Exercises for
Introduction to Pattern Recognition (IntroPR)
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Edge Detection

Exercise 17 The Laplacian operator is defined as

$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} \tag{1}$$

Show that it is invariant to rotations. Thus, show that

$$\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} = \frac{\partial^2 f}{\partial x'^2} + \frac{\partial^2 f}{\partial y'^2} \ , \tag{2}$$

where (x, y) are unrotated, and (x', y') are rotated coordinates of the same object.

The relationship between (x, y) and (x', y') can be expressed as

$$x = x' \cos\theta - y' \sin\theta \tag{3}$$
$$y = x' \sin\theta + y' \cos\theta \tag{4}$$

Exercise 18 **Programming Task:**

One popular image enhancement method is combining an image with its Laplacian-filtered image. Test this approach on the image `moon.jpg` from our website.

- Create a Laplacian filtered version of the image using the filter mask

  $$[1, 1, 1; 1, -8, 1; 1, 1, 1]$$

- Calculate the enhanced version of the image:

  $$g(x, y) = f(x, y) - \nabla^2 f(x, y) \tag{5}$$

Exercise 19 **Programming Task:** Besides Laplacian, use another appropriate convolution kernel and extract the edges of the object in the image `moon.jpg`.