

Texture

- Key issue: representing texture
 - Texture based matching
 - little is known, key issue seems to be representing texture
 - Texture segmentation
 - key issue: representing texture
 - Texture synthesis
 - useful; also gives some insight into quality of representation
 - Shape from texture
 - cover superficially



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(Tri-arr)

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(Ti-ell)

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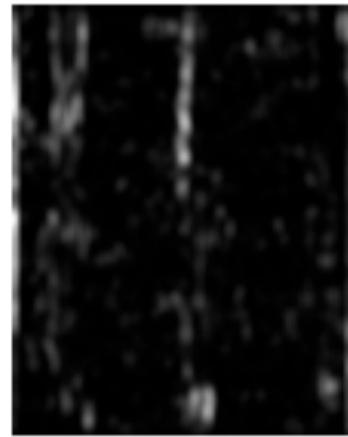
(Plus-ti)

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 R R R R R R R R
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 R R R R R R R R
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(RR-RL)

squared responses

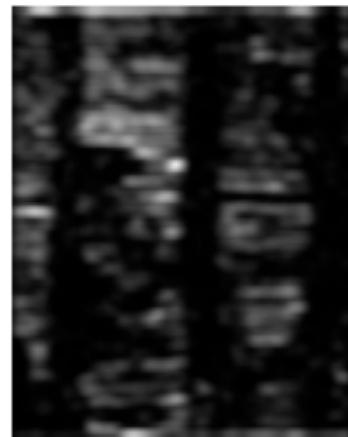
vertical



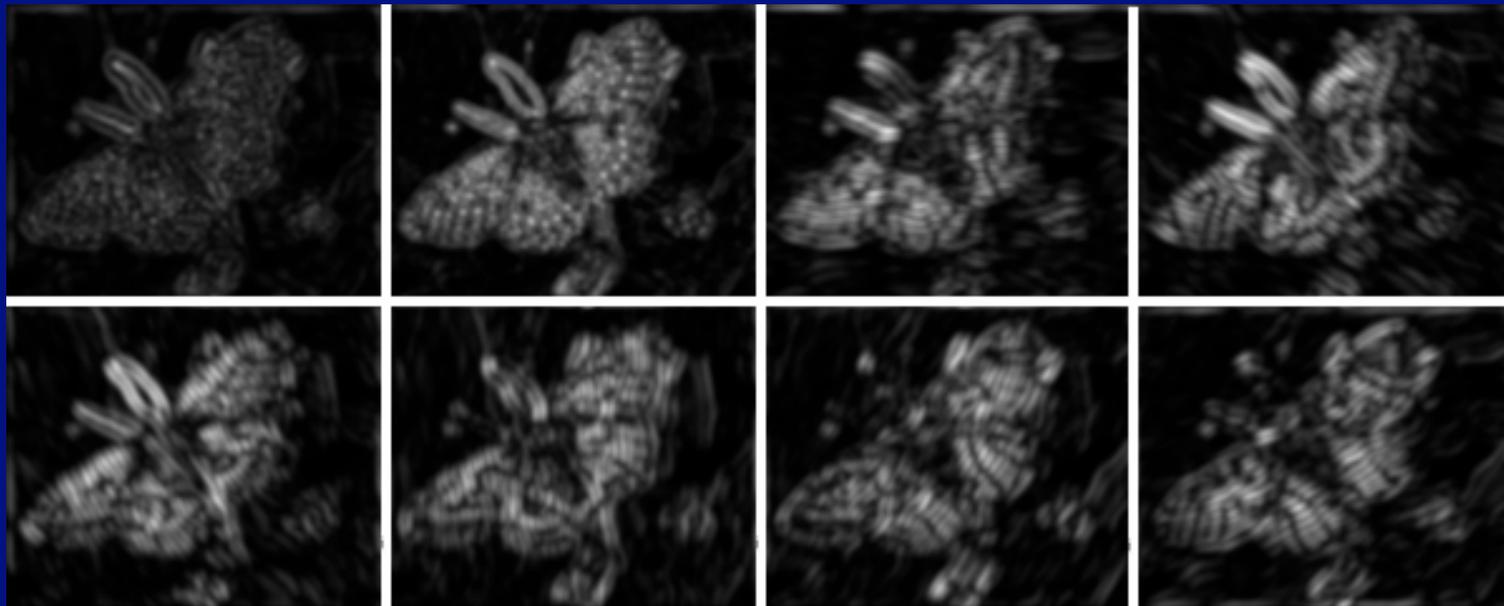
classification

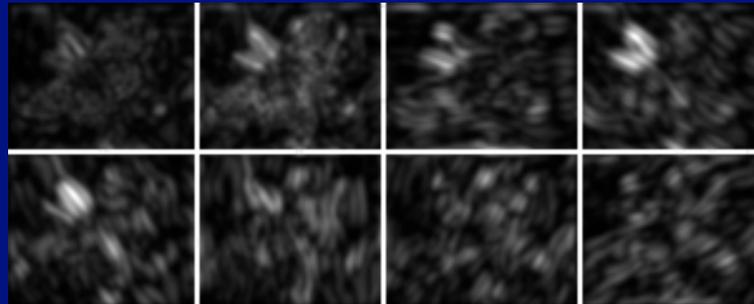


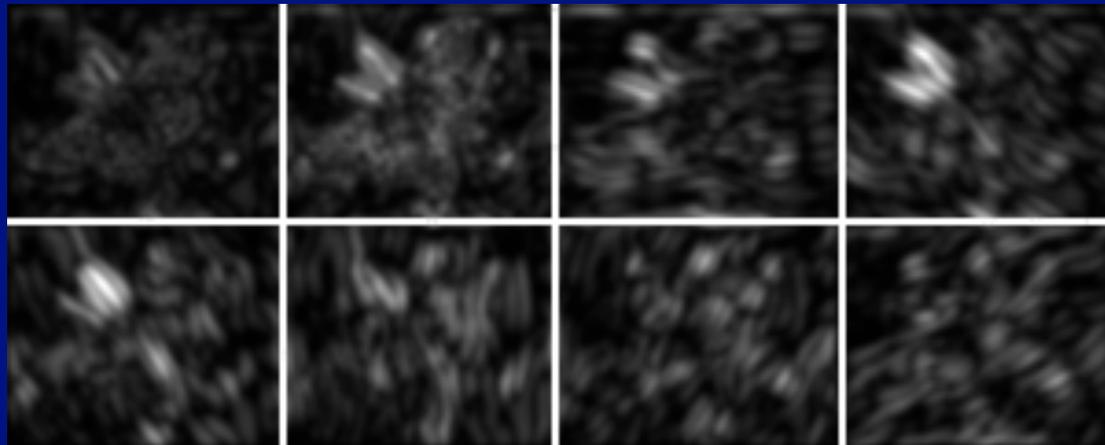
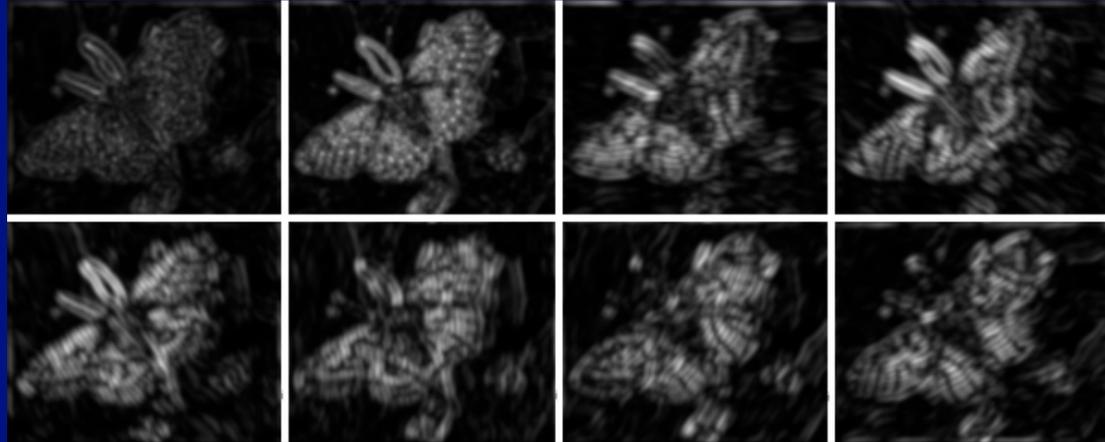
horizontal



smoothed mean

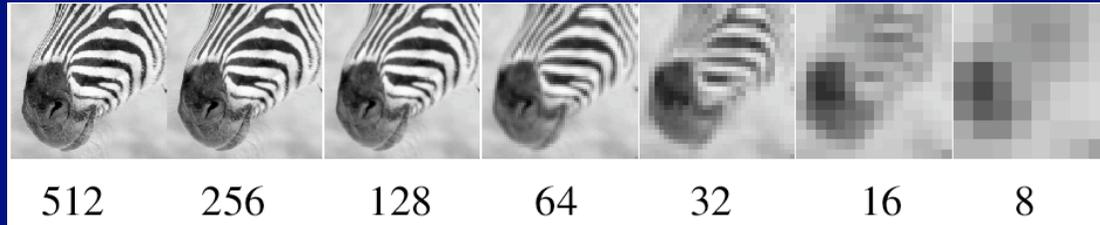


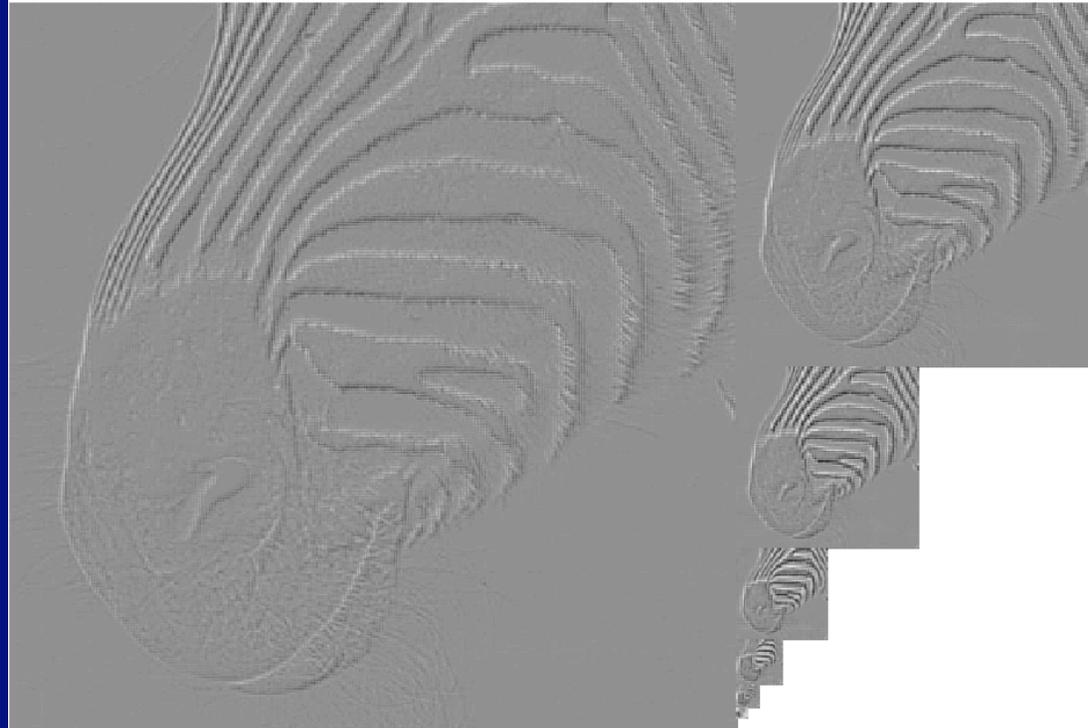
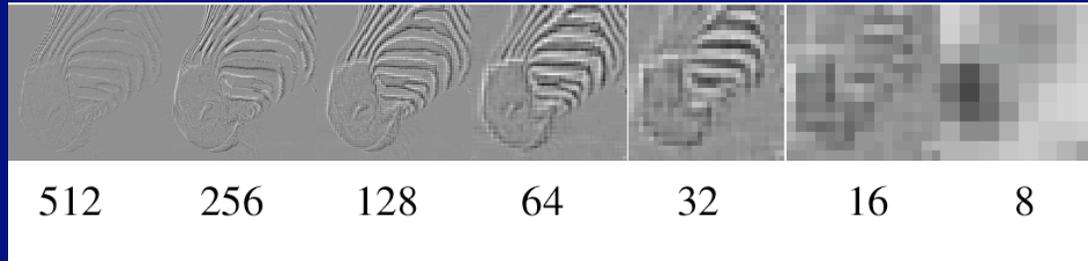




The Laplacian Pyramid

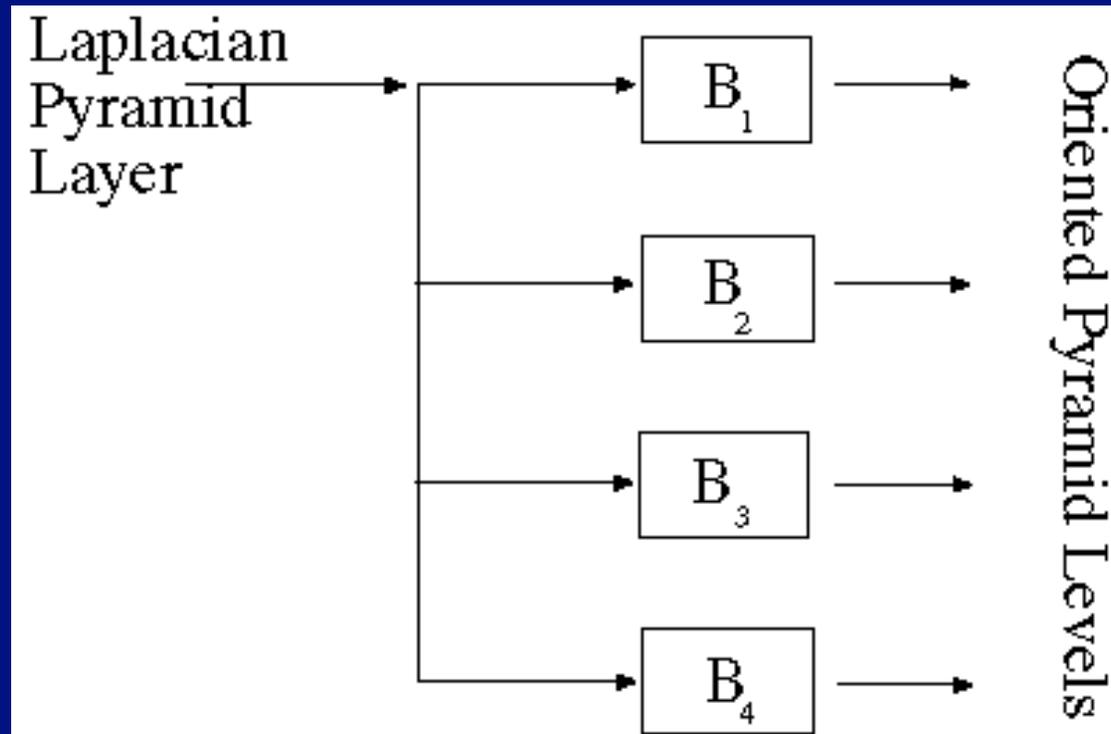
- **Synthesis**
 - preserve difference between upsampled Gaussian pyramid level and Gaussian pyramid level
 - band pass filter - each level represents spatial frequencies (largely) unrepresented at other levels
- **Analysis**
 - reconstruct Gaussian pyramid, take top layer





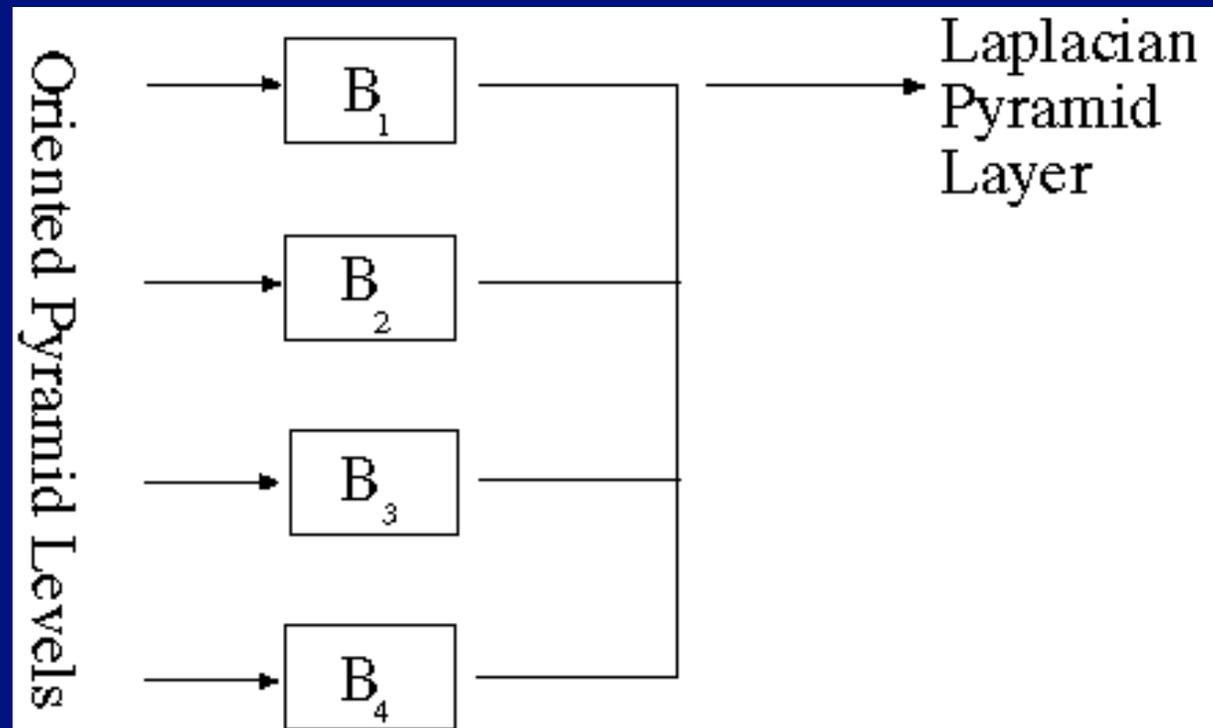
Oriented pyramids

- Laplacian pyramid is orientation independent
- Apply an oriented filter to determine orientations at each layer
 - by clever filter design, we can simplify synthesis
 - this represents image information at a particular scale and orientation



Analysis

synthesis



Filter Kernels



Image



Coarsest scale 

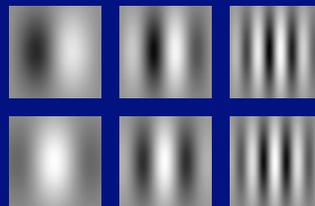


Finest scale

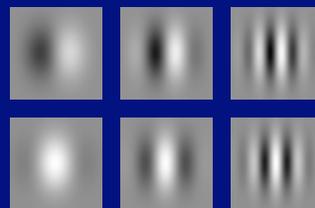


Other filters can be used

Gabor filters at different scales and spatial frequencies



top row shows anti-symmetric (or odd) filters, bottom row the symmetric (or even) filters.



$$G_{\text{antisymmetric}}(x, y) = \sin(k_0x + k_1y) \exp - \left\{ \frac{x^2 + y^2}{2\sigma^2} \right\}$$

$$G_{\text{Symmetric}}(x, y) = \cos(k_x x + k_y y) \exp - \left\{ \frac{x^2 + y^2}{2\sigma^2} \right\}$$

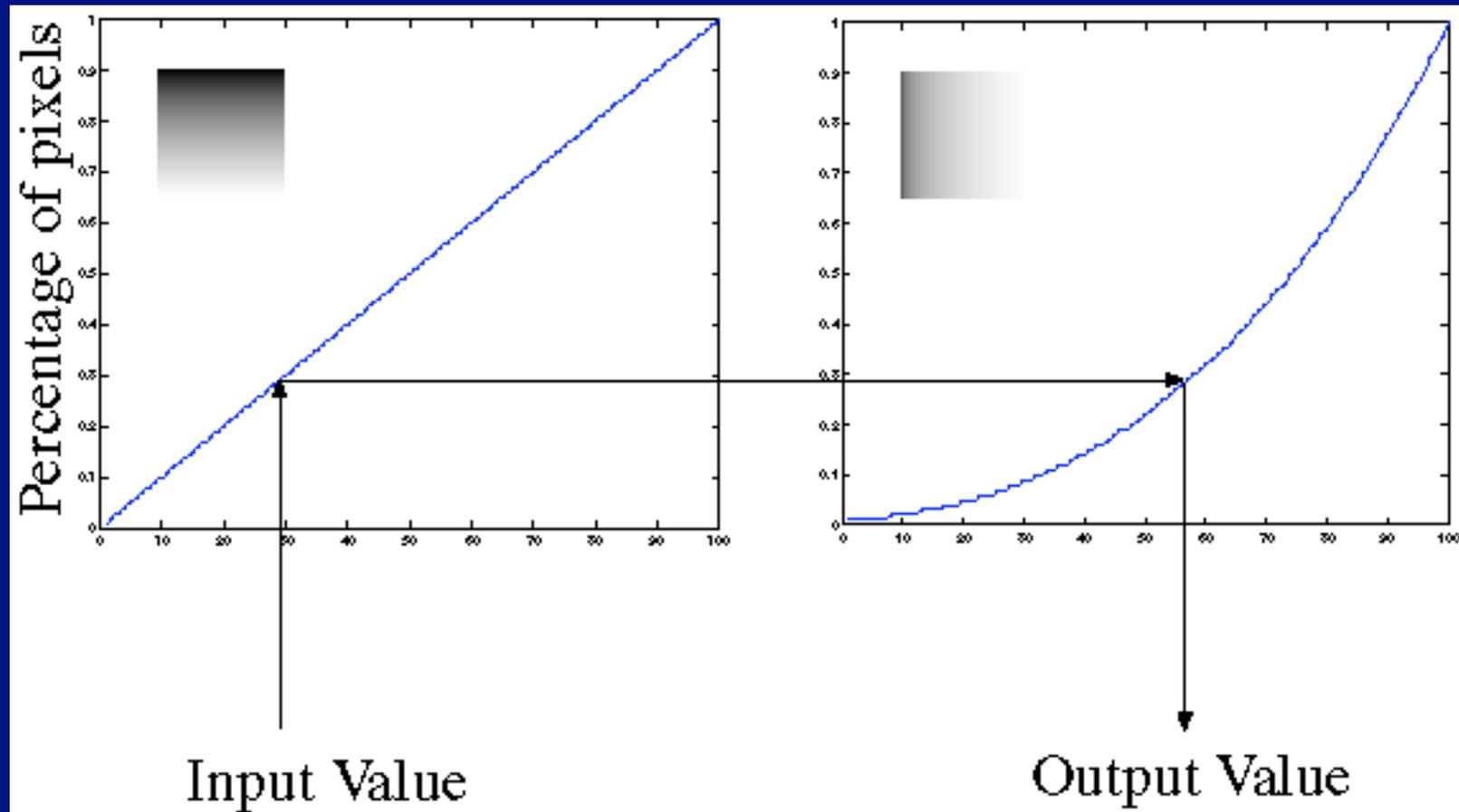
Texture synthesis

- Important applications
 - make more texture for texture mapping
- Interesting examples
- Methods:
 - pyramid based synthesis (not great)
 - nonparametric (spectacular)

Pyramid methods

- Idea:
 - Take each layer of an oriented pyramid and adjust it independently so that its histogram looks like that of the pyramid constructed from an example image (Heeger+Bergen)
 - Repeat
 - Synthesize example image from the pyramid
 - Create the pyramid from the image
 - adjust the pyramid to match the example
- Modification
 - condition on earlier layers (de Bonet)

Histogram equalisation



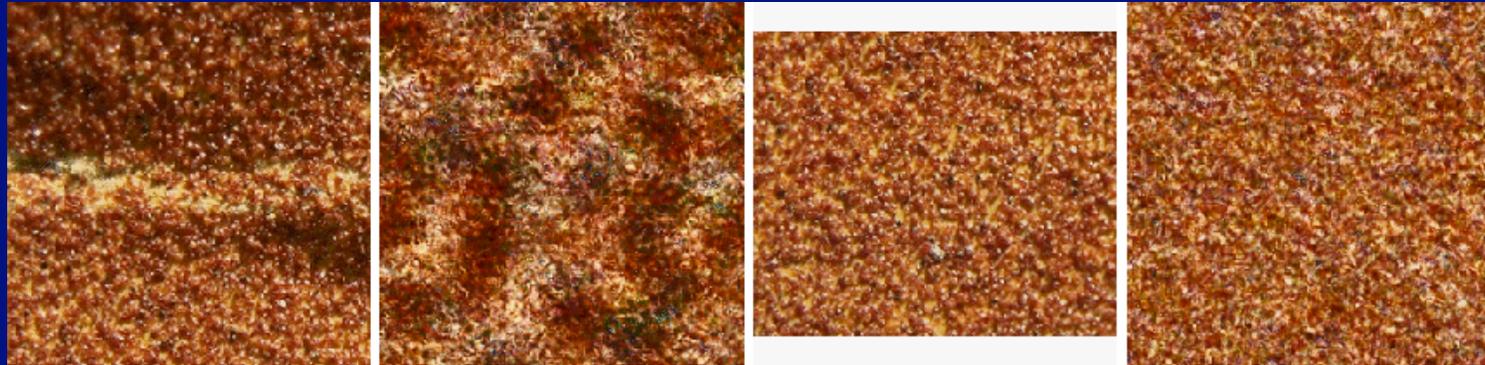
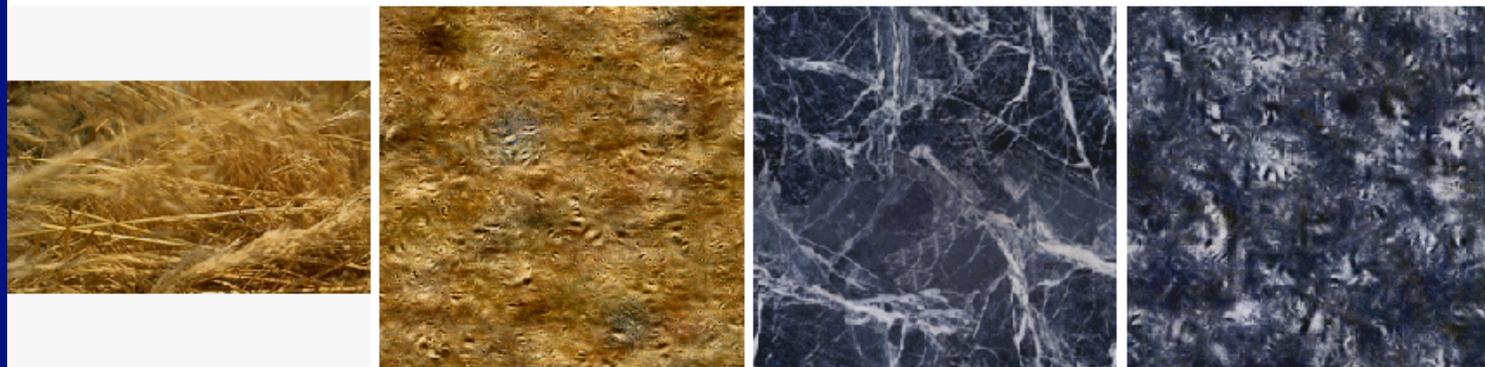


Figure 7: (Left pair) Inhomogeneous input texture produces blotchy synthetic texture. (Right pair) Homogeneous input

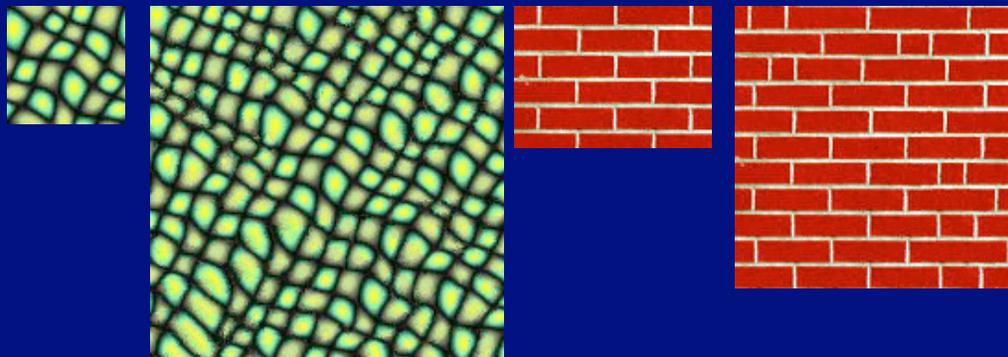


Figure 8: Examples of failure: wood grain and red coral.



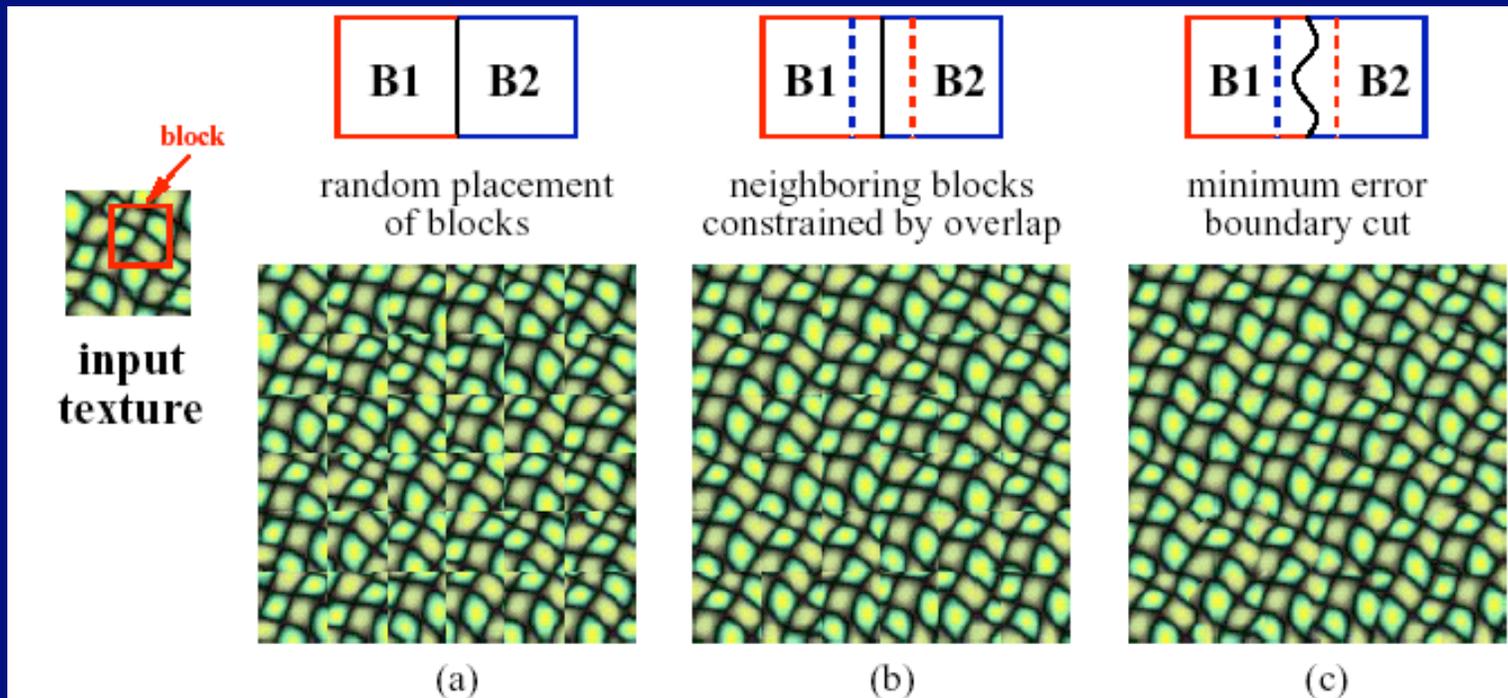
Non-parametric texture synthesis

- (Efros+Leung) Use image as a source of probability model
- Choose pixel values by
 - matching neighborhood, then filling in
- Matching process
 - look at pixel differences
 - count only synthesized pixels

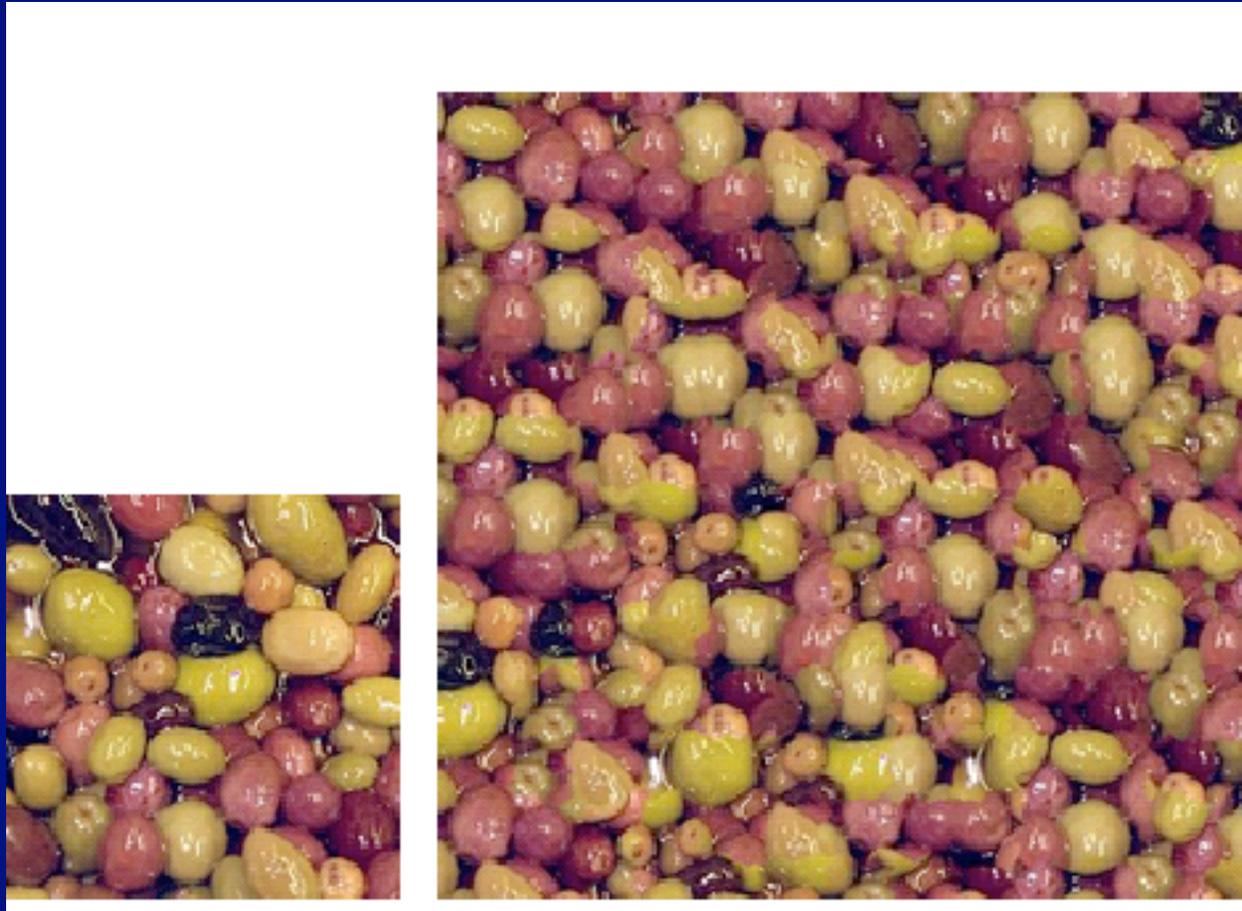


Vast cottage industry

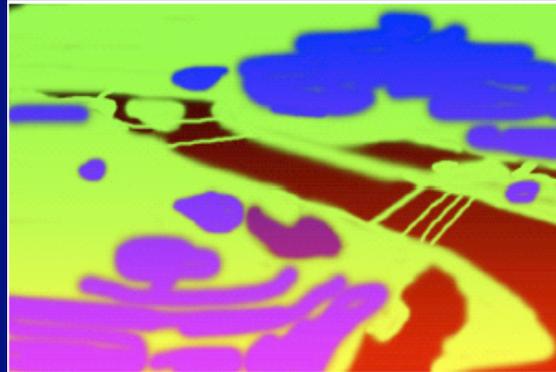
- Texture synthesis at multiple scales
- Texture synthesis on surfaces
- Texture synthesis by tiles
- Texture synthesis by analogy



From "Image quilting for texture synthesis and transfer", Efros and Freeman, SIGGRAPH 2001



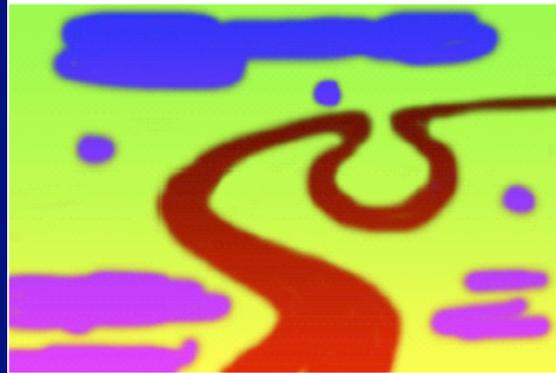
From “Image quilting for texture synthesis and transfer”, Efros and Freeman, SIGGRAPH 2001



Unfiltered source (A)



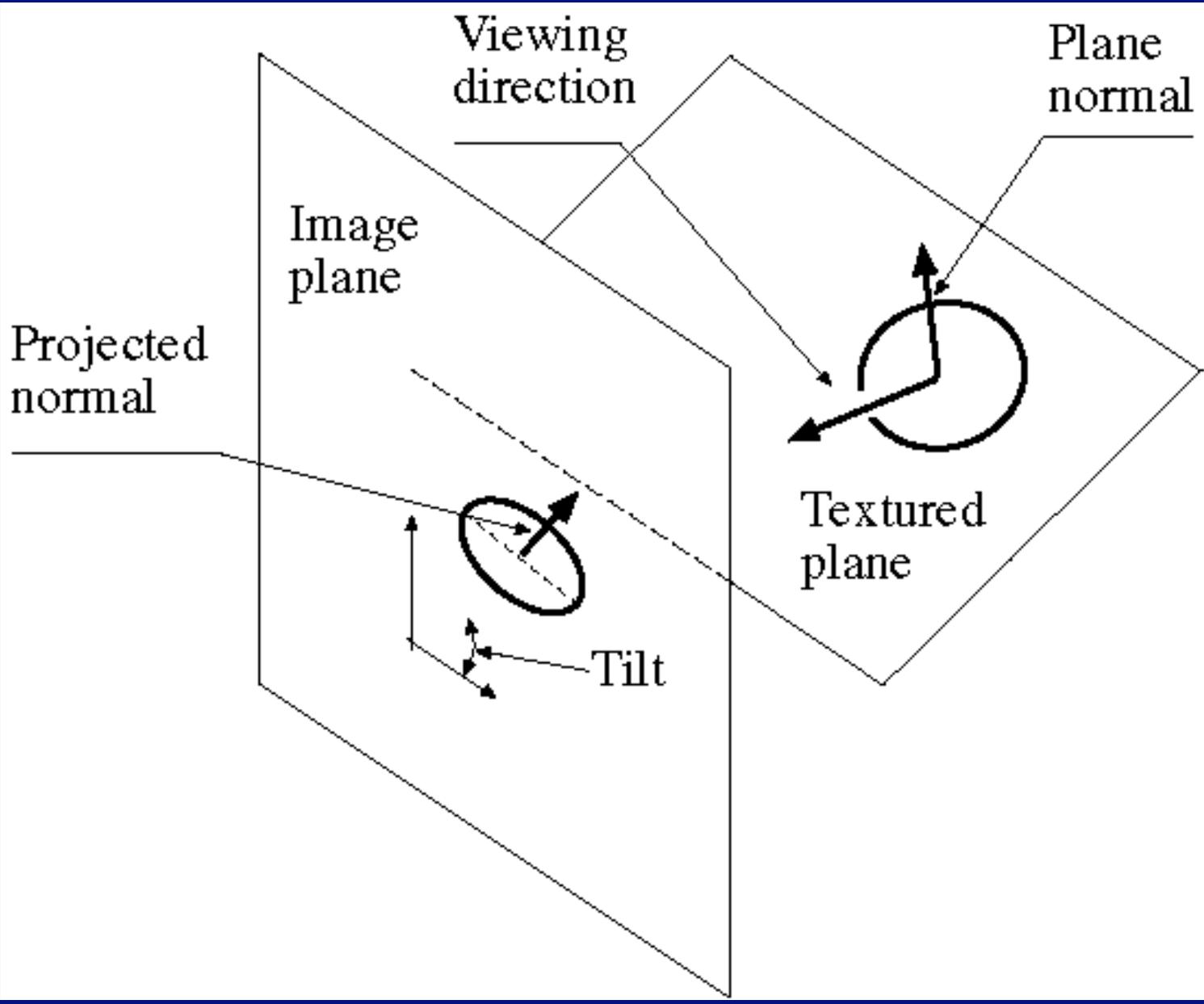
Filtered source (A')



From “Image analogies”, Herzmann et al, SIGGRAPH 2001

Shape from texture

- Texture distorts
 - distortion is a cue to orientation
 - changes in distortion are a cue to curvature
- But how do we use this cue?
 - impose a regularity condition
 - e.g. isotropy yields the orientation of a plane
 - e.g. homogeneity can be made to yield normal and curvature
 - Infer element from repetition

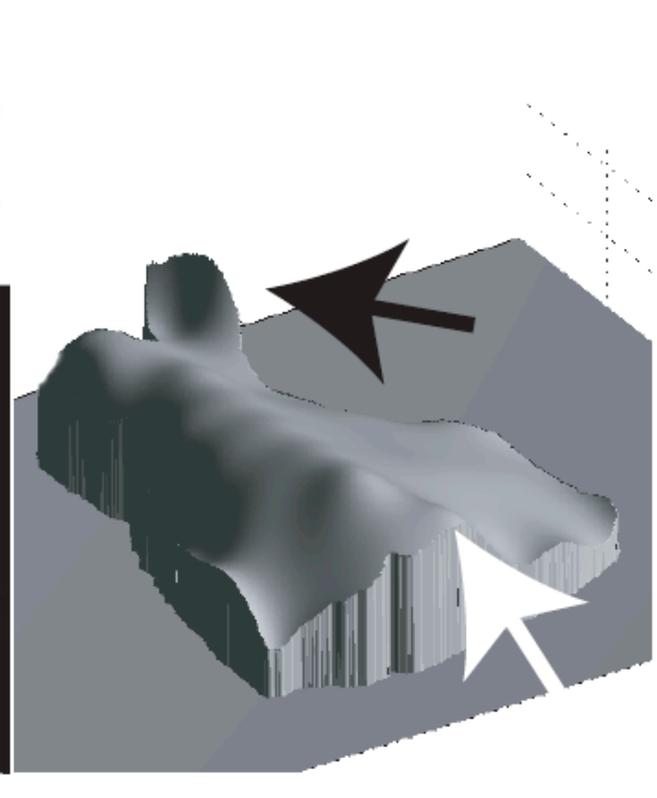
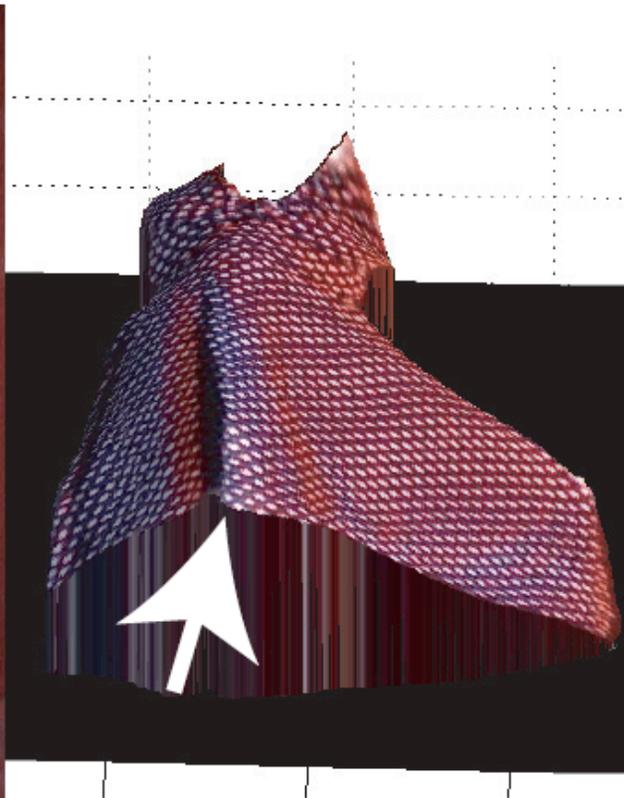


Strategy

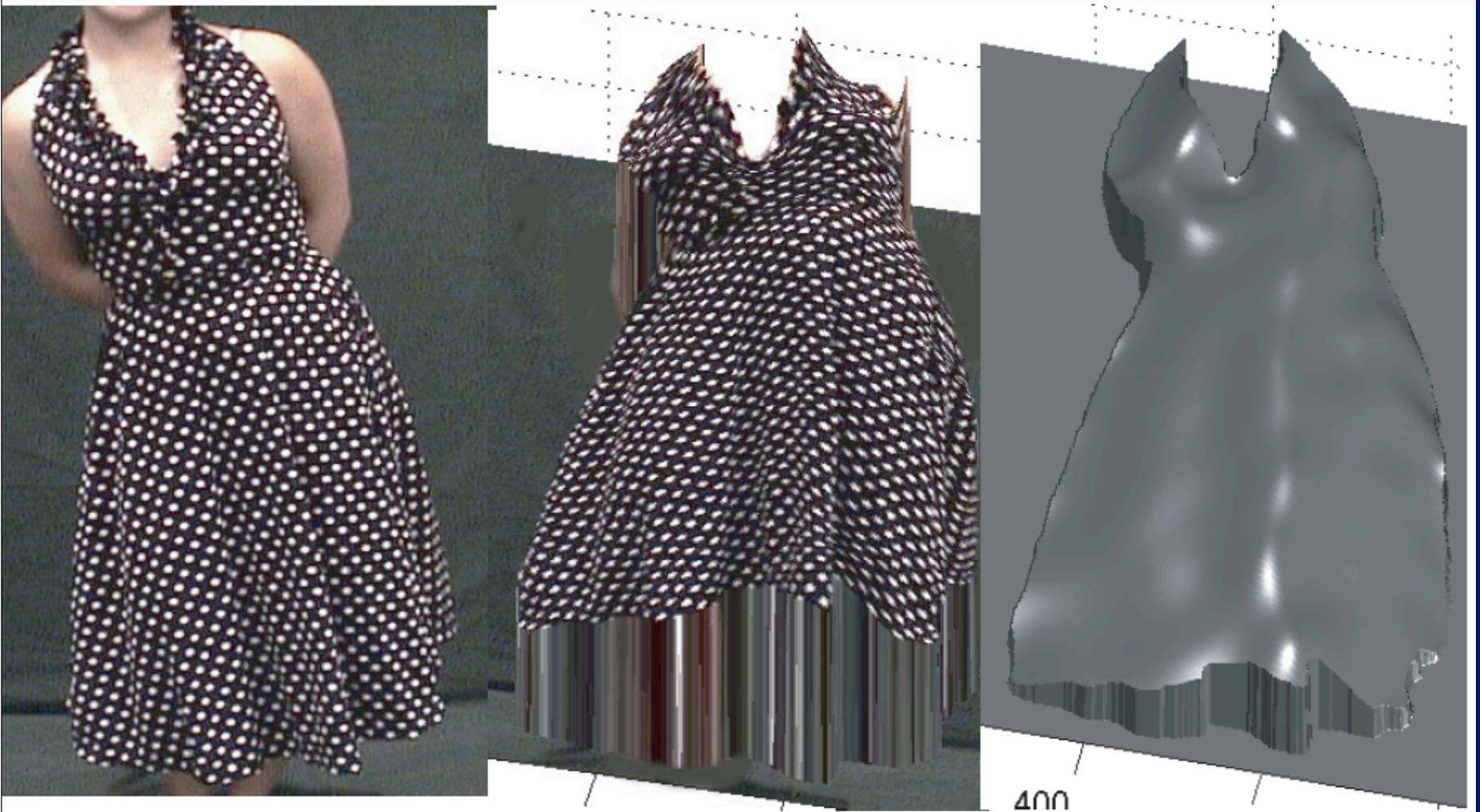
- Identify repeated elements
 - using clustering methods we haven't yet discussed
- Infer the frontal element
 - using a geometric result too tricky to prove here
- Reconstruct the surface
 - using an algorithm we'll describe in about three weeks time
- Repetition gives an estimate of irradiance
 - easily!



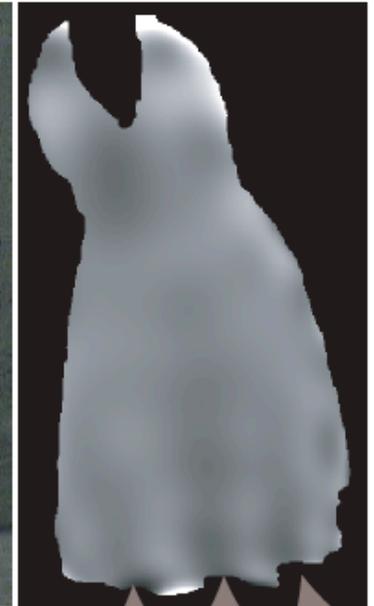
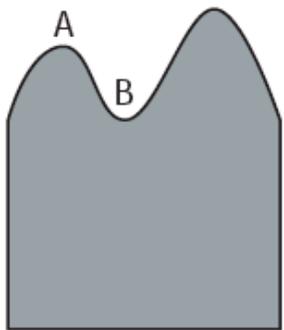
Lobay+Forsyth, 06



Lobay+Forsyth, 06



Lobay+Forsyth, 06



Lobay+Forsyth, 06