



# The Subject: Computer Graphics

- Computer Graphics:
  - Using computers to generate and display images
- Issues that arise:
  - Modeling
  - Rendering
  - Animation
  - Perception
  - Lots of details...

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# Computer Graphics

- Applications (in other words, why we care)
  - Movies
  - Video Games
  - Simulation
  - Analysis
  - Design
  - Others...

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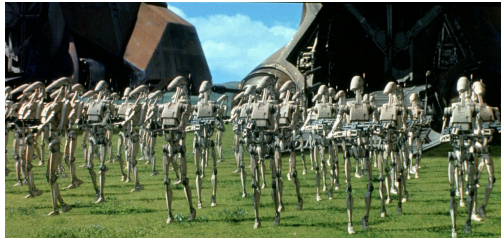
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# Computer Graphics

- Applications (in other words,why we care)

- Movies
- Video Games
- Simulation
- Analysis
- Design
- Others...



From Star Wars Episode I, Lucasfilm Ltd.

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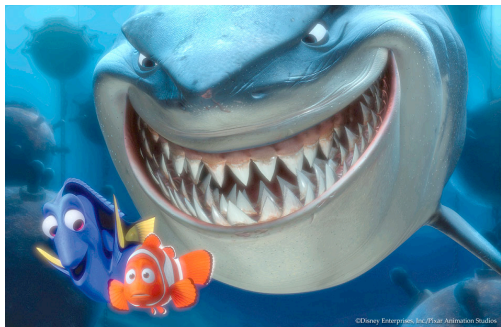
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# Computer Graphics

- Applications (in other words,why we care)

- Movies
- Video Games
- Simulation
- Analysis
- Design
- Others...



From Finding Nemo, Pixar Animation Studios

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# Computer Graphics

- Applications (in other words,why we care)
  - Movies
  - Video Games
  - Simulation
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  - Design
  - Others...



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# Computer Graphics

- Applications (in other words,why we care)
  - Movies
  - Video Games
  - Simulation
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  - Design
  - Others...



From Star Wars: The Force Unleashed by Lucas Arts

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# Computer Graphics

- Applications (in other words, why we care)

- Movies
- Video Games
- Simulation
- Analysis
- Design
- Others...



From America's Army

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# Computer Graphics

- Applications (in other words, why we care)

- Movies
- Video Games
- Simulation
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- Others...



Image from CAE Inc.

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# Computer Graphics

- Applications (in other words, why we care)
  - Movies
  - Video Games
  - Simulation
  - Analysis
  - Design
  - Others...



Carlo Sequin

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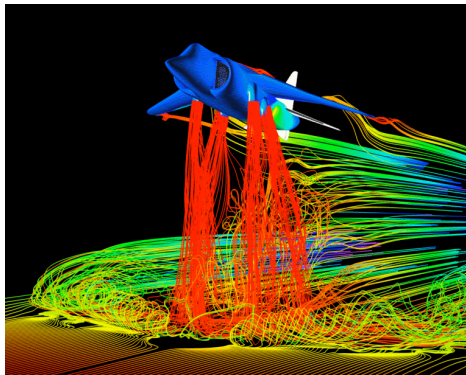
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# Computer Graphics

- Applications (in other words, why we care)
  - Movies
  - Video Games
  - Simulation
  - Analysis
  - Design
  - Others...



Fluid simulation w/ NASA FAST

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# Computer Graphics

- Applications (in other words, why we care)
  - Movies
  - Video Games
  - Simulation
  - Analysis
  - Design
  - Others...



Sucker Punch Copyright 2011 Warner Bros  
Visual effects by Moving Picture Company

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# Course Topics

- Image representation and manipulation
- 2D and 3D drawing algorithms
- Object representations
- Rendering
- Animation
- Interaction techniques

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# People



James O'Brien



Fu-Chung Huang

Aayush Dawra

Send class related email to [cs184@iemail.eecs.berkeley.edu](mailto:cs184@iemail.eecs.berkeley.edu)

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# Contact Information

- Class web site:
  - <http://inst.eecs.berkeley.edu/~cs184>
  - Handouts assignments, **etc.** will be posted there
  - Lecture notes posted there (*hopefully*) before classes
- Discussion group:
  - Piazza discussion group
  - <https://piazza.com/berkeley/fall2013/cs184>
  - Not reading discussion group... bad idea
- Staff email addresses, office hours, etc on website

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# Computing Resources

- Class accounts handed shortly
- Can also use CS Labs
  - Linux
  - Windows
  - Mac

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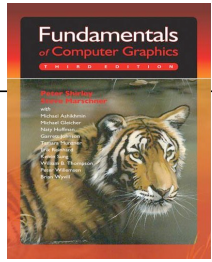
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# Text Book



- *Fundamentals of Computer Graphics*  
by P. Shirley, S. Marschner, et al.
  - \* *Get the current version*
- Also handouts and other supplemental material will be provided
- See other books listed in course information handout

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# Grading

- Assignments: 40%
  - Mix of written and programing
  - Average 1 or 2 weeks to do them
- Midterm: 20%
  - Wednesday, October 23, in class
- Final Project: 20%
  - Thursday, Dec. 12, 11:00 am - 2:00 pm, Soda 5th floor
- Final: 20%
  - Wednesday, Dec. 18, 7:00 pm - 10:00 pm
- Check **now** for conflicts!

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# Prerequisites

- You must know how to program C or C++
  - Big final project, several programing assignments
  - No hand holding
- Data structures (CS61B)
- Math: linear algebra, calc, trig

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	Waitlist
	<ul style="list-style-type: none"><li>• Quite a few people will drop</li><li>• Hopefully everyone will fit...</li></ul> <p style="text-align: right;">21</p>

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	Class Participation
	<ul style="list-style-type: none"><li>• Reasons to participate<ul style="list-style-type: none"><li>• More fun for me and you</li><li>• You learn more</li><li>• I won't give stupid little annoying quizzes in class</li></ul></li><li>• How to participate<ul style="list-style-type: none"><li>• Ask questions</li><li>• Make comments</li></ul></li><li>• Stupid questions/comments<ul style="list-style-type: none"><li>• That's okay</li></ul></li></ul> <p style="text-align: right;">22</p>

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# Assignments #1 and #2

- Assignment #0
  - Setup CS184 account and let us know who you are
  - Get very simple OpenGL program working
    - **Due Friday Sept. 13th, Midnight**
- Homework #1
  - Tests math prerequisites
    - **Due Friday Sept. 13th, 5pm**

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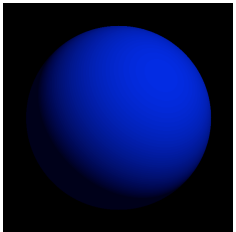
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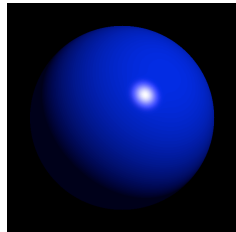
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# Assignment: Shading

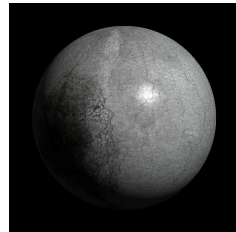
[Ritchie & Cho, F08]



Diffuse Only



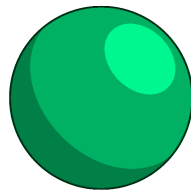
Diffuse & Specular



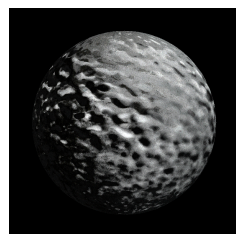
Diff. & Spec. & Texture



Diff. & Spec. & Texture



Toon Shading



Bump Mapping

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## Final Project: Open Ended

Your image/animation/game here!

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## Academic Honesty

- If you use an external resource cite it clearly!
- Don't do things that would be considered dishonest... if in doubt ask.
- Cheating earns you:
  - An 'F' in the class and
  - Getting reported to the University
  - No exceptions.

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# Questions?

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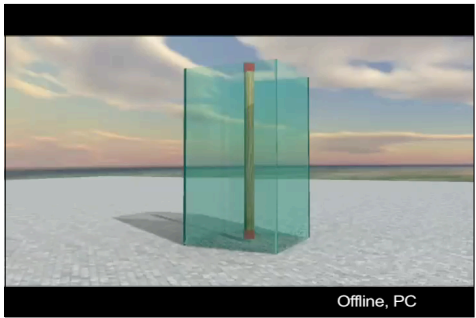
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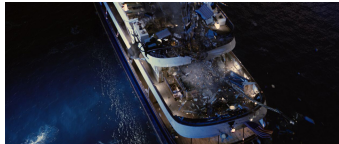
# My research

- Simulation



Offline, PC

With Eric Parker



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Tuesday, September 3, 13

My research	
<ul style="list-style-type: none"><li>• Simulation</li></ul> <p>With Huamin Wang and Ravi Ramamoorthi</p>	 <p><b>Cloth Draping</b></p>

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My research	
<ul style="list-style-type: none"><li>• Simulation</li></ul>	<p>With Rahul Narain and Armin Samii</p>  <p><b>Adaptive Anisotropic Remeshing for Cloth Simulation</b></p> <p>Rahul Narain, Armin Samii, James F. O'Brien University of California, Berkeley</p> <p>SIGGRAPH Asia 2012</p>

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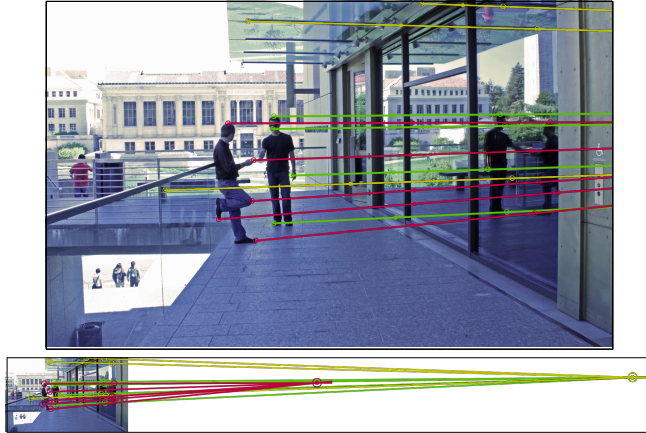




# My research

- Forensics

With Hany Farid



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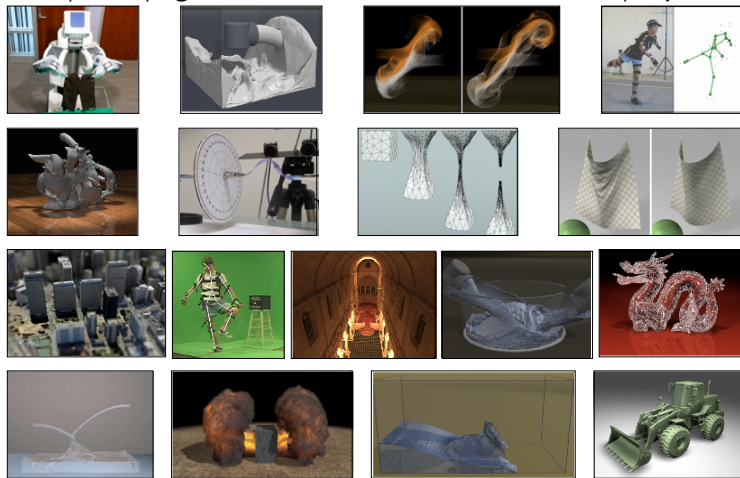
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# My research

See my webpage for more information and other projects...



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# Images

- Something that represents a *pattern of light* that will be *perceived* by something
- Computer representations
  - Sampled (pixel based)
  - Object based
  - Functional

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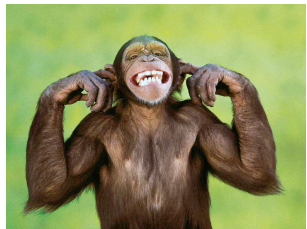
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# Images

- Something that represents a *patten of light* that will be *perceived* by something
- Computer representations
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# Images

- Something that represents a *patten of light* that will be *perceived* by something
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# Images

- Something that represents a *patten of light* that will be *perceived* by something
- Computer representations
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  - Functional



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# Images

• Something that represents a *patten of light* that will be *perceived* by something

• Computer representations

- Sampled (pixel based)
- Object based
- Functional

PS Type I font →



← Vector- or stroke-based

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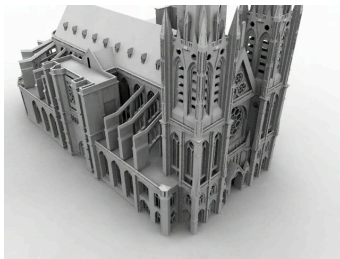
# Images

• Something that represents a *patten of light* that will be *perceived* by something

• Computer representations

- Sampled (pixel based)
- Object based
- Functional

Well, this *used* to be in an object based representation...



Okan Anikan

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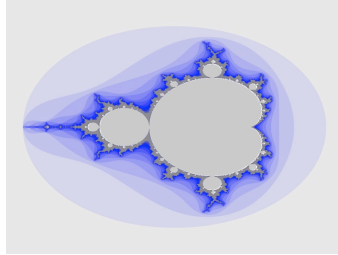
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# Images

- Something that represents a *patten of light* that will be *perceived* by something
- Computer representations
  - Sampled (pixel based)
  - Object based
  - Functional



Mandelbrot Fractal Plot by Vincent Stahl

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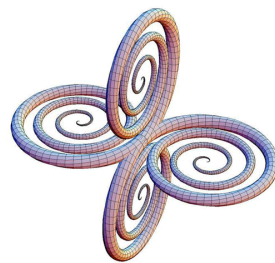
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# Images

- Something that represents a *patten of light* that will be *perceived* by something
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  - Functional



"Spiral Crossed" by Sandor Kabai

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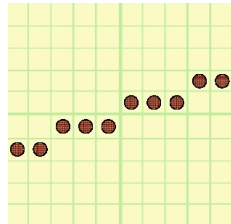
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Function → Polygons → Pixels

Think about making edits...

# Storing Images

- Object and Function representations basically arbitrary ...later...
- Raster Images
  - 2D array of memory
  - Pixels store different things
    - Intensity
    - RGB color
    - Depth
    - Others...
  - May be mapped to special HW



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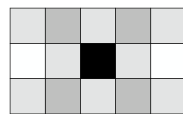
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# Storing Images

- Object and Function representations basically arbitrary ...later...
- Raster Images
  - 2D array of memory
  - Pixels store different things
    - Intensity (scalar value, e.g. float, int)
    - RGB color (vector value)
    - Depth
    - Others...
  - May be mapped to special HW



0.25	0.5	0.25	0.5	0.25
1	0.25	0	0.25	1
0.25	0.5	0.25	0.5	0.25

Stephen Cheney

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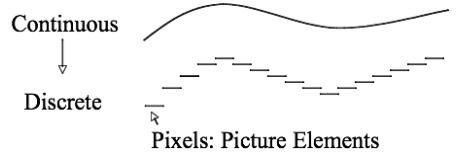
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# Discretization

- Real world and “object” representations are continuous.
- Raster images have discrete pixel *locations* and discrete pixel *values*



Stephen Cheney

- We will see problems from this soon...

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# Monitor Intensity and Gamma

Monitors convert **pixel value** into **intensity level**

- 0.0 maps to zero intensity = black (well not quite)
- 1.0 maps to full intensity = white

Monitors are not linear

- 0.5 does not map to “halfway” gray, (e.g. 0.5 might map to 0.217)
- Nonlinearity characterized by exponential function

$$I = a^\gamma$$

where  $I$  = displayed intensity and  $a$  = pixel value (between 0 and 1)

- For many monitors  $\gamma$  is near 2 (often between 1.8 and 2.2)

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## Determining Gamma $I = a^\gamma$

Suppose I know displayed intensity of a patch  $I = 0.5$

$$0.5 = a^\gamma$$

Let viewer adjust pixel value  $a$  of nearby patch until match

$$\gamma = \frac{\ln 0.5}{\ln a}$$

Patch of known $I = 0.5$	Viewer adjusts pixel values $a$ until this patch visually matches
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How do we make a patch of known intensity?

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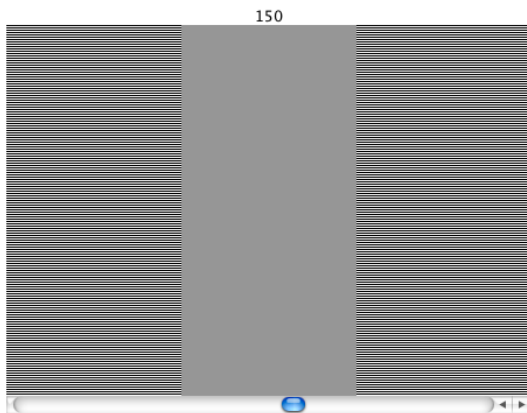
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## Determining Gamma



<http://www.cs.cornell.edu/Courses/cs4620/2008fa/homeworks/gamma.htm>

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# High Dynamic Range Images



Jack Tumblin

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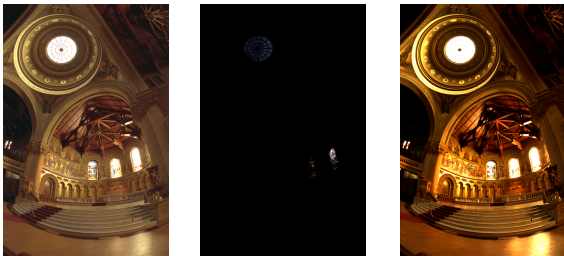
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# High Dynamic Range Images

- Dynamic range of the human eye >> range of standard monitors
- Eye adjusts as we look around



Paul Debevec and Jitendra Malik

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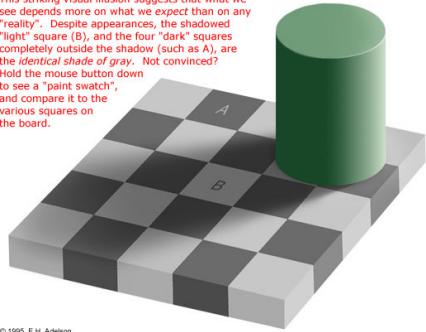
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# Perception

- The eye does not see intensity values...

This striking visual illusion suggests that what we see depends more on what we expect than on any "reality". Despite appearances, the shadowed "light" square (B), and the four "dark" squares completely outside the shadow (such as A), are the *identical shade of gray*. Not convinced? Hold the mouse button down to see a "paint swatch", and compare it to the various squares on the board.



© 1995, E.H. Adelson

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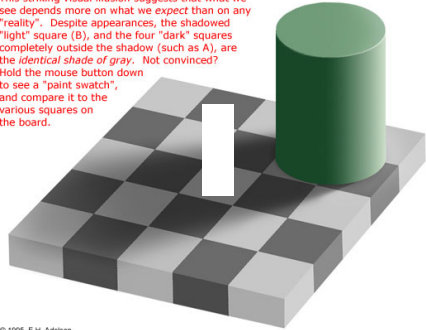
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© 1995, E.H. Adelson

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# Perception

- The eye does not see intensity values...

What  
is on  
your  
screen  
right  
now?



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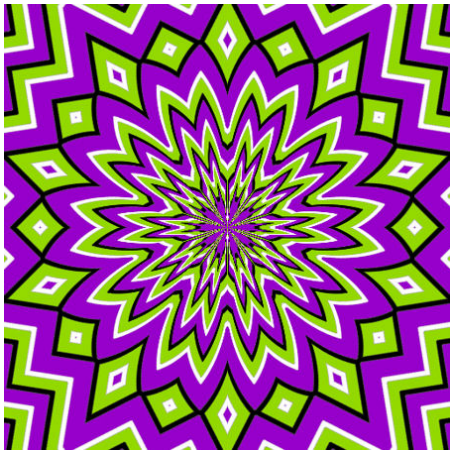
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# Perception



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# Storing Images

- Digital file formats
  - TIFF, JPEG, PNG, GIF, BMP, PPM, *etc.* ...
  - Compression (lossless and lossy)
  - Interlaced (**e.g.** NTSC television)
  - Tend to be complex... use libraries
- Mapping to memory

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