Automated Segmentation and Measurement of Aortic Aneurysms in Computed Tomography Angiography Using Deep Learning

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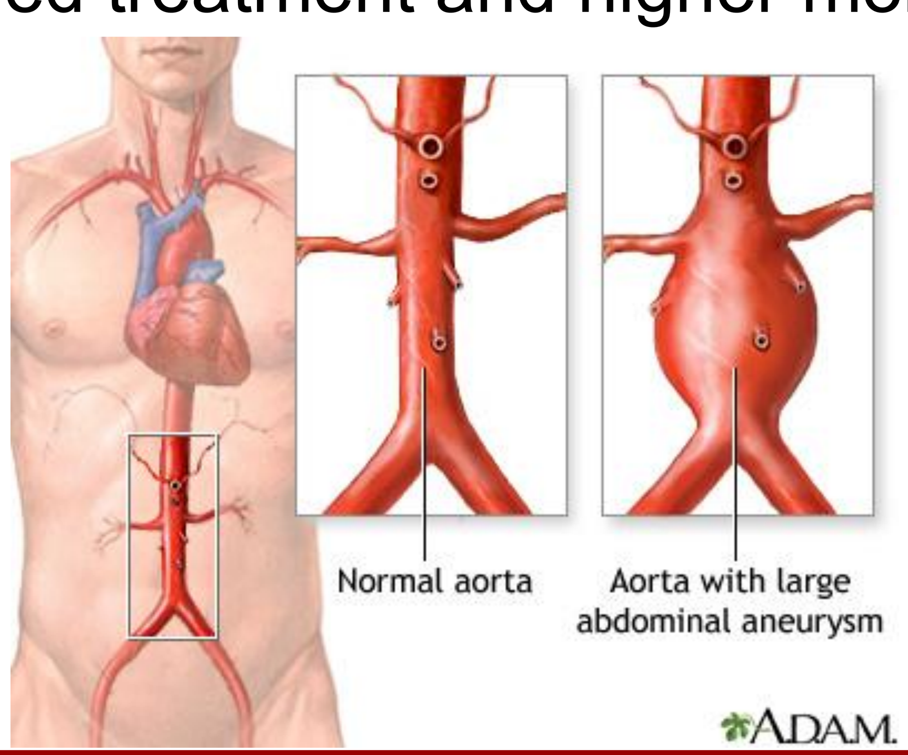
Introduction

Aortic aneurysms (AAs) are dangerous dilations of the aortic wall that can be fatal. They are often symptomless and require radiologic testing for diagnosis. Current methods for determining intervention rely on subjective and time-consuming manual interpretation of CTAs. This study introduces an automated deep learning system that accurately measures AAs, reducing variability and saving time.

Background

Monitoring and intervening in Aortic Aneurysms (AAs) is vital as they can be fatal when they reach over 50% normal diameter or exceed 3 cm. However, measuring the maximum aortic diameter is subjective, variable, and time-consuming, leading to delayed treatment and higher mortality.



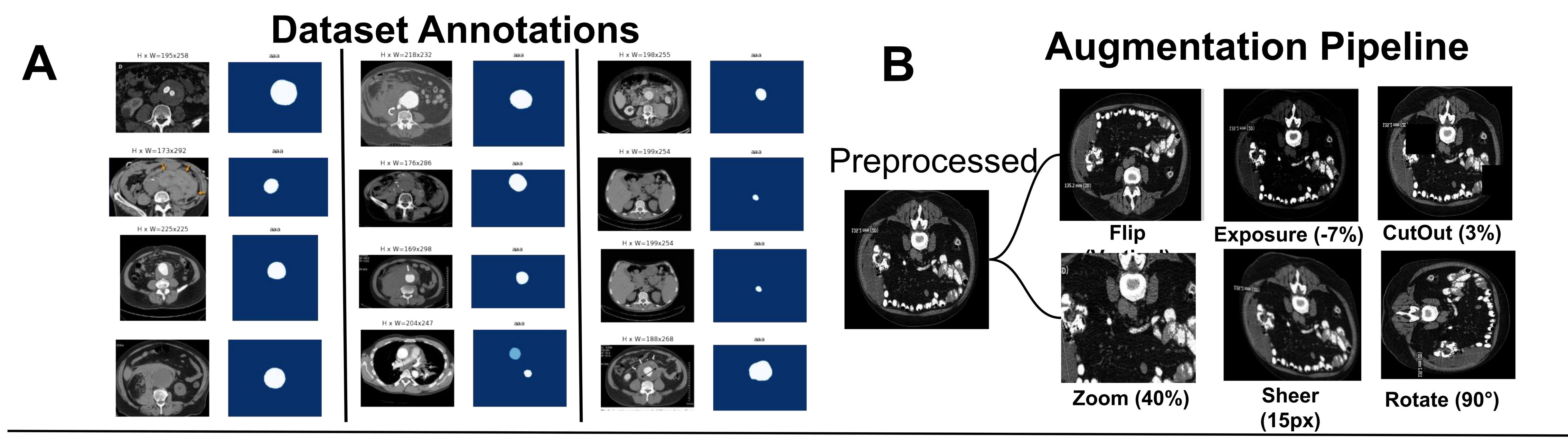
Engineering Goal

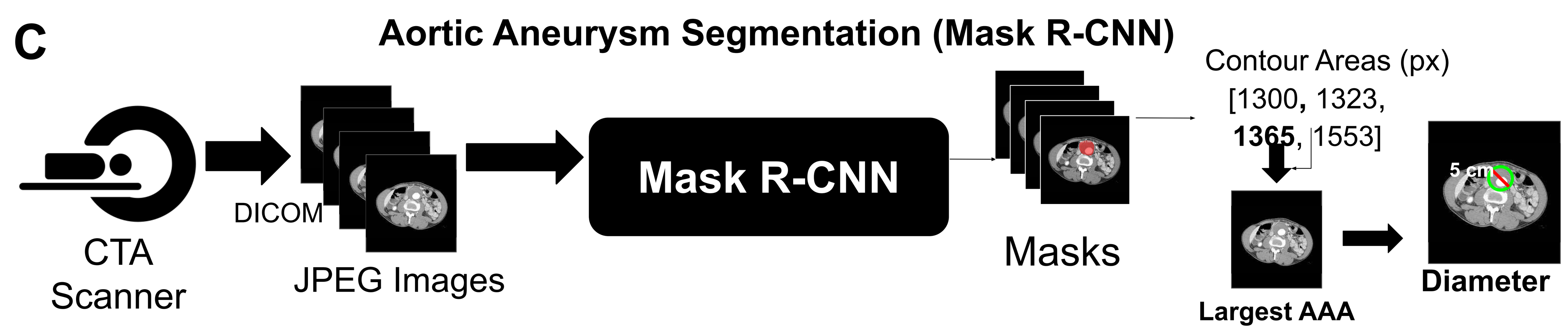
To develop a AI system for AA segmentation to reduce subjectivity, improve accuracy, speed up analysis, and increasing accessibility.

Clinical Study

Vascular specialists annotated web-scraped CTAs of thoracic and abdominal AAs (223 images). Retrospective IRB obtained for clinical study on abdominal CTAs from Stanford (240 patients)

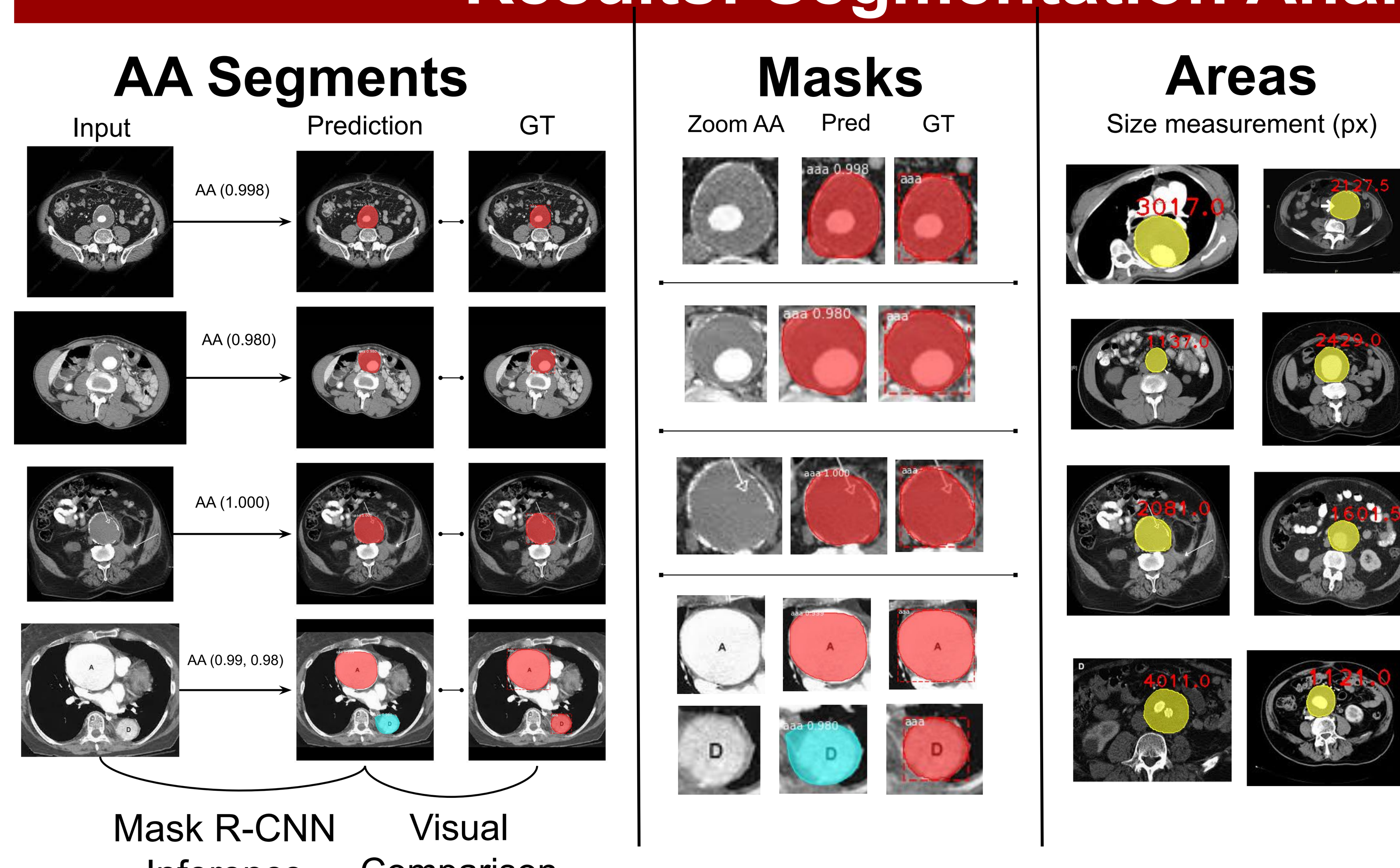
Deep Learning Methods





The vascular team used polygonal annotations (Fig. A) to locate the AA in CTA scans. Data augmentation pipeline increased the dataset size three-fold (Fig. B). The DL system involves a Mask R-CNN, which masks AAA. After slice-by-slice mask generation, Green's theorem measured the area of each mask to output the largest AA, and an inscribed ellipse.

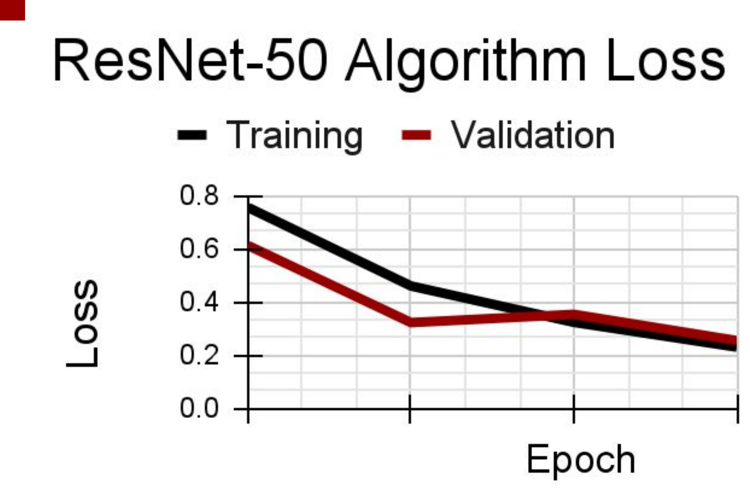
Results: Segmentation Analysis

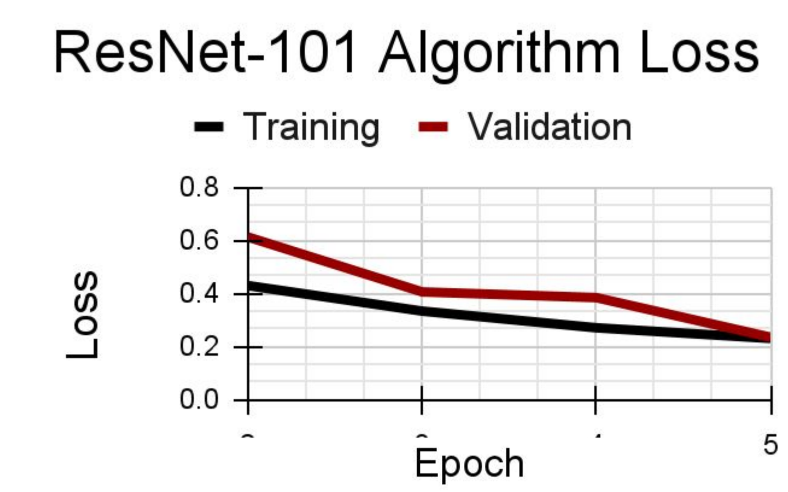


Model is qualitatively evaluated using segmentations, mask comparisons, and area measurements as shown. High concordance is achieved.

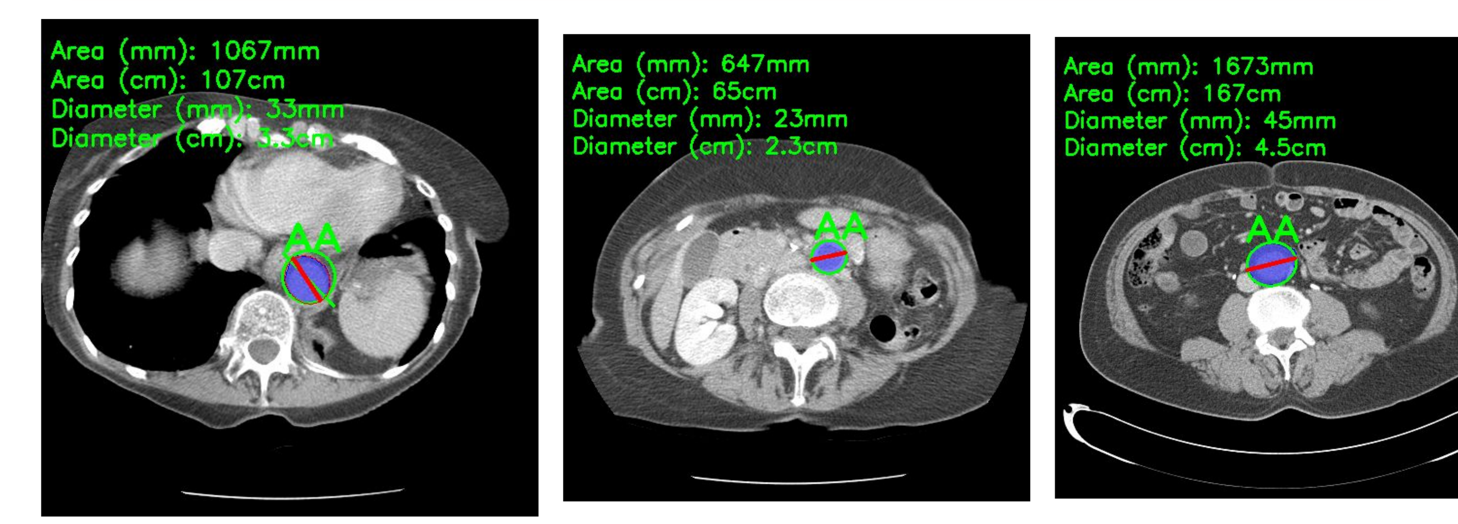
Results: Quantitative Analysis

Segmentation Model	AP50 (%)	AP75 (%)	DICE
Mask R-CNN + ResNet-50	92.43	74.32	78.41
Mask R-CNN + ResNet-101	93.56	87.51	79.98





Clinical Results Interpretation



GT diameter 3.5cm	GT diameter 2.2cm	GT diameter 4.5cm

Clinical patient validation samples from the Stanford IRB cohort. Variations of 0.1-0.2 cm observed in this preliminary study.

Conclusion

This study proposed a deep learning system for automated AA segmentation and quantification, which could improve the efficiency and objectivity of AA analysis. Thank you to Dr. Oliver Aalami for introducing me to this problem and providing medical guidance.

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