

# Homework 1

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Introduction to Signal and Image Processing

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## 1 Regular Tessellation

### 1.1

There are three shapes that satisfy the two conditions above: triangles, squares and regular hexagon.

### 1.2

**Theorem 1.** *There are three shapes that satisfy the two conditions above: triangles, squares and regular hexagon.*

*Proof.* The sum of the angles in a polygon is  $180(a - 2)$ ,  $a$  is the number of angles. Using the three polygons from above we know that in all three polygons the sum of the angles where the vertices meet is 360, also point  $b$ . By that circumstances we can use

$$\frac{180(a - 2)}{a}b = 360$$

In a simple matter this leads us to

$$(a - 2)b = 2a$$

The result of the equation above leads us to 6 solutions:

$$a = -2, b = 1; a = 1, b = -2; a = 3, b = 6; a = 4, b = 4; a = 6, b = 3$$

As can only use the positives integer solutions, we have ( $b$  corresponds number of edges) the polygons with 3, 4 and 6 edges.  $\square$

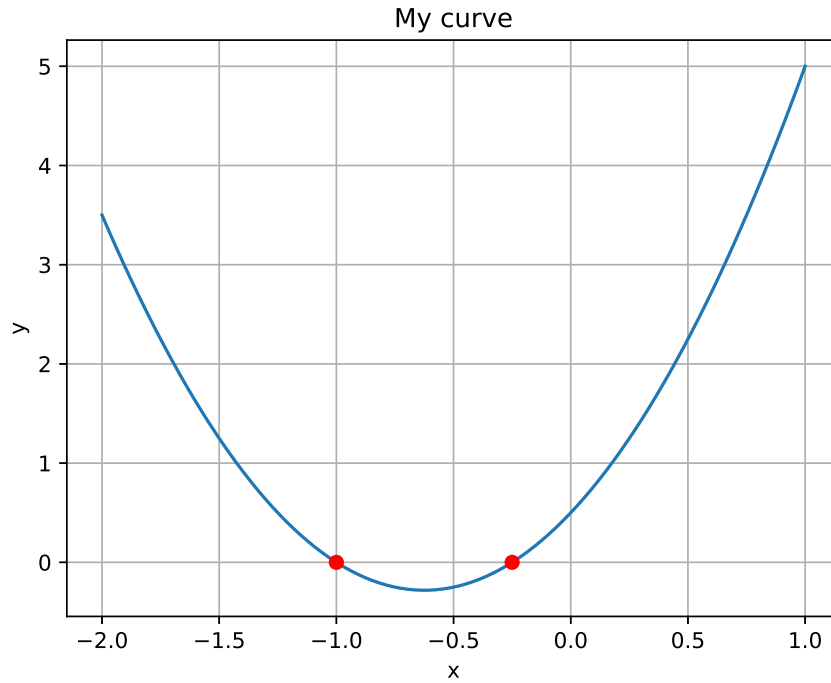


Figure 1: Example of quadratic function  $a = 2$ ,  $b = 2.5$ ,  $c = 0.5$ . Roots are highlighted in red.

## 2 2D convolution

We experiment with a box-filter and apply the built-in scipy function as in listing 1. An example filtered image is shown in fig. 2.

Listing 1: My 2D convolution approach.

```
from scipy import signal
img = plt.imread('cat.jpg').astype(np.float32)

def boxfilter(n):
    # this function returns a box filter of size nxn
    return (1./(n ** 2))*np.ones((n, n))

bsize = 10
box_filter = boxfilter(bsize)
conv_image_box = signal.convolve2d(img, box_filter)
```

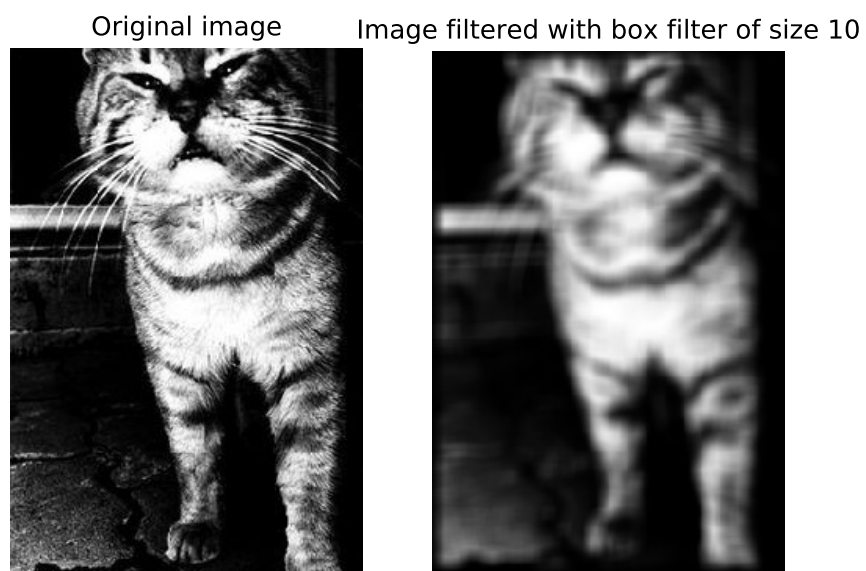


Figure 2: Filtering with a box-filter of size  $10 \times 10$ .