Diabetic Retinopathy

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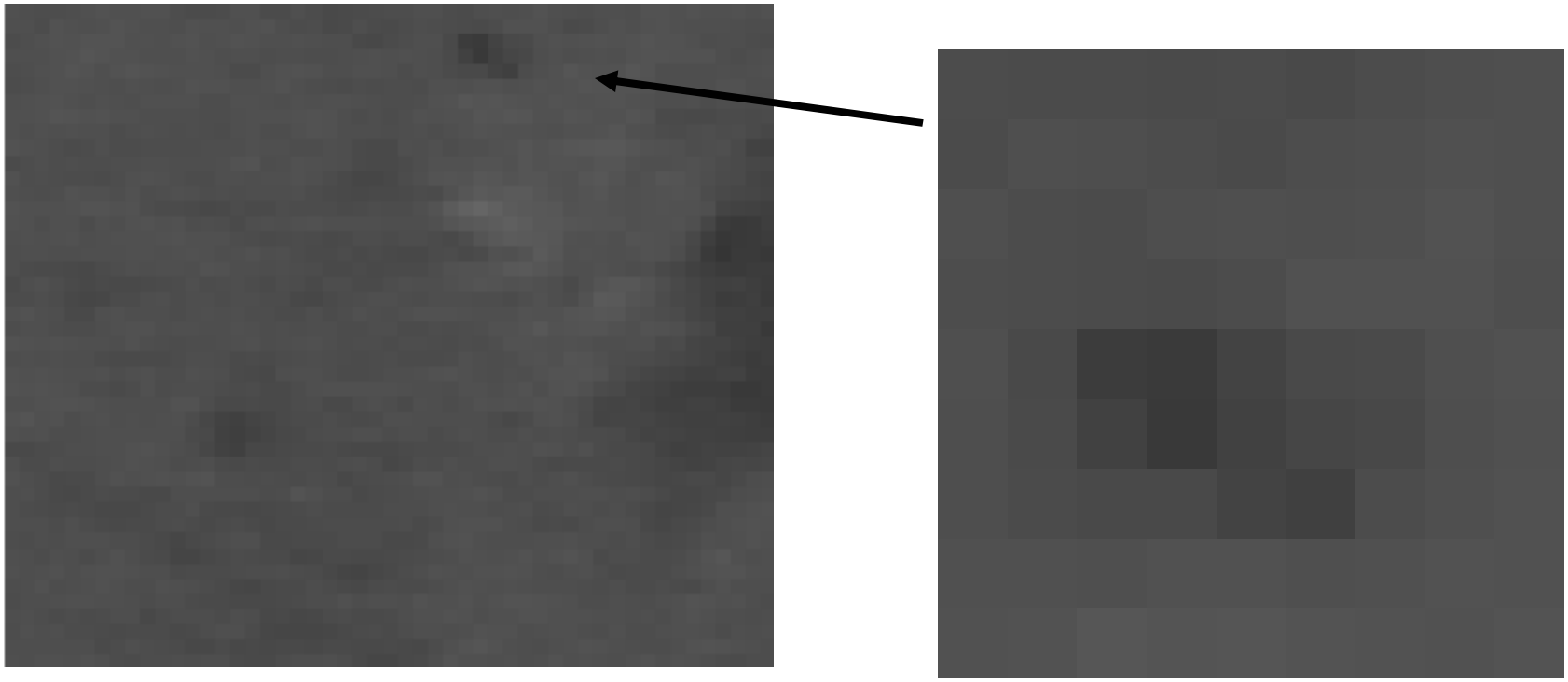
Diabetic Retinopathy

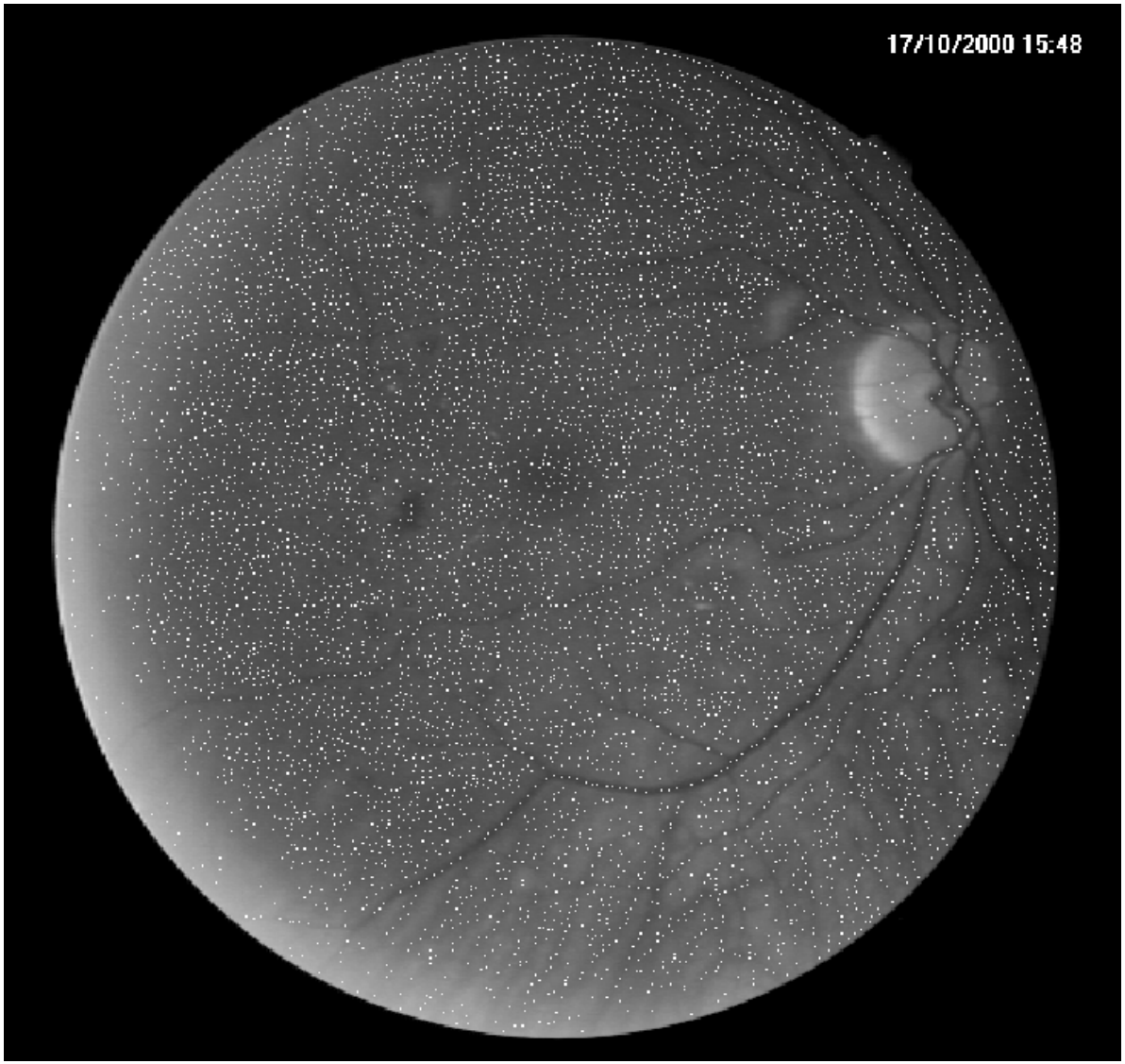
- The leading cause of blindness in the developed world
  - Several million diabetics require annual screening in the UK alone
- Primary indictor: small “dots and spots” on special retinal photographs
- Vascular changes – beading and neovascularization
- Macula Oedema – swelling (discoloration and surface shape)

Diabetic Retinopathy

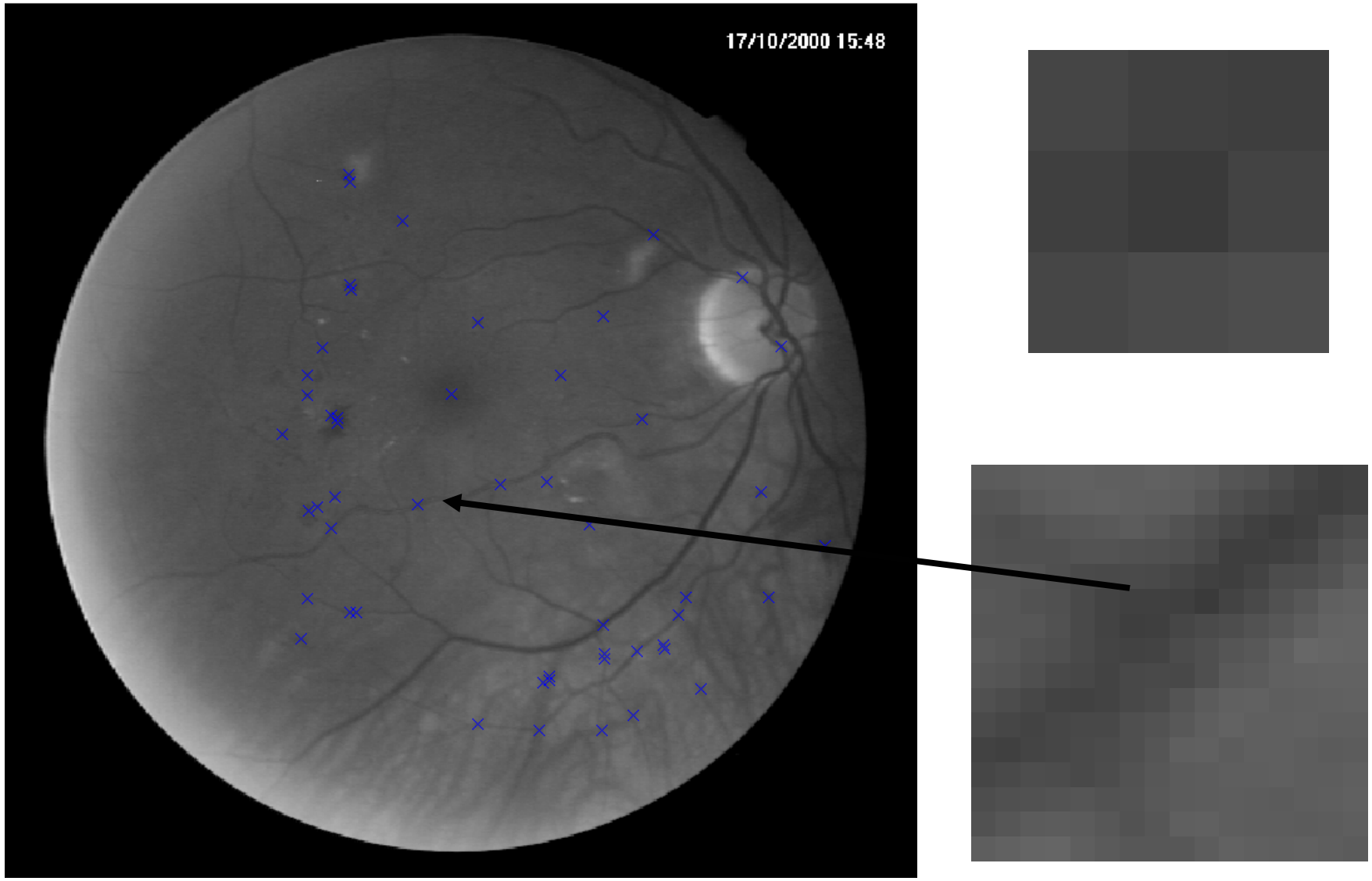
A Haemorrhage in detail



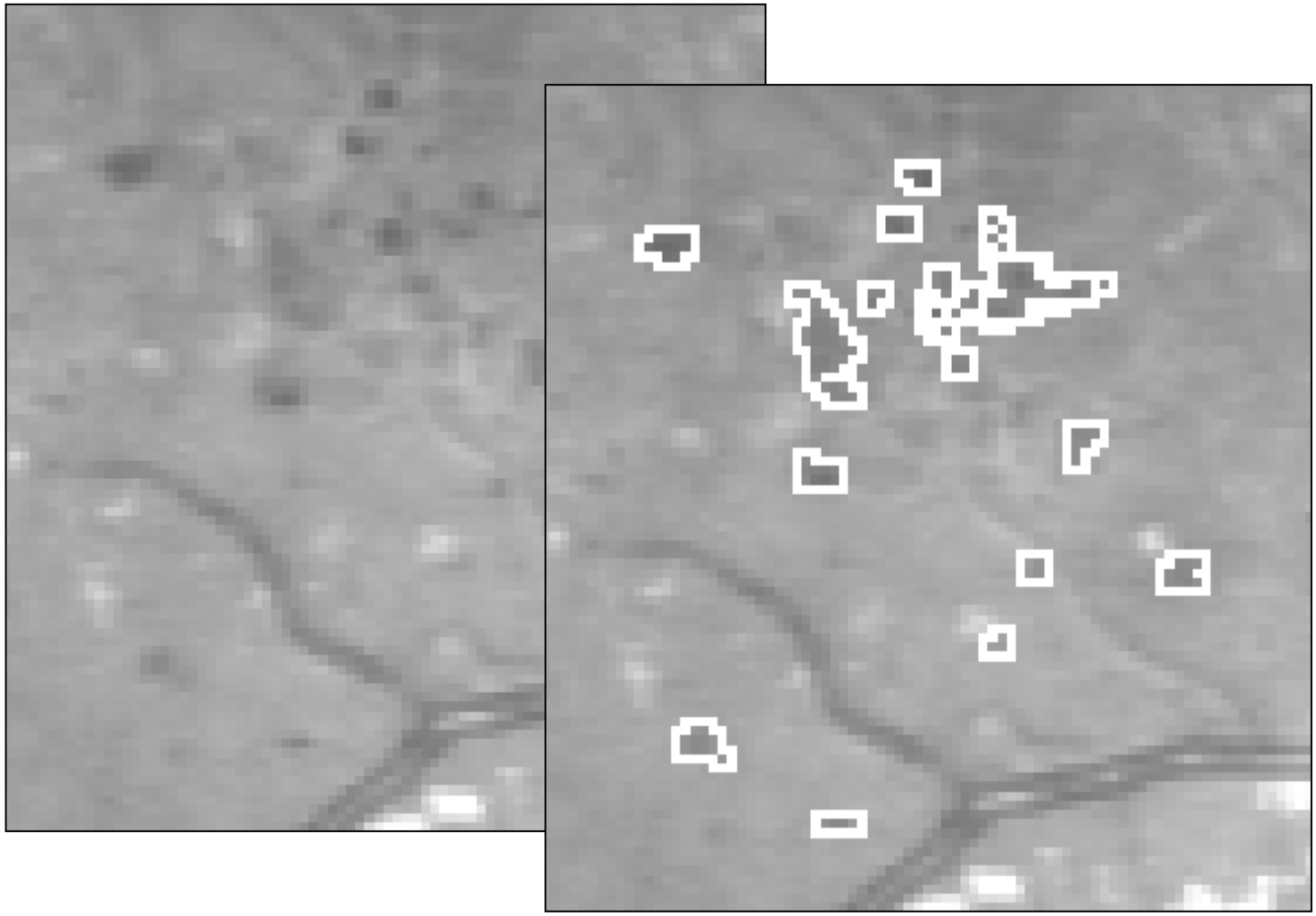
Peak points



Circular Peak Points

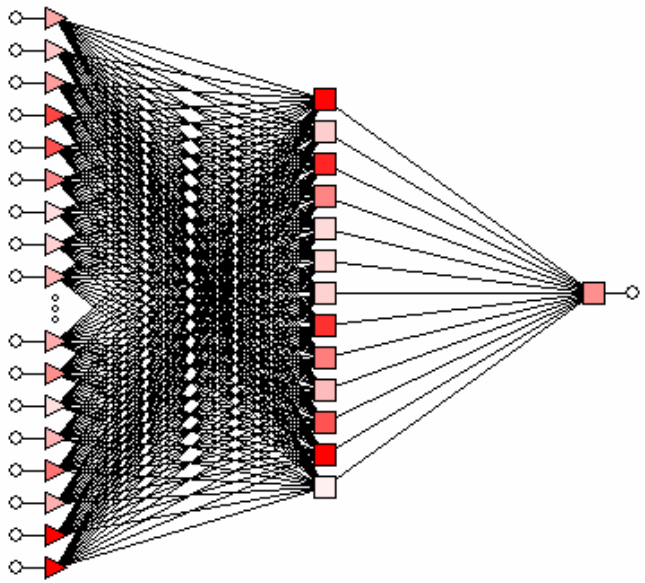


Lesion Growing



An algorithm to find dark lesions

- Extract *features* (measurements)
- Contrast, shape, size, blurriness, etc. etc.
- Feed these measurements to a neural network which *learns* to distinguish lesions from distractors



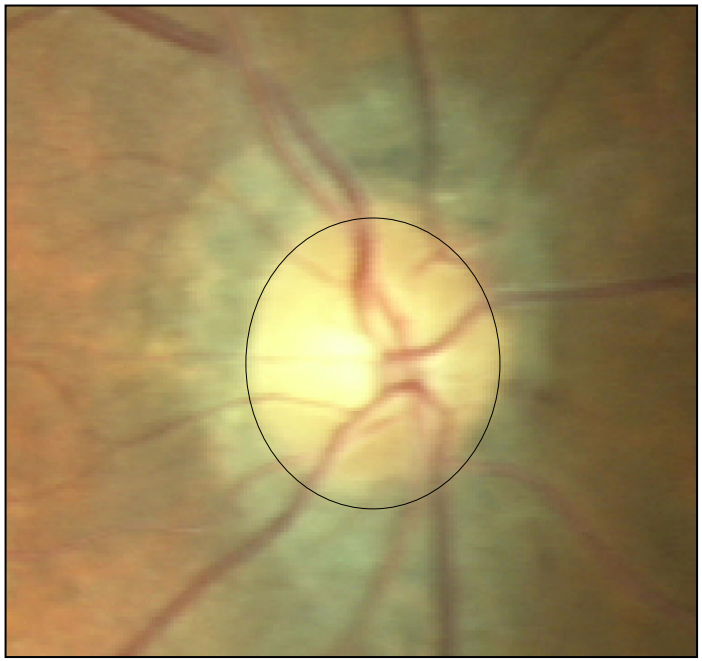
Feature Selection Method

- Use of sensitivity analysis for classifier inputs
- Exploits “missing value substitution” procedure
- Ratio of performance with and without available information
- Hierarchical feature selection

Optic Nerve Head segmentation

- Interesting problem in deformable modelling
- Fundamental shape is fairly simple – elliptical with vertical major axis
- Overlapping blood vessels
- Presence of pallor and peri-papilliary atrophy distractors

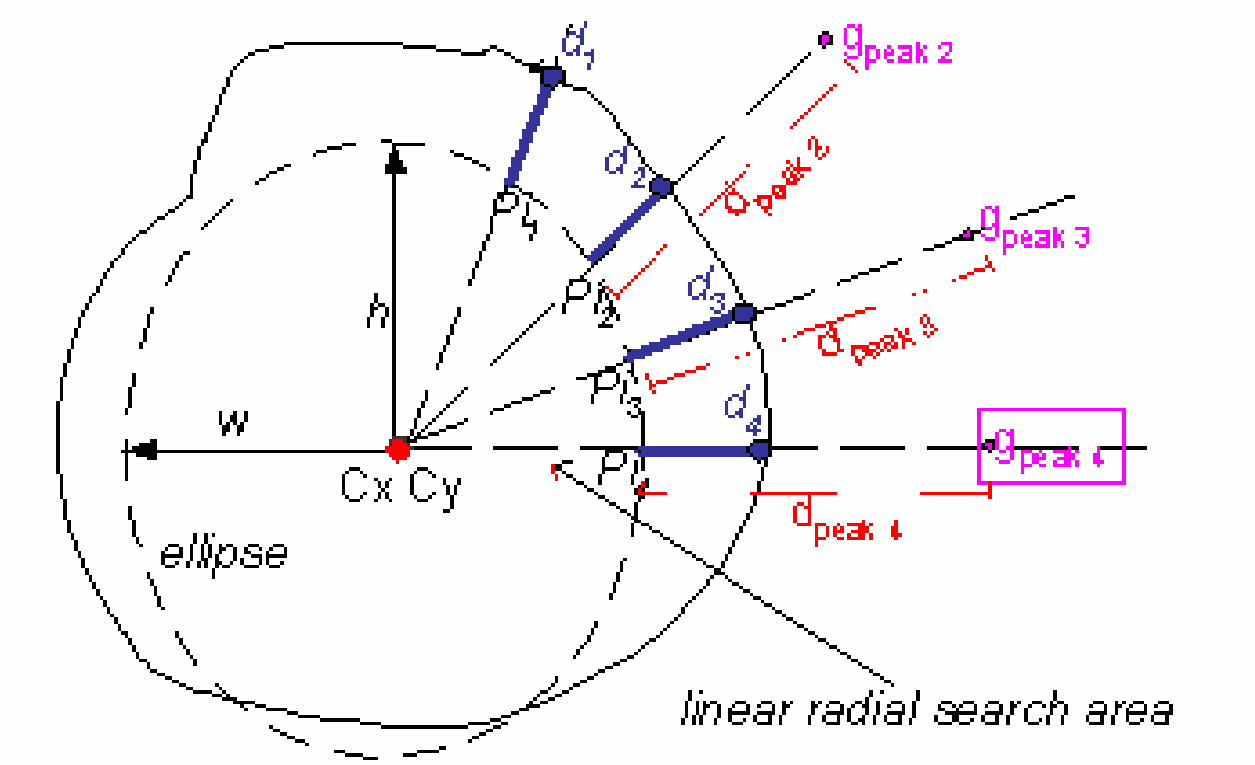
Sample Optic Nerve Heads



The Algorithm

- Global/local deformable model
- Global model – fixed aspect ratio ellipse
- Local model – distortions away from this
- Spokes projected at 15 degree angles
- Attractor points at maximum coincident gradients (or second order local gradient)
- Balance of global, local, smoothing forces

The Deformable Model



Deformable Model

The stages

- Fit global model against temporal sector of ONH only (temporal lock phase)
- Fit global model against whole ONH
- Let the local model loose to fit the full model

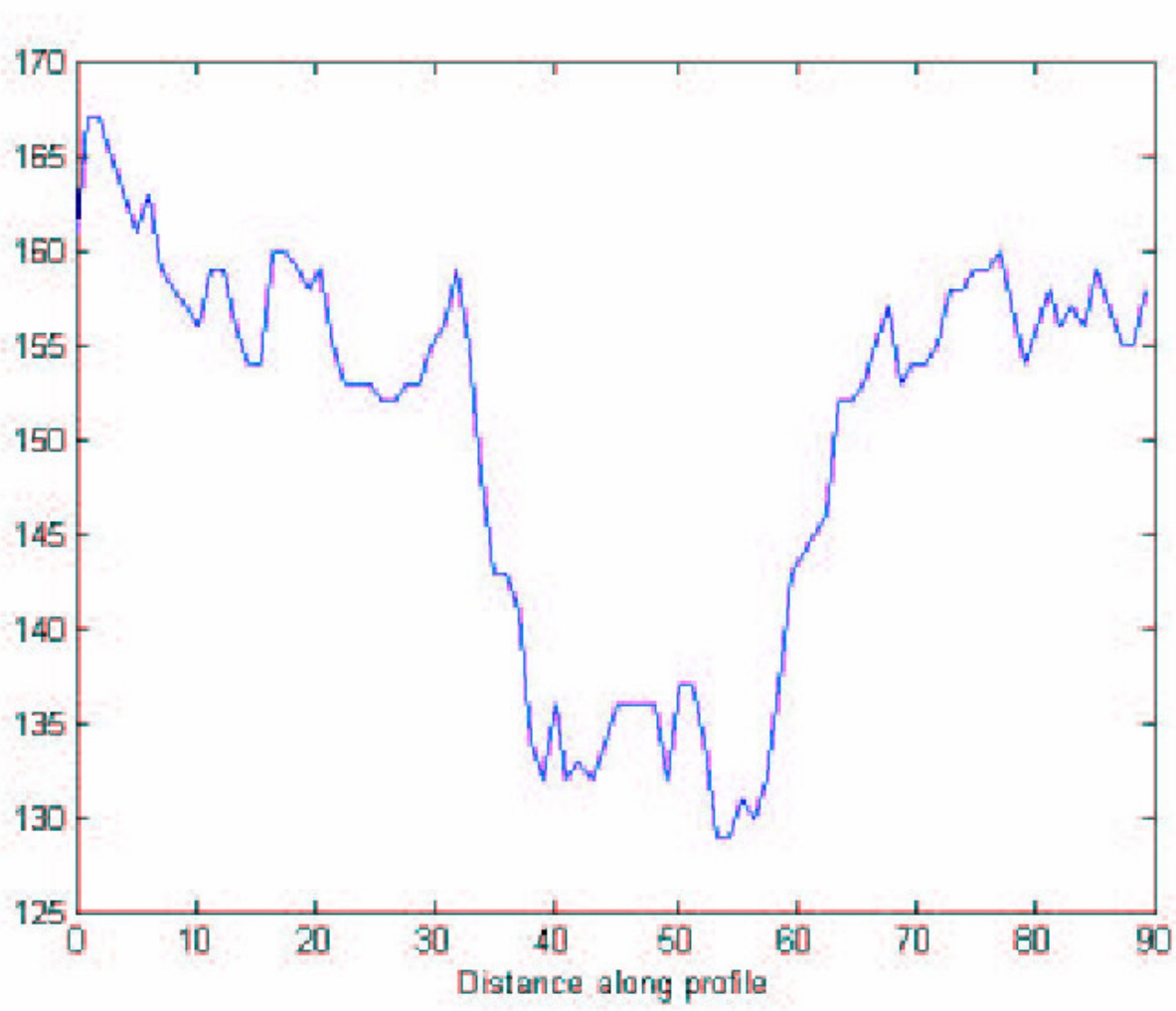
Vascular Measurement

- Changes in widths of vessels are very diagnostic
- Typical vessels no more than 6-8 pixels wide
- Require width measurements to sub-pixel accuracy

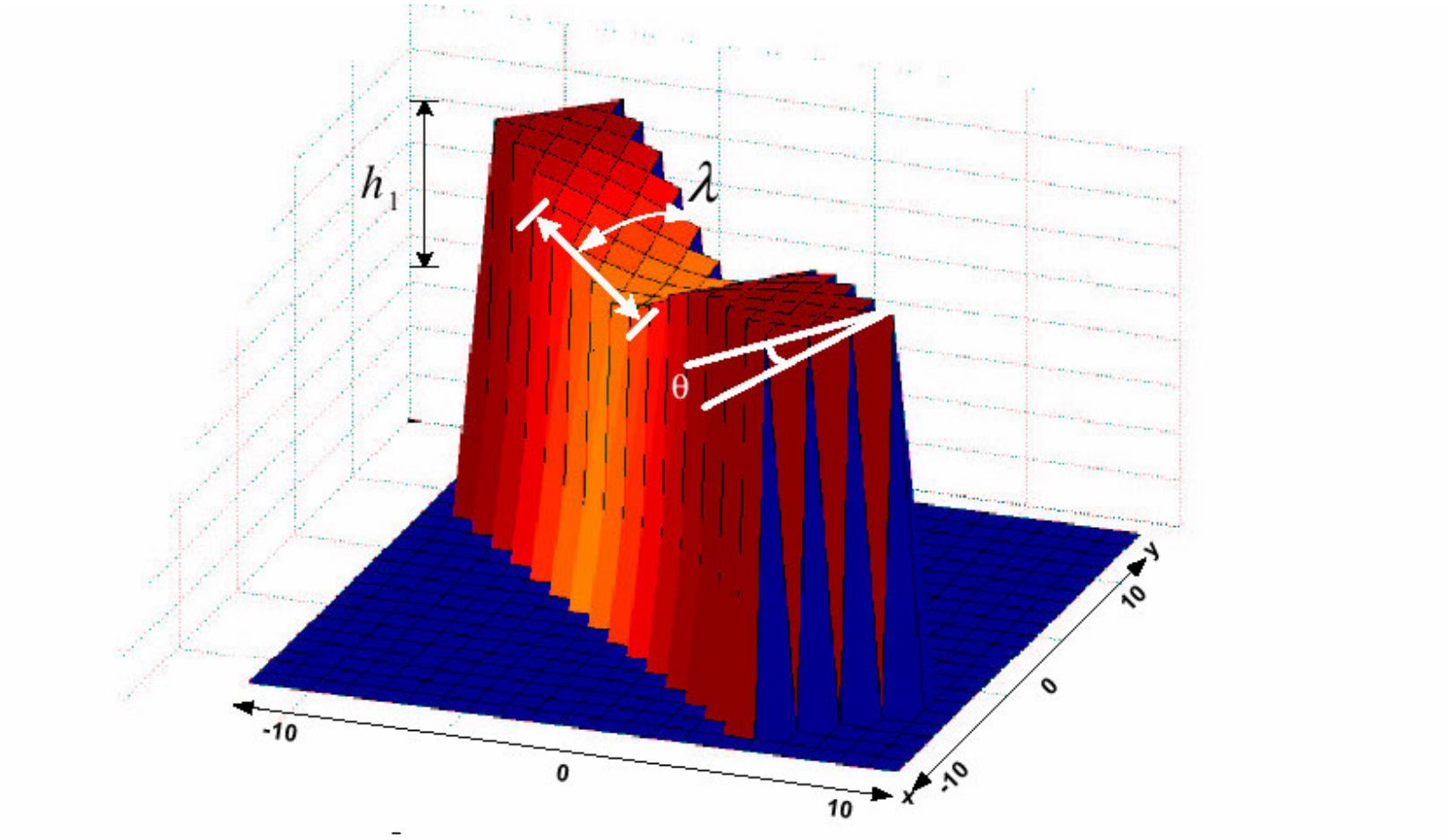
Vascular Model

- A gaussian extruded forms a reasonable shape model for a vessel
- A difference of gaussians models specular highlights

A vessel profile



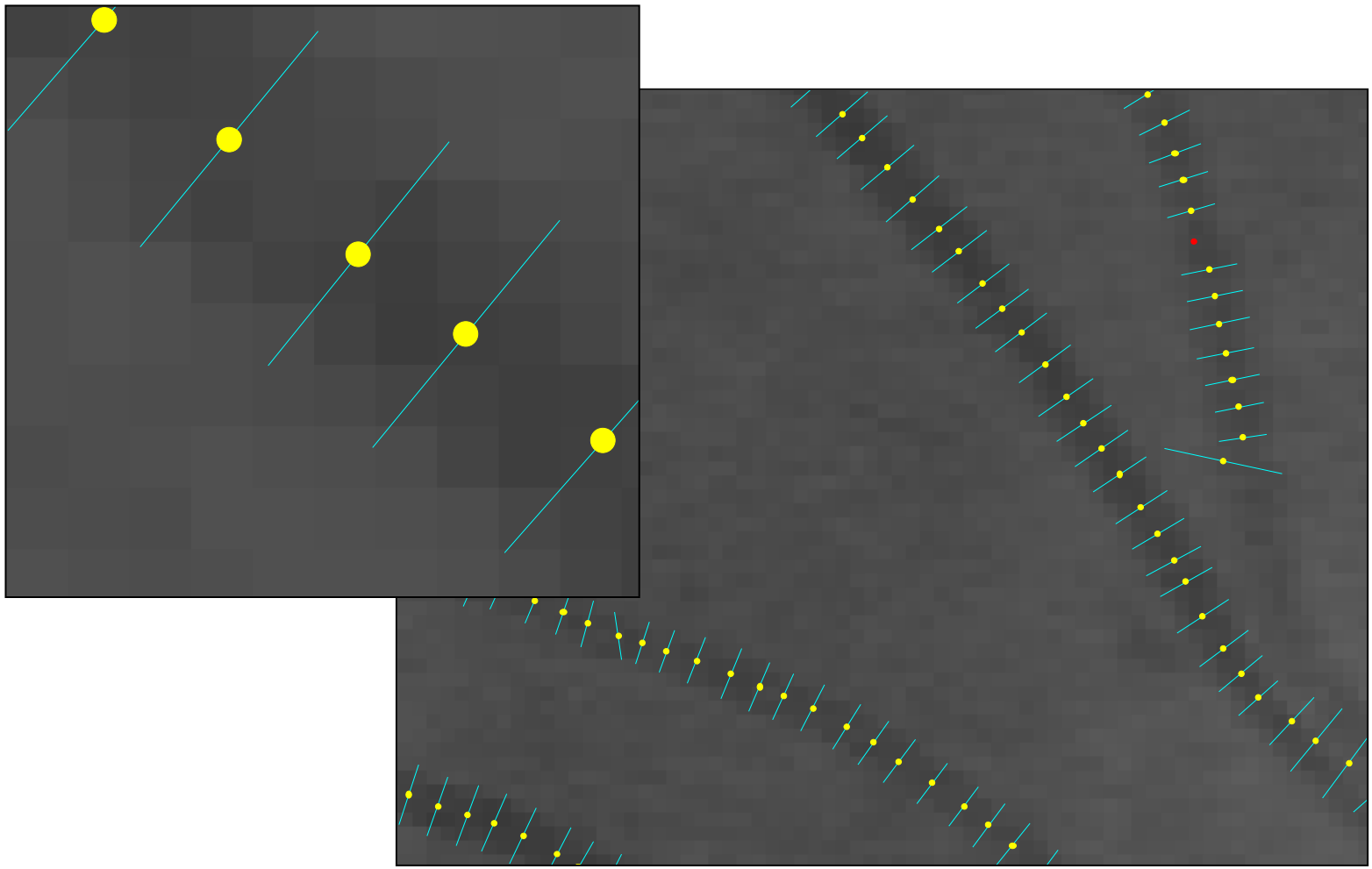
Vascular Model



Sub-pixel accuracy

- Deformable models like this can fit boundaries to sub-pixel accuracy
- Exploitation of anti-aliasing effect
- Human beings do this routinely
  - That's how a television works!
- Accurate to at least 0.34 pixels on our tests
- Used high-resolution images rescaled for the algorithm (by a factor of 4).

Algorithm at work



Real World Use?

- Sensitivity / specificity for Sight Threatening Retinopathy
  - Lesions near to the macula
- 97% sensitivity (one error), 75% specificity
- This is still insufficient! – why?
  - Unanticipated disease conditions
  - Severe disease conditions
- Planning use in audit rather than automated screening