Removing Noise

- Images can be noisy (sensors imperfect, transmission noise, compression artifacts)

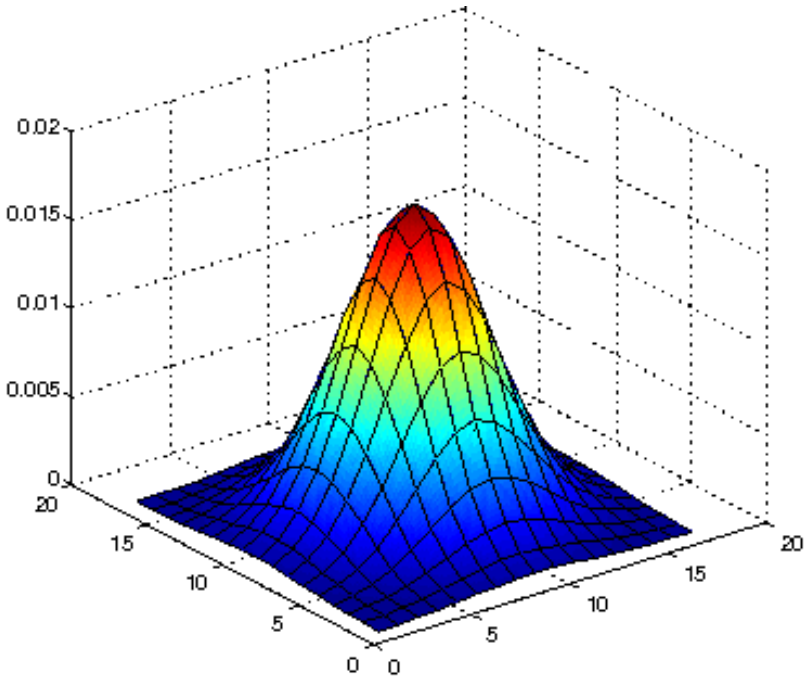
10% noise

Removing Noise: Spatial Linear Filtering

- Already seen Gaussian smoothing

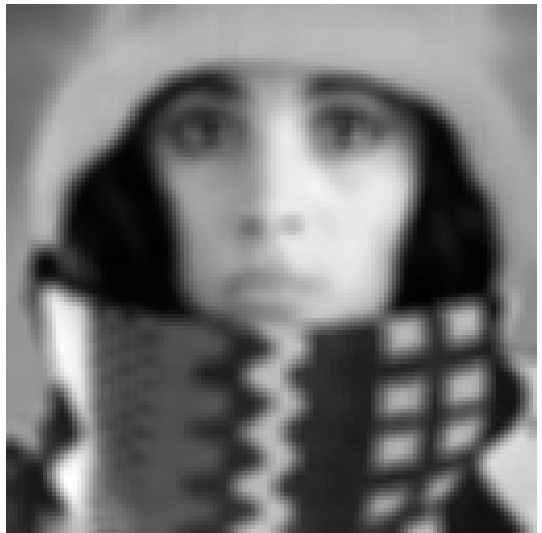
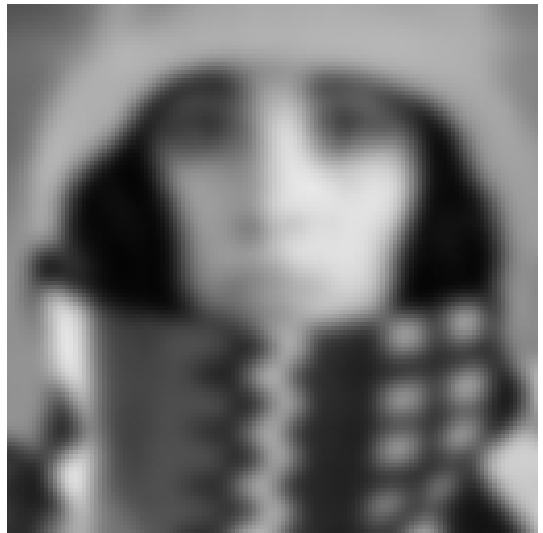
$$\begin{bmatrix} 0.0113 & 0.0838 & 0.0113 \\ 0.0838 & 0.6193 & 0.0838 \\ 0.0113 & 0.0838 & 0.0113 \end{bmatrix}$$

- (Here is a Gaussian, but this time using real numbers)



Removing Noise: Gaussian Smoothing

- The box filter was all 1's – this is an average of all pixels local to the filter
- The Gaussian multiplies pixels by values – its called a *weighted average*
- It smoothes all parts of an image – including across edges
- Therefore sometimes known as a blurring filter
- Test it out in your assignment – note it does not blur as much as the box filter (because of the high weight on the central pixel)

Removing Noise: Non-linear Filtering

- Median filtering
- This is a non-linear filter because it no longer applies a filter kernel (or weighting) to pixel values
- Its different to all the previously presented filter techniques in these lectures
- Instead of weighting, the median (middle) value of the local neighbourhood is used

Removing Noise: Non-linear Filtering

- Using a small image (left), take the median filter size (e.g. 3x3)

80	89	78	80	81
82	88	86	90	85
81	83	52	85	83
78	80	78	82	80
76	77	77	75	73

[88, 86, 90, 83, 52, 85, 80, 78, 82]

Create a list of those pixels, and sort it

[52, 78, 80, 82, 83, 85, 86, 88, 90]

80	89	78	80	81
82	88	86	90	85
81	83	83	85	83
78	80	78	82	80
76	77	77	75	73

Find the median pixel (i.e. always the 5th pixel in the case of 3x3 region). Use it as the new value

Would have been 64, if using a 3X3 Gaussian kernel:

$$\begin{bmatrix} 0.0113 & 0.0838 & 0.0113 \\ 0.0838 & 0.6193 & 0.0838 \\ 0.0113 & 0.0838 & 0.0113 \end{bmatrix}$$

Removing Noise: Non-linear Filtering

- It preserves edges better than smoothing operators
- Its good at removing dots and lines (scratches)
- Not so affected by outliers (see previous slide)
- But sharp corners are smoothed (see below images)



Gaussian Blur

Median Filter

Photoshop: Dust and scratches