Filters 1

What is filtering?

Filtering is a technique for modifying or enhancing an image.

For example, you can filter an image to emphasize certain features or remove other features.

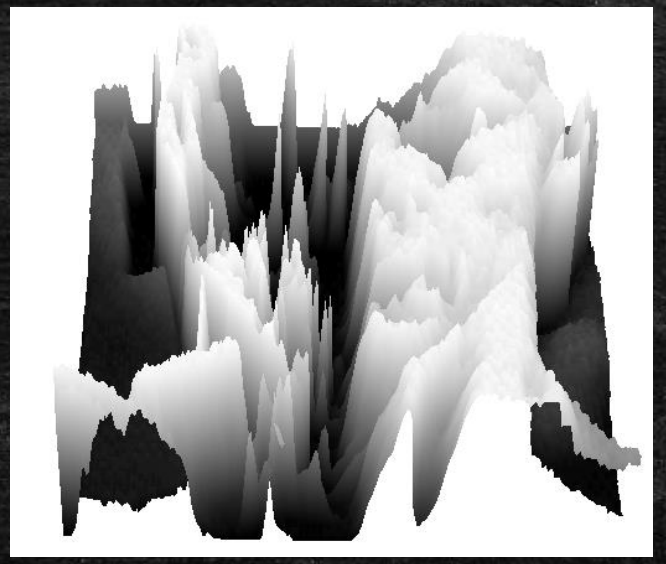
Image processing operations implemented with filtering include smoothing, sharpening, and edge enhancement.

Examples (sharpening)

Examples (blurring)

Images as functions

- We can think of a (grayscale) image as a **function**, where
  - $f(x,y)$ gives the **intensity** at position (x,y)



  - A **digital** image is a discrete (**sampled**, **quantized**) version of this function

Image transformations

- As with any function, we can apply operators to an image

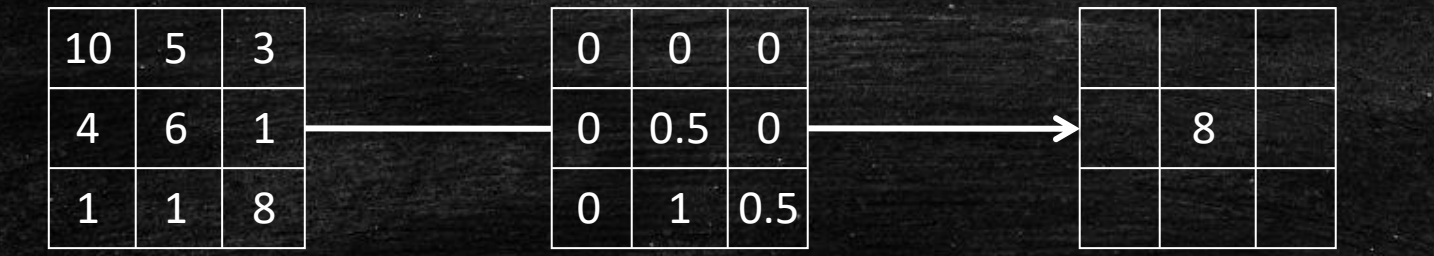

$g\,(x,y) = f\,(x,y) + 20$


$g\,(x,y) = f\,(-x,y)$

Kernel Transformations

Replace each pixel by a linear combination of its neighbors

- The prescription for the linear combination is called the "kernel" (or "mask", "filter")
- Involves sliding a kernel (filter) across an image.
- A mask should always be in odd number, because other wise you cannot find the mid of the mask.



Source: L. Zhang

Calculation

Assume original image is H. Filter is F. G is the resultant image. Each resultant pixel in G is calculated by:

$$G[i,j] = \sum_{u=-k}^{k} \sum_{v=-k}^{k} H[u,v]F[i-u,j-v]$$

How to do it

In order to perform a filter on an image, following steps should be taken.

1) Slide the mask onto the image.
2) Multiply the corresponding elements and then add them
3) Repeat this procedure until all values of the image have been calculated.

Linear filters: examples

Original

*

0	0	0
0	1	0
0	0	0

=

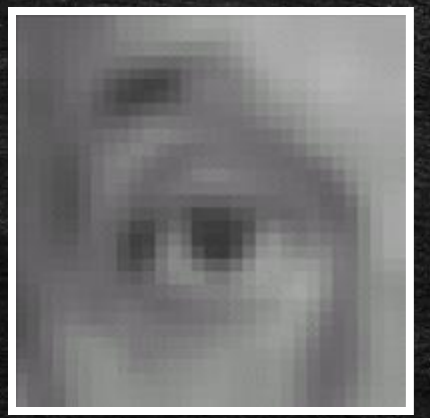
Identical image

Source: D. Lowe

Linear filters: examples

Original

$$* \frac{1}{9} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} =$$



Blur (with a mean filter)

Source: D. Lowe

We just did blurring with a 3x3 mask.

Consider a 5x5 mask:

1) What would the effect on blurring be?
2) What would the values of the mask need to be?

It is also possible to have masks that are 7x7, 9x9, etc… Try it out!

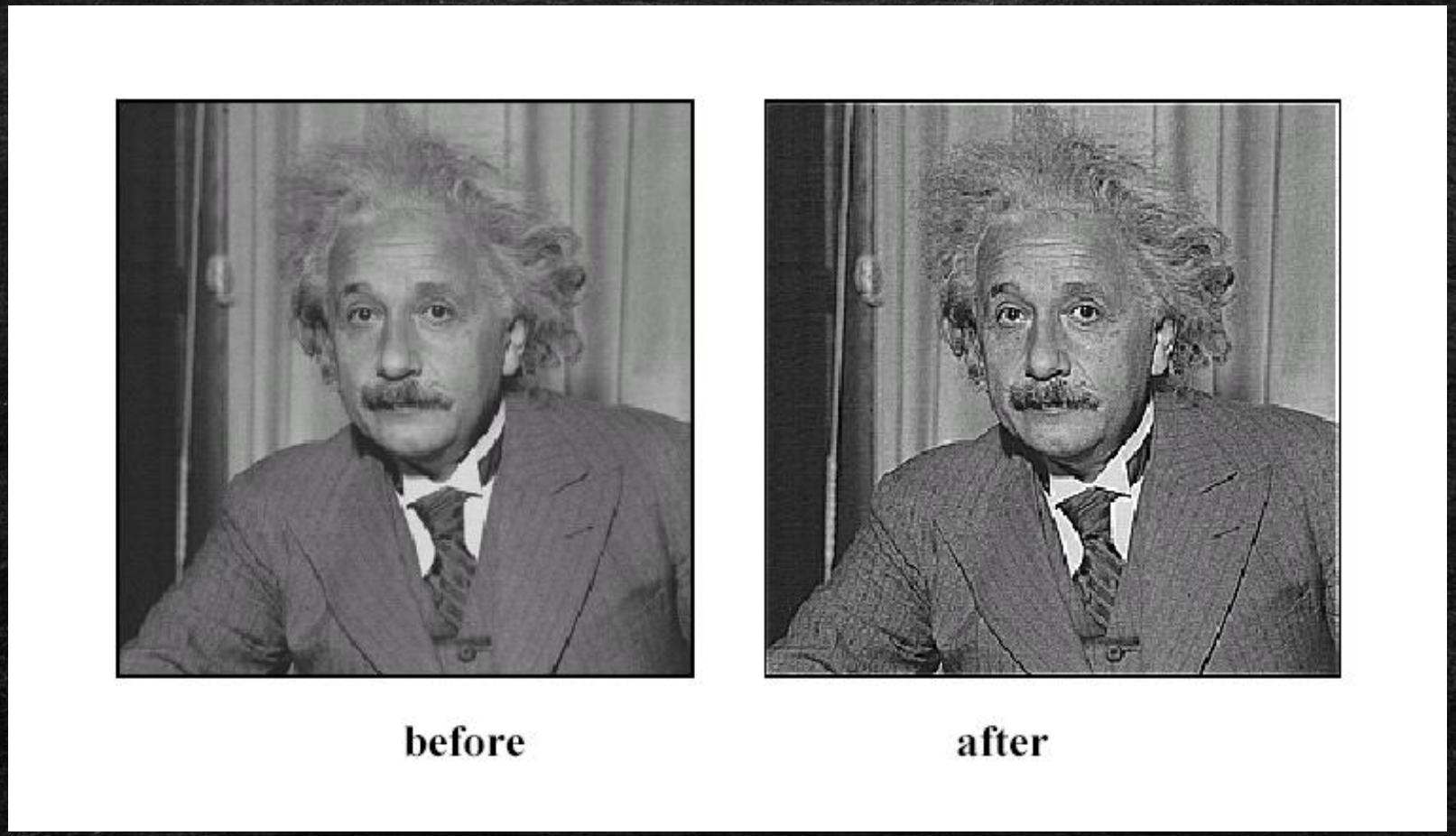
Source: D. Lowe

Python Implementation

```
img = cv2.imread('images/lena.jpg')
img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
#kernel = np.ones((5,5),np.float32)/25  or
kernel = np.array([[1, 1, 1], [1, 1, 1], [1, 1, 1]])
dst = cv2.filter2D(img,-1,kernel)
```

Try implementing different levels of blurring!

High-pass filters - Sharpening



Source: D. Lowe

Sharpening

- What does blurring take away?

Let's add it back:

Source: S. Lazebnik

Questions?