



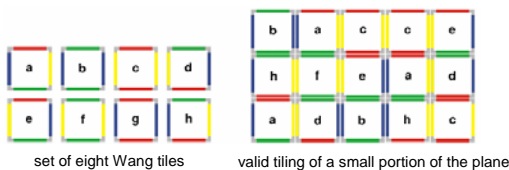
Wang Tiles for Image and Texture Generation

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Wang tiles

- A set of squares in which each edge of each tile is colored.
- Matching colored edges are aligned to tile the plane.
- As few as 8 tiles are needed to non-periodically cover the plane.
- Tiles are filled with 2D texture, 2D poisson distributions, or 3D geometry.

Wang tiles

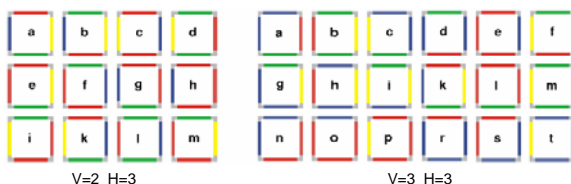


- Square tiles with color coded edges. Cannot be rotated.
- If set contains at least two tiles for each NW combination then there are at least two choices for each step.

Wang tiles

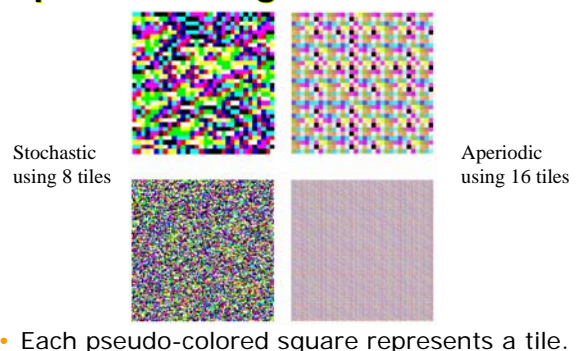
- Wang '61 conjectured: any set of tiles that tiles the plane also tiles it periodically.
- Culik '96 refuted: discovered a set of 13 tiles that are strictly aperiodic.

Wang tiles



- At least two tiles for each NW combination.
- If choice is made with uniform probability then the plane will be tiled non-periodically.
- Number of tiles = $2 * V \text{ colors} * H \text{ colors}$.
- A larger set reduces artifacts.

Stochastic vs. aperiodic tiling

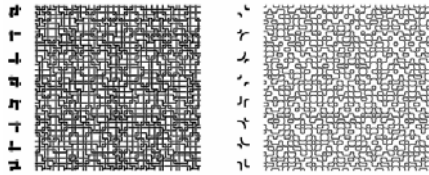


Stochastic
using 8 tiles

Aperiodic
using 16 tiles

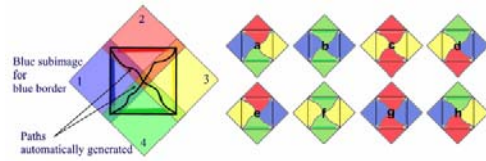
- Each pseudo-colored square represents a tile.

Interactive tile design



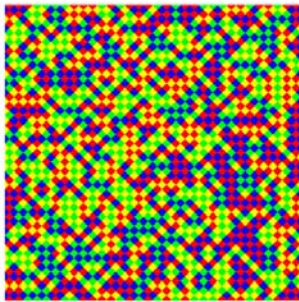
- Place geometric primitives within a set.
- If a primitive is moved such that it overlaps an edge it will automatically appear in all tiles with the same opposing edges.

Automatic tile design



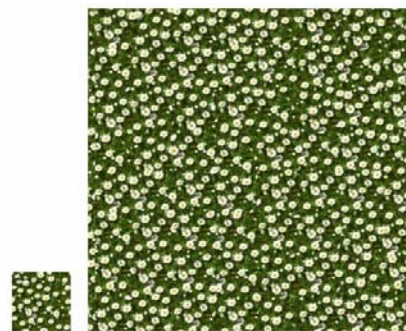
- Combine diamond shaped sample portions of the source image (squares rotated by 45), one for each edge color.
- Find cutting paths to combine the samples by quilting.
- Cut along sample diagonals to form tile.

Pseudocolored tiling



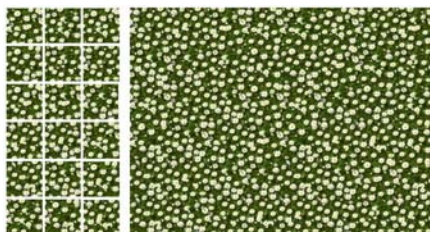
- Each diamond represents one edge color.

Image quilting

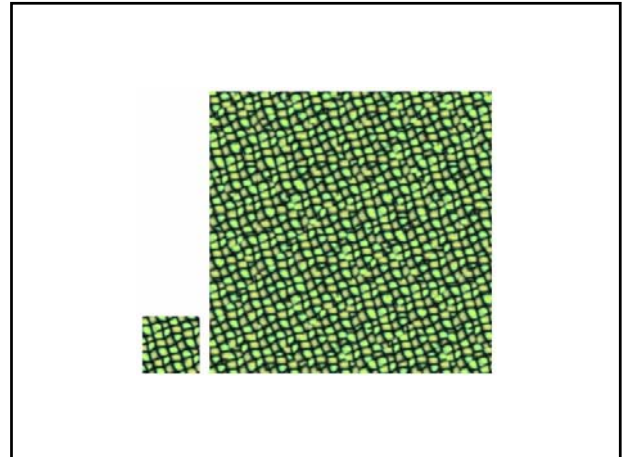
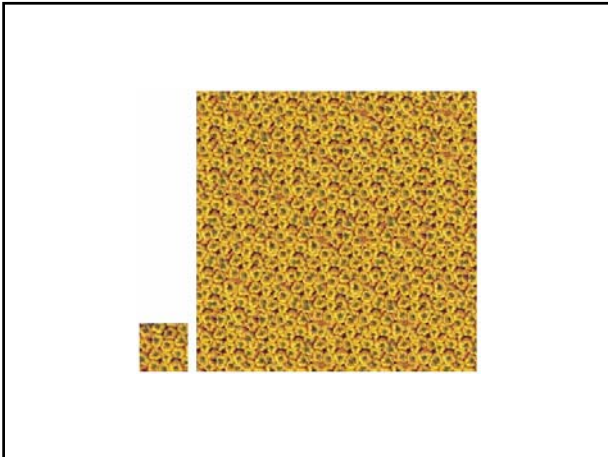


- Efron and Freeman, SIGGRAPH 2001.

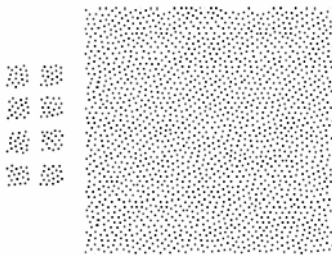
Wang tiles



- Simple algorithm: choose first tile, and then randomly choose from edge matching tiles for each step in scanline.
- Fast: generate large textures at runtime.



Pseudorandom distributions



- Each tile contains a set of point positions.

Poisson disc distribution

- A small disc around each point defines a region in which no other object of the distribution is found.
- Dart throwing: incrementally add random point if it doesn't overlap with any discs of points already inserted.
- Problem: distribution of tile boundaries.
- Solution: Lloyd's method, iterative relaxation.

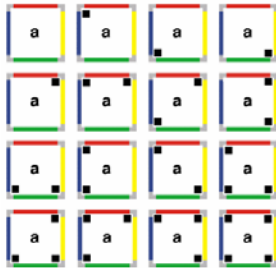
Poisson disc distribution



- Distribution generated from one tile with 160 plants (top).
- Distribution generated from 8 Wang tiles with 20 plants each (bottom).

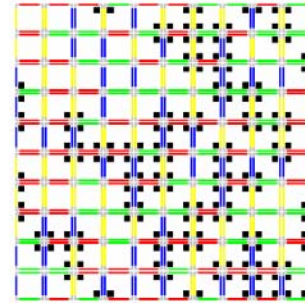


Corners

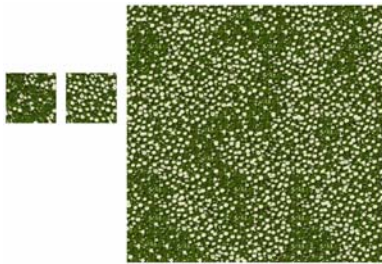


- For each Wang tile, 16 combinations of marked corners.

Tiling



Inhomogeneous tiling



- Choose one source image for parts of tile marked with a corner and the other source image for the rest.



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