TRAINABLE V4-LIKE FILTERS
FOR DETECTING RETINAL VASCULAR BIFURCATIONS

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Abstract

We propose a novel method to detect vascular bifurcations in retinal fundus images. Our method is implemented in trainable filters that mimic the properties of some neurons in area V4 of visual cortex. Such a filter is configured by combining given channels of a bank of Gabor filters using an AND-type operation. Their selection is determined by an automatic analysis of a user-specified feature. With only 25 filters we report a recall rate of 98.52% at a precision rate of 95.19% on 40 images.

Motivation

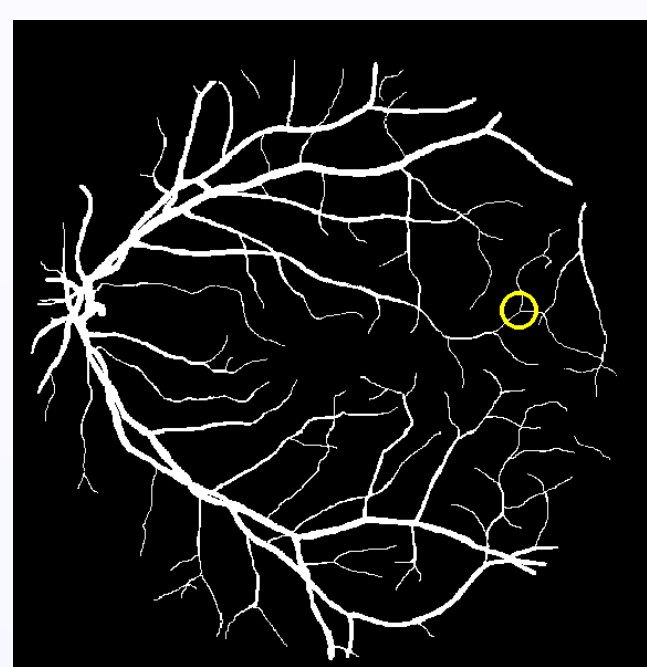To automate a time consuming manual process
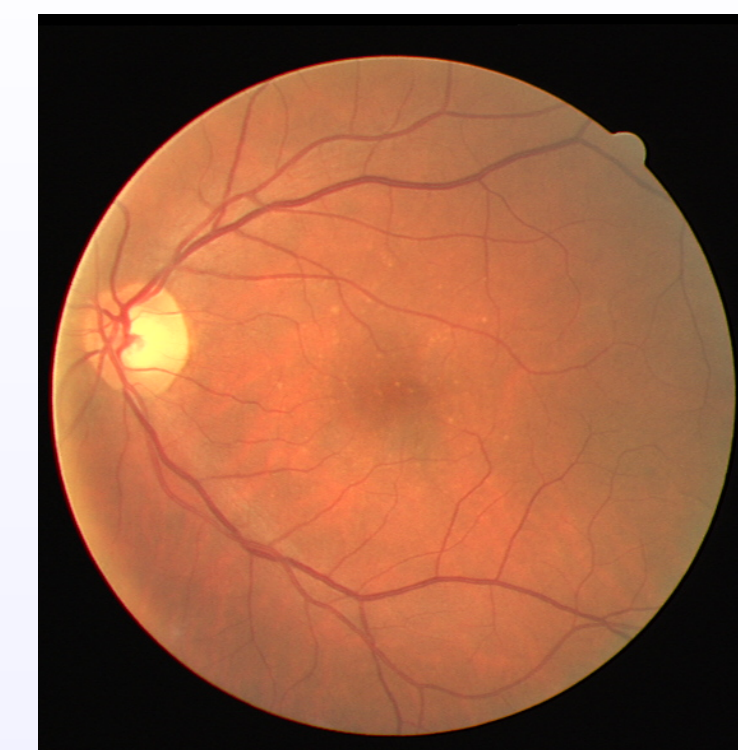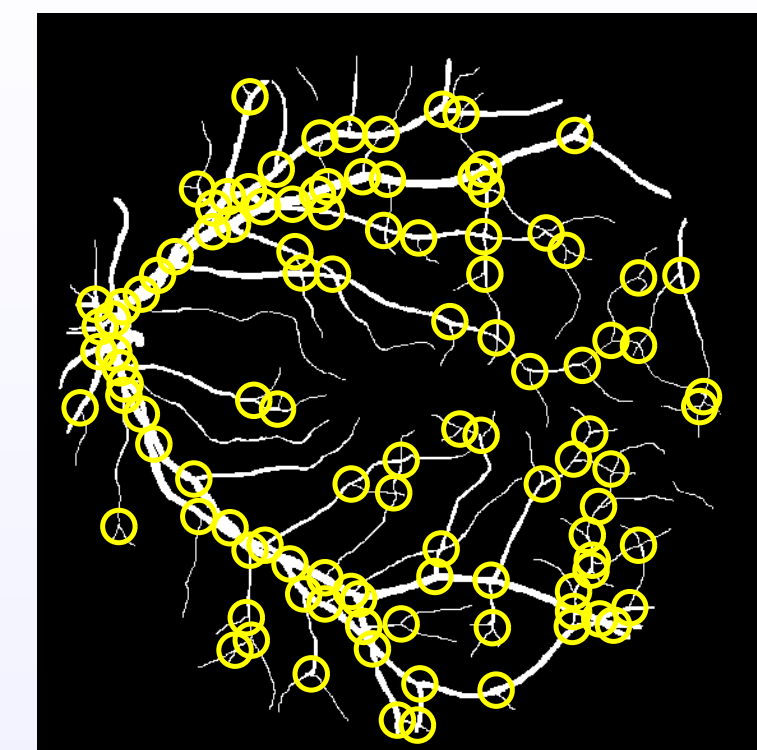
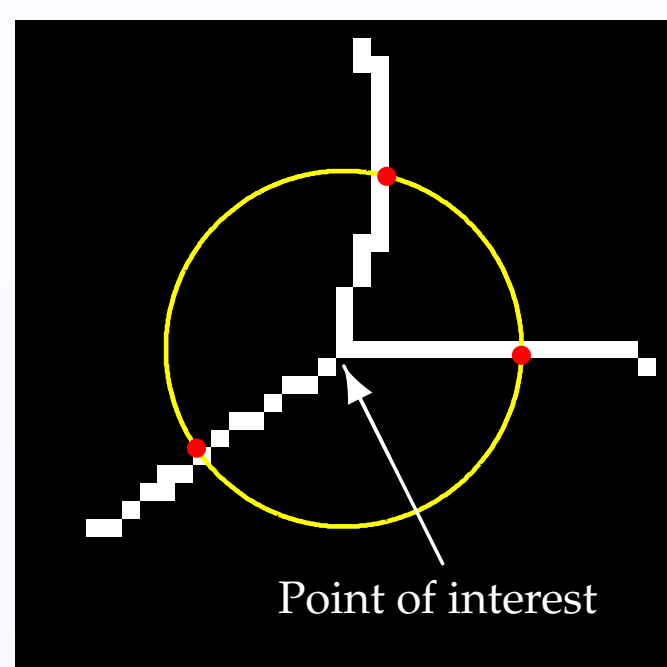Retinal fundus image   Marked bifurcations

Method: Filter configuration

a. Automatic analysis of a specified feature

Extract information about:

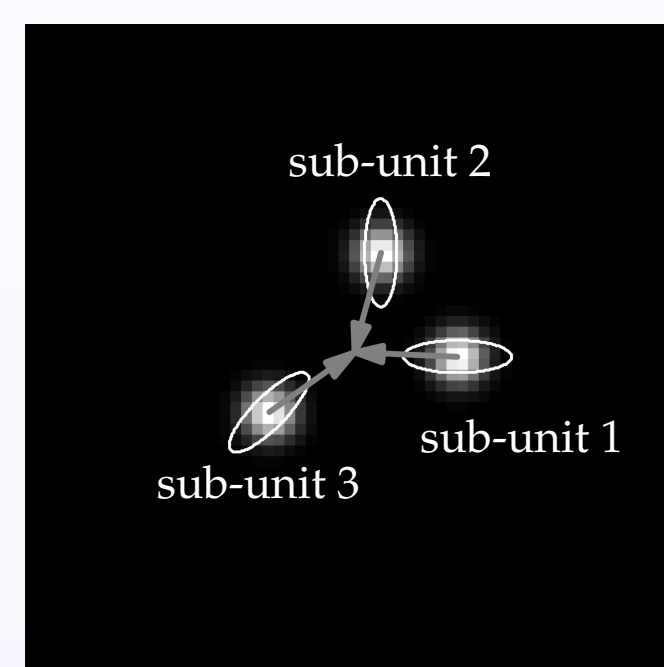- Dominant oriented line segments (red markers) around the point of interest

Point of interest

User selects a feature   Selected feature

b. Configuration of sub-units

Sub-units: detectors of line segments
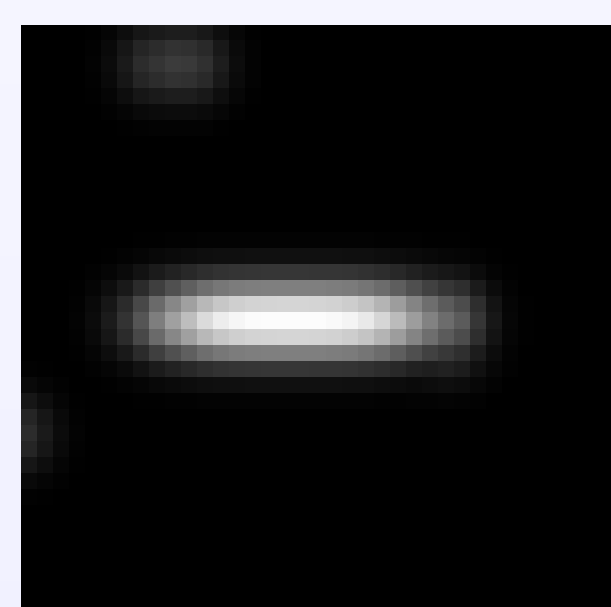

sub-unit 2
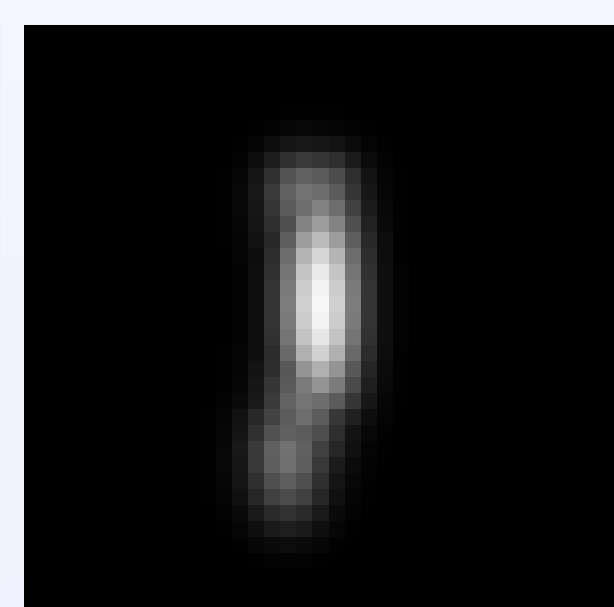
sub-unit 1

sub-unit 3

Configured sub-units

Computation of a sub-unit output at position (x, y):

1. Filter image with a **Gabor filter** (bright ellipse) of preferred orientation and wavelength

2. **Weight** the responses of the Gabor filter with a **Gaussian function** (circular blob) centered at (x, y)

3. Output is the **maximum** value of the weighted responses, **shifted** in the direction of the arrow
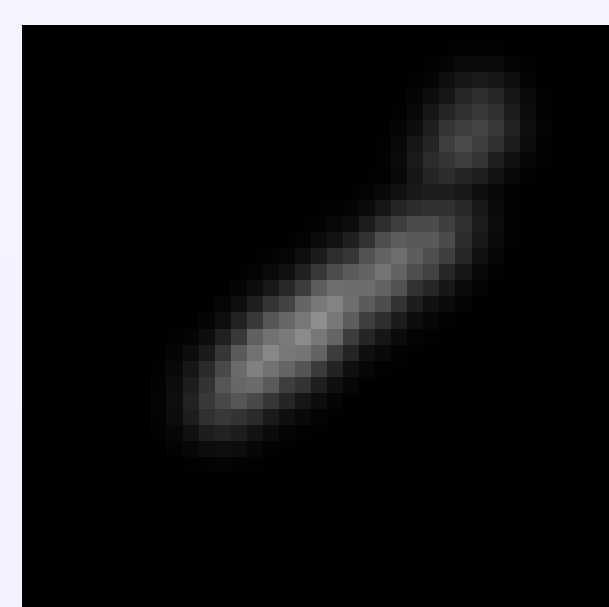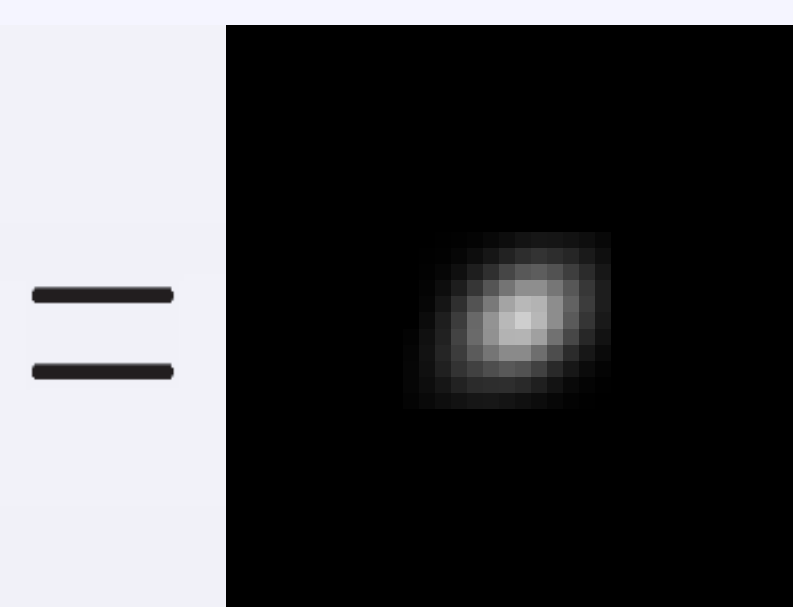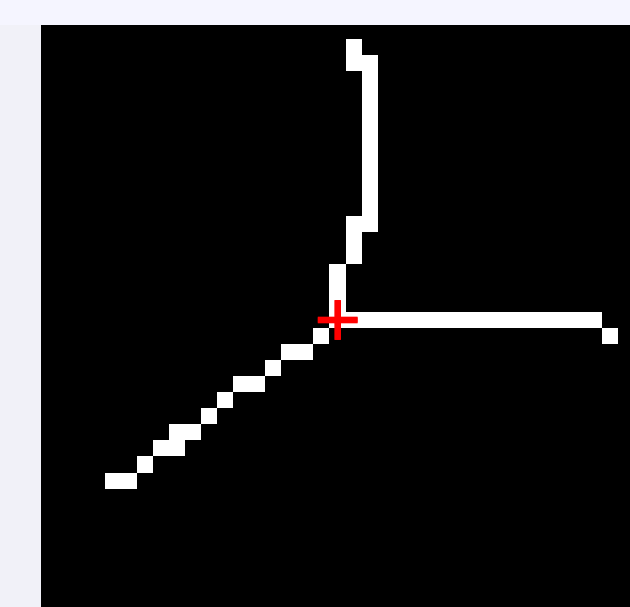
c. Combine sub-unit responses

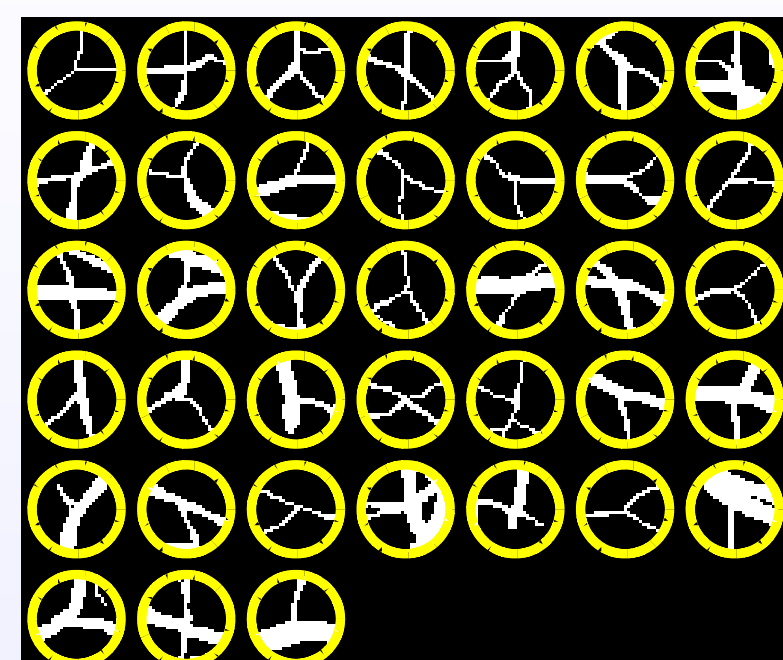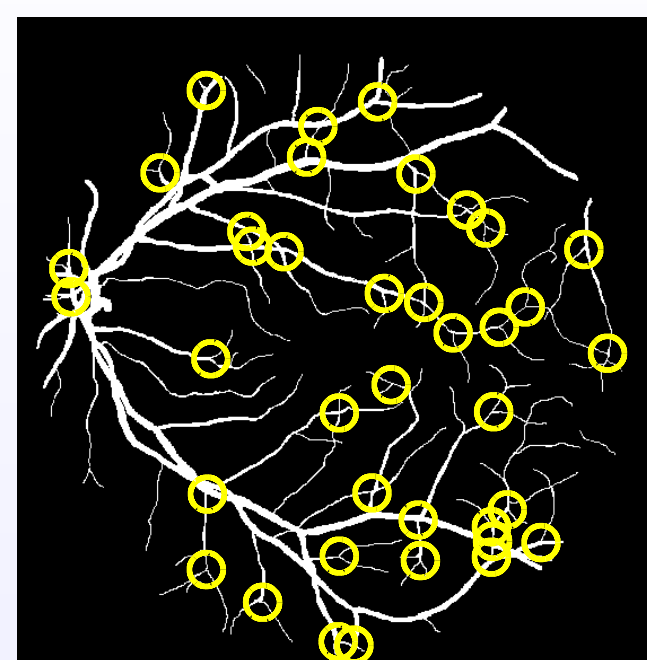Sub-unit 1 output   ×   Sub-unit 2 output   ×   Sub-unit 3 output   =   Filter output   →   Local maximum

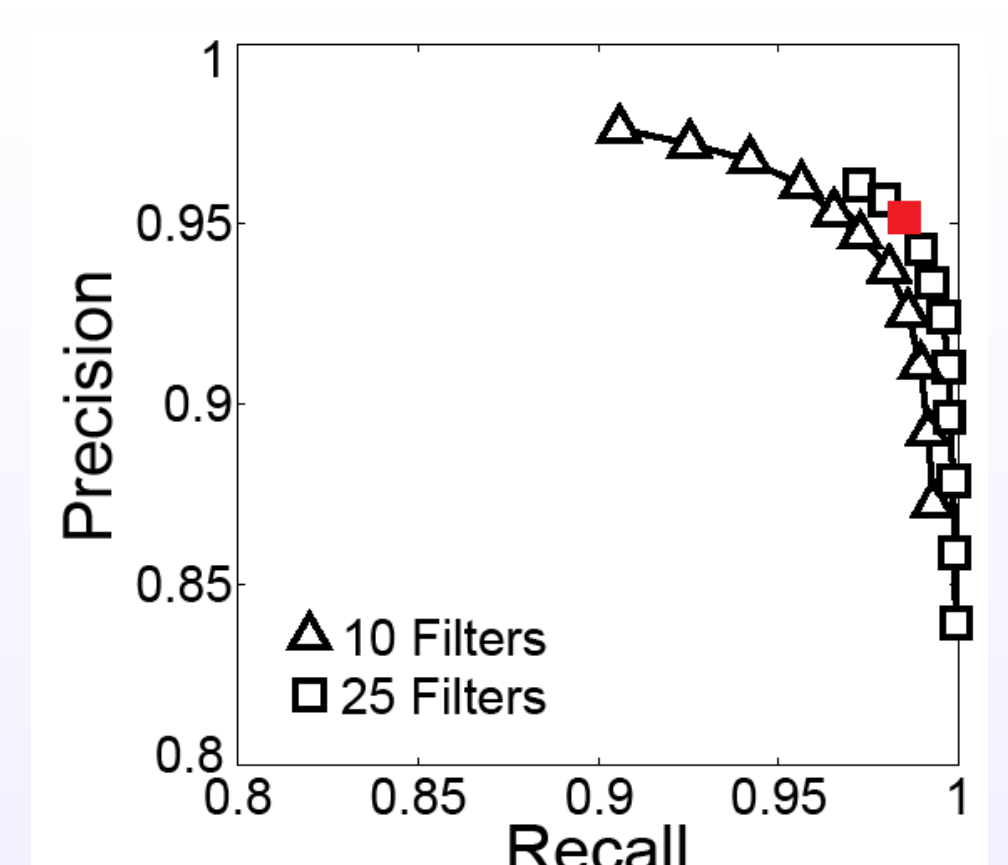## Filter application example

A single filter detects 38 out of 107 bifurcations

Results

- **Dataset:** 40 binary images from the DRIVE dataset [1]

- Results
  - **Recall rate: 98.52%**
  - **Precision rate: 95.19%**

Conclusion

- **Effective** for the concerned medical application

- **Trainable filters** can be used in various applications

Reference

[1] Staal J., Abramoff M.D., Niemeijer M., Viergever M.A., van Ginneken B., Ridge-based vessel segmentation in color images of the retina, in *IEEE Transactions on Medical Imaging*, 2004