Texture Synthesis by Non-Parametric Sampling

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

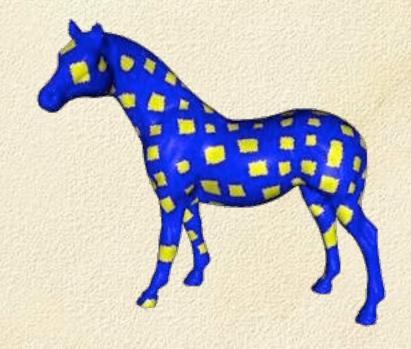
Texture Synthesis

- 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.

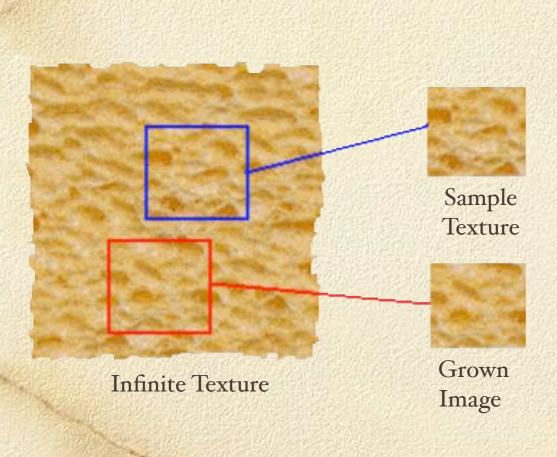
The Problem

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





The Solution

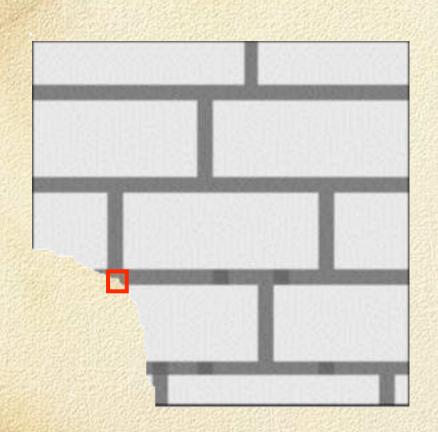


- Grow the tiny texture to the needed size.
- Given a representative segment of a texture, it should be possible to create any size required

Growing a texture

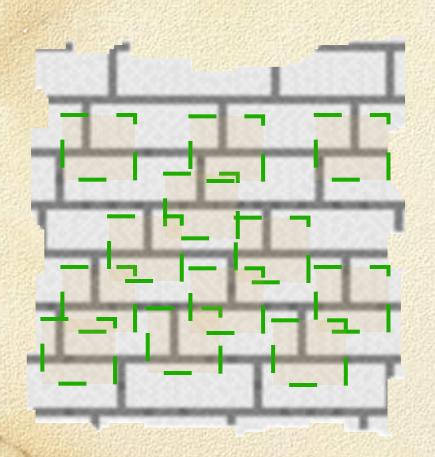
- Use early work in language prediction
 - Probabilistic prediction of the next element well understood.
 - Build a probability function for the next element, and choose one at random.
 - "I spent an interesting evening recently with a grain of salt."
- Require a sample image and do this in 2-Dwith the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

Growing a Texture



- 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



- Find the similar regions
- Choose the next pixel

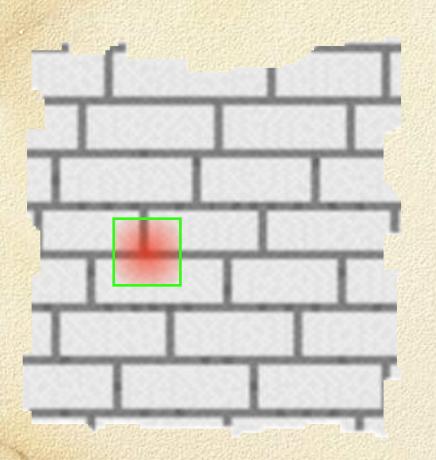
In Reality...

- 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

- Many of these problems can be solved by sadis... er 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

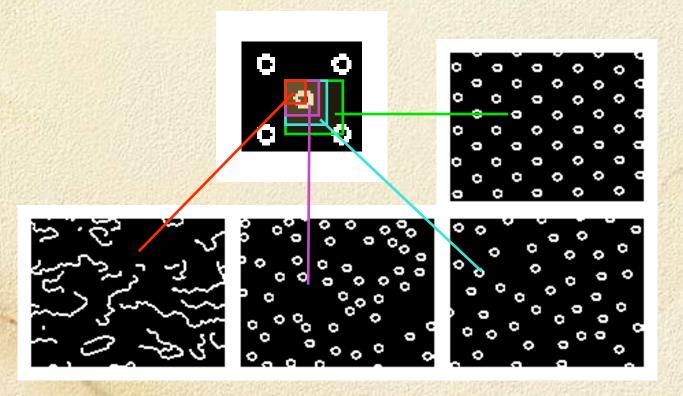
Building a PDF



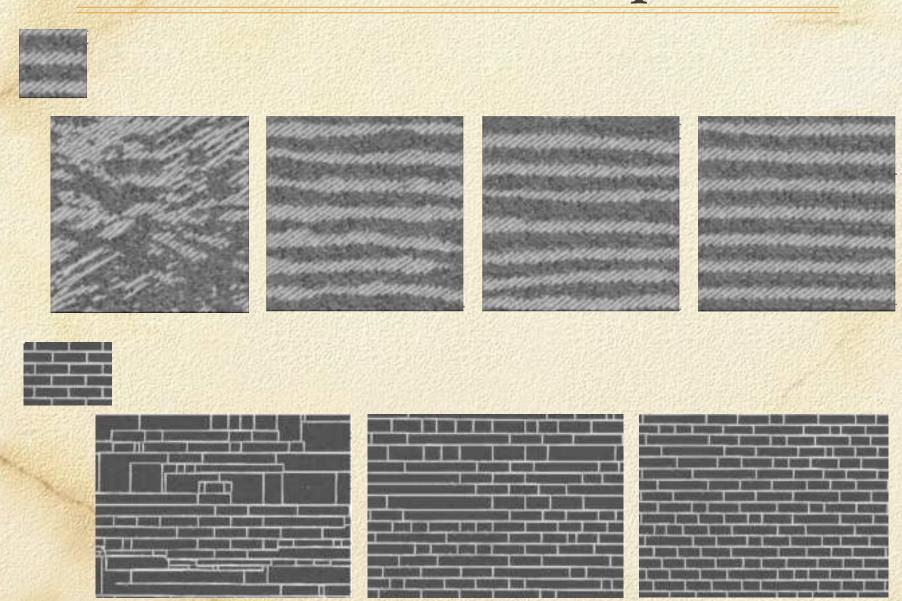
- Use a weighted function
- Emphasize local points

Window Sizes

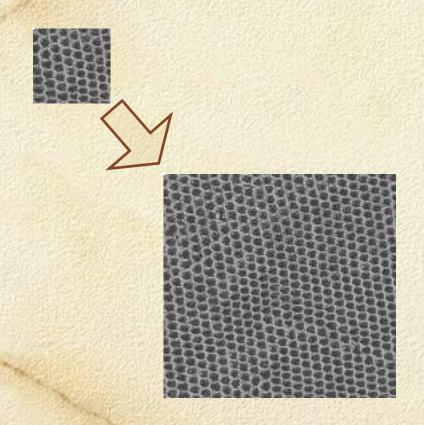
- What size window should be used?
- Depends on structure in the sample image

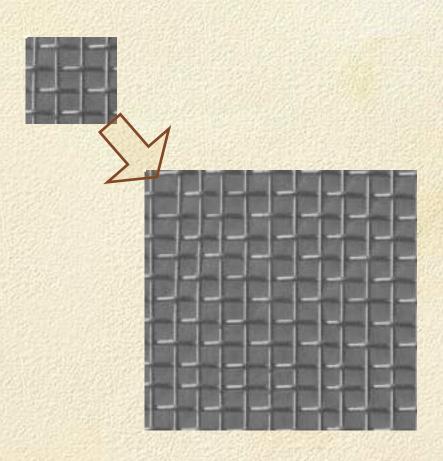


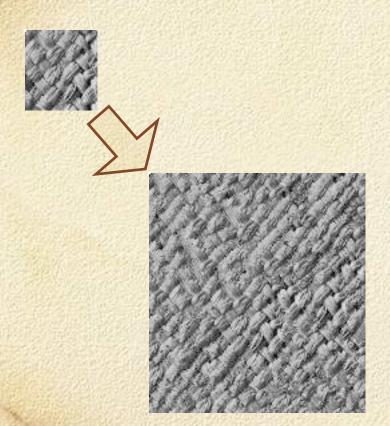
Window Size Examples

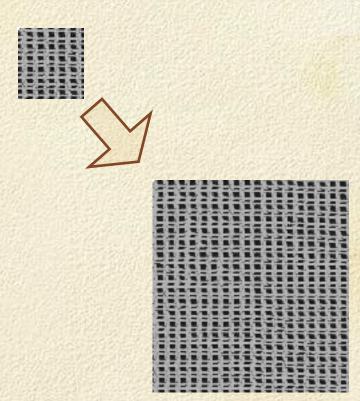




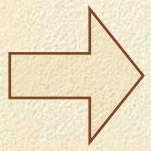




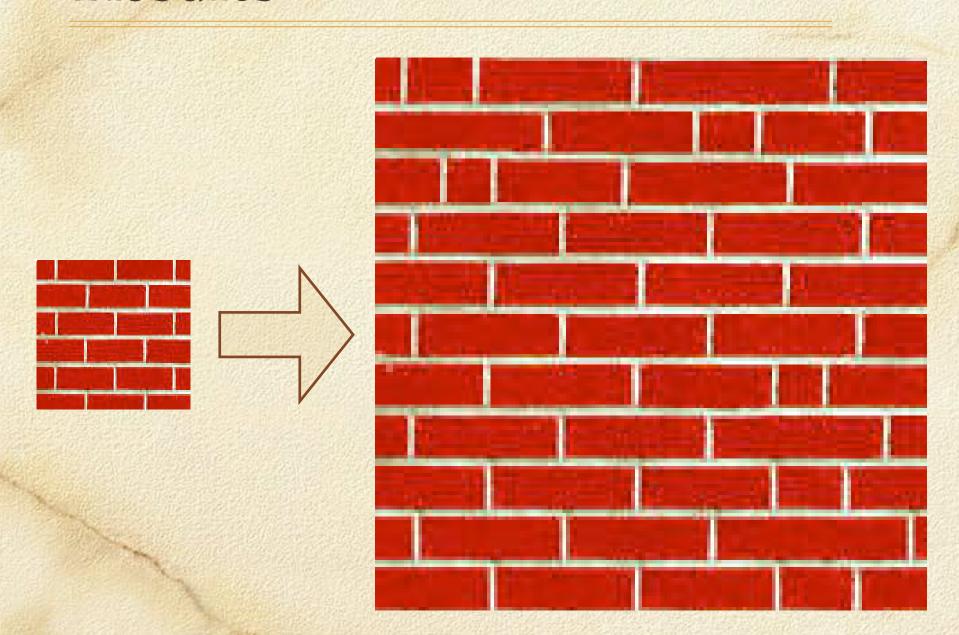


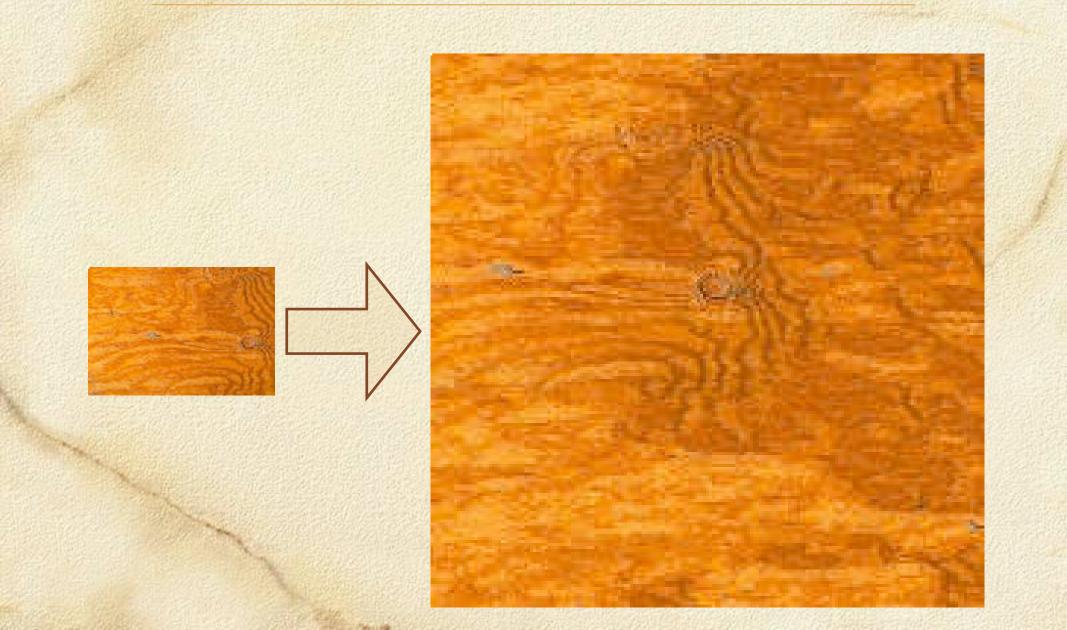


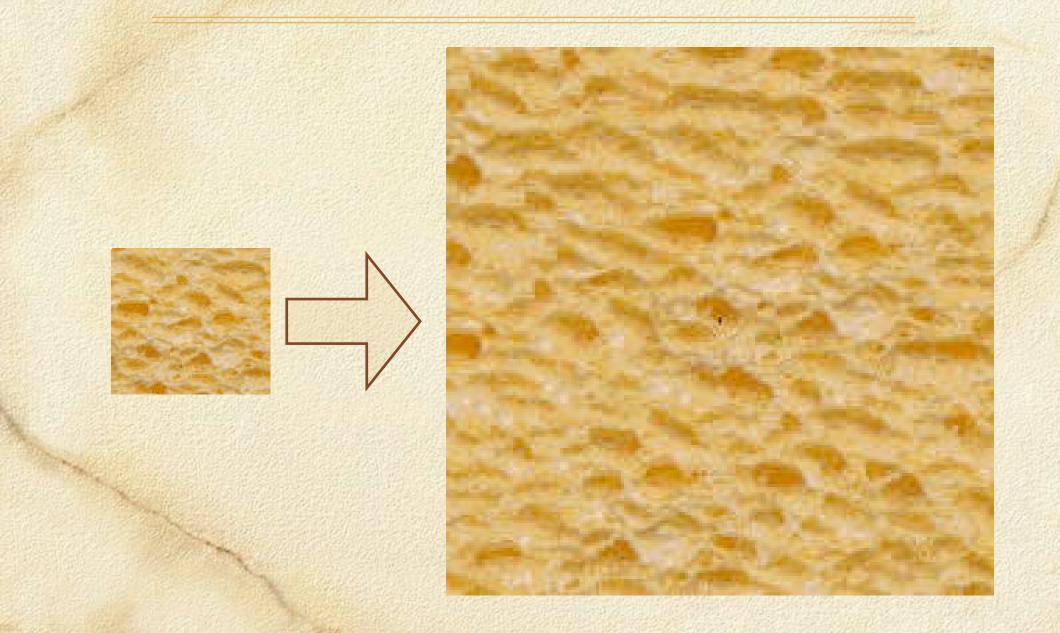
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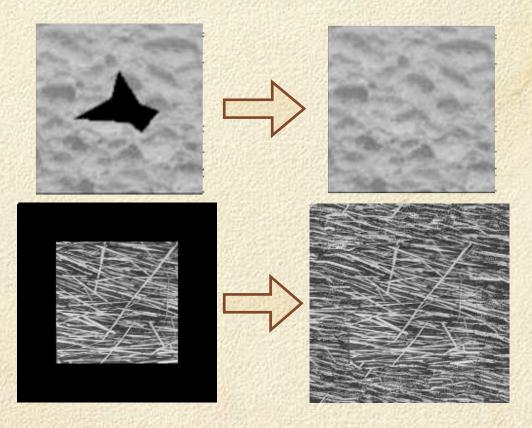






Applications

- What other problems can this approach solve?
 - Fill in Texturegaps Just growinwards
 - Extend picturesto make themlarger



Applications



Applications



Similar Work

- DeBonnet, '97
- ☐ Wei & Levoy '99
- Wei & Levoy '02







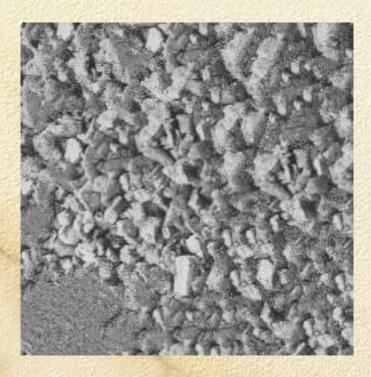
Problems

- 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









Subsequent Work

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

Conclusions

- 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