Exercise 7: Robust model fitting

02504 Computer vision

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Learning objectives

These exercises will introduce you to robust model fitting. You will implement straight line finding using RANSAC.

RANSAC

Here you should estimate a line to a data set consisting of inliers with noise and outliers. Such data is generated by the following function:

```
def test_points(n_in, n_out):
    a = (np.random.rand(n_in)-.5)*10
    b = np.vstack((a, a*.5+np.random.randn(n_in)*.25))
    points = np.hstack((b, 2*np.random.randn(2, n_out)))
    return np.random.permutation(points.T).T
```

It is recommended that you do so in the following steps.

Exercise 7.1

Make a function that estimates a line, in homogeneous coordinates, given two points.

Exercise 7.2

Make a function that determines if a given 2D point is an inlier or an outlier with respect to a given line. The threshold should be supplied as parameter to this function, such that it can easily be tuned later

Exercise 7.3

Make a function that calculates the consensus, i.e. the number of inliers, for a line with respect to a set of points

Exercise 7.4

Make a function that randomly draws two of n 2D points.

Exercise 7.5

Assemble the functions made above to a working RANSAC algorithm for estimating lines. Set the number of iterations and the threshold manually.

Exercise 7.6

Experiment with the algorithm, what is a good threshold for distinguishing between inliers and outliers?

Exercise 7.7

Add the final step to your implementation, where you fit a new line to all inliers of the best line. The total least squares fit of a straight line to a set of points is given by the first principal component of them. Consider using the code below to get a homogeneous line along the first principal component.

```
def pca_line(x): #assumes x is a (2 x n) array of points
    d = np.cov(x)[:, 0]
    d /= np.linalg.norm(d)
    l = [d[1], -d[0]]
    l.append(-(l@x.mean(1)))
    return l
```

Exercise 7.8

Implement the stopping criteria for RANSAC as described on the slides. Use $p = 0.99$.