Courbes et Surfaces: interpolation par surfaces paramétriques simples

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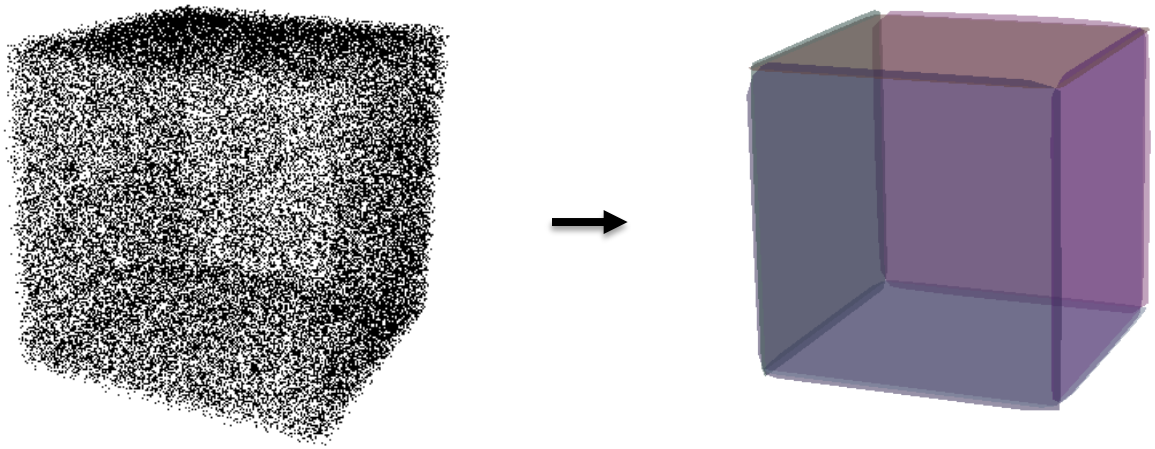
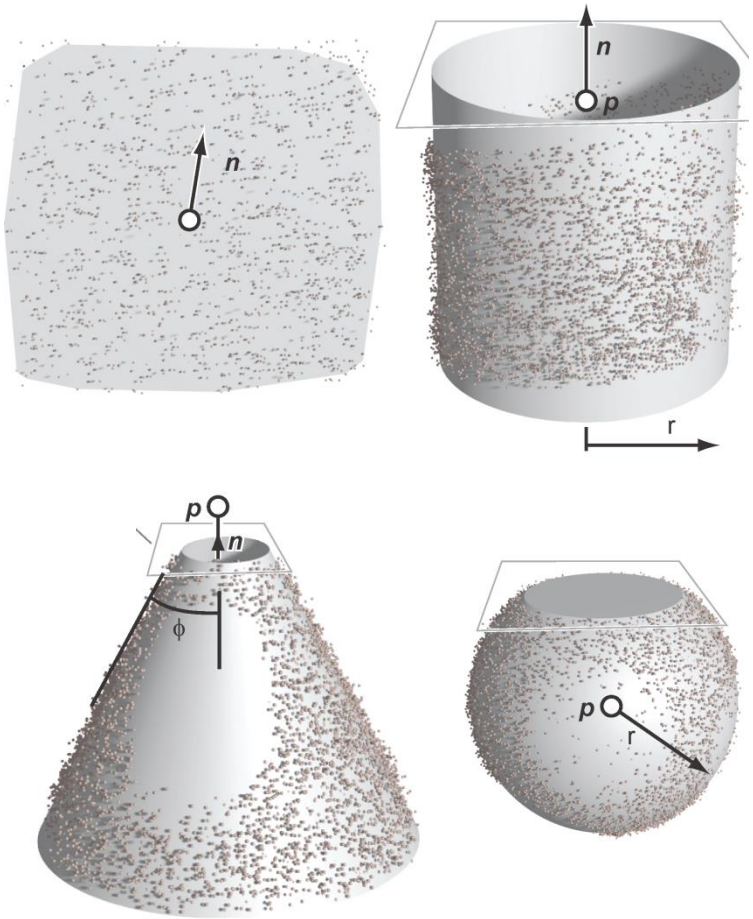
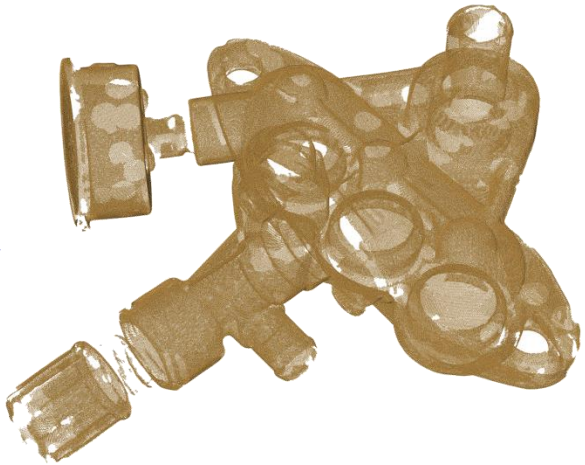
- Geometric primitive extraction
  - Region growing
  - Ransac
  - Accumulation methods
  - Global regularities

3D physical measurements, eg point clouds

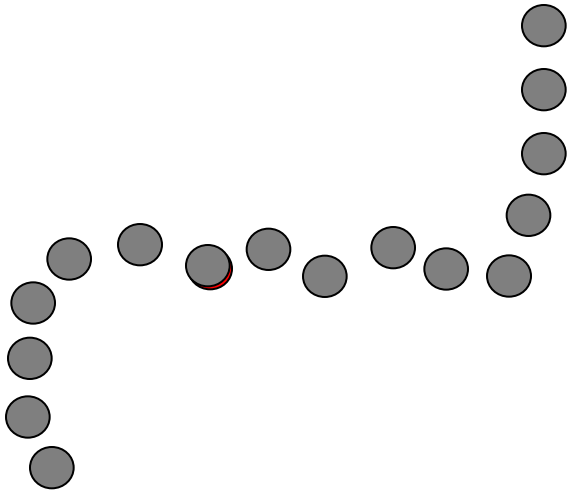


How to extract Geometric primitives from point sets ?





Region growing



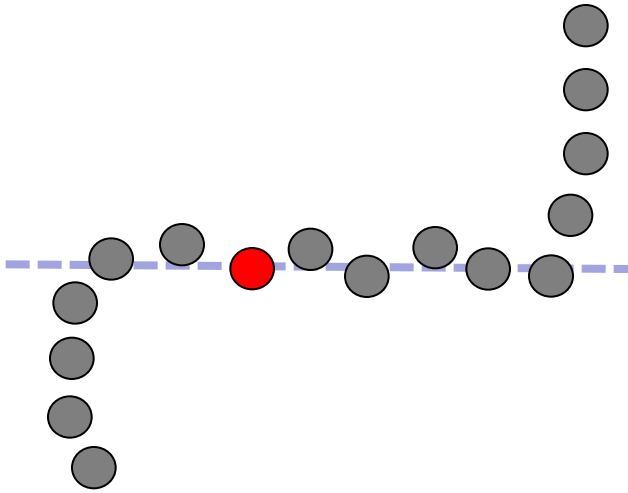
- Iterative method
- Spatial propagation of a primitive

Hypothesis

- deterministic
- Efficient for relatively “clean” Data

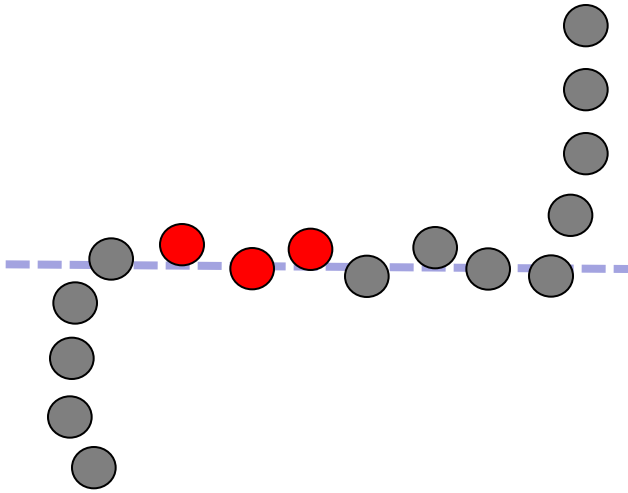
Region growing

- select a point and a primitive hypothesis

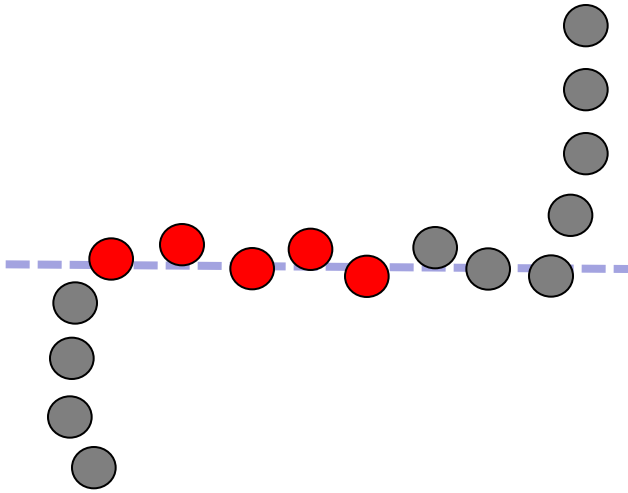


Region growing

- select a point and a primitive hypothesis
- propagate to the neighbors if they verify the hypothesis



Region growing



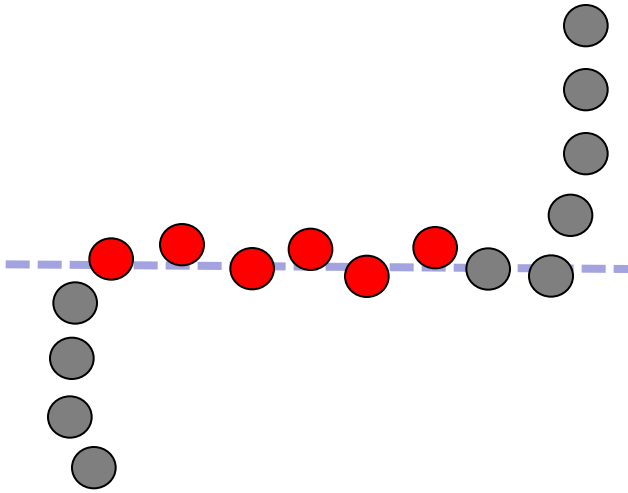
- select a point and a primitive

hypothesis

- propagate to the neighbors if

they verify the hypothesis, and iterate until no point verifies the hypothesis anymore.

Region growing



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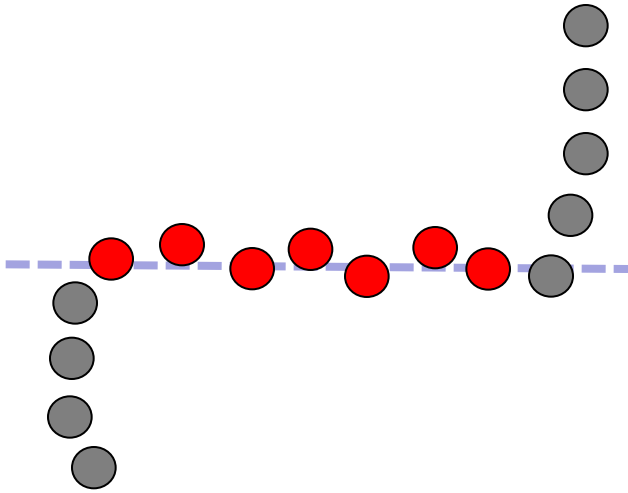
Region growing



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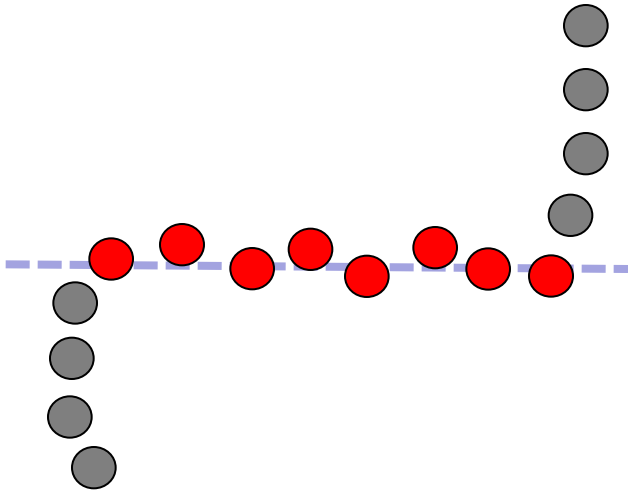
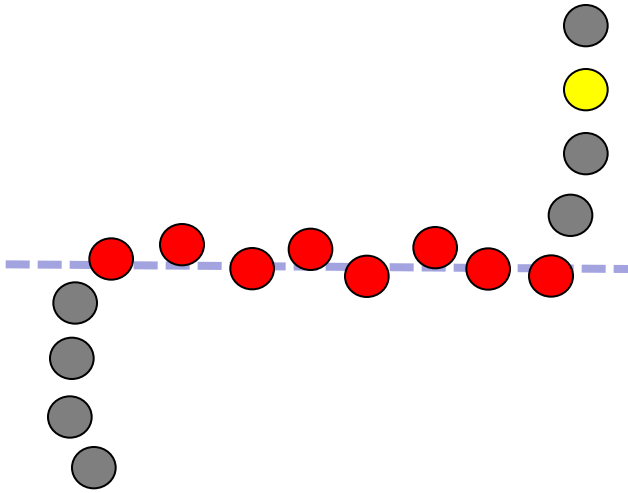
Region growing



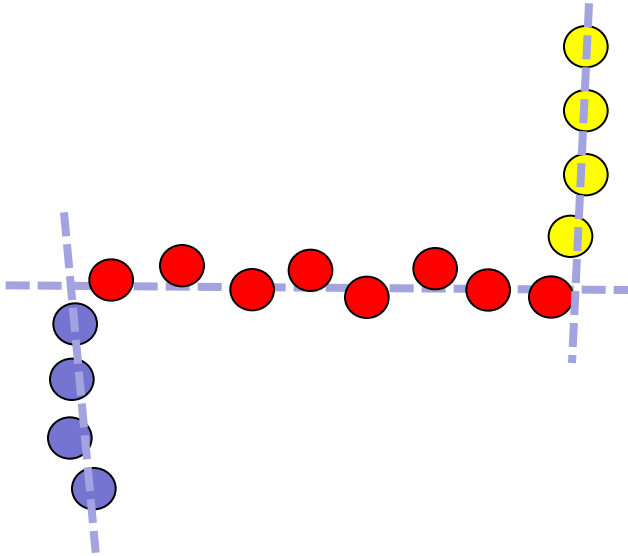
- select a point and a primitive hypothesis
- propagate to the neighbors if they verify the hypothesis, and iterate until no point verifies the hypothesis anymore.

Region growing



- select a point and a primitive hypothesis
- propagate to the neighbors if they verify the hypothesis, and iterate until no point verifies the hypothesis anymore.
- select a remaining point and a primitive Hypothesis, and iterate

Region growing



- select a point and a primitive hypothesis
- propagate to the neighbors if they verify the hypothesis, and iterate until no point verifies the hypothesis anymore.
- select a remaining point and a primitive Hypothesis, and iterate

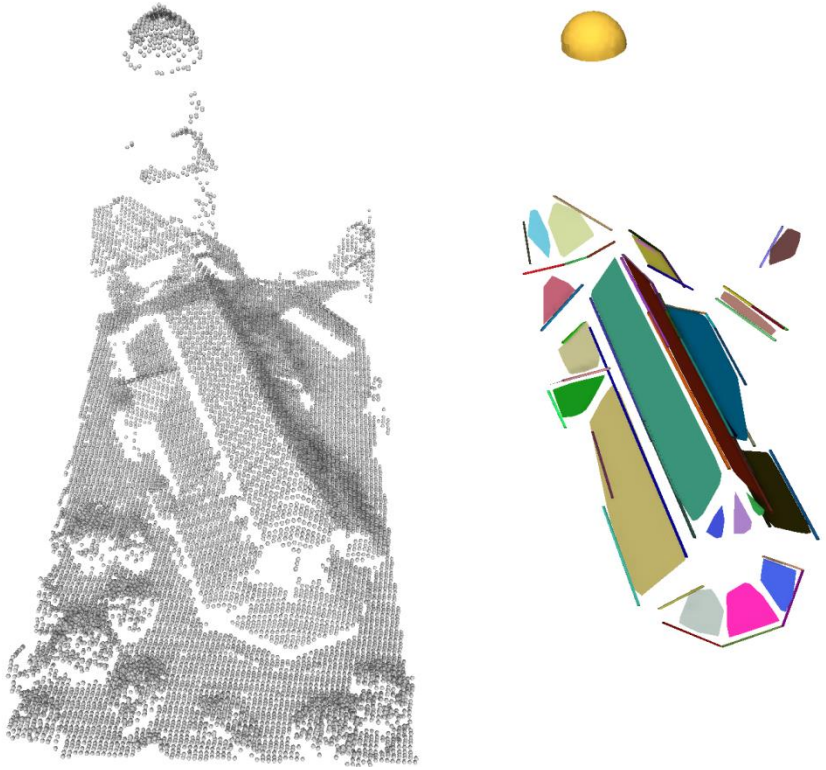
the parameters to specify

- minimum number of points needed to fit the primitive
- Distance threshold

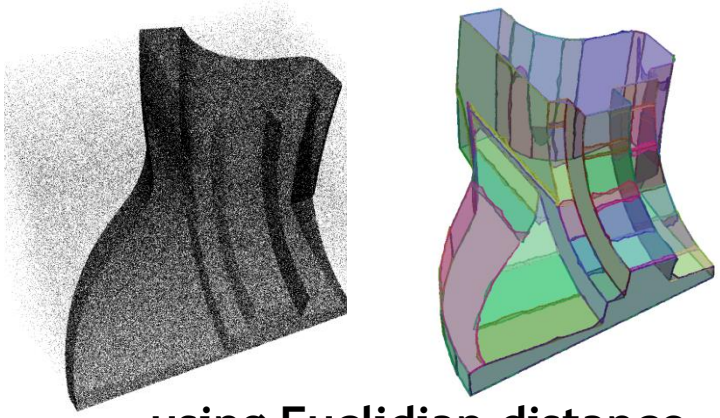
Region growing

- need to know the nearest neighbors
- the primitive hypothesis has to be relevant when starting the growing
- .. but the primitive hypothesis can also be updated during the growing
- not optimal when noisy data

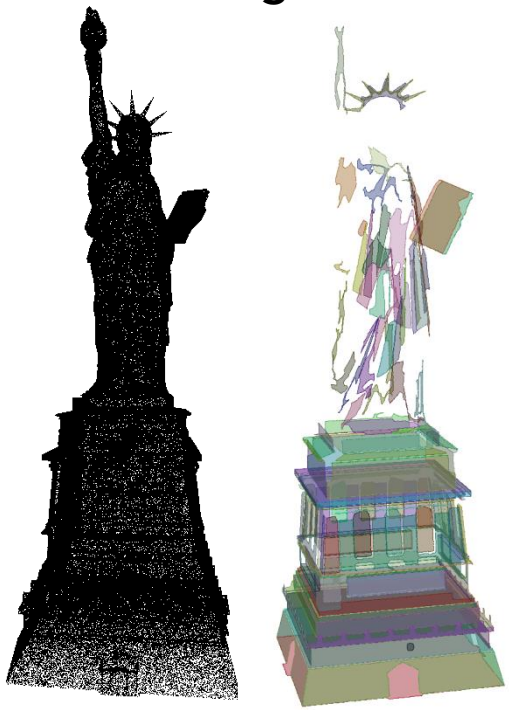
Region growing



using normals



using Euclidian distance

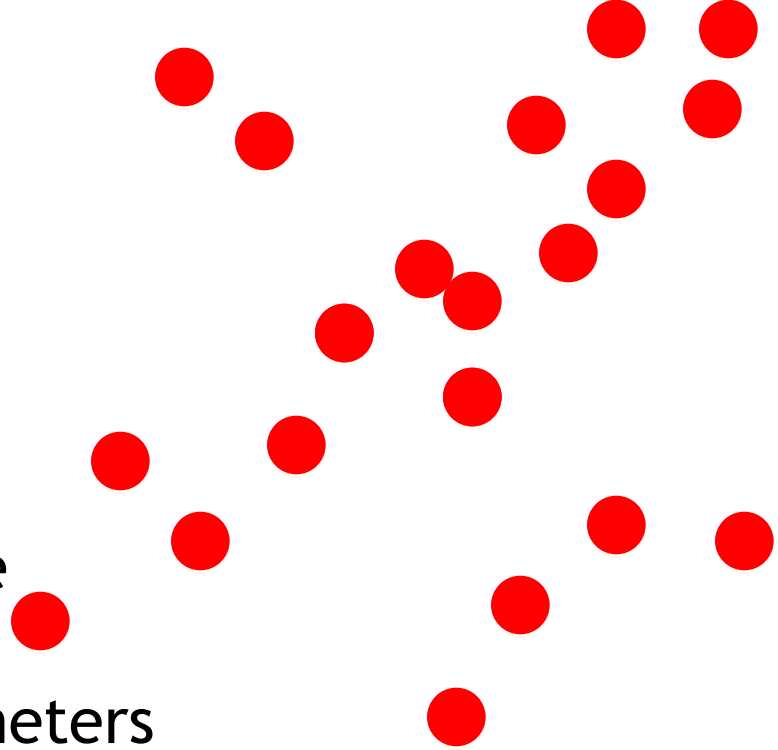


using normals and Euclidian distance

Ransac (RANdom SAmple Consensus)

- Iterative method
- Estimation of the primitive parameters by a random sampling of data
- Designed to be efficient with outlier-laden Data
- Non-deterministic

Ransac Algorithm



- Sample (randomly)
the number of points
required to fit the primitive

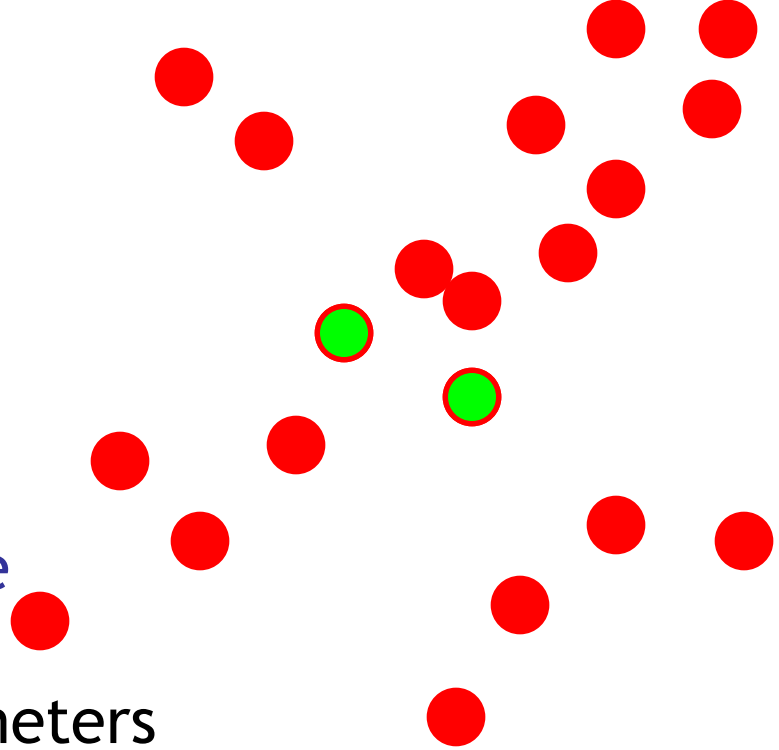
- Solve for primitive parameters
using samples

- Score by the fraction of inliers
within a preset threshold of the primitive

Repeat these 3 steps until the best primitive is found with high confidence

[Fischler & Bolles]

Ransac Algorithm



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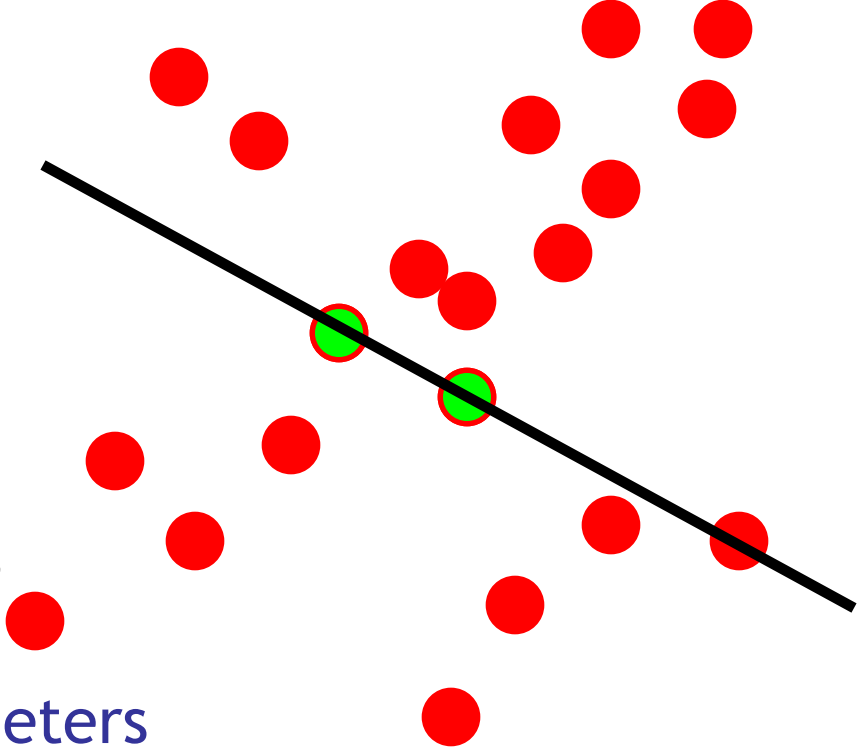

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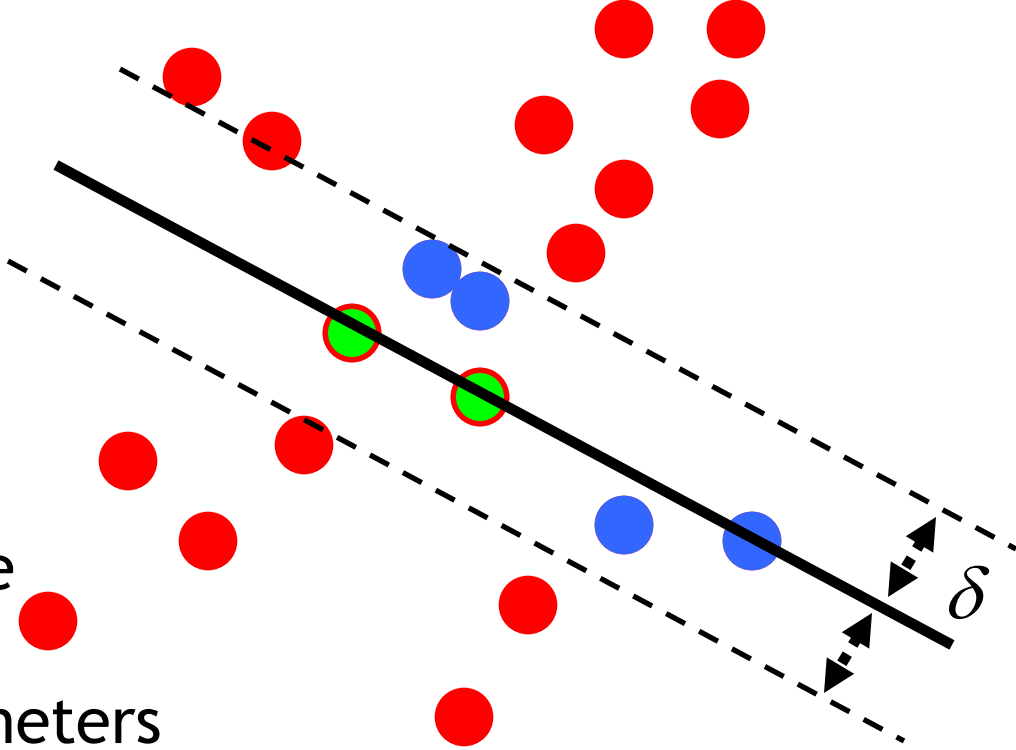
Repeat these 3 steps until the best primitive is found with high confidence

Ransac Algorithm



- Sample (randomly) the number of points required to fit the primitive

- Solve for primitive parameters using samples

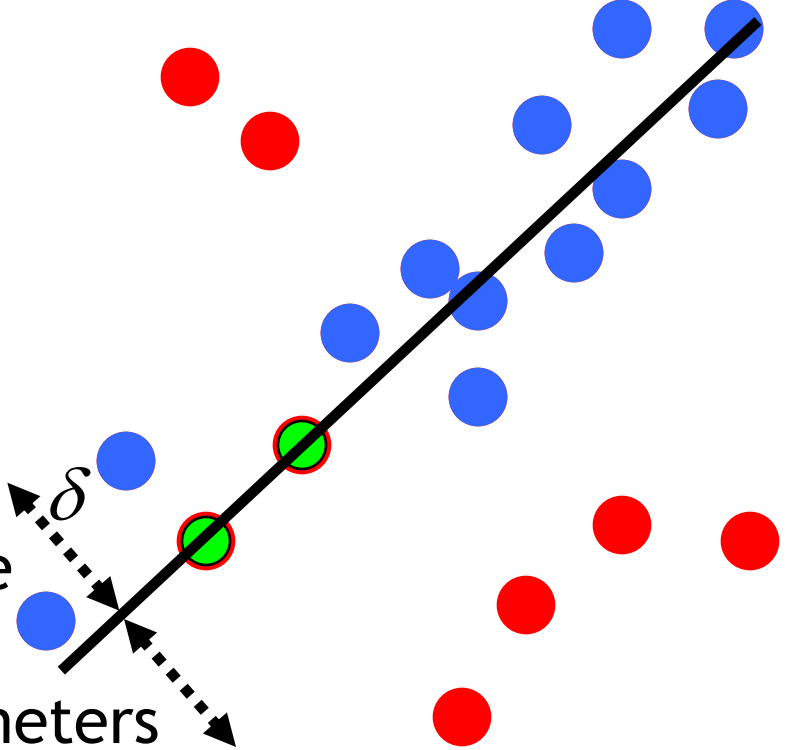
$$N_I = 6$$

- Score by the fraction of inliers within a preset threshold of the primitive

Repeat these 3 steps until the best primitive is found with high confidence

Ransac Algorithm

- Sample (randomly) the number of points required to fit the primitive



- Solve for primitive parameters using samples

$$N_I = 14$$

- Score by the fraction of inliers within a preset threshold of the primitive

Repeat these 3 steps until the best primitive is found with high confidence

the parameters to specify

- minimum number of points needed to fit the primitive
- Distance threshold δ
- Number of samples

To be chosen so that at least one random sample is free from outliers with a certain probability

Accumulation methods

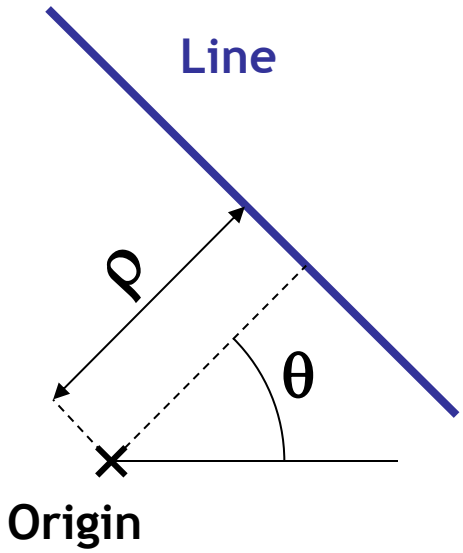
- Accumulate local primitive hypotheses in a space of primitive parameters

- extract the local maxima from the parameter space

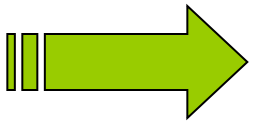
- the parameter space must be discretized

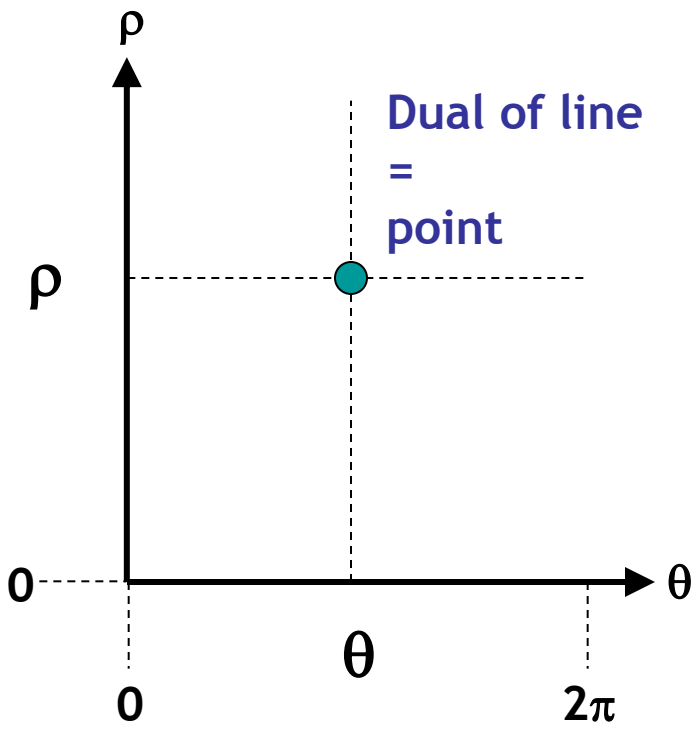
Accumulation methods: Hough transform

Case of lines in 2D



(x,y) space

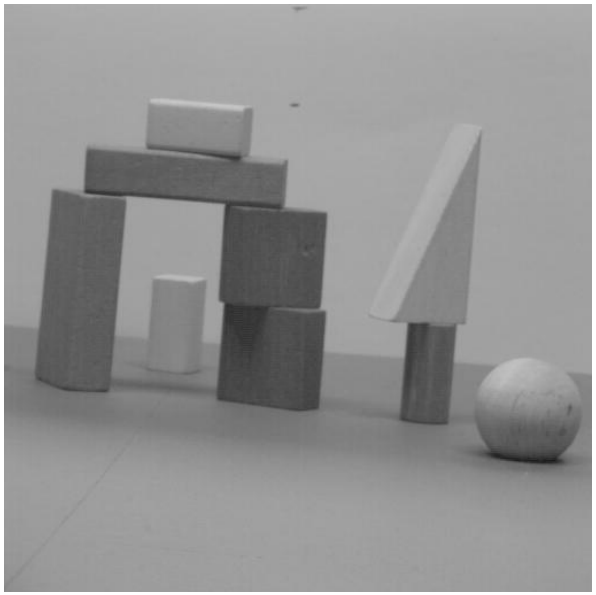


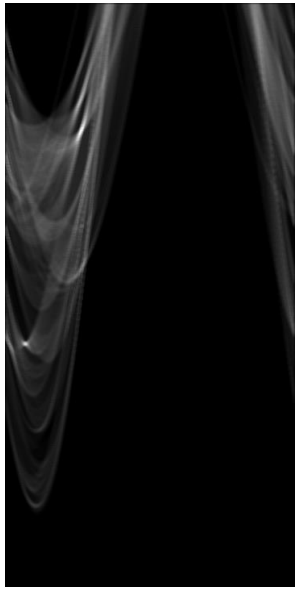


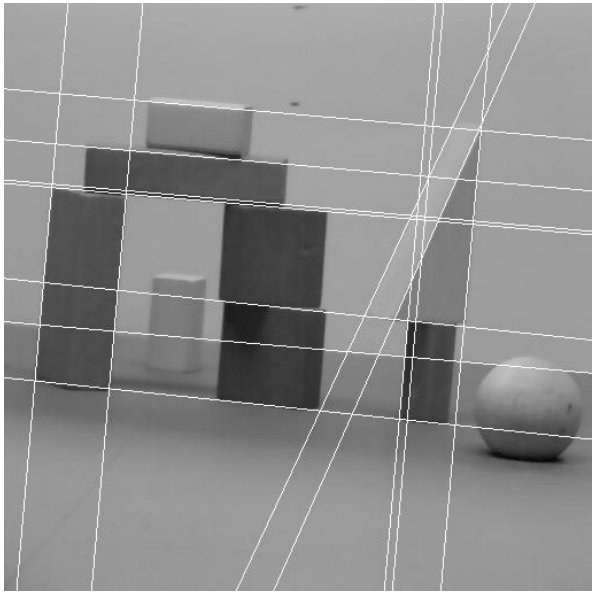
parameter space

[Hough, 1959]

Accumulation methods: Hough transform

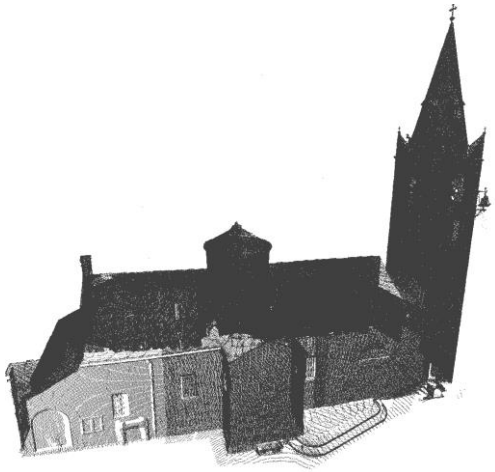


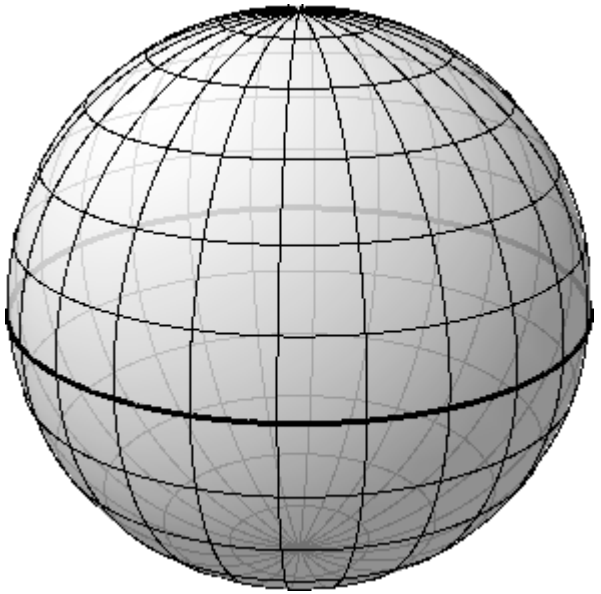




[Hough, 1959]

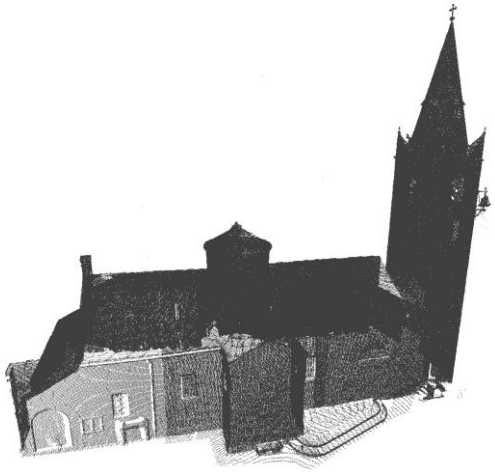
Accumulation methods: Gaussian sphere





For each point of the data, we increment the sphere cell targeted by the point normal from the sphere center

Accumulation methods: Gaussian sphere



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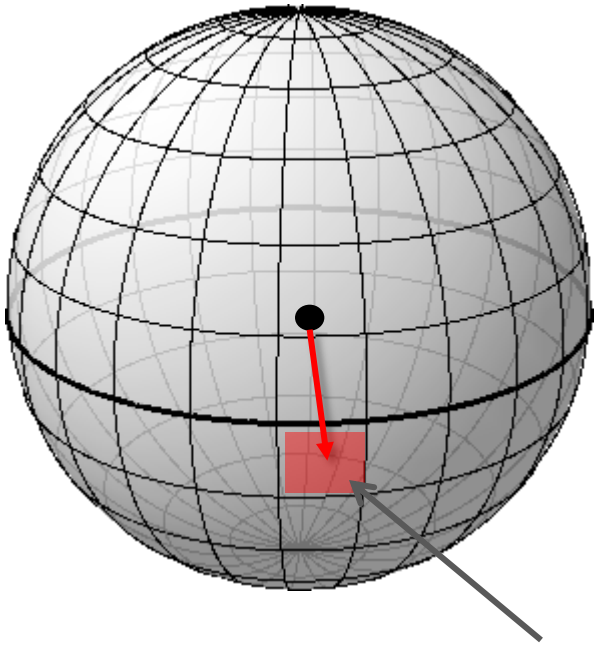
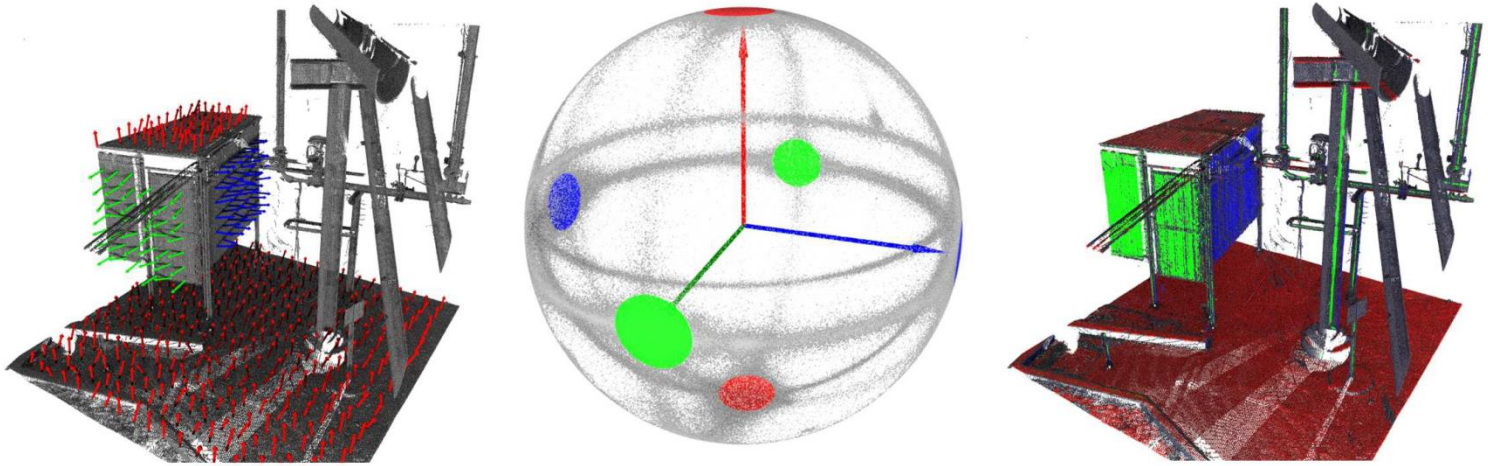
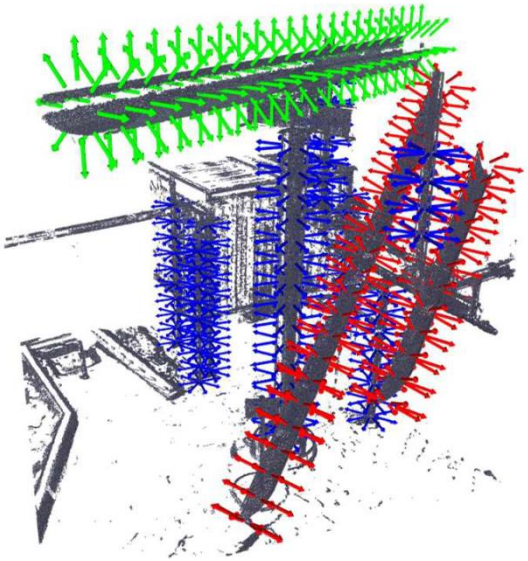


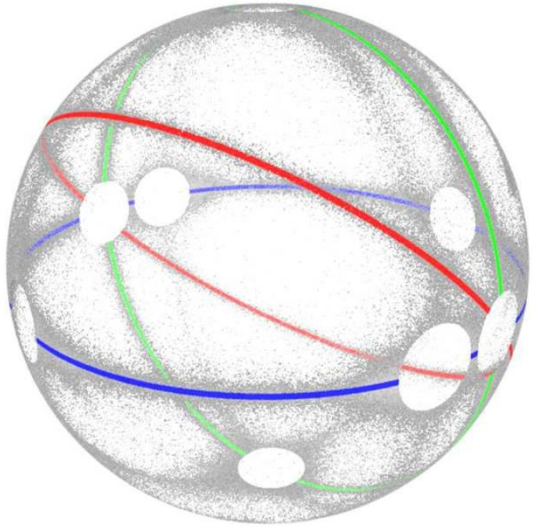
Accumulation methods: Gaussian sphere

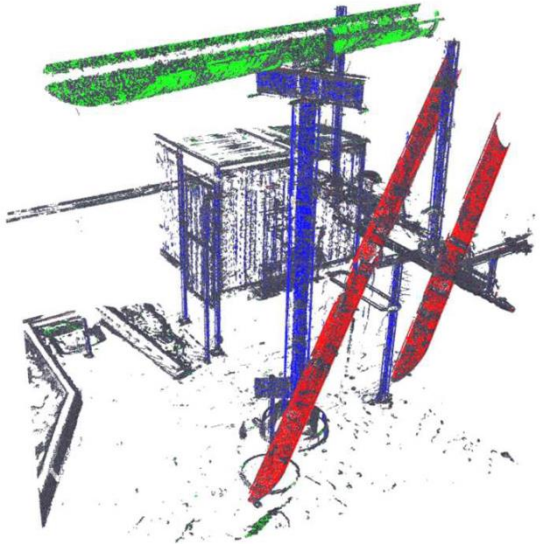


An accumulation of points in the Gaussian sphere
Allows the detection of one or several planes with a similar orientation

Accumulation methods: Gaussian sphere





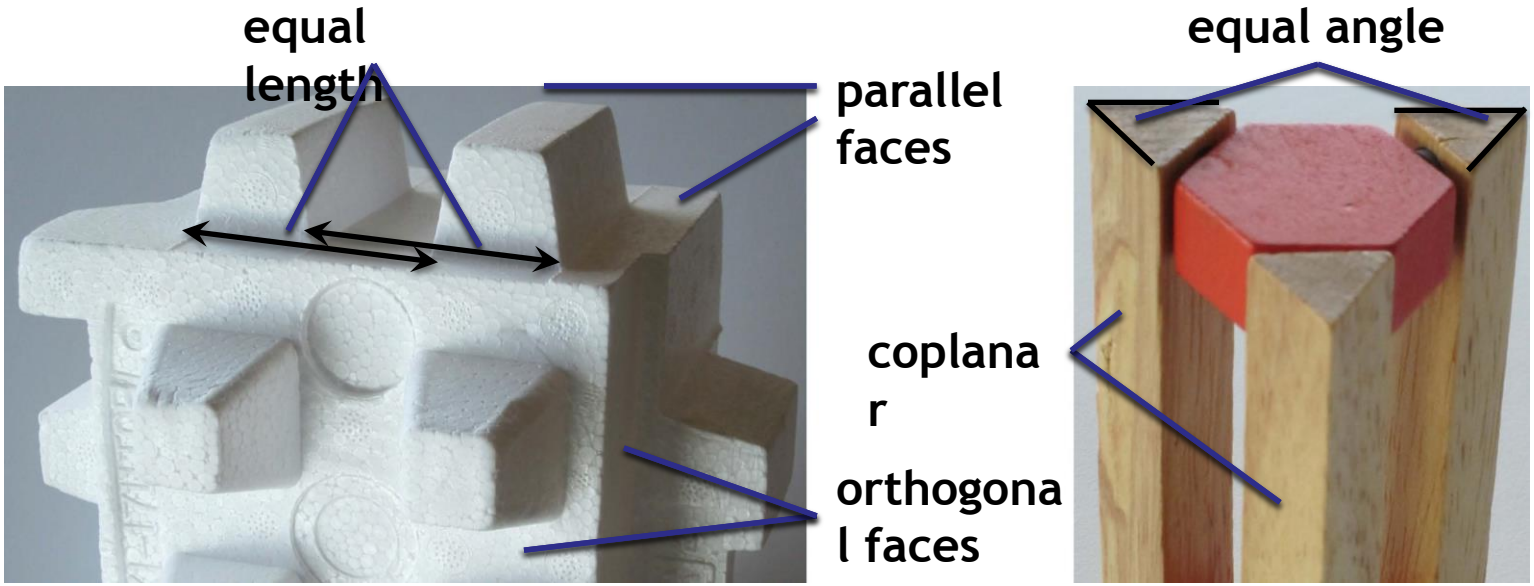


An accumulation of points along a circle in the Gaussian sphere allows the detection of one or several cylinders with a similar orientation

Accumulation methods

- can be computationally expensive
- restricted to certain types of primitives
- can be interesting for “structuring” the primitive configuration with global regularities

Global regularity discovering

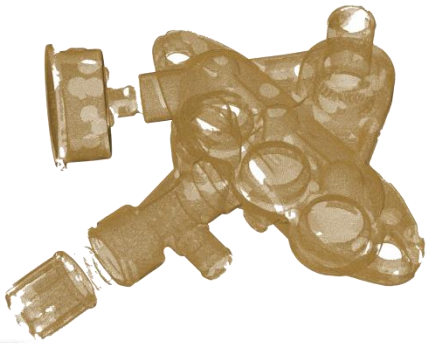


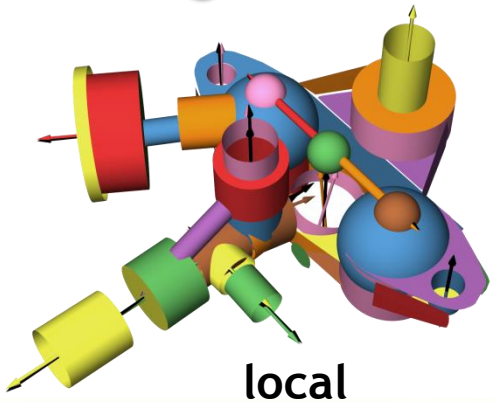
[Li et al., 2011]

Global regularity discovering

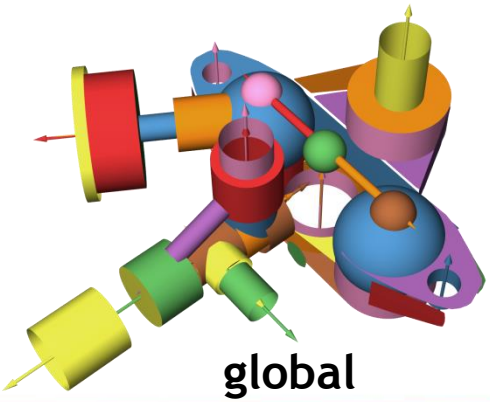
- usually primitives are detected locally, without interaction between each others

- It can be usefull to introduce interactions between primitives at a global scale





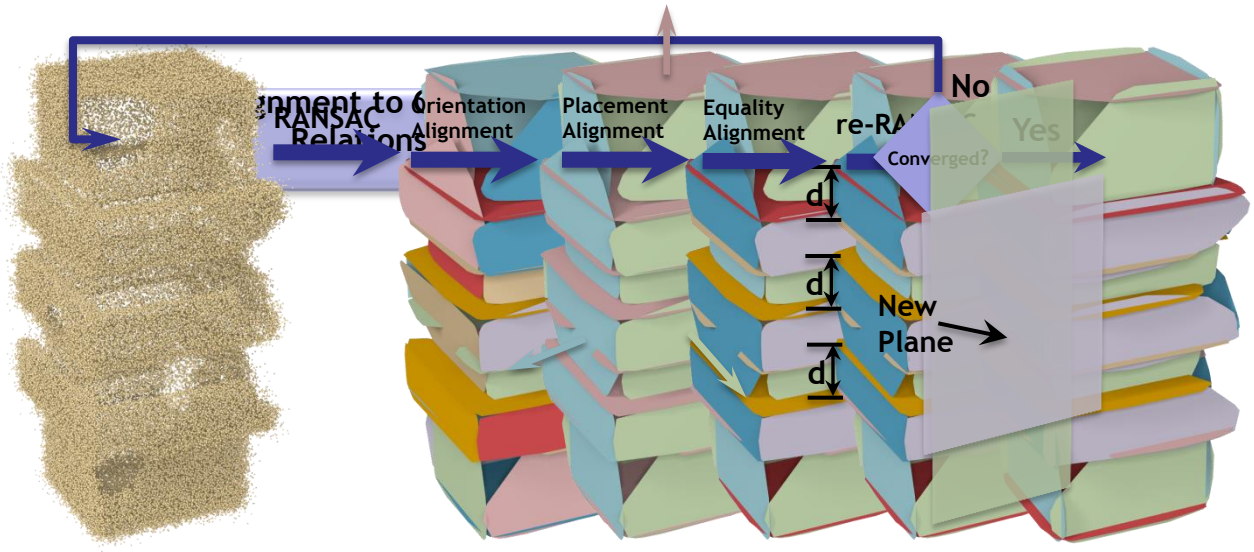
local



global

[Li et al., 2011]

Global regularity discovering [Globfit]



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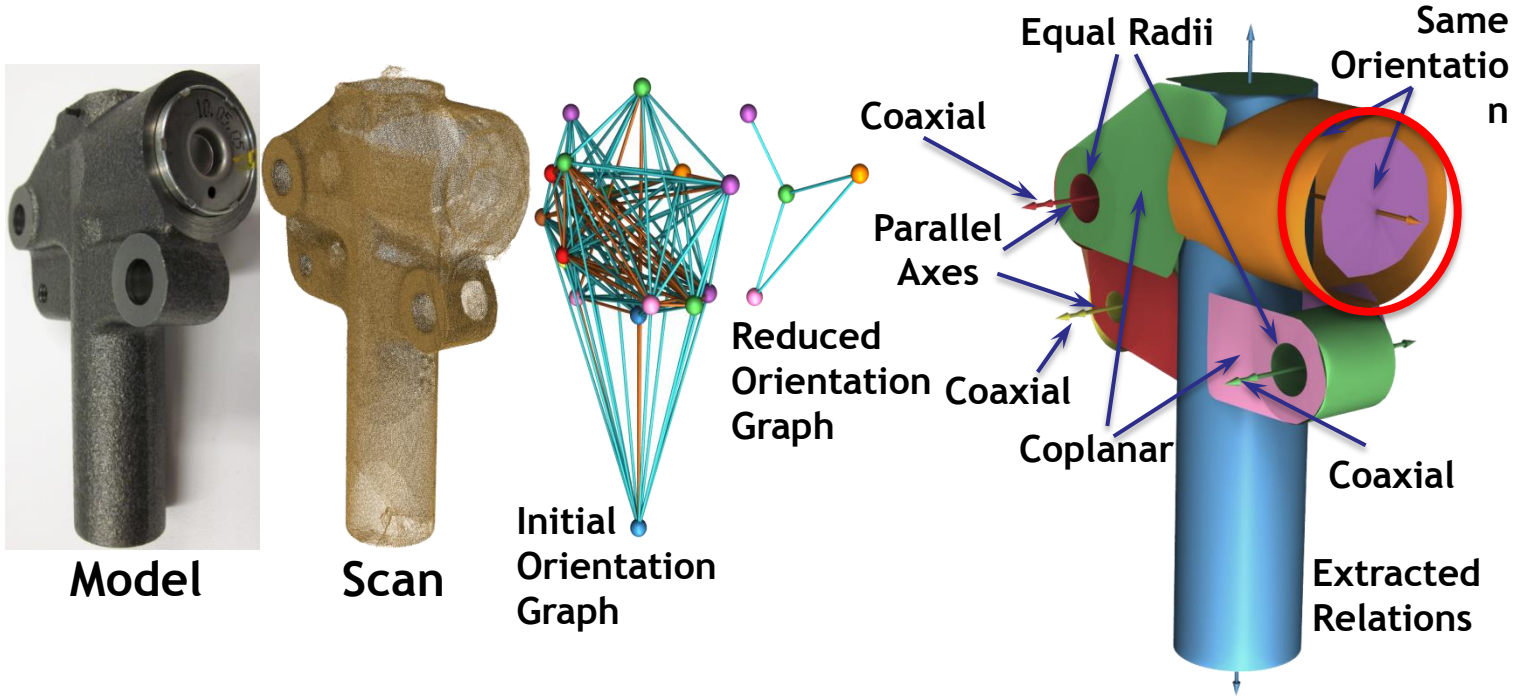

[Li et al., 2011]