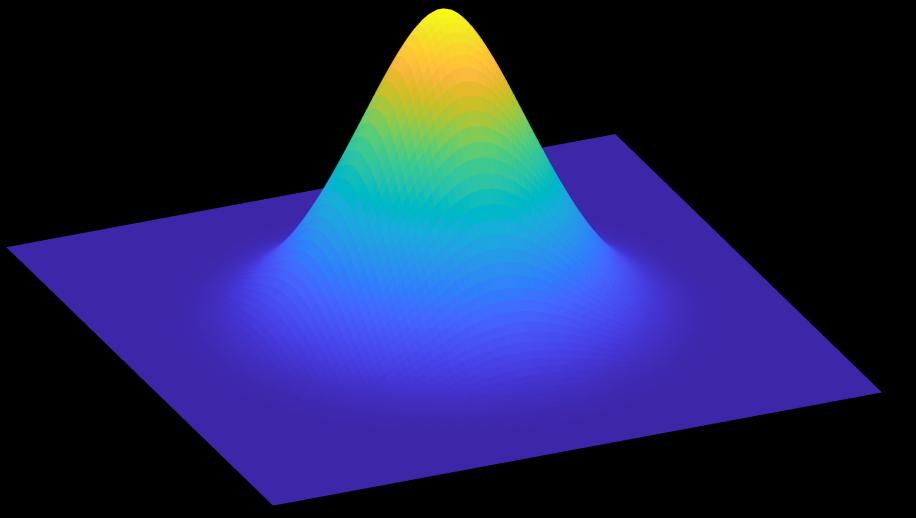


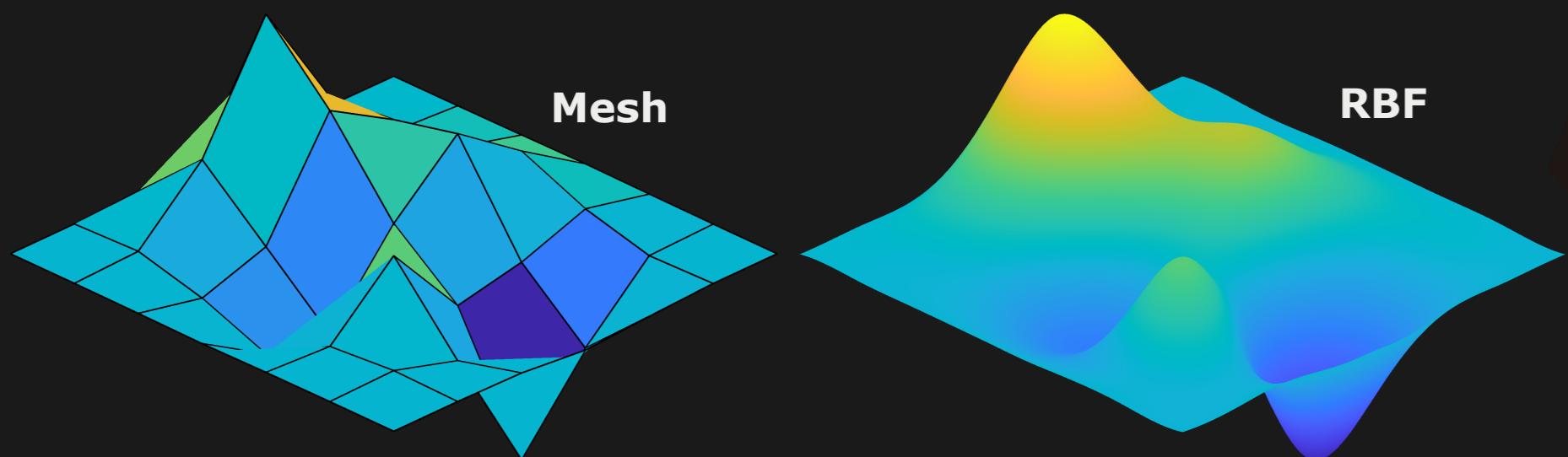


Surface reconstruction using radial basis functions



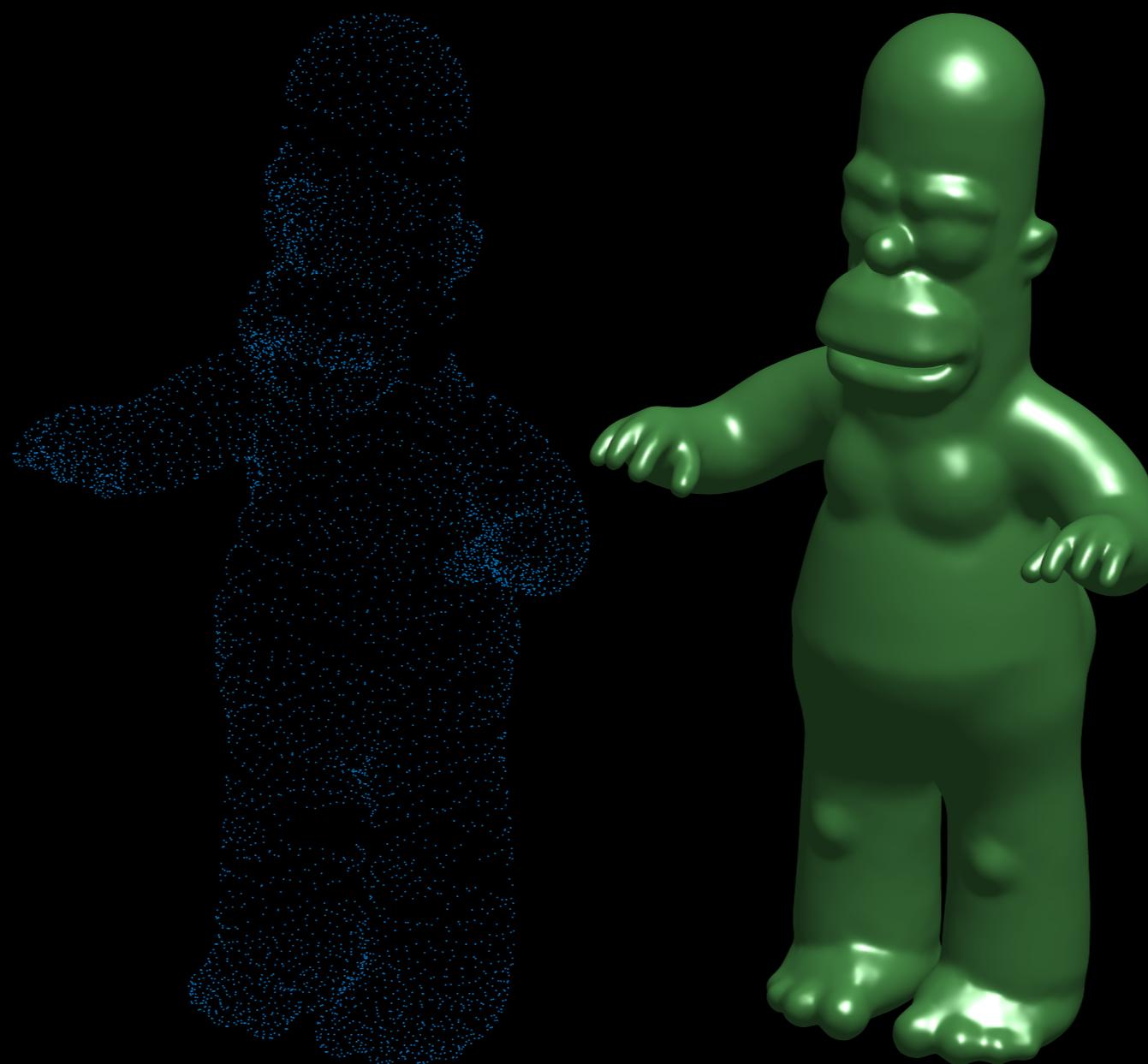
Background

- Surface reconstruction:
 - Reconstruct a surface from a point cloud.
 - Ill-posed problem since solution is not unique.
- Mesh-based methods are more commonly used.
- Meshfree-methods was used in this project.



Radial basis functions

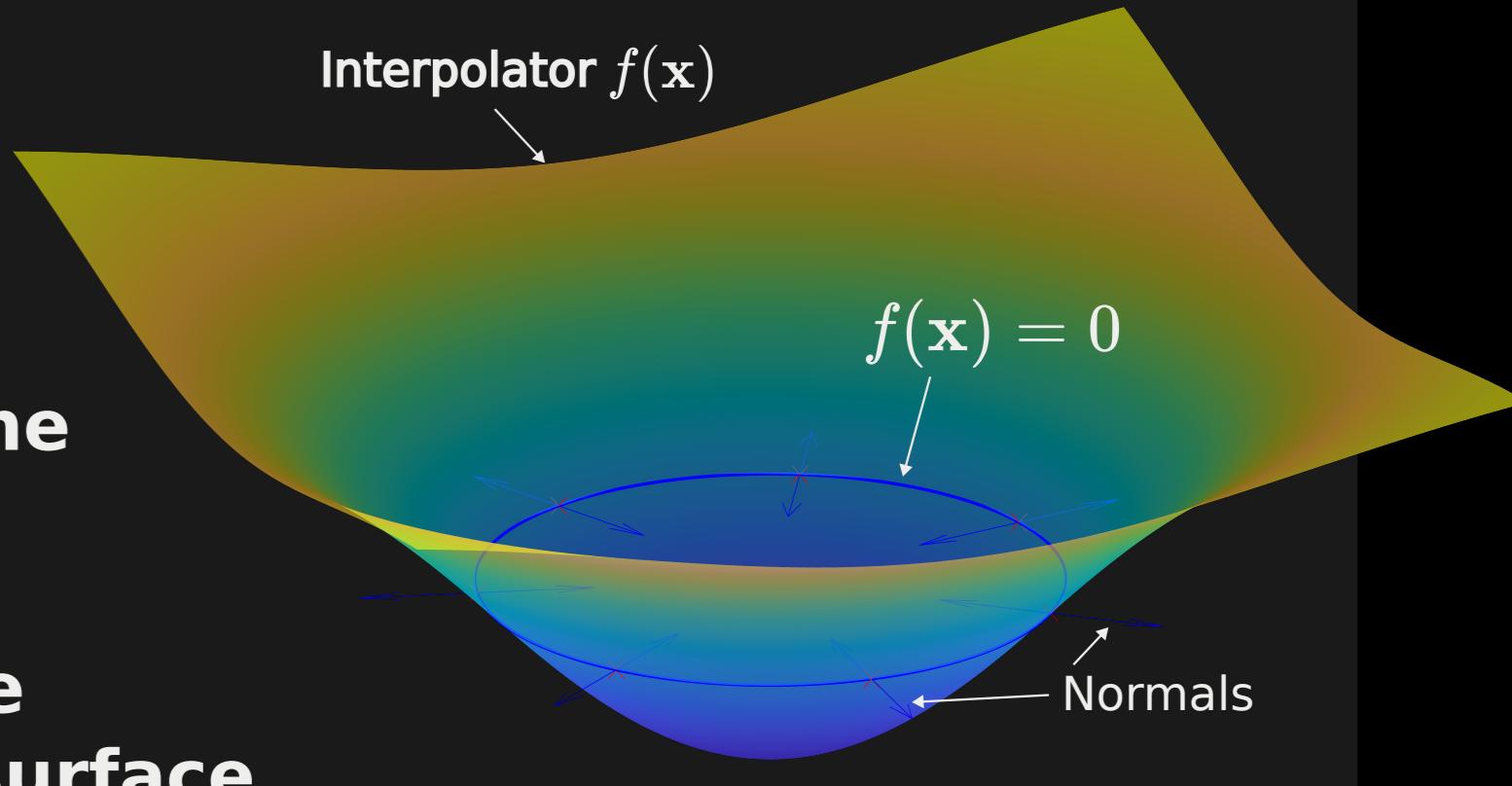
- Positive definite function of the distance between points.
- Interpolation:
 - Place an RBF at each point.
 - Scale them such that the linear combination passes through all points by solving a linear system.
- Partition of unity:
 - Divide the domain into patches.
 - Only points in the same patch affect each other.
 - Faster and better numerical stability.



Off-point method

- Use normals to generate off-points just outside and inside the surface
- Let

$$f(\mathbf{x}) = 0$$
$$f(\mathbf{x} + \delta\mathbf{n}) = 1$$
$$f(\mathbf{x} - \delta\mathbf{n}) = -1$$
- This will force the interpolant to cross the zero-surface of f . The reconstructed surface can be obtained by solving for $f(\mathbf{x}) = 0$.



Curl-free method

- Based on the concept that a smooth surface has curl-free normals.
- Interpolate the normals (vector field).
- RBF:
 - 3x3 matrix with curl-free columns.
 - Can be constructed as Hessian of scalar RBF.
- The surface is reconstructed by the zero-surface of the potential of the interpolated vector field.