

# **Textures for Data Storage: Noise & Maps**

**CSCI 4239/5239**

**Advanced Computer Graphics  
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# Storing Data in Textures

- A texture can be thought of as a function
  - 1D => 1 independent variable
  - 2D => 2 independent variables
  - 3D => 3 independent variables
- Each texture is actually four functions
  - RGBA values are independent
  - Shader translates integer values to [0-1]
- Piecewise linear function description
  - User sets values at pixels
  - OpenGL interpolates between pixels

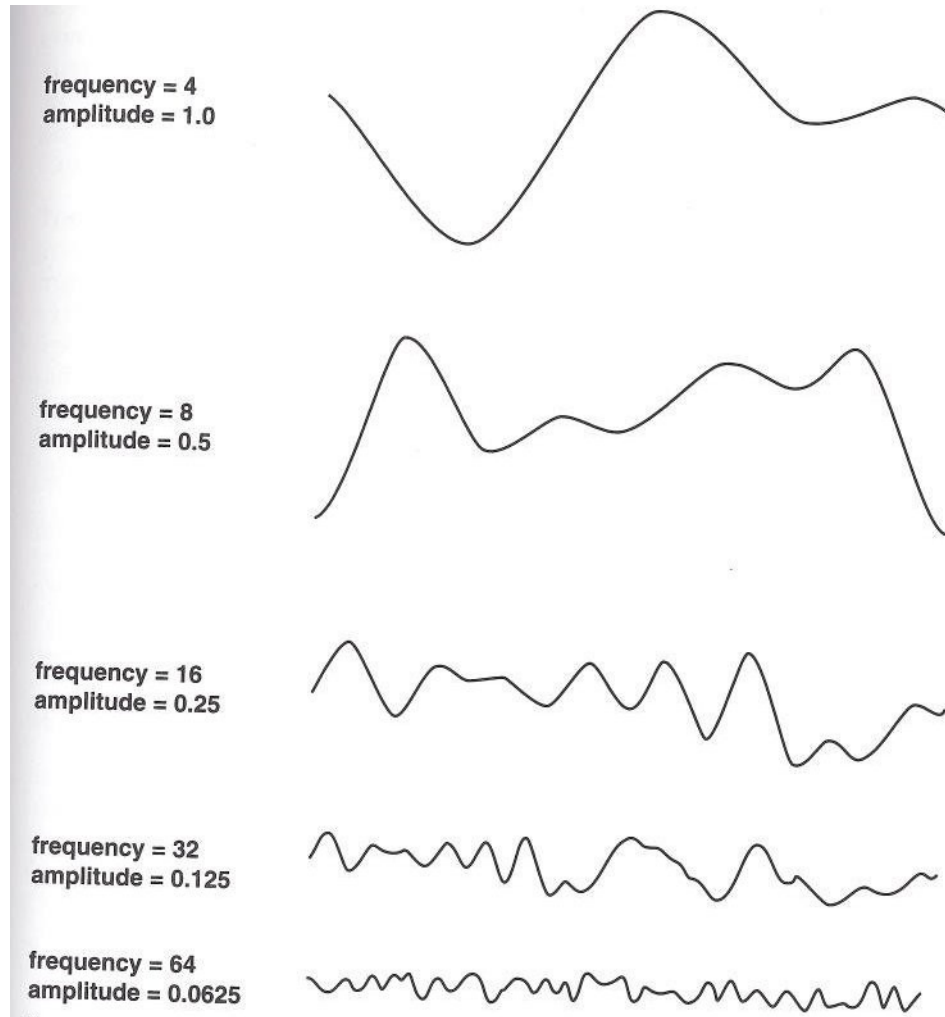
# Applications

- Color translations
  - temperature to color
- Function approximation
  - sine, cosine
- Deformations/deviations
  - bump maps
- Distance
  - shadows
- Noise
  - parameters
  - results

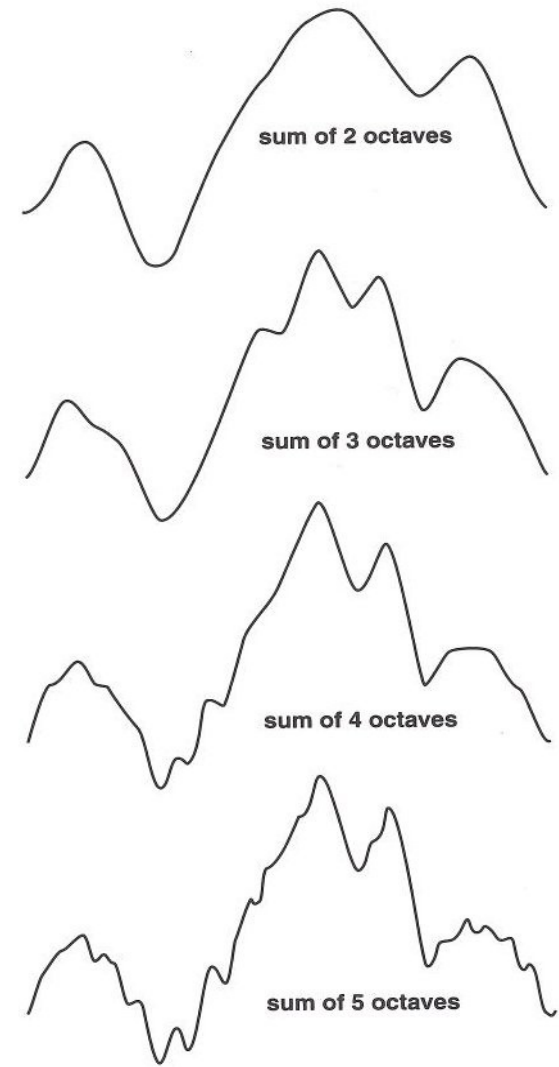
# Noise

- What is noise?
  - Random signals
  - Imperfections
  - Snoop Dogg
- Properties
  - Random (but not like random numbers)
  - Continuous
  - Range of frequencies

# One Dimensional Noise

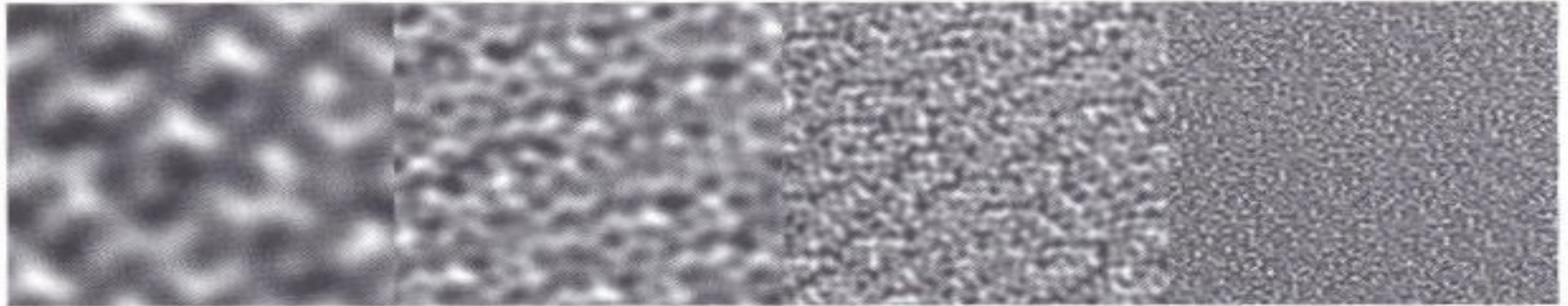


Components

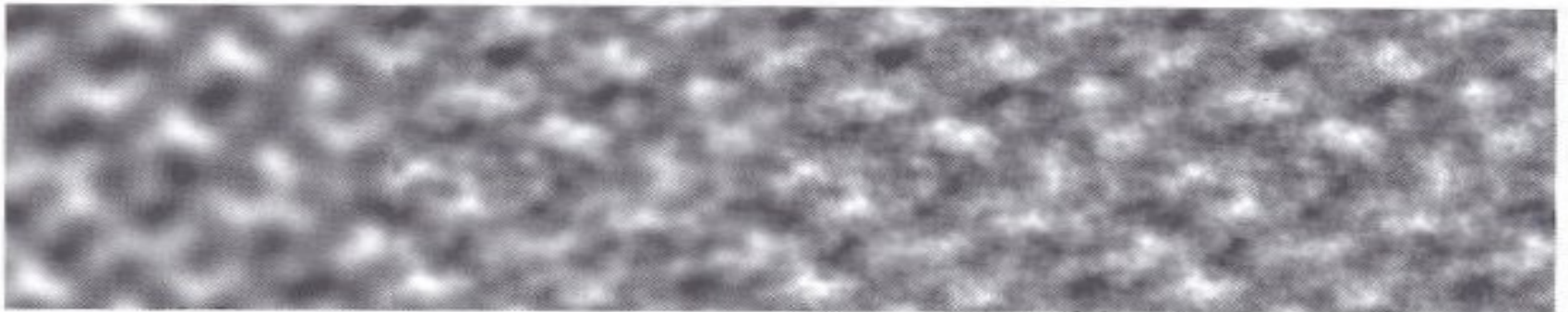


Summation

# Two Dimensional Noise



Components



Summation

# Noise in Computer Graphics

- Introduced by Ken Perlin
  - First used in *Tron*
  - Academic paper in 1985
- Purpose
  - Rendering natural phenomena like clouds
  - Rendering materials like wood or concrete
  - Adding imperfections to surfaces like bumps
  - Adding imperfections to motion like jitters
- Noise and random numbers are related but quite different

# Properties of noise

- Appear random
- Continuous
- Reproducible
- Well defined domain and range
- No obvious regularity (with some exceptions)
- Isotropic (with some exceptions)



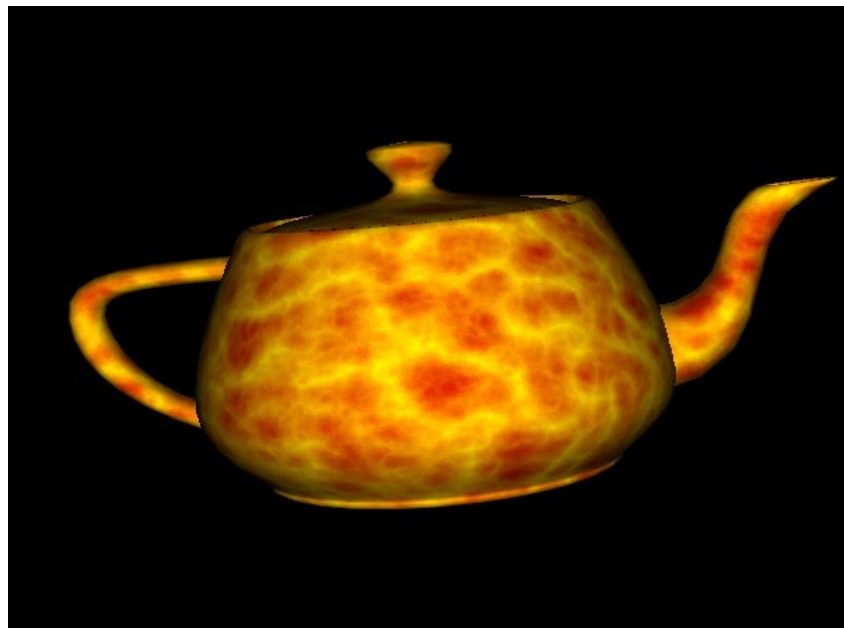
# Types of Noise

- Value noise
  - Values interpolated from points
- Gradient noise
  - Values generated from random gradients
  - Perlin (Classical) noise
  - Simplex noise
    - Faster and simpler than Perlin
  - Wavelet noise
    - More realistic

# Noise in GLSL

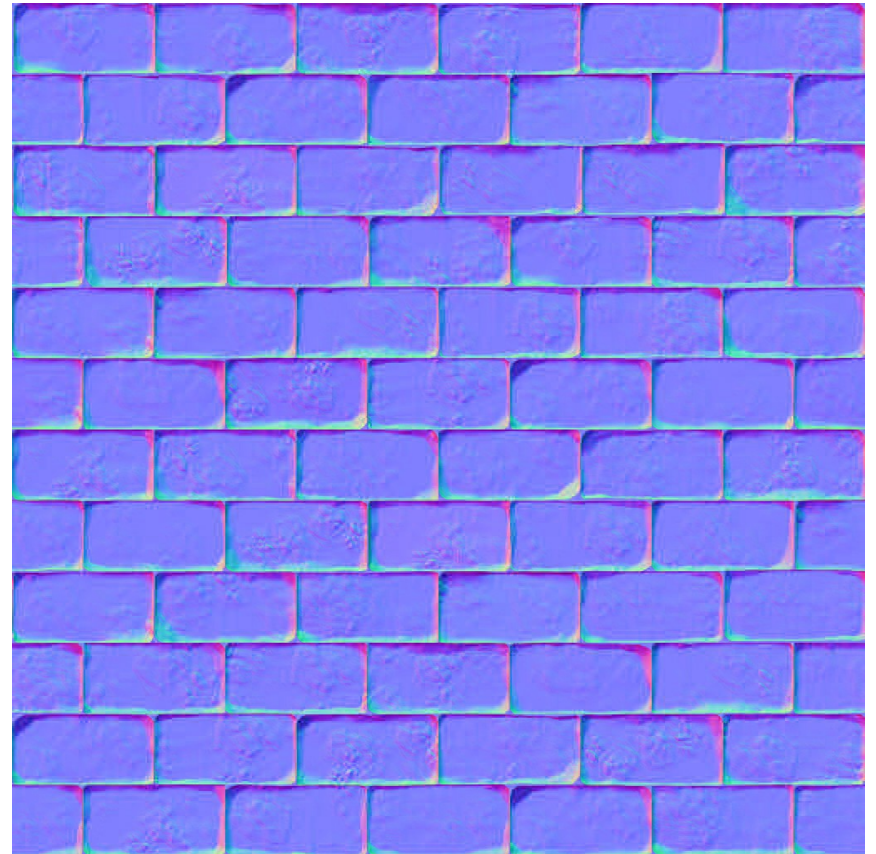
- Part of the language
  - noiseX(vecY)
  - rarely implemented
    - no compiler error, just returns 0
- D-I-Y
  - Noise texture (ex13)
    - Generates Perlin noise texture and sample in shader
  - Noise shader (ex14)
    - Store coefficients in texture
    - Compute Perlin and simplex noise in fragment shader

# Results



# Property Maps

- Used to specify properties by pixel
  - Height map
  - Normal map
  - Bump map
  - Parallax map
  - Displacement map
- Modifies properties at the pixel level



# Tangent Space

- Orthogonal space perpendicular to surface
  - Normal
  - Tangent orients direction
  - Bitangent = Normal  $\times$  Tangent
- Computing the tangent
  - By observation
  - Precomputed from texture coordinates
  - Compute in geometry shader
- Normal map sets multipliers for base vectors