جامعة الحسين التقنية
Al Hussein Technical University

Brain Tumor Classification Based on Deep CNN using MRI images

Capstone project

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From the CRP to The Capstone Project

Why the Medical Field?

The Problem Statement

1.

The Need for Automated Clinical Support

2.

The "Black Box" Problem in Medical AI

3.

Model Generalization and Stability

4.

Technical and Resource Constraints

Research Phase (CRP)

What We Learned

1.

Architecture Efficiency vs. Performance

The study evaluated five pre-trained models

Xception ResNet50 Inception V3 VGG16 **MobileNet**

on an extensive MRI dataset

MobileNet emerged as the most efficient model

balancing high accuracy with
the lowest memory footprint

2.

The Negative Impact of Data Augmentation

3.

Image Enhancement is Key

Capstone Phase

What Did I do

High Accuracy

Optimizing MobileNetV2 to achieve >90% accuracy

Explainable AI

Integrate Score-CAM for clean, localized tumor heatmaps

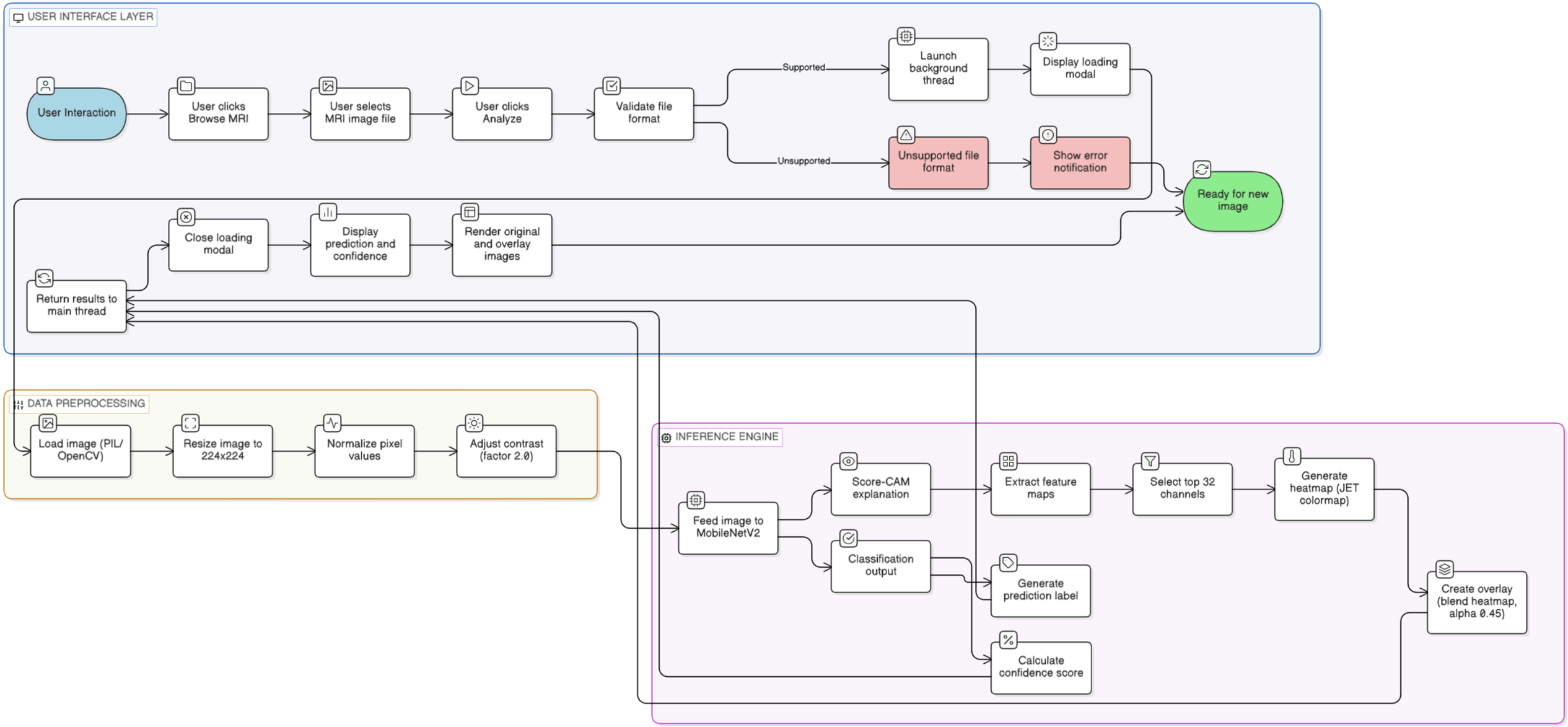
Efficiency

Ensure CPU inference under 1,5s for rapid triage.

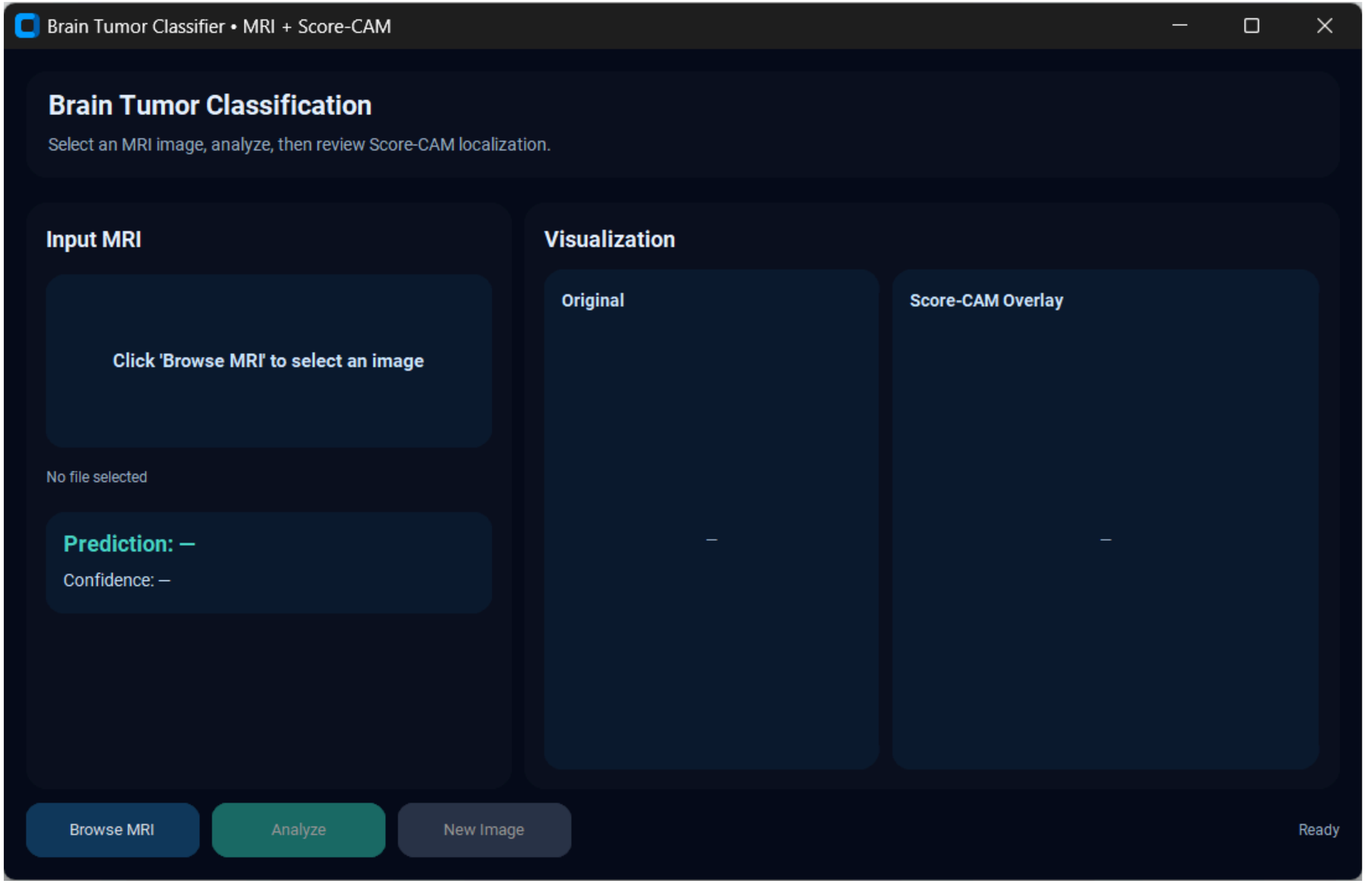
Usability

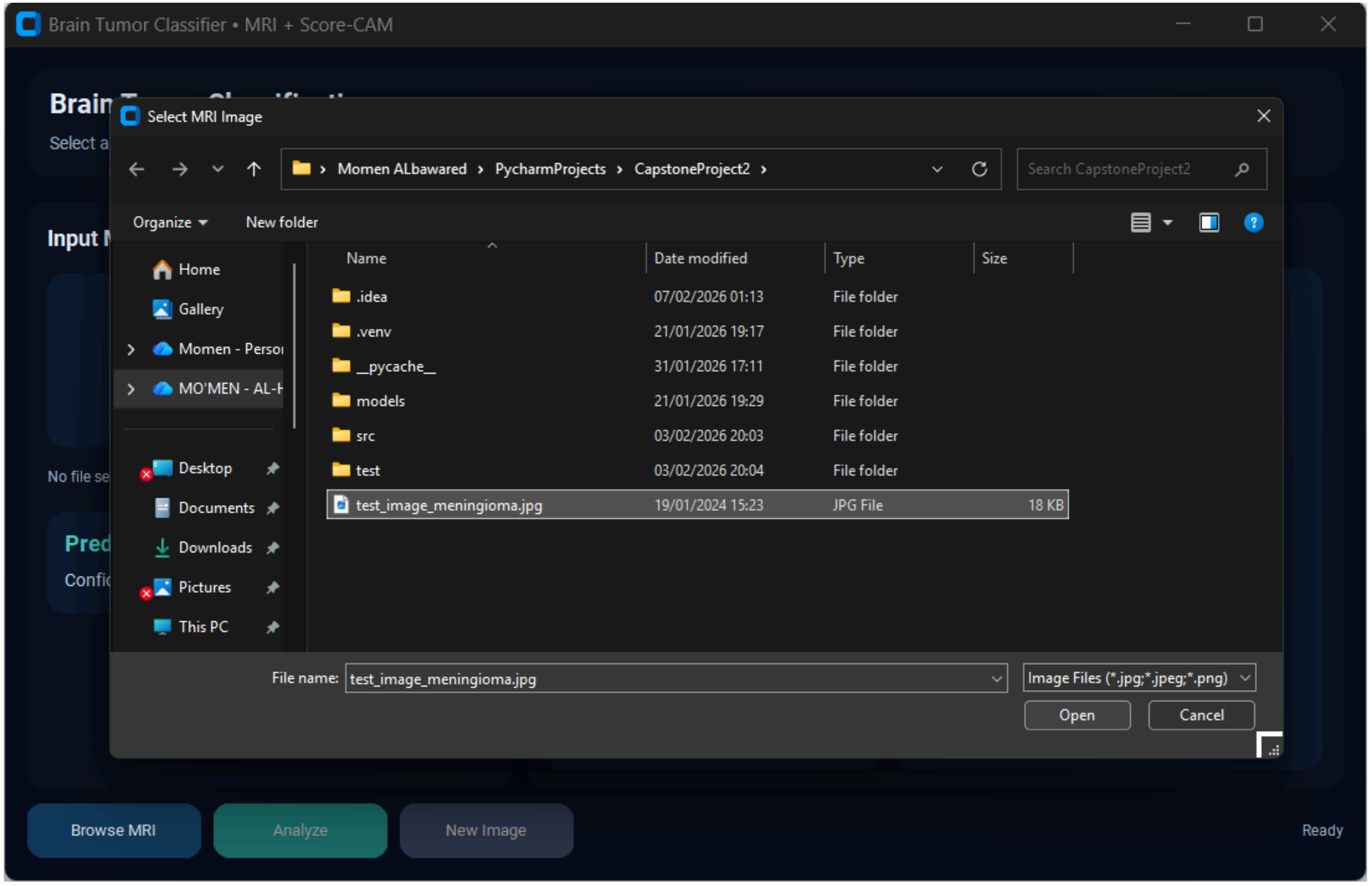
Desktop GUI for users

System Architecture


USER INTERFACE LAYER
User Interaction
User clicks Browse MRI
User selects MRI image file
User clicks Analyze
Validate file format
Supported
Launch background thread
Display loading modal
Unsupported
Unsupported file format
Show error notification
Ready for new image
Close loading modal
Display prediction and confidence
Render original and overlay images
Return results to main thread
DATA PREPROCESSING
Load image (PIL/ OpenCV)
Resize image to 224x224
Normalize pixel values
Adjust contrast (factor 2.0)
INFERENCE ENGINE
Feed image to MobileNetV2
Score-CAM explanation
Classification output
Extract feature maps
Select top 32 channels
Generate heatmap (JET colormap)
Generate prediction label
Calculate confidence score
Create overlay (blend heatmap, alpha 0.45)

Application Walkthrough


Brain Tumor Classifier • MRI + Score-CAM
Brain Tumor Classification
Select an MRI image, analyze, then review Score-CAM localization.
Input MRI
Click 'Browse MRI' to select an image
No file selected
Prediction: —
Confidence: —
Visualization
Original
Score-CAM Overlay
Browse MRI
Analyze
New Image
Ready


Brain Tumor Classifier • MRI + Score-CAM
Select MRI Image
Momen ALbawared › PycharmProjects › CapstoneProject2 ›
Search CapstoneProject2
Organize
New folder
Home
Gallery
Momen - Perso
MO'MEN - AL-H
Desktop
Documents
Downloads
Pictures
This PC
Name
Date modified
Type
Size
.idea 07/02/2026 01:13 File folder
.venv 21/01/2026 19:17 File folder
__pycache__ 31/01/2026 17:11 File folder
models 21/01/2026 19:29 File folder
src 03/02/2026 20:03 File folder
test 03/02/2026 20:04 File folder
test_image_meningioma.jpg 19/01/2024 15:23 JPG File 18 KB
File name: test_image_meningioma.jpg
Image Files (*.jpg;*.jpeg;*.png)
Open
Cancel
Input M
No file se
Pred
Confi
Browse MRI
Analyze
New Image
Ready

Brain Tumor Classifier • MRI + Score-CAM

Brain Tumor Classification

Select an MRI image, analyze, then review Score-CAM localization.

Input MRI

Click 'Browse MRI' to select an image

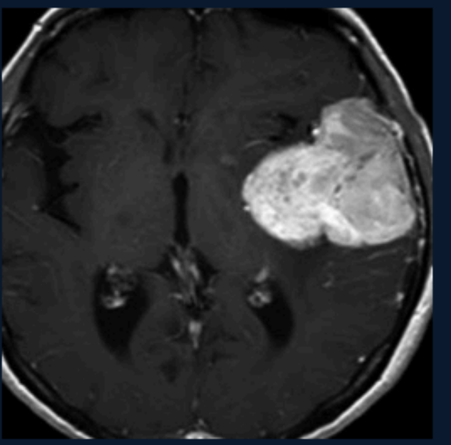
C:/Users/DELL/PycharmProjects/CapstoneProject2/test_image_meningioma.jpg

Prediction: —

Confidence: —

Visualization

Original

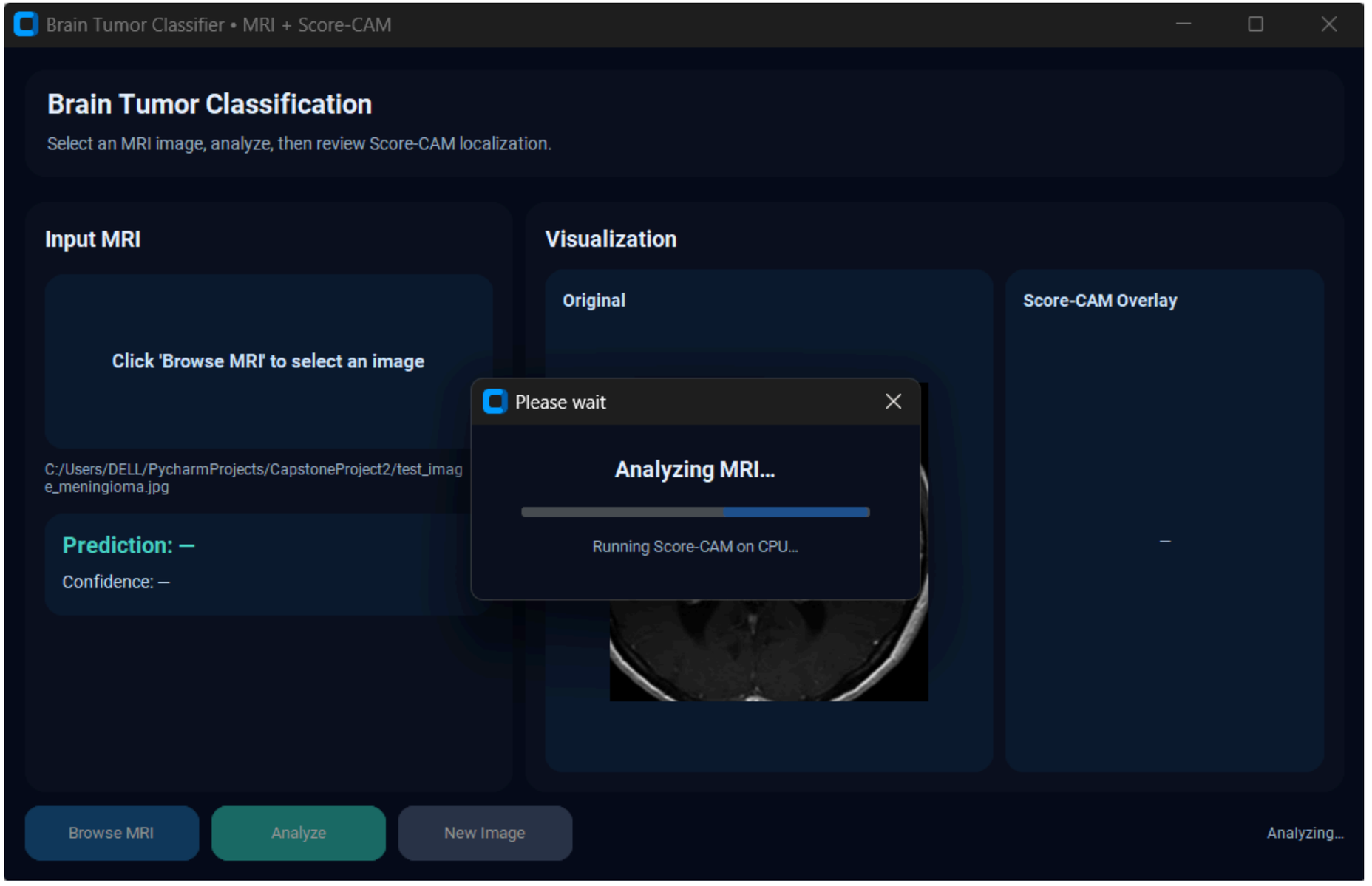


Score-CAM Overlay

—

Browse MRI | Analyze | New Image

Image loaded. Press Analyze.


Brain Tumor Classifier • MRI + Score-CAM
Brain Tumor Classification
Select an MRI image, analyze, then review Score-CAM localization.
Input MRI
Click 'Browse MRI' to select an image
C:/Users/DELL/PycharmProjects/CapstoneProject2/test_image_meningioma.jpg
Prediction: —
Confidence: —
Visualization
Original
Score-CAM Overlay
—
Please wait
Analyzing MRI...
Running Score-CAM on CPU...
Browse MRI
Analyze
New Image
Analyzing...

Brain Tumor Classifier • MRI + Score-CAM

Brain Tumor Classification

Select an MRI image, analyze, then review Score-CAM localization.

Input MRI

Click 'Browse MRI' to select an image

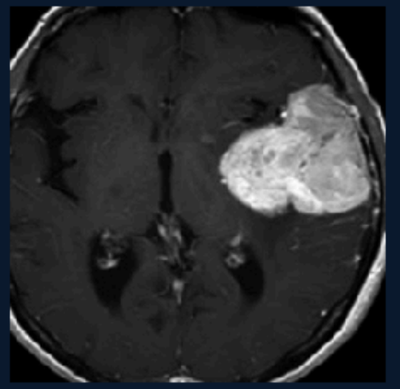
C:/Users/DELL/PycharmProjects/CapstoneProject2/test_image_meningioma.jpg

Prediction: Meningioma Tumor

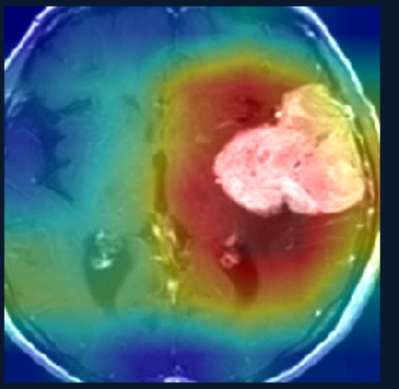
Confidence: 1.000

Visualization

Original

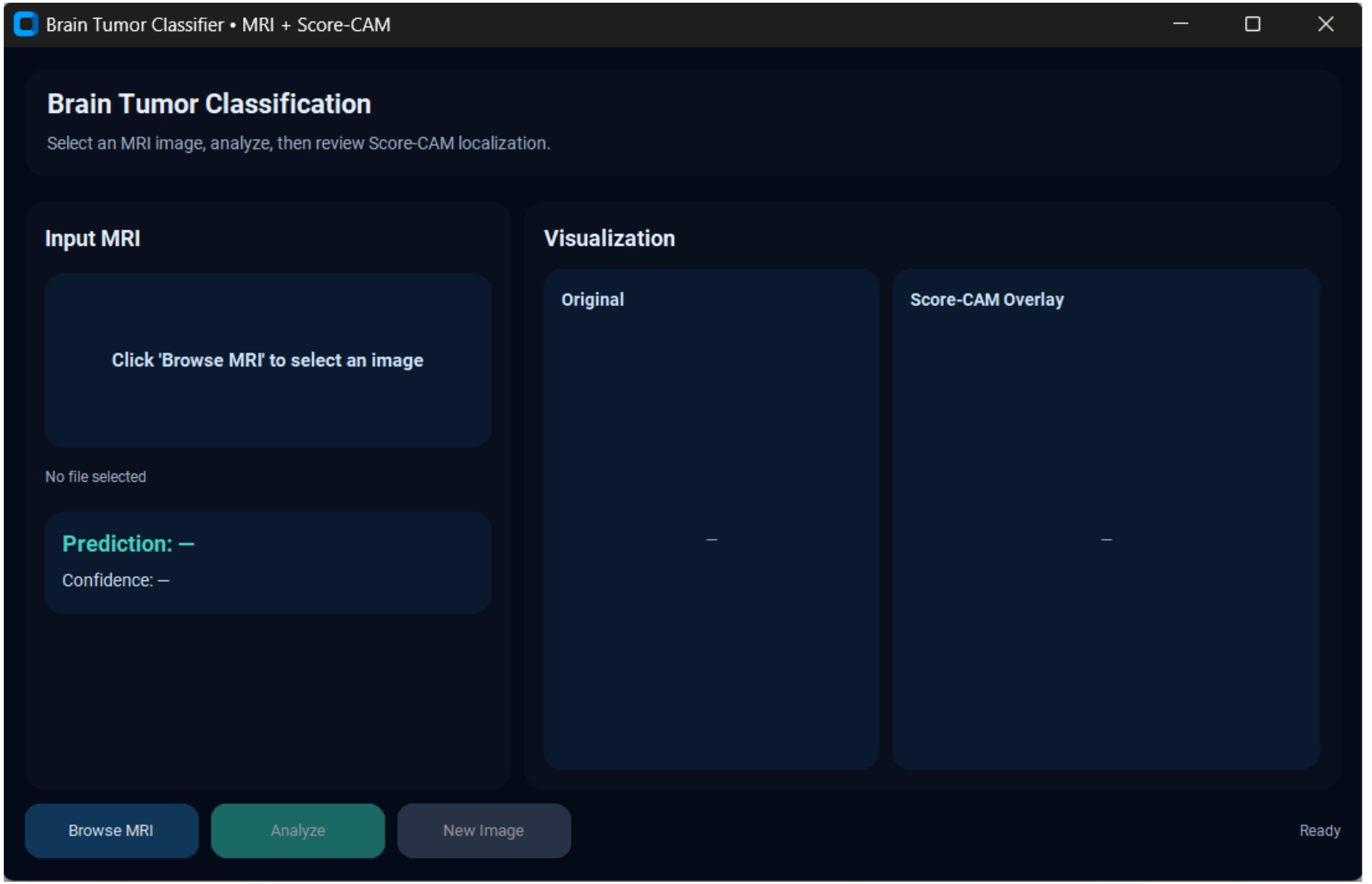


Score-CAM Overlay



Browse MRI | Analyze | New Image

Done. Click New Image to analyze another.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Visualization
Original
—
Score-CAM Overlay
—
Browse MRI
Analyze
New Image
Ready

Performance and Results Evaluation

The final model achieved a 93% Test Accuracy
on a hold-out set of 3,961 images

	Precision	Recall	F1-Score
Glioma	0.94	0.96	0.95
Meningioma	0.9	0.86	0.88
No Tumor	0.92	0.95	0.93
Pituitary	0.96	0.98	0.97
Weighted Avg	0.93	0.93	0.93

Resource & Speed Efficiency

A key goal was making the tool run on standard consumer hardware

Inference Speed

The average analysis takes less than 1.5 seconds on a standard CPU.

Memory Footprint

The model uses only ~200MB of RAM, compared to ~1400MB required by heavier models like Xception.

Startup Optimization

The system is designed to load the .h5 model once at startup, which removes any "lag" during subsequent image checks.

Software Reliability (Manual Testing)

A key goal was making the tool run on standard consumer hardware

Test ID	Scenario	Action Performed	Expected Result	Status
1	**Standard Workflow**	Load a valid .jpg MRI image and click "Analyze".	Prediction and Heatmap appear side-by-side. Status updates to "Done".	**PASS**
2	**File Compatibility**	Load a valid .png MRI image.	Image loads and analyzes correctly (same as JPG).	**PASS**
3	**Invalid File Type**	Attempt to load a .txt or .pdf file.	File dialog automatically filters view to only show supported formats (.jpg, .png), preventing invalid selection.	**PASS**
4	**Concurrency**	Click "Analyze", then immediately drag the window.	Window moves smoothly; no "Not Responding" freeze.	**PASS**
5	**Empty State**	Click "Analyze" **without** selecting an image first.	The 'Analyze' button remains disabled (grayed out) until a valid image is loaded.	**PASS**
6	**Rapid Clicks**	Click "Analyze" button 5 times quickly.	Button disables after 1st click; only one analysis runs.	**PASS**
7	**Session Reset**	Analyze Image A, then immediately load Image B.	Previous results (prediction/heatmap) clear; new image loads ready for analysis.	**PASS**

Challenges and Limitation

The "Grid" Issue in Explainable AI (XAI)

Resource and Computing Constraints

Data Quality and Diversity

Future Work

Clinical & Machine Integration

Direct MRI Integration

3D Volumetric Analysis

Automated Medical Reporting

Technical Advancements

Segmentation Techniques

Advanced Architectures

Thank you for listening