Perlin Noise
CS4300
The Oscar™

To Ken Perlin for the development of Perlin Noise, a technique used to produce natural appearing textures on computer generated surfaces for motion picture visual effects.
The Movies

- James Cameron Movies (Abyss, Titanic, ...)
- Animated Movies (Lion King, Moses, ...)
- Arnold Movies (T2, True Lies, ...)
- Star Wars Episode I
- Star Trek Movies
- Batman Movies
- and lots of others

In fact, after around 1990 or so, every Hollywood effects film has used it.
What is Noise?

- Noise is a mapping from $\mathbb{R}^n$ to $\mathbb{R}$ - you input an $n$-dimensional point with real coordinates, and it returns a real value.
- $n=1$ for animation
- $n=2$ cheap texture hacks
- $n=3$ less-cheap texture hacks
- $n=4$ time-varying solid textures
Noise is Smooth Randomness
Making Noise

1. Generate random values at grid points.

2. Interpolate smoothly between these values.
Linear Noise
The basic operation of linear interpolation between two values is so commonly used in computer graphics that it is sometimes called a lerp in the jargon of computer graphics.

Lerp operations are built into the hardware of all modern computer graphics processors.
lerping

\[ \text{lerp}(v_1, v_2, t) = (1 - t)v_1 + tv_2 \]

\( t \) of the distance from \( P \) to \( Q \)

\( (1-t)P + tQ \)
2D Linear Noise

```
253 45 3
199 57 20
145 68 37
207 133 174
154 74 178
139 80 230
101 15 182
50 5 241
228 154 219
```
3D Linear Noise
Noise is Smooth Randomness
Perlin Noise Sphere
Turbulence or Sum $1/f$ (noise)

\[
\text{noise}(p) + \frac{1}{2} \text{noise}(2p) + \frac{1}{4} \text{noise}(4p) \ldots
\]
Perlin Sum $1/f(noise)$ Sphere
Perlin Sum $1/f(|\text{noise}|)$ Sphere
2D Normalized Turbulence

Just Noise
2D Turbulence - Clipped
factorG = sqrt(abs(sin(x + twist*turbulence(x, y, noise))))
color = (0, trunc(factorG*255), 255);
\[
\begin{align*}
\text{Clouds} \\

r &= \sqrt{(x-200/d)^2 + (y-200/d)^2}; \\
factorB &= \text{abs(cos(r + fluff*turbulence(x, y, noise))}; \\
\text{color} &= (127 + 128*(1 - factorB), 127 + 128*(1 - factorB), 255); \\
\end{align*}
\]
Student Images
Student Images
Student Images
Perlin's Clouds and Corona