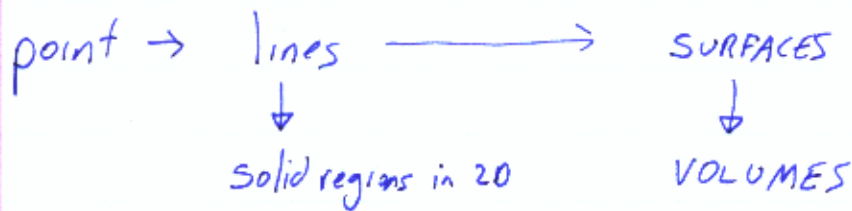


①

SURFACES AND 3D GEOMETRY



SURFACES vs. VOLUMES

VOLUMES ARE HARD

BUT IMPORTANT FOR ENGINEERING!

↑ REAL OBJECTS ARE SOLIDS

NEED TO INSURE THAT YOU ALWAYS HAVE
A SOLID ← PROVABLE ALGORITHMS

SURFACES ARE EASIER

GOOD ENOUGH FOR MAKING PICTURES

HARD ENOUGH

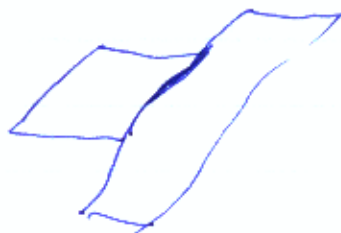
SIMILAR ISSUES TO CURVES - BUT WORSE!

NAMED vs. FREE-FORM

↑ HOW MANY 3D SHAPES CAN YOU NAME

BREAK INTO SMALL PIECES →

BUT HARD TO KEEP PIECES TOGETHER



②

SURFACE GEOMETRY - DIFFERENTIAL PROPERTIES

What do you see if you were on the surface

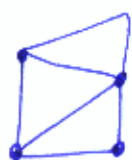


NORMAL

TANGENT PLANE

PUTTING PIECES TOGETHER -

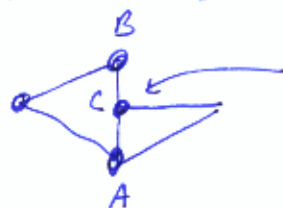
TRIANGLES



MESHES

↑ SHARE VERTICES

WHAT IF DO NOT SHARE VERTICES?



COMPUTE $C = \alpha A + (1-\alpha) B$

Theoretically OK -

CRACKING

"WATER-TIGHT"

UNIFORM VS. NON-UNIFORM GRIDS



TOPOLOGY
DETAIL

WINGED EDGE REPRESENTATION

- EACH EDGE KNOWS ITS 2 TRIANGLES
- IF SOLID - ALL EDGES HAVE EXACTLY 2 TRIS
- GOOD FOR PROCESSING

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



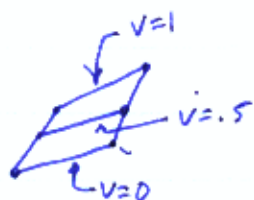
EDGES ARE CURVES

SOME KIND OF BLENDING IN BETWEEN

LINEAR

EACH EDGE MAPS TO A LINE

BI-LINEAR



$$p(u,v) = \begin{pmatrix} 1-v \\ v \end{pmatrix} \begin{pmatrix} 1-v \\ v \end{pmatrix} \begin{pmatrix} p_{00} & p_{01} & p_{02} \\ p_{10} & p_{11} & p_{12} \end{pmatrix} \begin{pmatrix} 1-v \\ v \end{pmatrix}$$

4

$$[u \quad v \quad uv \quad 1] \begin{bmatrix} \\ \\ \\ \end{bmatrix} \begin{bmatrix} p_{00} \\ p_{10} \\ p_{01} \\ p_{11} \end{bmatrix}$$

Cubic Patches



$$\begin{array}{cccc} u^3 & u^2 & u & 1 \\ vu^3 & vu^2 & vu & v \\ v^2u^3 & v^2u^2 & v^2u & v^2 \\ v^3u^3 & v^3u^2 & v^3u & v^3 \end{array}$$

16 variables!

Patch defined by 16 points

16 x 16 matrices

JUST LIKE CURVES, BUT BIGGER!

EVERYTHING FROM CURVES - BUT MORE!

BEZIER - interpolate corners
~~interpolate~~ approximate other parts

B-Splines - approximate

5

DOES THIS SOUND LIKE A NIGHTMARE?
IT GETS WORSE!

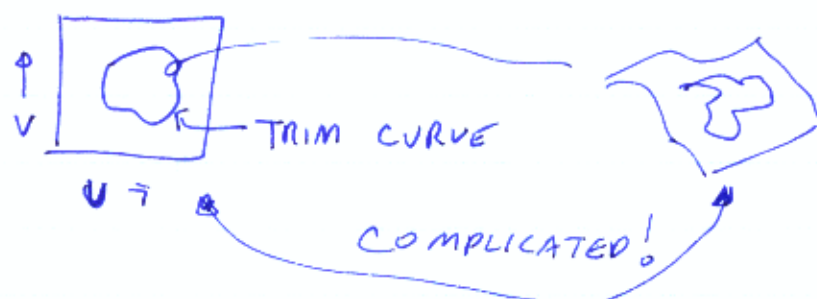
How TO STITCH 2 TOGETHER?

NEED TO SHARE CURVES 

⇒ REGULAR GRID

WHAT IF YOU DON'T WANT A REGULAR GRID?

How ABOUT CUTTING A HOLE?



How TO GO FROM  TO 
VERY TOUGH!

How ABOUT STITCHING SOMETHING TO THAT HOLE



BASICALLY IMPOSSIBLE

How TO MAKE A SHARP CREASE?

KNOT DOUBLING - HARD TO DO (need uniformity)

⑥

How TO DEAL WITH THIS?

NURBS + PAIN

OR

SUBDIVISION SURFACES

← I VOTE FOR THESE

SOME WARMUP.....

BACK TO CURVES

How MANY LINES TO DRAW?

FIXED SAMPLING - WASTEFUL

ADAPTIVE SAMPLING



Error, decide to make another point

All sorts of strategies

DRAW BY DIVIDING -

START WITH COARSE OBJECT

DIVIDE UNTIL SMOOTH

DRAW A LINE BY SUBDIVISION

LIMIT CURVE