CS-184: Computer Graphics

Lecture #1: Introduction, Overview, and Image Basics

Prof. James O'Brien
University of California, Berkeley

V2011-F-01-1.0

Today

- Introduction and Course Overview
- Assignments #1 and #2
- Digital Images

The Subject: Computer Graphics

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

Computer Graphics

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

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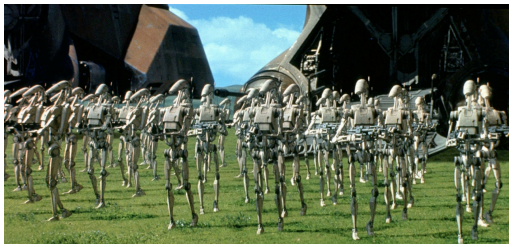

From *Star Wars Episode I*, Lucasfilm Ltd.

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Computer Graphics

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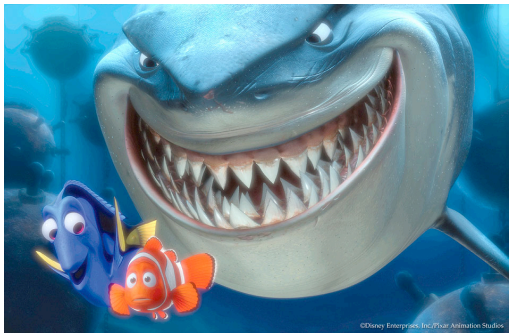

From *Finding Nemo*, Pixar Animation Studios

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From Halo 2, by Bungie Entertainment

Computer Graphics

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  - Others...

From *Star Wars: The Force Unleashed* by Lucas Arts

Computer Graphics

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  - Others...

From America's Army

Computer Graphics

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  - Design
  - Others...

Image from CAE Inc.

Computer Graphics

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Carlo Sequin

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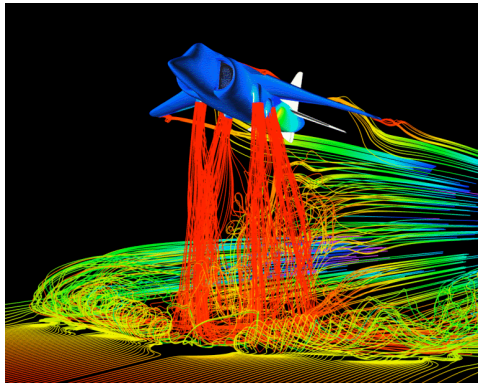

Fluid simulation w/ NASA FAST

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Computer Graphics

- Applications (in other words,why we care)
  - Movies
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  - 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

Prof. James O'Brien

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3:00 - 4:00 Fri
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T.A. Natarajan Chakrapani

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T.A. Yusuke Yasui

Email: yasui@berkeley.edu

Send class related email to
cs184@imail.eecs.berkeley.edu

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:
  - Google Group
    - URL: http://groups.google.com/group/cs184-f11
    - Email: cs184-f11@googlegroups.com
  - Not reading discussion group... bad idea
  - Request access now, not when you need it.
- Staff email addresses on previous page...

Computing Resources

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

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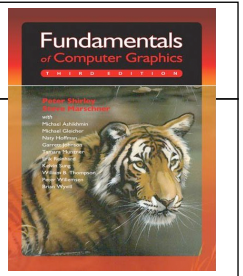
Text Book



- *Fundamentals of Computer Graphics*
  by P. Shirley, M. Ashikhmin, and S. Marschner

  * *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
- Final Project: 20%
  - Presentation: TBA prior to midterm
- Midterm: 20%
  - Thursday, October. 13th, in class
- Final: 20%
  - Tuesday, Dec. 13th, 8:00 am - 11:00 am
- Check ***now*** for conflicts!

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

Waitlist

- Adding an extra section now.
- Hopefully everyone will fit...

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Class Participation

- Reasons to participate
  - More fun for me and you
  - You learn more
  - I won't give stupid little annoying quizzes in class
- How to participate
  - Ask questions
  - Make comments
- Stupid questions/comments
  - That's okay

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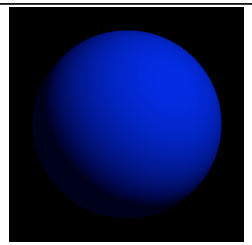
Assignments #1 and #2

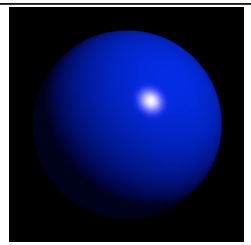
- Assignment #1
  - Setup CS184 account and let us know who you are
  - Get very simple OpenGL program working
  - ***Due Sept. 2nd***
- Assignment #2
  - Tests math prerequisites
  - ***Due Sept. 6th***

Assignment #3: Shading

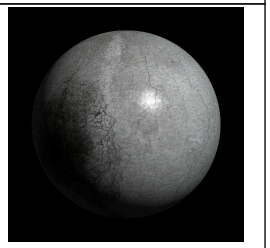
[Ritchie & Cho, F08]



Diffuse Only

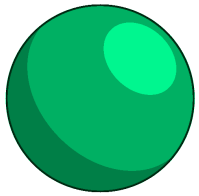


Diffuse & Specular

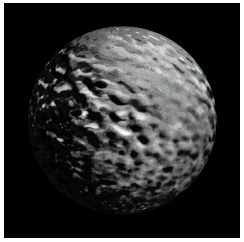


Diff. & Spec. & Texture

Diff. & Spec. & Texture



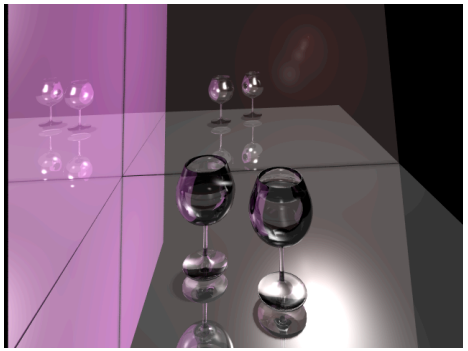
Toon Shading



Bump Mapping

Assignment #4: Ray Tracing

[Ritchie & Cho, F08]



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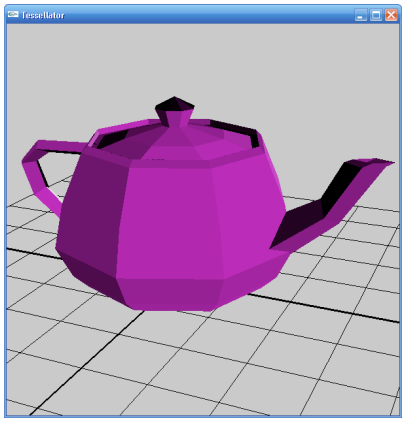
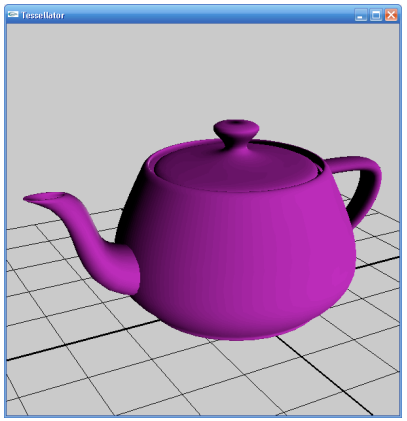
Assignment #5: Parametric Surfaces

[Ritchie & Cho, F08]





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Final Project: Open Ended

Your image/animation/game here!

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.

Questions?

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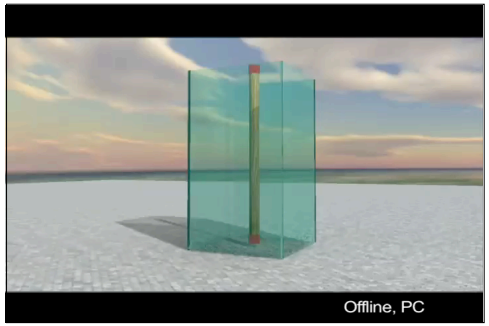
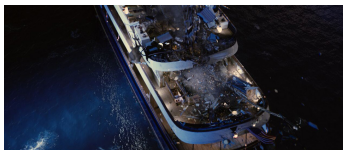
My research

- Simulation



With Eric Parker



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My research

- Simulation

With Huamin Wang
and Ravi Ramamoorthi

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My research

- Simulation

With Nuttapong Chentanez,
Ron Alterovitz, Daniel Ritchie,
Lita Cho, Kris K. Hauser,
Ken Goldberg, and
Jonathan R. Shewchuk

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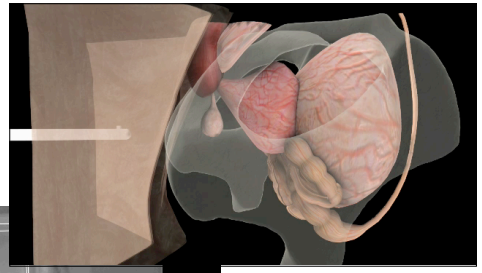
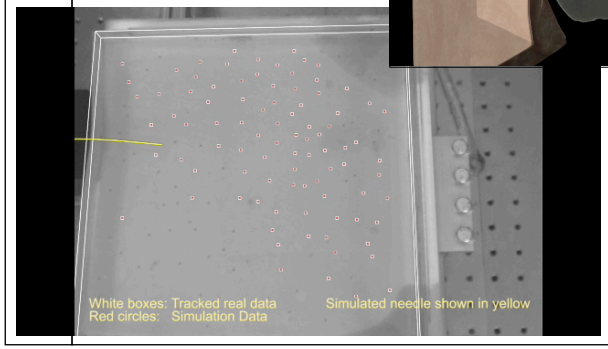
My research

- Simulation





With Nuttapong Chentanez, Ron Alterovitz, Daniel Ritchie, Lita Cho, Kris K. Hauser, Ken Goldberg, and Jonathan R. Shewchuk

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My research

- Simulation

With Adam Kirk

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My research

- Forensics

With Hany Farid

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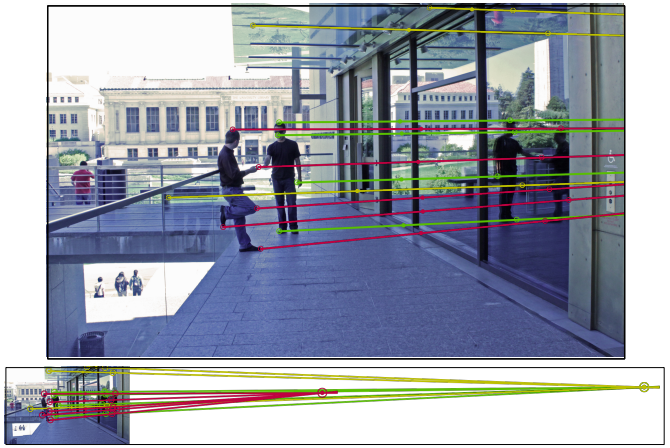
My research

- Forensics

With Hany Farid



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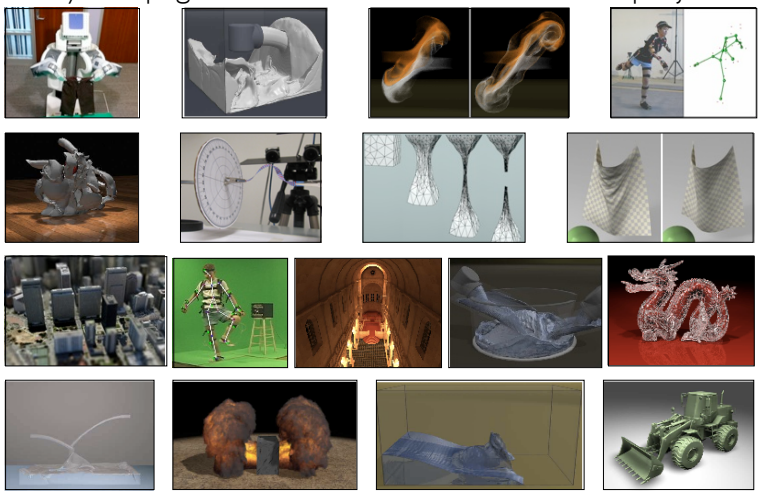
My research

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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Images

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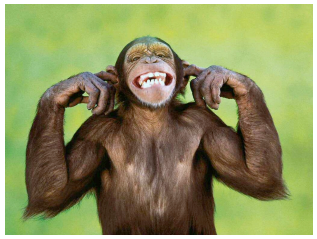

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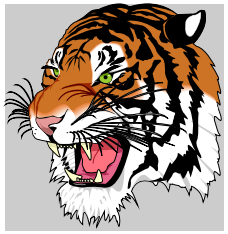

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Images

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Vector- or stroke-based

PS Type 1 font

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Images

- Something that represents a ***patten of light*** that will be ***perceived*** by something
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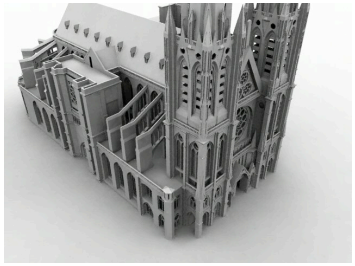
Well, this ***used*** to be in an object based representation...



Okan Arikan

Images

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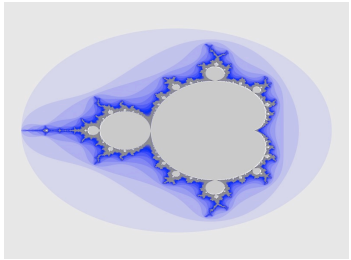

Mandelbrot Fractal Plot by Vincent Stahl

Images

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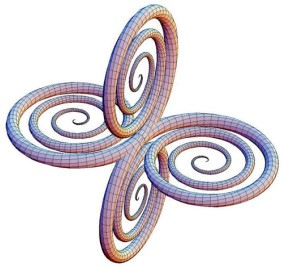
Function→**Polygons**→**Pixels**

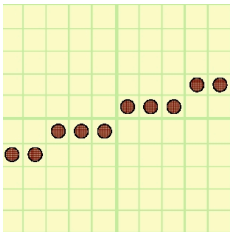
Think about making edits...



"Spiral Crossed" by Sandor Kabai

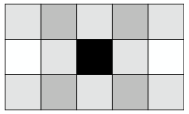
Storing Images

- 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



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

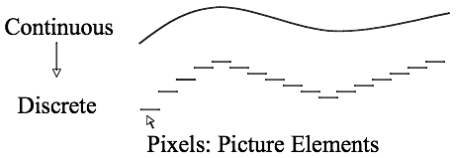


0.25	0.5	0.25	0.5	0.25
1	0.25	0	0.25	1
0.25	0.5	0.25	0.5	0.25

Stephen Chenney

Discretization

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



Stephen Chenney

- We will see problems from this soon...

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 γ 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

How do we make a patch of known intensity?

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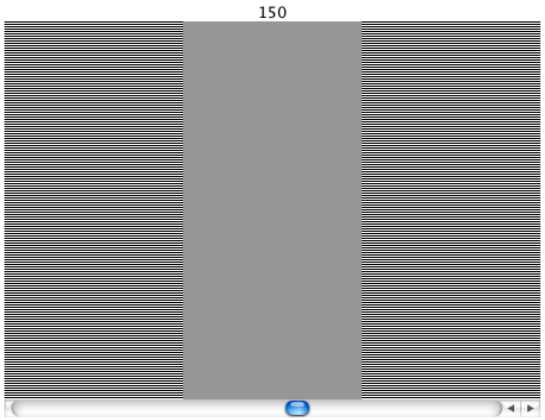
Determining Gamma



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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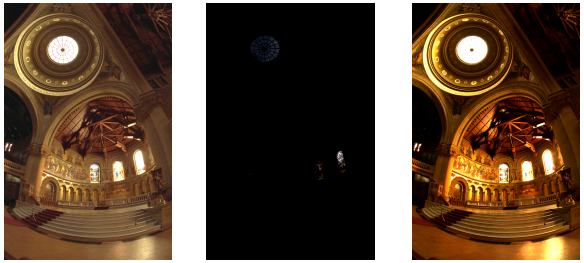
High Dynamic Range Images

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



Paul Debevec and Jitenrda Malik

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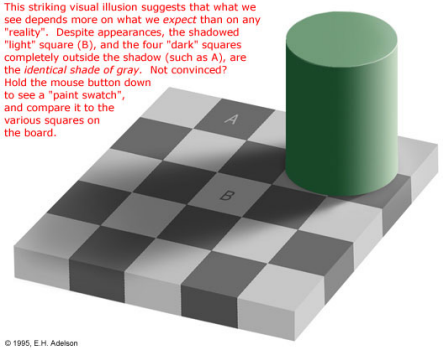
Perception

- The eye does not see intensity values...



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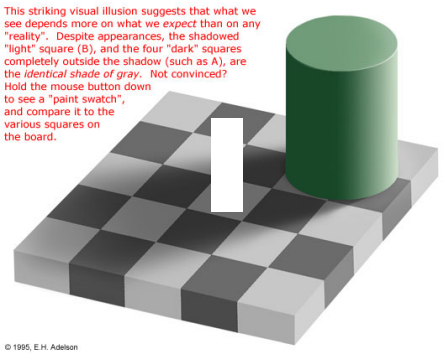
Perception

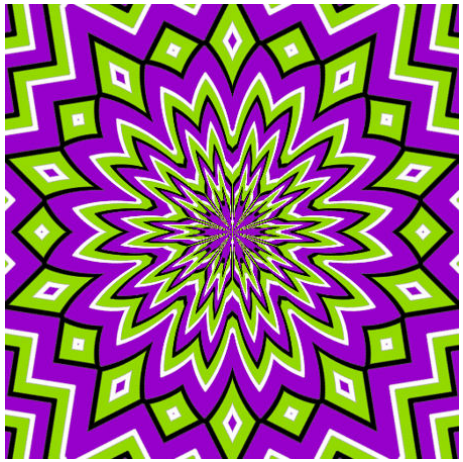
- The eye does not see intensity values...



Perception

- The eye does not see intensity values...

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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