

ISTA 352

Lecture 33

Image Analysis

Administrivia

- Quiz 3 next Friday, material up to the end of today
- Homework 4B now posted, due Nov 13
 - questions?

Image processing

- Image processing takes an input image and computes an output image (with some desired characteristic).
- Examples
 - Noise reduction
 - Contrast enhancement
 - Image restoration (e.g., sharpening blurry images)
 - Removal of “red eye”
 - Compression

Image analysis

- Image analysis (typically) takes an input image and computes quantities of interest
- Result can be displayed as an image, but the focus is on some added value, or information extraction.
- Examples
 - Measuring neuron curvature
 - Counting seeds in an image
 - Estimating speed of objects being tracked
 - Reading license plates
 - Finding faces in images

Filtering

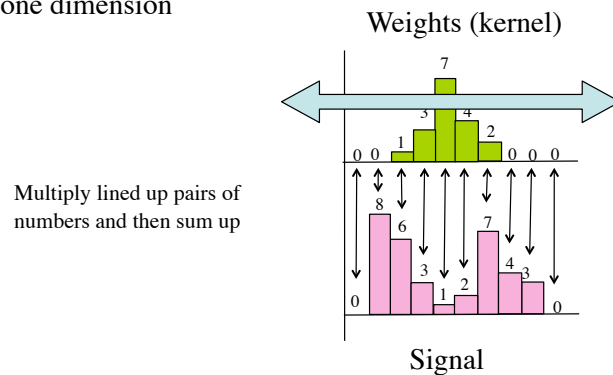
- Local operations that replace a pixel value with one computed from (typically) nearby ones
- Examples
 - Block averaging
 - Replace pixel with median value of neighborhood
 - Replace pixel with max value of neighborhood
 - Replace pixel with local change estimated by the difference between a pixel and its neighbors

Linear Filtering

- Important class of filters
- Examples from before that are linear
 - Block averaging
 - Replace pixel with local change estimated by the difference between a pixel and its neighbors

Linear Filtering

- Basic operation is a **dot product** between pixels values in “block”, and those in a “filter”.
- In one dimension

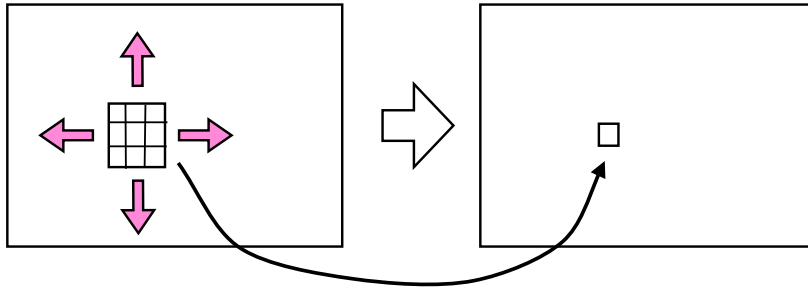


Linear Filtering

- Basic operation is a **dot product** between pixels values in “block”, and those in a “filter”.
- These words all refer to the same thing
 - filter
 - mask
 - weights
 - kernel

Linear Filtering (2D)

Gray scale image (matrix)



Compute product of the weights in the mask with corresponding image ones, and sum up (dot product)

Result goes into a new image at the same place as the mask location

Then slide mask over one pixel and do it again (etc.)

Linear Filter Examples

Replace each pixel with the the average of itself and immediate neighbors (block average)

$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$
$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$
$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$

Example: Smoothing by Averaging

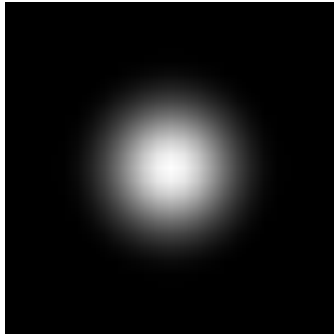


Linear Filter Examples

Same as before, but suppose the you want 1/2 of the weight from the middle pixel.

$\frac{1}{16}$	$\frac{1}{16}$	$\frac{1}{16}$
$\frac{1}{16}$	$\frac{1}{2}$	$\frac{1}{16}$
$\frac{1}{16}$	$\frac{1}{16}$	$\frac{1}{16}$

An Isotropic Gaussian Filter



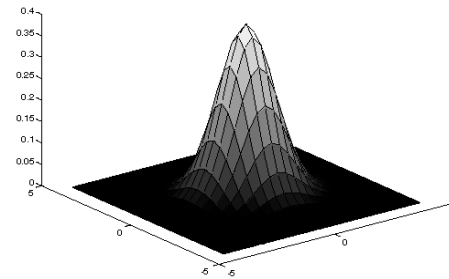
- The picture shows a smoothing kernel proportional to

$$\exp\left(-\left(\frac{x^2 + y^2}{2\sigma^2}\right)\right)$$

(a reasonable model of a circularly symmetric fuzzy blob)

- The Gaussian filter is the standard way to smooth images

An Isotropic Gaussian Filter



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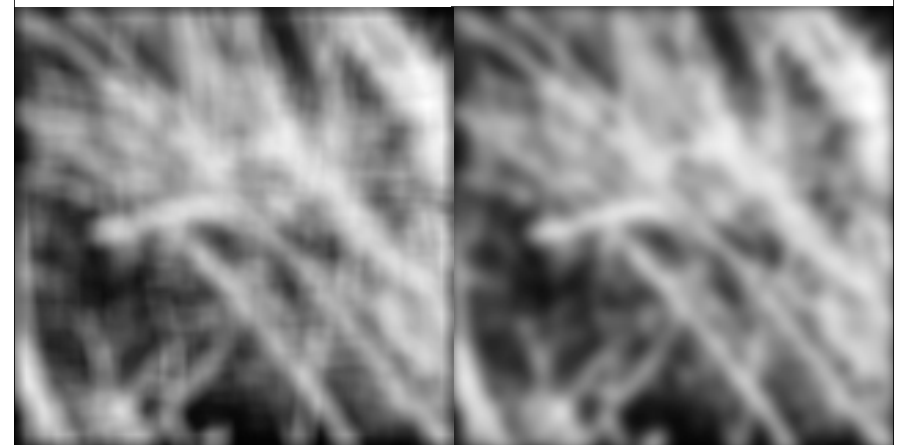
(a reasonable model of a circularly symmetric fuzzy blob)

- The Gaussian filter is the standard way to smooth images

Smoothing with a Gaussian



Block Averaging



Gaussian



Image Scale

- The difference between a tree in the distance, and its leaves up close, is one of image scale
- An arbitrary image will have multiple arbitrary scales
- Typically we analyze images at various scales
- A good way to think of rescaling an image is to smooth with a Gaussian and sub sample the results.

