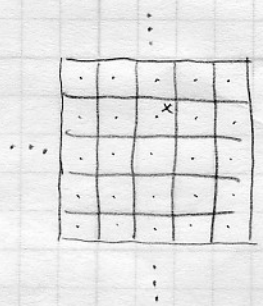
CSE 185
Chap 2.
Image Interpolation

Nearest-neighbor Interpolation

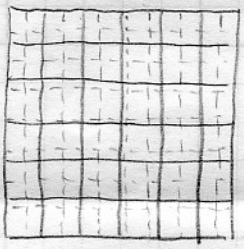


Know values at ·
want value at ×

→ Choose value from closest pixel

Ex. Resizing image

6×6 → 8×8 pixels



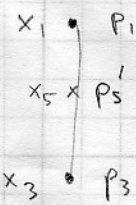
Bilinear Interpolation

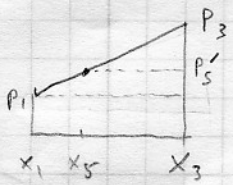
- Assumes image intensity is linear along axis dimensions and quadratic in any other direction.
- First compute average along one dimension (linearly interpolate)
- Then compute average along other dimension
- Order doesn't matter

Assuming pixels are grid aligned

Know
$(x_1, y_1) \rightarrow p_1$
$(x_2, y_2) \rightarrow p_2$
$(x_3, y_3) \rightarrow p_3$
$(x_4, y_4) \rightarrow p_4$

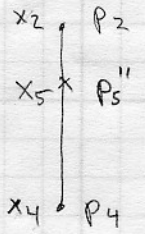
want p_5 at (x_5, y_5)



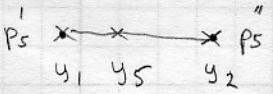


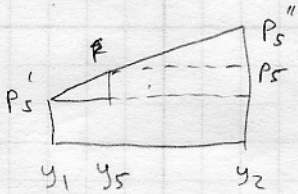
$$\frac{p_5' - p_1}{x_5 - x_1} = \frac{p_3 - p_1}{x_3 - x_1}$$

$$p_5' = \frac{(p_3 - p_1)(x_5 - x_1)}{(x_3 - x_1)} + p_1$$



$$p_5'' = (p_4 - p_2)\frac{(x_5 - x_2)}{(x_4 - x_2)} + p_2$$

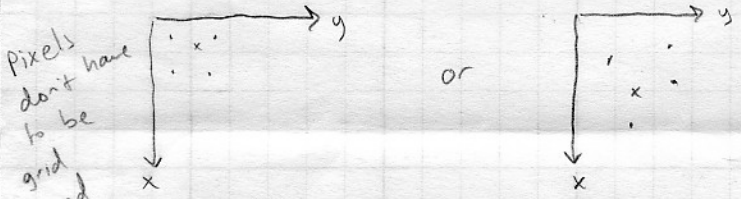




$$\frac{p_5 - p_5'}{y_5 - y_1} = \frac{p_5'' - p_5'}{y_2 - y_1}$$

$$p_5 = (p_5'' - p_5')\frac{(y_5 - y_1)}{(y_2 - y_1)} + p_5'$$

Alternately - Fit function of form $v(x,y) = ax + by + cxy + d$ to surface
- Form of bilinear surface



$v(x,y) = ax + by + cxy + d$ equation of bilinear surface (1)

want $v(x_5, y_5) = ax_5 + by_5 + cx_5y_5 + d$

Need to know a, b, c, d

Use known data:

$$p_1 = ax_1 + by_1 + cx_1y_1 + d$$
$$p_2 = ax_2 + by_2 + cx_2y_2 + d$$
$$p_3 = ax_3 + by_3 + cx_3y_3 + d$$
$$p_4 = ax_4 + by_4 + cx_4y_4 + d$$

4 equations
4 unknowns

$$\begin{bmatrix} x_1 & y_1 & x_1y_1 & 1 \\ x_2 & y_2 & x_2y_2 & 1 \\ x_3 & y_3 & x_3y_3 & 1 \\ x_4 & y_4 & x_4y_4 & 1 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = \begin{bmatrix} p_1 \\ p_2 \\ p_3 \\ p_4 \end{bmatrix}$$

$$Ag = h$$

Can solve by:

$$g = A^{-1} h$$

Now that know $g = \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix}$

can find p_s using equation (1) above.

Bicubic Interpolation - Fit higher order polynomial function to image surface

16 nearest neighbors

$$v(x,y) = \sum_{i=0}^{3} \sum_{j=0}^{3} a_{ij} x^i y^j$$

16 coefficients are detemined from 16 equations from nearest neighbors.
