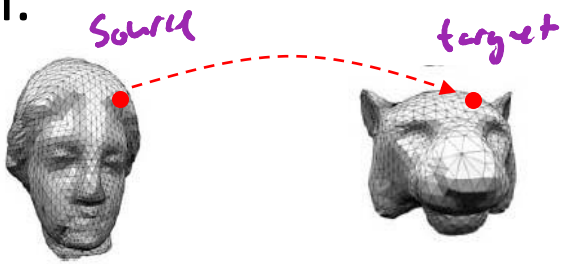
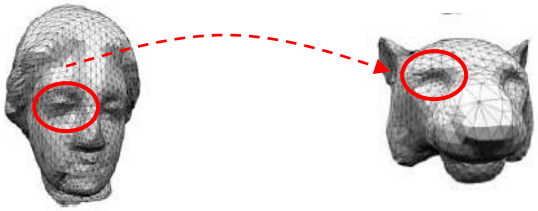
# Mesh Morphing

Mesh morphing is the process of gradual shape transformation of a source mesh to a target mesh.

- Vertex correspondence problem: For each vertex of the source mesh, we need to find a corresponding vertex on the target mesh.

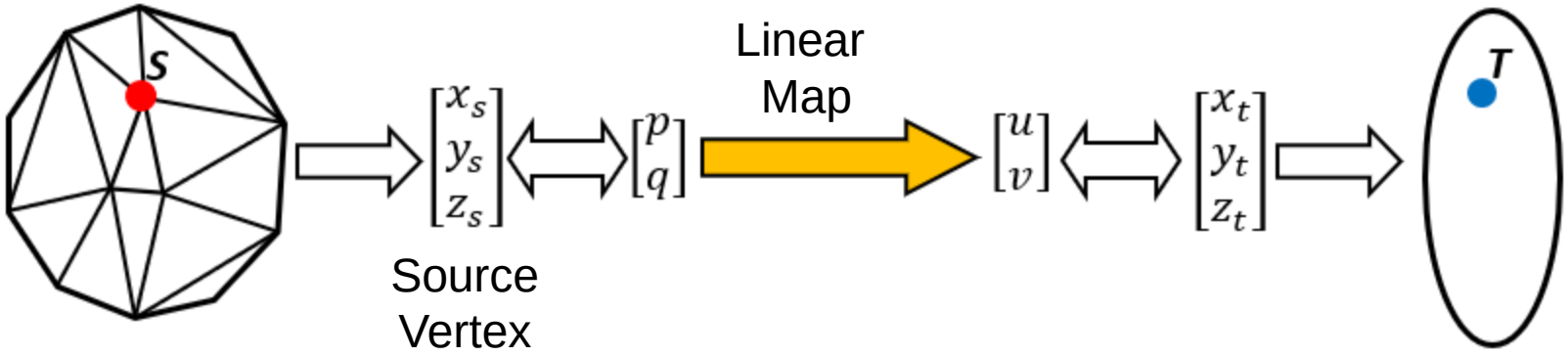



- Feature Correspondence Problem: A morphing sequence must map primary shape features of the source mesh to the corresponding features of the target mesh.



# Morphing Using Parametric Space

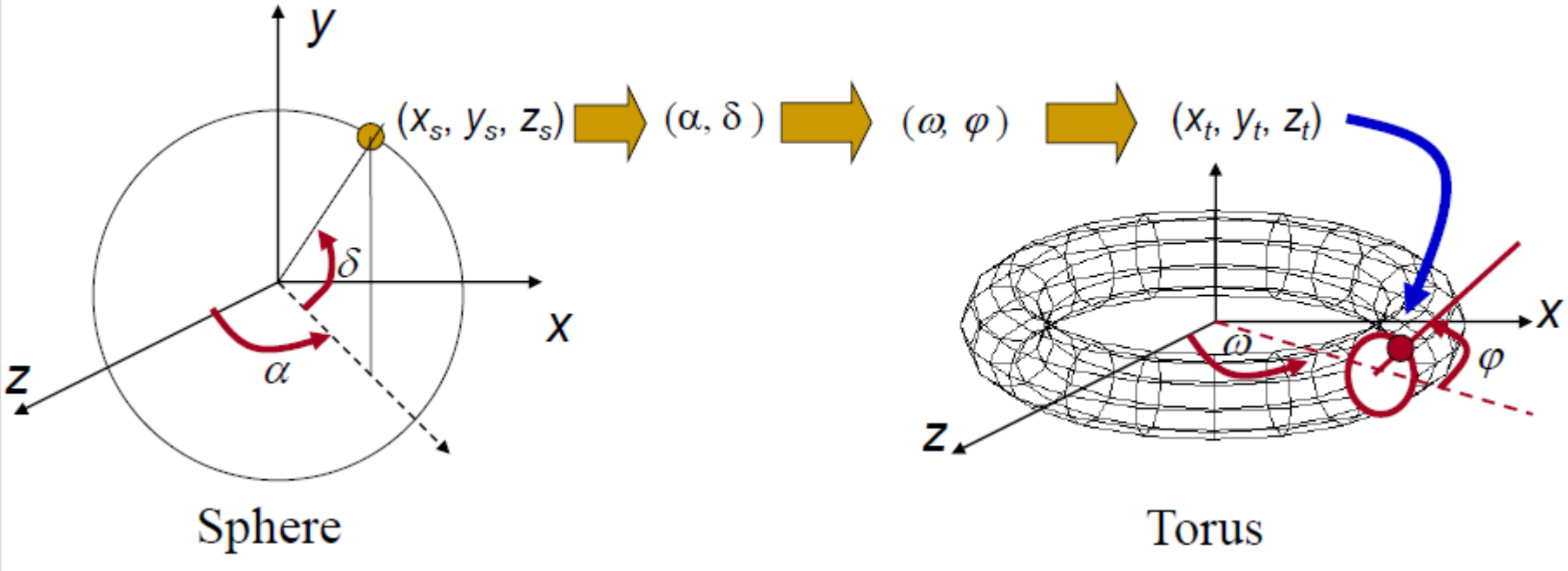
- Shapes that have 2D parametric representations (e.g., sphere, cylinder, cone etc.) can be morphed using a linear map between the parameters.



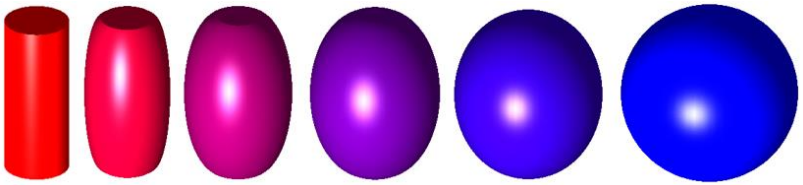

$$p \rightarrow u \ : \quad \frac{p - p_{min}}{p_{max} - p_{min}} = \frac{u - u_{min}}{u_{max} - u_{min}}$$

$$q \rightarrow v \ : \quad \frac{q - q_{min}}{q_{max} - q_{min}} = \frac{v - v_{min}}{v_{max} - v_{min}}$$

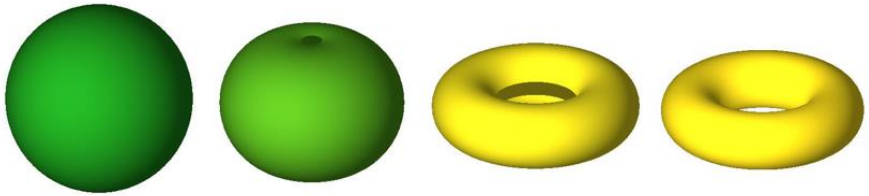
# Morphing Using Parametric Space




Cylinder -> Sphere

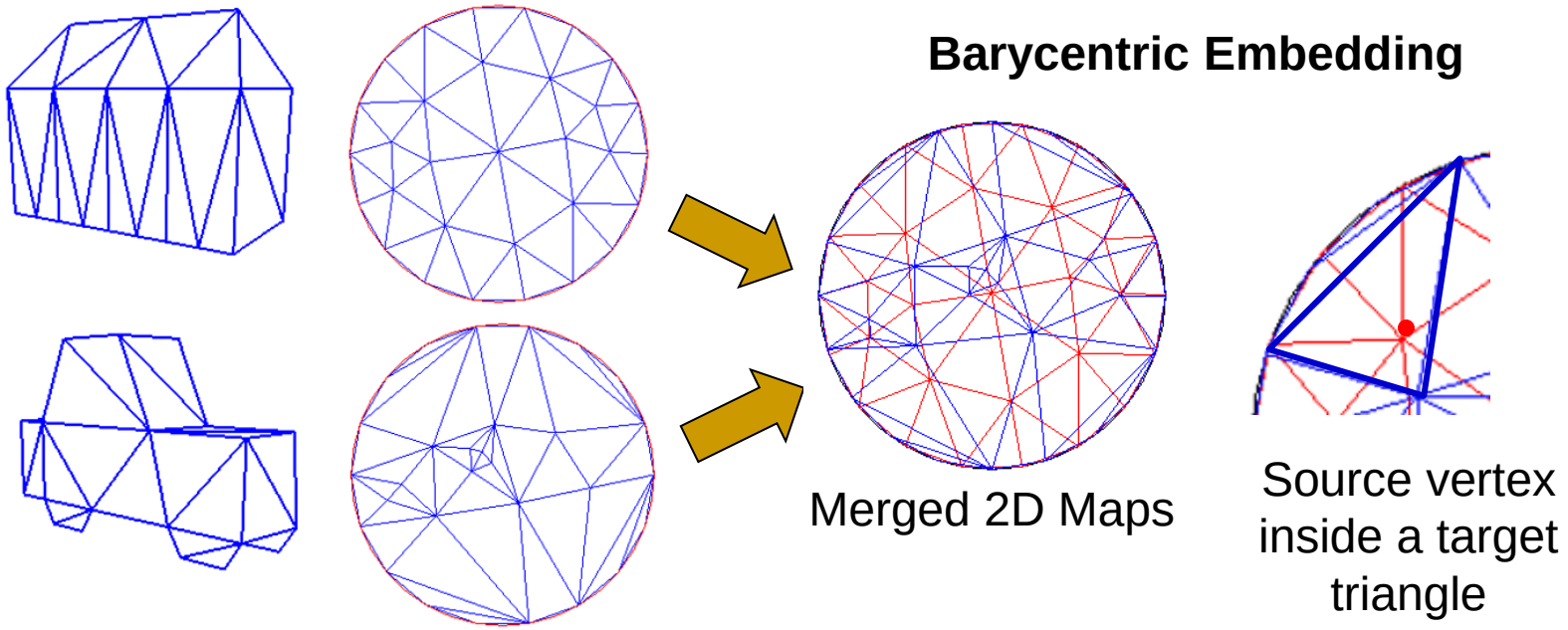


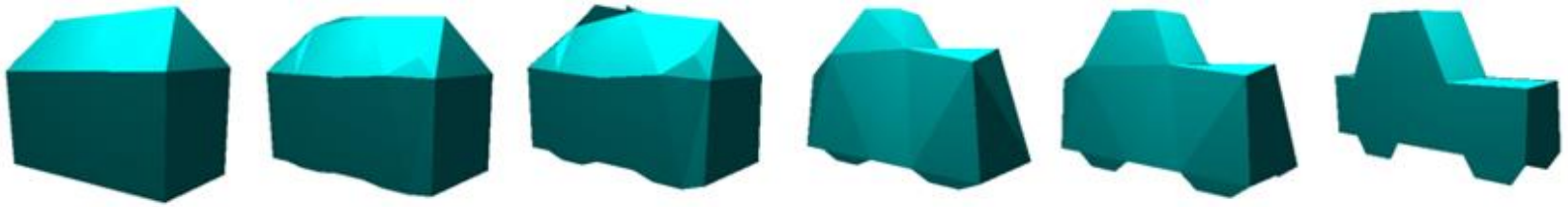
Sphere -> Torus



# Morphing Using Parametric Embedding

- Map 3D points to a 2D domain ($\Re^3 \rightarrow \Re^2$)
- Establish the mapping in 2D space

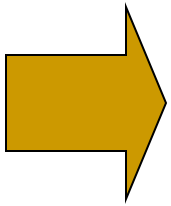


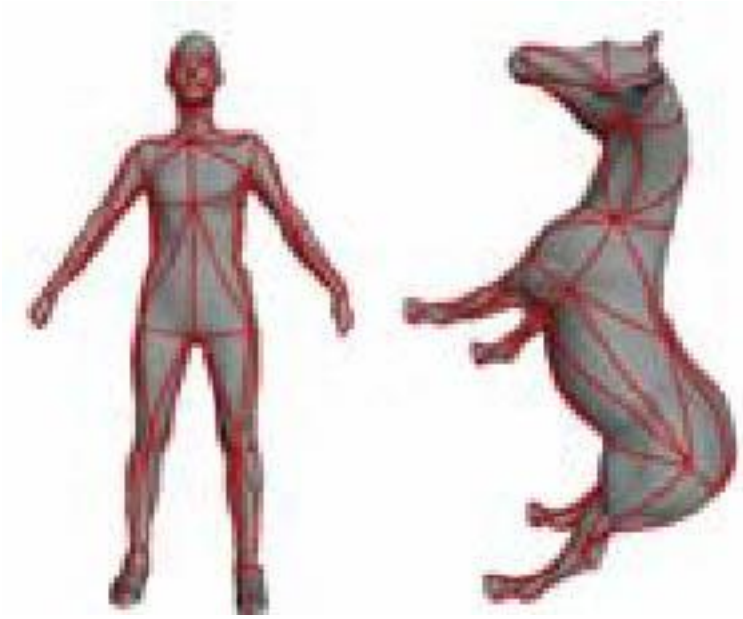



# Patch-Based Models

- Simple and accurate mesh morphing using iterative subdivision of a coarse base mesh.
- A coarse base mesh is created for both source and target meshes
  - Both base meshes have the same number of vertices and same polygonal connectivity

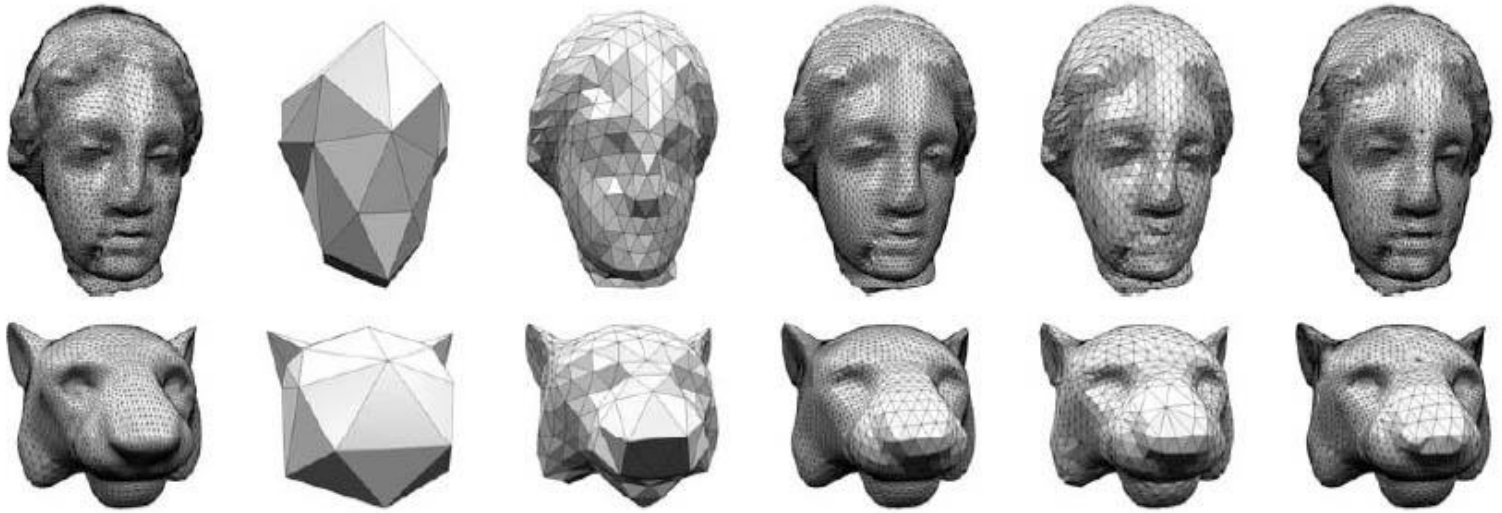
Base Mesh





# Patch-Based Models

- A uniform subdivision of the base mesh with the coordinates of the new vertices updated using the closest point on the original mesh, creates higher resolution mesh.
- Repeating the process a few times for both meshes creates two mesh objects with the same number of vertices and polygonal connectivity.



Original Mesh

Base Mesh

Two meshes with the same number of vertices

# Summary

- Mesh processing is fun!
- Many complex mesh shapes can be created using subdivision tools.
- Mesh decimation algorithms are used primarily for creating multiple levels of detail
- OpenMesh is a versatile mesh processing library that can be used for
  - Approximation (Chales-Loop, Catmull-Clark)
  - Interpolation (Buttefly)
  - Decimation (Edge collapse)
  - Conversion (Read-write, Triangulation)
  - Visualization