Prediction of Geographic Atrophy Enlargement using Various Deep Learning Approaches

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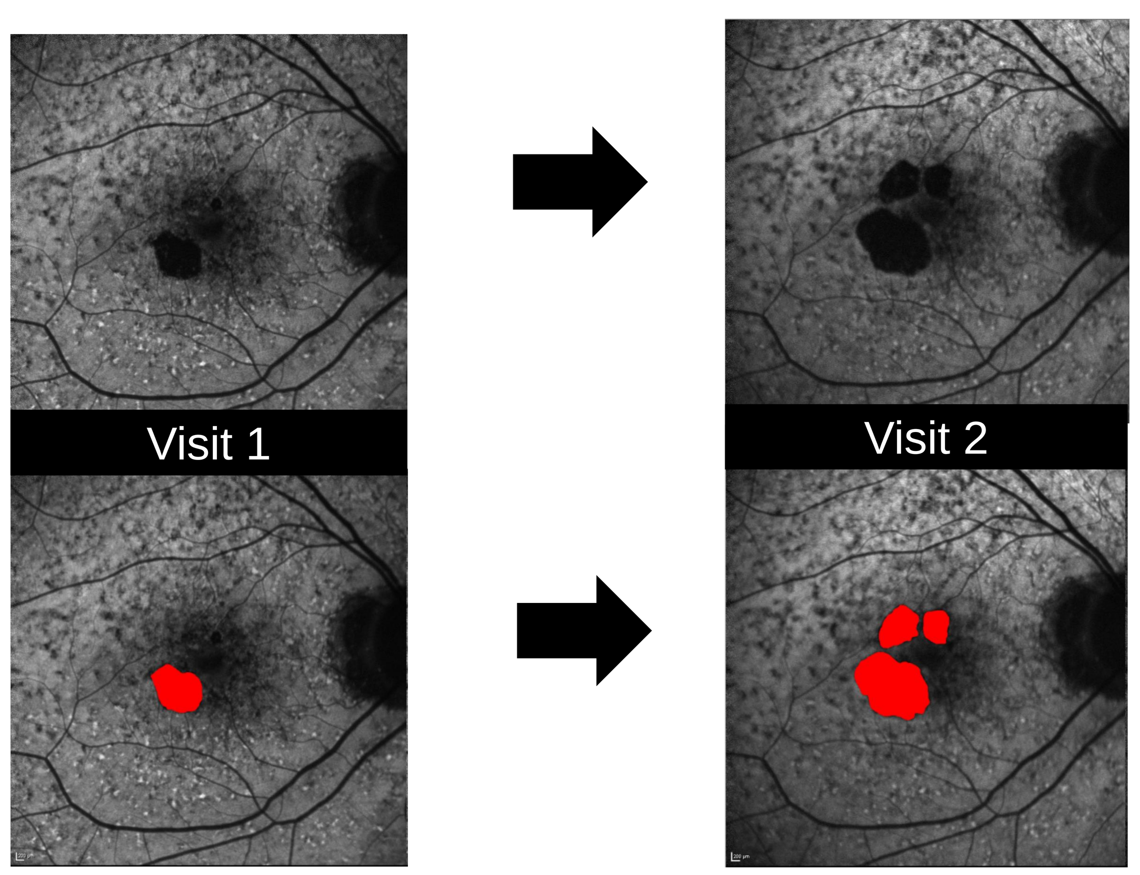
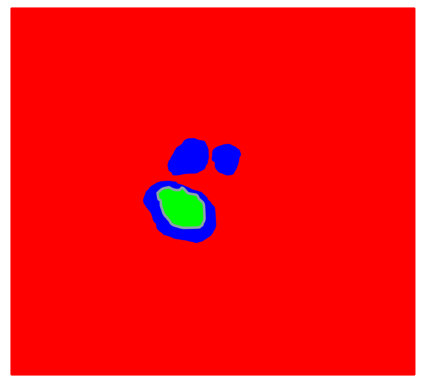
Background and Purpose

- Fundus autofluorescence (FAF) imaging is used to monitor geographic atrophy (GA) growth in clinical trials.
- There is significant variability in the growth rate of GA with studies reporting between 0.5 – 2.6mm/year.[1]
- Multiple imaging risk factors for rapid enlargement have been studied but do not fully explain the variability. [2]
- *Predictive models rely on the hypothesis that baseline images have signal for future growth*
- **The purpose of this project is to use AI to predict GA enlargement using various approaches.**

Methods

- Heidelberg FAF images with annual visits from the Age-Related Eye Disease Study 2 were utilized[2]
- Training dataset: 208 paired FAF images
- Testing dataset: 43 paired FAF images
- GA was segmented on FAF images using planimetry and areas measured in mm^2 by trained and certified human graders





Disclosures

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Classifier Models

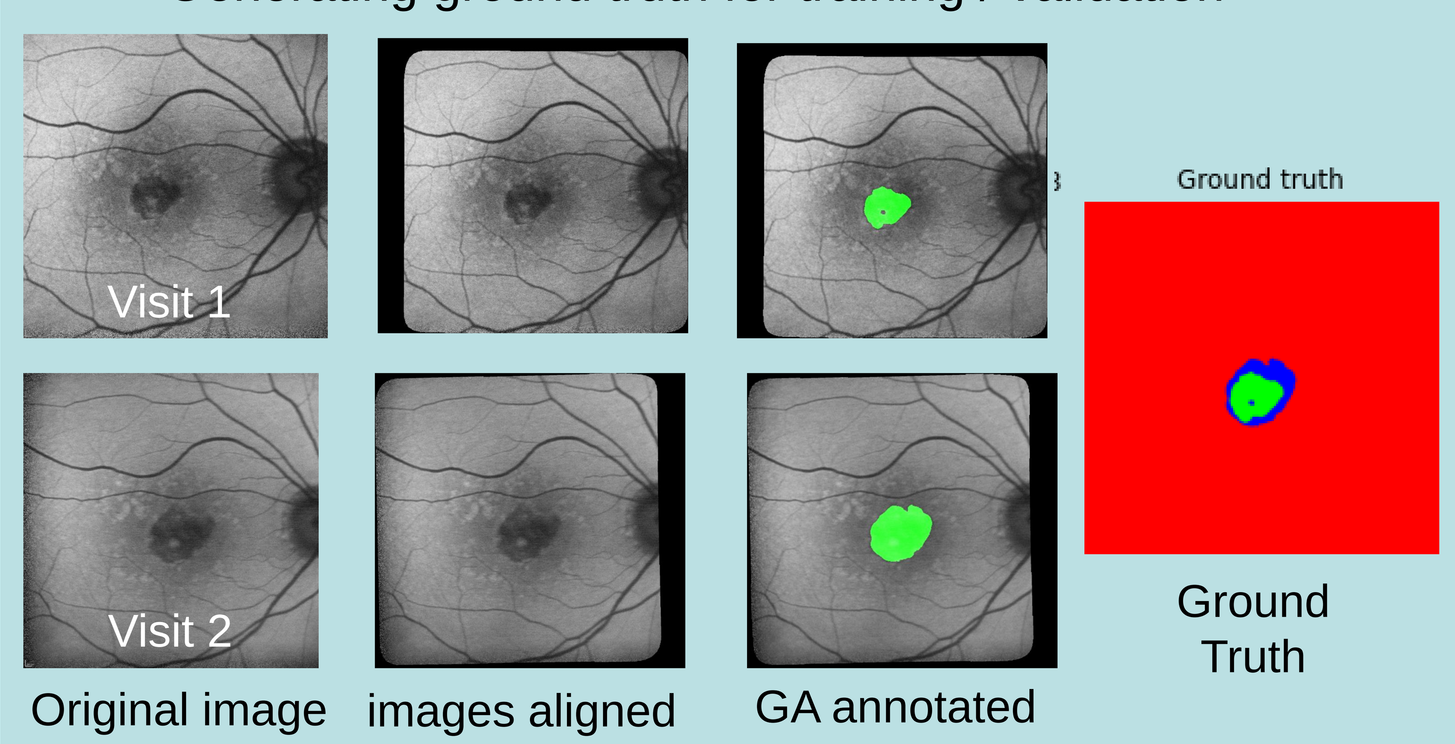
Table 1	Slow Progressors (GA growth rate < 1.1. mm^2/ year)	Fast Progressors (GA growth rate > 1.75mm^2/year)
Sensitivity	73 %	61%
Specificity	57 %	83%
Accuracy	65 %	77%
Precision	64 %	62%
False Positive	43 %	16%
False Negative	27 %	38%
F1 score	68%	62%

Table 2

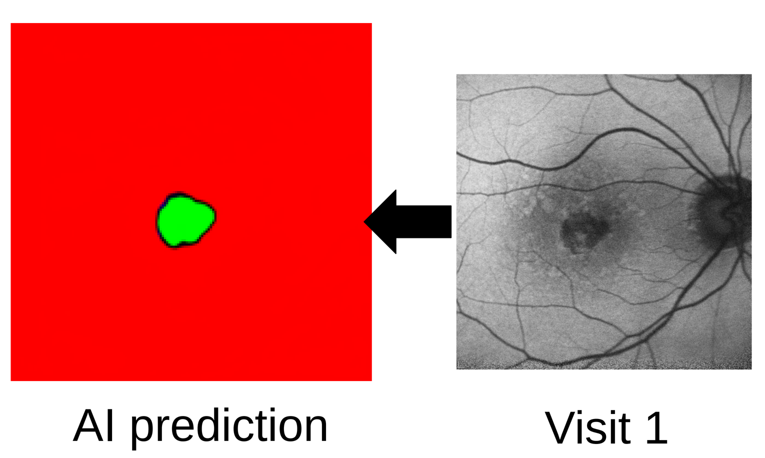
	SLOW	AI prediction	
Ground Truth	N=43	**Slow progressor**	**Not so slow progressor**
	Slow progressor	12	9
	Not so slow progressor	6	16

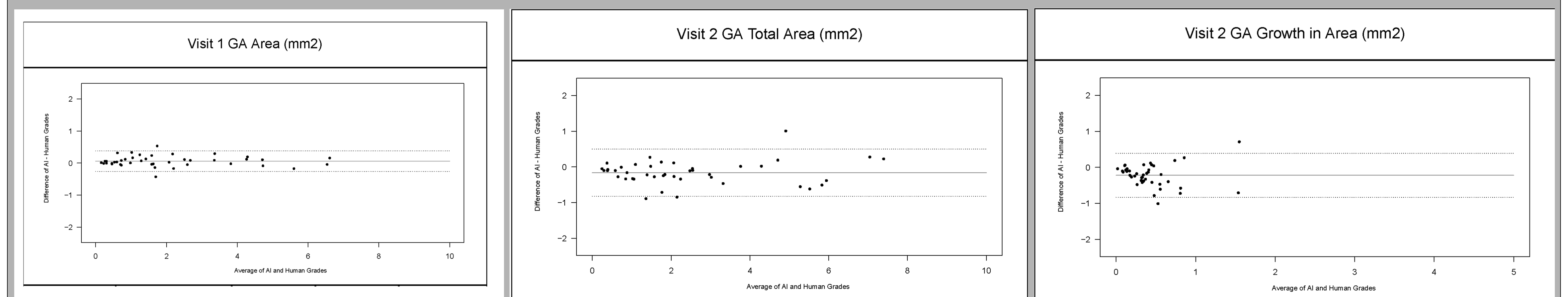
	FAST	AI prediction	
Ground Truth	N = 43	**Not so fast progressor**	**Fast progressor**
	Not so fast progressor	25	5
	Fast progressor	5	8

Segmentation Model

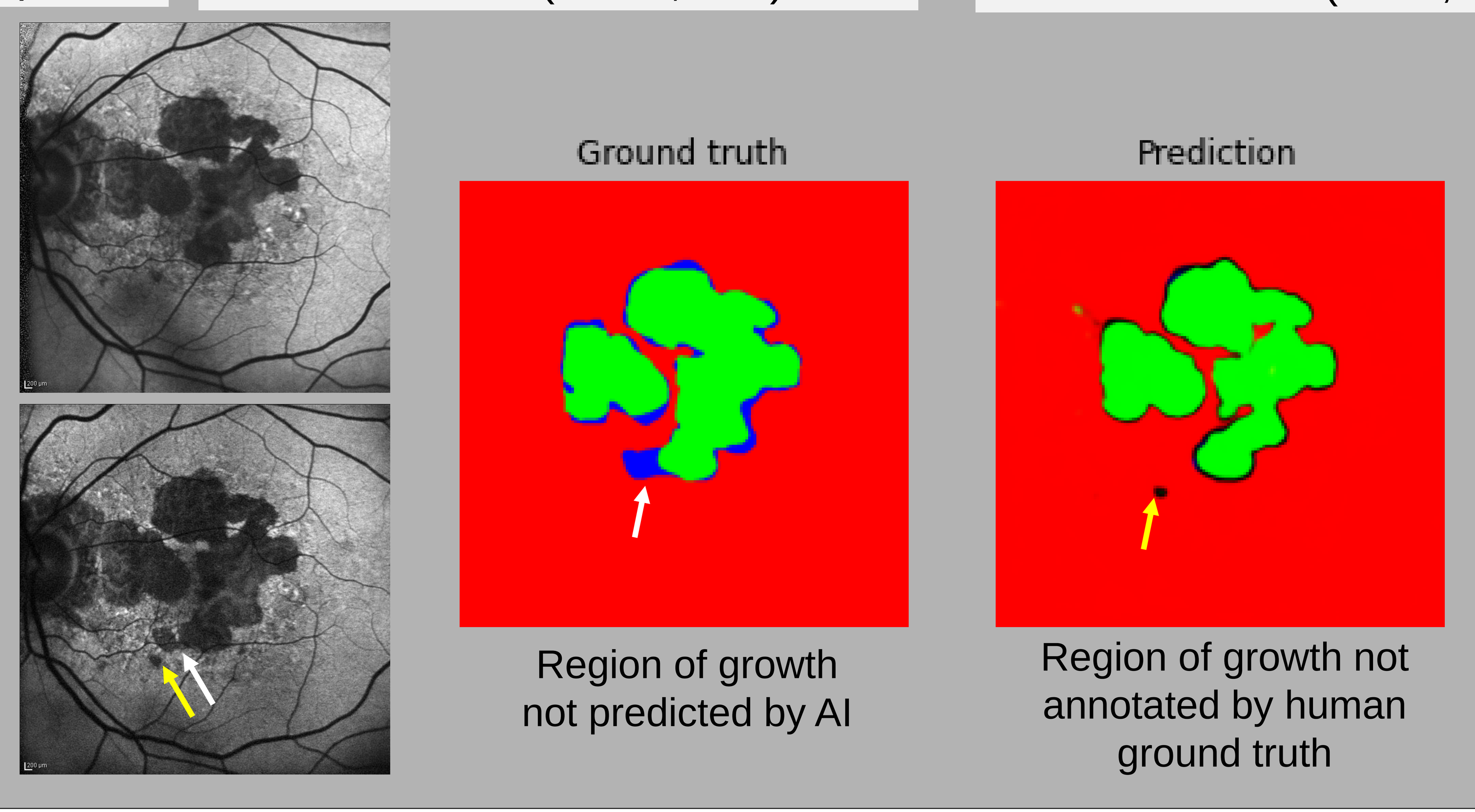


AI Segmentation Model – uses Visit 1 image to predict current area and future growth





Mean diff 0.06 (-0.26,0.38) mm^2 | Mean diff -0.16 (-0.82,0.50) mm^2 | Mean diff -0.22 (-0.83,0.39) mm^2



Results

	Mean (SD)	Median (IQR)
Visit 1 area	2.00 (1.75) mm^2	1.47 (1.93) mm^2
Visit 2 area	2.53 (1.93) mm^2	1.98 (2.37) mm^2
Growth rate	0.53 (0.37) mm^2 / year	0.47 (0.35) mm^2 / year

- Classifier Models: Performance of slow and fast classifier models is shown in table 1 with confusion matrix in table 2.
- **The segmentation model is a triple model that uses visit1 FAF image to predict regions of non-GA, visit 1 GA area and future growth at visit2**
- The Dice coefficient comparing the segmentation of visit1 area and future growth are shown in table 3.

Table 3

AI predictions	Dice coefficient	R^2	ICC
Visit 1 GA area	0.90	0.990	0.995
Visit 2 GA area	0.99	0.963	0.499
GA Growth area	0.26	-0.10	0.982

Conclusions

- Classifier models are useful for enrolling appropriate patient population in clinical trials.
- Excluding the slow progressors and enriching with fast progressors helps achieve robust trial effects. AI models are useful for prescreening enrollment in clinical trials for GA treatments.
- The segmentation model can predict both current area and future growth. The model performance is robust for current area. Larger validation sample with a wider range of growth is needed to confirm the performance of growth prediction.

References

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2. Keenan TD, Agrón E, Domalpally A, et al. Progression of Geographic Atrophy in Age-related Macular Degeneration: AREDS2 Report Number 16. *Ophthalmology*. Dec 2018;125(12):1913-1928. doi:10.1016/j.ophtha.2018.05.028