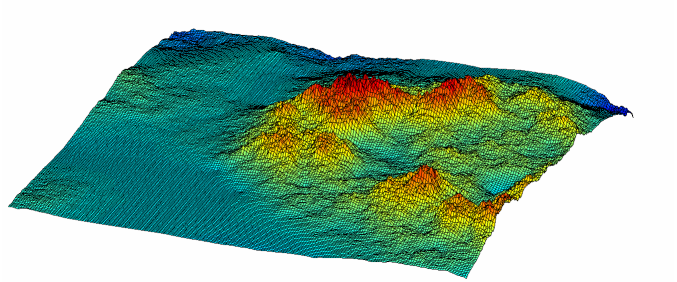
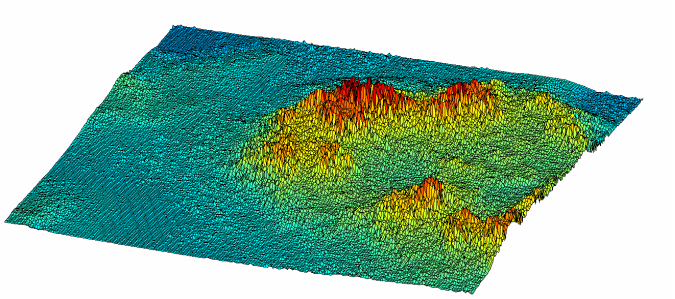
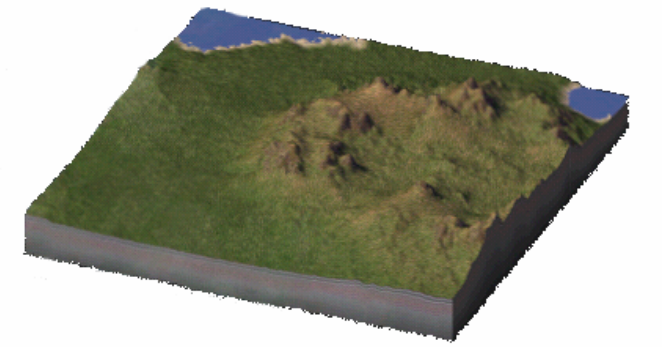

Fractal Terrain Generation and
Erosion for Playful Applications
By David Coats

Overview:

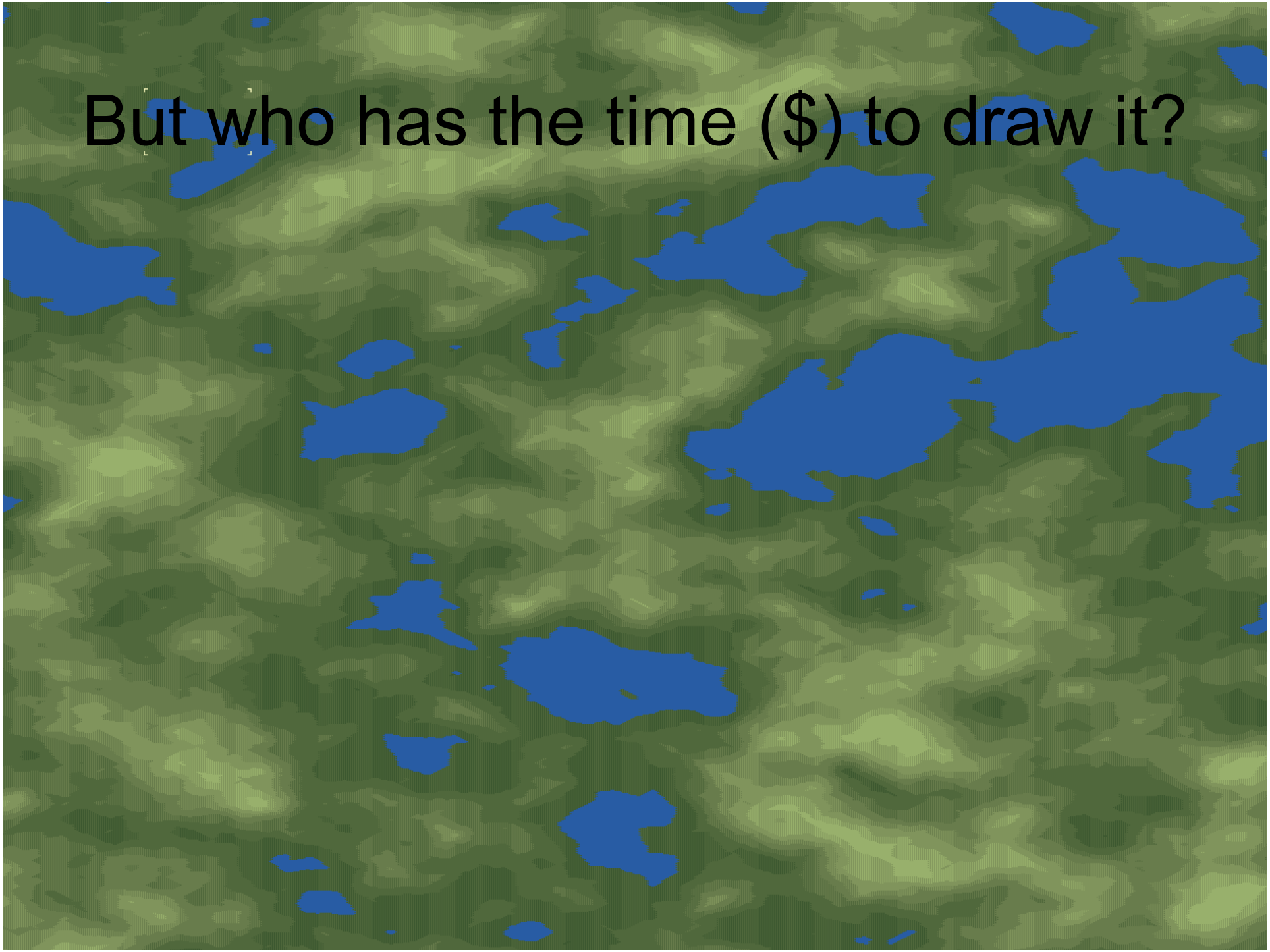
- Fractal Terrain
  - Diamond-Square
  - Perlin fractal
- Erosion
  - Musgrave Ad Hoc
  - My Ad Hoc
- Rendering (SC4)



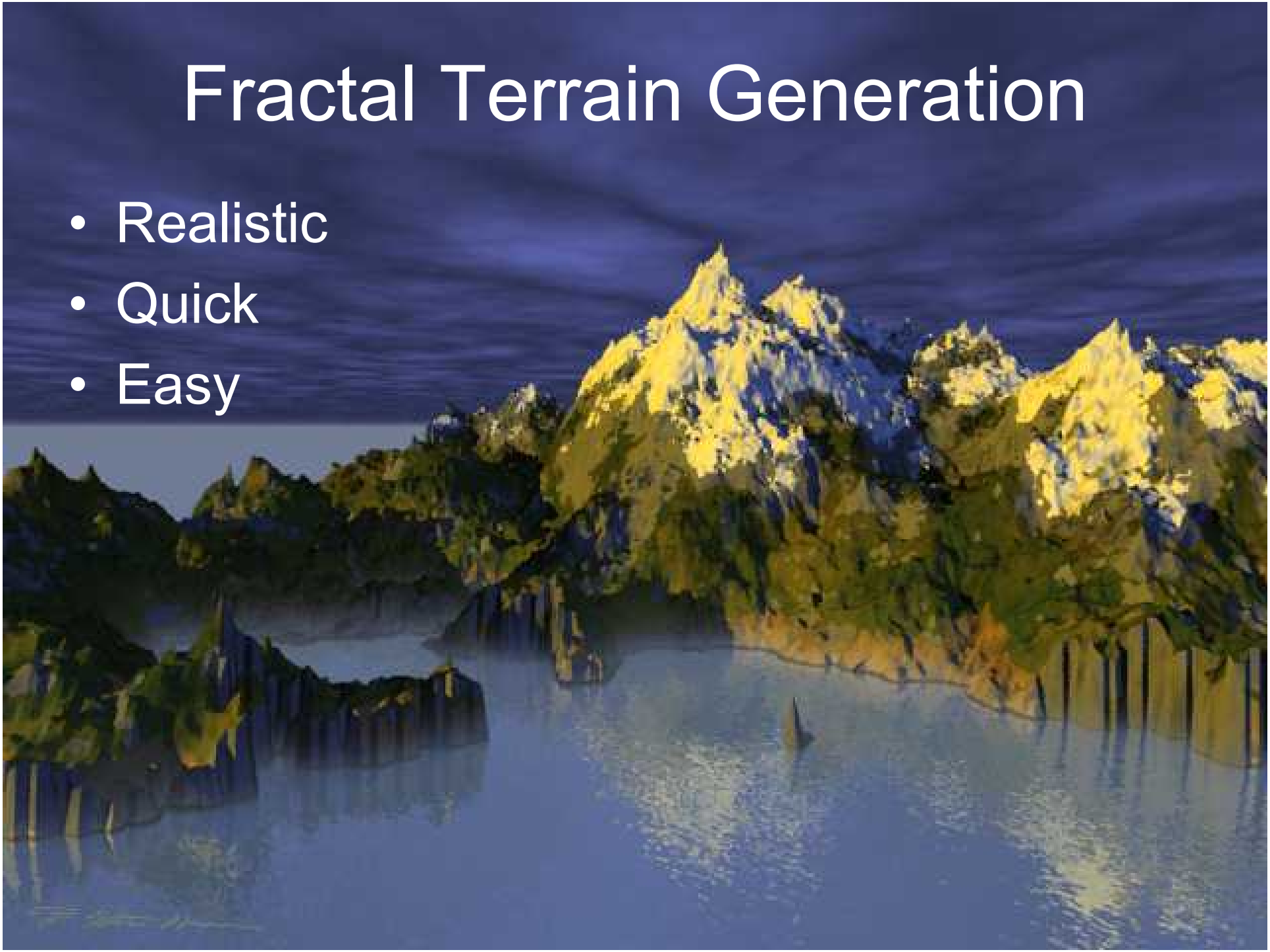




Games Need Terrain


But who has the time ($) to draw it?

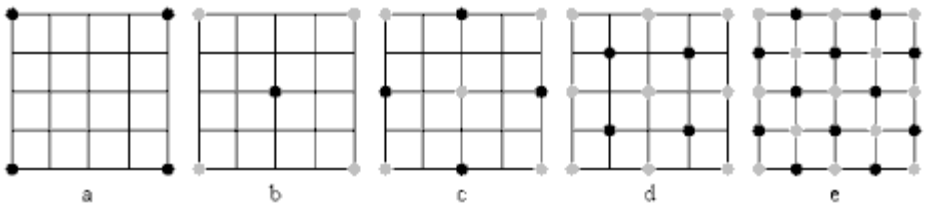
Fractal Terrain Generation

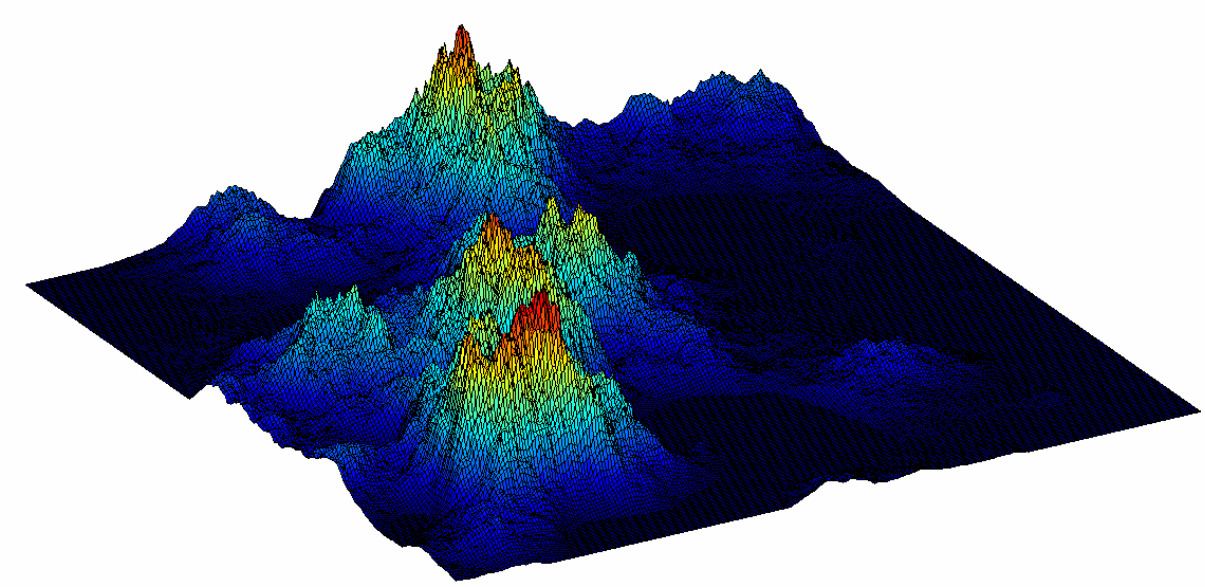


- Realistic
- Quick
- Easy

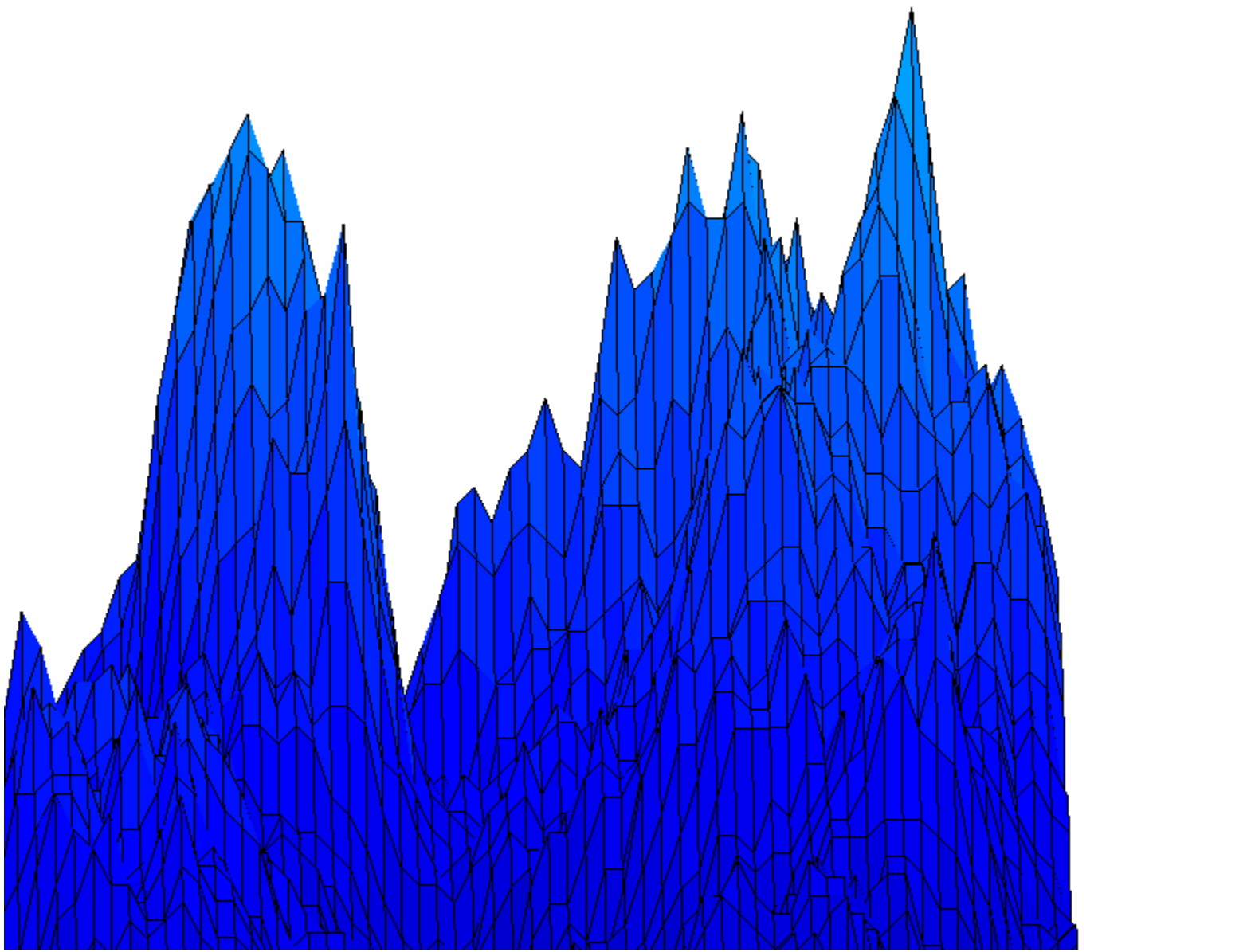
Diamond-Square Algorithm

- Stochastic Additions to Discrete Average





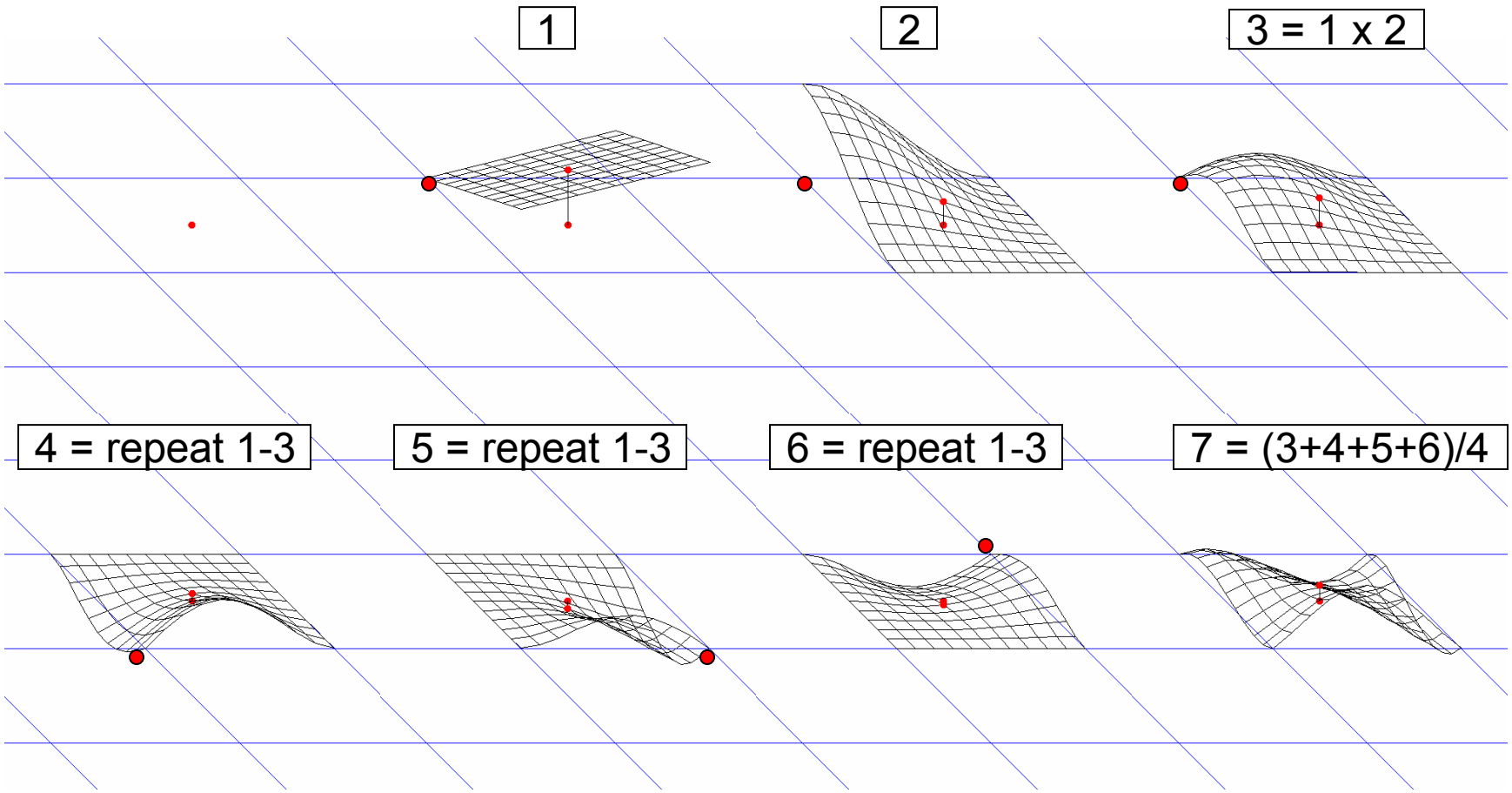
Drawback: Unnatural Sharpness



Perlin Noise Generation

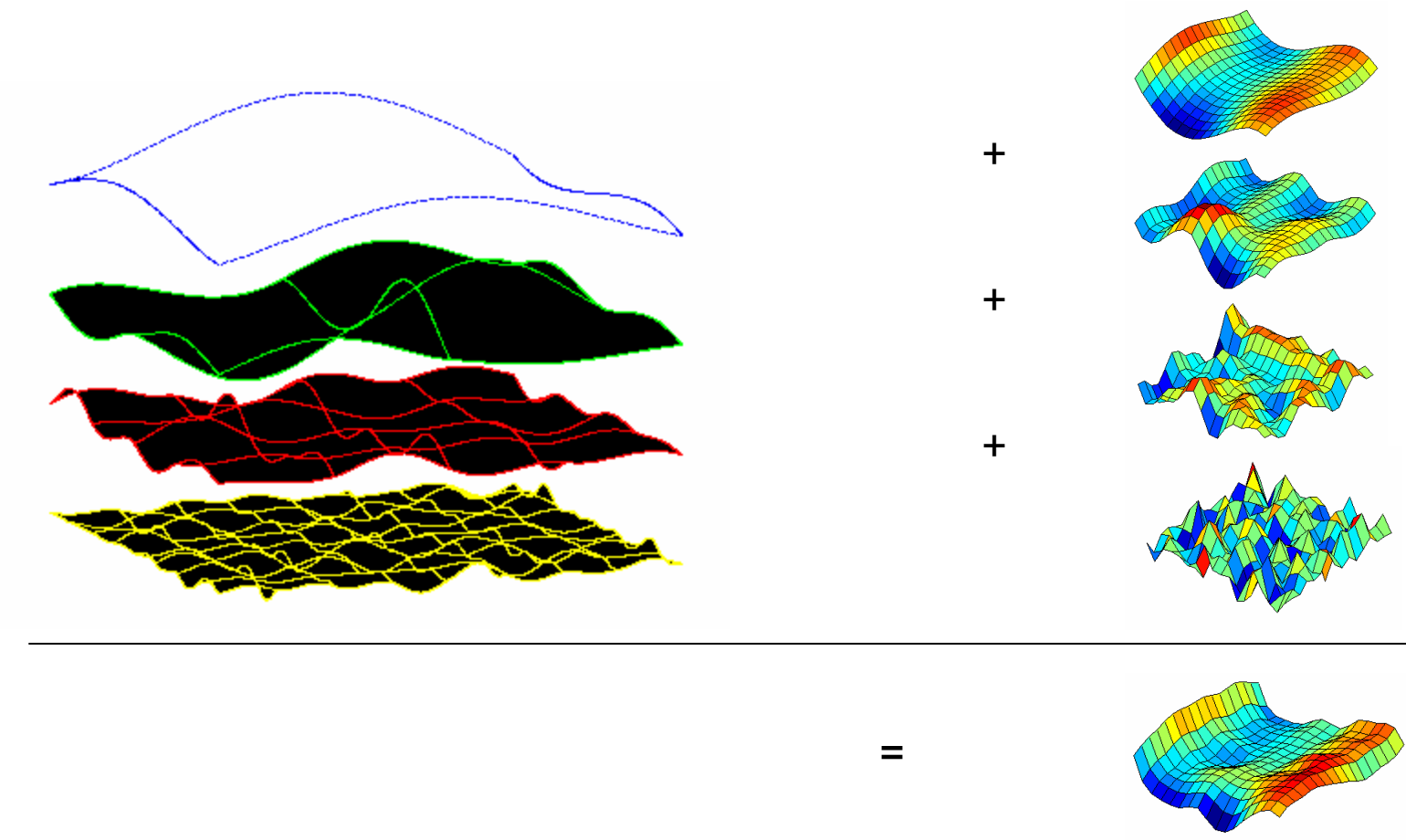
- Continuous and Smooth
- Process:
    1. Generate Primitive
    2. Generate Higher Frequency Primitives
    3. Add according to power spectrum

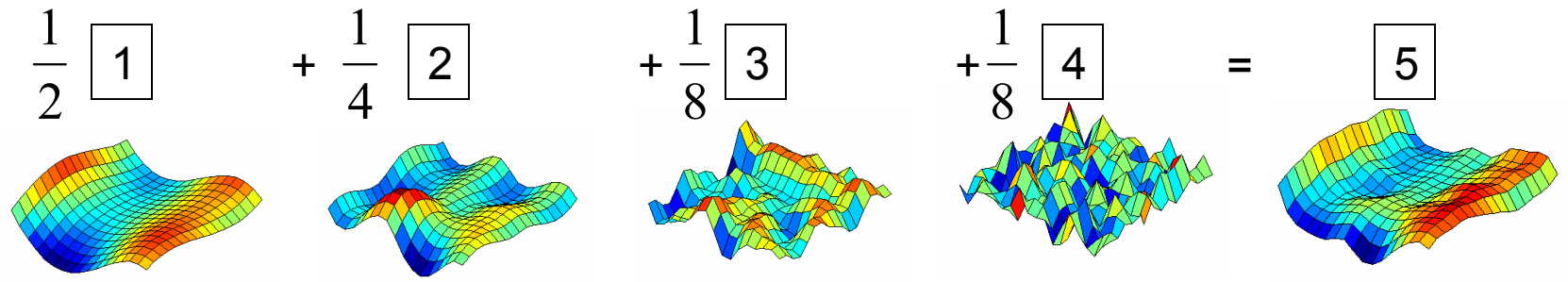
Perlin Primitive Generation



Multiple Frequencies

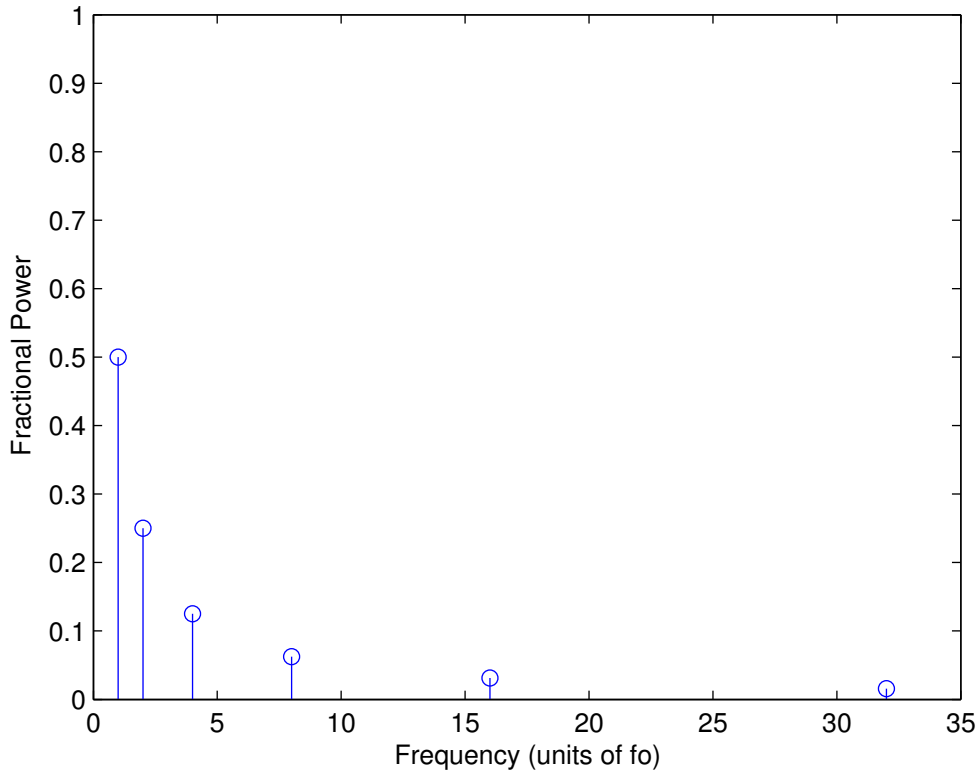
- Perlin primitive is zero at corners



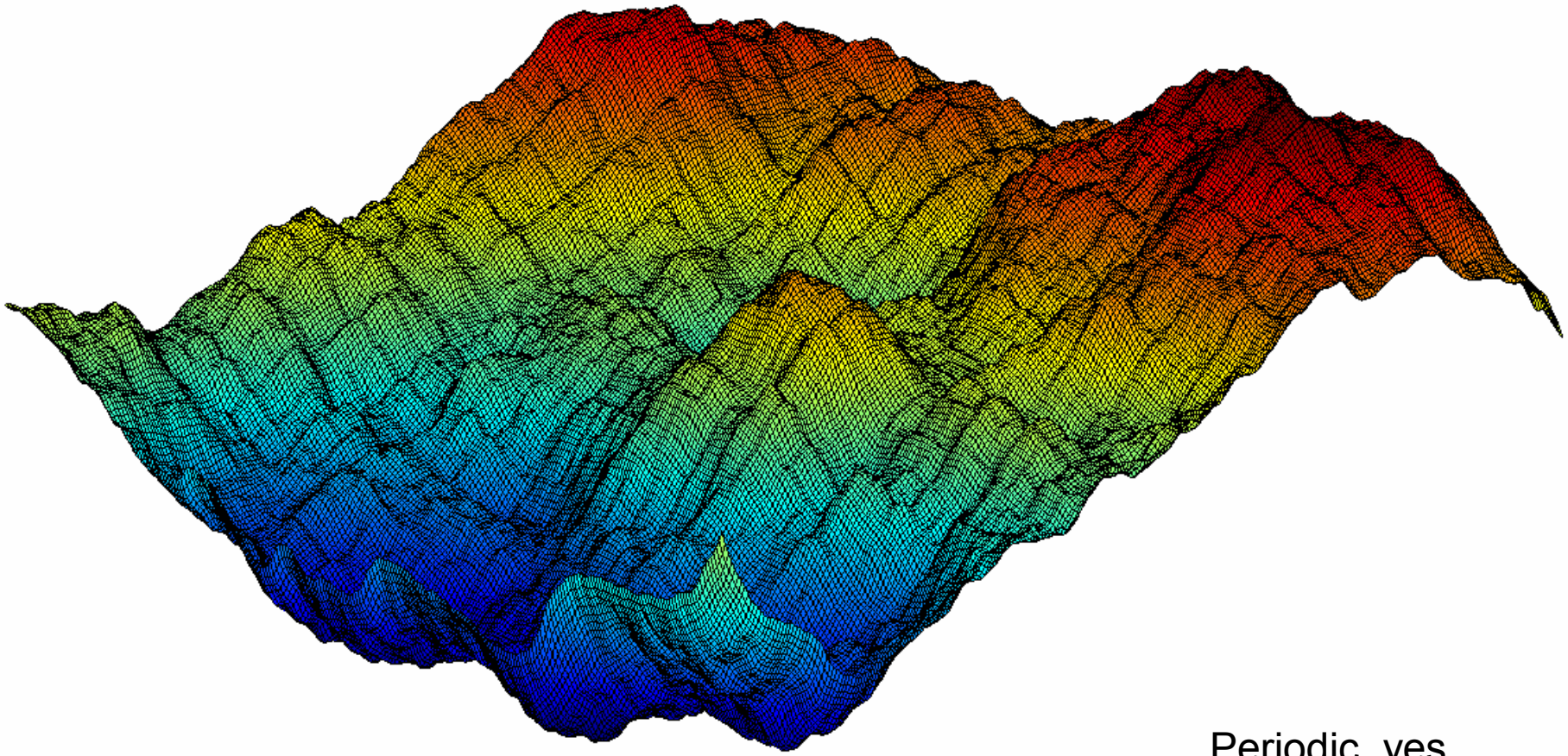

1/2 1
+ 1/4 2
+ 1/8 3
+ 1/8 4
= 5

Power Spectrum

$$P(x,y) = 1/2\ P(x,y,f_0) + 1/4\ P(x,y,2f_0) + 1/8\ P(x,y,4f_0) + \ldots$$



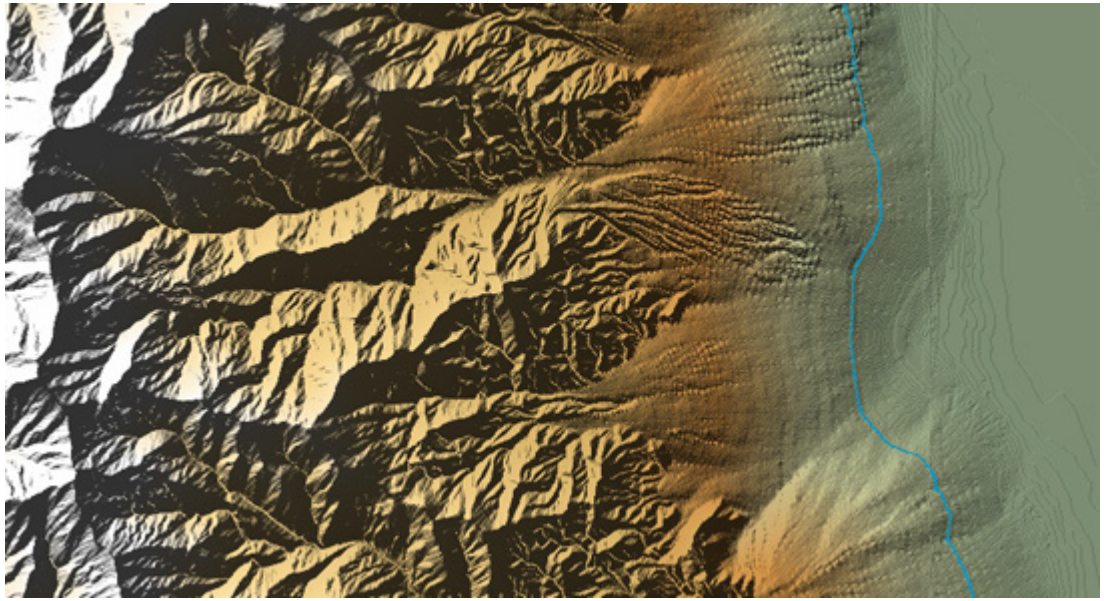
Perlin Result



Periodic, yes…

Smooth, But Unnaturally So

- What's missing?
  - Erosion



Musgrave's Ad Hoc

$$\Delta w = \min\left(w_t^v, (w_t^v + a_t^v) - (w_t^u + a_t^u)\right)$$

$$a_{t+1}^v = a_t^v + K_d s_t^v$$

$$s_{t+1}^v = (1 - K_d) s_t^v$$

$$c_s = K_c \Delta w$$

$$s_{t+1}^v = s_t^v - c_s$$

$$s_{t+1}^u = s_t^u + c_s$$

$$s_{t+1}^v = 0$$

$$s_{t+1}^u = s_t^u + s_t^v + K_s (c_s - s_t^v)$$

$$a_{t+1}^v = a_t^v - K_s (c_s - s_t^v)$$

$$a_{t+1}^v = a_t^v + K_d s_t^v$$

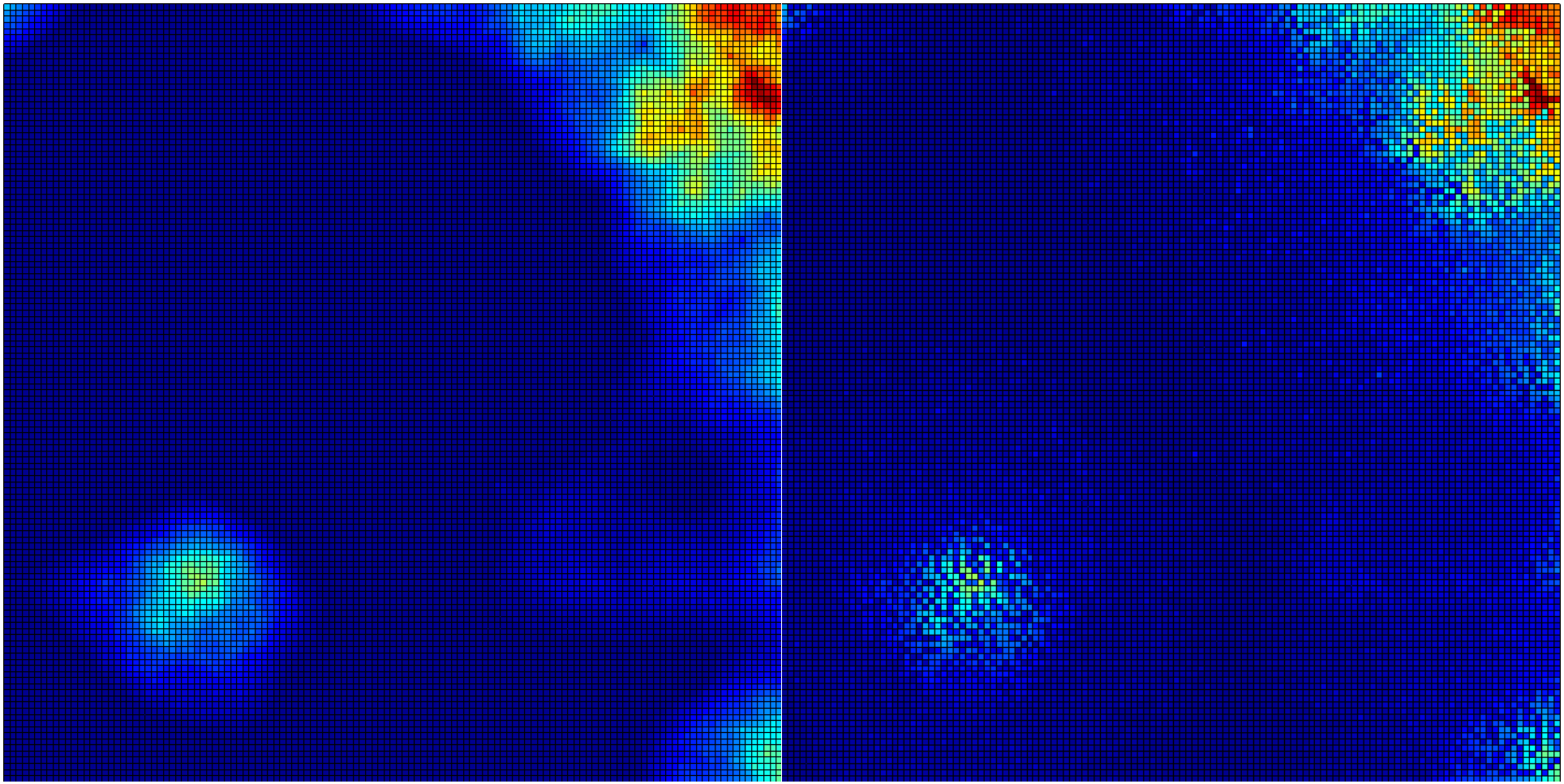
$$s_{t+1}^v = s_t^v - K_d s_t^v$$

The Coats Ad Hoc Algorithm

- Raindrops fall with uniform probability over landscape
- X% Probability of eroding a vertex
  - If not, carry on
- Then uniform probability of eroding between 0 and E_{max}% of vertex height
- Then travel to the lowest tile found

The Coats Algorithm

- Note Alluvial Fan and Canyons



Rendering in SimCity 4

Thank You

- References:

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