Mathematical Tools

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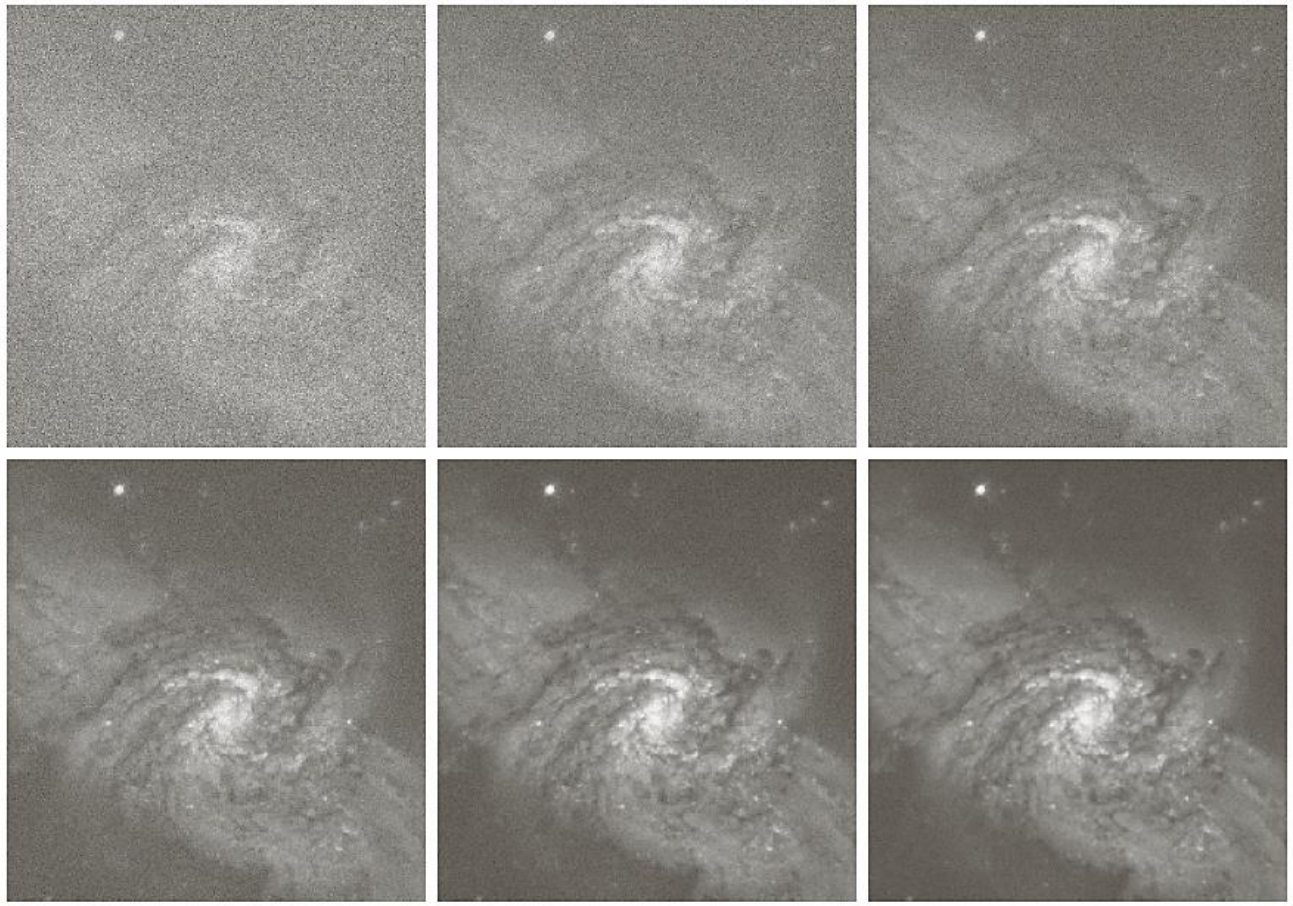
- Distance measures
- Array vs Matrix operations
- Linear vs Nonlinear
- Arithmetic operations

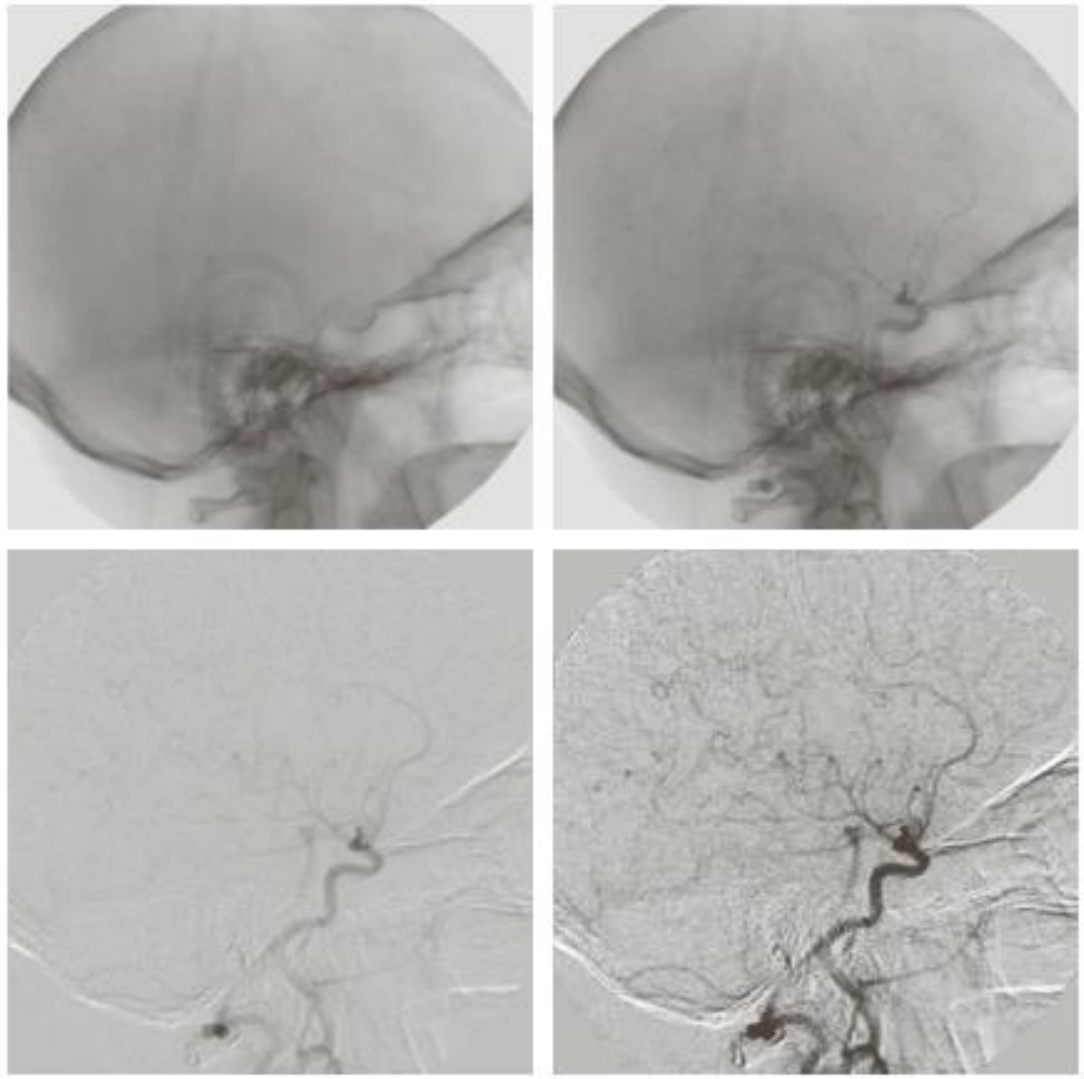


a b c
d e f

FIGURE 2.26 (a) Image of Galaxy Pair NGC 3314 corrupted by additive Gaussian noise. (b)–(f) Results of averaging 5, 10, 20, 50, and 100 noisy images, respectively. (Original image courtesy of NASA.)

Mask Mode Radiography

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

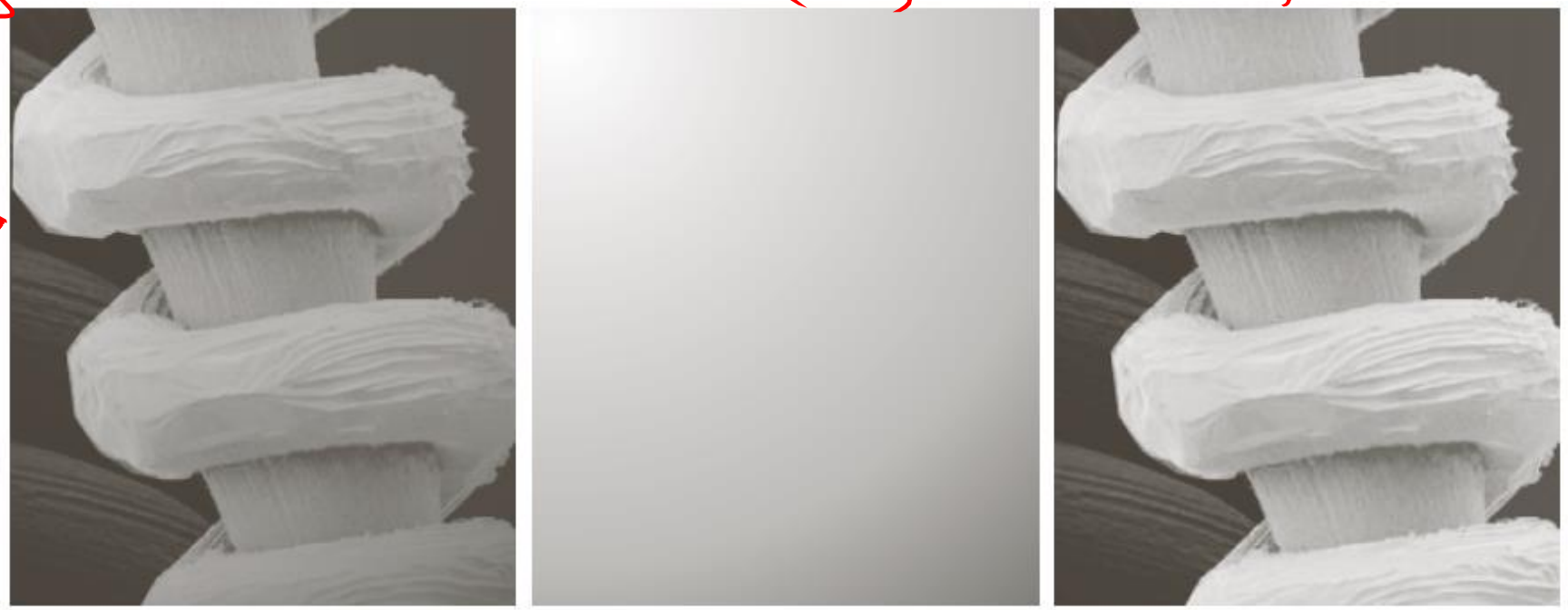


a b
c d

FIGURE 2.28 Digital subtraction angiography. (a) Mask image. (b) A live image. (c) Difference between (a) and (b). (d) Enhanced difference image. (Figures (a) and (b) courtesy of The Image Sciences Institute, University Medical Center, Utrecht, The Netherlands.)

using division

Shading Correction

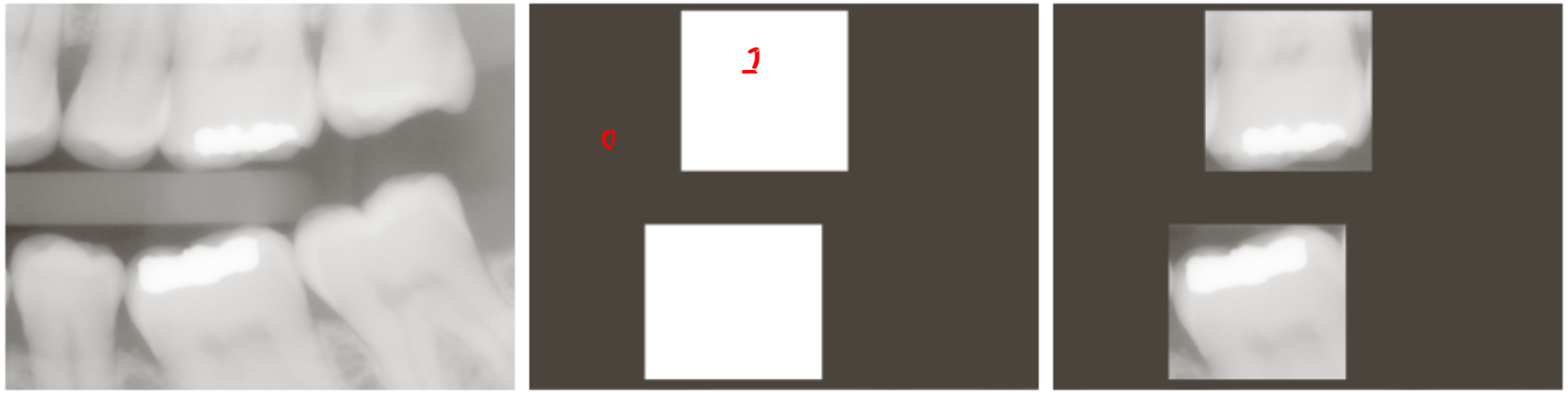


a b c

FIGURE 2.29 Shading correction. (a) Shaded SEM image of a tungsten filament and support, magnified approximately 130 times. (b) The shading pattern. (c) Product of (a) by the reciprocal of (b). (Original image courtesy of Mr. Michael Shaffer, Department of Geological Sciences, University of Oregon, Eugene.)

ROI

using multiplication



a b c

FIGURE 2.30 (a) Digital dental X-ray image. (b) ROI mask for isolating teeth with fillings (white corresponds to 1 and black corresponds to 0). (c) Product of (a) and (b).

Comments about arithmetic operations

- Most images are displayed using 8 bits.
- Image intensities are expected to be in the range from 0 to 255.
- Standard formats such as JPEG or TIFF maintain this.
- Difference between two 8-bit images can range from a minimum -255 to a maximum of 255.
- Addition of two images can range from 0 to 510.
- Some software packages simply set all negative values to 0 and set to 255 all values that exceed the limit of 255 when converting images to 8 bits.
- Full range of intensities should be captured.