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| **Subject: Capstone Project (01CT0715)** | **Testing And Validation** | |
| **Validation** | **Date: 25/09/2025** | **Enrolment No: 92200133018** |

# MRI Impression Assistant

## Testing

Different parts of the system were tested separately (PDF extraction, input validation, impression generation). End-to-end tests were done by giving actual MRI text and checking the generated impressions. Edge cases like empty inputs or extra-long text were also tested to make sure the tool responds properly.

## Unit Testing

For unit testing, I checked each part of the system separately to confirm that it works as expected:

**UT-01: Text Input**

**Input:** Inputted the valid MRI findings like the radiologist can write " *Skin marker is noted on the left side of the neck at the level of the C4/5 intervertebral disc space. Cervical spine alignment is normal. Vertebral bodies are preserved in signal and height. Intervertebral disc spaces are normal in height with mild loss of intervertebral disc space signal at C2/3 through C5/6, consistent with desiccation. There are shallow disc-osteophyte complex is at C4/5 and C5/6. The facet joints are normal. There is no evidence of spinal canal or foraminal stenosis. The visualized spinal cord and posterior fossa are normal in signal and contour. There is no evidence of intra or extradural mass lesion. There is a T2 and T1 hyperintense encapsulated mass in the left posterior cervical space, between the sternocleidomastoid muscle and left paraspinal muscles. The mass is posterior to the carotid space without appreciable mass effect in the carotid space. The mass measures approximately 4 x 1.3 x 6 cm in AP, lateral and craniocaudad dimensions respectively. The mass follows normal fat in signal intensity. This most likely represents an incidental lipoma. Consider further evaluation with contrast enhanced CT or MRI to exclude an enhancing component which may indicate neoplasia. Remaining cervical soft tissues are normal*".

Expected: The system accepts the text as valid input for impression generation.

Actual: Text extracted correctly.

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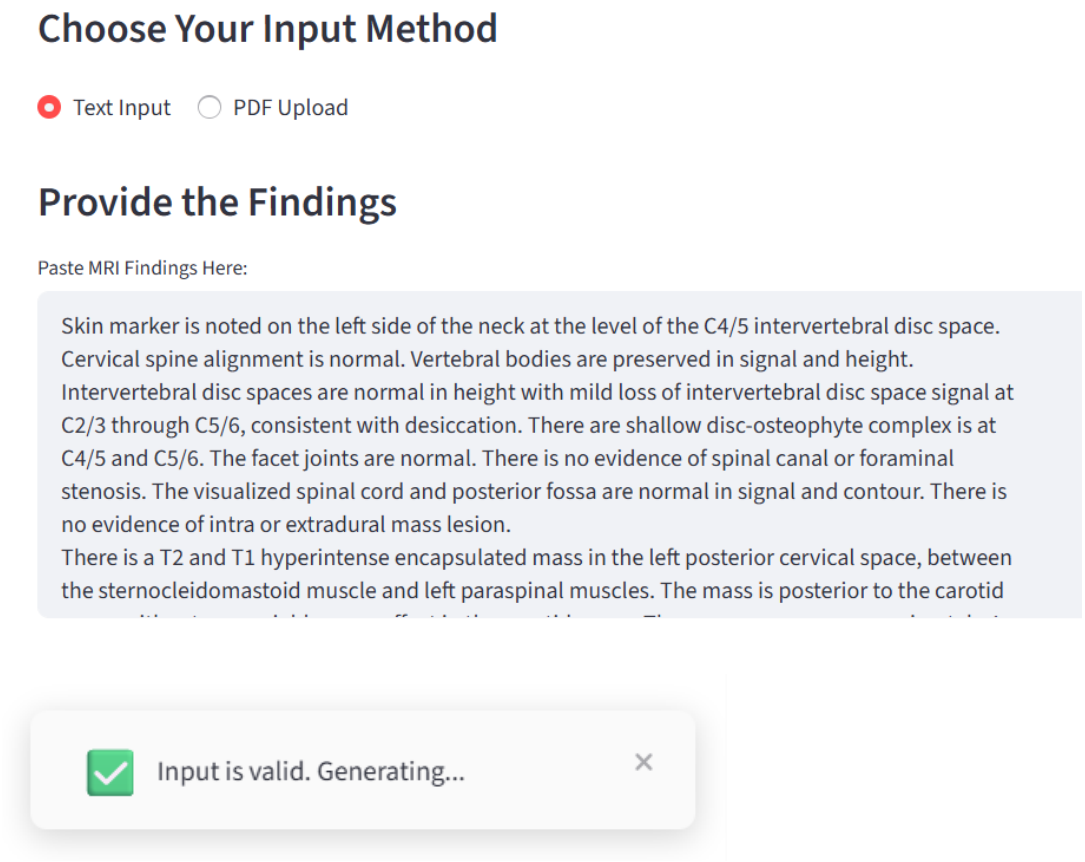


Result: Pass

**UT-02: PDF Extraction**

**Input: Uploaded mri_knee.pdf containing valid MRI findings.**

Pdf link: https://usarad.com/pdf/MRI/MRI%20Knee.pdf

Expected: The system extracts clean plain text without corruption.

Actual: Text extracted correctly.

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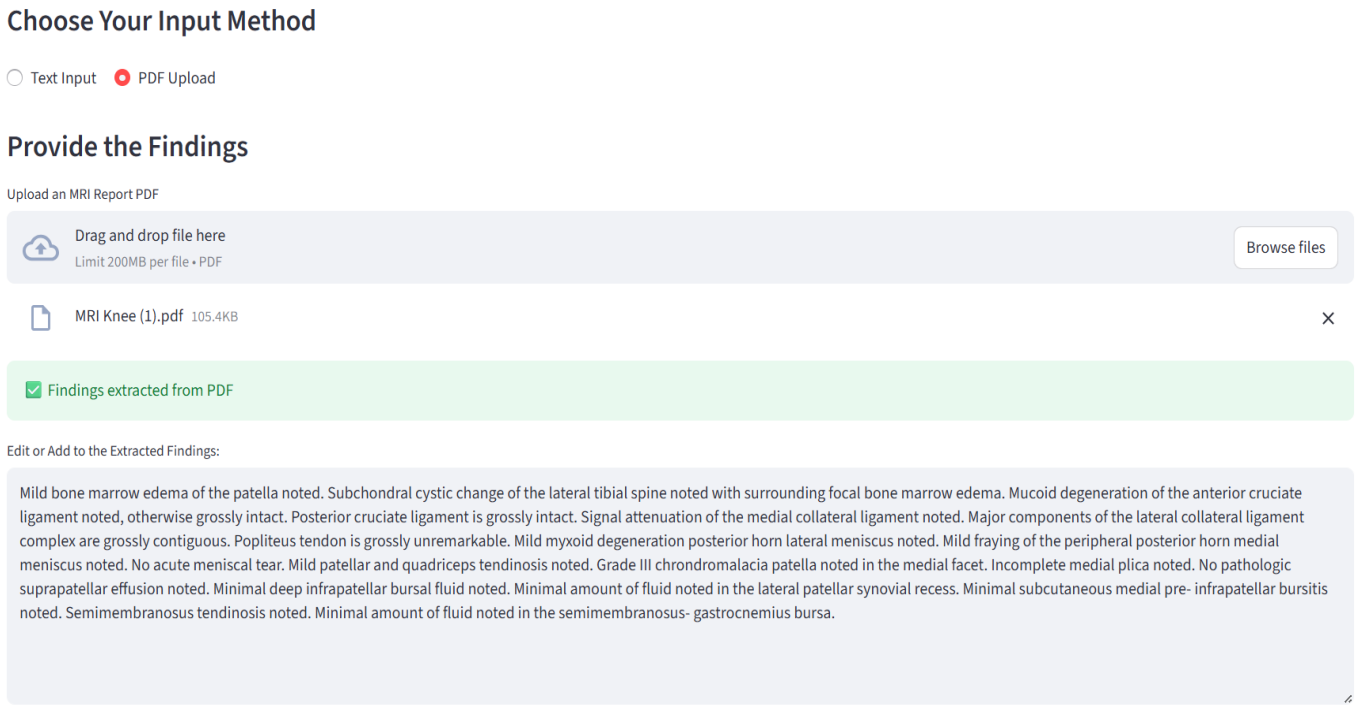


**Result: Pass**

**UT-3: Input Validation**

Input: Typed “Rajnikant is the hero.”

Expected: System should reject as invalid since it is not MRI-related.

Actual: Input was rejected.

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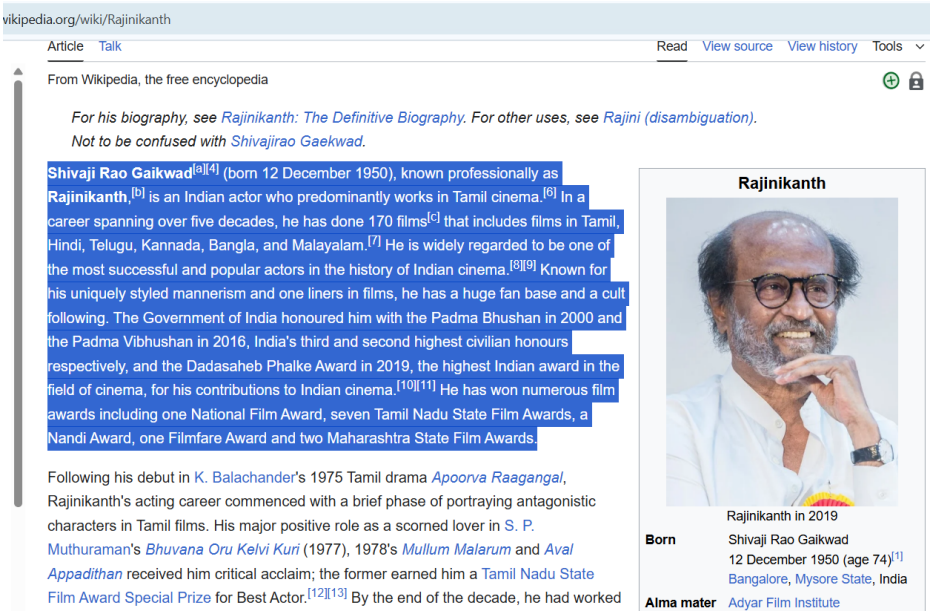

wikipedia.org/wiki/Rajinikanth

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From Wikipedia, the free encyclopedia

*For his biography, see Rajinikanth: The Definitive Biography. For other uses, see Rajini (disambiguation).*
*Not to be confused with Shivajirao Gaekwad.*

**Shivaji Rao Gaikwad**[a][4] (born 12 December 1950), known professionally as **Rajinikanth**,[b] is an Indian actor who predominantly works in Tamil cinema.[6] In a career spanning over five decades, he has done 170 films[c] that includes films in Tamil, Hindi, Telugu, Kannada, Bangla, and Malayalam.[7] He is widely regarded to be one of the most successful and popular actors in the history of Indian cinema.[8][9] Known for his uniquely styled mannerism and one liners in films, he has a huge fan base and a cult following. The Government of India honoured him with the Padma Bhushan in 2000 and the Padma Vibhushan in 2016, India's third and second highest civilian honours respectively, and the Dadasaheb Phalke Award in 2019, the highest Indian award in the field of cinema, for his contributions to Indian cinema.[10][11] He has won numerous film awards including one National Film Award, seven Tamil Nadu State Film Awards, a Nandi Award, one Filmfare Award and two Maharashtra State Film Awards.

Following his debut in K. Balachander's 1975 Tamil drama *Apoorva Raagangal*, Rajinikanth's acting career commenced with a brief phase of portraying antagonistic characters in Tamil films. His major positive role as a scorned lover in S. P. Muthuraman's *Bhuvana Oru Kelvi Kuri* (1977), 1978's *Mullum Malarum* and *Aval Appadithan* received him critical acclaim; the former earned him a Tamil Nadu State Film Award Special Prize for Best Actor.[12][13] By the end of the decade, he had worked

**Rajinikanth**

Rajinikanth in 2019

| | |
|---|---|
| **Born** | Shivaji Rao Gaikwad<br>12 December 1950 (age 74)[1]<br>Bangalore, Mysore State, India |
| **Alma mater** | Adyar Film Institute |

## Choose Your Input Method

(•) Text Input ( ) PDF Upload

## Provide the Findings

Paste MRI Findings Here:

Shivaji Rao Gaikwad[a][4] (born 12 December 1950), known professionally as Rajinikanth,[b] is an Indian actor who predominantly works in Ta
has done 170 films[c] that includes films in Tamil, Hindi, Telugu, Kannada, Bangla, and Malayalam.[7] He is widely regarded to be one of the m
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contributions to Indian cinema.[10][11] He has won numerous film awards including one National Film Award, seven Tamil Nadu State Film Av
Maharashtra State Film Awards.

## Generate the Report

Generate Impressions

Validation Failed: The provided text does not appear to be MRI findings. Please provide a relevant medical report.

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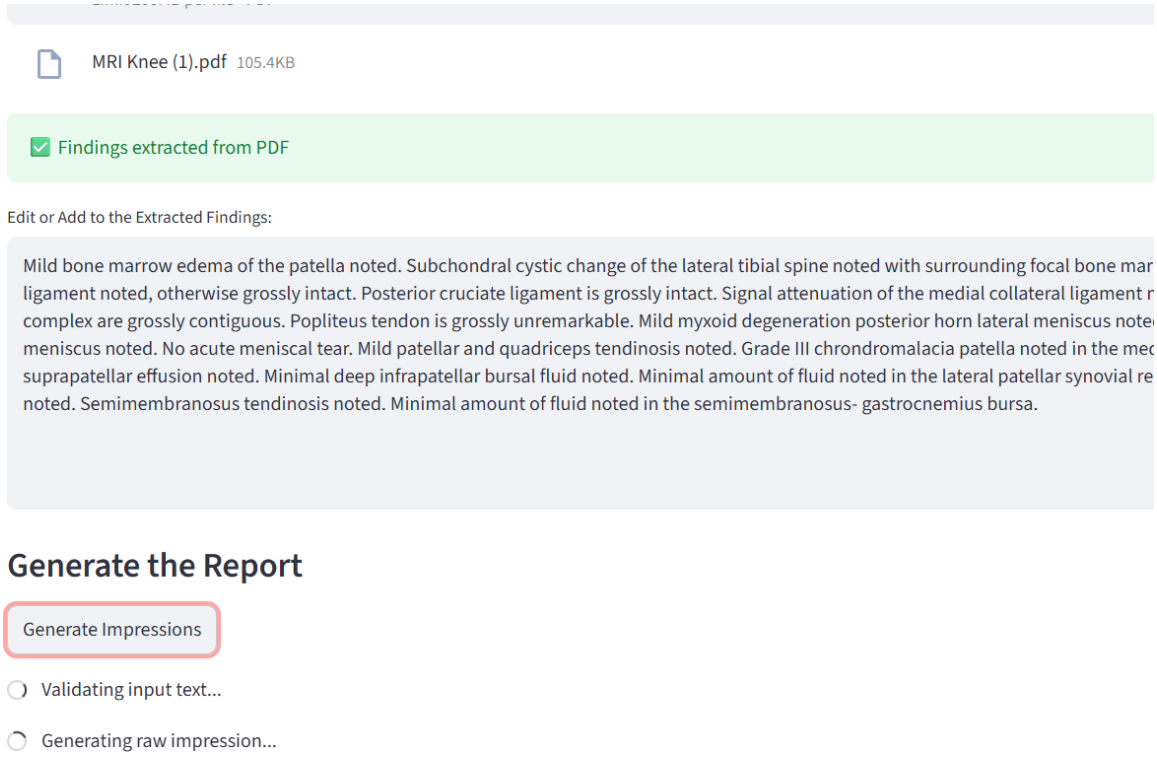
**Result: Pass because we expected input is not valid !**

UT-04: Model Inference!

Input: MRI finding "*Mild bone marrow edema of the patella noted. Subchondral cystic change of the lateral tibial spine noted with surrounding focal bone marrow edema. Mucoid degeneration of the anterior cruciate ligament noted, otherwise grossly intact. Posterior cruciate ligament is grossly intact. Signal attenuation of the medial collateral ligament noted. Major components of the lateral collateral ligament complex are grossly contiguous. Popliteus tendon is grossly unremarkable. Mild myxoid degeneration posterior horn lateral meniscus noted. Mild fraying of the peripheral posterior horn medial meniscus noted. No acute meniscal tear. Mild patellar and quadriceps tendinosis noted. Grade III chrondromalacia patella noted in the medial facet. Incomplete medial plica noted. No pathologic suprapatellar effusion noted. Minimal deep infrapatellar bursal fluid noted. Minimal amount of fluid noted in the lateral patellar synovial recess. Minimal subcutaneous medial pre- infrapatellar bursitis noted. Semimembranosus tendinosis noted. Minimal amount of fluid noted in the semimembranosus- gastrocnemius bursa*.

Expected: BioBART generates a concise and relevant draft impression.



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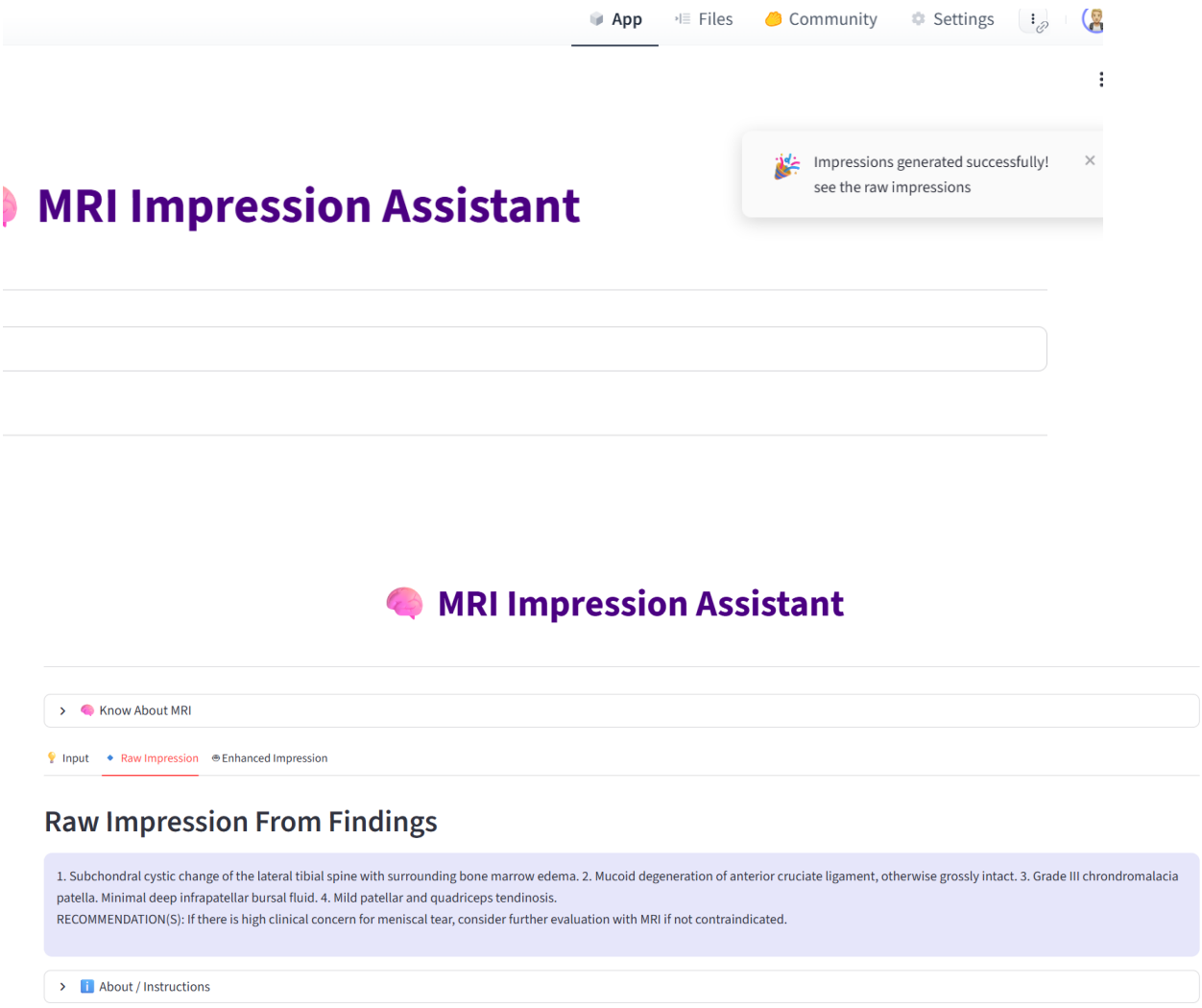



Actual: Draft impression generated successfully.

**Result: Pass**

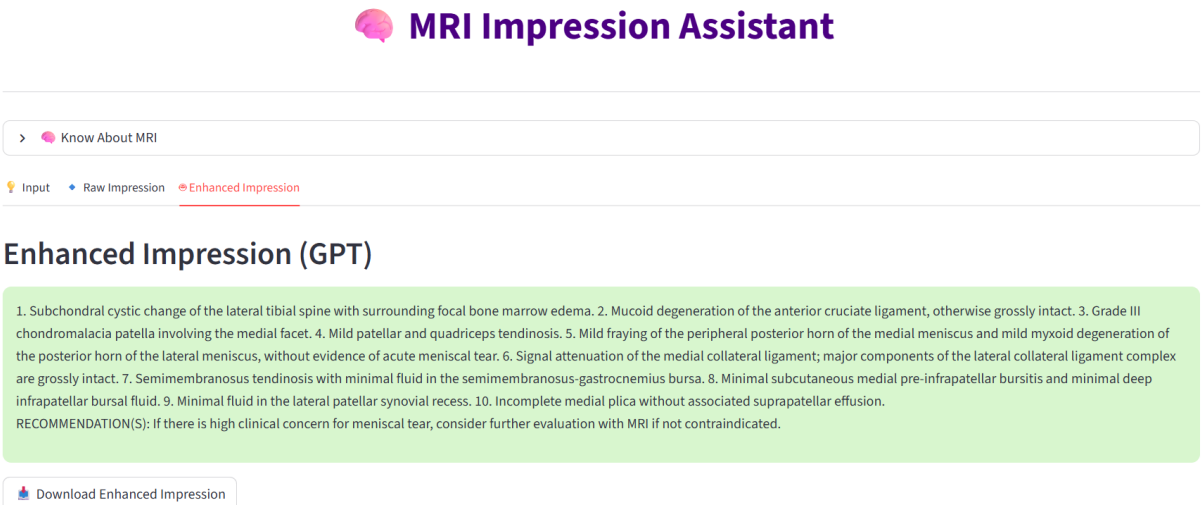
**UT-05: Refinement (GPT Layer)**

**Input:** Raw draft impression "1. Subchondral cystic change of the lateral tibial spine with surrounding bone marrow edema. 2. Mucoid degeneration of anterior cruciate ligament, otherwise grossly intact. 3. Grade III chrondromalacia patella. Minimal deep infrapatellar bursal fluid. 4. Mild patellar and quadriceps tendinosis.

**Expected:** Refined version "1. Subchondral cystic change of the lateral tibial spine with surrounding focal bone marrow edema. 2. Mucoid degeneration of the anterior cruciate ligament, otherwise grossly intact. 3. Grade III chondromalacia patella involving the medial facet. 4. Mild patellar and quadriceps tendinosis. 5. Mild fraying of the peripheral posterior horn of the medial meniscus and mild myxoid degeneration of the posterior horn of the lateral meniscus, without evidence of acute meniscal tear. 6. Signal attenuation of the medial collateral ligament; major components of the lateral collateral ligament complex are grossly intact. 7. Semimembranosus tendinosis with minimal fluid in the semimembranosus-gastrocnemius bursa. 8. Minimal subcutaneous medial pre-infrapatellar bursitis and minimal deep infrapatellar bursal fluid. 9. Minimal fluid in the lateral patellar synovial recess. 10. Incomplete medial plica without associated suprapatellar effusion.

"

Actual: Refined correctly.




**Result: Pass**

**UT-06: Download Option**

**Input**: Clicked the download button after impression generation.

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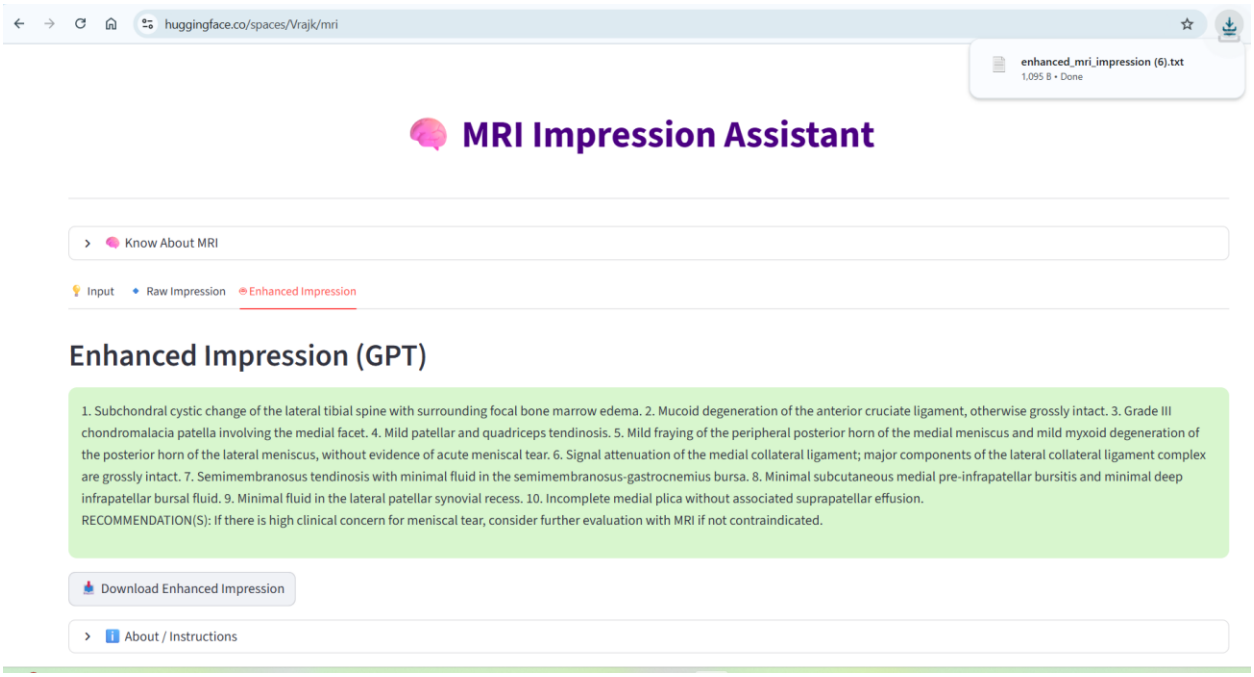
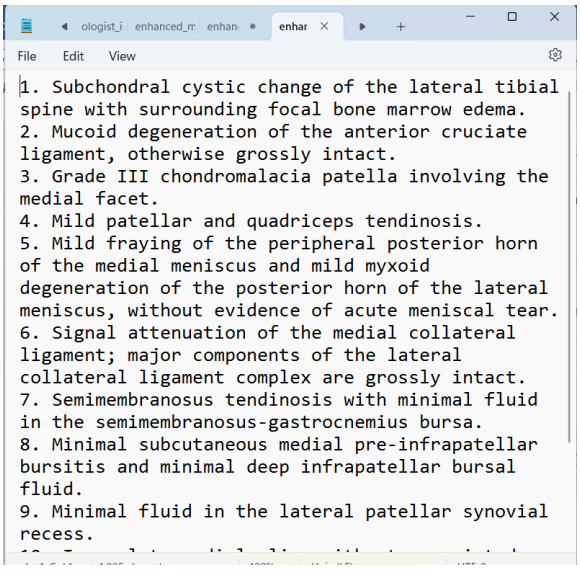
Expected: A enhanced impression.txt file with the final impression is downloaded.

Actual: File downloaded successfully.




**Result: Pass**

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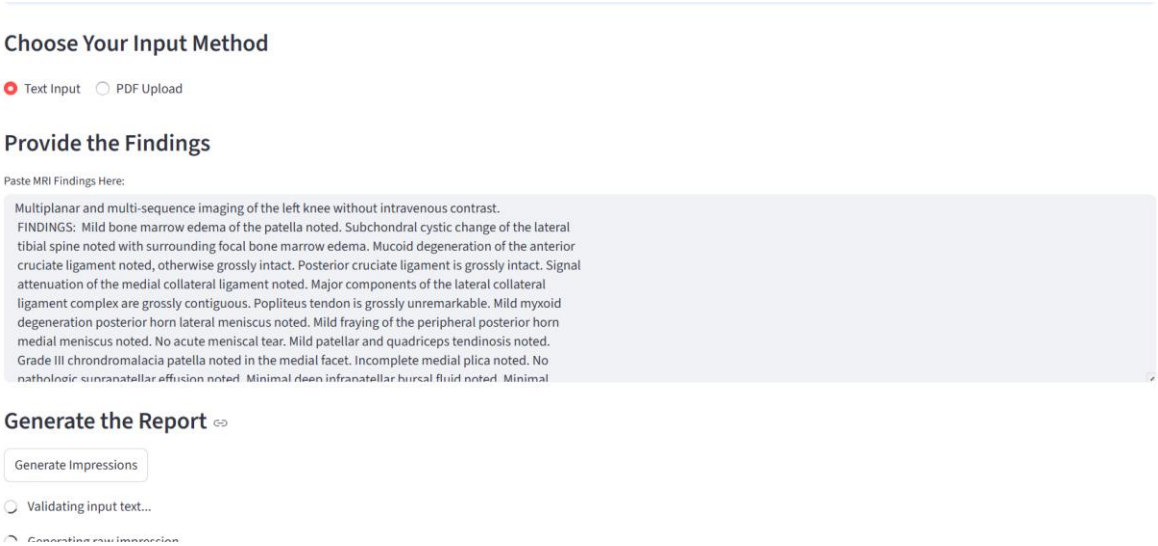
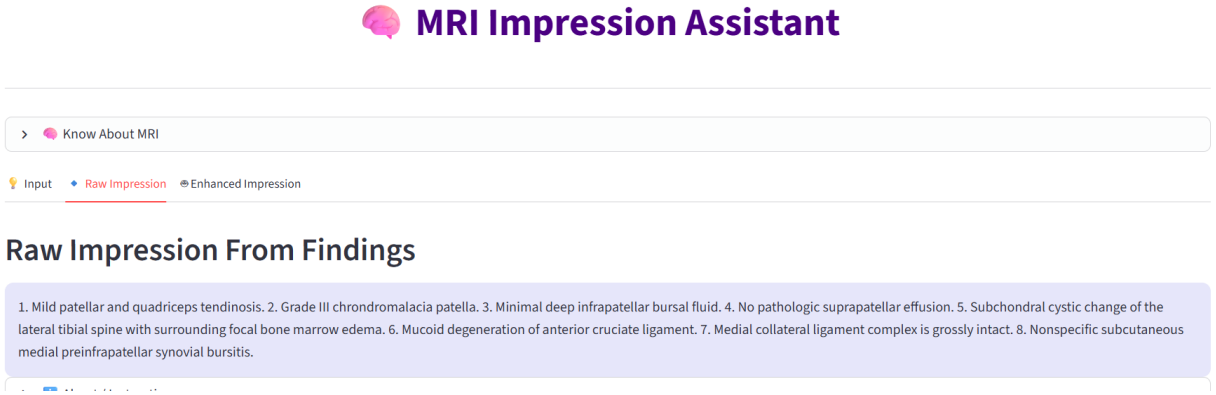
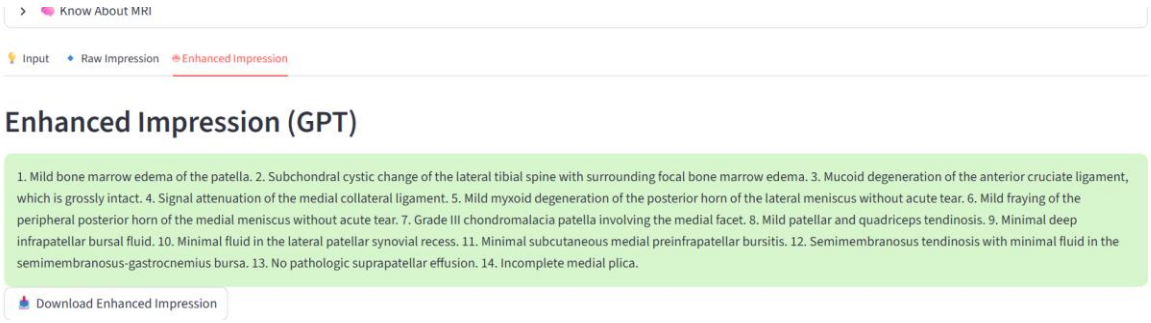
## Integration Testing

- **IT-01: Text Input to Final Output**
  Input: Typed MRI finding *"Mild posterior disc bulge at L5-S1 indenting the thecal sac."*
  Flow: Text → Validation → BioBART Draft → GPT Refinement → Output Display.
  Expected: The system generates and shows a polished impression without errors.
  Actual: Impression displayed correctly on Streamlit.

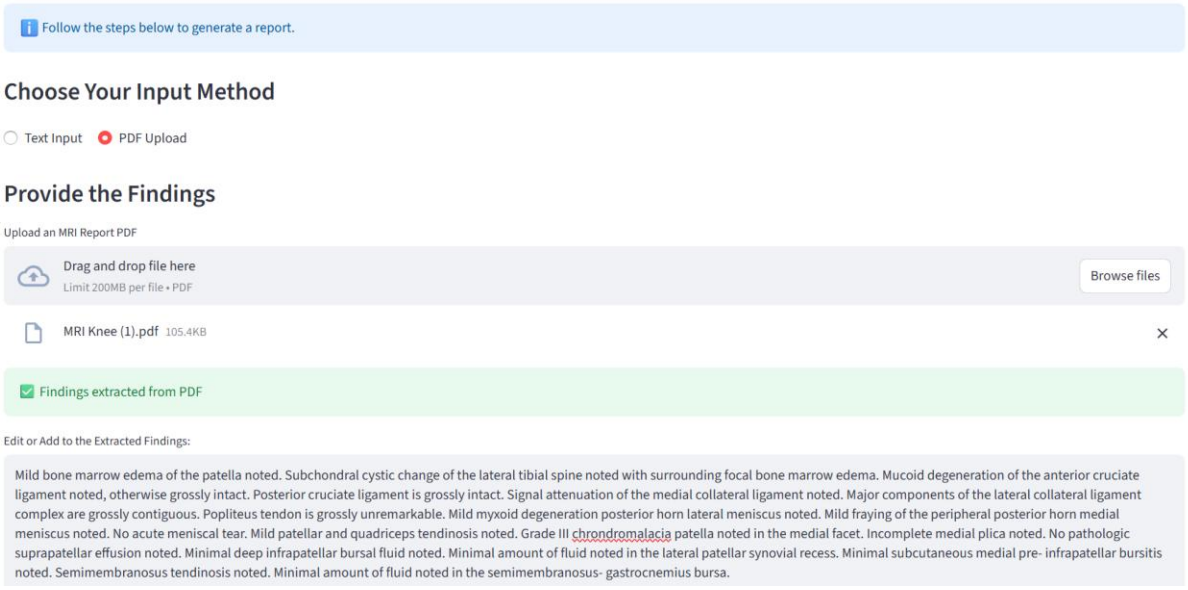





**Result: Pass**

- **IT-02: PDF Upload to Final Output**
  Input: Uploaded *knee_mri.pdf* containing valid MRI findings.
  Flow: PDF → Text Extraction → Validation → BioBART Draft → GPT Refinement → Output Display.
  Expected: Extracted text processed and final impression shown.
  Actual: Impression generated as expected.



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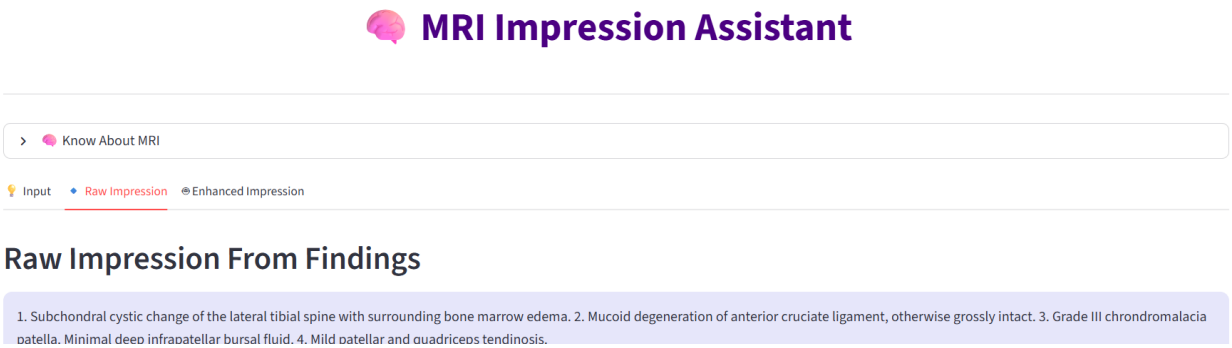


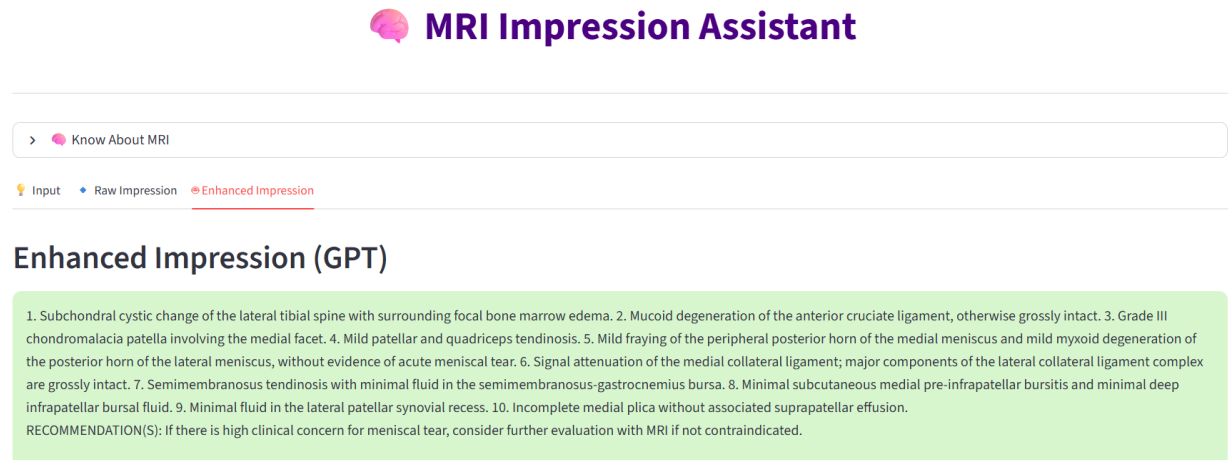


**Result: Pass**

- **IT-03: End-to-End Workflow with Download**
  Input: Uploaded MRI findings → system generated impression → clicked download.
  Expected: User sees the refined impression on screen and can download it as .txt.
  Actual: End-to-end workflow completed successfully; .txt file downloaded.
  Result: Pass

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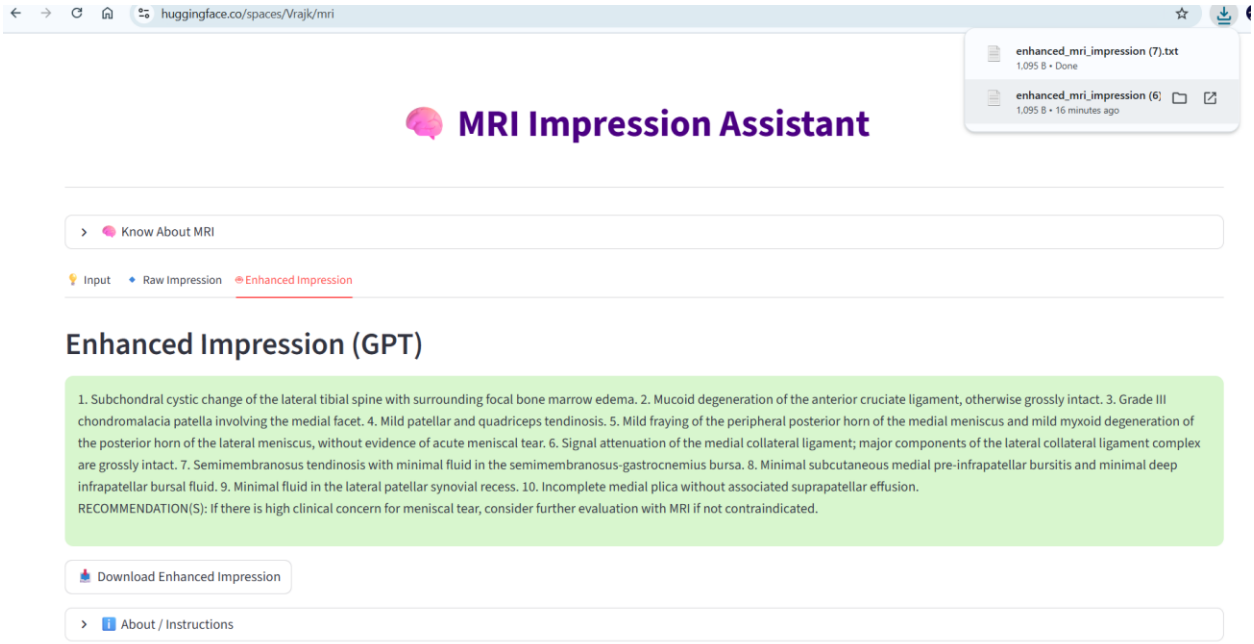


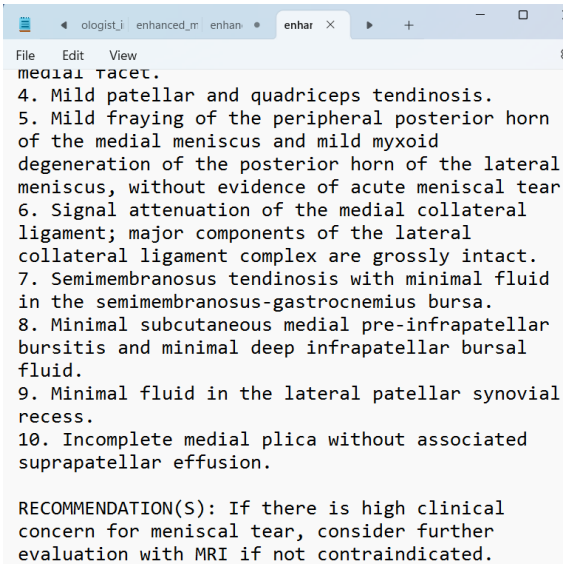

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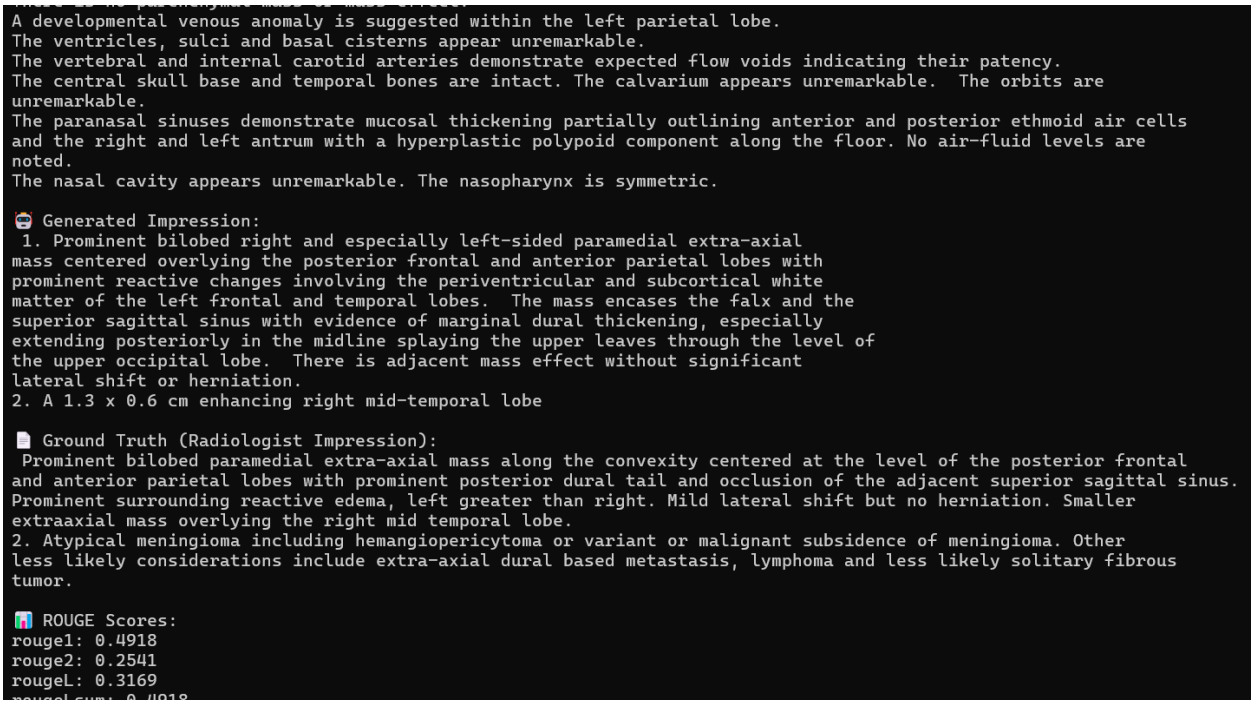
# Performance Metrics

### Model Accuracy (Quality of Impressions)

- The fine-tuned BioBART model was evaluated using **ROUGE score** before GPT refinement we were having some reference impressions already validated by dr and we have a .generated by us , and then both of them are compared , and also validated by gpt model.




- Result: ROUGE ≈ **0.49**compared to ground-truth MRI impressions.

After GPT refinement, radiology experts rated the impressions closer to **8.5/10**, showing improved clinical accuracy and readability.

### Response Time

- Average time from input (text/PDF) to final impression generation: **~8–12 seconds** on CPU.
- Caching ensures that after the first load, the model inference is faster (~5 seconds).

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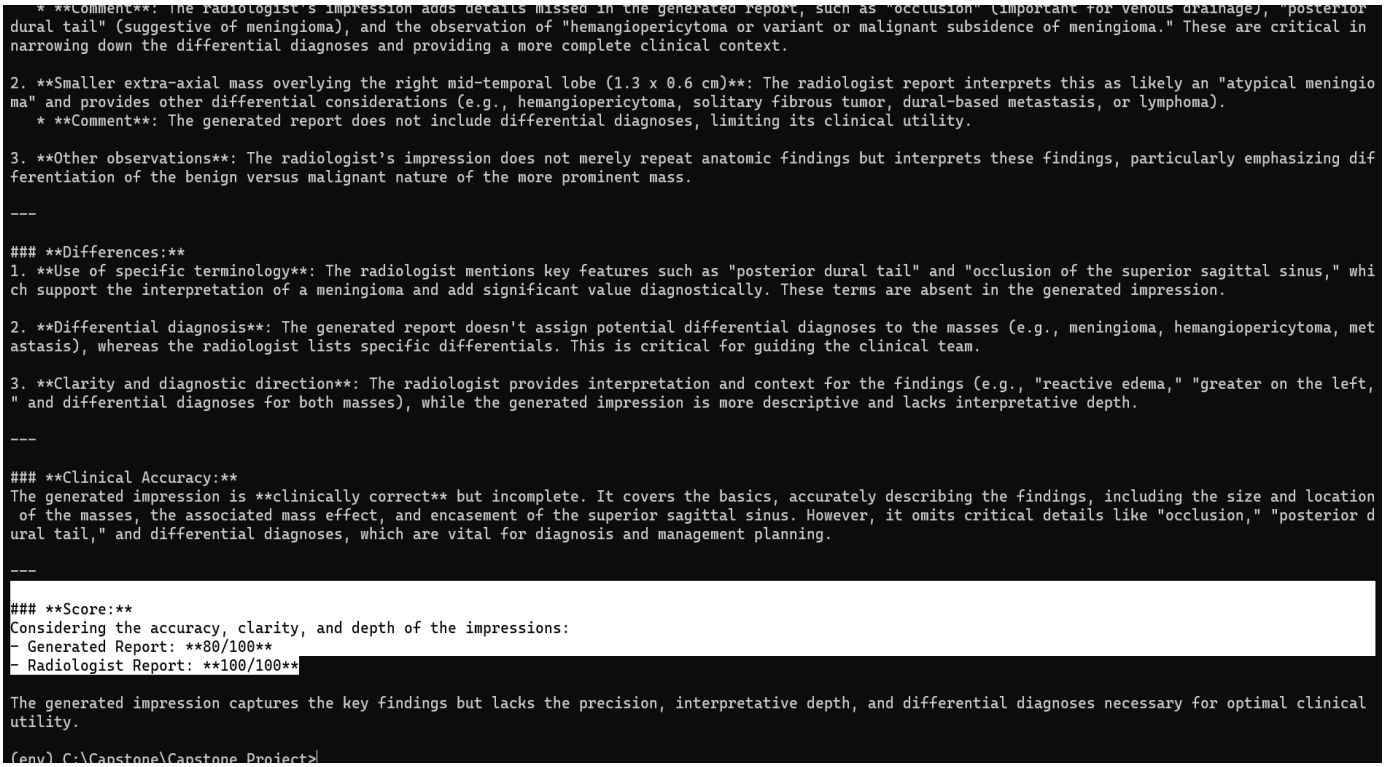


### Input Validation Efficiency

- Tested with 20 non-MRI texts (e.g., random sentences).
- Result: **100% rejection rate** for invalid inputs, preventing misuse of the tool.

### System Reliability

- Tool tested with around 35-40 **times with different MRI reports** (both text and PDF).
- Error handling ensured proper messages were shown for invalid cases (e.g., missing file, empty input).

The testing and validation process confirms that the MRI Impression Assistant meets its defined objectives. It provides accurate, concise, and clinically relevant impressions, while maintaining usability, reliability, and safeguards against misuse.