

Introduction to Modeling

Modeling

Mathematical representation of
virtual objects' geometry.

Modeling Problems

- representation
 - how to represent objects' shape?
- efficiency
 - what algorithms can be use to construct and render?
- manipulation
 - how to edit 3d objects' geometry?

Object Types by Dimensionality

- points (0D)
- curves (1D)
- surfaces (2D)
- volumes (3D)

Points

- surface approximation
- scanner output
- complex systems

- trivial representation

Curves

- complex systems
- build surfaces

- parametric representation

Surfaces

- object surfaces

- many representations
 - polygon meshes
 - subdivision
 - parametric
 - (implicit)



[Cornell PCG]

Volumes

- liquid/gases
- medical data
- solid modeling

- many representations
 - boundaries
 - CSG
 - voxels



[Nguyen et al., 2002]

Complex Systems

- vegetation
- simulation
- crowds

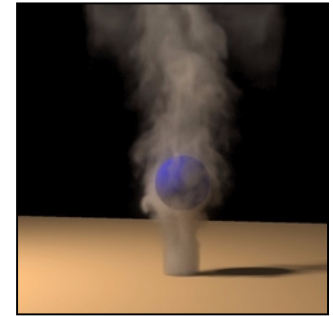
- ad-hoc representation
 - combines multiple types



Complex Systems

- vegetation
- simulation
- crowds

- ad-hoc representation
 - combines multiple types



[Stam et al.]

Choosing Surface Representations

- each representation has enough expressive power to model the shape of any geometric object
 - geometric operations can run on any representation!
 - but there are tradeoffs

- efficiency
 - complexity, space/time, numerical accuracy
- simplicity
 - acquisition, hardware acceleration, software engineering
- usability
 - user-driven editing operations

Topics Covered

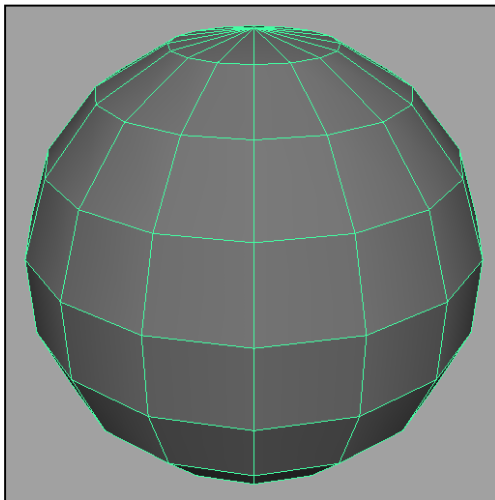
- curves
 - parametric
- surfaces
 - triangle meshes
 - subdivision
 - parametric

Surface Representation

Surface Representation Types

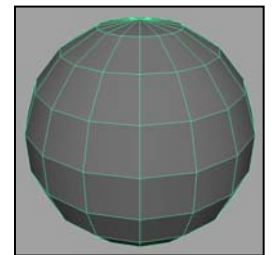
- non-smooth models
 - polygon meshes
- smooth models
 - parametric surfaces
 - subdivision surfaces

Polygon Meshes



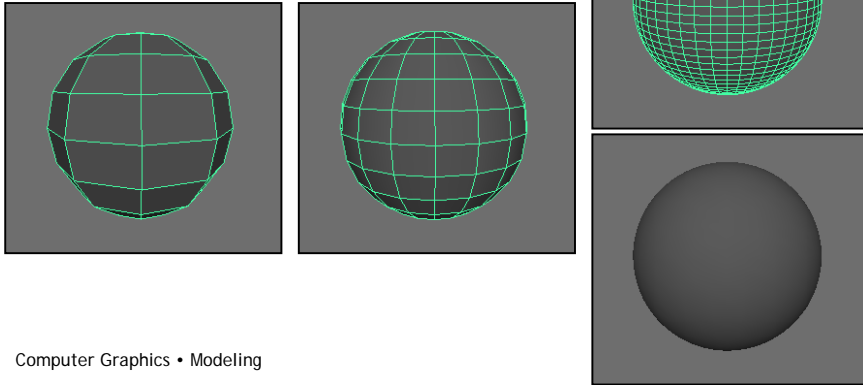
Polygon Meshes

- collection of polygons
- not smooth,
- easy to model any shape
- used by most low-level algorithms
 - convert other rep. to this one
- used in interactive graphics
 - very efficient



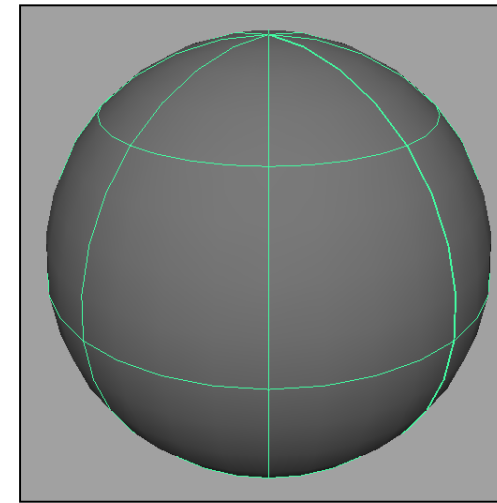
Polygon Meshes - Tessellation

- use more polygons to approximate smoothness
 - silhouettes, lighting



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Parametric Surfaces

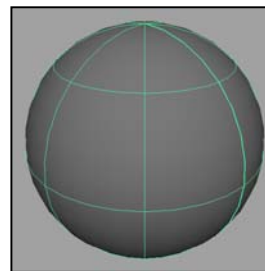


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Parametric Surfaces

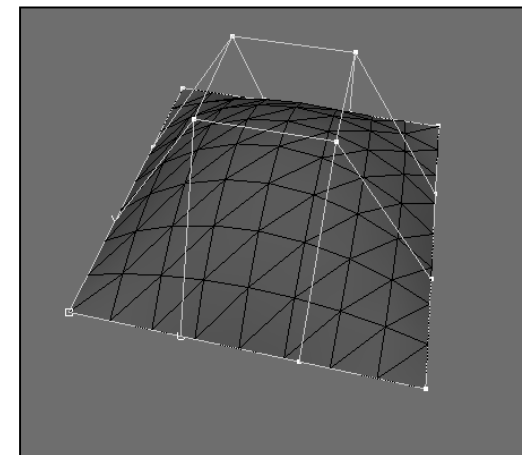
- smooth surfaces generated by simple control points
- smooth
- hard to model complex shapes



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Parametric Surfaces - Control Points

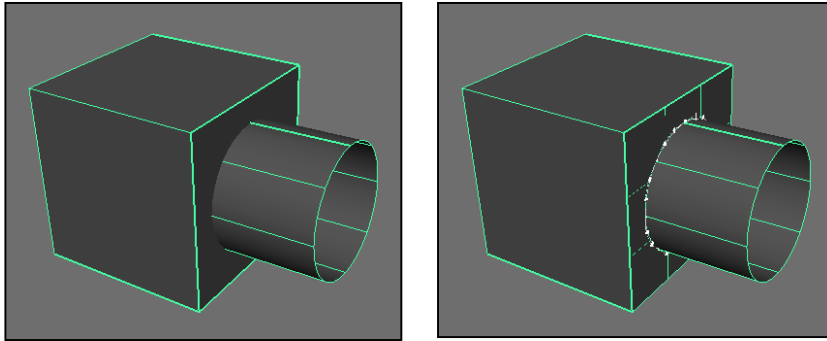


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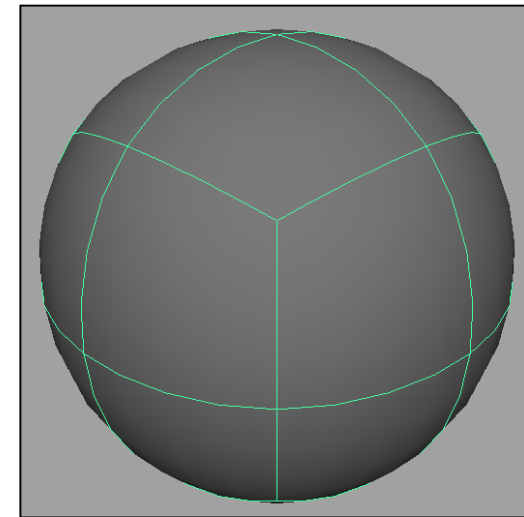
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Parametric Surfaces - Joining

- not easy to model arbitrary shapes
 - need to join patches

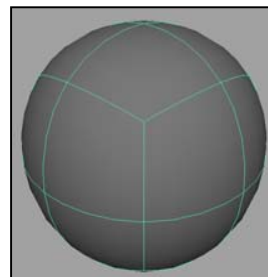


Subdivision Surfaces



Subdivision Surfaces

- “smooth polygon meshes”
 - rules for subdividing surface
- smooth
- easier to model complex shapes



Subdivision Surfaces

- start with a polygon mesh
- apply subdivision rule
 - different types exists
- converge to continuo limit surface

