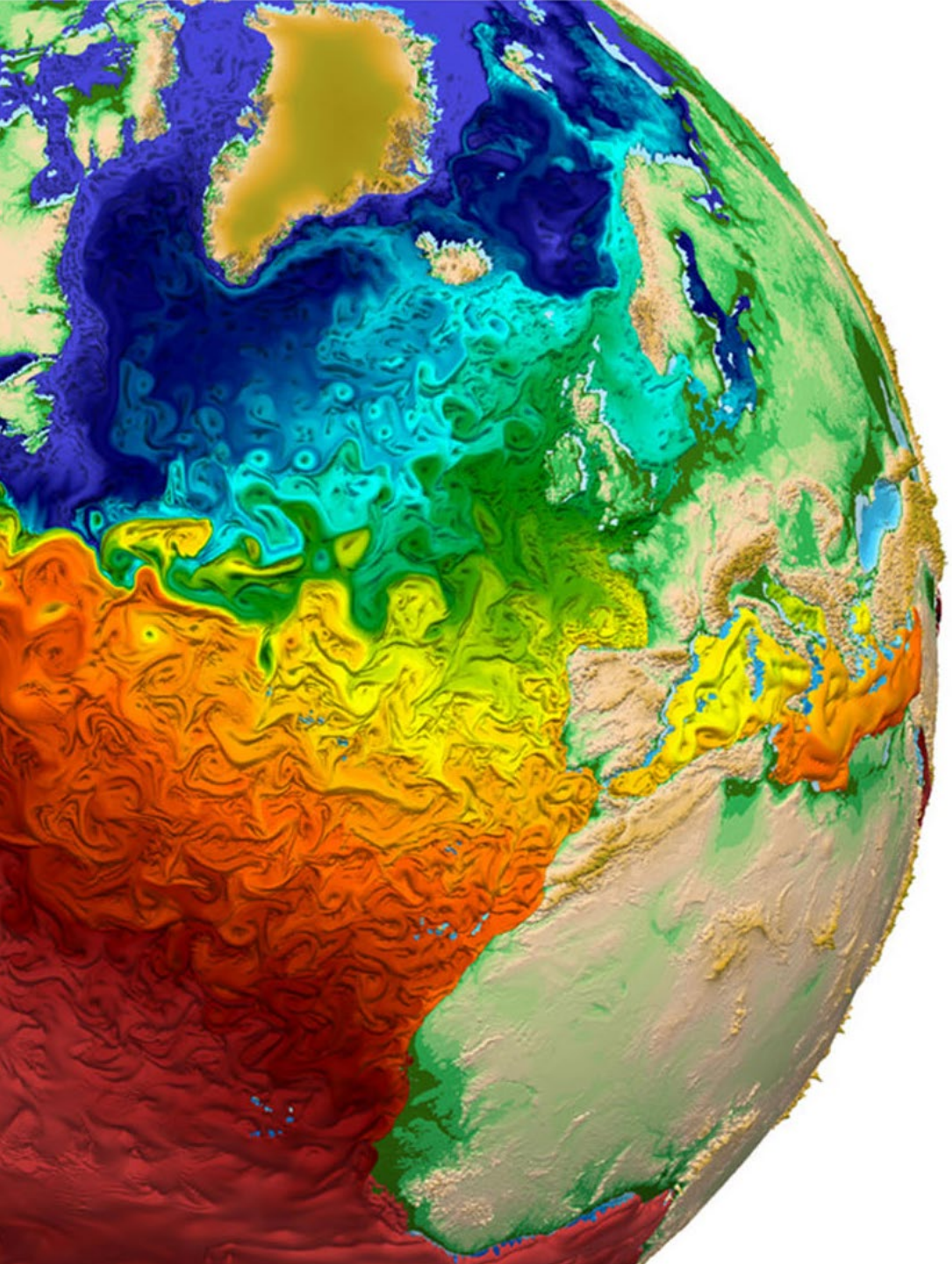


Digital Images

Representing Intensity

Scientific Visualization

Professor Eric Shaffer

ILLINOIS

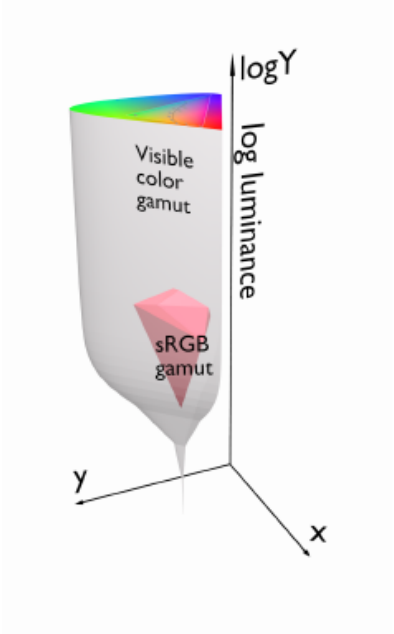
Intensity

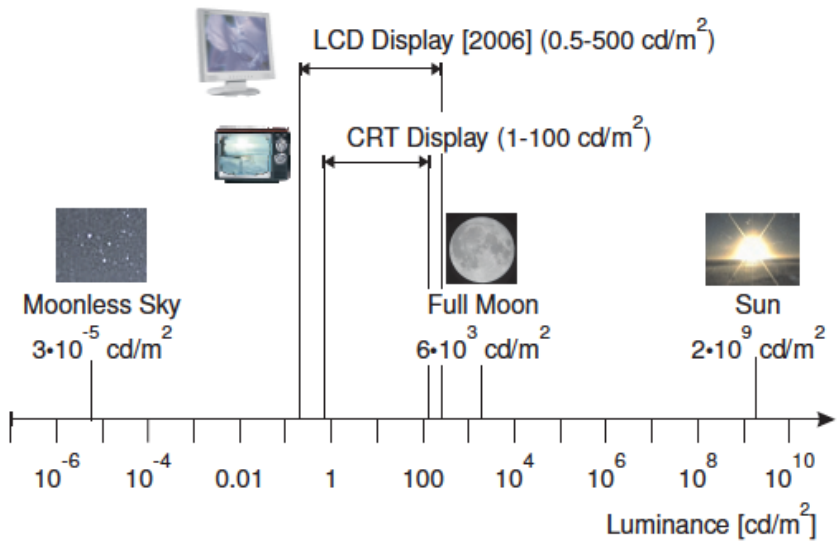
- At display time intensity values typically are in 8-bit representations
- 8 bits per color channel (24-bit color)

Byte 0	Byte 1	Byte 2	Byte 3
Red	Green	Blue	Alpha

  - Each channel is an 8-bit unsigned int
  - Will sometimes see hexadecimal expressions for color range [0x00, 0xFF]
  - Intensity levels in range [0,255]…can convert to float by dividing by 255

Luminance and Human Perception





Dictionary

Search for a word

lu·mi·nance

/ˈlo͞omənəns/

noun PHYSICS

the intensity of light emitted from a surface per unit area in a given direction.

- the component of a television signal which carries information on the brightness of the image.

Translations, word origin, and more definitions

- Many technologies do not record/display full range of luminance perceivable by humans
- HDR technologies offer higher contrast capabilities
- 256 gray levels is insufficient to look continuous

We can't see the entire range from moonless sky to sun in one scene…but much more than the LCD range

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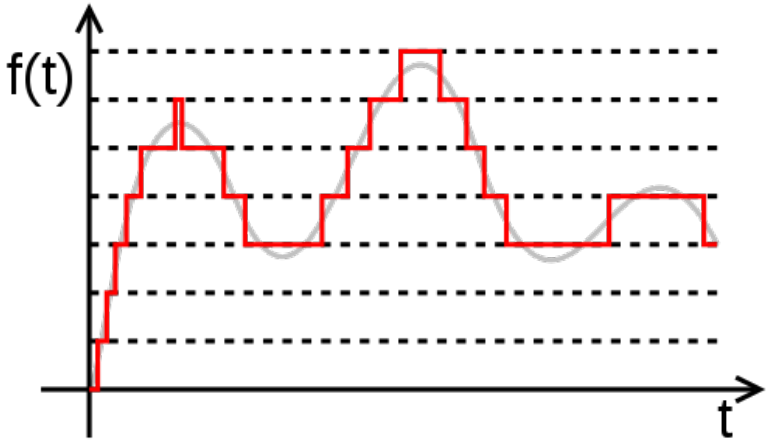
Intensity

- Some high-dynamic range (HDR) displays use a different representation
  - For HDR TV 10 bits or 12 bits per color channel
- OpenEXR file format can use 16-bit floating point for each channel
- In application level code, keep color values as at least 32-bit floats
  - Reduces impact of quantization on the colors
  - Reduction of precision will happen on the graphics processing unit (GPU)
- Quantization (in mathematics)



There are 1,056,964,609 single precision floating point numbers between 0 and 1 ….meaning $\frac{1}{2}$ of all the possible 32 bit words are used to represent numbers in [-1,1]

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The PNG Image File Format

Let’s quickly look at a popular storage format for digital images

Portable Network Graphics

File format

Portable Network Graphics is a raster-graphics file format that supports lossless data compression. PNG was developed as an improved, non-patented replacement for Graphics Interchange Format. PNG supports palette-based images, grayscale images, and full-color non-palette-based RGB or RGBA images. Wikipedia

Hex	As characters
89 50 4E 47 0D 0A 1A 0A 00 00 00 0D 49 48 44 52	.PNG........IHDR
00 00 00 01 00 00 00 01 08 02 00 00 00 90 77 53	..............wS
DE 00 00 00 0C 49 44 41 54 08 D7 63 F8 CF C0 00	.....IDAT..c....
00 03 01 01 00 18 DD 8D B0 00 00 00 00 49 45 4E	.........IEN
44 AE 42 60 82	D.B`.

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The PNG Image File Format

Header

Values (hex)	Purpose
89	Has the high bit set to detect transmission systems that do not support 8-bit data and to reduce the chance that a text file is mistakenly interpreted as a PNG, or vice versa.
50 4E 47	In ASCII, the letters *PNG*, allowing a person to identify the format easily if it is viewed in a text editor.
0D 0A	A DOS-style line ending (CRLF) to detect DOS-Unix line ending conversion of the data.
1A	A byte that stops display of the file under DOS when the command type has been used—the end-of-file character.
0A	A Unix-style line ending (LF) to detect Unix-DOS line ending conversion.

Chunks

Length	Chunk type	Chunk data	CRC
4 bytes	4 bytes	*Length* bytes	4 bytes

Pixel formats

PNG color types

Color type	Name	Binary				Masks
			A	C	P	
0	Grayscale	0	0	0	0	
2	Truecolor	0	0	1	0	color
3	Indexed	0	0	1	1	color, palette
4	Grayscale and alpha	0	1	0	0	alpha
6	Truecolor and alpha	0	1	1	0	alpha, color

Pay attention to how you save important images

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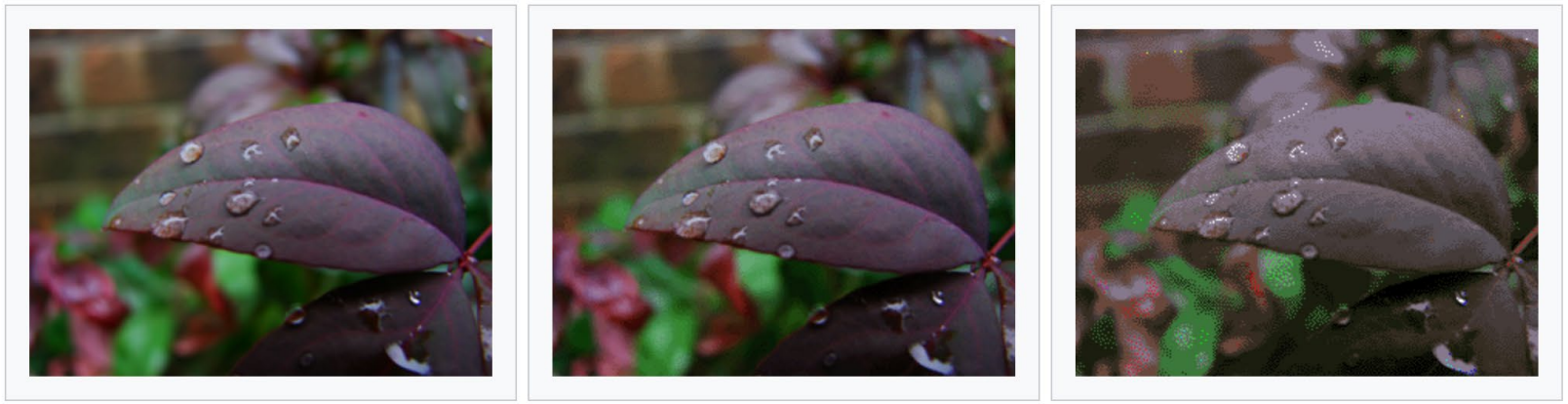
Implications for Visualization

- Cannot be sure viewers will see the same colors that you compute
  - Display differences
  - Quantization in storage and/or transmission to display

- If you map values to color, allow users to query for the original numerical value



24 bit.png
16,777,216 colors
98 KB

8 bit.png
256 colors
37 KB (−62%)

4 bit.png
16 colors
13 KB (−87%)

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