RANSAC = RANdom SAmple Consensus

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RANSAC informally

- Random sample consensus (RANSAC) is an iterative method estimating parameters of a (parametric) mathematical model from a set of observed data that contains outliers.
- Outliers should have no influence on the values of the estimates. Consequently, RANSAC can serve for outlier detection.
- A basic assumption is that the data consists enough of inliers.

RANSAC

[Fischler, Bolles 1981]

- RANSAC = Random Sampling and Consensus.
- One of the most cited papers in computer vision.

In:

$U = \{x_i\}$	set of data points, $\|U\| = N$
$f(S)\colon S \to p$	function f computes model parameters p given a sample S from U
$\rho(p, x)$	the cost function for a single data point x

Out:

p^*	p^*, parameters of the model maximizing the cost function

RANSAC algorithm

$k := 0$

Repeat until P{better solution exists} $< \eta$ (a function of C^* and number of steps k)

$k := k + 1$

I. Hypothesis

(1) select randomly set $S_k \subset U$, $|S_k| = m$

(2) compute parameters $p_k = f(S_k)$

II. Verification

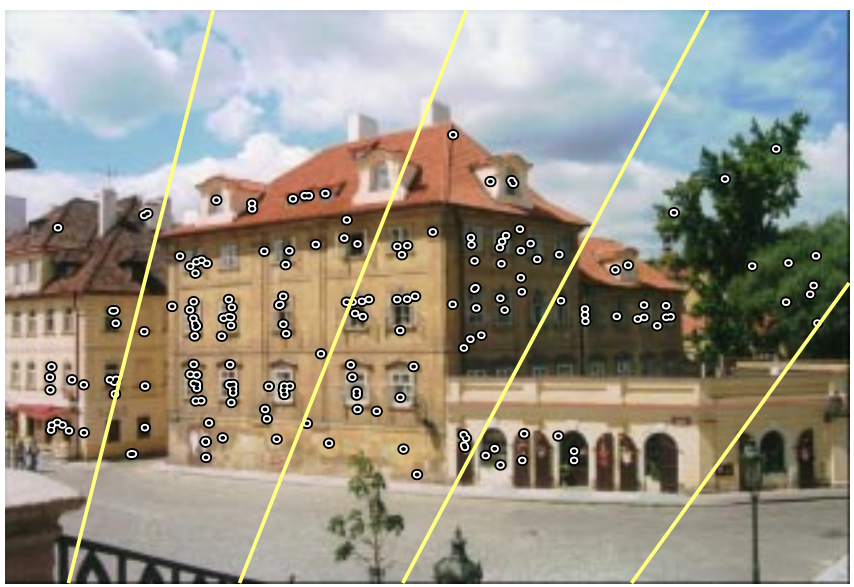
(3) compute cost $C_k = \sum_{x \in U} \rho(p_k, x)$

(4) if $C^* < C_k$ then $C^* := C_k$, $p^* := p_k$

end

Example I: Epipolar geometry estimation by RANSAC

- Data points U: a set of correspondences, i.e., pairs of 2D points
- Sample size $m = 7$
- Model parameters f: seven-point algorithm - gives 1 to 3 independent solutions
- Cost function ρ: thresholded Sampson's error



Example II: Line detection by RANSAC.

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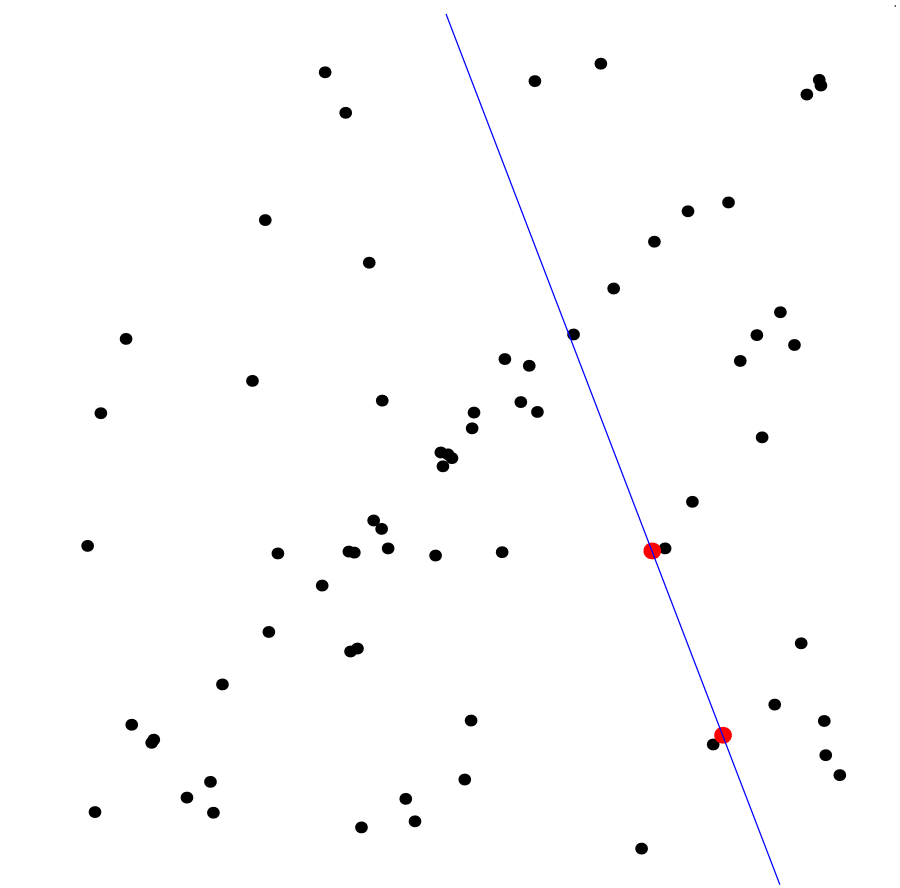
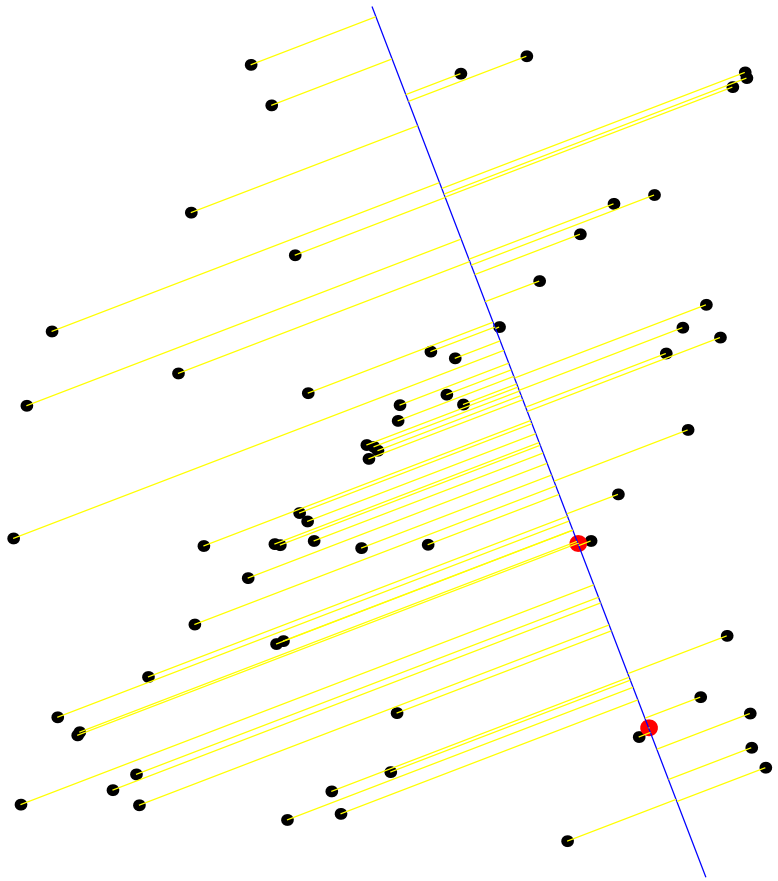


- Select randomly two points.
- The hypothesised model is the line passing through the two points.

Example II: Line detection by RANSAC.



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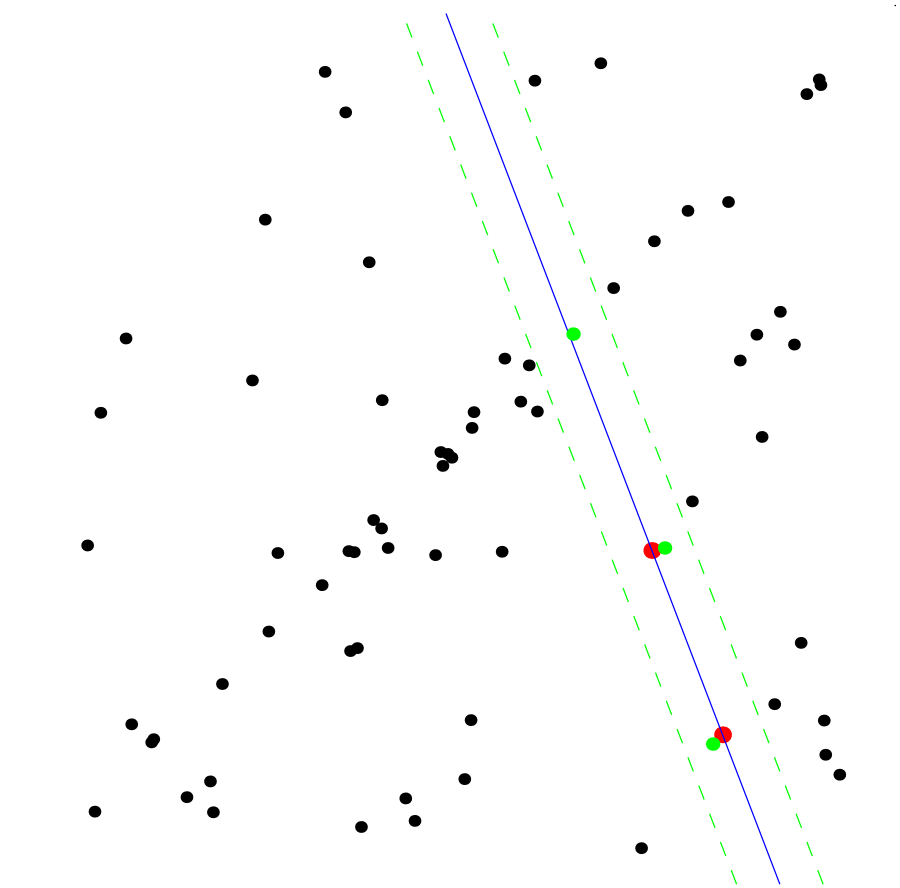

- Select randomly two points.
- The hypothesised model is the line passing through the two points.
- The error function is a distance from the line.
- Points consistent with the model.

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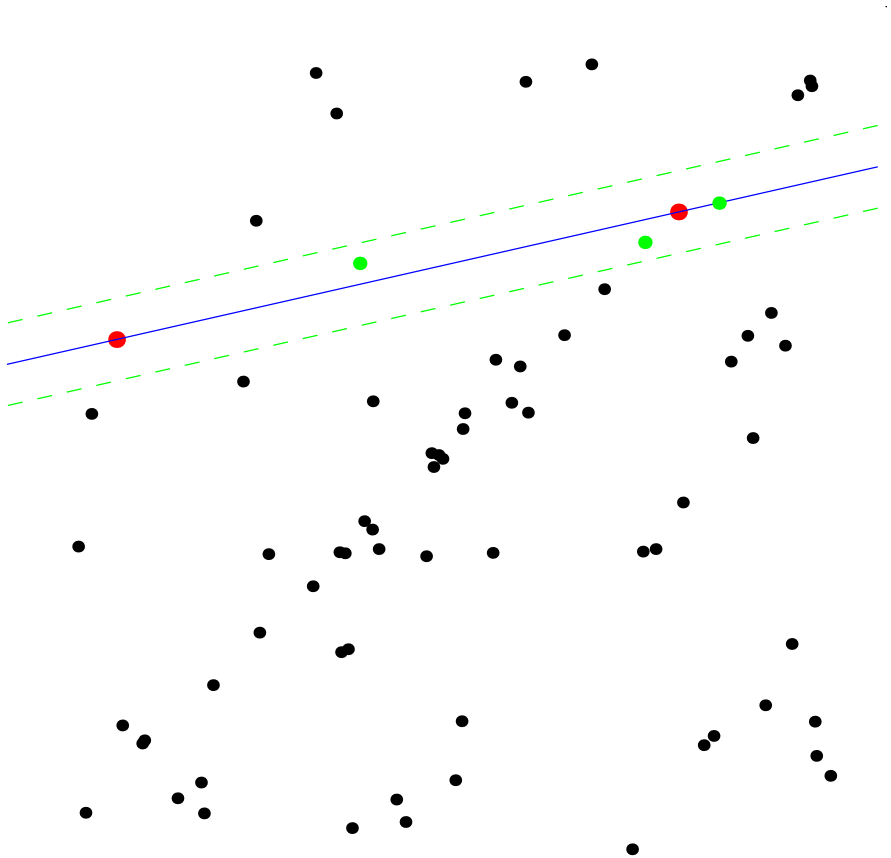
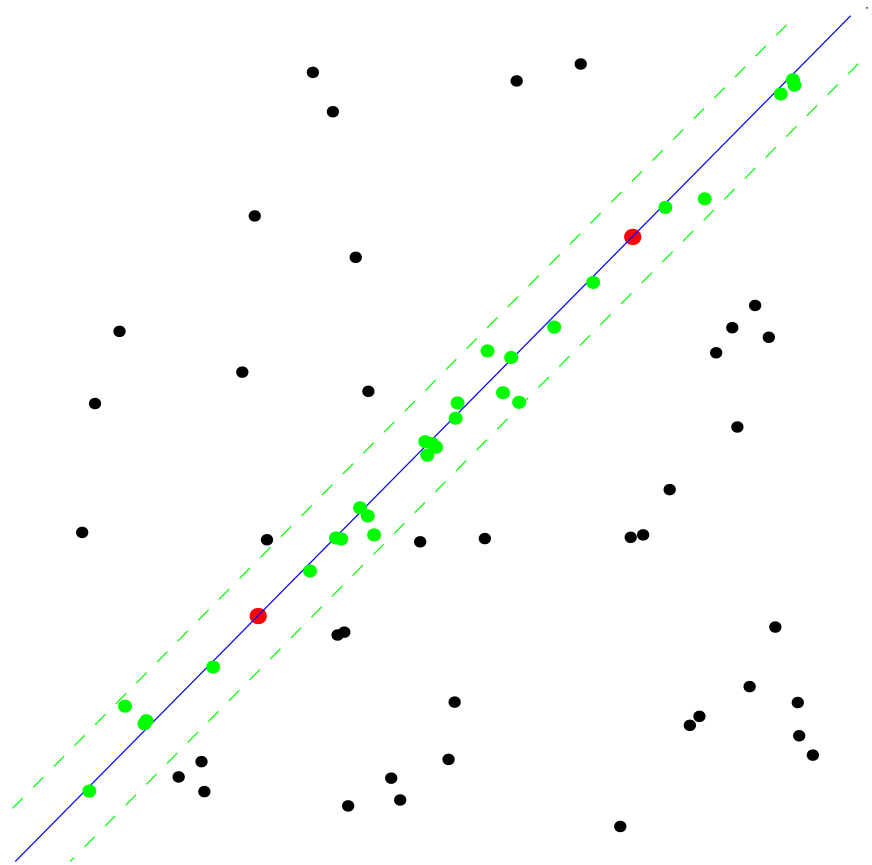


RANSAC Time Complexity



Uncontaminated sample

RANSAC time: $J = k(t_M + N)$

- N - number of data points
- ε - fraction of inliers
- m - size of the sample
- ε^m - probability that uncontaminated sample is selected
- $k = 1/\varepsilon^m$ - the average number of samples before uncontaminated one
- t_M - time to calculate the model

Number of Data Points

- For each hypothesised model, all the data points are verified.
- The more data points the longer RANSAC takes.
- The majority of samples are contaminated.

Solution:

- Randomize the verification