

# Physics based Methods in Vision (a.k.a. Appearance Modeling)

Instructor: Narasimhan

Tuesday - Thursday

1:30pm - 2:50pm

NSH 3002

# A Picture is Worth 1000 Words

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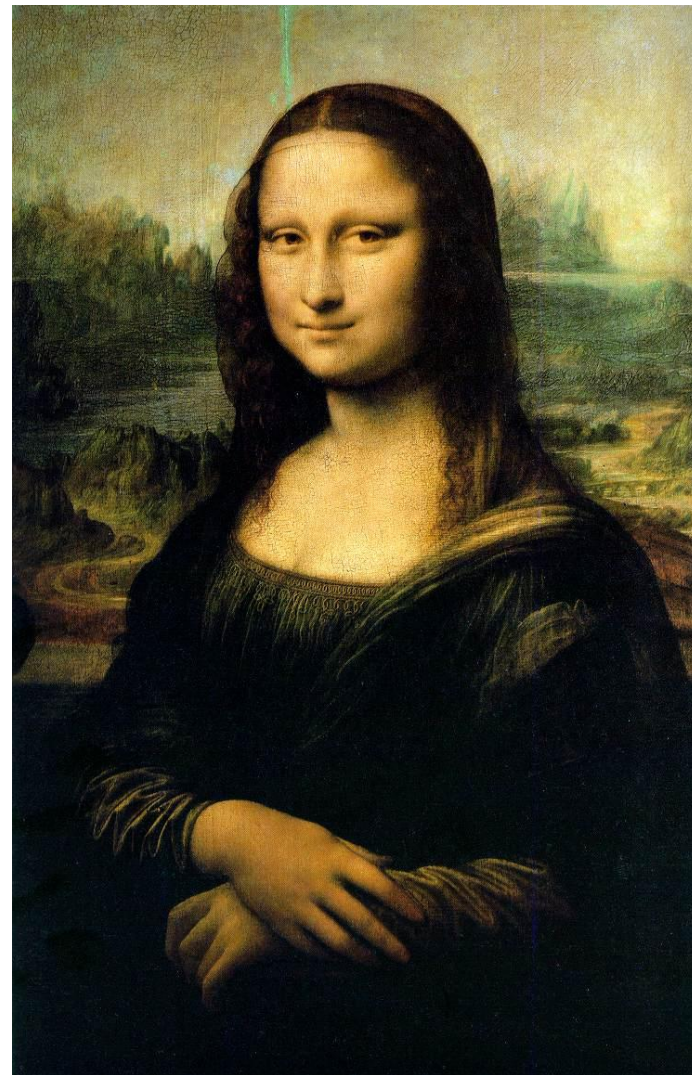
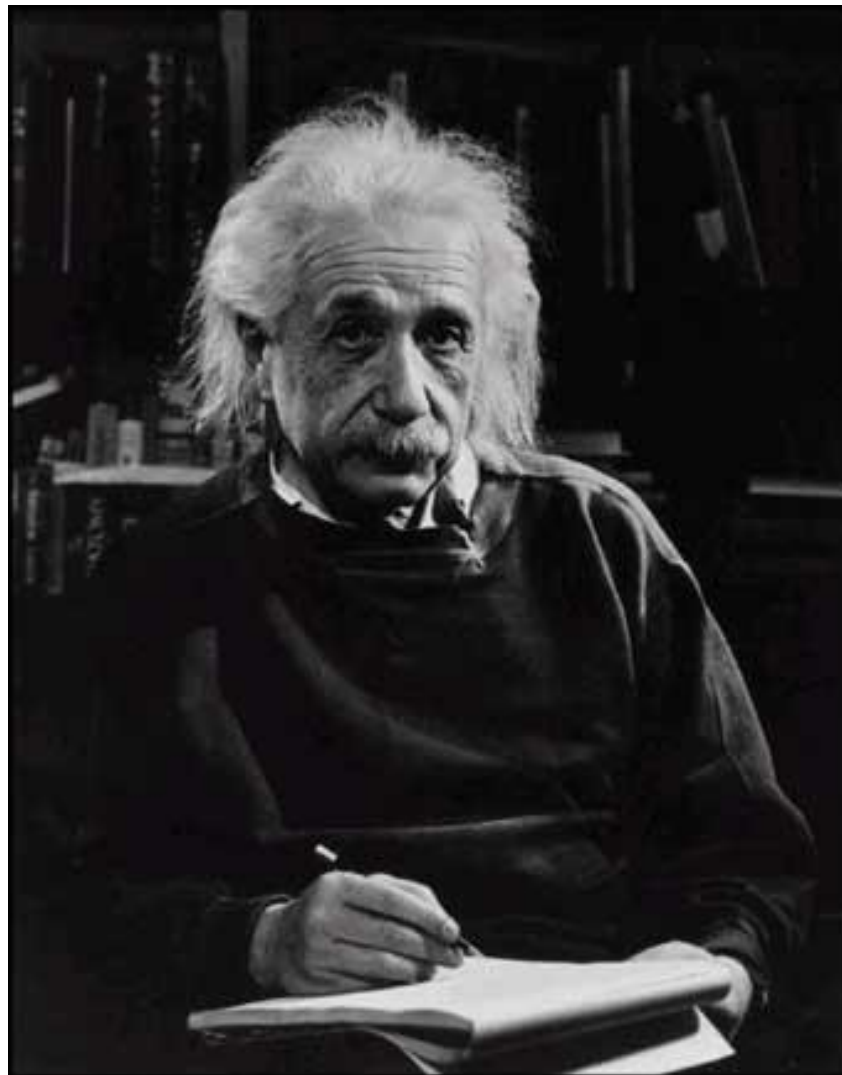
# A Picture is Worth 100,000 Words

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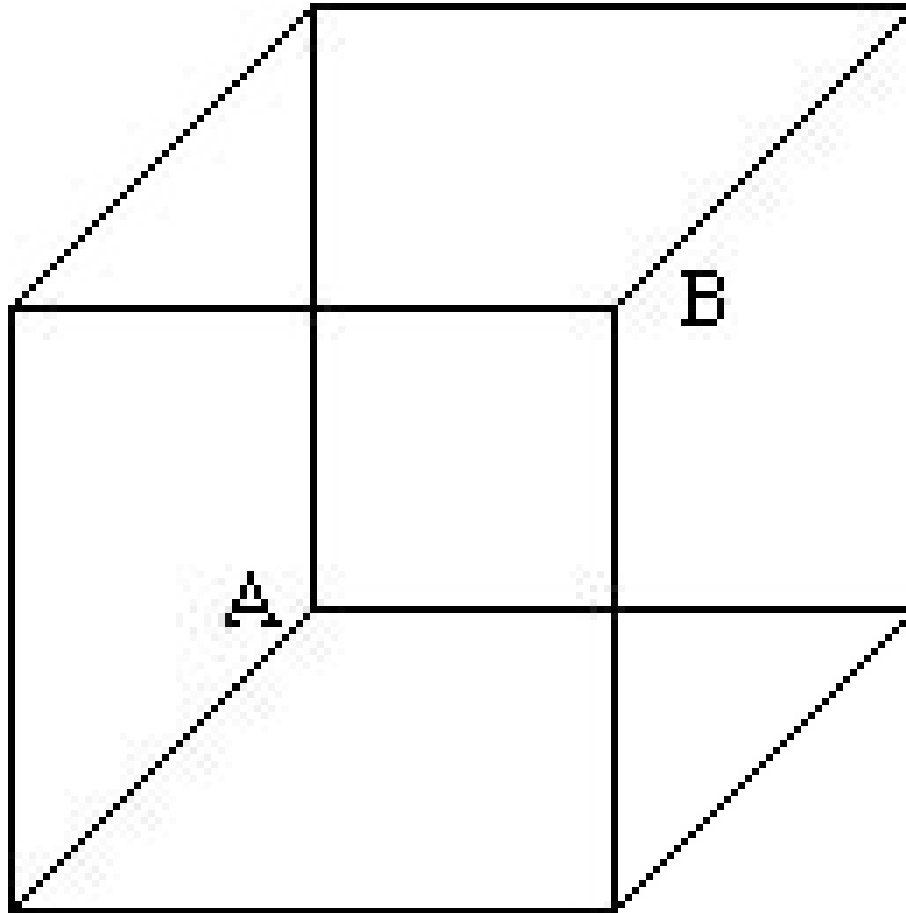
# A Picture is Worth a Million Words

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# A Picture is Worth a ...?

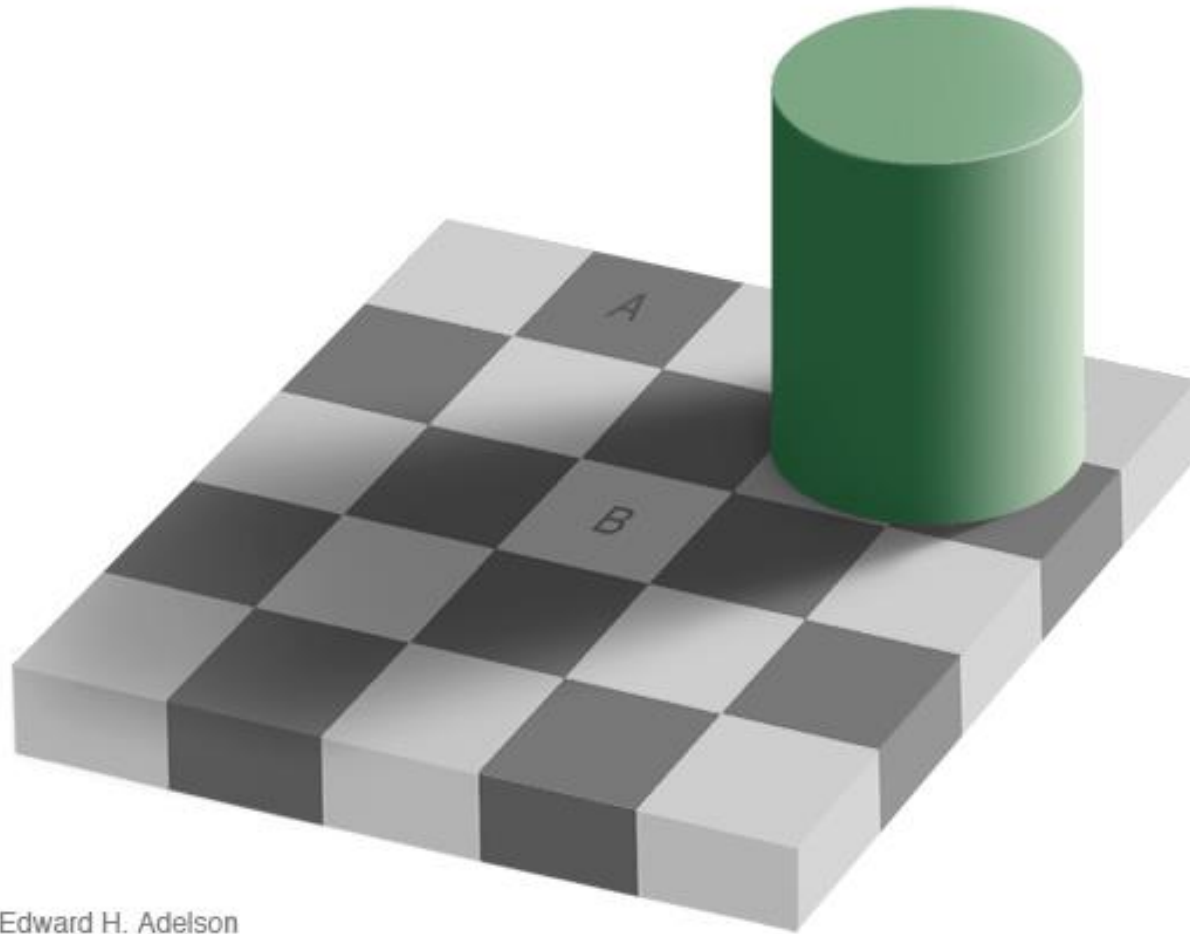
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Necker's Cube Reversal

# A Picture is Worth a ...?

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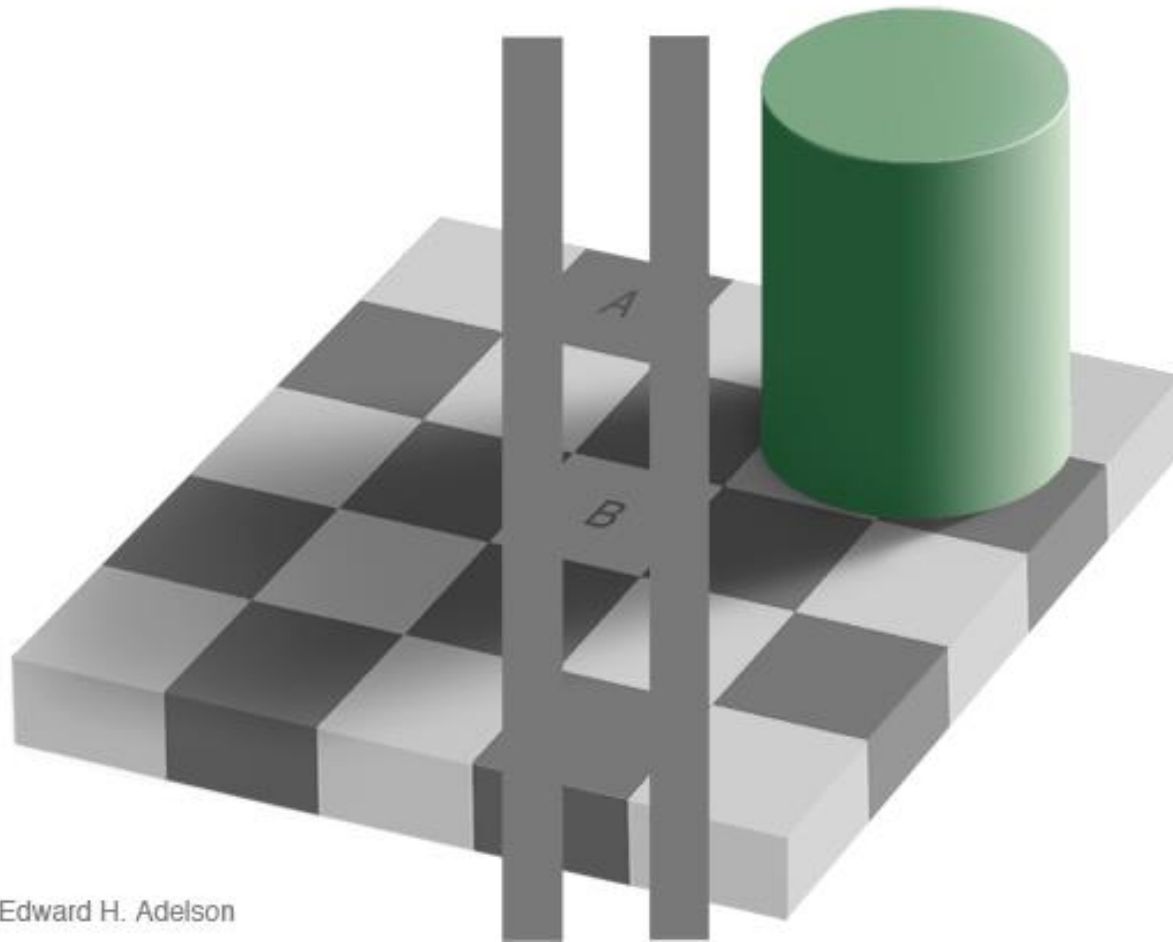


Edward H. Adelson

Checker Shadow Illusion – [E. H. Adelson]

# A Picture is Worth a ...?

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Edward H. Adelson

Checker Shadow Illusion – [E. H. Adelson]

# Human Vision

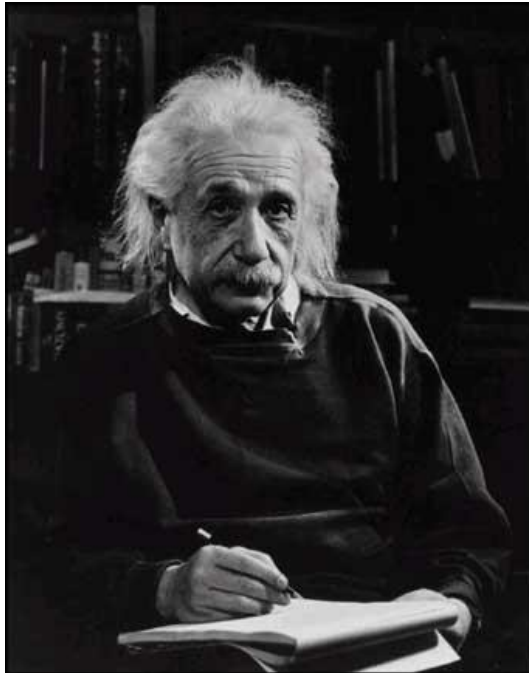
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- Can do amazing things like:
  - Recognize people and objects
  - Navigate through obstacles
  - Understand mood in the scene
  - Imagine stories
- But still is not perfect:
  - Suffers from Illusions
  - Ignores many details
  - Ambiguous description of the world
  - Doesn't care about accuracy of world



# Computer Vision

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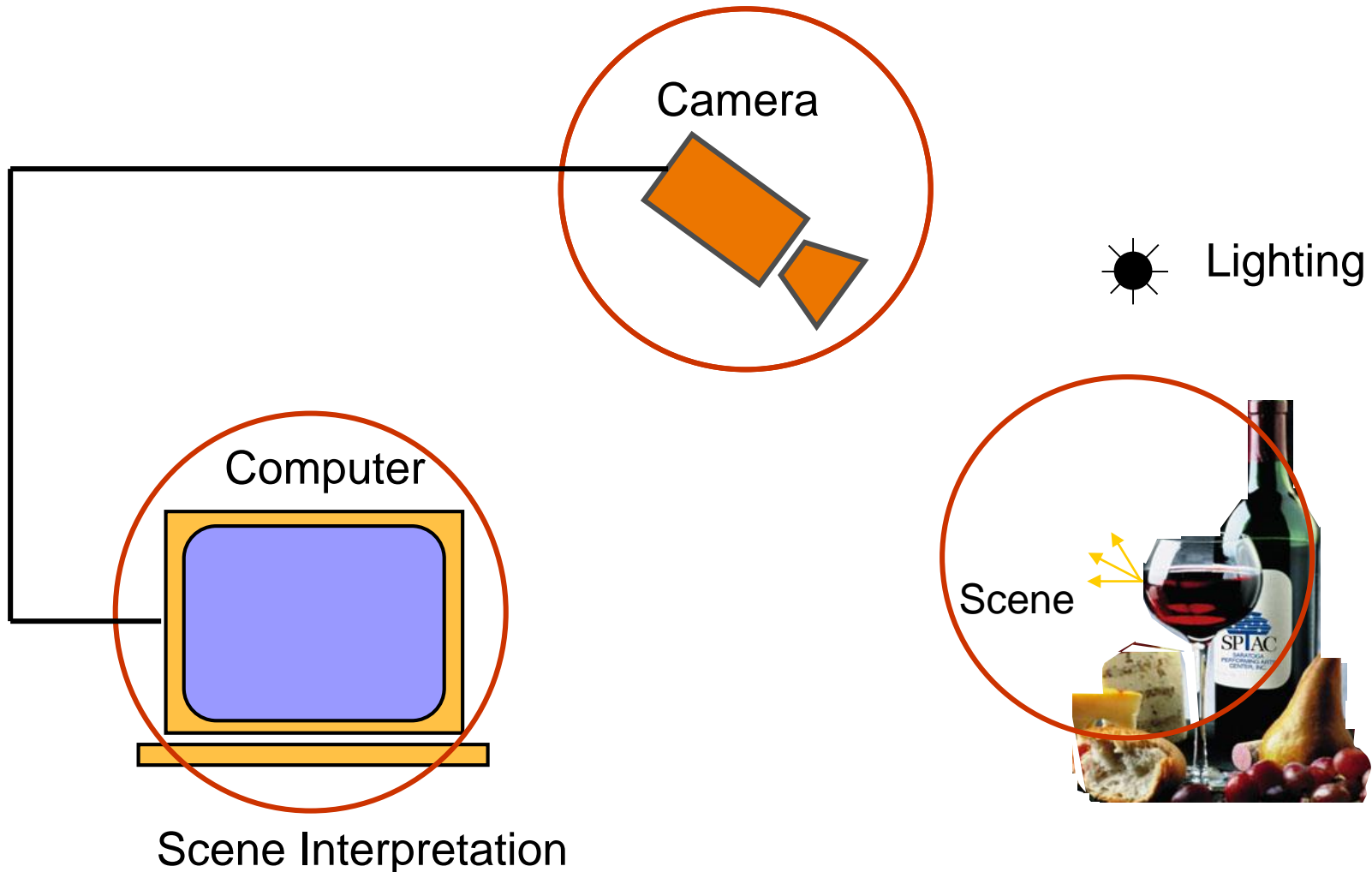
What we see

0	3	2	5	4	7	6	9	8
3	0	1	2	3	4	5	6	7
2	1	0	3	2	5	4	7	6
5	2	3	0	1	2	3	4	5
4	3	2	1	0	3	2	5	4
7	4	5	2	3	0	1	2	3
6	5	4	3	2	1	0	3	2
9	6	7	4	5	2	3	0	1
8	7	6	5	4	3	2	1	0

What a computer sees

# Components of a Computer Vision System

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# What is Computer Vision?

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- Inverse Optics
- Intelligent interpretation of Imagery
- Building a Visual Cortex
  
- No matter what your definition is...
  - Vision is hard.
  - But is fun...

# What is Physics-based Vision?

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- “How did the Pixel get its value?”

[ - Jitendra Malik, UC Berkeley ]

- We must understand scene appearance

What is Appearance?

Lets see some pictures!

# Light and Shadows









# Reflections















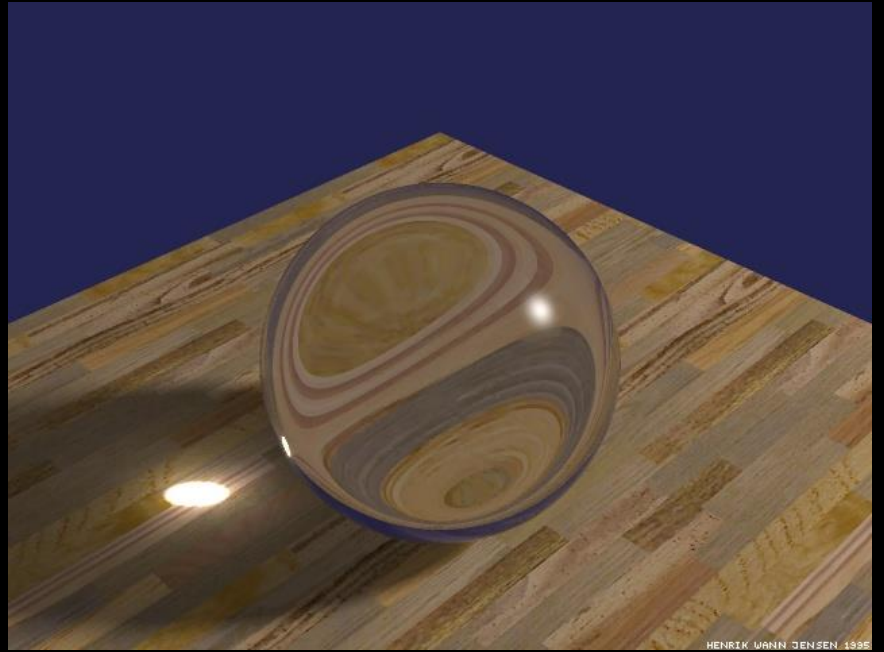
# Refractions







HENRIK WANN JENSEN, 1998



HENRIK WANN JENSEN, 1998



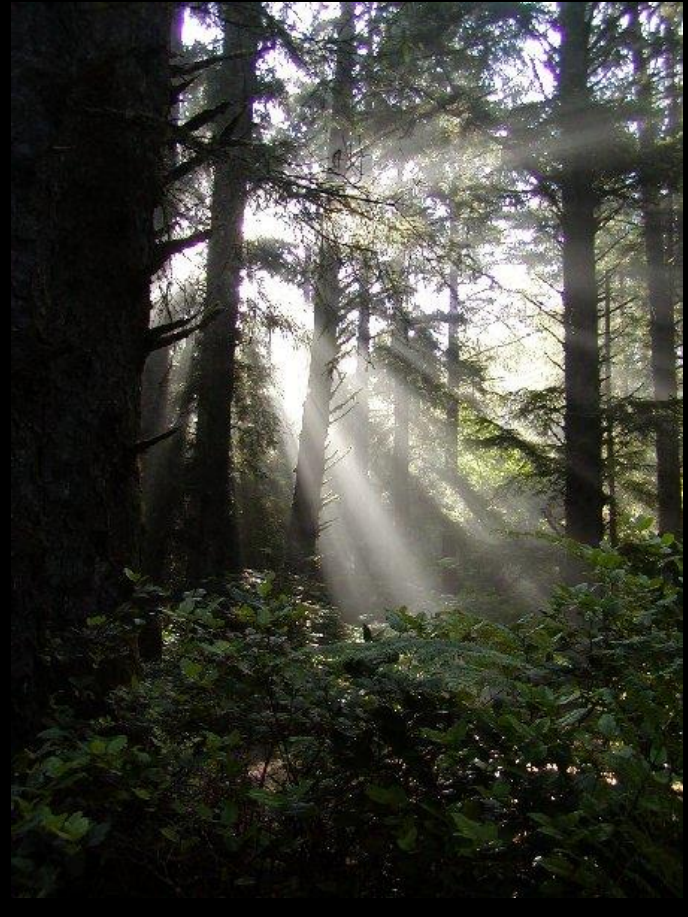
# Interreflections

Mies Courtyard House with Curved Elements





# Scattering







Haze



De-hazed



















More Complex Appearances



RENDERED BY HENRIK HANN JENSEN - 2004



RENDERED BY HENRIK HANN JENSEN - 2004











# Concepts in Optics you Learn

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Reflection

Caustics

Refraction

Interreflections

Polarization

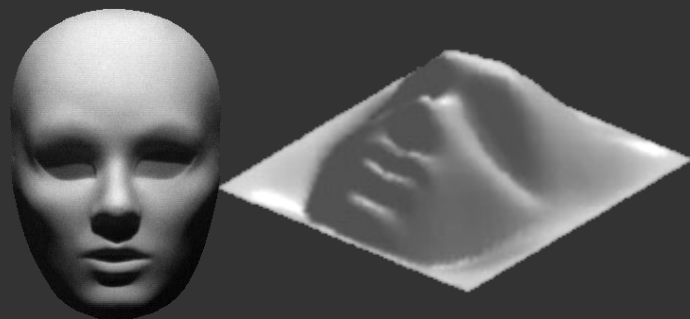
Scattering

Diffraction

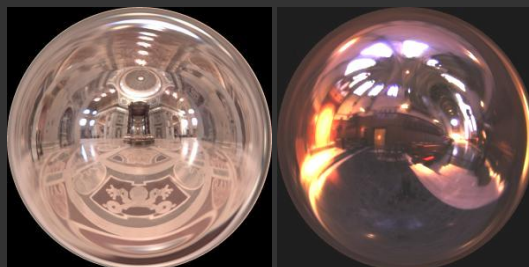
Interference

Why Understand Appearance?

# Appearance in Vision



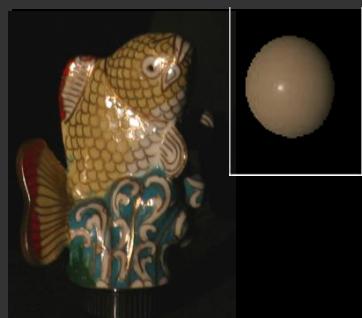
Shape from Shading



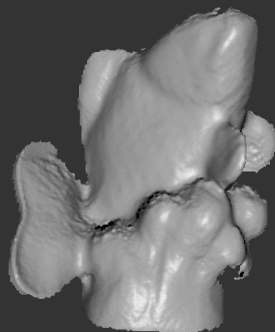
Illumination Estimation



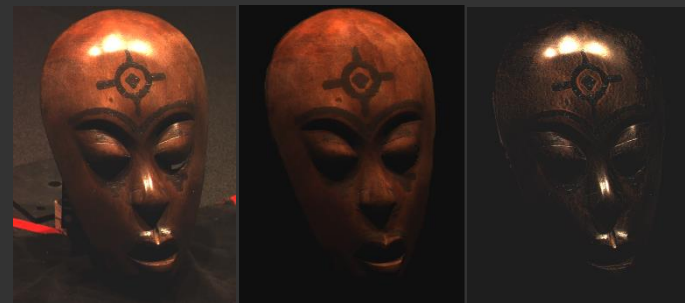
Texture Modeling



Photometric Stereo



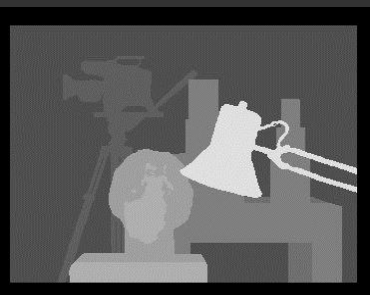
Color Constancy



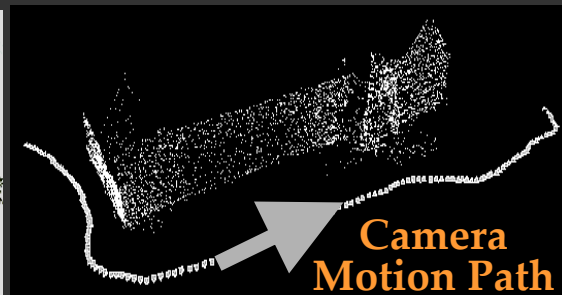
Reflection Separation



Stereo



Motion



Camera Motion Path

# Good Vision in Bad Weather



Haze



Mist



Fog



Rain

# Driving in Bad Weather



# Applications in Graphics

Final Fantasy



Shrek





Computer Vision



Computer Graphics



Underwater Imaging



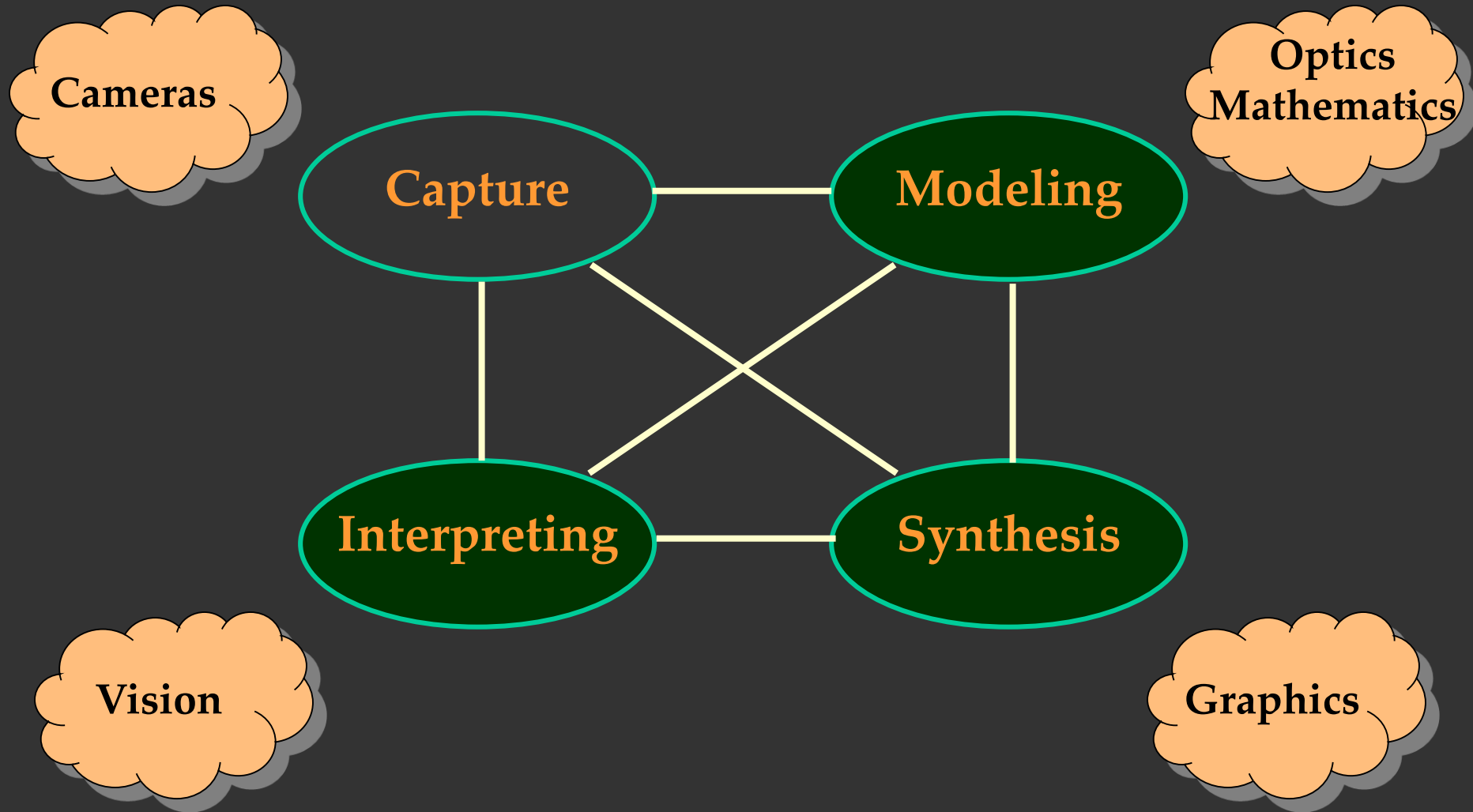
Medical Imaging



Satellite Imaging

# Exploring the Visual Appearance of Nature

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What to model?

How much to model?



**Scale is Everything**  
**Geometry vs. Reflectance vs. Statistics vs. Sensor**

# Course Format

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- Semester-long research project - 60 %
- One Paper Presentation - 30 %
- Nature Photography Competition - 10 %

## IMPORTANT:

- Do you have access to a good camera?
- Do you have access to a good machine with Matlab?

# Lectures Format

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Each Week:

First Lecture: Optical Phenomenon

Second Lecture: Applications in Vision and Graphics

# Research Project

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- Teams of 2 or 3 for a project.
- Meet me this or next week for initial discussion.
- Set small goals throughout the semester.
- Meet me once in two weeks to show progress and discuss next steps.
- Give final presentation/demo in December.
- If you get great results, we can even try to write a paper.

# Sample Research Projects

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Dimensionality of Outdoor Lighting and Reduced Dimension models

Lighting insensitive features, shadow detection and elimination

Reconstructing Illumination from Images

Image based rendering from Webcam data

Rendering appearance effect X,Y,Z,A,B,C...

More details next class...



# Webcams everywhere!

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Image-based Rendering

Lighting Insensitive Recognition

Reduced dimensional models for appearance

# Photography Competition

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Take 10 Great Photographs of the appearance effects discussed in class.

Give a five minute slide presentation with only those pictures (point to the effects).

Vote for the best photographer.

A few faculty will also vote.

Win a Prize!

No...not a round trip to Hawaii!