Color: (color spaces)

R, G, B red, green, blue
additive primaries

C, M, Y Cyan, magenta, yellow
subtractive primaries
printing CMY + K

(-R), (-G), (-B)

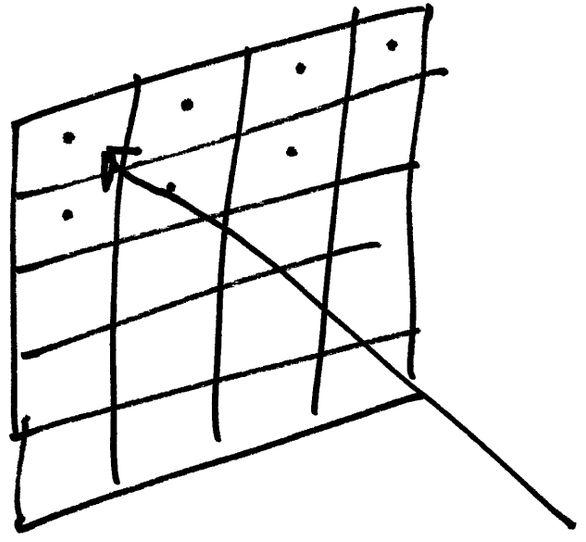
I, H, S intensity, hue, saturation
often used
for
pan-sharpening

YIQ — NTSC

- I — chrominance (color)
- Y — Luminance (±intensity)

YUV — PAL

YC_bC_r — JPEG (internal)



motivation for resampling + interpolation

1D

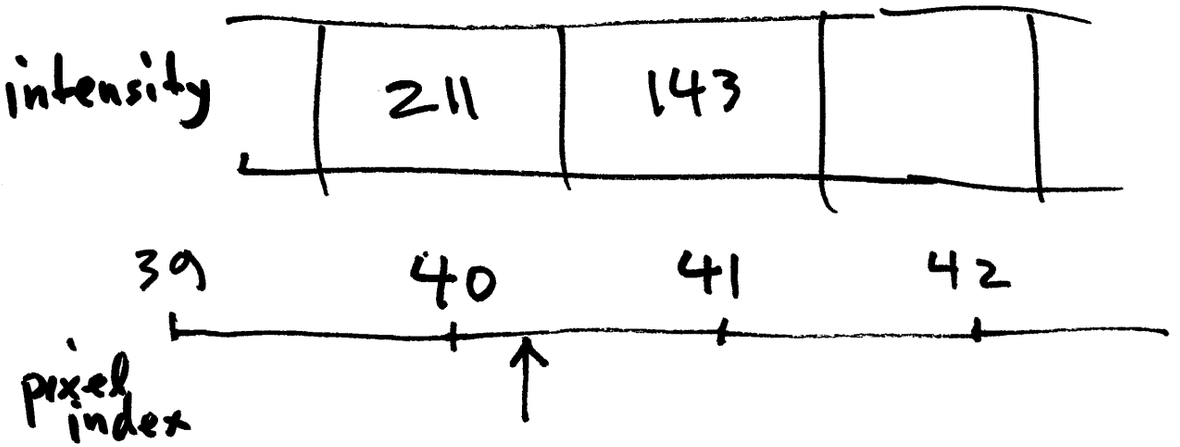
radiometric resolution 8-bit, $2^8 = 256$, intensity levels

10-bit $2^{10} = 1024$ intensity levels

INTERPOLATION

intensities unsigned integers 0 - 255

(black) (white)



$I_{NN}(40.25) \Rightarrow 211$

nearest neighbor interpolation

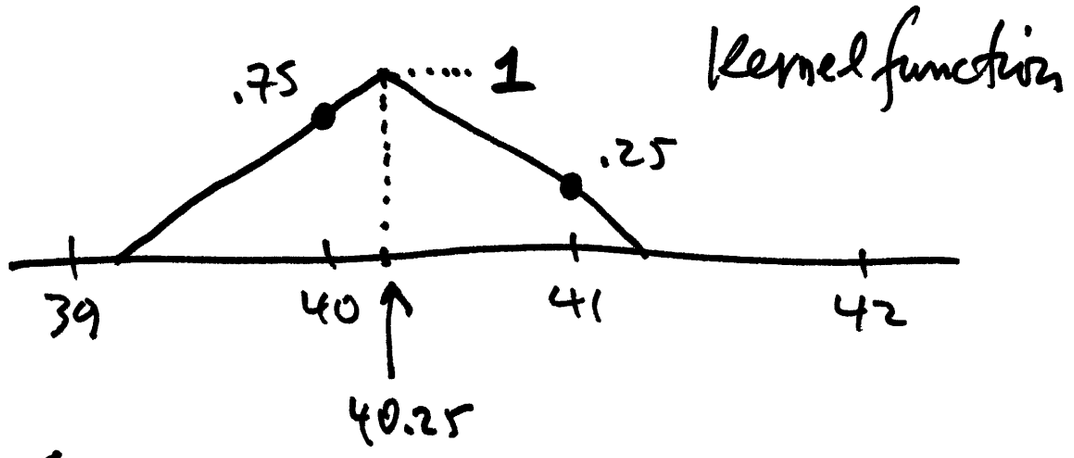
what is intensity at this location?

nearest neighbor : round index value

Matlab : round (40.25) ⇒ 40

fix (40.25 + 0.5) ⇒ 40

linear interpolation

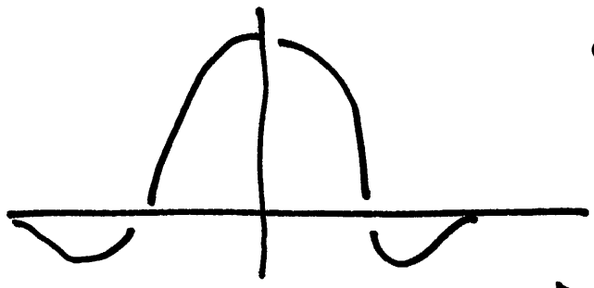


$0.75 \times 211 + 0.25 + 143$

$= 194$, I_L

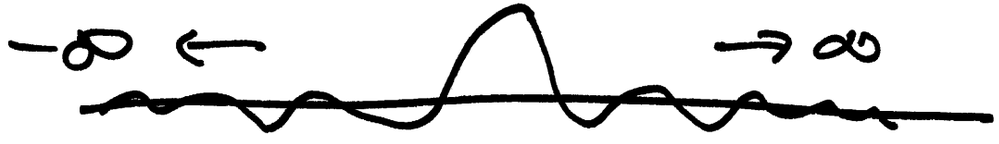
center the kernel or interpolating function at the point to be interpolated. Then evaluate the function at pixel locations to obtain weights for the respective intensities.

1D cubic interpolation



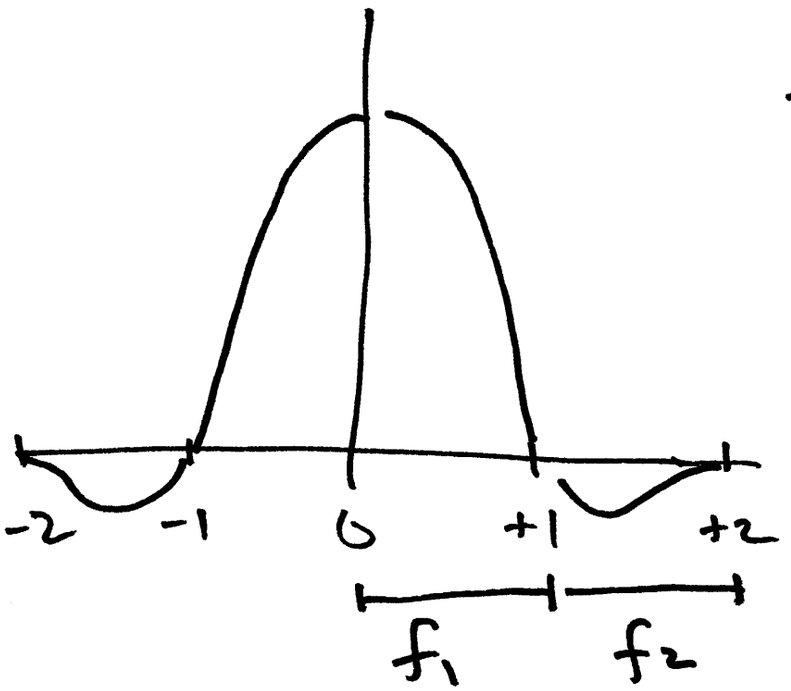
approximation of Sinc function

$$\mathrm{sinc}(x) = \frac{\sin(x)}{x}$$



if band limited function, if it is correctly sampled by Nyquist, then perfect reconstruction is possible using SINC function.

Nyquist: sample at least 2 times per period of the highest frequency present



$$f_1(x) = |x|^3 - 2|x|^2 + 1 \qquad 0 \le |x| < 1$$

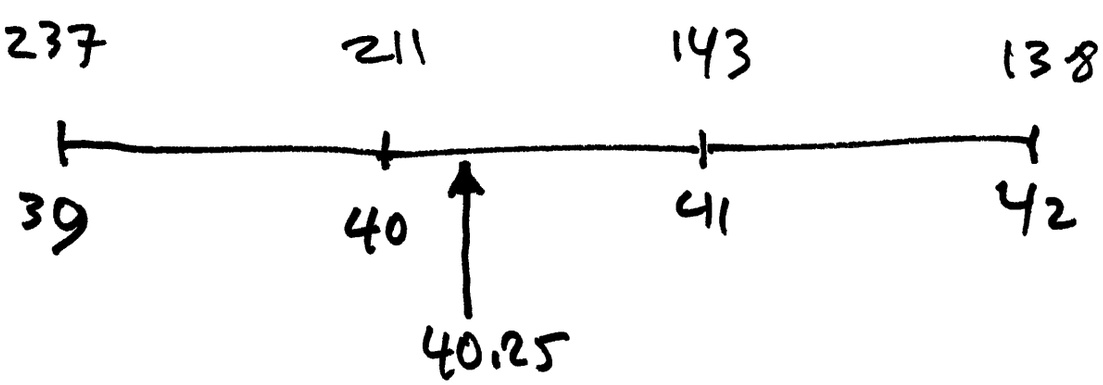
$$f_2(x) = -|x|^3 + 5|x|^2 - 8|x| + 4 \qquad 1 \le |x| < 2$$

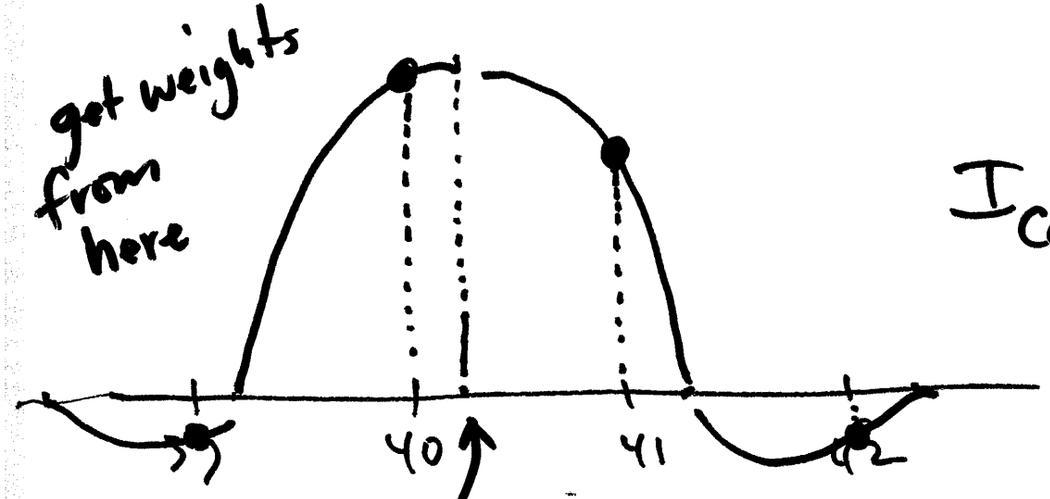
Piece-wise cubic polynomial approximation to the truncated SINC function.

$$f(x) = \begin{cases} f_1(x) & 0 \le |x| < 1 \\ f_2(x) & 1 \le |x| < 2 \\ 0 & |x| \ge 2 \end{cases}$$

interpolate @ 40.25

1D



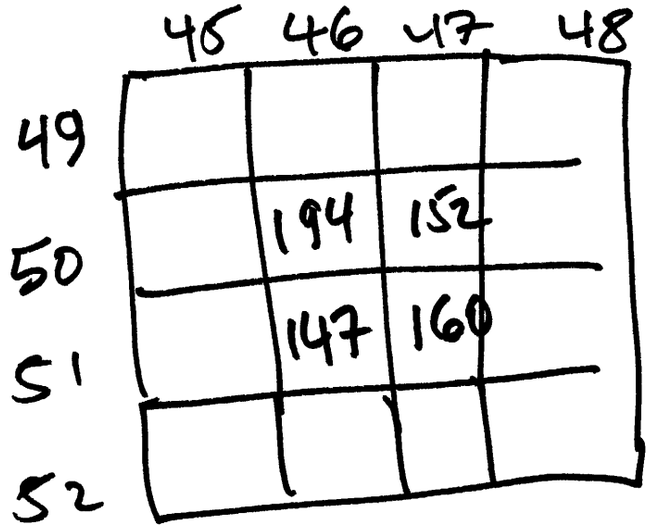


$$I_{cc} = 237 \cdot f(40.25-39) + 211 \cdot f(40.25-40) + 143 \cdot f(40.25-41) + 138 \cdot f(40.25-42)$$

center the interpolating function at the point to be interpolated – as in linear.

$$I_{cc}(40.25) = 190.3 \Rightarrow 190$$

2D



row = 50.3, col = 46.8

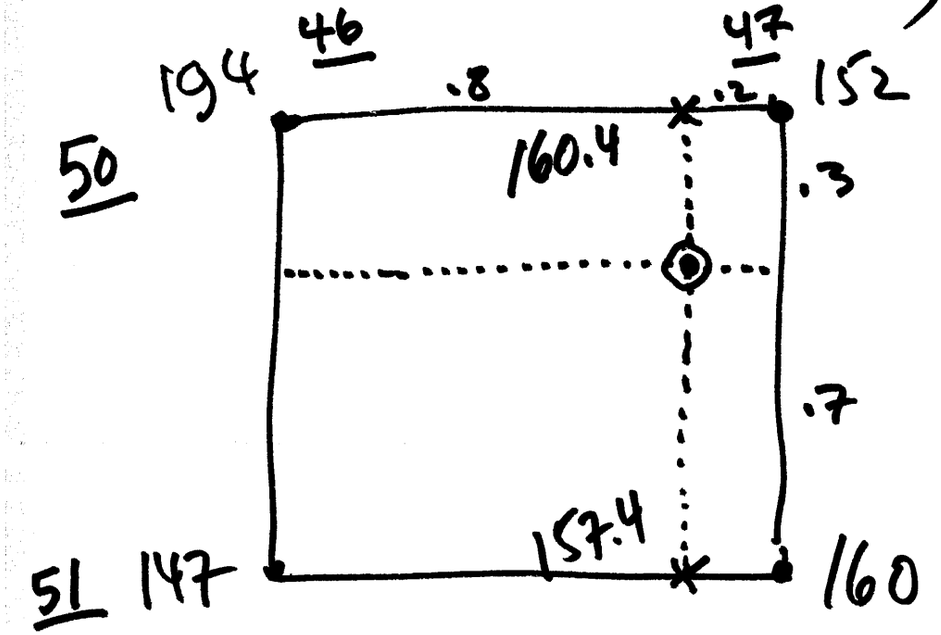
Nearest Neighbor

I_{NN} : 152

50, 47

round both fractional indices to obtain integer indices.

linear : bi-linear, bilinear



1. interpolate along top row
2. interpolate along bottom row
3. interpolate in column direction between intermediate values from 1 & 2.

(or you can reverse roles of rows + columns)

$g_{50} = 0.8 \times 152 + 0.2 \times 194 = \underline{160.4}$

$g_{51} = 0.8 \times 160 + 0.2 \times 147 = \underline{157.4}$

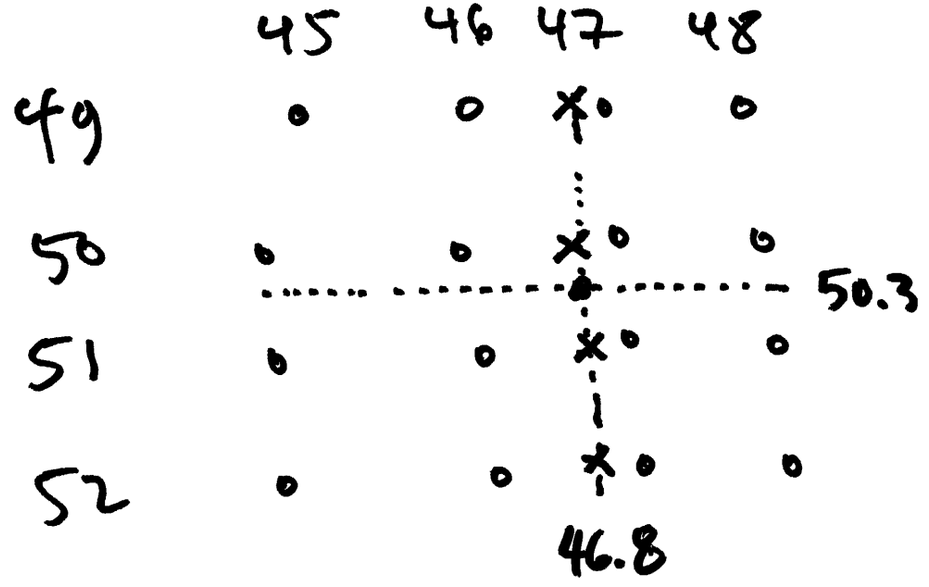
$g = 0.3 \times 157.4 + 0.7 \times 160,4 = 159.5$

$\underline{\underline{159}}$

bilinear interpolation

$z = a_0 + a_1 x + a_2 y + a_3 xy$ ⇐ another way to represent the bilinear model.

Bicubic



row 50.3
col 46.8

first along row
followed by 1 interp. along column

weights for row

$$f_r = \begin{bmatrix} f(46.8-45) \\ f(46.8-46) \\ f(46.8-47) \\ f(46.8-48) \end{bmatrix}$$

interpolate along 4 rows, these are weights

$$\begin{bmatrix} r_{49} \cdot f_r \\ r_{50} \cdot f_r \\ r_{51} \cdot f_r \end{bmatrix} \quad \begin{bmatrix} r_{52} \cdot f_r \end{bmatrix}$$

← weights

intensities

dot products of intensity vector times weight vector yields the interpolant (s)

$$f_c = \begin{bmatrix} f(50.3-49) \\ f(50.3-50) \\ f(50.3-51) \\ f(50.3-52) \end{bmatrix}$$

weights for the column interpolation

$$f_c \cdot \begin{bmatrix} r_{49} \cdot f_r \\ r_{50} \cdot f_r \\ r_{51} \cdot f_r \\ r_{52} \cdot f_r \end{bmatrix}$$

dot product of column weights + intermediate values.

$$I_{cc} = \begin{bmatrix} f_{c_1} f_{c_2} f_{c_3} f_{c_4} \end{bmatrix} \begin{bmatrix} \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \end{bmatrix} \begin{bmatrix} f_{r_1} \\ f_{r_2} \\ f_{r_3} \\ f_{r_4} \end{bmatrix} = f_c^T I f_r$$

: full interpolation expression for bicubic

$$I_{cc} = 157.2 \text{ , } \underline{\underline{157}}$$

Rectified Image Production flowchart

1. specify projection model G→I (Back projection)
   - collinearity ✓
   - 8-parameter
   - mapping polynomials (*)
   - replacement RPC, RFM

   } G→I

2. specify extent, location, orientation
3. GSD, sampling interval