



# Ajustement de maillage à nuage de points

2 et 3 juillet 2020

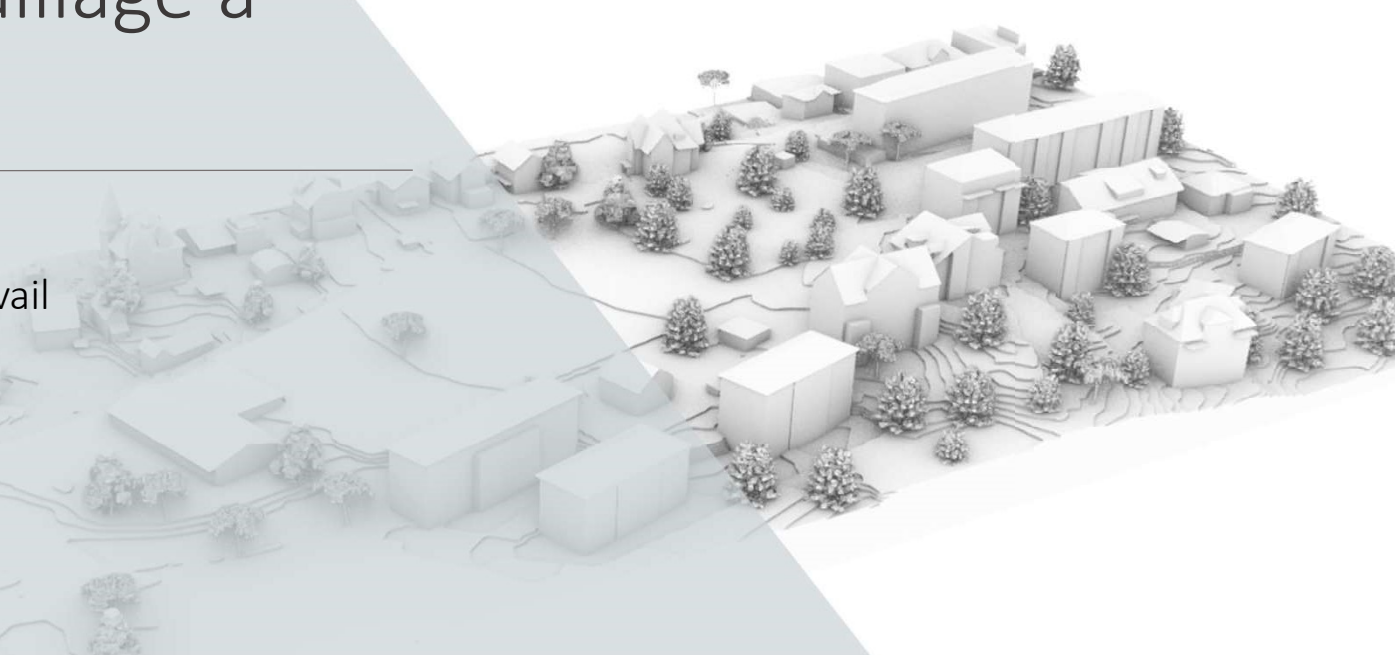
GTMG : Journées du Groupe de Travail en Modélisation Géométrique

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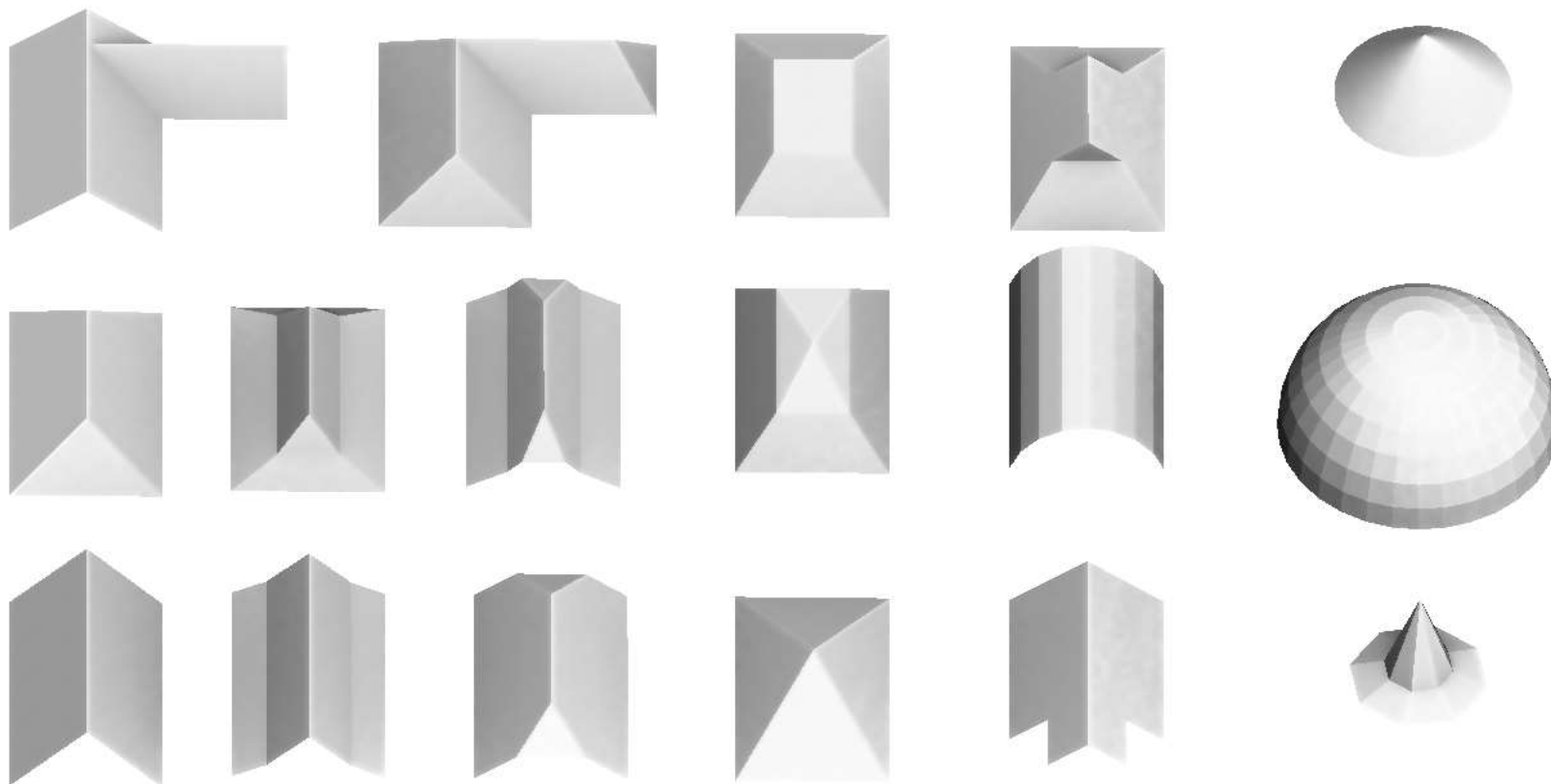
**PIXEL**

# Modèle de ville

Ville de Berlin

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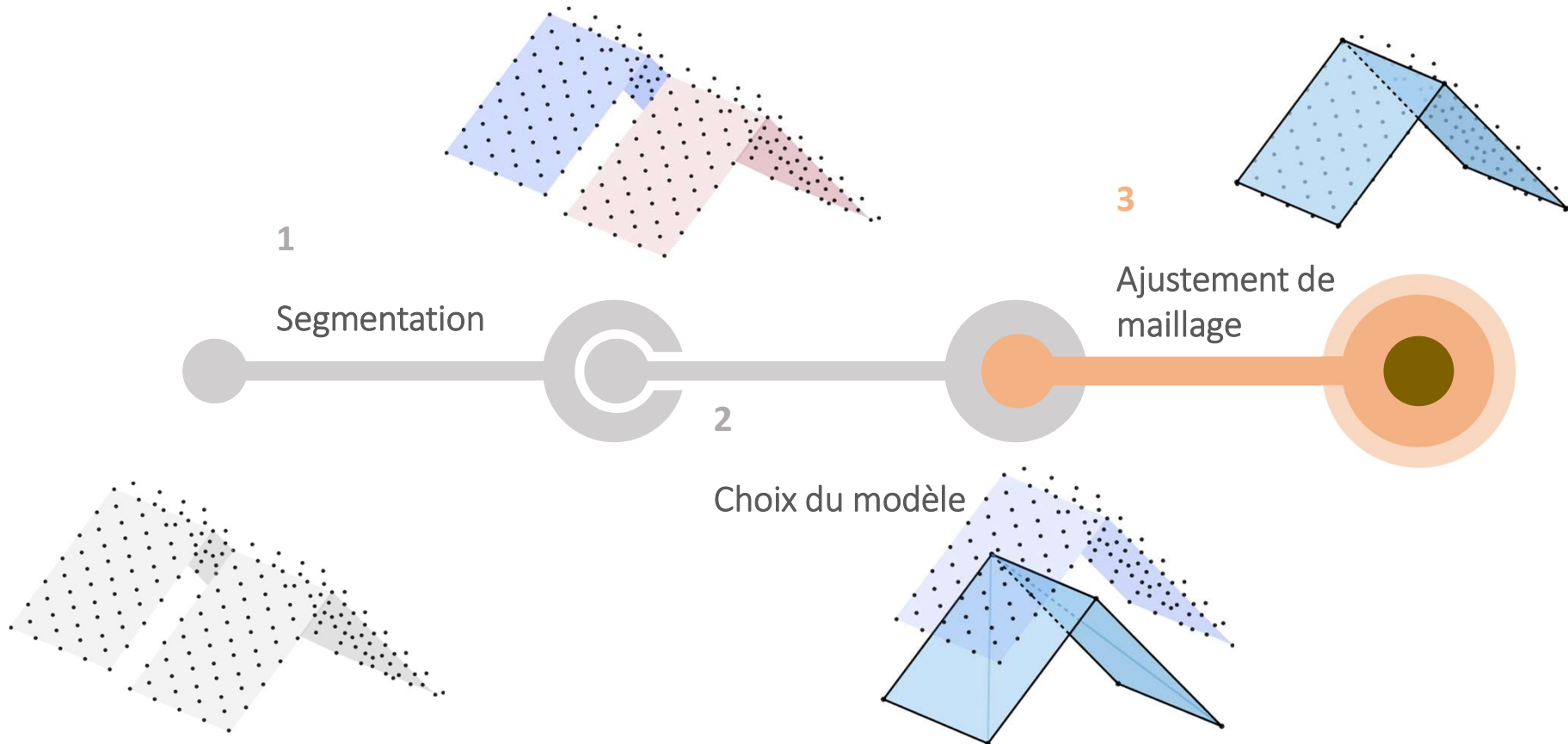




# Nuage de points lidar



Ville de Breuschwickersheim





Points de classes différentes





Toits complexes



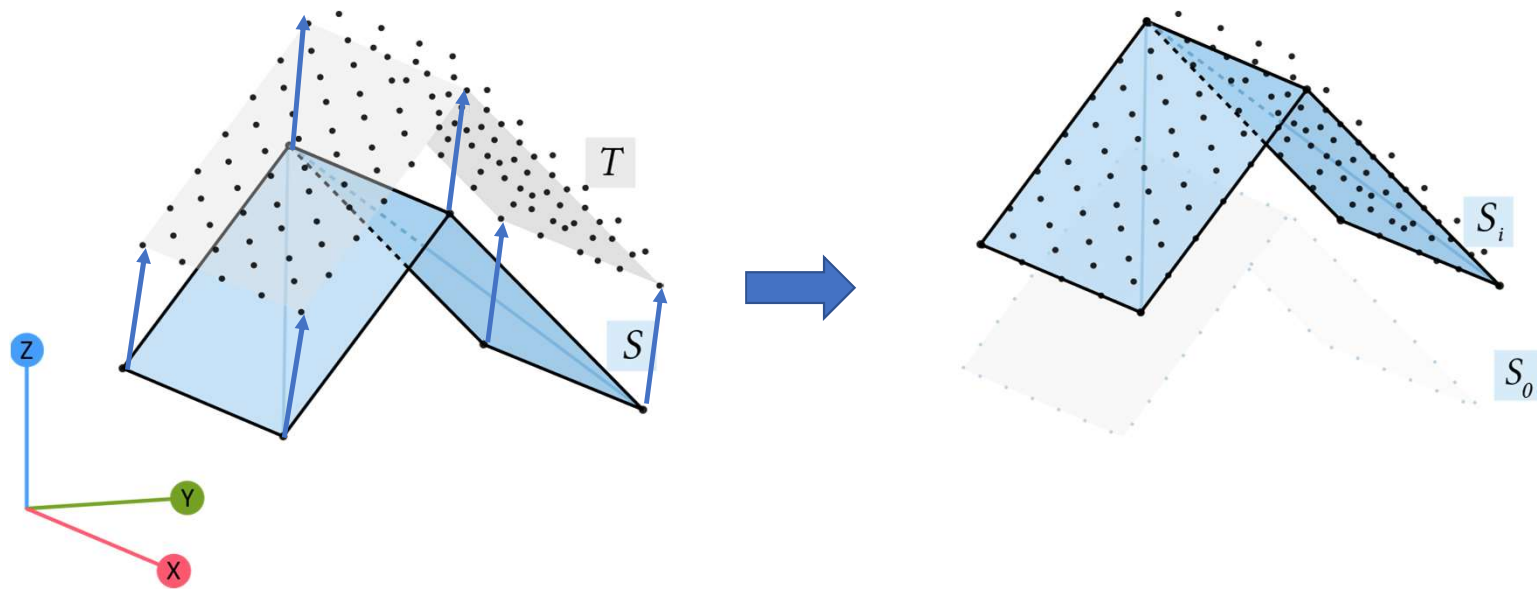
Bruit, données aberrantes



Planarité des pans de toits



Alignement ou orthogonalité de certains axes.



À partir de ces contraintes, peut-on faire correspondre le maillage S source au nuage de points T cible ?

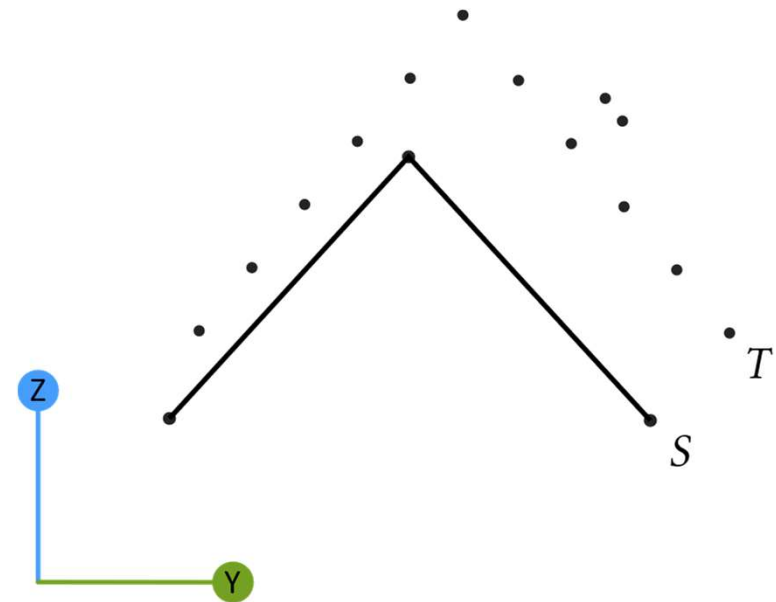
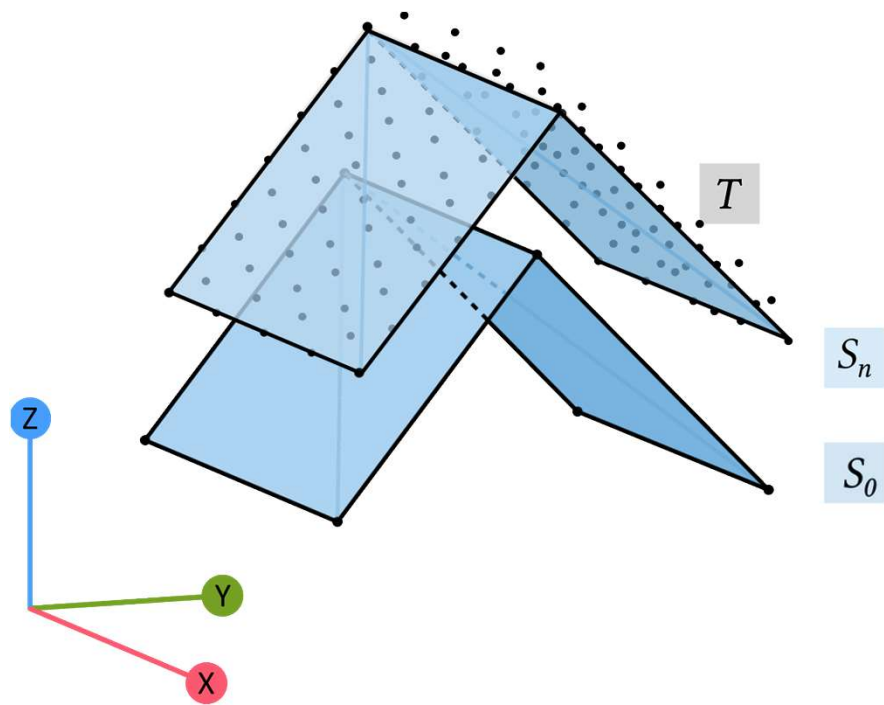
- 1 Ajustement point-surface
- 2 Contraintes architecturales
- 3 Résultats



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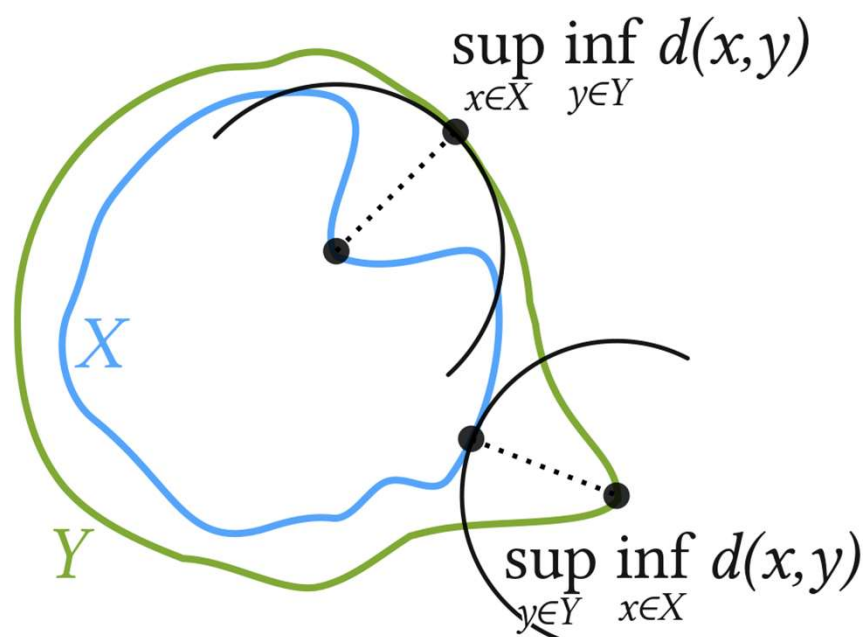
# Ajustement point-surface

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# Définition d'une énergie

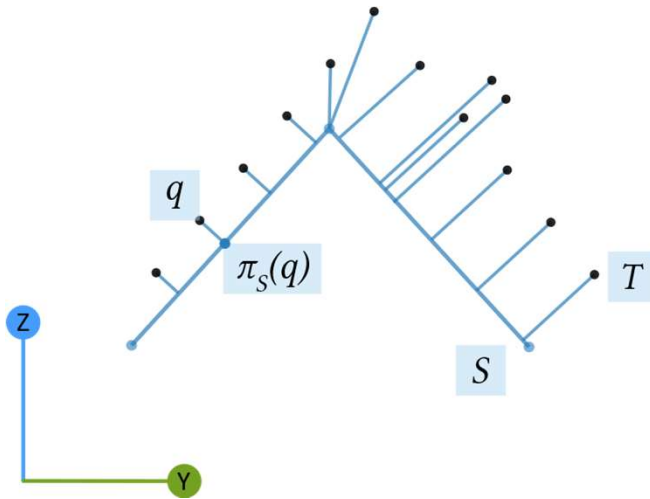
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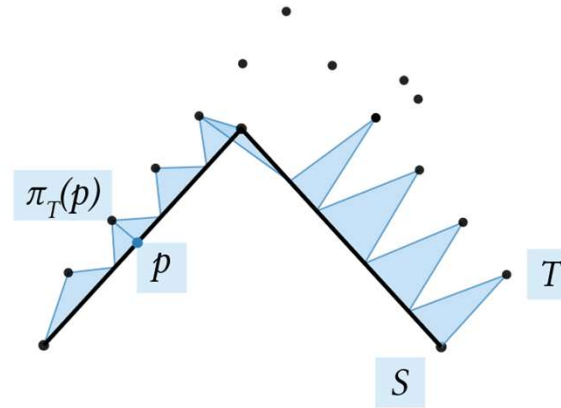
Distance de Hausdorff :  $H(X, Y) = \max \left\{ \sup_{x \in X} \inf_{y \in Y} d(x, y), \sup_{y \in Y} \inf_{x \in X} d(x, y) \right\}$ .

# Définition d'une énergie

Distance de Hausdorff :  $d(S, T) = \max \left\{ \sup_{s \in S} \inf_{t \in T} \delta(s, t), \sup_{t \in T} \inf_{s \in S} \delta(s, t) \right\}$ .



$$F_{T \rightarrow S} = \sum_{q \in T} \|q - \Pi_S(q)\|^2$$



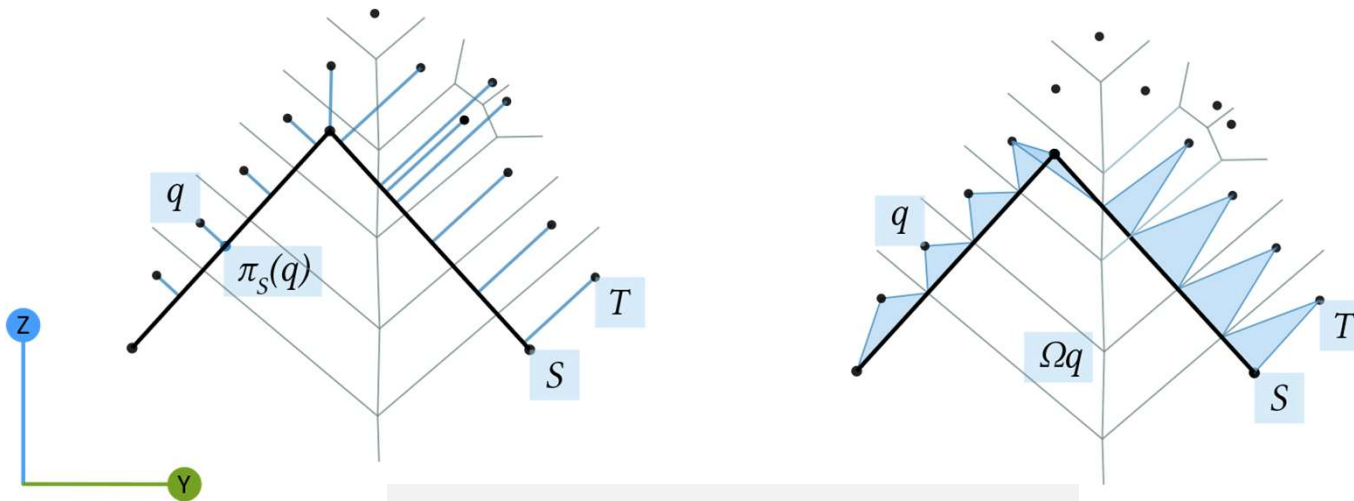
$$F_{S \rightarrow T} = \int_S \|p - \Pi_T(p)\|^2 dp$$

# Diagramme de Voronoï restreint

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$$F_{T \rightarrow S} = \sum_{q \in T} \|q - \Pi_S(q)\|^2$$

$$F_{S \rightarrow T} = \sum_{q \in T} \int_{\Omega_q \cap S} \|p - q\|^2 dp$$

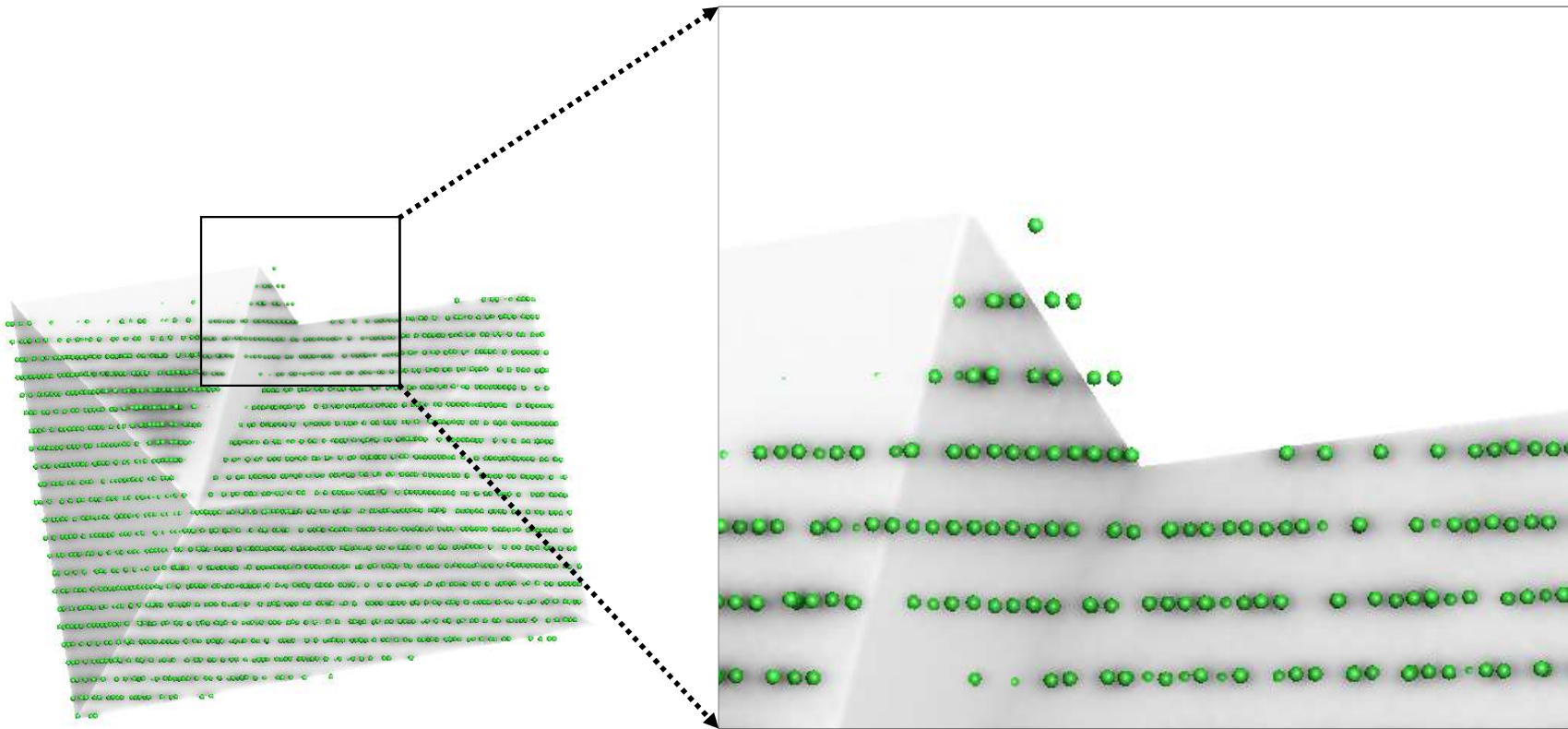


$$E = F_{T \rightarrow S} + F_{S \rightarrow T}$$

Minimisation de l'énergie par algorithme BFGS (Broyden-Fletcher-Goldfarb-Shanno)

Nivoliers, V., Yan, D. M., & Lévy, B. (2014). Fitting polynomial surfaces to triangular meshes with Voronoi squared distance minimization. *Engineering with Computers*, 30(3), 289-300.

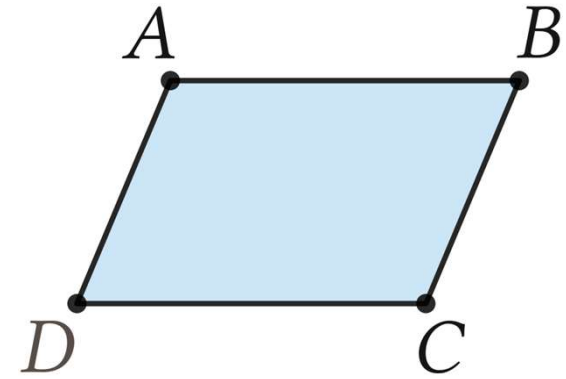
# Vers l'introduction de contraintes



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$$\sum_{i=1}^{3n} \alpha_i p_i = 0; \quad p = Mr.$$

$M$  une matrice  $3n \times m$ , avec  $m < 3n$ .



$$\overrightarrow{AD} = \overrightarrow{BC}$$

$$\begin{cases} D_x - A_x = C_x - B_x \\ D_y - A_y = C_y - B_y \end{cases}$$

$$\overrightarrow{AD} = R_{90} \overrightarrow{BC}$$

$$\begin{cases} D_x - A_x = B_y - C_y \\ D_y - A_y = C_x - B_x \end{cases}$$

$$\overrightarrow{AD} \perp \overrightarrow{BC}$$

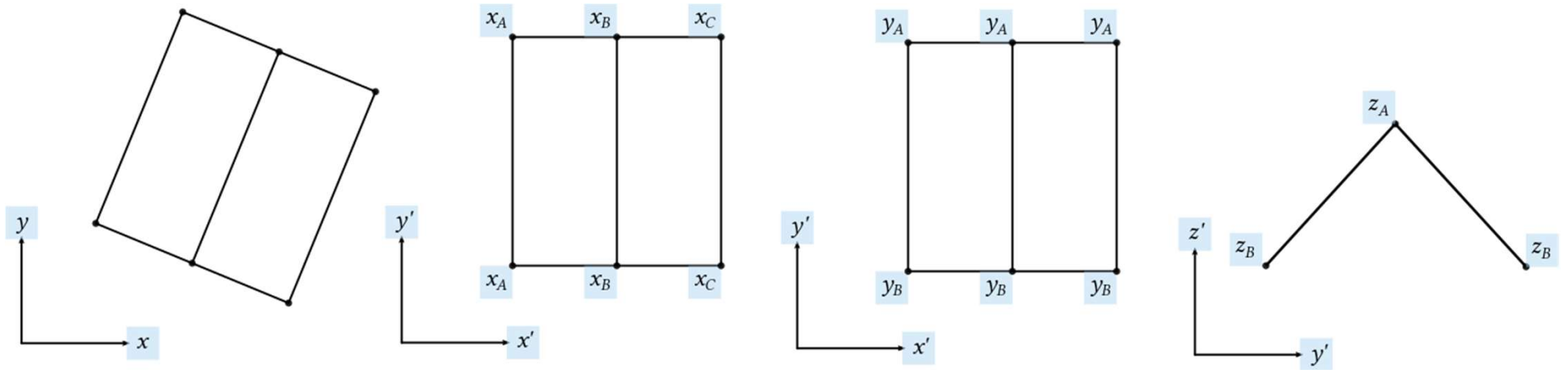
$$\begin{cases} \alpha(D_x - A_x) = B_y - C_y \\ \alpha(D_y - A_y) = C_x - B_x \end{cases}$$

$$\overrightarrow{AD} \parallel \overrightarrow{BC}$$

$$\begin{cases} \alpha(D_x - A_x) = C_x - B_x \\ \alpha(D_y - A_y) = C_y - B_y \end{cases}$$

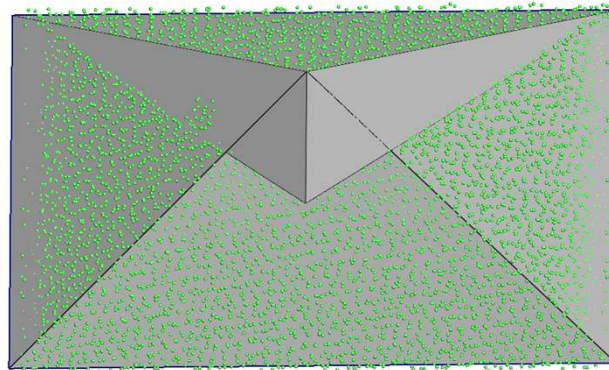


# Expression des contraintes non linéaires



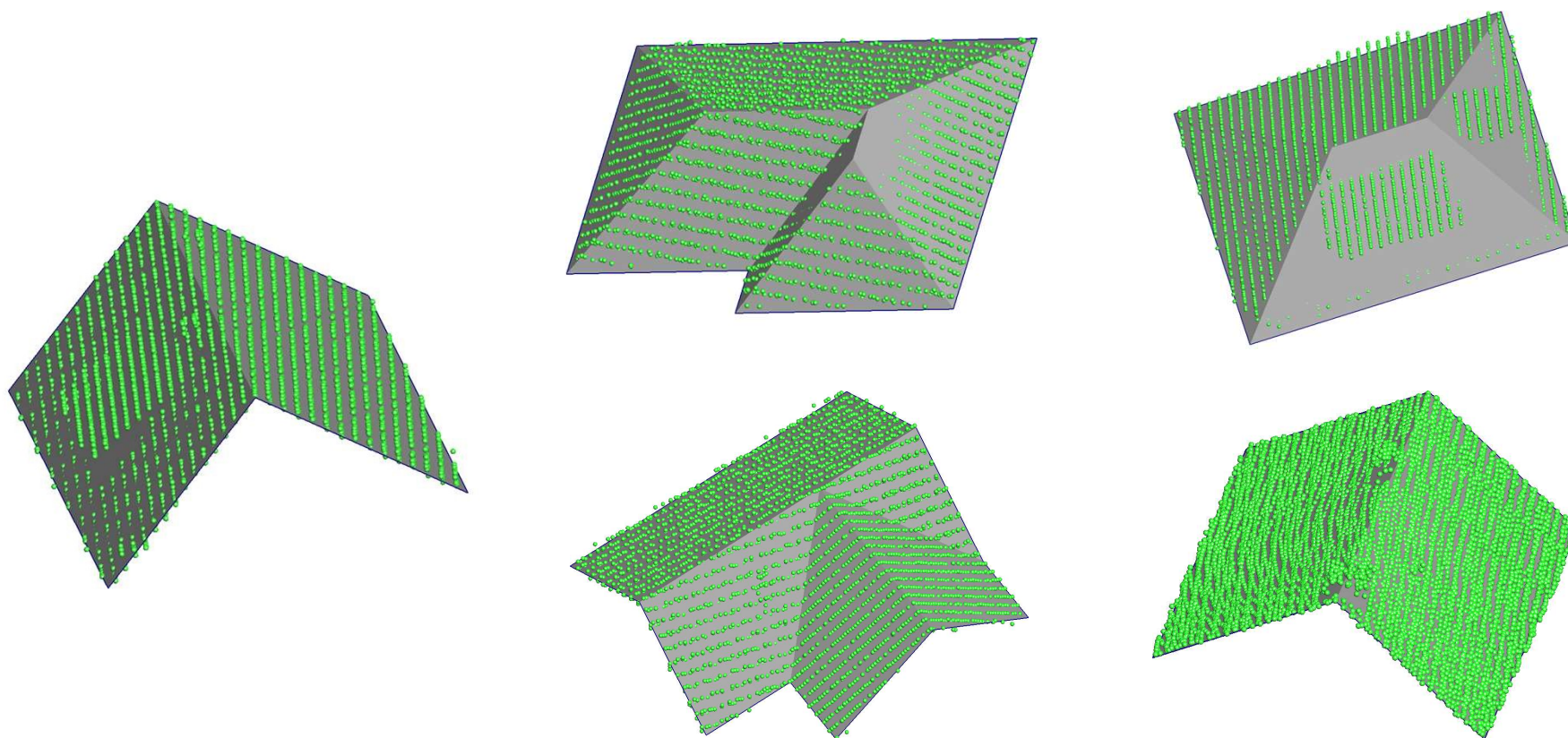
# Nécessité de contraintes d'inégalités

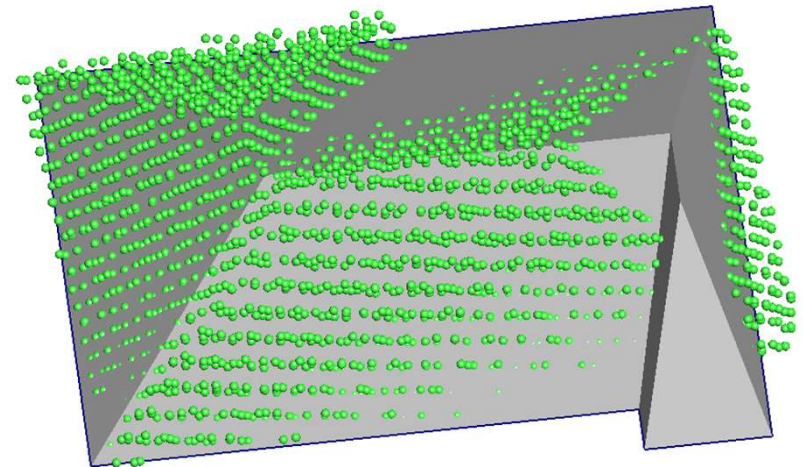
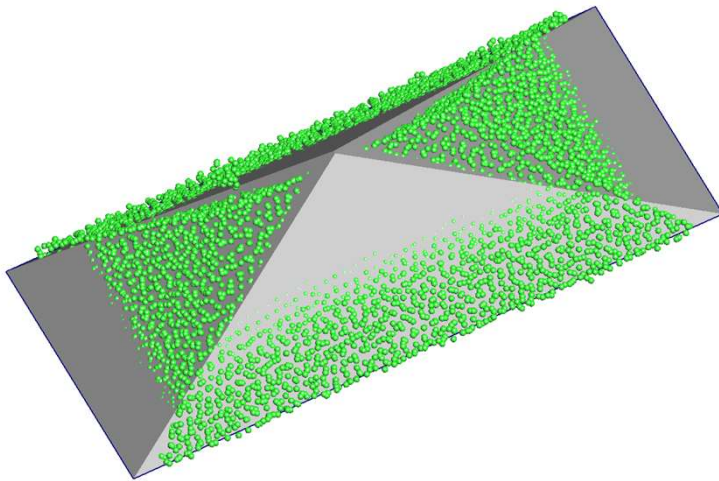
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Ajout d'un terme barrière :  $Ec(i, j) = a * \log(1 + \exp(-b * (p_i - p_j)))$ .  $(a, b) \in R$

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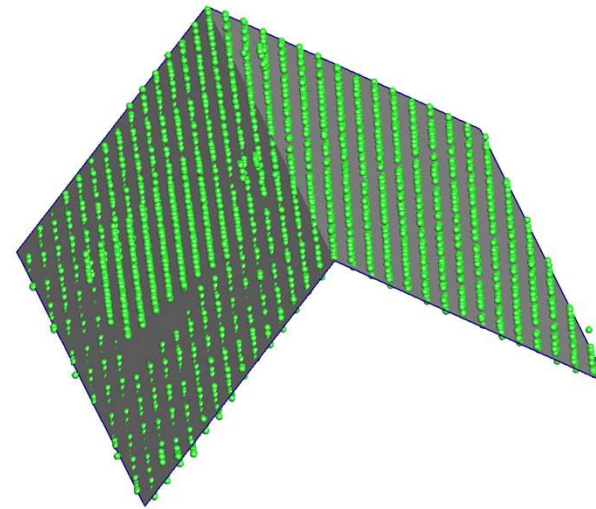




Méthode d'ajustement

Respect des contraintes imposées

Robustesse aux données bruitées



Merci de votre attention

