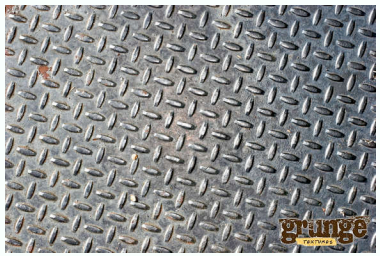
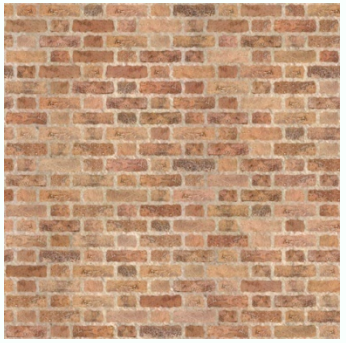
Texture

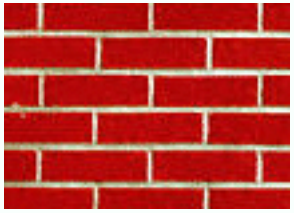
CS 419

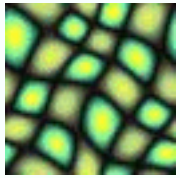
Slides by Ali Farhadi

What is a Texture?



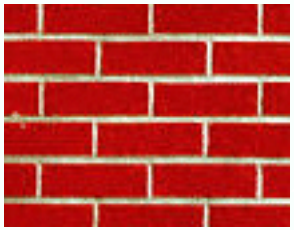


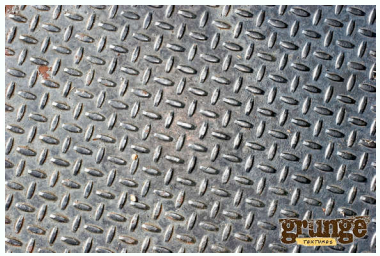




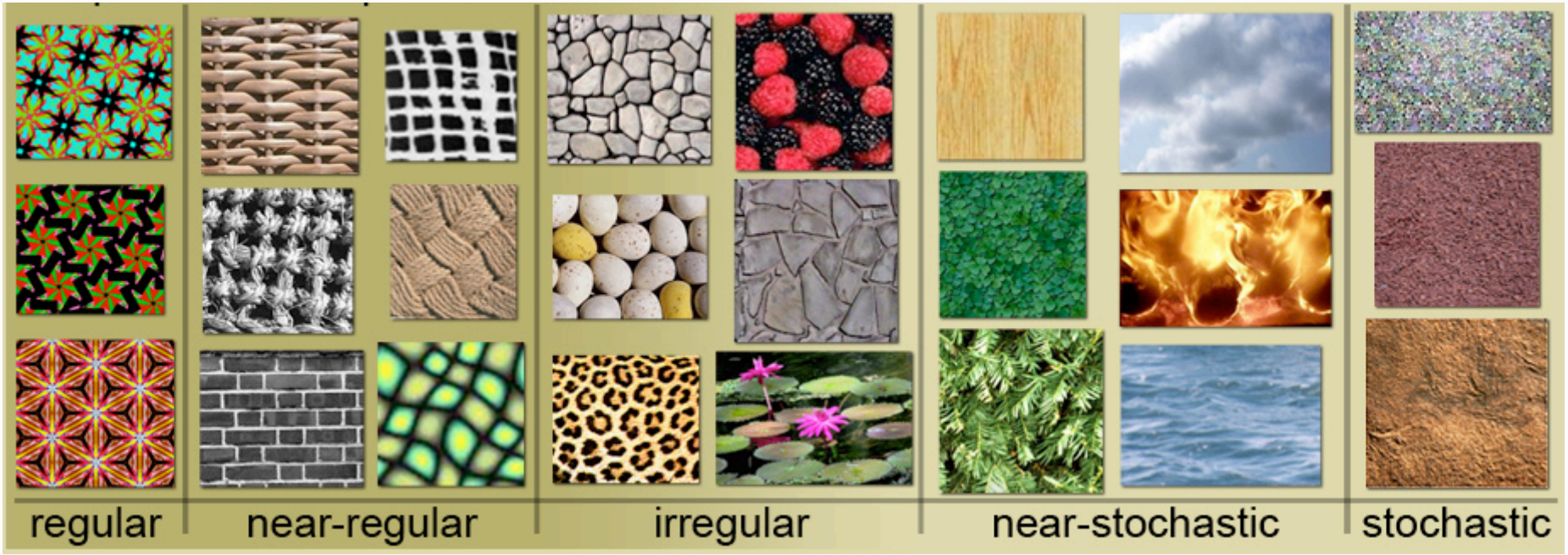
Texture

- Easy to recognize, Hard to define
- Spatial pattern
- It's all about scale

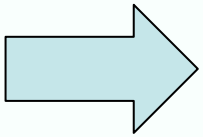




Texture Spectrum

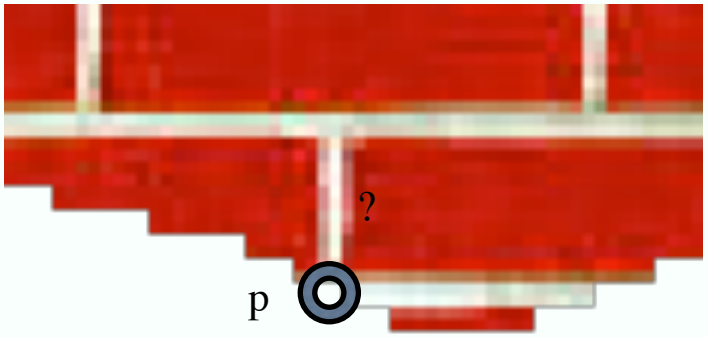


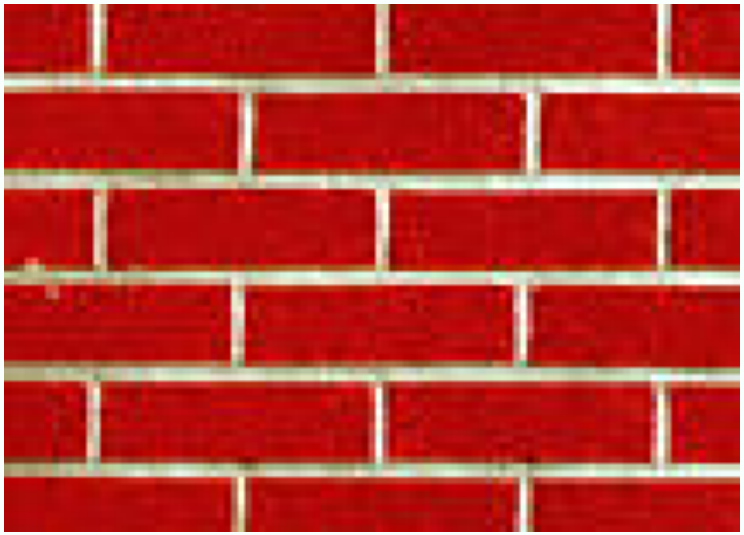
Texture Synthesis



Efros & Leung ICCV99

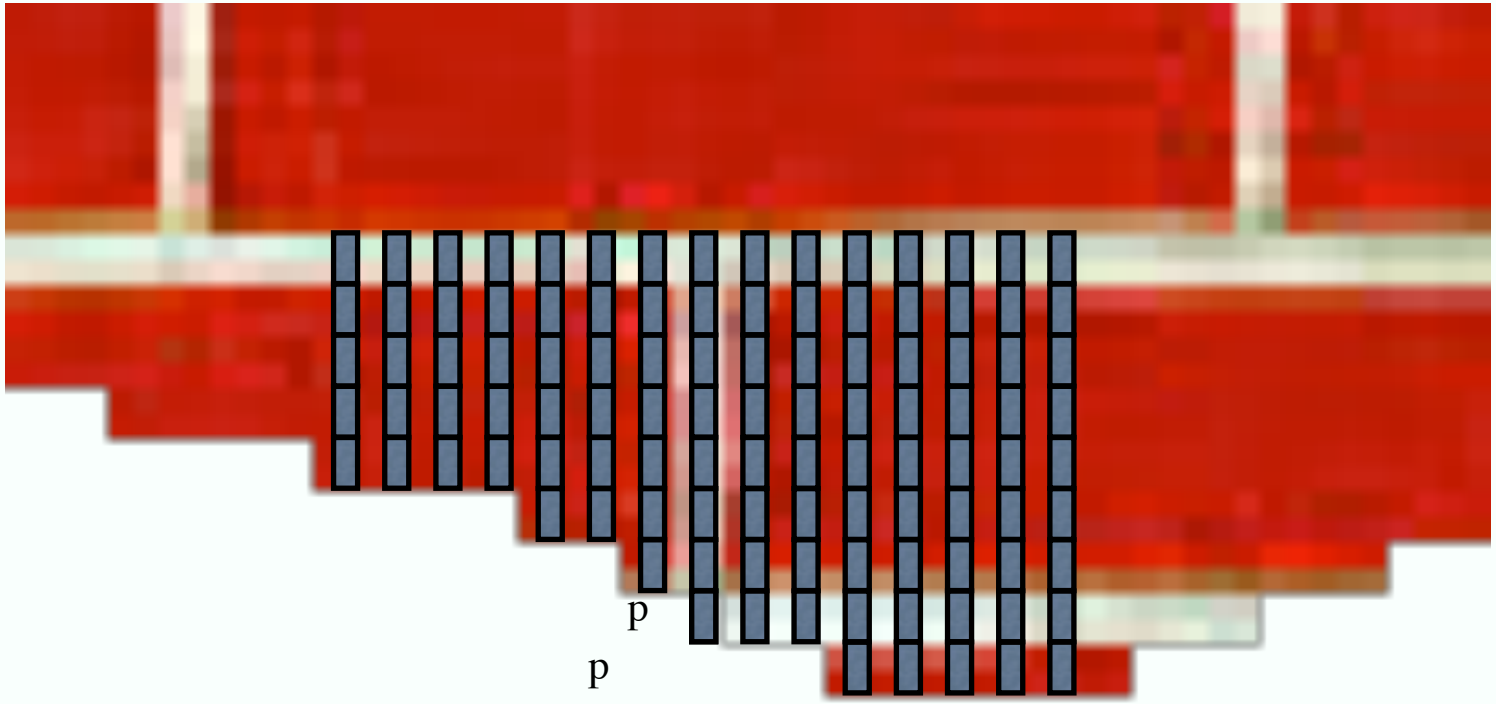
How to paint this pixel?



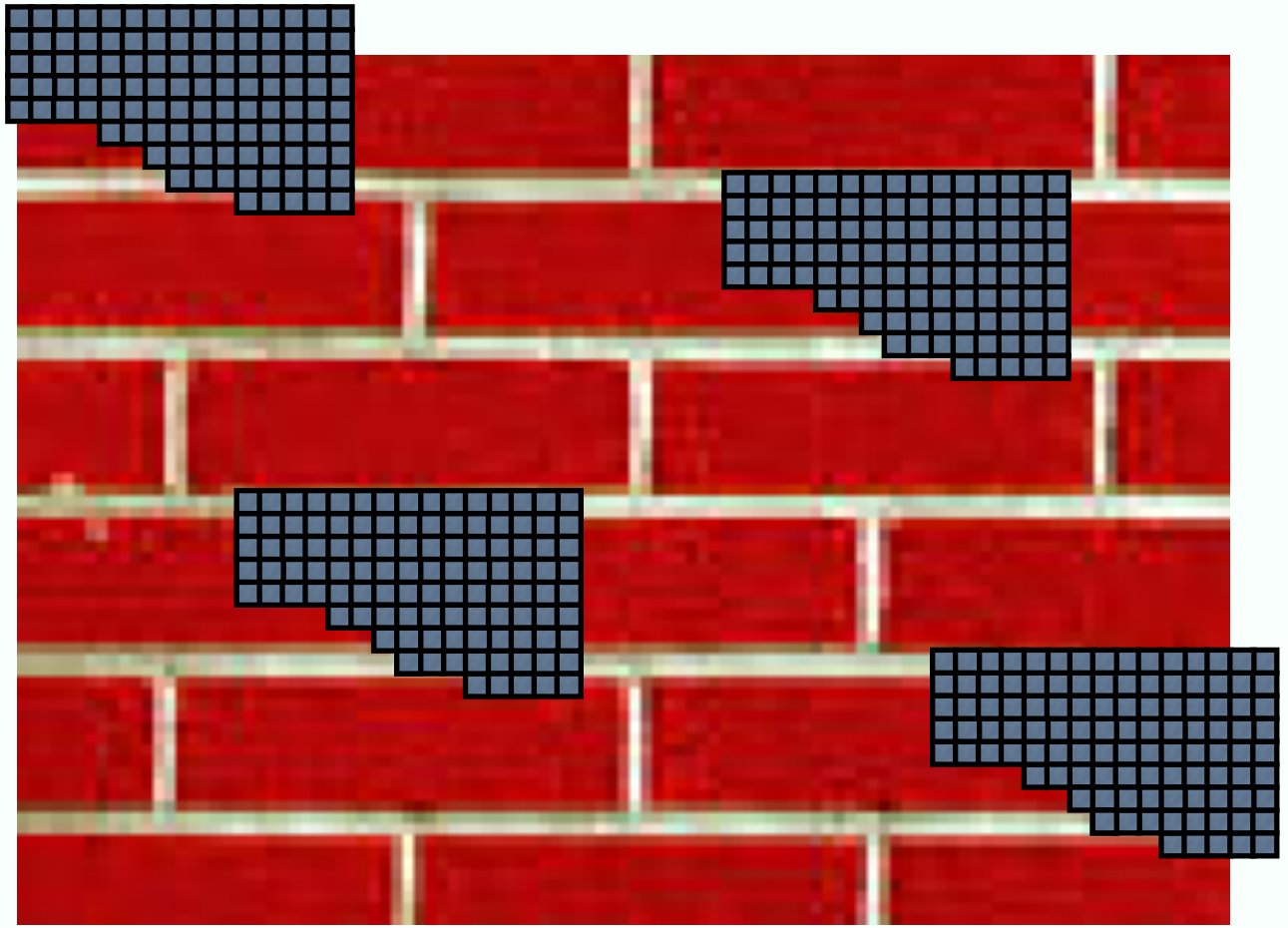


Input texture

Ask Neighbors



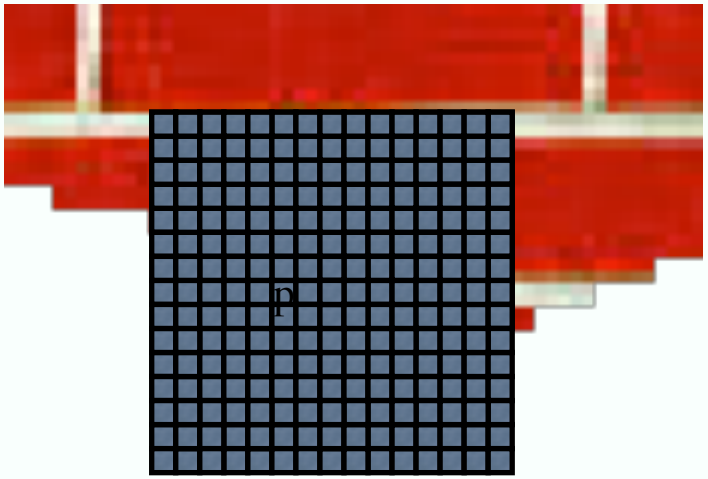
- What is the conditional probability distribution of p, given it's neighbors?



Input image

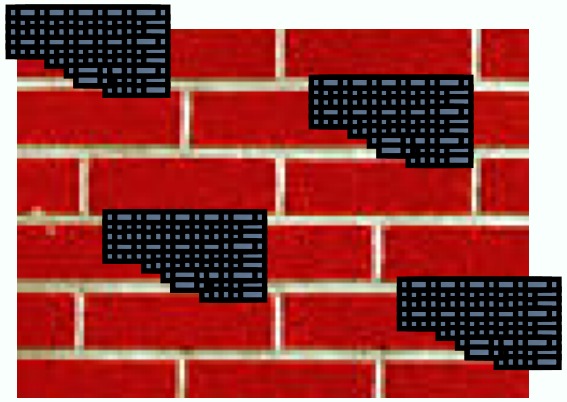
- Don’t bother to model the distribution
  - It’s already there, in the image

Efros & Leung Algorithm



Synthesizing a pixel

non-parametric
sampling



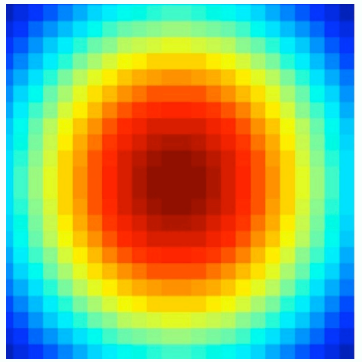
Input image

Concerns

- Distance metric
- Neighborhood size
- Order to paint

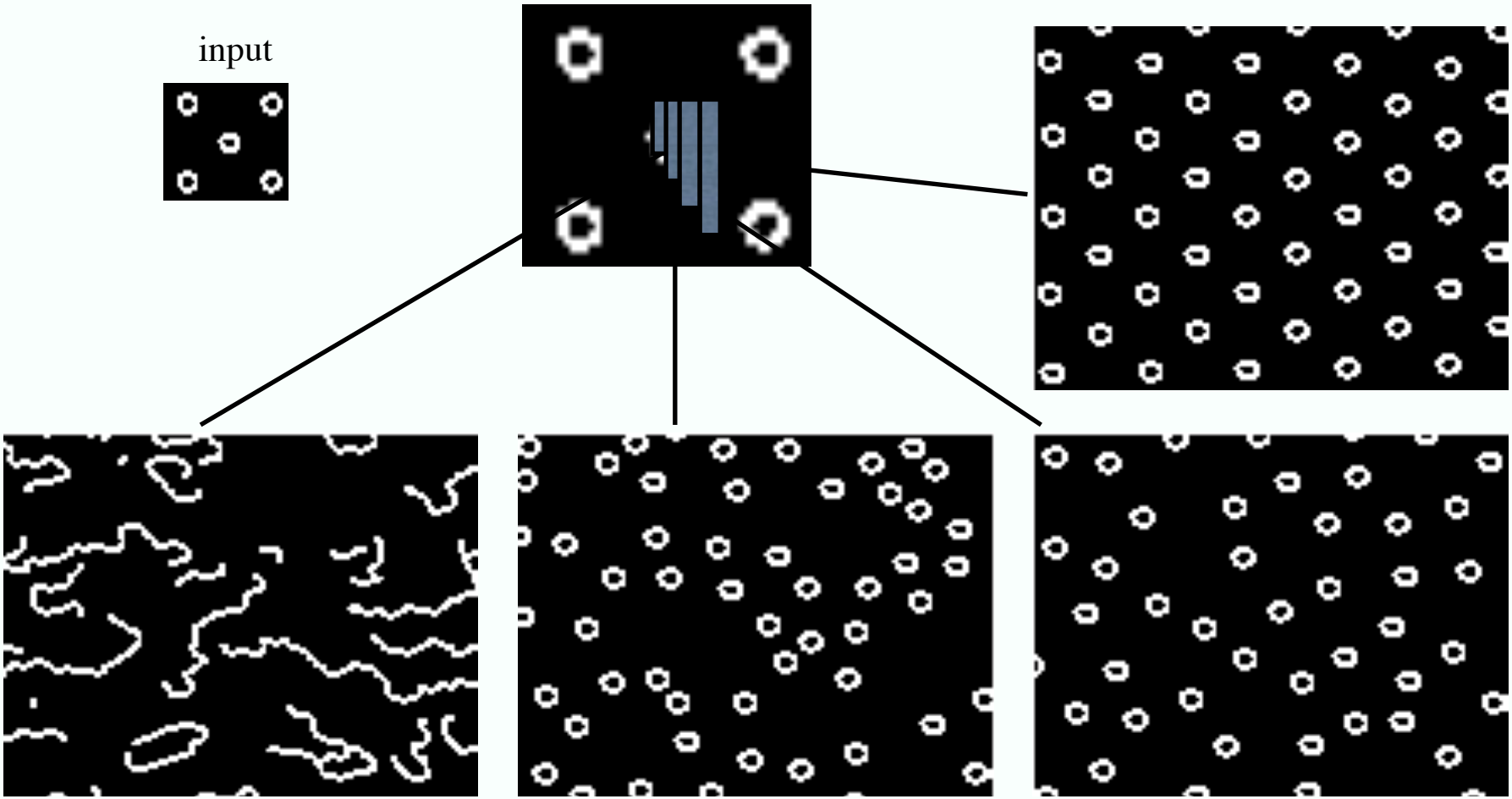
Distance metric

- Normalized sum of squared distances
- Not all the neighbors worth the same
  - Gaussian mask



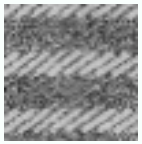
- Preserve the local structure
- Pick among reasonably similar neighborhoods

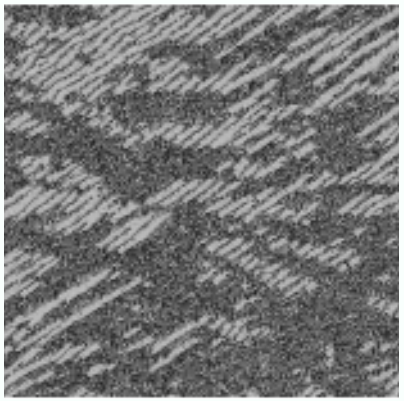
Neighborhood size

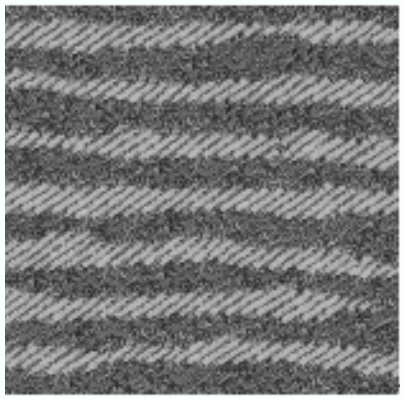


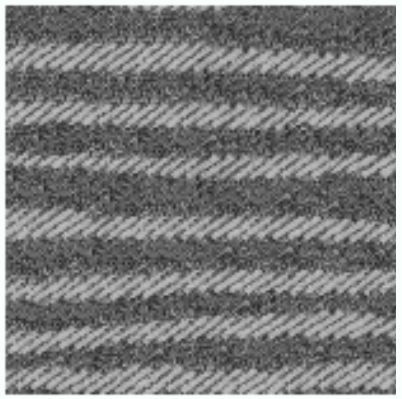
Efros & Leung ICCV99

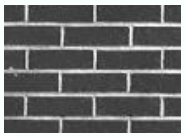
Varying Window Size

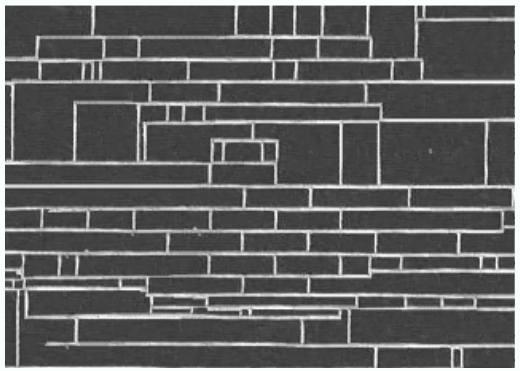


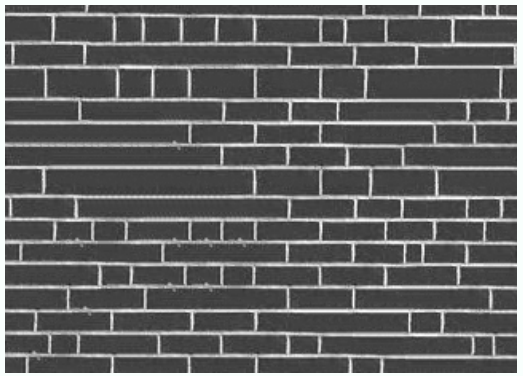


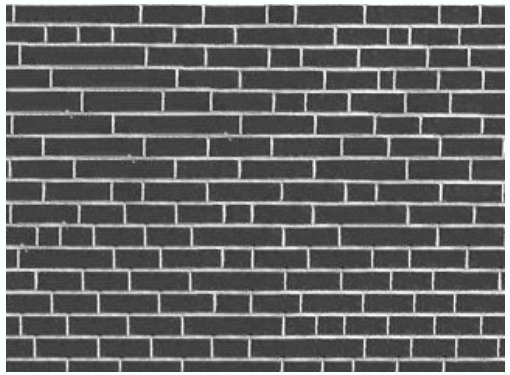






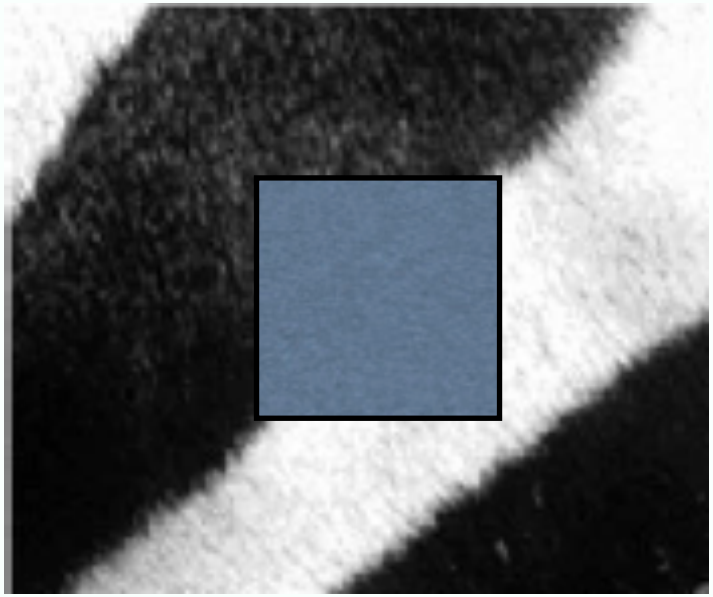




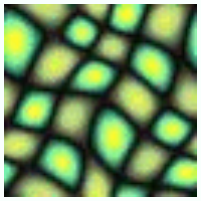


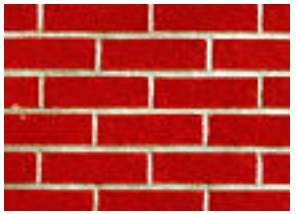
Increasing window size

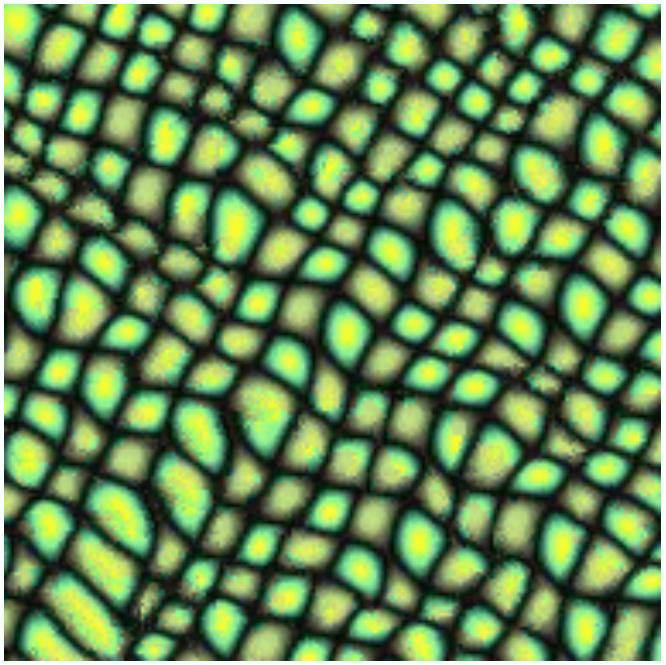
The Order matters

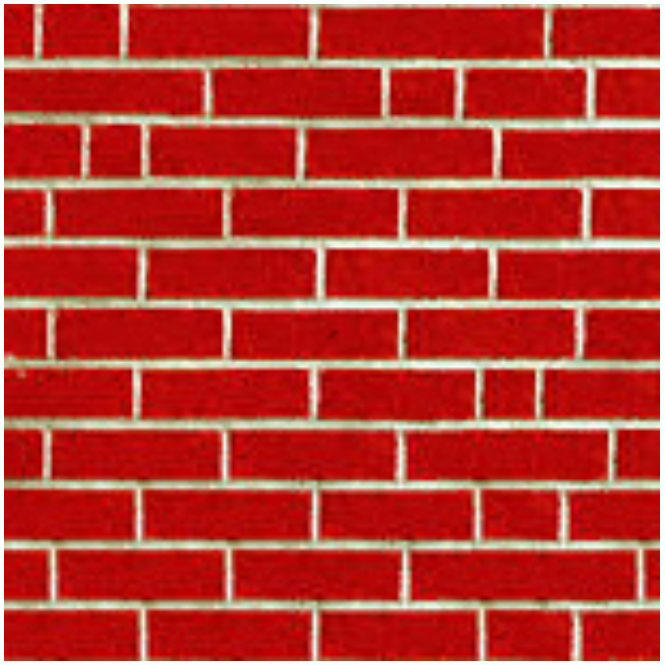


Some Results

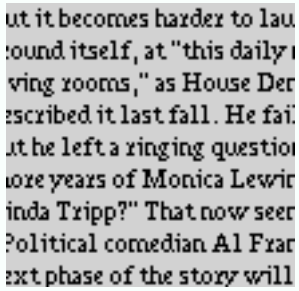


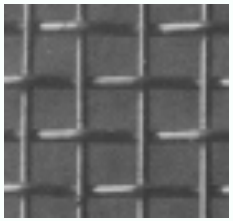


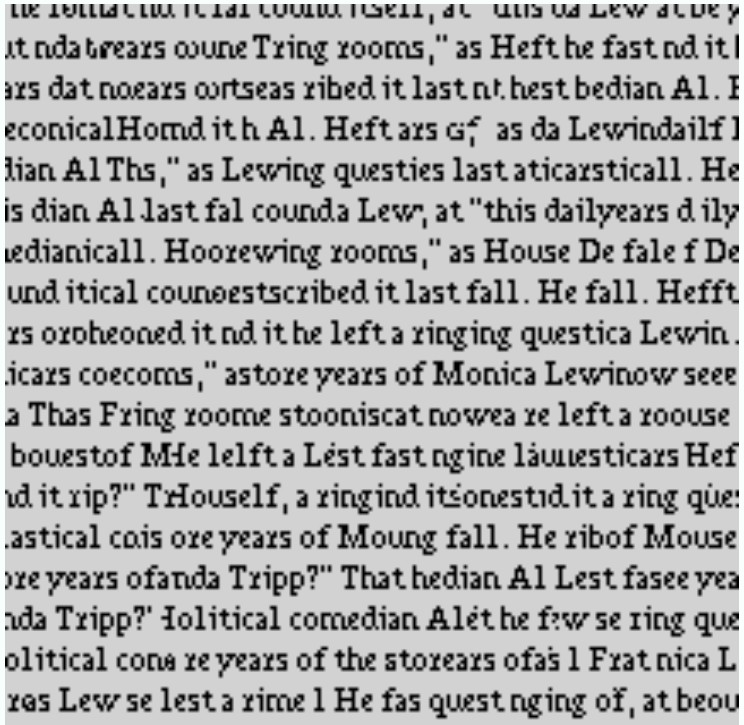


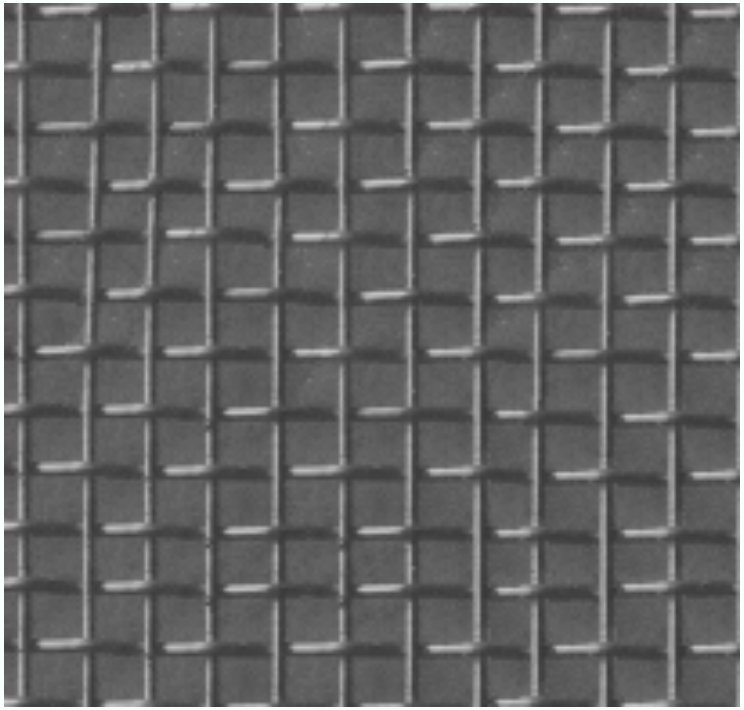


More Results









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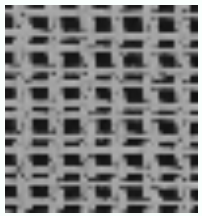
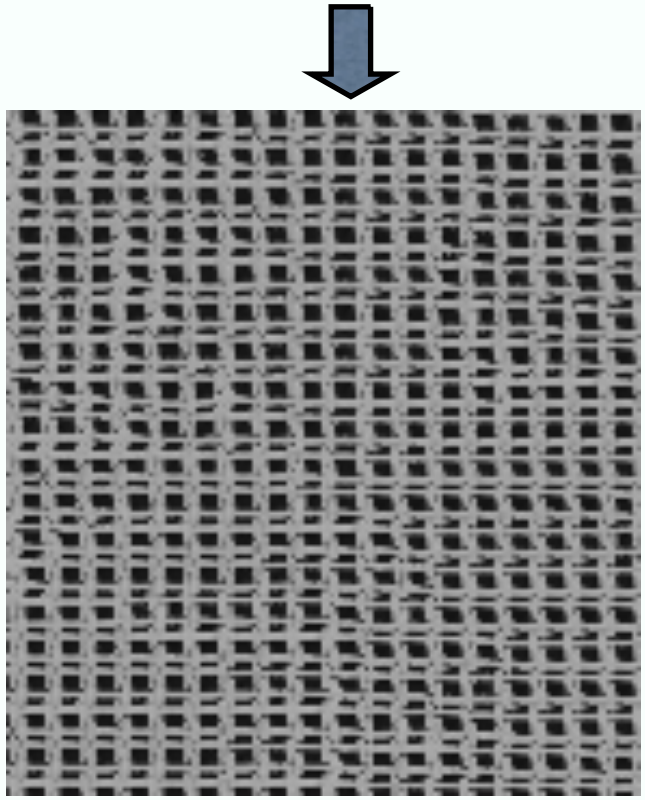
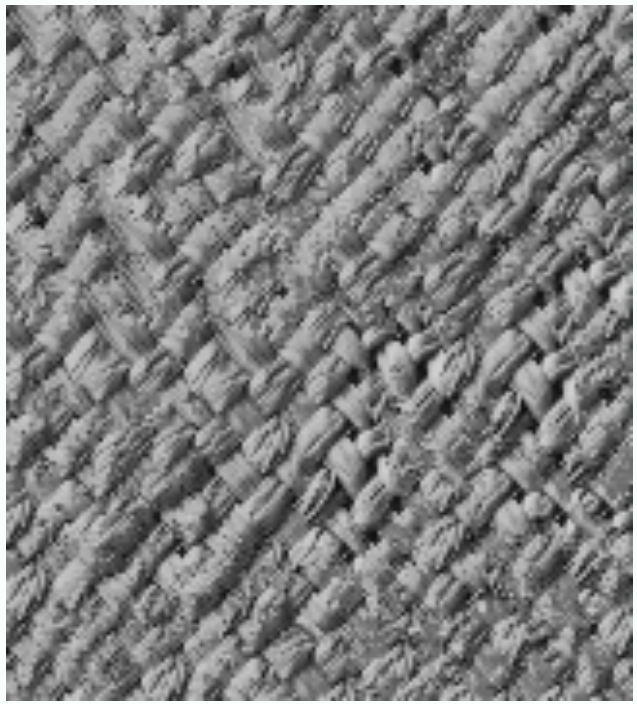
More Results

french canvas





rafia weave

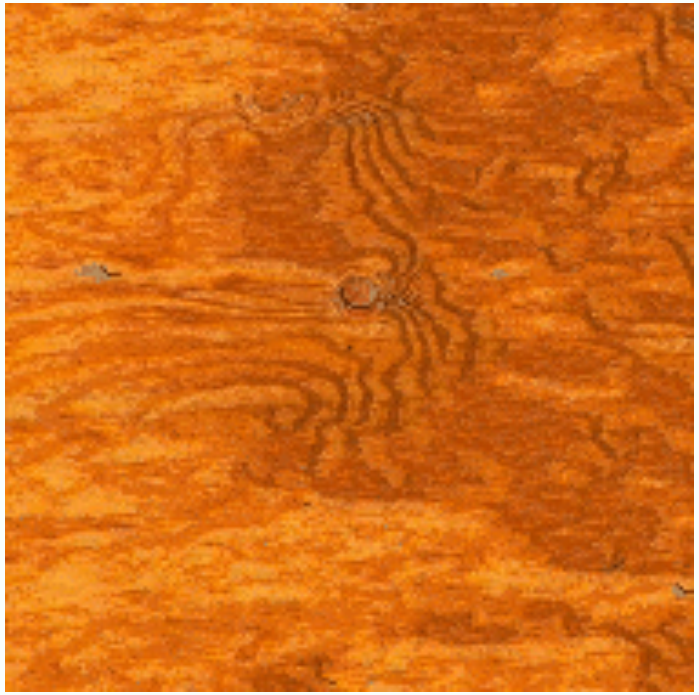


Efros & Leung ICCV99

More Results

wood

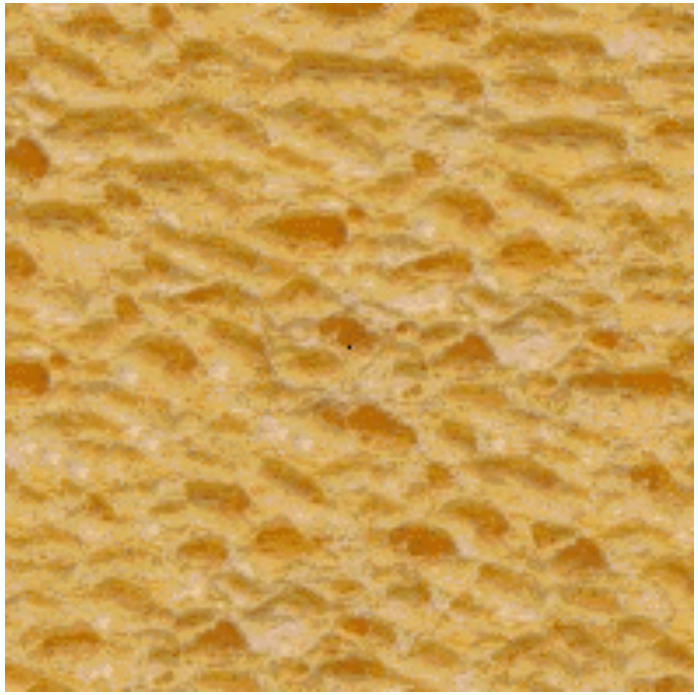
granite



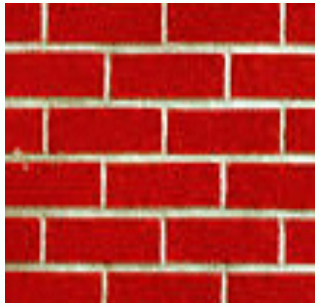
Efros & Leung ICCV99

More Results

white bread

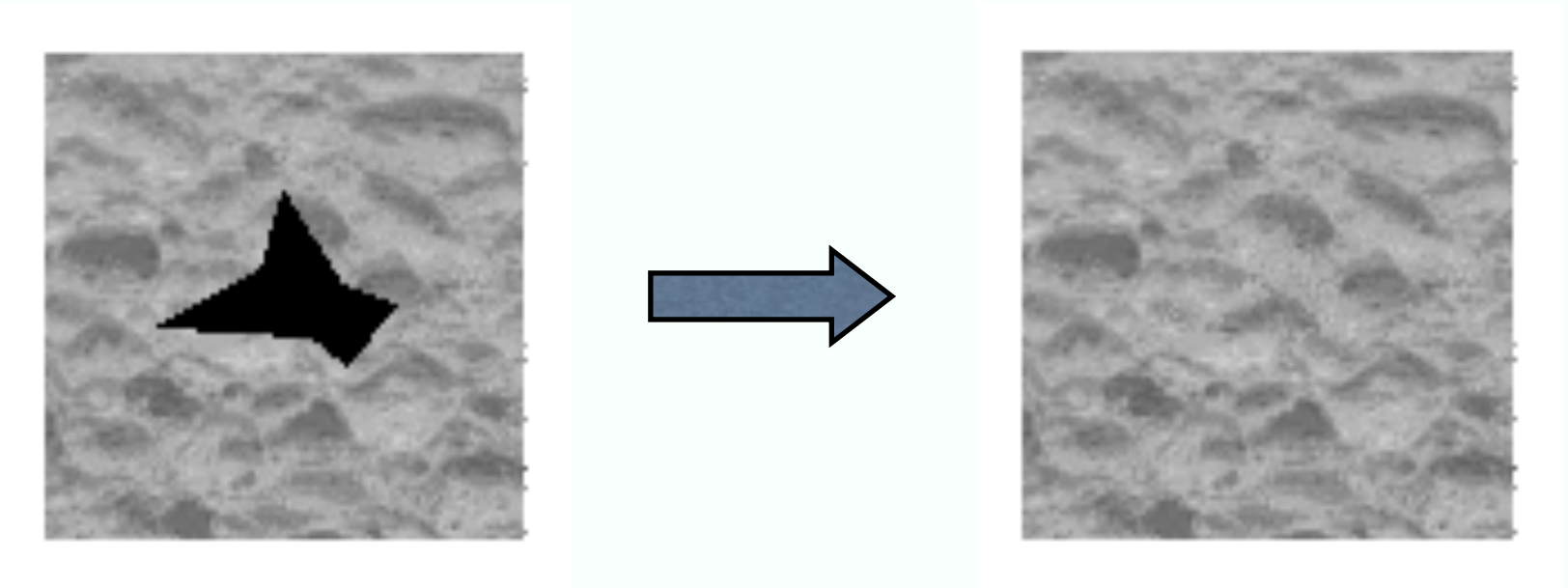


brick wall

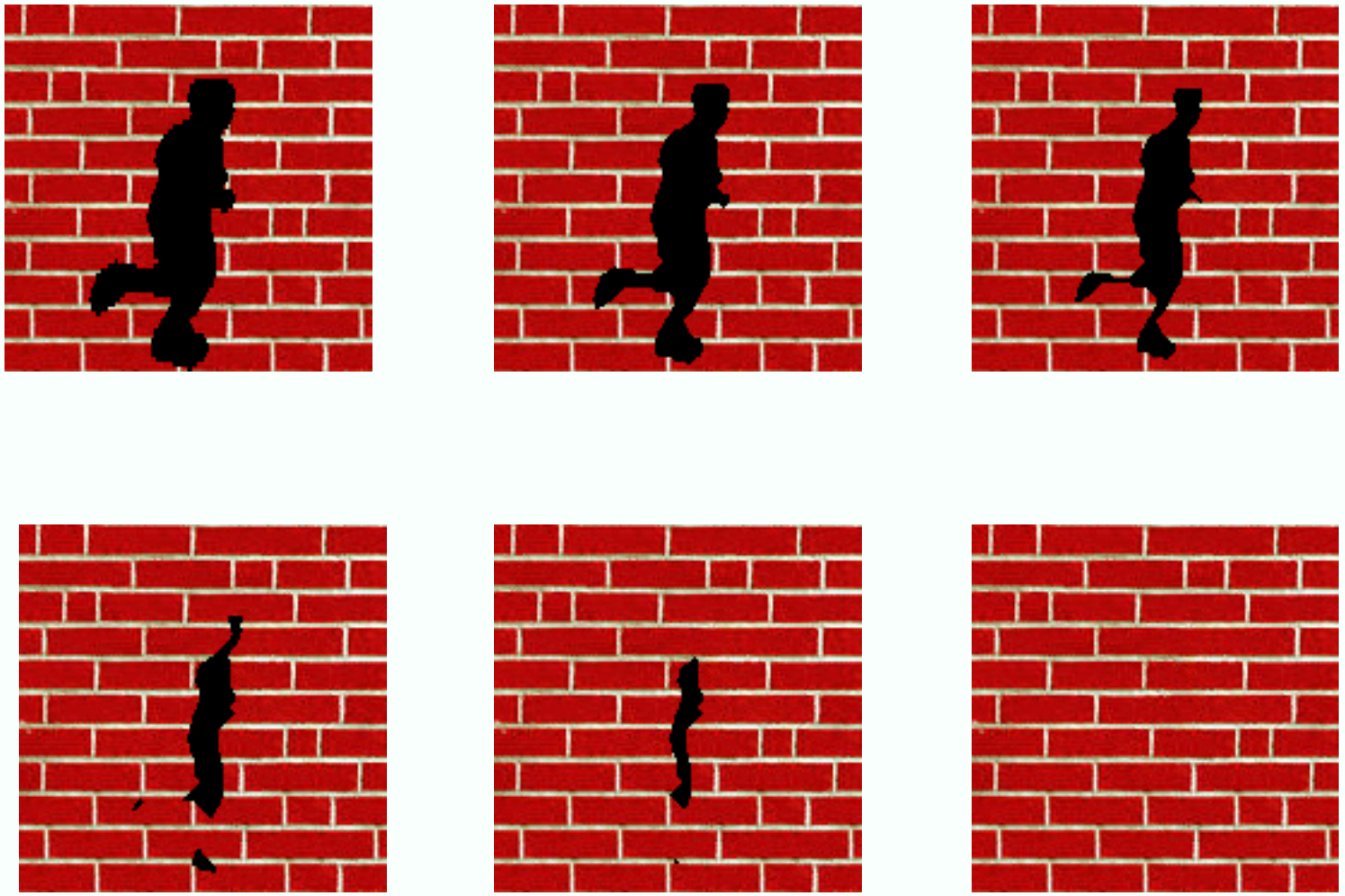


Efros & Leung ICCV99

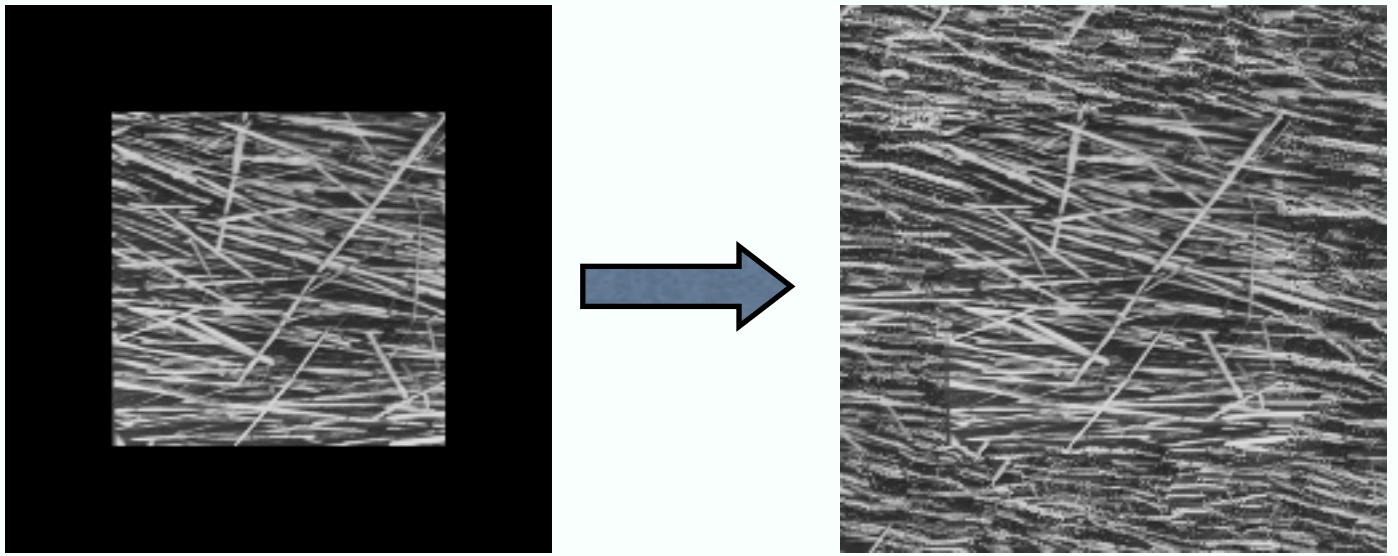
Growing Regions
Hole Filling

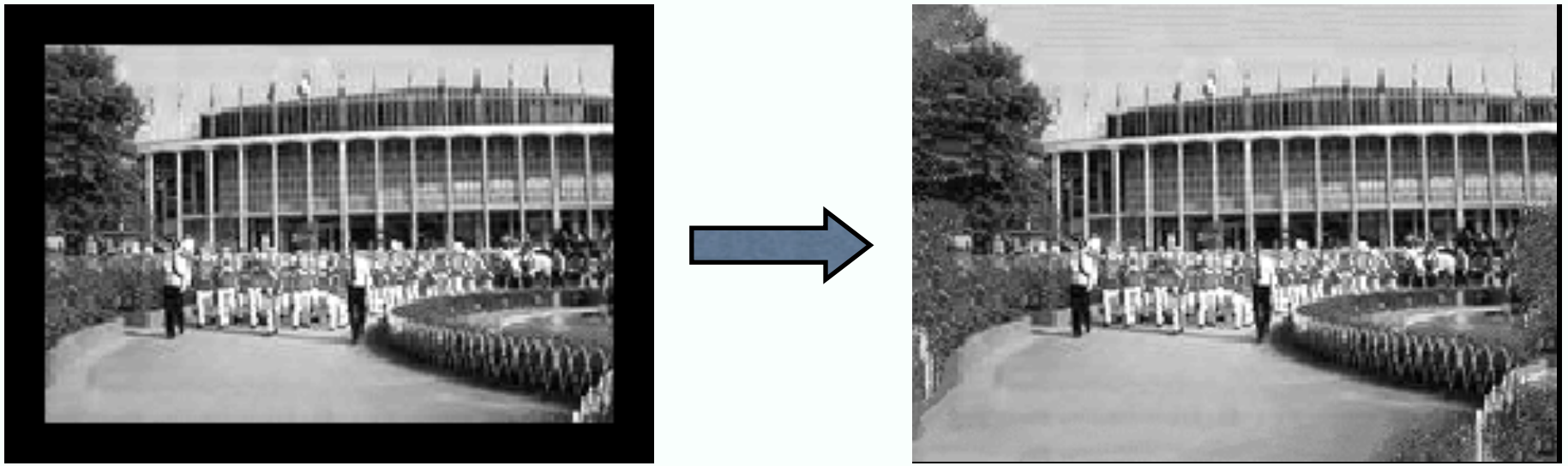


Hole Filling



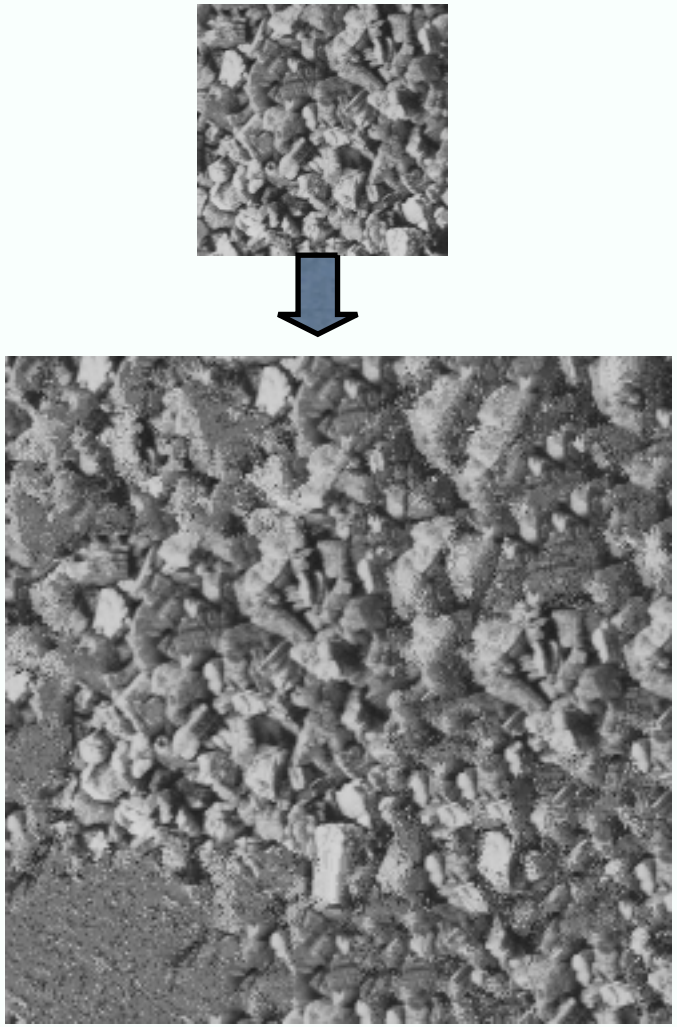
Extrapolation



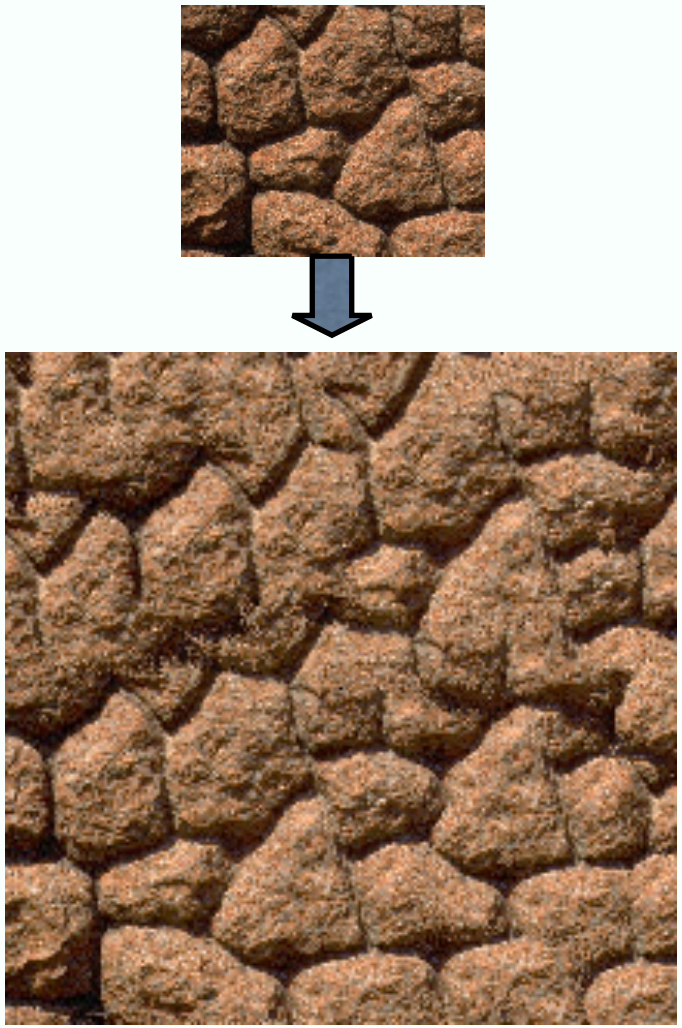


Efros & Leung ICCV99

Failure Cases



Growing garbage



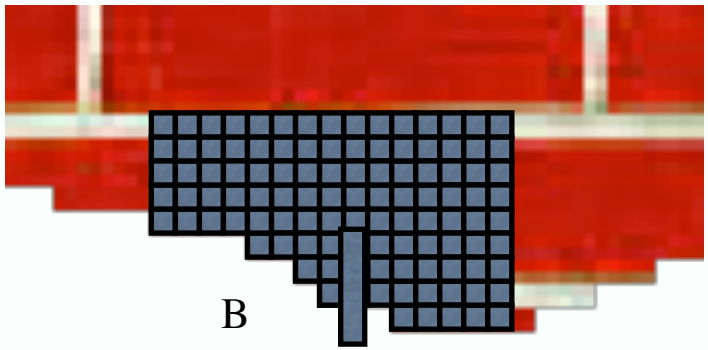
Verbatim copying

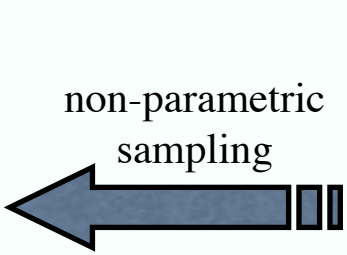
Pros and Cons

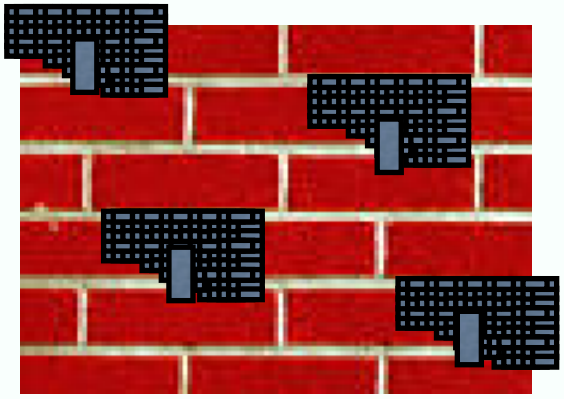
- Very simple
- Easy to implement
- Promising results

- Very slooooooooowwwwwww
- Idea:
  - Patches instead of pixels

Patch based



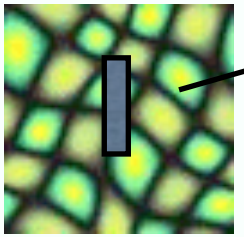




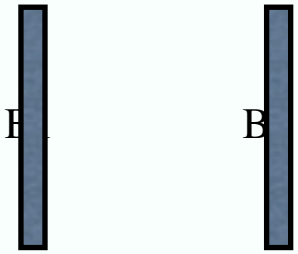
Synthesizing a block

Input image

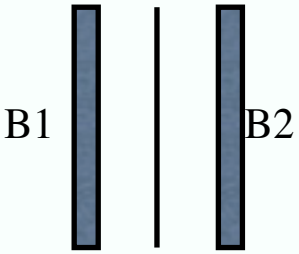
- Observation
  - neighbouring pixels are highly correlated
- Idea:
  - unit of synthesis = block



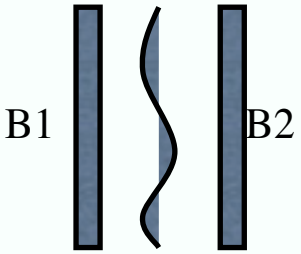
Input texture



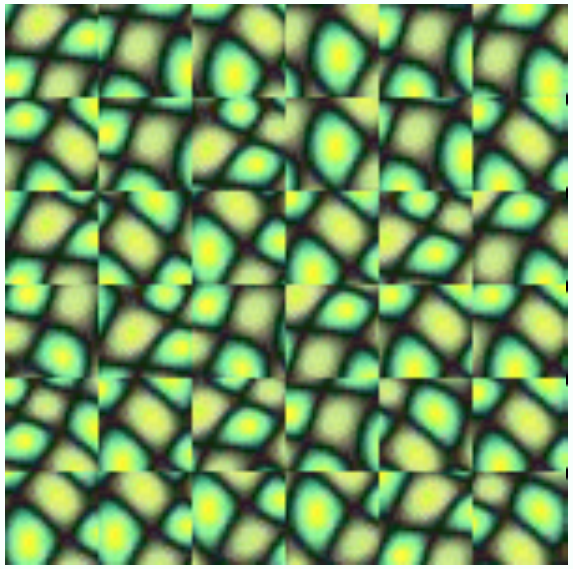
Random placement
of blocks

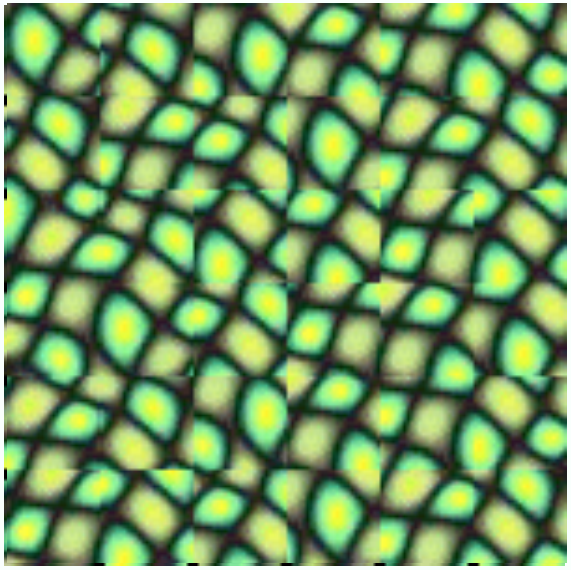


Neighboring blocks
constrained by overlap



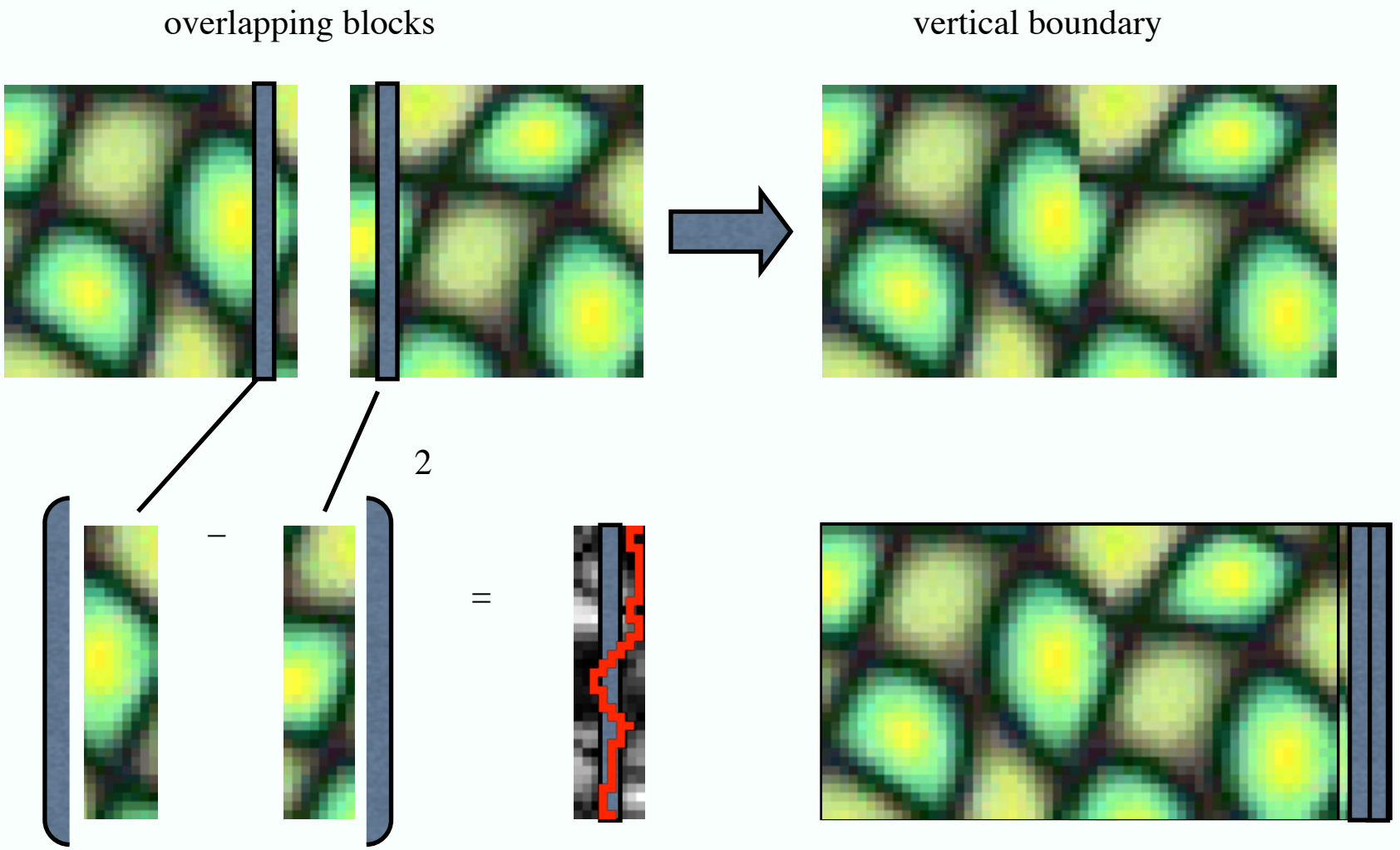
Minimal error
boundary cut



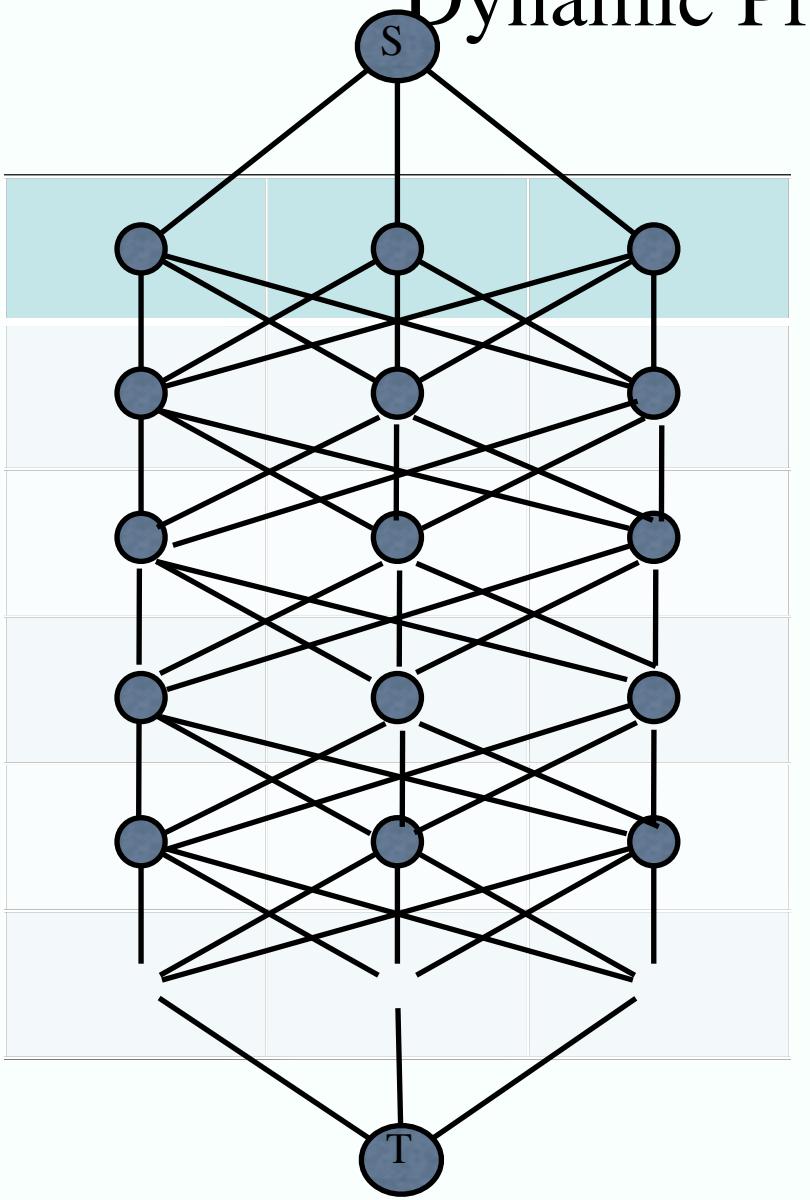


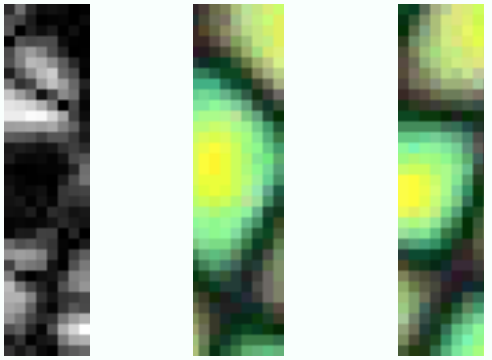
Efros & Freeman SIGGRAPH01

Minimal error boundary



Dynamic Programming

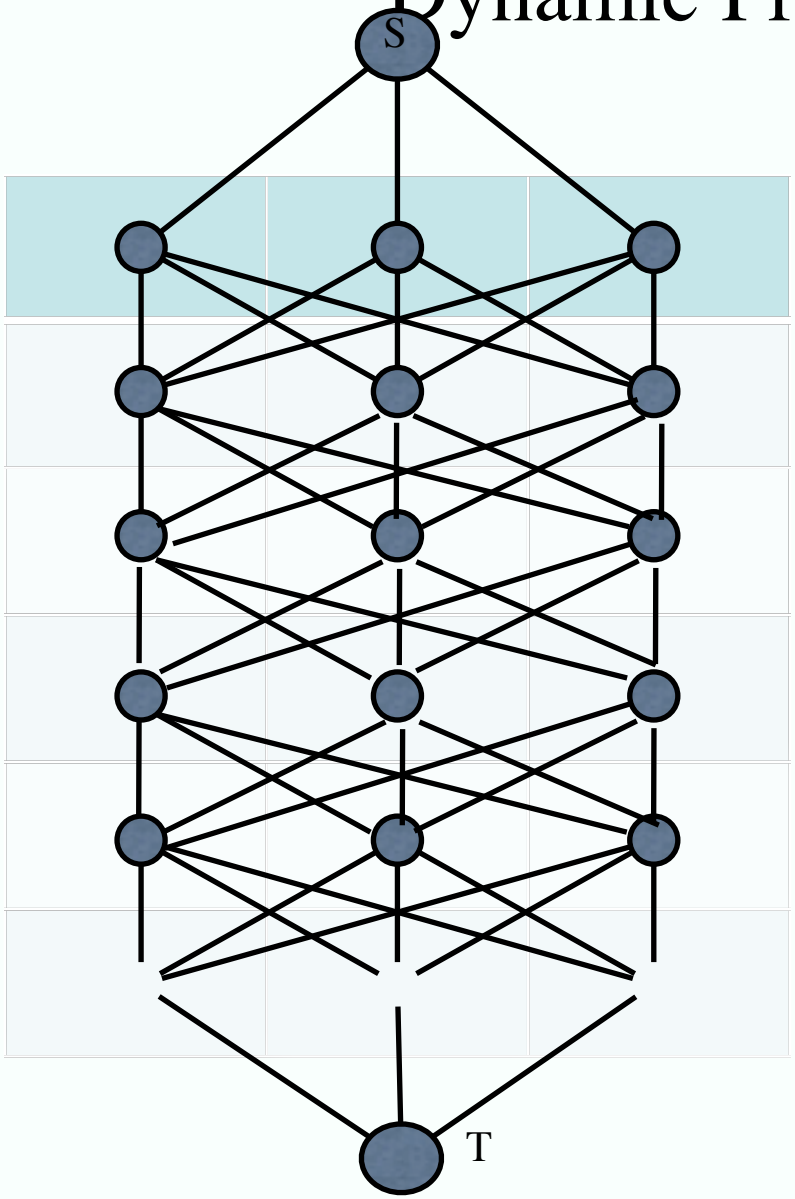


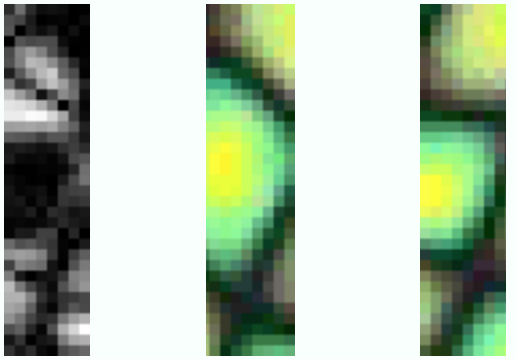


$$e_{ij} = (B1_{ij}^{ov} - B2_{ij}^{ov})^2$$

$$E_{i,j} = e_{i,j} + \min(E_{i-1,j-1}, E_{i-1,j}, E_{i-1,j+1})$$

Dynamic Programming





$$e_{ij} = (B1_{ij}^{ov} - B2_{ij}^{ov})^2$$

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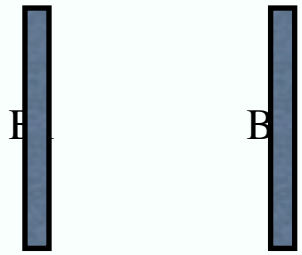
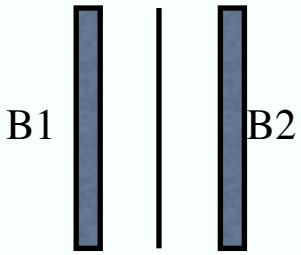
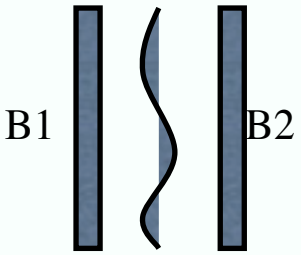


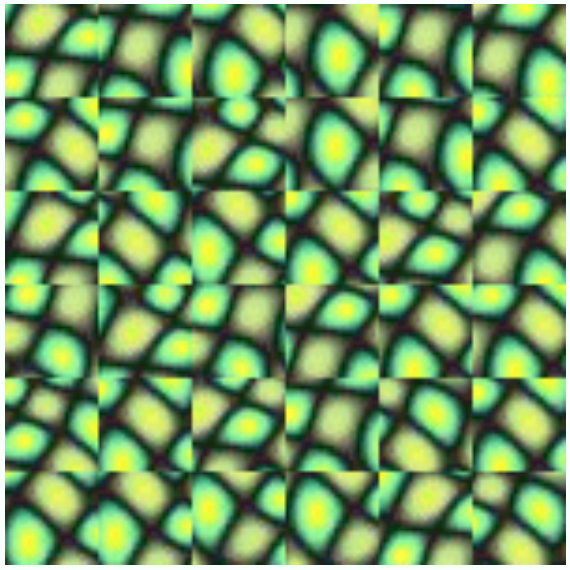
Random placement
of blocks

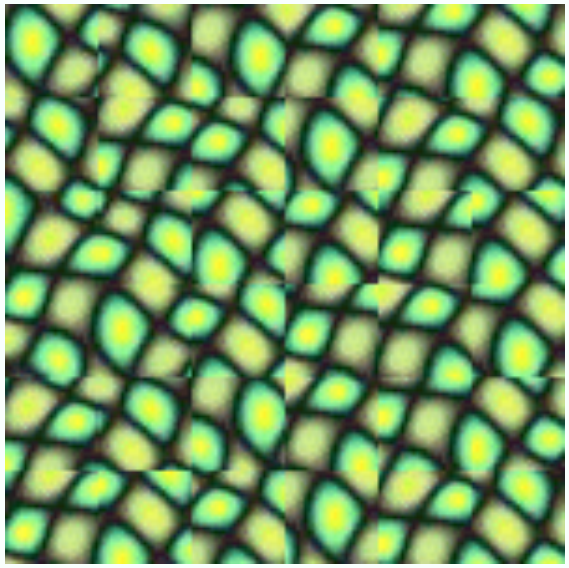


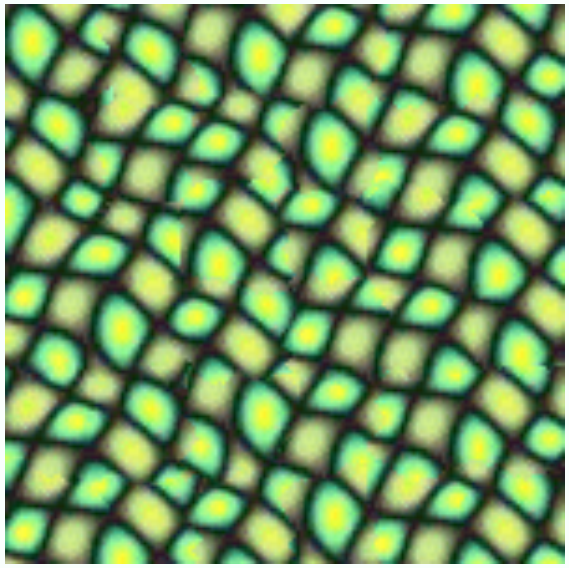
Neighboring blocks
constrained by overlap



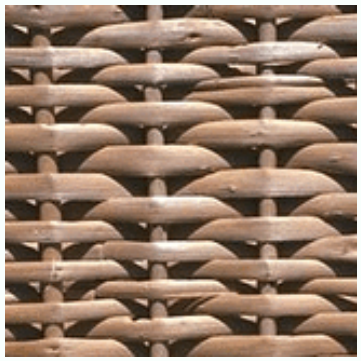
Minimal error
boundary cut

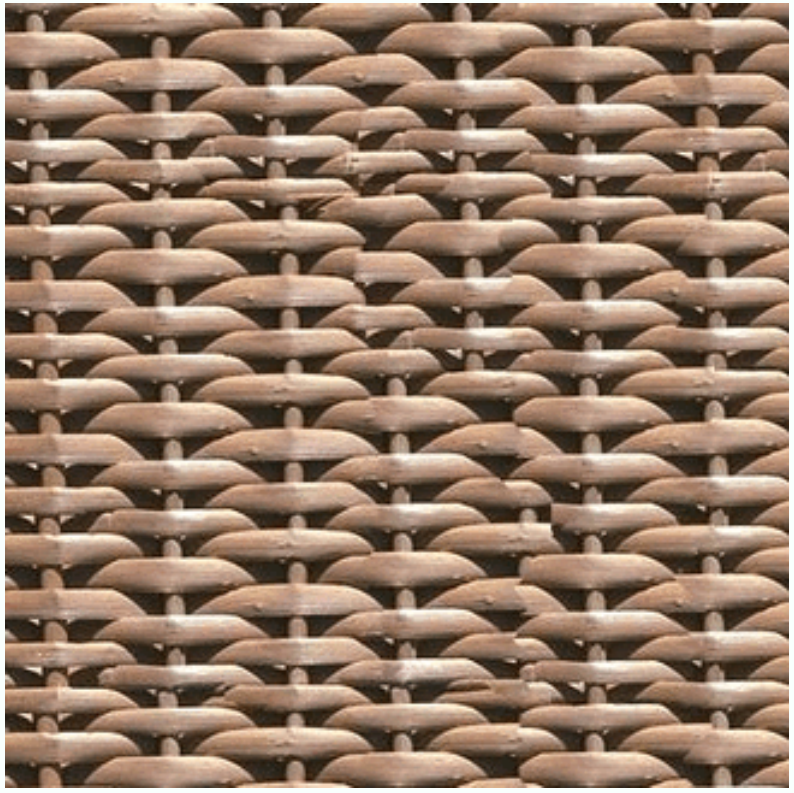




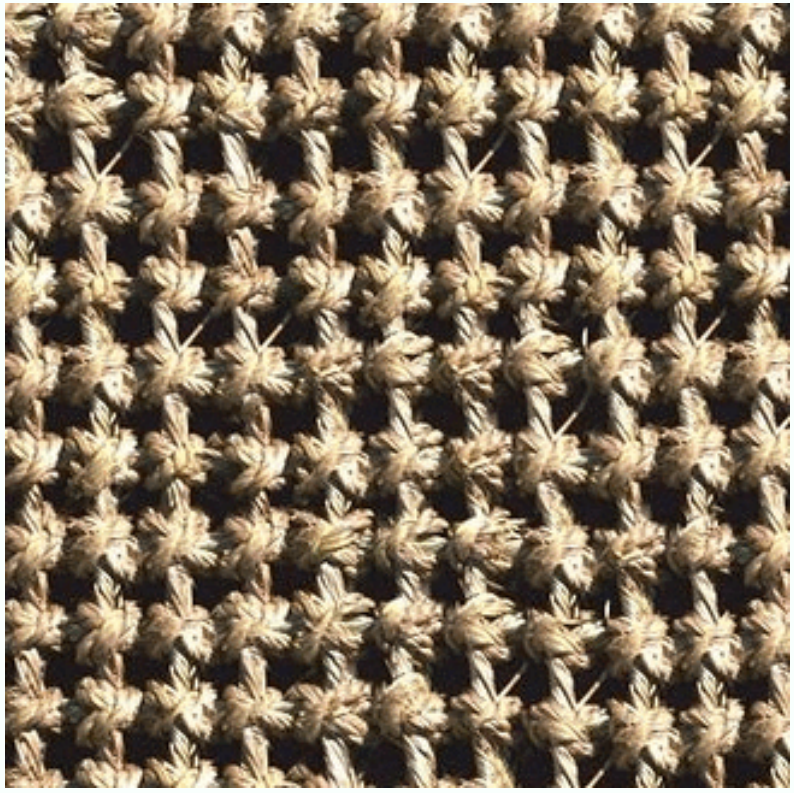


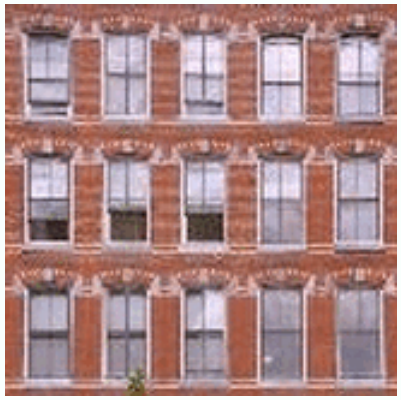
More Results





More Results





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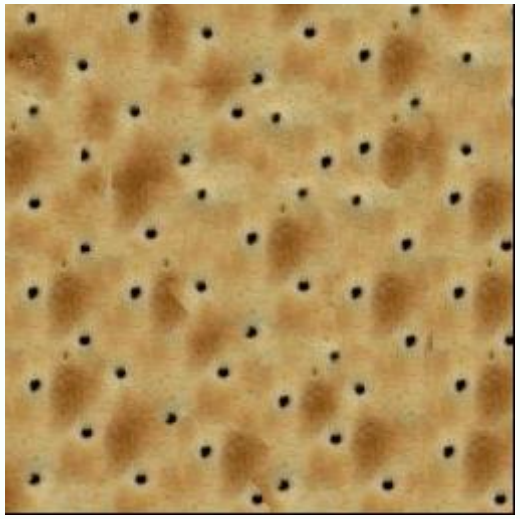

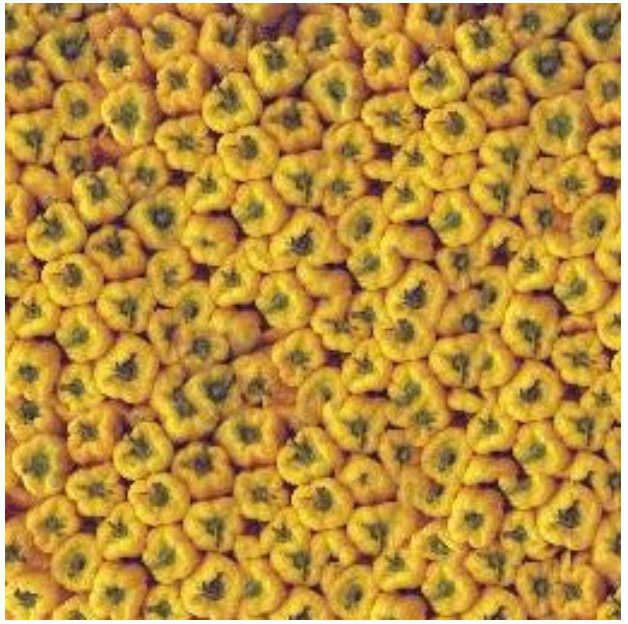

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Failures

Texture Transfer

- Take the texture from on object and paint it on another object

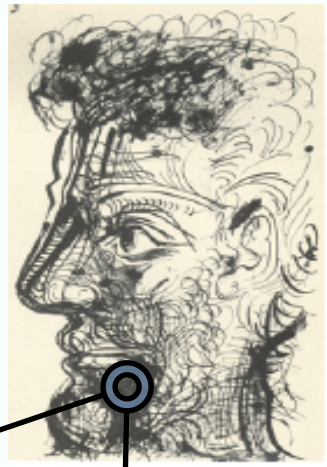
Decomposing shape and texture

Very challenging

Walk around

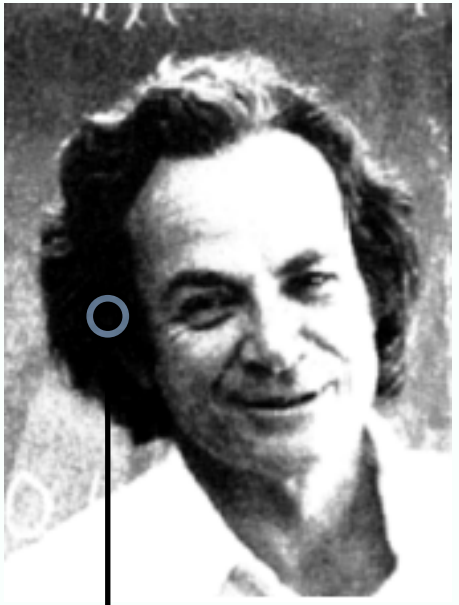
Add some constraint to the search

Source Texture

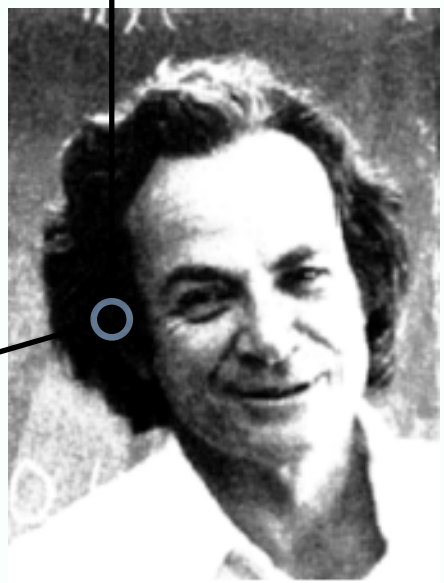


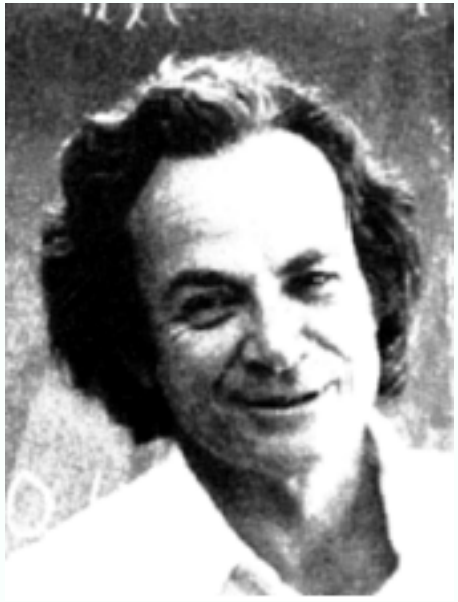
Source Map

Destination

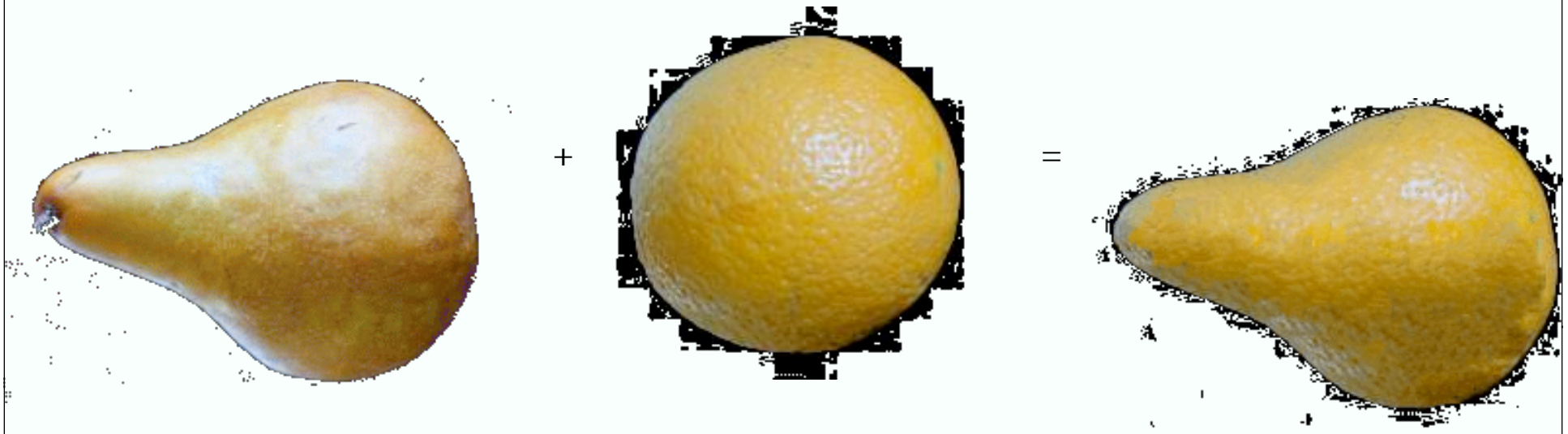


Destination Map





Texture Transfer



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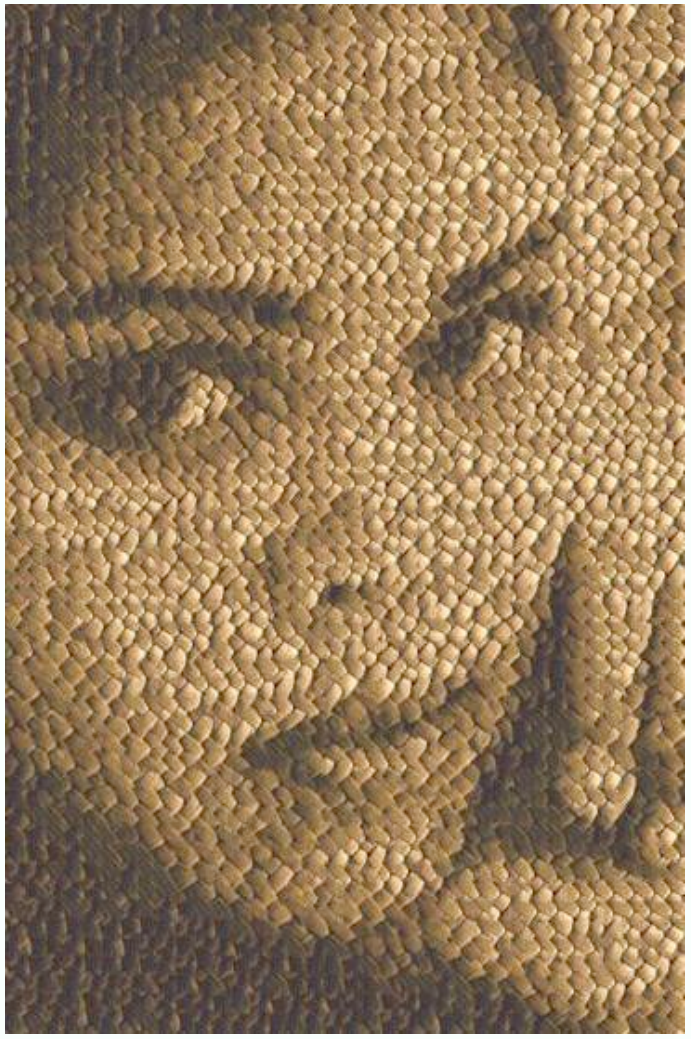

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Efros & Freeman SIGGRAPH01

Image Analogies

Hertzman, Jacobs, Oliver, Curless, and Salesin, SIGGRAPH01

Image Analogies

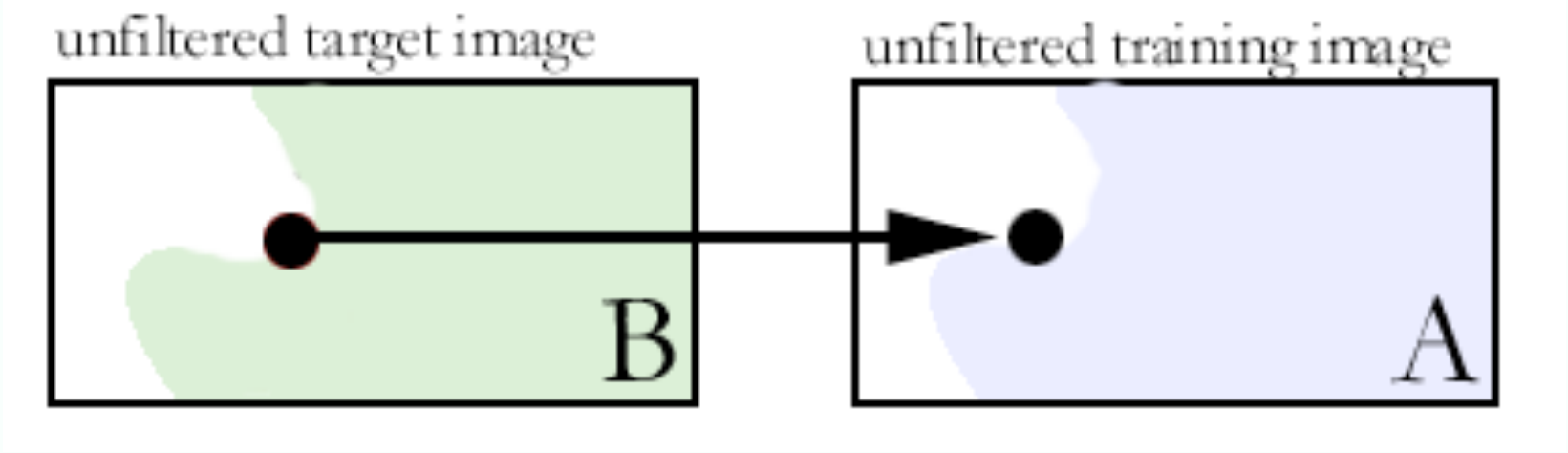
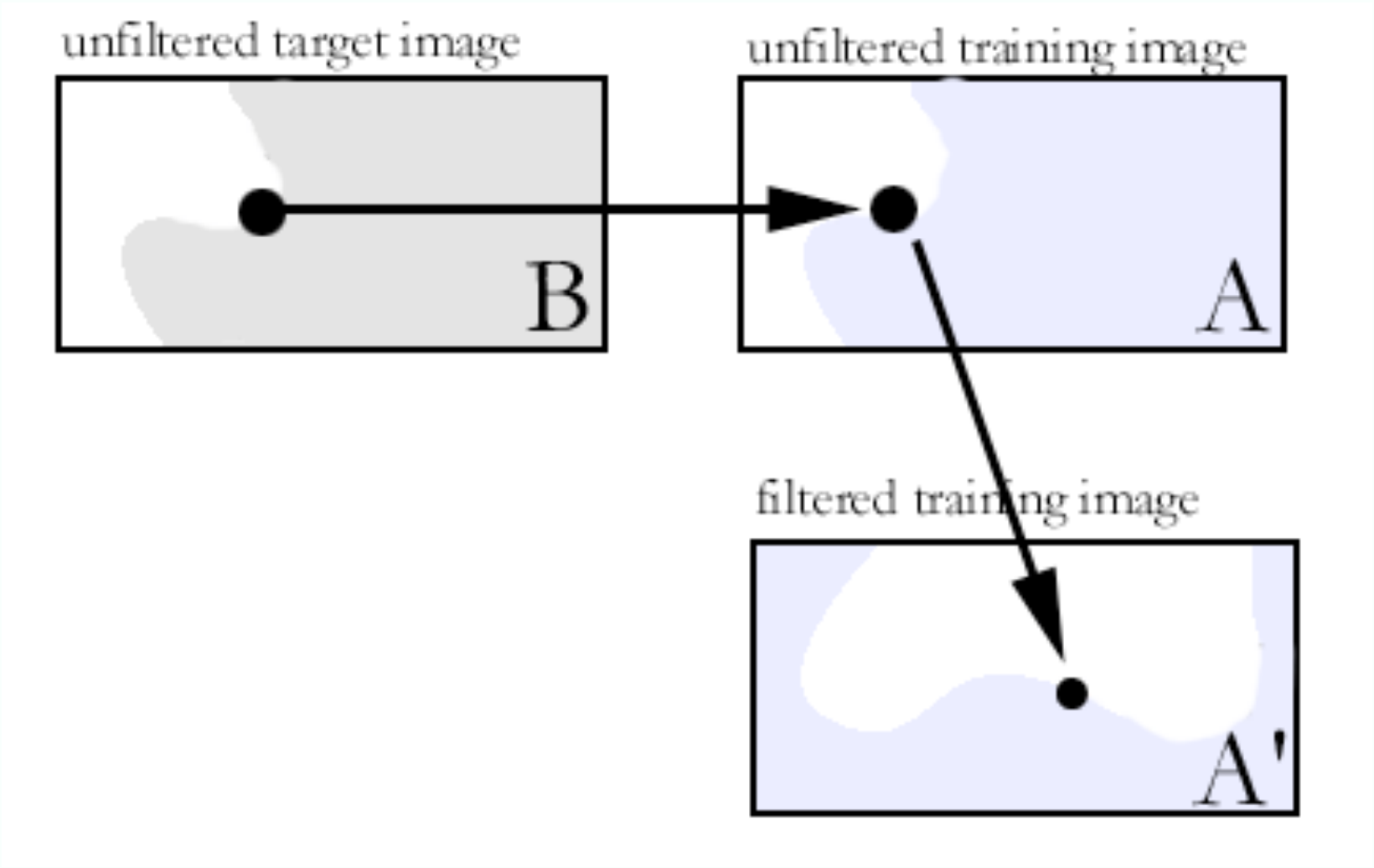
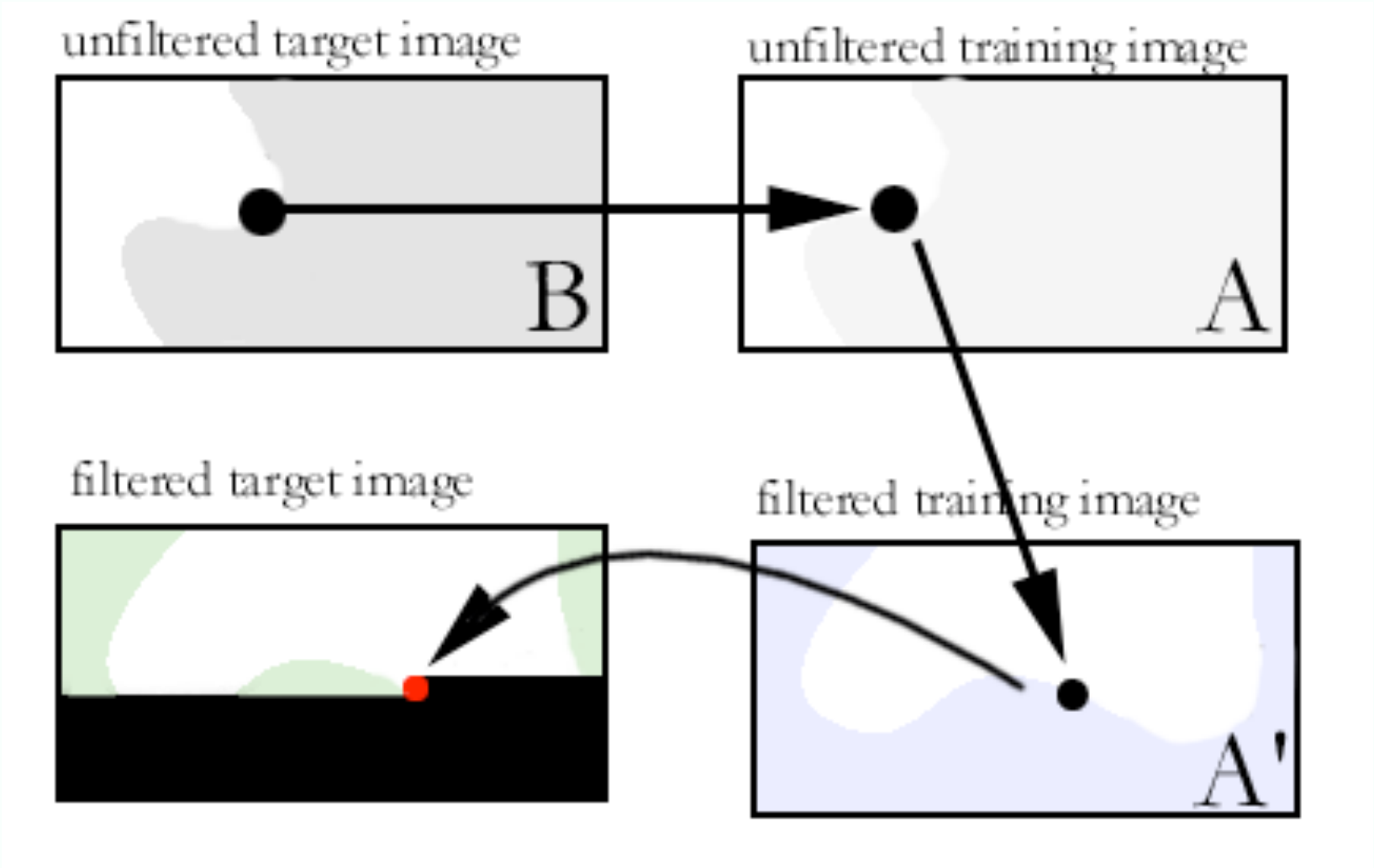


Image Analogies



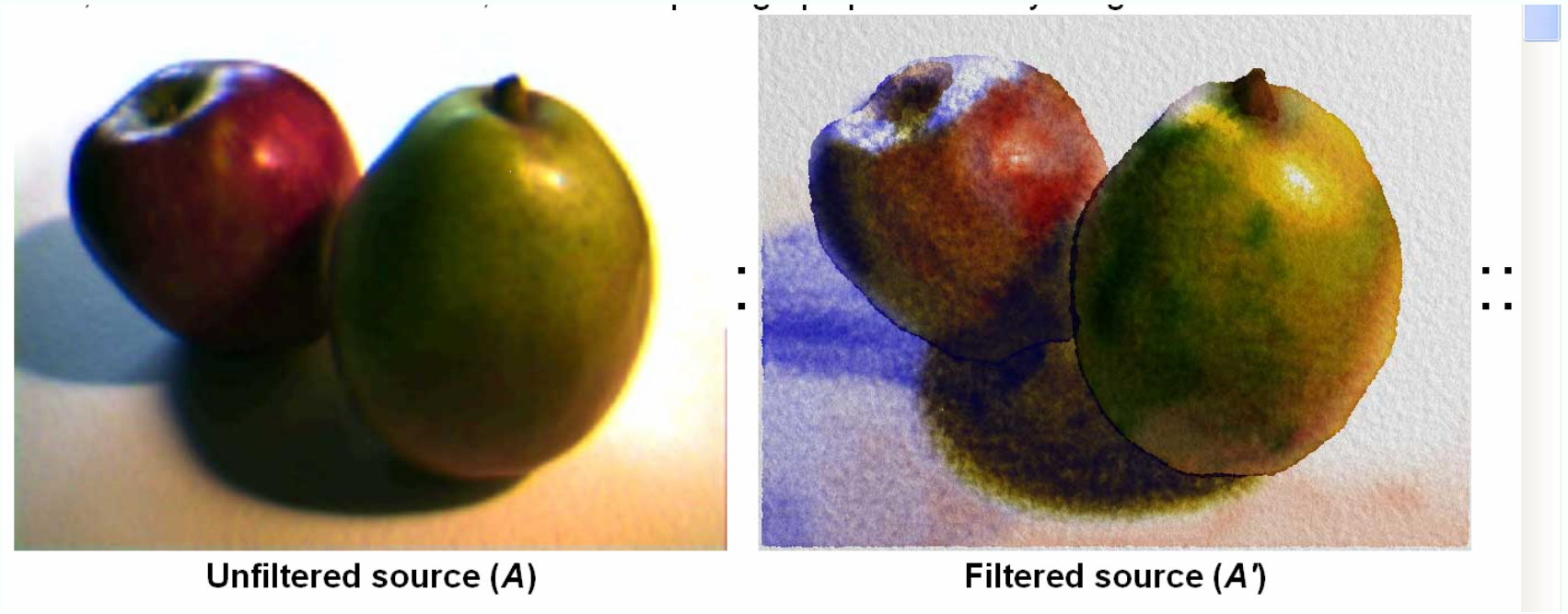
Hertzman, Jacobs, Oliver, Curless, and Salesin, SIGGRAPH01

Image Analogies



Hertzman, Jacobs, Oliver, Curless, and Salesin, SIGGRAPH01

Training



Hertzman, Jacobs, Oliver, Curless, and Salesin, SIGGRAPH01

::

:

B

B’

Hertzman, Jacobs, Oliver, Curless, and Salesin, SIGGRAPH01

::

B

:

B’

Learn to Blur

Unfiltered source (A)

Filtered source (A')

Unfiltered target (B)

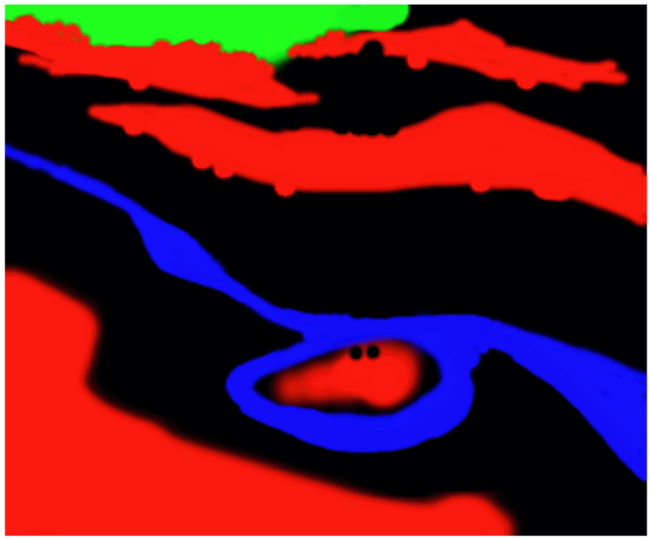
Filtered target (B')

Hertzman, Jacobs, Oliver, Curless, and Salesin, SIGGRAPH01

Texture by Numbers

Unfiltered source (A)

Filtered source (A')

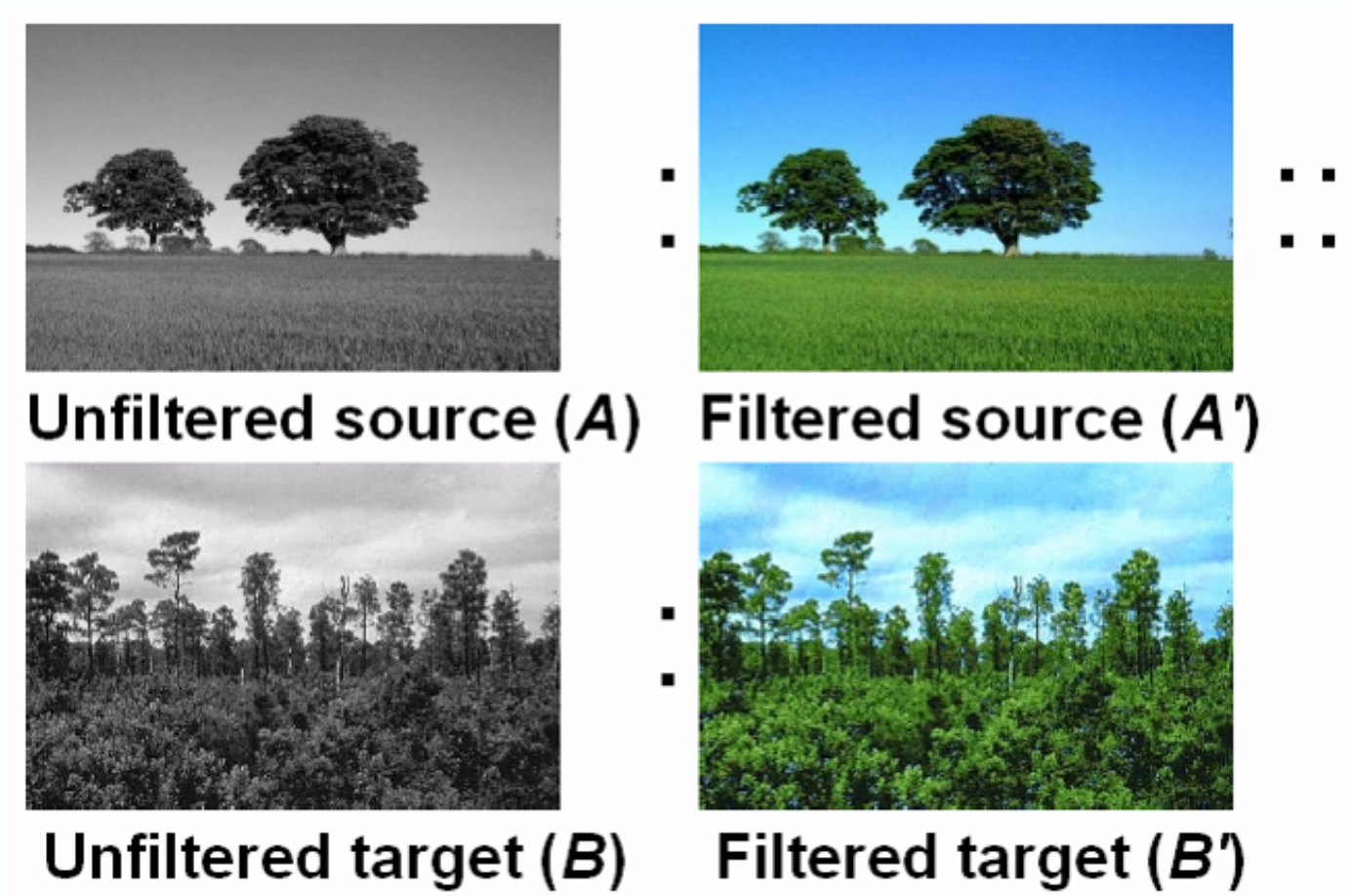


Unfiltered (B)

Filtered (B')

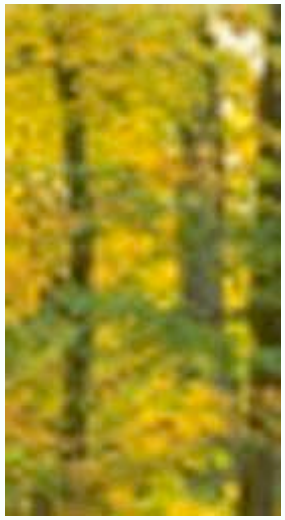
Hertzman, Jacobs, Oliver, Curless, and Salesin, SIGGRAPH01

Colorization

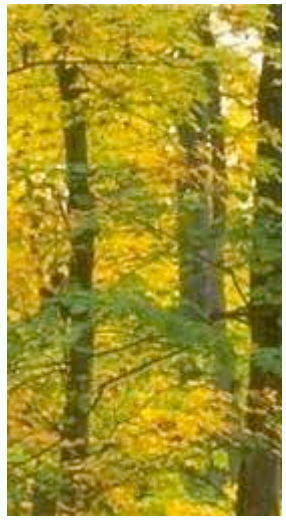


Hertzman, Jacobs, Oliver, Curless, and Salesin, SIGGRAPH01

Super-resolution



A

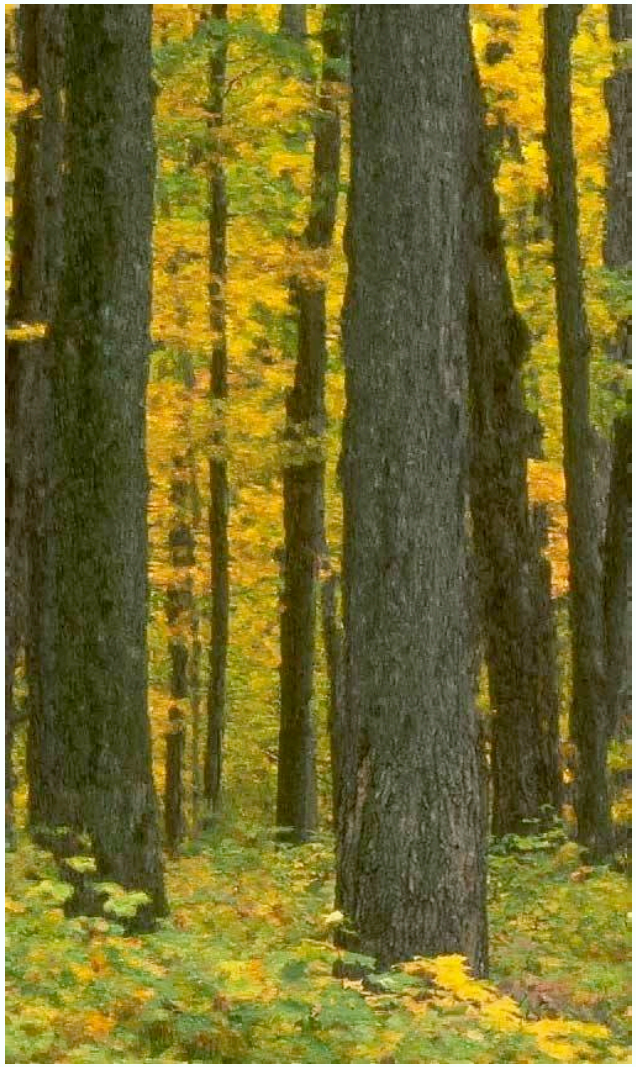


A’

Hertzman, Jacobs, Oliver, Curless, and Salesin, SIGGRAPH01

Super-resolution (result!)

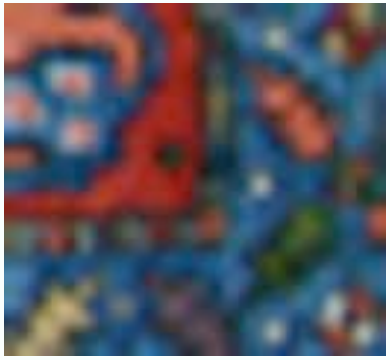
B



B’

Hertzman, Jacobs, Oliver, Curless, and Salesin, SIGGRAPH01

Training images



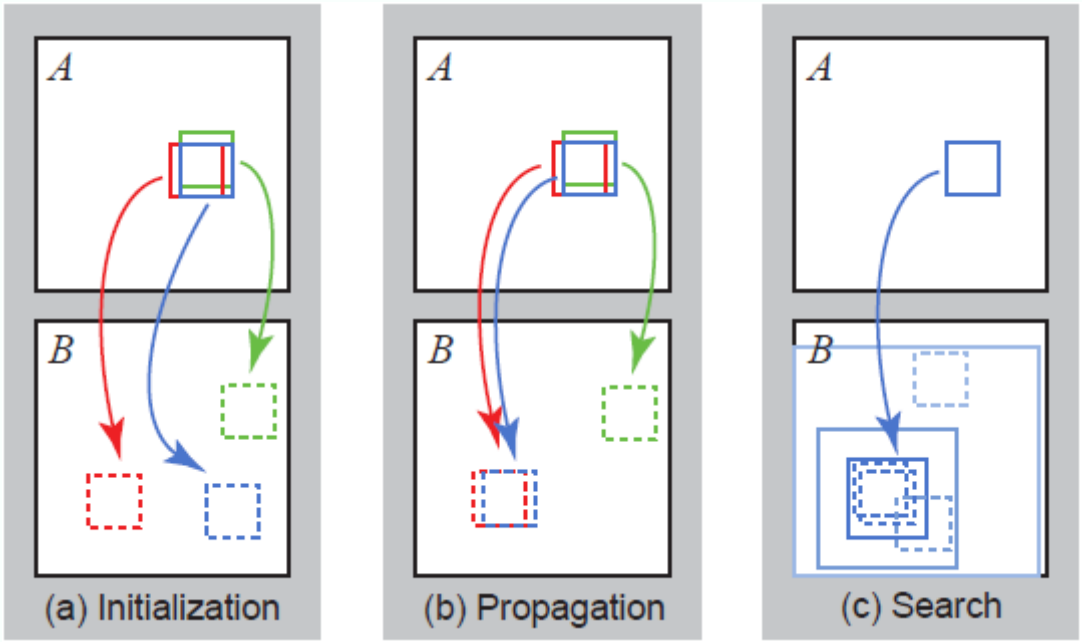
Hertzman, Jacobs, Oliver, Curless, and Salesin, SIGGRAPH01

Hertzman, Jacobs, Oliver, Curless, and Salesin, SIGGRAPH01

Nearest Neighbor search

The core of most of the patch based methods
Very slow

Smarter neighborhood search



Barnes et.al. SIGGRAPH09

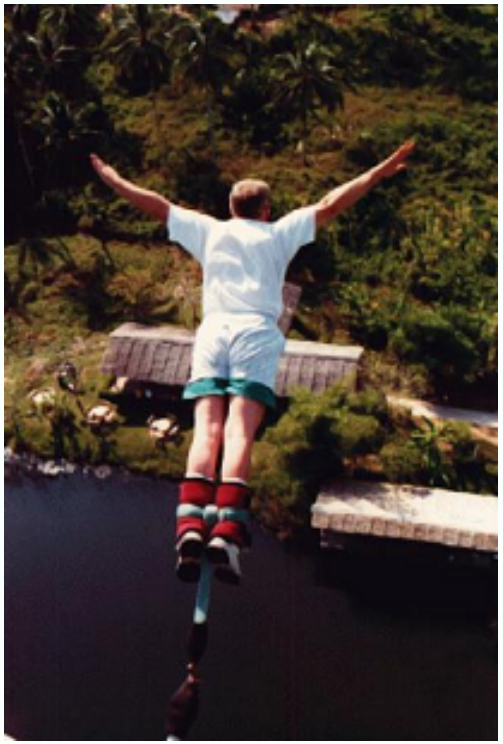
Applications

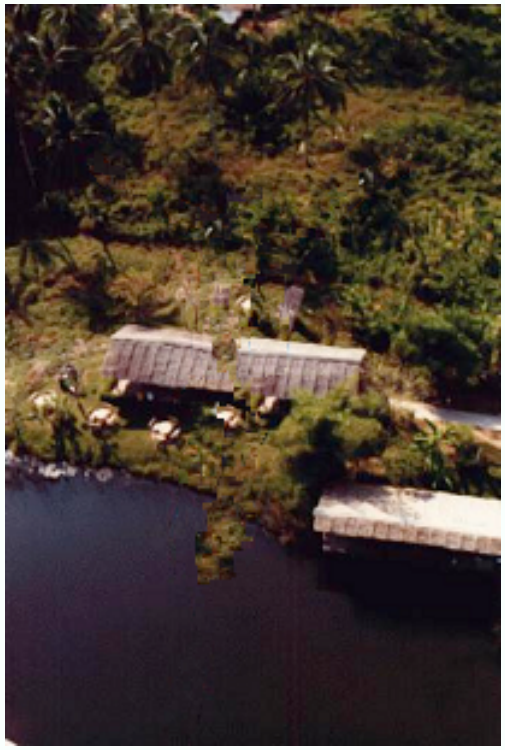
(a) original (b) hole+constraints (c) hole filled

(d) constraints (e) constrained retarget (f) reshuffle

Barnes et.al. SIGGRAPH09

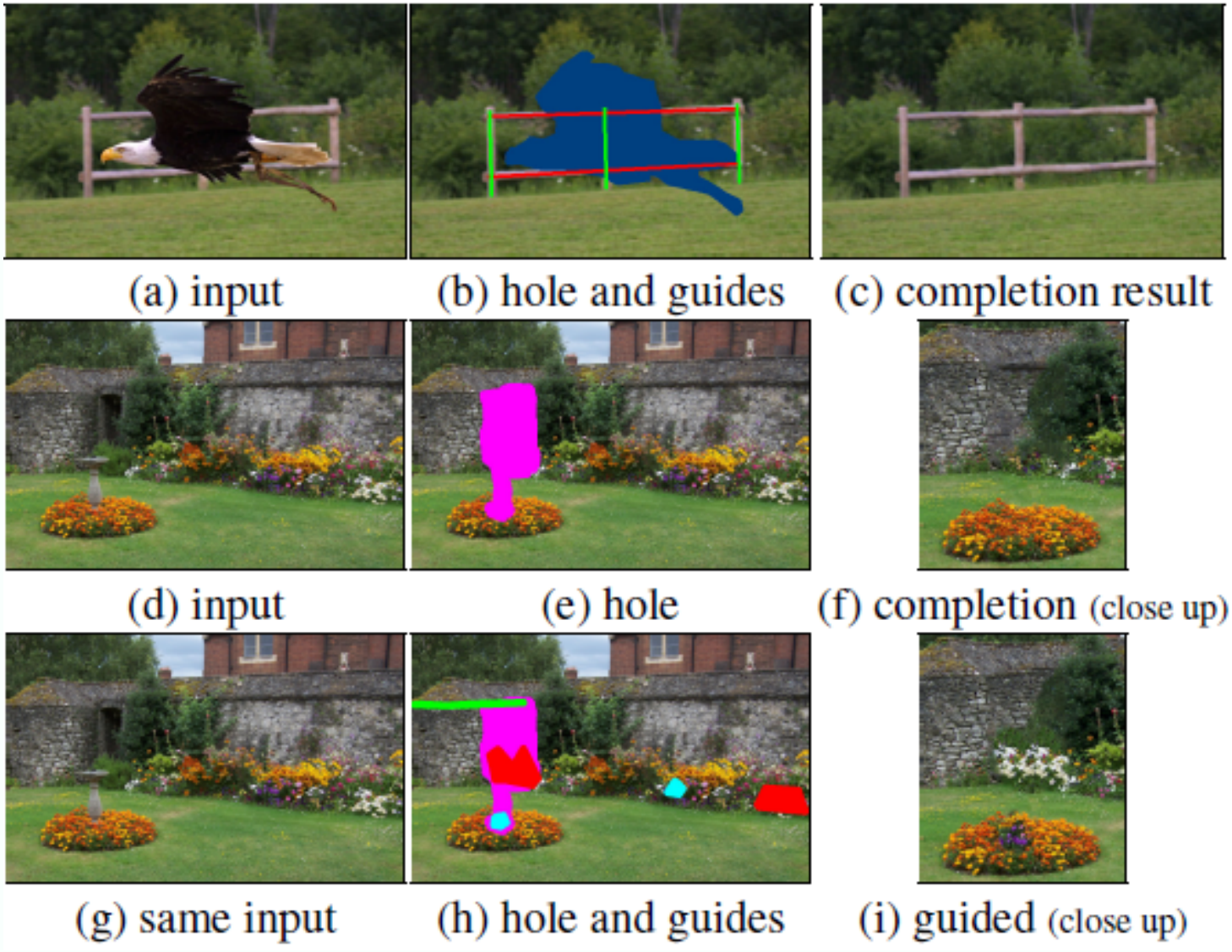
Inpainting





Criminisi et.al. CVPR03

Inpainting



Barnes et.al. SIGGRAPH09

Retargeting

Avidan, Shamir, SIGGRAPH07

Seam removal

Scaling

Cropping

Avidan, Shamir, SIGGRAPH07

Retargeting

Avidan, Shamir, SIGGRAPH07

Avidan, Shamir, SIGGRAPH07

Retargeting

Barnes et.al. SIGGRAPH09

Retargeting

Barnes et.al. SIGGRAPH09

Local scale editing

(a) building marked by user

(b) scaled up, preserving texture

(c) bush marked by user

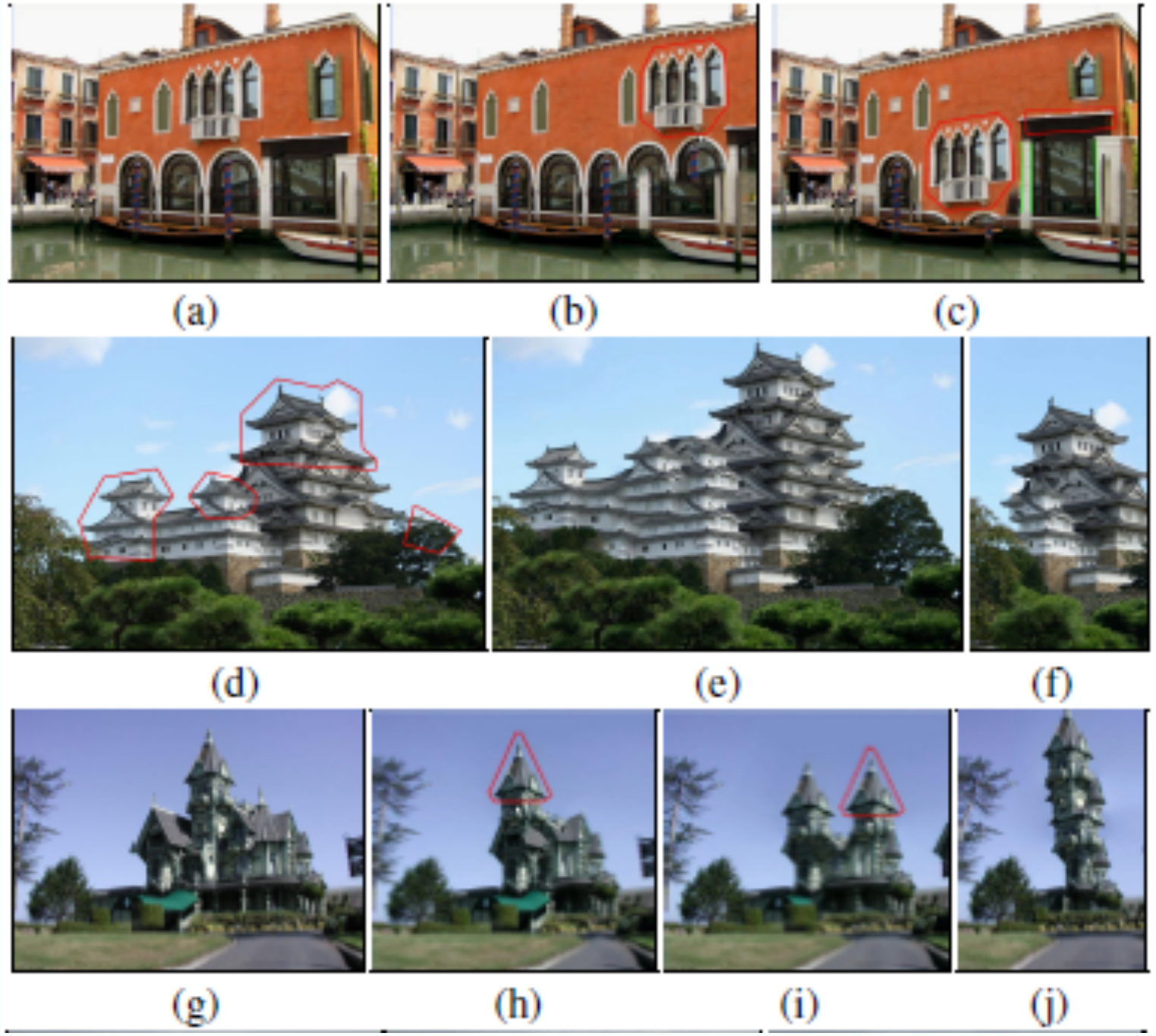
(d) scaled up, preserving texture.

Barnes et.al. SIGGRAPH09

reshuffling

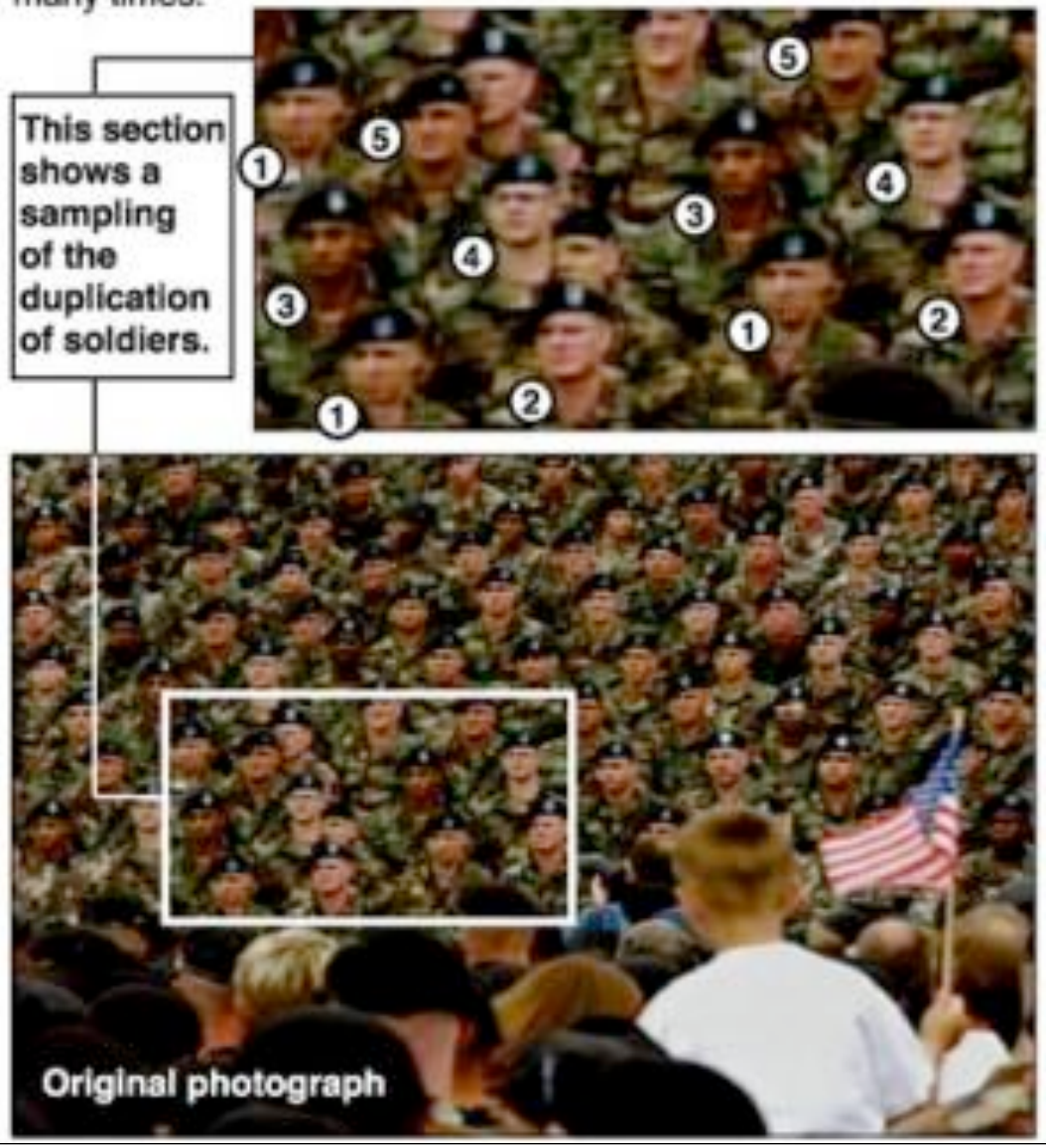
(a) input (b) our reshuffling

Barnes et.al. SIGGRAPH09



Barnes et.al. SIGGRAPH09

Texture scandals!!

Bush campaign digitally altered TV ad

President Bush's campaign acknowledged Thursday that it had digitally altered a photo that appeared in a national cable television commercial. In the photo, a handful of soldiers were multiplied many times.