

# An Introduction to Mathematical Image Processing

## IAS, Park City Mathematics Institute, Utah

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## Topics

### Introduction

### Fundamental steps in image processing

### A simple image formation model

### Image sampling and quantization

### Intensity transformations and spatial filtering

- Histogram equalization
- Histogram matching (suggested reading)
- Spatial filtering (correlation, convolution, spatial filter masks)
- Smoothing (linear) spatial filters
- Sharpening spatial filters using the Laplacian

### Filtering in the frequency domain

- 1D and 2D continuous and discrete Fourier transforms
- convolution theorem
- properties of the Fourier transform
- filtering in the frequency domain (smoothing and sharpening, low-pass and high-pass filtering)
- the Laplacian in the frequency domain, enhancement
- homomorphic filtering
- band-reject and band-pass filters

### Image restoration and reconstruction

- noise models
- mean filters
- order statistics filters
- adaptive median filter
- periodic noise reduction
- NL Means filter
- linear, position-invariant degradations
- examples of degradation (PSF) functions

- inverse filtering (Wiener filter, constrained least squares filtering, total variation minimization)
- image reconstruction from projections (Radon transform, computed tomography, the Fourier slice Thm., filtered backprojections using parallel beam)

### **Image segmentation**

- image gradient, gradient operators, gradient-based edge detection
- the Marr-Hildreth edge detector, Canny edge detector
- active contours
- global processing using the Hough transform