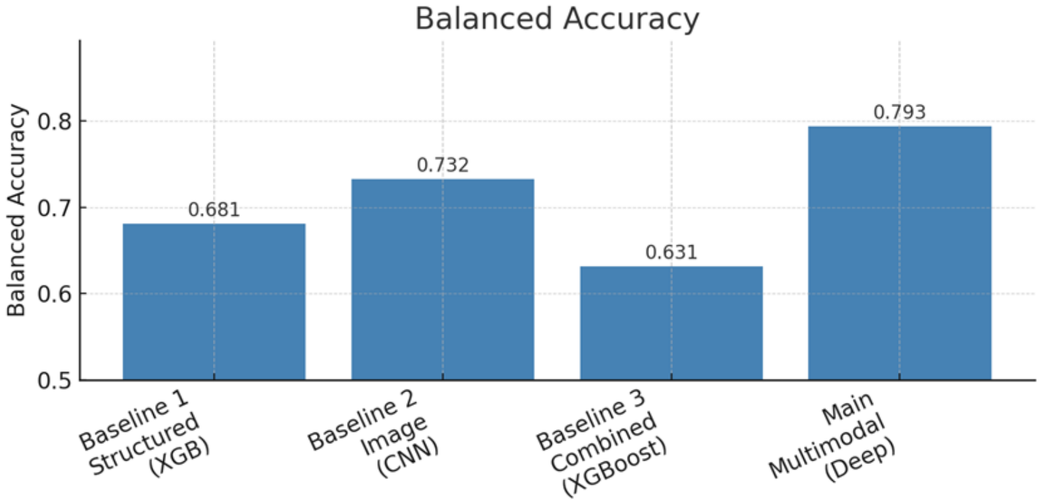
| Model | AUC (ROC) | Balanced Accuracy | Accuracy | Recall (Class 1) |
|---|---|---|---|---|
| Baseline 1: Structured Only (XGB) | 0.9294 | 0.6806 | 0.9892 | 0.3671 |
| Baseline 2: Image Only (CNN) | 0.8071 | 0.7324 | 0.8178 | 0.6456 |
| Baseline 3: Combined Feat. (XGBoost) | 0.935 | 0.6314 | 0.9912 | 0.2658 |
| Main: Multimodal (Deep) | 0.8516 | 0.7935 | 0.8394 | 0.7468 |

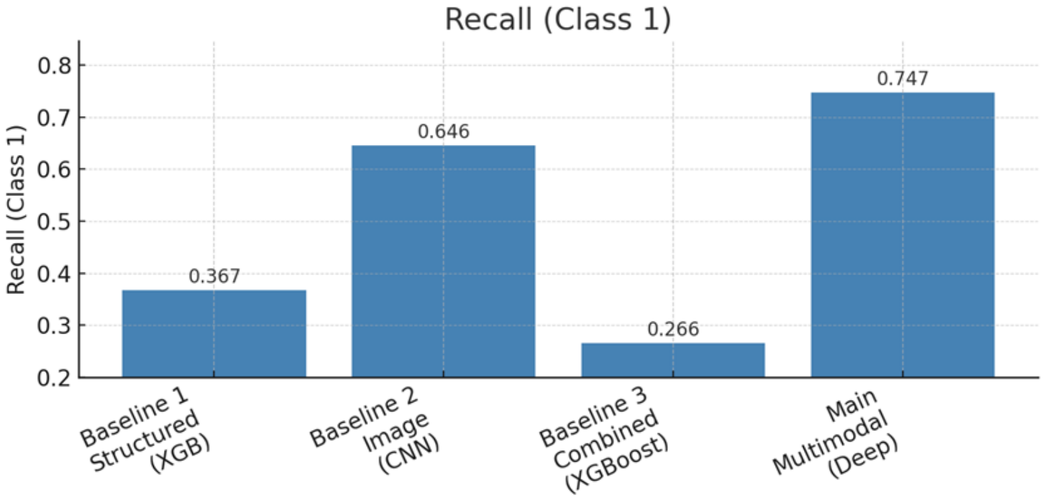
# AUC vs Balanced Accuracy & recall

## HIGHEST AUC MODELS



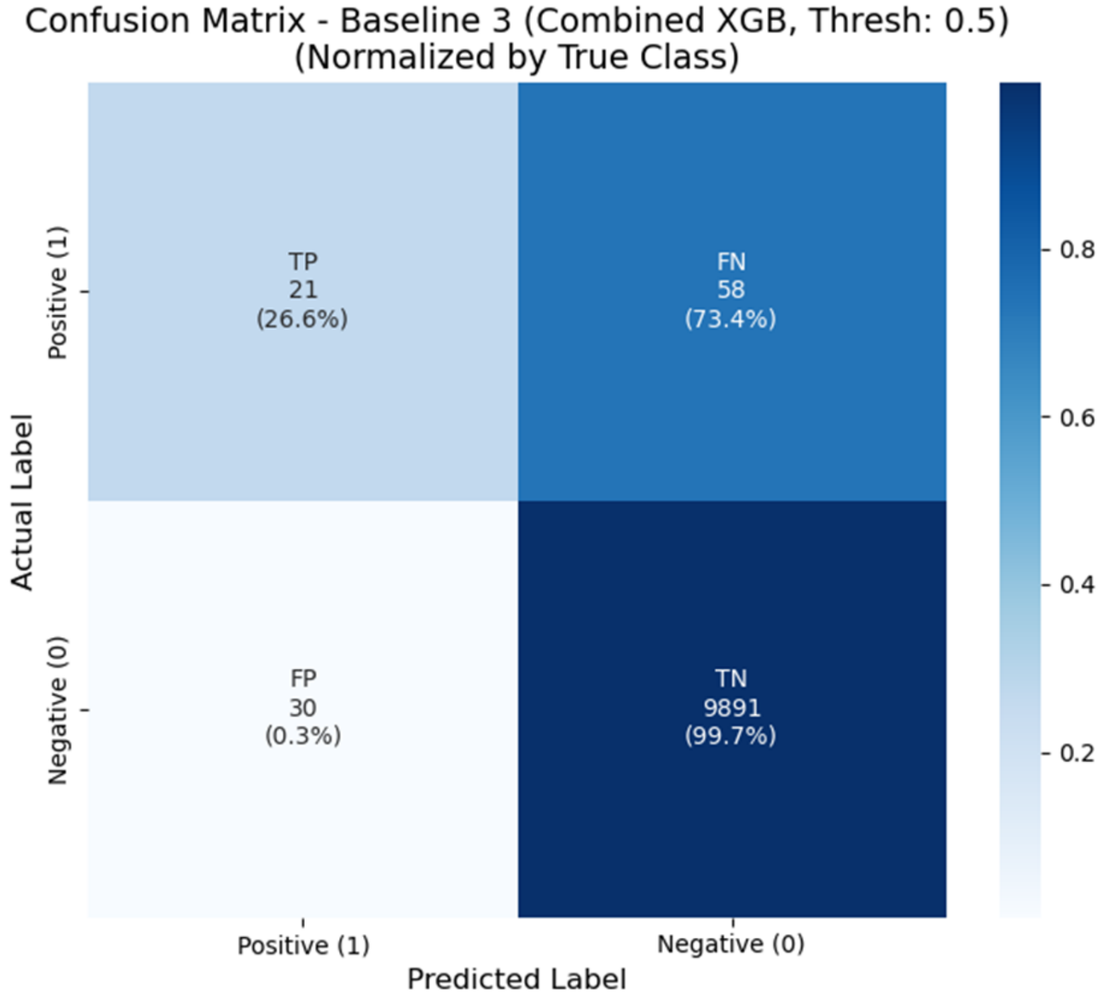

## HIGHEST RECALL & BALANCED ACCURACY MODELS



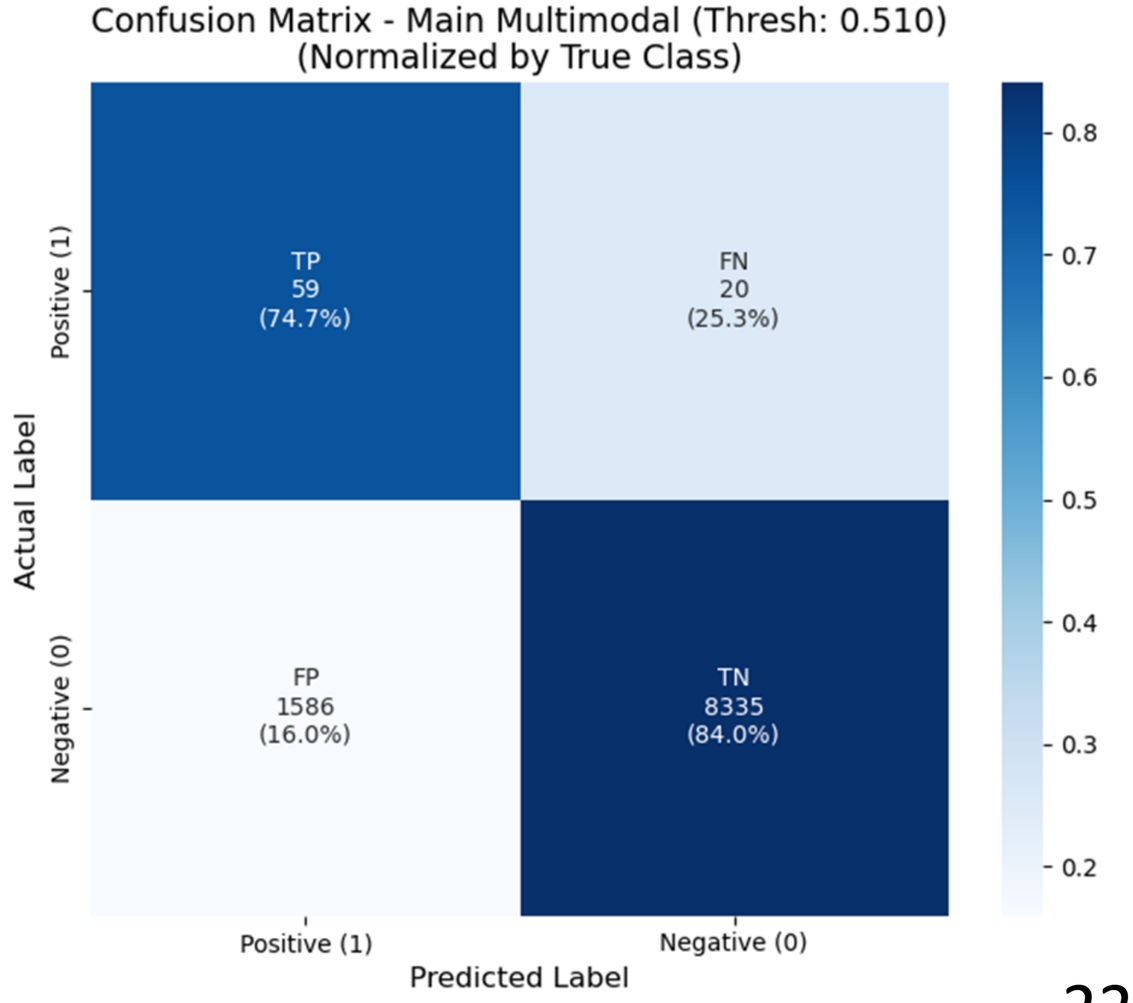



# Error Analysis

## BASELINE 3: COMBINED FEATURES (XGBOOST)




## MAIN MULTIMODAL MODEL



# Conclusions & Key Findings

- The Multimodal Deep Learning model achieved the best balanced performance, making it the most suitable for the clinical task.
- Metrics like AUC can be misleading in cases of extreme imbalance; a holistic view including Balanced Accuracy and Recall is essential.
- The project successfully developed a strong Proof-of-Concept model, demonstrating that synergistic information is captured from combining images and structured data.

# THANK YOU