BRAIN TUMOR CLASSIFICATION

and assorted issues.

GOAL

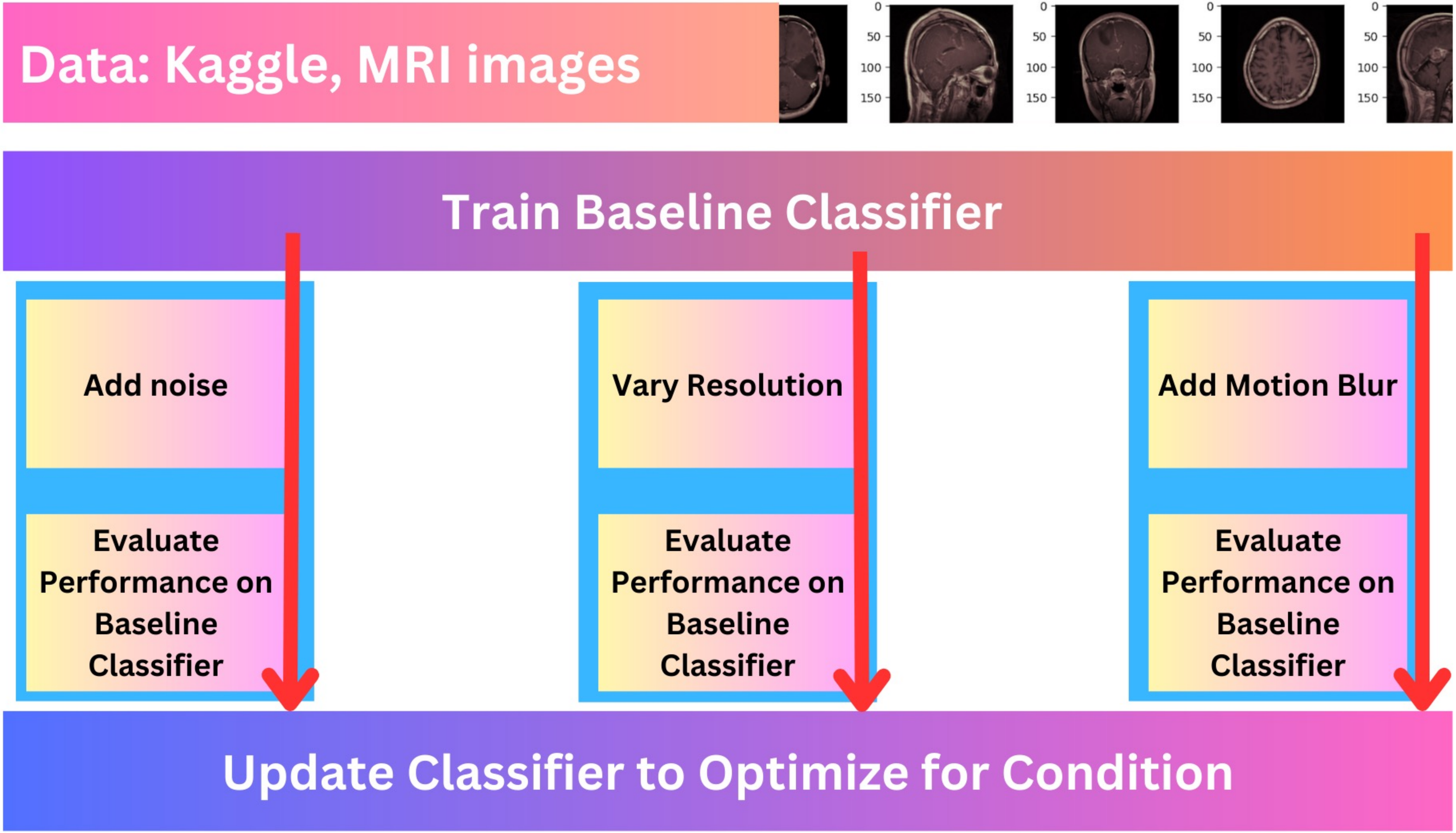
- Build a classifier that is resistant to noise under a variety of conditions.

CONDITIONS

- Types of noise
- Resolutions
- Blur

EXPERIMENTAL DESIGN

1. Build a baseline classifier
2. Evaluate performance with ”perfect” images
3. Add condition to image
4. Evaluate performance
5. Update classifier to optimize performance

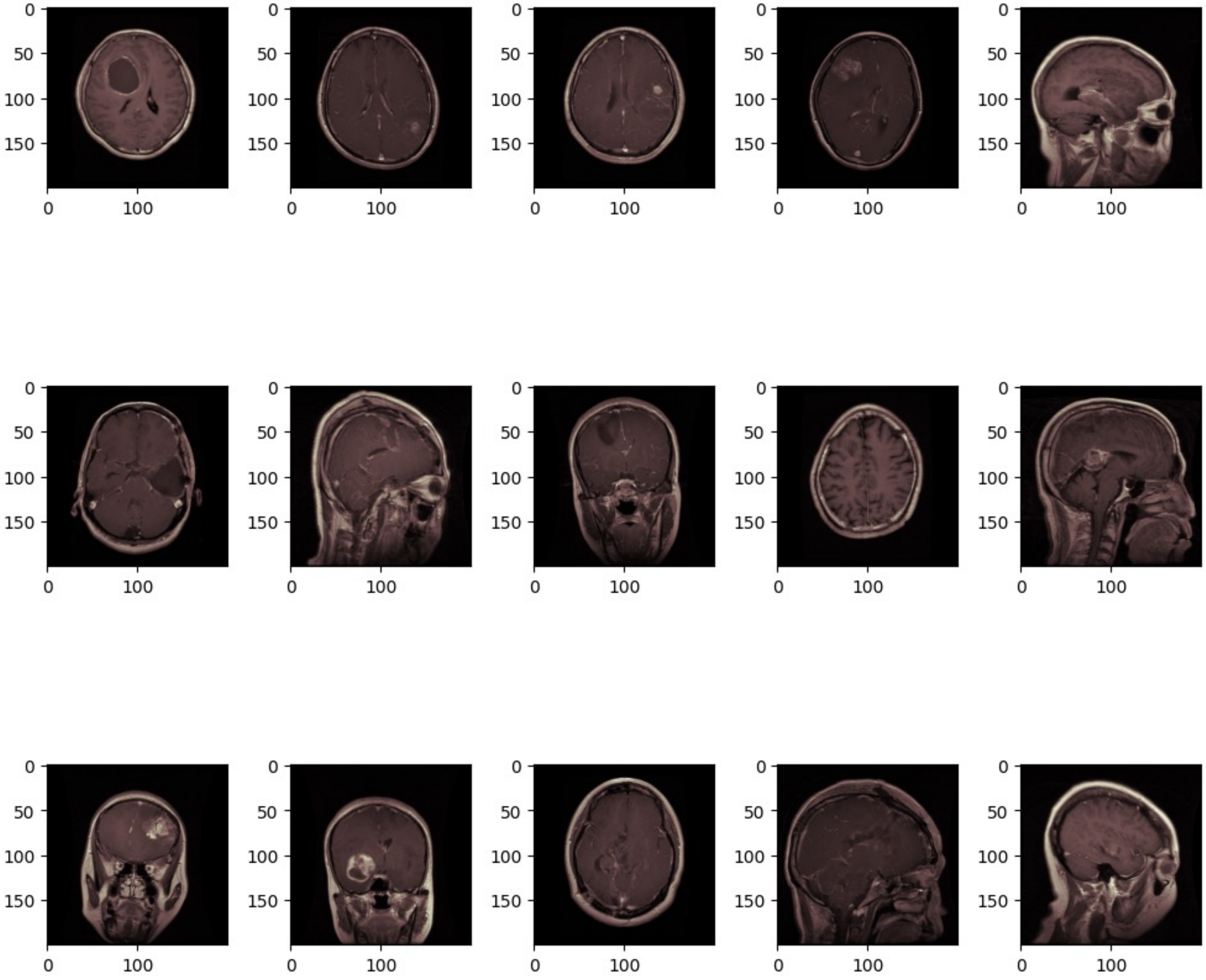

Data: Kaggle, MRI images
0
50
100
150
Train Baseline Classifier
Add noise
Evaluate Performance on Baseline Classifier
Vary Resolution
Evaluate Performance on Baseline Classifier
Add Motion Blur
Evaluate Performance on Baseline Classifier
Update Classifier to Optimize for Condition

DATA

- Data is from Kaggle
- Brain MRI Images showing 3 types of tumors and a "no tumor" category.
- Images from a variety of angles

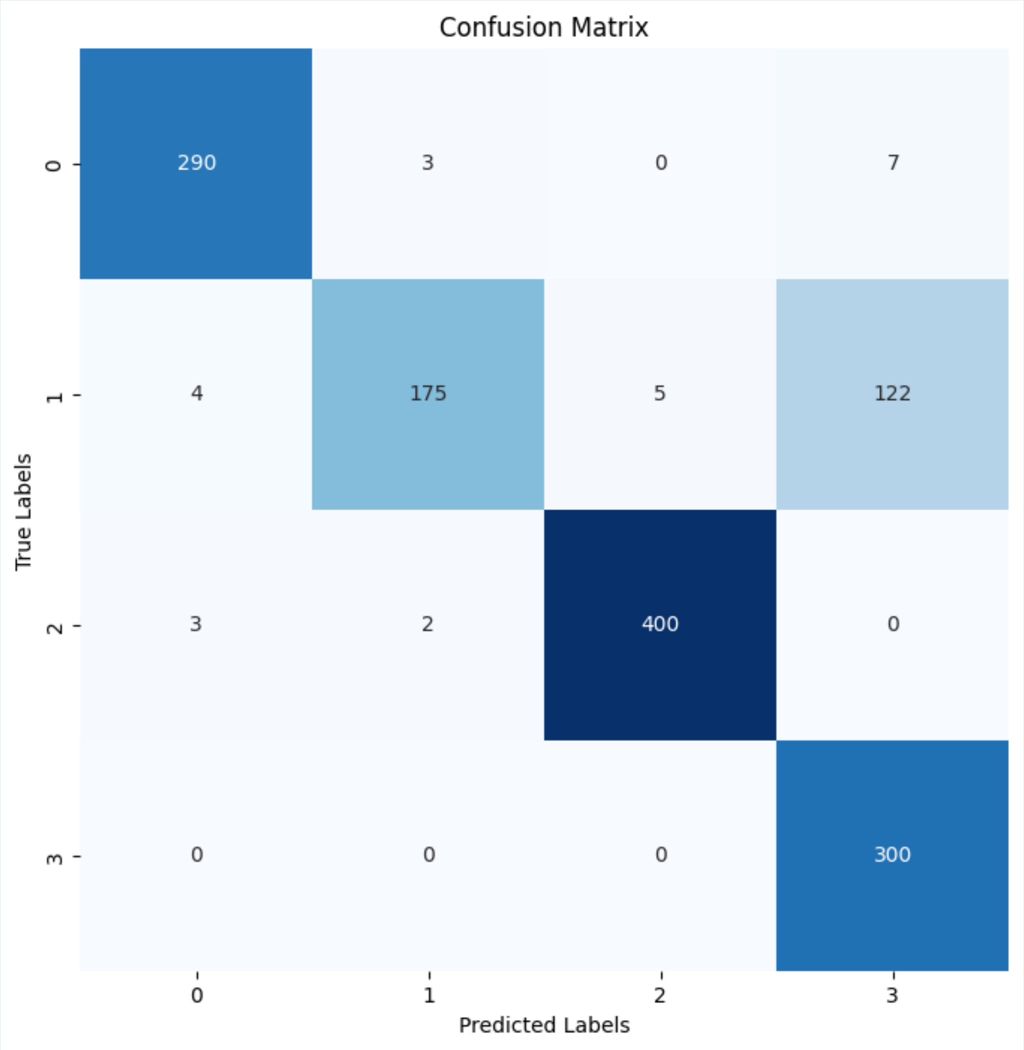
	Train Quantity	Test Quantity
Pituitary	1457	300
Glioma	1321	300
Meningioma	1339	306
No Tumor	1595	405

EXAMPLE DATA



BASELINE CLASSIFIER EVALUATION

BASELINE CLASSIFIER EVALUATION



<u>Class Labels</u>

0: Glioma

1: Meningioma

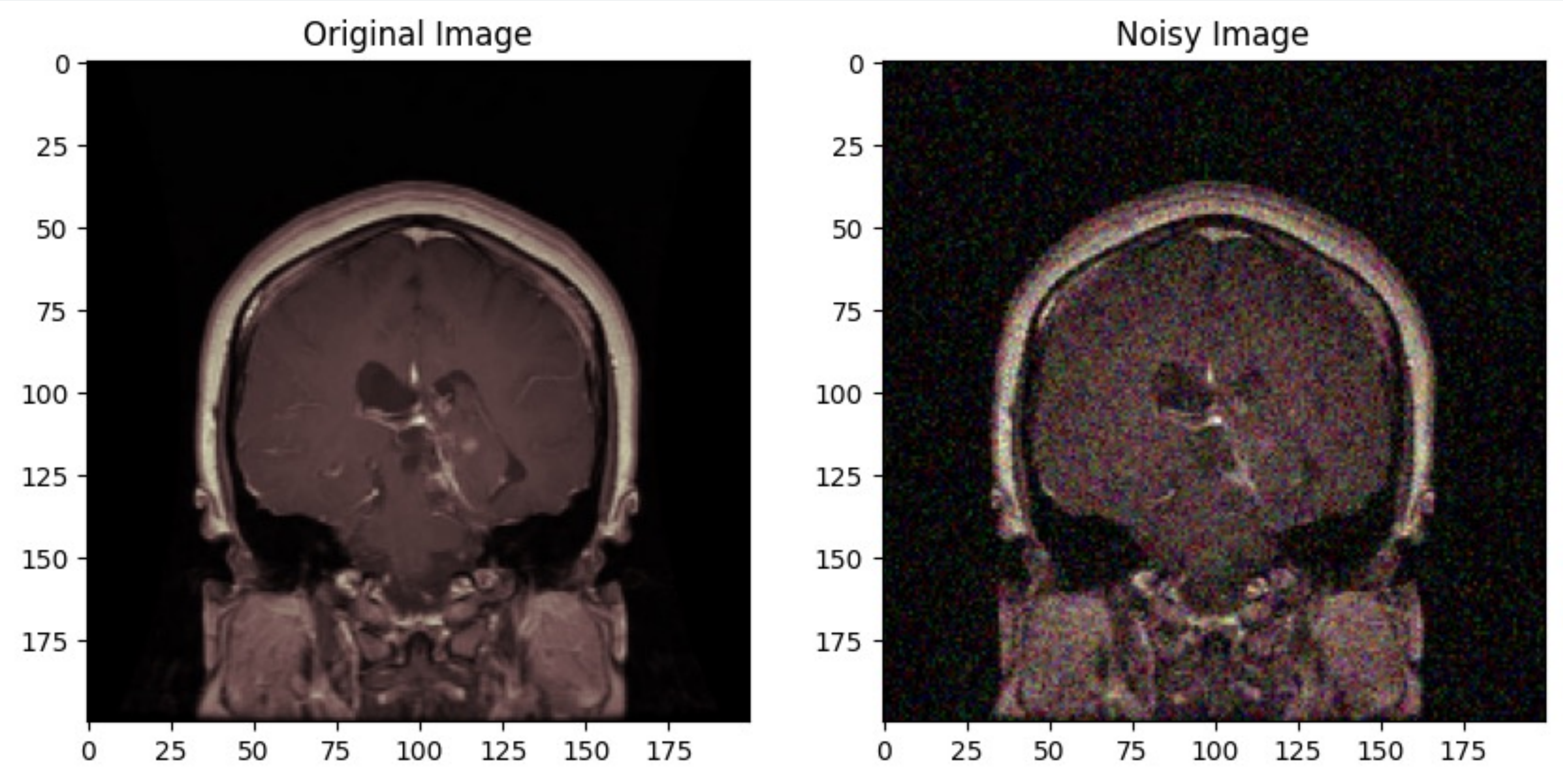
2: No Tumor

3: Pituitary

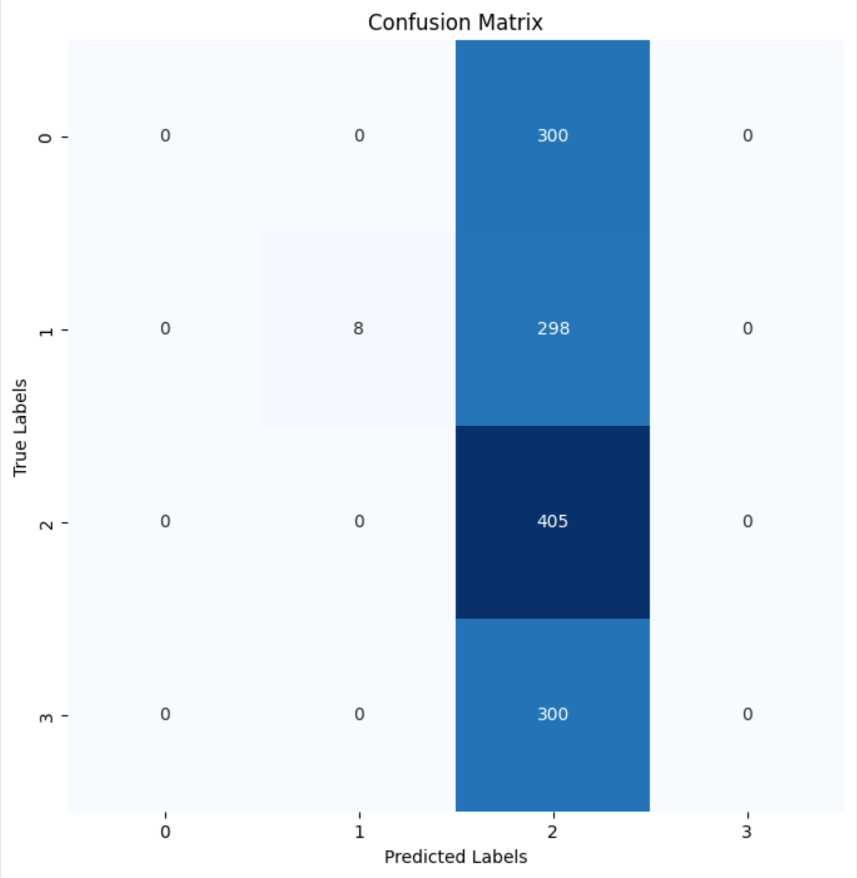
WHAT IS GAUSSIAN NOISE?

- Gaussian noise refers to random variations in the pixel values of the image that follow a Gaussian distribution.
- These variations can be caused by factors such as electronic noise in the MRI machine or imperfections in the signal acquisition process.

ADDING GAUSSIAN NOISE. STANDARD DEVIATION = 0.1 MEAN = 0

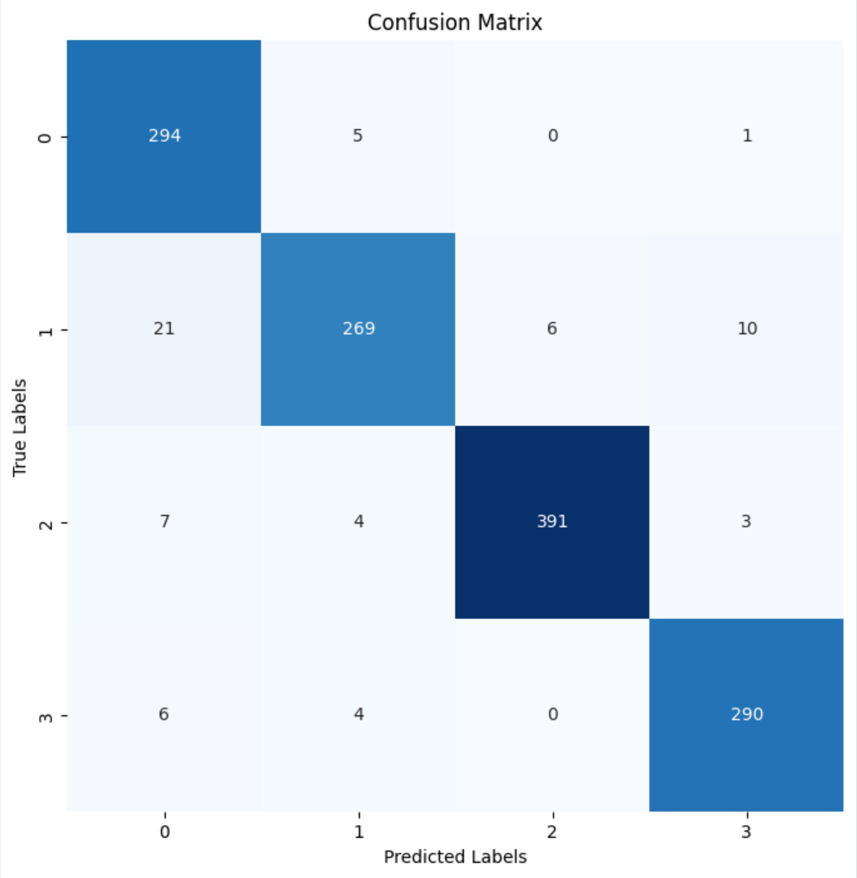


Gaussian Noise: Before Training



Accuracy = 31.5%

Gaussian Noise: After Retraining



Accuracy = 93.83%

<u>Class Labels</u>

0: Glioma

1: Meningioma

2: No Tumor

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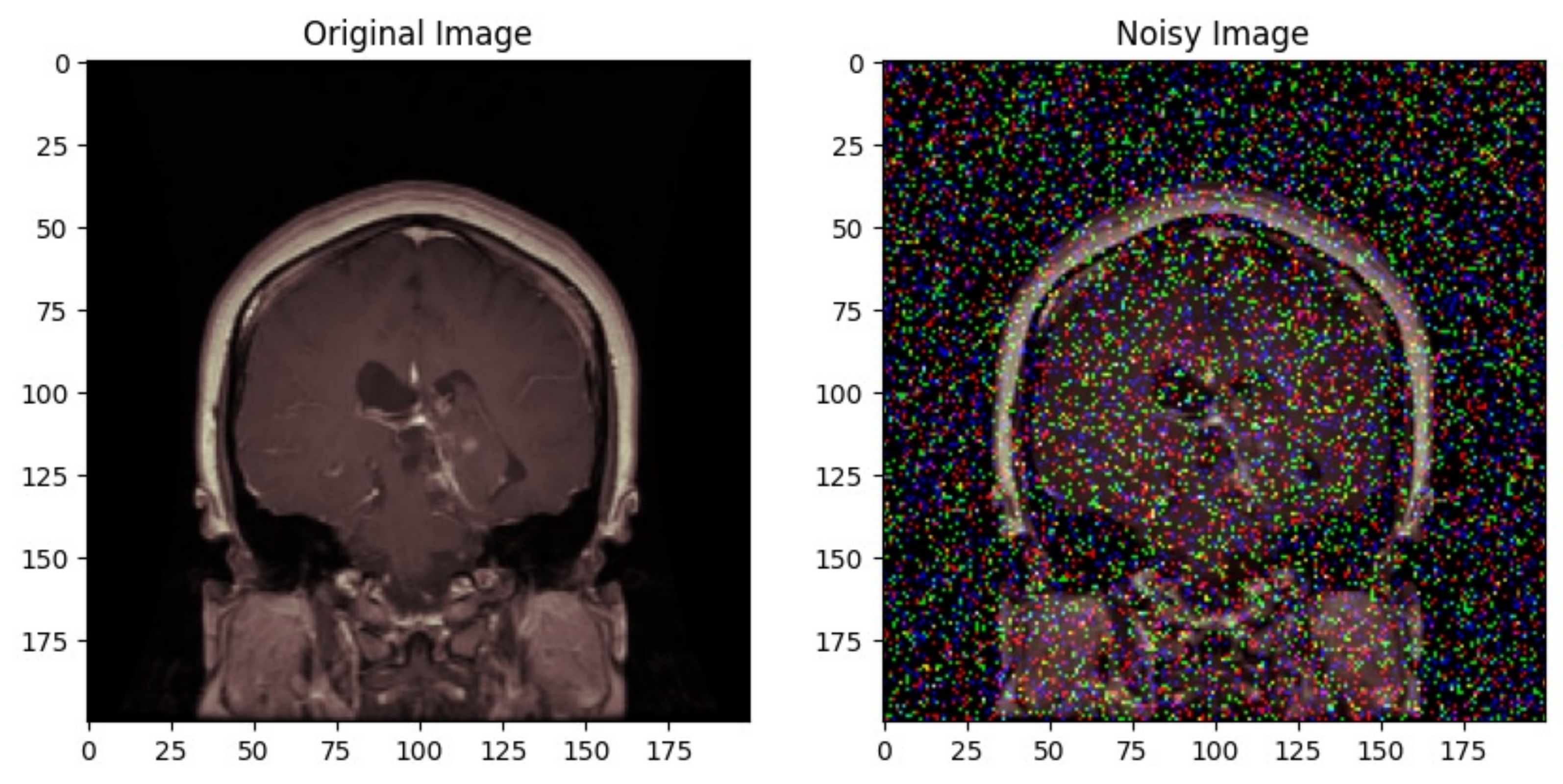
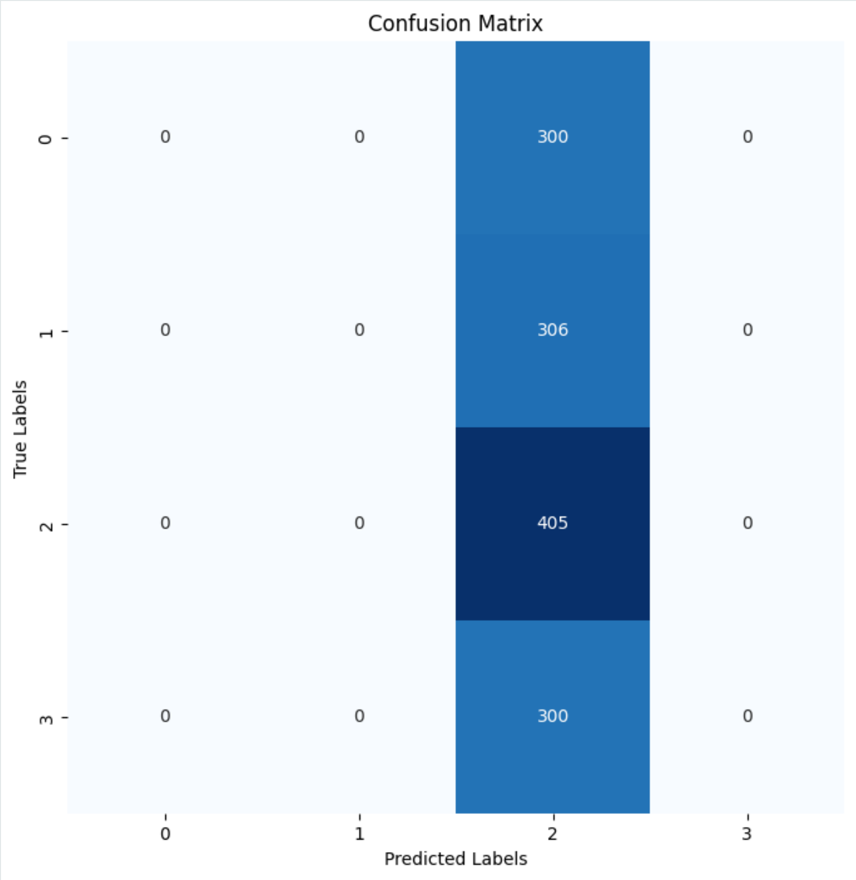
WHAT IS POISSON NOISE?

- Poisson noise arises from the statistical nature of photon or particle detection, and it can be especially pronounced in low light conditions.
- Poisson noise can result in a "salt-and-pepper" effect in images, where random bright or dark pixels are introduced.
- In MRI, Poisson noise can be caused by various factors, such as variations in magnetic field strength or in the number of spins that emit a signal and can be amplified using higher magnetic fields.

ADDING POISSON NOISE. LAM = 0.1



POISSON NOISE: BEFORE TRAINING



Accuracy = 30.89%

Class Labels

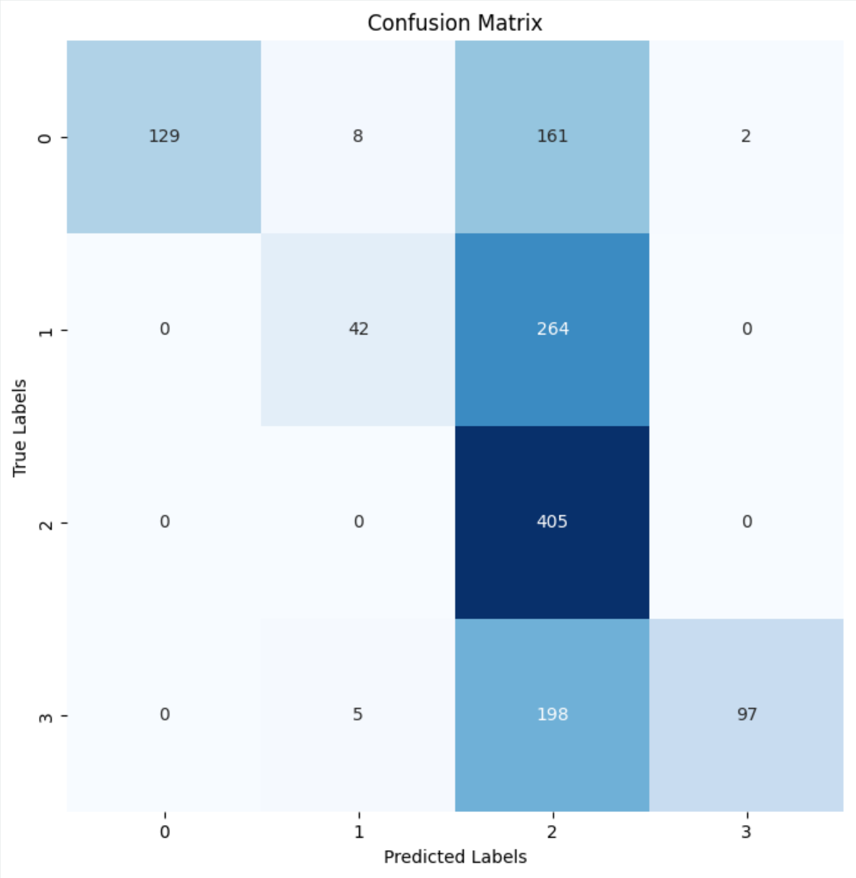
0: Glioma

1: Meningioma

2: No Tumor

3: Pituitary

POISSON NOISE: AFTER RETRAINING

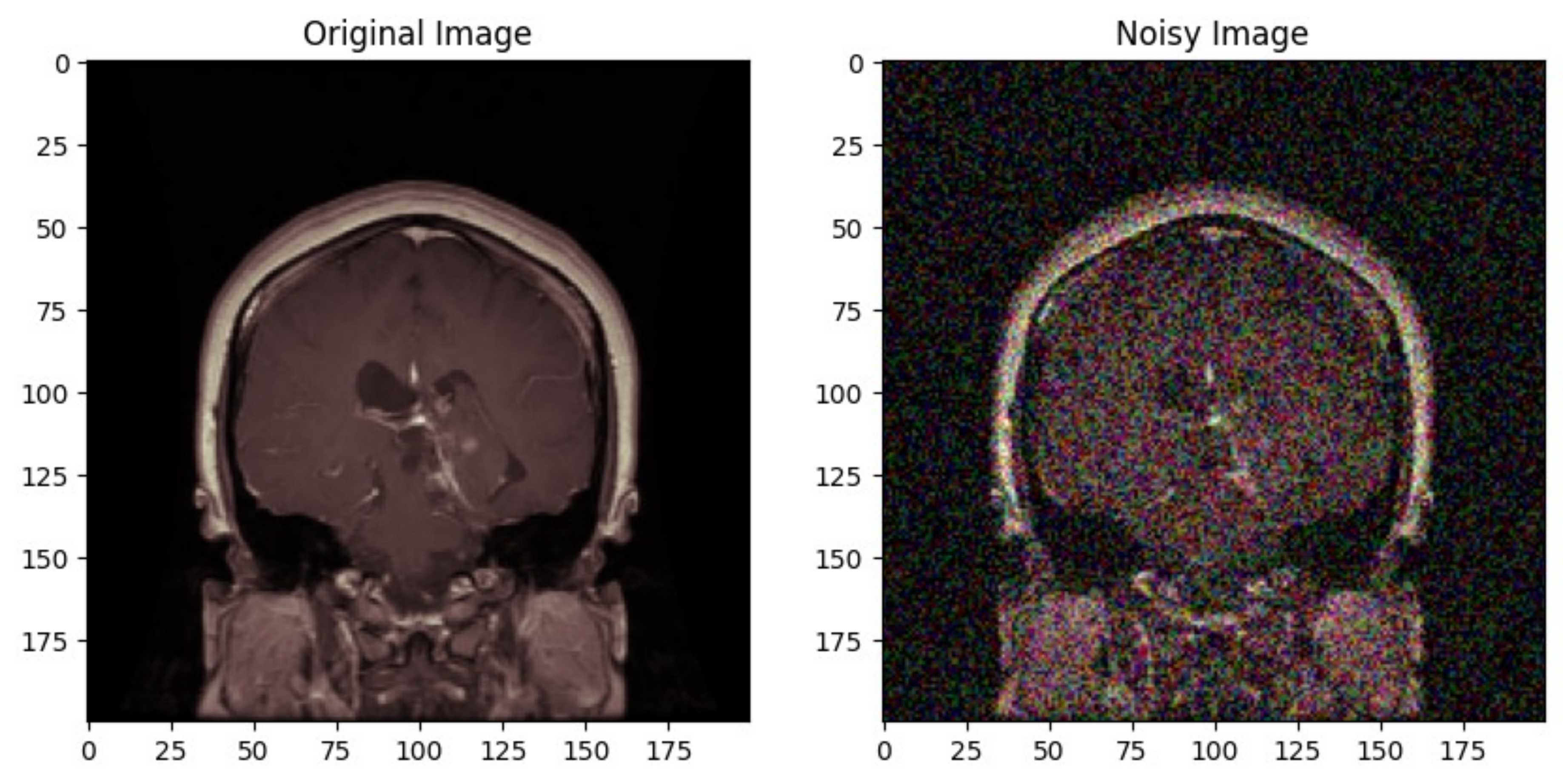


Accuracy = 94.87%

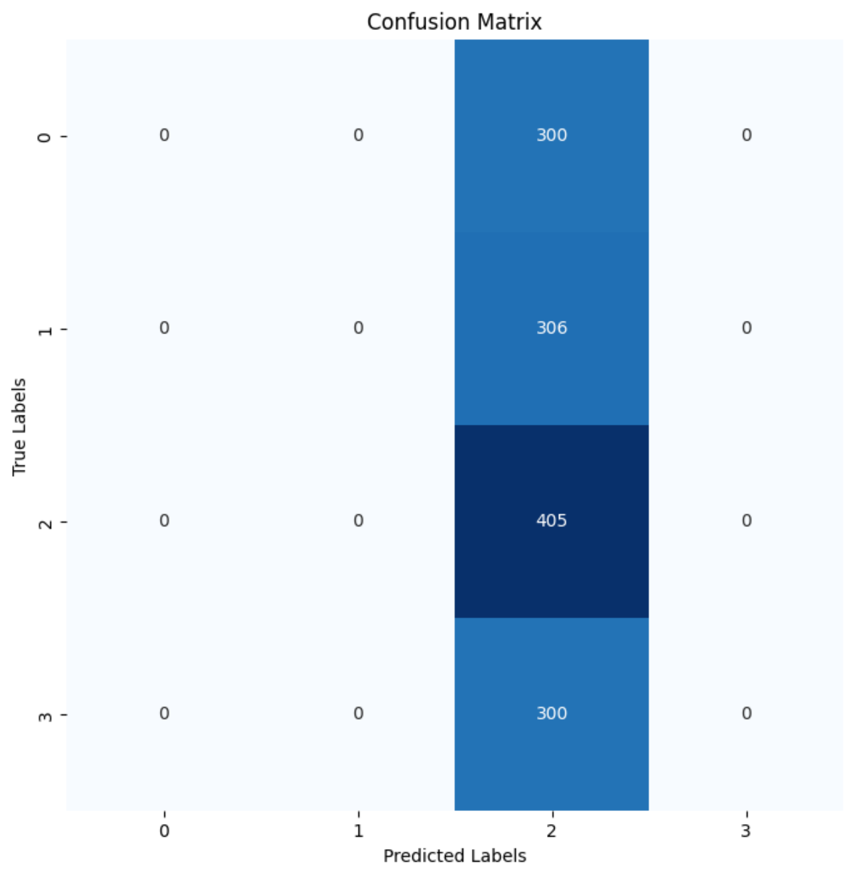
WHAT IS QUANTIZATION NOISE?

- Quantization noise refers to the error introduced when representing continuous analog signals in a discrete form.
- Quantization noise can occur during the digitization process where the continuous image signal is sampled and then converted to a digital representation with a limited number of bits.
- This can result in a loss of information and the introduction of noise in the form of rounding errors and signal approximation.

ADDING QUANTIZATION NOISE.
32 LEVELS
NOISE LEVEL 10



QUANTIZATION NOISE: BEFORE TRAINING



Accuracy = 30.89%

Class Labels

0: Glioma
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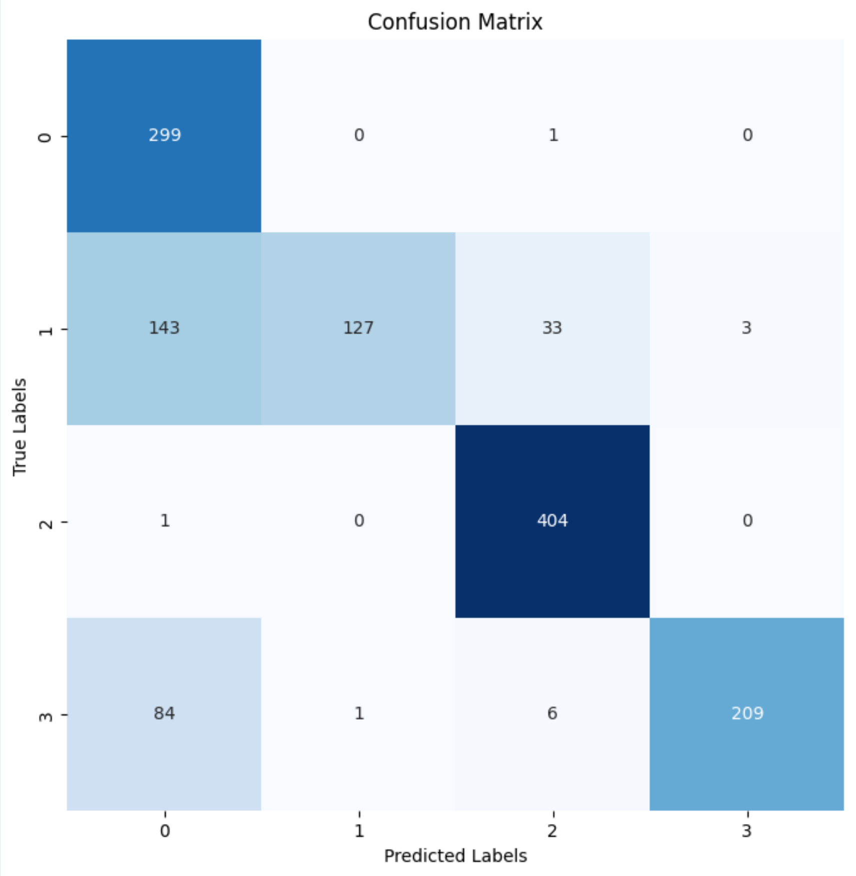
2: No Tumor
3: Pituitary

QUANTIZATION NOISE: AFTER RETRAINING

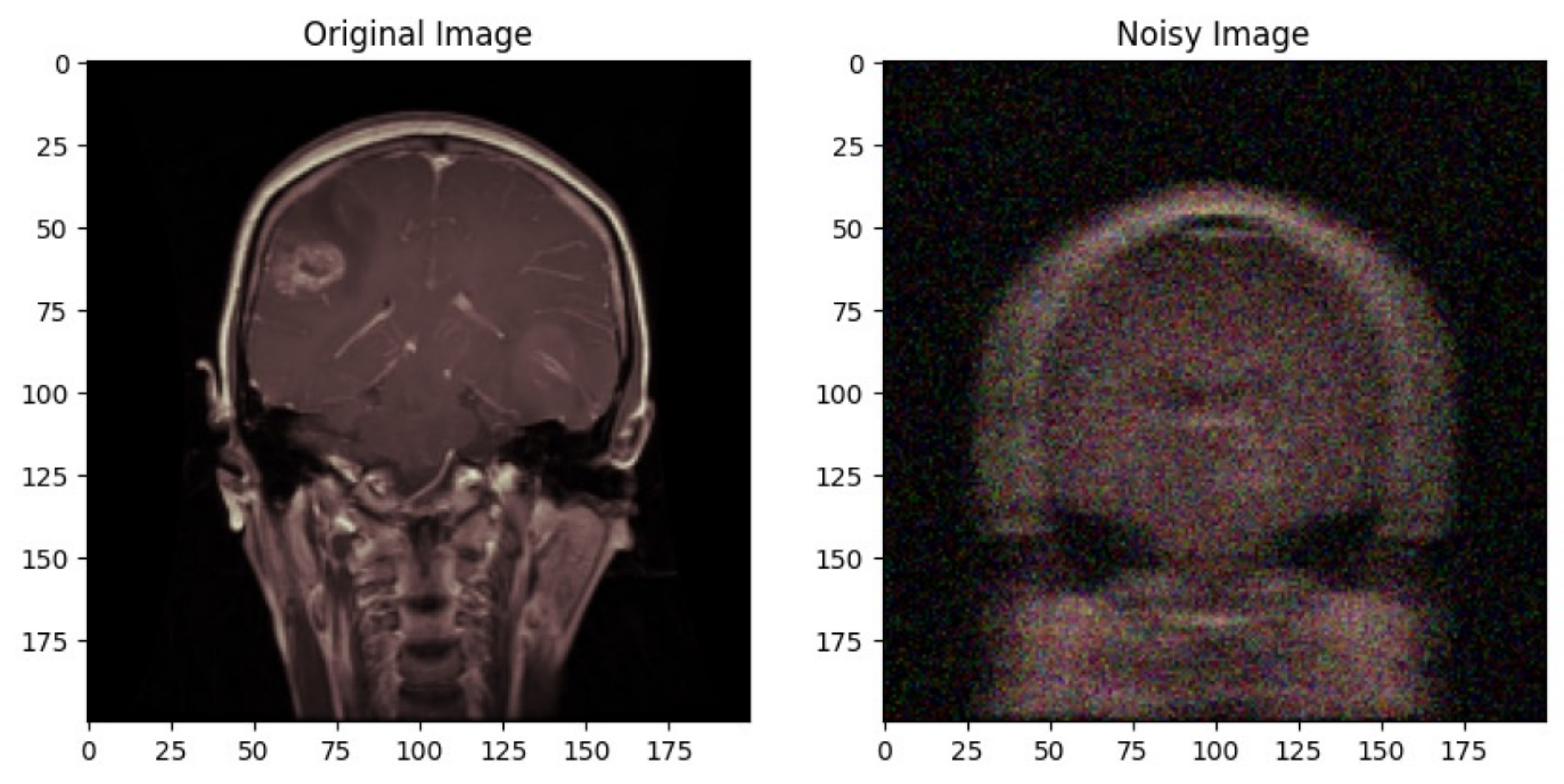


Accuracy = 76.15%

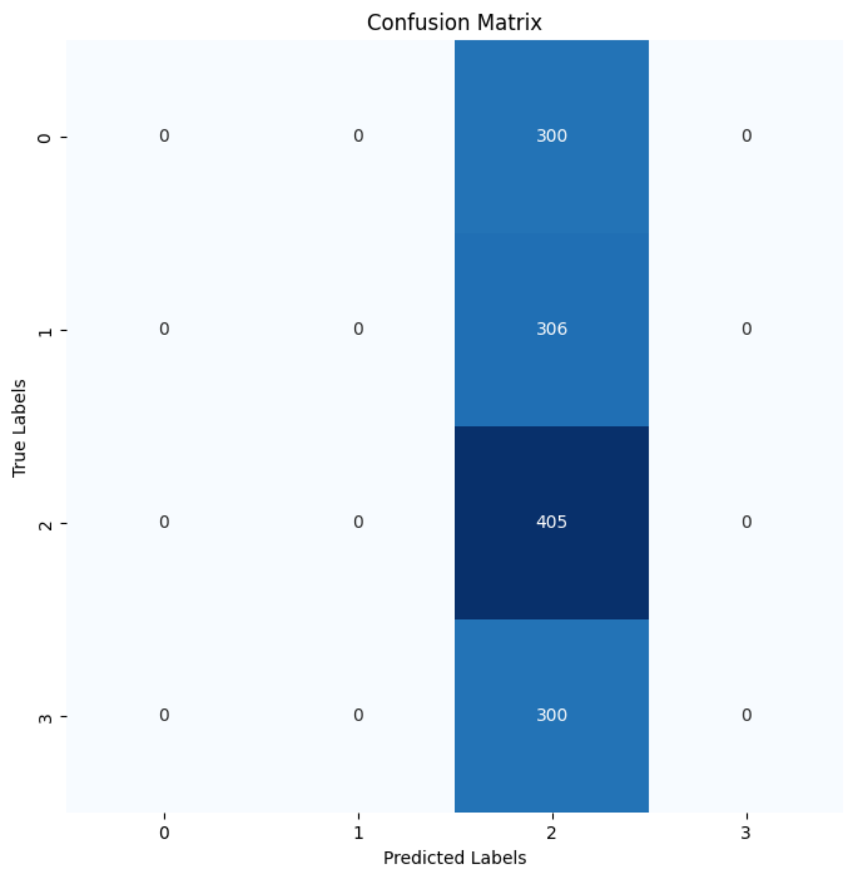
WHAT IS MOTION BLUR?

- Motion blur may occur due to patient motion during image acquisition or scanner instability.
- This can result in image blurring and distortion, reducing the quality of the image and potentially affecting the accuracy of diagnostic information.

ADDING MOTION BLUR.



MOTION BLUR: BEFORE TRAINING

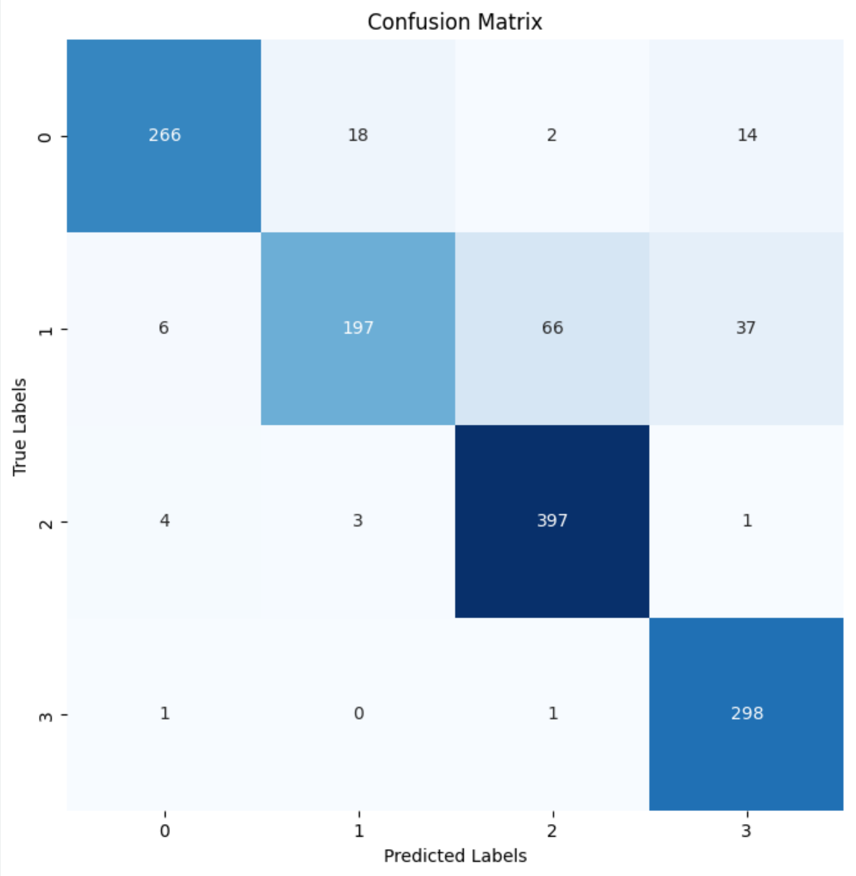


Accuracy = 30.89%

Class Labels

0: Glioma
1:
Meningioma
2: No Tumor
3: Pituitary

MOTION BLUR: AFTER RETRAINING

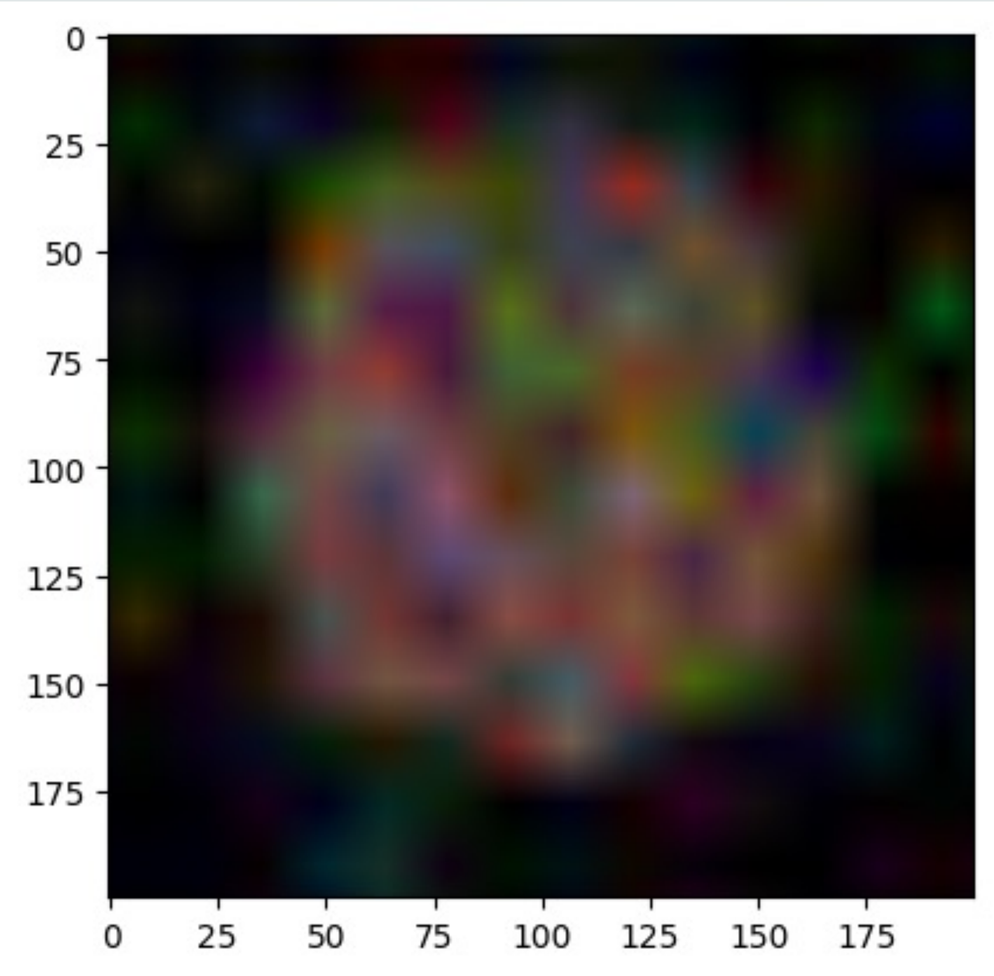


Accuracy = 89.58%

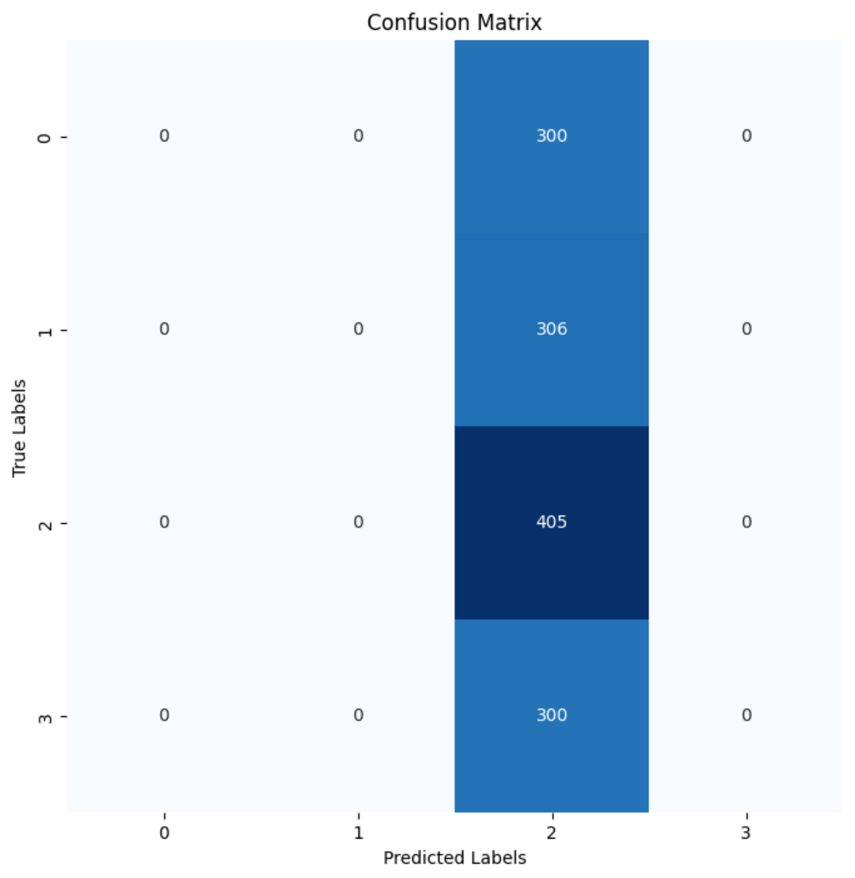
WHAT IS LOWERING RESOLUTION?

- Lowering the resolution can be used to reduce the size of the image and make it easier to store and process.
- However, it can also result in a loss of important details and features that may be important for diagnosis or analysis.

LOWERING RESOLUTION BY A FACTOR OF 2

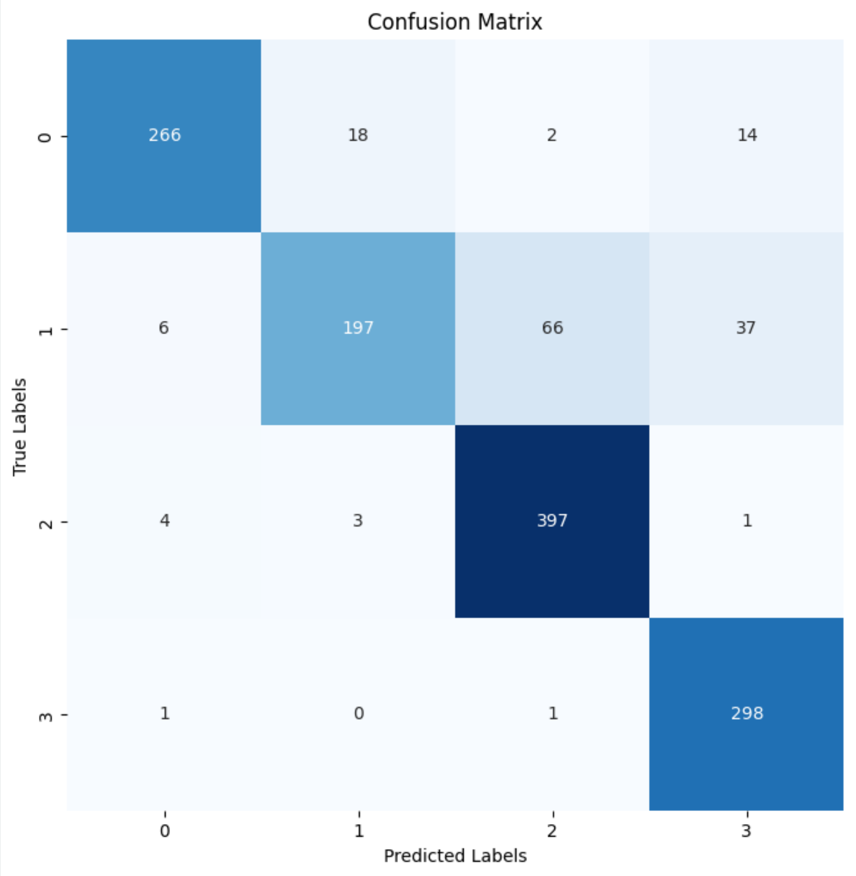


LOWER RESOLUTION: BEFORE TRAINING



Accuracy = 31.27%

LOWER RESOLUTION: AFTER RETRAINING



Accuracy = 77.68%

<u>Class Labels</u>

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CONCLUSION

- Gaussian noise and Poisson noise did not affect the performance very much after the model was retrained.

- Quantization noise suffered, even after retraining (76%).
  - Probably due to the magnitude of noise added.

- Motion blur maintained almost a 90% accuracy.
  - Despite the high level of blur added.

- Lowering the resolution also lowered the accuracy (77%).
  - Probably due to the level at which the resolution was lowered.