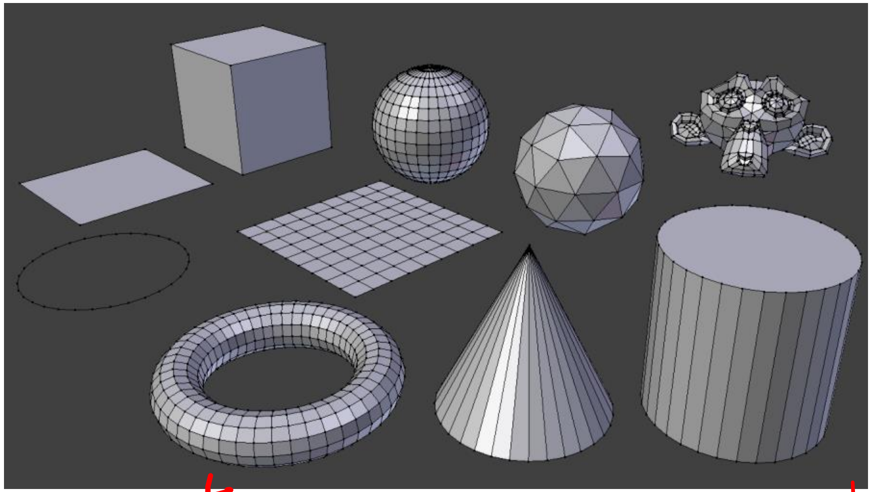
CMSC427
Parametric Surfaces

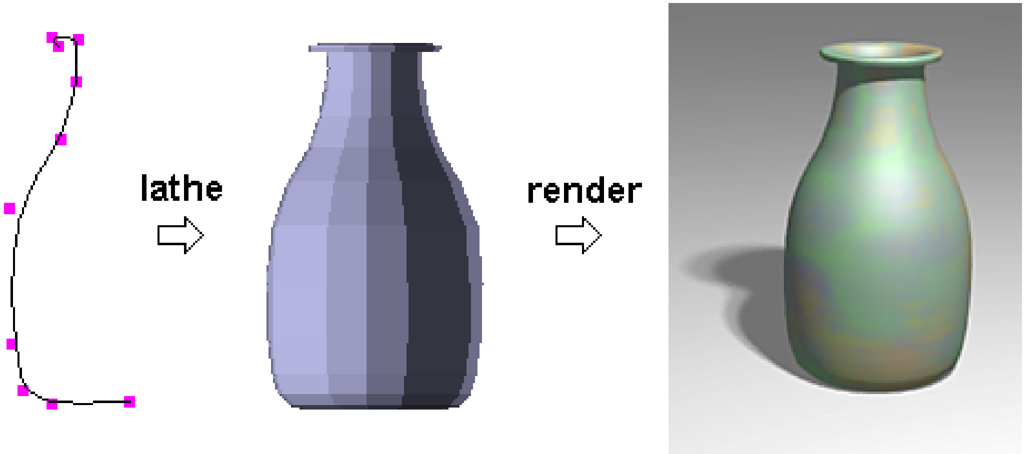
Moving to 3D

- Polygonal meshes
  - Set of standard shapes in Blender



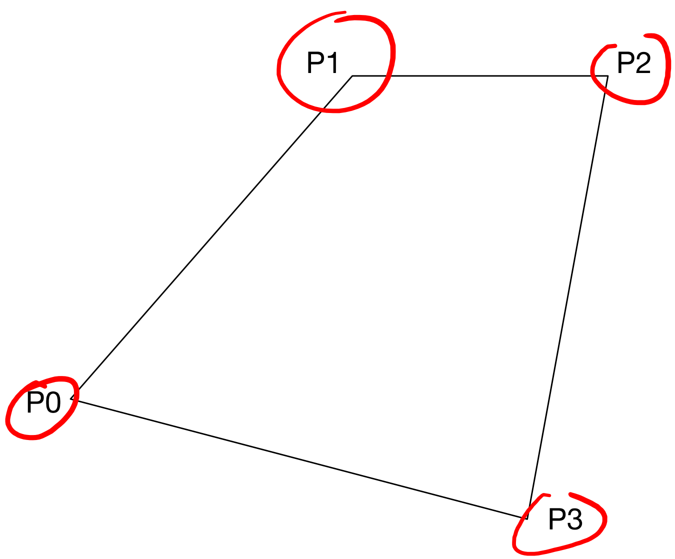
torus cone cylinder

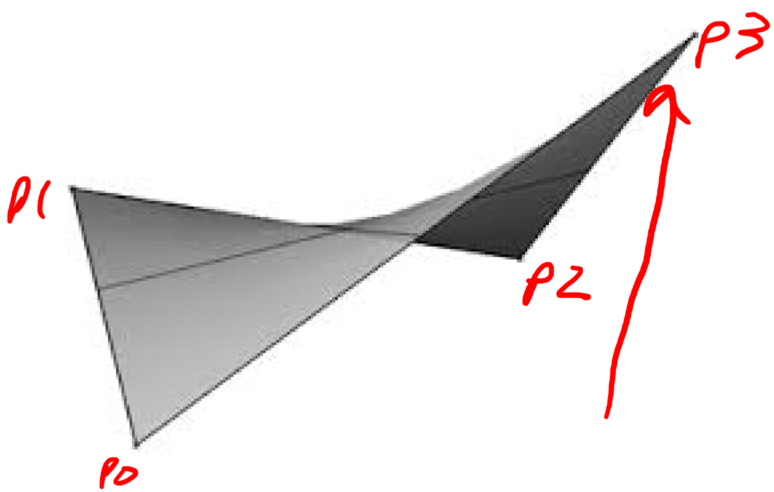
- And how to create them
  - And store them
  - And draw them



Bilinear patch

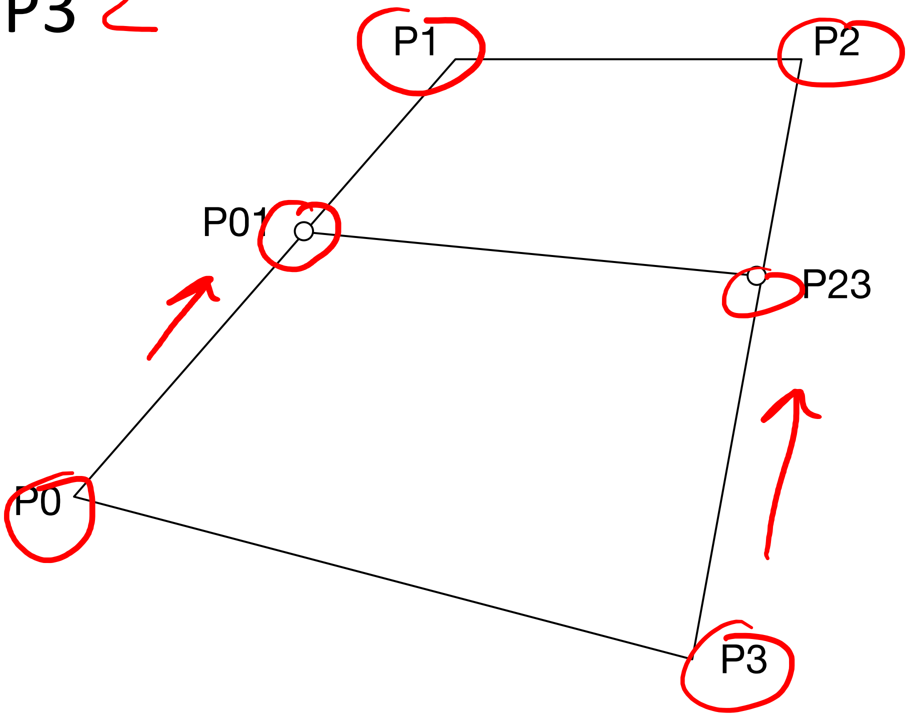
- Blending of four 3D points
- Ruled surface
  - Swept out by sequence of lines





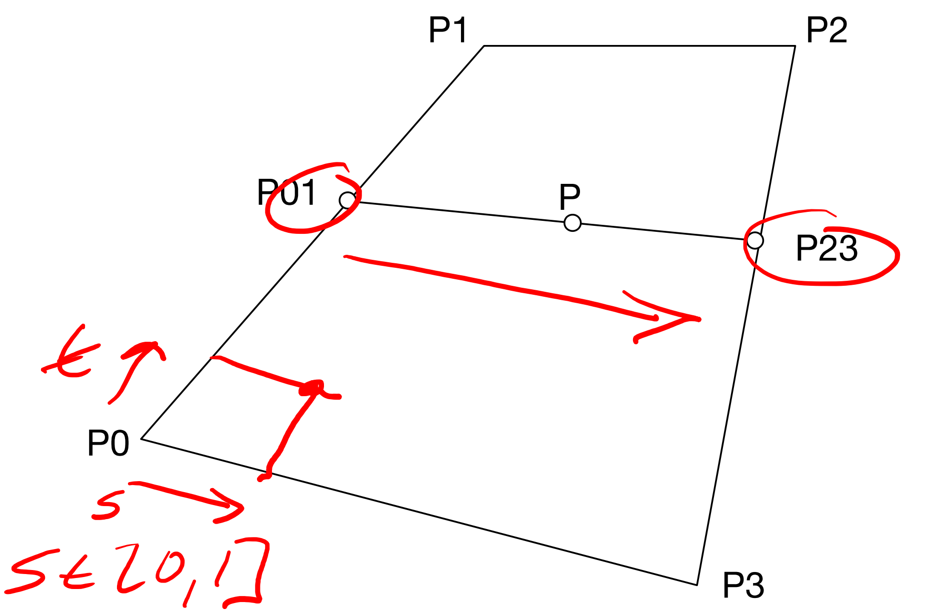
Bilinear patch

- Blend simultaneously along two lines
- P01 = t(P1-P0) + P0
- P23 = t(P2-P3) + P3
- Same t in [0,1]



Bilinear patch

- Blend simultaneously along two lines
- P01 = tP1 + (1-t)P0
- P23 = tP3 + (1-t)P2
- Same t in [0,1]



- Then blend between the two lines

- P = sP23 + (1-s)P01
- P = s(tP1 + (1-t)P0) + (1-s)(tP3 + (1-t)P2)

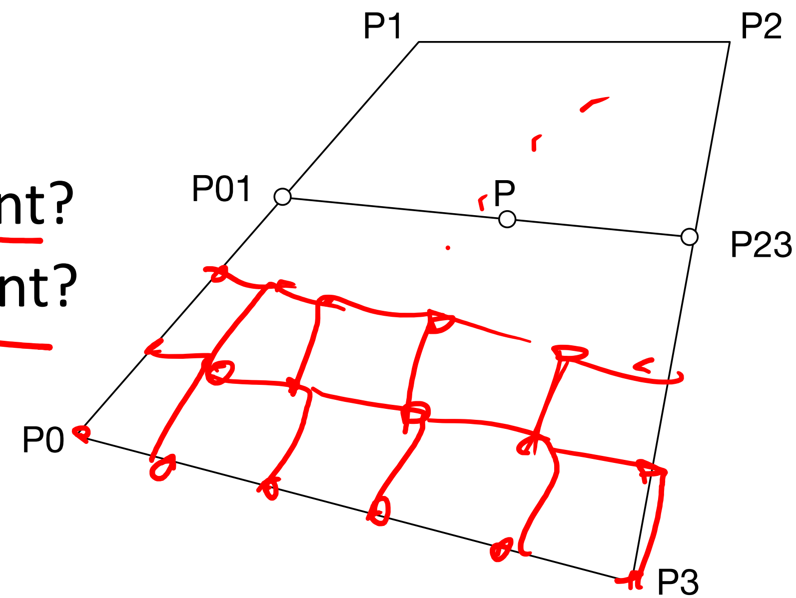
Convex combination?

P(s,t)

verify with coefficients

Bilinear patch

- Questions
  - What order polynomial?
  - Convex combination?
  - What is drawn if t is constant?
  - What is drawn if s is constant?



for (t=0 to 1 by inc)
for (s=0 to 1 by inc)

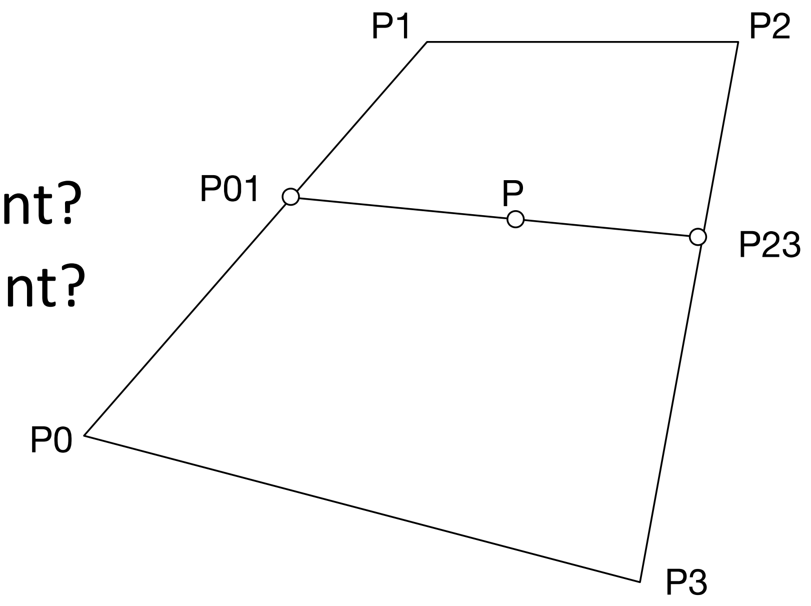
- P = s(tP1 + (1-t)P0) + (1-s)(tP3 + (1-t)P2)

vertices

not the topology

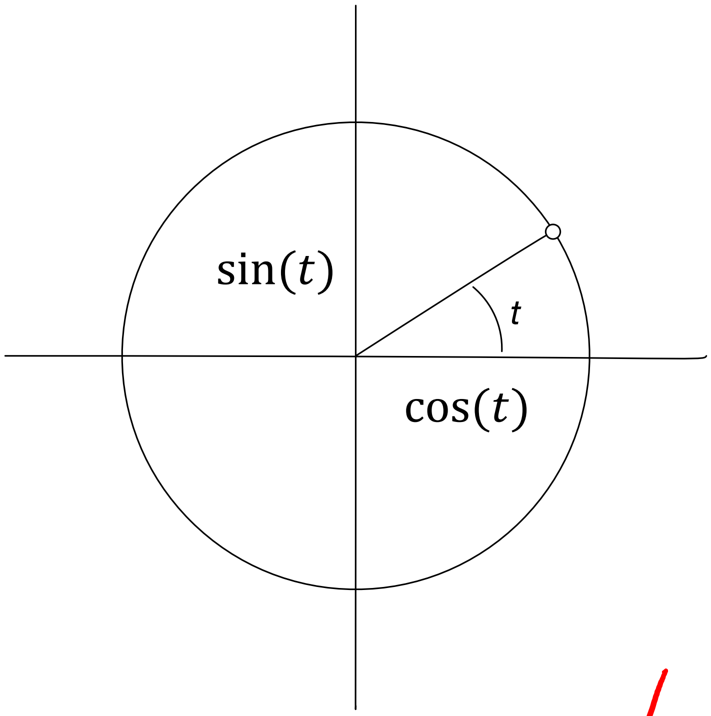
Bilinear patch

- Questions
  - What order polynomial?
  - Convex combination?
  - What is drawn if t is constant?
  - What is drawn if s is constant?



- $P = s(tP1 + (1\text{-}t)P0) + (1\text{-}s)(tP3 + (1\text{-}t)P2)$
- $P = stP1 + s(1\text{-}t)P0 + (1\text{-}s)tP3 + (1\text{-}s)(1\text{-}t)P2$

Circle with trig: review



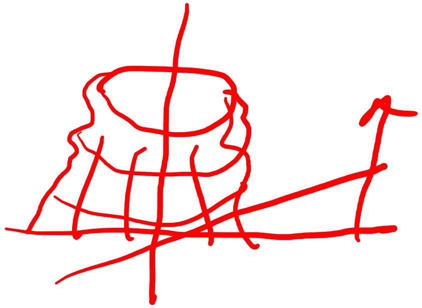
Parametric equation

$$x = R\cos(t)$$

$$y = R\sin(t)$$

$$0 \leq t \leq 1$$

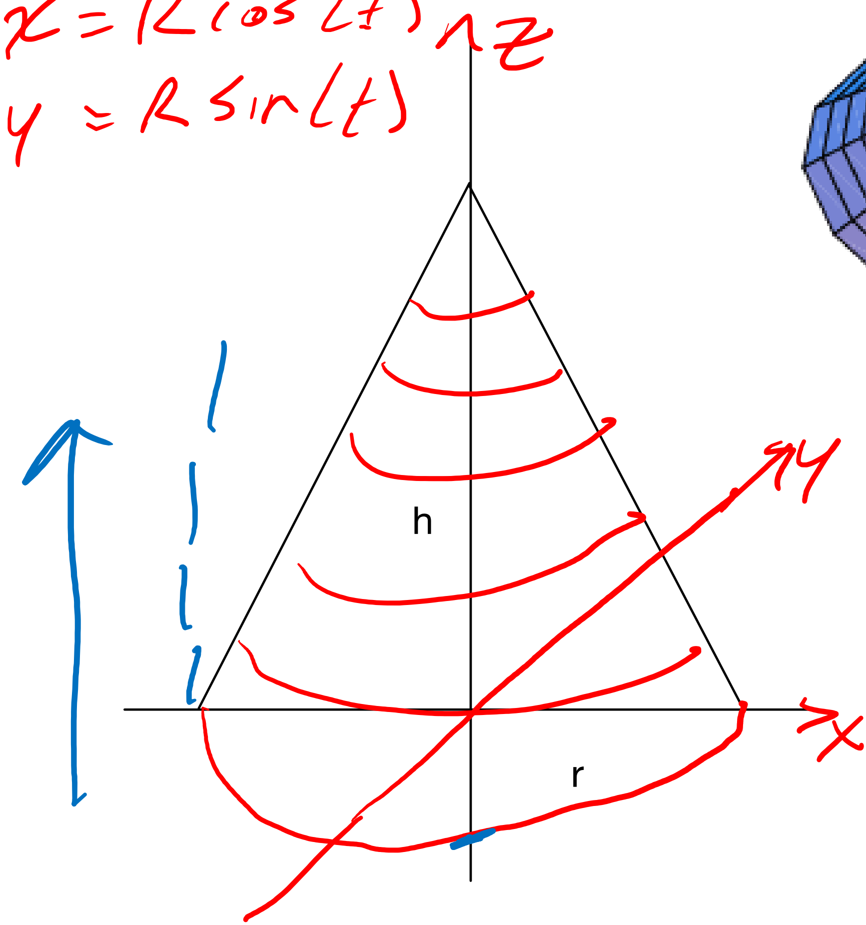
lathing

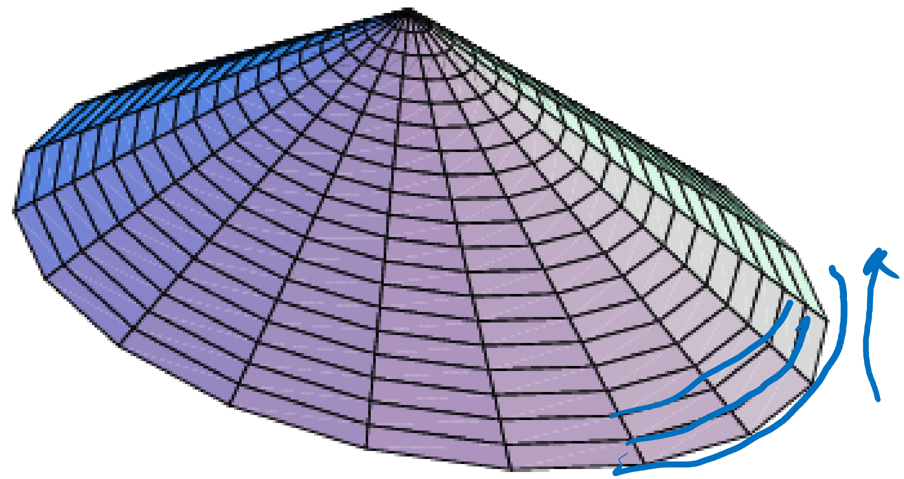


Parametric cone: lathing

$x = R\cos(t)$

$y = R\sin(t)$





$x = \underline{R(1-s)}\cos(t)$

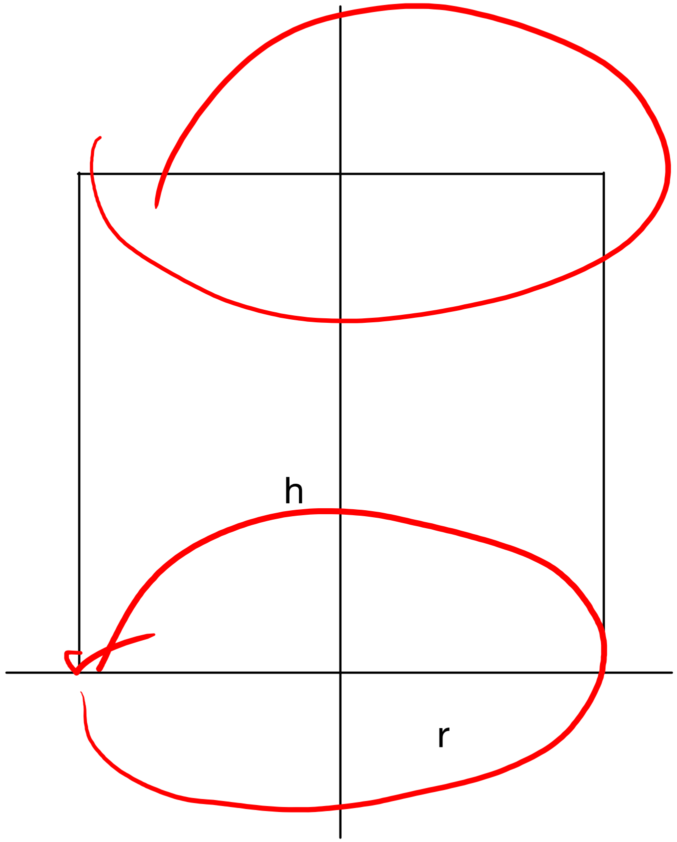
$y = \underline{R(1-s)}\sin(t)$

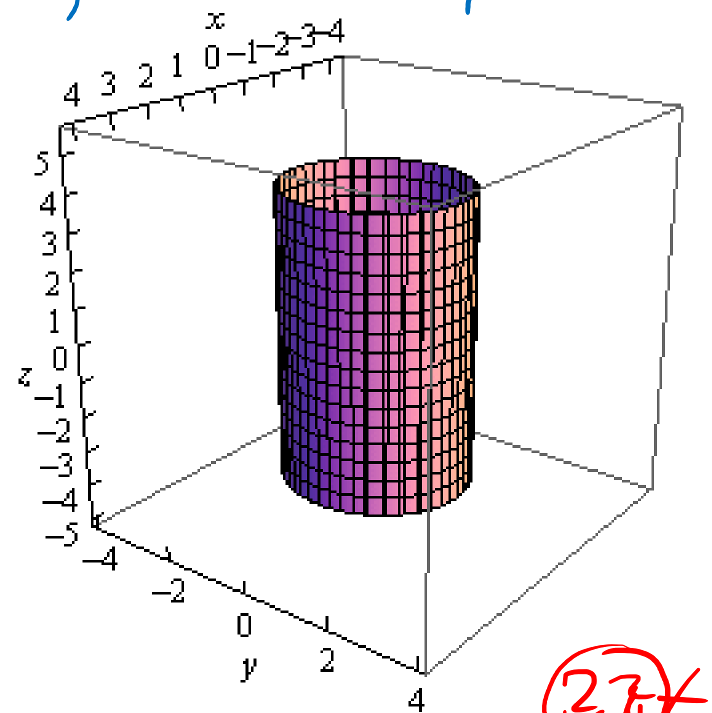
$z = \underline{\quad h s \quad}$

$s: 0 \to 1$

Parametric cylinder: lathing

$$P(s,t) = \langle R\cos(2\pi t), R\sin(2\pi t), hs \rangle$$





$2\pi t$

$$x = R\cos(t)$$

$$y = R\sin(2\pi t)$$

$$z = hs$$

$t = [0,1]$

Creating polygonal meshes: summary

- Fixed shapes.
  - Any shape based on idiosyncratic data, such as the exact shape of a stone, foot, sculpture, etc. All hard-coded, some from real world data collection
- Regular polyhedron
  - Cubes, tetrahedrons, icosahedrons, dodecahedrons, ...
- Operations that create shapes
  - Extrusion
  - Lathing (surfaces of rotation) → parametric cylinder
  - Surface subdivision
- Parametric shapes (related to operations)
  - Bilinear patches, quadrics, superellipses, etc.