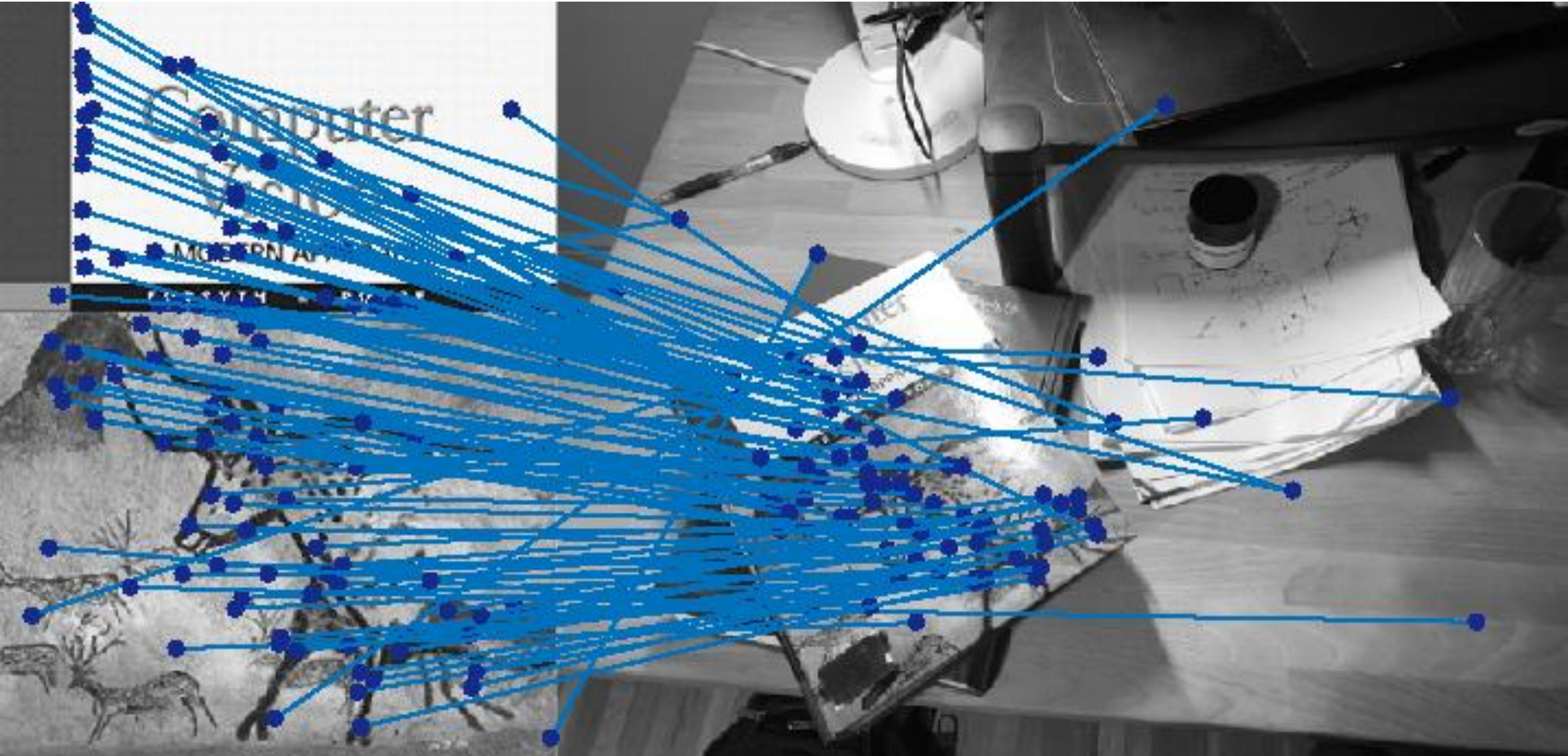
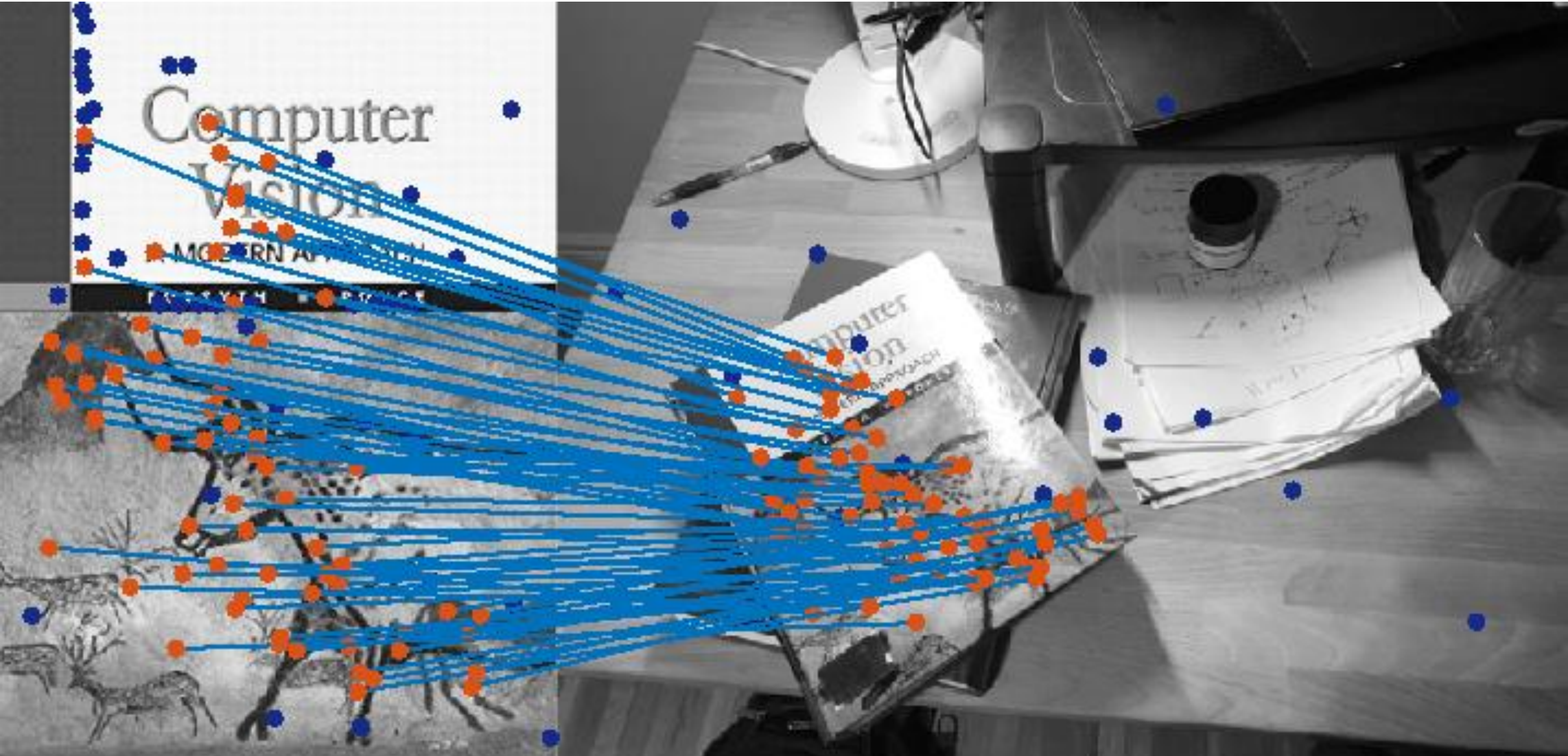
RANSAC

Hyun Soo Park

RECALL: LOCAL FEATURE MATCHING



RECALL: ROBUST FILTERING

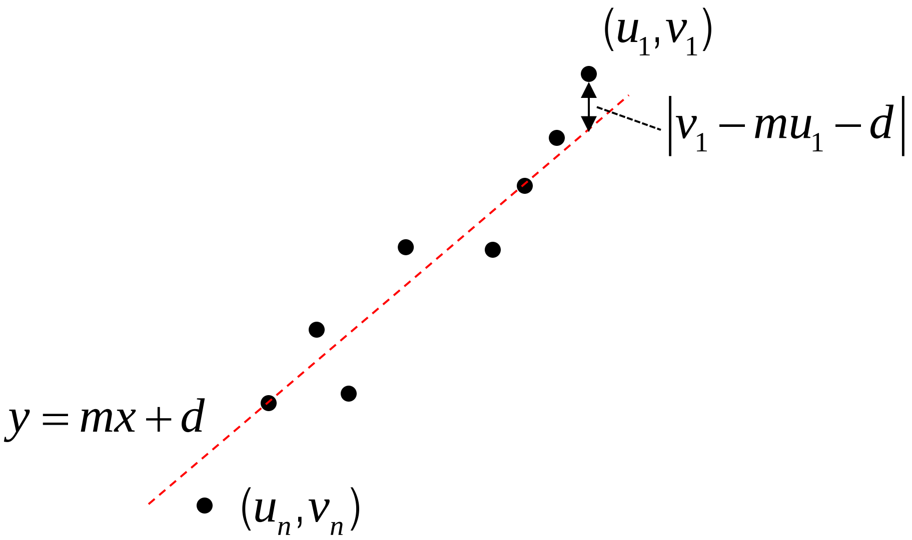


Line Fitting

Given points: $(u_1, v_1), \cdots (u_n, v_n)$

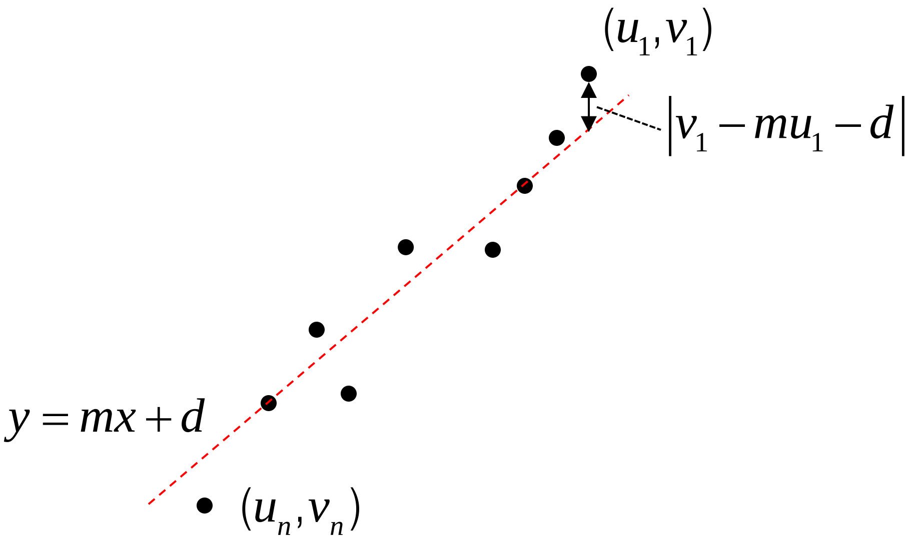
Find the best line:

$$v_1 \approx m u_1 + d$$
$$\vdots$$
$$v_n \approx m u_n + d$$



$$\rightarrow \begin{bmatrix} u_1 & 1 \\ \vdots & \vdots \\ u_n & 1 \end{bmatrix} \begin{bmatrix} m \\ d \end{bmatrix} = \begin{bmatrix} v_1 \\ \vdots \\ v_n \end{bmatrix}$$

LINE FITTING



Given points: $(u_1, v_1), \cdots (u_n, v_n)$

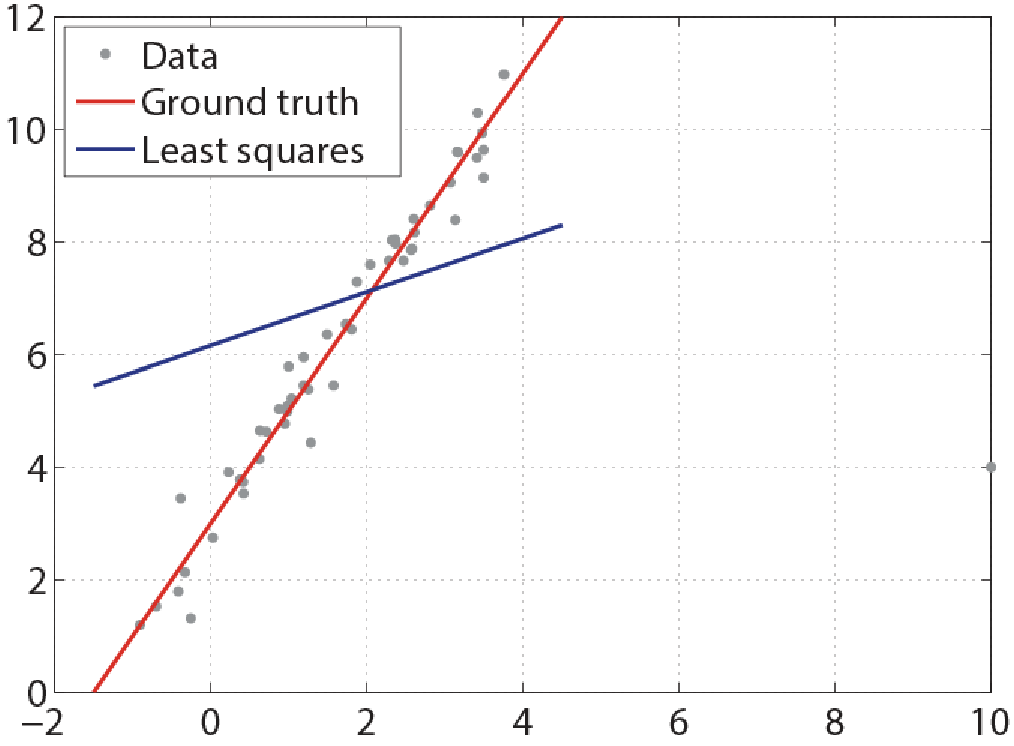
Find the best line:

$$v_1 \approx mu_1 + d$$
$$\vdots$$
$$v_n \approx mu_n + d$$

$$\rightarrow \underbrace{\begin{bmatrix} u_1 & 1 \\ \vdots & \vdots \\ u_n & 1 \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} m \\ d \end{bmatrix}}_{x} = \underbrace{\begin{bmatrix} v_1 \\ \vdots \\ v_n \end{bmatrix}}_{b}$$

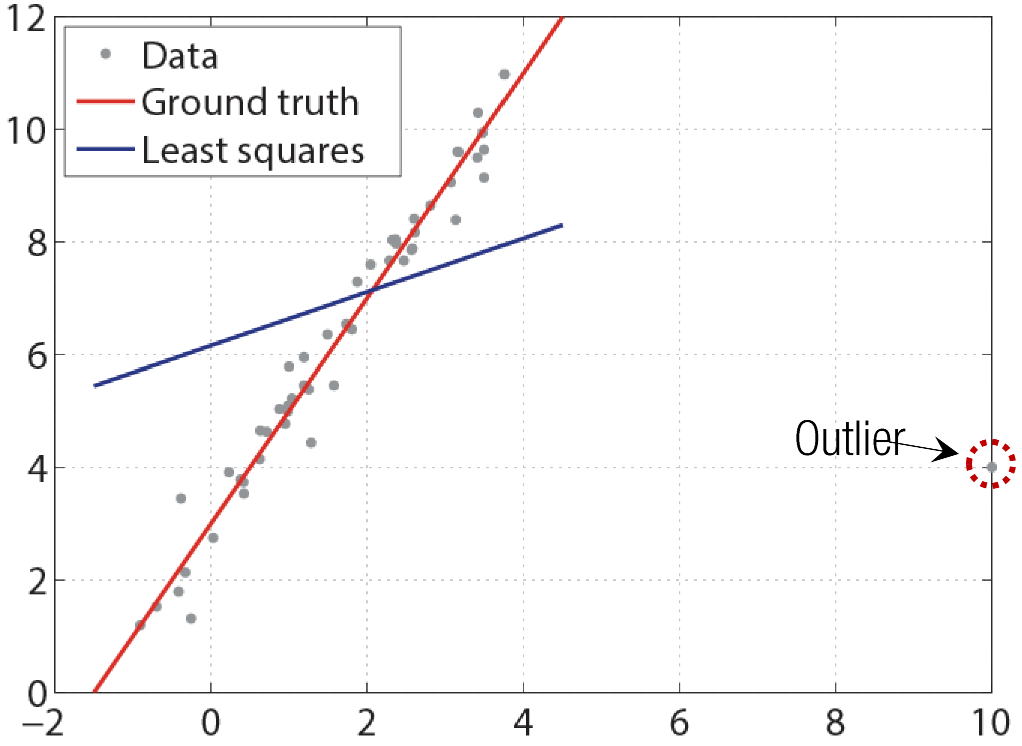
Least squares solution: $x = \left(A^T A\right)^{-1} A^T b$

OUTLIER

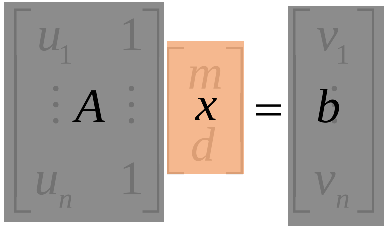


$$\underbrace{\begin{bmatrix} u_1 & 1 \\ \vdots & \vdots \\ u_n & 1 \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} m \\ d \end{bmatrix}}_{x} = \underbrace{\begin{bmatrix} v_1 \\ \vdots \\ v_n \end{bmatrix}}_{b}$$

OUTLIER

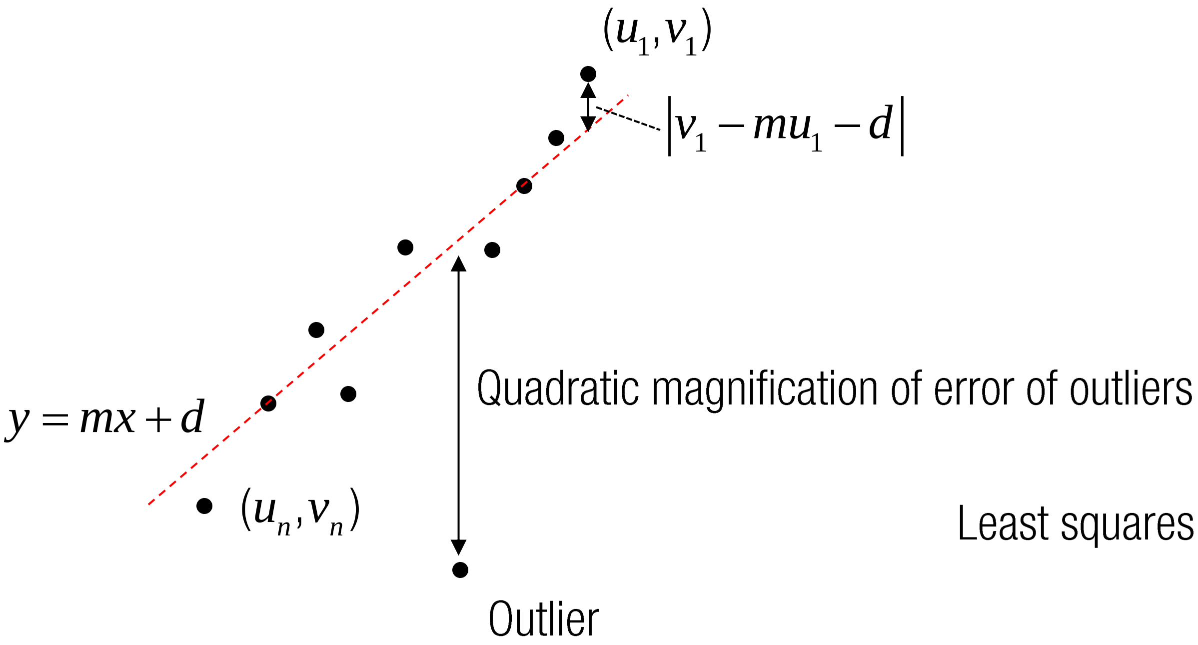


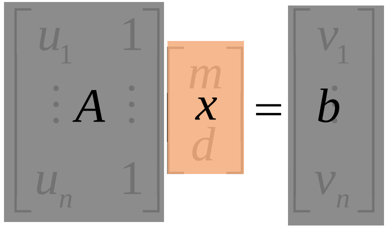
Data
Ground truth
Least squares
Outlier
12
10
8
6
4
2
0
−2
0
2
4
6
8
10



u_1 1
A
u_n 1
m
x
d
=
v_1
b
v_n

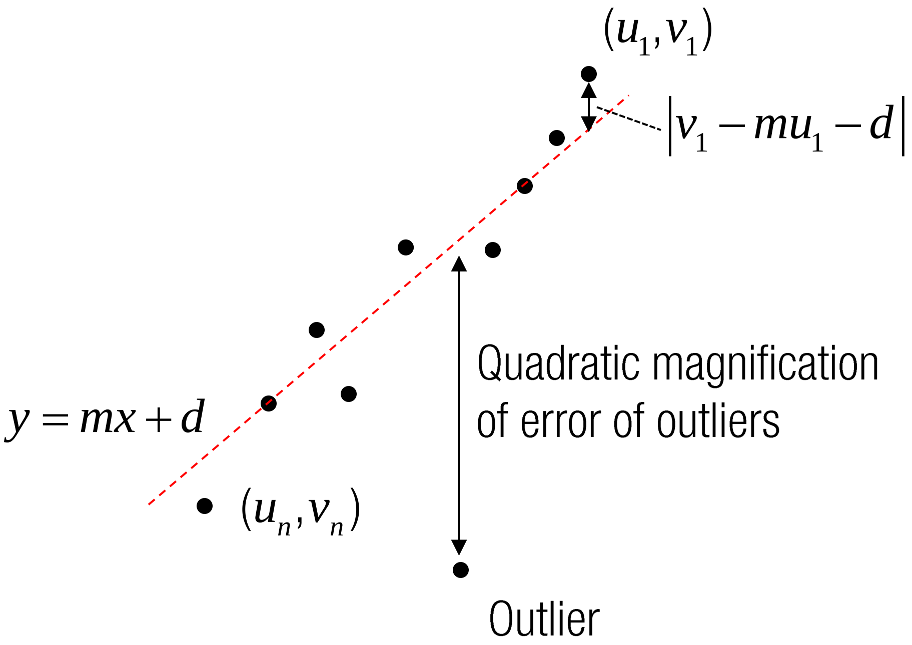
Outlier Sensitivity





Least squares solution: $x = \left(A^T A\right)^{-1} A^T b$

OUTLIER REJECTION STRATEGY

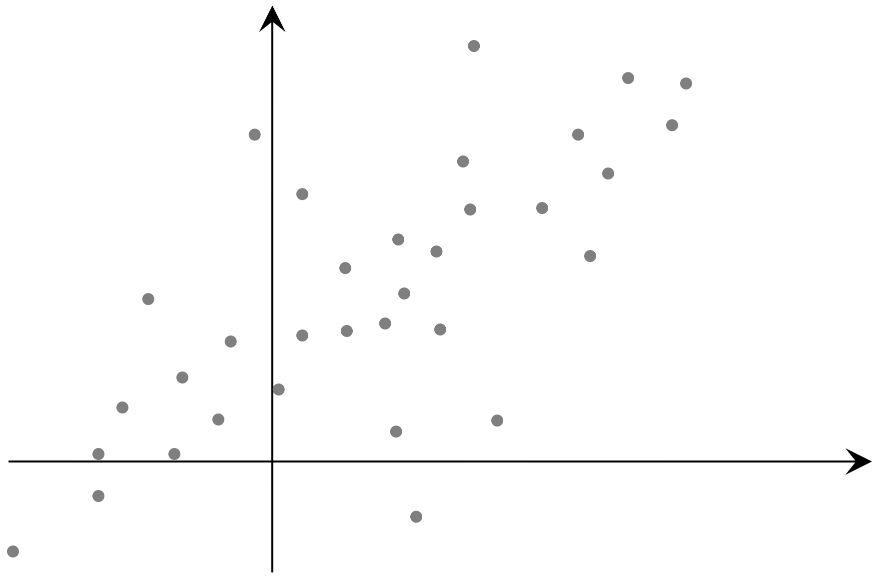


Outlier rejection strategy:

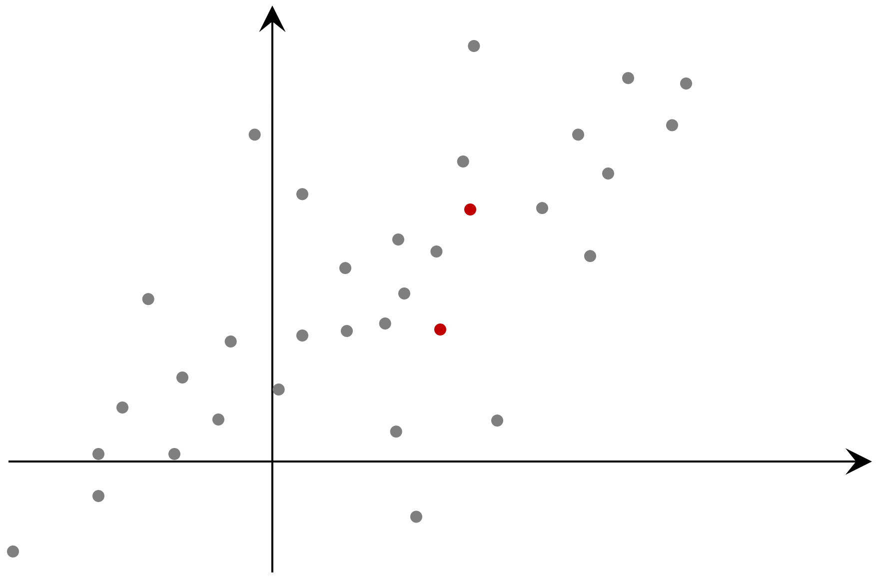
To find the best line that explains the maximum number of points.

Assumptions:

1. Majority of good samples agree with the underlying model.
2. Bad samples does not consistently agree with a single model.

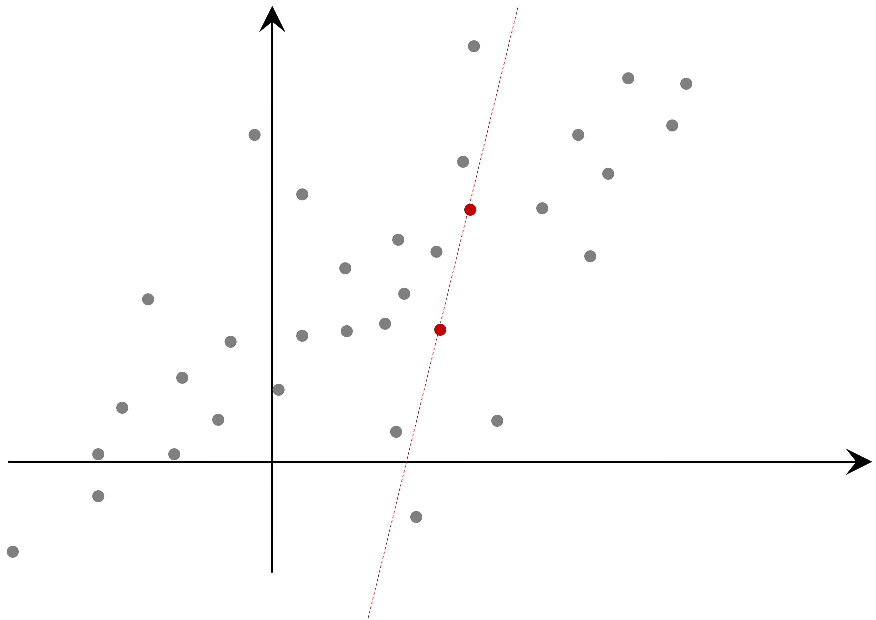


RANSAC: RAndom SAmple Consensus



1.Random sampling

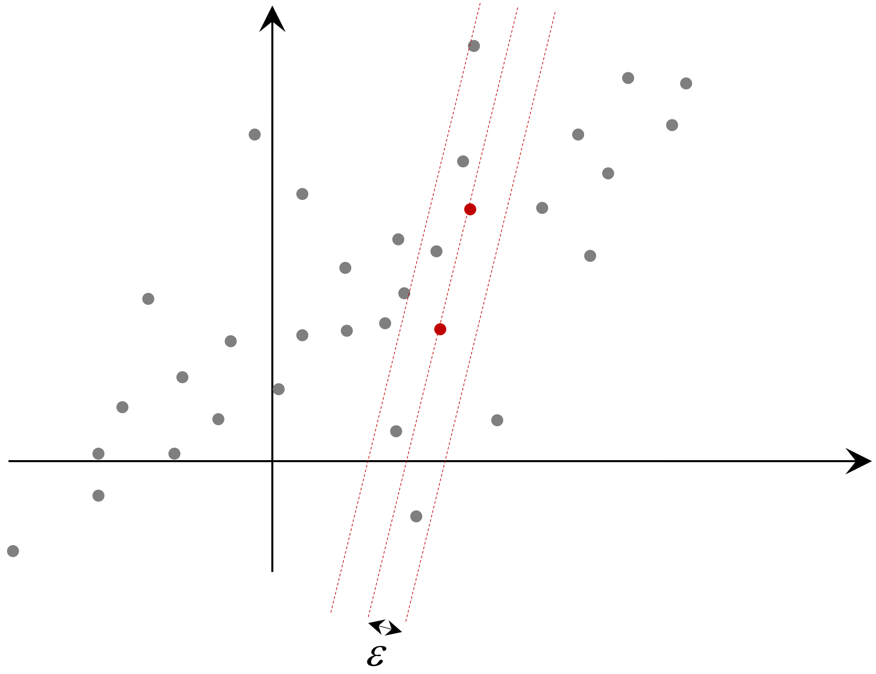
RANSAC: RAndom SAmple Consensus



1.Random sampling

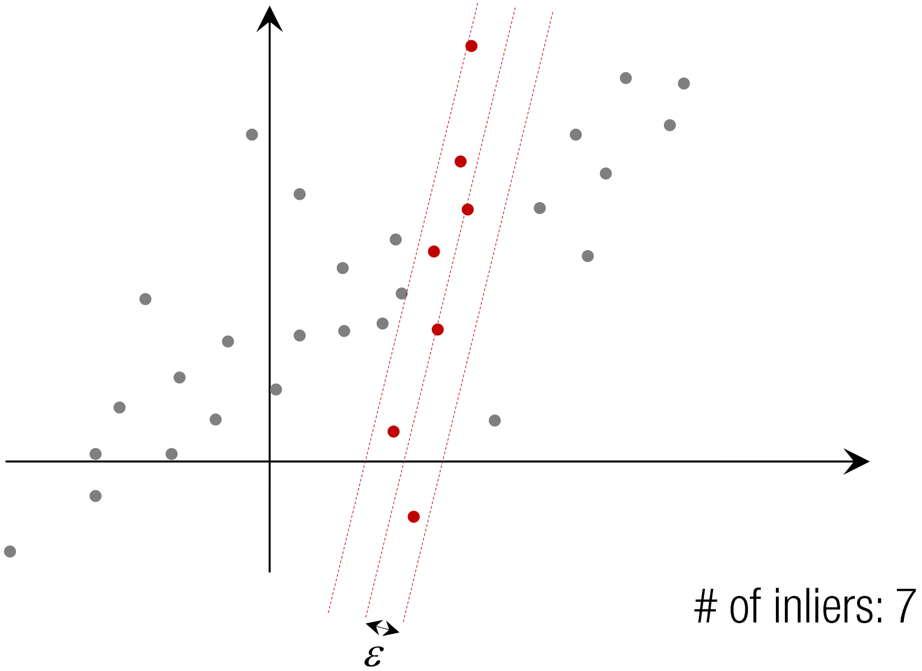
2.Model building

RANSAC: RAndom SAmple Consensus



1. Random sampling
2. Model building
3. Thresholding

RANSAC: RAndom SAmple Consensus



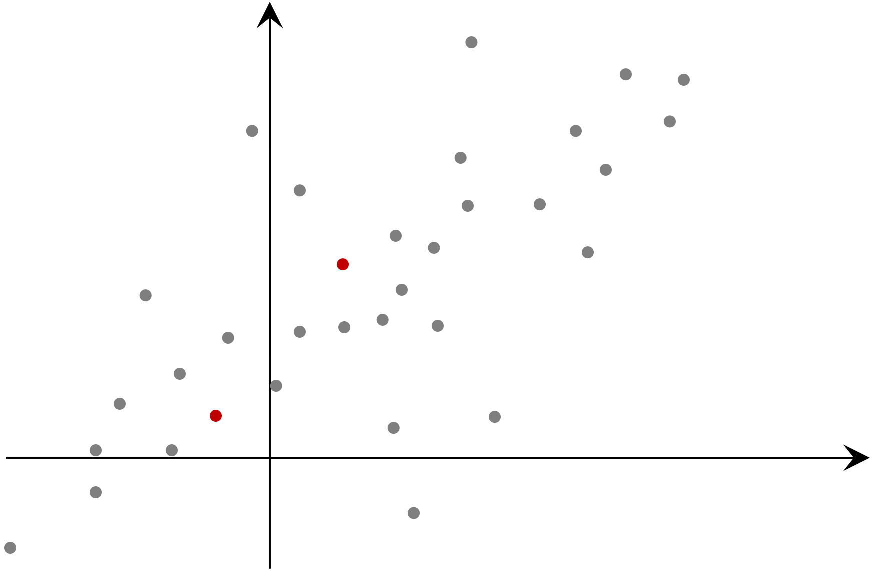
1.Random sampling

2.Model building

3.Thresholding

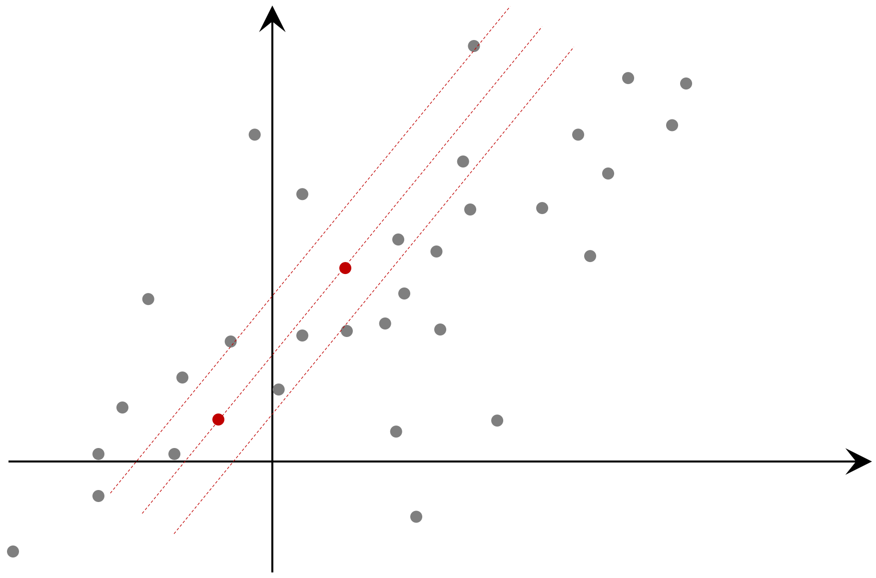
4.Inlier counting

RANSAC: RAndom SAmple Consensus



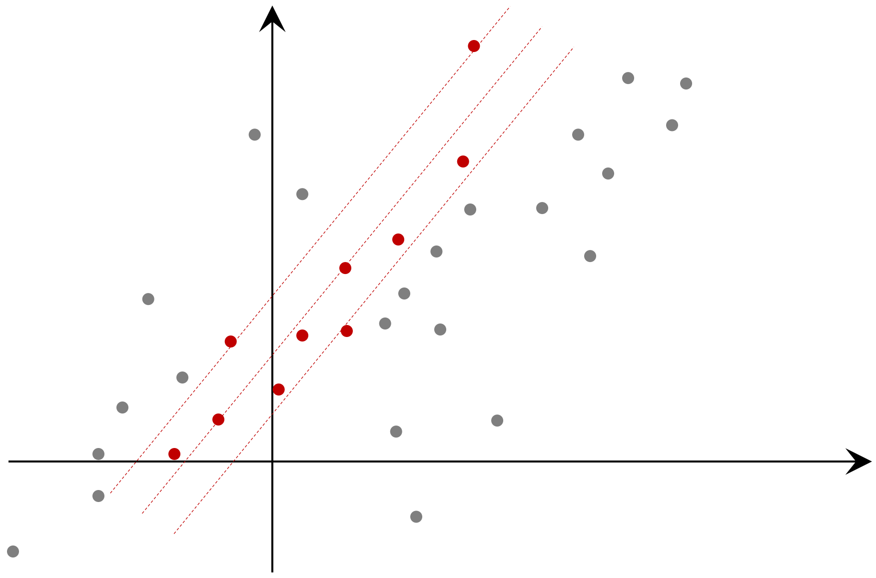
1. Random sampling
2. Model building
3. Thresholding
4. Inlier counting

RANSAC: RAndom SAmple Consensus



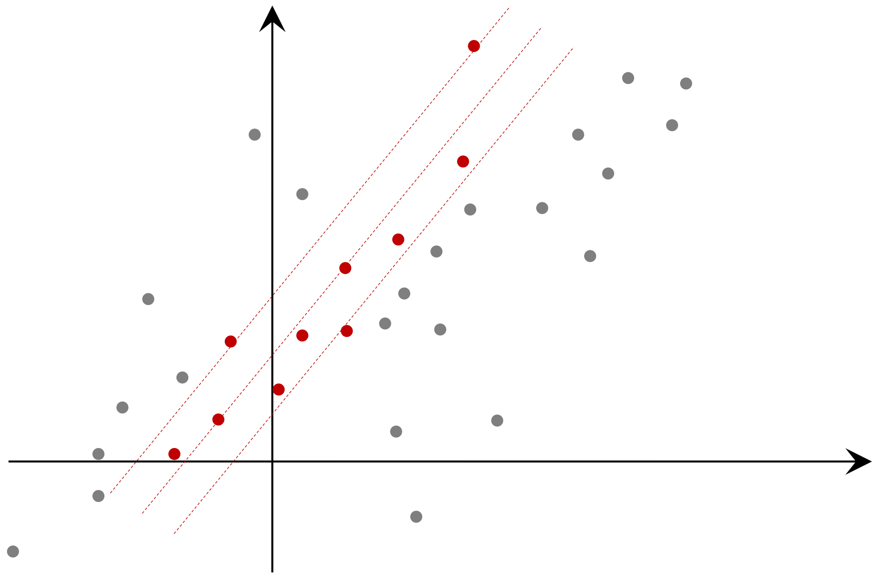
1. Random sampling
2. Model building
3. Thresholding
4. Inlier counting

RANSAC: RAndom SAmple Consensus



1. Random sampling
2. Model building
3. Thresholding
4. Inlier counting

RANSAC: RAndom SAmple Consensus



# of inliers: 10

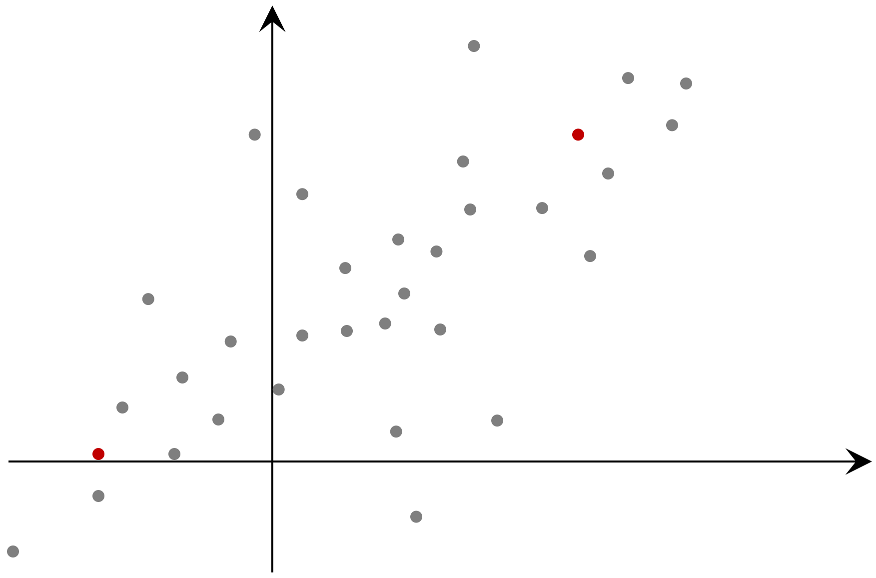
1. Random sampling

2. Model building

3. Thresholding

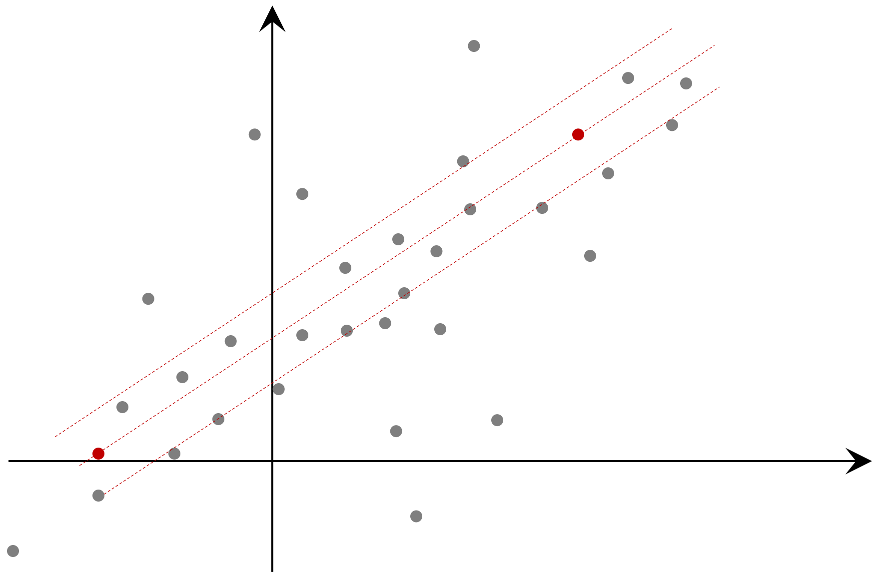
4. Inlier counting

RANSAC: RAndom SAmple Consensus



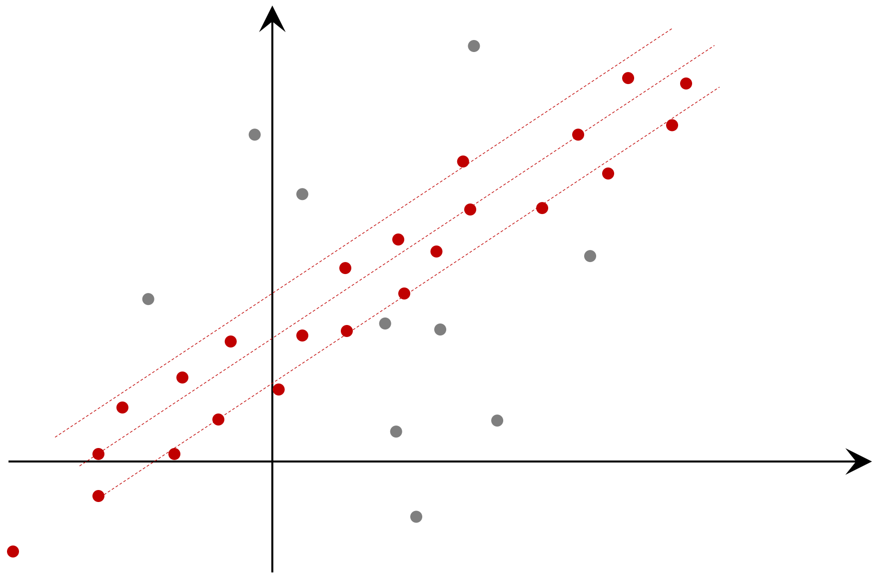
1. Random sampling
2. Model building
3. Thresholding
4. Inlier counting

RANSAC: RAndom SAmple Consensus



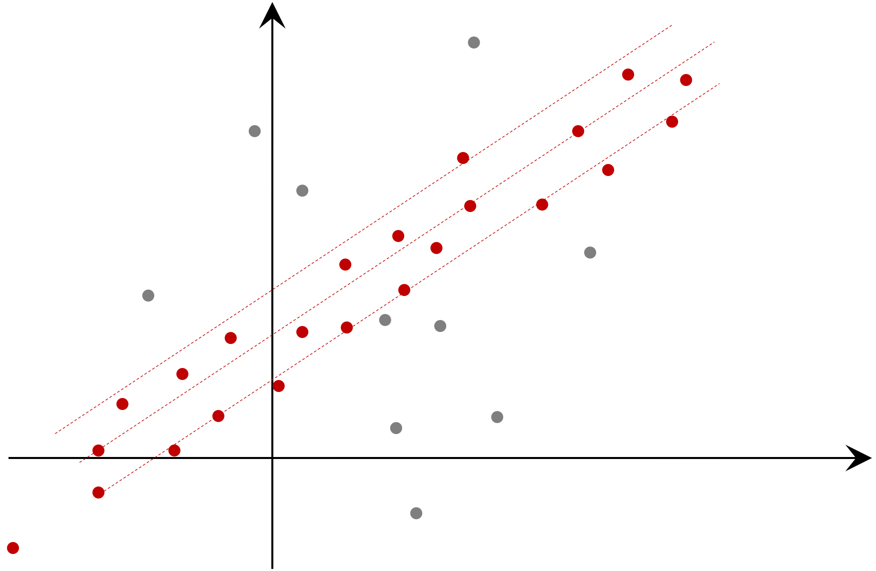
1. Random sampling
2. Model building
3. Thresholding
4. Inlier counting

RANSAC: RAndom SAmple Consensus



1. Random sampling
2. Model building
3. Thresholding
4. Inlier counting

RANSAC: RAndom SAmple Consensus

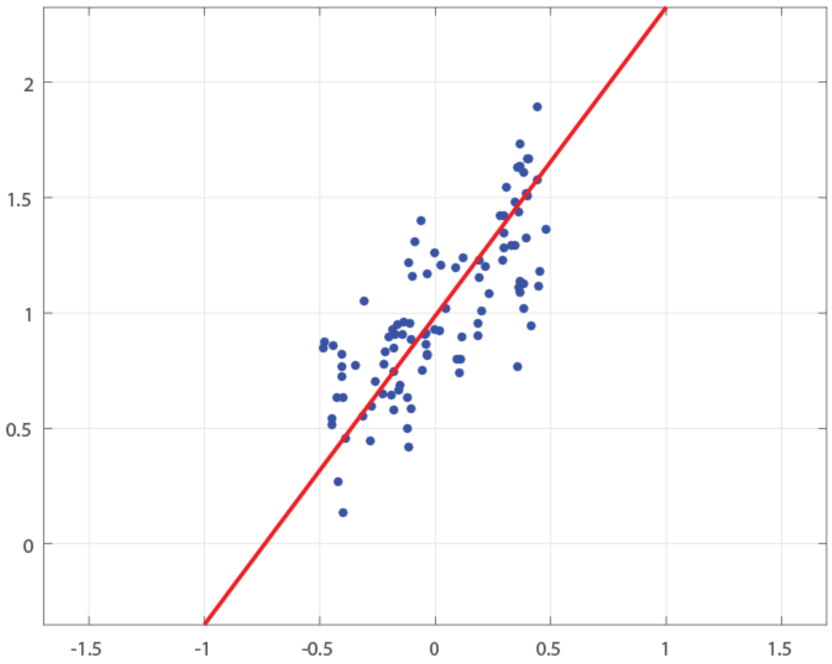


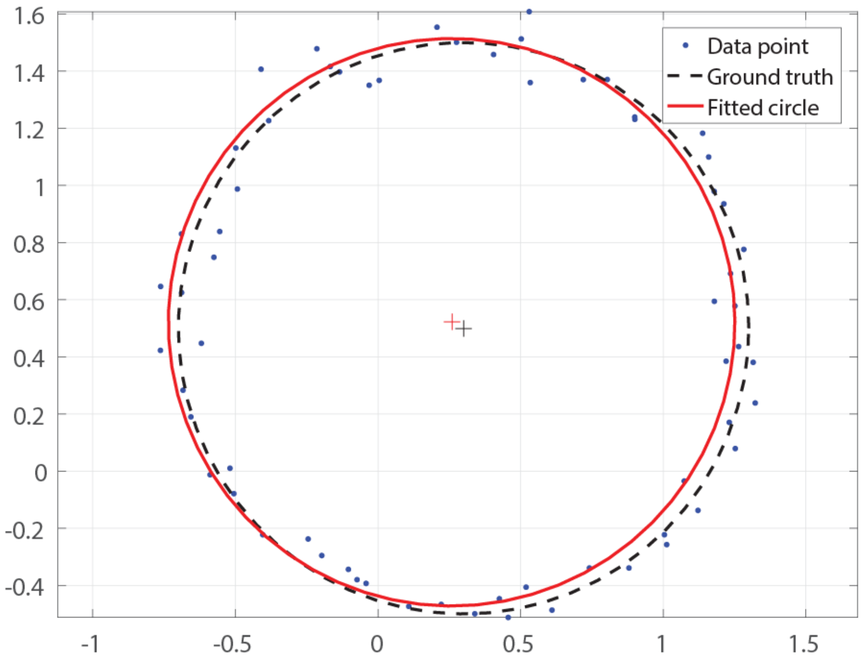
1. Random sampling
2. Model building
3. Thresholding
4. Inlier counting

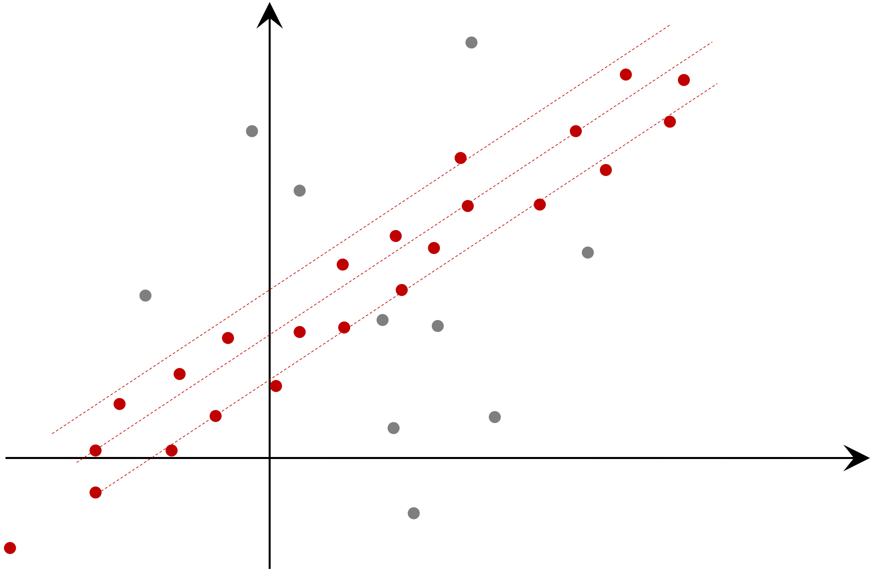
# of inliers: 23

Maximum number of inliers

RANSAC: RAndom SAmple Consensus

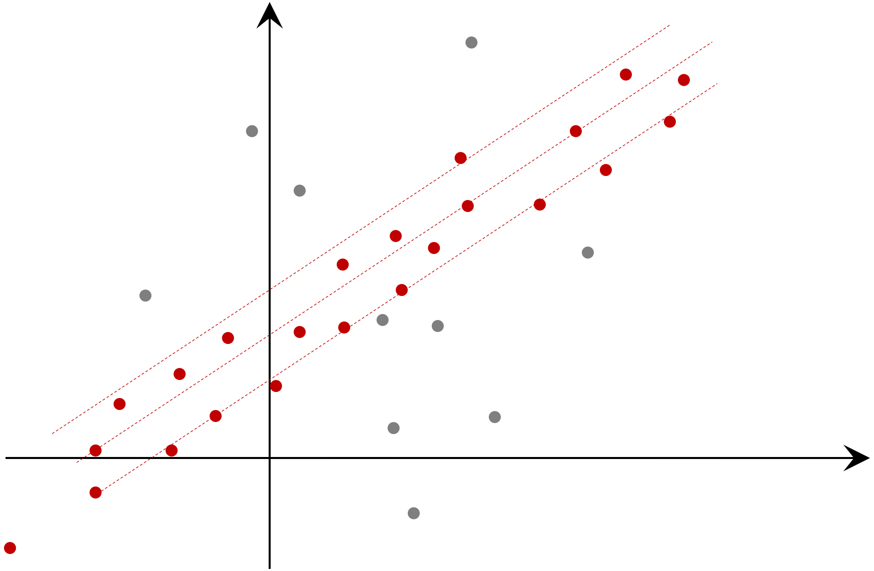

2
1.5
1
0.5
0
-1.5
-1
-0.5
0
0.5
1
1.5


Data point
Ground truth
Fitted circle
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-1
-0.5
0
0.5
1
1.5



Required number of iterations with *p* success rate:

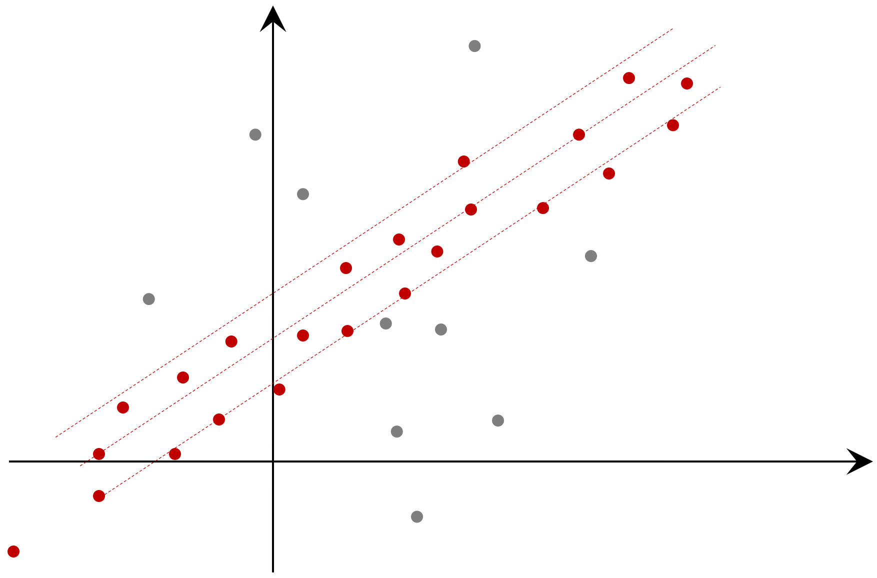
Prob. of success > Prob. of desired success p



Required number of iterations with *p* success rate:

Prob. of success > Prob. of desired success p

Prob. of success: 1- (1-prob. of success per trial)^k



Required number of iterations with *p* success rate:

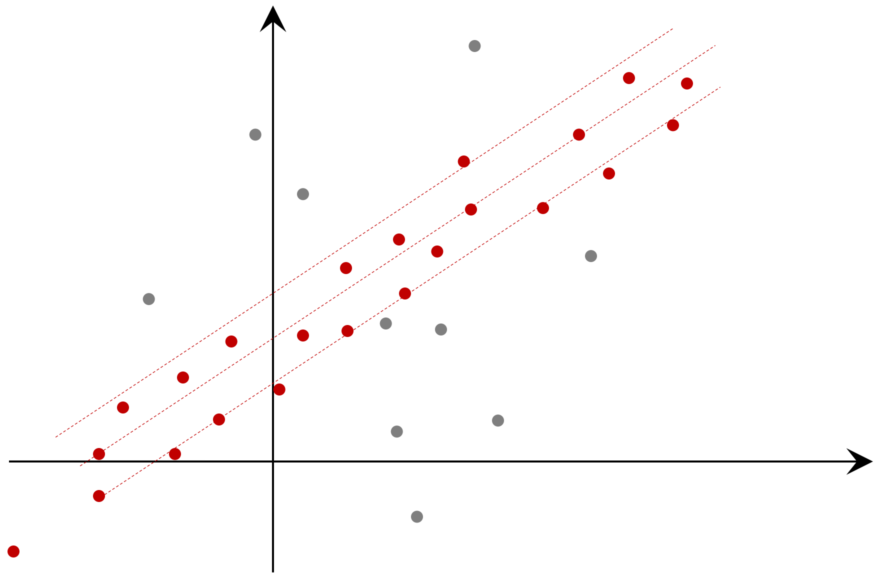
Prob. of success > Prob. of desired success p

Prob. of success: 1- (1-prob. of success per trial)^k

Prob. of success per trial: w^n

where $w = \frac{\text{\# of inliers}}{\text{\# of samples}}$

and n is the number of samples to build a model.



Required number of iterations with *p* success rate:

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Prob. of success per trial: w^n

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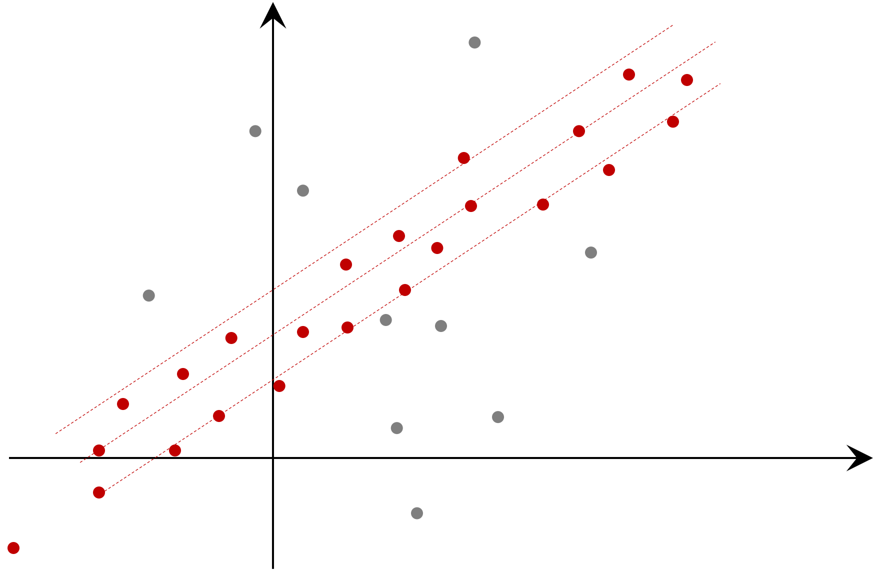
and n is the number of samples to build a model.

Prob. of success: $1-\left(1-w^n\right)^k$



Required number of iterations with *p* success rate:

Prob. of success > Prob. of desired success p

Prob. of success: 1- (1-prob. of success per trial)^k

Prob. of success per trial: w^n

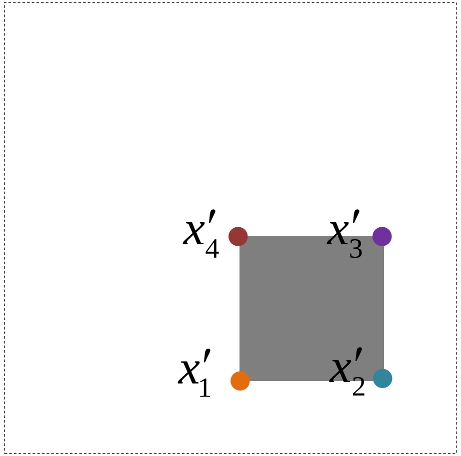
where $w = \frac{\text{\# of inliers}}{\text{\# of samples}}$

and n is the number of samples to build a model.

Prob. of success: $1-\left(1-w^n\right)^k$

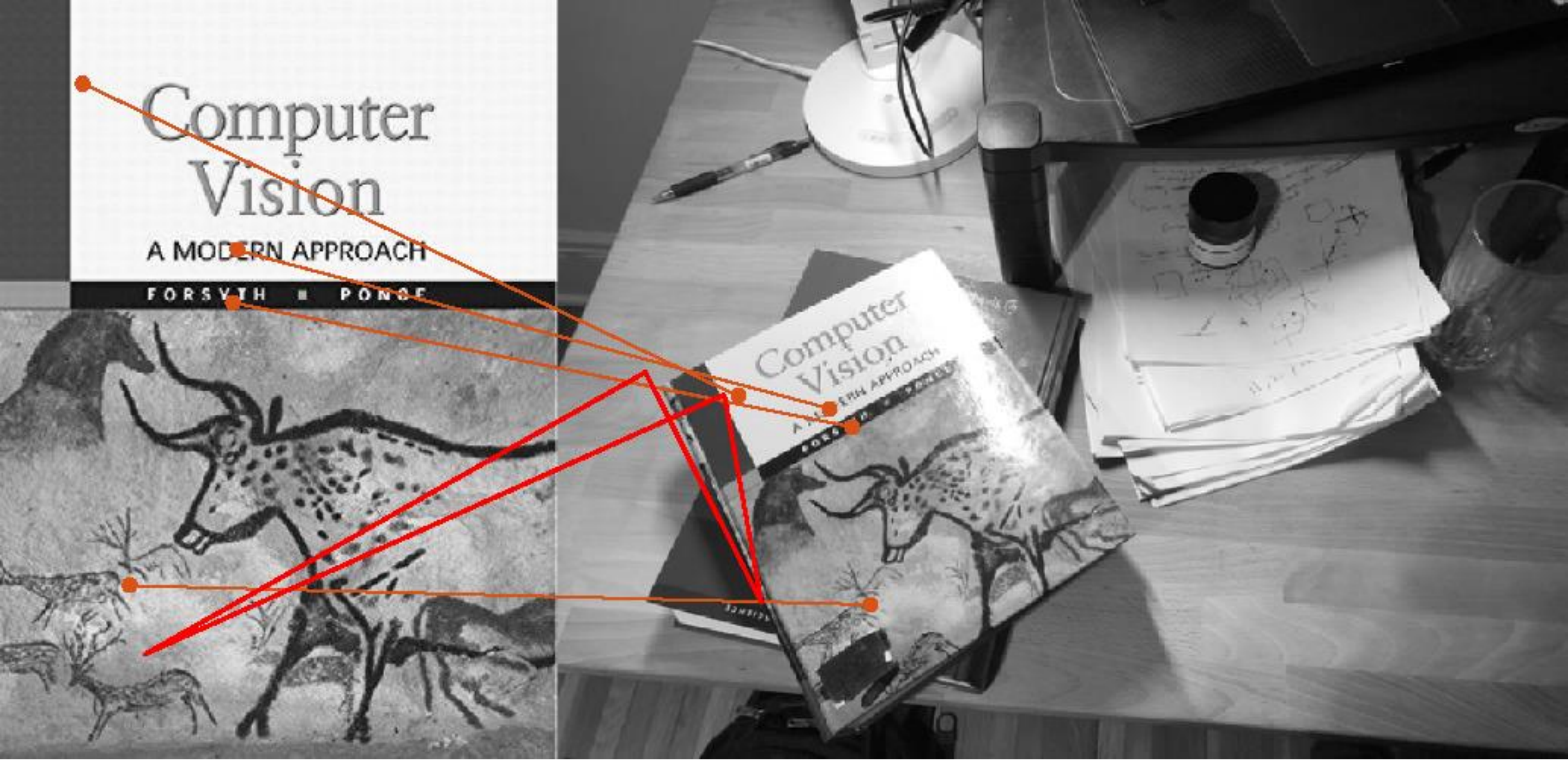
$$k = \frac{\log\left(1-p\right)}{\log\left(1-w^n\right)}$$

Recall: Homography Computation

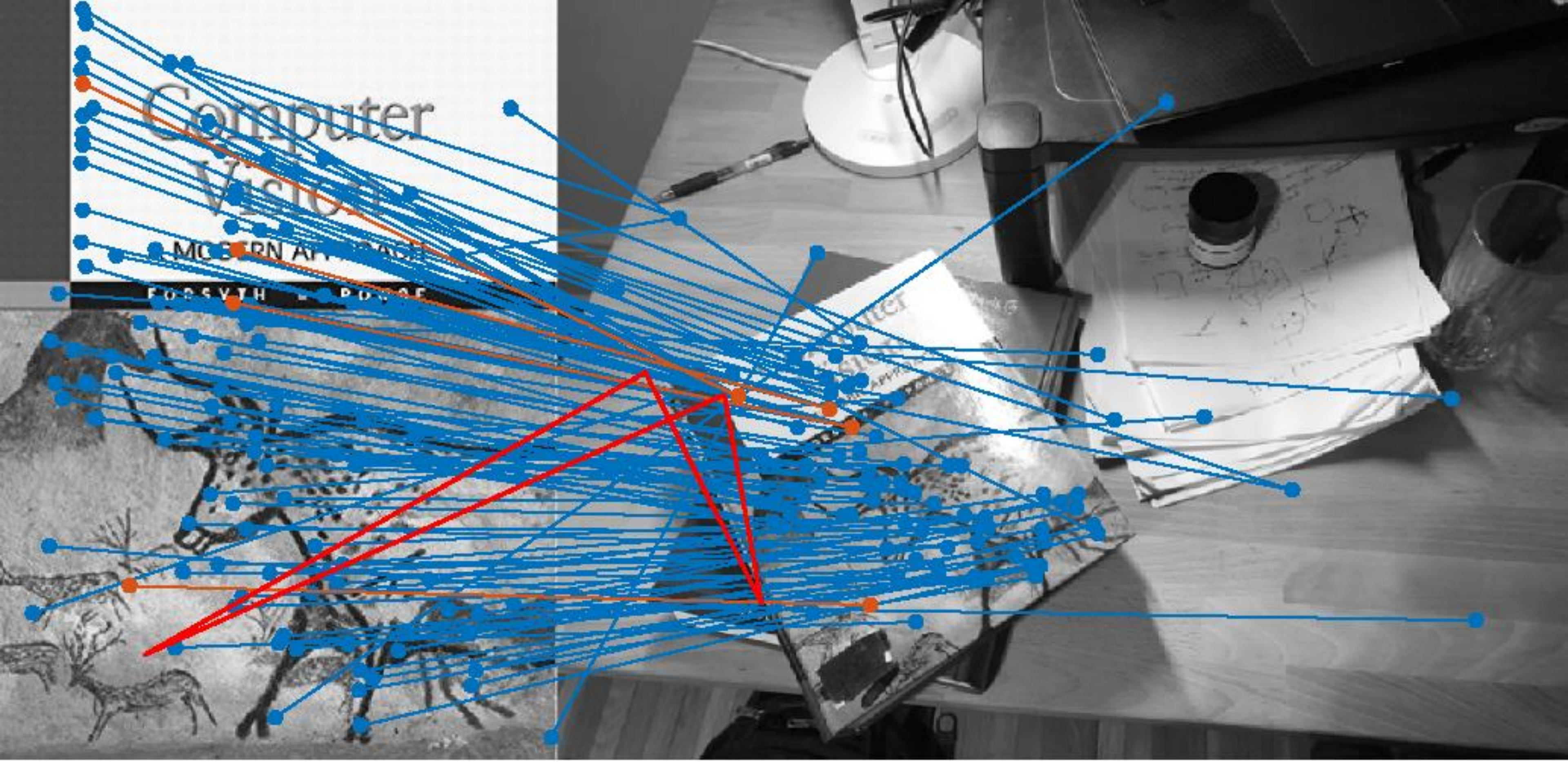


$$\underbrace{\begin{bmatrix} u_1 & v_1 & 1 & 0 & 0 & 0 & -u_1u_1' & -v_1u_1' \\ 0 & 0 & 0 & u_1 & v_1 & 1 & -u_1v_1' & -v_1v_1' \\ & & & & \vdots & & & \\ u_4 & v_4 & 1 & 0 & 0 & 0 & -u_4u_4' & -v_4u_4' \\ 0 & 0 & 0 & u_4 & v_4 & 1 & -u_4v_4' & -v_4v_4' \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} h_{11} \\ h_{12} \\ h_{13} \\ h_{21} \\ h_{22} \\ h_{23} \\ h_{31} \\ h_{32} \end{bmatrix}}_{x} = \underbrace{\begin{bmatrix} u_1' \\ v_1' \\ \vdots \\ u_4' \\ v_4' \end{bmatrix}}_{b}$$

$$Ax = b \longrightarrow x = \left(A^T A\right)^{-1} A^T b$$

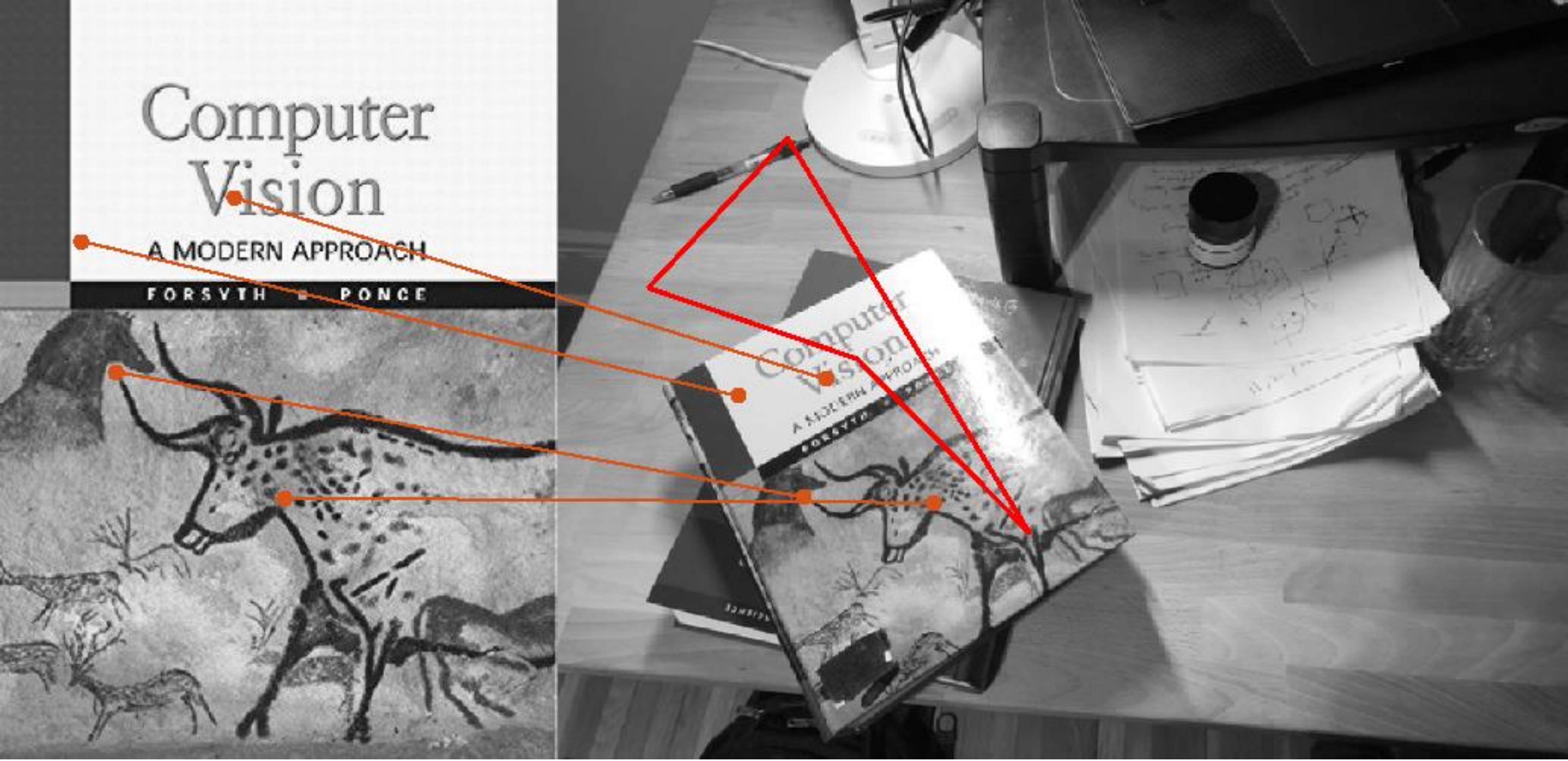


Homography from 4 random correspondences

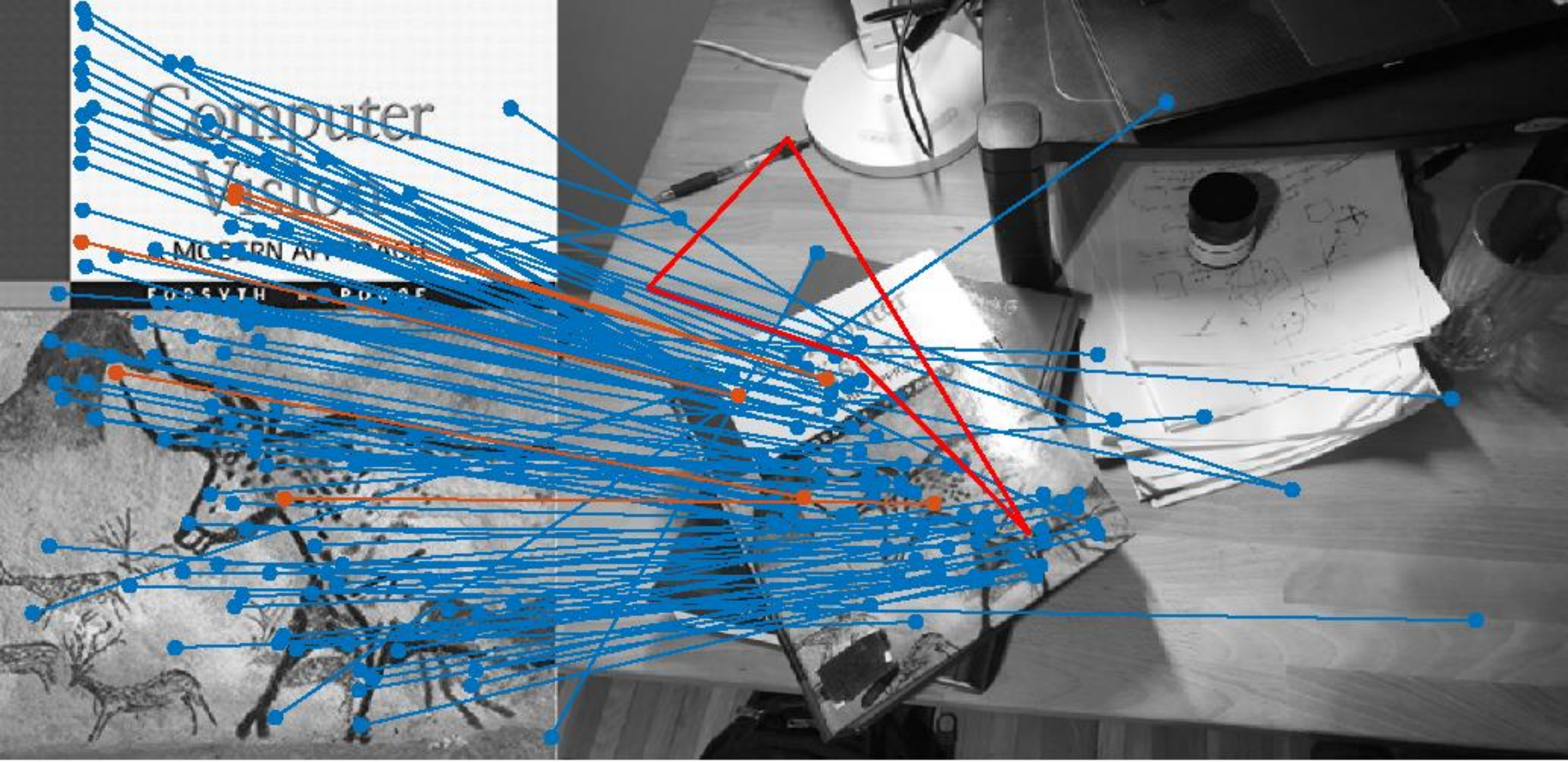


Inlier counting

Number of inliers: 5

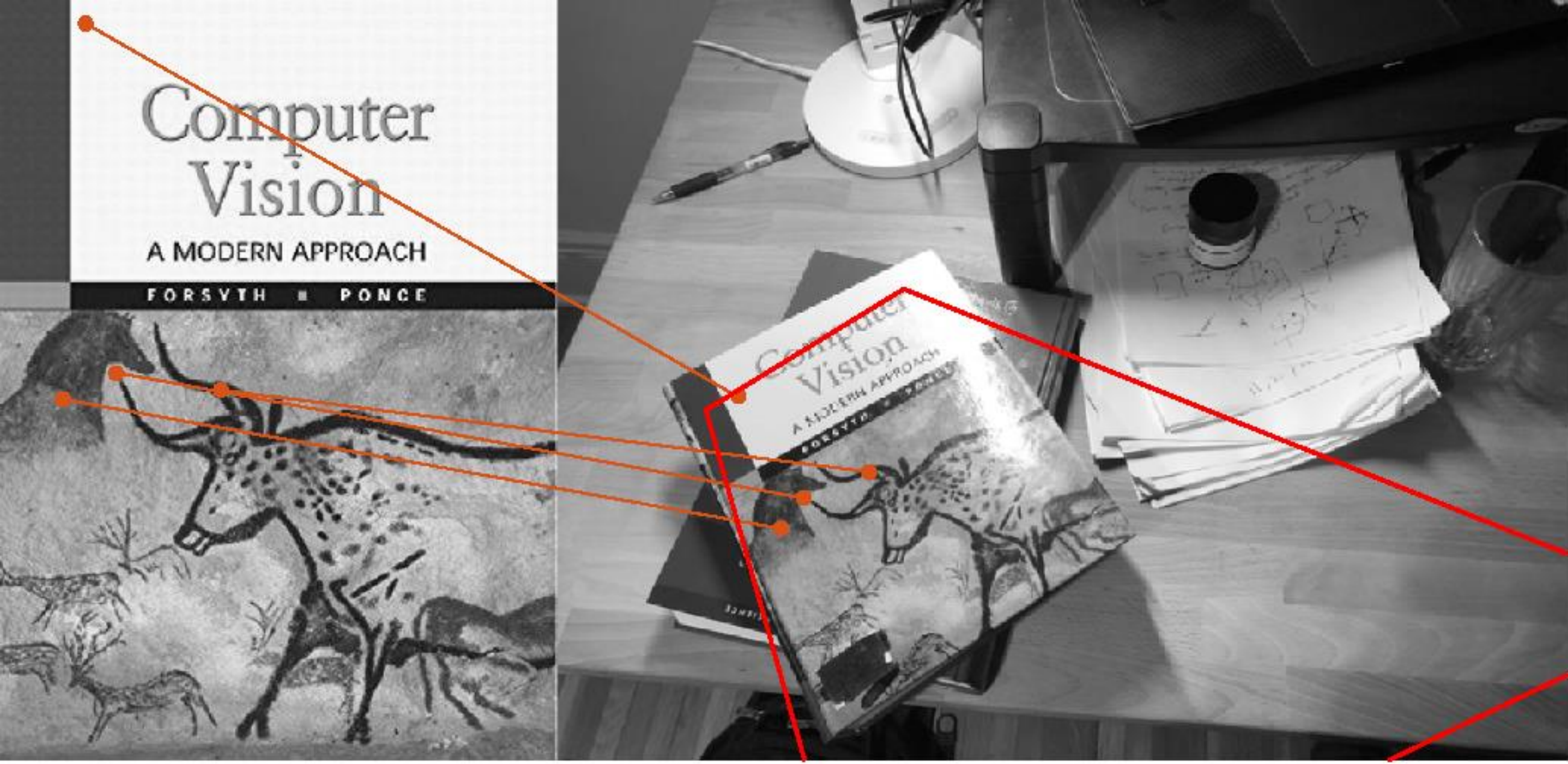


Homography from 4 random correspondences

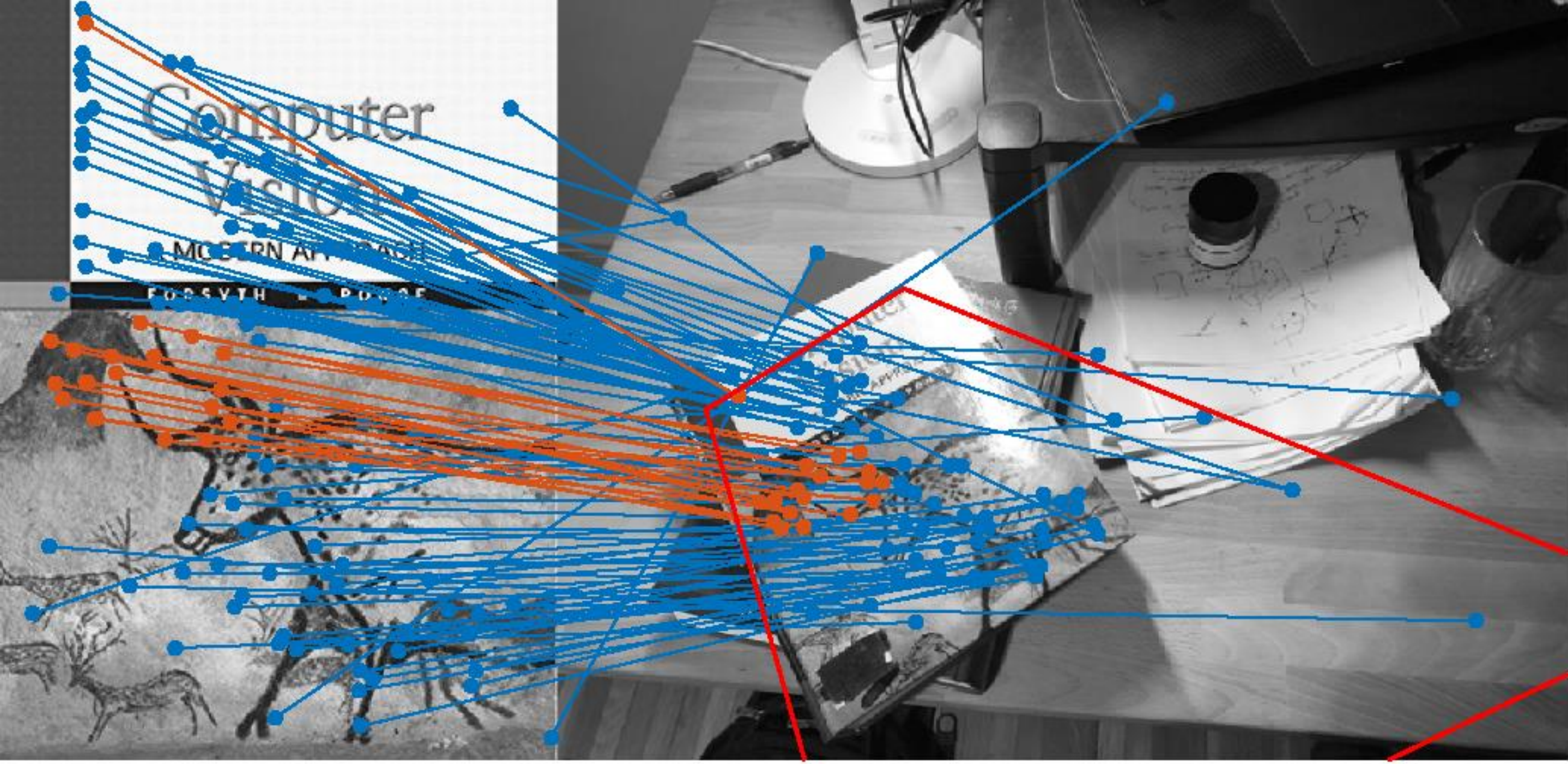


Inlier counting

Number of inliers: 8

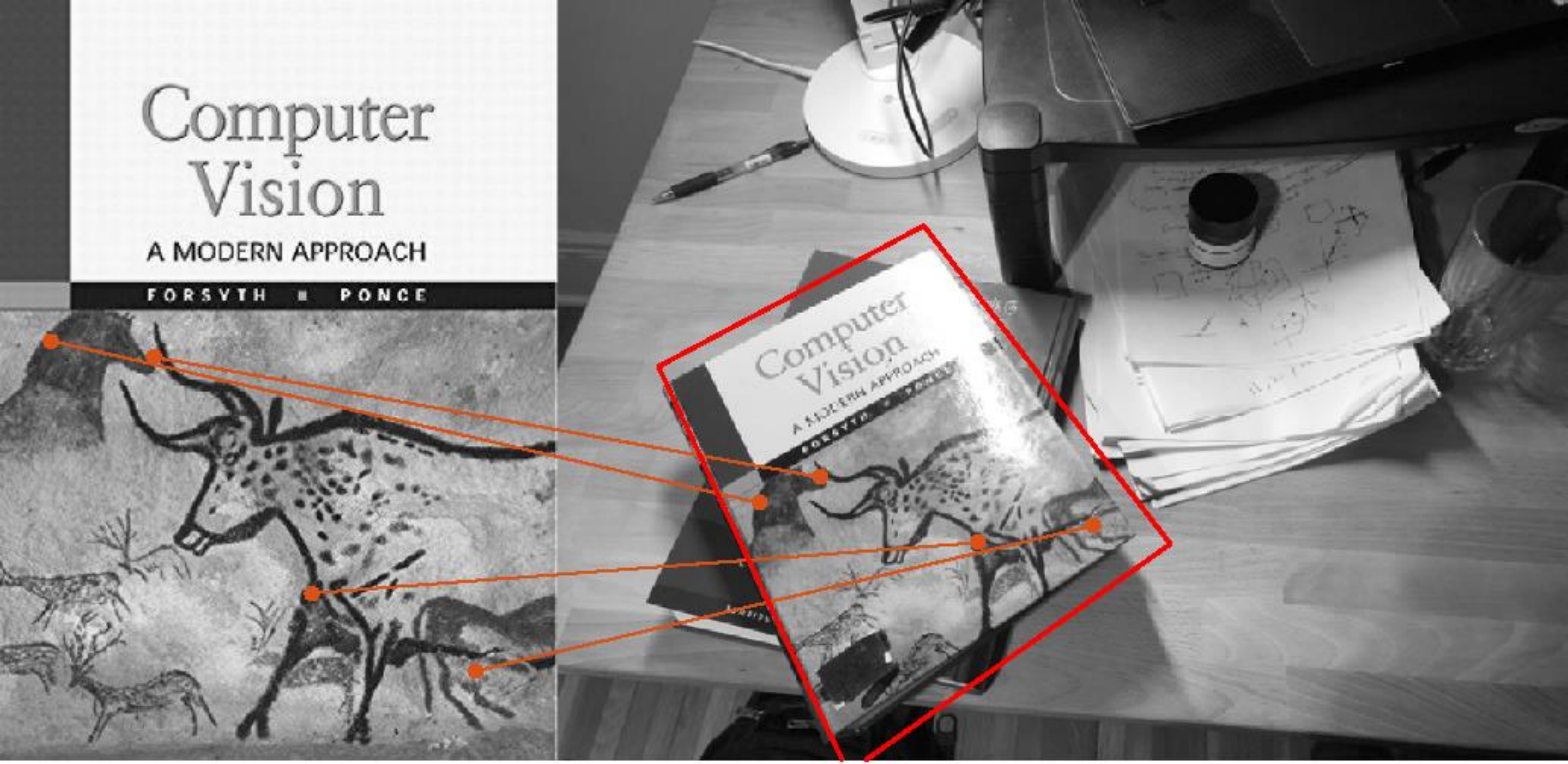


Homography from 4 random correspondences

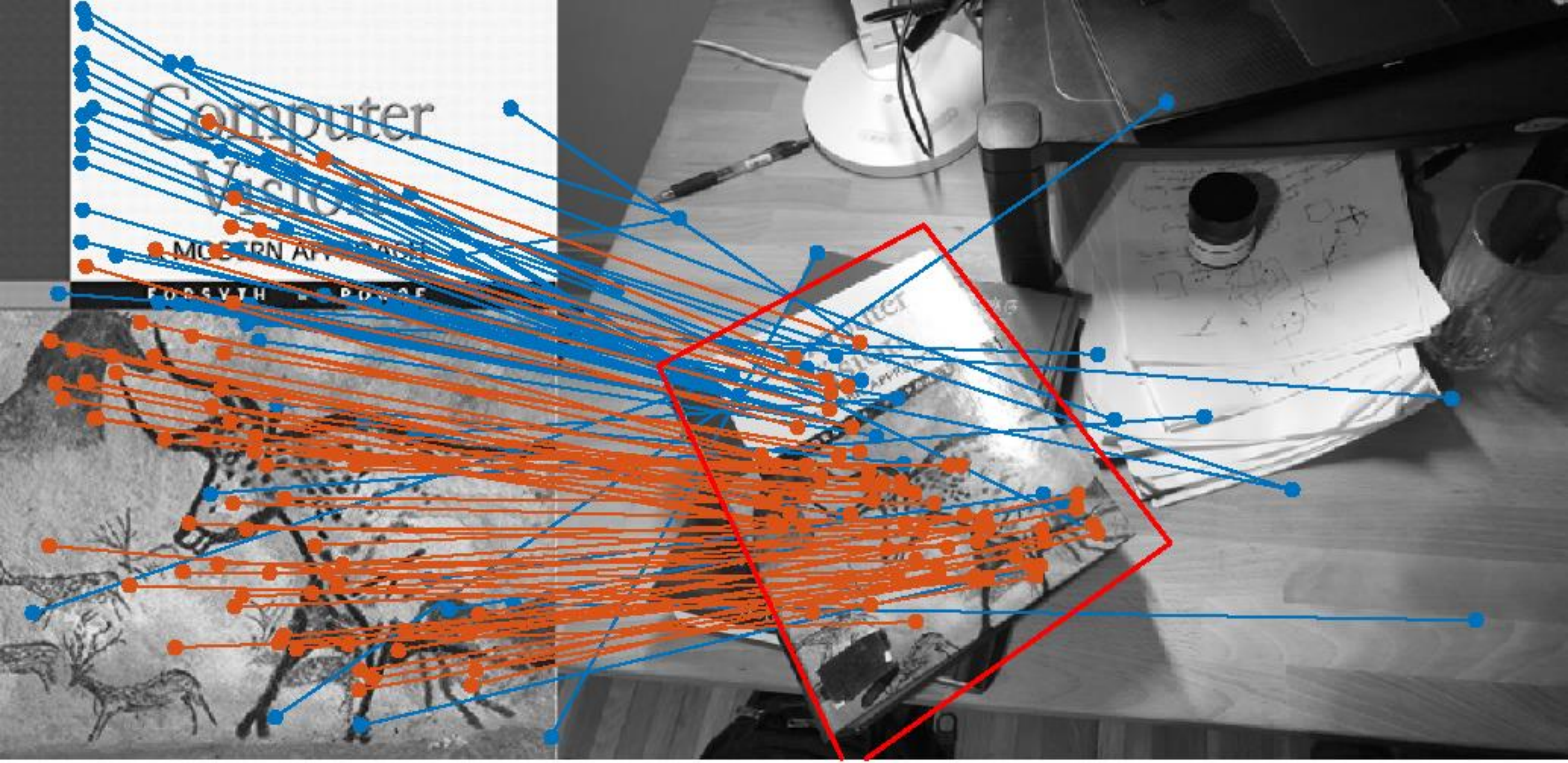


Inlier counting

Number of inliers: 25



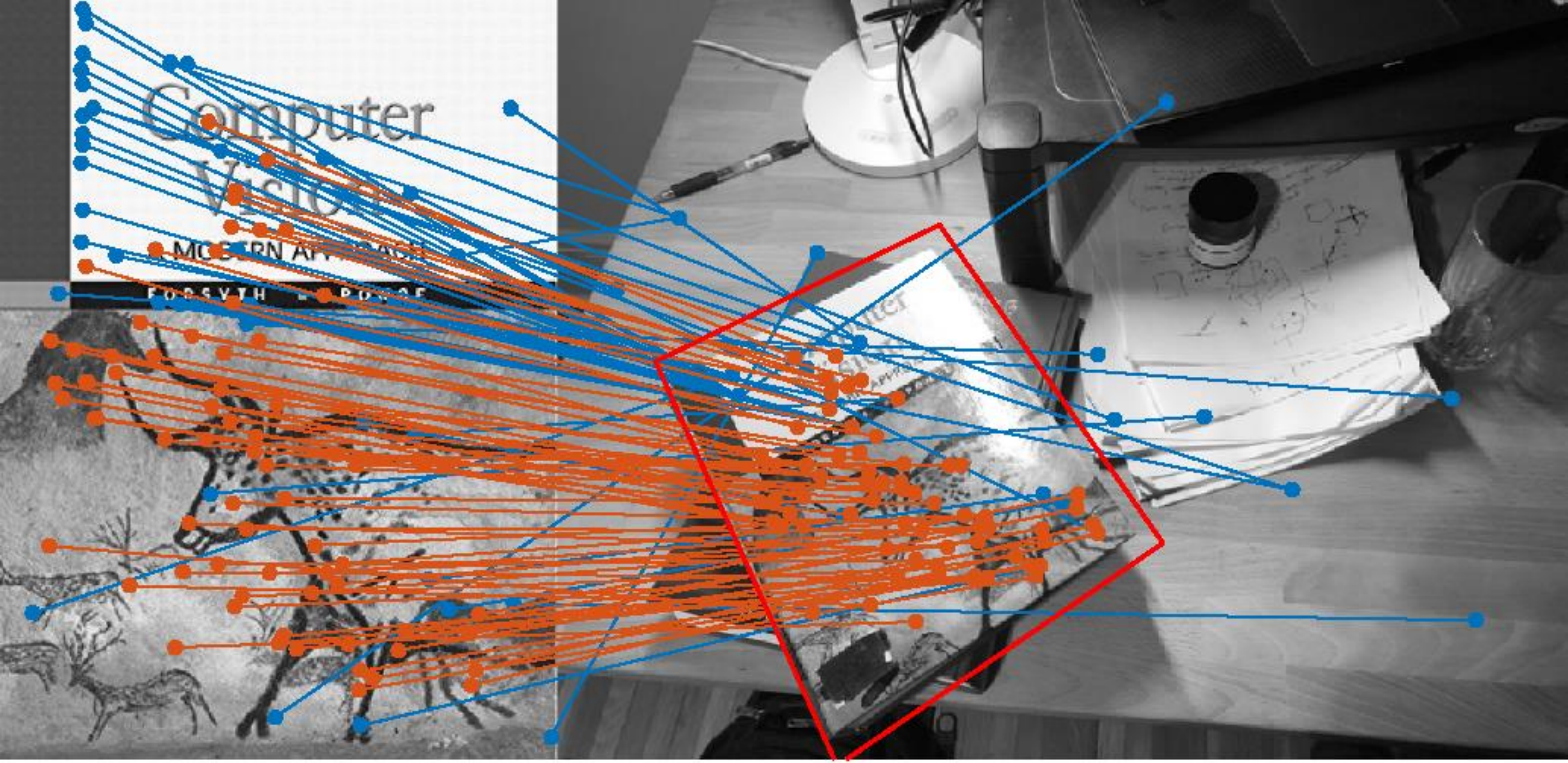
Homography from 4 random correspondences



Inlier counting

Number of inliers: 76

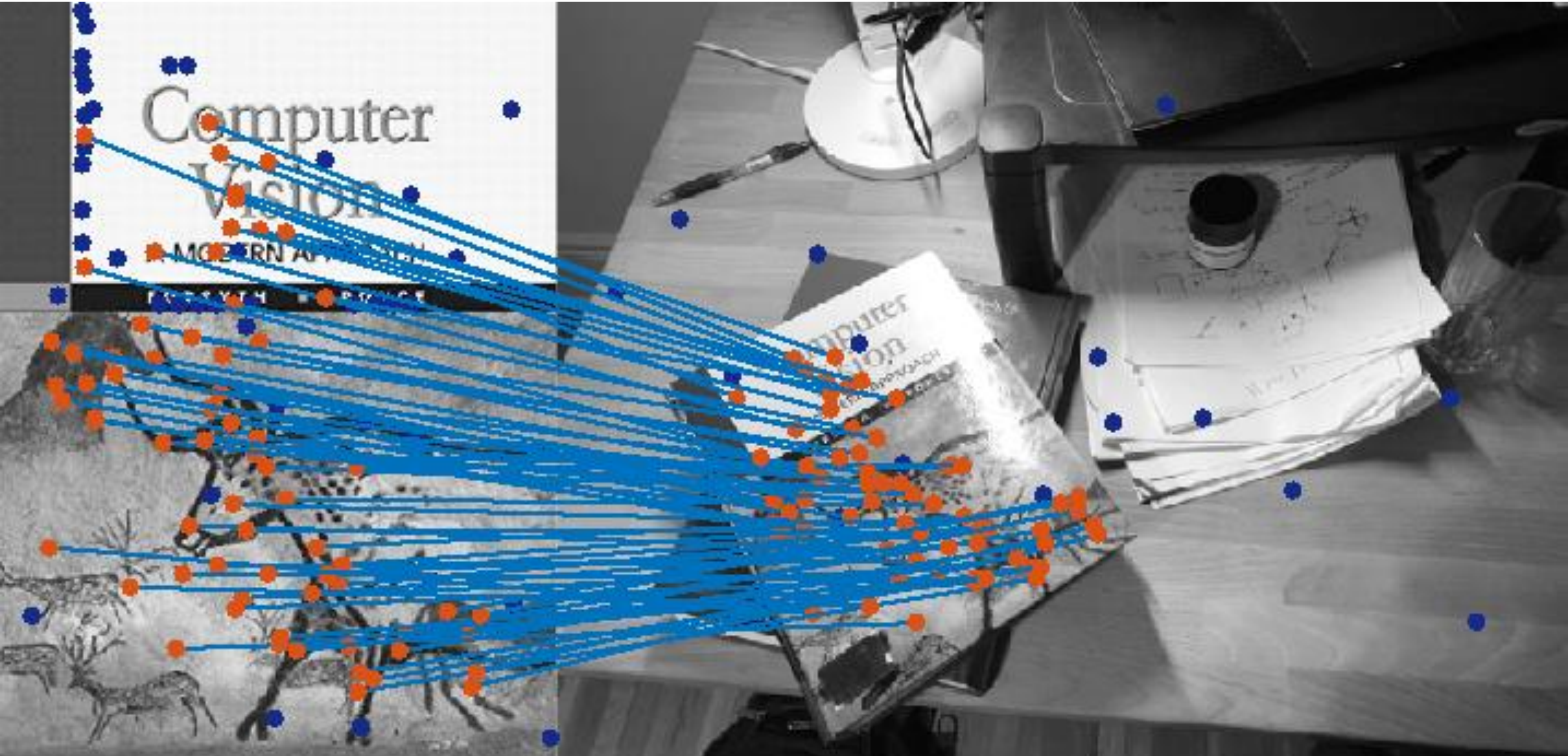
Homography from 4 random correspondences



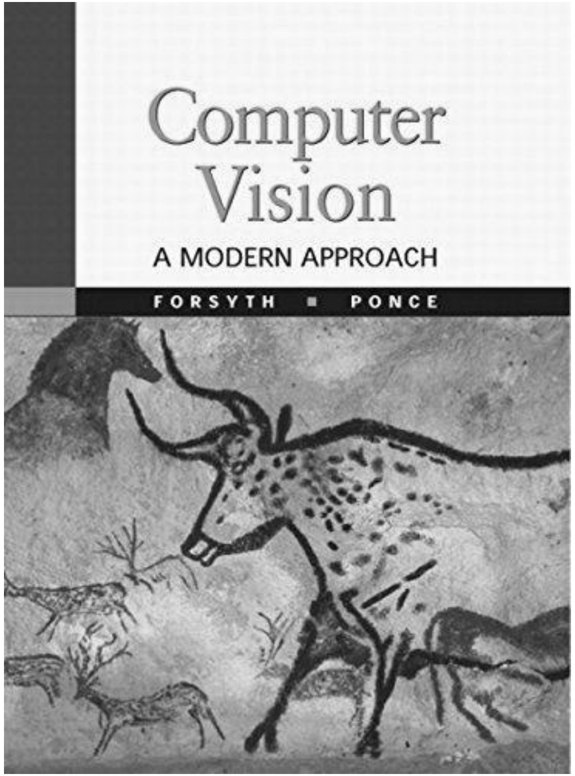
Inlier counting

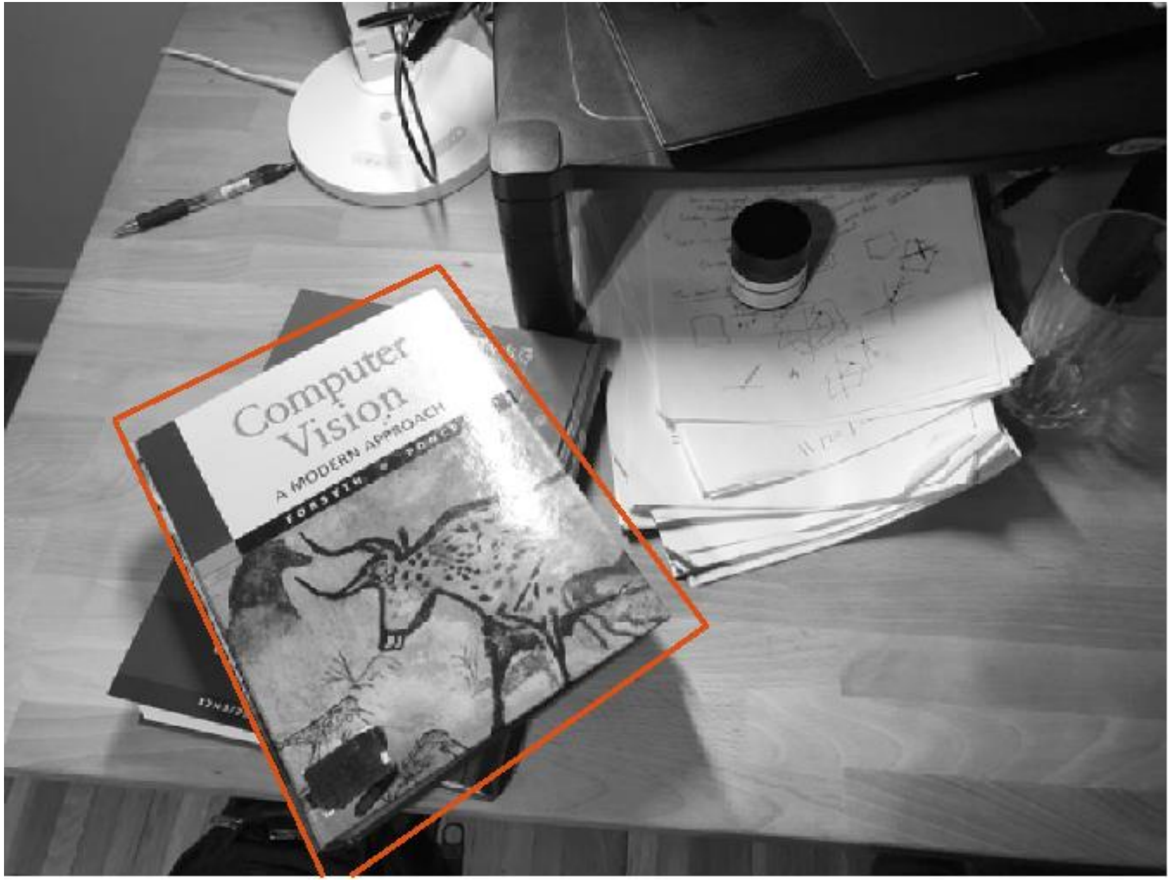
Number of inliers: 83

RECALL: ROBUST FILTERING



RECALL: PARAMETRIC MODEL





RECALL: IMAGE WARPING