

# Texture Synthesis by Non-Parametric Sampling

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\*\* Figures for this presentation were adapted from the original Efros and Leung presentation

# Texture Synthesis

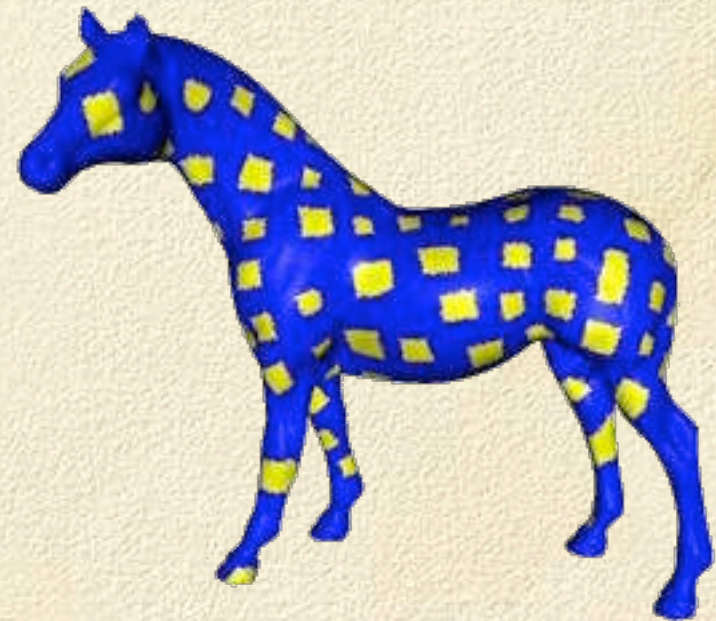
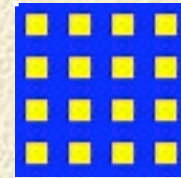
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- ❑ Texture Synthesis aims to solve the problem of covering Big Things with tiny scraps of paper.
- ❑ Previous methods are totally inadequate.
- ❑ Large research area, but little success.

# The Problem

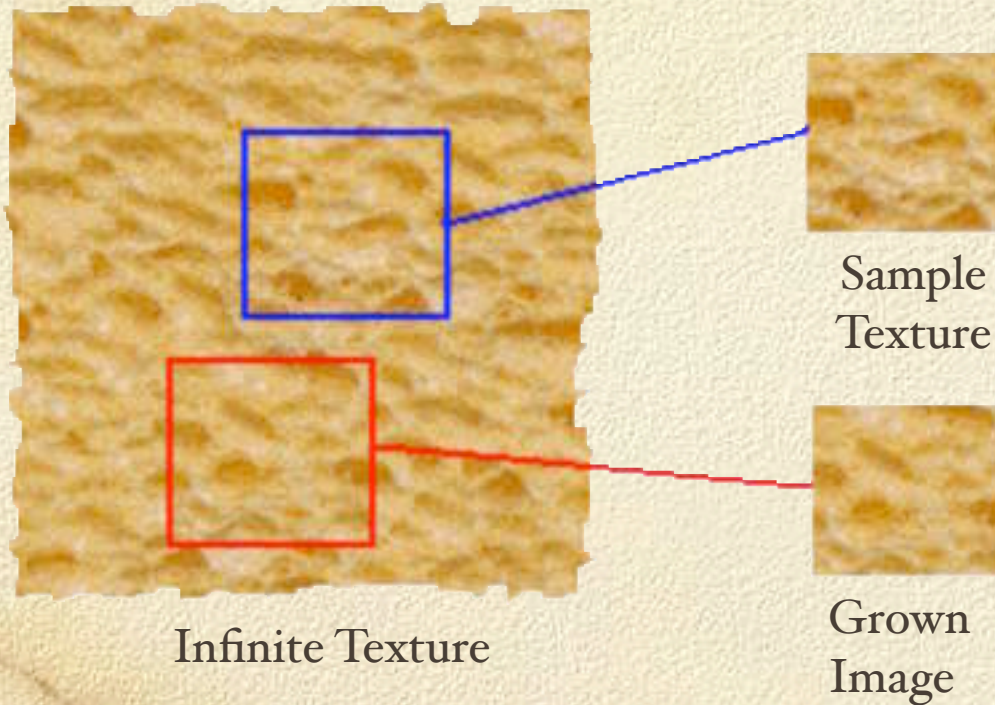
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- ❑ It's easy to find a small texture.
- ❑ Mapping a large object with a small texture requires tiling or stretching.



# The Solution

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- Grow the tiny texture to the needed size.
- Given a representative segment of a texture, it should be possible to create any size required

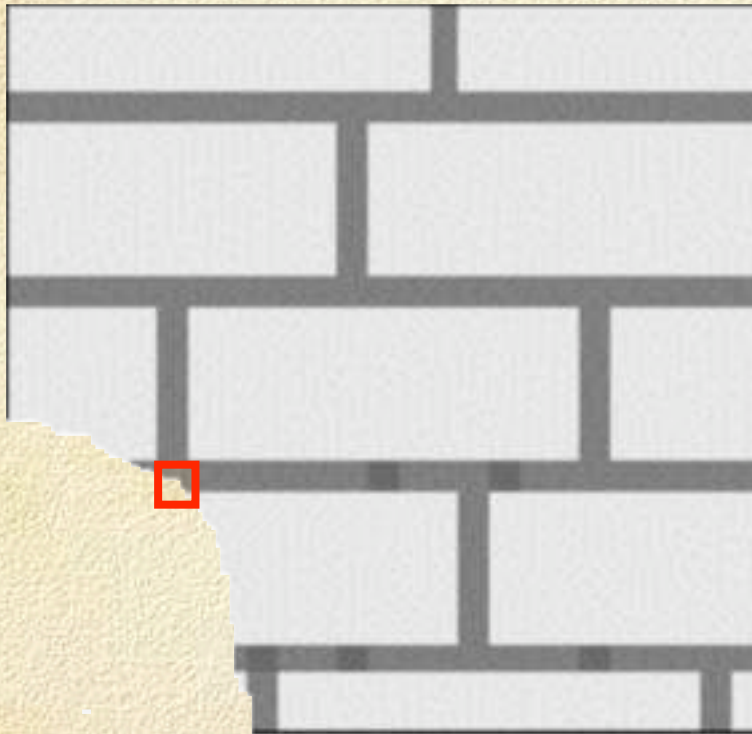
# Growing a texture

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- Use early work in language prediction
  - Probabilistic prediction of the next element well understood.
  - Build a probability function for the next element, and choose one at random.
  - “I spent an interesting evening recently with a grain of salt.”
- Require a sample image and do this in 2-D with the image

# Growing a Texture

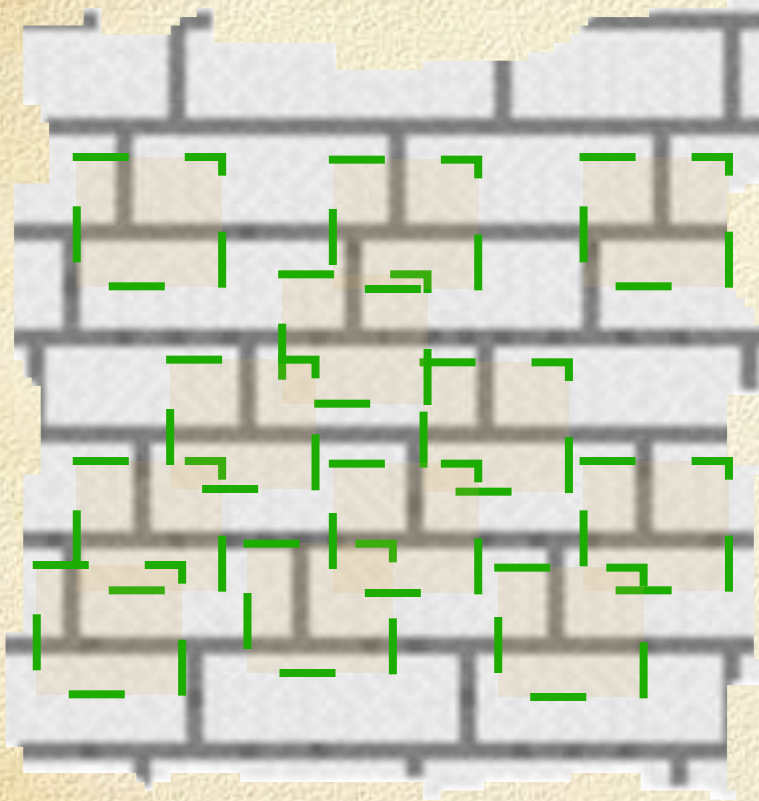
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- We want to create the next pixel
- Based on the surrounding neighborhood, it should be easy to determine what goes here

# Find the similar areas

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- Find the similar regions
- Choose the next pixel

# In Reality...

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- ❑ This works well for simple textures.
- ❑ How big a window do you look at?
- ❑ In big textures, we wish to emphasize local structure
- ❑ What about pixels that have few neighbors?
- ❑ What if you can't find *any* regions like the sample region?
- ❑



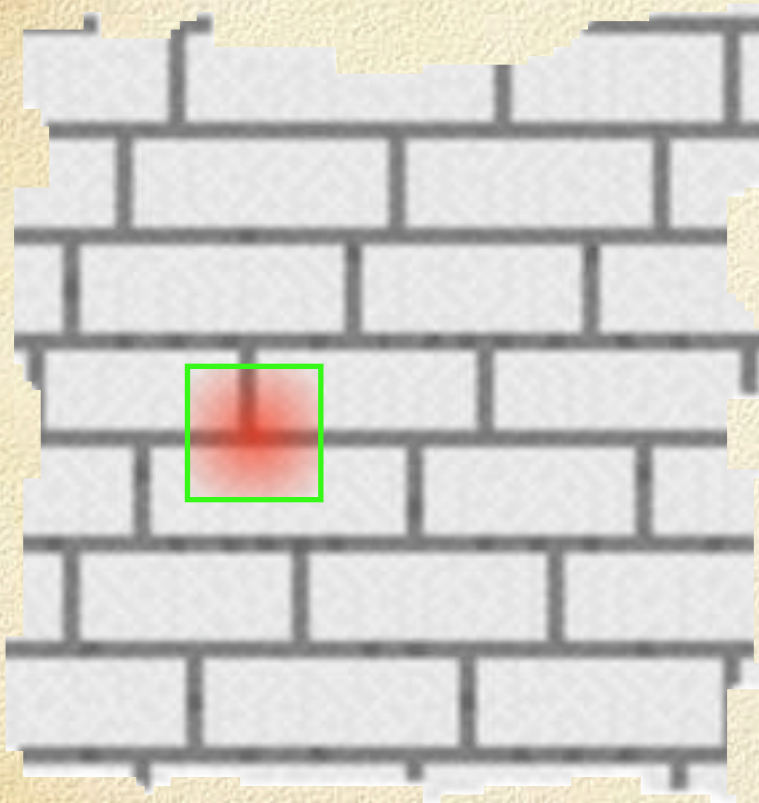
# Fixing the holes

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- ❑ Many of these problems can be solved by statistics
- ❑ Instead of finding exact matches, build probability functions and select all points that match within some epsilon
- ❑ For pixels with few neighbors, normalize over the parts you have
- ❑ For each layer being grown, always grow the more matchable parts first

# Building a PDF

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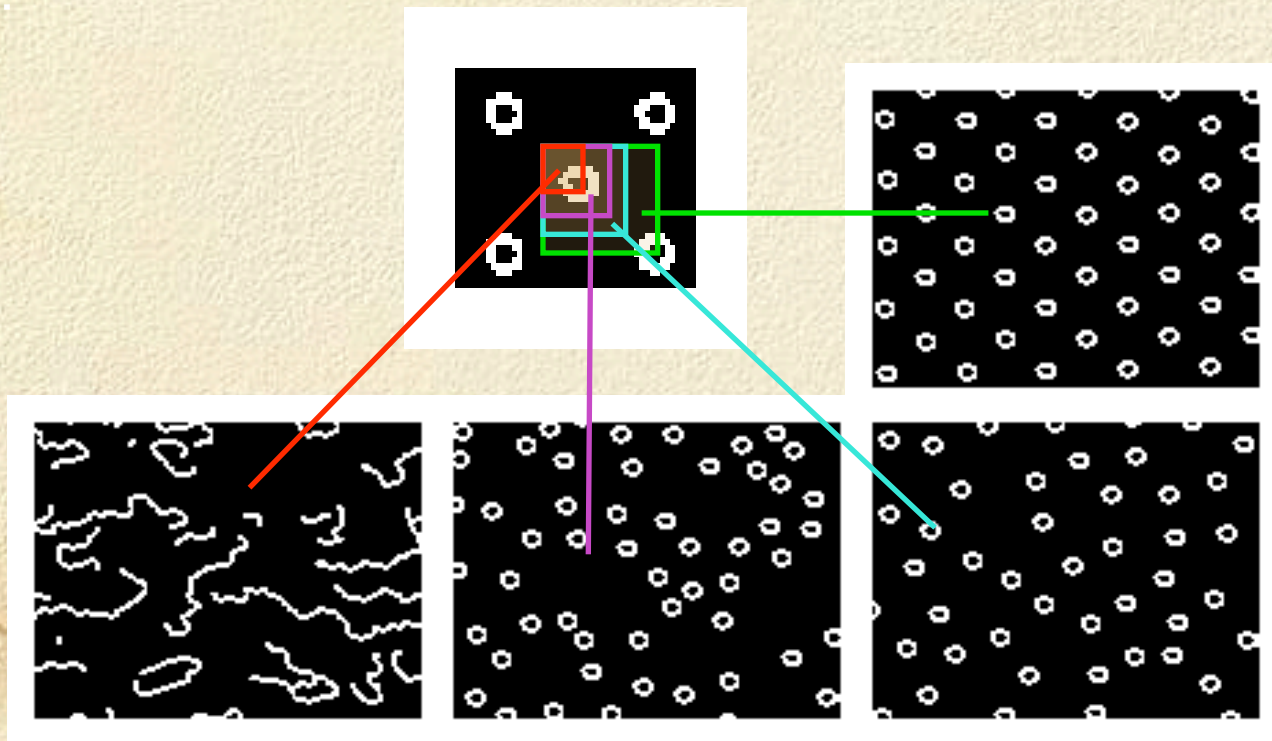


- Use a weighted function
- Emphasize local points

# Window Sizes

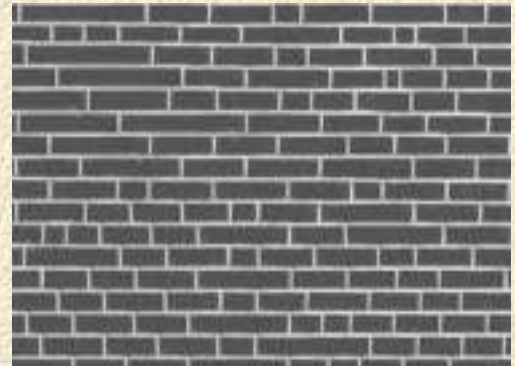
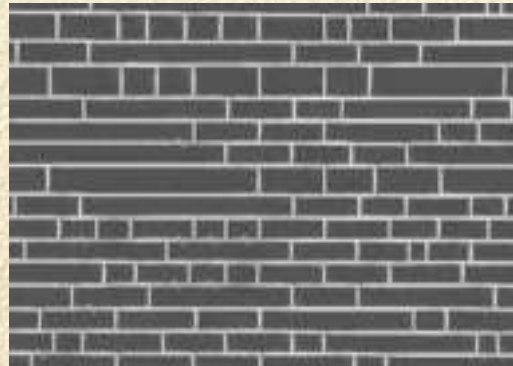
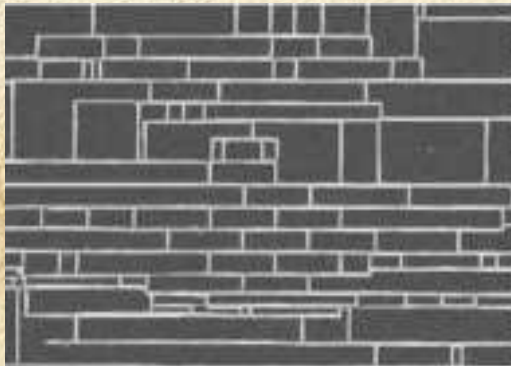
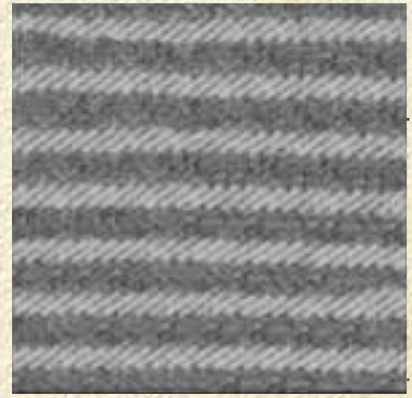
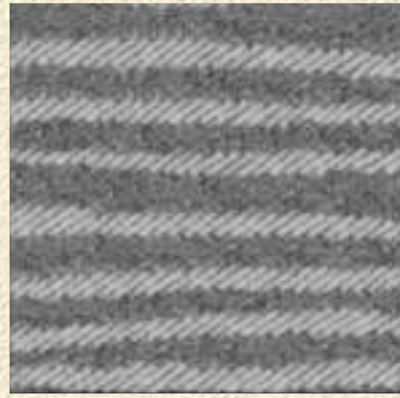
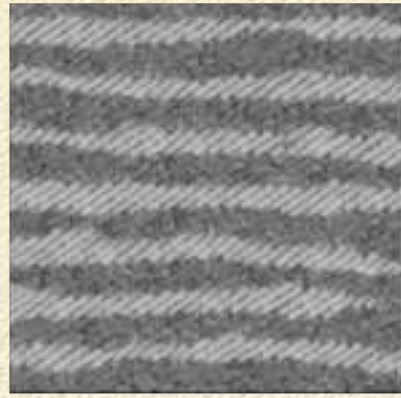
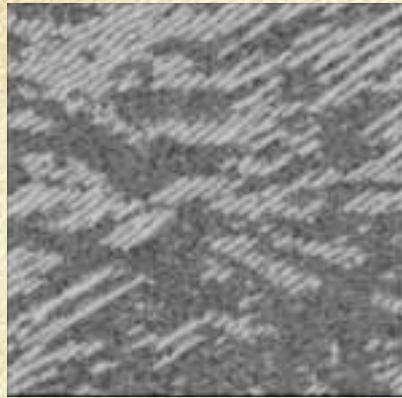
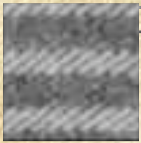
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- What size window should be used?
- Depends on structure in the sample image



# Window Size Examples

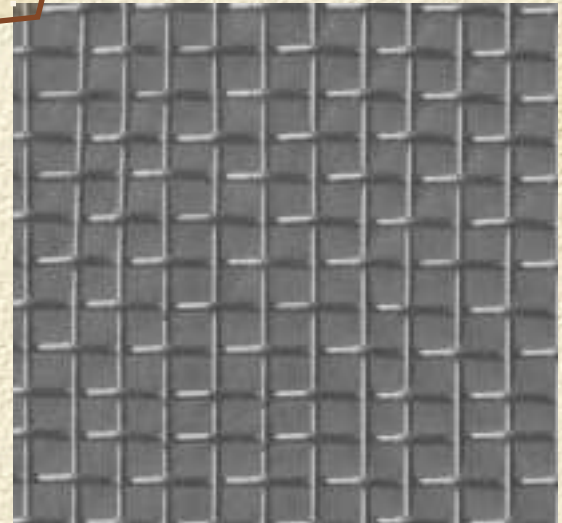
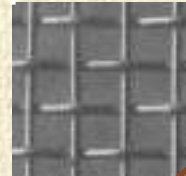
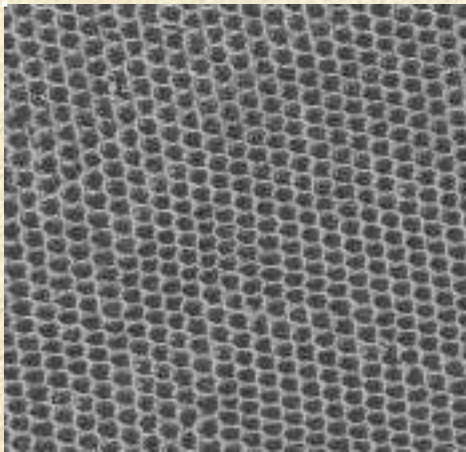
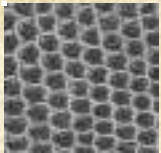
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# Results

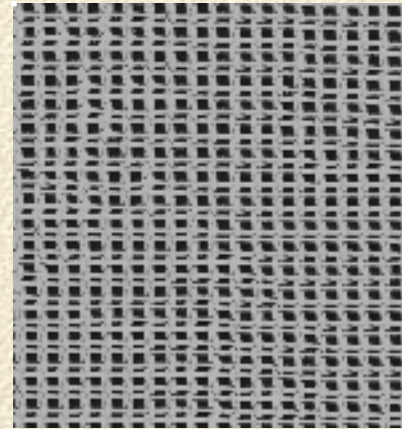
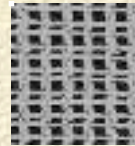
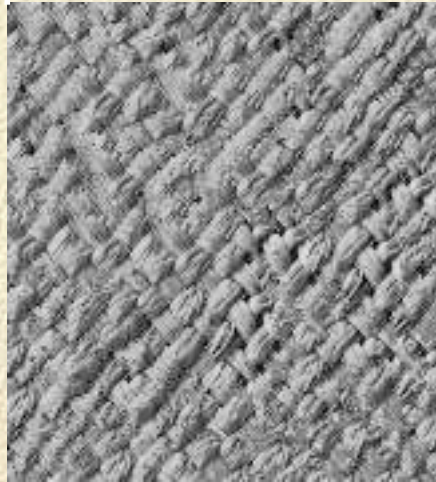
# Results

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# Results

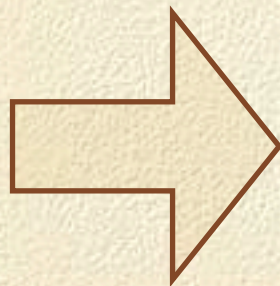
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# Results

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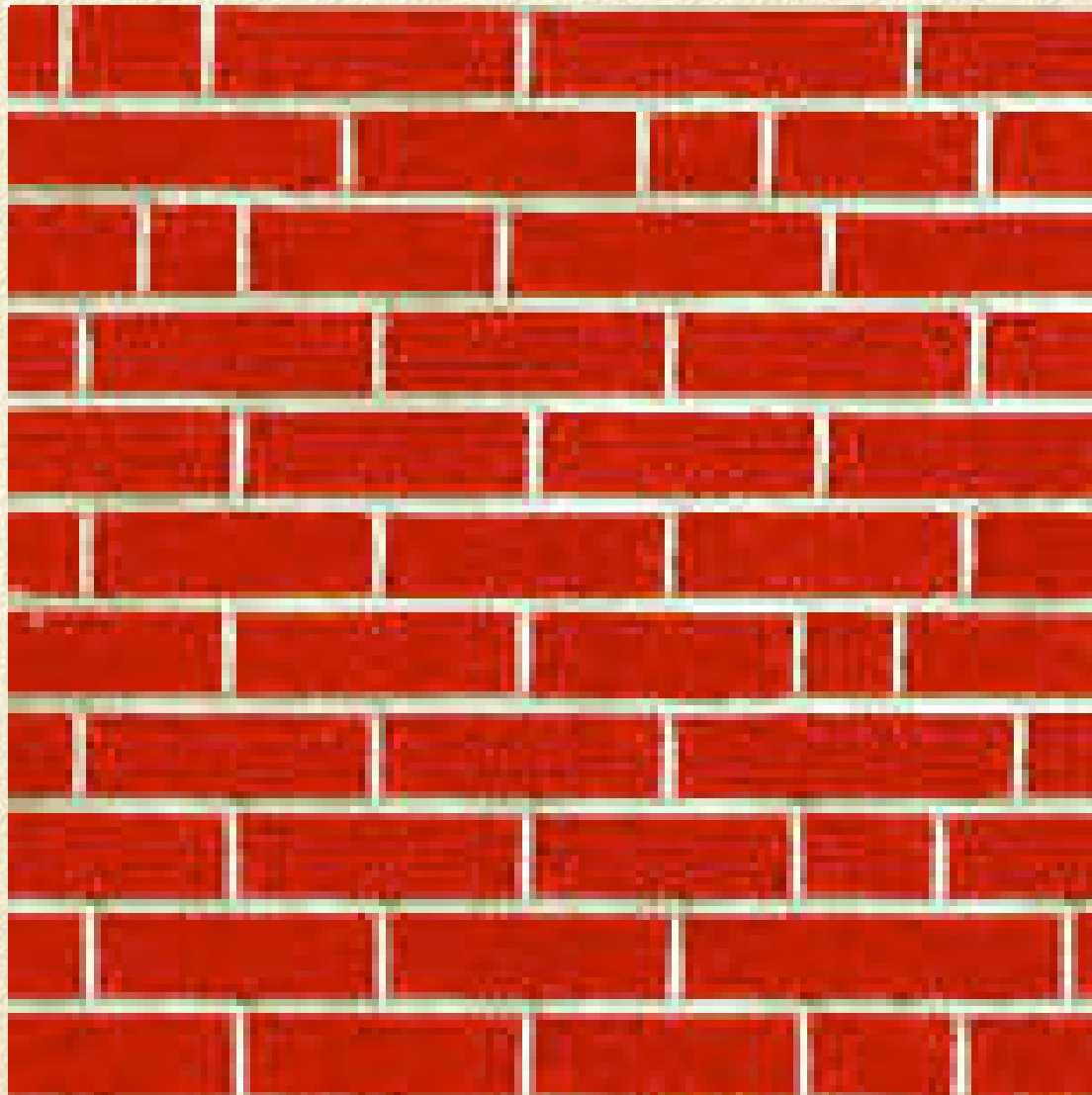
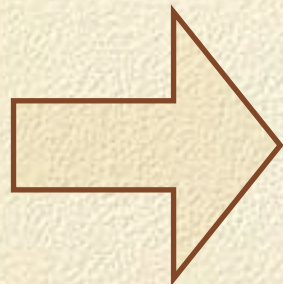
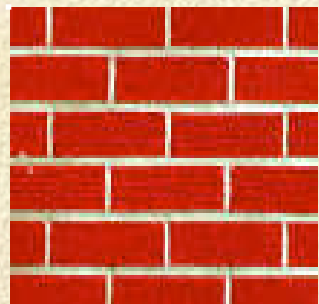


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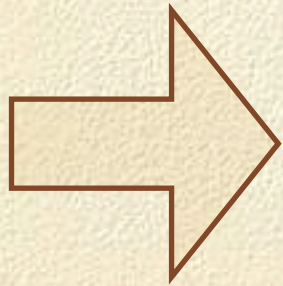
# Results

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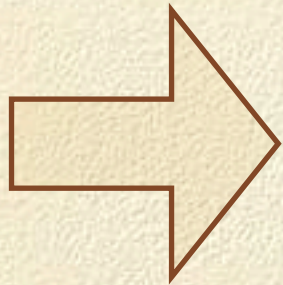
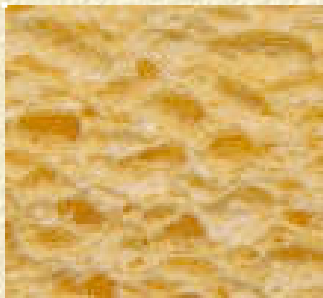
# Results

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# Results

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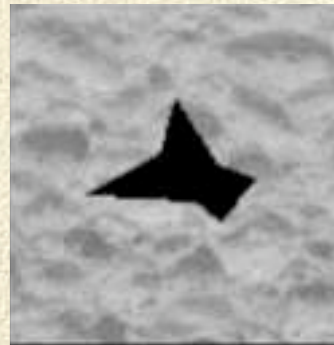


# Applications

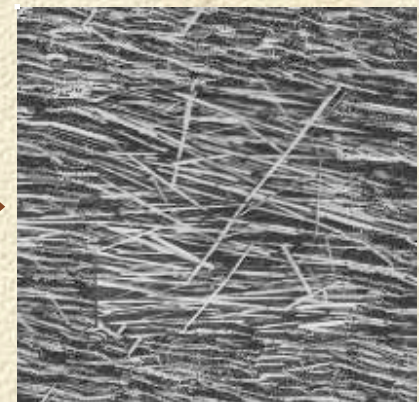
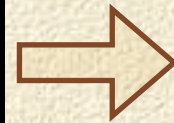
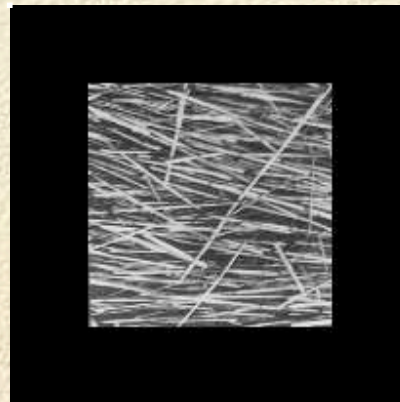
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- What other problems can this approach solve?

- Fill in Texture gaps -- Just grow inwards



- Extend pictures to make them larger



# Applications

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# Applications

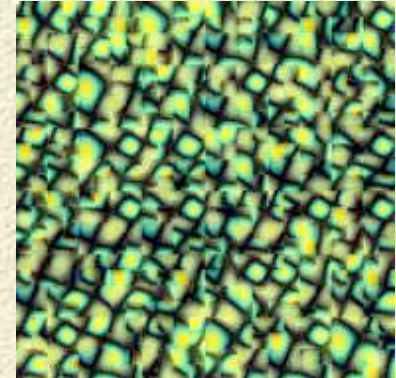
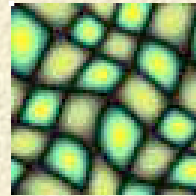
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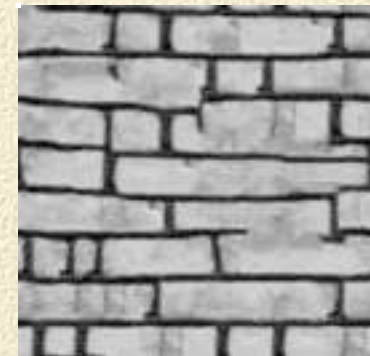
# Similar Work

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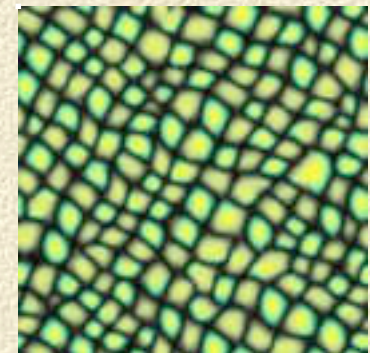
□ DeBonnet, '97



□ Wei & Levoy '99



□ Wei & Levoy '02



# Problems

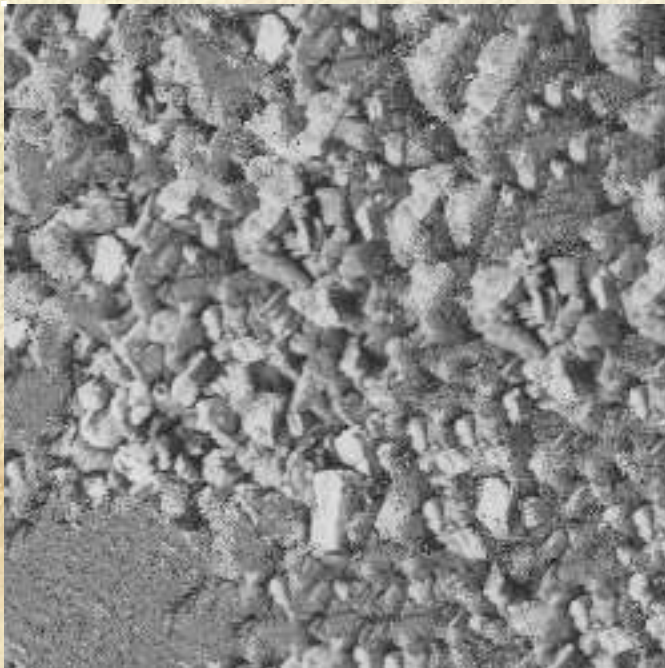
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- ❑ SLOW (at least the original algorithm)
- ❑ Can get locked-in to one part of a texture, producing garbage or overly-regular images
  - ❑ Larger samples can help this



# Failures

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# Subsequent Work

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- Harrison '01 - GIMP Plugin for Synthesis
- Wei & Levoy - Various
  - Smoke and Ocean videos
  - Mapping synthesized textures onto objects

# Conclusions

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- ❑ This was one of the original papers on texture synthesis
- ❑ For well ahead of everyone else in 1999
- ❑ Subsequent work has improved speed, but not quality

