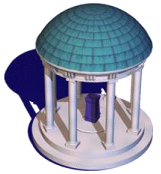
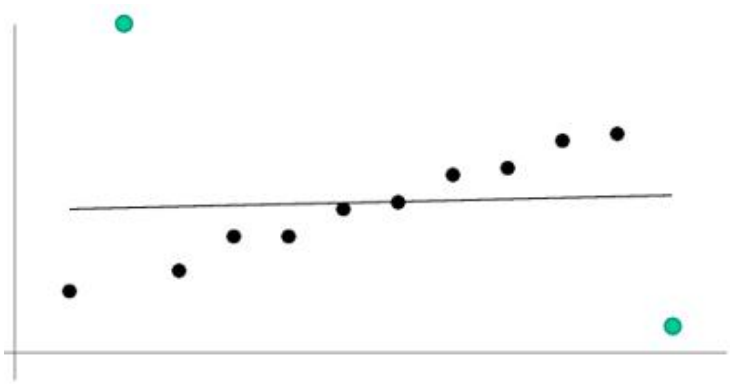
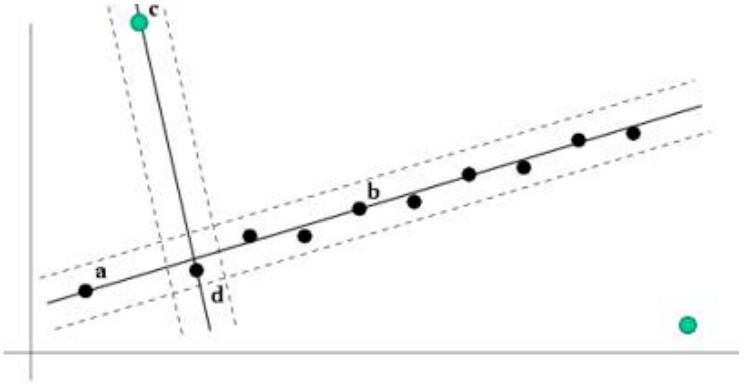
RANdom SAmple Consensus (RANSAC)

P117

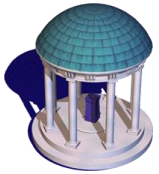


Robust estimation





- Two of the points are selected randomly, these points define a line
- The support for this line is measured by the number of points that lie within a distance threshold.
- This random selection is repeated a number of times.
- The line with most support is deemed the robust fit of matches.
- Use the robust fit to identify outliers.



RANSAC

Objective

Robust fit of model to data set S which contains outliers

Algorithm

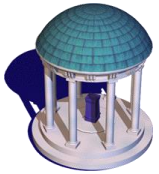
I. Randomly select a sample of *s* data points from S and instantiate the model from this subset.

II. Determine the set of data points S_i which are within a ***distance threshold t*** of the model. The set S_i is the ***consensus set*** of samples and defines the inliers of S.

III. If the subset of S_i is greater than some **threshold *T***, re-estimate the model using all the points in S_i and terminate

IV. If the size of S_i is less than *T*, select a new subset and repeat the above.

V. After ***N*** trials the largest consensus set S_i is selected, and the model is re-estimated using all the points in the subset S_i



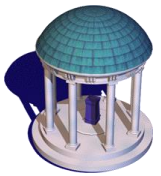
Distance threshold

Choose t so probability for inlier is α (e.g. 0.95)

- Often empirically
- Zero-mean Gaussian noise σ then $d_{\perp}^{2}$ follows χ_{m}^{2} distribution with m=codimension of model

(dimension+codimension=dimension space)

Codimension	Model	t^2
1	l,F	$3.84\sigma^2$
2	H,P	$5.99\sigma^2$
3	T	$7.81\sigma^2$



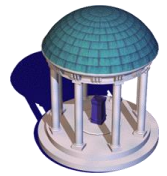
How many samples?

Choose N so that, with probability p, at least one random sample is free from outliers. e.g. p=0.99

$$\left(1-\left(1-e\right)^{s}\right)^{N}=1-p$$

$$N=\log\left(1-p\right)/\log\left(1-\left(1-e\right)^{s}\right)$$

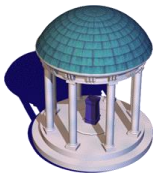
	proportion of outliers e						
s	5%	10%	20%	25%	30%	40%	50%
2	2	3	5	6	7	11	17
3	3	4	7	9	11	19	35
4	3	5	9	13	17	34	72
5	4	6	12	17	26	57	146
6	4	7	16	24	37	97	293
7	4	8	20	33	54	163	588
8	5	9	26	44	78	272	1177



Adaptively determining the number of samples

e is often unknown a priori, so pick worst case, e.g. 50%, and adapt if more inliers are found, e.g. 80% would yield e=0.2

- N=∞, *sample_count* =0
- While $N >$ *sample_count* repeat
  - Choose a sample and count the number of inliers
  - Set e=1-(number of inliers)/(total number of points)
  - Recompute N from e $\left(N = \log(1-p)/\log\left(1-(1-e)^s\right)\right)$
  - Increment the *sample_count* by 1
- Terminate



Acceptable consensus set?

- Typically, terminate when inlier ratio reaches expected ratio of inliers

$$T = (1 - e)n$$