

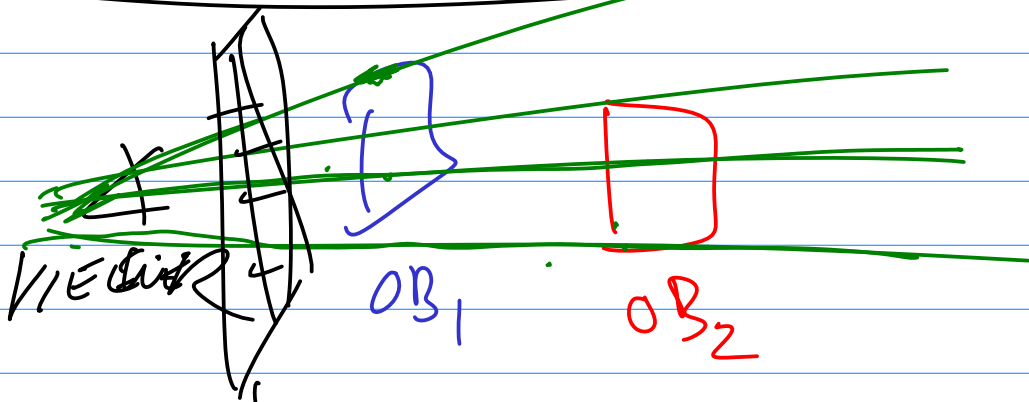
OPENGL 2 - EASY, SLOW DEPRELATED

3.0

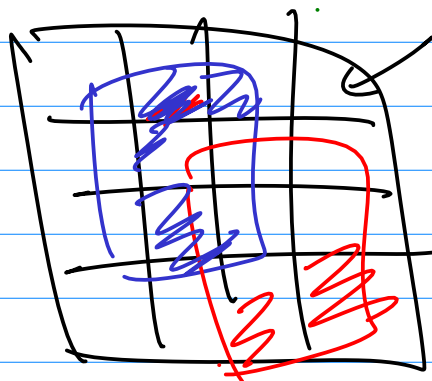
4

DEPTH BUFFER

WHY?



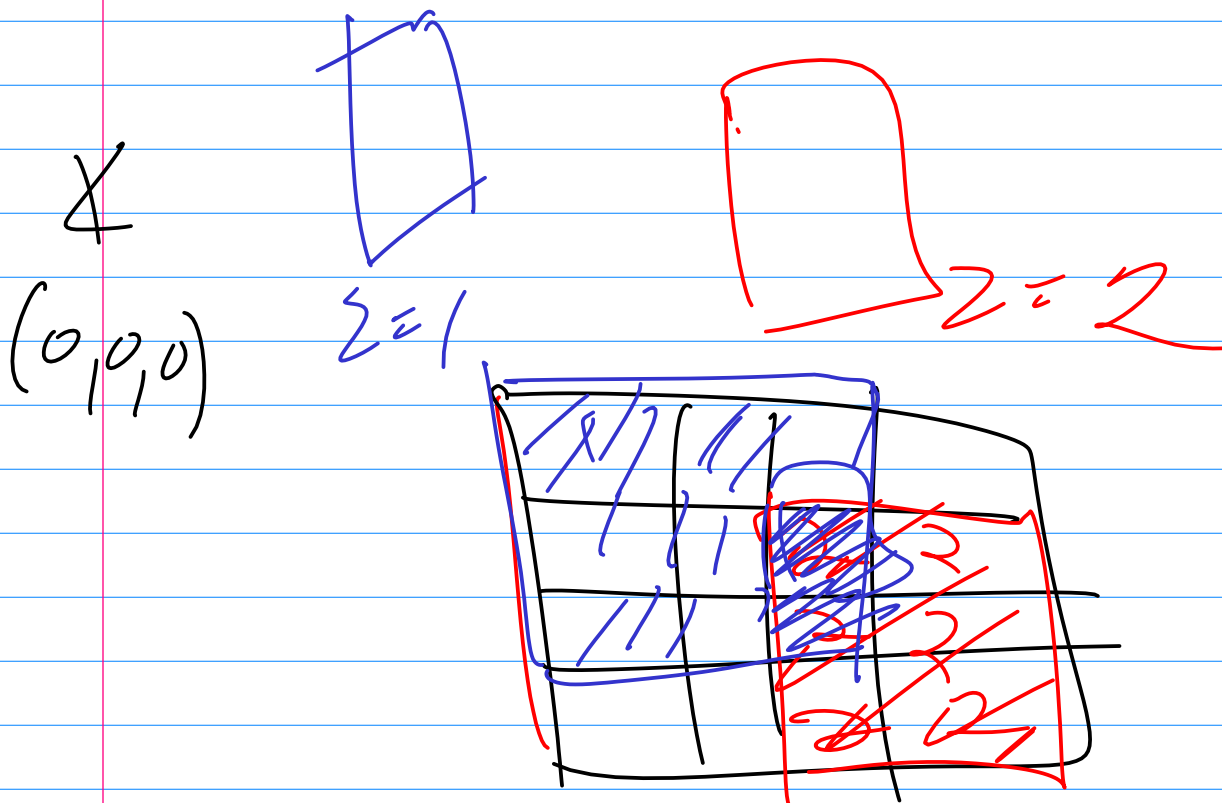
COLOR BUFFER



COLOR IN EACH PIXEL
~~AND~~ ALSO STORE
IN EACH PIXEL
DEPTH OF
CLOSEST OBJECT
BEHIND THAT PIXEL

2

When writing a new object into the color buffer, overwrite the color in a pixel only if the new object is closer than the stored depth. In that case, also overwrite the depth.



Q: Why not just paint the farther objects into the color buffer first?

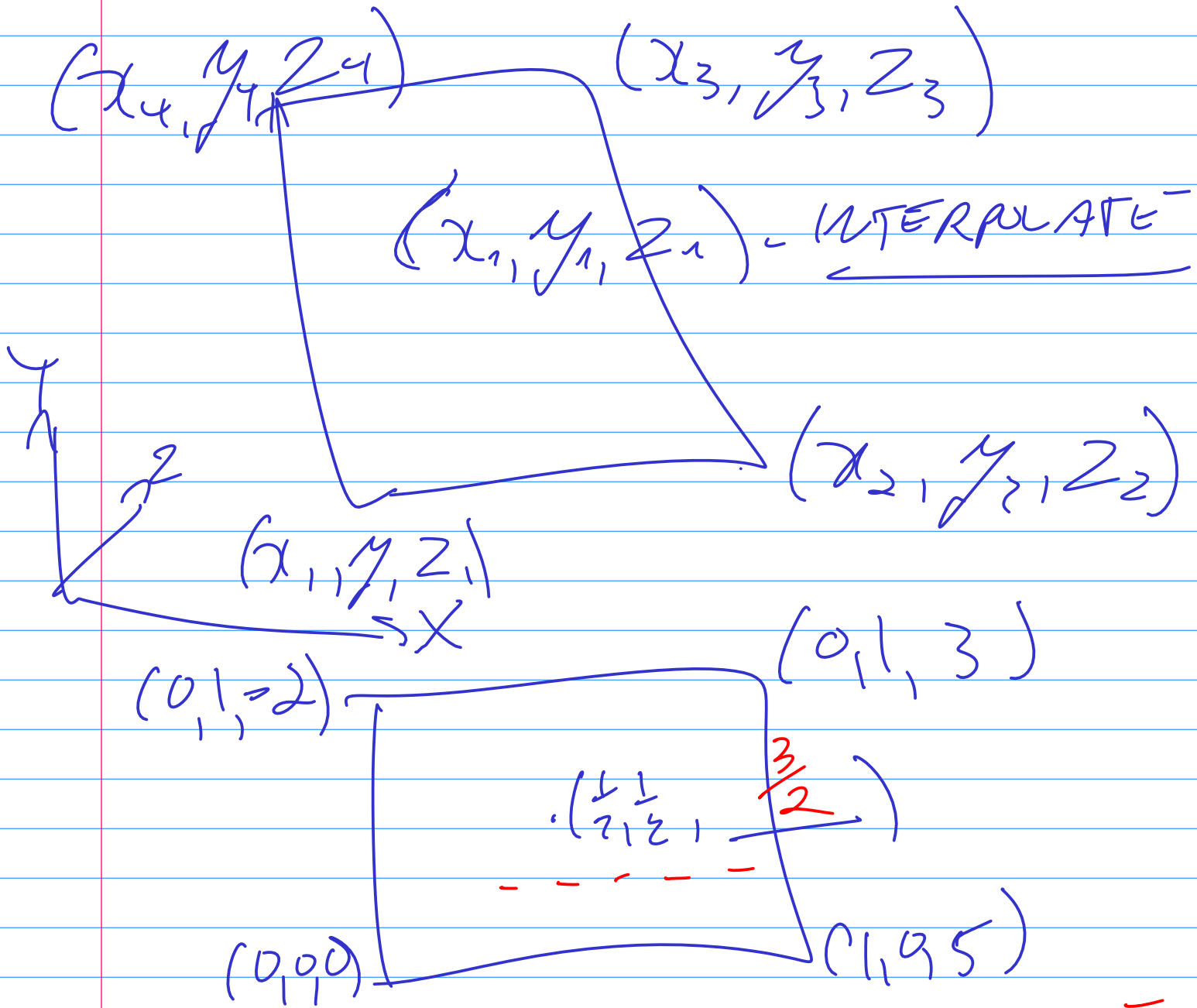
A: Sometimes you know that, so do it. Often you don't know.

Maybe the objects are spinning around each other.

3

Implementation:

You need to find the distance of each pixel of the object.



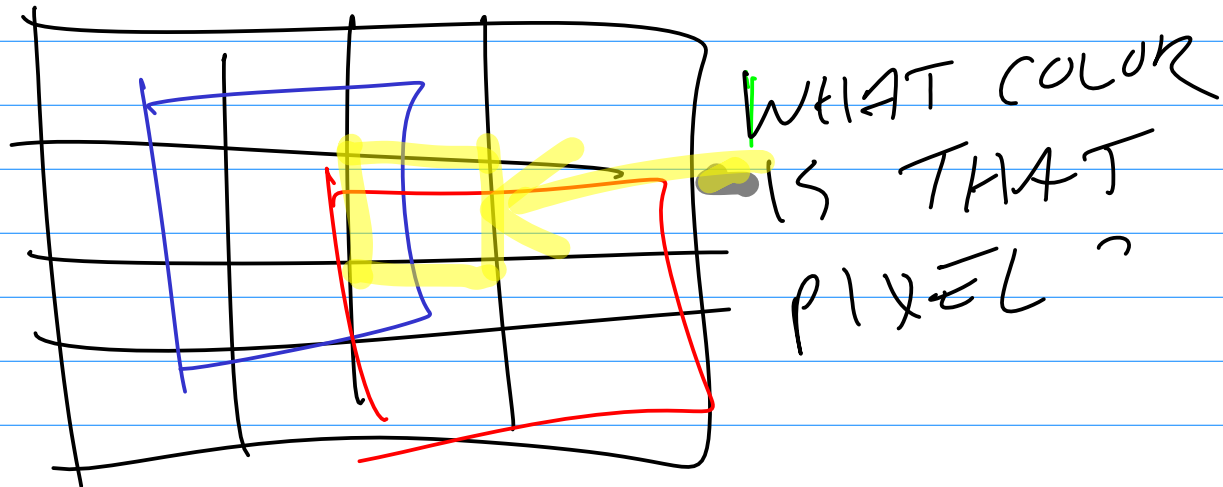
VERY FAST TO STEP ALONG LINE
COMPUTING Σ

4

- ALLOCATE DEPTH BUFFER
- ENABLE
- DRAW OBJECTS WITH Zs.

Complications:

1. You often want 2 color buffers. Draw into 1 while displaying from the other.
2. What if the object covers only part of a pixel?

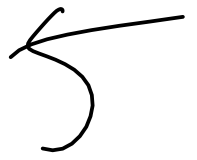


A1: COMPUTE HOW MUCH OF PIXEL IS COVERED BY EACH OBJECT MAJORITY WINS.

A2: JUST PICK 1

A3: WEIGHTED AVERAGE

A4: USE THE CLOSER OBJECT



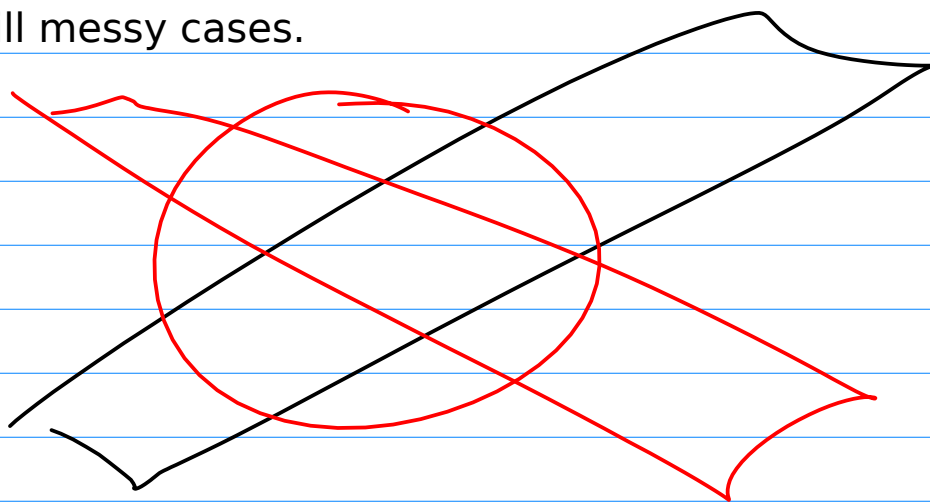
a2 is easiest, but randomly coloring conflicted pixels can cause flashing alternating colors. Very obnoxious.

The Mach band effect: Your visual system has a hi-pass filter. Your retina is a neural network with negative feedback.

A1,3: If you're going to compute areas, better to weight the colors.

A4: best to draw closer objects.

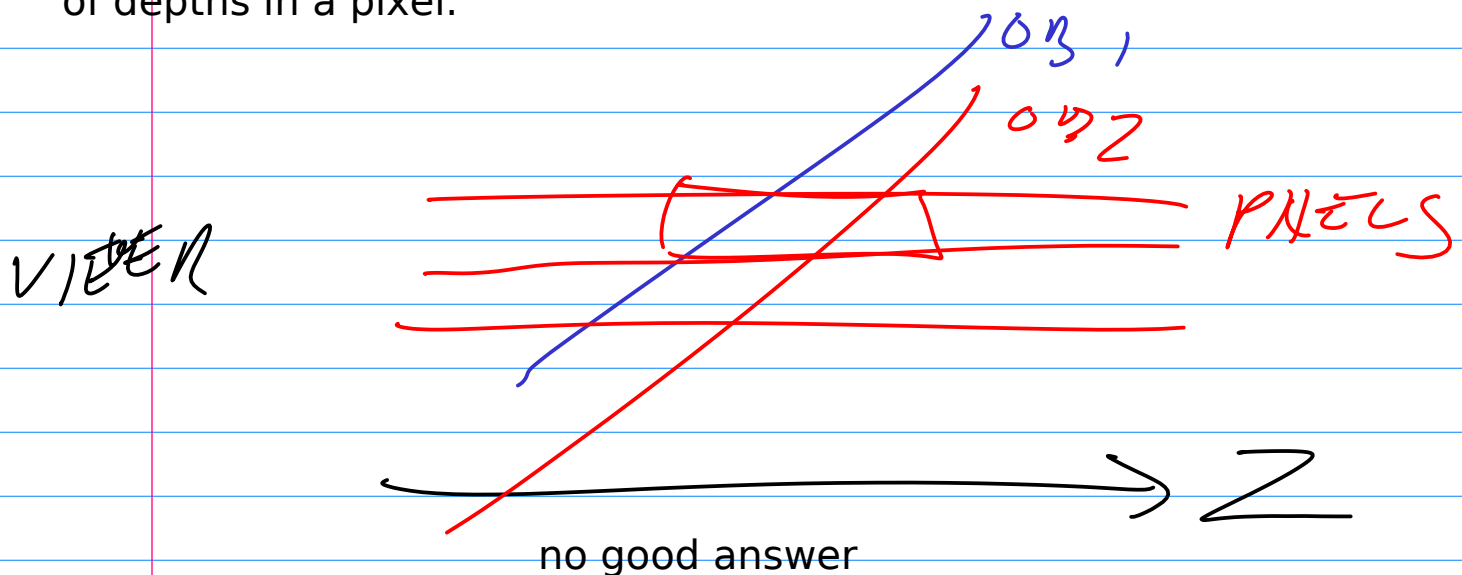
But there are still messy cases.



Best to subdivide complicated pixels, then average.

This bring in "aliasing" and "antialiasing".

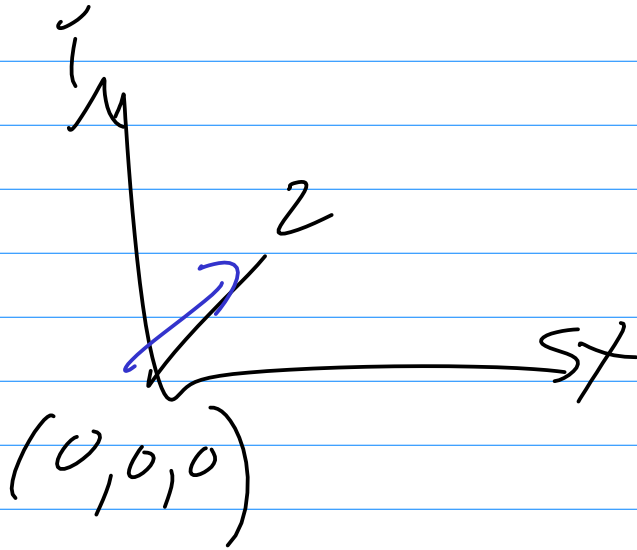
Another depth buffer problem is that slanted objects have a range of depths in a pixel.



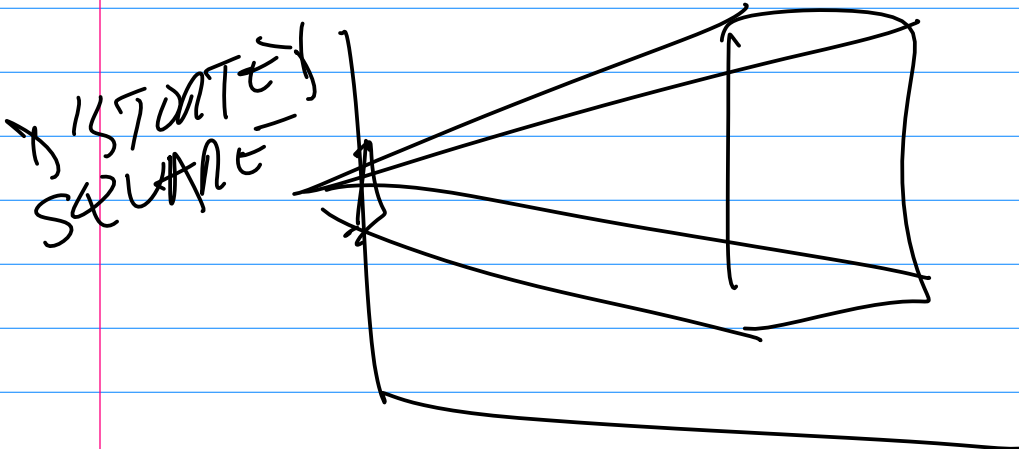
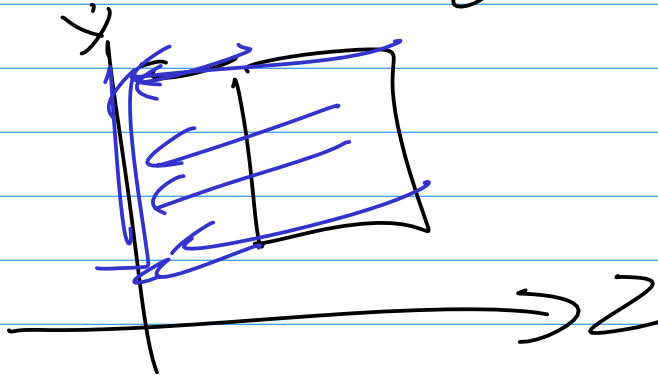
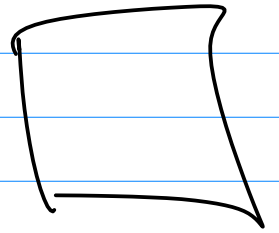
To be fair, these problems are rare.

PROJECTIONS

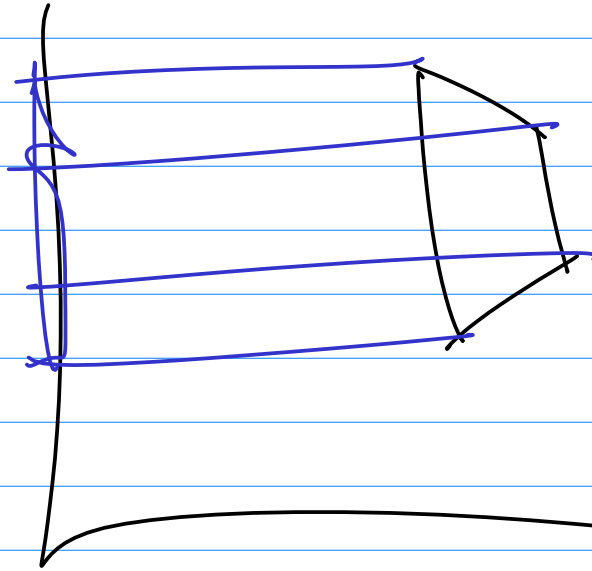
Calling `glFrustum` transforms the object so that it appears that you are using a perspective projection. Really it's still a parallel projection, but the object is now distorted.



START WITH A SQUARE



OPENOL (+ COMPETITORS)
DISTORT SQUARE THEN
PARALLEL PROJECT IT,



DISTORTED
SQ

The LAST transformation whose function you call is the FIRST transformation applied to the object.

8

$$\underbrace{I T R_2 R_y R_x}_{\text{COMBINED MODEL VIEW MATRIX}} \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

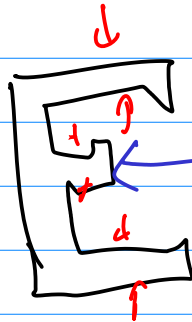
Fonts

How to Draw Text

1. BITMAP

0000
6
60
6
0000

2. OUTLINE



Parametric quadratic
or cubic curves.

Bitmap better for small text on lo-res displays.
Outline better for hi-res. It scales.

Font hints help with scaling down outline fonts.