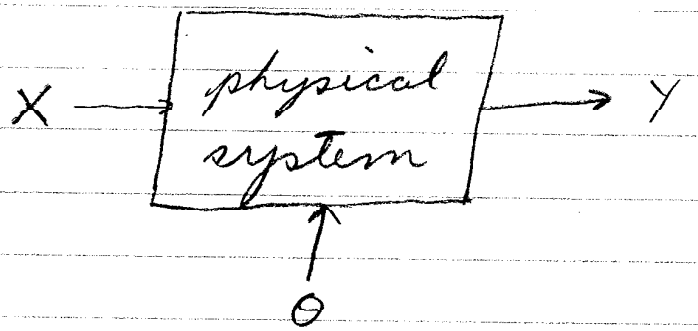
Digital Image Processing II

Lecture I

- Themes of course
  - A. Analytical Models. (Stochastic)
  - B. Optimal solutions (estimates)
  - C. Fast Computation (optimization)

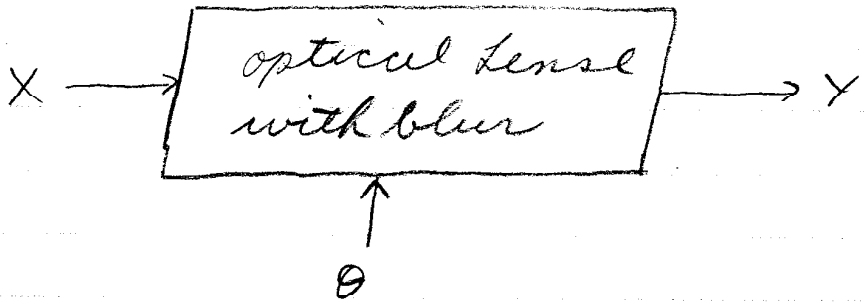
I Analytical Models



X - Unknown image data
Y - physical measurements
Θ - Unknown system parameters

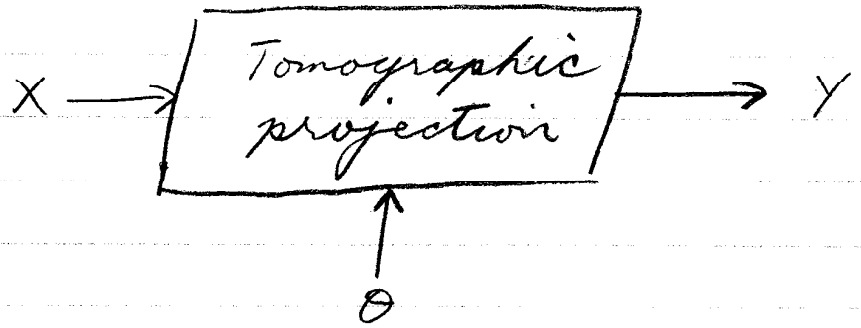
- X is what we would like to know
- Y is what we have
- Θ are possibly unknown settings or knobs in our model

Examples: image restoration



X - sharp original image
Y - blurred version of X
θ - point spread function for optical system

Example:



X - object cross section
Y - projection measurements
θ - calibration parameters.

II Optimal Solutions - find the "best" image X given the data Y.

A. "Exact" solutions are often not possible
1. noise makes deterministic relations erroneous
2. Missing information may allow for more than one valid solution
3. Modeling errors

B. How do we choose the "best" solution for X?
1. Best fit to data
a. depends on system noise
b. Maximum likelihood (ML) estimate
c. ML estimate is "too noisy"

2. Reasonable solution
a depends on prior model
b. Maximum a posteriori (MAP) estimate

3. Pick the right model
a. use a family of models selected by unknown parameter θ
b. estimate θ from data

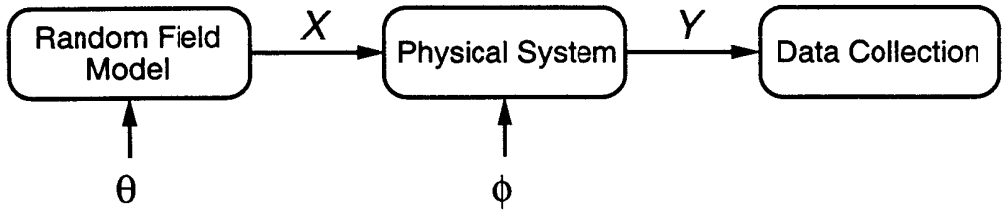
The Bayesian Approach

θ - Random field model parameters

X - Unknown image

ϕ - Physical system model parameters

Y - Observed data



- Random field may model:
  - Achromatic/color/multispectral image
  - Image of discrete pixel classifications
  - Model of object cross-section
- Physical system may model:
  - Optics of image scanner
  - Spectral reflectivity of ground covers (remote sensing)
  - Tomographic data collection