Identifying Age-Related Macular Degeneration from OCT Images

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Background

- Age-related macular degeneration (AMD):
  - Affects 8 million people in the United States
  - Early diagnosis leads to earlier treatment
  - Indicated by deposits called drusen
  - Symptoms – drusen structures
  - Diagnosis
  - Treatment

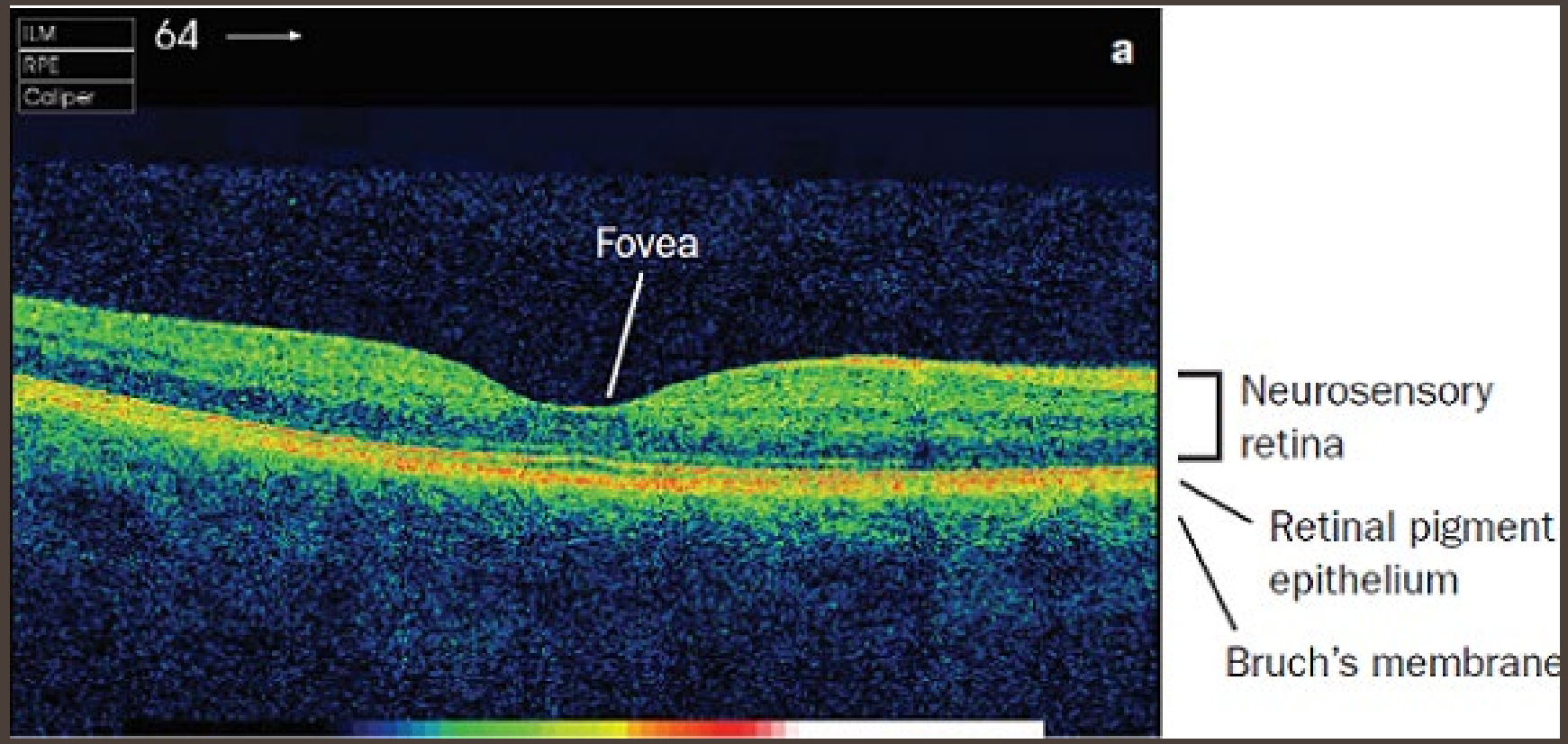
Background

- Stages of AMD:
  - 1: No AMD – a few small or no drusen
  - 2: Early AMD – several small, some intermediate
  - 3: Intermediate AMD – several intermediate 1+ large
  - 4: Advanced AMD – geographic atrophy and/or choroidal neovascularization – vision loss

Background

- Optical Coherence Tomography (OCT):
  - Uses interferometry to obtain images
  - Very high resolution of surface features

Background

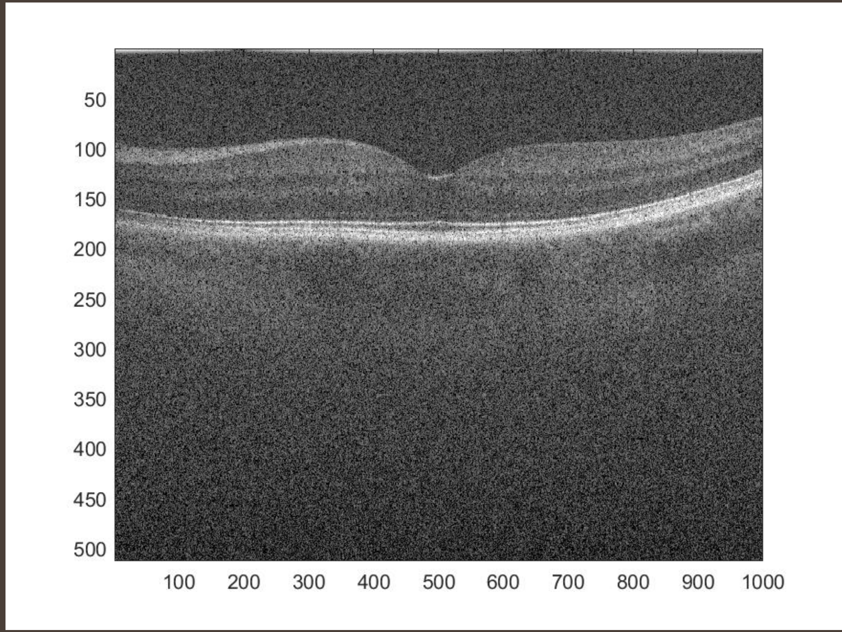


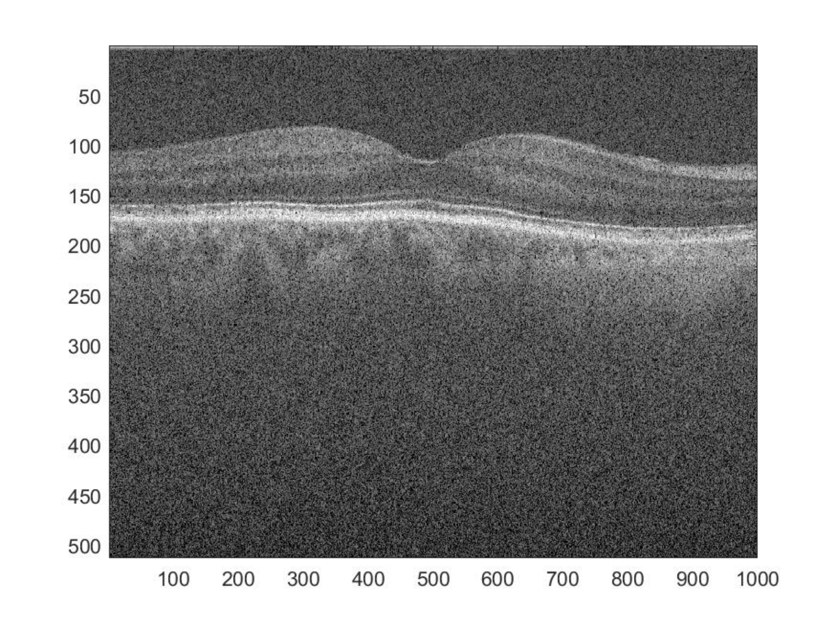
https://www.prescriber.co.uk/article/prevention-treatment-age-related-macular-degeneration/

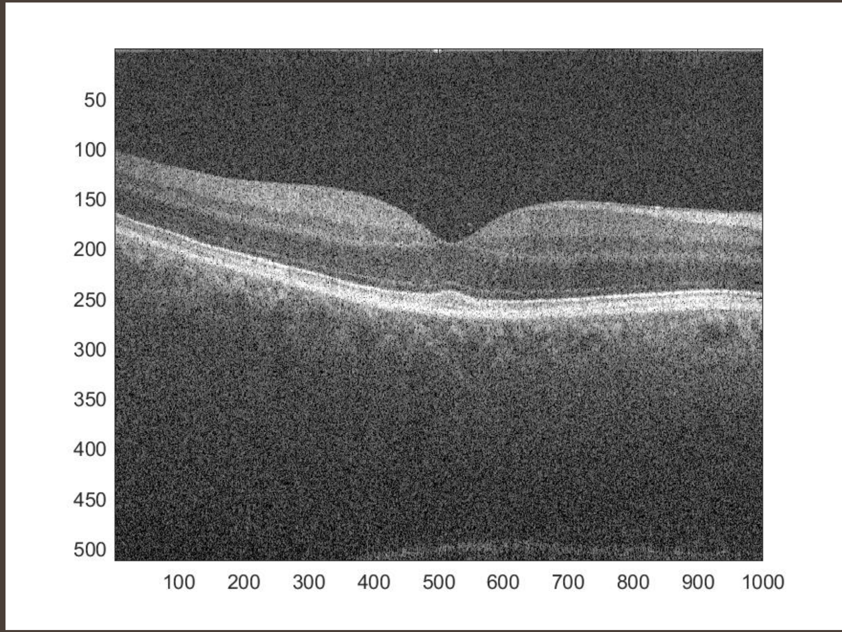
Background

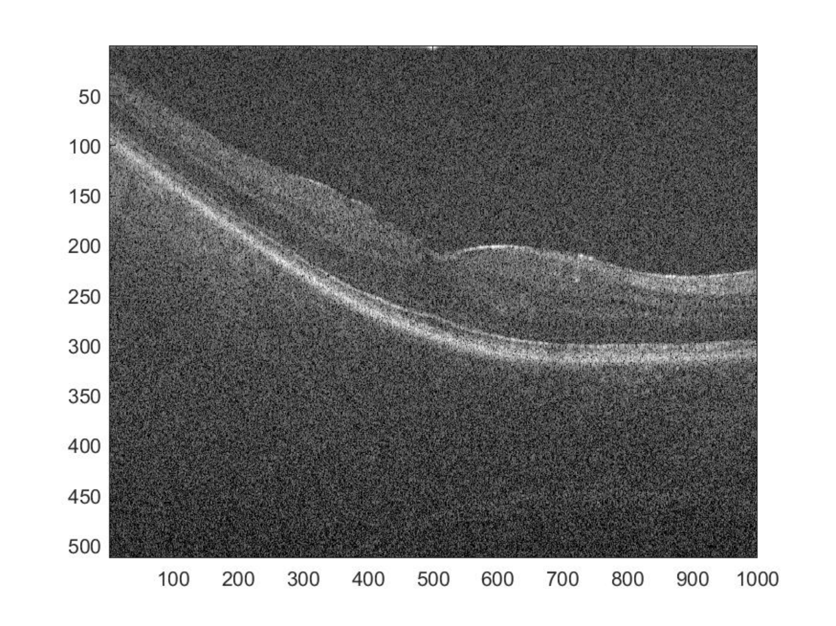
- Dataset from Duke University
  - 384 patients
  - 269 AMD patients
  - 115 control
  - 100 images per patient
  - Depth varies with center of fovea at image 50

Sample Images – Normal

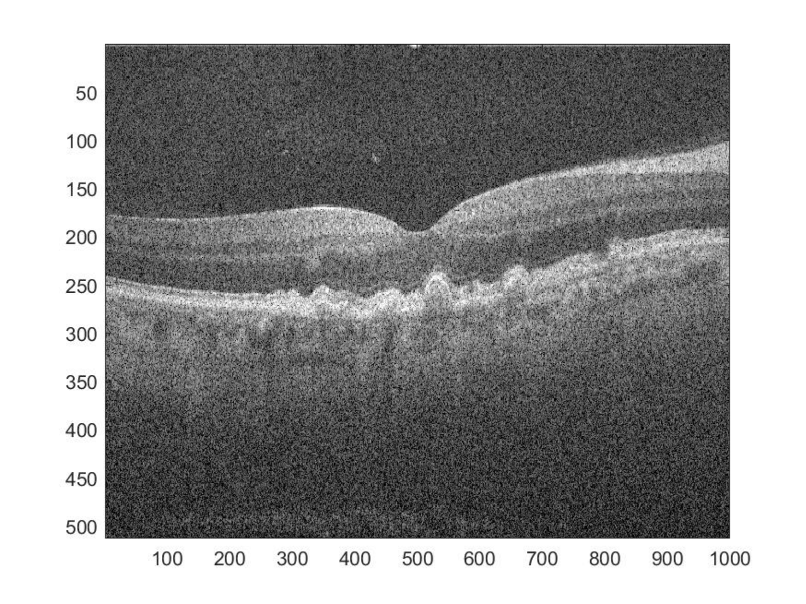


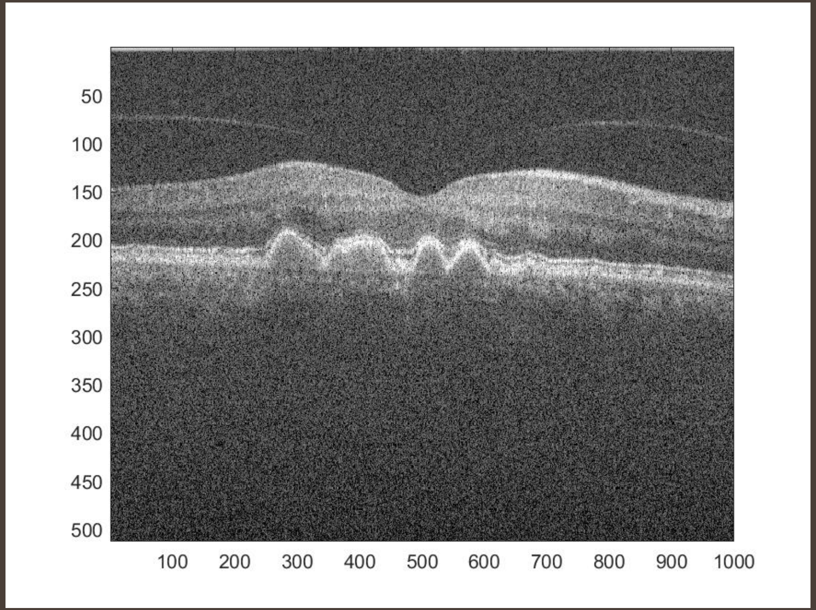


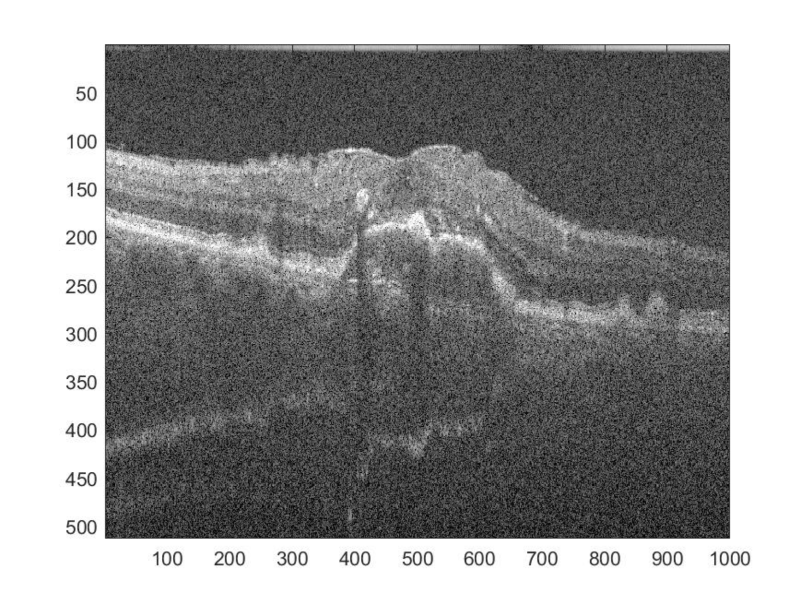


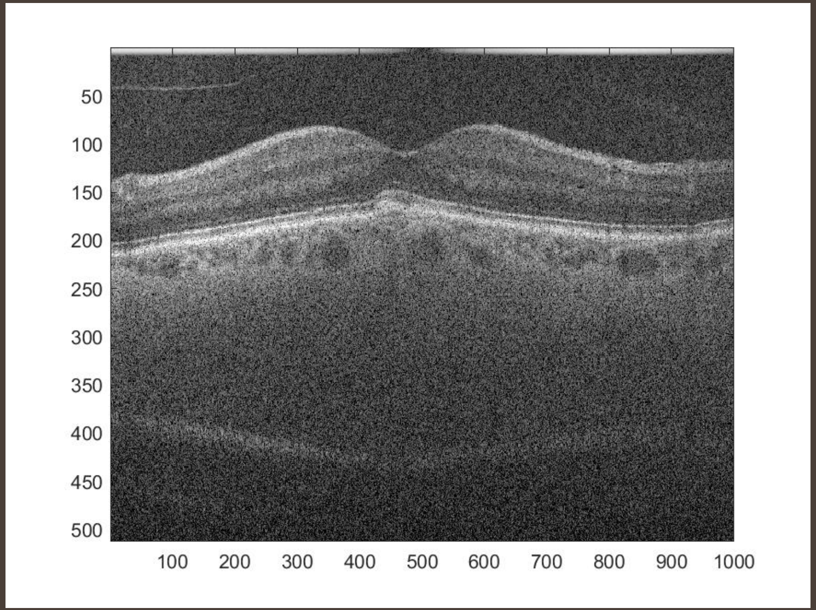


Age-Related Macular Degeneration





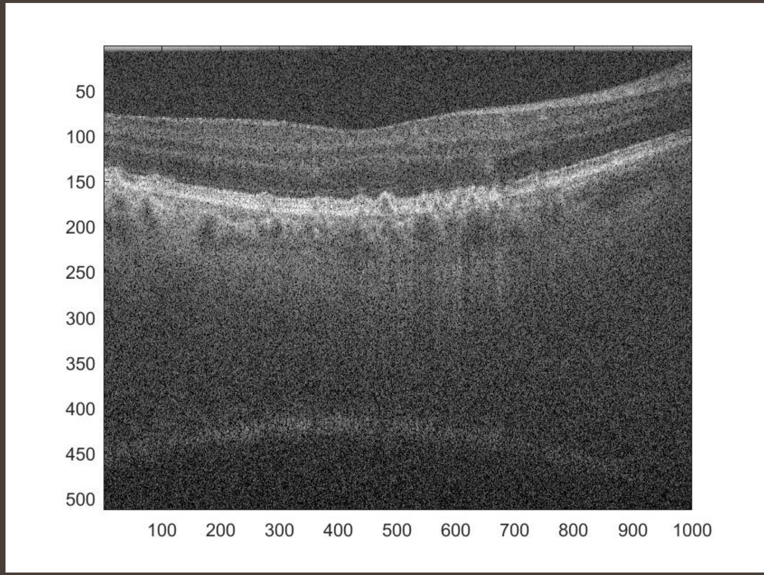


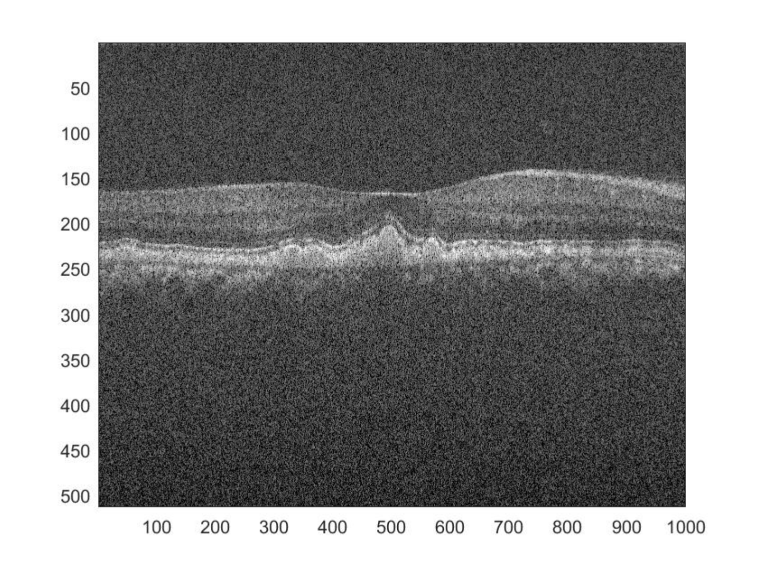


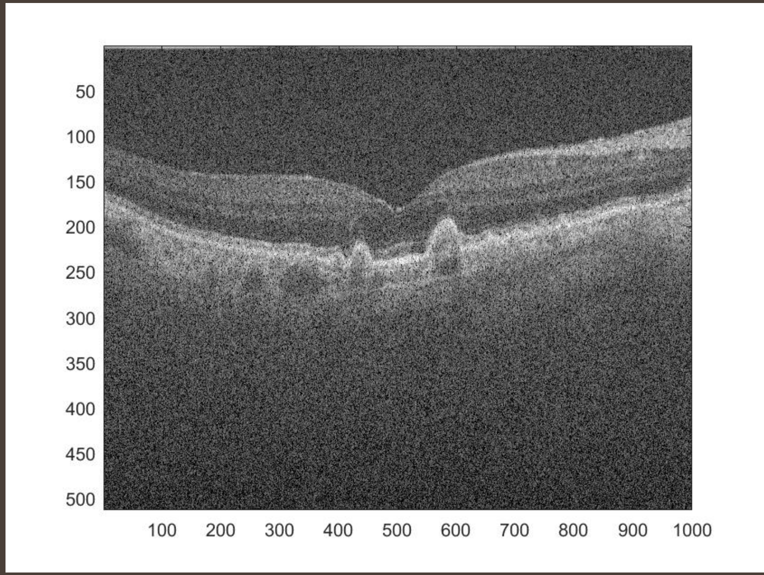
Methods

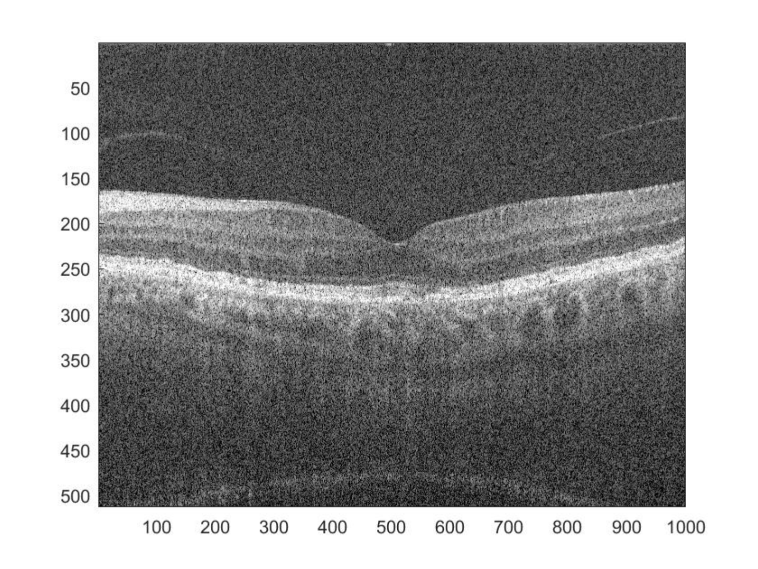
- Pre-filtering
- Binarization
- Filtering Binary Images
- Isolating Retinal Pigment Epithelium
- Comparing key measurements of the region
- Creating a threshold for classification

Original Images







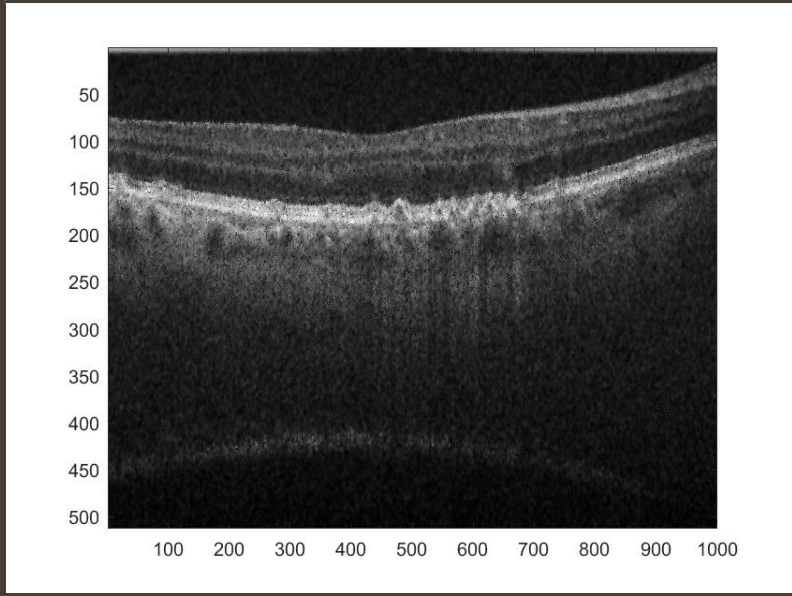


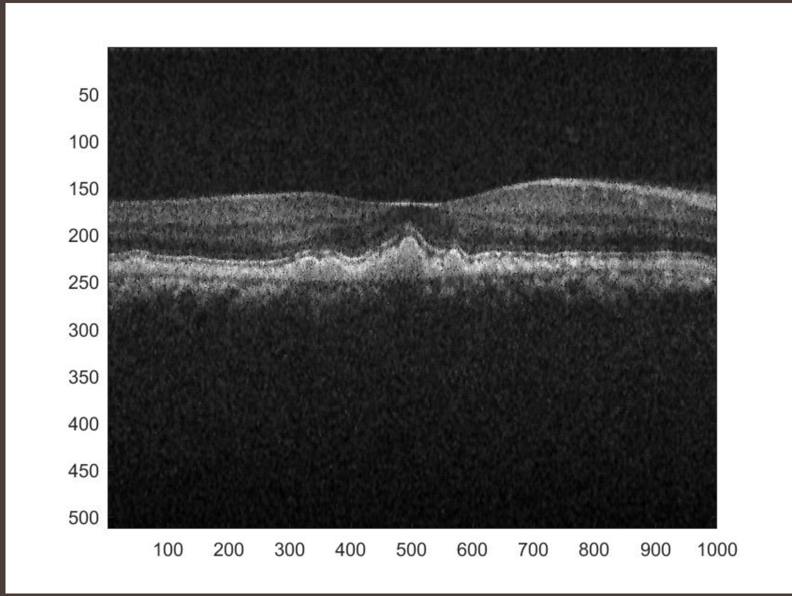
- Need filtering to remove noise, join segments, and isolate without losing information

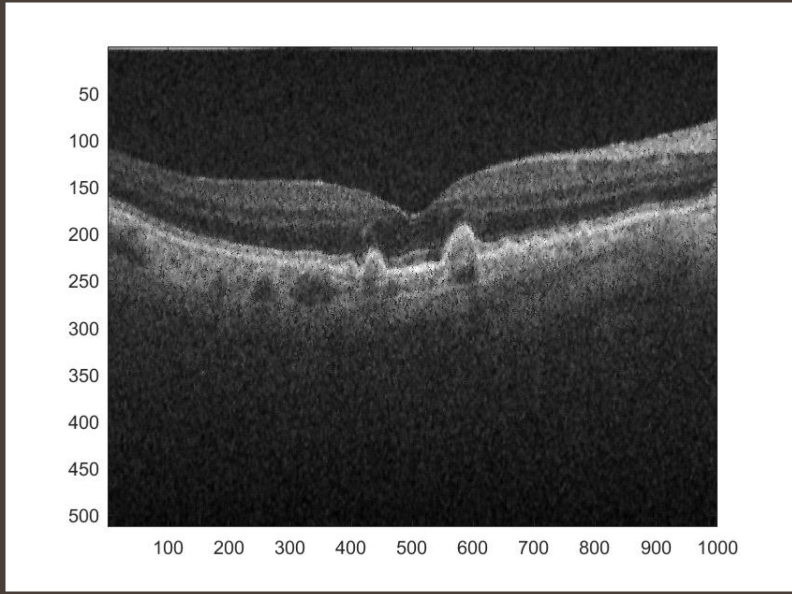
Pre-filtering

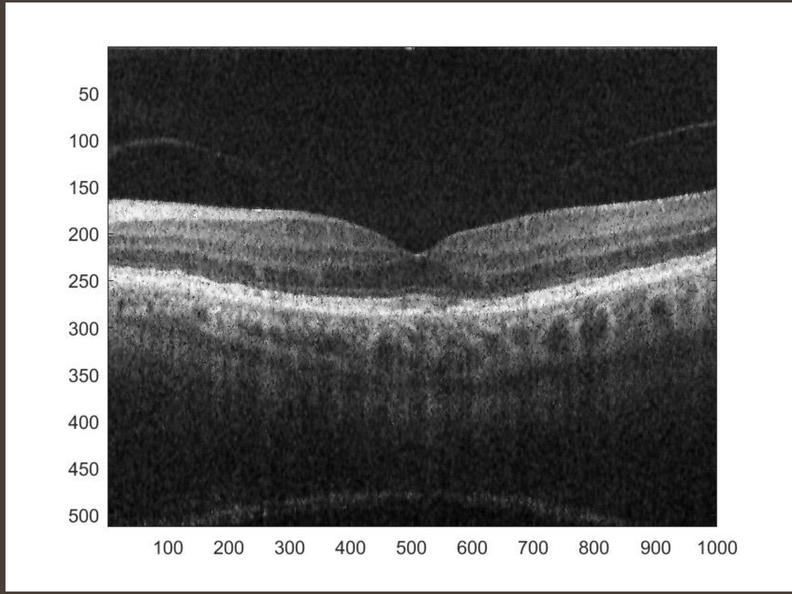
- Windowing – treat everything below 20% as black – “imadjust” function
- Wiener Filter – adaptive low pass filter for smoothness – “wiener2” function

Pre-filtering

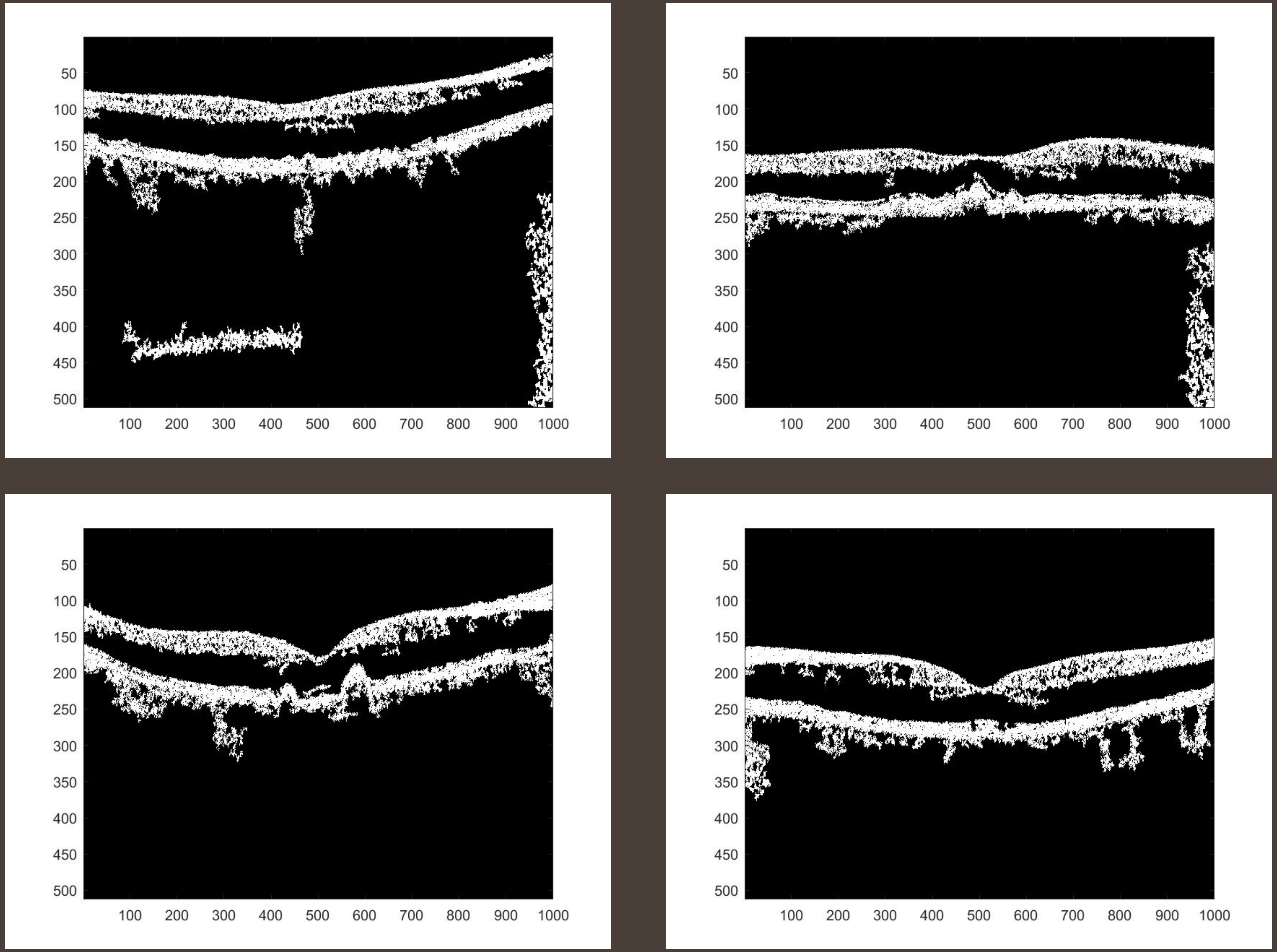








Binarization

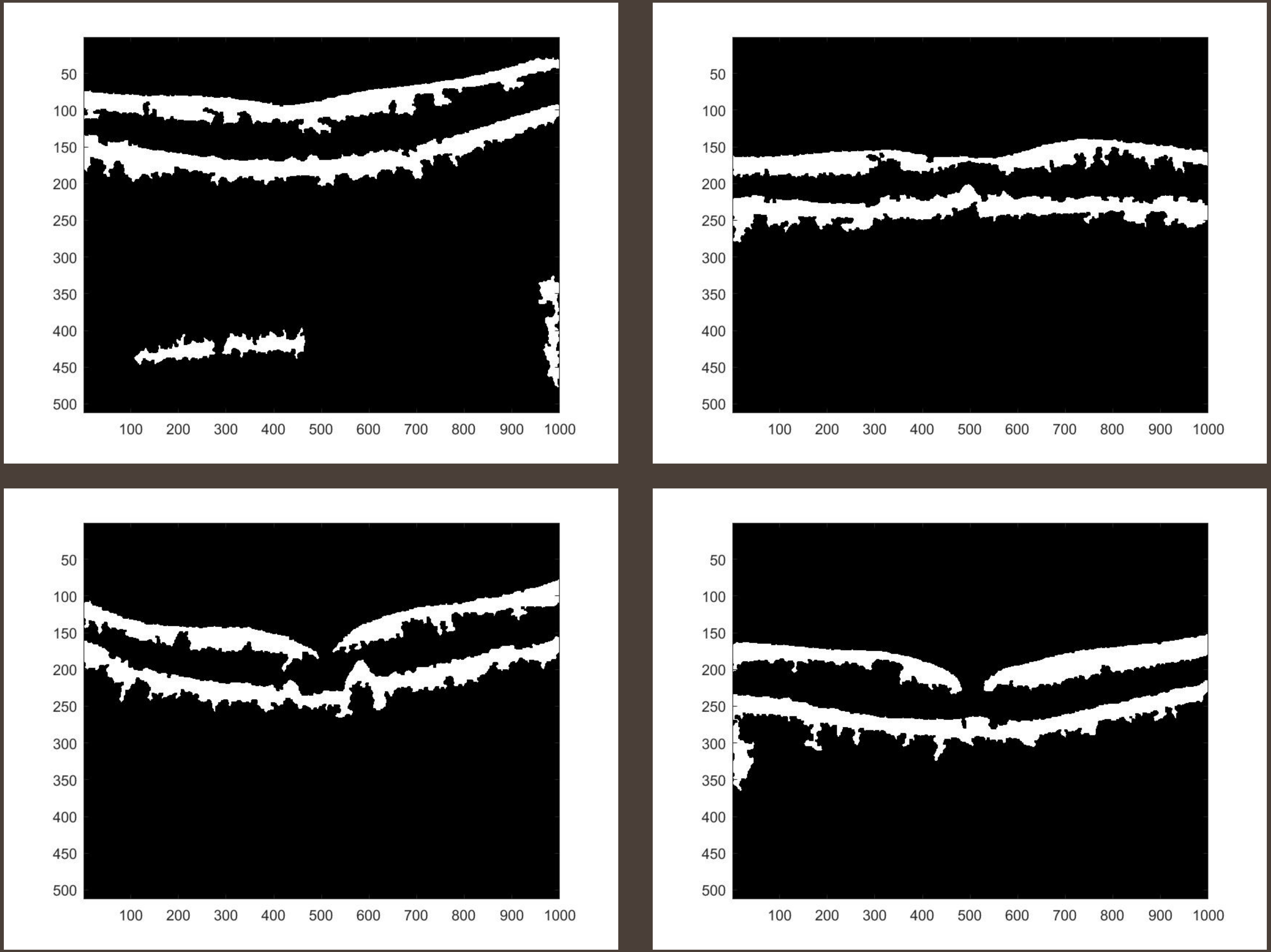


- Distinct regions already observed

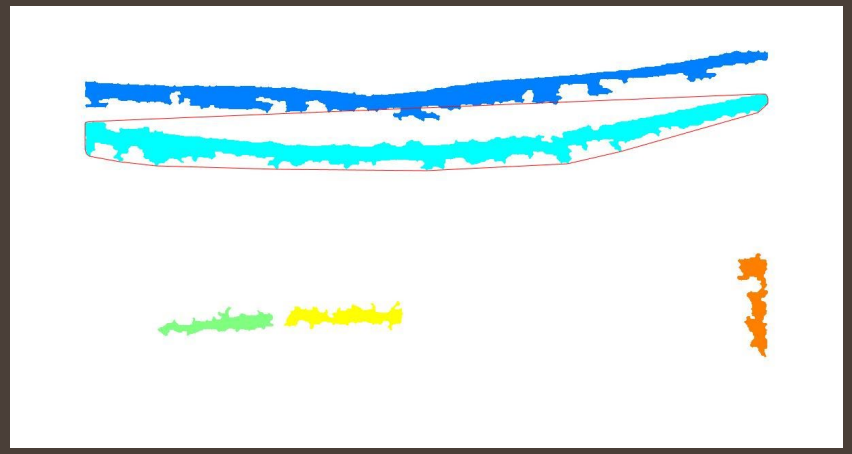
Filtering Binary Images

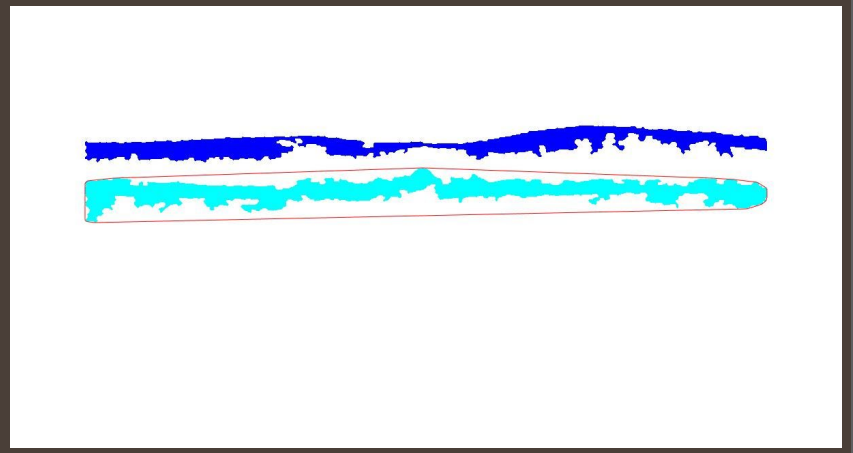
- Removing small objects – ignore regions smaller than 5000 pixels – "bwareaopen" function
- Erosion and dilation – small disk – "imopen" function
- Remove small objects again – 1000 pixels
- Fill holes in remaining objects – "imflll" function
- Dilation and erosion – slightly larger disk – "imclose" function
- Repeat

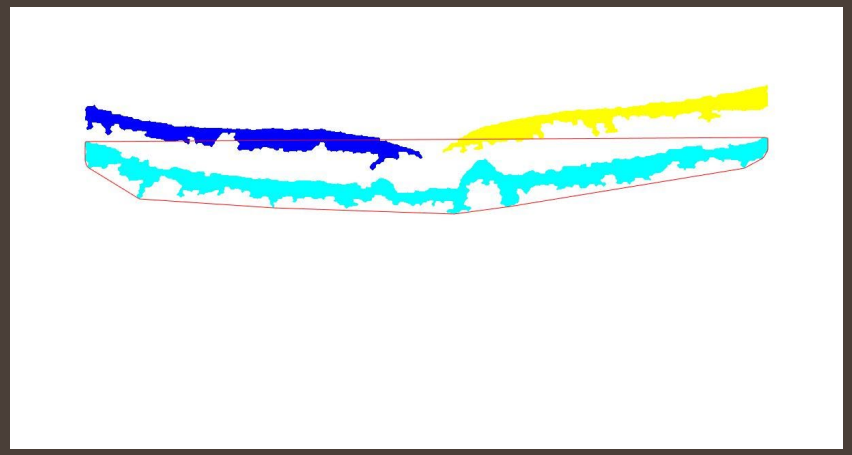
Filtering Binary Images

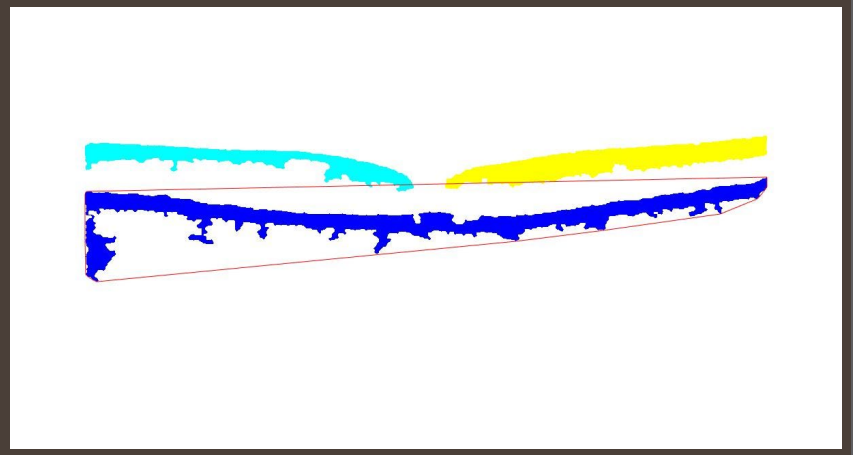


RPE Isolation



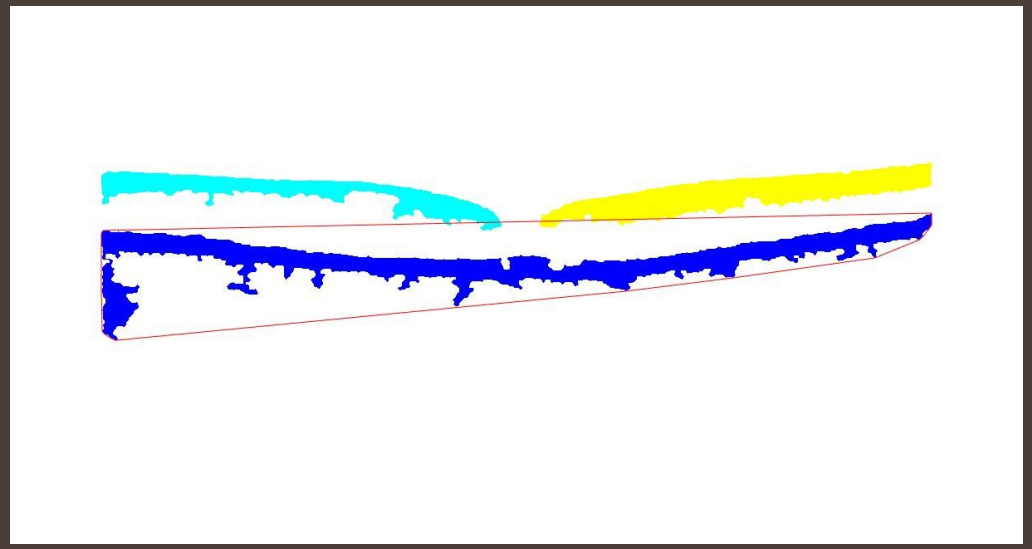




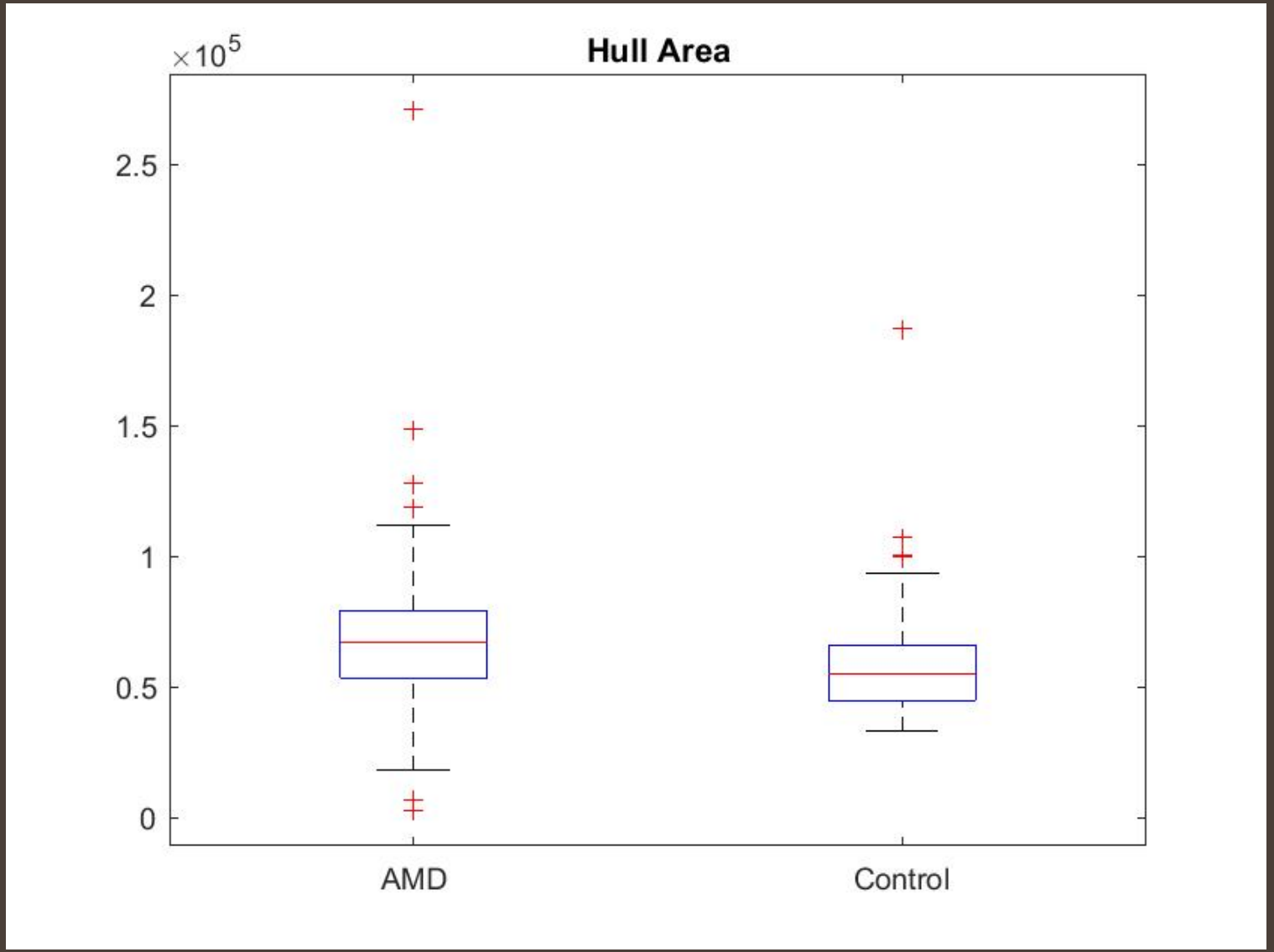


RPE Parameters

- Convex Hull Area
- Perimeter
- Area
- Area/Perimeter
- Area/Major Axis



Comparisons



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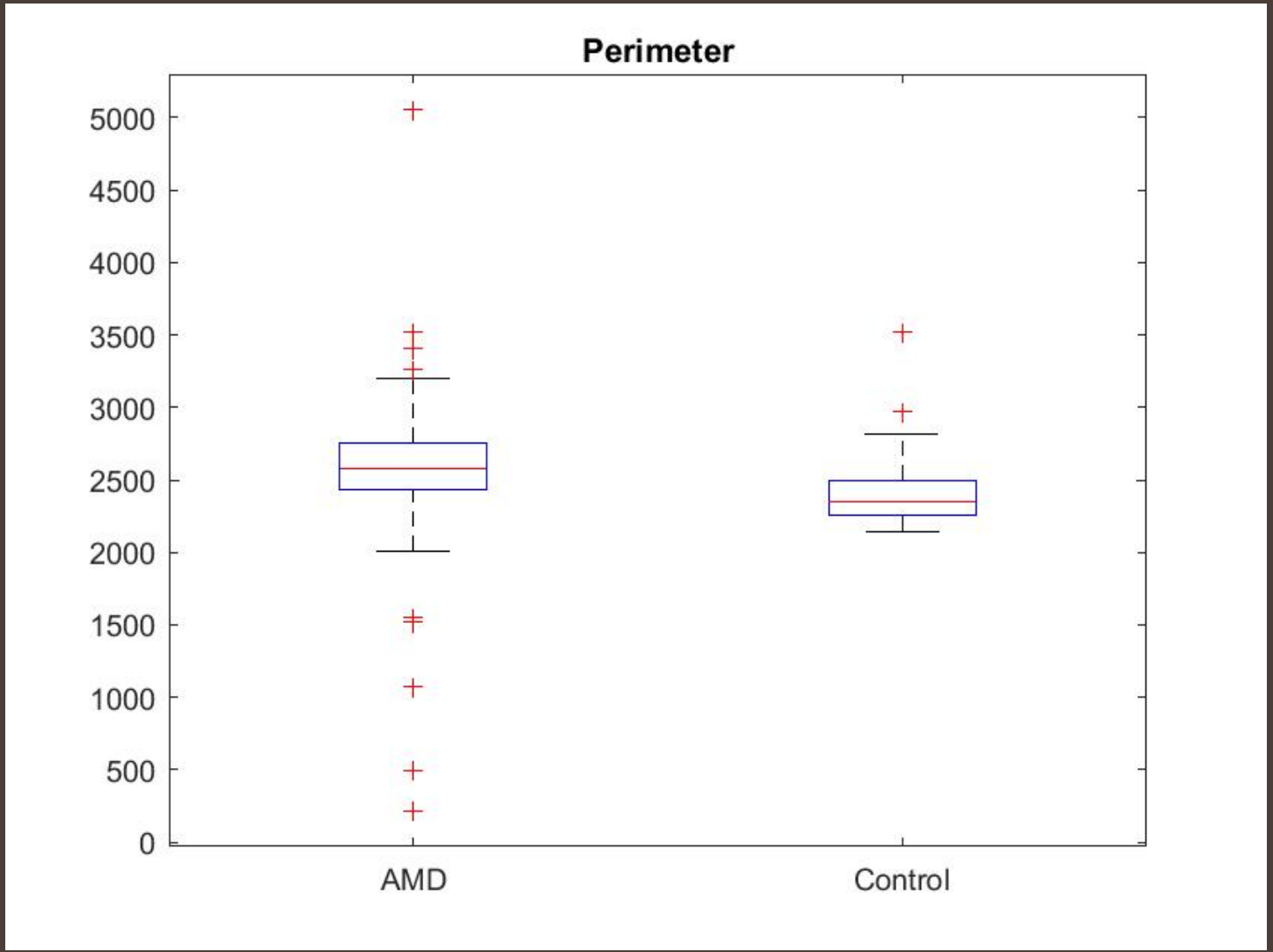

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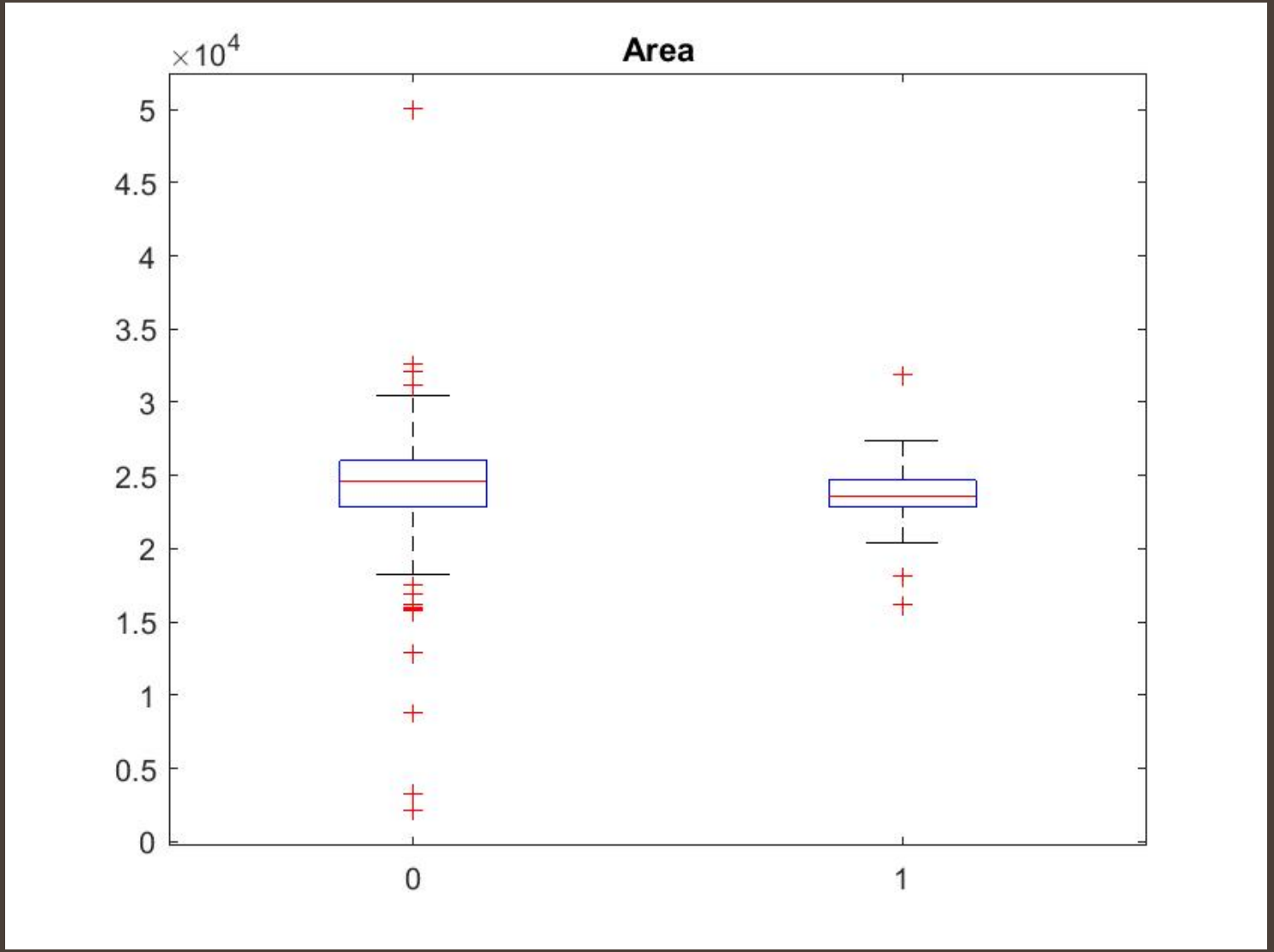

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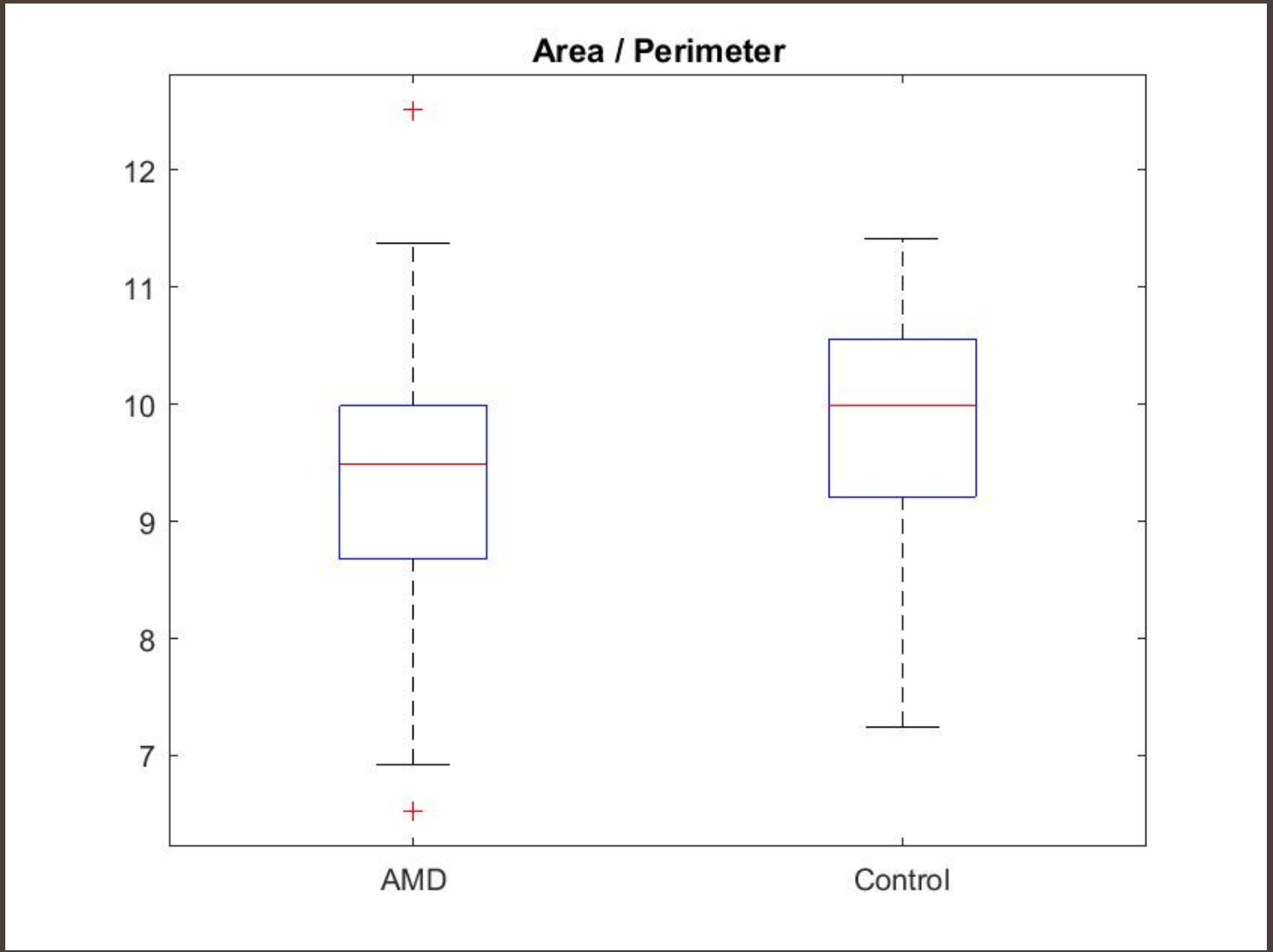

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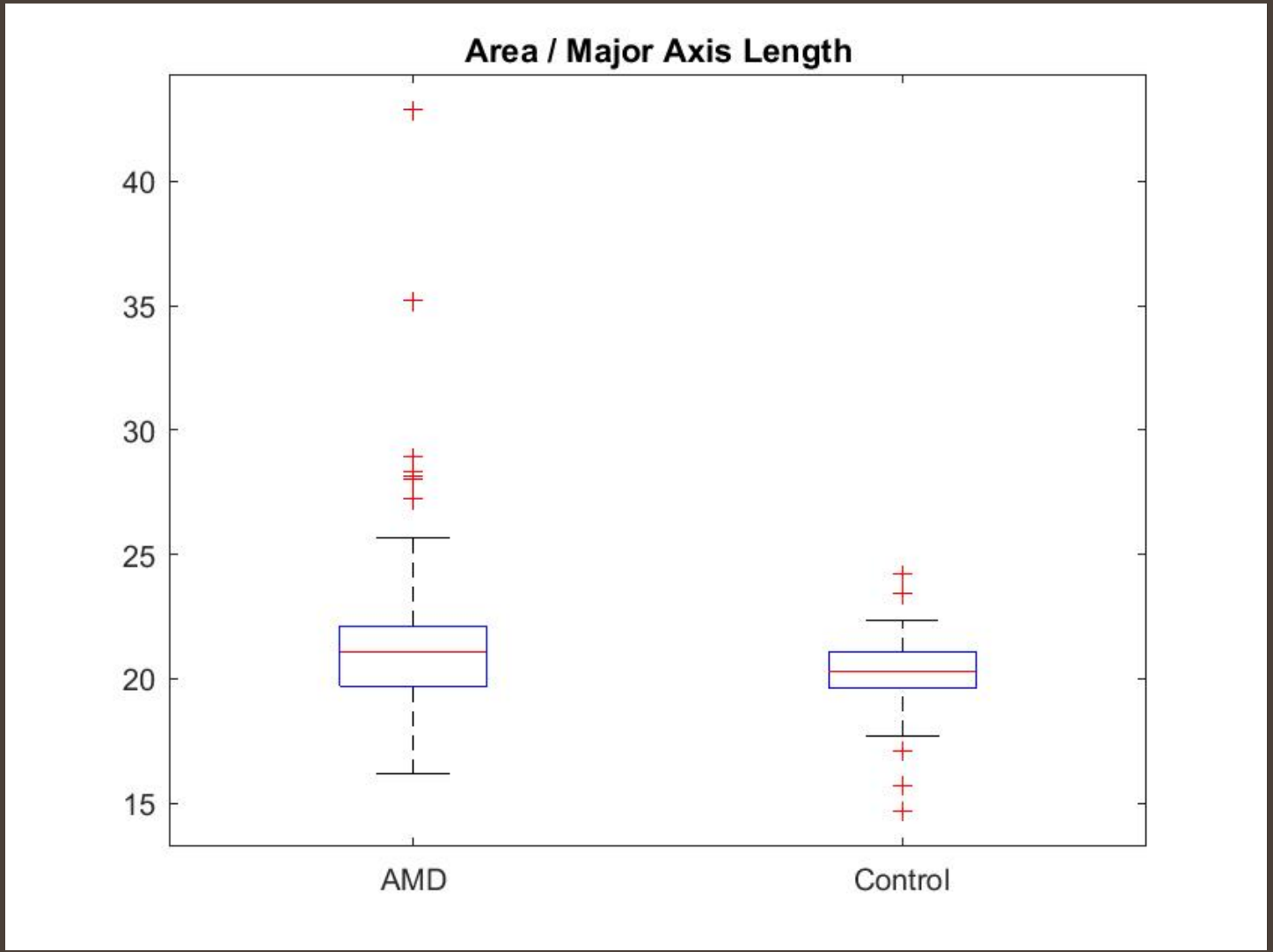

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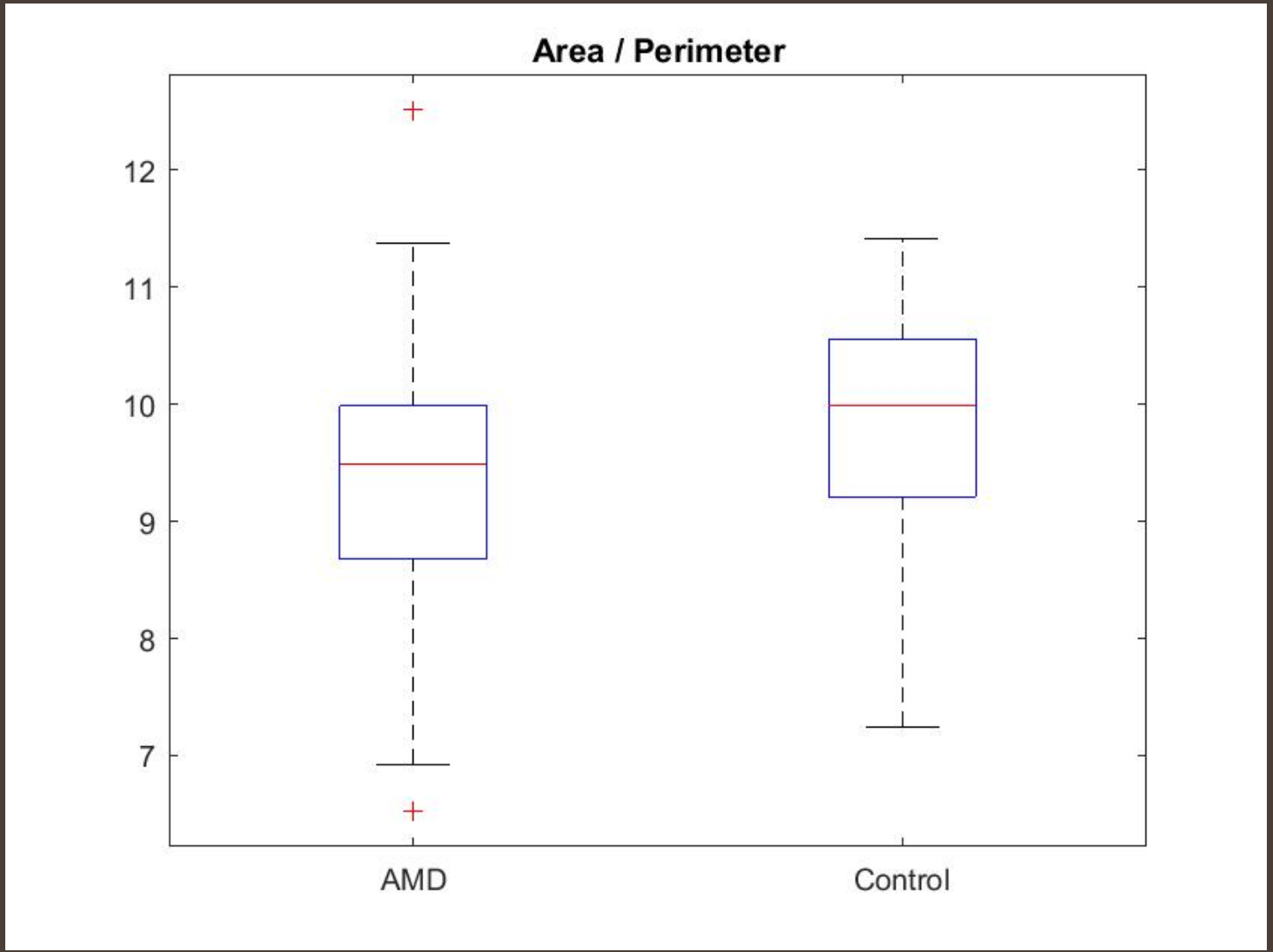

Classification Threshold

- It was not possible to create a useable threshold from any of the variables analyzed in this model.
- Variations could be combined into a weighted system

Conclusion

- Successful identification and isolation of RPE
- Consistent variations between variables of interest
- No single identifier to distinguish AMD and control patients
- Combination of variables may be possible for a classification system

References

- [1] Farsiu, S., Chiu, S. J., Oconnell, R. V., Folgar, F. A., Yuan, E., Izatt, J. A., & Toth, C. A. (2014). Quantitative Classification of Eyes with and without Intermediate Age-related Macular Degeneration Using Optical Coherence Tomography. *Ophthalmology*, *121*(1), 162–172. doi: 10.1016/j.ophtha.2013.07.013.