Day 1

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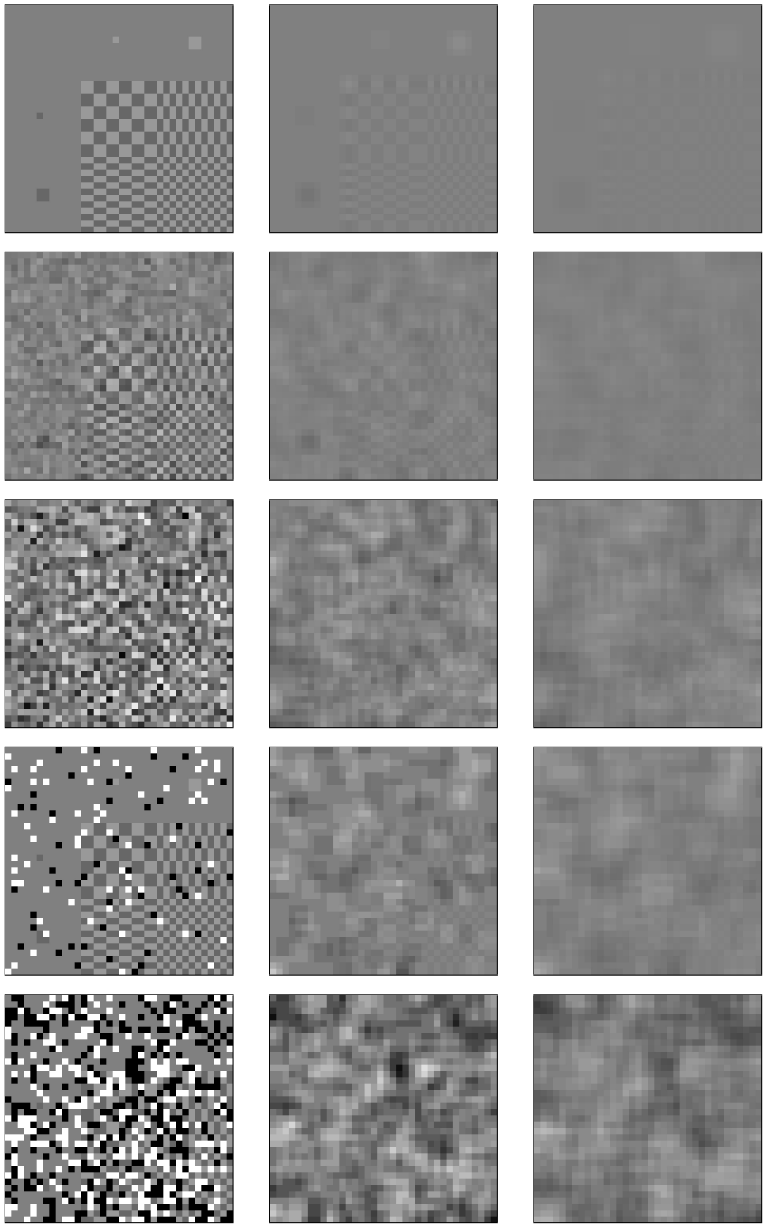
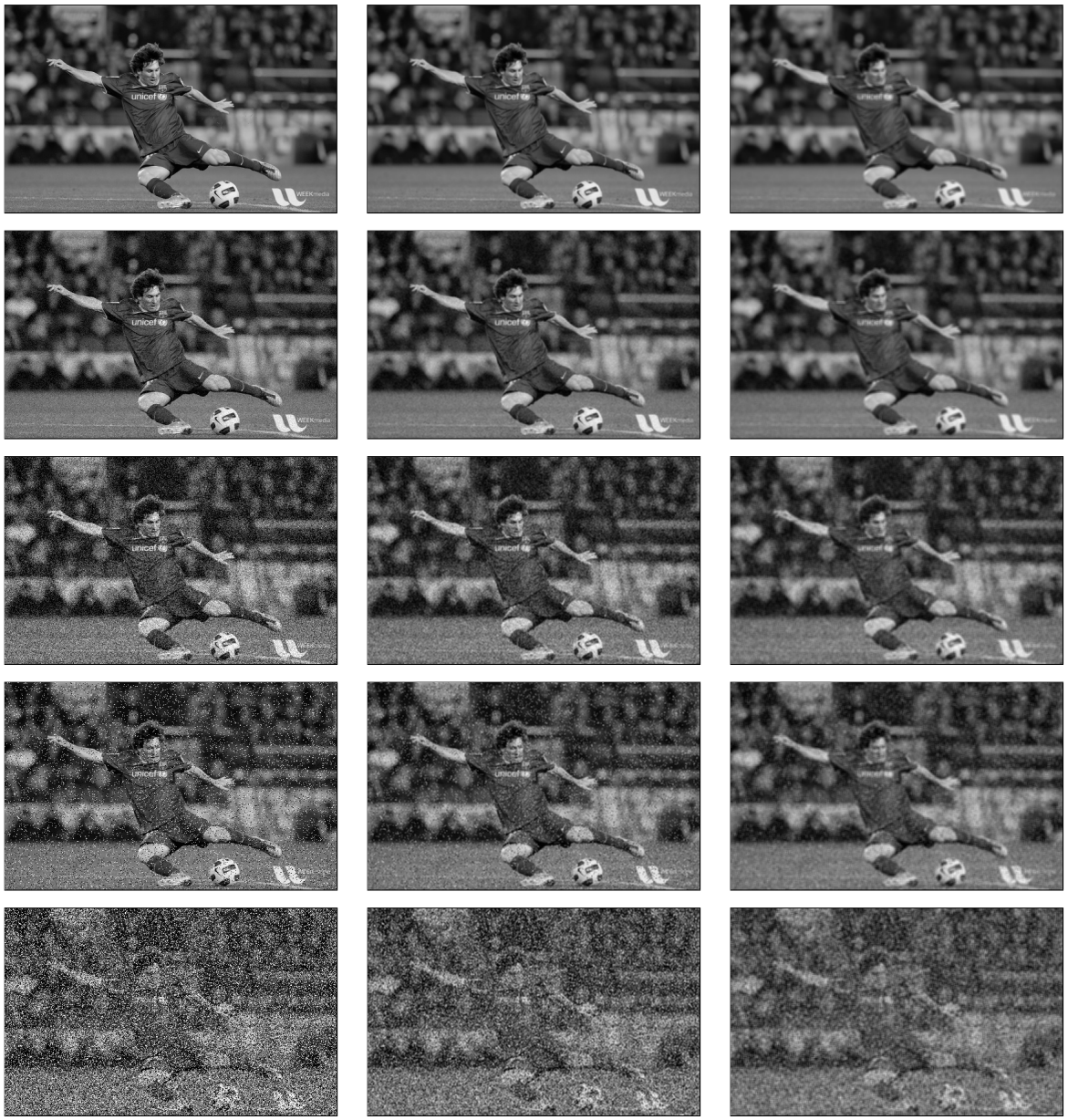
1 Original, noisy and filtered images

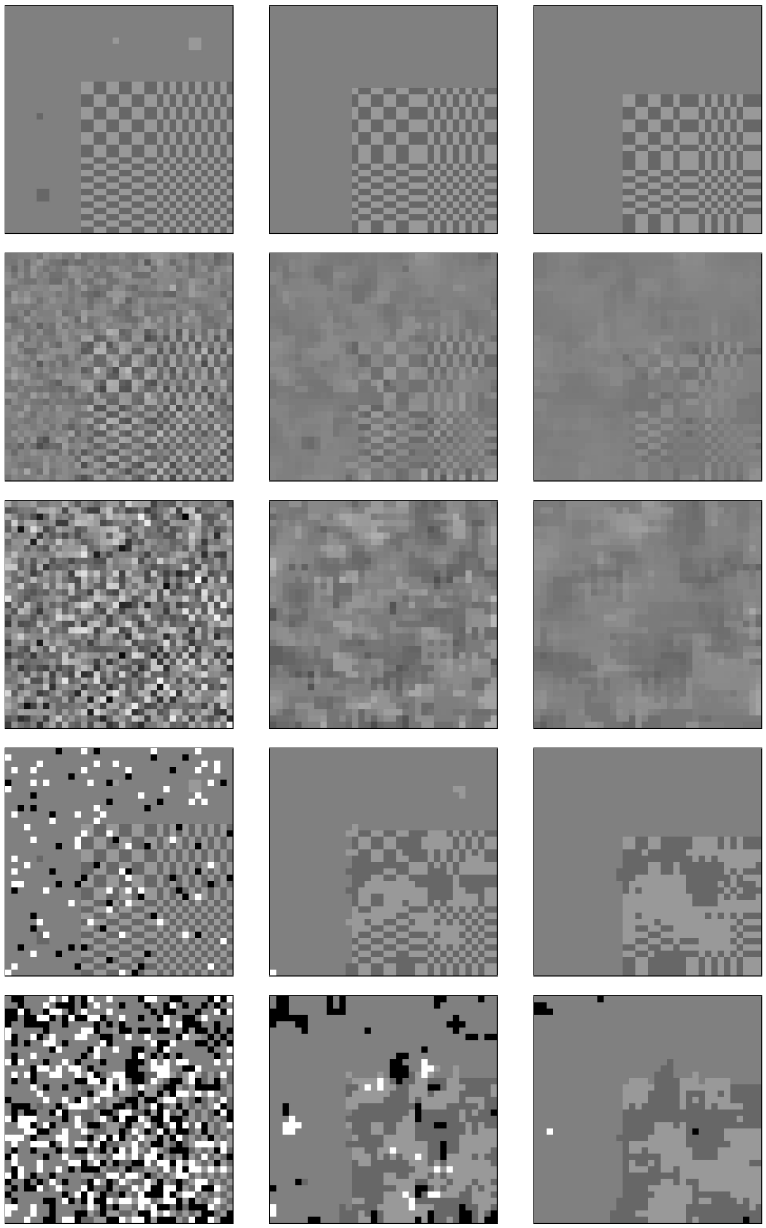
pattern low pass



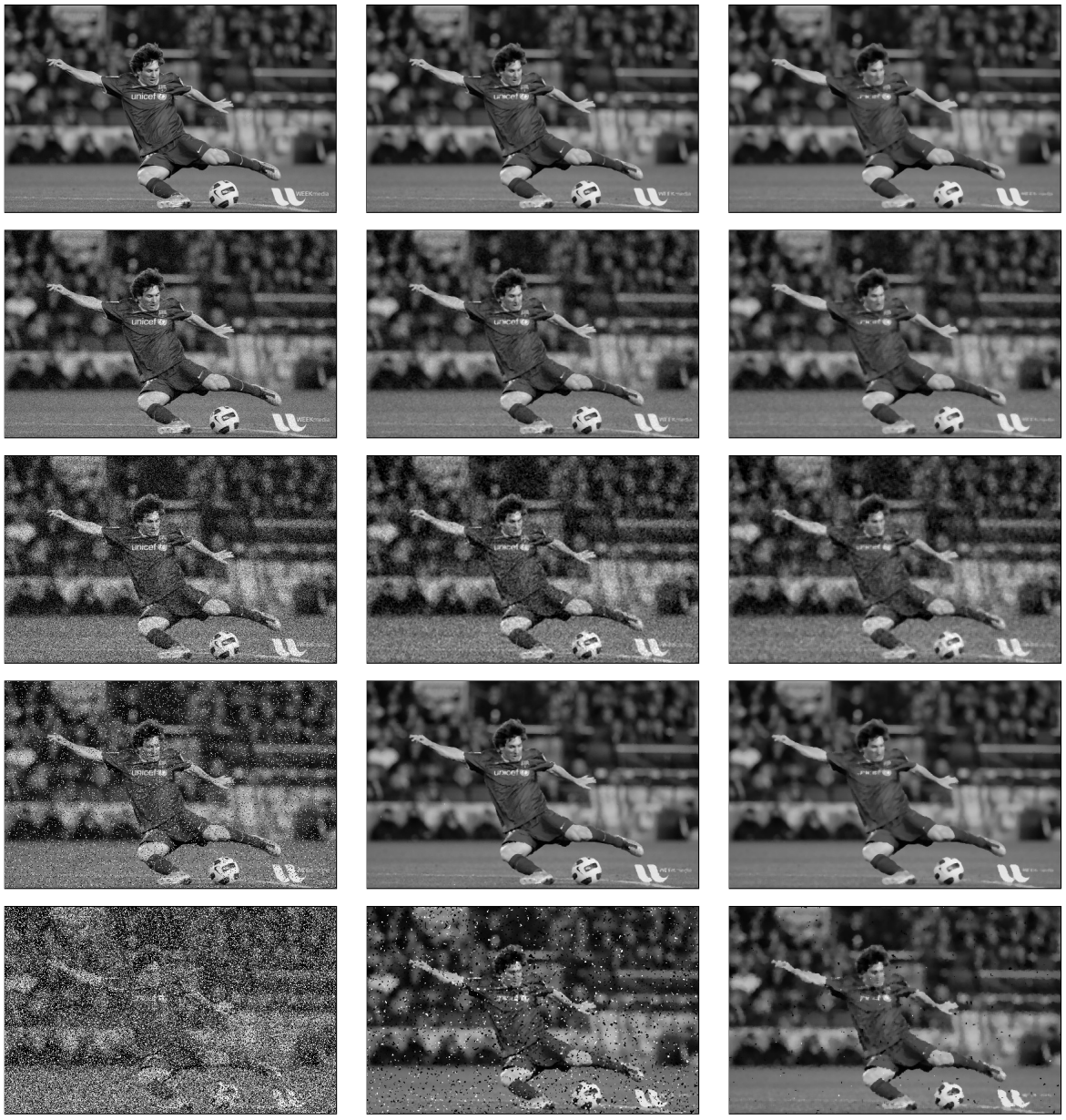
messi low pass



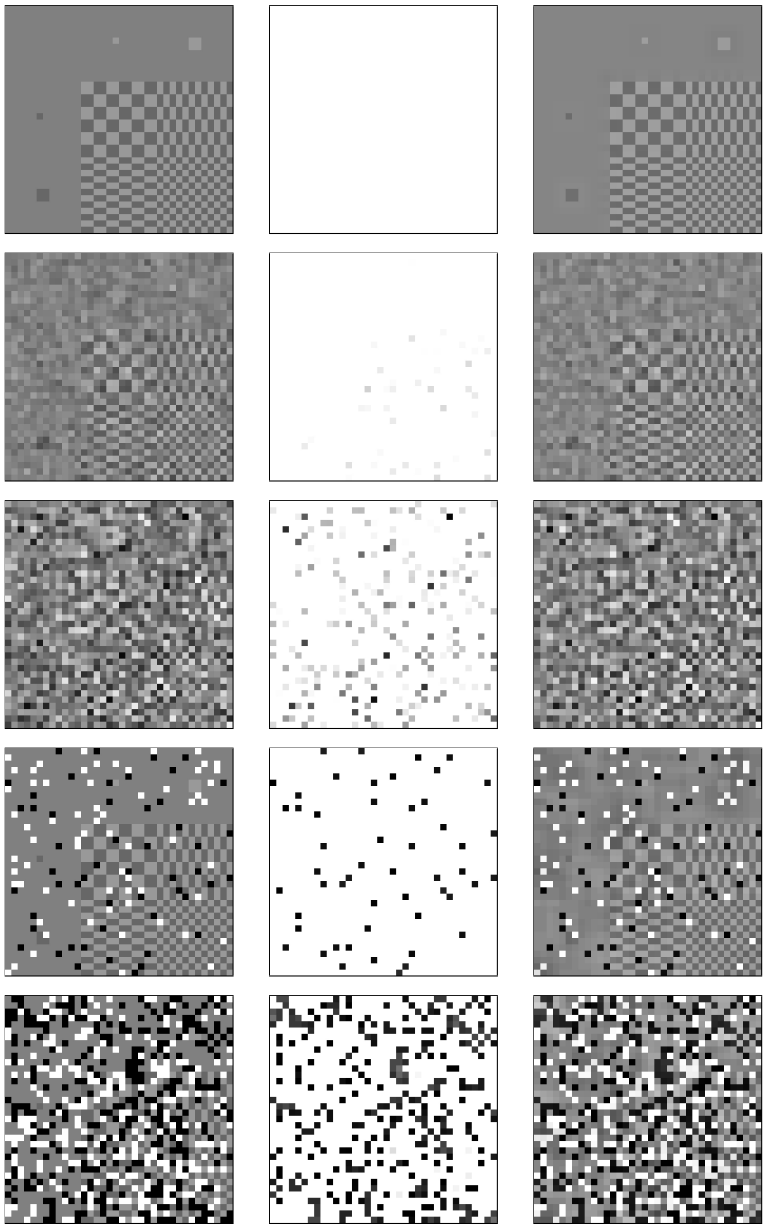
pattern median



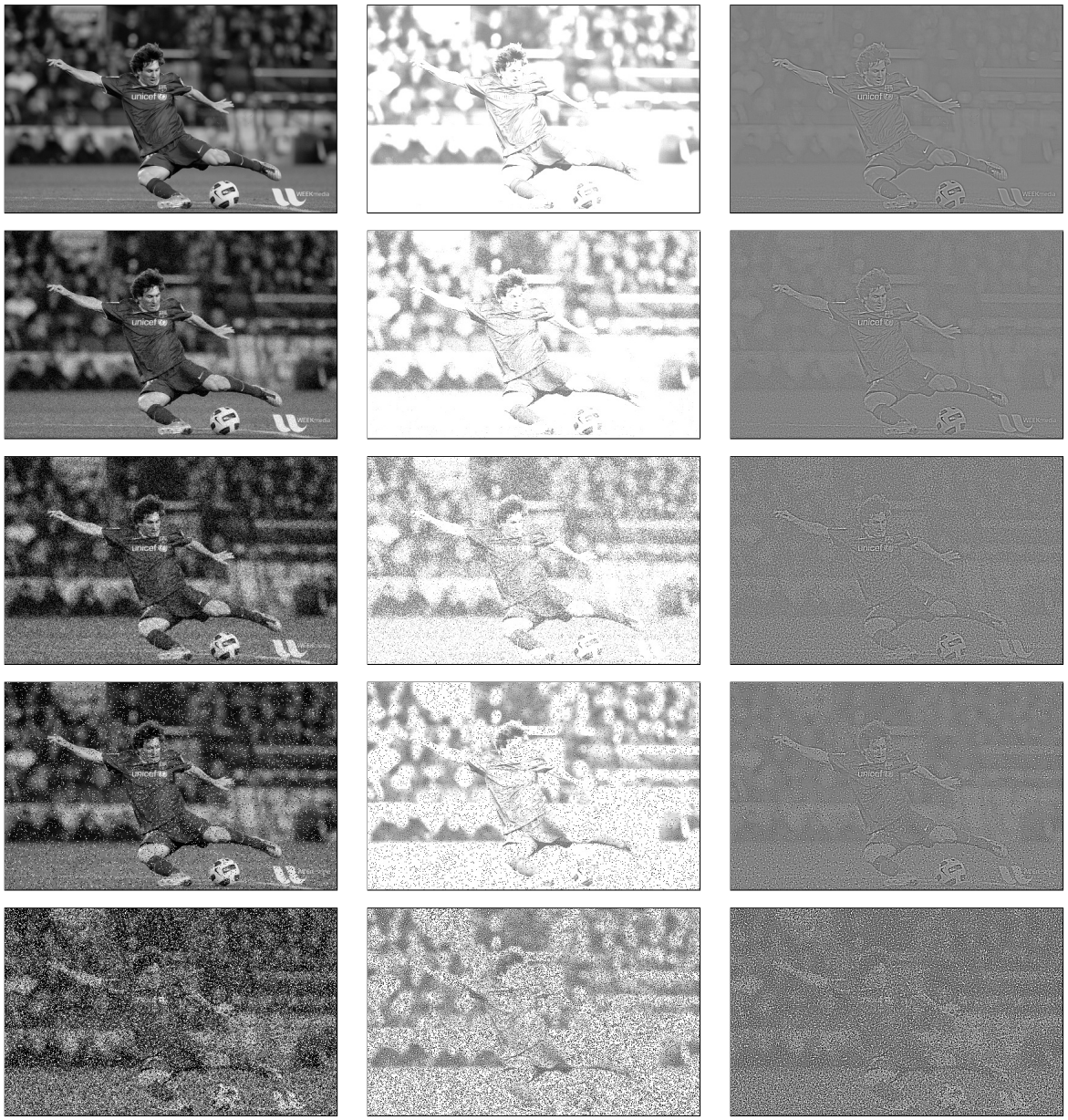
messi median



pattern high pass



messi high pass



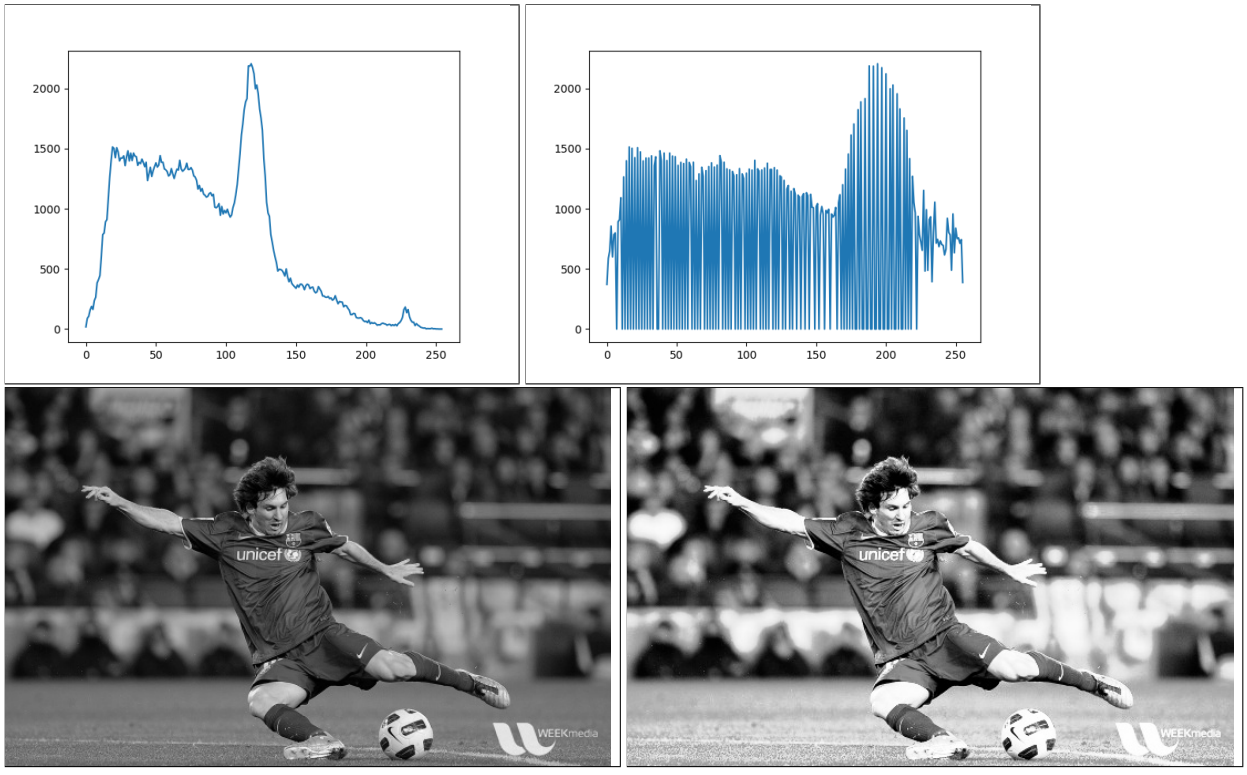
2

2.1 Analyse what happened to pattern image and the messi images in all filterings and compare the properties of low-pass and median filerings

Low-pass "smudged" the image in both cases, was able to remove a little bit of noise. The pattern was quickly erased by it. Median smoothed out things, and was especially good at removing noise. High-pass brought out the edges in both pattern and messi image, but didn't remove any noise.

Low pass resulted in more noisy and smudgy images compared to median. Median keeped it smoother, and was able get much better results for removing high amounts of salt&pepper noise.

2.2 Finally, perform OpenCV's histogram equalization to the original messi image and show also the histograms before and after equalization



2.3 Report also, how long it took for you to complete the hands-on exercise

5 - 6 hours

3 Code used

```
    #! /usr/bin/env python3

# https://docs.opencv.org/3.1.0/d6/d00/tutorial_py_root.html
# https://github.com/abidrahmank/OpenCV2-Python-Tutorials

import cv2
import numpy as np
import matplotlib.pyplot as plt
from scipy import ndimage as nd


def random_gauss(A, r):
    return np.random.normal(0, r, A.shape)

def clip(i):
    return np.clip(i, 0, 1)

p = cv2.imread('pattern.pbm', cv2.IMREAD_GRAYSCALE) / 255
m = cv2.imread('messi-gray.tiff', cv2.IMREAD_GRAYSCALE) / 255

p_ga1 = clip(p + random_gauss(p, 0.05))
p_ga2 = clip(p + random_gauss(p, 0.15))

### Tehtävä 5
gaussed_m1 = clip(m + random_gauss(m, 0.05))
gaussed_m2 = clip(m + random_gauss(m, 0.15))

### Tehtävä 6
def random_saltpepper(A, r):
    B = A + np.random.binomial(1, r/2, A.shape) # pepper
    C = B * np.random.binomial(1, 1 - (r/2), A.shape) # salt
    return C

### Tehtävä 7
pattern_peppered1 = clip(random_saltpepper(p, 0.1))
pattern_peppered2 = clip(random_saltpepper(p, 0.5))
m_peppered1 = clip(random_saltpepper(m, 0.1))
m_peppered2 = clip(random_saltpepper(m, 0.5))
```

```
### Tehtävä 8
def lowpass(A, n):
    weights = [[1 for x in range(n)] for y in range(n)]
    return nd.filters.convolve(A, weights) / (n*n)

### Tehtävä 9

pattern_lp1 = lowpass(p, 3)
pattern_lp2 = lowpass(p, 5)
gaussed_pattern1_lp1 = lowpass(p_ga1, 3)
gaussed_pattern1_lp2 = lowpass(p_ga1, 5)
gaussed_pattern2_lp1 = lowpass(p_ga2, 3)
gaussed_pattern2_lp2 = lowpass(p_ga2, 5)
pattern_peppered1_lp1 = lowpass(pattern_peppered1, 3)
pattern_peppered1_lp2 = lowpass(pattern_peppered1, 5)
pattern_peppered2_lp1 = lowpass(pattern_peppered2, 3)
pattern_peppered2_lp2 = lowpass(pattern_peppered2, 5)


m_lp1 = lowpass(m, 3)
m_lp2 = lowpass(m, 5)
gaussed_m1_lp1 = lowpass(gaussed_m1, 3)
gaussed_m1_lp2 = lowpass(gaussed_m1, 5)
gaussed_m2_lp1 = lowpass(gaussed_m2, 3)
gaussed_m2_lp2 = lowpass(gaussed_m2, 5)
m_peppered1_lp1 = lowpass(m_peppered1, 3)
m_peppered1_lp2 = lowpass(m_peppered1, 5)
m_peppered2_lp1 = lowpass(m_peppered2, 3)
m_peppered2_lp2 = lowpass(m_peppered2, 5)

# Tehtävä 10
def highpass(A, n):
    w = 25
    weights = [[(-1) for x in range(n)] for y in range(n)]
    x = int(n/2)
    y = int(n/2)
    weights[x][y] = w
    return nd.filters.convolve(A, weights) / (n*n)


### Tehtävä 11
pattern_hp1 = clip(highpass(p, 3) + 0.5)
pattern_hp2 = clip(highpass(p, 5) + 0.5)
gaussed_pattern1_hp1 = clip(highpass(p_ga1, 3) + 0.5)
gaussed_pattern1_hp2 = clip(highpass(p_ga1, 5) + 0.5)
```

```
gaussed_pattern2_hp1 = clip(highpass(p_ga2, 3) + 0.5)
gaussed_pattern2_hp2 = clip(highpass(p_ga2, 5) + 0.5)
pattern_peppered1_hp1 = clip(highpass(pattern_peppered1, 3) + 0.5)
pattern_peppered1_hp2 = clip(highpass(pattern_peppered1, 5) + 0.5)
pattern_peppered2_hp1 = clip(highpass(pattern_peppered2, 3) + 0.5)
pattern_peppered2_hp2 = clip(highpass(pattern_peppered2, 5) + 0.5)

m_hp1 = clip(highpass(m, 3) + 0.5)
m_hp2 = clip(highpass(m, 5) + 0.5)
gaussed_m1_hp1 = clip(highpass(gaussed_m1, 3) + 0.5)
gaussed_m1_hp2 = clip(highpass(gaussed_m1, 5) + 0.5)
gaussed_m2_hp1 = clip(highpass(gaussed_m2, 3) + 0.5)
gaussed_m2_hp2 = clip(highpass(gaussed_m2, 5) + 0.5)
m_peppered1_hp1 = clip(highpass(m_peppered1, 3) + 0.5)
m_peppered1_hp2 = clip(highpass(m_peppered1, 5) + 0.5)
m_peppered2_hp1 = clip(highpass(m_peppered2, 3) + 0.5)
m_peppered2_hp2 = clip(highpass(m_peppered2, 5) + 0.5)

### Tehtävä 12
def median(A, n):
    return nd.filters.median_filter(A, n)

### Tehtävä 13
pattern_md1 = median(p, 3)
pattern_md2 = median(p, 5)
gaussed_pattern1_md1 = median(p_ga1, 3)
gaussed_pattern1_md2 = median(p_ga1, 5)
gaussed_pattern2_md1 = median(p_ga2, 3)
gaussed_pattern2_md2 = median(p_ga2, 5)
pattern_peppered1_md1 = median(pattern_peppered1, 3)
pattern_peppered1_md2 = median(pattern_peppered1, 5)
pattern_peppered2_md1 = median(pattern_peppered2, 3)
pattern_peppered2_md2 = median(pattern_peppered2, 5)

m_md1 = median(m, 3)
m_md2 = median(m, 5)
gaussed_m1_md1 = median(gaussed_m1, 3)
gaussed_m1_md2 = median(gaussed_m1, 5)
gaussed_m2_md1 = median(gaussed_m2, 3)
gaussed_m2_md2 = median(gaussed_m2, 5)
m_peppered1_md1 = median(m_peppered1, 3)
m_peppered1_md2 = median(m_peppered1, 5)
m_peppered2_md1 = median(m_peppered2, 3)
m_peppered2_md2 = median(m_peppered2, 5)

### Tehtävä 14
```

```
cv2.imwrite('p.jpg', cv2.resize(p * 255, None, fx=20, fy=20, interpolation=cv2.INTER_AREA))
cv2.imwrite('p-ga1.jpg', cv2.resize(p_ga1 * 255, None, fx=20, fy=20, interpolation=cv2.INTER
cv2.imwrite('p-ga2.jpg', cv2.resize(p_ga2 * 255, None, fx=20, fy=20, interpolation=cv2.INTER
cv2.imwrite('p-sp1.jpg', cv2.resize(pattern_peppered1 * 255, None, fx=20, fy=20, interpolati
cv2.imwrite('p-sp2.jpg', cv2.resize(pattern_peppered2 * 255, None, fx=20, fy=20, interpolati

cv2.imwrite('p-l3.jpg', cv2.resize(pattern_lp1 * 255, None, fx=20, fy=20, interpolation=cv2.
cv2.imwrite('p-l5.jpg', cv2.resize(pattern_lp2 * 255, None, fx=20, fy=20, interpolation=cv2.
cv2.imwrite('p-ga1-l3.jpg', cv2.resize(gaussed_pattern1_lp1 * 255, None, fx=20, fy=20, inter
cv2.imwrite('p-ga1-l5.jpg', cv2.resize(gaussed_pattern1_lp2 * 255, None, fx=20, fy=20, inter
cv2.imwrite('p-ga2-l3.jpg', cv2.resize(gaussed_pattern2_lp1 * 255, None, fx=20, fy=20, inter
cv2.imwrite('p-ga2-l5.jpg', cv2.resize(gaussed_pattern2_lp2 * 255, None, fx=20, fy=20, inter
cv2.imwrite('p-sp1-l3.jpg', cv2.resize(pattern_peppered1_lp1 * 255, None, fx=20, fy=20, inte
cv2.imwrite('p-sp1-l5.jpg', cv2.resize(pattern_peppered1_lp2 * 255, None, fx=20, fy=20, inte
cv2.imwrite('p-sp2-l3.jpg', cv2.resize(pattern_peppered2_lp1 * 255, None, fx=20, fy=20, inte
cv2.imwrite('p-sp2-l5.jpg', cv2.resize(pattern_peppered2_lp2 * 255, None, fx=20, fy=20, inte

cv2.imwrite('p-h3.jpg', cv2.resize(pattern_hp1 * 255, None, fx=20, fy=20, interpolation=cv2.
cv2.imwrite('p-h5.jpg', cv2.resize(pattern_hp2 * 255, None, fx=20, fy=20, interpolation=cv2.
cv2.imwrite('p-ga1-h3.jpg', cv2.resize(gaussed_pattern1_hp1 * 255, None, fx=20, fy=20, inter
cv2.imwrite('p-ga1-h5.jpg', cv2.resize(gaussed_pattern1_hp2 * 255, None, fx=20, fy=20, inter
cv2.imwrite('p-ga2-h3.jpg', cv2.resize(gaussed_pattern2_hp1 * 255, None, fx=20, fy=20, inter
cv2.imwrite('p-ga2-h5.jpg', cv2.resize(gaussed_pattern2_hp2 * 255, None, fx=20, fy=20, inter
cv2.imwrite('p-sp1-h3.jpg', cv2.resize(pattern_peppered1_hp1 * 255, None, fx=20, fy=20, inte
cv2.imwrite('p-sp1-h5.jpg', cv2.resize(pattern_peppered1_hp2 * 255, None, fx=20, fy=20, inte
cv2.imwrite('p-sp2-h3.jpg', cv2.resize(pattern_peppered2_hp1 * 255, None, fx=20, fy=20, inte
cv2.imwrite('p-sp2-h5.jpg', cv2.resize(pattern_peppered2_hp2 * 255, None, fx=20, fy=20, inte

cv2.imwrite('p-m3.jpg', cv2.resize(pattern_md1 * 255, None, fx=20, fy=20, interpolation=cv2.
cv2.imwrite('p-m5.jpg', cv2.resize(pattern_md2 * 255, None, fx=20, fy=20, interpolation=cv2.
cv2.imwrite('p-ga1-m3.jpg', cv2.resize(gaussed_pattern1_md1 * 255, None, fx=20, fy=20, inter
cv2.imwrite('p-ga1-m5.jpg', cv2.resize(gaussed_pattern1_md2 * 255, None, fx=20, fy=20, inter
cv2.imwrite('p-ga2-m3.jpg', cv2.resize(gaussed_pattern2_md1 * 255, None, fx=20, fy=20, inter
cv2.imwrite('p-ga2-m5.jpg', cv2.resize(gaussed_pattern2_md2 * 255, None, fx=20, fy=20, inter
cv2.imwrite('p-sp1-m3.jpg', cv2.resize(pattern_peppered1_md1 * 255, None, fx=20, fy=20, inte
cv2.imwrite('p-sp1-m5.jpg', cv2.resize(pattern_peppered1_md2 * 255, None, fx=20, fy=20, inte
cv2.imwrite('p-sp2-m3.jpg', cv2.resize(pattern_peppered2_md1 * 255, None, fx=20, fy=20, inte
cv2.imwrite('p-sp2-m5.jpg', cv2.resize(pattern_peppered2_md2 * 255, None, fx=20, fy=20, inte


cv2.imwrite('m.jpg', cv2.resize(m * 255, None, fx=20, fy=20, interpolation=cv2.INTER_AREA))
cv2.imwrite('m-ga1.jpg', gaussed_m1 * 255)
cv2.imwrite('m-ga2.jpg', gaussed_m2 * 255)
cv2.imwrite('m-sp1.jpg', m_peppered1 * 255)
cv2.imwrite('m-sp2.jpg', m_peppered2 * 255)
```

```
cv2.imwrite('m-l3.jpg', m_lp1 * 255)
cv2.imwrite('m-l5.jpg', m_lp2 * 255)
cv2.imwrite('m-ga1-l3.jpg', gaussed_m1_lp1 * 255)
cv2.imwrite('m-ga1-l5.jpg', gaussed_m1_lp2 * 255)
cv2.imwrite('m-ga2-l3.jpg', gaussed_m2_lp1 * 255)
cv2.imwrite('m-ga2-l5.jpg', gaussed_m2_lp2 * 255)
cv2.imwrite('m-sp1-l3.jpg', m_peppered1_lp1 * 255)
cv2.imwrite('m-sp1-l5.jpg', m_peppered1_lp2 * 255)
cv2.imwrite('m-sp2-l3.jpg', m_peppered2_lp1 * 255)
cv2.imwrite('m-sp2-l5.jpg', m_peppered2_lp2 * 255)

cv2.imwrite('m-h3.jpg', m_hp1 * 255)
cv2.imwrite('m-h5.jpg', m_hp2 * 255)
cv2.imwrite('m-ga1-h3.jpg', gaussed_m1_hp1 * 255)
cv2.imwrite('m-ga1-h5.jpg', gaussed_m1_hp2 * 255)
cv2.imwrite('m-ga2-h3.jpg', gaussed_m2_hp1 * 255)
cv2.imwrite('m-ga2-h5.jpg', gaussed_m2_hp2 * 255)
cv2.imwrite('m-sp1-h3.jpg', m_peppered1_hp1 * 255)
cv2.imwrite('m-sp1-h5.jpg', m_peppered1_hp2 * 255)
cv2.imwrite('m-sp2-h3.jpg', m_peppered2_hp1 * 255)
cv2.imwrite('m-sp2-h5.jpg', m_peppered2_hp2 * 255)

cv2.imwrite('m-m3.jpg', m_md1 * 255)
cv2.imwrite('m-m5.jpg', m_md2 * 255)
cv2.imwrite('m-ga1-m3.jpg', gaussed_m1_md1 * 255)
cv2.imwrite('m-ga1-m5.jpg', gaussed_m1_md2 * 255)
cv2.imwrite('m-ga2-m3.jpg', gaussed_m2_md1 * 255)
cv2.imwrite('m-ga2-m5.jpg', gaussed_m2_md2 * 255)
cv2.imwrite('m-sp1-m3.jpg', m_peppered1_md1 * 255)
cv2.imwrite('m-sp1-m5.jpg', m_peppered1_md2 * 255)
cv2.imwrite('m-sp2-m3.jpg', m_peppered2_md1 * 255)
cv2.imwrite('m-sp2-m5.jpg', m_peppered2_md2 * 255)

### Tehtävä 15
### Tehtävä 16
m_uint8 = (m * 255).astype(np.uint8)
m_hist = cv2.equalizeHist(m_uint8)

h = [0]*255
for i in m_uint8.flatten():
    h[i] += 1


# plt.plot(h)
# plt.savefig('messi_hist_before.png')
```

```
h2 = [0]*256
for i in m_hist.flatten():
    h2[i] += 1

plt.plot(h2)
plt.savefig('messi_hist_after.png')

cv2.imwrite('messi_after_hist.jpg', m_hist)
```