

20 – Procedural Synthesis

Acknowledgment: Daniele Panozzo, Sylvain Lefebvre, Jeremie Dumas
CAP 5726 - Computer Graphics - Fall 18 – Xifeng Gao



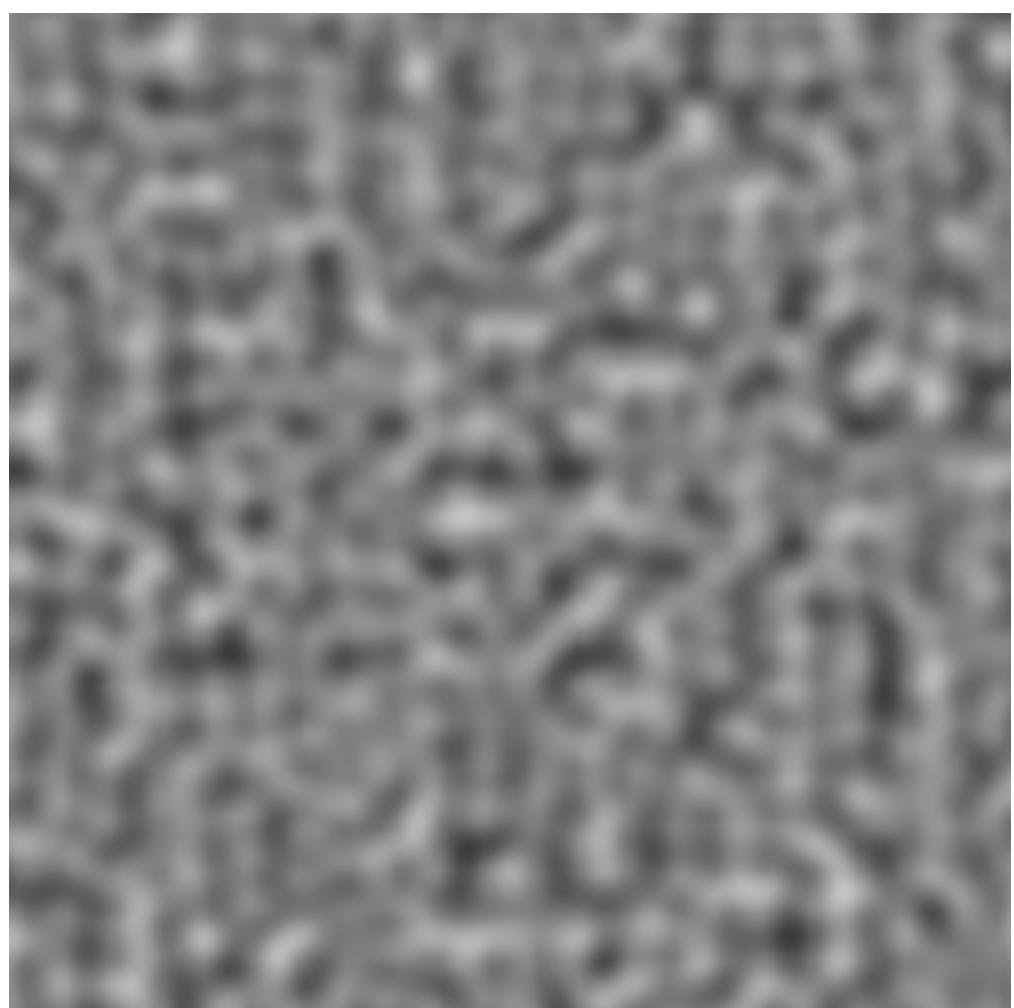
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Inigo Quilez (<https://www.shadertoy.com/view/4ttSWf>)

We start with noise functions

- Goal: create realistic “textures” at inexpensive costs.

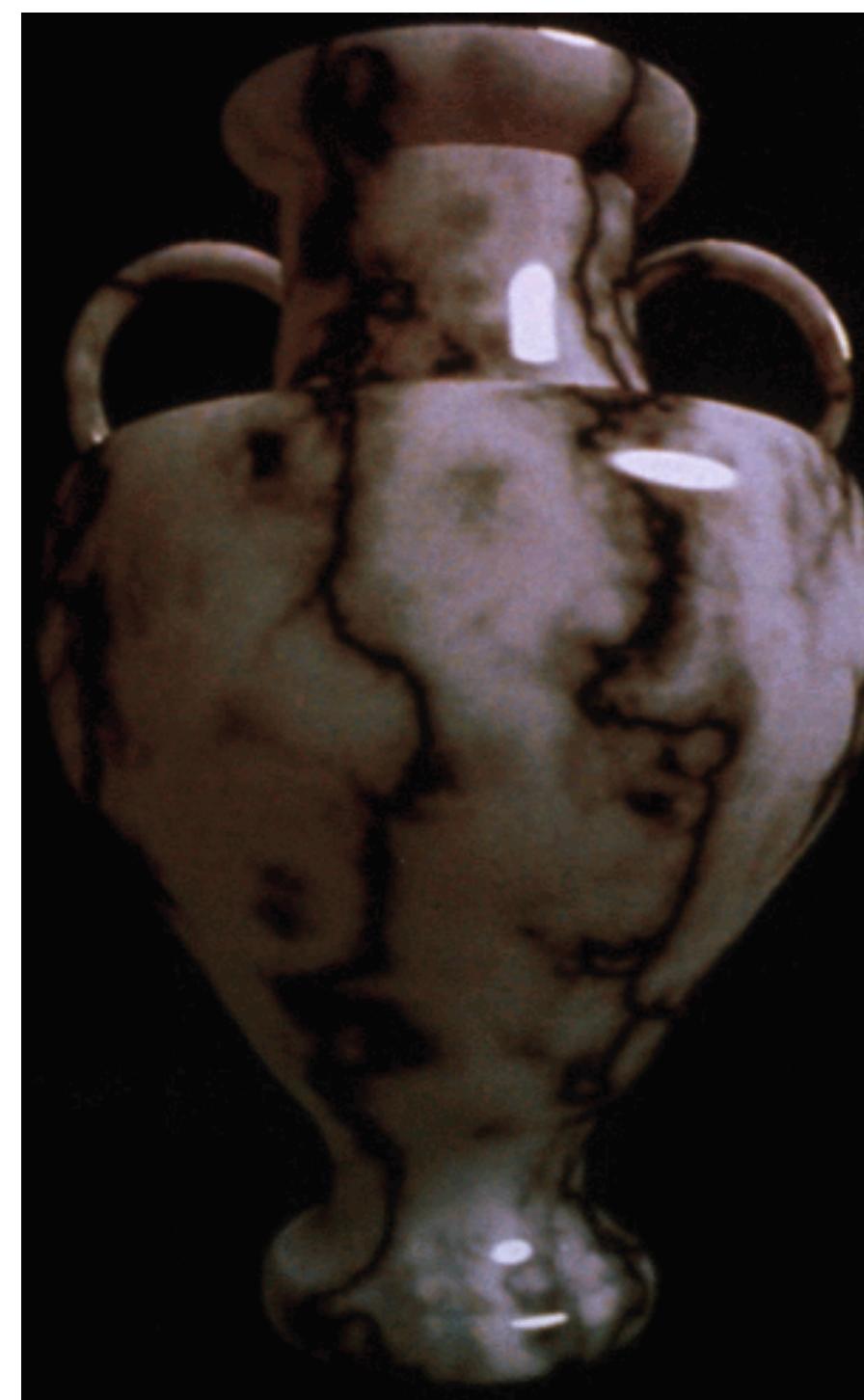


Procedural noise

$F(\text{noise})$



colors,
normals,
roughness...



Procedural texture
[Perlin 1985]

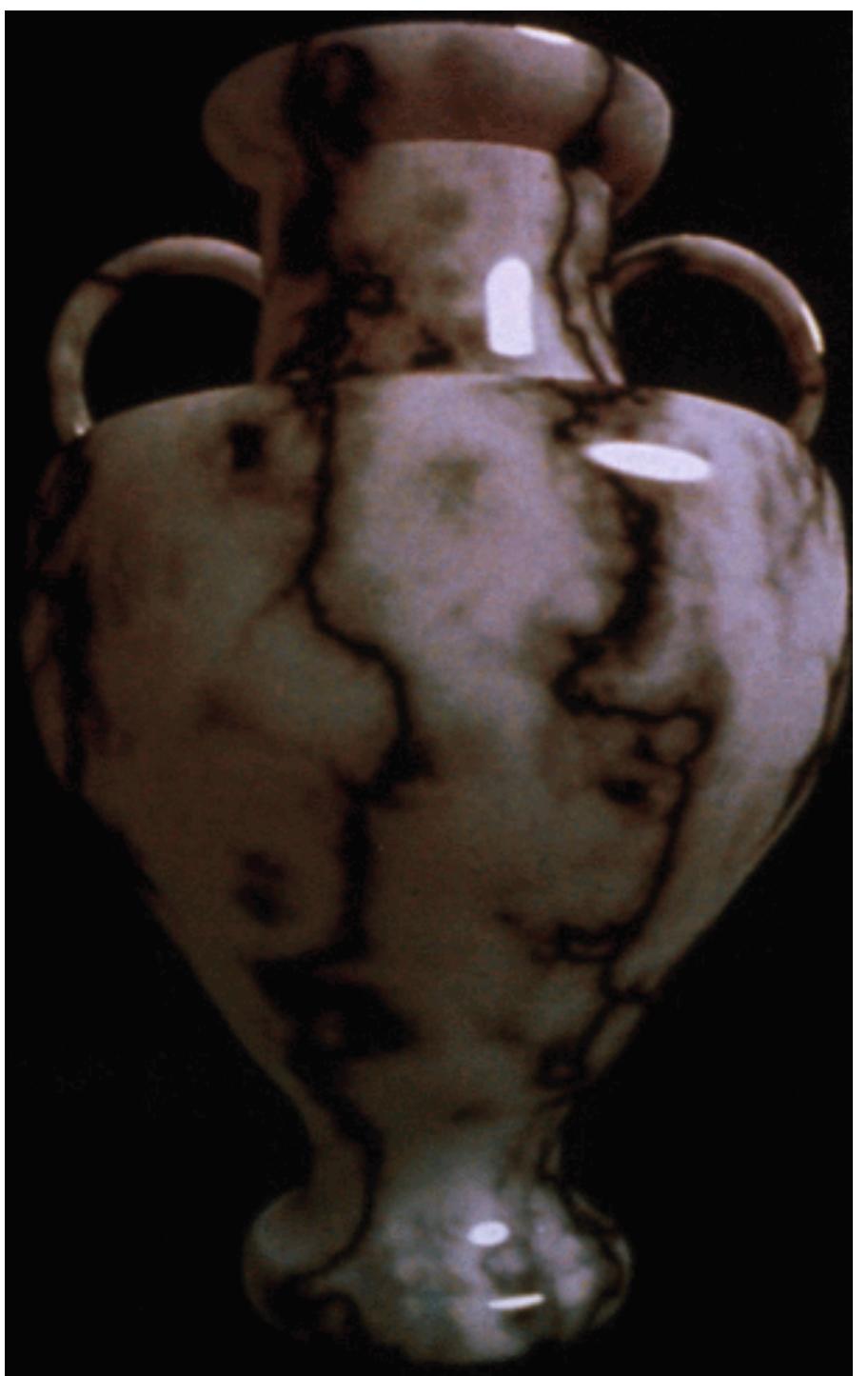
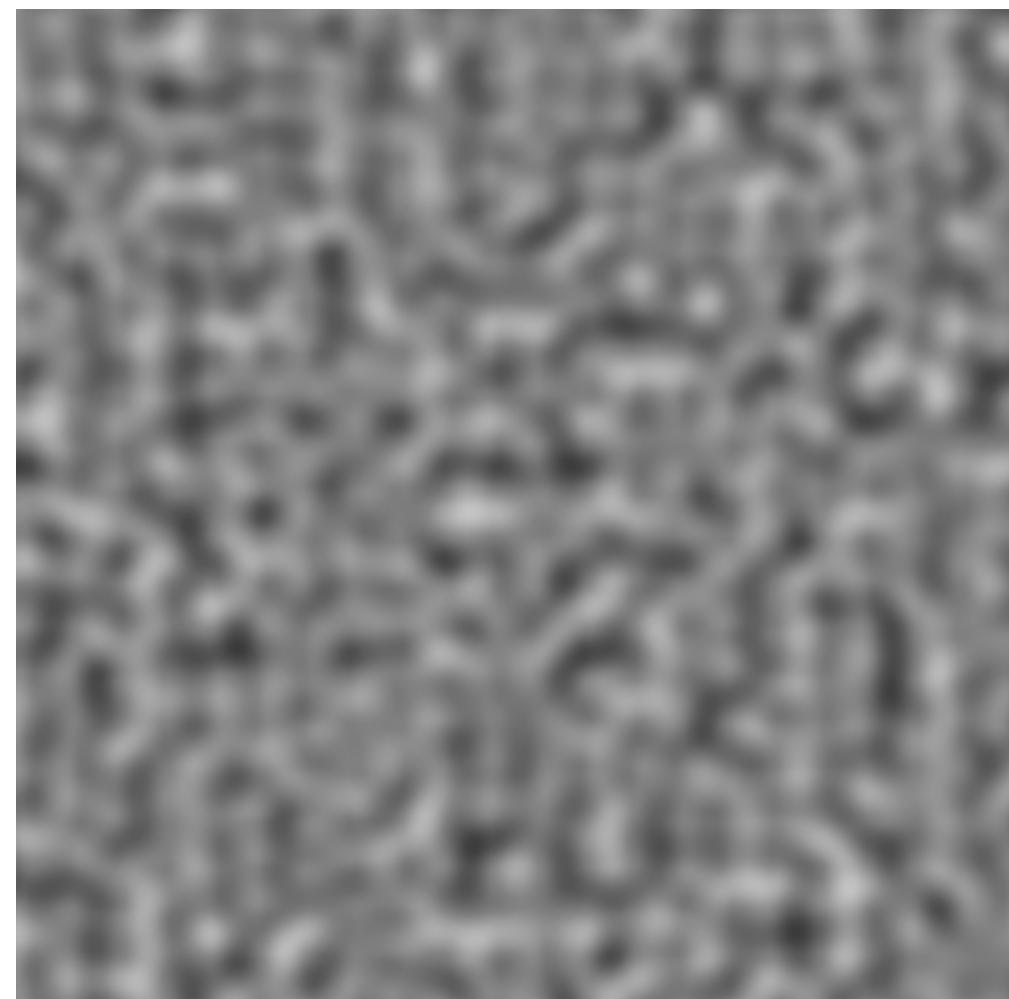


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What is a good noise function?

Randomly controlled primitive $F(p) \in \mathbb{R}$

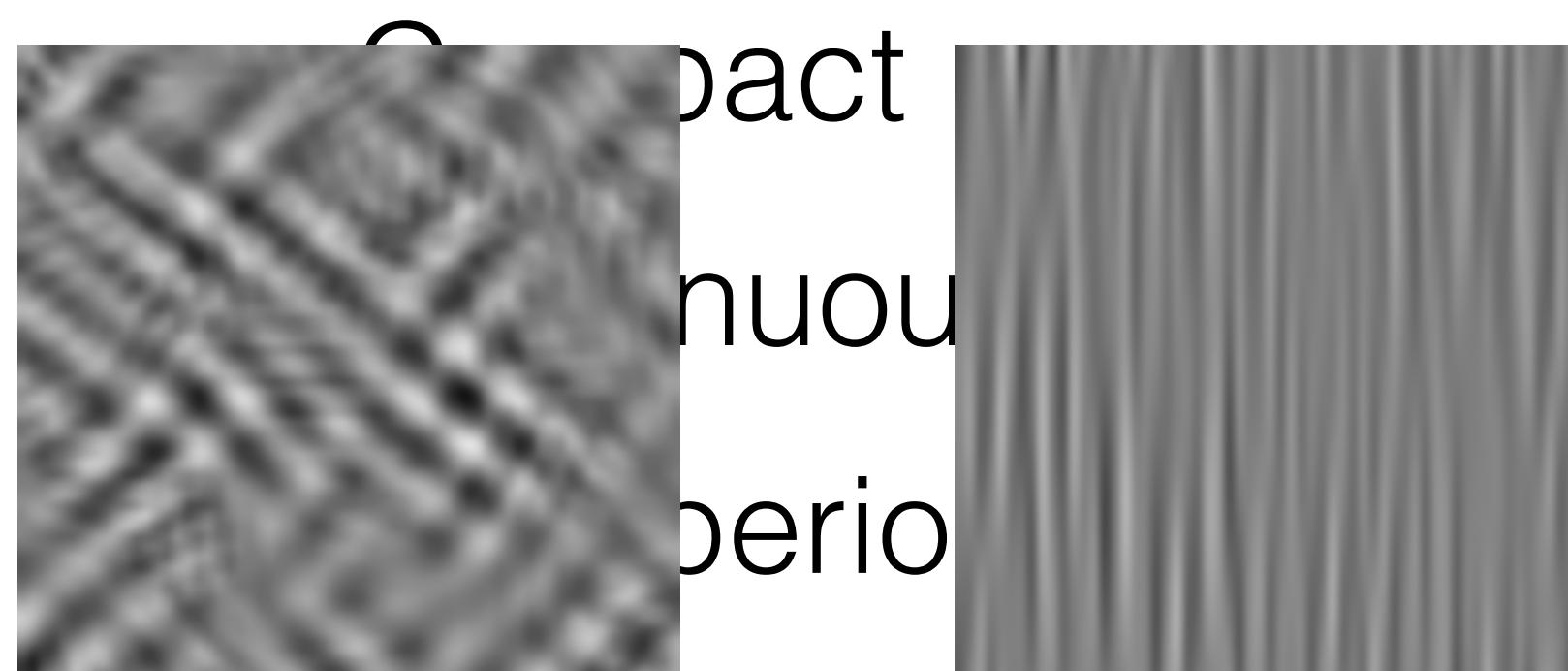
- ✗ White noise (salt)
- ✗ Smooth function
- ✓ Smooth function + salt



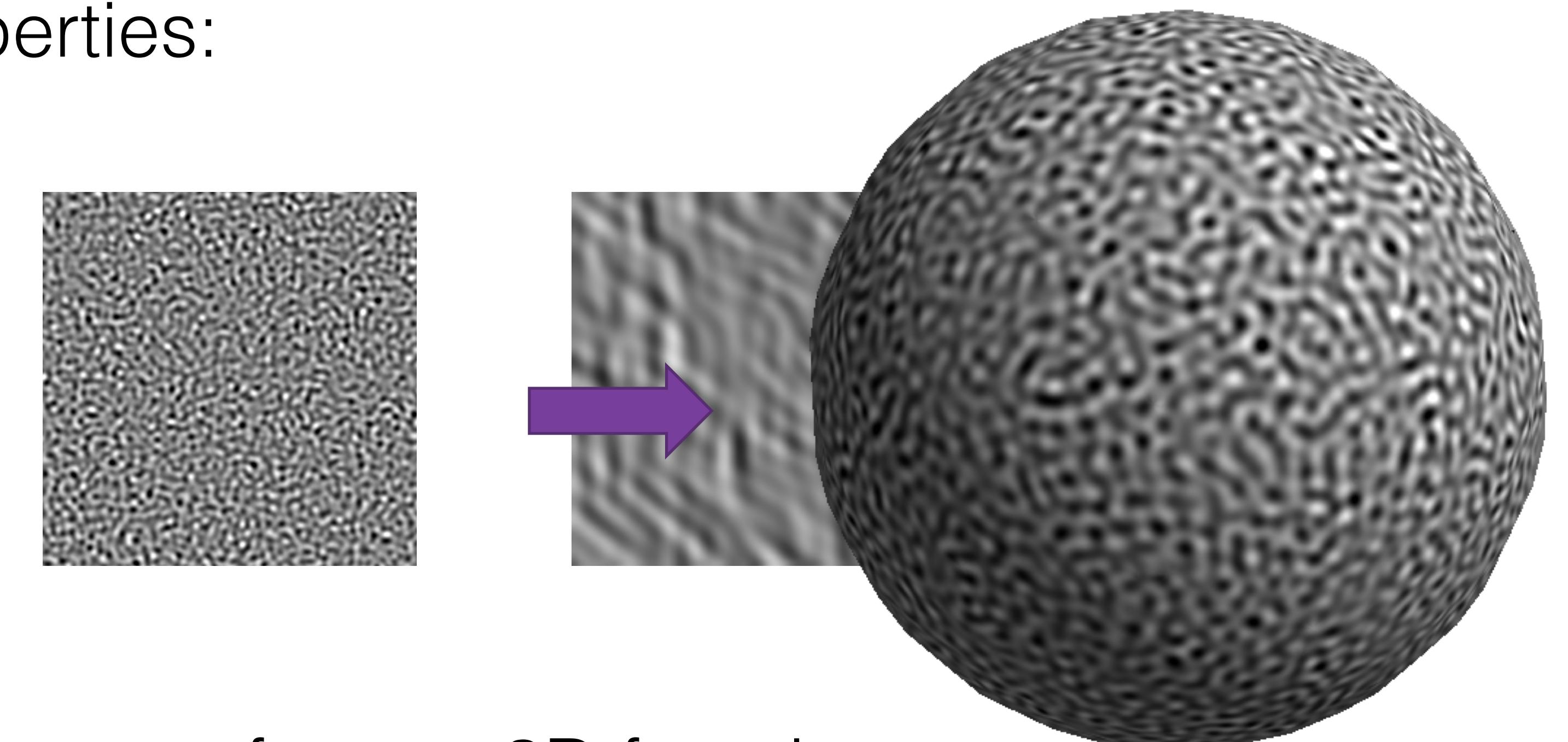
Perlin noise [85]

Noise Requirements

- We want noise with **controllable appearance**
- Other desirable noise properties:

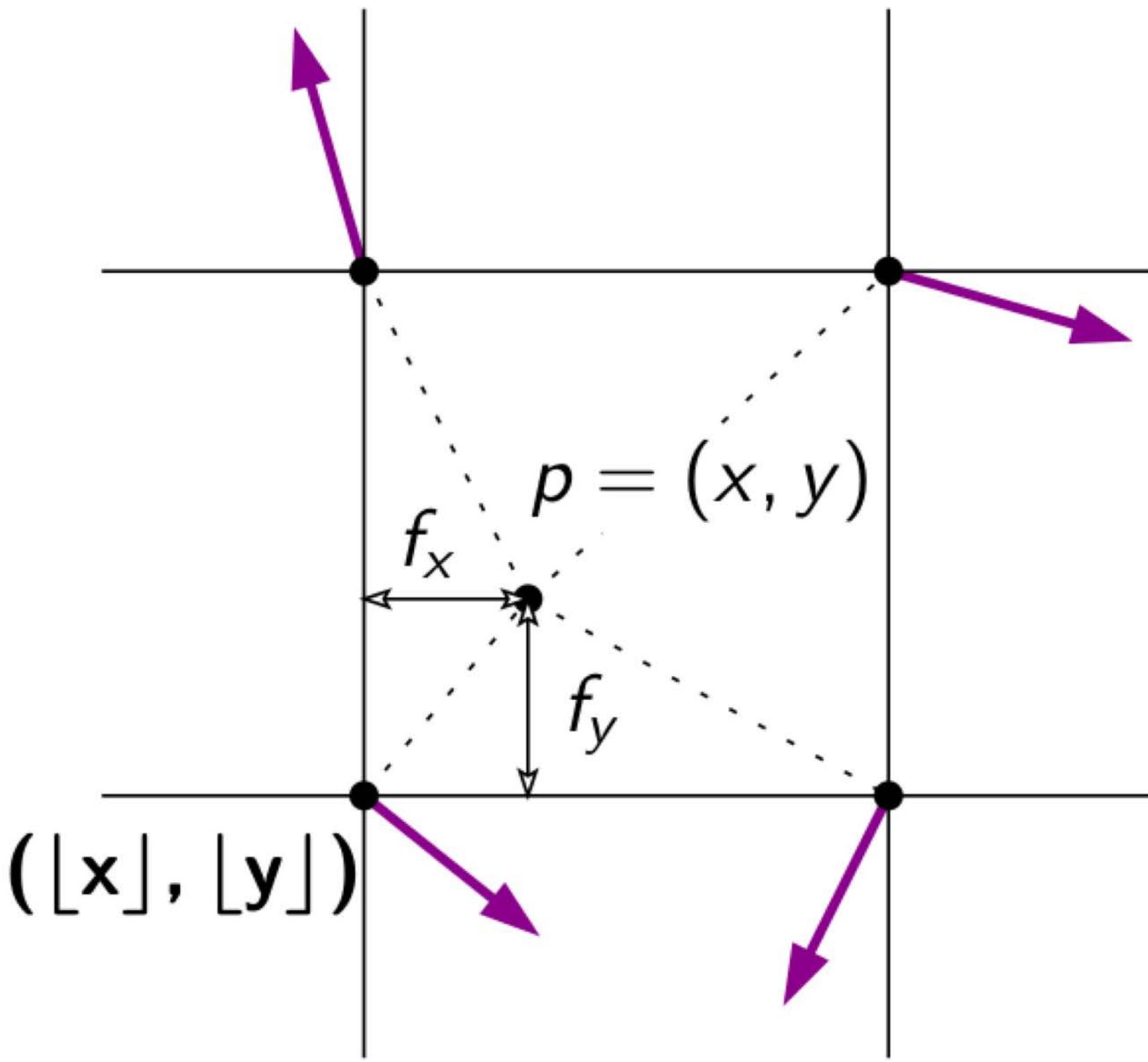


- Fast
- Applied to 3D objects: map to surface or 3D function



Perlin Noise

- Uses a regular lattice
- Basic algorithm:
 - Given a point \mathbf{p} in 2D, find lattice corners \mathbf{c}
 - Compute $\text{hash}(\mathbf{c}) \cdot (\mathbf{p} - \mathbf{c}) \in \mathbb{R}$ for each corner
 - Perform bilinear interpolation with weights given by \mathbf{u}



$$\text{hash}([\mathbf{x}], [\mathbf{y}]) \in \mathbb{R}^2$$

$$f_{\bullet} \in [0, 1]$$

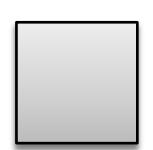
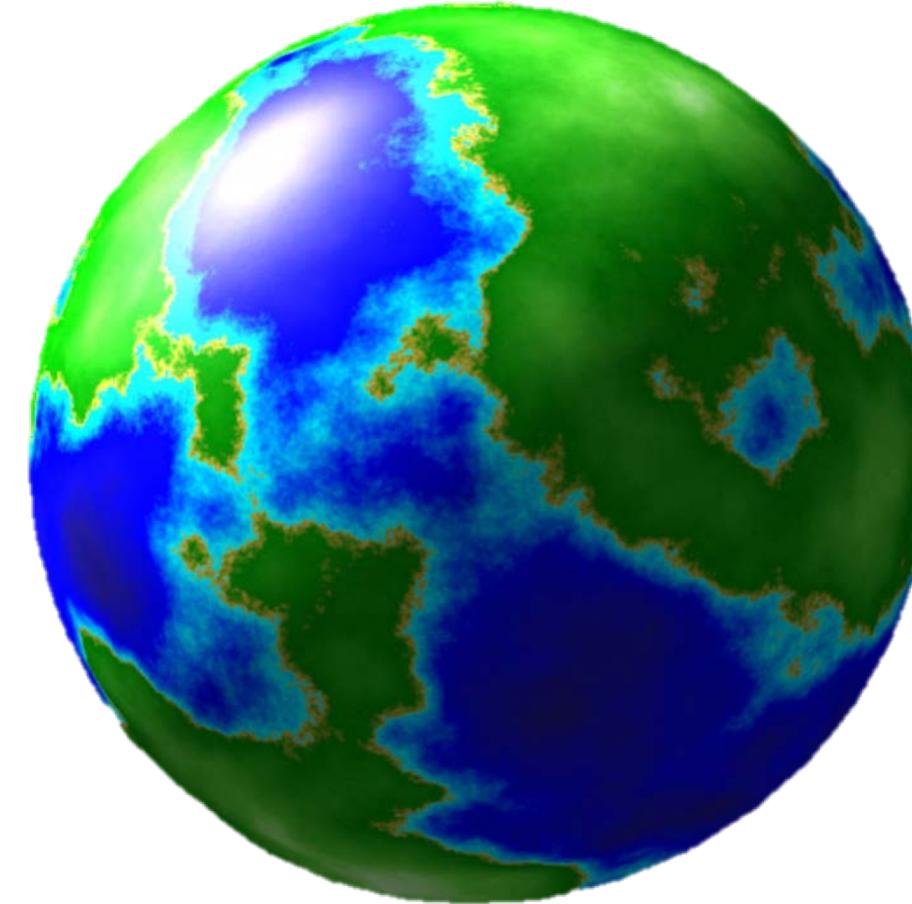
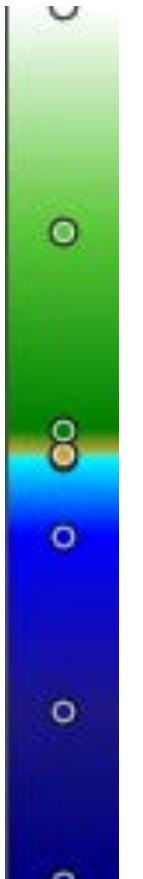
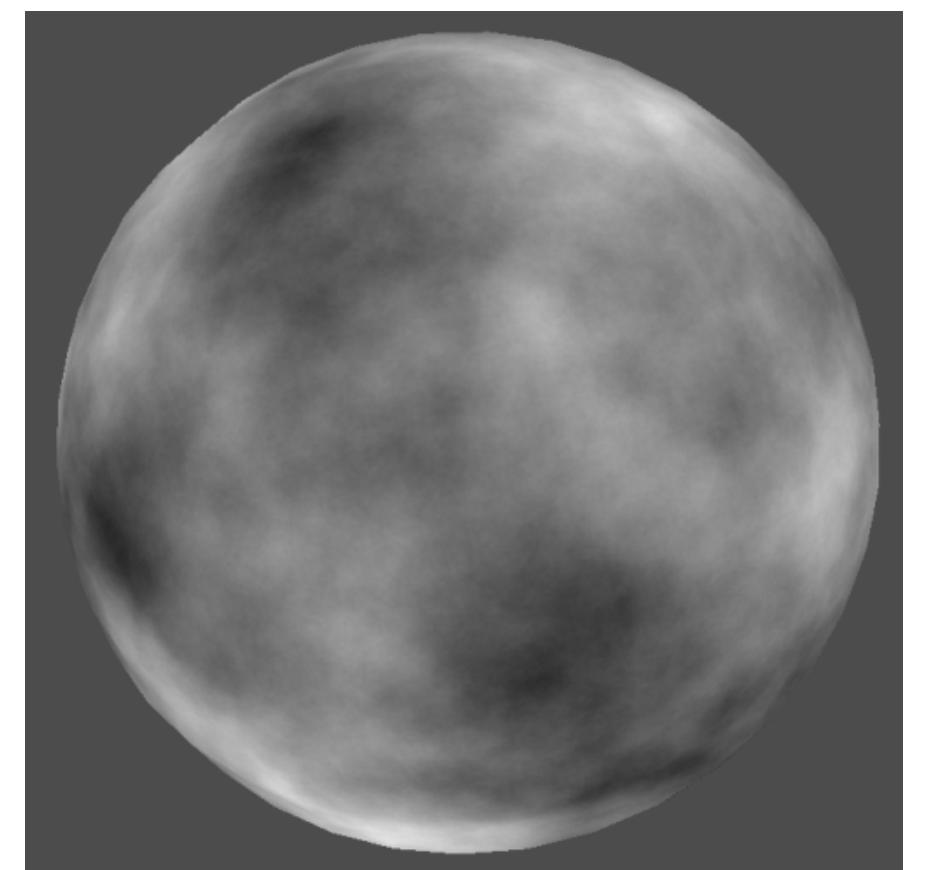
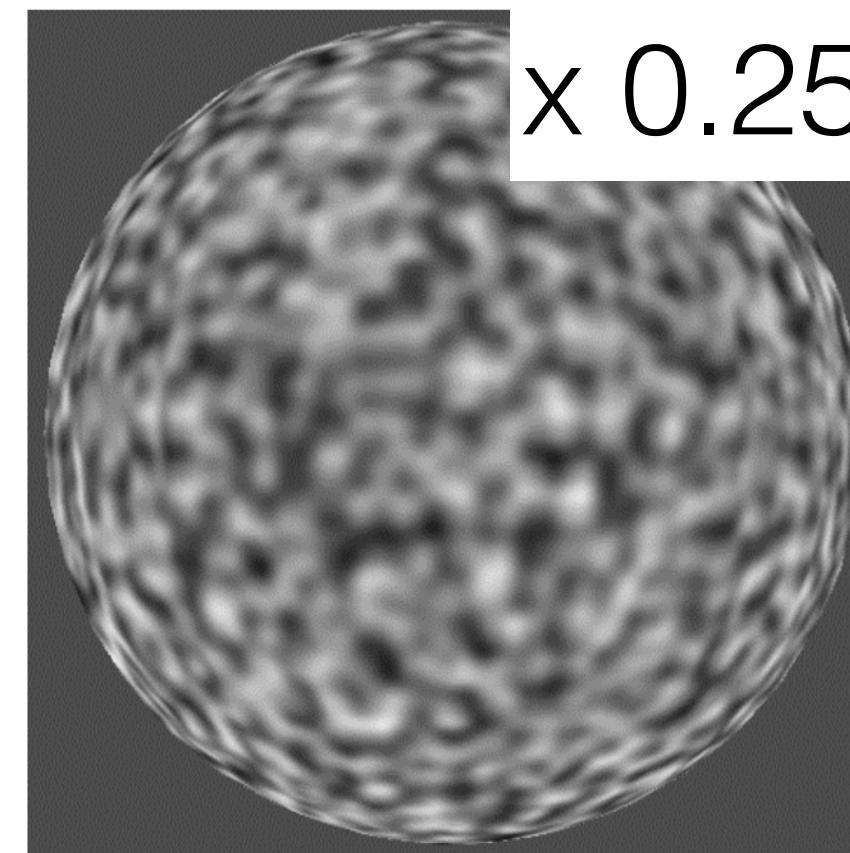
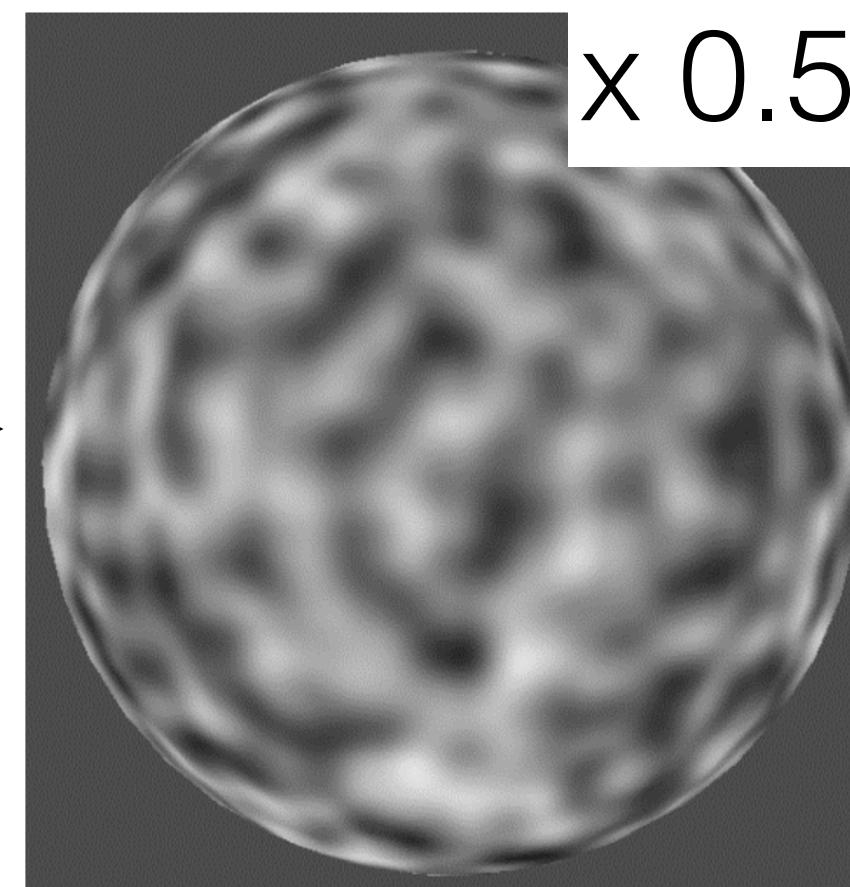
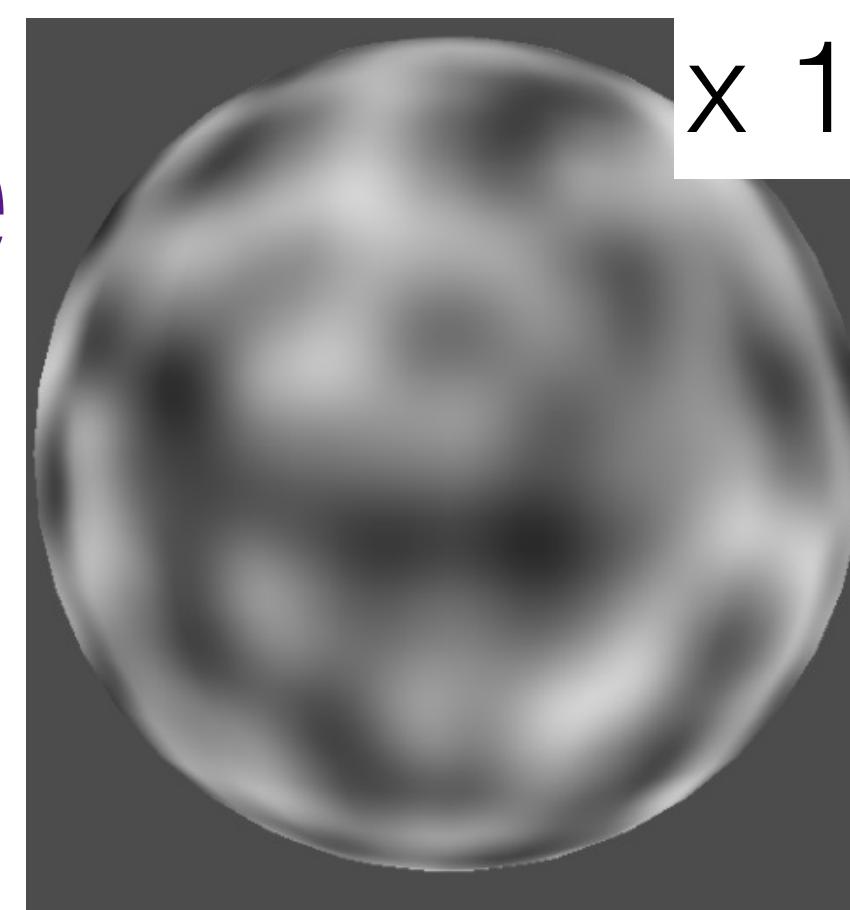
$$u_{\bullet} = f_{\bullet} f_{\bullet} (3 - 2f_{\bullet}) \in [0, 1]$$



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Combine

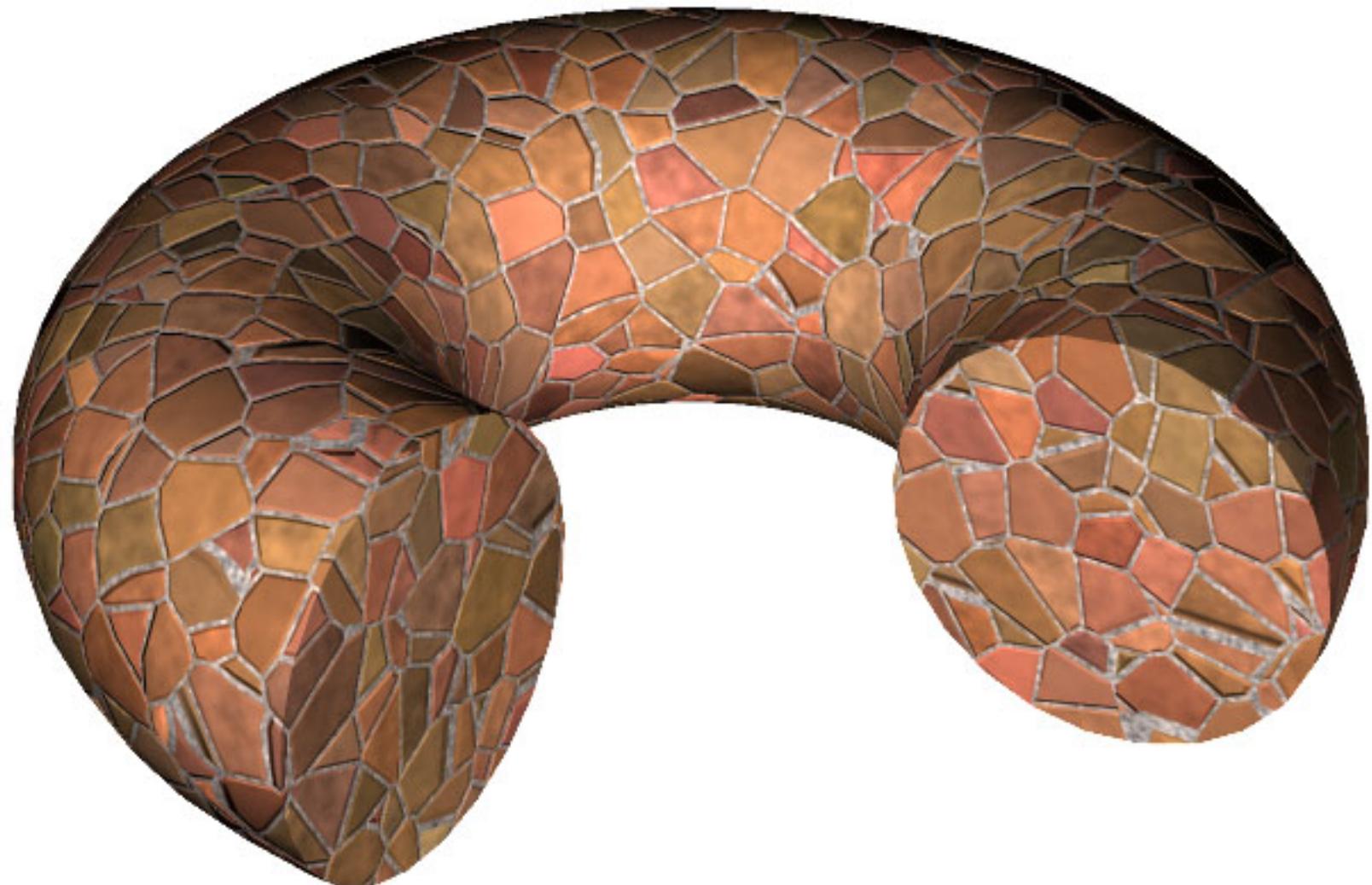
42 →
seed



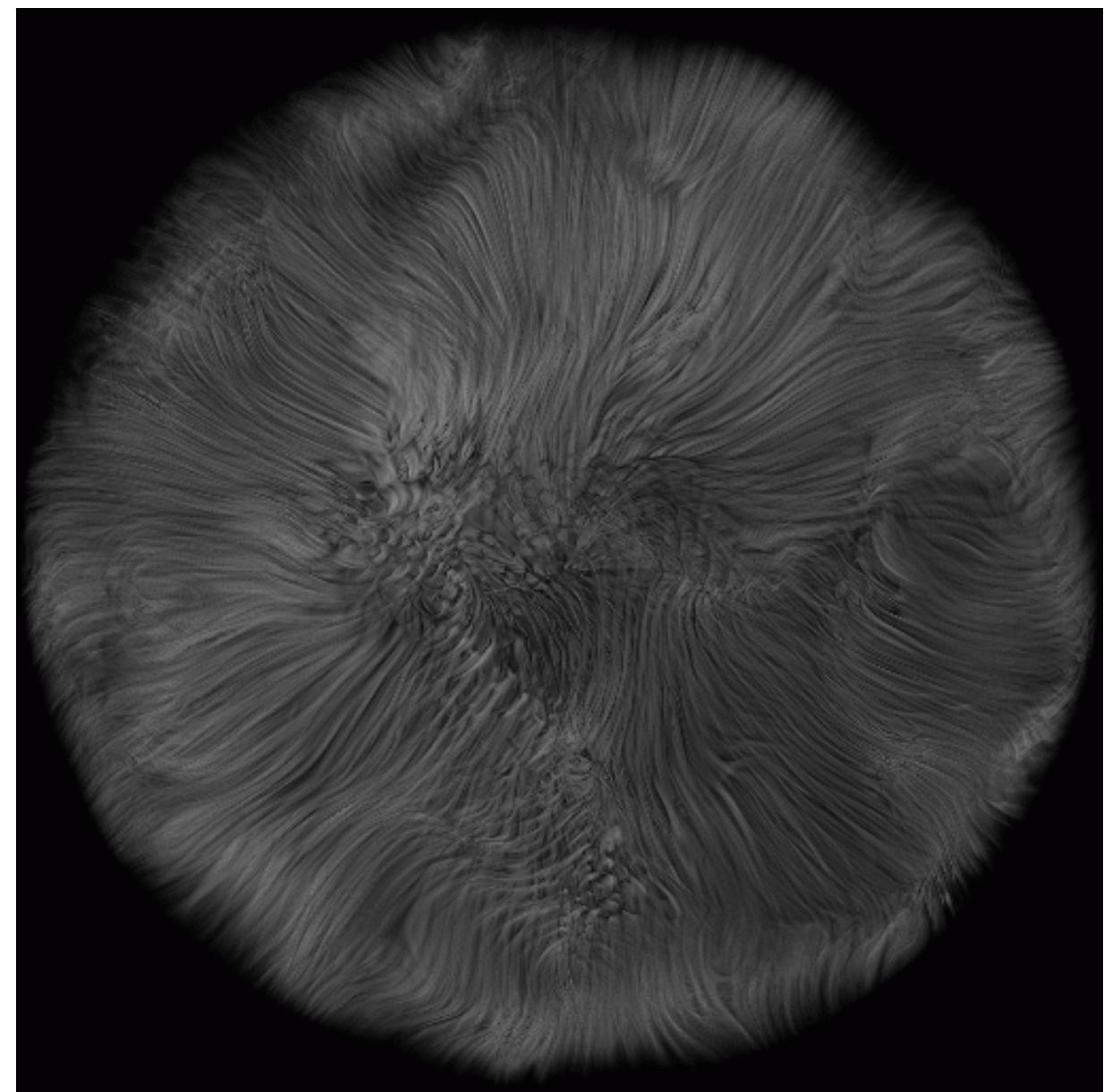
color = $f(x,y,z)$

and add colors!

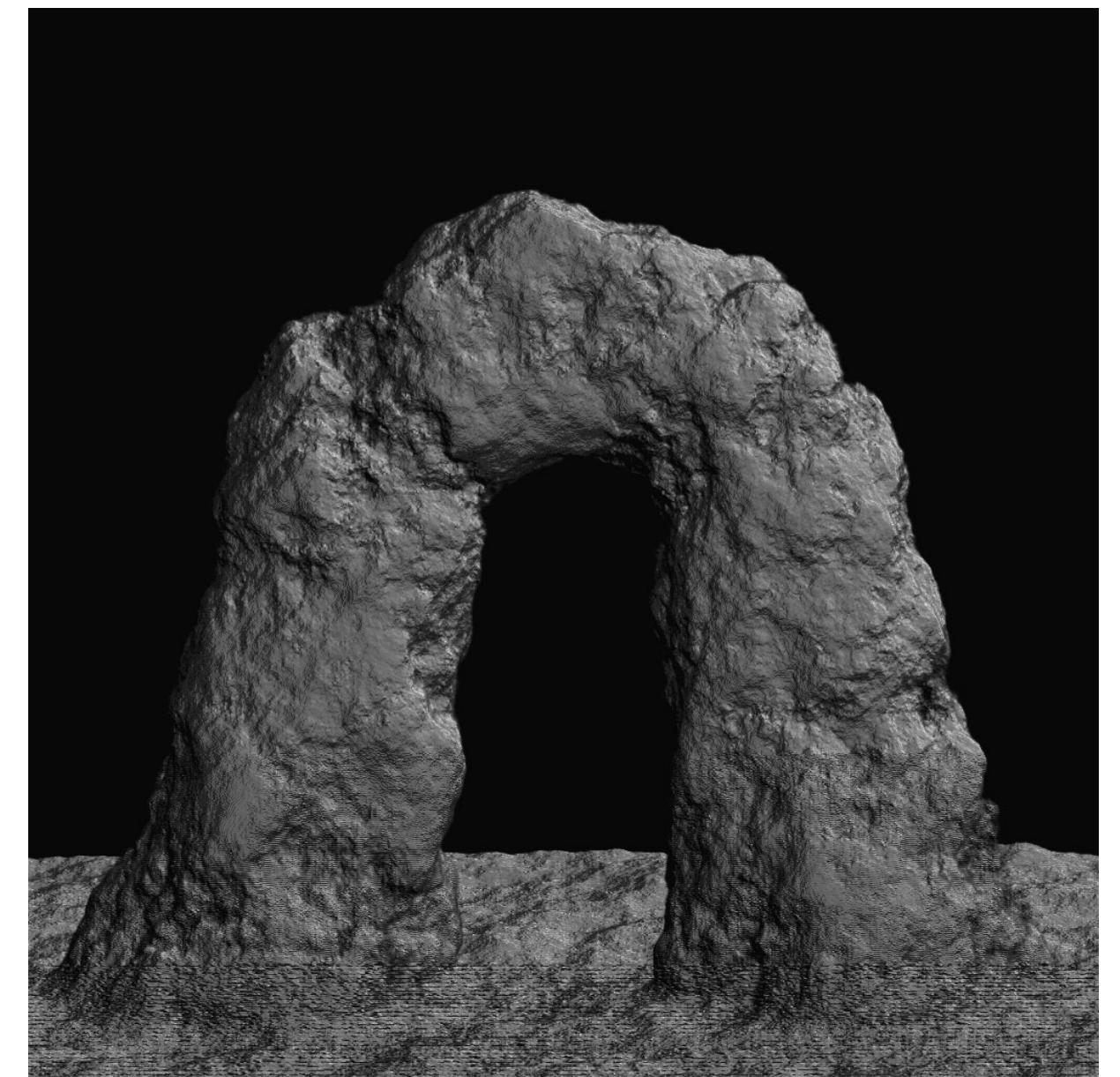
Solid Textures and Hypertextures



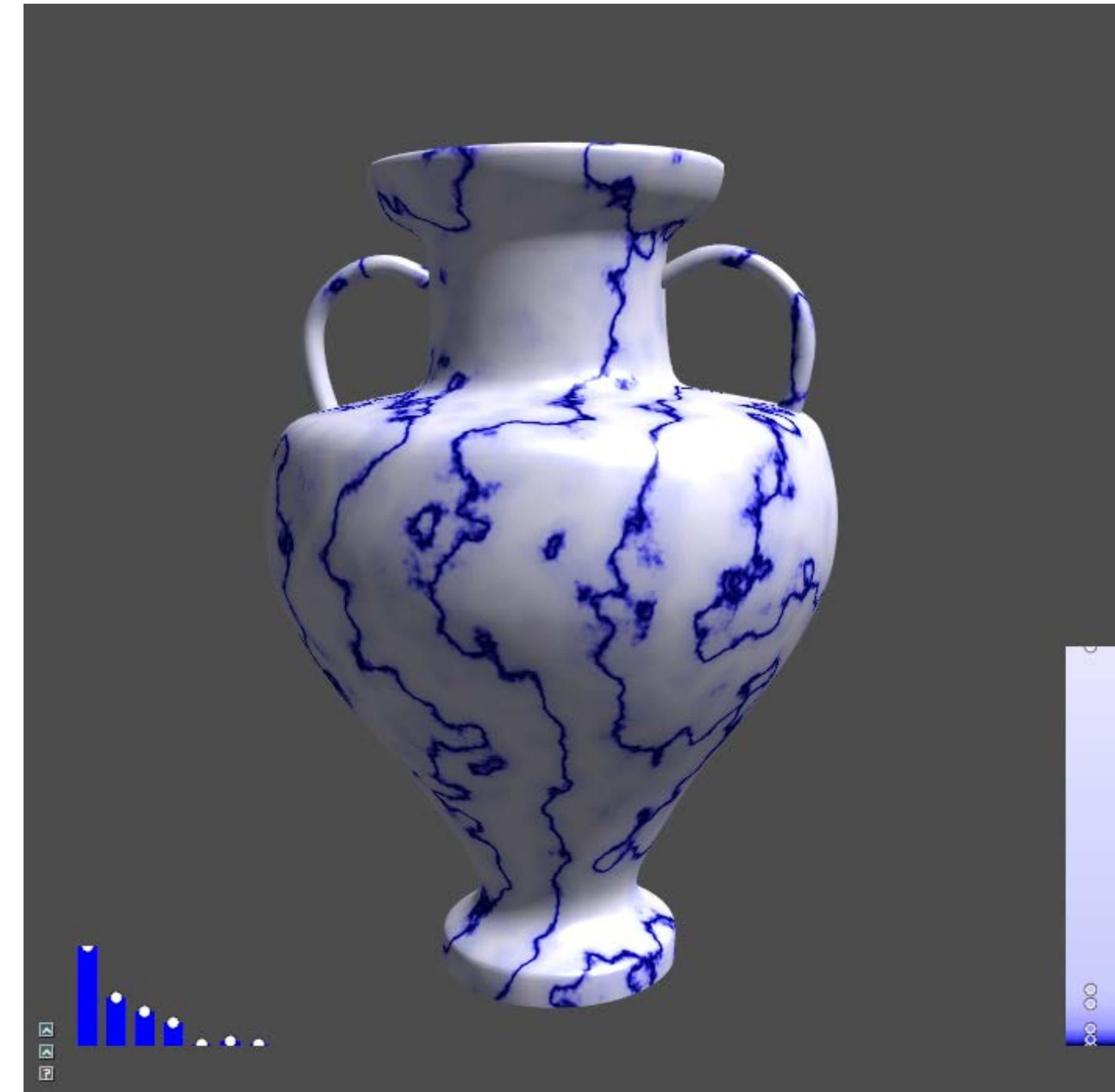
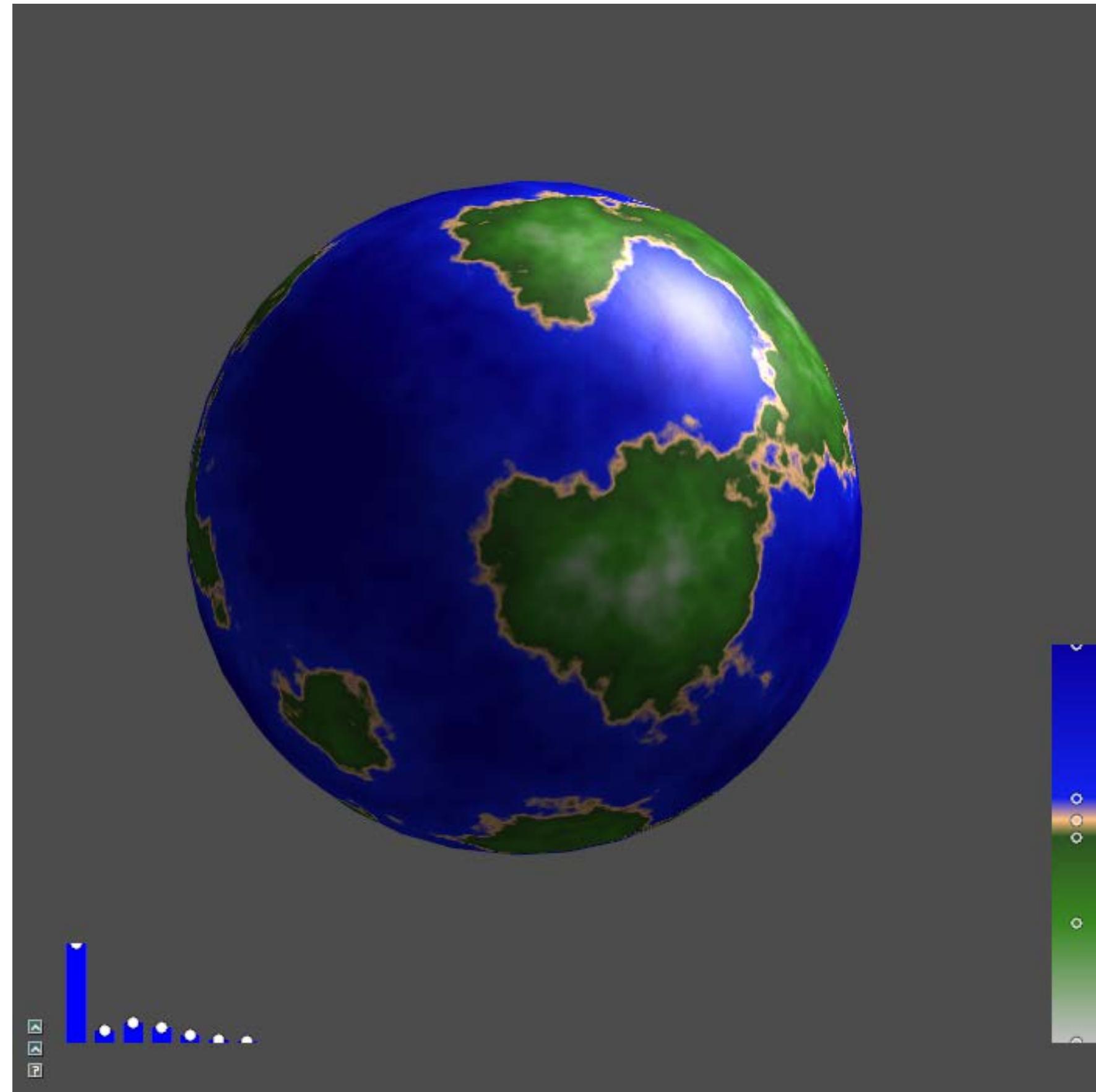
Cellular Noise [Worley 1996]



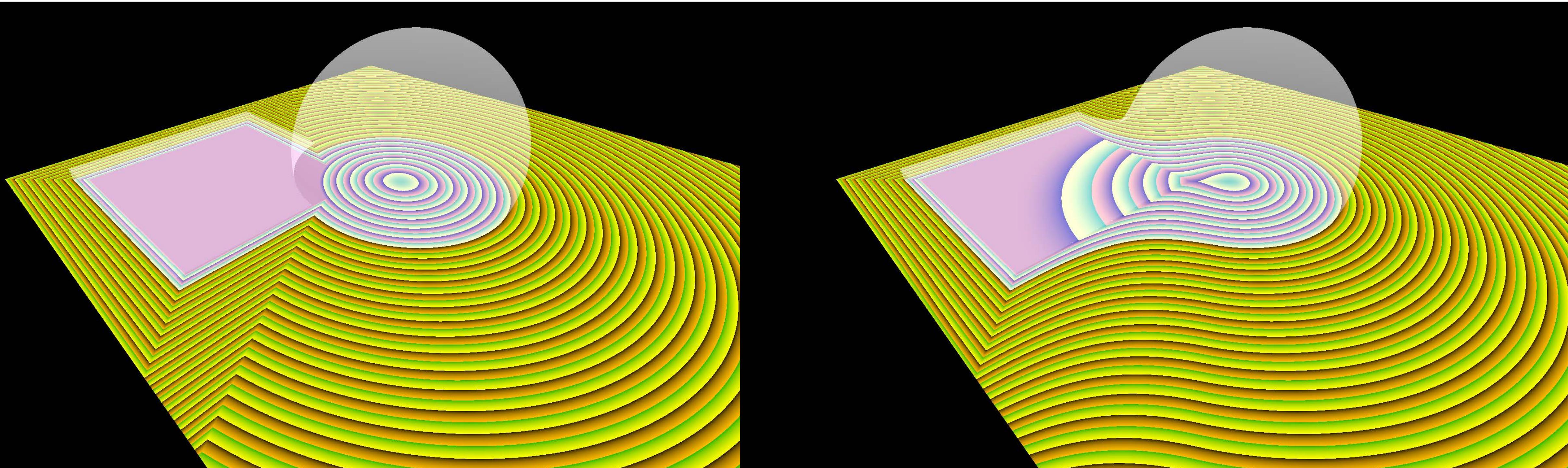
Hypertextures [Perlin 1989]



Solid vs Surface Textures



Modelling With Implicits



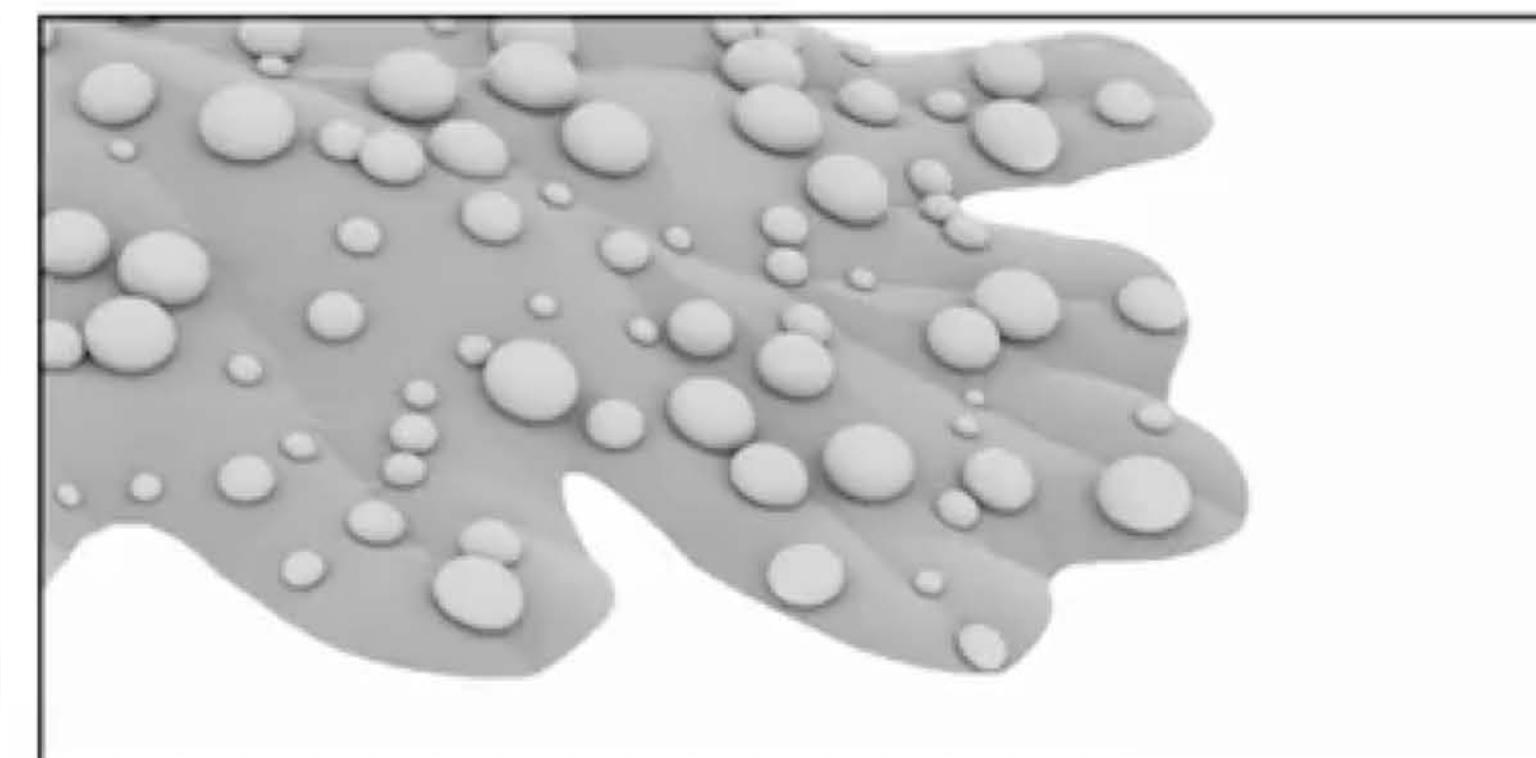
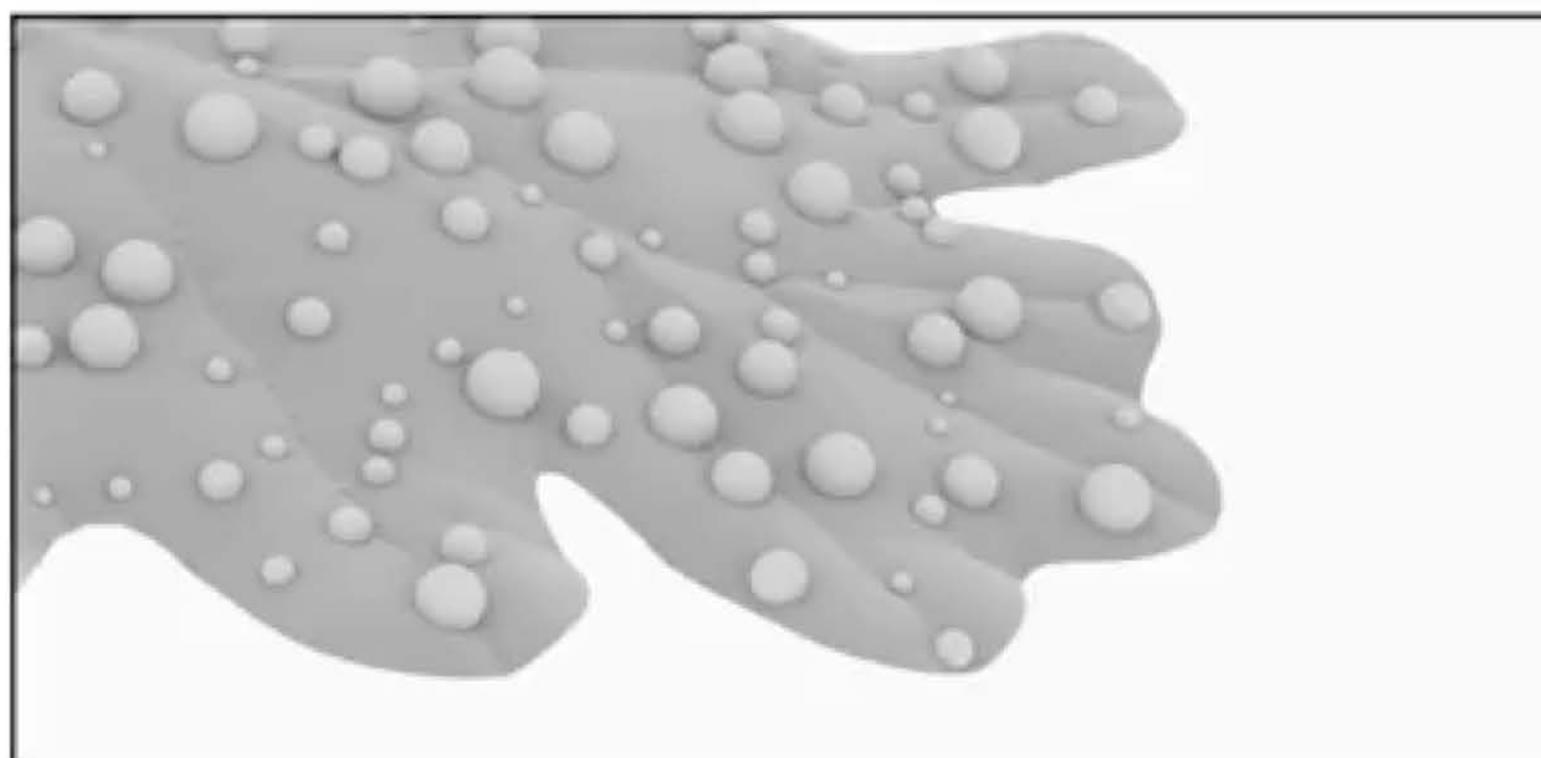
Alex Evans at SIGGRAPH 2015

https://www.mediamolecule.com/blog/article/siggraph_2015



Sketch-Based Implicit Blending

Baptiste Angles^{1,2}, Marco Tarini³, Brian Wyvill¹, Loïc Barthe², Andrea Tagliasacchi¹



1. University of Victoria



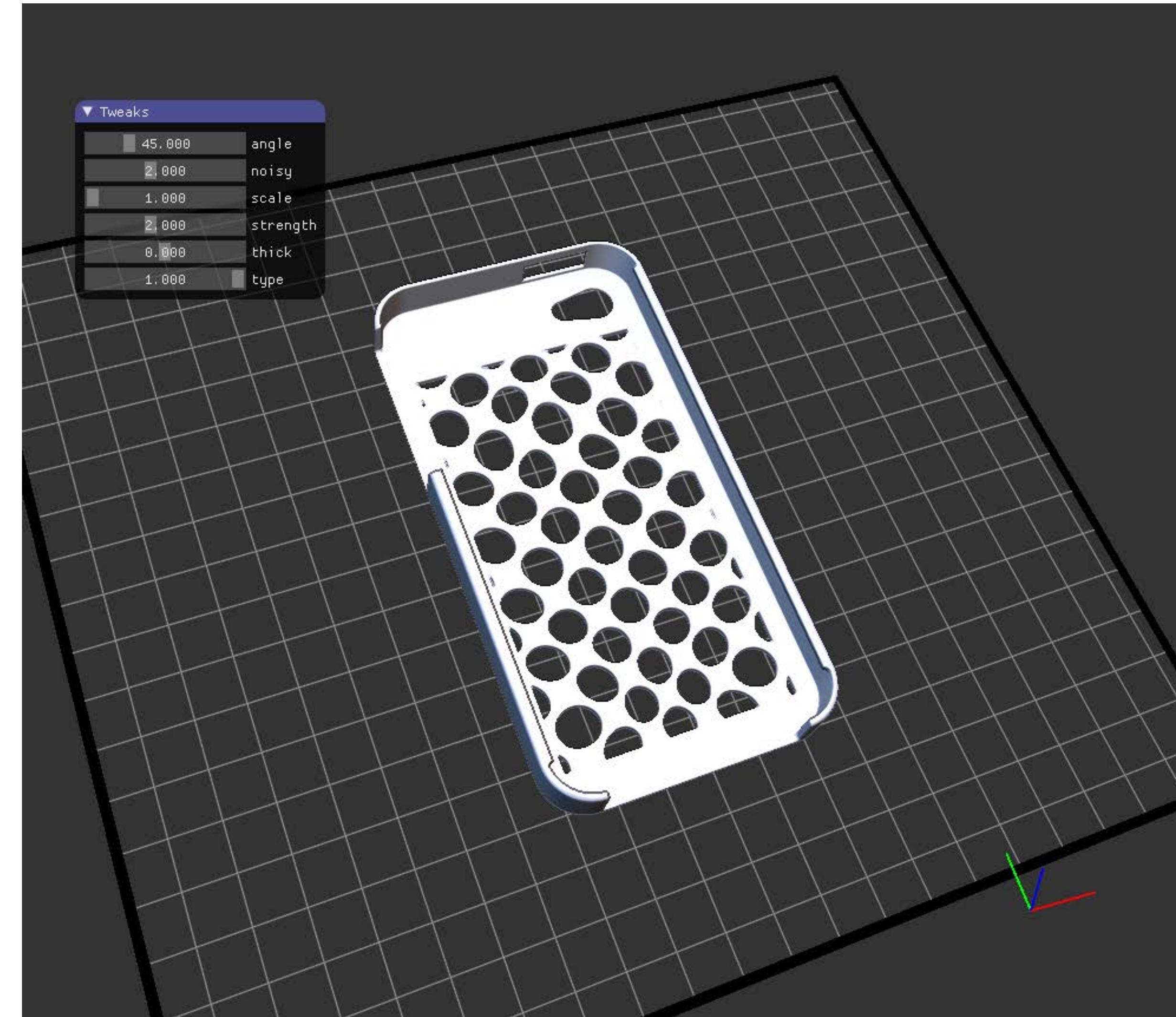
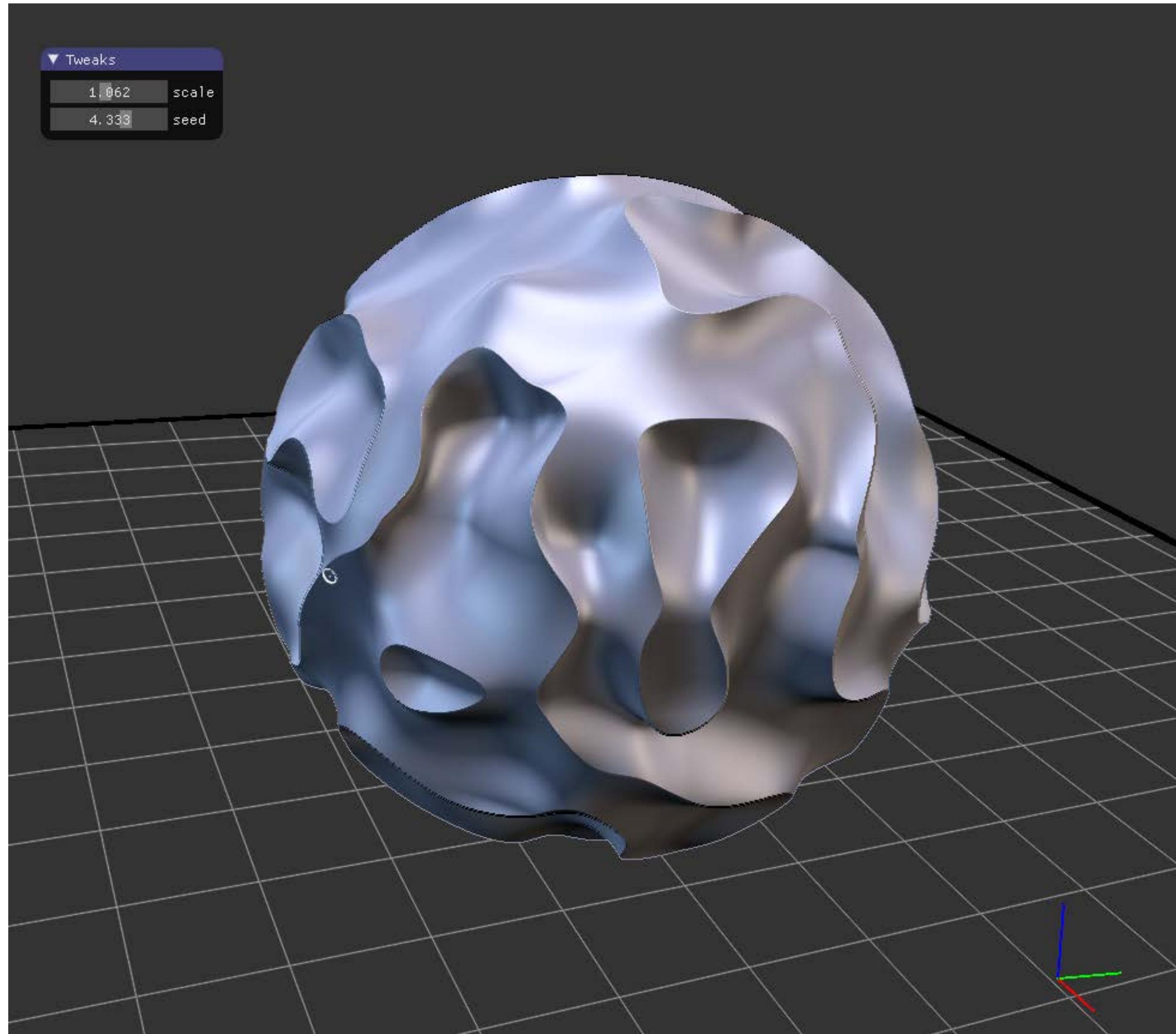
2. Université de Toulouse, IRIT/CNRS



3. Università dell'Insubria, ISTI / CNR

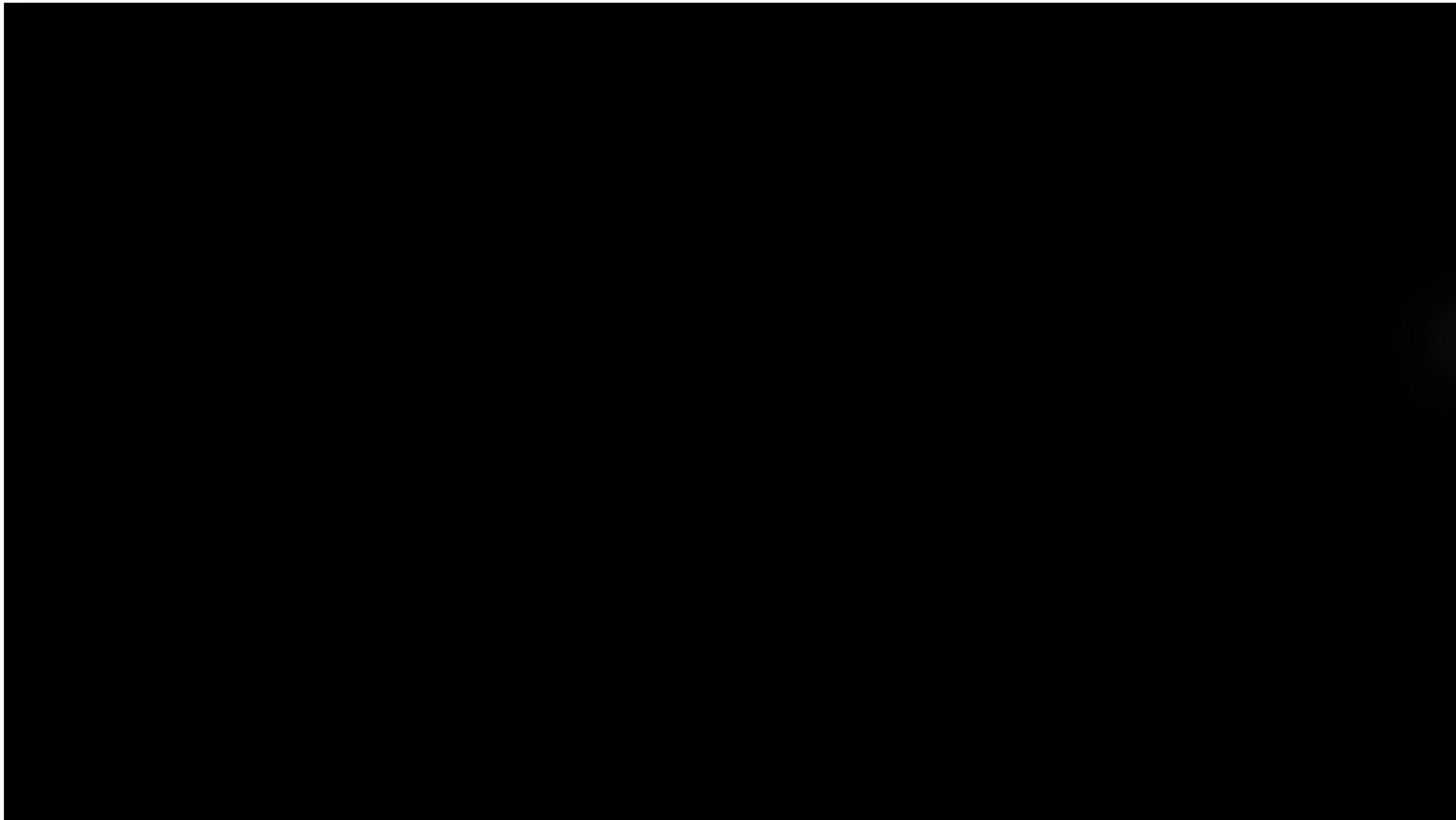


IceSL



<http://shapeforge.loria.fr/icesl/>

Modeling Complex Scenes

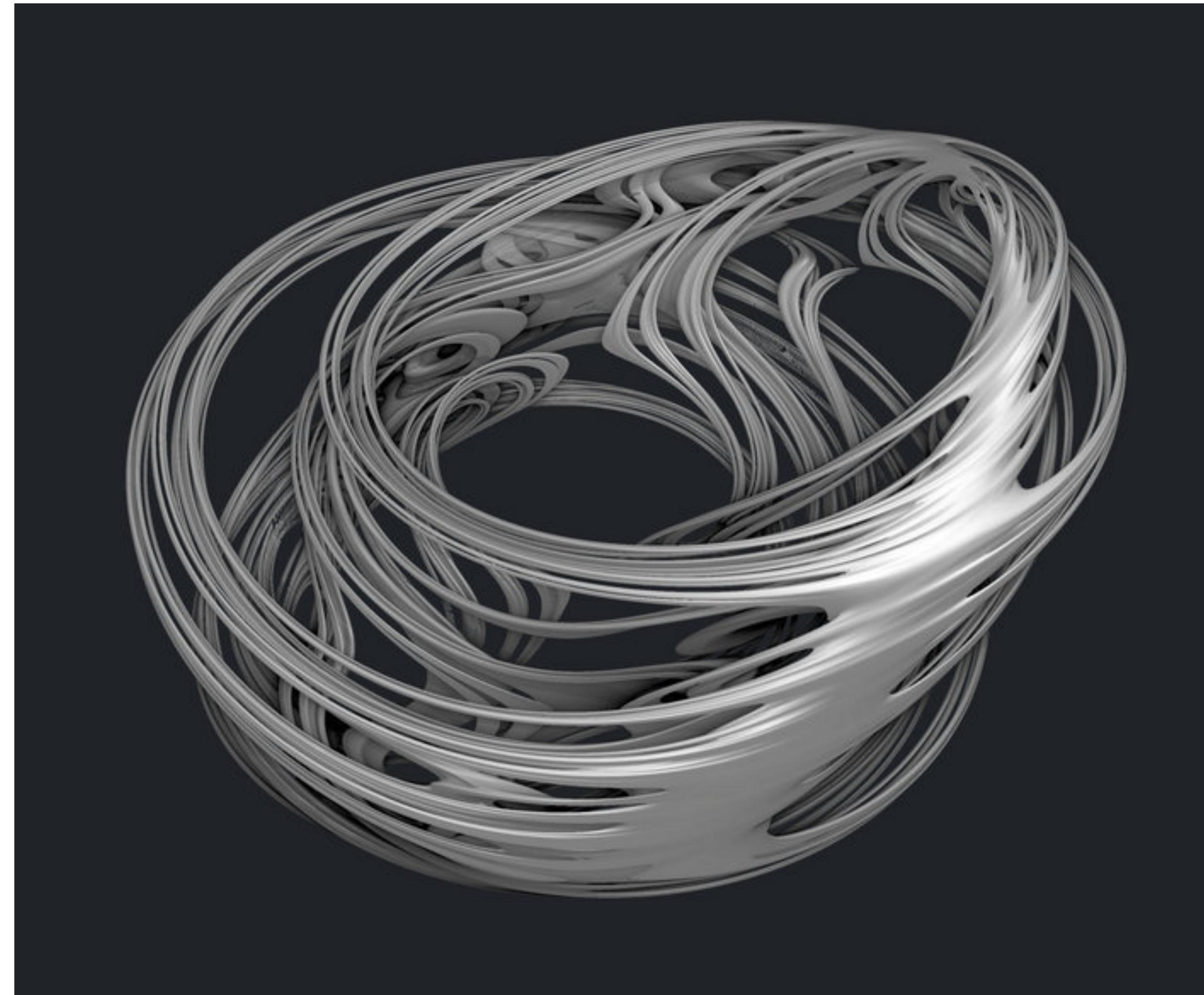


<http://iquilezles.org/www/articles/raymarchingdf/raymarchingdf.htm>



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Fractals

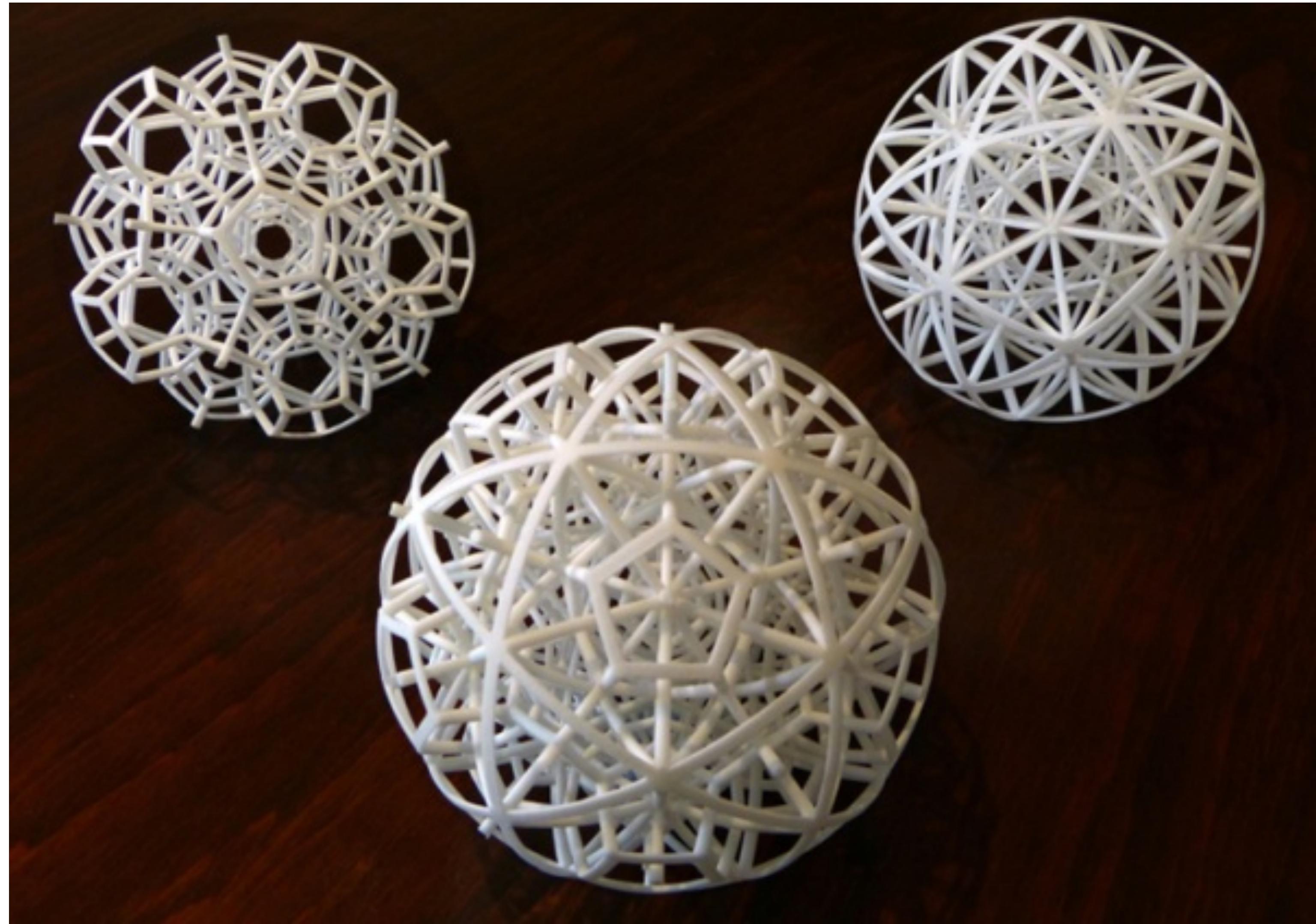


http://2008.sub.blue/blog/2009/9/20/quaternion_julia.html



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Tilings



[Henry Segerman]

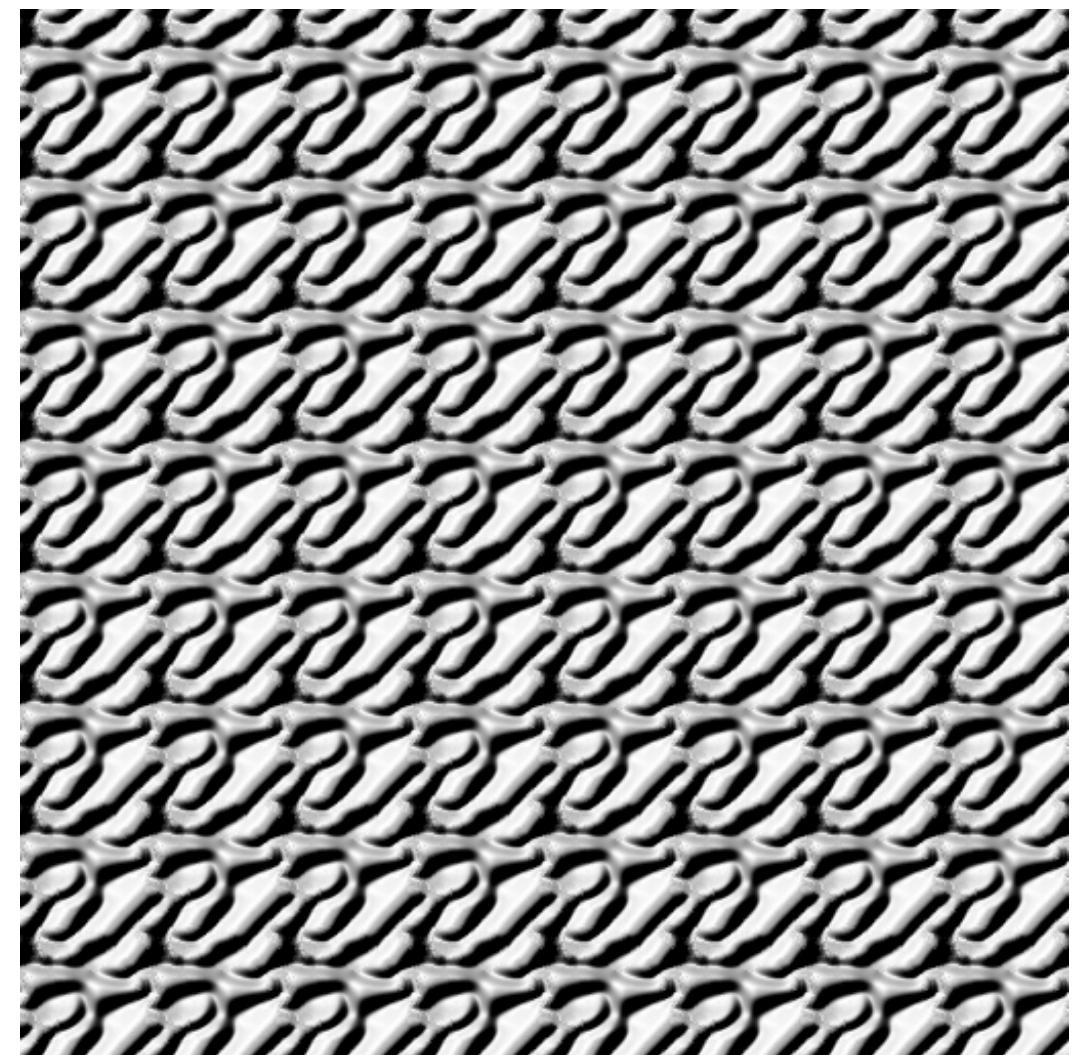


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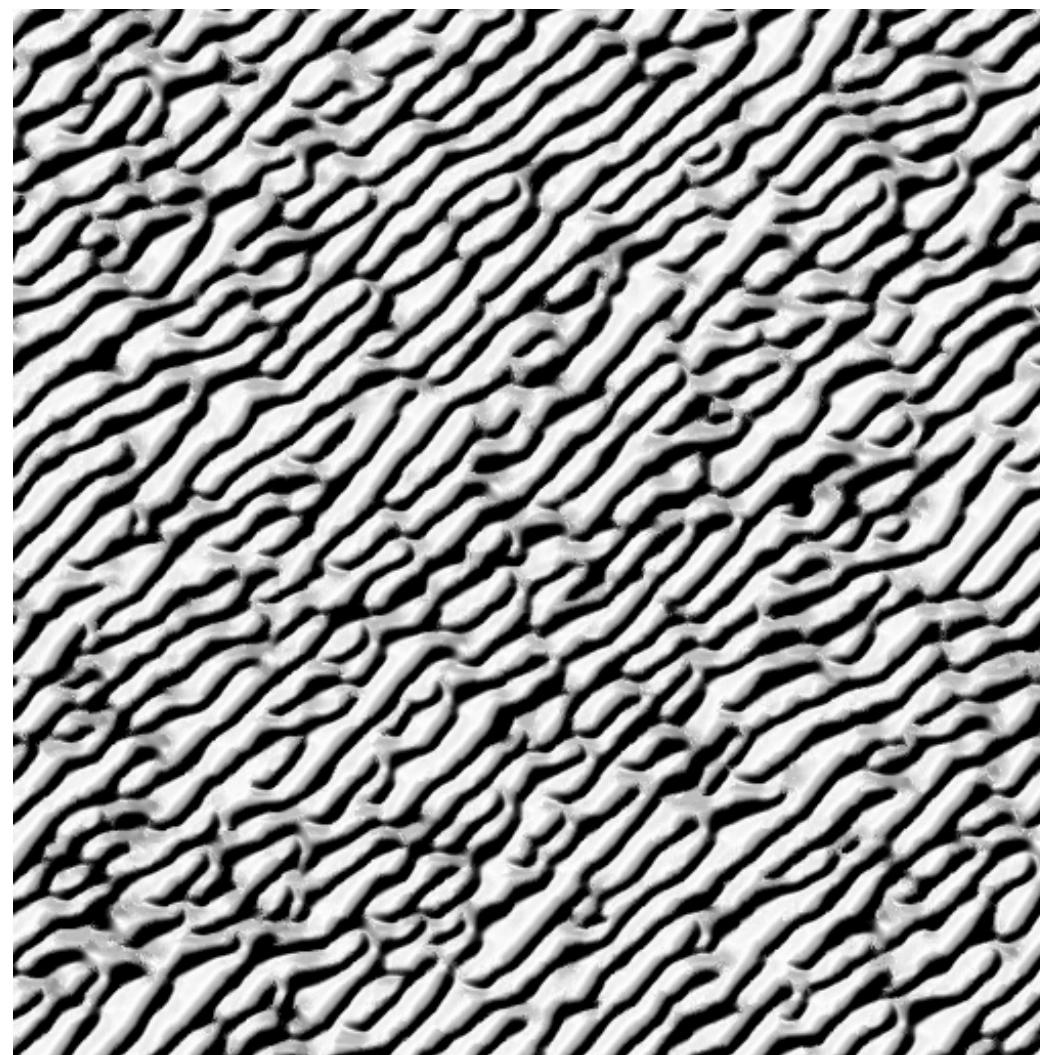
By-Example Texture Synthesis



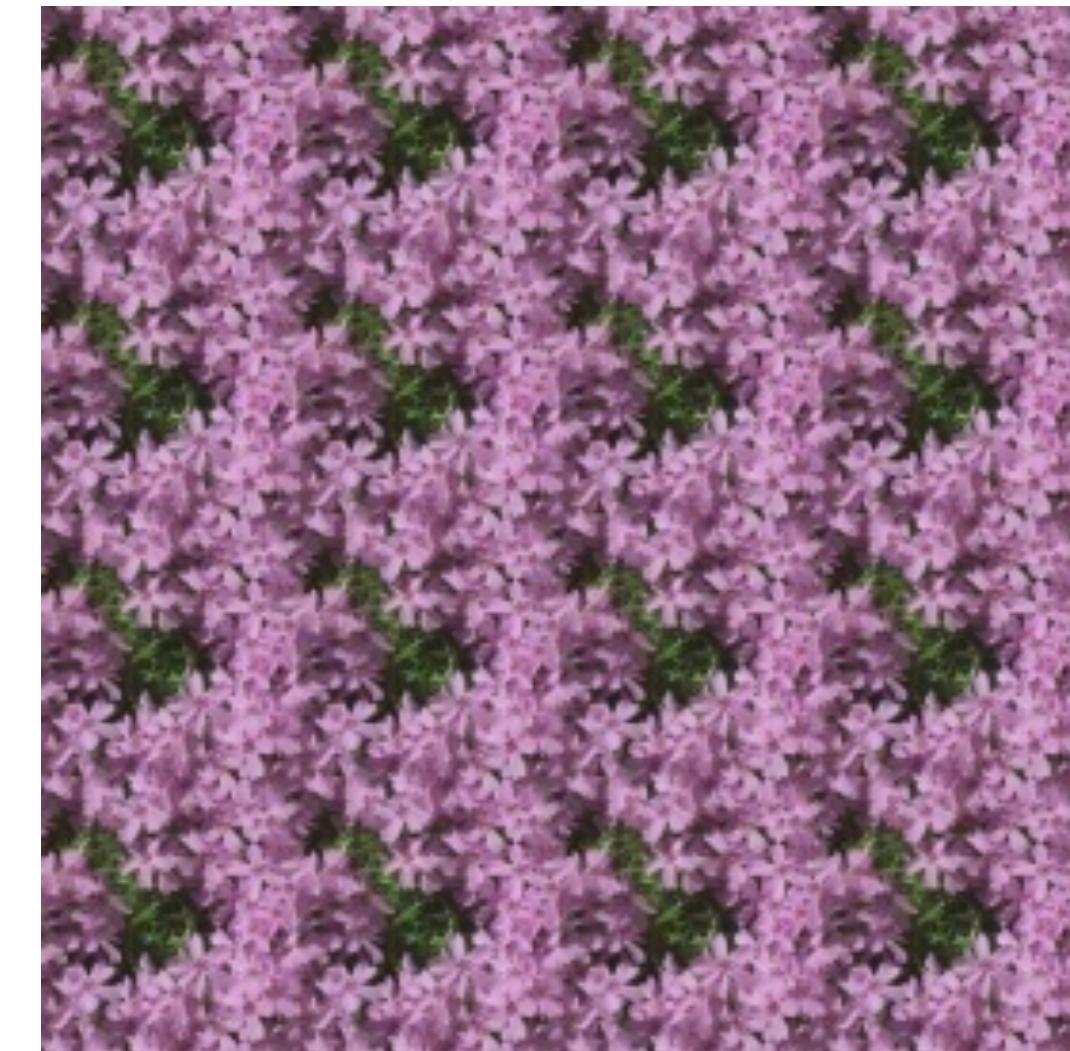
Texture synthesis from example



Tiling



Synthesis

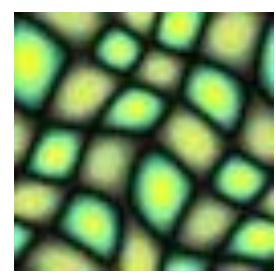


Tiling

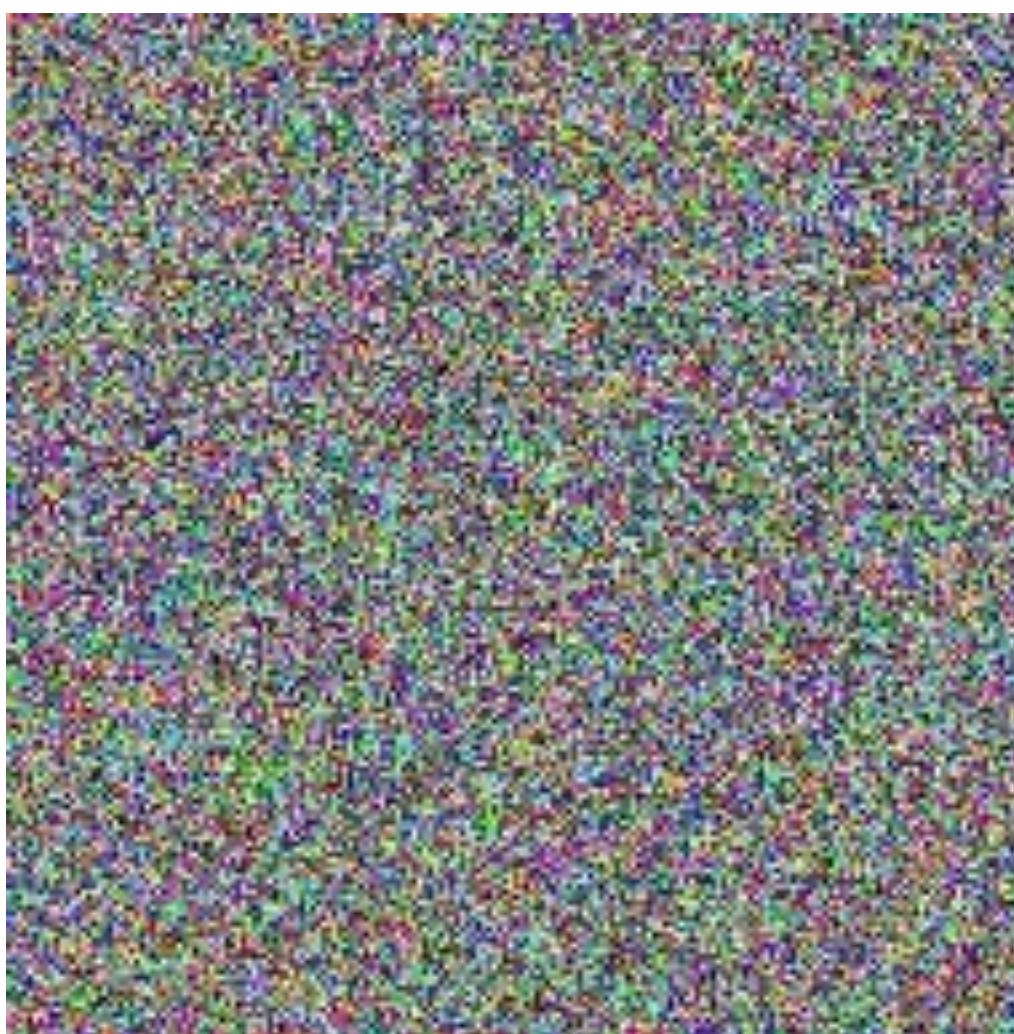


Synthesis

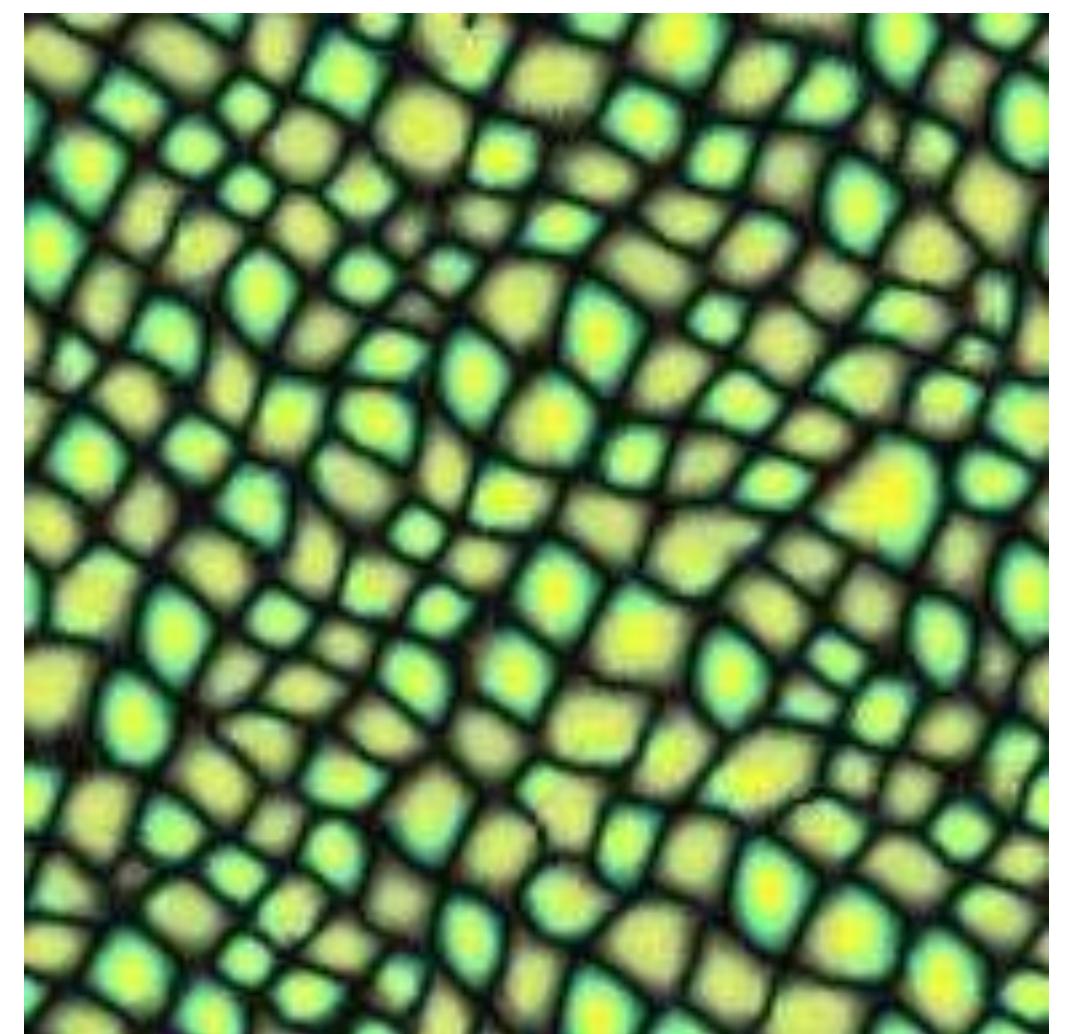
Basic Idea



Example Image



Random Initial Guess



Final Result



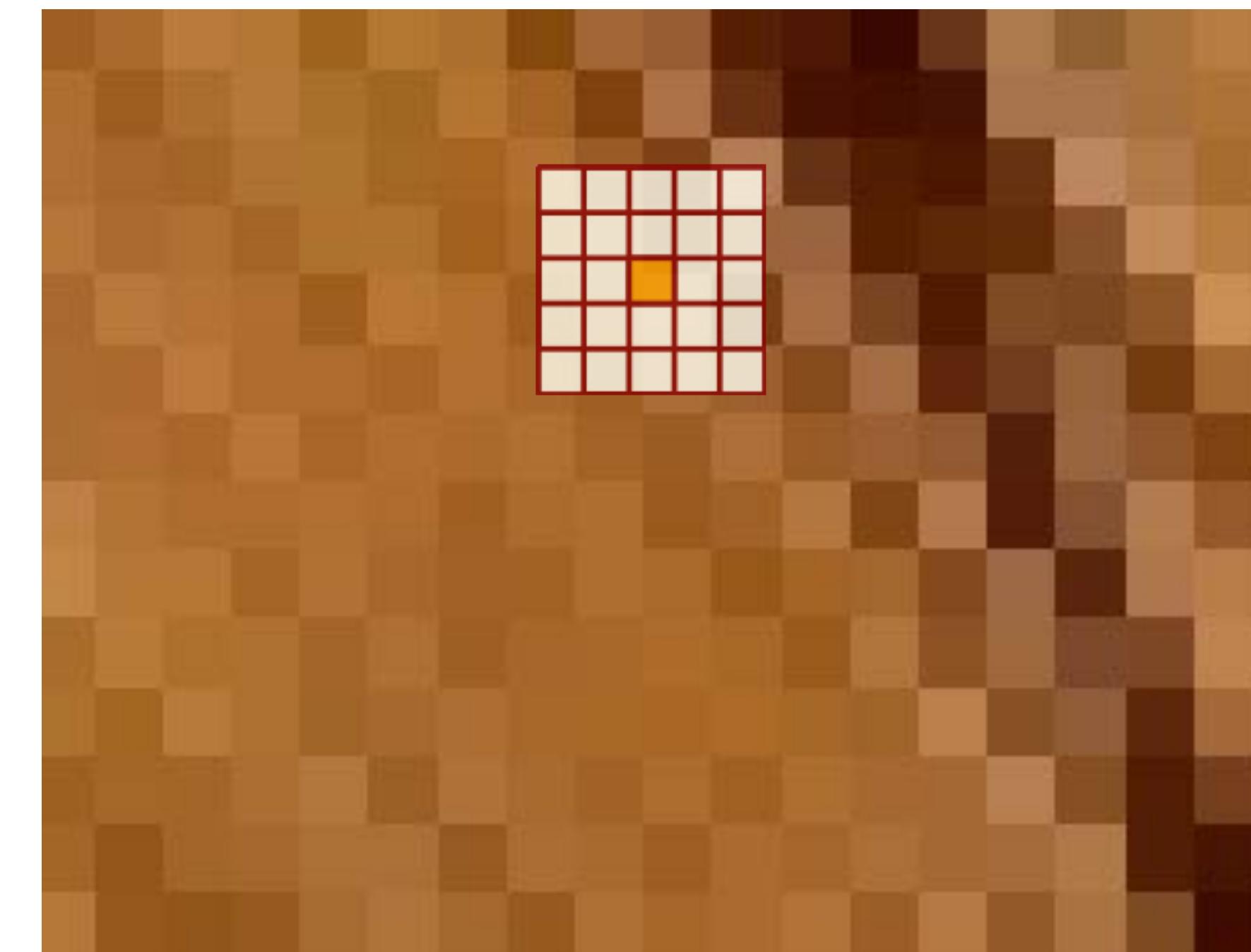
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Measuring Similarity

- Neighborhood Matching:



Exemplar

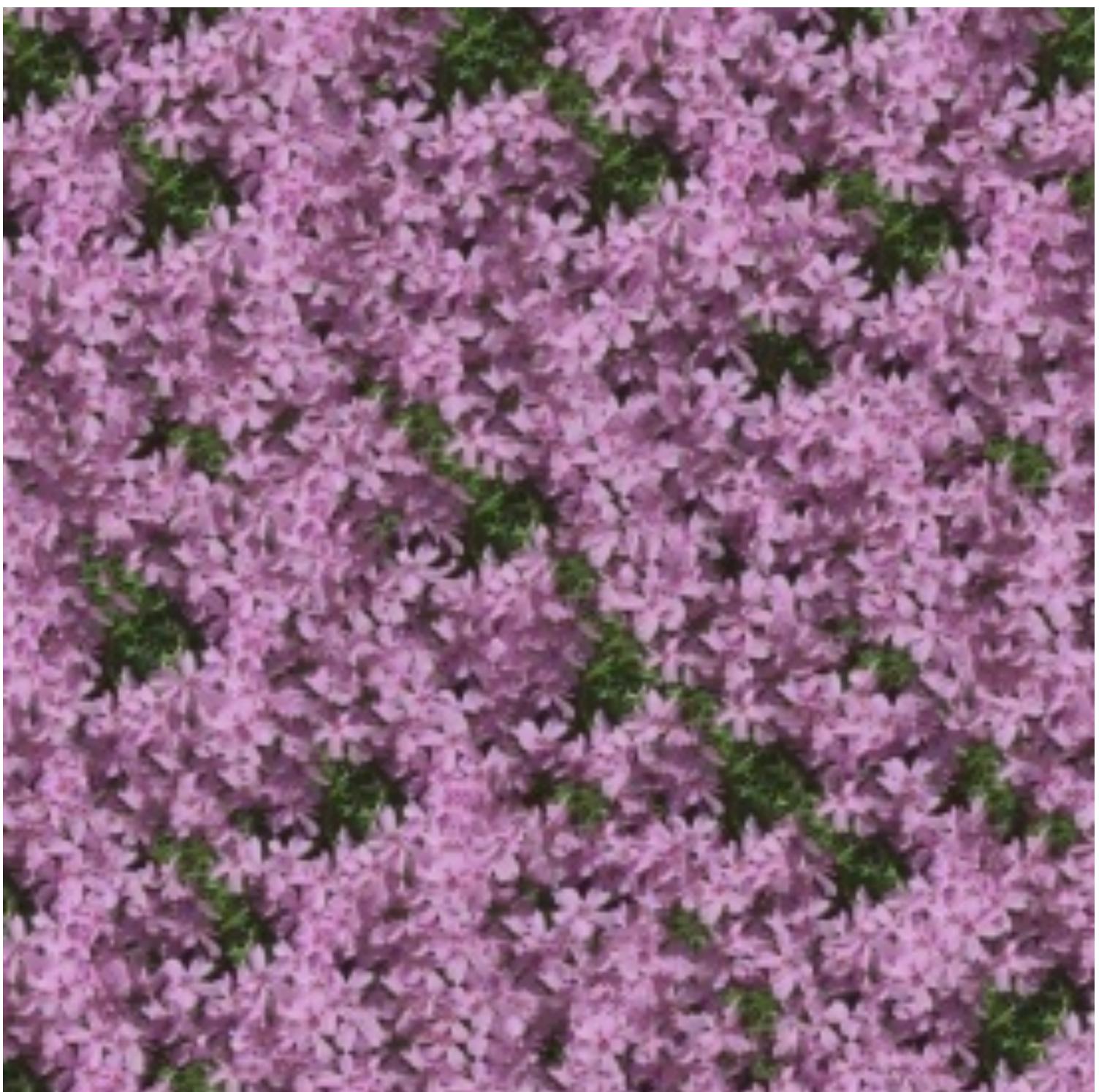


Texture being synthesized



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What is a good exemplar?



Stochastic Image

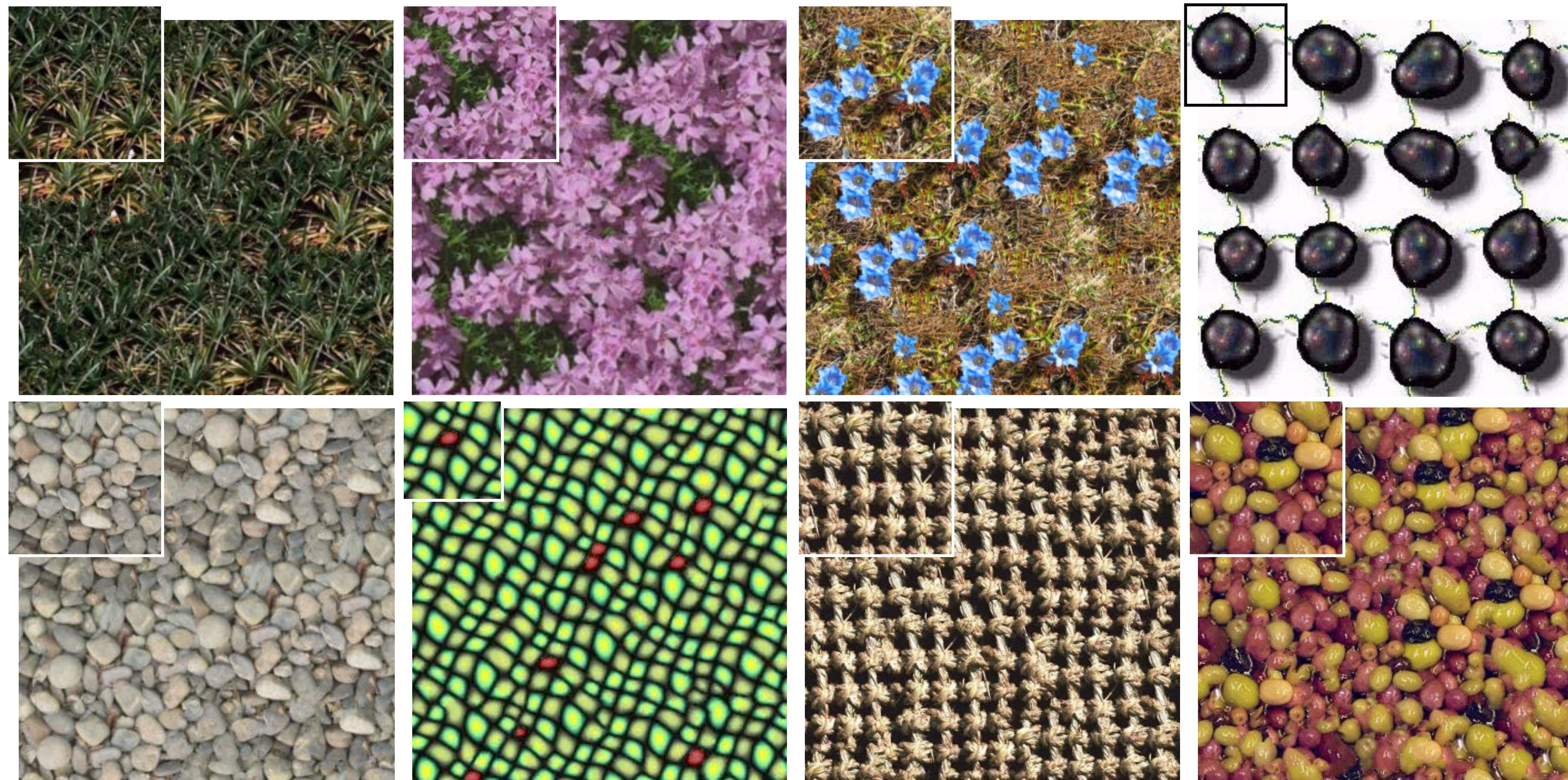


✗ Structured Image



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Results

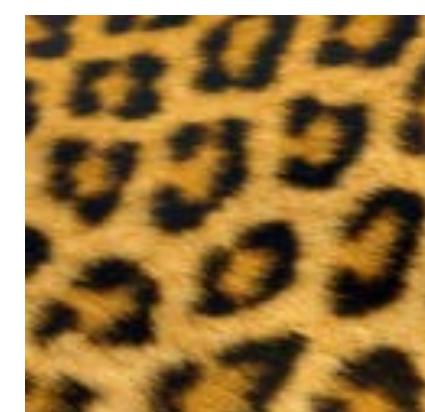


<http://research.microsoft.com/projects/ParaTexSyn/>

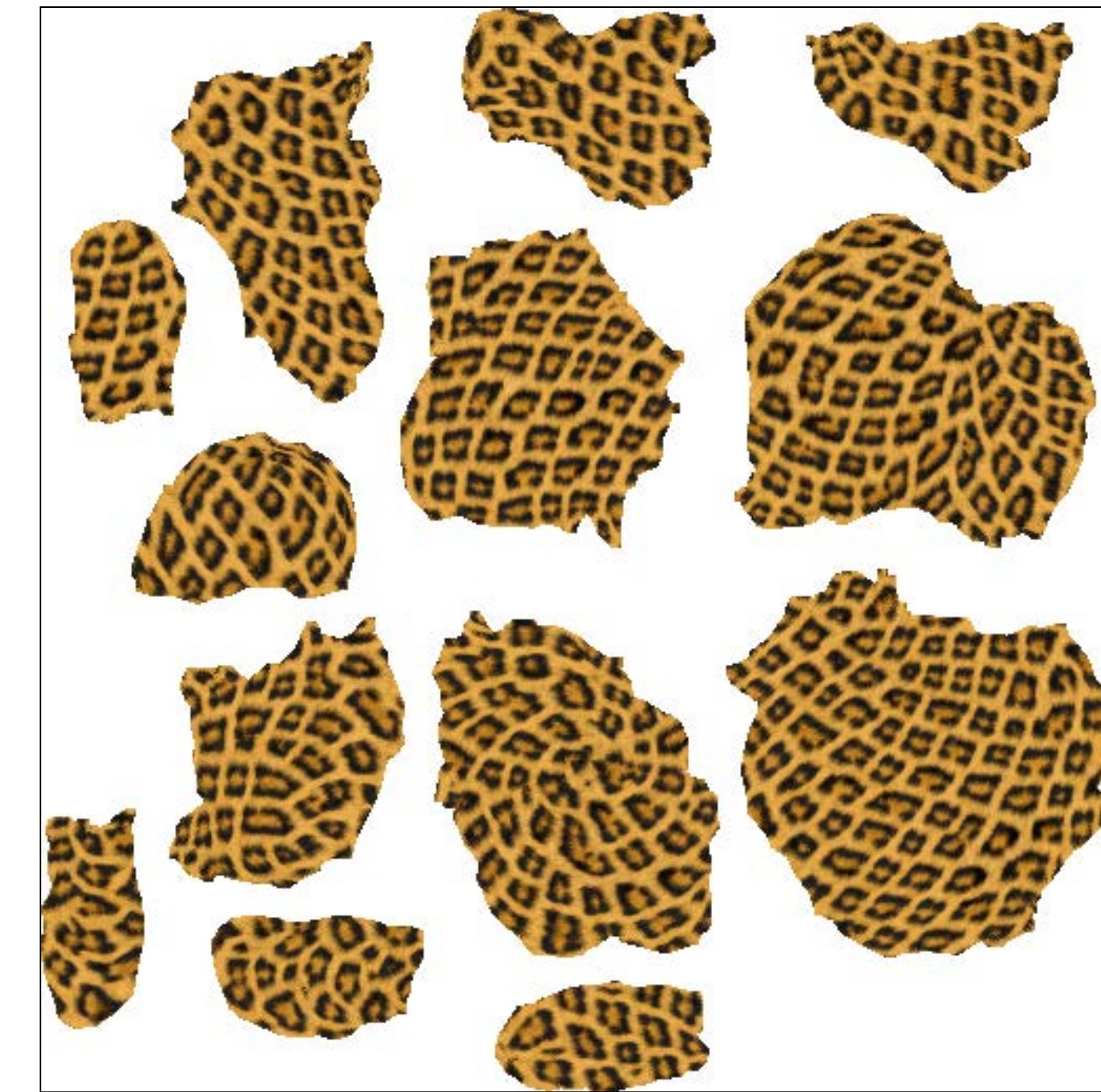


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Surface Texture Synthesis

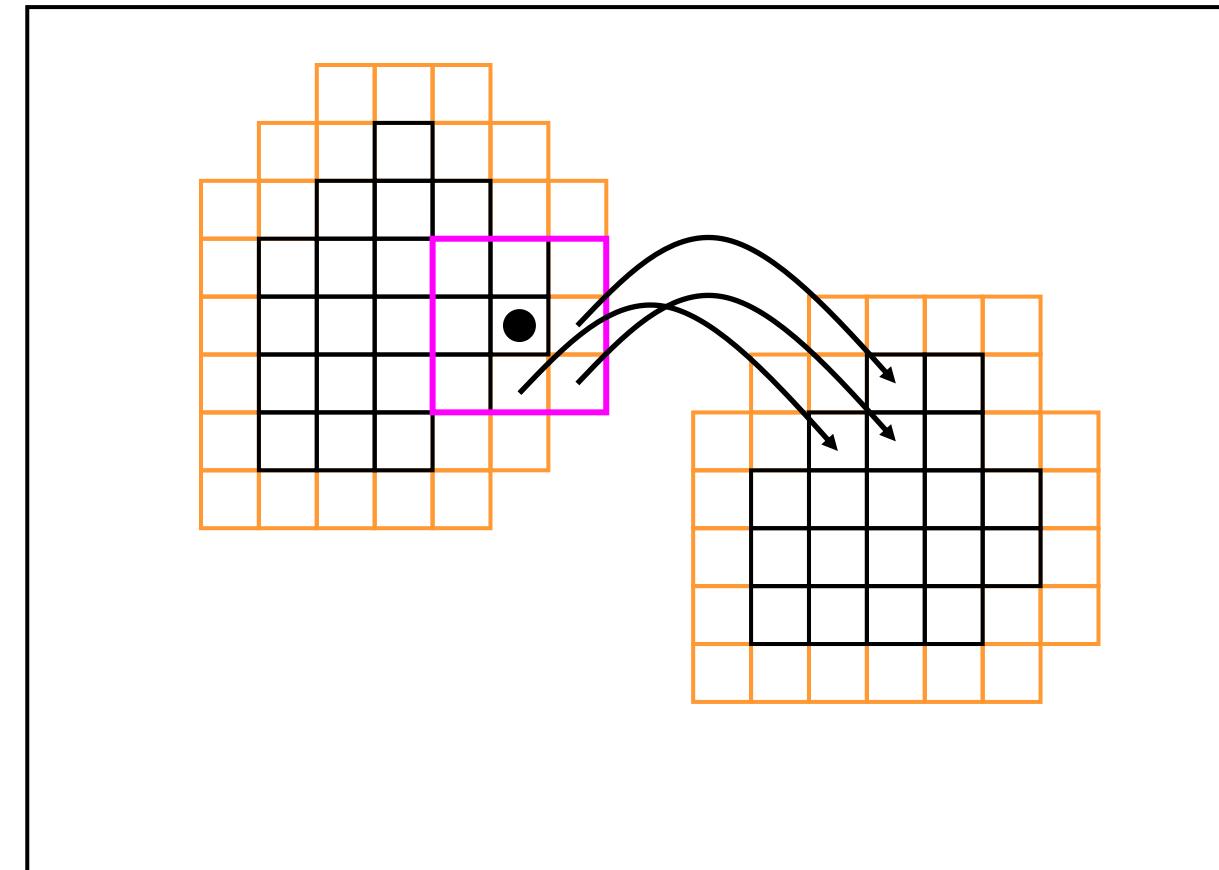
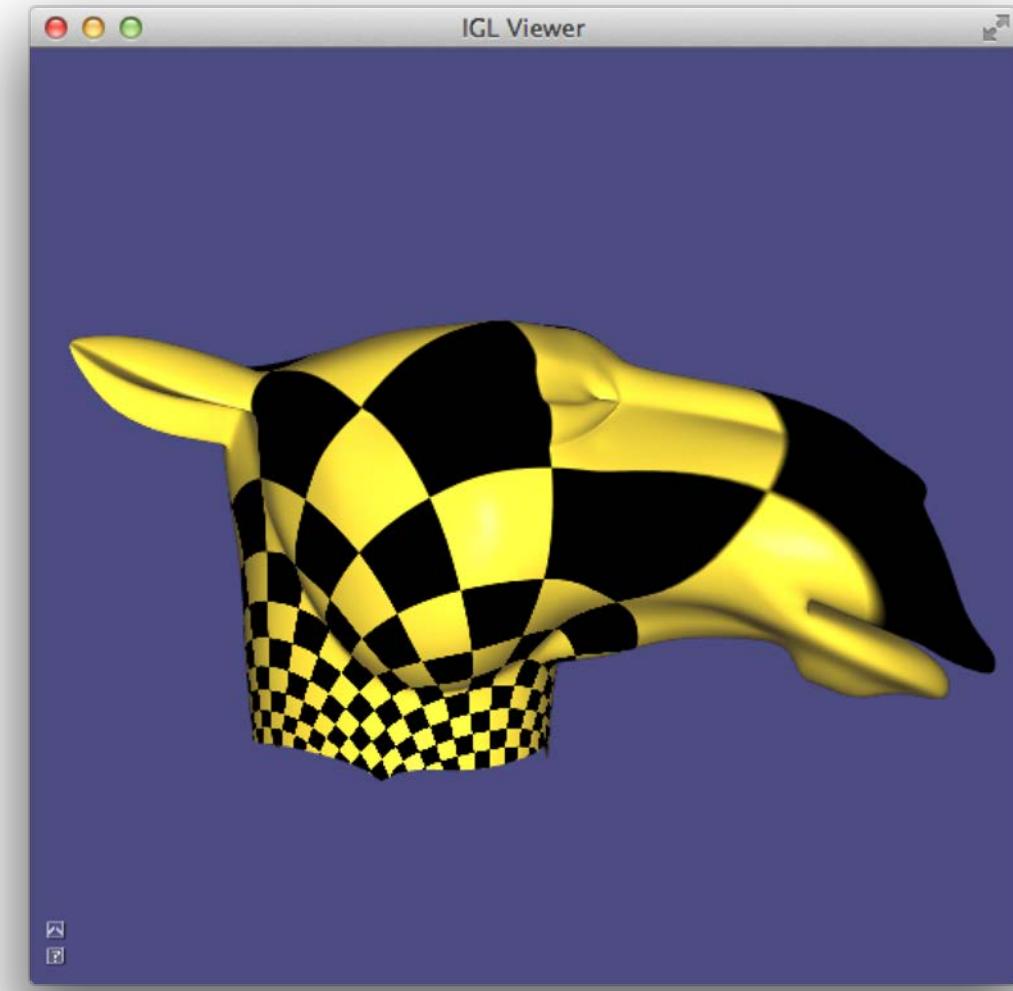


Exemplar

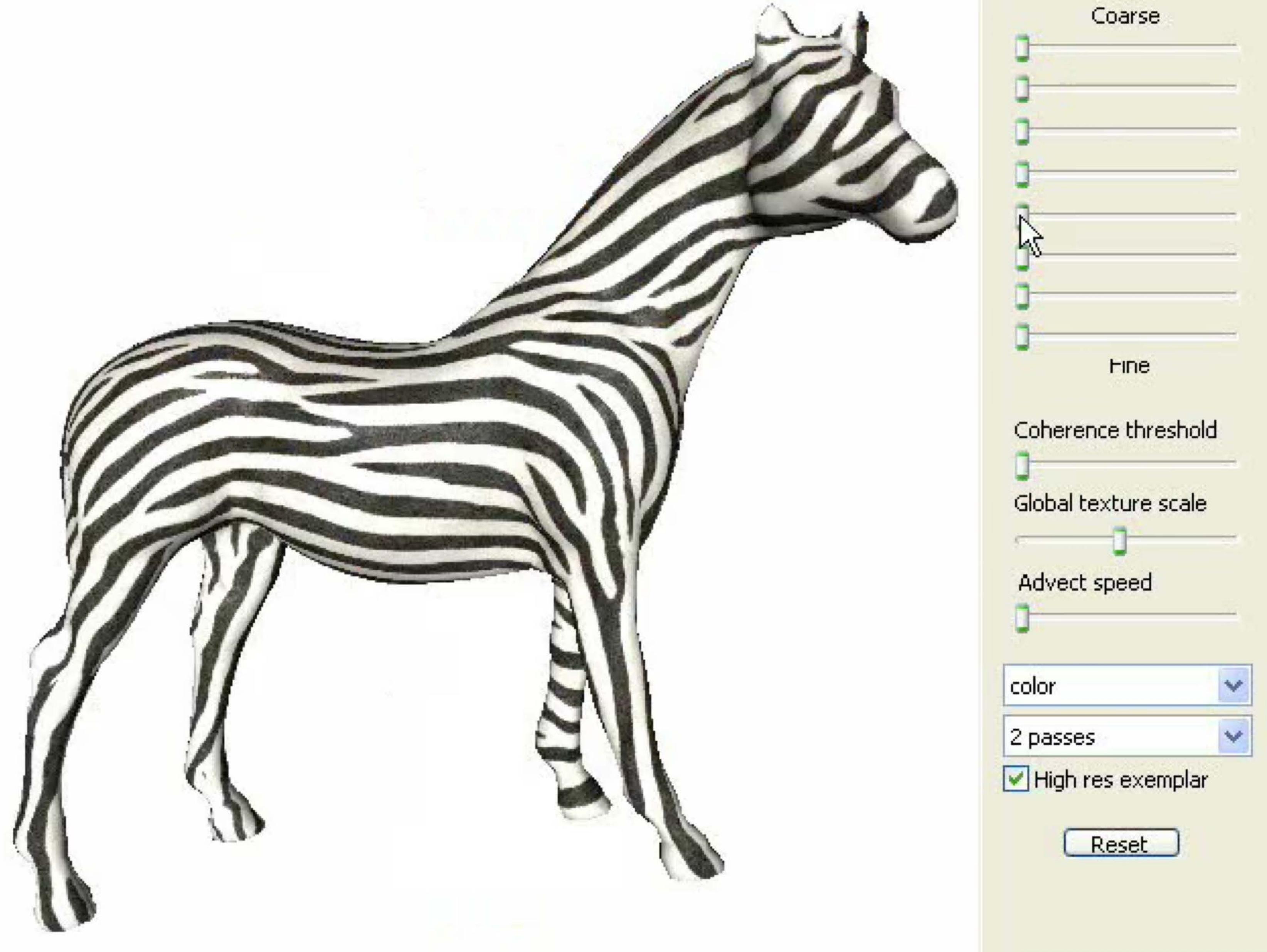


Surface Texture Synthesis

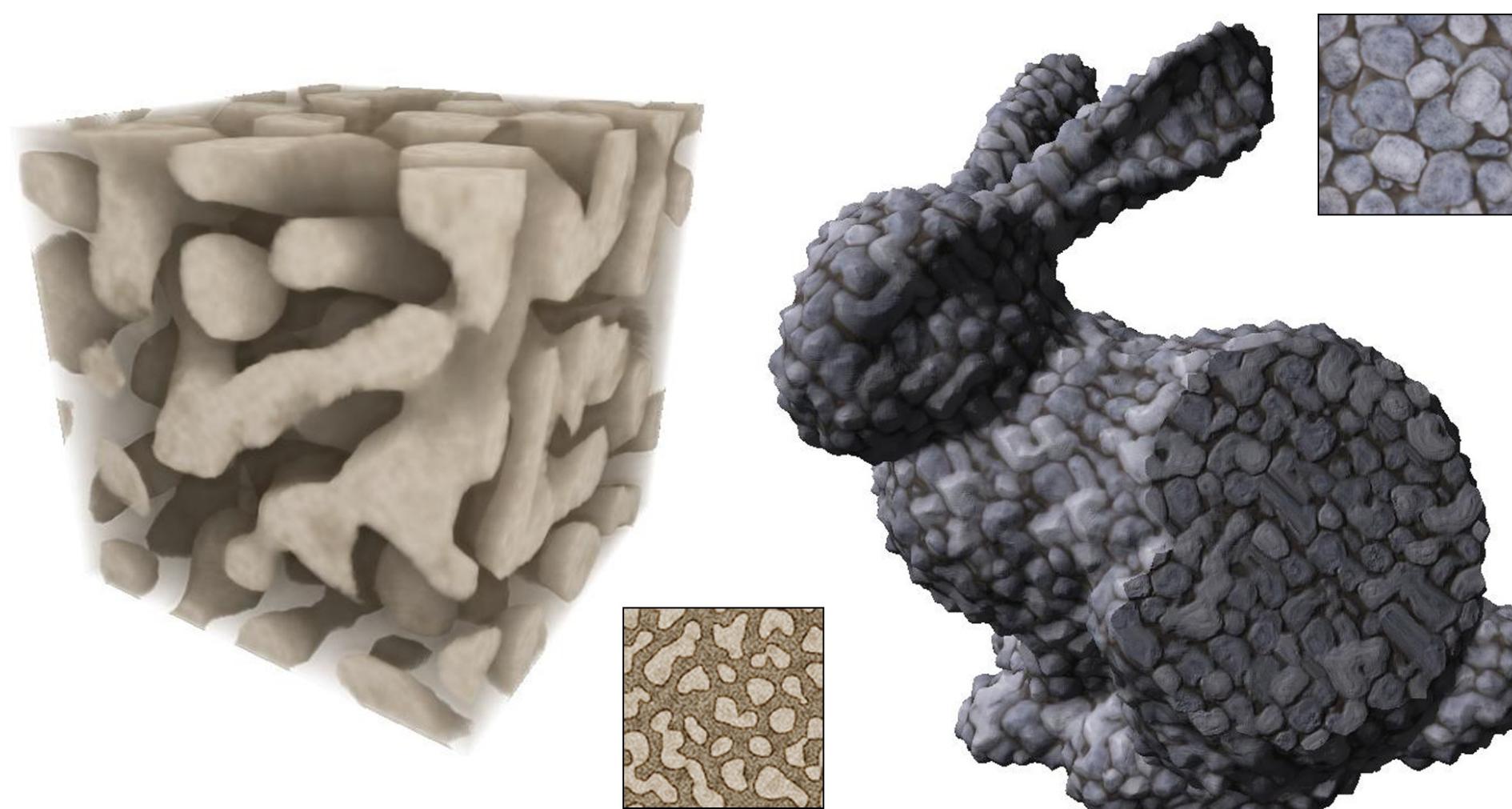
- Caveats:
 - Mapping introduces **distortions**
 - Texture atlas contains **seams**



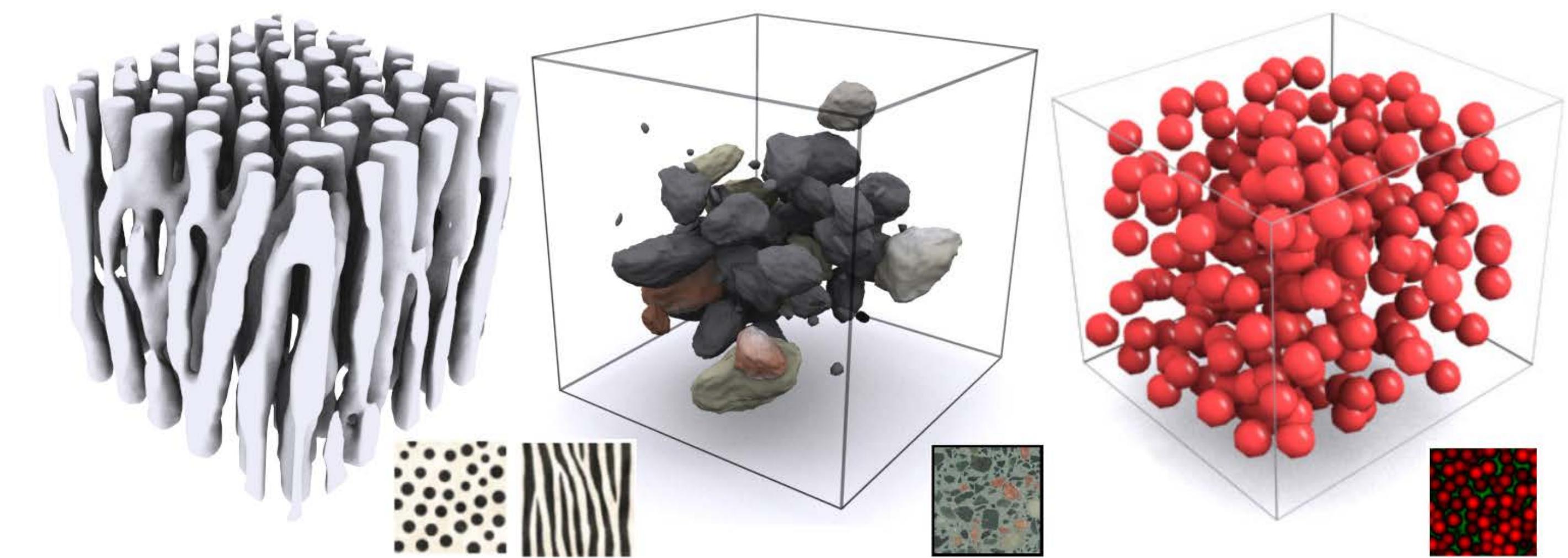
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By-Example Solid Textures

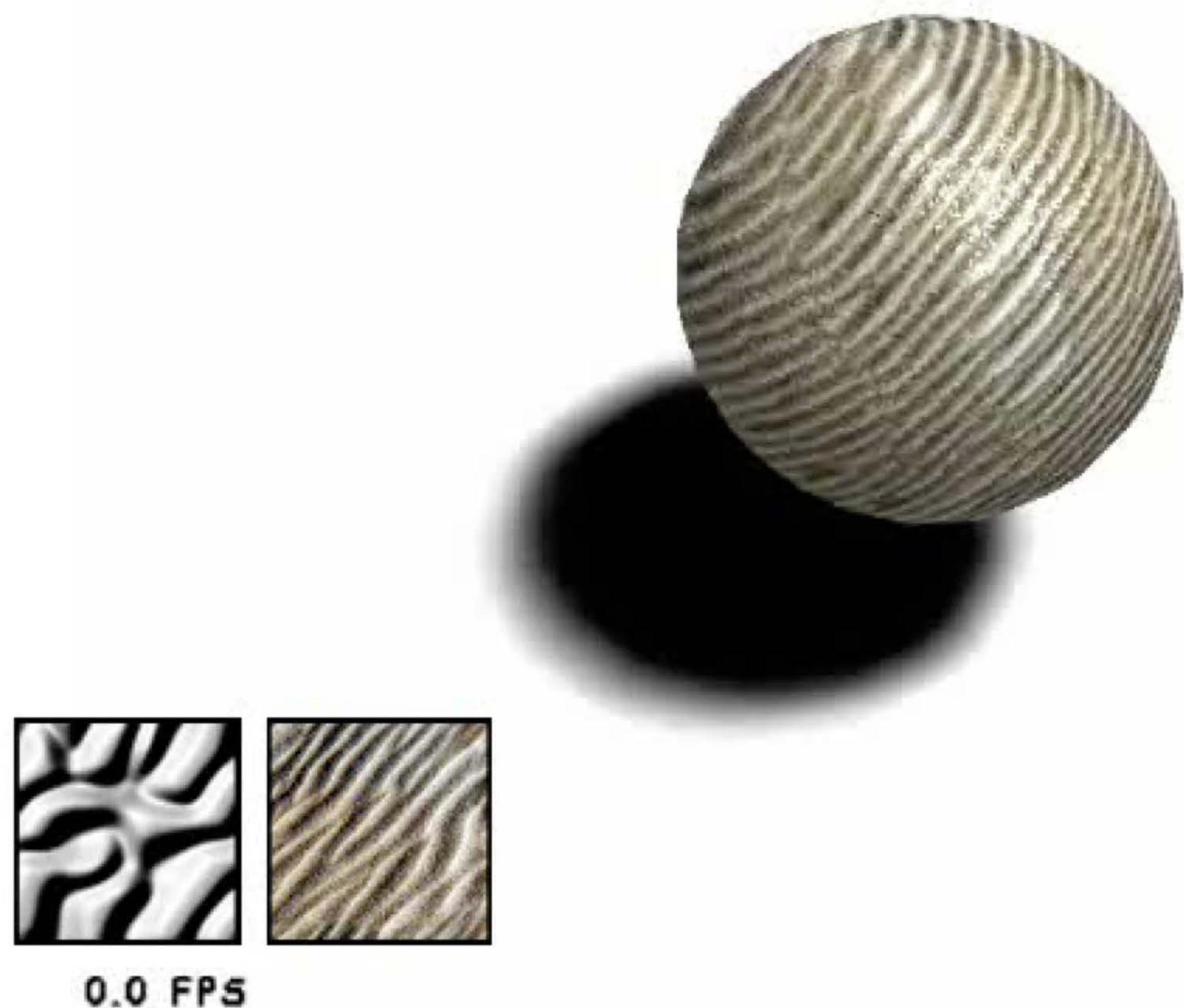


Solid Texture Synthesis [Kopf07]



Lazy Solid Texture Synthesis [Dong08]

By-Example Solid Textures



Lazy Solid Texture Synthesis
[Dong et al. 2008]



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References

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<https://thebookofshaders.com/>

<http://www.quilez.org/>

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Eurographics 2009 - State of the Art Reports 2009

State of the Art in Procedural Noise Functions

Ares Lagae, Sylvain Lefebvre, Rob Cook, Tony DeRose, George Drettakis, D.S. Ebert, J.P. Lewis, Ken Perlin, Matthias Zwicker
Eurographics 2010 - State of the Art Reports 2010



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