Spring 2018

CSCI 621: **Digital Geometry Processing**

Exercise 3. Implicit Surface Reconstruction

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Implicit Surface Reconstruction

- Estimate point cloud normals (precomputed)
- **Estimate signed distance function (SDF)**
- Evaluate the distances on a uniform grid
- Extract mesh via marching cubes

Exercise 3

- You will be given 3 sets of point clouds
- Implement two popular methods to estimate signed distance function for implicit surface reconstruction:
  - Hoppe distance from tangent planes [Hoppe 92]
  - Triharmonic Radial Basis Functions (RBFs)

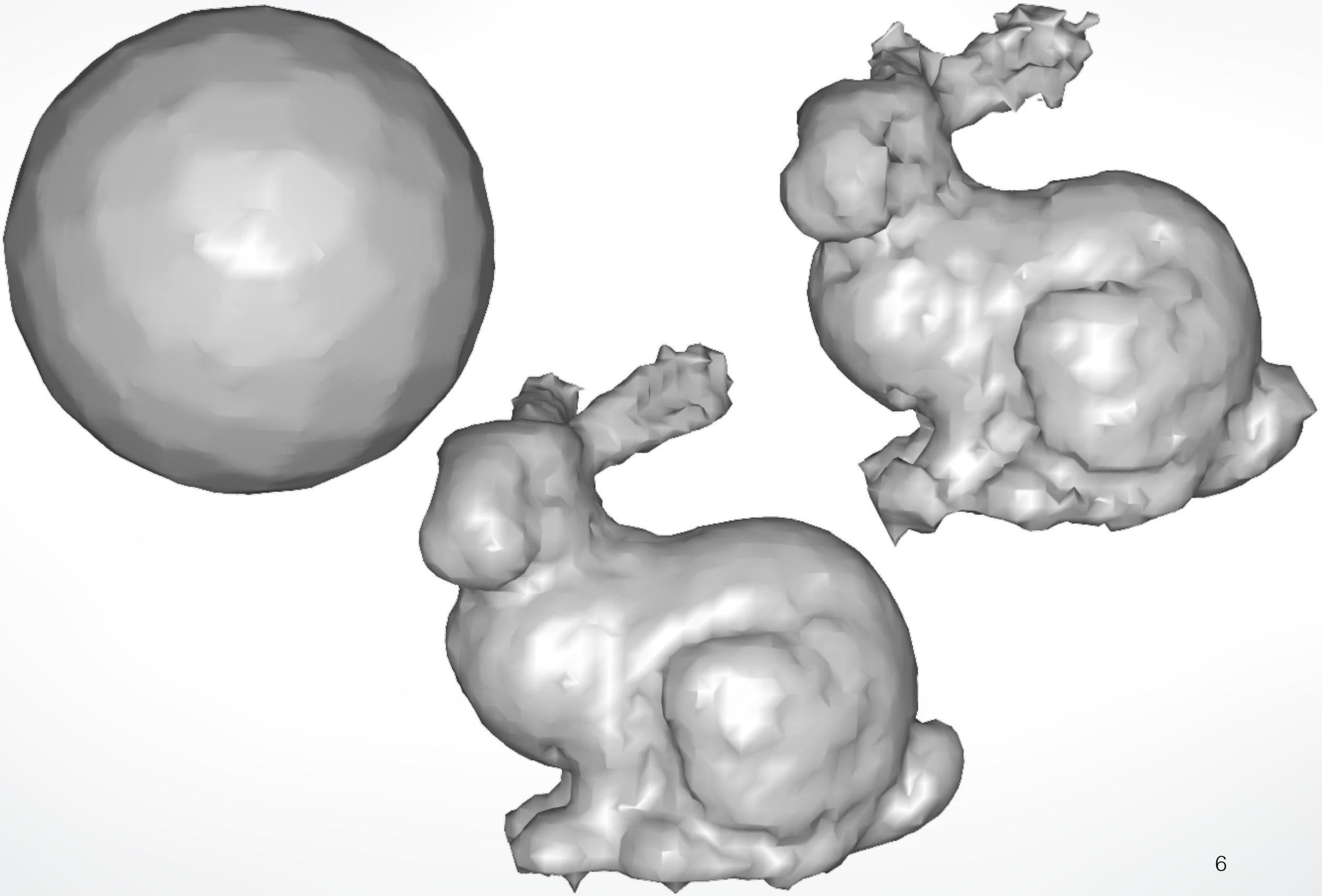
Libraries

- OpenGL, OpenMesh
- Generic Matrix Methods (gmm)
  - used for solving linear equation
- IsoEx: marching cubes

Hoppe Distance

- Distance from tangent plane
  - point & normal forms a local tangent plane
  - use distance from closest point's tangent plane
- `ImplicitHoppe::operator()` in ImplicitHoppe.hh
- Surface reconstruction from unorganized points. [Hoppe et al. '92]

Results



RBF

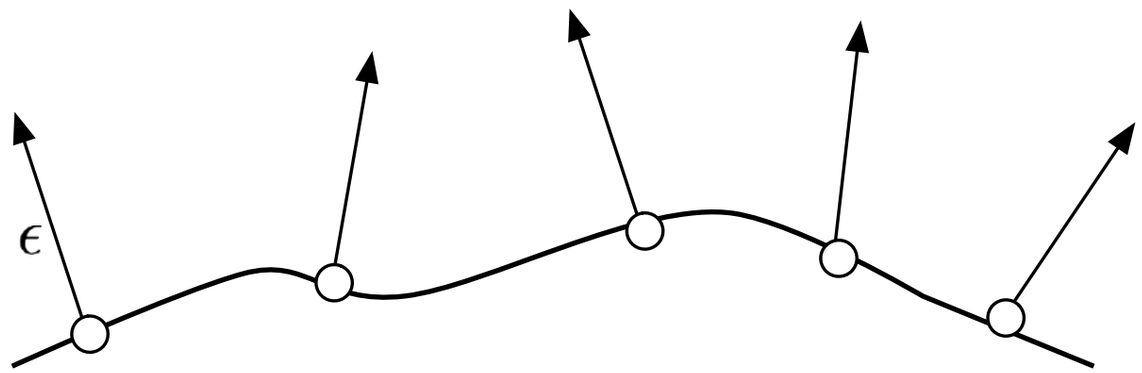
- Radial Basis Functions (RBFs)
  - Sum of shifted, weighted kernel functions

$$d(\mathbf{x}) = \sum_i w_i \phi(\|\mathbf{x} - \mathbf{c}_i\|)$$

- Triharmonic RBFs: $\phi(x) = x^3$
- Solve for the weights using on- and off-surface constraints and gmm library
- `ImplicitRBF::ImplicitRBF()` in ImplicitRBF.cc

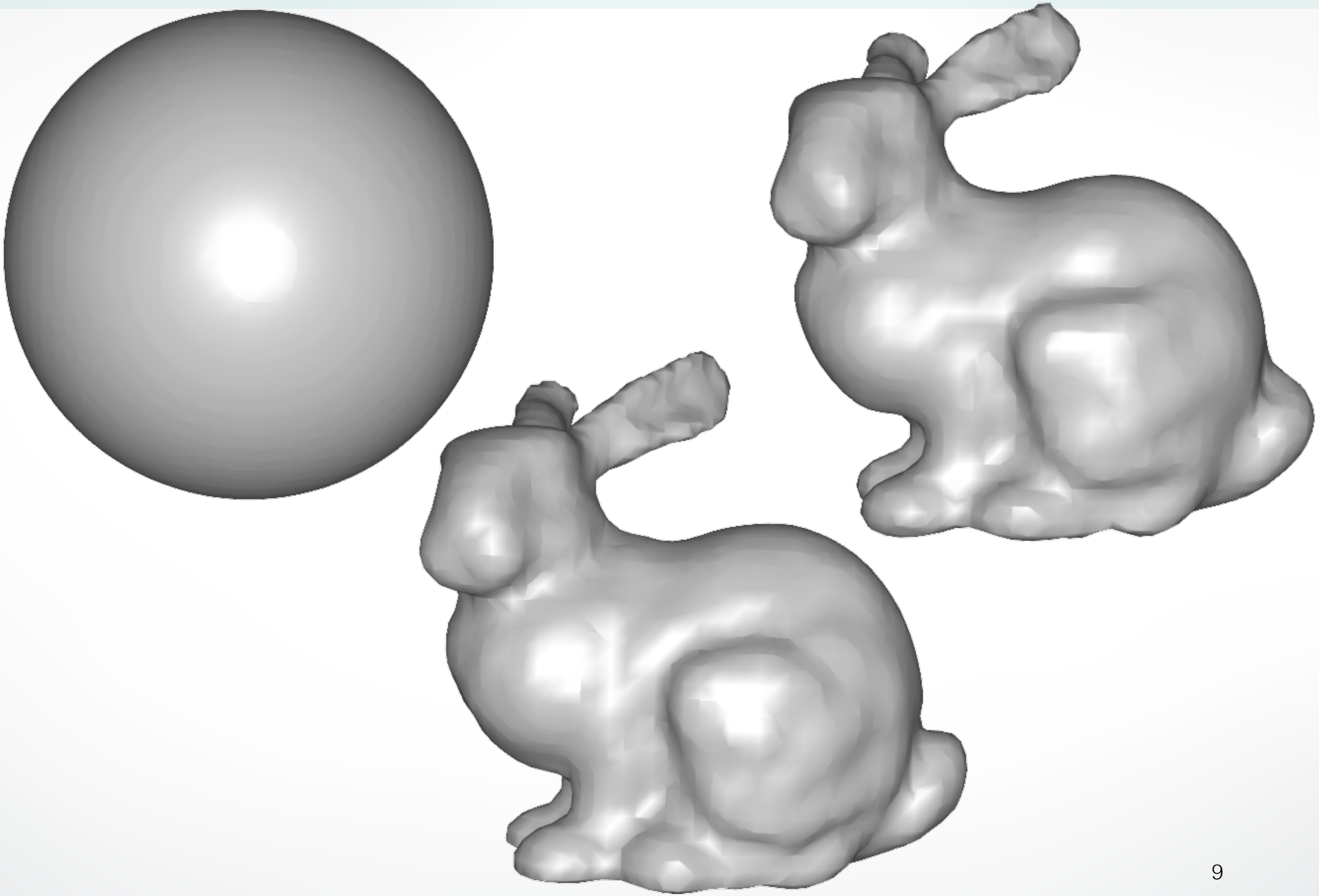
On- and Off-Surface Constraints

$$d(\mathbf{x}_i + \epsilon \mathbf{n}_i) = \epsilon$$



$$\begin{bmatrix} \phi(\|\mathbf{x}_1 - \mathbf{x}_1\|) & \dots & \phi(\|\mathbf{x}_1 - (\mathbf{x}_n + \epsilon\mathbf{n}_n)\|) \\ \vdots & \ddots & \vdots \\ \phi(\|(\mathbf{x}_n + \epsilon\mathbf{n}_n) - \mathbf{x}_1\|) & \dots & \phi(\|(\mathbf{x}_n + \epsilon\mathbf{n}_n) - (\mathbf{x}_n + \epsilon\mathbf{n}_n)\|) \end{bmatrix} \begin{bmatrix} w_1 \\ \vdots \\ w_{2n} \end{bmatrix} = \begin{bmatrix} d_1 \\ \vdots \\ d_{2n} \end{bmatrix}$$

Results



Submission

- Deadline: **Mar 6, 2018 12:00pm (noon)**
- Upload a .zip compressed file named “Exercise3-YourName.zip” to Blackboard
- Include a “readme.txt” file describing how you solve each exercise and the encountered problems

Contact

- Office Hours: Monday 3:00 - 4:00pm, PHE 108
- email: tianyeli@usc.edu
- Highly recommended to post your question on Piazza.

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Thanks!