Point Set Surfaces

AYUSHI SINHA

Outline

- Defining the surface – projecting
- Generating the representation point set
- Rendering

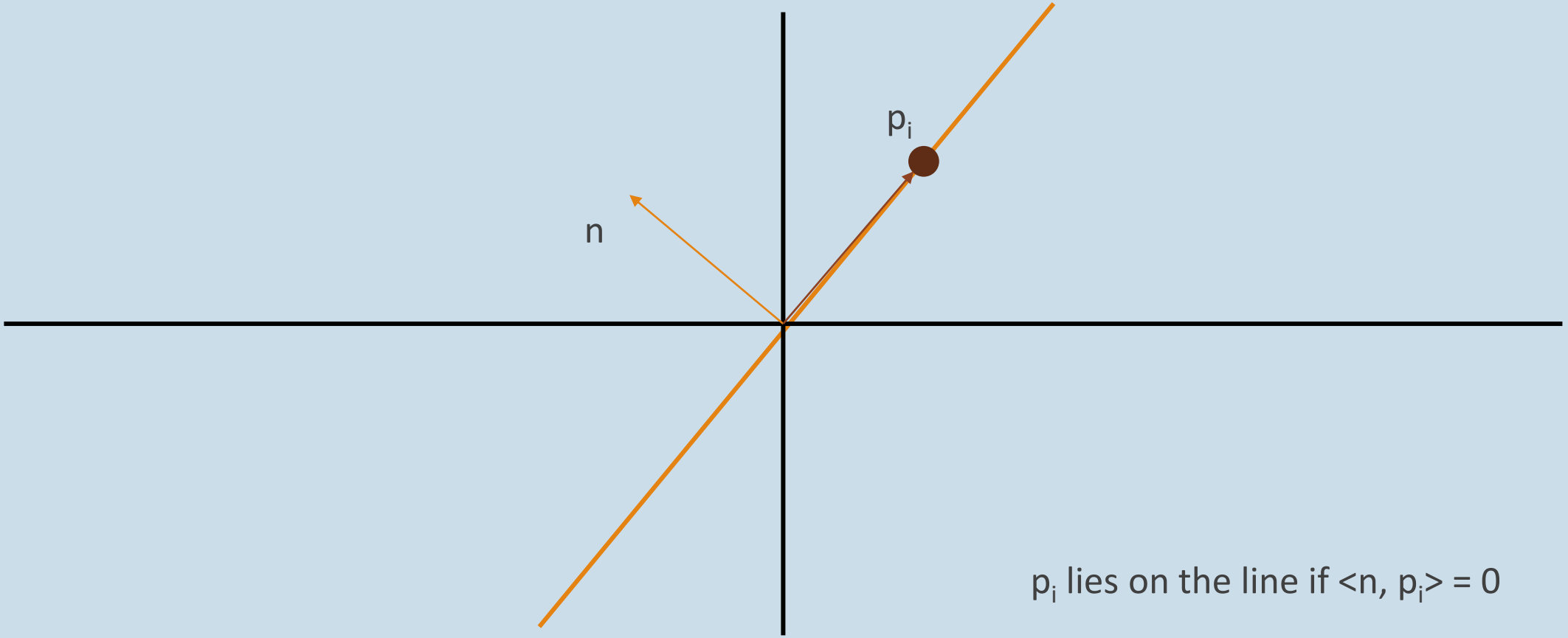
Outline

- Defining the surface – projecting
- Generating the representation point set
- Rendering

Defining the surface – projecting

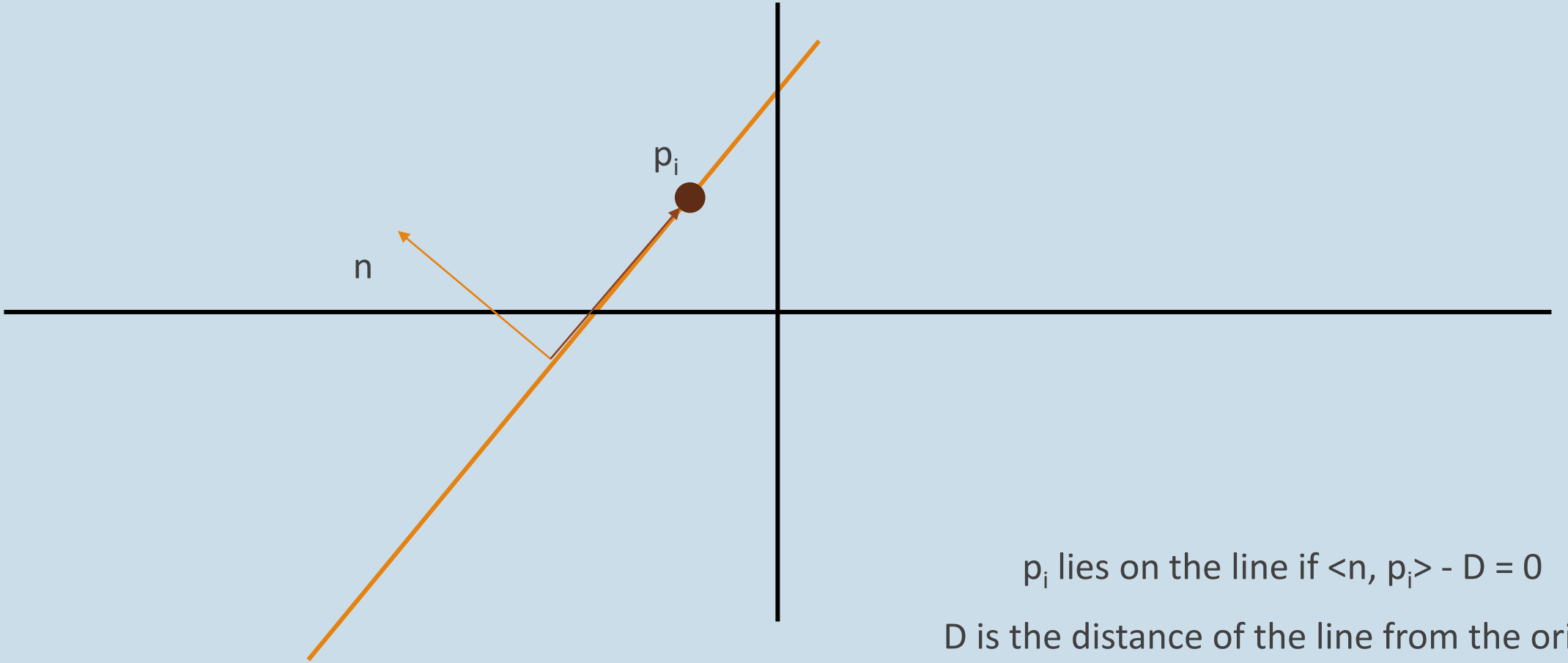
- The projection procedure relies on the idea that a given point set implicitly defines a surface

Defining the surface – projecting



p_i lies on the line if $\langle n, p_i \rangle = 0$

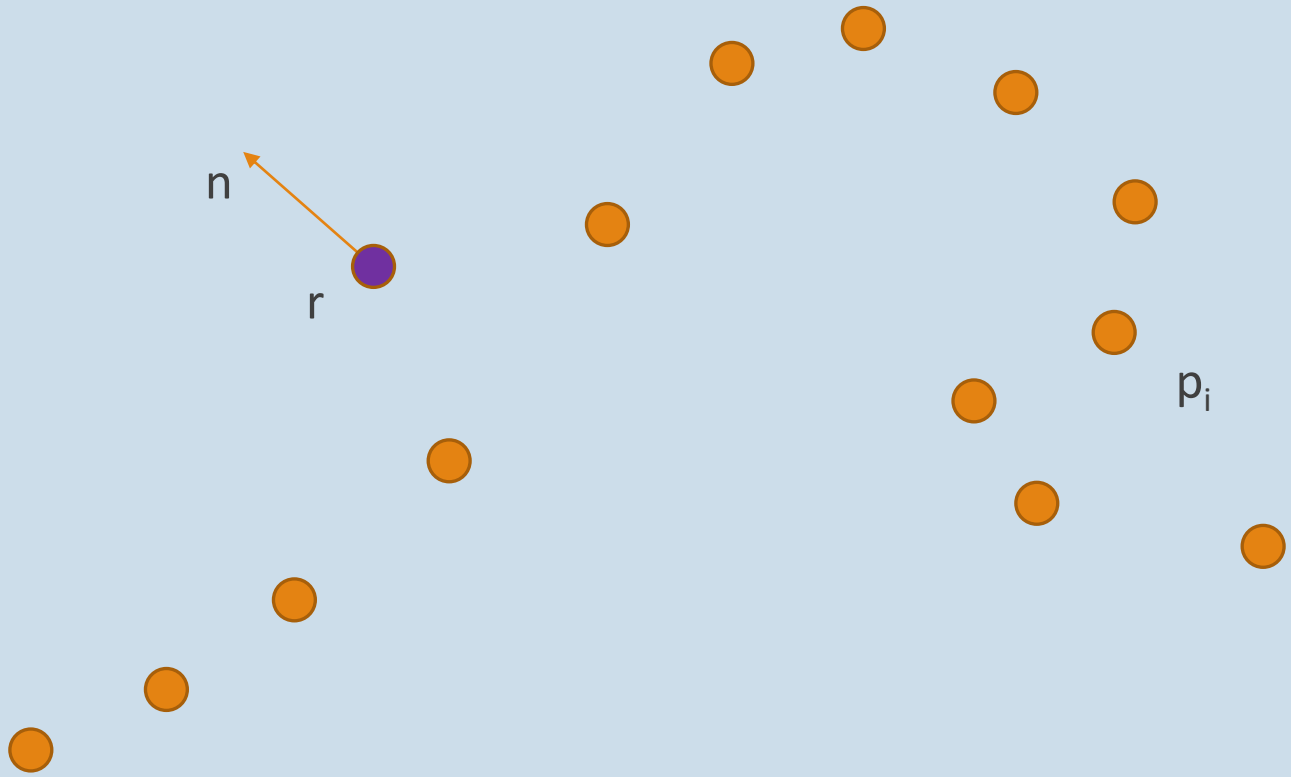
Defining the surface – projecting



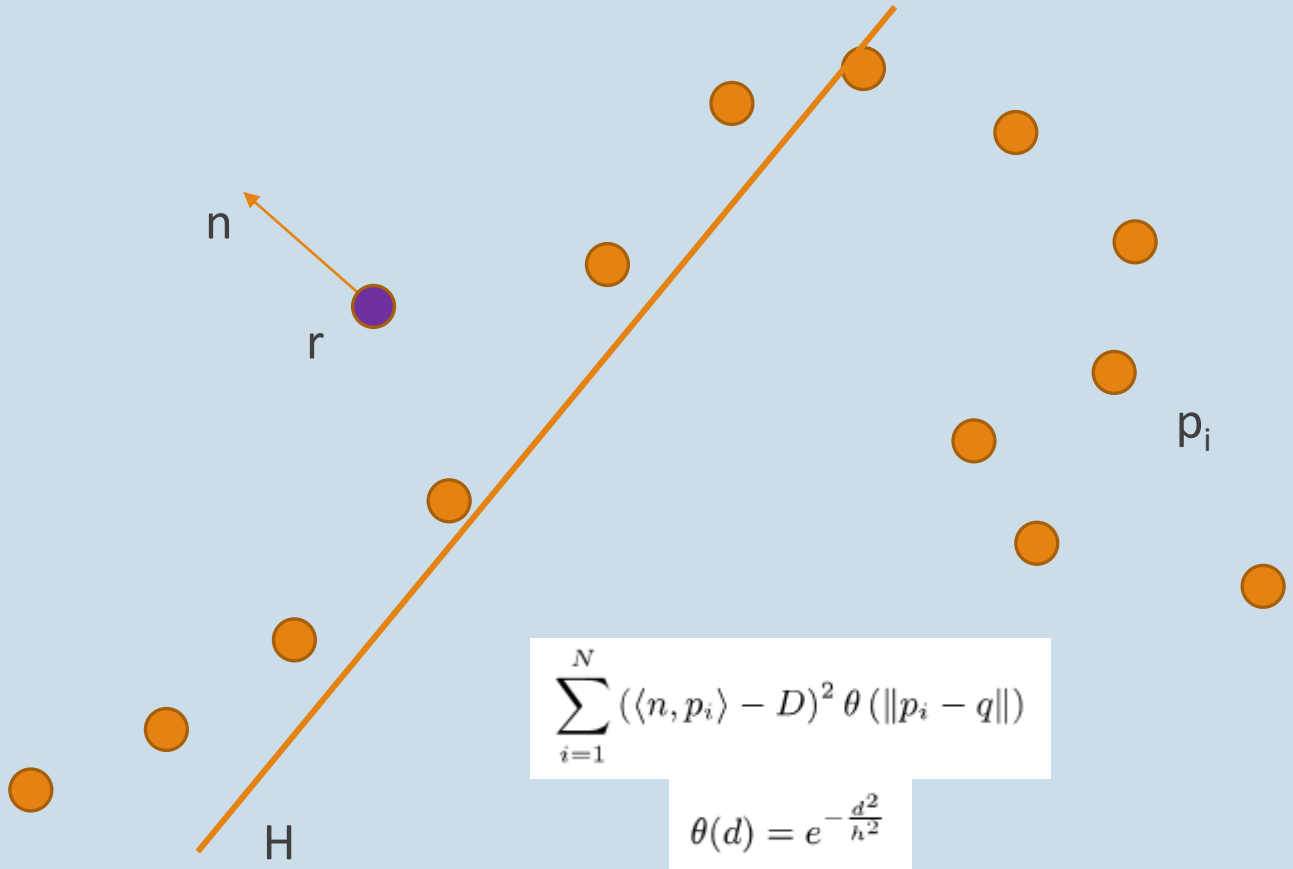
p_i lies on the line if $\langle n, p_i \rangle - D = 0$

D is the distance of the line from the origin

Defining the surface – projecting



Defining the surface – projecting



$$\sum_{i=1}^{N} (\langle n, p_i \rangle - D)^2 \, \theta \left(\| p_i - q \| \right)$$

$$\theta(d) = e^{-\frac{d^2}{h^2}}$$

Defining the surface – projecting

- Assuming *q*, the projection of r on H, as the origin of this system, and writing $q = r + tn$, where $t \in \mathbb{R}$, we can write

$$\sum_{i=1}^{N} \langle n, p_i - r - tn \rangle^2 \, \theta\left(\|p_i - r - tn\|\right)$$

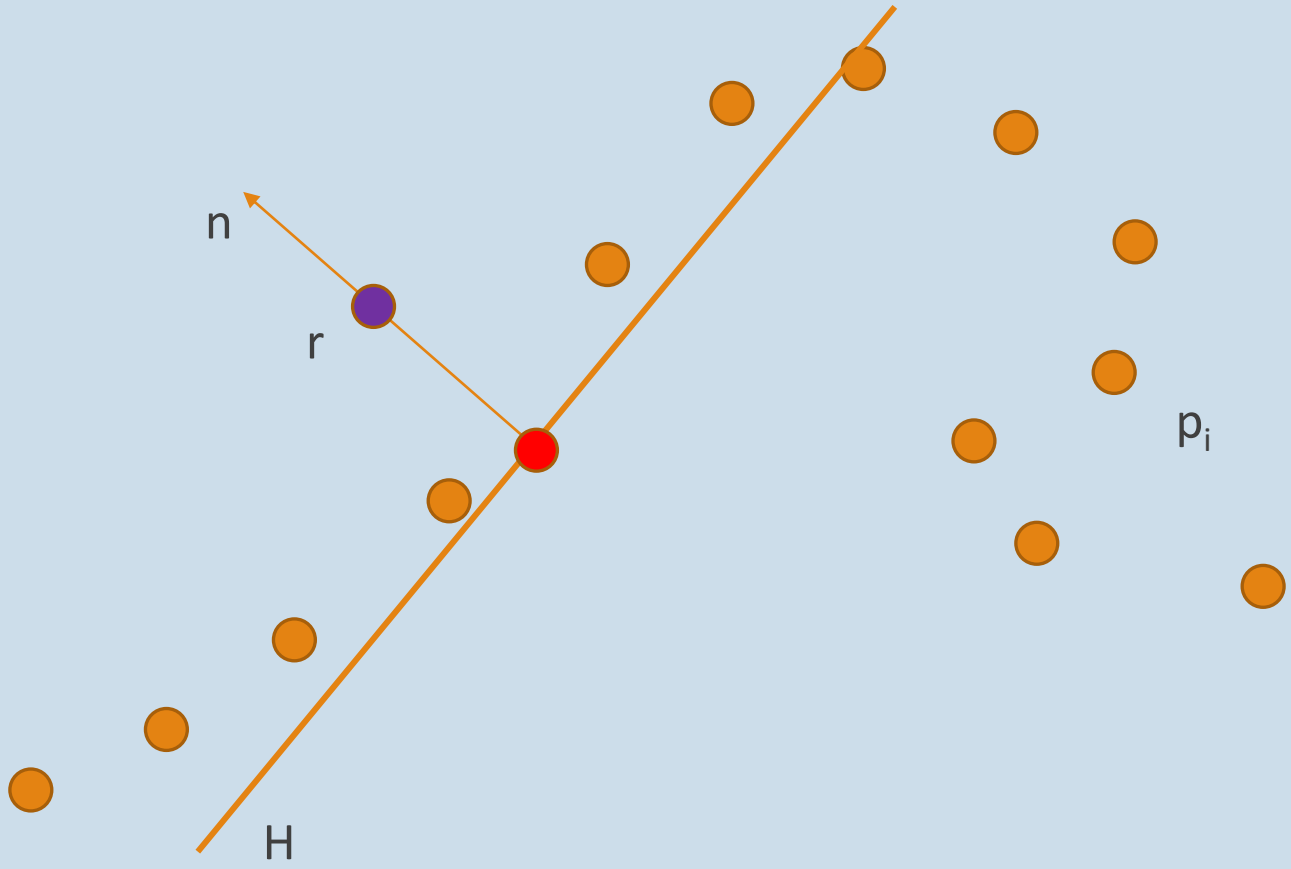
- Intuitively, the plane should be close to *r*. We must ensure the minimization converges to a local minimum with small *t*. Therefore, setting $t = 0$, we can write

$$\sum_{i=1}^{N} \langle n, p_i - r \rangle^2 \, \theta_i, \quad \theta_i = \theta\left(\|p_i - r\|\right)$$

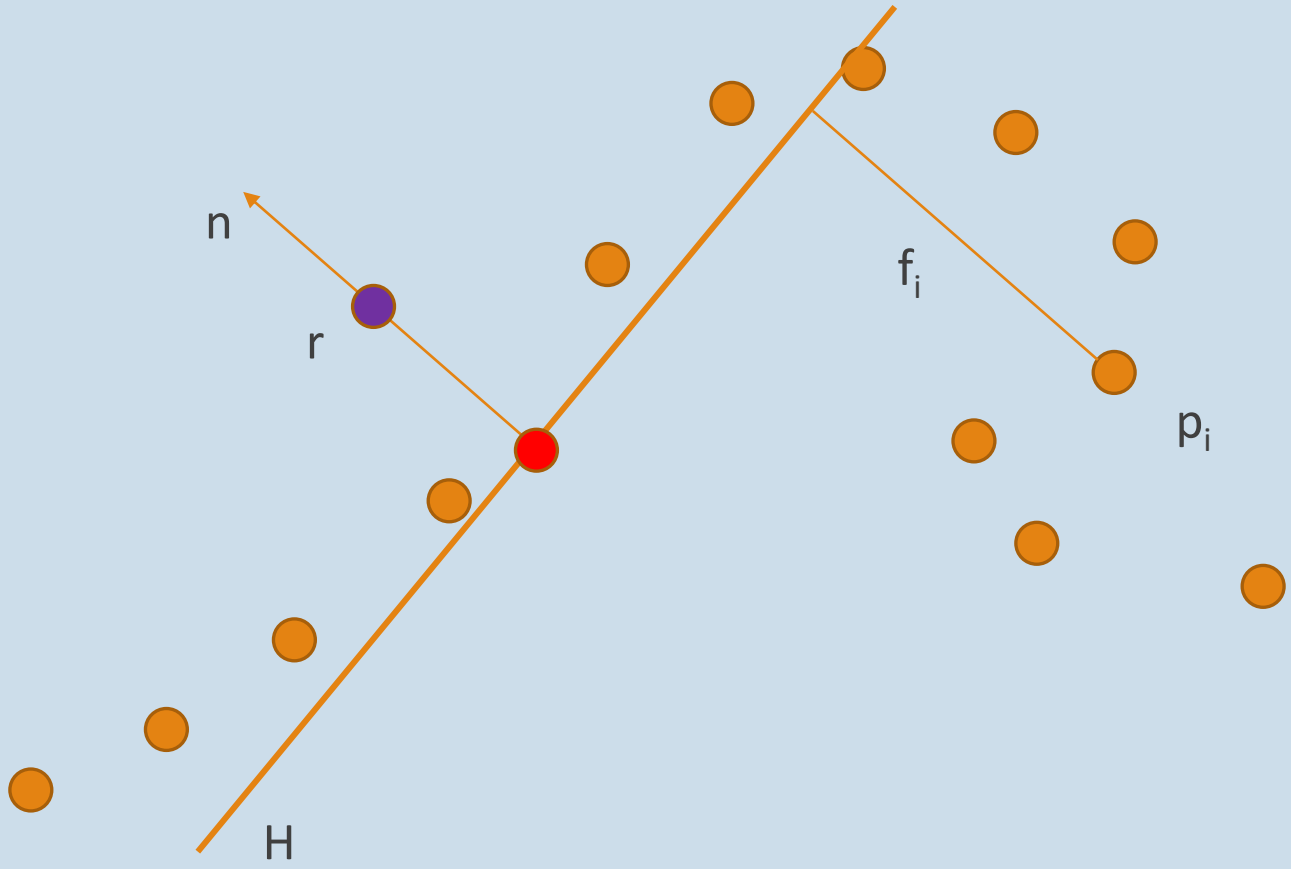
- Finally, this can be minimized by setting its gradient to zero

$$\sum_{i=1}^{N} 2\theta_i \, \langle n, p_i - r \rangle \, (p_i - r)$$

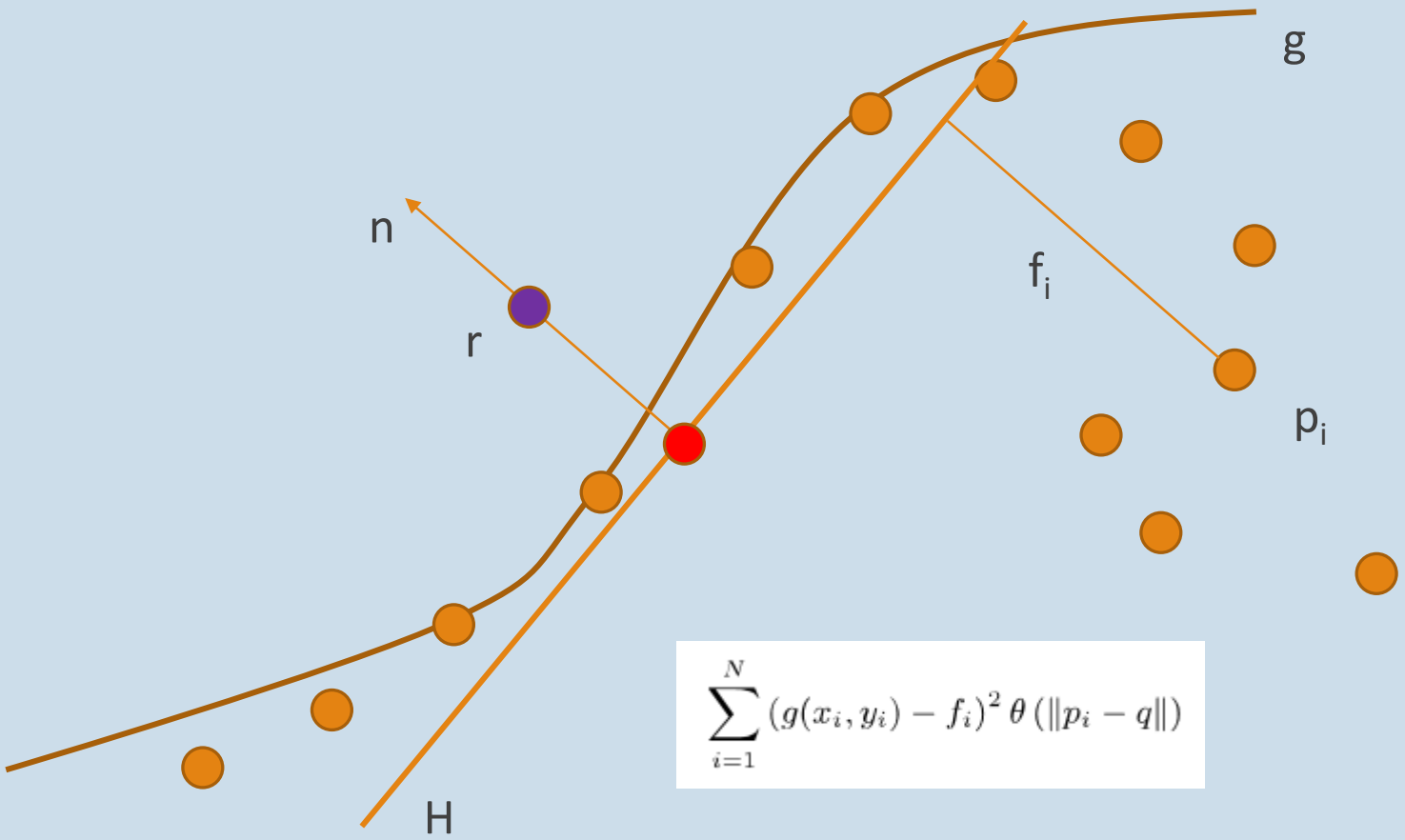
Defining the surface – projecting



Defining the surface – projecting



Defining the surface – projecting

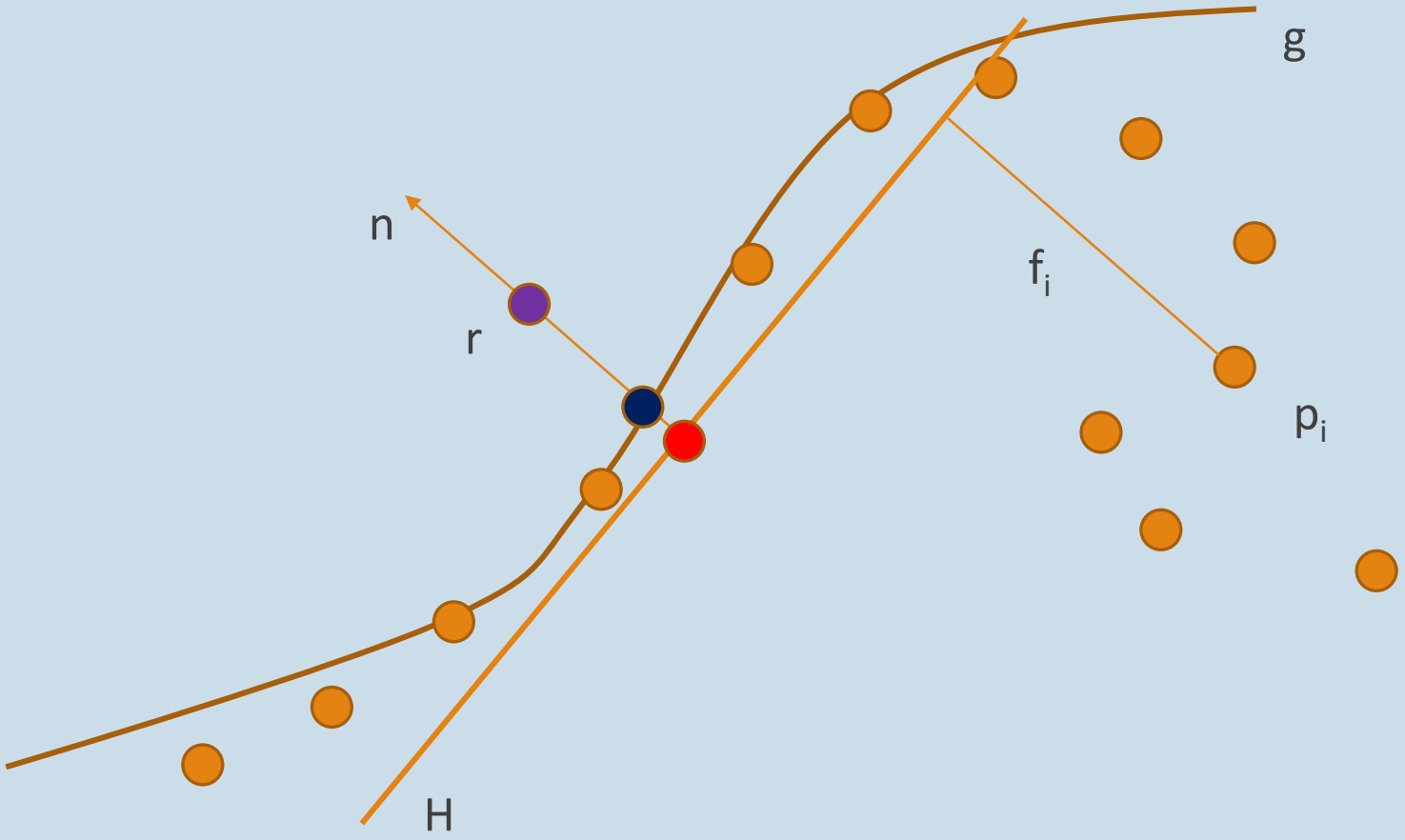


$$\sum_{i=1}^{N} \left(g(x_i, y_i) - f_i\right)^2 \theta\left(\|p_i - q\|\right)$$

Defining the surface – projecting

- Computing the coefficients of g using a hierarchical method
  - An octree is filled with p_i
  - Leaf nodes contain p_i
  - Inner nodes contain information about # points in subtree and their centroid
  - If node's dimensions are smaller than its distance to r, the centroid is used for computing coefficients; otherwise, the subtree is traversed
  - If the distance to r is larger than a predefined constant, we neglect the nodes

Defining the surface – projecting

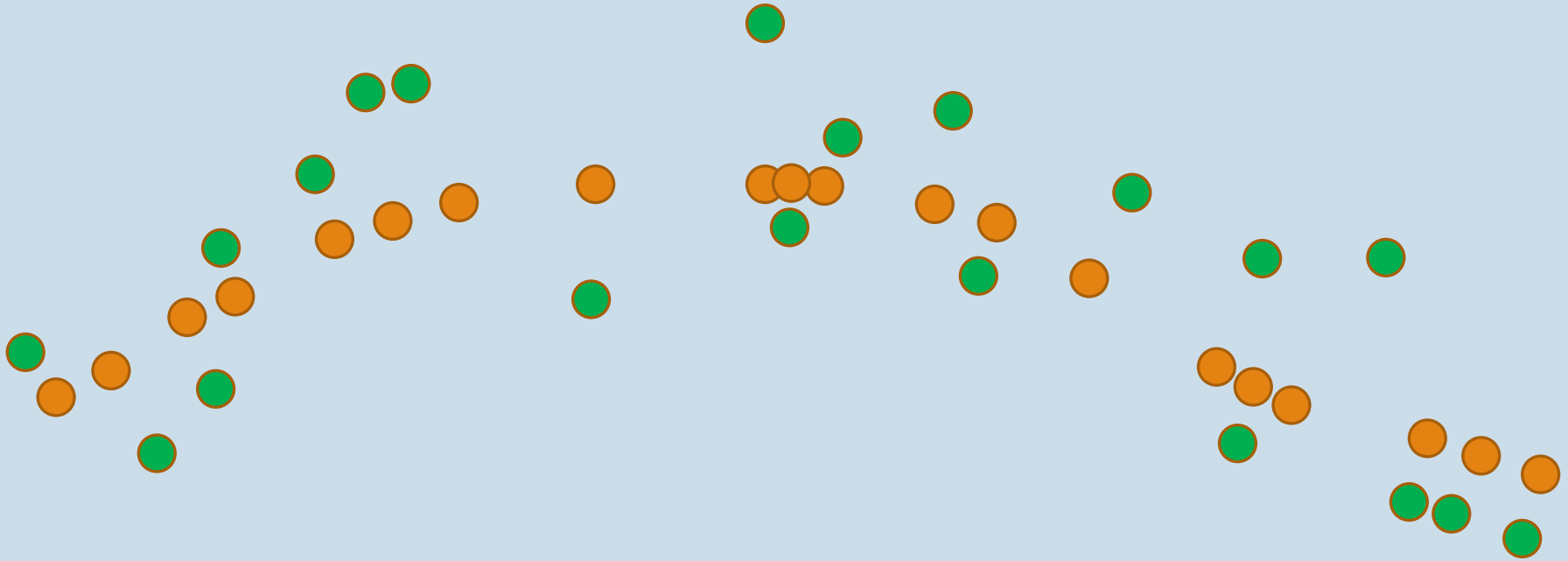


Outline

- Defining the surface – projecting
- Generating the representation point set
- Rendering

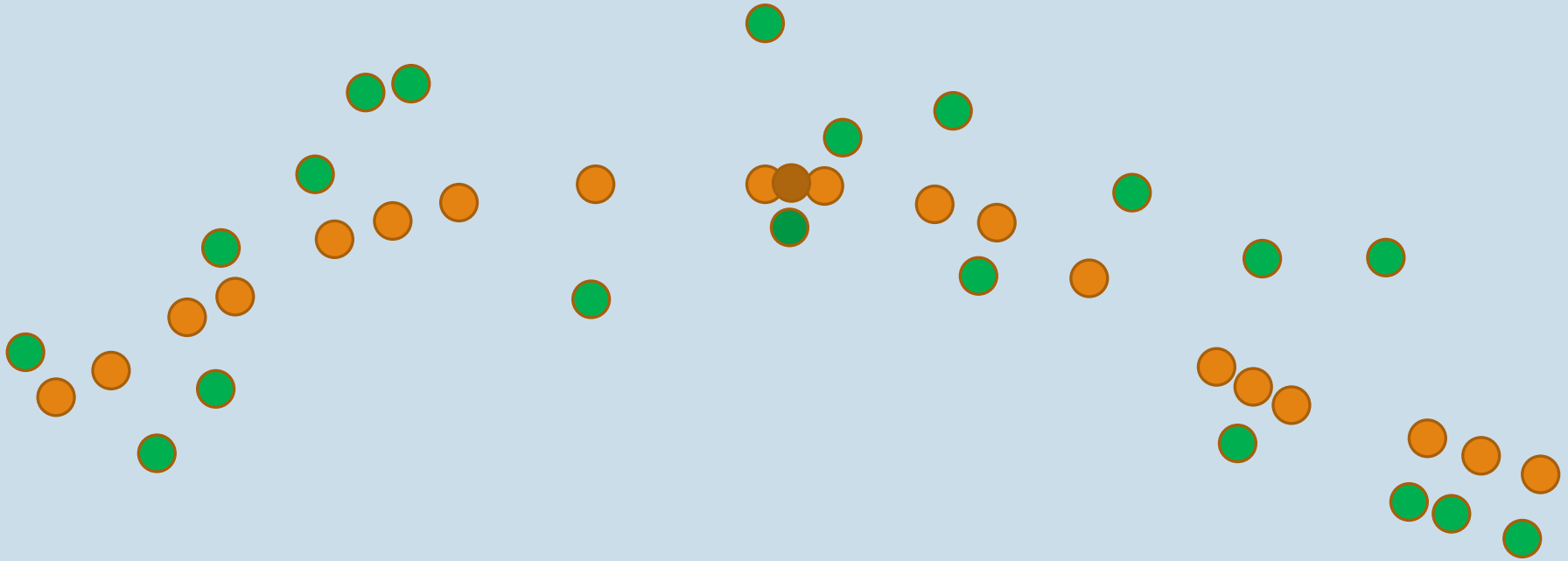
Generating the representation point set

- Down-sampling



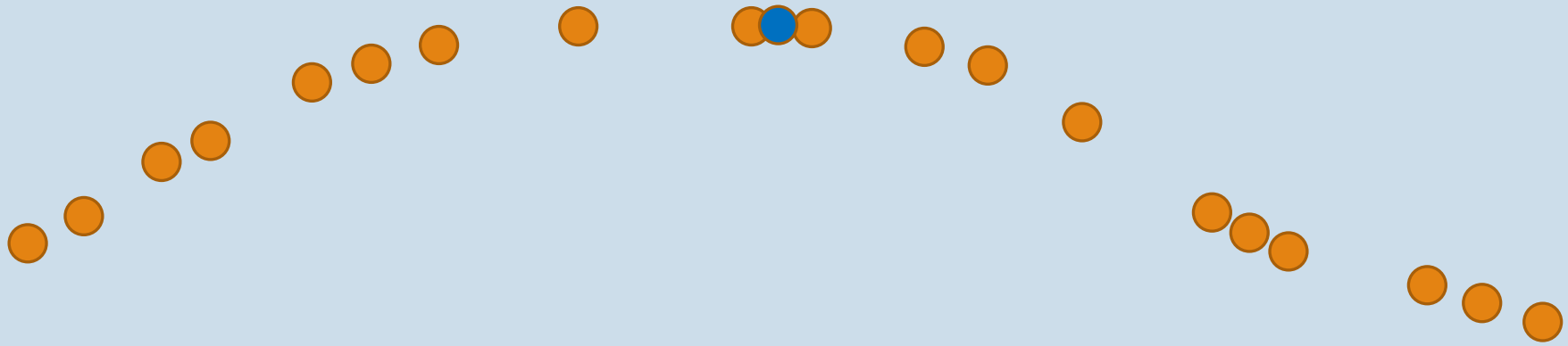
Generating the representation point set

- Down-sampling



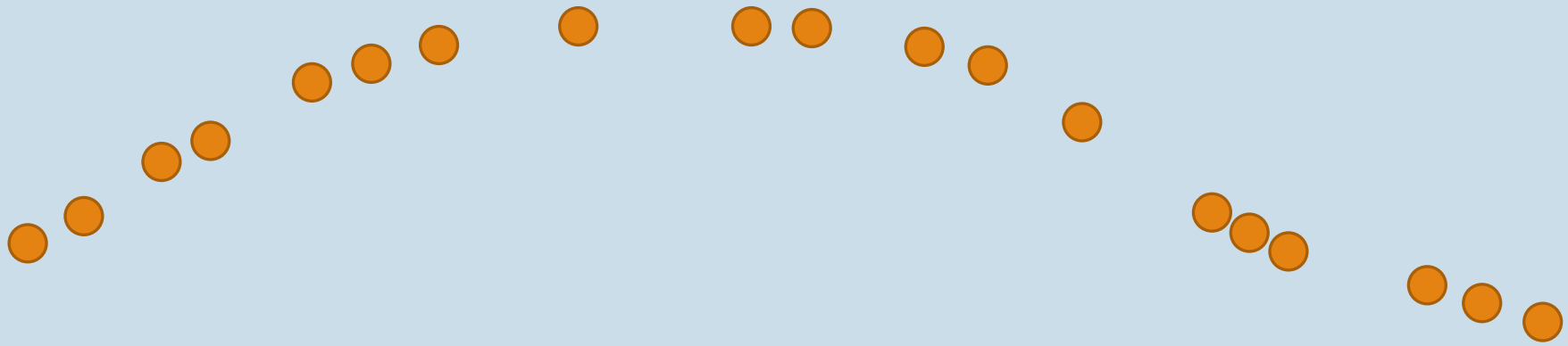
Generating the representation point set

- Down-sampling



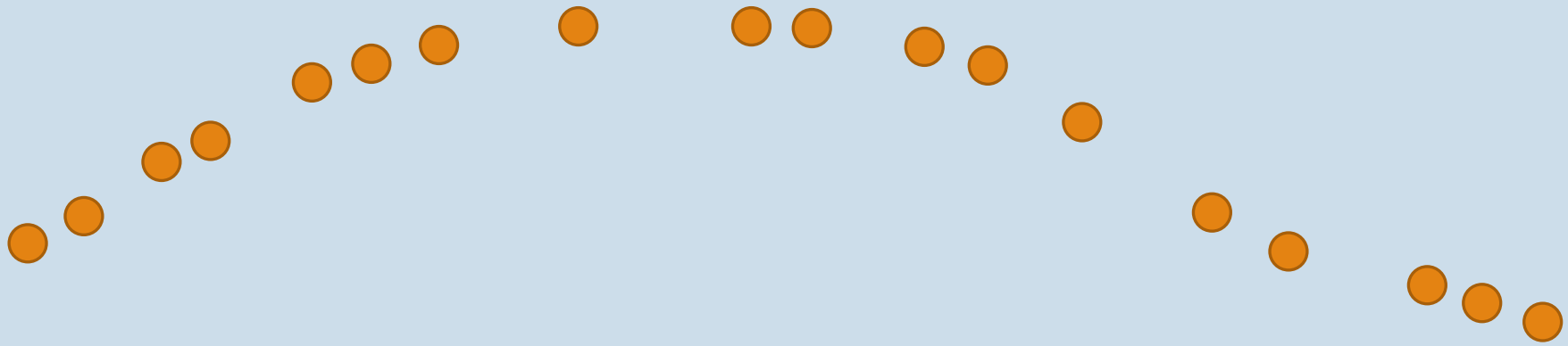
Generating the representation point set

- Down-sampling



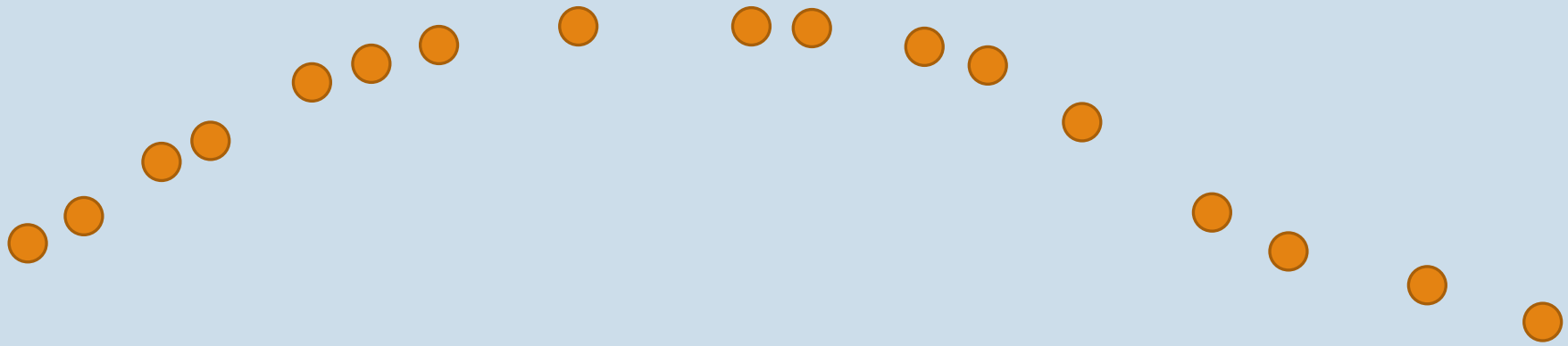
Generating the representation point set

- Down-sampling



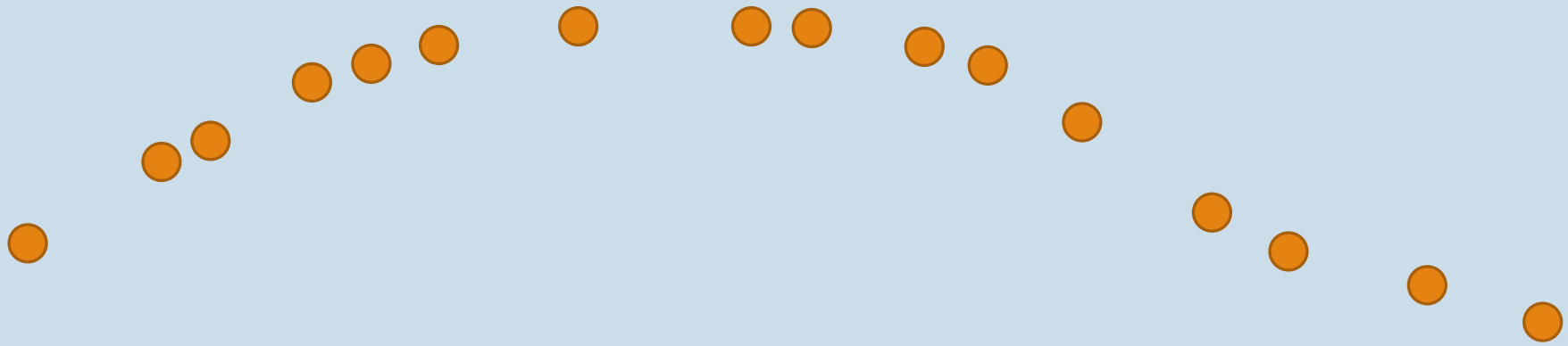
Generating the representation point set

- Down-sampling



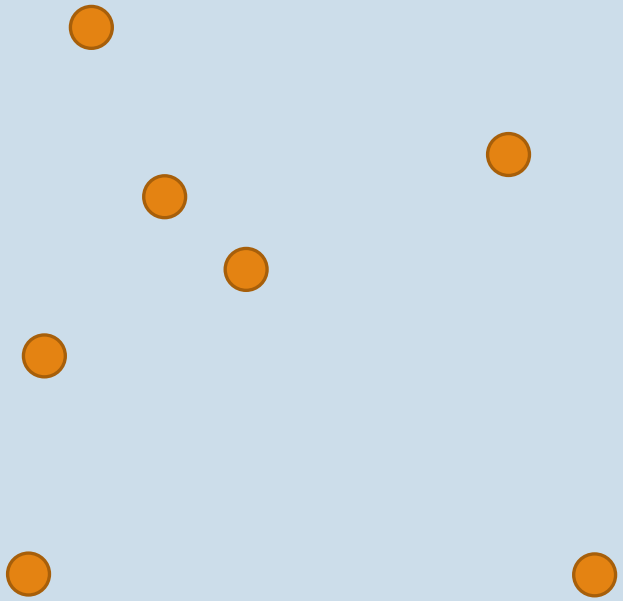
Generating the representation point set

- Down-sampling



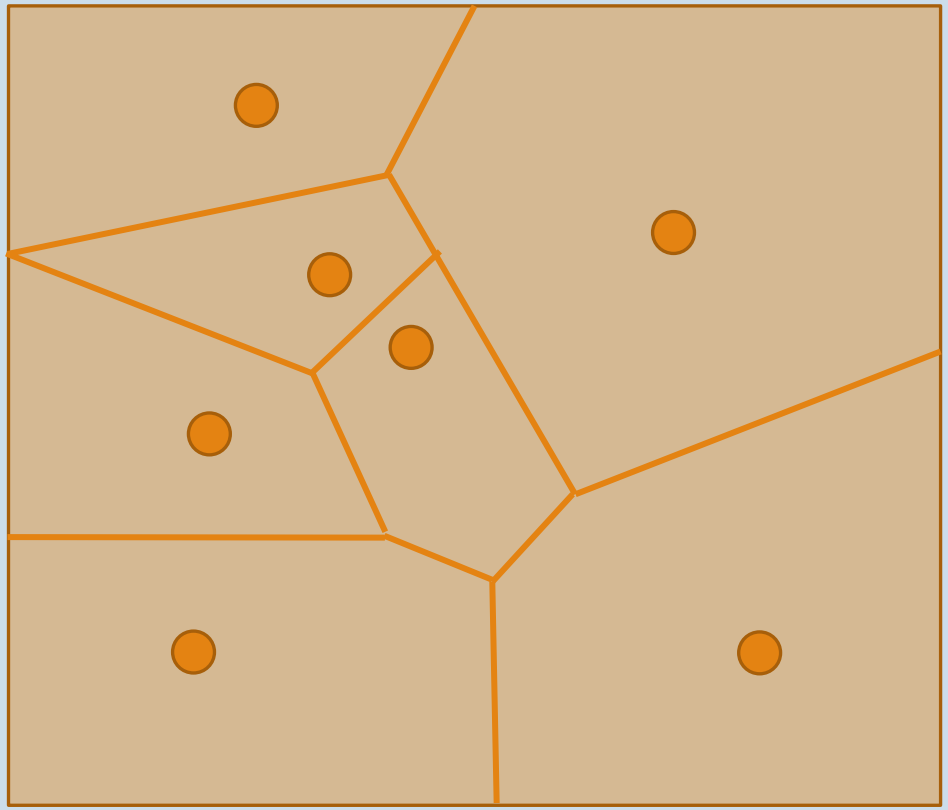
Generating the representation point set

- Up-sampling



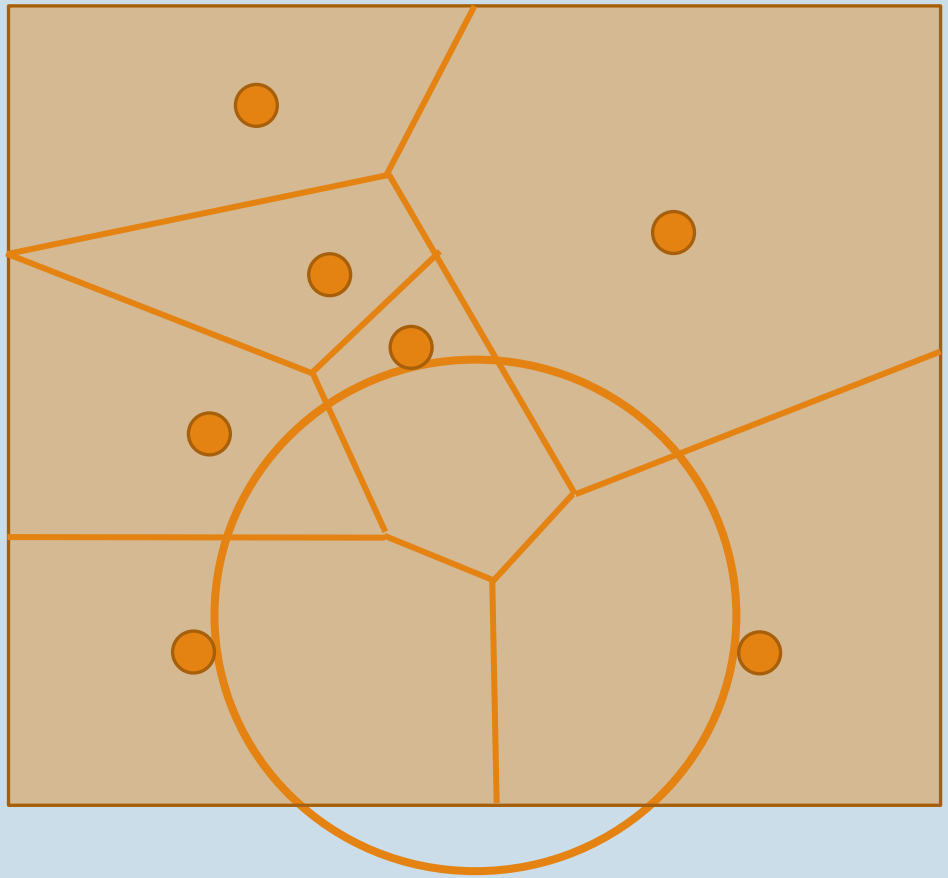
Generating the representation point set

- Up-sampling



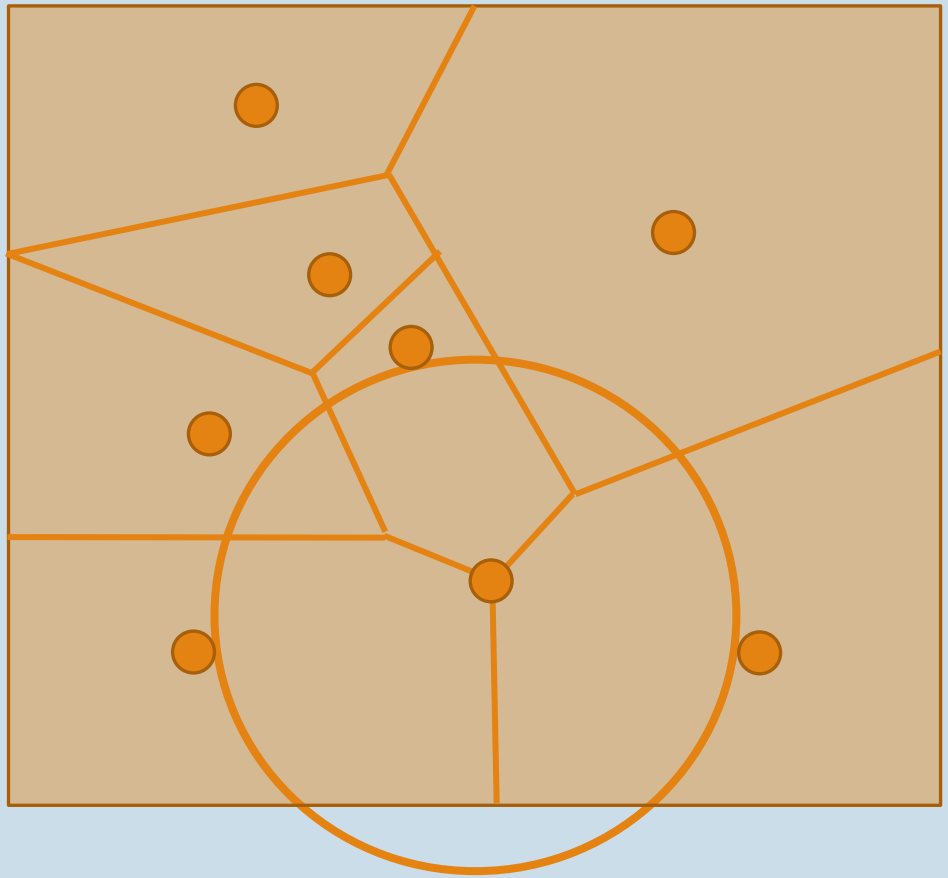
Generating the representation point set

- Up-sampling



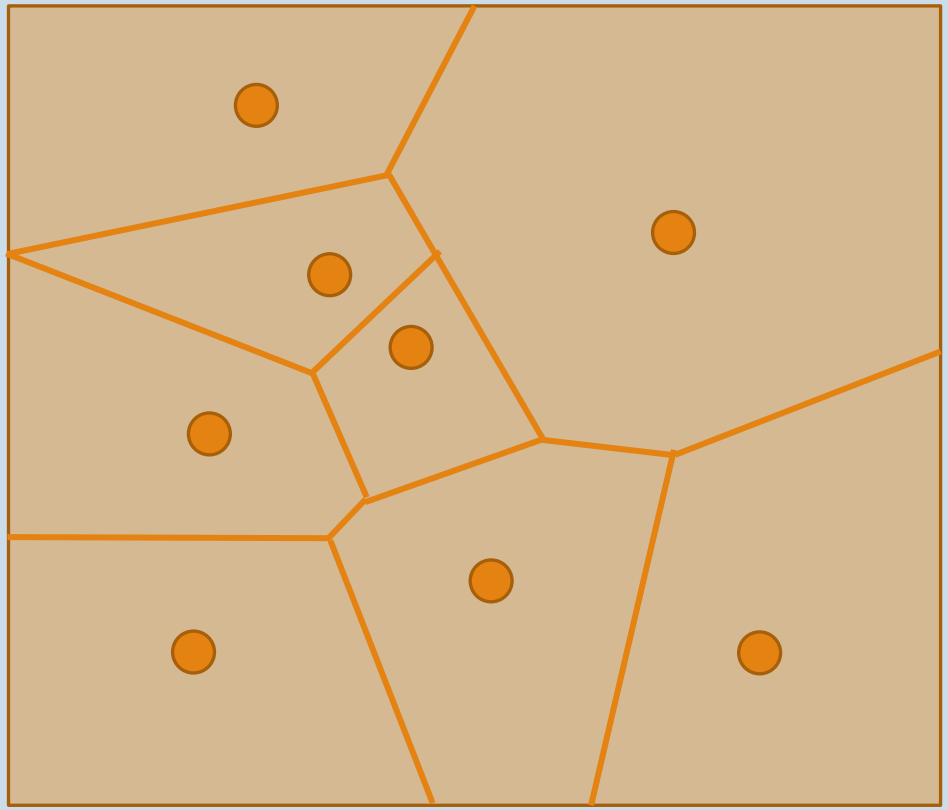
Generating the representation point set

- Up-sampling



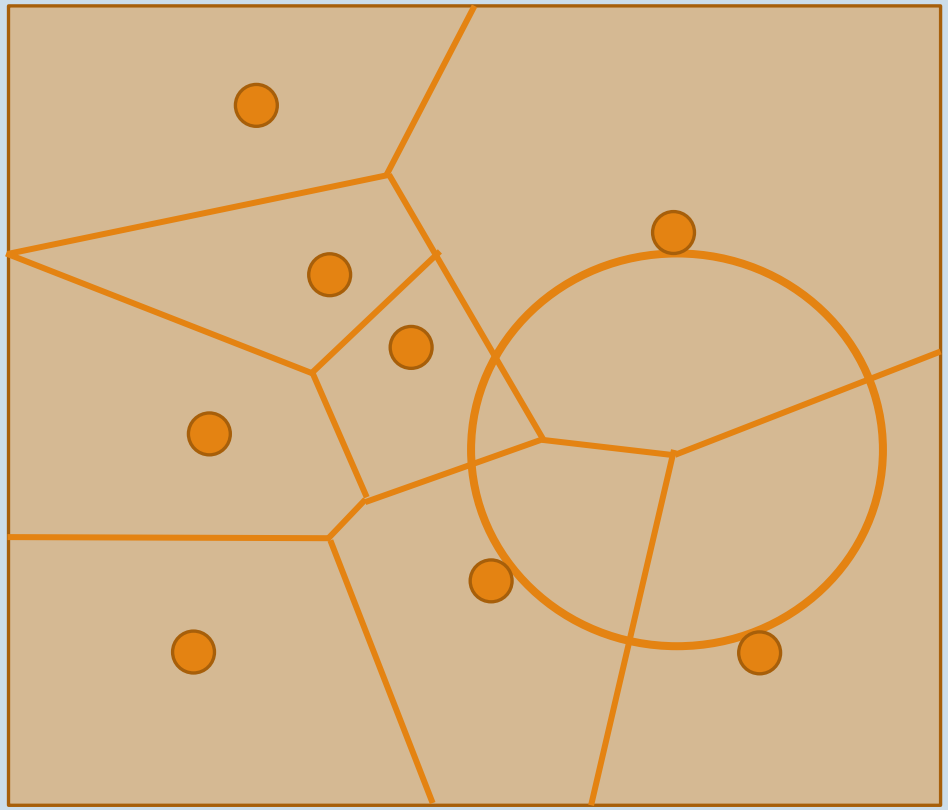
Generating the representation point set

- Up-sampling



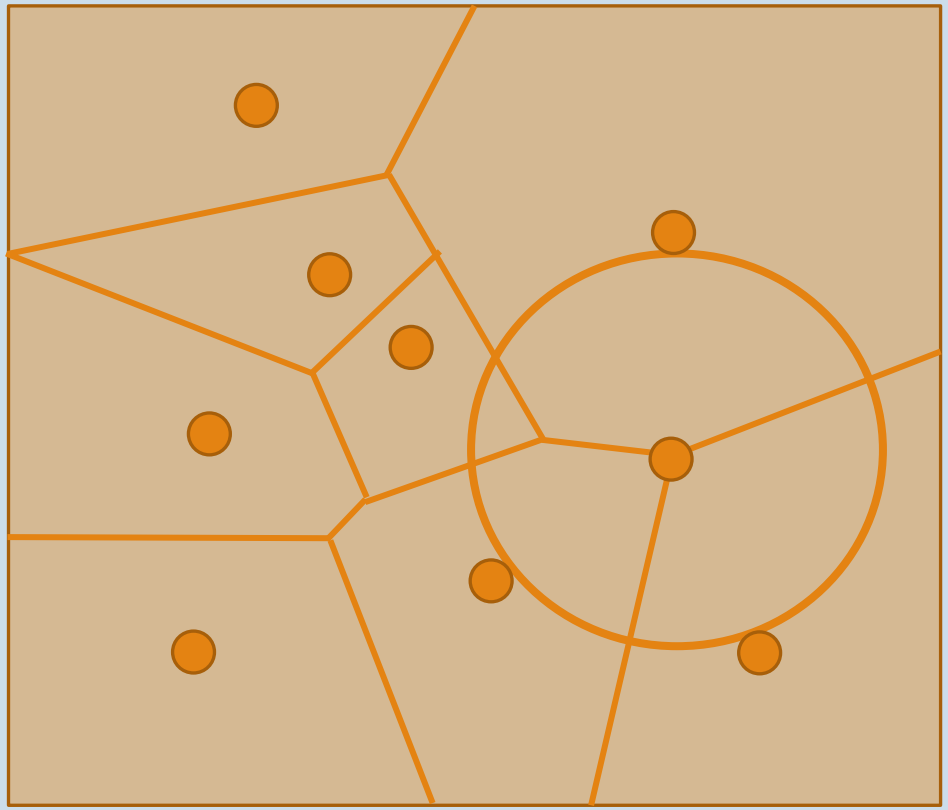
Generating the representation point set

- Up-sampling



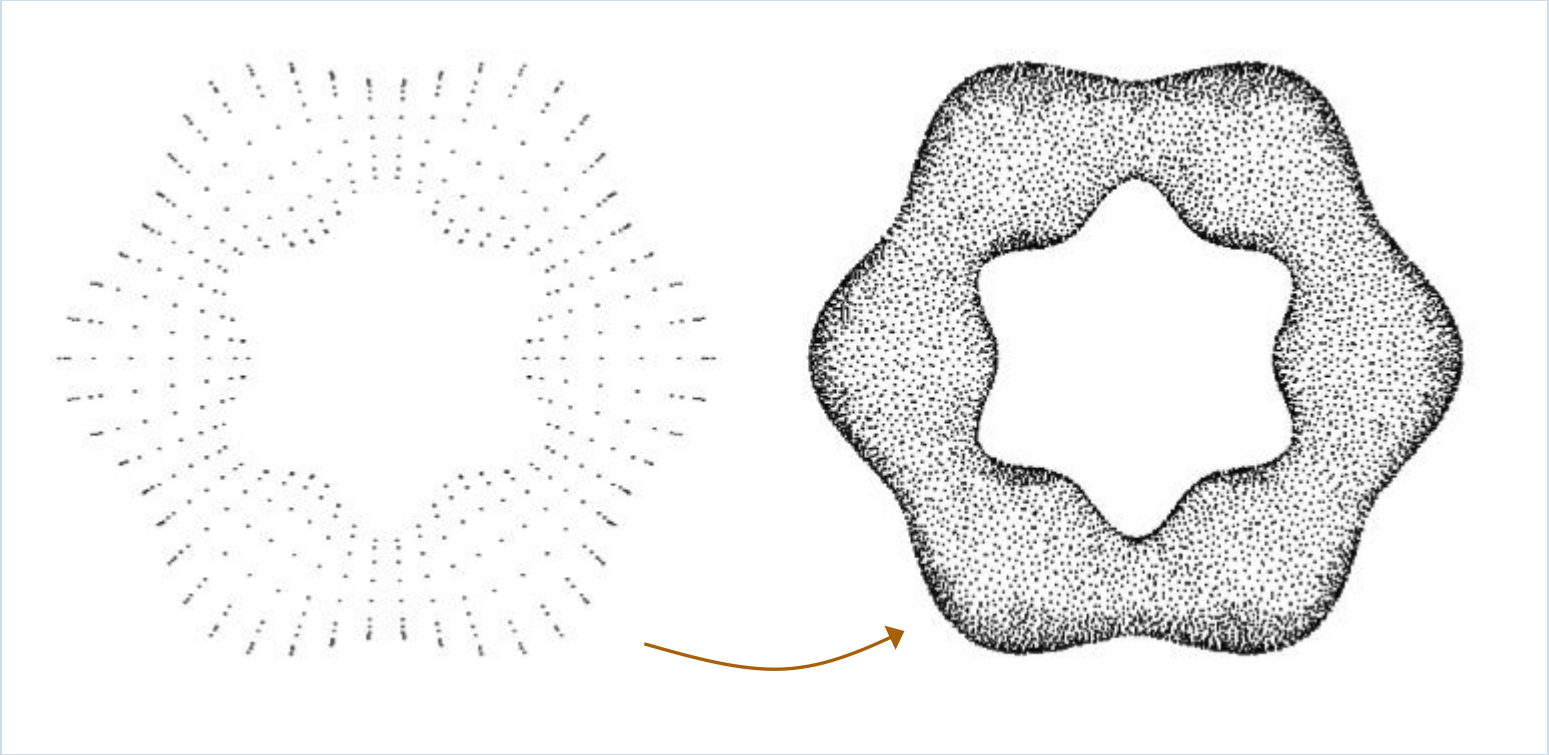
Generating the representation point set

- Up-sampling



Generating the representation point set

- Up-sampling

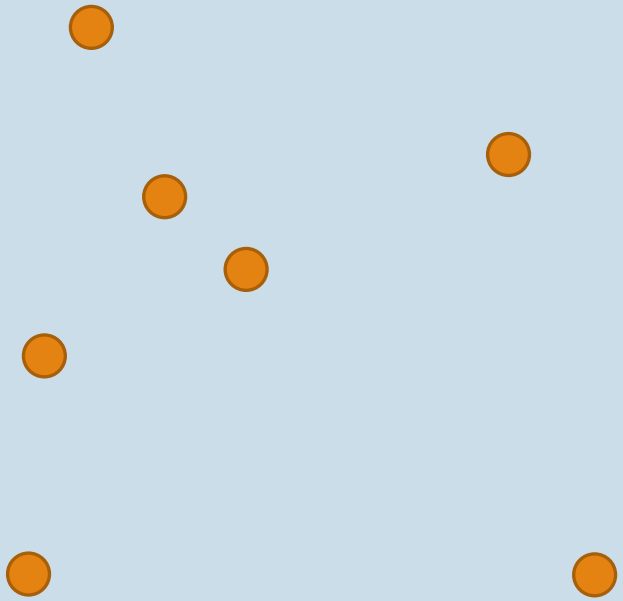


Outline

- Defining the surface – projecting
- Generating the representation point set
- Rendering

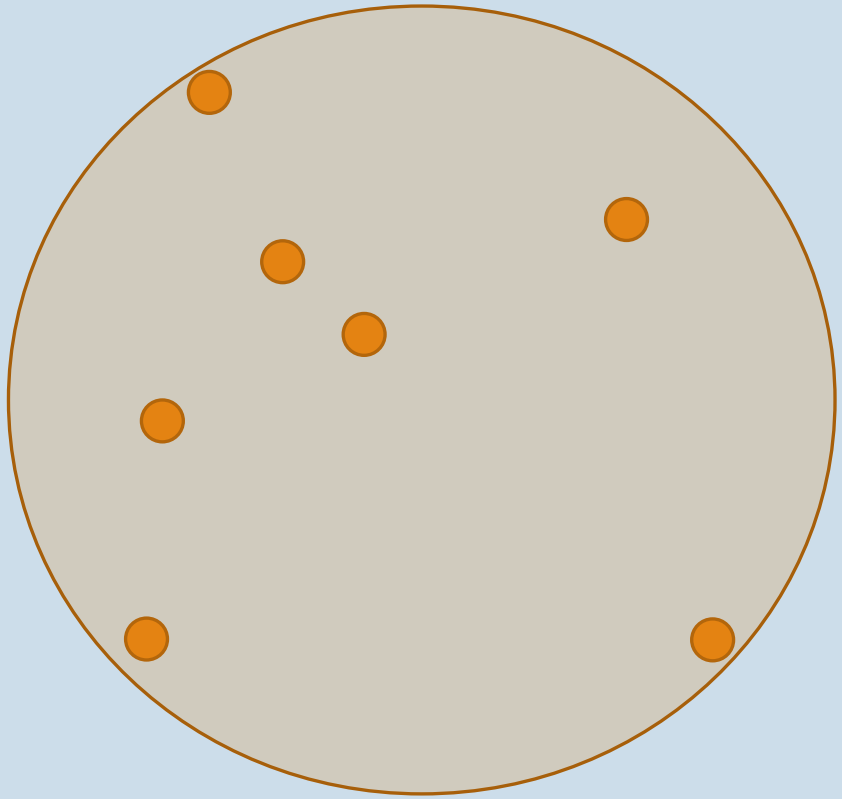
Rendering

- Bounding Sphere Hierarchy



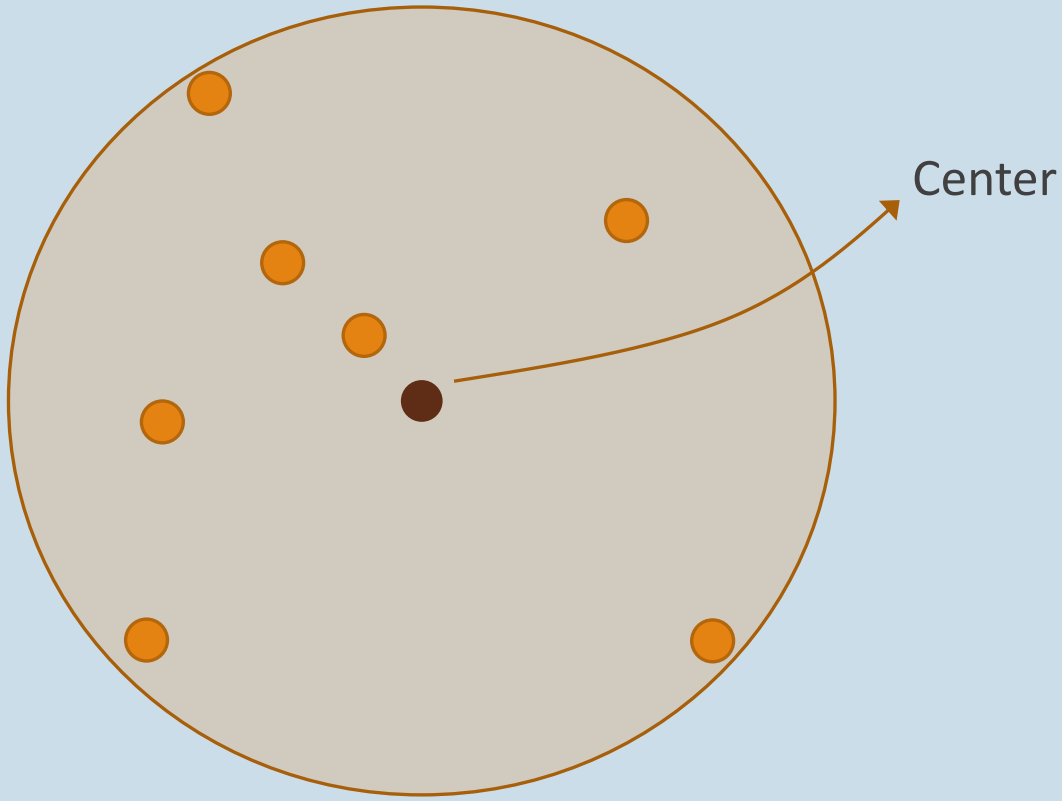
Rendering

- Bounding Sphere Hierarchy



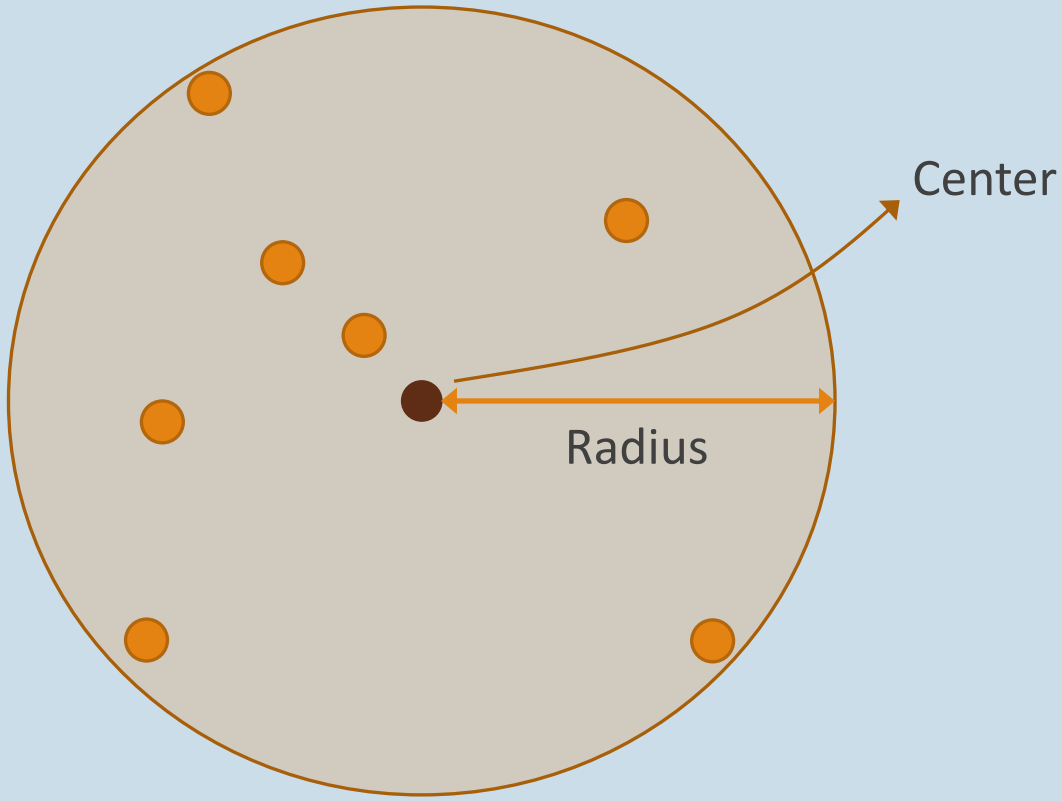
Rendering

- Bounding Sphere Hierarchy



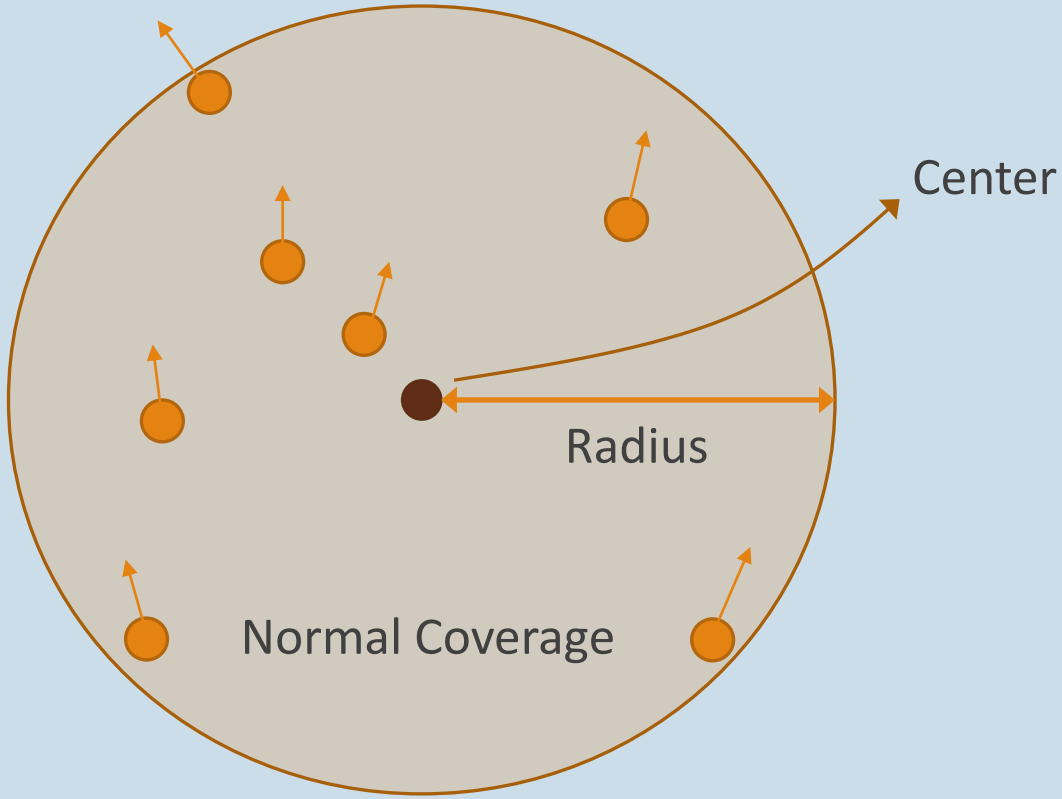
Rendering

- Bounding Sphere Hierarchy



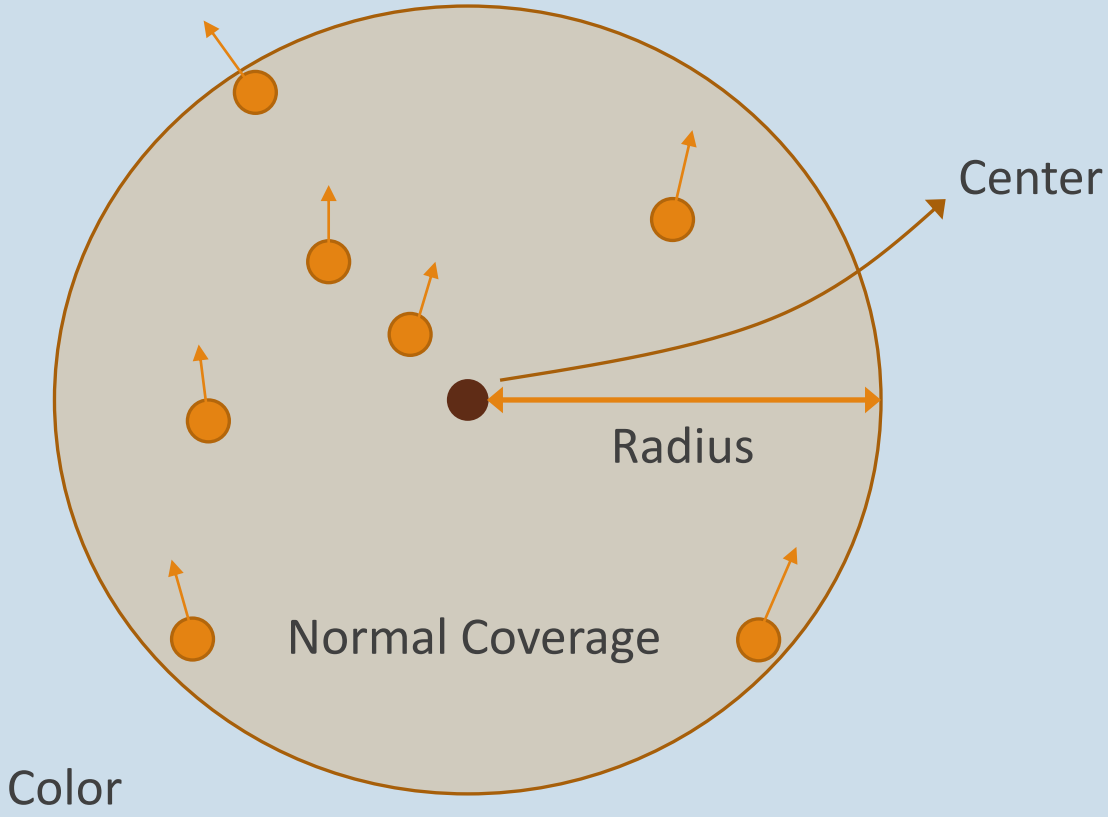
Rendering

- Bounding Sphere Hierarchy



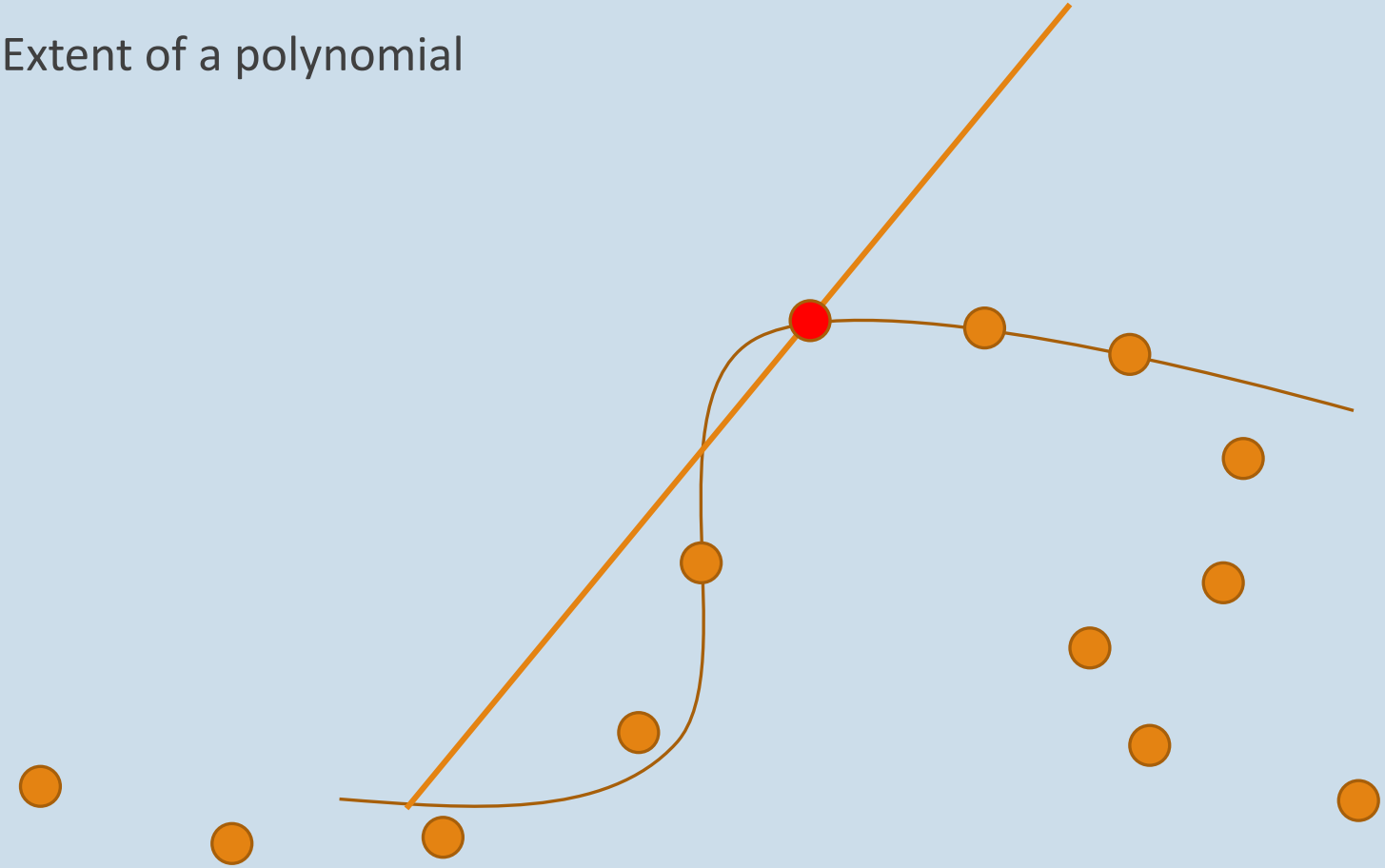
Rendering

- Bounding Sphere Hierarchy



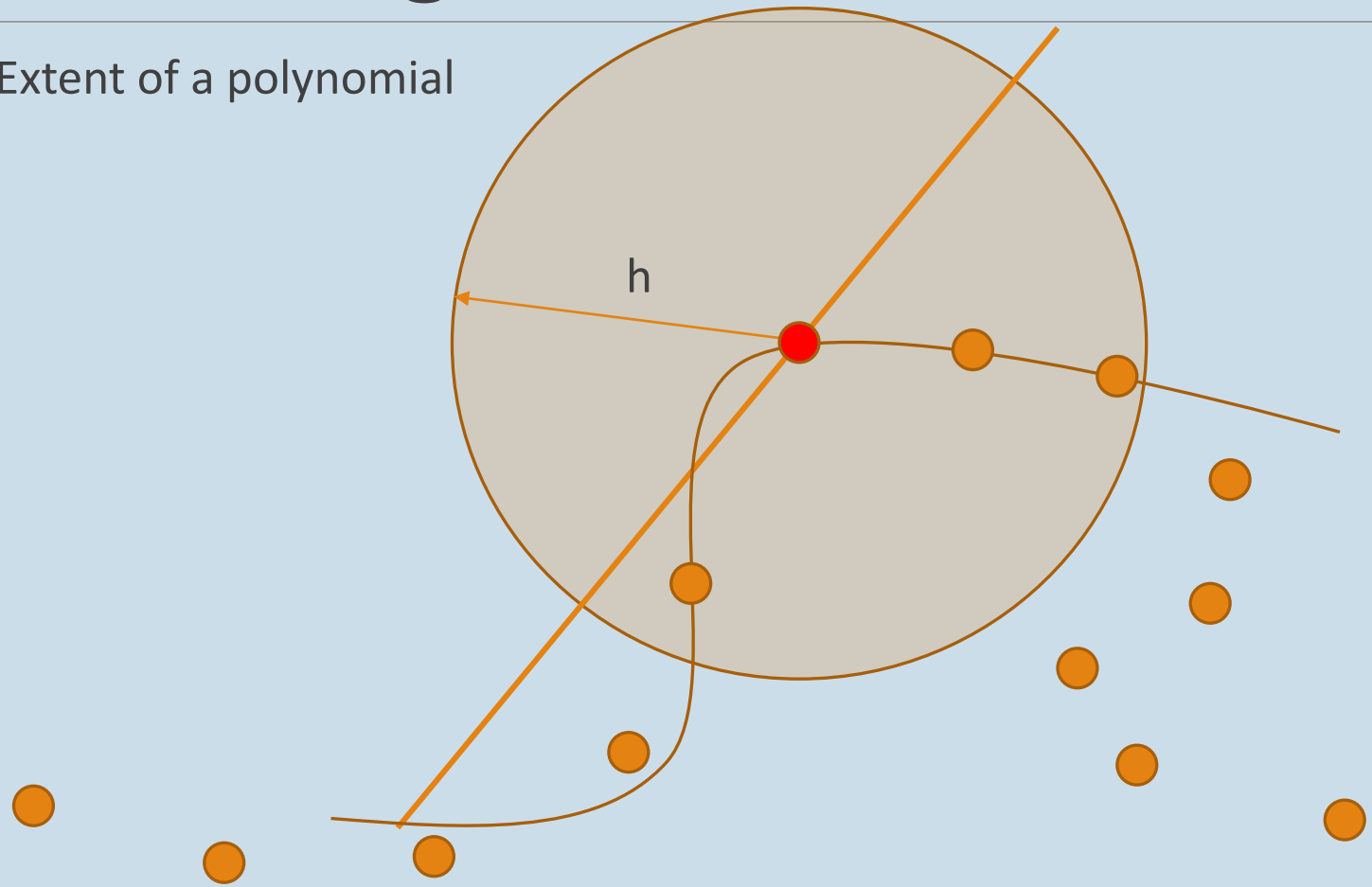
Rendering

- Extent of a polynomial



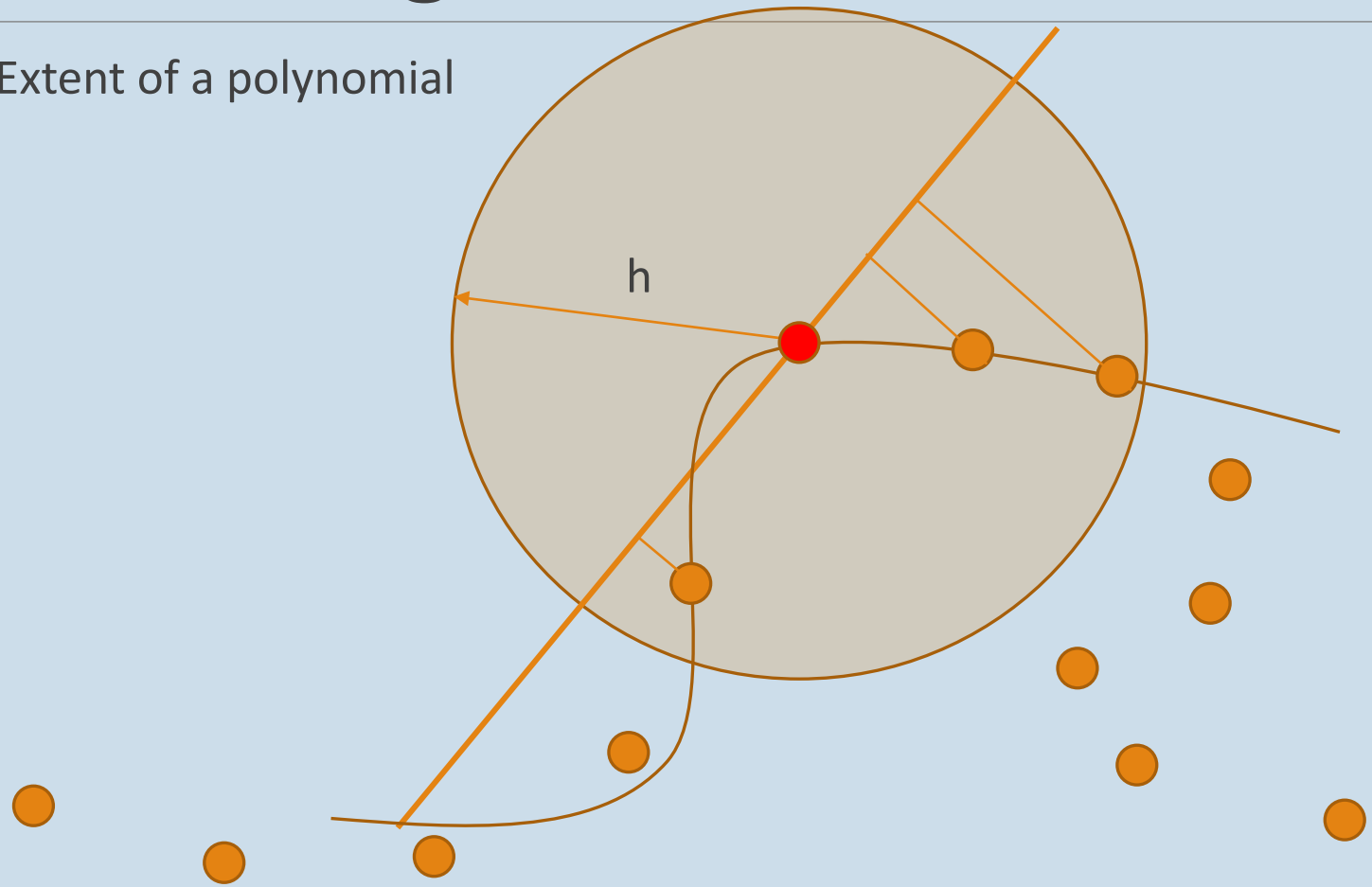
Rendering

- Extent of a polynomial



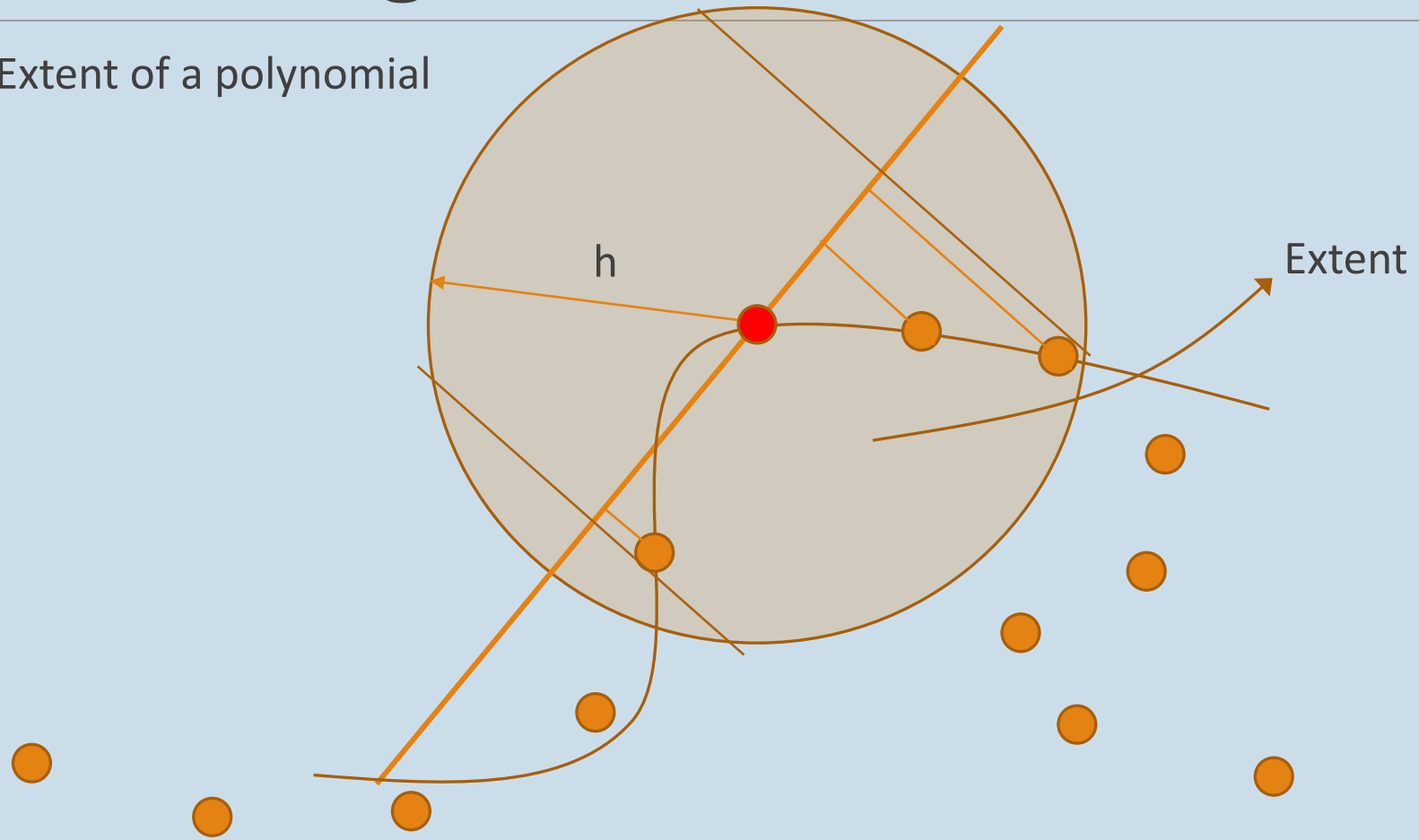
Rendering

- Extent of a polynomial



Rendering

- Extent of a polynomial



Rendering

- To accelerate rendering, grid pyramids are created and stored with various resolutions per point
- When a specific resolution is needed, the pyramid level that slightly oversamples the polynomial for a given resolution is chosen
- Small changes in the viewing position will, therefore, not require new evaluations.