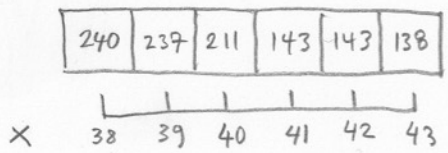
1D



(a) do nearest neighbor interpolation for $x_0 = 40.25$

$I_{NN}(40.25) = 211$

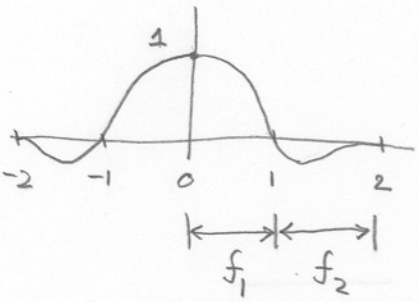
(b) do linear interpolation for same $x_0 = 40.25$

$I_L(40.25) = 0.25 \times I(41) + 0.75 \times I(40)$

$= 0.25 \times 143 + 0.75 \times 211$

$I_L(40.25) = 194$

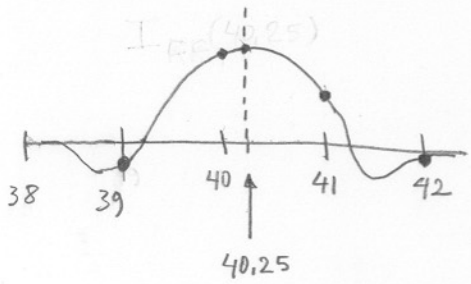
(c) do interpolation by cubic convolution for $x_0 = 40.25$



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

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

To use: slide the interpolating function until the zero point corresponds with the point to be interpolated.



$$I_{cc}(x_0) = \sum_{k=1}^{4} I(x_k)\, f(x_k - x_0)$$

$x_0 = 40.25$

$x_1 = 39 \quad I(x_1) = I(39) = 237$

$x_2 = 40 \quad I(x_2) = I(40) = 211$

$x_3 = 41 \quad I(x_3) = I(41) = 143$

$x_4 = 42 \quad I(x_4) = I(42) = 143$

$$I_{cc}(40.25) = \underset{237}{I(39)} \cdot \underset{-.1406}{f(39-40.25)} + \underset{211}{I(40)} \cdot \underset{.8906}{f(40-40.25)} + \underset{143}{I(41)} \cdot \underset{.2969}{f(41-40.25)} +$$

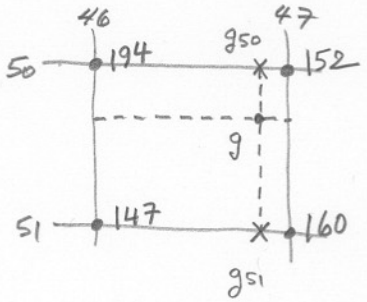
$$\underset{143}{I(42)} \cdot \underset{-.0469}{f(42-40.25)}$$

$I_{cc}(40.25) = 190.3$

2D

row \ column	44	45	46	47	48
48	225	232	240	227	185
49	237	242	213	152	148
50	244	220	194	152	156
51	235	192	147	160	154
52	234	226	202	153	141

$r_0 = 50.3$
$c_0 = 46.8$
} location to interpolate gray value



(a) nearest neighbor interpolation

$$I_{NN}(r_0, c_0) = I_{NN}(50.3, 46.8) = \underline{\underline{152}}$$

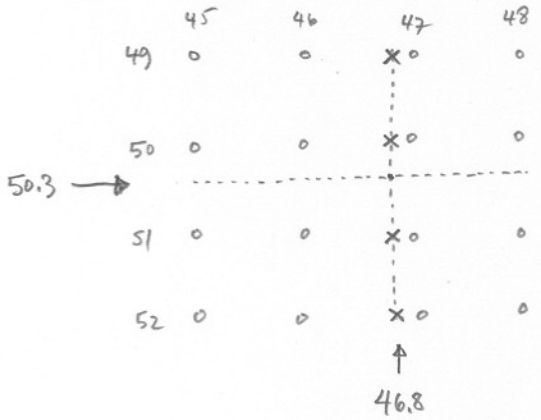
(b) bilinear interpolation

$$g_{50} = .8 \times 152 + .2 \times 194 = 160.4$$
$$g_{51} = .8 \times 160 + .2 \times 147 = 157.4$$

{ linear interpolation along top and bottom of cell

$$g = 0.3 \times g_{51} + 0.7 \times g_{50}$$
$$g = 0.3 \times 157.4 + 0.7 \times 160.4$$
$$g = 159.5 = I_{BL}(r_0, c_0) = I_{BL}(50.3, 46.8)$$

(c) cubic convolution



(i) do 4 1D cubic convolutions along rows, 4 inner products of row values and function values

$$\begin{bmatrix} \mathbf{r}_{49} \cdot \mathbf{f}_r \\ \mathbf{r}_{50} \cdot \mathbf{f}_r \\ \mathbf{r}_{51} \cdot \mathbf{f}_r \\ \mathbf{r}_{52} \cdot \mathbf{f}_r \end{bmatrix} \qquad \mathbf{f}_r = \begin{bmatrix} f(45-46.8) \\ f(46-46.8) \\ f(47-46.8) \\ f(48-46.8) \end{bmatrix}$$

(ii) take inner product of prior result and function values along column

$$\mathbf{f}_c \cdot \begin{bmatrix} \mathbf{r}_{49} \cdot \mathbf{f}_r \\ \mathbf{r}_{50} \cdot \mathbf{f}_r \\ \mathbf{r}_{51} \cdot \mathbf{f}_r \\ \mathbf{r}_{52} \cdot \mathbf{f}_r \end{bmatrix}$$

(note: inner product = dot product)

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

In compact form,

$$I_{cc}(r_0, c_0) = \begin{bmatrix} f_{c_1} & f_{c_2} & f_{c_3} & f_{c_4} \end{bmatrix} \begin{bmatrix} - & - & - & - \\ - & - & - & - \\ - & - & - & - \\ - & - & - & - \end{bmatrix} \begin{bmatrix} f_{r_1} \\ f_{r_2} \\ f_{r_3} \\ f_{r_4} \end{bmatrix} = \underset{(1,4)}{\mathbf{f}_c} \underset{(4,4)}{\mathbf{I}} \underset{(4,1)}{\mathbf{f}_r}$$

along column function values

4×4 image matrix

along row function values

$$I_{cc}(50.3, 46.8) = \begin{bmatrix} -.1470 & .8470 & .3630 & -.0630 \end{bmatrix} \begin{bmatrix} 242 & 213 & 152 & 148 \\ 220 & 194 & 152 & 156 \\ 192 & 147 & 160 & 154 \\ 226 & 202 & 153 & 141 \end{bmatrix} \begin{bmatrix} -.0320 \\ .2320 \\ .9280 \\ -.1280 \end{bmatrix}$$

$$I_{cc}(50.3, 46.8) = 157.2$$

$$\mathbf{f}_c = \begin{bmatrix} f(r_1-r_0) & f(r_2-r_0) & f(r_3-r_0) & f(r_4-r_0) \end{bmatrix}$$

$$\mathbf{f}_r = \begin{bmatrix} f(c_1-c_0) \\ f(c_2-c_0) \\ f(c_3-c_0) \\ f(c_4-c_0) \end{bmatrix}$$

useful matlab code:

myfun.m
```
function result = myfun(arg1)
result = 2*arg1 + 5;
```

```
y = myfun(x)
logical operators: &, |, ~, ==, ~=, >, <, >=, <=
img = imread('file', 'tif')
imwrite(img, 'file2', 'tif')
colormap(gray)
colormap('default')
image(img) ; img = repmat(uint8(0), m, n)
diary logfile
diary off
```
(allocate a blank, 8-bit image array)