Introduction

- Diabetic retinopathy (DR) is one of the most common causes of blindness in the western world [1].
- Microaneurysms (MA) are the hallmark of diabetic retinopathy (DR) [2].
- We present a machine learning algorithm for the automatic detection of pathologic capillary dilation and looping, features consistent with MAs, as an aide in the diagnosis of MAs.

Data

- Patients were enrolled at the New England Eye Center at Tufts Medical Center in Boston.
- OCTA data were acquired from 8 patients with varying severities of DR using an OptoVue Avanti device.
- 16 OCTA volumes with field sizes of 3x3 mm were acquired in each imaging session.
- The Avanti software was used to segment the retinal layers and generate en face projections.
- An expert grader at the Boston Imaging Reading Center generated annotated data by labeling vascular abnormalities such as dilation and looping.
- Three data sets were used as test sets (see figure 2).

Method

- Structure tensor and Hessian matrix features were computed on the en face projections.
- The projections and their features, see figure 1, were tiled into 11x11 pixel patches.
- A random forest was trained to classify the center pixel of each patch as being normal or abnormal.
- The algorithm was implemented in Python using scikit-learn and scikit-image [3].

Results and Discussion

<table>
<thead>
<tr>
<th>En Face Projection</th>
<th>Classification Result</th>
<th>Label Map</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Image" /></td>
<td><img src="image2" alt="Image" /></td>
<td><img src="image3" alt="Image" /></td>
</tr>
</tbody>
</table>

Figure 2: Results of detection algorithm on two test data sets. The top row shows the deep capillary plexus of a 66 year old male and the bottom row the superficial capillary plexus of a 28 year old male patient. White areas in the classification and label map columns denote areas pathologic capillary dilation and looping.

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>0.96</td>
</tr>
<tr>
<td>Precision (TP / (TP + FP))</td>
<td>0.91</td>
</tr>
<tr>
<td>Recall (TP / (TP + FN))</td>
<td>0.62</td>
</tr>
<tr>
<td>F1-Score</td>
<td>0.74</td>
</tr>
</tbody>
</table>

Table 1: Classification results using 3-fold cross-validation

Conclusions

This approach shows that it is possible to fully automate the detection of vascular abnormalities consistent with MAs, thereby enabling detection of early stage DR, even with a small amount of training data. More training data are needed to improve the classification.

References