Smooth Surfaces

Patch - a small segment of surfaces generally square \(\Rightarrow\) something just as line segment to something pieces of paper, tape together

Tensor Product Surfaces
Polynomials in each direction

Edges are curves some kind of blending in between

Linear
Each edge maps to a line
Bi-linear

\[
p(u,v) = (1-u)(1-v) p_{00} + (u)(1-v) p_{01} + (1-u)(v) p_{10} + (u)(v) p_{11}
\]
Cubic Patches

\[
\begin{bmatrix}
U & V & UV & 1
\end{bmatrix}
\begin{bmatrix}
\ldots
\end{bmatrix}
\begin{bmatrix}
P_{00} \\
P_{01} \\
P_{11} \\
\end{bmatrix}
\]

16 variables!

Patch defined by 16 points
16 x 16 matrices

Just like curves, but BIGGER!

Everything from curves - but more!

BEZIER - interpolate corners
approximate other parts

B-Splines - approximate
Does this sound like a nightmare?
It gets worse!

How to stitch 2 together?
Need to share curves \Rightarrow regular grid
What if you don't want a regular grid?

How about cutting a hole?

\[ \text{Trim curve} \]

How to go from \text{to}

Very tough!

How about stitching something to that hole

How to make this seamless?

Basically impossible

How to make a sharp crease?
Knot doubling - hard to do (need uniformly)
How to deal with this?

NURBS + pain
or
Subdivision surfaces – vote for these

Some warmup . . .

Back to curves

How many lines to draw?
Fixed sampling – wasteful
Adaptive sampling

All sorts of strategies

Draw by dividing -
Start with coarse object
Divide until smooth

Draw a line by subdivision

Limit curve