Exercises for
Introduction to Pattern Recognition (IntroPR)
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Normalization with Moments

Exercise 19 During the lecture, the normalization of the position, orientation, location or size of features using moments has been introduced. One key aspect are the central moments for a transformed image h(x',y'), given as

$$\mu_{pq} = \int_{-\infty}^{+\infty} (x - x_c)^p (y - y_c)^q h(x', y') dx' dy'$$

Prove some of the discussed properties:

(a) After applying the transform $x' = x - x_c$, $y' = y - y_c$ and $h(x', y') = \frac{I(x,y)}{m_{00}}$ the following statements are true for the moments of the transformed feature:

$$\mu_{00} = 1 \quad \text{und} \quad \mu_{01} = \mu_{10} = 0$$

(b) Show that $\mu_{11} = 0$, when setting $h(x', y') = I(x, y)$ after applying the linear transform

$$\begin{pmatrix} \cos(\alpha) & \sin(\alpha) \\ -\sin(\alpha) & \cos(\alpha) \end{pmatrix}$$

where α corresponds to the direction of the images' first principal axis.

Exercise 20 **Programming Task:** Download the image `momented.bmp` from our website. Try to use moments to shift and rotate the rectangle back into the middle of the image, to look similar to `unmomented.bmp`.