# ISTA 352

Lecture 25

*finishing* **Light interacting with the world and Visual display of data**

Administrivia

- I will accept questions for the bonus assignment through the weekend. (We are late getting the video up).
  - Please send me questions in multiple choice format

- Homework 3B due Sunday Oct 21

Specularities

Fuzzy mirror

Specular surfaces

from point source

specular direction

fuzzy mirror
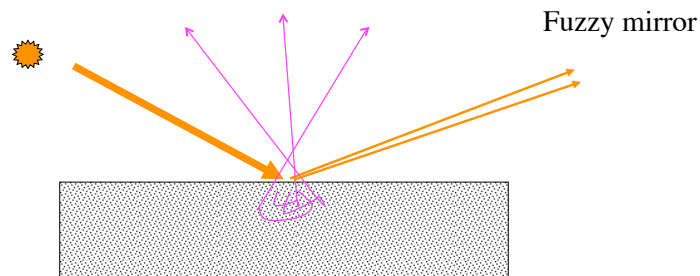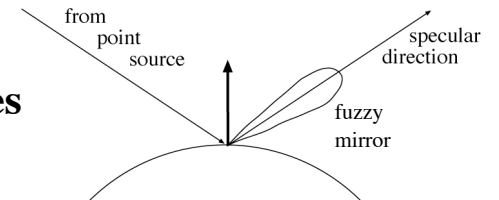
- Important point: The specular part of the reflected light usually carries the color of the **light**
- Technically, this is the case for dielectrics--plastics, paints, glass.
- Important exception is metals (e.g. gold, copper)

Dielectric Specularities
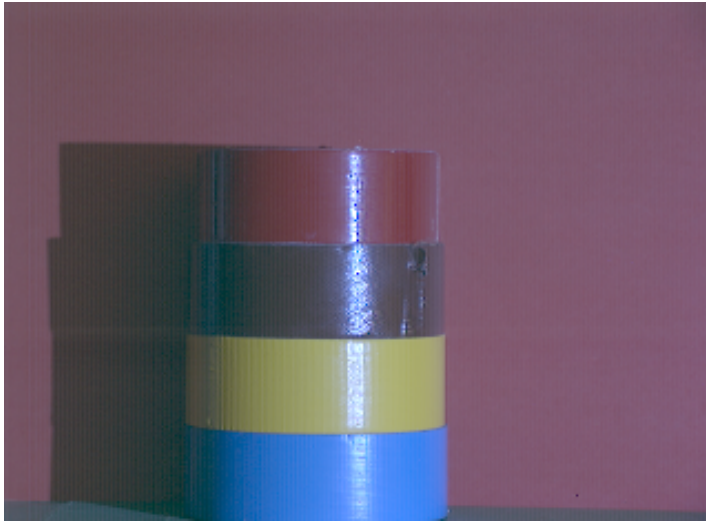
Shadows

Shadows cast by a point source

- A point that can't see the source is in its shadow
- For point sources, the geometry is simple
- For extended sources, we have an **umbra** (points seeing no light), and a **penumbra** (seeing some parts of the light but not all)

Cast Shadow Boundary

Point Source

Self Shadow Boundary
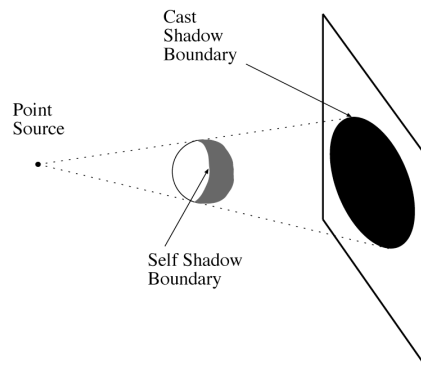
The Shadow Identification Problem

Material Edge

Shadow Edge

Shadows in paintings

Shadows in paintings

- Shadows help the 3D illusion a lot, but they need not be mathematically correct or consistent

- The human vision system uses shadows as cues, but does not seem to care much about global consistency
  - Perhaps too hard to compute to evolve?
  - Evolving to be able to verify that the real world is "real" might not make a lot of sense
  - Figuring out why shadows are where they are, or whether they are missing, as an exercise can be hard (try it at home!)
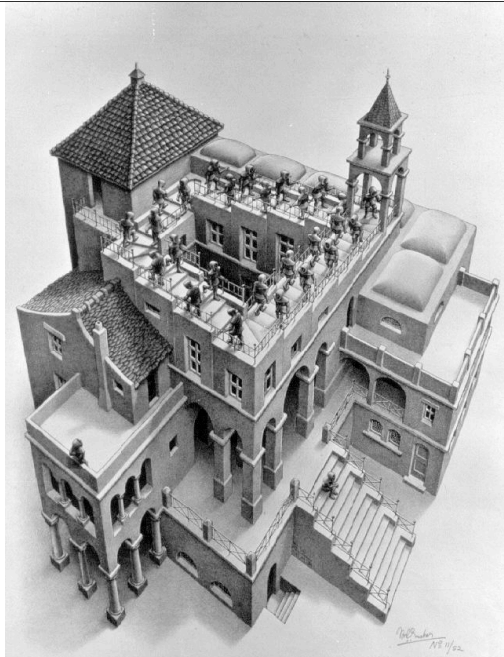
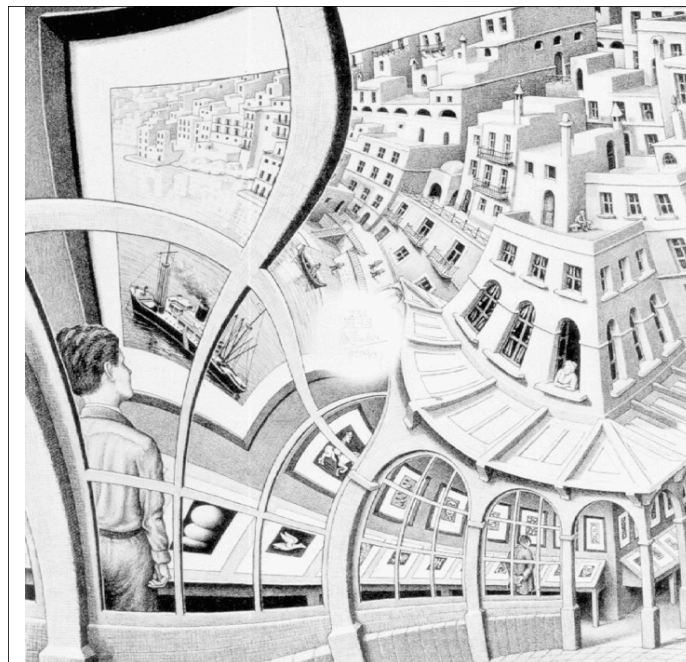# More examples of locally reasonable, globally inconsistent

M.C.Escher,
Waterfall, 1961

M.C.Esher, *Belvedere*, 1960

M.C.Esher, *Ascending
and Descending*, 1960

M.C.Esher, *Print
Gallery*, 1956

Visual Communication

- A documents should tell a story
  - People respond to stories
    - There is a problem, an approach, and resolution
    - There is logic, ordering, and choice of material
    - Relations among facts is important
    - Which facts matter is important

Visual Communication

- Telling technical stories well often demand figures
  - You should know why you are using a figure
    - e.g., to present visual evidence about something in particular
  - The reader should know why they are looking at a figure
    - Often the caption should make this clear
  - Figures can tell the story in different ways
  - Figures can present and explain complex information

- We assume the shared goal of telling stories honestly

Visual Display of Data

- Subsequent material is largely drawn from Tufte's books
  - *Envisioning information*
  - *The visual display of quantitative information*
  - *Visual explanations*

Five minute video of highlights from a Tufte talk

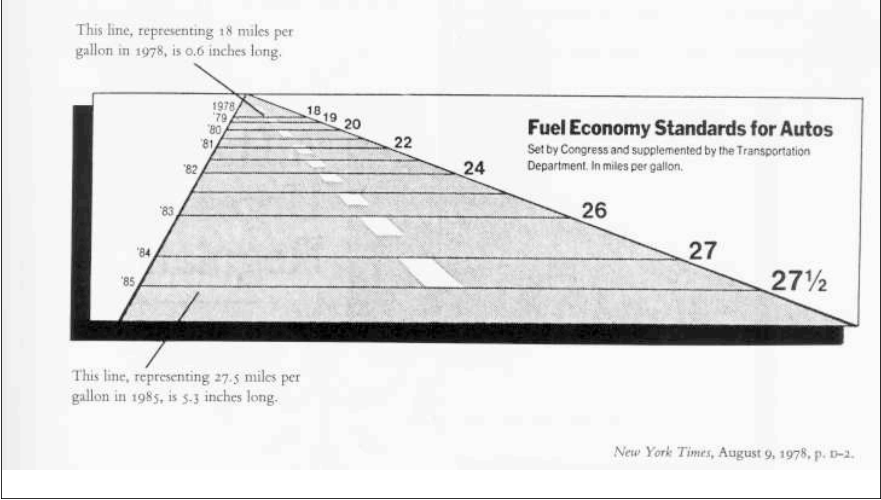|	I		II		III		IV	
	X	Y	X	Y	X	Y	X	Y
	10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
	8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
	13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
	9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
	11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
	14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
	6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
	4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
	12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
	7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
	5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

N = 11
mean of X's = 9.0
mean of Y's = 7.5
equation of regression line: Y = 3 + 0.5X
standard error of estimate of slope = 0.118
t = 4.24
sum of squares X − $\overline{X}$ = 110.0
regression sum of squares = 27.50
residual sum of squares of Y = 13.75
correlation coefficient = .82
r^2 = .67
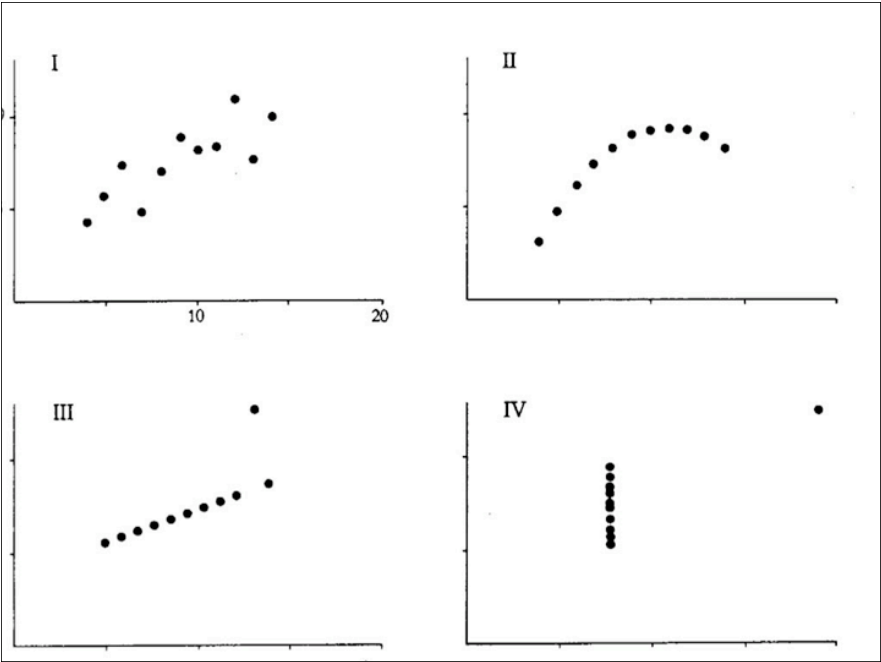
Four ways to lie with graphs

- (1) Distances not in proportion to the numbers

- (2) Vary the graph design in the figure
  - Now variation reflects design variation, not data variation

- (3) Present data out of context
  - Choose data that fits your point

- (4) Use dimensions (i.e., area) incorrectly

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(1) Distances not in proportion to the numbers

This line, representing 18 miles per gallon in 1978, is 0.6 inches long.

Fuel Economy Standards for Autos
Set by Congress and supplemented by the Transportation Department. In miles per gallon.

This line, representing 27.5 miles per gallon in 1985, is 5.3 inches long.

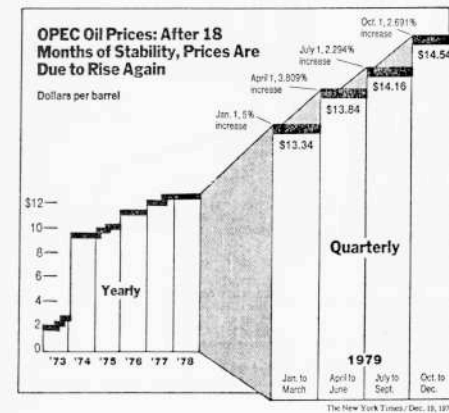New York Times, August 9, 1978, p. D-2.

Ways to lie with graphs

- (2) Vary the graph design in the figure
  - Now variation reflects design variation, not data variation

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Varying graph design creates perceived data variation

Ways to lie with graphs

- (3) Present data out of context
  - Choose data that fits your point
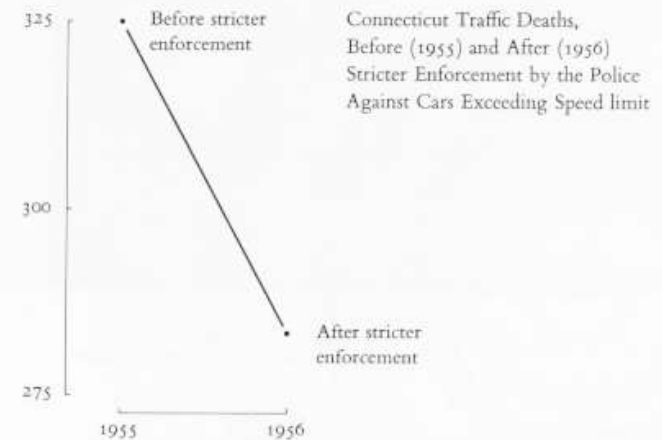
A few more data points add immensely to the account:

Connecticut Traffic Deaths, 1951–1959
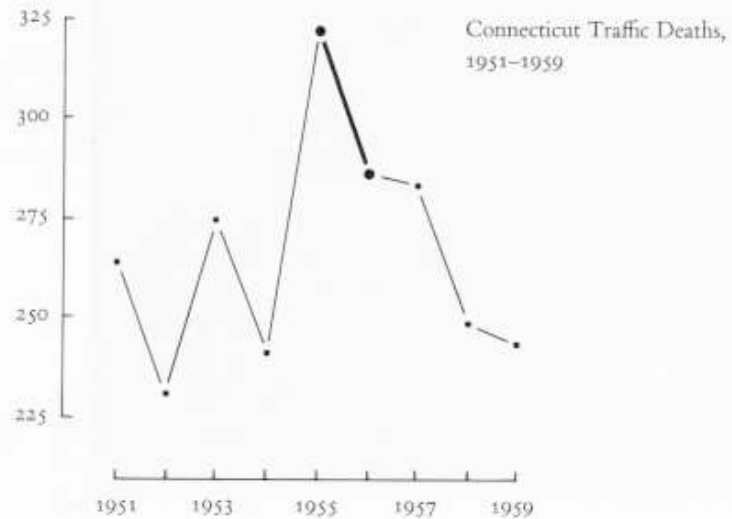
Ways to lie with graphs

- (4) Use dimensions (e.g., area) incorrectly
  - If you scale both dimensions by 2, the area goes up by 4
    - Although perception of area does not go up quite as fast as length squared, it is still a lie
    - Tufte says that the number of dimensions depicted should not exceed that number of dimensions in the data

THE SHRINKING FAMILY DOCTOR
In California

Percentage of Doctors Devoted Solely to Family Practice

1964	1975	1990
27%	16.0%	12.0%

1: 4,232
6,212

1: 3,167
6.694

1: 2,247 RATIO TO POPULATION
8.023 Doctors
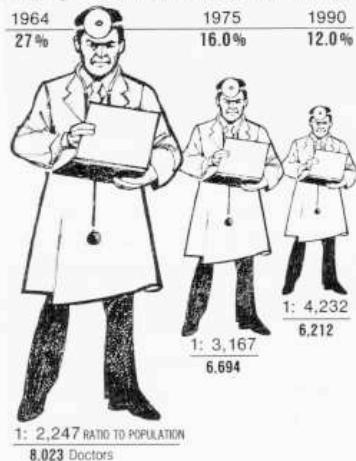
Los Angeles Times, August 5, 1979, p. 3