# Diagnosing Endometriosis Using Artificial Intelligence on Ultrasound

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## Introduction

Endometriosis is a non-malignant process that affects more than 11% of American women between 15 and 44. It can cause severe dysmenorrhea, dyspareunia, and chronic pelvic pain. Because 30-50% of women with endometriosis are infertile, there is a significant need to diagnose patients at an early stage. While the current gold standard for diagnosis is laparoscopy with biopsy, ultrasound detection would provide a safer, more cost-effective diagnostic tool than surgery and/or MRI. Our objective is to evaluate the accuracy of diagnosing endometriosis at an early stage by detecting features on ultrasound not visible to the naked eye.

## Objectives

1) Evaluate the feasibility of diagnosing Stage 1 and Stage 2 endometriosis via ultrasound
2) Identify image characteristics present in endometriosis but not visible on standard sonography
3) Investigate the accuracy of AI in the diagnosis of endometriosis

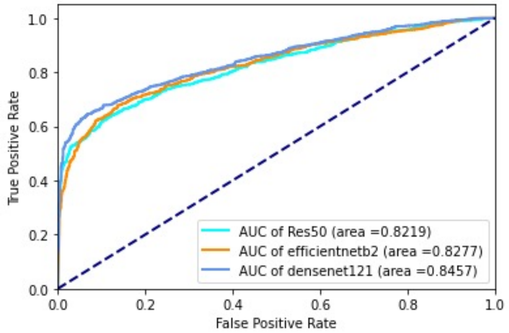
## Materials and Methods

A retrospective cohort of subjects receiving care from 2015-2020 at Rutgers was evaluated for inclusion. Two groups of 50 subjects were defined. The endometriosis group included subjects > 21 years old, diagnosed with endometriosis via laparoscopy or laparotomy, and assessed via transabdominal and transvaginal ultrasounds at Rutgers. The normal group met the same criteria except for the diagnosis of endometriosis. A multitask neural network was evaluated on both sets of ultrasounds. All proposed networks were trained for 50 epochs, using the early stopping technique to avoid overfitting, a learning rate of 0.001 for the first epoch and a learning rate decay of 0.1 every 15 epochs with a mini-batches of size 32. All images were normalized to have zero mean and unit variance and resized to the suitable size for each network during training. All techniques were implemented in Python using the Pytorch framework.

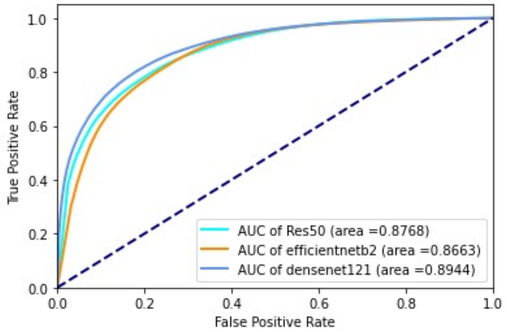
## Results

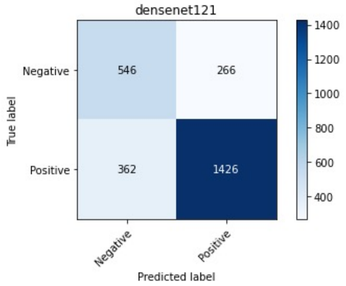
| NN | AUC Test 1 | ACC Test 1 | AUC Test 2 | ACC Test 2 |
|---|---|---|---|---|
| EfficientnetB2 | 0.8278 | 0.75 | 0.8758 | 0.794 |
| ResNet50 | 0.8219 | 0.74 | 0.8839 | 0.778 |
| Densenet121 | **0.8457** | **0.76** | **0.8995** | **0.802** |

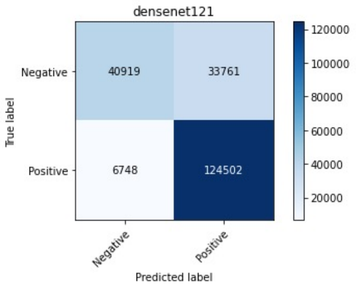
Initial Data – 100 Ultrasounds




Data Augmentation




Three neural network algorithms, EfficientNetB2 (AUC=0.8758), ResNet50 (AUC=0.8839), and DenseNet121(AUC=0.8995) were initially evaluated on the data. To improve accuracy, the dataset size was increased via data augmentation.

## Conclusion

Diagnosing endometriosis early can improve pelvic pain. We expect to identify early-stage endometriosis, which would reduce the need for diagnostic laparoscopies and lead to new therapeutic pathways. Future work includes evaluating a multitask neural network on both sets of ultrasounds and increasing the cohort size to validate results.

## References

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