A stylized illustration of a human head in profile, facing right. The head is filled with a blue-to-teal gradient, representing a brain MRI. A red, irregular shape is visible in the upper left portion of the brain, representing a tumor. The background is dark blue with several white dots and thin blue lines, suggesting a network or data flow.

Automated Classification of **Brain** **Tumor MRI** **Images**

By Sarah Roe

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Background info on Brain Cancer



What is Brain Cancer?

Occurrence of a Brain Tumor



The presence of a malignant tumor in the brain



Tumors are made up of abnormal cells that grow uncontrollably and can invade surrounding brain tissues

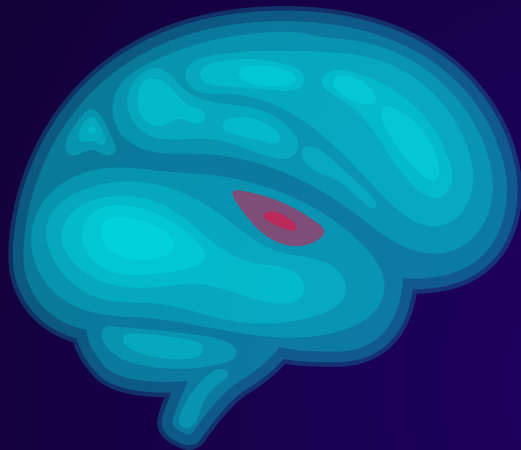
Tumor Classification



Primary Brain Tumors: Originate in the brain



Secondary Brain Tumors: Originate elsewhere in the body



5th Most Common

Type of cancer

90,000

Receive a primary brain tumor diagnosis annually

12%

Survive for 5 years

Symptoms & What's Next

Symptoms

- Headaches
- Seizures
- Vision issues
- Vomiting
- Mental Changes
- Difficulty walking/speaking

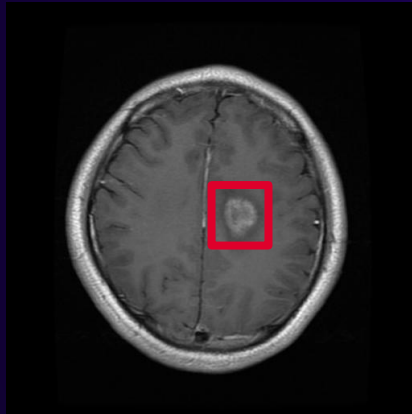
Primary Care Appt

- Medical history
- Lab testing
- Imaging (MRI or CT scan)

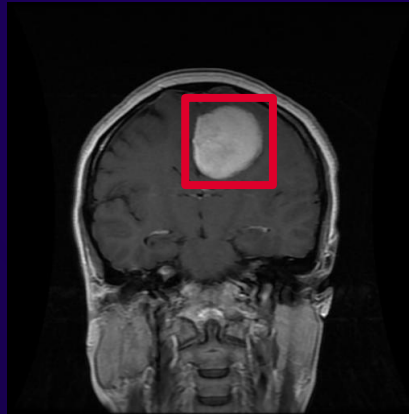


Three Tumor Types

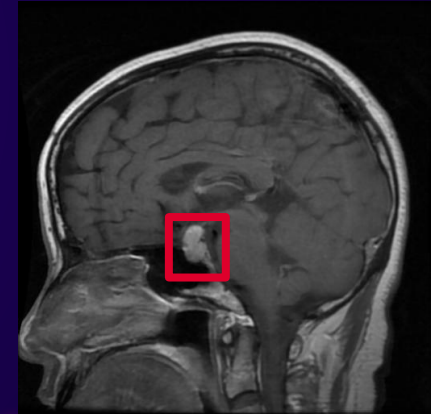
Glioma



Meningioma



Pituitary



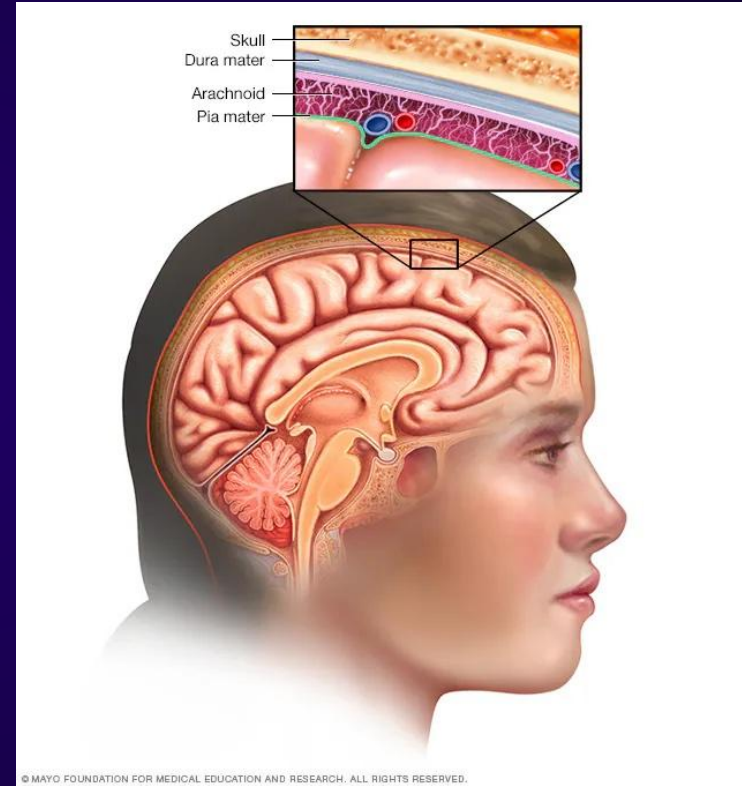
Glioma

- Primary tumor that starts in the glial cells of the brain or spinal cord
- 80% of malignant brain tumors
- Classification based on tumor grade I-IV
- Causes:
 - Genetic mutations and syndromes
 - Environmental Factors (exposure to radiation and some chemicals)
 - Family history of brain tumors



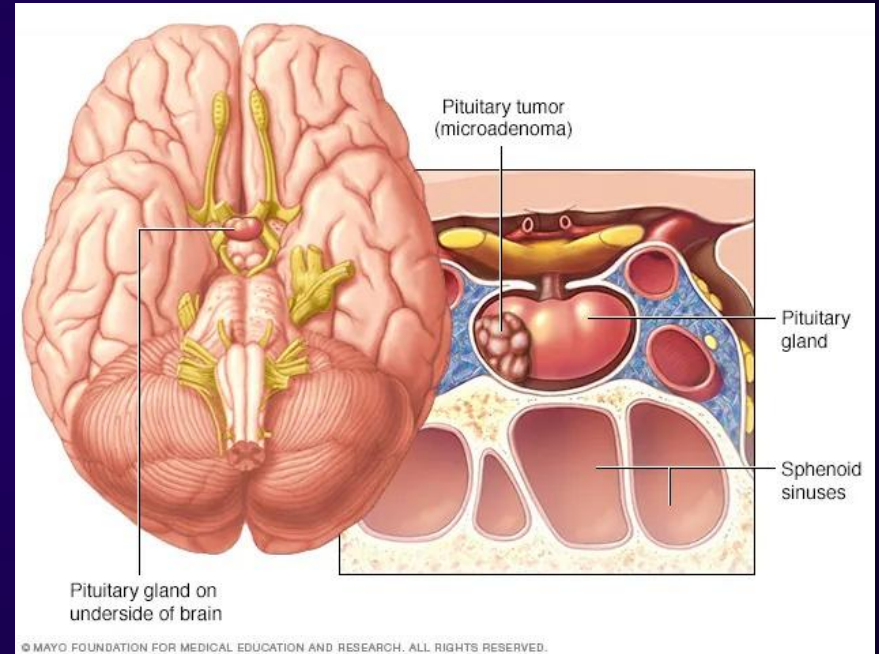
Meningioma

- Primary tumors that originate from the meninges
- 30% of all brain tumors
- Classification based on tumor grade I-III
- Causes:
 - Not incredibly well understood
 - Some genetic factors
 - Radiation



Pituitary

- Tumors that develop in the pituitary gland.
- Relatively common
- Most are benign but influence hormone secretion in the body
- Causes:
 - Only known risk factors are rare hereditary conditions

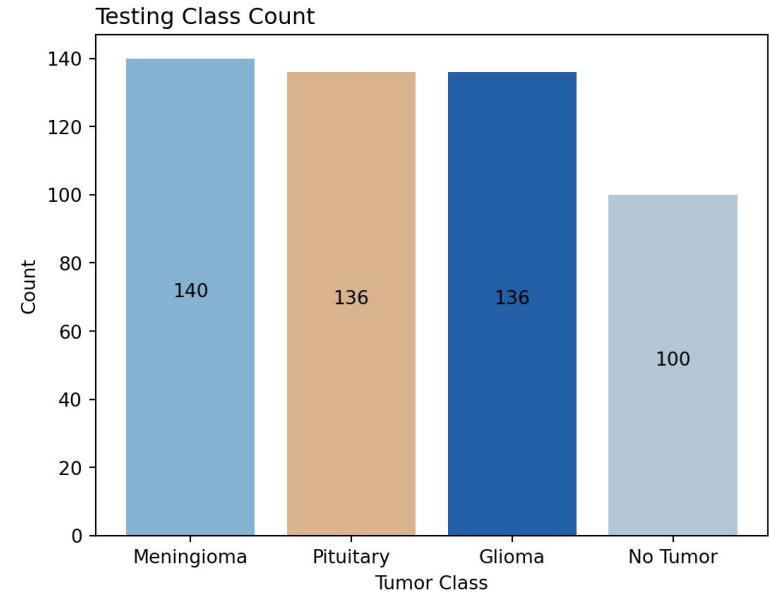
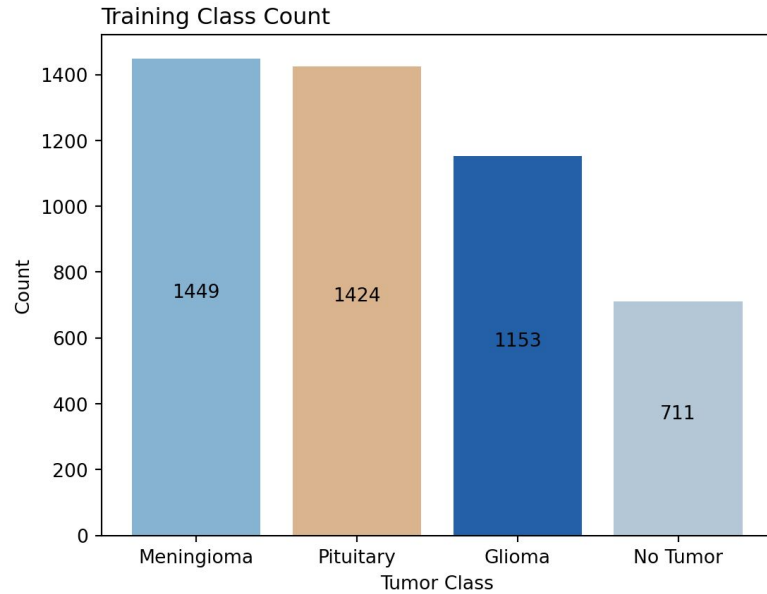


2

CNN Modeling



Baseline Counts



CNN - MaxPooling + Drop Out

Sequence of Layers:

Conv2D (32, 5, activation=relu),
MaxPooling2D (2),
Dropout (0.2),

Conv2D (64, 5, activation=relu),
MaxPooling2D (2),
Dropout (0.25),

Flatten (),
Dense (128, activation=relu),
Dropout (0.25),

Dense (4, activation='softmax')

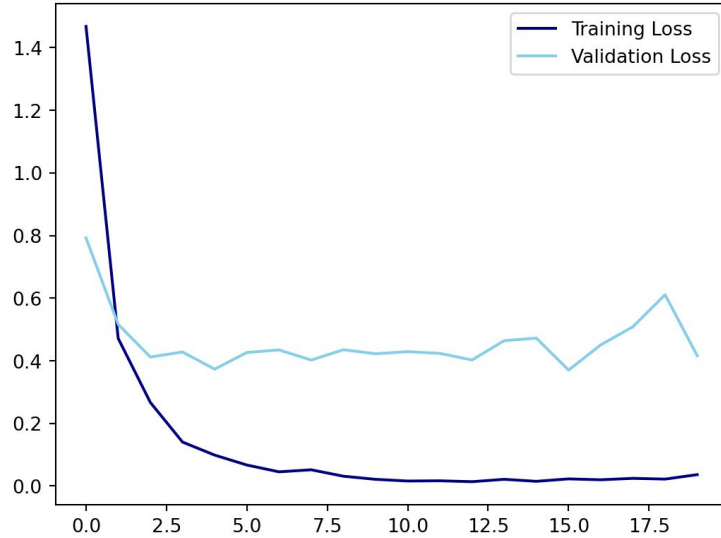
OVERALL ACCURACY: 0.93

| | Precision | Recall | f1-Score |
|------------|-----------|--------|----------|
| Glioma | 0.90 | 0.90 | 0.90 |
| Meningioma | 0.87 | 0.95 | 0.91 |
| No Tumor | 0.98 | 0.88 | 0.93 |
| Pituitary | 0.99 | 0.97 | 0.98 |

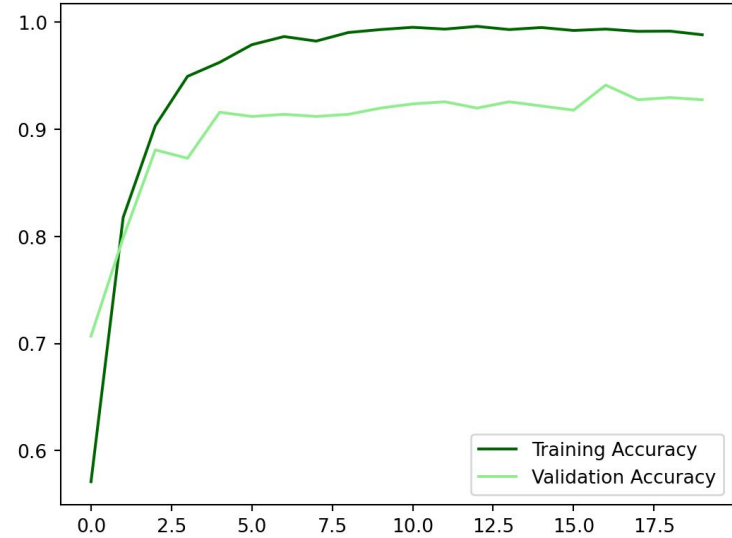
| | Pred Glioma | Pred Meningioma | Pred No Tumor | Pred Pituitary |
|-------------------|-------------|-----------------|---------------|----------------|
| Actual Glioma | 122 | 14 | 0 | 0 |
| Actual Meningioma | 6 | 133 | 1 | 0 |
| Actual No Tumor | 5 | 4 | 88 | 2 |
| Actual Pituitary | 2 | 1 | 1 | 132 |

Loss and Accuracy

Training vs. Validation Loss



Training vs. Validation Accuracy



CNN - MaxPooling + Drop Out + l2 Reg

* l2 regularization of 0.001

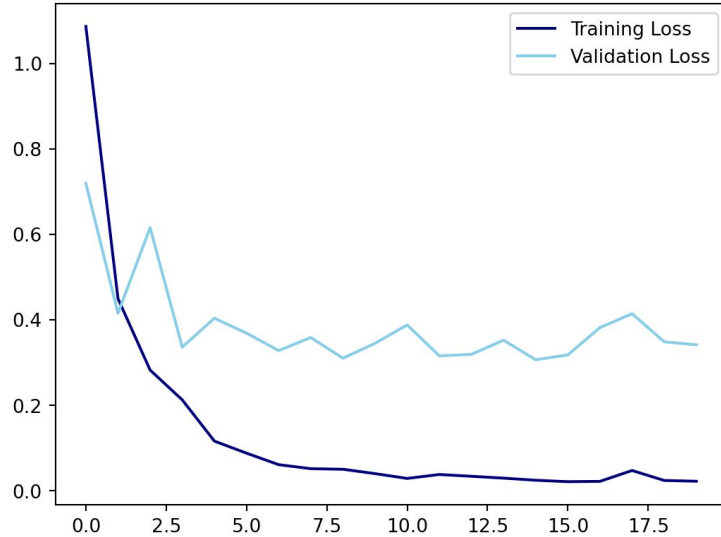
OVERALL ACCURACY: 0.93

| | Precision | Recall | f1-Score |
|------------|-----------|--------|----------|
| Glioma | 0.91 | 0.93 | 0.92 |
| Meningioma | 0.87 | 0.92 | 0.90 |
| No Tumor | 0.98 | 0.86 | 0.91 |
| Pituitary | 0.99 | 0.99 | 0.99 |

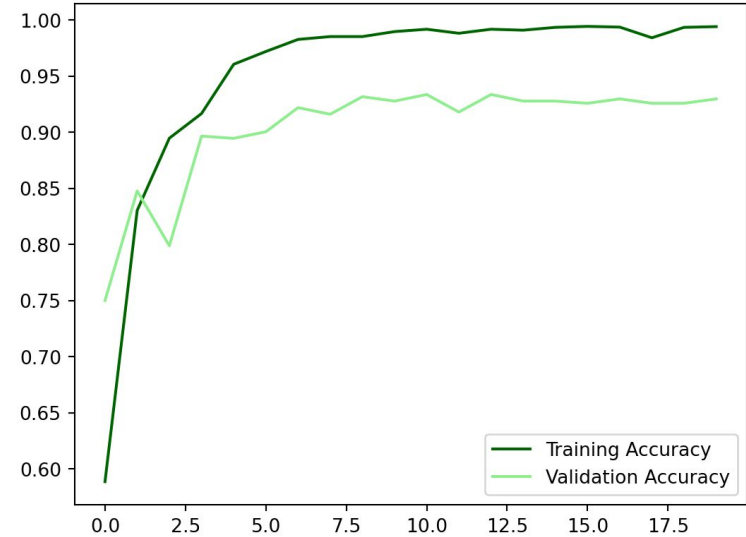
| | Pred Glioma | Pred Meningioma | Pred No Tumor | Pred Pituitary |
|-------------------|-------------|-----------------|---------------|----------------|
| Actual Glioma | 127 | 9 | 0 | 0 |
| Actual Meningioma | 9 | 139 | 2 | 0 |
| Actual No Tumor | 3 | 9 | 86 | 2 |
| Actual Pituitary | 1 | 1 | 0 | 134 |

Loss and Accuracy

Training vs. Validation Loss



Training vs. Validation Accuracy



CNN - Transfer Learning + Xception

Total Params: 22, 963, 756

Trainable Params: 2, 102, 776

Final **hidden dense layer** with
1024 neurons

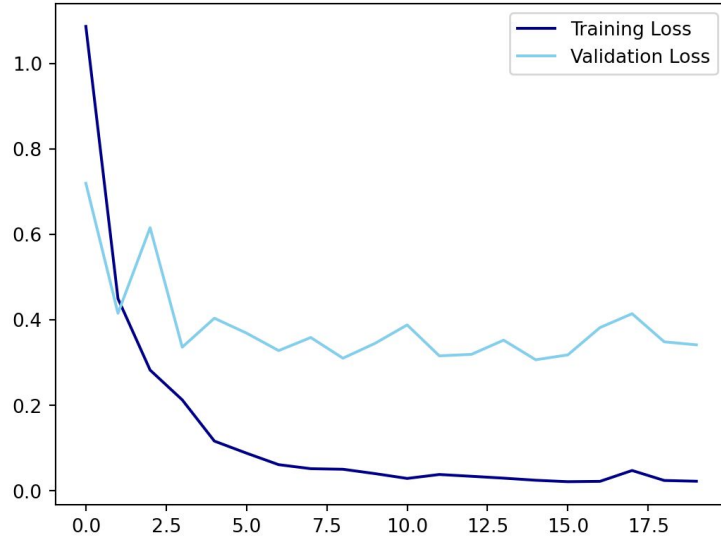
OVERALL ACCURACY: 0.95

| | Precision | Recall | f1-Score |
|------------|-----------|--------|----------|
| Glioma | 0.98 | 0.90 | 0.94 |
| Meningioma | 0.86 | 0.97 | 0.91 |
| No Tumor | 1.00 | 0.95 | 0.97 |
| Pituitary | 0.98 | 0.97 | 0.97 |

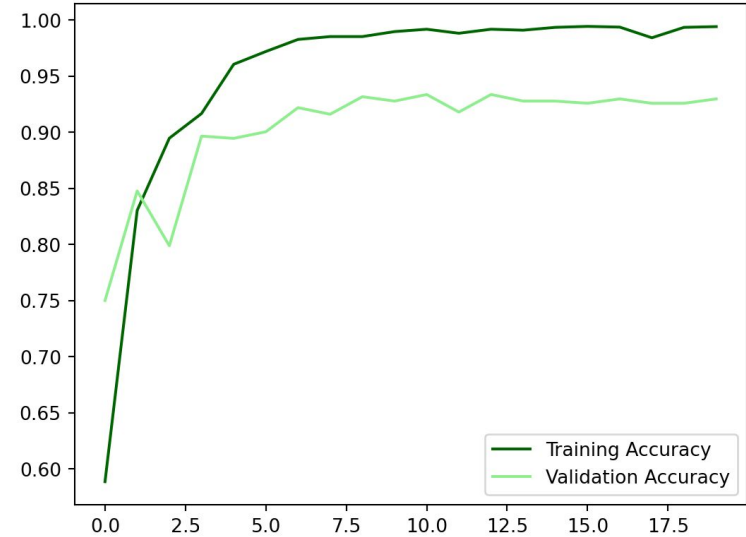
| | Pred Glioma | Pred Meningioma | Pred No Tumor | Pred Pituitary |
|-------------------|-------------|-----------------|---------------|----------------|
| Actual Glioma | 122 | 13 | 0 | 1 |
| Actual Meningioma | 2 | 136 | 0 | 2 |
| Actual No Tumor | 0 | 5 | 95 | 0 |
| Actual Pituitary | 0 | 4 | 0 | 132 |

Loss and Accuracy

Training vs. Validation Loss



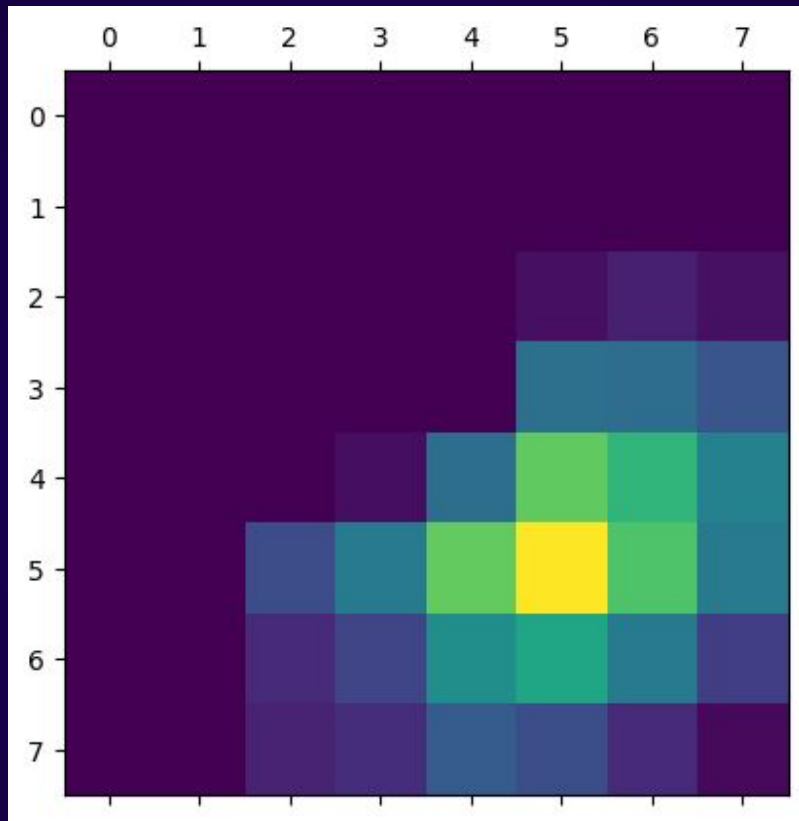
Training vs. Validation Accuracy



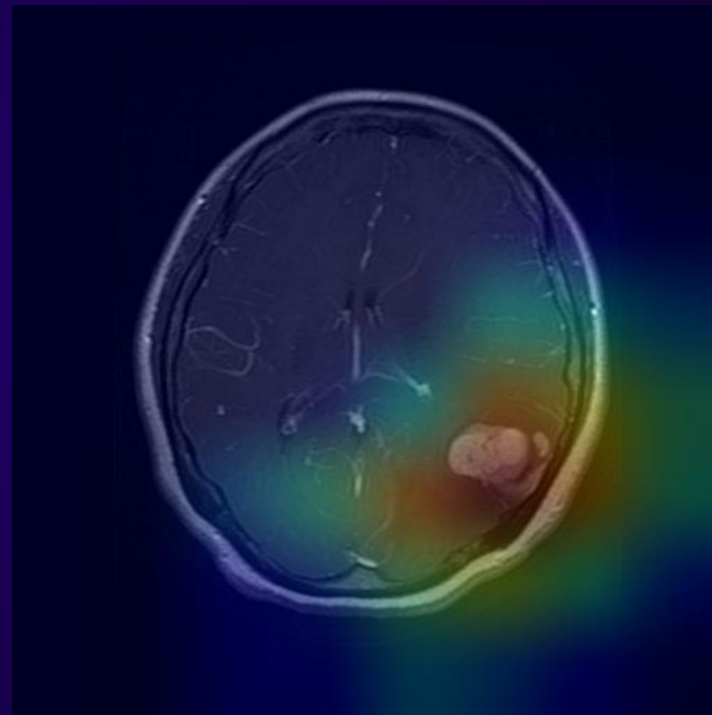
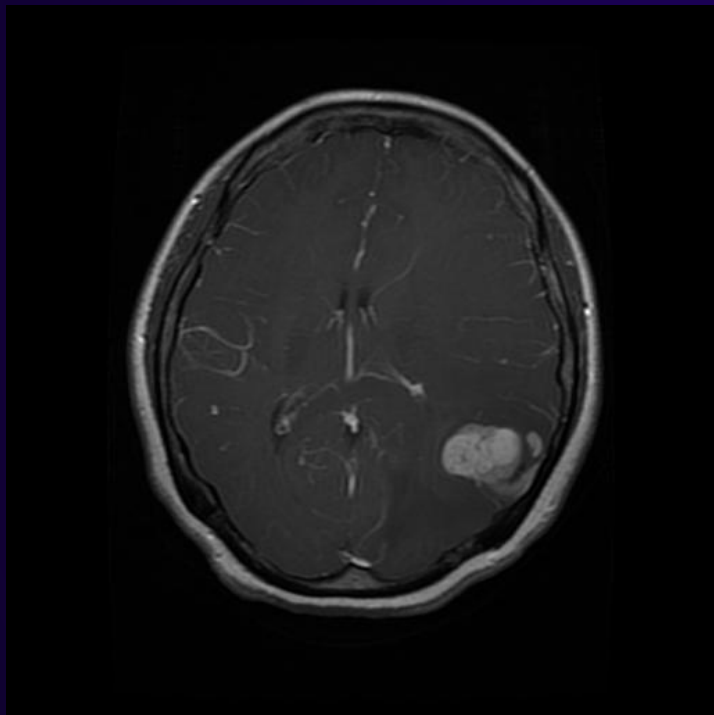
3

Grad-CAM Heatmap

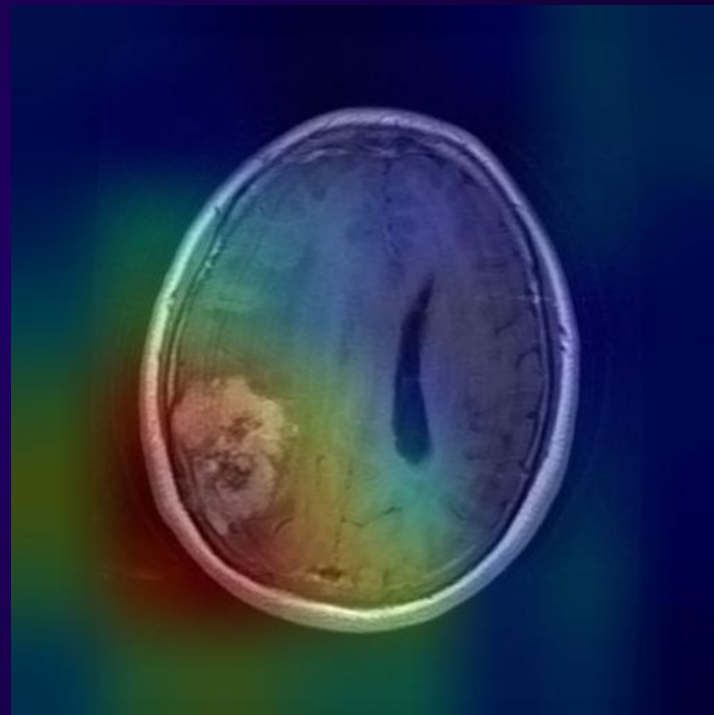
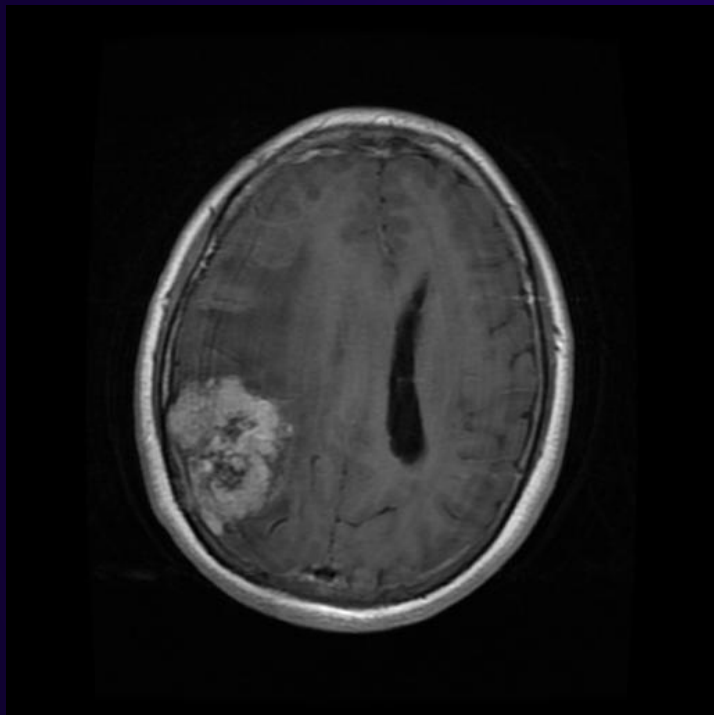




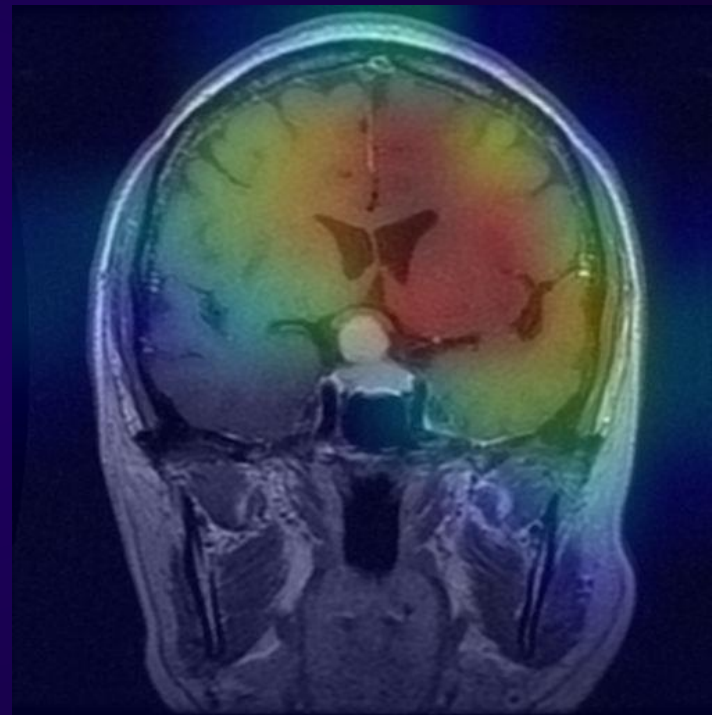
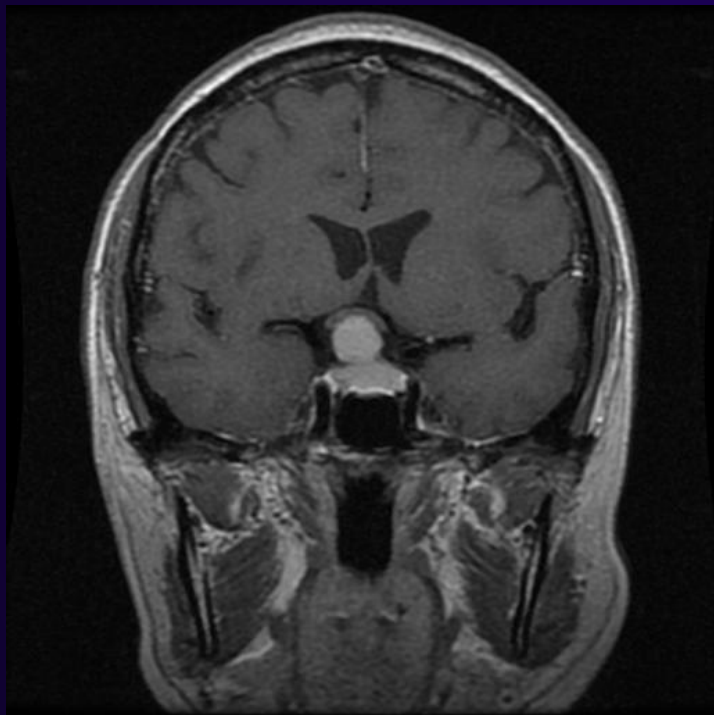
Predicted: Glioma



Predicted: Meningioma



Predicted: Pituitary



4

Streamlit App



5

Real World Impact/ Conclusions





Real life **impact**

Mark Ruffalo:

- Diagnosed with benign tumor in 2001
- Suffered temporary facial paralysis

Wilma Rudolph:

- Diagnosed in July 1994
- Passed in November 1994 (Age 54)

Janet Johnson:

- Diagnosed with Glioblastoma in early July 1999
- Passed on August 21st, 1999 (Age 59)



Why is this **Important?**



Early Detection



**Advancement in Med
Tech**



**Fast and accurate
diagnosis**



**Improving healthcare
disparities**



Workload relief



**Educational
opportunities**

Work Cited

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9132094/#:~:text=Glioma%20APT%20images%20are%20larger,the%20infiltration%20of%20brain%20tumors.>

https://matplotlib.org/stable/gallery/lines_bars_and_markers/bar_colors.html#sphx-glr-gallery-lines-bars-and-markers-bar-colors-py

<https://www.mayoclinic.org/diseases-conditions/glioma/symptoms-causes/syc-20350251>

<https://www.mayoclinic.org/diseases-conditions/brain-tumor/symptoms-causes/syc-20350084#:~:text=A%20brain%20tumor%20is%20a,the%20surface%20of%20the%20brain.>

<https://www.aaroncohen-gadol.com/en/patients/brain-tumor/types/statistics#:~:text=Malignant%20Brain%20Tumors%20Statistics,-32.&text=33..7%20per%20100%2C000%20individuals%20annually.&text=35.>

https://en.wikipedia.org/wiki/Wilma_Rudolph

https://en.wikipedia.org/wiki/Mark_Ruffalo

[https://en.wikipedia.org/wiki/Janet_Johnson_\(politician\)](https://en.wikipedia.org/wiki/Janet_Johnson_(politician))

[https://braintumourresearch.org/en-us/pages/types-of-brain-tumours-glioma#:~:text=Grade%202%20gliomas%20\(such%20as,of%20around%205%2D10%25.](https://braintumourresearch.org/en-us/pages/types-of-brain-tumours-glioma#:~:text=Grade%202%20gliomas%20(such%20as,of%20around%205%2D10%25.)

<https://www.mayoclinic.org/diseases-conditions/meningioma/symptoms-causes/syc-20355643>

<https://www.mayoclinic.org/diseases-conditions/pituitary-tumors/symptoms-causes/syc-20350548>

Thanks

Questions??

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