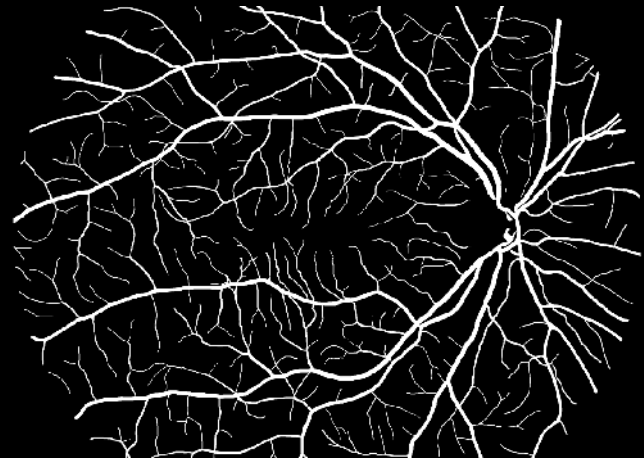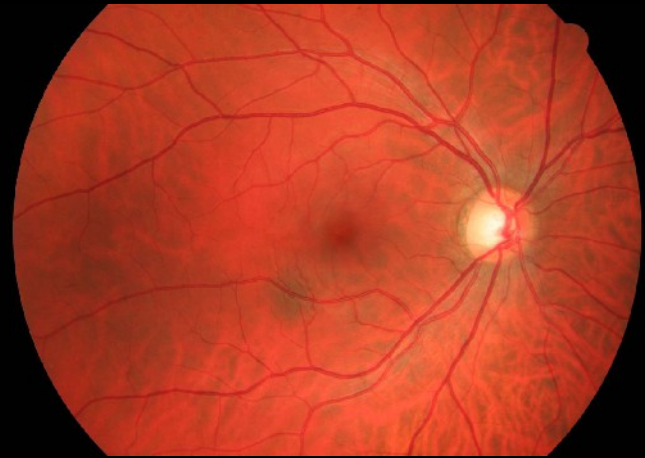# Vessel segmentation of the retina

## SSIP 2012, Vienna

Jianli Li, Kristína Lidayová, Karel Štěpka,
Krisztián Koós, Bodnár Péter

# **Motivation**

- SSIP 2012
- Diagnostics
  - Measurements
  - Abnormalities
  - Laser surgery
- Registration
  - Different modalities

# Difficulties of segmentation

- No universal solution
- Methods depend on:
    - Modality
    - Approach
    - Automatic / Manual
- Complex problem
    - Combination of different approaches
    - Specific detectors for all situations

# Possible approaches

- Pattern recognition
    - ridge-based (local peaks in max surface gradient)
    - skeleton-based (centerlines)
    - region growing (postprocessing, cavities, smoothing)
    - matching filters (+ centerline detection/thresholding)
    - morphology-based (nonlinear filtering)
- Model-based
    - explicit models
    - active contours (requires good initial state)
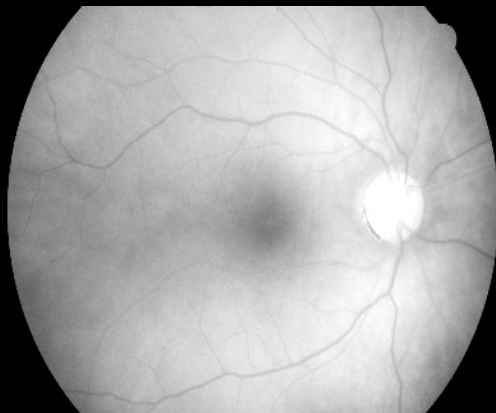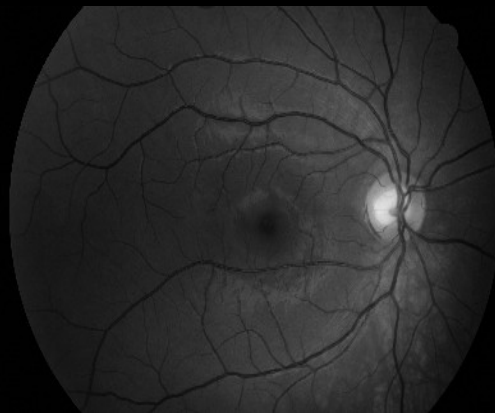    - deformable models

# Original image

# Channel selection
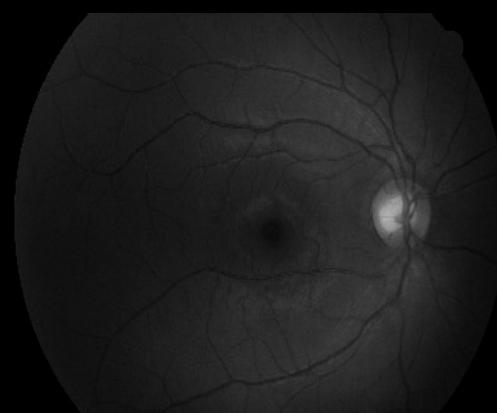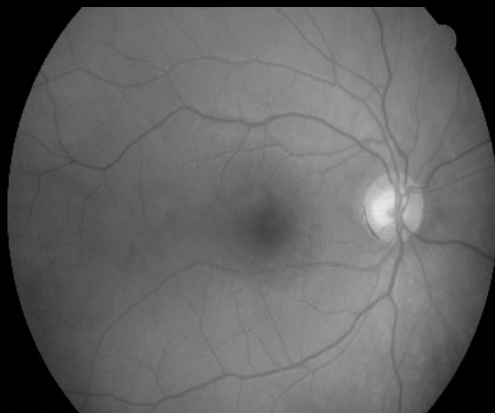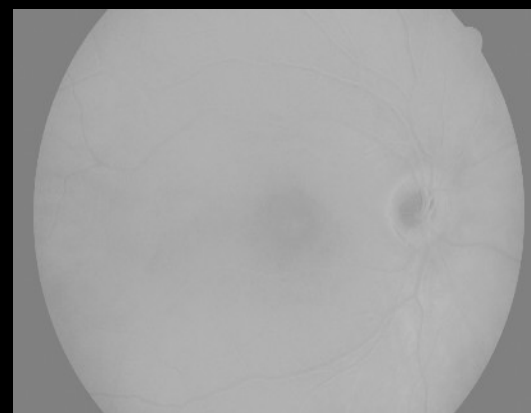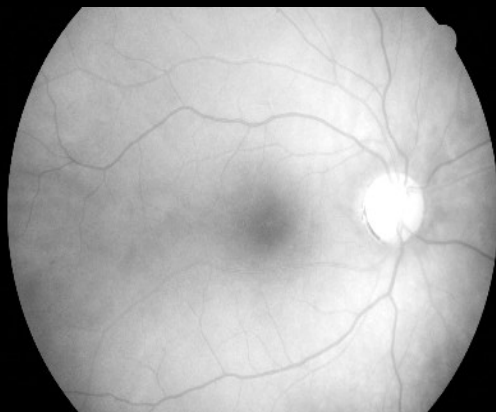
# Channel selection
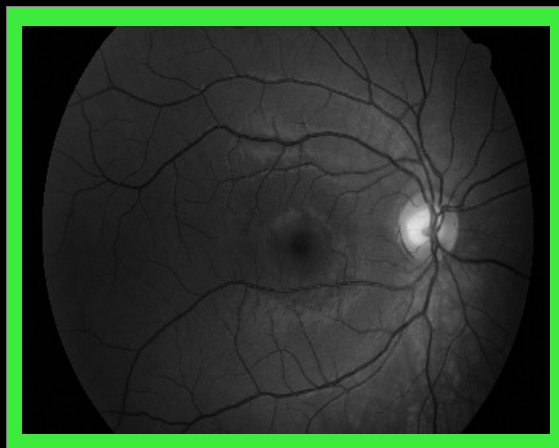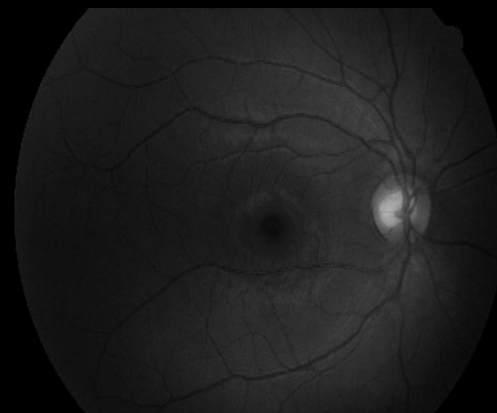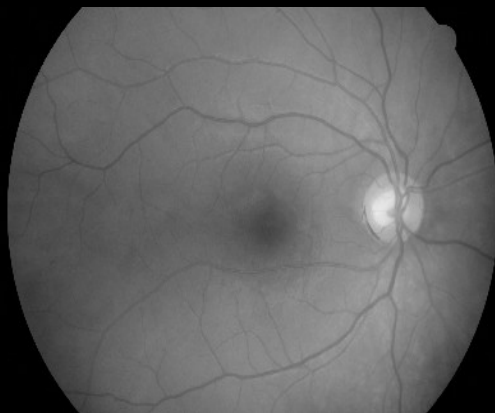
# Proposed method

- Core of the algorithm: morphological reconstruction by dilation

- Mask and marker images are prepared in a similar way:

  ◦ Morphological opening to fill the interior of wider vessels
  ◦ Black top-hat to isolate small dark structures (vessels)
  ◦ Coherence enhancing diffusion so that the thresholding doesn't break the vessels (used only for the mask)
  ◦ Thresholding – global for the marker, adaptive for the mask
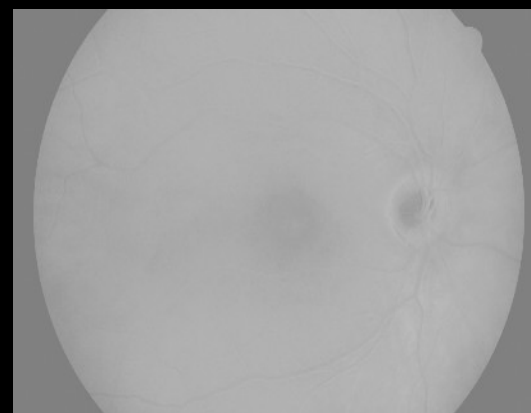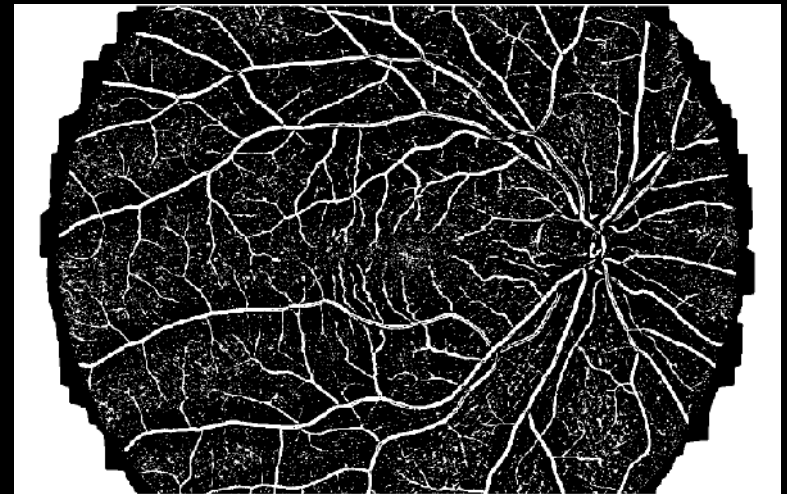  ◦ Median filtering of the marker (removes most noise)

- Removal of very small components by area opening

- Removal of larger (but still small) components that are far enough from other components by using a sliding window (removal of the spots in retinopathy images)

# Marker and Mask
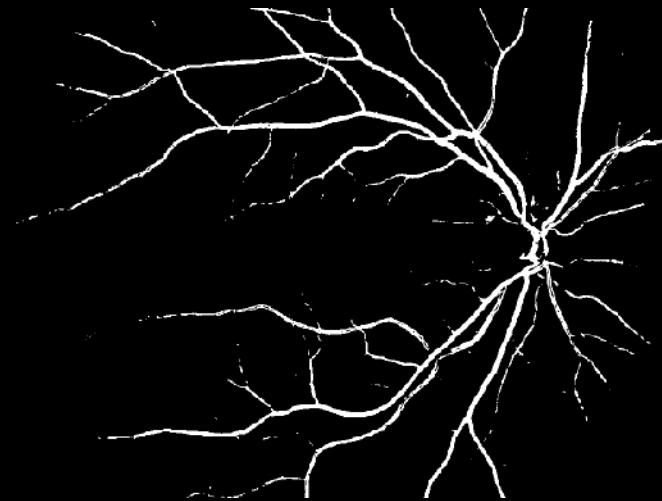
# Clutter removal
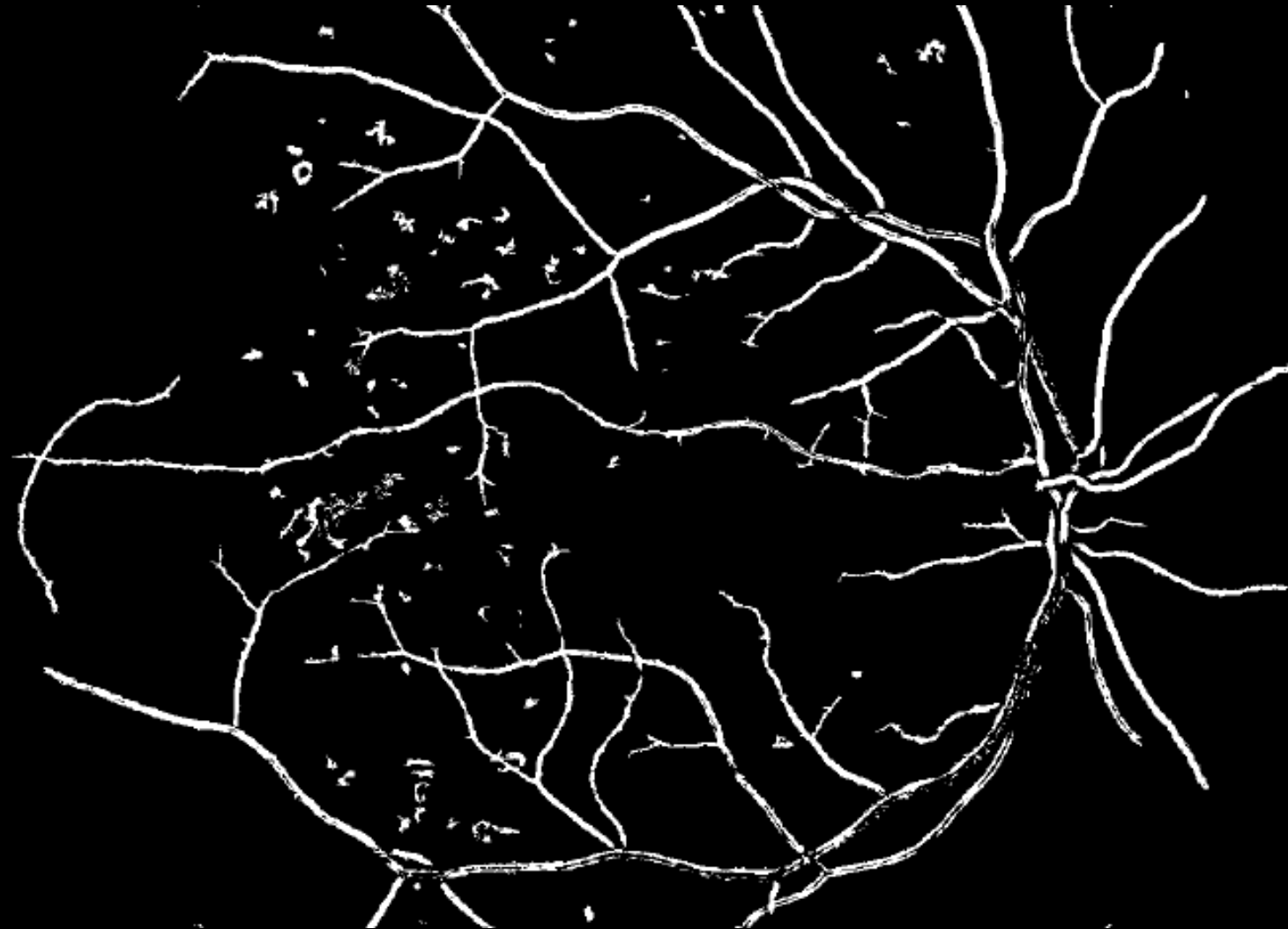
# Clutter removal

# Comparison to the state of the art

- Segmentation by thresholding
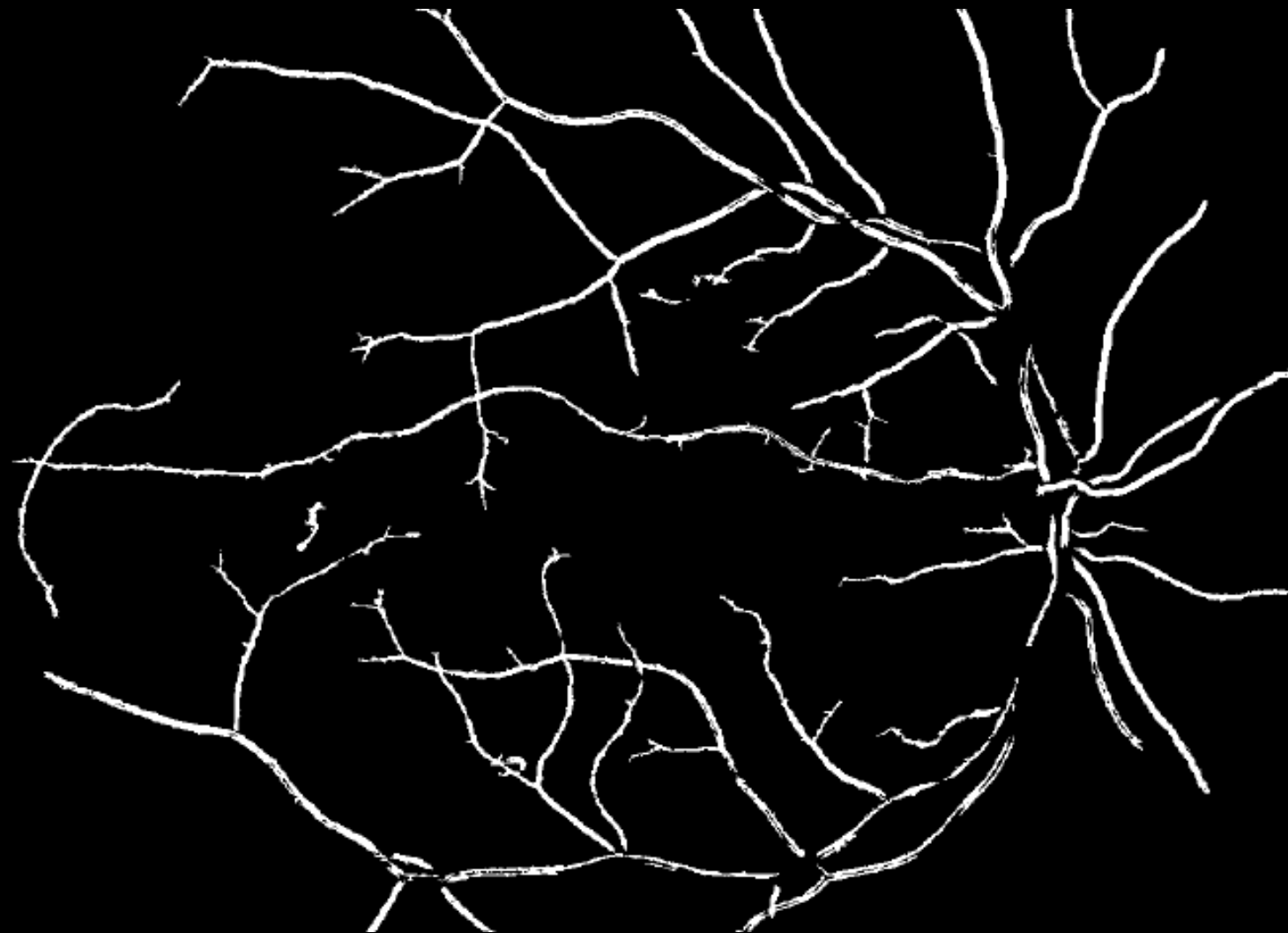  - Thitiporn Chanwimaluang, PhD thesis
- Hessian-based "vesselness" filter
  - Dirk-Jan Kroon

# Results

| | Adaptive thresholding | Vesselness filter | Proposed method |
|---|---|---|---|
| sensitivity | | | |
| specificity | | | |
| accuracy | | | |
| connectivity | | | |
| area | | | |
| length | | | |

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# Visual comparison
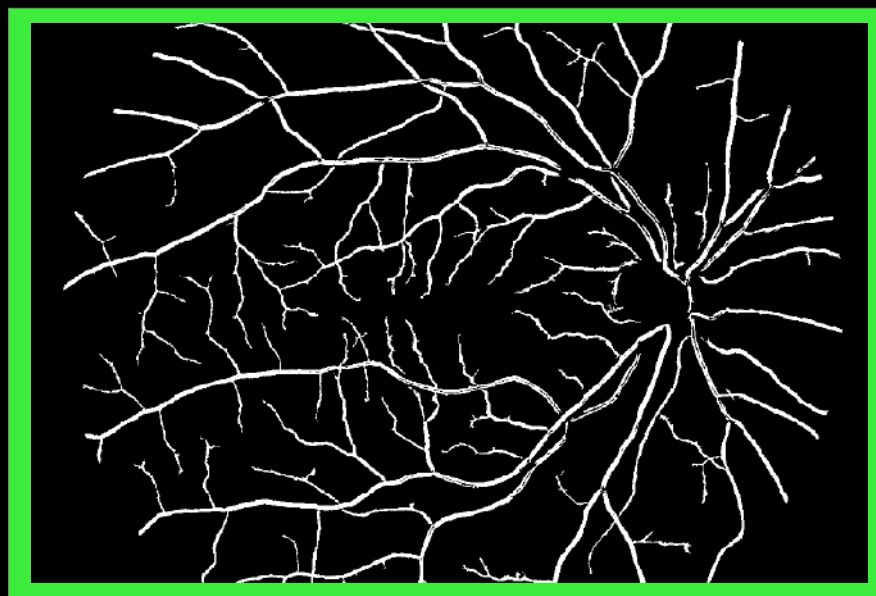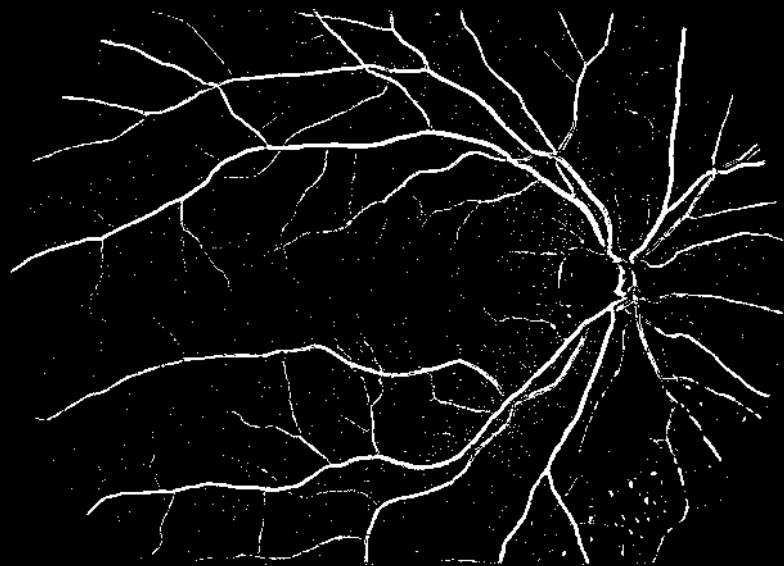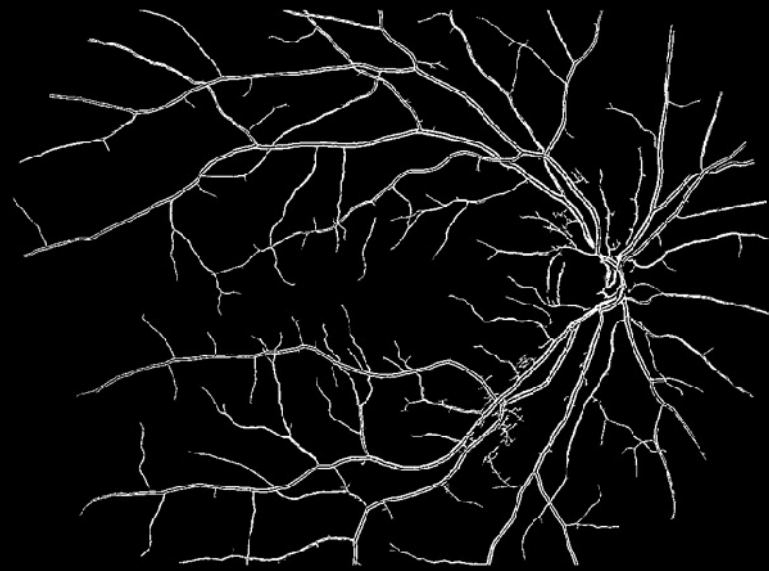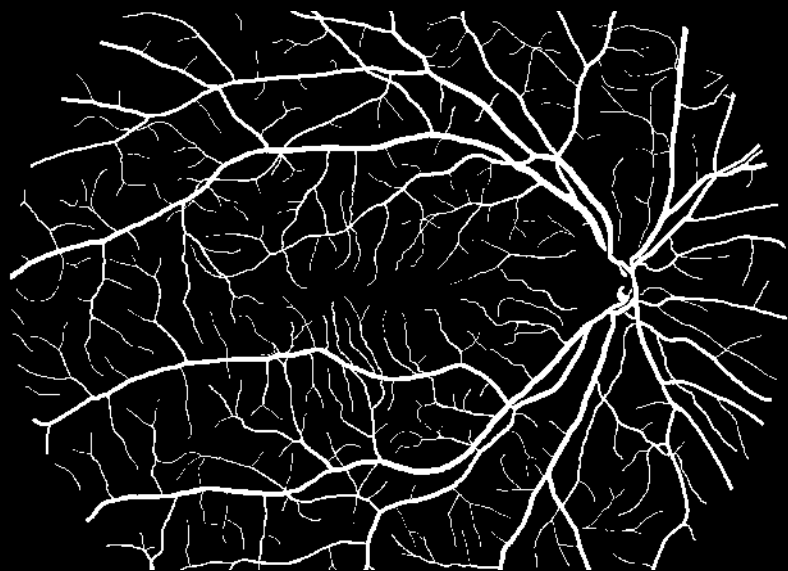
# Conclusion

- No general solution for unhealthy cases

- Many different approaches

- Selection of color space

- Pre- and post-processing are important

# Thank you for your attention